Section 4
Risk Assessment

Contents of this Section

4.1 IFR Requirement for Risk Assessment

IFR §201.6(c)(2)(i): *The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.*

IFR §201.6(c)(2)(ii): *[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.*

IFR §201.6(c)(2)(ii)(A): *The plan* ***should*** *describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.*

IFR §201.6(c)(2)(ii)(B): *[The plan* ***should*** *describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate.*

IFR §201.6(c)(2)(ii)(C): *[The plan* ***should*** *describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*

IFR §201.6(c)(2)(iii): *For multi-jurisdictional plans, the risk assessment* ***must*** *assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

4.2 Overview of Sussex County's Assets and Development Trends

To better understand a community's risks, an evaluation of which assets are exposed to hazard events must be completed. The inventory of assets that should be considered includes the population, structures, and lifelines that could be impacted by hazard events. Section 3 provided brief descriptions of historical hazard impacts, the locations and extent of the hazards, and the impact on life and property due to each of the hazards. Section 4.3 goes into greater detail of the potential impacts due to dam failures, earthquake/geological, flood, high wind – straight-line winds, and severe winter weather. First, this Section will describe the county's overall inventory that could be injured, damaged, or destroyed during the occurrence of a hazard and possible future development trends. FEMA's spatial loss estimation software, HAZUS-MH, includes data for a number of inventory categories and was used as the foundation for the inventory data for this Plan. HAZUS-MH utilizes a number of data sources, including Census 2000 data, 2006 Dun & Bradstreet data, and Homeland Security Infrastructure Protection data to create the inventory database. Since this is a national inventory database, the accuracy of HAZUS-MH outputs can be improved by refining the inventory data based on local data. A significant improvement that can be made is to review and update the essential facilities data, which includes police stations, fire stations, medical facilities, emergency operation centers, and schools.

4.2.1 Population and Demographics

According to Census Bureau statistics, there was a population of 49,255 in 1960 in Sussex County. This increased by 57.40% by 1970, again by 49.78% in the following decade, and by 12.77% from 1980 to 1990. According to the 2000 Census data, Sussex saw an increase from 1990 to 2000 of 10.10%, for a total population of 144,166. Table 4.2.1-1 shows the population growth from 1980 to 2000 in individual municipalities. Figure 4.2.1-1 shows the population levels by municipality based on 2000 Census data.

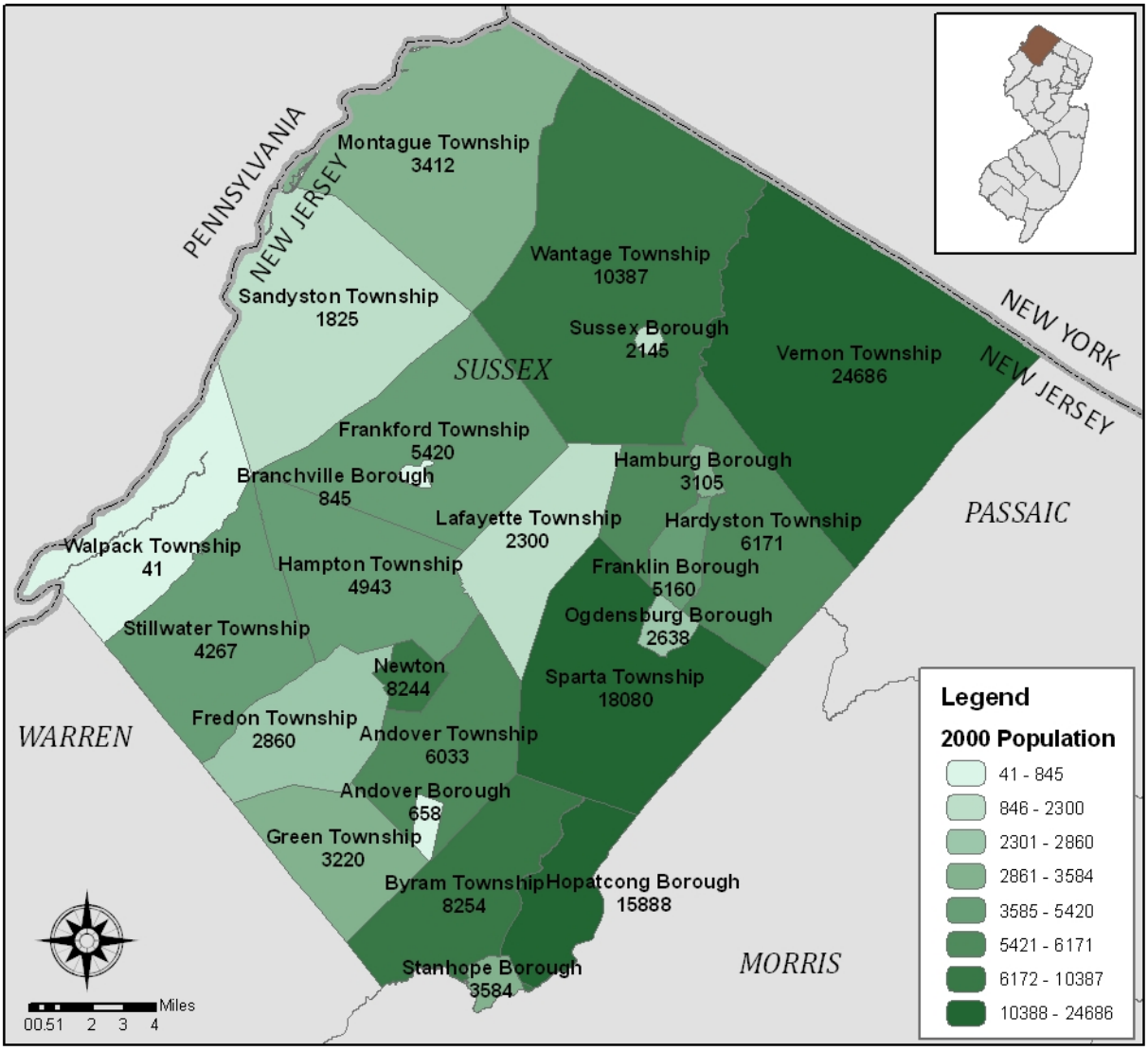
Table 4.2.1-1: Population Growth from 1980 to 2000 by Municipality in Sussex County

Municipality	1980 Population	1990 Population	2000 Population	% Change from 1980 to 2000
Andover Borough	892	700	658	-26.23%
Andover Township	4,506	5,438	6,033	33.89%
Branchville Borough	870	851	845	-2.87%
Byram Township	7,502	8,048	8,254	10.02%
Frankford Township	4,654	5,114	5,420	16.46%
Franklin Borough	4,486	4,977	5,160	15.02%
Fredon Township	2,281	2,763	2,860	25.38%
Green Township	2,450	2,709	3,220	31.43%
Hamburg Borough	1,832	2,566	3,105	69.49%
Hampton Township	3,916	4,438	4,943	26.23%
Hardyston Township	4,553	5,275	6,171	35.54%
Hopatcong Borough	15,531	15,586	15,888	2.30%
Lafayette Township	1,614	1,902	2,300	42.50%

Municipality	1980 Population	1990 Population	2000 Population	% Change from 1980 to 2000
Montague Township	2,066	2,832	3,412	65.15%
Newton Town	7,748	7,521	8,244	6.40%
Ogdensburg Borough	2,737	2,722	2,638	-3.62%
Sandyston Township	1,485	1,732	1,825	22.90%
Sparta Township	13,333	15,157	18,080	35.60%
Stanhope Borough	3,638	3,393	3,584	-1.48%
Stillwater Township	3,887	4,253	4,267	9.78%
Sussex Borough	2,418	2,201	2,145	-11.29%
Vernon Township	16,302	21,211	24,686	51.43%
Walpack Township	150	67	41	-72.67%
Wantage Township	7,268	9,487	10,387	42.91%
Total	**116,119**	**130,943**	**144,166**	**24.15%**

Source: NJOIT, OGIS January 2009. GIS data retrieved from http://www.state.nj.us/dep/gis/.

Figure 4.2.1-1: 2000 Population in Sussex County by Municipality



Source: NJOIT, OGIS January 2009. GIS data retrieved from http://www.state.nj.us/dep/gis/.

4.2.2 General Building Stock

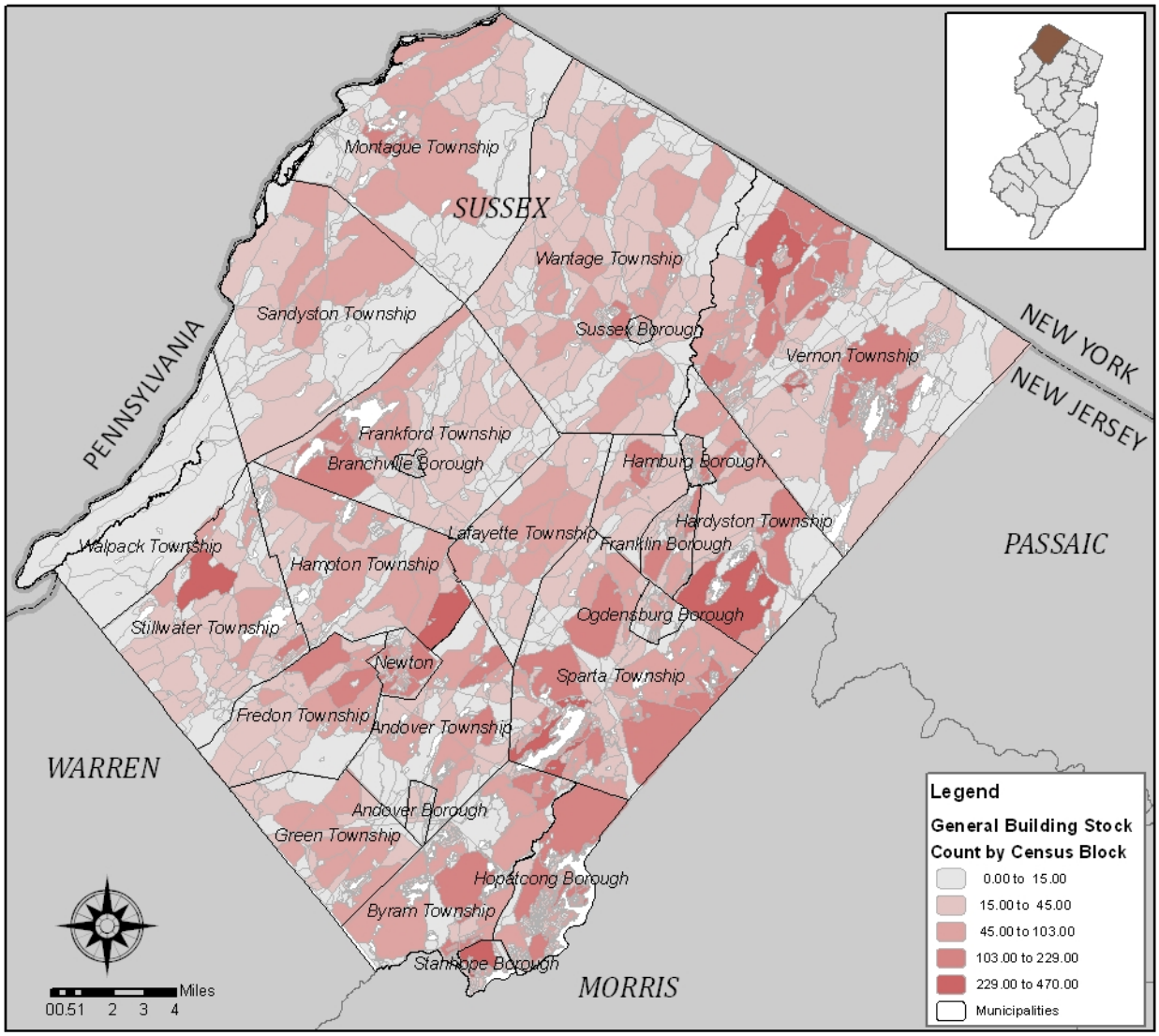
Sussex County is 521 square miles, contains 40 census tracts, and 3,600 census blocks with over 51,000 households. There are an estimated 59,480 buildings in the region with a total building replacement value (excluding contents) of $12,783,000,000. Approximately 91% of the county's structures and 76% of the building value are associated with residential housing. Wood frame construction makes up 81% of the building inventory, with the other 19% constructed of steel, concrete, precast, reinforced masonry, unreinforced masonry, or manufactured housing. In HAZUS-MH analysis, the general building stock is grouped and evenly distributed at the census block or tract level.

Table 4.2.2-1: Building Exposure by Occupancy in Sussex County

Occupancy	Exposure	% of Total Building Inventory
Residential	$9,749,907,000	76.3%
Commercial	$1,974,813,000	15.4%
Industrial	$537,894,000	4.2%
Agricultural	$58.329,000	0.5%
Religious	$148,356,000	1.2%
Government	$74,189,000	0.6%
Education	$239,268,000	1.9%
Total	**$12,782,756,000**	**100.0%**

Source: HAZUS-MH MR4, Patch 2 Analysis completed June 2010.

Figure 4.2.2-1: Building Count by Census Block Based on 2000 Census Data



Source: HAZUS-MH MR4, Patch 2 Analysis completed June 2010.

4.2.3 Critical Facilities

For this Plan, a focus on the accuracy of the essential facilities and some of the lifeline data was a priority. The lifeline data that was updated for this Plan included potable water system facilities and waste water treatment plants. The Delaware River Basin Commission (DRBC) shared the HAZUS-MH data that was updated based on their partnerships with certain communities, which they compiled in 2007 for the *Multi-Jurisdictional Flood Mitigation Plan for Municipalities in the Non-tidal, New Jersey Section of the Delaware River Basin*. This update did not include the entire county, only those municipalities within the designated watershed who chose to participate (see Figure 3.3.4-1 in Section 3 for a map of the participating communities in Sussex County). During this Plan's process, the DRBC updated data was provided to the county, and updates were received from the municipalities to varying degrees. Sussex County GIS Department also provided data for essential facilities updates. All of the relevant data was then compiled and reloaded into HAZUS-MH for use in the analysis and loss estimations.

Table 4.2.3-1 provides the facility class codes for essential facilities and utilities that are included in Tables 4.2.3-2 through 4.2.3-8.

Table 4.2.3-1: Facility Class Code Definitions

Facility Class	Type of Facility	Occupancy Class	Description
EFEO	ESF: Emergency Response	Emergency Operation Centers	-
EFFS	ESF: Emergency Response	Fire Station	-
EFPS	ESF: Emergency Response	Police Station	-
EFHS	ESF: Medical Care	Small Hospital	Hospital with less than 50 beds
EFHM	ESF: Medical Care	Medium Hospital	Hospital with beds between 50-150
EFHL	ESF: Medical Care	Large Hospital	Hospital with greater than 150 beds
EFMC	ESF: Medical Care	Medical Clinic	Clinics, Labs, Blood Banks
MDFLT	ESF: Medical Care	Default for Medical	
EFS1	ESF: School	School	Primary and High School, K-12
EFS2	ESF: School	College/University	Community and State Colleges, State and Private Universities
PDFLT	Utility	Default for Potable Water	-
WDFLT	Utility	Default for Waste Water Facility	-

Source: HAZUS-MH MR4 Technical and User Manuals.

There are 14 Emergency Operations Centers in the Sussex County essential facility inventory that were used for analysis, as listed in Table 4.2.3-2.

Table 4.2.3-2: Essential Facilities – Emergency Operation Centers in Sussex County

Facility Name	City	Facility Class
Blue Ridge Rescue Squad	Frankford	EFEO
Blue Ridge Station No 2	Montague	EFEO
Byram Twp Lakeland Emergency Squad	Byram	EFEO
Civil Defense Dir	Newton	EFEO
Emergency Management Office	Sussex Borough	EFEO
Hopatcong Ambulance Squad	Hopatcong	EFEO
Lafayette Fire/EMS	Lafayette	EFEO
Newton First Aid Squad 65	Newton	EFEO
Sparta Ambulance Service	Sparta	EFEO
St. Clares MICU	Lafayette	EFEO
Stanhope American Legion First Aid	Stanhope	EFEO
Stanhope Emergency Management	Stanhope	EFEO
Stillwater EMS	Stillwater	EFEO

Source: HAZUS-MH, DRBC, and local data sources.

There are 39 fire station facilities in the Sussex County essential facility inventory that were used for analysis, as listed in Table 4.2.3-3.

Table 4.2.3-3: Essential Facilities – Fire Station Facilities in Sussex County

Facility Name	City	Facility Class
Andover Boro Fire Department	Andover	EFFS
Andover Twp Fire 2	Andover Township	EFFS
Andover Twp Fire Co 1	Andover Township	EFFS
Beemerville Fire Department	Wantage	EFFS
Branchville Fire Department	Branchville	EFFS
Byram Twp Fire Department Cranberry Lake	Byram	EFFS
Byram TWP Fire Department - Lee Hill Road	Byram	EFFS
Byram Twp Lackawanna Fire Department	Byram	EFFS
Culver Lake Fire Tower	Frankford	EFFS
Frankford Twp Volunteer Fire Department 1	Frankford	EFFS
Frankford Twp Volunteer Fire Department 2	Frankford	EFFS
Franklin Fire Department	Franklin	EFFS
Fredon Volunteer Fire Company	Fredon	EFFS
Green Township Fire Department	Green Township	EFFS
Hamburg Fire Department Inc.	Hamburg	EFFS
Hampton Fire Department /EMS Station 1	Hampton	EFFS
Hampton Fire Department /EMS Station 2	Hampton	EFFS
Hampton Fire Department /EMS Station 3	Hampton	EFFS
Highland Lakes Volunteer Fire Department	Vernon	EFFS
Hopatcong Fire Co. #4	Hopatcong	EFFS
Hopatcong Fire Department	Hopatcong	EFFS
Hopatcong Fire Department #2	Hopatcong	EFFS
Hopatcong Fire Department #3	Hopatcong	EFFS
Lafayette Fire Department	Lafayette	EFFS
Montague Volunteer Fire Department	Montague	EFFS

Facility Name	City	Facility Class
Ogdensburg Fire Department	Ogdensburg	EFFS
Sandyston Hainesville Fire Department	Sandyston Township	EFFS
Sparta Fire Department Seneca	Sparta	EFFS
Sparta Township Fire Department Headquarters	Sparta	EFFS
Sparta Twp Sparta Lake Fire Department	Sparta	EFFS
Stanhope Fire Department	Stanhope	EFFS
Stillwater Area Volunteer Fire Company	Stillwater	EFFS
Sussex Fire Department	Sussex	EFFS
Swartswood Fire Department	Stillwater	EFFS
Vernon Township Fire Department	Vernon	EFFS
Wantage Fire Department - Colesville	Wantage	EFFS

Source: HAZUS-MH, DRBC, and local data sources.

There are 16 police station facilities in the Sussex County essential facility inventory that were used for analysis, as listed in Table 4.2.3-4.

Table 4.2.3-4: Essential Facilities – Police Station Facilities in Sussex County

Facility Name	City	Facility Class
Andover Twp Police Department	Newton	EFPS
Byram Twp Police Department	Stanhope	EFPS
Franklin Police Department	Franklin	EFPS
Hamburg Police Department	Hamburg	EFPS
Hardyston Police Department	Hardyston	EFPS
Hopatcong Borough Police Department	Hopatcong	EFPS
New Jersey State Police	Augusta	EFPS
Newton Police Department	Newton	EFPS
Ogdensburg Borough Police Department	Ogdensburg	EFPS
Sparta Twp Police Department	Sparta	EFPS
Stanhope Borough Police Department	Stanhope	EFPS
Stillwater Police Department	Middleville	EFPS
Sussex County Prosecutors' Office	Newton	EFPS
Sussex County Sheriff Office	Newton	EFPS
Vernon Twp Police Athletic	Vernon	EFPS
Vernon Twp Police Department	Vernon	EFPS

Source: HAZUS-MH, DRBC, and local data sources.

There is 1 medical care facility in the Sussex County essential facility inventory that was used for analysis, as listed in Table 4.2.3-5.

Table 4.2.3-5: Essential Facilities – Medical Care Facility in Sussex County

Facility Name	City	Facility Class
Newton Memorial Hospital	Newton	Efhm

Source: HAZUS-MH, DRBC, and local data sources.

There are 72 school facilities in the Sussex County essential facility inventory that were used for analysis, as listed in Table 4.2.3-6.

Table 4.2.3-6: Essential Facilities – School Facilities in Sussex County

Facility Name	City	Facility Class
Alpine Montessori	Sparta	EFS1
Bible Conference	Montage	EFS1
Blessed Beginnings Preschool,	Sparta	EFS1
Branchville School	Branchville	EFS1
Byram Lakes Elementary	Stanhope	EFS1
Byram Township Intermediate	Stanhope	EFS1
Camp Auxilium Learning Center	Newton	EFS1
Cedar Mountain School	Vernon	EFS1
Childrens Garden	Sparta	EFS1
Clifton E. Lawrence	Wantage	EFS1
Durban Avenue School	Hopatcong	EFS1
Fire Training Academy	Hampton twp	EFS1
Fledglings Montessori School	Vernon	EFS1
Florence M. Burd	Andover twp	EFS1
Frankford Township	Branchville	EFS1
Franklin Elementary	Franklin	EFS1
Fredon Township	Fredon	EFS1
Garden State Academy	Green twp	EFS1
Glen Meadow	Vernon	EFS1
Green Hills School	Green	EFS1
Halsted Street	Newton	EFS1
Hamburg	Hamburg	EFS1
Hardyston Elementary School	Franklin	EFS1
Hardyston Middle School	Hardyston	EFS1
Helen Morgan	Sparta	EFS1
High Point Regional High School	Wantage	EFS1
Hopatcong High School	Hopatcong	EFS1
Hopatcong Middle School	Hopatcong	EFS1
Hudson Maxim	Hopatcong	EFS1
Immaculate Conception Regional	Franklin	EFS1
Kiddie Academy Child Care Lear	Sparta	EFS1
Kittatinny Regional High School	Hampton	EFS1
Lafayette Township	Lafayette	EFS1
Lakeland-Andover School	Lafayette	EFS1

Facility Name	City	Facility Class
Lenape Valley Regional High School	Stanhope	EFS1
Little Children's World	Branchville	EFS1
Long Pond	Andover Township	EFS1
Lounsberry Hollow	Vernon	EFS1
Marian McKeown	Hampton Township	EFS1
Merriam Ave.	Newton	EFS1
Mohawk Avenue School	Sparta	EFS1
Montague Twp	Montague	EFS1
Newton High	Newton	EFS1
Northwest Christian School	Hampton Township	EFS1
Ogdensburg	Ogdensburg	EFS1
Prince of Peace Early Learning	Hamburg	EFS1
Rainbows of Learning	Newton	EFS1
Rev George A. Brown School	Sparta	EFS1
Rolling Hills	Vernon	EFS1
Sandyston Walpack Cons	Sandyston Township	EFS1
Sparta Alpine	Sparta	EFS1
Sparta High School	Sparta	EFS1
Sparta Middle School	Sparta	EFS1
Special Children's School	Sparta	EFS1
St Joseph Regional	Newton	EFS1
Stillwater Township	Stillwater	EFS1
Sussex Christian School Association	Sussex	EFS1
Sussex County Charter School For Te	Sparta	EFS1
Sussex County Community College	Newton	EFS2
Sussex Cty Tech High School	Sparta	EFS1
Sussex Middle School	Sussex	EFS1
The Children's School, Inc.	Vernon	EFS1
The Hilltop Country Day School	Sparta	EFS1
Tiny Town Pre-School	Sparta	EFS1
Tranquility Adventist School	Green Township	EFS1
Tulsa Trail Elementary School	Hopatcong	EFS1
Valley Road School	Stanhope	EFS1
Vernon Township High School	Vernon	EFS1
Wallkill Valley Regional High School	Hardyston	EFS1
Walnut Ridge	Vernon	EFS1
Wantage Elementary School	Wantage	EFS1
Willowglen Academy	Andover Township	EFS1

Source: HAZUS-MH, DRBC, and local data sources.

There are 2 potable water facilities in the Sussex County utilities inventory that were used for analysis, as listed in Table 4.2.3-7.

Table 4.2.3-7: Utilities – Potable Water Facilities in Sussex County

Facility Name	City	Facility Class
Germany Flats Pump Facility	Sparta	PDFLT
Pump House	Andover Borough	PDFLT

Source: HAZUS-MH, DRBC, and local data sources.

There are 7 waste water system facilities in the Sussex County utilities inventory that were used for analysis, as listed in Table 4.2.3-8.

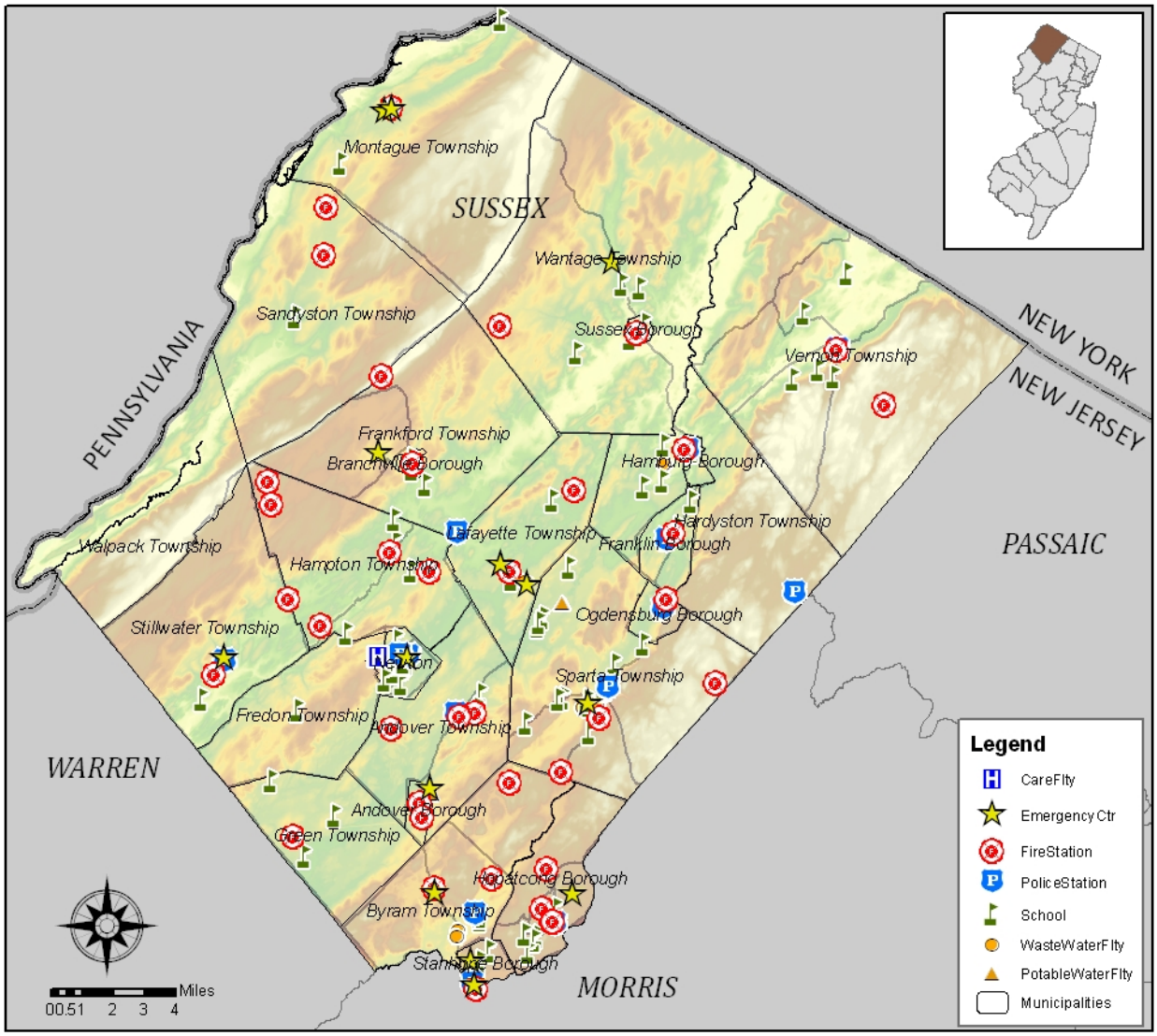
Table 4.2.3-8: Utilities – Waste Water System Facilities in Sussex County

Facility Name	City	Facility Class
Newton Town of Water & Sewer Department	Newton	WDFLT
Pope John XXIII HS Water Treatment Plan	Sparta	WDFLT
Sewer Pump Station	Byram	WDFLT
Sewer Pump Station	Byram	WDFLT
Sparta Township Sewage Treatment Plant	Sparta	WDFLT
Sussex County Municipal Waste Complex	Lafayette	WDFLT
Upper Walkill Valley Water	Hamburg	WDFLT

Source: HAZUS-MH, DRBC, and local data sources.

Figure 4.2.3-1 shows the locations of the essential facilities, potable water facilities, and waste water system facilities throughout Sussex County that were used in this analysis.

Figure 4.2.3-1: Essential Facilities, Potable Water Facilities, and Waste Water System Facilities in Sussex County



Source: HAZUS-MH, DRBC, and local data sources.

In Sussex County, the replacement value of the transportation systems is estimated to be approximately $2,052,000,000 and the utility lifeline systems to be about $398,000,000, for a total of over $2,450,000,000. This inventory includes approximately 290 kilometers of highways, 155 bridges, and 6,383 kilometers of pipes.

4.2.4 Future Land Use and Development

As shown in Table 4.2.1-1 and Figure 4.2.1-1, various municipalities in Sussex County have experienced varying degrees of increases and decreases in population over the past few decades. The majority of the municipalities have seen an increase since 1980, with the exception of Andover Borough, Branchville Borough, Ogdensburg Borough, Stanhope Borough, Sussex Borough, and Walpack Township, which had decreases in population.

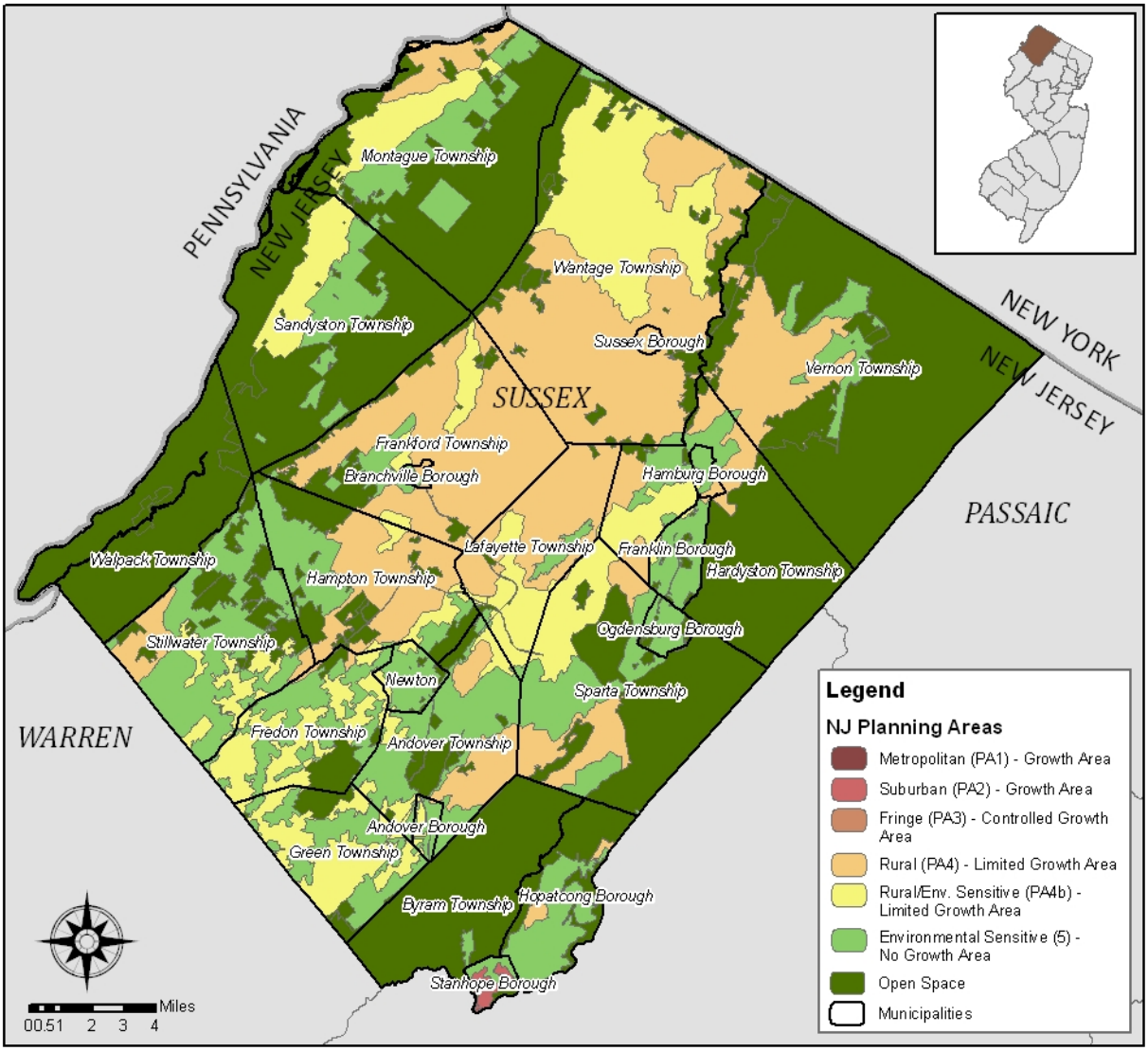
This may be reflective of some future population and related development trends, however it is difficult to predict future development due to the variety of factors that can affect it, such as zoning and land use restrictions, economic changes, and real estate market variability.

Figure 4.2.4-1 shows the five Planning Area designations as designated by the final draft of New Jersey's 2010 State Development and Redevelopment Plan (NJDRP). The five Planning Areas (PA) are as follows:

- **PA1 - The Metropolitan PA, (Growth Area):** A variety of municipalities that have strong ties to major metropolitan areas. Includes mature settlement patterns, infrastructure systems that are approaching their reasonable life expectancy, aging housing stock in need of rehabilitation, recognition that redevelopment will be the predominant form of growth, and a growing need to regionalize services and systems. Intended to provide for much of the State's future development and redevelopment.
- **PA2 – The Suburban PA, (Growth Area):**: Located adjacent to PA1, but has a lack of high intensity centers, available developable land, and more dispersed and fragmented pattern of predominantly low-density development. Served by regional infrastructure and often designated for growth in municipal master plans. Intended to provide for much of the state's future development.
- **PA3 – The Fringe PA, (Controlled Growth Area):**: Predominantly still a rural landscape that is not prime agricultural or environmentally sensitive land, with scattered small communities and free-standing residential, commercial, and industrial development. Large investments in water and sewer and local road networks have not yet occurred. Intended to direct growth into and revitalize cities and towns, where future growth does occur accommodate it through more compact, center-based developments, and protect the existing environs primarily as open space and farmlands.
- **PA4 – The Rural Planning Area, (Limited Growth Area)**: Comprises much of NJ's countryside, where large masses of cultivated or open land surround rural regional centers, towns, villages, and hamlets. Relatively isolated residential, commercial, and industrial sites are clearly distinguishable from typical suburban development. Includes most of NJ's prime farmland. Intended to maintain the environs as large contiguous tracts of farmland and open space , promote a viable agricultural industry and compatible off-the-farm economic opportunities for farmers, and revitalize existing rural centers.
    - **PA4B – The Rural/Environmentally Sensitive PA**: A sub-PA with similar characteristics of PA4 but intended to support continued agricultural development on lands with environmentally sensitive features.
- **PA5 – The Environmentally Sensitive PA, (No Growth Area):** Contains large contiguous land areas with valuable eco-systems, geological features and wildlife habitats. NJ's future environmental integrity and a substantial portion of its economy depends on the protection of these irreplaceable resources. Existing centers within PA5 are the focus of residential and commercial growth and public facilities and services for their region. Intended to protect environmental resources through the protection of large contiguous tracts of open space, accommodate growth in exiting cities and towns and new center-based developments, and revitalize existing cities and towns.[1]

[1] January 2010 Final Draft of NJ State Development and Redevelopment Plan, p31-38. Plan retrieved from http://www.nj.gov/dca/divisions/osg/plan/df.html

Figure 4.2.4-1: NJDRP 2010 Planning Areas and Expected Areas of Development



Source: GIS data from NJ Office of Smart Growth, 2010 NJDRP. Retrieved from http://www.nj.gov/dca/divisions/osg/plan/df.html#gis.

4.3 Estimate of Potential Losses

Following the hazard profiling in Section 3, Sussex County chose to include a more detailed risk assessment for the six highest impact hazards to the county; which include dam failure, earthquake/geological, flood, high wind – straight-line winds, winter severe weather, and wildfire. Understanding vulnerable assets and quantifying risk for specific hazards can help guide mitigation strategies and efforts. Each estimate of potential losses section contains at a minimum the following subsections for each of the chosen hazards:

Methodology

Explanation of the approach used in the loss estimations. FEMA's HAZUS-MH MR4 Patch 2 software is utilized for flood, hurricane winds, and earthquake scenarios to predict potential losses. Although considered one of the best available models, there are inaccuracies associated with HAZUS-MH and the results should be utilized for planning purposes only. As mentioned in Section 4.2.3, some of the site-specific data inventory was updated in HAZUS-MH prior to the running the risk assessments, including essential facilities, potable water system facilities, and waste water treatment plants. (Note that the Hurricane Wind HAZUS-MH module will not model damages to potable water system facilities and waste water treatment plants.) The analysis is restricted to the county boundaries, so damage assessments do not contain information regarding adjacent counties. Note that HAZUS-MH provides the following disclaimer with all result reports: *The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific [event]. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.*

The dam failure risk assessment is based on a few specific examples, using GIS analysis with inundation boundaries, county parcel data, and HAZUS-MH data references. For the severe winter weather hazard, a traditional 100-year planning approach was utilized based on historical information.

Potential Losses

Display and explanation of data assessing the potential losses in the county for future hazard events.

Critical Facilities Risk

Summary of critical facilities at risk due to specific hazards per available information. See Section 4.2.3 for a list of critical facilities that could be impacted in Sussex County. Essential facilities, potable water facilities, and waste water system facilities were updated based on DRBC and local data. Replacement costs for updated essential facilities are not known, but are necessary to provide accurate loss estimations based on damages in HAZUS. Instead of providing potentially inaccurate loss estimates, the number of facilities damaged and the severity will be provided.

Results for Specific Scenarios

If there are multiple scenarios used in a risk assessment, the losses (general building stock and critical facilities) will be broken into separate results sub-sections.

Risk Assessment Next Steps

Includes any relevant information or suggestions for future loss estimation improvements or necessary actions.

4.3.1 Dam Failure

Methodology for Dam Failure

As discussed in Section 3.3.1-2, Sussex County is home to 36 high hazard dams, 45 significant dams, and 153 low hazard dams. In order to conduct a loss estimation, three specific dam sites were chosen by the county: Morris Lake Dam, Lake Wallenpaupack in Wilsonville, Pennsylvania, and Mongaup River complex in Sullivan County, New York. All are considered 'High' hazard dams and have existing Emergency Action Plans (EAPs). Part of these EAPs are inundation maps that show the areas that would become inundated under various scenarios.

For the Mongaup River complex, the original hardcopy inundation maps were scanned and digitally mosaicked together. This was then georeferenced in ESRI ArcGIS using orthoimagery and roadways as references. The inundation boundaries were then digitized. For Morris Lake Dam, shapefiles of the inundation boundaries were obtained from NJDEP's Dam Safety & Flood Control Bureau, and Lake Wallenpaupack's EAP included GIS files. Once the spatial inundation boundary file was obtained or created, it was overlaid in GIS with Sussex County parcel data and parcels that intersected with the inundation boundary were selected. These were compiled based on occupancy/zoning type for parcel counts. Depth of flooding was not a consideration in this analysis, therefore true loss estimations cannot be provided. However, the potentially affected areas are shown.

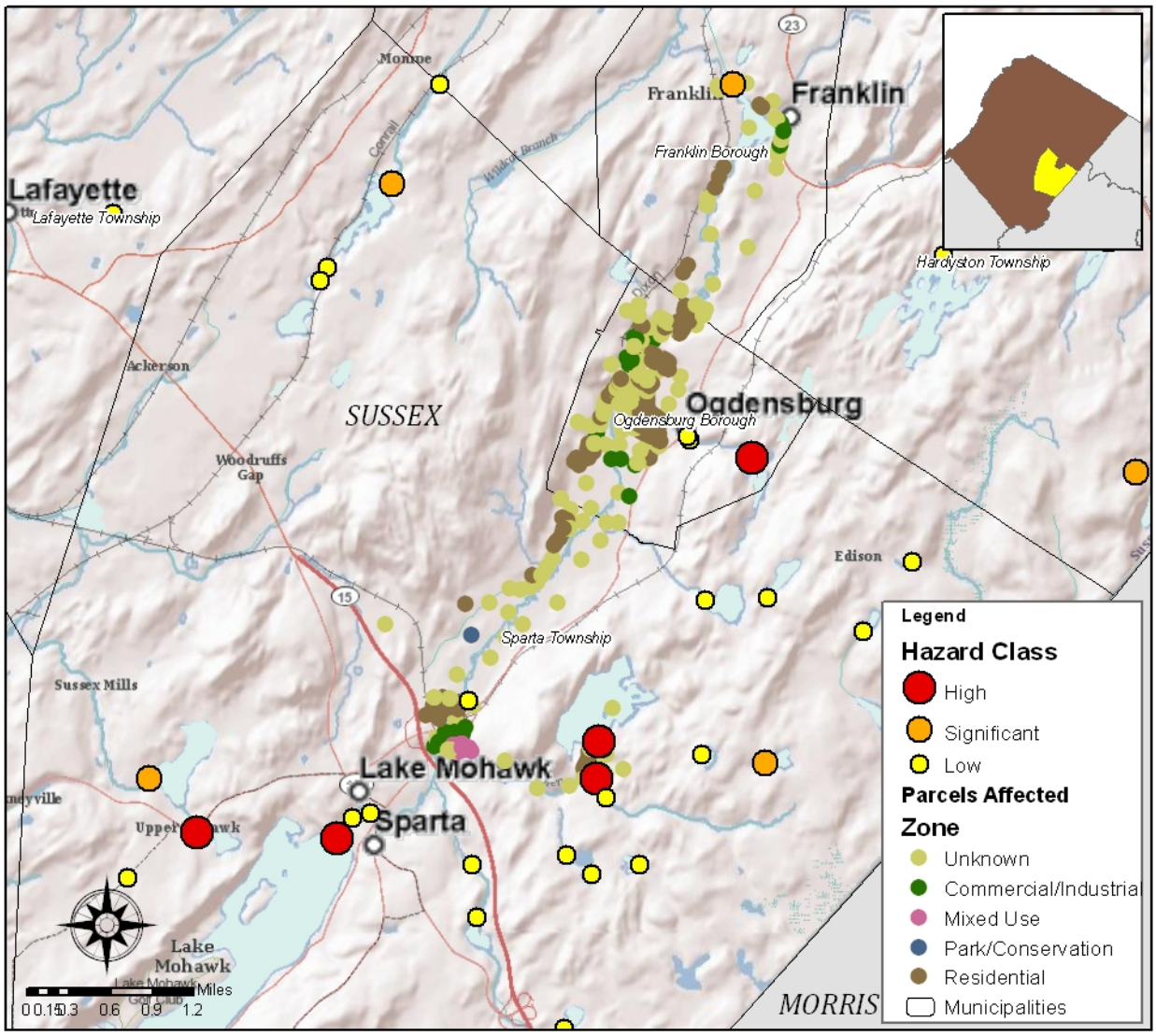
Although a dam failure may affect surrounding areas and counties, this analysis focuses on the impacts in Sussex County only. Note that this is not an indication that there is any known likelihood that these dams will fail; this is only a risk assessment for planning purposes.

Potential Losses, Results for Dam Failure Scenario #1- Morris Lake Dam

Morris Lake Dam is owned and operated by the Town of Newton. Morris Lake Dam's EAP includes three inundation scenarios: probable maximum precipitation flood with no breach, probable maximum precipitation flood with dam breach, and a sunny day with dam breach scenario. The probable maximum precipitation flood with breach will be used for this assessment, as it represents the worst-case scenario.

A dam breach would affect areas of Sparta Township, Ogdensburg Borough, and Franklin Borough. According to this scenario, if the dam was to fail, it would impact 166 unknown zone type parcels, 33 commercial/industrial parcels, 9 mixed use, 1 park/conservation, and 182 residential parcels in Sussex County. Each parcel may have multiple structures built on it or none.

Figure 4.3.1-1: Affected Parcels if Morris Lake Dam Failed



Critical Facilities, Results for Dam Failure Scenario #1- Morris Lake Dam

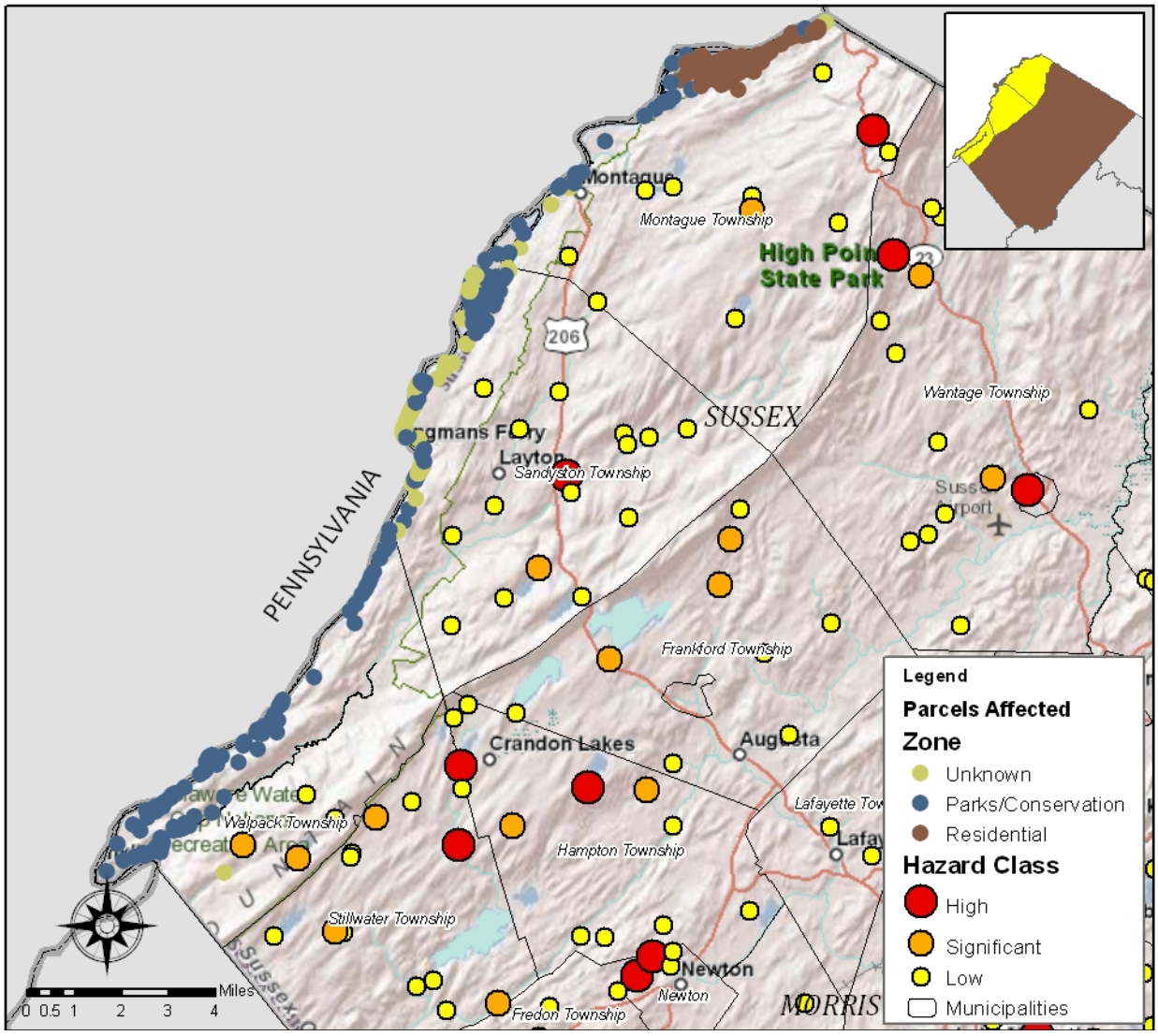
If this dam were to fail, there would be no care facilities, no EOCs, no fire stations, 1 police station, 3 schools, no potable water facilities, and no waste water system facilities impacted in Sussex County.

Potential Losses, Results for Dam Failure Scenario #2- Lake Wallenpaupack Dam

The Wallenpaupack hydroelectric station in Wilsonville, Pennsylvania is owned and operated by PPL Generation, LLC. Wallenpaupack's EAP includes two inundation scenarios: a fair weather breach and a probable maximum failure. The probable maximum precipitation flood with breach will be used for this assessment, as it represents the worst-case scenario.

A dam breach would affect areas of Montague Township, Sandyston Township, and Walpack Township. According to this scenario, if the dam was to fail, it would impact 80 unknown zone type parcels, 293 park/conservation, and 93 residential parcels in Sussex County. Each parcel may have multiple structures built on it or none.

Figure 4.3.1-2: Affected Parcels if Lake Wallenpaupack Dam Failed



Critical Facilities, Results for Dam Failure Scenario #2- Lake Wallenpaupack Dam

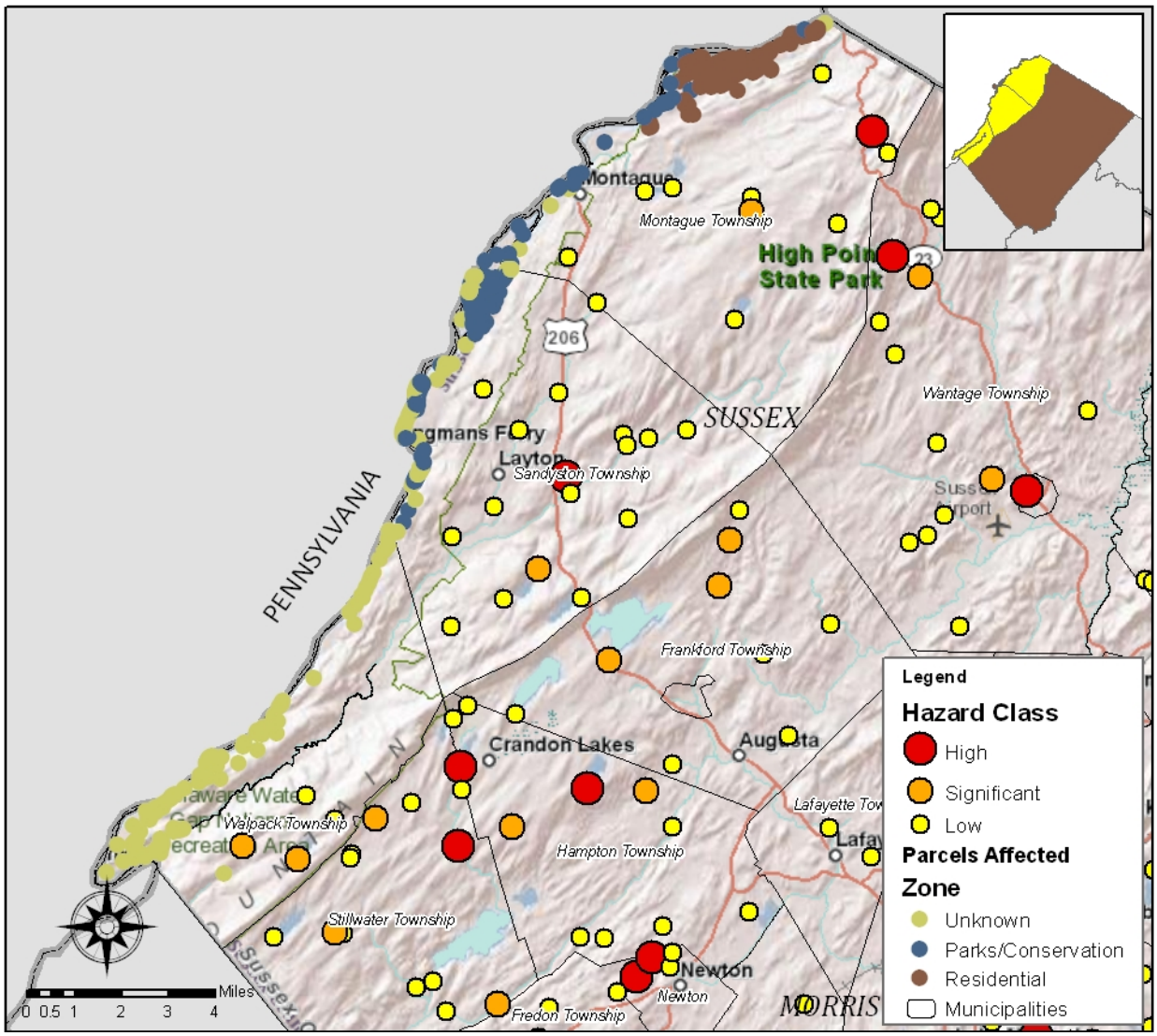
No essential facilities, potable water facilities, or waste water system facilities are predicted to be impacted if this dam were to fail.

Potential Losses, Results for Dam Failure Scenario #3- Mongaup River Hydro System

The Mongaup River Hydro System consists of Swinging Bridge, Mongaup, and Rio dam systems. It is located in Sullivan County, New York and owned and operated by AER-NY Gen, LLC. Mongaup's EAP includes two inundation scenarios: a sunny day breach and a flood breach. The flood with breach will be used for this assessment, as it represents the worst-case scenario.

A dam breach would affect areas of Montague Township, Sandyston Township, and Walpack Township. According to this scenario, if the dam was to fail, it would impact 81 unknown zone type parcels, 297 park/conservation, and 118 residential parcels in Sussex County. Each parcel may have multiple structures built on it or none.

Figure 4.3.1-3: Affected Parcels if Mongaup River Hydro System Failed



Critical Facilities, Results for Dam Failure Scenario #3- Mongaup River Hydro System

No essential facilities, potable water facilities, or waste water system facilities are predicted to be impacted if this dam were to fail.

Risk Assessment Next Steps for Dam Failure

There are over two hundred additional dams in Sussex County that were not analyzed and pose some risk to the surrounding communities. Those that were assessed do not take the depth of flooding into consideration and therefore the potential cost of a dam failure. This analysis could be completed in the future utilizing HAZUS-MH and inundation boundaries, cross-sections, and base flood elevation information. On-site inspections and regular maintenance are important to the health of the county's dams to reduce the risk of dam failure.

4.3.2 Earthquake/Geological

Methodology for Earthquake/Geological

Three different earthquake scenarios were chosen for analysis in HAZUS-MH MR4 Patch 2 after discussion with the New Jersey Geological Survey. One was a deterministic scenario based on a Moment Magnitude of 5.5, earthquake depth of 10 kilometers, Central Eastern United States attenuation function, and epicenter location in the center of Sussex County. Although it is unlikely that an earthquake's epicenter will occur in the exact center of the county, this provides a good planning scenario for losses.

The other two scenarios are probabilistic (statistical) scenarios that are based on ground shaking parameters derived from U.S. Geological Survey probabilistic seismic hazard curves. The first was a 500-year return period scenario also based on a Moment Magnitude of 5.5. The second probabilistic scenario allowed for calculation of Annualized Earthquake Loss (AEL). AEL is the estimated long-term value of earthquake losses to the general building stock in any single year in a specified geographic area, such as a county.[2] The annualized loss analysis in HAZUS-MH averages potential losses from future scenarios while considering their probabilities of occurrence. This is based on eight different return periods, including the 100-, 250-, 500-, 750-, 1000-, 1500-, 2000-, and 2500-year return period earthquake events. In this way, AEL incorporates historic patterns of smaller frequent earthquakes with larger, infrequent events to create a balanced assessment of earthquake risk.[1] See the HAZUS-MH MR4 Technical Manual, Chapter 17 for a more detailed description of the Annualized Losses methodology the model utilizes. AEL does not offer as many results as the other types of scenarios, but provides estimated average annualized losses for general building stock and casualties.

NEHRP soil classifications can be updated using local data in HAZUS-MH for more accurate results. Unfortunately, a National Earthquake Hazards Reduction Program (NEHRP) soil classification map or data was not available for Sussex County. The default soil type

[2] FEMA, *FEMA 366: Estimated Annualized Earthquake Losses for the United States* (April 2008). Retrieved from http://www.fema.gov/library/viewRecord.do?id=3265

classification in HAZUS-MH is Class D, which is acceptable for most areas, but may not be the best choice in glaciated rock areas.

Potential Losses for Earthquake/Geological

Building losses are separated into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage to the building and its contents. Direct building damages are categorized based on the structure's building occupancy or use; such as residential, commercial, industrial, and others. The business interruption losses are the losses associated with the inability to operate a business and includes the temporary living expenses for people displaced from their homes due to damages from the earthquake.

For the earthquake model, estimates of casualties are provided by HAZUS-MH based on four severity levels that describe the extent of the injuries: Severity Level 1 – injuries require medical attention but no hospitalization, Severity Level 2 – injuries require hospitalization but are not life-threatening, Severity Level 3 – injuries require hospitalization and can become life-threatening if not treated promptly, and Severity Level 4 – victims are killed by the earthquake. Casualty estimates are provided for three different times of day, at 2:00 AM, 2:00PM, and 5:00PM.

HAZUS-MH also provides estimates for the number of displaced households that might be displaced from their homes due to the earthquake and the number of displaced people that may seek accommodations in temporary public shelters.

HAZUS-MH estimates the amount of debris that will be generated due to the earthquake event and separates debris into two types; brick/wood and reinforced concrete/steel. This distinction is made because there are different types of material handling equipment needed to handle the two types of debris.

Critical Facilities Risk for Earthquake/Geological

All critical facilities are vulnerable to earthquakes. A critical facility would encounter many of the same impacts as any other building within the county, depending on the level of building code used to construct the structure. These impacts include structural failure and loss of facility functionality. In other words, a damaged police station may not be able to serve the community.

The HAZUS-MH earthquake module also provides loss estimates for some transportation and utility lifeline losses. As previously mentioned, essential facilities, potable water facilities, and waste water facilities were updated before analysis based on DRBC and local updates.

Potential Losses, Results for Earthquake Scenario #1- Deterministic: 5.5 Moment Magnitude with Epicenter Centrally Located in Sussex County

In this scenario, HAZUS-MH estimates that about 6,535 buildings will be at least moderately damaged, which is over 11% of the total number of buildings in the county. Approximately 189 buildings will be damaged beyond repair. Table 4.3.2-1 shows the approximate expected building damage by occupancy. As shown, single family housing suffered the most damage, with other residential occupancy structures with second-most damage. Note that some of the inventory includes data that is also included in the critical facilities data and should not be double-counted when losses are determined, for example education and schools.

Table 4.3.2-1: Approximate Expected Building Damage by Occupancy Based on a Centrally Located 5.5 Moment Magnitude Event in Sussex County

Occupancy	No Damage		Slight Damage		Moderate Damage		Extensive Damage		Complete Damage	
	Count	%	Count	%	Count	%	Count	%	Count	%
Agriculture	218	0.54	69	0.55	42	0.80	11	1.05	2	0.89
Commercial	2,014	4.99	598	4.75	455	8.63	134	12.52	23	12.23
Education	59	0.15	18	0.14	14	0.27	4	0.38	1	0.40
Government	65	0.16	17	0.13	13	0.26	4	0.34	1	0.29
Industrial	805	1.99	218	1.73	180	3.41	52	4.84	8	4.17
Other Residential	3,729	9.24	1,341	10.65	806	15.28	196	18.38	33	17.61
Religion	121	0.30	41	0.33	28	0.54	9	0.84	2	0.98
Single Family	33,346	82.63	10,287	81.72	3,738	70.83	659	61.67	120	63.44
Total	**40,358**		**12,589**		**5,277**		**1,068**		**190**	

Source: HAZUS-MH MR4, Patch 2 Earthquake Analysis completed June 2010.

Notes:

(1) These results are based on a default, Level I analysis utilizing aggregated 2000 Census Bureau data. These results should be used for planning purposes only.

HAZUS-MH also estimated total building-related losses for this scenario, which total approximately $799,530,000, with 13% of the total related to the business interruption of the County.

Casualties are also estimated for three different times of day in HAZUS-MH earthquake modeling as shown in Table 4.3.2-2.

Table 4.3.2-2: Approximate Expected Casualties Based on a Centrally Located 5.5 Moment Magnitude Event in Sussex County

Time of Day	Level 1 (Injuries without Hospitalization)	Level 2 (Injuries with Hospitalization)	Level 3 (Life-threatening if not Treated)	Level 4 (Death)
2:00 AM (Highest Residential Load)	133	24	3	5
2:00 PM (Highest Educational, Commercial, and Industrial Load)	122	25	3	6
5:00 PM (Highest Commute Time)	120	25	4	6

Source: HAZUS-MH MR4, Patch 2 Earthquake Analysis completed June 2010.

Notes:

(1) These results are based on a default, Level I analysis utilizing aggregated 2000 Census Bureau data. These results should be used for planning purposes only.

HAZUS-MH estimates that approximately 346 households will be displaced due to this earthquake event. Of these displaced households, the model estimates that about 200 people will seek temporary shelter in public shelters.

For this earthquake scenario, HAZUS-MH predicts that approximately 170,000 tons of debris may be generated or approximately 6,600 truckloads (at 25 tons per truck). Of the total, 59% will consist of brick/wood and 41% of reinforced concrete/steel.

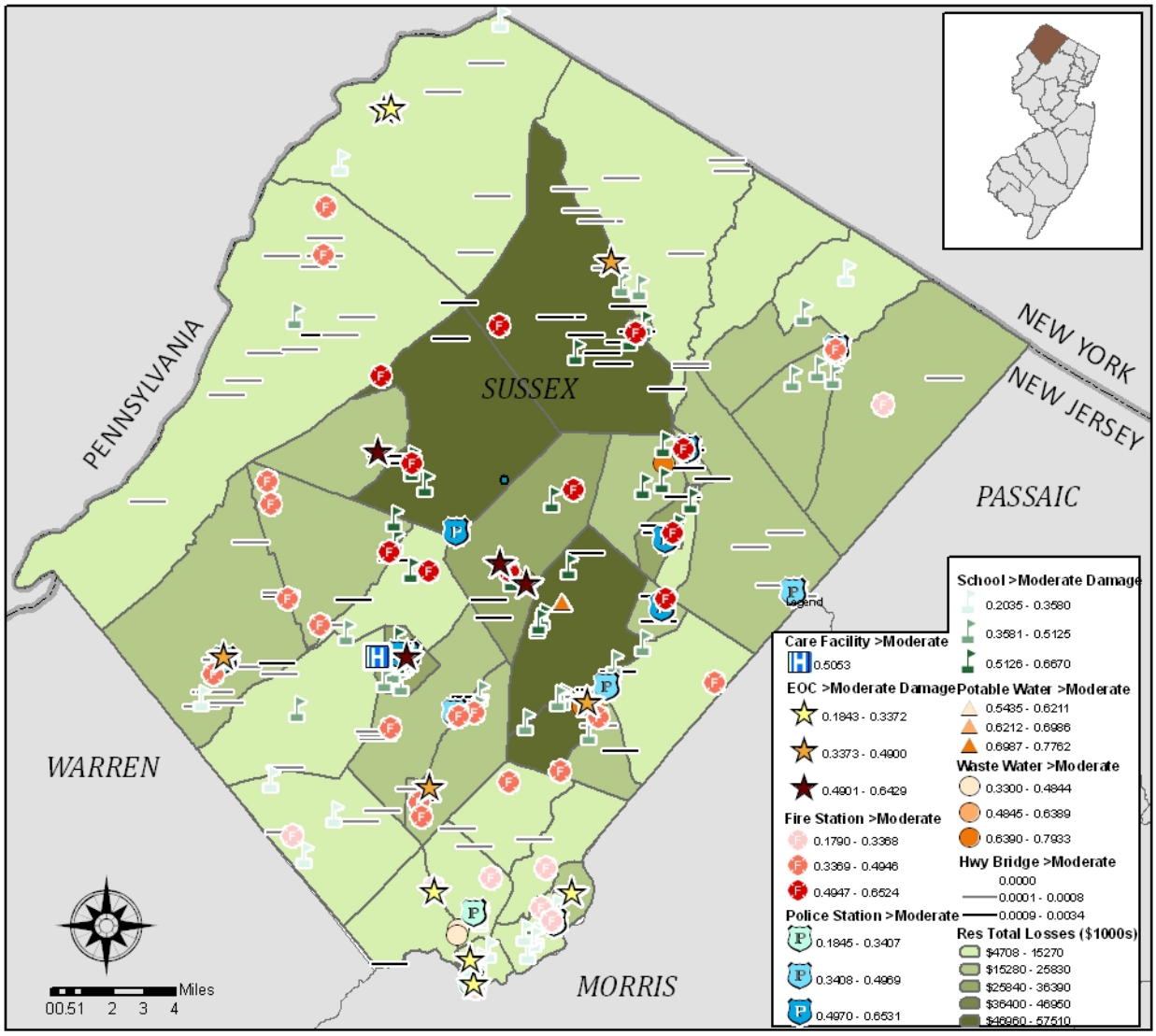
Critical Facilities at Risk, Results for Earthquake Scenario #1- Deterministic: 5.5 Moment Magnitude with Epicenter Centrally Located in Sussex County

HAZUS-MH estimates that the 1 county medical facility will experience at least moderate damage due to this earthquake. On the day of the earthquake, only 2% of the county's hospital beds will be available for use by patients already in the hospital and those injured by the earthquake. After one week, 48% of the beds will be back in service, and 78% after 30 days.

The model predicts that 32 of the 72 schools, 4 of the 14 emergency operations centers, 7 of the 16 police stations, and 12 of the 39 fire stations may expect at least moderate damage due to this event.

Figure 4.3.2-1 shows the various critical facilities and the degree of damage; the darker the symbol, the more damage it sustained. The background shows the total losses for residential structures in each census tract in thousands of dollars based on this scenario.

Figure 4.3.2-1: At Least Moderately Damaged Critical Facilities Based on a Centrally Located 5.5 Moment Magnitude Event in Sussex County



Source: HAZUS-MH MR4, Patch 2 Earthquake Analysis completed June 2010.

In terms of transportation systems, HAZUS-MH predicts that approximately one airport facility will be at least moderately damaged, but will have at least 50% functionality after a day.

For utility lifelines, the model estimates that two potable water systems, five waste water systems, one natural gas facility, and five communication systems will incur at least moderate damage. All are expected to be at least 50% functional after one week. It is estimated that out of 50,831 households, all will have potable water and 27,507 will not have electrical power at day one. By day three, 15,641 are still without electricity. This decreases to about 5,213 households without electricity at one week, 770 after one month, and 36 after three months.

Potential Losses, Results for Earthquake Scenario #2- 500-year Probabilistic: 5.5 Moment Magnitude in Sussex County

In this scenario, HAZUS-MH estimates that about 484 buildings will be at least moderately damaged, which is over 1% of the total number of buildings in the county. Approximately 5 buildings will be damaged beyond repair. As shown, single family housing suffered the most damage, with other residential occupancy structures with second-most damage. Table 4.3.2-3 shows the approximate expected building damage by occupancy. Note that some of the inventory includes data that is also included in the critical facilities data and should not be double-counted when losses are determined, for example education and schools.

Table 4.3.2-3: Approximate Expected Building Damage by Occupancy Based on a 500-year Probabilistic, 5.5 Moment Magnitude Event in Sussex County

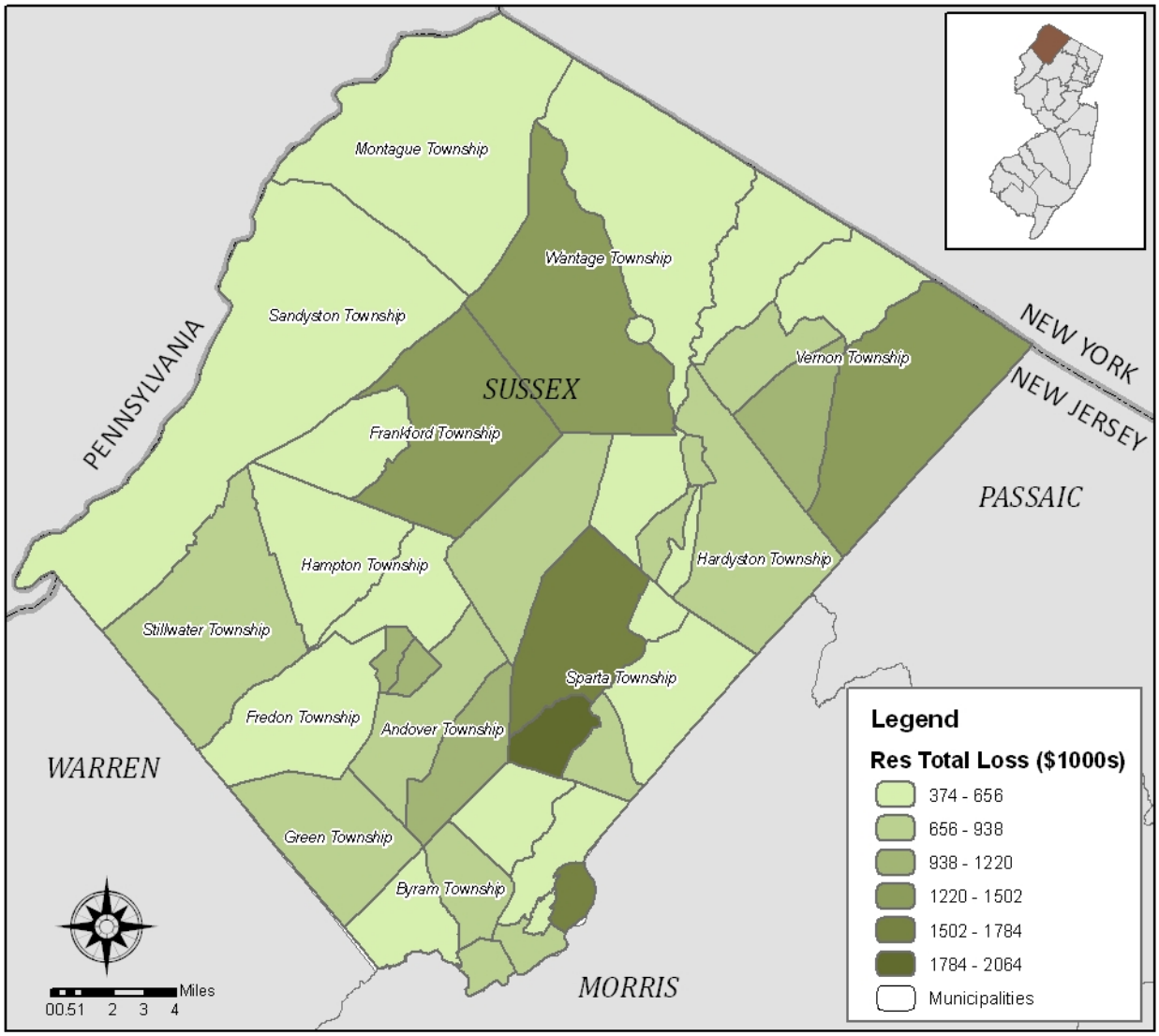
Occupancy	No Damage		Slight Damage		Moderate Damage		Extensive Damage		Complete Damage	
	Count	%	Count	%	Count	%	Count	%	Count	%
Agriculture	321	0.56	16	0.93	5	1.1	1	1.11	0	0.62
Commercial	3,006	5.24	154	9.25	56	13.15	8	13.26	1	10.35
Education	90	0.16	4	0.26	2	0.36	0	0.33	0	0.33
Government	94	0.16	4	0.27	2	0.37	0	0.32	0	0.24
Industrial	1,181	2.06	57	3.44	21	4.96	3	4.56	0	3.16
Other Residential	5,778	10.08	237	14.22	81	19.2	9	15.61	1	14.07
Religion	189	0.33	9	0.53	3	0.81	1	0.93	0	0.91
Single Family	46,670	81.41	1,187	71.11	254	60.05	36	63.88	4	70.32
Total	**57,328**		**1,669**		**423**		**57**		**5**	

Source: HAZUS-MH MR4, Patch 2 Earthquake Analysis completed June 2010.

Notes:

(1) These results are based on a default, Level I analysis utilizing aggregated 2000 Census Bureau data. These results should be used for planning purposes only.

Figure 4.3.2-2: Total Residential Losses by Census Tract Based on 500-year Probabilistic, 5.5 Moment Magnitude Event in Sussex County



Source: HAZUS-MH MR4, Patch 2 Earthquake Analysis completed June 2010.

HAZUS-MH also estimated total building-related losses for this scenario, which total approximately $32,460,000, with 24% of the total related to the business interruption of the county.

Casualties are also estimated for three different times of day in HAZUS-MH earthquake modeling as shown in Table 4.3.2-4.

Table 4.3.2-4: Approximate Expected Casualties Based on a 500-year Probabilistic, 5.5 Moment Magnitude Event in Sussex County

Time of Day	Level 1 (Injuries without Hospitalization)	Level 2 (Injuries with Hospitalization)	Level 3 (Life-threatening if not Treated)	Level 4 (Death)
2:00 AM (Highest Residential Load)	8	1	0	0
2:00 PM (Highest Educational, Commercial, and Industrial Load)	8	1	0	0
5:00 PM (Highest Commute Time)	8	1	0	0

Source: HAZUS-MH MR4, Patch 2 Earthquake Analysis completed June 2010.

Notes:

(1) These results are based on a default, Level I analysis utilizing aggregated 2000 Census Bureau data. These results should be used for planning purposes only.

HAZUS-MH estimates that approximately 13 households will be displaced due to this type of earthquake event. Of these displaced households, the model estimates that about 7 people will seek temporary shelter in public shelters.

For this earthquake scenario, HAZUS-MH predicts that approximately 10,000 tons of debris may be generated or approximately 560 truckloads (at 25 tons per truck). Of the total, 74% will consist of brick/wood and 26% of reinforced concrete/steel.

Critical Facilities at Risk, Results for Earthquake Scenario #2- 500-year Probabilistic: 5.5 Moment Magnitude in Sussex County

HAZUS-MH estimates that none of the county's medical facilities will experiences at least moderate damage due to this earthquake. On the day of the earthquake, 53% of the county's hospital beds will be available for use by patients already in the hospital and those injured by the earthquake. After one week, 97% of the beds will be back in service, and 100% after 30 days.

The model predicts that none of the schools, emergency operations centers, police stations, and fire stations will expect at least moderate damage due to this type of event.

In terms of transportation systems, HAZUS-MH predicts that none of the railway facilities, light rail facilities, and airport facilities will have at least moderate damage due to this type of event.

For utility lifelines, the model estimates that none of the potable water systems, waste water systems, oil systems, electrical power systems, and communication systems will incur at least moderate damage. It is estimated that out of 50,831 households, all will have water and electricity at day one.

Potential Losses, Results for Earthquake Scenario #3- Annualized Earthquake Losses for Sussex County

In this scenario, HAZUS-MH estimates that about 4,942 buildings will be at least moderately damaged, which is over 8% of the total number of buildings in the county. It is estimated that 89 buildings will be damaged beyond repair. Table 4.3.2-5 shows the approximate expected building damage by occupancy. As shown, single family housing had the most damage. Note that some of the inventory includes data that is also included in the critical facilities data and should not be double-counted when losses are determined, for example education and schools.

Table 4.3.2-5: Approximate Expected Building Damage by Occupancy Based on Annualized Earthquake Losses for Sussex County

Occupancy	No Damage		Slight Damage		Moderate Damage		Extensive Damage		Complete Damage	
	Count	%	Count	%	Count	%	Count	%	Count	%
Agriculture	72	0.19	12	0.11	2	0.05	0	0	0	0
Commercial	632	1.69	59	0.52	23	0.55	2	0.3	0	0
Education	0	0	0	0	0	0	0	0	0	0
Government	6	0.02	0	0	0	0	0	0	0	0
Industrial	230	0.62	10	0.09	9	0.21	0	0	0	0
Other Residential	3,031	8.12	969	8.57	458	10.93	41	6.17	1	1.12
Religion	33	0.09	2	0.02	0	0	0	0	0	0
Single Family	33,305	89.27	10,249	90.69	3,697	88.25	621	93.52	88	98.88
Total	**373,098**		**11,301**		**4,189**		**664**		**89**	

Source: HAZUS-MH MR4, Patch 2 Earthquake Analysis completed June 2010.

Notes:

(2) These results are based on a default, Level I analysis utilizing aggregated 2000 Census Bureau data. These results should be used for planning purposes only.

HAZUS-MH also estimated total building-related losses for this scenario, which total approximately $50,000, with 23% of the total related to the business interruption of the county.

There are estimated to be no casualties for estimated average losses.

HAZUS-MH estimates that approximately 346 households will be displaced due to this type of earthquake event. Of these displaced households, the model estimates that about 202 people will seek temporary shelter in public shelters.

As previously mentioned, AEL does not offer the full range of results that the other HAZUS-MH scenarios offer, and as such, critical facilities are not estimated by the AEL model.

Risk Assessment Next Steps for Earthquake / Geological Hazards

The population, demographics, and aggregated building stock in HAZUS-MH could be updated using 2010 Census data once available, or if local data is available to increase the accuracy of the results and produce a Level II analysis. The creation of a NEHRP soils class dataset for input into HAZUS-MH would also improve the results of the analysis, similar to the earthquake loss estimation studies that were conducted by the NJDEP's NJGS available at http://www.state.nj.us/dep/njgs/enviroed/hazus.htm. Documentation of any changes to zoning or building codes or any other mitigation actions may alter future risk assessments.

4.3.3 Flood

Methodology for Flood Hazard

Three different flood scenarios were chosen for analysis in HAZUS-MH MR4 Patch 2, a 100-year return period (1% annual chance), 500-year return period (.2% annual chance), and annualized losses. Annualized loss calculates five return periods, including the 10-, 50-, 100-, 200-, and 500-year, and estimates the maximum potential annual loss based on a sum of losses over all return periods multiplied by the probability of those floods occurring. Annualized losses only returns limited results, such as direct economic annualized losses for buildings.

The topographic data used in this analysis was the USGS's National Elevation Dataset at the 1/3 arc-second resolution, which is often referred to as the approximate 10 meter data. This data is publicly accessible, and can be downloaded from http://seamless.usgs.gov/. HAZUS-MH defaults to the 1 arc-second resolution dataset, however taking the extra time to download and process the 1/3 arc-second dataset can provide improved results in the model.

A simplified explanation of the process HAZUS-MH utilizes in the flood model is:

- Utilize topography (in this case, USGS NED data) to generate a stream network
- Choose the reaches to be included in the analysis
- Run hydrology to create discharge values
- Run hydraulics and create flood elevations, flood depth grids, and delineate floodplains
- Run analysis to generate results based on data created in previous steps, inventory, and damage curves (degree of damage to a structure is based on depth of flooding)

Again, this is an extremely simplified description of the modeling process, for a more detailed description; see the HAZUS-MH MR4 Technical and User Manuals available online from FEMA.

Potential Losses for Flood

Building losses are separated into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage to the building and its contents. Direct building damages are categorized based on the structure's building occupancy or use; such as residential, commercial, industrial, and others. The business interruption losses are the losses associated with the inability to operate a business and includes the temporary living expenses for people displaced from their homes due to damages from flooding.

Estimates of casualties are not provided by the HAZUS-MH flood model.

HAZUS-MH provides estimates for the number of displaced households that might be displaced from their homes due to flooding and the number of displaced people that may seek accommodations in temporary public shelters. In the flood model, displacement includes households evacuated from within or very near to the inundated area.

HAZUS-MH estimates the amount of debris that will be generated due to the flood event and separates debris into three types: finishes (dry wall, insulation, etc), structural (wood, brick, etc), and foundations (concrete slab, concrete block, rebar, etc). This distinction is made because there are different types of material handling equipment needed to handle the three types of debris.

Critical Facilities Risk for Flood

The risk to critical facilities is dependent on their proximity to flood areas. Although flooding can occur anywhere, it is best to choose critical facility locations that are outside the floodplain.

A critical facility would encounter many of the same impacts as any other building within the county, depending on the level of building code used to construct the structure. These impacts include structural failure and loss of facility functionality. In other words, a damaged police station may not be able to serve the community.

The HAZUS-MH flood model also estimates losses for some transportation and utility lifeline categories, including highway bridges, waste water facilities, and potable water facilities.

As previously mentioned, essential facilities, potable water facilities, and waste water facilities were updated before analysis based on DRBC and local updates.

Potential Losses, Results for Flood Scenario #1- 100-year Return Period Event in Sussex County

In a 100-year return period event, HAZUS-MH estimates that about 102 buildings will be at least moderately damaged, which is over 5% of the total number of buildings in the county. Approximately 20 buildings will be damaged beyond repair. As shown, residential housing suffered the most damage.

Table 4.3.3-1 shows the approximate expected building damage by occupancy. In Table 4.3.3.-1, the "damage states" are 1-10% is considered slight, 11-20%, 21-30%, 31-40%, 41-50%, and any structures damaged more than 50% are considered substantially damaged.

Note that some of the inventory includes data that is also included in the critical facilities data and should not be double-counted when losses are determined, for example education and schools.

Table 4.3.3-1: Approximate Expected Building Damage by Occupancy Based on 100-year Event in Sussex County

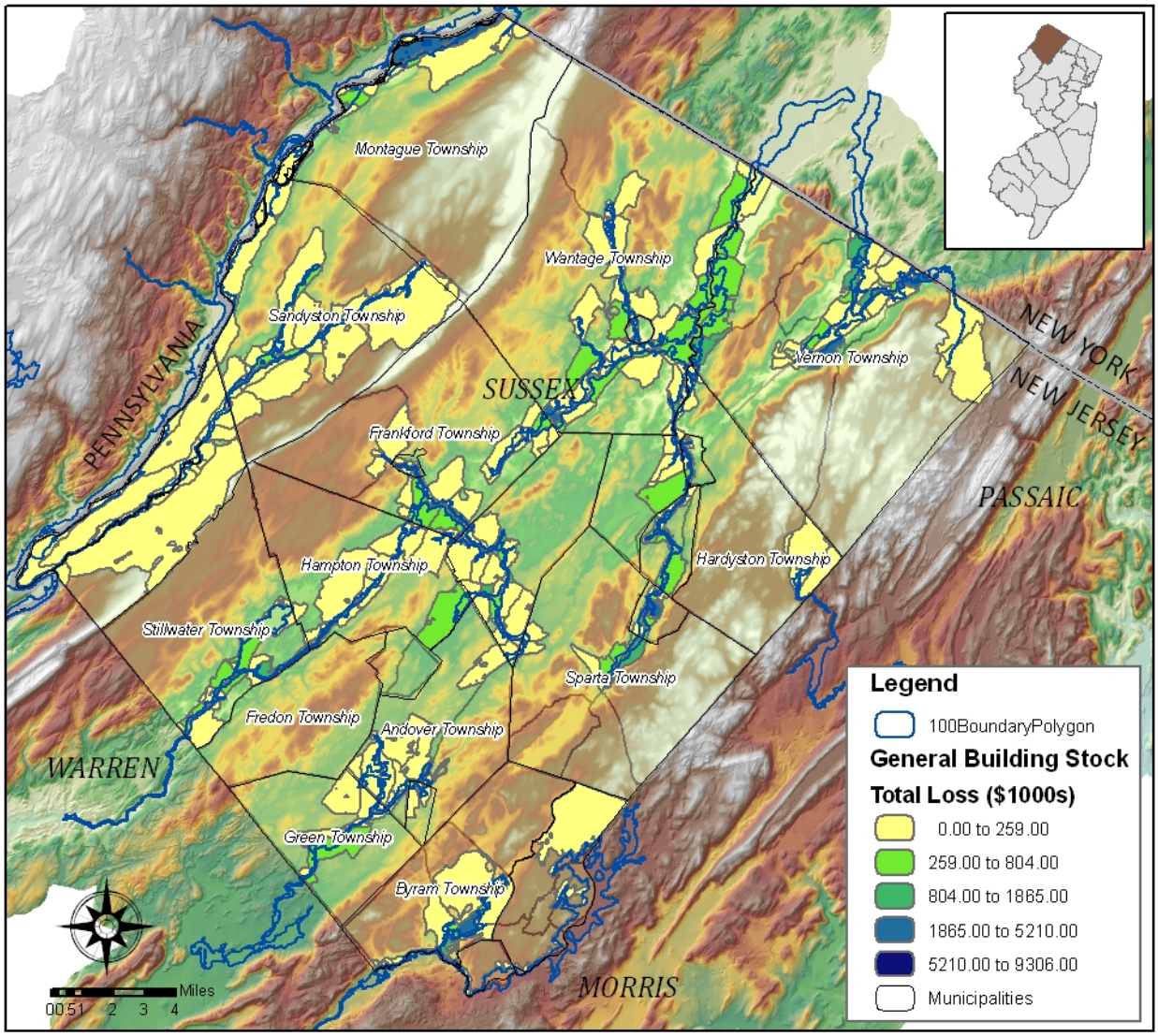
Occupancy	1-10		11-20		21-30		31-40		41-50		Substantially	
	Damaged Structures	%	Damaged Structures	%	Damaged Structures	%	Damaged Structures	%	Damaged Structures	%	Damaged Structures	%
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	2	100	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	0	0	10	10	7	7	34	34	29	29	20	20
Total	**0**		**12**		**7**		**34**		**29**		**20**	

Source: HAZUS-MH MR4, Patch 2 Flood Analysis completed June 2010.

Notes:

(1) These results are based on a default, Level I analysis utilizing aggregated 2000 Census Bureau data. These results should be used for planning purposes only.

Figure 4.3.3-1: General Building Stock Damaged Based on 100-year Flood Event in Sussex County



Source: HAZUS-MH MR4, Patch 2 Flood Analysis completed June 2010.

The total economic loss estimated for the flood is about $129,000,000, which represents 5.95% of the total replacement value of the scenario buildings. HAZUS-MH also estimated total building-related losses for this scenario, which total approximately $128,190,000, with 1% of the total related to the business interruption of the county.

HAZUS-MH estimates that approximately 820 households will be displaced due to this flooding event. Of these displaced households, the model estimates that about 1,094 people will seek temporary shelter in public shelters.

For this flooding scenario, HAZUS-MH predicts that approximately 5,580 tons of debris may be generated or approximately 223 truckloads (at 25 tons per truck). Of the total, finishes comprise 60%, structure comprises 23%, and foundations about 17%.

Critical Facilities at Risk, Results for Flood Scenario #1- 100-year Return Period Event in Sussex County

HAZUS-MH estimates that two of the county's fire stations and three of the schools will experience at least moderate damage and loss of use due to the flooding event, as shown in Table 4.3.3-2.

Table 4.3.3-2: Expected Damaged Essential Facilities Based on 100-year Event in Sussex County

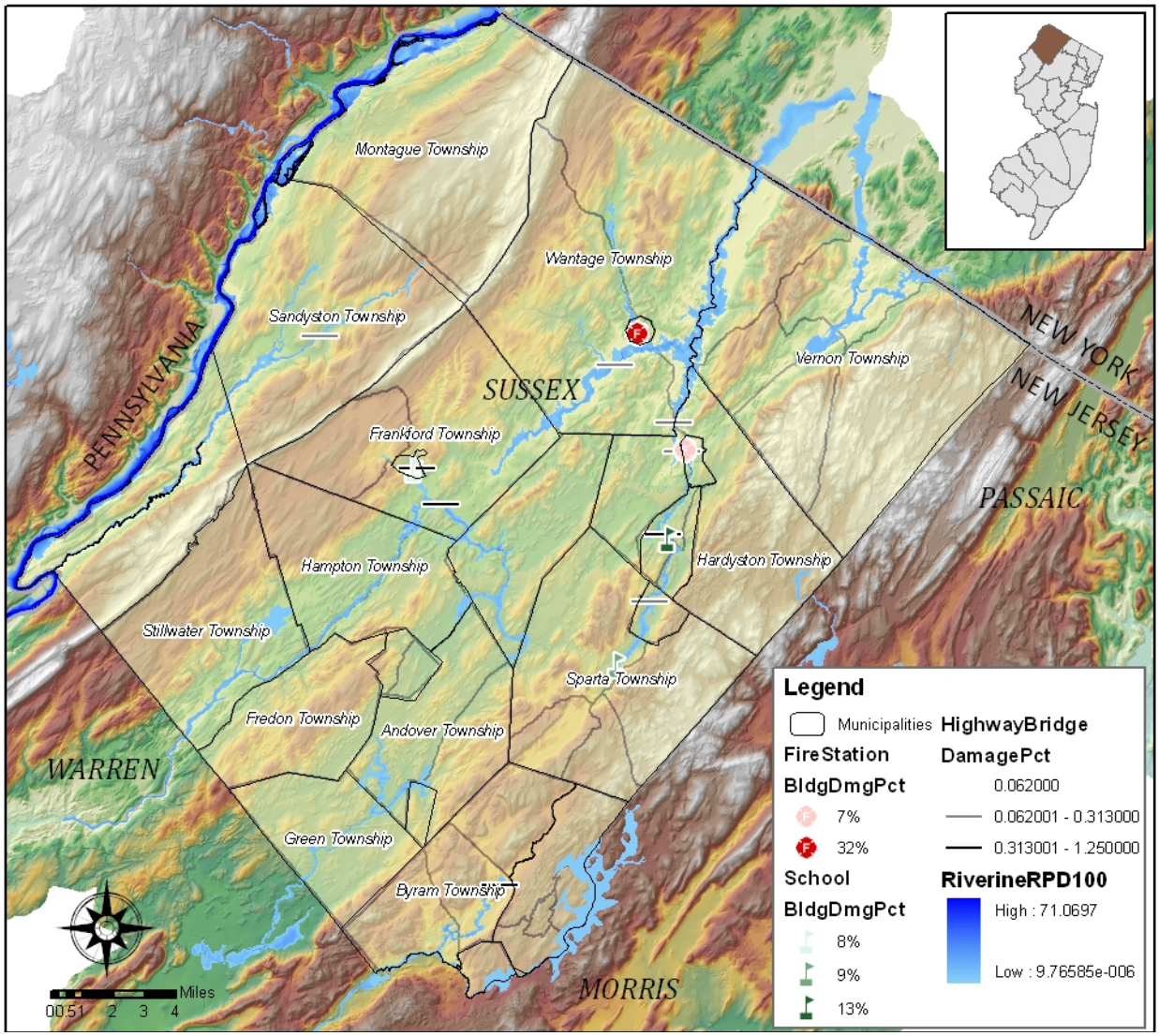
Facility Name	Facility Type	Total Building Damage %	Total Content Damage %	Non-Functional Facility?	Average Restoration Time
Hamburg Fire Department	Fire Station	7.15%	8.60%	Yes	480 Days
Sussex Fire Department	Fire Station	32.12%	100.00%	Yes	720 Days
Immaculate Conception Regional	School	13.00%	72.00%	Yes	630 Days
Sparta High School	School	9.17%	64.68%	Yes	630 Days
Little Children's World	School	8.34%	48.05%	Yes	630 Days

Source: HAZUS-MH MR4, Patch 2 Flood Analysis completed June 2010.

Notes:

(1) These results are based on a default, Level I analysis utilizing a combination of default HAZUS-MH data and updated local data. These results should be used for planning purposes only.

Figure 4.3.3-2: Damaged Critical Facilities Based on 100-year Flood Event in Sussex County



Source: HAZUS-MH MR4, Patch 2 Flood Analysis completed June 2010.

In terms of transportation systems, HAZUS-MH predicts that none of the railway facilities, light rail facilities, and airport facilities will have damage due to this type of event. However, twelve highway bridges will sustain less than 2% damage.

For utility lifelines, the model estimates that none of the potable water facilities, waste water system facilities, oil systems, electrical power systems, and communication systems will incur any damage.

Potential Losses, Results for Flood Scenario #2- 500-year Return Period Event in Sussex County

In a 500-year return period event, HAZUS-MH estimates that about 155 buildings will be at least moderately damaged, which is over 6% of the total number of buildings in the county. Approximately 40 buildings will be damaged beyond repair. As shown, residential housing suffered the most damage. Table 4.3.3-3 shows the approximate expected building damage by occupancy. In Table 4.3.3.-3, the "damage states" are 1-10% is considered slight, 11-20%, 21-30%, 31-40%, 41-50%, and any structures damaged more than 50% are considered substantially damaged. Note that some of the inventory includes data that is also included in the critical facilities data and should not be double-counted when losses are determined, for example education and schools.

Table 4.3.3-3: Approximate Expected Building Damage by Occupancy Based on 500-year Event in Sussex County

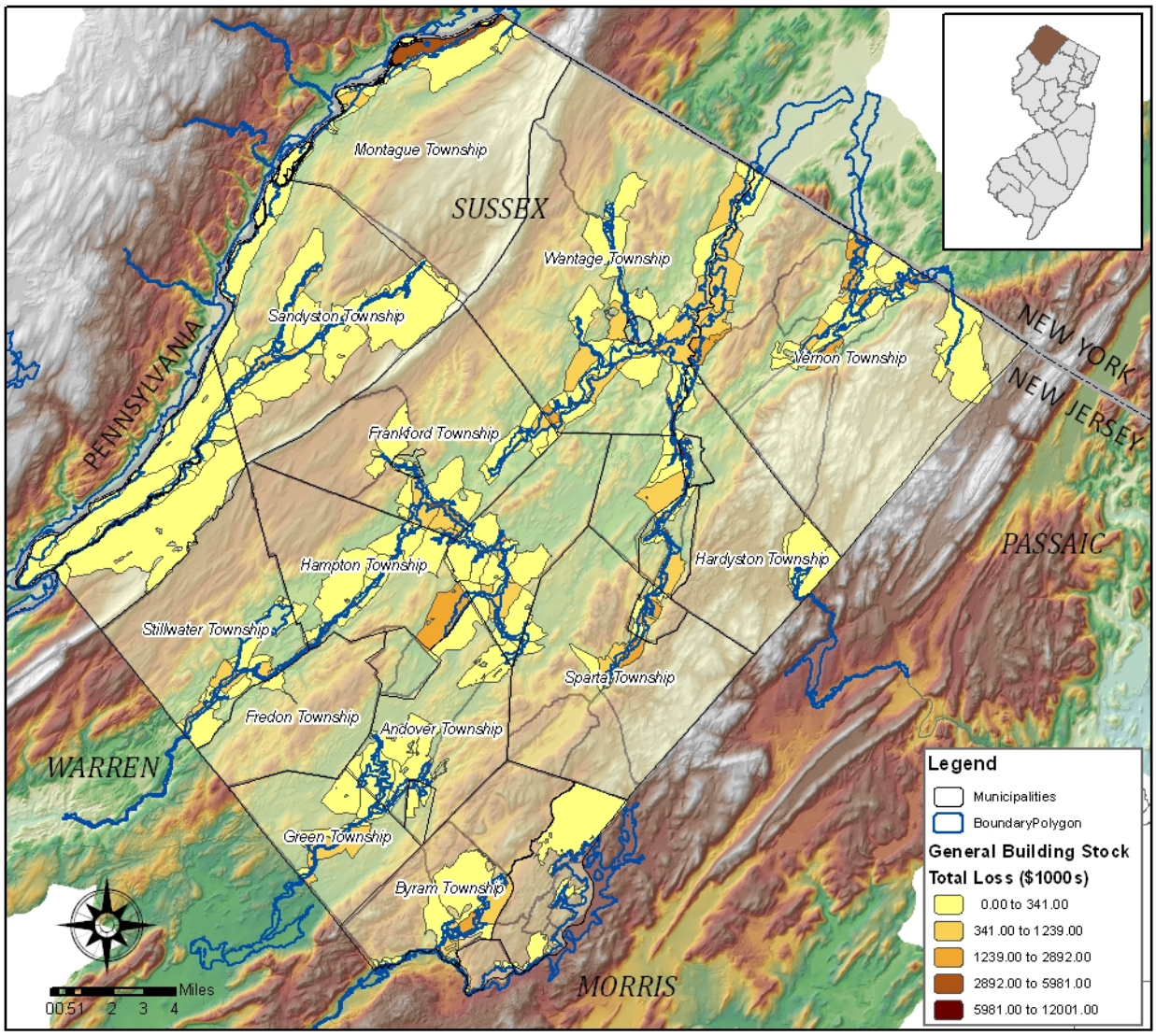
Occupancy	1-10		11-20		21-30		31-40		41-50		Substantially	
	Damaged Structures	%	Damaged Structures	%	Damaged Structures	%	Damaged Structures	%	Damaged Structures	%	Damaged Structures	%
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	1	100	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	3	100	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	0	0	10	6.62	11	7.28	50	33.11	41	27.15	39	25.83
Total	**0**		**14**		**11**		**50**		**41**		**39**	

Source: HAZUS-MH MR4, Patch 2 Flood Analysis completed June 2010.

Notes:

(2) These results are based on a default, Level I analysis utilizing aggregated 2000 Census Bureau data. These results should be used for planning purposes only.

Figure 4.3.3-3: General Building Stock Damaged Based on 500-year Flood Event in Sussex County



Source: HAZUS-MH MR4, Patch 2 Flood Analysis completed June 2010.

The total economic loss estimated for the flood is about $163,000,000, which represents 7.51% of the total replacement value of the scenario buildings. HAZUS-MH also estimated total building-related losses for this scenario, which total approximately $161,930,000, with 1% of the total related to the business interruption of the county.

HAZUS-MH estimates that approximately 945 households may be displaced due to this flooding event. Of these displaced households, the model estimates that about 1,350 people will seek temporary shelter in public shelters.

For this flooding scenario, HAZUS-MH predicts that approximately 8,298 tons of debris may be generated or approximately 322 truckloads (at 25 tons per truck). Of the total, finishes comprise 53%, structure comprises 27%, and foundations about 20%.

Critical Facilities at Risk, Results for Flood Scenario #2- 500-year Return Period Event in Sussex County

HAZUS-MH estimates that one of the county's medical facilities, two of the EOCs, three of the fire stations, three of the police stations, and five of the schools will experiences at least moderate damage and loss of use due to the flooding event, as shown in Table 4.3.3-4.

Table 4.3.3-4: Expected Damaged Essential Facilities Based on 500-year Event in Sussex County

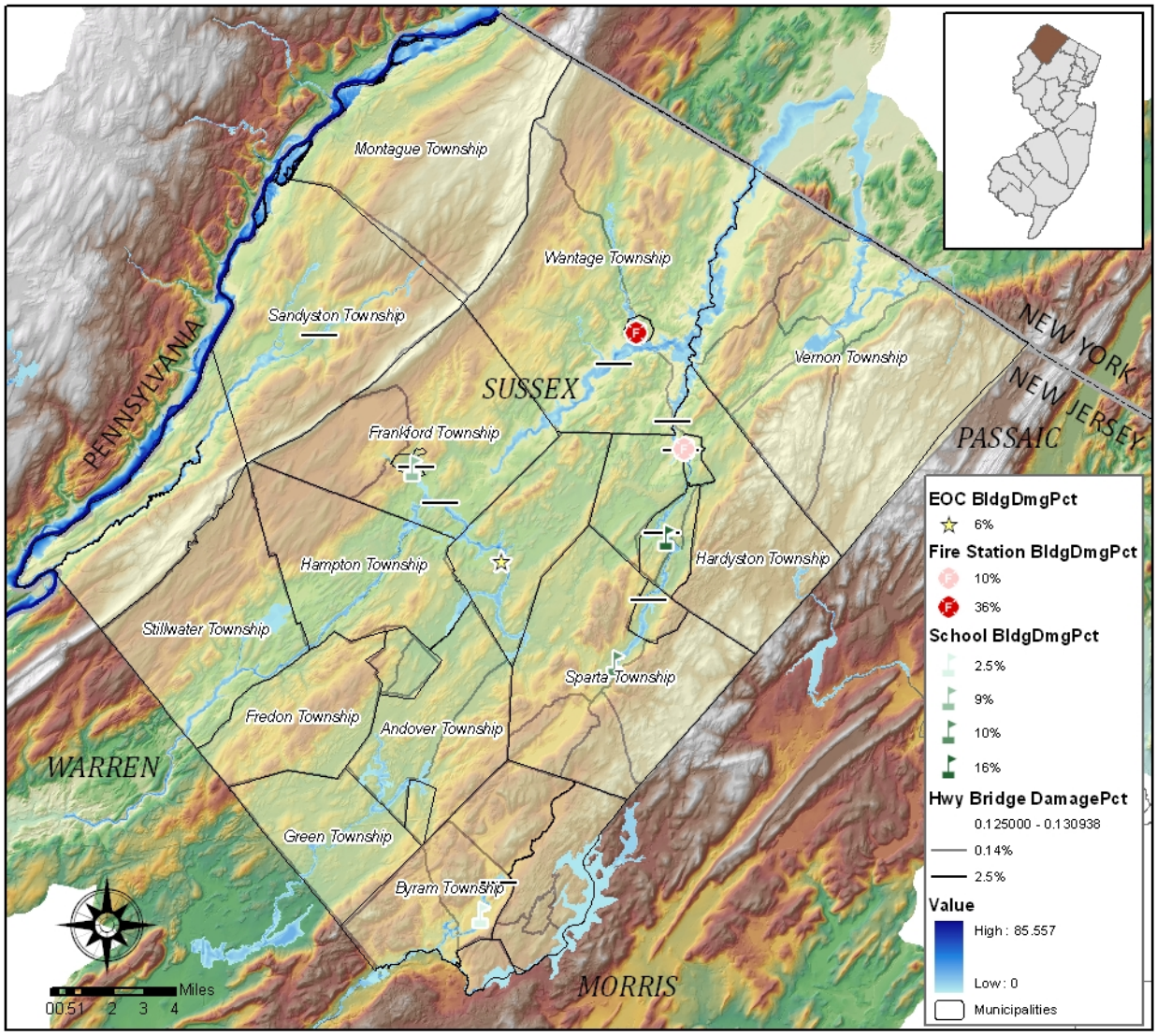
Facility Name	Facility Type	Total Building Damage %	Total Content Damage %	Non-Functional Facility?	Average Restoration Time
Lafayette Fire/EMS	EOC	6.11%	6.98%	Yes	480 Days
Hamburg Fire Department	Fire Station	9.61%	18.43%	Yes	480 Days
Sussex Fire Department	Fire Station	36.14%	100.00%	Yes	720 Days
Immaculate Conception Regional	School	15.85%	76.71%	Yes	720 Days
Sparta High School	School	10.24%	68.48%	Yes	630 Days
Little Children's World	School	9.00%	59.51%	Yes	480 Days
Byram Lakes Elementary	School	2.48%	13.39%	No	480 Days

Source: HAZUS-MH MR4, Patch 2 Flood Analysis completed June 2010.

Notes:

(2) These results are based on a default, Level I analysis utilizing a combination of default HAZUS-MH data and updated local data. These results should be used for planning purposes only.

Figure 4.3.3-4: Damaged Critical Facilities Based on 500-year Flood Event in Sussex County



Source: HAZUS-MH MR4, Patch 2 Flood Analysis completed June 2010.

In terms of transportation systems, HAZUS-MH predicts that none of the railway facilities, light rail facilities, and airport facilities will have damage due to this type of event. However, twelve highway bridges will sustain less than 3% damage.

For utility lifelines, the model estimates that none of the potable water facilities, waste water system facilities, oil systems, electrical power systems, and communication systems will incur any damage.

Potential Losses, Results for Flood Scenario #3- Annualized Flood Losses in Sussex County

HAZUS-MH estimates that the maximum potential annualized loss in Sussex County totals approximately $13,116,000 for building damages, $22,296,000 for contents damages, and $1,375,000 for inventory losses. This is a building loss ratio of 0.6%. Income losses include $2,000 for relocation losses, $15,000 for capital related losses, $169,000 for lost wages, and nothing in rental income losses. The total annualized loss is approximately $36,973,000.

As previously mentioned, annualized losses does not offer the full range of results that the other HAZUS-MH scenarios offer, and as such, critical facilities are not estimated.

Risk Assessment Next Steps for Flood Hazard

The population, demographics, and aggregated building stock in HAZUS-MH could be updated using 2010 Census data once available, or if local data is available to increase the accuracy of the results and produce a Level II analysis. The DFIRM data or DFIRM-generated depth grids could be input directly into HAZUS-MH for a more accurate depiction of the hazard and loss results for a Level II analysis. Documentation of any changes to zoning or building codes or any other mitigation actions that may alter future risk assessments.

4.3.4 High Wind – Straight-line Winds

Methodology for High Wind – Straight-line Winds

As discussed in Section 3.3.6, straight line high wind hazards include a variety of different types of wind events, however HAZUS-MH offers a tested methodology in its hurricane wind model that is representative of straight line wind events. HAZUS-MH will be used to simulate a historic event using current inventory and a probabilistic scenario. The first scenario is as if Hurricane Floyd was to occur today, and the second is a 100 year probabilistic event, with some annualized results provided.

Potential Losses for High Wind – Straight-line Winds

The hurricane wind model is the least comprehensive of the three HAZUS-MH models, but provides a number of useful results. Building losses are separated into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage to the building and its contents. Direct building damages are categorized based on the structure's building occupancy or use; such as residential, commercial, industrial, and others. The business interruption losses are the losses associated with the inability to operate a business and includes the temporary living expenses for people displaced from their homes due to damages from hurricane winds.

HAZUS-MH also provides estimates for the number of displaced households that might be displaced from their homes due to the earthquake and the number of displaced people that may seek accommodations in temporary public shelters.

HAZUS-MH estimates the amount of debris that will be generated due to the earthquake event and separates debris into three types; brick/wood, reinforced concrete/steel, and tree debris. This distinction is made because there are different types of material handling equipment needed to handle the three types of debris.

Critical Facilities Risk for High Wind – Straight-line Winds

All critical facilities are vulnerable to wind events. A critical facility would encounter many of the same impacts as any other building within the county, depending on the level of building code used to construct the structure. These impacts include structural failure and loss of facility functionality. In other words, a damaged police station may not be able to serve the community.

The HAZUS-MH hurricane wind model does not provide transportation and utility system losses at this time.

As previously mentioned, essential facilities were updated before analysis based on DRBC and local updates.

Potential Losses, Results for Hurricane Winds Scenario #1- Hurricane Floyd Wind Event in Sussex County

In this scenario, HAZUS-MH estimates that the peak wind gust will be 70 mph, which will cause about 2 buildings to sustain at least moderate damage, which is less than 1% of the total number of buildings in the county. Zero buildings will be damaged beyond repair. Table 4.3.4-1 shows the approximate expected building damage by occupancy. As shown, residential housing suffered the most damage. Note that some of the inventory includes data that is also included in the critical facilities data and should not be double-counted when losses are determined, for example education and schools.

Table 4.3.4-1: Approximate Expected Building Damage by Occupancy Based on Hurricane Floyd Wind Event in Sussex County

Occupancy	None		Minor Damage		Moderate Damage		Severe Damage		Complete Damage	
	Count	%	Count	%	Count	%	Count	%	Count	%
Agriculture	341	99.68	1	0.31	0	0	0	0	0	0
Commercial	3,211	99.6	13	0.4	0	0	0	0	0	0
Education	96	99.57	0	0.43	0	0	0	0	0	0
Government	100	99.54	0	0.46	0	0	0	0	0	0

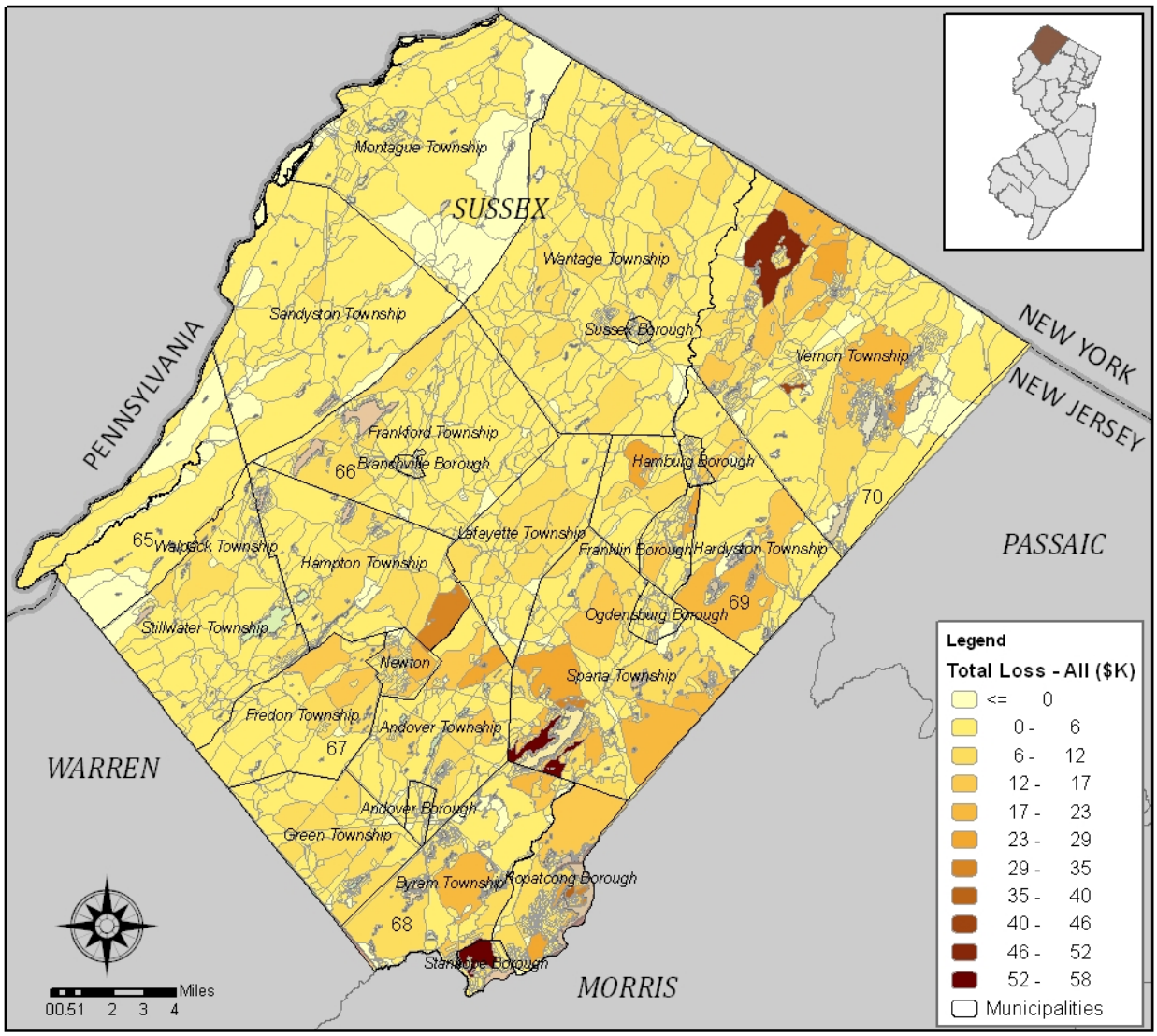
Occupancy	None		Minor Damage		Moderate Damage		Severe Damage		Complete Damage	
	Count	%	Count	%	Count	%	Count	%	Count	%
Industrial	1,256	99.56	6	0.44	0	0	0	0	0	0
Religion	201	99.69	1	0.31	0	0	0	0	0	0
Residential	54,179	99.86	76	0.14	2	0	0	0	0	0
Total	**59,383**		**97**		**2**		**0**		**0**	

Source: HAZUS-MH MR4, Patch 2 Hurricane Wind Analysis completed June 2010.

Notes:

(2) These results are based on a default, Level I analysis utilizing aggregated 2000 Census Bureau data. These results should be used for planning purposes only.

Figure 4.3.4-1: Total Losses by Census Tract and Wind Speeds Based on Hurricane Floyd Wind Event in Sussex County



Source: HAZUS-MH MR4, Patch 2 Hurricane Wind Analysis completed June 2010.

HAZUS-MH also estimated total building-related losses for this scenario, which total approximately $6,000,000, with 1% of the total related to the business interruption of the county.

HAZUS-MH estimates that 6 households will be displaced due to this wind event, and no one will seek temporary shelter in public shelters.

For this hurricane wind scenario, HAZUS-MH predicts that approximately 14,139 tons of debris may be generated, or approximately 8 truckloads (at 25 tons per truck). Of the total, 1% will consist of brick/wood, 0% of reinforced concrete/steel, and 99% tree debris.

Critical Facilities at Risk, Results for Hurricane Winds Scenario #1- Hurricane Floyd Wind Event in Sussex County

HAZUS-MH estimates that none of the county's medical facilities, emergency operations centers, police stations, fire stations, or schools should expect any damage due to this wind event.

Potential Losses, Results for Hurricane Winds Scenario #2- 100-year Wind Event in Sussex County

In this scenario, HAZUS-MH estimates that the peak wind gust will be 72 mph, which will cause about 2 buildings to sustain at least moderate damage, which is less than 1% of the total number of buildings in the county. No buildings will be damaged beyond repair. Table 4.3.4-2 shows the approximate expected building damage by occupancy. As shown, residential housing suffered the most damage. Note that some of the inventory includes data that is also included in the critical facilities data and should not be double-counted when losses are determined, for example education and schools.

Table 4.3.2-2: Approximate Expected Building Damage by Occupancy Based on 100-year Wind Event in Sussex County

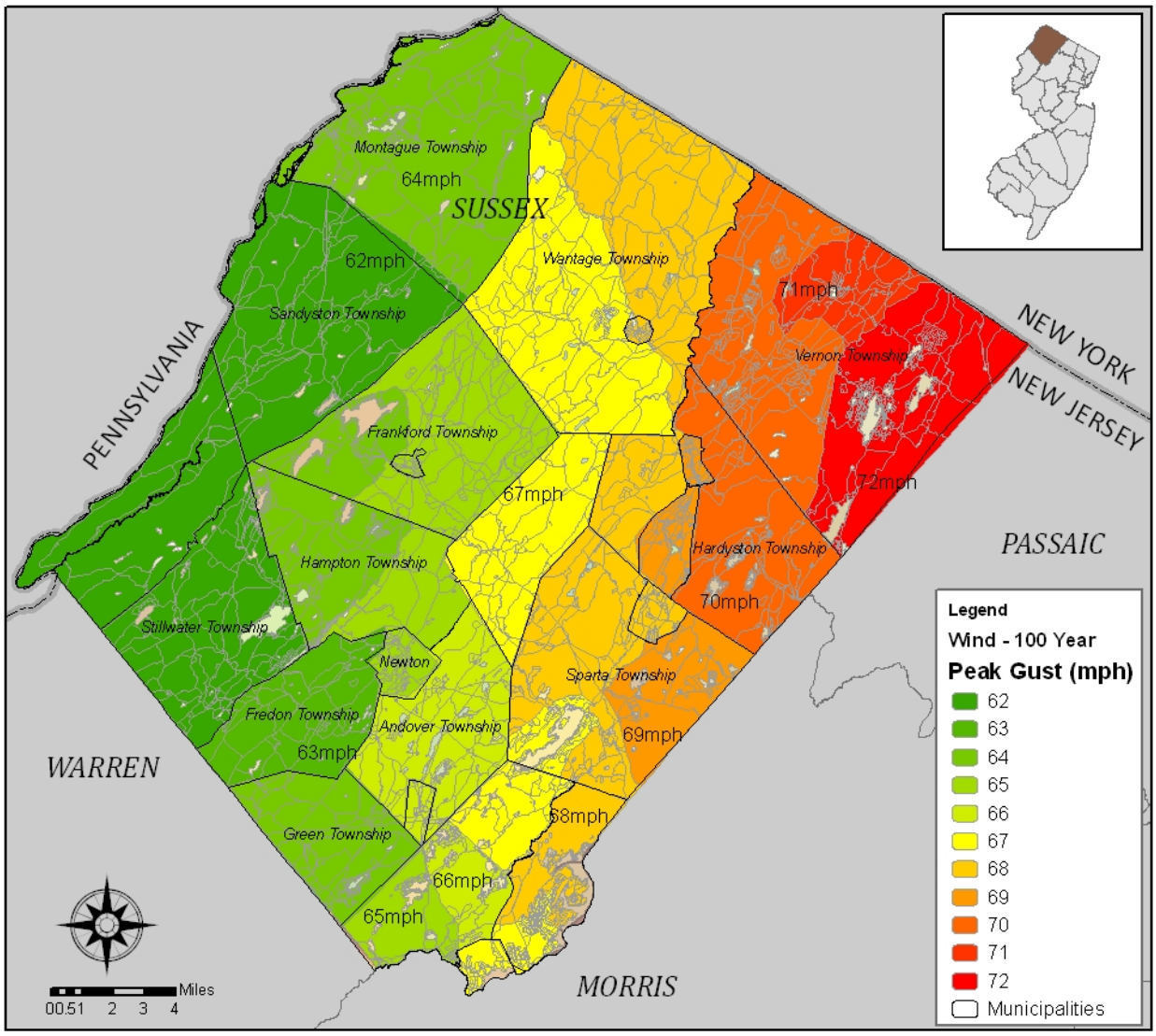
Occupancy	None		Minor Damage		Moderate Damage		Severe Damage		Complete Damage	
	Count	%	Count	%	Count	%	Count	%	Count	%
Agriculture	341	99.68	1	0.31	0	0	0	0	0	0
Commercial	3,211	99.6	13	0.4	0	0	0	0	0	0
Education	96	99.57	0	0.43	0	0	0	0	0	0
Government	100	99.54	0	0.46	0	0	0	0	0	0
Industrial	1,256	99.56	6	0.44	0	0	0	0	0	0
Religion	201	99.69	1	0.31	0	0	0	0	0	0
Residential	54,179	99.86	76	0.14	2	0	0	0	0	0
Total	**59,383**		**97**		**2**		**0**		**0**	

Source: HAZUS-MH MR4, Patch 2 Hurricane Wind Analysis completed June 2010.

Notes:

(1) These results are based on a default, Level I analysis utilizing aggregated 2000 Census Bureau data. These results should be used for planning purposes only.

Figure 4.3.4-2: Peak Gust Wind Speeds Based on 100-year Wind Event in Sussex County



Source: HAZUS-MH MR4, Patch 2 Hurricane Wind Analysis completed June 2010.

HAZUS-MH also estimated total building-related losses for this scenario, which total approximately $6,000,000, with 1% of the total related to the business interruption of the county.

The hurricane wind model provides annualized economic losses for a hurricane wind event. The residential property damage annualized losses are approximately $452,000 and total property damage (all occupancy types) around $506,000. Annualized business interruption (income) losses are estimated at $43,000.

HAZUS-MH estimates that 6 households will be displaced due to this wind event, and no one will seek temporary shelter in public shelters.

For this hurricane wind scenario, HAZUS-MH predicts that approximately 14,139 tons of debris may be generated or approximately 8 truckloads (at 25 tons per truck). Of the total, 1% may consist of brick/wood, 0% of reinforced concrete/steel, and 99% tree debris.

Critical Facilities at Risk, Results for Hurricane Winds Scenario #2 – 100-year Wind Event in Sussex County

HAZUS-MH estimates that none of the county's medical facilities, emergency operations centers, police stations, fire stations, or schools should expect any damage due to this wind event.

Risk Assessment Next Steps for High Wind – Straight-line Wind Hazard

The population, demographics, and aggregated building stock in HAZUS-MH could be updated using 2010 Census data once available, or if local data is available to increase the accuracy of the results and produce a Level II analysis in the Hurricane Wind model. Attention could be paid to the scientific community and the news of any new or significant improvements for high wind risk assessment methodologies that could be implemented in future analysis. Documentation could be made of any changes to zoning or building codes or any other mitigation actions that may alter future risk assessments.

4.3.5 Severe Weather – Winter

Methodology for Severe Weather – Winter

Unlike flood, earthquake, or hurricane wind hazards, there are no standard loss estimation models or methodologies for the winter storm hazard. In most cases, potential losses from winter storms are difficult to quantify. The SHELDUS 7.0 and NCDC database compiled in Section 3.3.10 is used to project future expected damages for Sussex County utilizing a 100-year planning horizon and the OMB required 7% discount rate.

Potential Losses Due to Severe Weather – Winter

Table 4.3.5-1 shows the basic data that is utilized for the risk assessment and lists the data source.

Table 4.3.5-1: Severe Winter Weather Risk Assessment Parameters for Sussex County for 1960 – 2010

Data	Source	Value
Loss-Causing Winter Storm Events	SHELDUS and NCDC	38
Time Extent in Years	SHELDUS and NCDC go back to 1960	50 years

Data	Source	Value
Average Annual Number of Significant Winter Storm Events	# events/# years =	.76 average events per year
Total Reported Damages Due to Winter Storms (Adjusted for 2010 Inflation)	SHELDUS and NCDC	$6,355,927 in 2010 dollars
Estimated Annual Damages	Total $/# years =	$127,119
Reported Death	# deaths/# years =	17.48 deaths
Average Annual Deaths	SHELDUS and NCDC	.3496 average deaths per year
Value of Single Death	FEMA's *BCA Reference Guide*, Final June 2009	$5,800,000
Estimated Annual Cost of Deaths Due to Winter Storms	Average annual deaths * Value =	$2,027,680
Reported Injuries	SHELDUS and NCDC	6.27 injuries
Average Annual Injuries	# injuries/# years =	.1254 average injuries per year
Value of Single Injury	FEMA's *BCA Reference Guide*, Final June 2009 (see Note (3))	$396,667
Estimated Annual Cost of Injuries Due to Winter Storms	Average annual injuries * Value =	$49,742

Source: SHELDUS 7.0 and NCDC

Notes:

(1) For further information regarding specific significant winter weather events, see Table 3.3.10-1.
(2) Valuations for a single death obtained from FEMA's *BCA Reference Guide*, Final June 2009, p94.
(3) Valuation for a single injury is an average of the three severity categories of injury from FEMA's *BCA Reference Guide*, Final June 2009, p94. Since it is unknown whether these injuries are considered 'Hospitalized', 'Treat & Release', or 'Self-Treatment'.

The calculated annual damages, estimated annual cost of deaths, and annual cost of injuries data from Table 4.3.5-1 can be used for a simplified projection of future expected damages based on a standard present value coefficient of 14.27. This represents the 100-year planning horizon with the calculated 7% discount rate that is required by OMB.

Table 4.3.5-2: Estimated Risk for Sussex County Due to Severe Winter Storms

Data	Value
Estimated Annual Damages	$127,119
Projected 100-year Risk Due to Winter Storm Damages	$1,813,988
Estimated Annual Cost of Deaths	$2,027,680
Projected 100-year Risk Due to Winter Storm Deaths	$28,934,994
Estimated Annual Cost of Injuries	$49,742
Projected 100-year Risk Due to Winter Storm Injuries	$709,818
Estimated Average Annual Risk Due to Winter Storms	**$2,204,541**
Estimated 100-year Total Risk Due to Severe Winter Storms	**$31,458,800**

The total estimated 100-year risk from severe winter storm events for Sussex County is $31,458,800, as shown in Table 4.3.5-2. Unfortunately, municipality specific data is not available from SHELDUS 7.0 or NCDC regarding winter weather hazards. However, 2000 Census Bureau data can be used to calculate the percentage of the population in each municipality, and then multiply the percentage of the county's population in that municipality by the estimated 100 year total risk. This is a rough estimate, and should be utilized for planning purposes only.

Table 4.3.5-3: Estimated 100-year Projected Risk from Winter Weather Events in Sussex County Municipalities

Municipality	2000 Census Bureau Population	Percentage of County Population	Estimated Average Annual Risk	Estimated 100-year Total Risk
Andover Borough	658	0.46%	$10,062	$143,584
Andover Township	6,033	4.18%	$92,255	$1,316,475
Branchville Borough	845	0.59%	$12,921	$184,389
Byram Township	8,254	5.73%	$126,218	$1,801,125
Frankford Township	5,420	3.76%	$82,881	$1,182,711
Franklin Borough	5,160	3.58%	$78,905	$1,125,976
Fredon Township	2,860	1.98%	$43,734	$624,087
Green Township	3,220	2.23%	$49,239	$702,644
Hamburg Borough	3,105	2.15%	$47,481	$677,549
Hampton Township	4,943	3.43%	$75,587	$1,078,624
Hardyston Township	6,171	4.28%	$94,365	$1,346,588
Hopatcong Borough	15,888	11.02%	$242,954	$3,466,958
Lafayette Township	2,300	1.60%	$35,171	$501,888
Montague Township	3,412	2.37%	$52,175	$744,540
Newton Town	8,244	5.72%	$126,065	$1,798,943
Ogdensburg Borough	2,638	1.83%	$40,339	$575,644
Sandyston Township	1,825	1.27%	$27,907	$398,238
Sparta Township	18,080	12.54%	$276,474	$3,945,279
Stanhope Borough	3,584	2.49%	$54,805	$782,073
Stillwater Township	4,267	2.96%	$65,250	$931,112
Sussex Borough	2,145	1.49%	$32,801	$468,065
Vernon Township	24,686	17.12%	$377,491	$5,386,790
Walpack Township	41	0.03%	$627	$8,947
Wantage Township	10,387	7.20%	$158,835	$2,266,572
County Totals	**144,166**	**100%**	**$2,204,54`**	**$31,458,800**

As shown in Table 4.3.5-3, Vernon Township, Sparta Township, Hopatcong Borough, Wantage Township, and Byram Township have the highest estimated risk. However, this is simply due to the fact that there is equal risk for a significant winter weather event throughout the county and these were the largest populated municipalities according to the 2000 Census Bureau Data.

Critical Facilities Risk Due to Severe Weather – Winter

All of the critical facilities throughout Sussex County are at equal risk of damage from a significant winter weather event. Critical facilities include the following essential facilities: police stations, fire stations, medical facilities, emergency operation centers, and schools. See Section 4.2.3 for a summary of the inventory of the critical facilities that could be impacted in Sussex County.

4.3.6 Wildfire

Methodology for Wildfire

In response to the increase in the number, size, and severity of wildfires in the U.S., Congress mandated the National Fire Plan which shifts wildfire efforts from pure fire repression strategies towards reducing fuels that cause severe wildfires. In order to support the National Fire Plan, the LANDFIRE project provides spatial data that identifies fuel build-up or extreme departure from historical conditions.[3] This data is meant to be utilized at a regional level and consists of 30-meter resolution datasets; therefore LANDFIRE data will be used in this Plan to provide county-wide estimates and not municipal-level conclusions. LANDFIRE data will be used in conjunction with WUI areas, previously discussed in Section 3.3.11.

Potential Losses Due to Wildfire

Since there have been no previous wildfire events in Sussex County that have caused deaths, injuries, property, or crop damages, it is difficult to assess risk using traditional methods. The WUI categories shown in Figure 3.3.11-1 and explained in Section 3.3.11 were used to locate the distribution of Census 2000 population within the WUI area. The majority of the county's population was found to be in census blocks that overlapped with a WUI area. Note that the boundaries of the two datasets were not consistent; therefore this information should be used to call attention to the need for more localized assessment in most municipalities that involve surveys and field verification to pinpoint specific areas in need of attention. Actions can, and may have already been taken in some areas or surrounding individual structures to reduce the risk associated with the WUI area.

[3] http://www.landfire.gov

Table 4.3.6-1: 2000 Census Bureau Populations at Risk to Wildfire Based on Proximity to WUI Area in Sussex County by Municipality

Municipality	2000 Population	2000 Population in WUI Area Census Blocks	2000 Households in WUI Area Census Blocks	% of 2000 Population in WUI Area Census Blocks
Andover Borough	658	658	261	100.00%
Andover Township	6,033	5874	1833	97.36%
Branchville Borough	845	837	352	99.05%
Byram Township	8,254	7872	2691	95.37%
Frankford Township	5,420	3921	1382	72.34%
Franklin Borough	5,160	5160	1898	100.00%
Fredon Township	2,860	2839	974	99.27%
Green Township	3,220	3145	1017	97.67%
Hamburg Borough	3,105	3105	1173	100.00%
Hampton Township	4,943	4536	1709	91.77%
Hardyston Township	6,171	4784	1841	77.52%
Hopatcong Borough	15,888	15883	5654	99.97%
Lafayette Township	2,300	1367	451	59.43%
Montague Township	3,412	3120	1165	91.44%
Newton Town	8,244	8244	3258	100.00%
Ogdensburg Borough	2,638	2638	881	100.00%
Sandyston Township	1,825	1568	587	85.92%
Sparta Township	18,080	16927	5874	93.62%
Stanhope Borough	3,584	3575	1382	99.75%
Stillwater Township	4,267	4184	1466	98.05%
Sussex Borough	2,145	298	135	13.89%
Vernon Township	24,686	21388	7063	86.64%
Walpack Township	41	4	3	9.76%
Wantage Township	10,387	7491	2495	72.12%
Total	**144,166**	**129,418**	**45,545**	**89.77%**

Source: WUI 2000 GIS data retrieved from http://silvis.forest.wisc.edu/Library/WUIDefinitions.asp, Population and Household data from 2000 U.S. Census Bureau.

In addition to population, there are approximately 59,480 structures in the area that have an aggregate total replacement value of $12,783,000,000 that may be at risk for wildfire in the county.

The Mean Fire Return Interval (MFRI) is the expected or historical number of years between wildfires. MFRI is available as part of the LANDFIRE spatial data, and is meant to be utilized at a regional scale, therefore Figure 4.3.6-2 should be used for planning purposes only. The lower the return interval, the higher the probability of wildfire before other factors is considered.

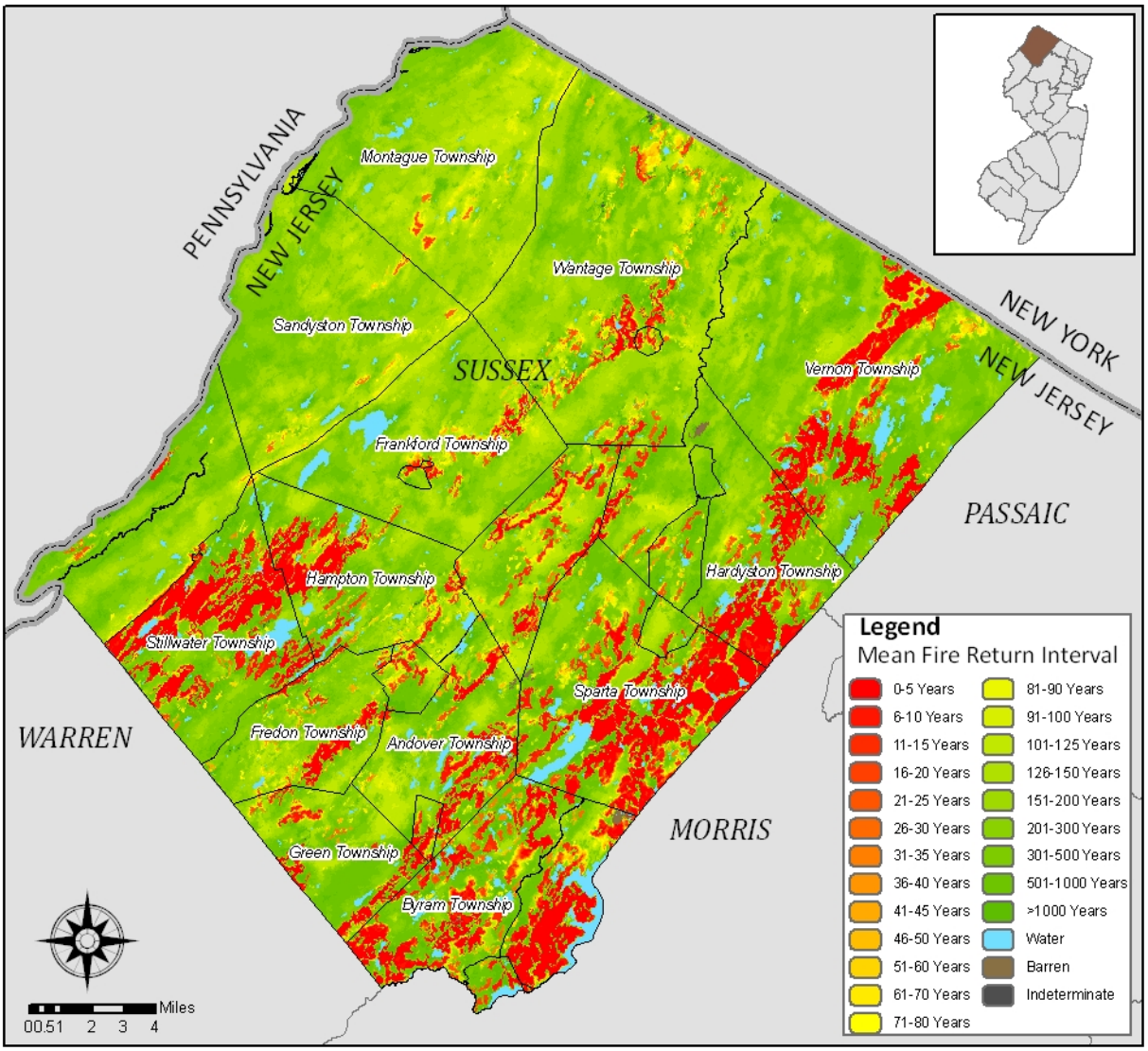
Table 4.3.6-2: Mean Fire Return Interval by Acreage in Sussex County

Mean Fire Return Interval	Acres	% of Land
0-5 Years	28765.16	8.39%
6-10 Years	8725.76	2.55%
11-15 Years	3644.62	1.06%
16-20 Years	2389.71	0.70%
21-25 Years	2113.99	0.62%
26-30 Years	1551.61	0.45%
31-35 Years	1535.87	0.45%
36-40 Years	1376.12	0.40%
41-45 Years	1299.05	0.38%
46-50 Years	1198.49	0.35%
51-60 Years	2434.40	0.71%
61-70 Years	2381.53	0.69%
71-80 Years	2478.11	0.72%
81-90 Years	3274.75	0.96%
91-100 Years	4215.80	1.23%
101-125 Years	21743.18	6.34%
126-150 Years	30924.91	9.02%
151-200 Years	54128.44	15.79%
201-300 Years	49162.95	14.34%
301-500 Years	61460.07	17.93%
501-1000 Years	38361.71	11.19%
>1000 Years	8553.51	2.50%
Water	10583.23	3.09%
Barren	381.36	0.11%
Indeterminate	79.17	0.02%
Total	**342763.50**	**100.00%**

Source: LANDFIRE MFRI layer. U.S. Department of Interior, Geological Survey. GIS data retrieved from http://landfire.cr.usgs.gov/viewer/

Figure 4.3.6-1 shows the MFRI by location, and the red areas are the areas that historically could expect wildfires most often. However, this map shows only the expected time frames for wildfires based on historic simulations, not taking into account human impacts and alterations to the environment, or the severity or intensity of potential wildfires. The severity will be considered in the Fire Regime Group (FRG) and Fire Regime Condition Classes (FRCC).

Figure 4.3.6-1: Sussex County Mean Fire Return Interval



Source: LANDFIRE MFRI layer. U.S. Department of Interior, Geological Survey. GIS data retrieved from http://landfire.cr.usgs.gov/viewer/

Understanding the historic fire regime is important to understanding the present risk of wildfire. The FRG is used to categorize historical fire regimes to describe the frequency and intensity of fires. There are five fire regime groups shown in Table 4.3.6-3.

Table 4.3.6-3: Fire Regime Group Categories

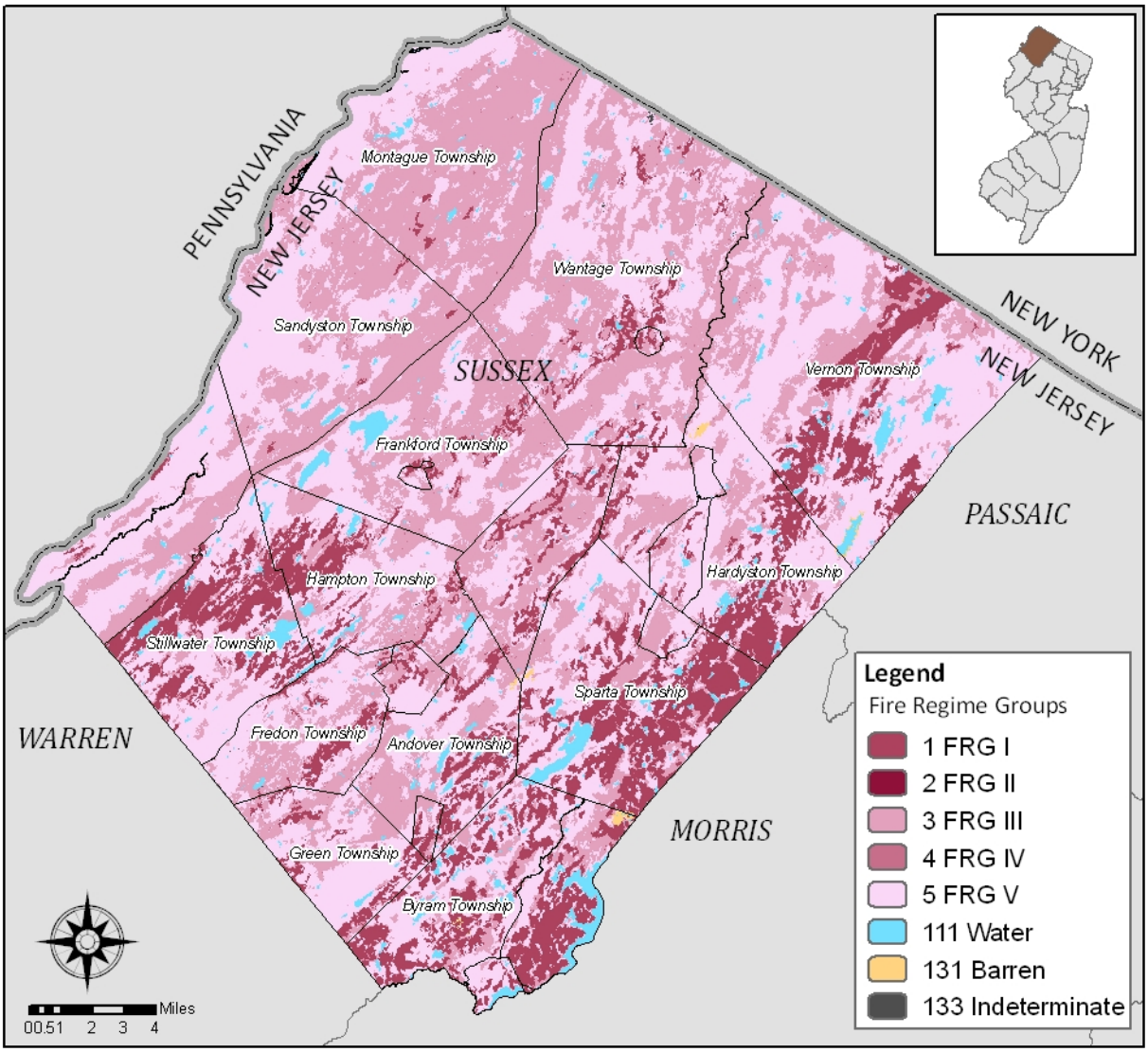
Fire Regime Group	Frequency	Severity
I	0-35 Years	Low and Mixed
II	0-35 Years	Replacement
III	35-200 Years	Low and Mixed

Fire Regime Group	Frequency	Severity
IV	35-200 Years	Replacement
V	200+ Years	Replacement and other fires occurring within this frequency range

Source: FRCC Guidebook Version 1.3.0, June 2008, p113. Retrieved from www.frcc.gov

Figure 4.3.6-2 shows the FRGs by location, and considers both frequency and severity for wildfires based on historical fire regimes. This is also part of the LANDFIRE spatial dataset.

Figure 4.3.6-2: Sussex County Fire Regime Groups



Source: LANDFIRE FRG layer. U.S. Department of Interior, Geological Survey. GIS data retrieved from http://landfire.cr.usgs.gov/viewer/

The FRCC measures the departure from reference (pre-settlement or natural or historical) ecological conditions that typically result in alterations of native ecosystem components. These ecosystem components include attributes such as species composition, structural stage, stand age, canopy closure, and fuel loadings. One or more of the following activities may have caused departures: fire suppression, timber harvesting, livestock grazing, introduction and establishment of exotic plant species, introduced insects or diseases, or other management activities. [4] There are three fire regime condition classes shown in Table 4.3.6-4.

Table 4.3.6-4: Fire Regime Condition Classes

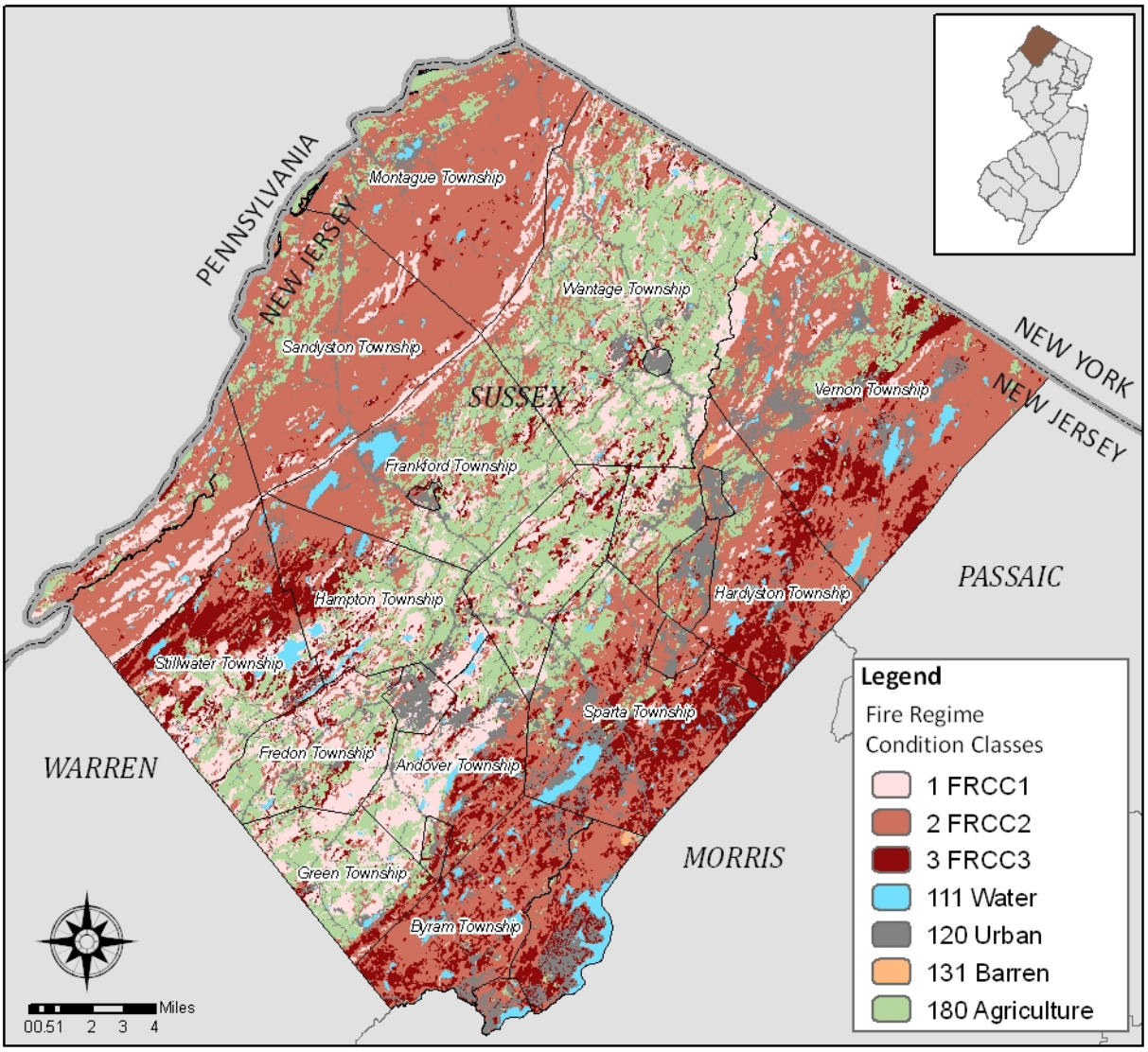
Fire Regime Condition Class	Description
1	Less than 33% departure from the central tendency of the historical range of variation: Fire regimes are within the natural or historical range and risk of losing key ecosystem components is low. Vegetation attributes (composition and structure) are well intact and functioning.
2	33% to 66% departure: Fire regimes have been moderately altered. Risk of losing key ecosystem components is moderate. Fire frequencies may have departed by one or more return intervals (either increased or decreased). This departure may result in moderate changes in fire and vegetation attributes.
3	Greater than 66% departure: Fire regimes have been substantially altered. Risk of losing key ecosystem components is high. Fire frequencies may have departed by multiple return intervals. This may result in dramatic changes in fire size, fire intensity and severity, and landscape patterns. Vegetation attributes have been substantially altered.

Source: FRCC Guidebook Version 1.3.0, June 2008, p113. Retrieved from www.frcc.gov

Figure 4.3.6-3 shows the FRCCs by location, and provides an indication of where future wildfire events may not be reflective of historical trends, particularly in FRCC 3 areas. This is also part of the LANDFIRE spatial dataset.

[4] FRCC Guidebook Version 1.3.0, June 2008, p113. Retrieved from www.frcc.gov

Figure 4.3.6-3: Sussex County Fire Regime Condition Classes



Source: LANDFIRE FRCC layer. U.S. Department of Interior, Geological Survey. GIS data retrieved from http://landfire.cr.usgs.gov/viewer/

See Figure 3.3.11-2 in Section 3.3.11 for a map of the wildfire fuel hazard risk based on NJDEP's New Jersey Forest Fire Service GIS data.

Critical Facilities Risk Due to Wildfire

The risk to critical facilities for wildfire is very site specific and individual assessments should be conducted for potential facilities. The majority of the essential facilities and utilities are located within the WUI areas, including: 12 of 14 EOCs, 35 of 39 fire departments, 12 of 16 police stations, 0 of 1 hospital, 61 of 72 schools, 2 of 2 potable water facilities, 7 of 7 waste water system facilities, 1 of 1 natural gas facility, 4 of 5 communications facilities.

Risk Assessment Next Steps for Wildfire Hazard

To further assess populations, structures, and critical facilities, the National Fire Protection Form 1144 can be used to gather community and site-specific information regarding the wildfire hazard and assess risk in further detail. Documentation of any changes to zoning or building codes or any other mitigation actions that may alter future risk assessments.

4.4 Summary of Risk Assessment

The purpose of conducting risk assessments for potential hazards in Mercer County is to provide a basis to make informed decisions and prioritizations for mitigation actions and efforts. Section 3 identifies and profiles hazards, while Section 4 goes into greater detail to evaluate where the most significant risks are and to quantify potential losses. Earthquake, flood, and hurricane winds have an established methodology for assessing losses, embodied in the HAZUS-MH software, whereas dam failure can be assessed building off of existing engineered data, and severe winter weather does not have a hazard-specific methodology to follow. Severe winter weather and straight-line high winds have a more uniform exposure to risk across the county, while flood and dam failure have more specific locations where the risk is highest. Earthquake hazards may have a higher risk in certain areas of the county due to soil type, proximity to faults, and landslide factors, these areas are difficult to identify at the present time based on current science and therefore the entire county is currently considered to be at equal risk to earthquakes.

Table 4.4-1 compares annualized losses by hazard for Sussex County. As shown, flood has the highest potential losses per year, then straight line high winds, earthquake, and finally winter severe weather. Placing these costs in a context of the percentage of building stock provides a way to quantify the risk and an indicator for prioritization. Keep in mind that all of the methodologies are not equal and that each hazard has its own characteristics, including geographic extent, which must be taken into consideration when planning mitigation actions.

Table 4.4-1: Summary of Potential Annualized Losses by Hazard for Sussex County

Hazard	Annualized Losses	Represents	Source / Methodology	% of Building Stock ($12,782,756,000)
Dam Failure	N/A	-	-	-
Earthquake / Geological	$500,000	Economic - Total Property Damage (Capital Stock Losses) & Business Interruption Losses	HAZUS-MH MR4, Patch 2 – Earthquake Model	.0039115%

Hazard	Annualized Losses	Represents	Source / Methodology	% of Building Stock ($12,782,756,000)
Flood	$36,790,000	Economic – Property, Contents, & Inventory (Capital Stock Losses) & Business Interruption Losses	HAZUS-MH MR 4, Patch 2 – Flood Model	.028780%
High Wind – Straight Line	$551,000	Economic - Total Property Damage (Capital Stock Losses) & Business Interruption Losses	HAZUS-MH MR 4, Patch 2 - Hurricane Wind Model	.004310%
Severe Weather – Winter	$127,119 ($2,204,541)	Estimated Average Annual Damages (includes deaths and injuries)	100-year planning horizon methodology	.000994% (.017246%)
Wildfire	N/A	-	-	-

Notes:

(1) When conducting comparisons, be sure to use the same type of losses; for example do not use severe winter weather's value that includes deaths and injuries in comparison to flood's total property damage or you will not get an accurate portrayal.

(2) For planning purposes only.

(3) Unable to provide annualized losses for dam failure based on current information.

Dam Failure

The infrastructure throughout our nation is aging, and inspections and maintenance by trained professionals such as engineers on-site is imperative. The analysis provided in Section 4 is a first step towards understanding the risks associated with dam failure. There are many other dams within the county that have inherent risk that are not studied in this Plan. There is not enough available information to make specific conclusions regarding the risks of dam failure as a whole throughout the county.

Earthquake/Geological

As discussed in Section 3.3.3, there is a moderate degree of earthquake risk in the county. The analysis provided in Section 4 provides three different scenarios, one being arbitrary utilizing a 5.5M event with a centrally-located epicenter, and the other two exploring probabilistic losses. All three are based on default soil, landslide data, and building codes.

Although earthquake science is not fully developed for the east coast, stricter building codes and construction methods can go a long way in reducing the risk for those structures. Retrofitting critical facilities, such as hospitals, is also an important consideration. HAZUS-MH can also be utilized to evaluate these specific mitigation actions; however a Level II analysis should be utilized for this type of study.

Flood

The HAZUS-MH Level I analysis provided here includes updates to the essential facilities, potable water facilities, and waste water facilities based on local data and is based on a higher resolution 1/3 arc-second Digital Elevation Model. In conjunction with the Repetitive Loss and Severe Repetitive Loss information provided in Section 3.3.4 and the new FEMA DFIRM maps and data, this analysis is a good basis for prioritizing efforts based on losses and geographic areas of risk. There are also a number of other excellent studies including; the *Delaware River Basin Flood Analysis Model Project* which evaluates effects of reservoir voids and release operations on downstream flood crests for the September 2004, April 2005, and June 2006 storm events, Delaware River Basin Commission's *A Multi-Jurisdictional Flood Mitigation Plan for Municipalities in the Non-tidal, New Jersey portion of the Delaware River Basin* discussed in Section 3.3.4 provides detailed flood mitigation actions for specific municipalities, *Updated Hydrologic Information for the Main Stem of the Delaware River* lead by USGS, NJ & NY Water Science Centers, and USACE Philadelphia District, and the very relevant upcoming *Delaware River Basin Interim Feasibility Study for New Jersey* led by USACE Philadelphia District expected 2013 to evaluate possible flood mitigation options.

High Wind – Straight-Line

As discussed in Section 3.3.3, there is a variety of different types of hazards that can affect the county and impact its communities. The analysis provided in this Plan utilizes HAZUS-MH's Hurricane Wind model to create a historical event based on Hurricane Floyd's characteristics and a second scenario utilizing probabilistic statistics. HAZUS-MH can also be utilized to evaluate specific mitigation actions, such as adding shutters to a certain number of structures. Before these types of analysis are undertaken, the inventory data should be updated further based on more recent and local information.

Severe Weather – Winter

As mentioned in Section 4, severe winter weather is difficult to evaluate as a risk, both geographically and by losses. In this Plan, a traditional 100-year planning horizon methodology that uses historic events was utilized to provide some basis for comparison. However, it is difficult to support specific conclusions or prioritizations based on this approach.

Wildfire

The analysis provided in Section 4 is a first step towards understanding the risks associated with wildfire in Sussex County. Although much of the County's population resides in the WUI, there is not enough available information to make specific conclusions regarding the risks of wildfire as a whole throughout the county.

Relative Risks by Municipality in Sussex County

Table 4.4-2 provides a general comparison of hazard vulnerabilities among the Sussex County municipalities. All hazards that are included in Section 4 and have in-depth risk assessments are included in the matrix. They are ranked high, medium, or low and are relative rankings based on a composite review of the risk data presented in this Plan and other aforementioned sources. Even if overall risks for a municipality are deemed medium or low, there may be specific sites or areas with populations that may still be at increased risk from certain hazards. This matrix should be utilized for planning purposes only as an indication of where future evaluations and efforts may be based.

Table 4.4-2: Sussex County Municipality-Level Hazard Risk Matrix

Municipality	Dam Failure	Earthquake / Geological	Flood	High Wind – Straight-Line	Severe Weather - Winter	Wildfire
Andover Borough	H	M(3)	L	M(1)	M(1)	L(5)
Andover Township	H	M(3)	M	M(1)	M(1)	L(5)
Branchville Borough	L	M(3)	L	M(1)	M(1)	L(5)
Byram Township	H	M(3)	M	M(1)	M(1)	L(5)
Frankford Township	M	M(3)	M	M(1)	M(1)	L(5)
Franklin Borough	M	M(3)	M	M(1)	M(1)	L(5)
Fredon Township	H	M(3)	L	M(1)	M(1)	L(5)
Green Township	H	M(3)	M	M(1)	M(1)	L(5)
Hamburg Borough	L	M(3)	M	M(1)	M(1)	L(5)
Hampton Township	H	M(3)	M	M(1)	M(1)	L(5)
Hardyston Township	H	M(3)	L	M(1)	M(1)	L(5)
Hopatcong Borough	M	M(3)	M	M(1)	M(1)	L(5)
Lafayette Township	L	M(3)	M	M(1)	M(1)	L(5)
Montague Township	H	M(3)	H	M(1)	M(1)	L(5)
Newton Town	H	M(3)	L	M(1)	M(1)	L(5)
Ogdensburg Borough	H	M(3)	M	M(1)	M(1)	L(5)
Sandyston Township	H	M(3)	M	M(1)	M(1)	L(5)
Sparta Township	H	M(3)	L	M(1)	M(1)	L(5)
Stanhope Borough	L	M(3)	L	M(1)	M(1)	L(5)
Stillwater Township	H	M(3)	L	M(1)	M(1)	L(5)
Sussex Borough	H	M(3)	H	M(1)	M(1)	L(5)
Vernon Township	H	M(3)	M	M(1)	M(1)	L(5)
Walpack Township	H	M(3)	H	M(1)	M(1)	L(5)
Wantage Township	H	M(3)	M	M(1)	M(1)	L(5)

Notes:

(1) Some hazards have equal risk throughout the county. The risk is not determined by the amount of potential damage; otherwise the municipalities with the highest building stock and population would always be at highest risk even if the hazard is equivalent.

(2) Flood risk determined based on a combination of RLs and SRLs, as summarized in Section 3.3.4, on DFIRM flood zones, and HAZUS-MH analysis.

(3) Although earthquake risk may not be equivalent throughout the county, there is no scientific basis to prioritize one area over another.

(4) Dam failure risk is not based on the condition of the dam, but on the consequences if a dam were to fail. Therefore prioritization based on number and proximity of high, significant, and low dams.

(5) Historically, there have been no deaths, injuries, or property damages associated with the wildfire hazard in Sussex County,

County and Municipal Mitigation Actions

The following are examples of mitigation actions included in the Section 6 as part of the Mitigation Action Plan that are intended to mitigate hazards included in the detailed risk assessment as well as all hazards identified in Section 3 as relevant for Sussex County.

Severe Weather – Winter

- Sussex County Action Item 1.A.1 and related actions items for all municipalities regarding developing an all-hazards public education and outreach program for hazard mitigation and preparedness.
- Sussex County Action Item 2.A.18
- Andover Borough 1

Dam Failure

- The analysis in Section 4.3.1 indicates that as many as six different municipalities could be impacted by failures of the NJDEP-designated high hazard dams that were analyzed as part of the Plan. In some cases, municipalities could be affected by more than one of the analyzed dams. However, no specific mitigation actions were identified in this Plan at the municipal level due to the complexity of the issues involved and the lack of clear mitigation action alternatives. Instead, Sussex County Action Items 2.A.21, 2.A.22 and 2.A.23 were included for follow-up investigations and actions by SCDEM with NJDEP.
- In addition, Sussex County Action Item 1.A.1 and related actions items for all municipalities regarding developing an all-hazards public education and outreach program for hazard mitigation and preparedness will include dam failure.

Earthquake/Geological

- The analysis is Section 4.3.2 indicates that numerous critical facilities could be impacted by earthquakes in Sussex County. However, no specific mitigation actions were identified in this Plan at the municipal level due to the need to verify site-specific conditions and vulnerabilities and the lack of specific mitigation action alternatives. Instead, Sussex County Action Items 2.A.5, 2.A.6, and 2.A.7 were included for follow-up investigations and actions by SCDEM with the New Jersey Geological Survey (NJGS).

- In addition, Sussex County Action Item 1.A.1 and related actions items for all municipalities regarding developing an all-hazards public education and outreach program for hazard mitigation and preparedness will include earthquake and other geological hazards.

Flood

- The analysis in Section 4.3.3 indicates that seven specific critical facilities are located in the 100-year and/or 500-year floodplains in Sussex County. These facilities have been addressed in Section 6 – Mitigation Strategy as follows:
  - Lafayette Fire/EMS – see action item Lafayette Township #11.
  - Hamburg Fire Department – see action item Hamburg Borough #3.
  - Sussex Fire Department – see action item Sussex Borough #12.
  - Immaculate Conception Regional School – see action item Franklin Borough #5
  - Sparta High School – see action item Sparta Township # 10.
  - Little Children's World – see action item Branchville Borough #5.
  - Byram Lakes Elementary - see action item Stanhope Borough #3.
- In addition, the following county and municipal actions have been developed in response to the results of Section 4.3.3:
  - Sussex County Action Item 1.A.1 and related actions items for all municipalities regarding developing an all-hazards public education and outreach program for hazard mitigation and preparedness will include flood.
  - Sussex County Action Item 3.A.1 and other county-level mitigation actions address issues related to repetitive flood losses in the county and participation in the NFIP and/or CRS.
  - Andover Borough 2 is one example of several municipal level action items included that specifically address flood risk.

High Wind – Straight-Line

- Sussex County Action Item 1.A.1 and related actions items for all municipalities regarding developing an all-hazards public education and outreach program for hazard mitigation and preparedness.
- Sussex County Action Item 2.A.10
- Andover Township 4

Severe Weather – Winter

- Sussex County Action Item 1.A.1 and related actions items for all municipalities regarding developing an all-hazards public education and outreach program for hazard mitigation and preparedness.
- Sussex County Action Item 2.A.18
- Andover Borough 1

Wildfire

- Sussex County Action Item 1.A.1 and related actions items for all municipalities regarding developing an all-hazards public education and outreach program for hazard mitigation and preparedness.
- Sussex County Action Item 2.A.11, 2.A.12, 2.A.13, and 2.A.14**.**
- Andover Borough 7.

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