4.3.6.9. State Facility Loss Estimation

The vulnerable state critical facilities identified in Section 4.3.6.7 are agriculture-related facilities, all but three of which are privately held entities for which replacement values are unavailable. The three publicly held agriculture facilities are offices and laboratory space of the Department of Agriculture which are unlikely to face serious impacts from hailstorms.

4.3.7. Hurricane, Tropical Storm, Nor'easter

4.3.7.1. Location and Extent

Pennsylvania does not have any open-ocean coastline. However, the impacts of coastal storm systems such as hurricanes, tropical storms, and nor'easters can extend well inland. Tropical storm systems (i.e. hurricanes, tropical storms, tropical depressions) impacting Pennsylvania develop in tropical or sub-tropical waters of the Atlantic Ocean, Gulf of Mexico, or Caribbean Sea. Nor'easters are extra-tropical storms which typically develop from low-pressure centers off the Atlantic Coast north of North Carolina during the winter months. Extra-tropical is a term used to describe a hurricane or tropical storm that's cyclone has lost its 'tropical' characteristics. While an extra-tropical storm donates a change in weather pattern and how the storm is gathering energy, it may still have winds that are tropical storm or hurricane force.

In some cases, the center of circulation for these storm systems where wind and precipitation effects are often most intense can track inland and move directly through Pennsylvania. However, due to the size of these storms, the Commonwealth is more often affected when circulation centers pass at a distance of several hundred miles. In either case, these coastal storms are regional events that can impact very large areas hundreds to thousands of miles across over the life of the storm. In general, coastal storm systems affect communities in the eastern portion of Pennsylvania more often than western communities. However, these storms have the potential to impact all communities across Commonwealth.

4.3.7.2. Range of Magnitude

Intense precipitation and wind resulting in flood and wind damage (see Sections 4.3.5 and 4.3.14 respectively) are the most common impacts associated with coastal storm systems in Pennsylvania. Nor'easters develop as extra-tropical cyclonic weather systems over the Atlantic Ocean and are capable of producing winds equivalent to hurricane or tropical storm force; precipitation from these storms may also come in the form of heavy snow or ice (see Section 4.3.16).

Tropical cyclones with maximum sustained winds of less than 39 miles per hour (mph) are called *tropical depressions*. A *tropical storm* is a cyclone with maximum sustained winds between 39-74 mph. These storms sometimes develop into *hurricanes* with wind speeds in excess of 74 mph. The impacts associated with hurricanes and tropical storms are primarily wind damage and flooding. It is not uncommon for tornadoes to develop during these events. Historically, tropical cyclone events have brought intense rainfall to Pennsylvania, sometimes leading to damaging floods, northeast winds, which, combined with waterlogged soils, caused trees and utility poles to fall.

The impact tropical storm or hurricane events have on an area is typically measured in terms of wind speed. Expected damage from hurricane force winds is measured using the Saffir-

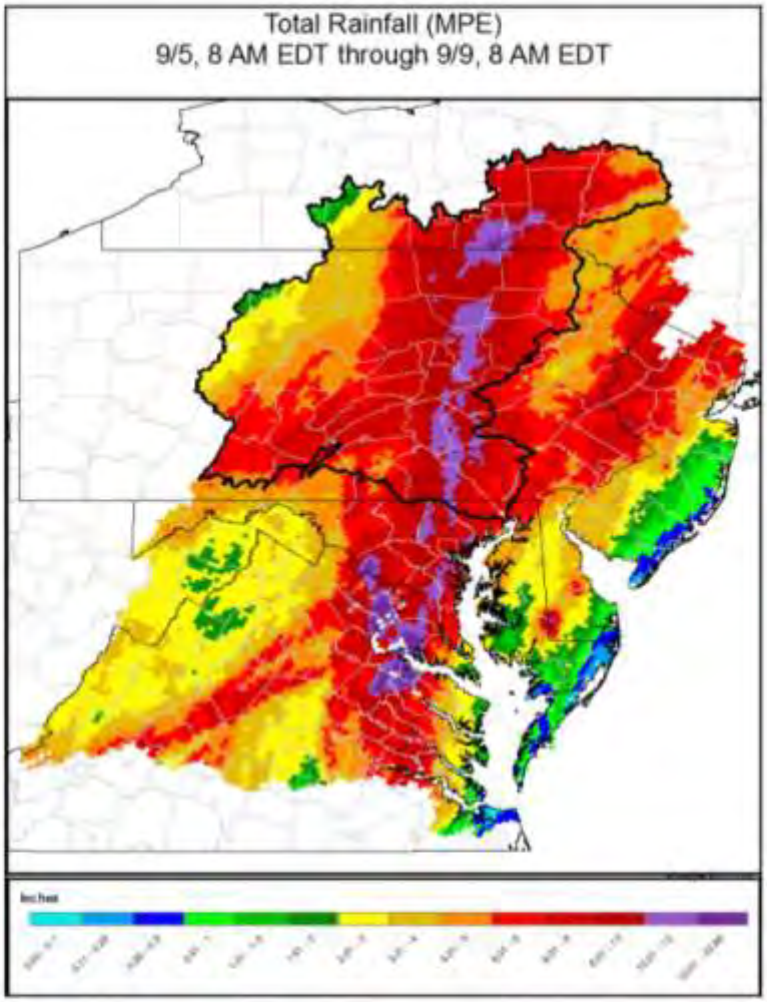
Simpson Scale. The Saffir-Simpson Scale categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure and storm surge potential (a threat only to the tidal portions of the Delaware River), which are combined to estimate potential damage. Table 4.3.7-1 lists Saffir-Simpson Scale categories with associated wind speeds and expected damages. Categories 3, 4 and 5 are classified as "major" hurricanes; however, even Category 1 storms can have potentially significant storm surge. While major hurricanes comprise only 20% of all tropical cyclones making landfall, they account for over 70% of the damage in the United States.

Table 4.3.7-1 Saffir-Simpson Scale categories with associated wind speeds and damages (NHC, 2009).

STORM CATEGORY	WIND SPEED (mph)	DESCRIPTION OF DAMAGES
1	74-95	*MINIMAL*: Damage is limited primarily to shrubbery and trees, unanchored mobile homes and signs. No significant structural damage.
2	96-110	*MODERATE*: Some trees are toppled, some roof coverings are damaged and major damage occurs to mobile homes. Some roofing material, door and window damage.
3	111-130	*EXTENSIVE*: Some structural damage to small residences and utility buildings, with a minor amount of curtain wall failures. Mobile homes are destroyed. Large trees are toppled. Terrain may be flooded well inland.
4	131-155	*EXTREME*: Extensive damage to roofs, windows and doors; roof systems on small buildings completely fail. More extensive curtain wall failures. Terrain may be flooded well inland.
5	>155	*CATASTROPHIC*: Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Massive evacuation of residential areas may be required.

Section 4.3.7.3 lists, maps, and describes the past hurricane, tropical storm, and nor'easter events occurring in Pennsylvania. However, it is important to indicate the worst-case scenario or event for a tropical storm in Pennsylvania, which was Tropical Storm Lee/Hurricane Irene in 2011. Hurricane Irene made landfall in the US on August 27, 2011 and again on August 28, dumping between 2 and 8 inches of rain in eastern Pennsylvania, with its worst rain occurring in the Delaware River basin. One and a half weeks later, beginning on September 5, Tropical Storm Lee and its associated heavy rainfall moved through Pennsylvania and New York. With large portions of the Susquehanna River Basin already saturated by Hurricane Irene, Lee's rain caused flash flooding and riverine flooding in and east of the Susquehanna River Valley. The heavy rain broke previous precipitation records set by the former worst-case, Tropical Storm Agnes, and caused multiple new floods of record throughout the state. Rainfall totals recorded by the National Weather Service are shown in Figure 4.3.7-1 below.

Figure 4.3.7-1 Total Rainfall from the remnants of Tropical Storm Lee (NWS, 2012).



Lee/Irene left significant amounts of water over nearly all of central and eastern Pennsylvania with the worst occurring in Northeastern Pennsylvania communities of Towanda, Wilkes-Barre, Bloomsburg, Danville, and Sunbury. According to the NWS, over 2,000 people were evacuated and 3,000 homes and businesses flooded in Bradford County alone. Bradford County's agricultural community was severely damaged with about $7 million in crop damage. In Luzerne County, 60,000 people were evaluated and while the Wyoming Valley levee system held, unprotected communities saw flood depths worse than in Hurricane Agnes. Lee/Irene forced the first ever closure of the Bloomsburg Fair, since fairgrounds were covered in 10-12 feet of water. There were ten fatalities statewide due to the storm: one in Bradford County, four in Dauphin, three in Lancaster, one in Lebanon, and one in Philadelphia. Of these fatalities, half occurred as a result of cars being washed away. The NWS reported at least 23,780 structures as being affected by the event, with over 1,000 completely destroyed and nearly 8,000 substantially damaged. With the event occurring in the active growing season, there was widespread crop damage reported to the Department of Agriculture. The State and many county EOCs were activated for extended periods, and the event received both a Presidential Emergency

Declaration and a Declaration of Major Disaster. As of May 2012, damages (including debris removal, emergency protective measures, road repair, bridge repair, buildings, utilities, and parks) topped $200 million for this event (NWS, 2012).

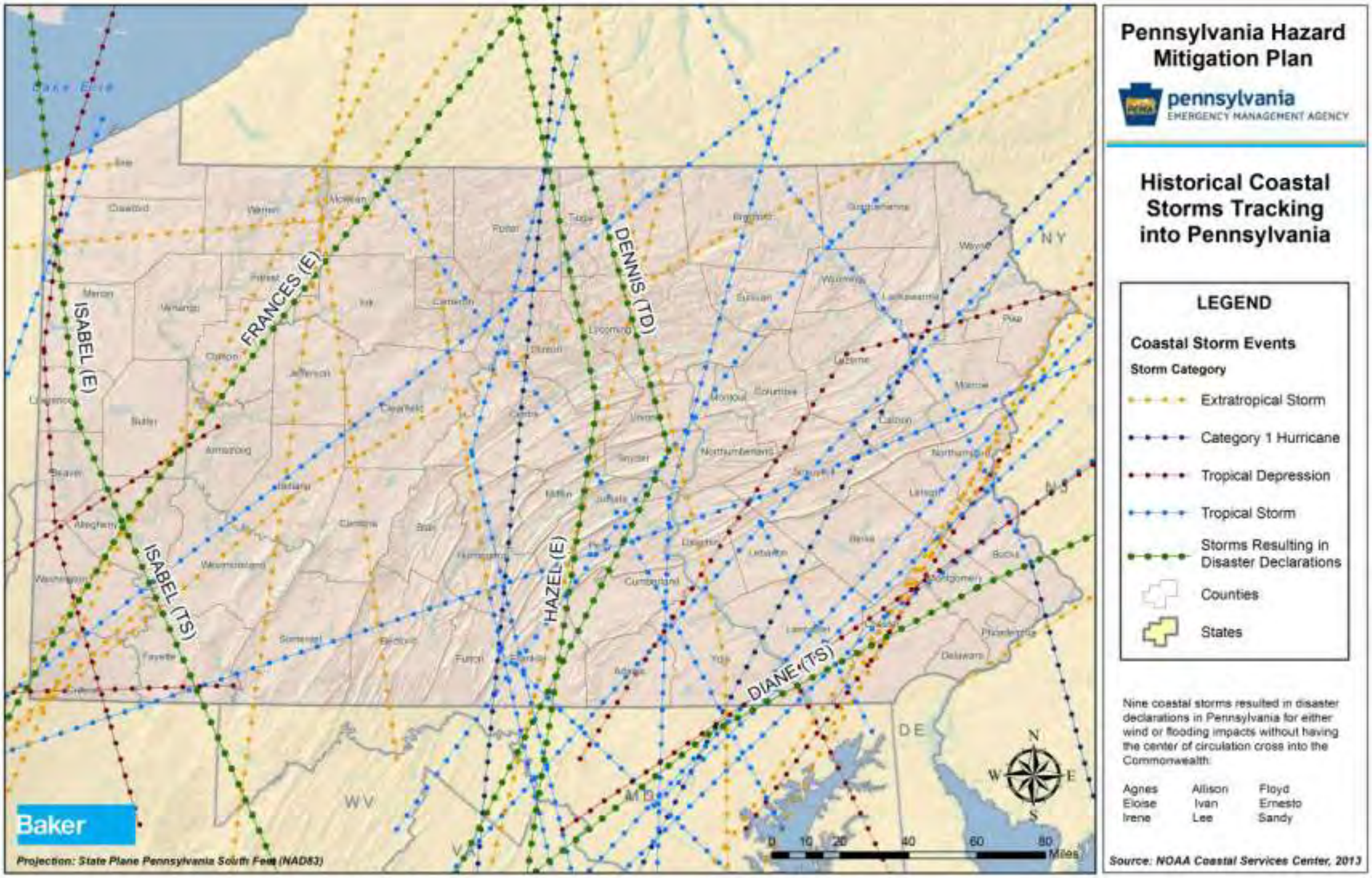
4.3.7.3. Past Occurrence

As shown in Section 4.2.1, 13 Presidential Disaster Declarations and two additional Gubernatorial Declarations have been made since 1955 due to coastal storm events in Pennsylvania. Using data from the National Oceanic and Atmospheric Administration, a query was performed for historic tropical cyclone events that tracked directly through Pennsylvania. Twenty-four unnamed storms tracked through Pennsylvania between 1876 and 1952. Since 1952, nineteen named tropical cyclones have tracked through Pennsylvania; a summary of these storms is provided in Table 4.3.7-2 with storm category as recorded over Pennsylvania. A map of all events since 1876 is provided in Figure 4.3.7-2.

Table 4.3.7-2 Tropical cyclone events which tracked through Pennsylvania between 1952 and present (NOAA CSC, 2010). Note that events with circulation centers that did not move through Pennsylvania are not included in this table, but are identified in text. Storm categories: E = Extra-tropical storm, TD = Tropical depression, TS = Tropical storm

YEAR	EVENT (STORM CATEGORY)
1952	Able (TS)
1954	Hazel (E)
1955	Connie(TS)
1955	Diane (TS)
1957	Audrey (E)
1959	Gracie (E)
1968	Candy (E)
1979	David (TS)
1979	Frederic (TS)
1988	Chris (TD)
1989	Hugo (TS)
1992	Danielle (TS)
1994	Beryl (TD)
1996	Fran (TD)
1999	Dennis (TD)
2002	Isidore (TD)
2003	Isabel (TS)
2004	Frances (E)
2006	Ernesto (E)

Figure 4.3.7-2 Map showing historical coastal storm events which tracked through Pennsylvania.



It is important to note that Table 4.3.7-2 and Figure 4.3.7-2 identify only events with centers of circulation that passed over the Commonwealth. Tropical cyclone events which may have affected Pennsylvania, but did not have circulation centers that crossed through the Commonwealth are not provided here due to space limitations. However, storms of this type have had serious impacts on Pennsylvania. Perhaps the best example of this is Hurricane Agnes (1972). While it was the most significant tropical storm event to impact the Commonwealth, the storm track for Agnes remained to the east of Pennsylvania and New Jersey until making landfall near New York City and traveling into upstate New York. After making first landfall as a minimal hurricane near Panama City, FL, Agnes weakened and exited back into the Atlantic off the North Carolina coast. However, the storm skirted along the coast, made a second landfall near New York City as a tropical storm and merged with an extra-tropical low pressure system over northern Pennsylvania. This brought extremely heavy rains to Pennsylvania, with particular concentrations of rain in the Susquehanna River Basin. Maximum rainfall from the storm, falling in the period of June 20-25, 1972, was about 18 inches the middle of the Susquehanna drainage area; however this is an unofficial measurement. The maximum official depth of 15.2 inches was recorded in Harrisburg, PA. Estimated losses in Pennsylvania alone were near $3 billion; total damages for the storm nationwide were estimated at $4 billion. Although storm damages were serious over the entire Commonwealth, both the eastern and western portions escaped the extreme rainfall and losses suffered in central areas. Other tropical cyclones which did not track through Pennsylvania, but caused significant damage to communities in the Commonwealth include Sandy (2012), Lee/Irene (2011), Ivan (2004), Allison (2001), Floyd (1999) and Eloise (1975).

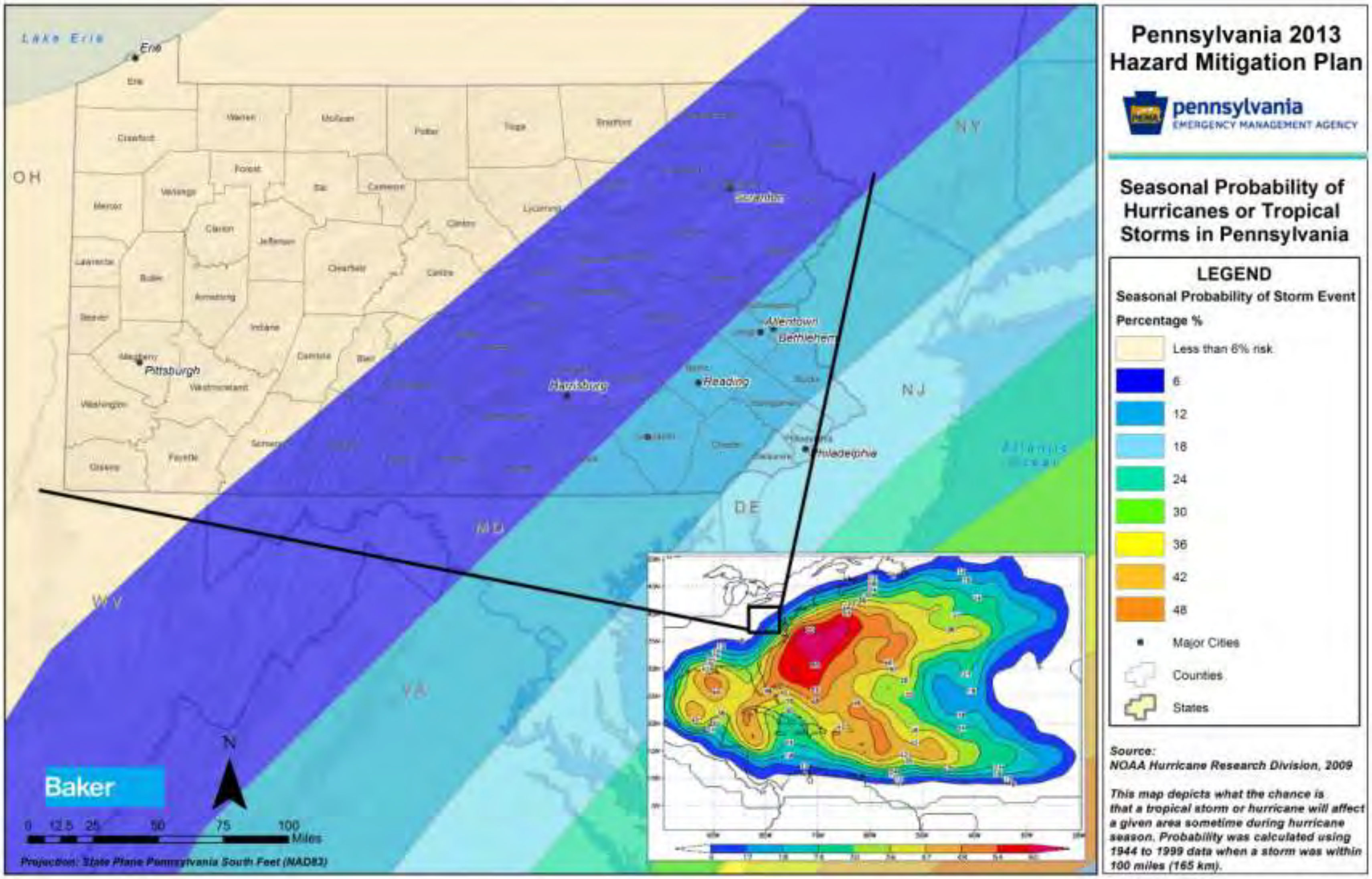
4.3.7.4. Future Occurrence

The National Oceanic and Atmospheric Administration Hurricane Research Division published the map included as Figure 4.3.7-3 showing the chance that a tropical storm or hurricane will affect a given area during the entire Atlantic hurricane season spanning from June to November. Note that this figure does not provide information on the probability of various storm intensities. However, based on historical data between 1944 and 1999, this map shows that areas of Pennsylvania a wide range of probabilities of experiencing a tropical storm or hurricane event between June and November of any given year (NOAA HRD, 2009).

Note that these probabilities are the result of only a single study and may differ from other seasonal probability estimates not identified in this report. Outlier storms may also have a large impact on Pennsylvania even though their probability is low. For instance, western and northwestern Pennsylvania's calculated risk is less than 6% annually. This is not to say that west and northwest Pennsylvania will not experience coastal storms, but indicates this area of Pennsylvania has comparatively the lowest probability of future events in the Commonwealth. This area is still subject to being impacted by a hurricane or tropical storm in a given year as shown in the storm tracks mapped in Figure 4.3.7-2. Southeastern Pennsylvania, on the other hand, has the highest calculated probability of future events with a calculated probability of 12-18% annually. It is important to balance various forms of research in prioritizing preparedness and mitigation solutions to all hazards.

Studies investigating the probability of future occurrence of nor'easters have not been identified. However, there is some evidence that as the earth continues to warm with climate change, there will be an increase in the overall intensity of coastal storms. Past storms have a strong correlation between sea surface temperatures and Atlantic Basin hurricanes; if surface temperatures continue to rise, there is a possible for more, larger storm events. NOAA states with the Intergovernmental Panel on Climate Change A1B scenario, there may be an increase in the number of intense storms, and models indicate that hurricanes by the end of the 21st century will likely see rainfall rates increase 20% within 100 km of storm centers (Knutson, 2013). This information, historical events, and input from the SPT indicate the annual occurrence of coastal storm events is considered *highly likely* as defined by the Risk Factor methodology.

Figure 4.3.7-3 Seasonal probability of Atlantic Basin hurricanes or tropical storms across Pennsylvania.



4.3.7.5. Environmental Impacts

The environmental impacts associated with coastal storms in Pennsylvania are consistent with those described for flood hazards in Section 4.3.5.5 and wind hazards in Section 4.3.14.5.

Beyond the environmental impacts of hurricanes, tropical storms, and nor'easters, Super Storm Sandy demonstrated the wide-ranging impacts of coastal storms. In addition to the flooding and wind-related impacts, Sandy illustrated the fuel and supply chain issues that can occur during a large, regional coastal storm. During and for weeks after the storm, both vehicles and generators could not be fueled. Transportation ground to a halt as well, with major roadway damage and limited power supply to enable safe traffic flow. The duration of Sandy also showed the long-term vulnerability of shelters in many states; few locations were equipped to shelter Sandy evacuees for the three weeks or more needed to get evacuees into temporary housing. The fuel shortages and widespread utility interruptions caused by Sandy illustrated the overall vulnerability of populations in hospitals and nursing homes; these populations are typically difficult to relocate and/or evacuate because of their medical needs, and electric power is frequently needed to keep these populations medically stable.

4.3.7.6. Jurisdictional Vulnerability Assessment

Table 4.3.7-3 lists which counties did and did not profile coastal storms in their most recent HMP, along with any ranking provided in those county plans. As stated in Section 4.1, the decision by a county to profile a hazard is one indicator of the presence of risk from that hazard. This indicator should be viewed complementary to other analysis in this section. Together this analysis from reputable sources addresses different aspects of risk for a full risk profile.

Of the 18 counties which currently have calculated risk factor values for hurricane, tropical storm, and nor'easter, the average value is 2.2; this average does not include Lebanon, Montour, Perry, and Philadelphia, who use an alternate Risk Factor/Ranking system. The State Risk Factor for hurricane, tropical storm, and nor'easter is 2.6, while the Pennsylvania THIRA scored hurricane, tropical storm, and nor'easter as an 8 out of 10. For more details on the State Risk Factor and THIRA rankings, please see Section 4.1.

Table 4.3.7-3 Counties profiling hurricane, tropical storm, and nor'easters with hazard ranking and risk factor (if available).

COUNTY	Profiled Hazard	Did Not Profile Hazard	Ranking (if available)	Risk Factor (If available)
Adams		X		
Allegheny	X		Low	1.9
Armstrong	X		Not Ranked	No RF
Beaver		X		
Bedford		X		
Berks	X		Not Ranked	No RF
Blair		X		
Bradford	X		Not Ranked	No RF

Table 4.3.7-3 Counties profiling hurricane, tropical storm, and nor'easters with hazard ranking and risk factor (if available).				
COUNTY	**Profiled Hazard**	**Did Not Profile Hazard**	**Ranking (if available)**	**Risk Factor (If available)**
Bucks	X		High	2.7
Butler		X		
Cambria		X		
Cameron	X		Medium	2.2
Carbon	X		Medium	2.2
Centre	X			
Chester		X		
Clarion		X		
Clearfield	X		Low	1.8
Clinton	X		Low	1.9
Columbia	X		Low	1.9
Crawford		X		
Cumberland	X		Medium	2.2
Dauphin	X		Not Ranked	No RF
Delaware	X		Medium	2.2
Elk		X		
Erie		X		
Fayette	X		Medium	2.3
Forest		X		
Franklin	X		Not Ranked	No RF
Fulton		X		
Greene		X		
Huntingdon		X		
Indiana		X		
Jefferson	X		Medium	2.1
Juniata		X		
Lackawanna	X		Not Ranked	No RF
Lancaster		X		
Lawrence		X		
Lebanon*		X		
Lehigh		X		
Luzerne	X		Not Ranked	No RF
Lycoming		X		

Table 4.3.7-3 Counties profiling hurricane, tropical storm, and nor'easters with hazard ranking and risk factor (if available).

COUNTY	Profiled Hazard	Did Not Profile Hazard	Ranking (if available)	Risk Factor (If available)
McKean		X		
Mercer	X		Medium	2.3
Mifflin		X		
Monroe	X		Low	1.9
Montgomery	X		High	3
Montour*	X		Not Ranked	9.6
Northampton		X		
Northumberland		X		
Perry*		X		
Philadelphia**	X		Medium	B
Pike	X		Medium	2.2
Potter		X		
Schuylkill	X		Not Ranked	No RF
Snyder		X		
Somerset		X		
Sullivan	X		Not Ranked	No RF
Susquehanna		X		
Tioga		X		
Union	X		Not Ranked	No RF
Venango		X		
Warren	X		Medium	2.2
Washington		X		
Wayne		X		
Westmoreland	X		Not Ranked	No RF
Wyoming	X		Not Ranked	No RF
York	X		Medium	2.2

* Lebanon, Montour, and Perry use an alternate weighted ranking where Risk Factor = Frequency x [(0.25 x Critical facilities) + (0.40 x Social) + (0.25 x Economic) + (0.10 x Environmental)]. While this risk factor was used to comparatively rank hazards, the number does not correspond to a high-medium-low rating.

**Philadelphia uses an A, B, C rating system where A is high, B is medium, and C is low.

As stated in Section 4.2.2, jurisdictional and state critical facility vulnerability assessments were completed by spatially overlaying hazards with census tracts and state critical facility layers in GIS. When spatial analysis determined that the hazard would impact a census tracts within a county or the location of state critical facilities these locations where deemed vulnerable to the hazard. Loss estimates were prepared based on the value of the facilities impacted by census tract and by state critical facility. Each hazard uses a methodology that is specific to the type of risk it may cause; Table 4.2.2-2 includes a complete methodology description for vulnerability assessments and loss estimates for each hazard.

The vulnerability of state critical facilities was evaluated as identifying facilities that are located in the hurricane probability zones of 12 and 18 percent. Four zones fall within Pennsylvania and the top two zones were chosen for analysis due to the higher percentage of chance of occurrence than the lowest percentage zone of 6 percent. Because a hurricane, tropical storm, or nor'easter event may happen anywhere in the Commonwealth, all jurisdictions and critical facilities face a small risk, but these events are most likely in the 12 and 18% zones, and thus the critical facilities and jurisdictions located in those zones are the most vulnerable to this hazard. See Figure 4.3.7-3 for an overview of the extent, which is focused on the southeastern portion of the Commonwealth.

Table 4.3.7-4 shows the number of critical facilities per county within the most vulnerable storm event probability zones of 12 and 18 percent. The top three counties having the most exposed critical facilities fall within the highest probability zone (18%) are Montgomery, Delaware, and Lancaster Counties.

Table 4.3.7-4 Number of State Critical Facilities within storm event probability zones of 12 and 18 percent.

COUNTY	NUMBER OF CRITICAL FACILITIES	COUNTY	NUMBER OF CRITICAL FACILITIES
Berks	124	Lehigh	66
Bucks	124	Monroe	13
Chester	123	Montgomery	201
Columbia	1	Northampton	79
Dauphin	1	Philadelphia	117
Delaware	140	Pike	1
Franklin	1	York	42
Lancaster	128		

4.3.7.7. State Facility Vulnerability Assessment

It was determined that 19% of all State critical facilities fall within the most vulnerable hurricane probability zones, with a total of 1,161. Table 4.3.7-6 lists a breakdown of the types of facilities contained within the zones. Due to the large number of fire departments, police stations, and hospitals in the Commonwealth, it is unsurprising that those categories of facility have the highest number of critical facilities.

Table 4.3.7-5 State Critical Facilities within 12 and 18 percent storm event probability zones by facility type.

STATE CRITICAL FACILITY TYPE	NUMBER OF IMPACTED FACILITIES
Agriculture	37
Banking	16
Chemical	5
Commercial Facilities	27
Communications	1
Dams	3
Defense Industrial Base	10
Education	59
Emergency Services	18
Energy	18
Fire Departments (Non-HSIP)	508
Government Facilities	12
Healthcare & Public Health	26
Hospital (Non-HSIP)	83
Information Technology	1
National Monuments & Icons	4
Nuclear Reactors, Materials & Waste	1
Police (Non-HSIP)	297
Postal & Shipping	3
Transportation	20
Water	12
TOTAL VULNERABLE CRITICAL FACILITIES	***1,161***

4.3.7.8. Jurisdictional Loss Estimation

Similar to the vulnerability analysis, jurisdictional loss estimates were based on the total exposed buildings and associated dollar value of exposure in Census tracts located within the 12 and 18% calculated probability zones for hurricane (See Figure 4.3.7-3). Jurisdictional loss estimates are provided in 0.

Table 4.3.7-6 Estimated jurisdictional losses in 12 and 18 percent storm event probability zones.		
COUNTY	NUMBER OF IMPACTED BUILDINGS	DOLLAR VALUE OF EXPOSURE, BUILDING AND CONTENTS (THOUSANDS $)
Adams	4,323	$1,070,018
Berks	184,069	$48,751,140
Bucks	321,764	$108,123,710
Carbon	1,590	$403,034
Chester	261,350	$89,860,597
Delaware	281,319	$86,856,472
Lancaster	229,390	$59,359,549
Lebanon	8,391	$2,282,914
Lehigh	197,004	$54,944,212
Monroe	44,251	$11,974,631
Montgomery	484,549	$160,866,480
Northampton	166,353	$46,823,603
Philadelphia	778,715	$201,276,171
York	83,493	$20,176,478
TOTAL	***3,046,561***	**$892,769,009**

FEMA's HAZUS-MH version 2.1 loss estimation model was used to explore the potential damage of hurricane wind hazards in the Commonwealth using a Level 2 analysis that incorporates more recent, more accurate 2010 Census Tract demographic data. While more refined than an out-of-the-box Level 1 analysis, this analysis is still an estimate of damage to buildings, essential facilities, transportation systems, utility systems, and high potential loss facilities based on national data and historical damage curves and storm tracks included in the HAZUS software. For more information on the data and methodology used in this analysis, see Section 4.1.4.

Probabilistic hurricane models for three historical storms were used to illustrate potential losses from a similar event. The historical storms selected are Hurricanes Floyd, Hazel, and Frances – each of which caused enough damage to warrant a disaster declaration in Pennsylvania. 0 displays a summary of hurricane losses predicted by HAZUS for these events and Figure 4.7.3-4 shows the HAZUS hurricane total economic loss estimates for the 100-year probabilistic hurricane scenario. Total economic loss estimates are the sum of building-related damages and business interruption losses, which are the losses associated with the inability to operate a business because of damage sustained in the scenario. As seen in Figure 4.3.7-4, HAZUS shows that the impact of the probabilistic 100-year hurricane event could be highest in south central Pennsylvania.

Table 4.3.7-7 Summary of hurricane losses predicted by HAZUS.						
EVENT NAME	BUILDINGS AT LEAST MODERATELY DAMAGED	BUILDINGS DAMAGED BEYOND REPAIR	TOTAL ECONOMIC LOSS (MILLIONS)	BUILDING-RELATED ECONOMIC LOSS (THOUSANDS)	SHELTER REQUIREMENT	DEBRIS (MILLIONS OF TONS)
Hurricane Hazel	8,884	270	$2,354.36	$2,239.88	70	3.99
Hurricane Floyd	1,277	6	$904.14	$879.39	0	0.63
Hurricane Frances	0	0	$0.034	$0.033	0	0

Figure 4.3.7-4 HAZUS 100-year probabilistic hurricane event estimated total economic losses by Census tract. Note that only tracts experiencing at least $1000 in losses are displayed on the map. Total economic losses include both direct building losses (shown in Table 4.3.7-9) and business interruption losses.

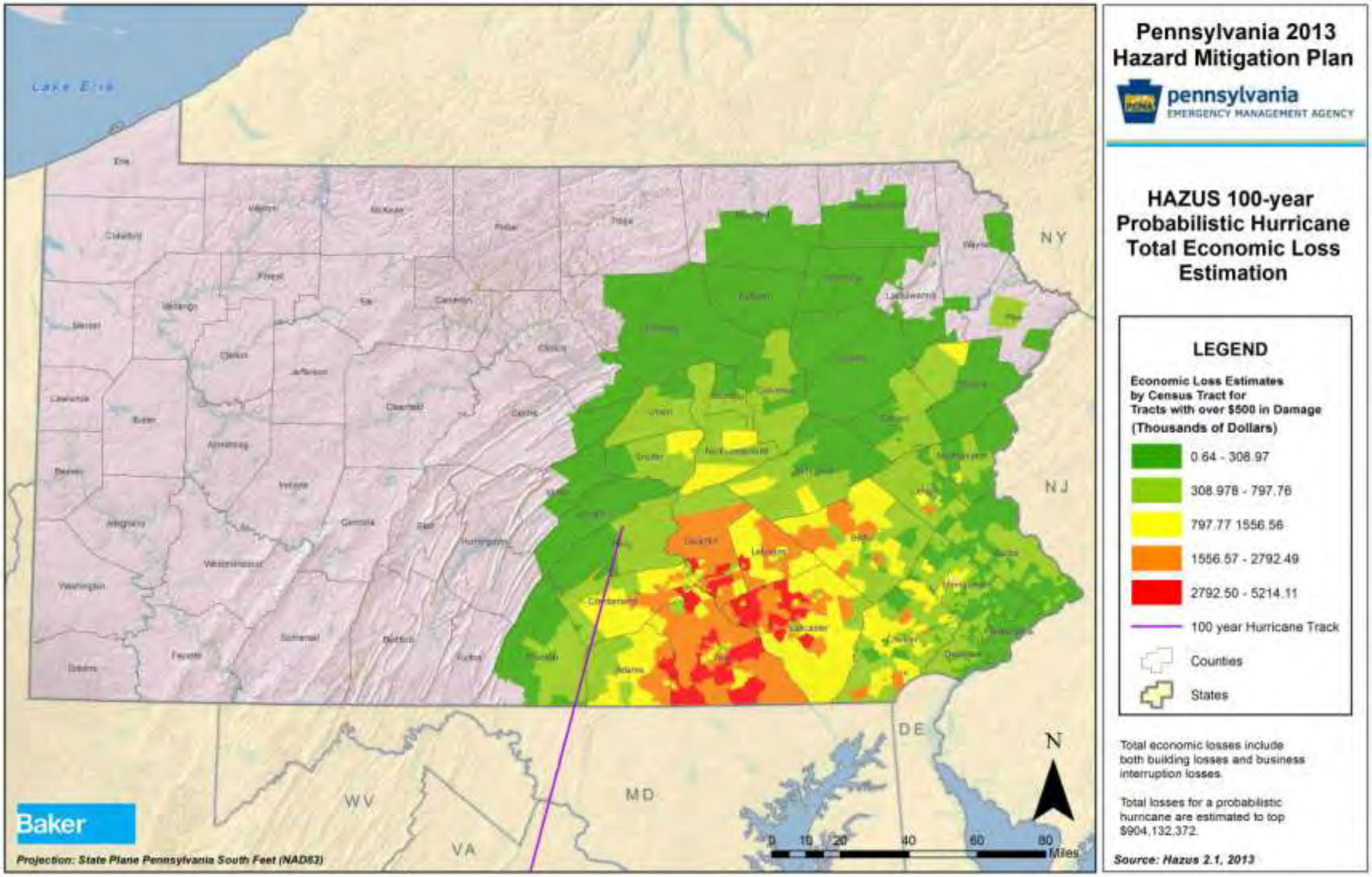


Table 4.3.7-8 shows the total building related losses by county for the 100-year probabilitstic hurricane model. *Appendix H* contains the full report on the HAZUS hurricane results. It is important to note that the building-related losses reported in this table are the estimated costs to repair or replace the damage caused to a building and its contents only. All counties with building-related losses of any magnitude are reported in this table.

Table 4.3.7-8 Total building-related losses from the HAZUS Probabilistic 100-year Hurricane Event.

COUNTY	TOTAL BUILDING-RELATED LOSSES (Thousands of $)	COUNTY	TOTAL BUILDING-RELATED LOSSES (Thousands of $)
Adams	$10,419,997	Huntingdon	$4,400,695
Allegheny	$160,352,004	Jefferson	$8,819,229
Armstrong	$6,962,784	Juniata	$4,652,843
Beaver	$19,658,974	Lancaster	$2,105,556
Bedford	$4,611,099	Lawrence	$24,616,085
Berks	$45,608,475	Lebanon	$55,845,528
Blair	$13,030,784	Lehigh	$9,300,394
Bradford	$5,622,523	Luzerne	$14,179,980
Bucks	$89,765,891	Lycoming	$40,540,454
Butler	$21,004,608	McKean	$35,569,644
Cambria	$15,834,947	Mercer	$11,967,239
Cameron	$905,333	Mifflin	$4,622,357
Carbon	$8,046,680	Montgomery	$12,896,775
Centre	$16,160,405	Montour	$4,439,219
Chester	$70,830,117	Northampton	$20,798,174
Clarion	$4,463,519	Northumberland	$118,942,877
Clearfield	$7,945,319	Perry	$2,083,139
Clinton	$3,972,137	Philadelphia	$36,378,693
Columbia	$6,954,372	Potter	$9,598,061
Crawford	$9,612,365	Schuylkill	$4,322,658
Cumberland	$26,979,564	Snyder	$178,499,440
Dauphin	$32,210,473	Somerset	$9,681,749
Delaware	$72,877,456	Sullivan	$2,448,085
Elk	$3,985,364	Tioga	$16,213,443
Erie	$30,307,615	Union	$3,980,579
Fayette	$12,795,592	Venango	$8,041,941
Forest	$1,433,676	Warren	$1,121,926
Franklin	$13,961,905	Washington	$4,385,455
Fulton	$1,378,326	Westmoreland	$4,040,863
Greene	$3,472,808	York	$4,018,048

4.3.7.9. State Facility Loss Estimation

The estimated replacement cost of all state critical facilities located in hurricane hazard zones is $6,867,999,216.

4.3.8. Invasive Species

4.3.8.1. Location and Extent

An invasive species is a species that is not indigenous to a given ecosystem and that, when introduced to a non-native environment, is likely to cause economic or environmental harm, or pose a hazard to human health. The Commonwealth of Pennsylvania plays host to a number of invasive pathogens, insects, plants, invertebrates, fish, and higher mammals. These species have largely been introduced by the actions of humans. Common pathways for invasive species threats include unintentional release of species, the movement of goods and equipment that may unknowingly harbor species, smuggling, ship ballast, hull fouling, and escape from cultivation (PISC, 2010). Invasive species threats are generally divided into two main subsets:

- ***Aquatic Invasive Species*** are nonnative viruses, invertebrates, fish, and aquatic plants that threaten the diversity or abundance of native species, the ecological stability of the infested waters, human health and safety, or commercial, agriculture, aquaculture, or recreational activities dependent on such waters.
- ***Terrestrial Invasive Species*** are nonnative arthropods, vascular plants, higher vertebrates, or pathogens that complete their lifecycle on land instead of in an aquatic environment and whose introduction does or is likely to cause economic or environmental harm or harm to human health.

The Governor's Invasive Species Council of Pennsylvania (PISC), the lead organization for invasive species threats, identifies a number of species threats that are or could potentially become significant in Pennsylvania but does not prioritize or rank them. These species are listed in Table 4.3.8-1.

Table 4.3.8-1 Invasive species of concern to the Commonwealth (PISC 2010).

INVASIVE SPECIES OF CONCERN IN PENNSYLVANIA*		
Aquatic Invasive Species		
Amphibians and Reptiles		
Red-Eared Slider	Yellow-bellied Slider	
Fishes, Diseases, Invertebrates		
Northern Snakehead	Round Goby	
European Rudd	Sea Lamprey	Zebra Mussel
Tubenose Goby	West Nile Virus	Asian Clam
Asian Carp	Viral Hemorrhagic Septicemia	Rusty Crayfish
Eurasian Ruffe	Spring Viremia of Carp	Spiny Waterflea
Flathead Catfish	Quagga Mussel	Fishhook Waterflea
Mammals and Birds		
Nutria	Mute Swans	Canada Goose
Submerged Aquatic Plants		
Wild Taro	Water Chestnut	Limnophila Sessiliflora