



4.3.11 Lightning

This section provides a profile and vulnerability assessment of the lightning hazard in Pike County. Lightning is a rapid discharge of electrical energy in the atmosphere. The clap of thunder is the result of a shock wave created by the rapid heating and cooling of the air in the lightning channel. All thunderstorms produce lightning and are very dangerous. It ranks as one of the top weather killers in the United States and kills approximately 50 people and injures hundreds each year. Lightning can occur anywhere there is a thunderstorm (NOAA 2014).

Location and Extent

Lightning can occur anywhere in Pike County. It can occur with all thunderstorms, making the entire county susceptible to the impacts of lightning. Different geographic areas may experience varying event frequencies, but in all cases, lightning strikes and associated fatalities occur primarily during the summer months.

According to the 2013 Commonwealth of Pennsylvania State Hazard Mitigation Plan, most lightning flashes occur in southwestern Pennsylvania; however, eastern and southeastern portions of the Commonwealth are at greater risk for death, injury or damage to lightning than central and north-central due to high population density (PA HMP 2013).

Range of Magnitude

Lightning causes an average of 55-60 fatalities and 400 injuries each year in the United States and costs more than \$1 billion in insured losses every year (NWS 2010). Many case histories show observed heart damage, inflated lungs, and brain damage in lightning-related fatalities. Many who have survived lightning strikes reported loss of consciousness, amnesia, paralysis, and burns. Death and injury to livestock and other animals; thousands of forest and brush fires; and damage to buildings, communications systems, power lines, and electrical systems are also the result of lightning (PA HMP 2013).

Between 1959 and 2014, Pennsylvania ranked ninth among all states in the United States for the number of lightning deaths with 133 deaths. This represents approximately 3% of all fatalities that occurred throughout the United States over this time frame (NWS 2015). Damages to property and crops as a result of lightning events totaled over \$15.5 million in Pennsylvania (NOAA NCEI 2016).

The worst-case scenario for lightning strikes would be a strike in a large group of people, such as at an outdoor sporting event, in Pike County (PEMA 2013). Numerous injuries or deaths could occur.

Past Occurrence

A lightning “event” is defined as a lightning strike which results in fatality, injury, and/or property or crop damage. The following table provides information regarding lightning events that occurred in Pike County between 1950 and 2016. Please note that not all lightning events that have occurred in Pike County are included due to the extent of documentation and the fact that not all sources may have been identified or researched. Loss and impact information could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP update.

Table 4.3.11-1. Lightning Events in Pike County, 1950 to 2016

Date	Location	Fatalities	Injuries	Property Damage (\$)
July 8,	Shohola	0	0	Lightning struck a tree and apparently traveled through its root system





Date	Location	Fatalities	Injuries	Property Damage (\$)
1994	Township			into a home in Shohola Township. It proceeded to blow up a television and engulfed a bedroom in flames. About 30 fire fighters prevented further damage to the house. Overall, this event caused approximately \$5,000 in property damage.
July 26, 1994	Delaware Township	0	0	Lightning struck a tree near a Delaware Township house and jumped to its television antenna and entered the house. This triggered a fire which heavily damaged a bedroom with heat and the remainder of the house had smoke damage. Overall, this event caused approximately \$17,000 in property damage.
July 1, 1995	Dingmans Ferry	0	0	Lightning struck and charred the steeple of the Holy Trinity Lutheran Church in Dingmans Ferry.
June 11, 2000	Milford	0	0	Pike County courthouse was damaged by a lightning strike
June 1, 2004	Milford	0	0	\$20,000 – lightning downed lines in the Town

Sources: NOAA National Centers for Environmental Information 2016

Future Occurrence

Lightning can be expected in any severe storm event. While injuries or fatalities caused by lightning strikes are rare, lightning events severe enough to be reported can be expected at least once every two years. It is estimated that the County will continue to experience lightning events annually. For the 2017 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of lightning events for Pike County. Information from NOAA-NCEI storm events database was used to identify the number of lightning strike events that occurred between 1950 and 2015. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimate percent chance of an incident occurring in a given year. Based on these statistics, there is an estimated 7.6-percent chance of a lightning strike event occurring in any given year in Pike County.

Table 4.3.11-2. Probability of Future Lightning Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Lightning	5	0.08	13.2	0.08	7.6%

Sources: NOAA-NCEI 2016

Based on available historical data, the future occurrence of lightning strikes can be considered *possible* as defined by the Risk Factor Methodology probability criteria (refer to Section 4.4).

Vulnerability Assessment

To understand risk, a community must evaluate the assets that are exposed or vulnerable in the identified hazard area. For lightning events, all of Pike County has been identified as the hazard area. Therefore, all assets (population, structures, critical facilities, and lifelines), as described in Section 2, are potentially vulnerable. This section evaluates and estimates the potential impact of lightning strike events on Pike County including the following subsections:

- Overview of vulnerability
- Data and methodology used for the evaluation



- Impact on (1) life; (2) health and safety; (3) general building stock; (4) critical facilities, (5) economy; and (6) future growth and development
- Effect of climate change on vulnerability
- Additional data and next steps.

Overview of Vulnerability

Evaluation of National Climatic Data Center lightning data for Pike County, along with data from the current and previous versions of the PA HMP, show that while the absolute number of lightning events has changed for individual municipalities, the basic pattern of vulnerability across the County has remained relatively consistent.

The potential for lightning strikes will continue to exist for all municipalities. The direct and indirect losses associated with these events include injury and loss of life, damage to structures and infrastructure, agricultural losses, utility failure (power outages), and stress on community resources.

Pike County is a StormReady county. This designation is obtained through participation in the NWS StormReady Program, which includes the following six guidelines met by the County:

- Communication – A 24-hour warning point (WP) must be fully staffed at all times, and a County Emergency Operations Center (EOC) must be established.
- NWS Information Reception – At least four redundant systems must be in place at the WP to receive weather warnings.
- Hydrometeorological Monitoring – At least four methods of monitoring hydrometeorological data must be available.
- Local Warning Dissemination – At least four redundant systems must be in place to notify the County of severe weather warnings, and there must be National Weather Radio-Specific Area Messaging Encoding receivers in public facilities.
- Community Preparedness – The County must present at least four annual weather safety talks, spotters and dispatchers must be trained biennially, and the County must host or co-host NWS spotter training annually.
- Administration – The County must also meet a number of administrative criteria that include formal hazardous weather operations planning, biennial visits of the County Emergency Management Coordinator (EMC) to the NWS office, and annual visits by an NWS official to the County.

Meeting the criteria of the StormReady program results in a decrease in vulnerability to all severe weather events, including lightning strikes.

Data and Methodology

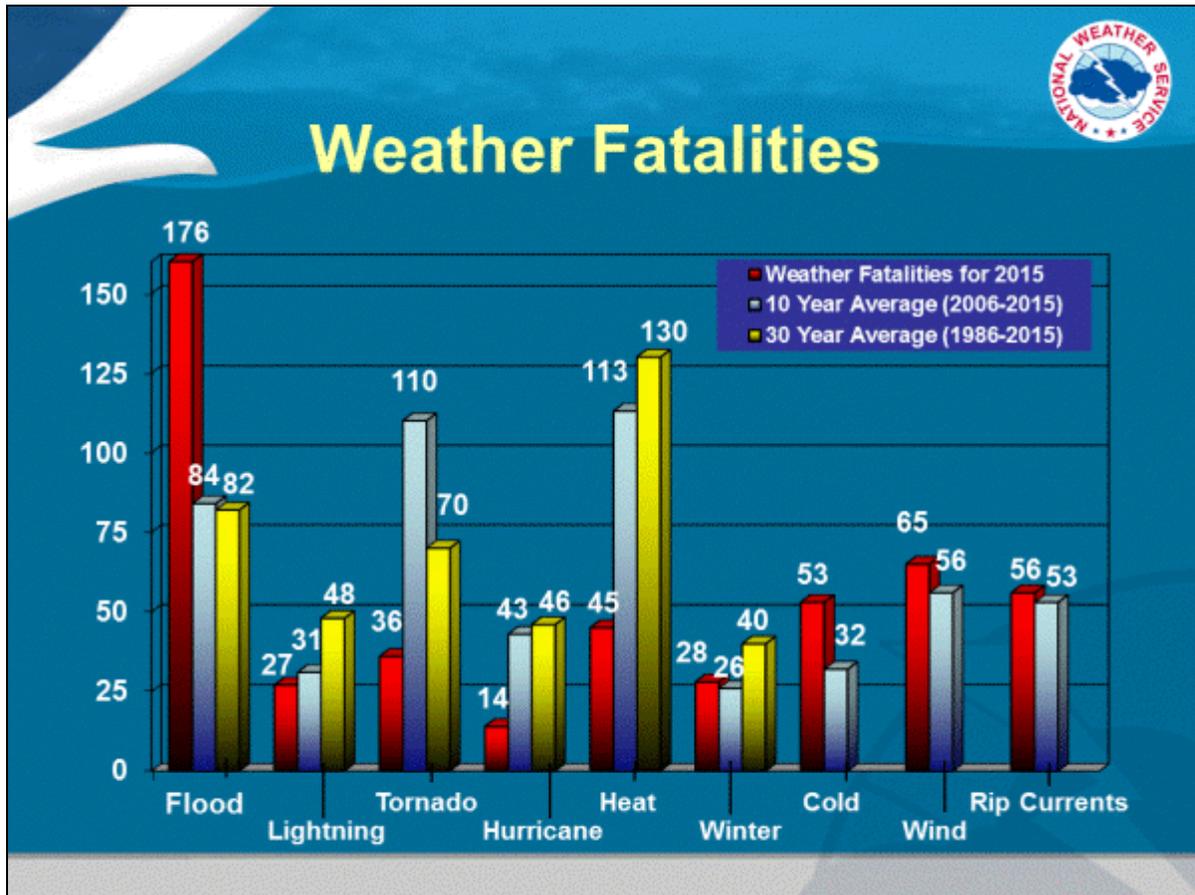
The NOAA, NWS, NCDC, and local resources were used to collect and analyze lightning impacts on Pike County.

Impact on Life, Health, and Safety

Across the United States, the 10-year average (2006 to 2015) for fatalities caused by lightning is 31, while the 30-year average (1986 to 2015) is 52 (NOAA 2016). Figure 4.3.1-1 illustrates these statistics. According to NOAA NCEI, there have been no fatalities or injuries associated with lightning strike events from 1950 to 2016 (NOAA NCEI 2016).



Figure 4.3.11-1. Weather Fatalities in the United States



Source: NOAA 2016



The entire population of the County is considered exposed to the lightning hazard. Lightning strikes in Pennsylvania occur primarily during the summer months. In general, population and building density have a correlation with hazard vulnerability and loss. The more-developed areas of Pike County are at greater risk to lightning strikes than others because of the greater population density. Populations located outdoors are considered at risk and more vulnerable to a lightning strike compared to those inside a shelter. Moving to a lower-risk location will decrease a person’s vulnerability.

Impact on General Building Stock, Critical Facilities, and the Economy

For the purposes of this HMP, the entire general building stock and all infrastructure of Pike County are considered exposed to the lightning strike hazard. In general, developed areas in the County are at greater risk than more rural areas others due to population and structure density. Taller buildings can act as lightning rods; therefore, they naturally have experienced greater vulnerability and loss during past lightning strike events (PEMA 2013).

The precise vulnerability of lightning strikes will depend on a facility’s height in relation to surrounding buildings, as well as the absence or presence of a lightning rod or other lightning channeling technology on the structure. According to the PA HMP, fire departments, schools, and police departments are the most vulnerable to lightning strikes. Food and agriculture facilities that raise livestock may also be more vulnerable to lightning strikes as these animals tend to shelter under trees in storm situations. It is important to note that most of the food and agriculture-related critical facilities are privately owned farms that may own sizeable herds of livestock; however, the Commonwealth critical facilities list does not indicate which of the farms own herds. Finally, if entertainment and recreation facilities include outdoor recreation spaces with wide-open spaces, there may be added lightning strike vulnerability (PEMA 2013).

According to NOAA’s Technical Paper titled *Lightning Fatalities, Injuries, and Damage Reports in the United States from 1959 - 1994*, monetary losses for lightning events range from less than \$50 to greater than \$5 million (larger losses associated with forest fires with homes destroyed and crop loss) (NOAA 1997). Lightning can be responsible for damages to buildings; cause electrical, forest, and/or wildfires; and damage infrastructure such as power transmission lines and communication towers. Agricultural losses caused by lightning and lightning-resulting fires can be devastating.

The 2013 State HMP estimated jurisdictional losses for the 21 counties most vulnerable to lightning strike, including Pike County. Using GIS, losses for the County were estimated to total over \$2.7 million. Note that losses due to lightning strikes will differ based on the magnitude of the event and the lightning protection measures on a given facility (PA HMP 2013).

Future Growth and Development

Areas targeted for potential future growth and development within the next 5 years have been identified across Pike County; refer to Section 2.4 of this HMP. New development is anticipated to be exposed to the lightning strike hazard.

Effect of Climate Change on Vulnerability

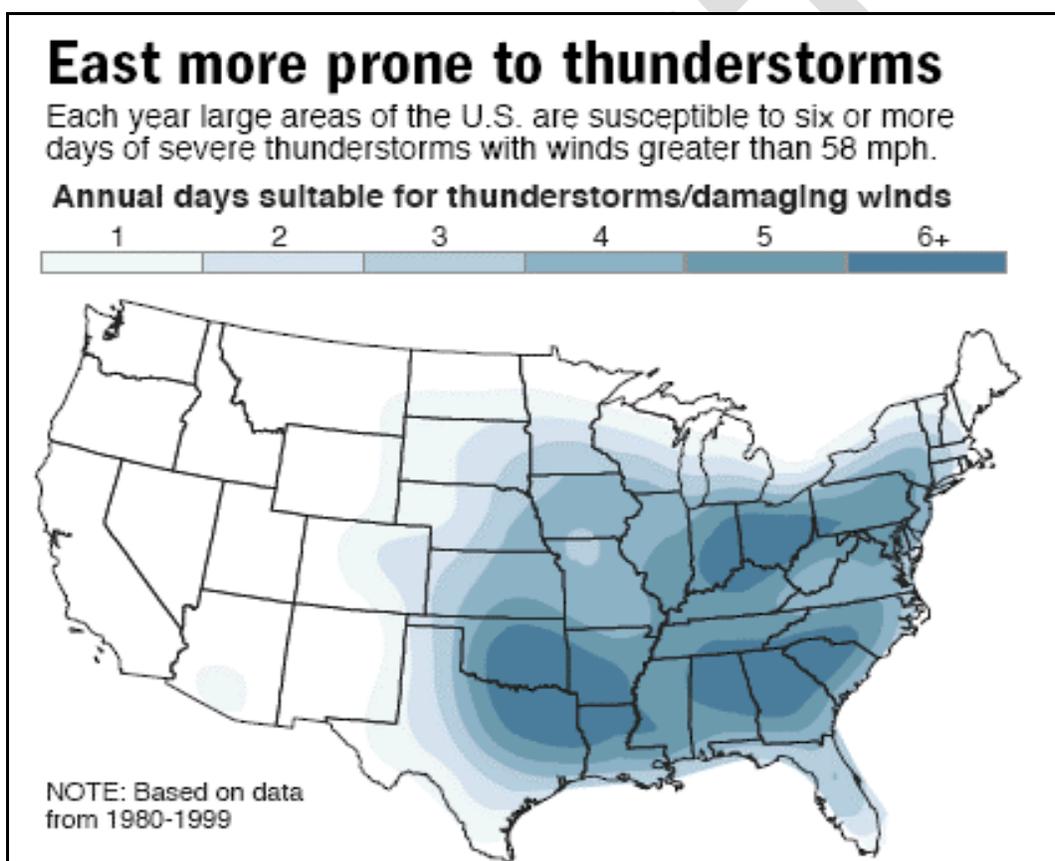
Climate is defined not simply as average temperature and precipitation but also by the type, frequency, and intensity of weather events. Both globally and the local level, climate change has the potential to alter the prevalence and severity of weather extremes such as storms, including those that may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



As the climate changes, temperatures and the amount of moisture in the air will both increase, thus leading to an increase in the severity of thunderstorms which can lead to derechos (or fast-moving windstorm/thunderstorm that moves across a great distance characterized by damaging winds) and tornadoes. Studies have shown that an increase in greenhouse gases in the atmosphere would significantly increase the number of days that severe thunderstorms occur in the southern and eastern United States (NASA 2013). As prepared by the NWS, Figure 4.3.1-2 identifies those areas, particularly within the eastern U.S., that are more prone to thunderstorms, including Pennsylvania.

National Aeronautics and Space Administration (NASA) scientists suggest that the U.S. will face more severe thunderstorms in the future, with deadly lightning, damaging hail, and the potential for tornadoes in the event of climate change. A recent study conducted by NASA predicts that smaller storm events like thunderstorms will also be more dangerous due to climate change.

Figure 4.3.11-2. Annual Days Suitable for Thunderstorms/Damaging Winds



Source: Borenstein, 2007
mph miles per hour

Additional Data and Next Steps

The assessment above identifies vulnerable populations and potential structural and economic losses associated with the lightning strike hazard. Research performed at NOAA and other private organizations is ongoing to improve warning and threat information for the public. The continued collection of additional/actual loss data specific to the Plan participants will further enhance Pike County’s vulnerability assessment.