4.3.6 Extreme Temperature

This section provides a profile and vulnerability assessment of the extreme temperature hazard in Pike County. Extreme temperature includes both heat and cold events, which can have a significant impact to human health, commercial/agricultural businesses and primary and secondary effects on infrastructure (e.g., burst pipes and power failure). What constitutes "extreme cold" or "extreme heat" can vary across different areas of the country, based on what the population is accustomed to.

Extreme cold events are when temperatures drop well below normal in an area. In regions relatively unaccustomed to winter weather, near freezing temperatures are considered "extreme cold." Extreme cold temperatures are generally characterized in temperate zones by the ambient air temperature dropping to approximately 0ºF or below (Centers of Disease Control and Prevention [CDC] 2013). Extremely cold temperatures often accompany a winter storm, which can cause power failures and icy roads. Although staying indoors as much as possible can help reduce the risk of car crashes and falls on the ice, individuals may also face indoor hazards. Many homes will be too cold—either due to a power failure or because the heating system is not adequate for the weather. The use of space heaters and fireplaces to keep warm increases the risk of household fires and carbon monoxide poisoning (CDC 2007).

Conditions of extreme heat are defined as summertime temperatures that are substantially hotter and/or more humid than average for a location at that time of year (CDC 2009). An extended period of extreme heat of three or more consecutive days is typically called a heat wave and is often accompanied by high humidity (NWS 2005). There is no universal definition of a heat wave because the term is relative to the usual weather in a particular area. The term heat wave is applied both to routine weather variations and to extraordinary spells of heat which may occur only once a century (Meehl and Tebaldi 2004). A basic definition of a heat wave implies that it is an extended period of unusually high atmosphere-related heat stress, which causes temporary modifications in lifestyle and which may have adverse health consequences for the affected population (Robinson 2013). A heat wave is defined has three consecutive days of temperatures ≥90°F.

Extreme heat is the number one weather-related cause of death in the U.S. In a ten-year average of weather fatalities across the nation from 2006 to 2015, excessive heat claimed more lives each year than floods, lightning, tornadoes, and hurricanes. In 2015, heat claimed 45 lives, with four occurring in Pennsylvania (NWS 2015).

Location and Extent

Location

Pike County is susceptible to extreme temperatures in the summer and winter seasons and they can occur anywhere in the County. Average minimum temperatures in Pike County ranged from 34°F to 38°F (Figure 4.3.6-1) and average maximum temperatures range from 55°F to 61°F (Figure 4.3.6-2) (PA HMP 2013). The average high temperature in July is 83.6°F and the average low temperature in January is 15.3°F (Sterlings Best Places 2016).

Figure 4.3.6-1. Average Minimum Temperature (1981-2010)

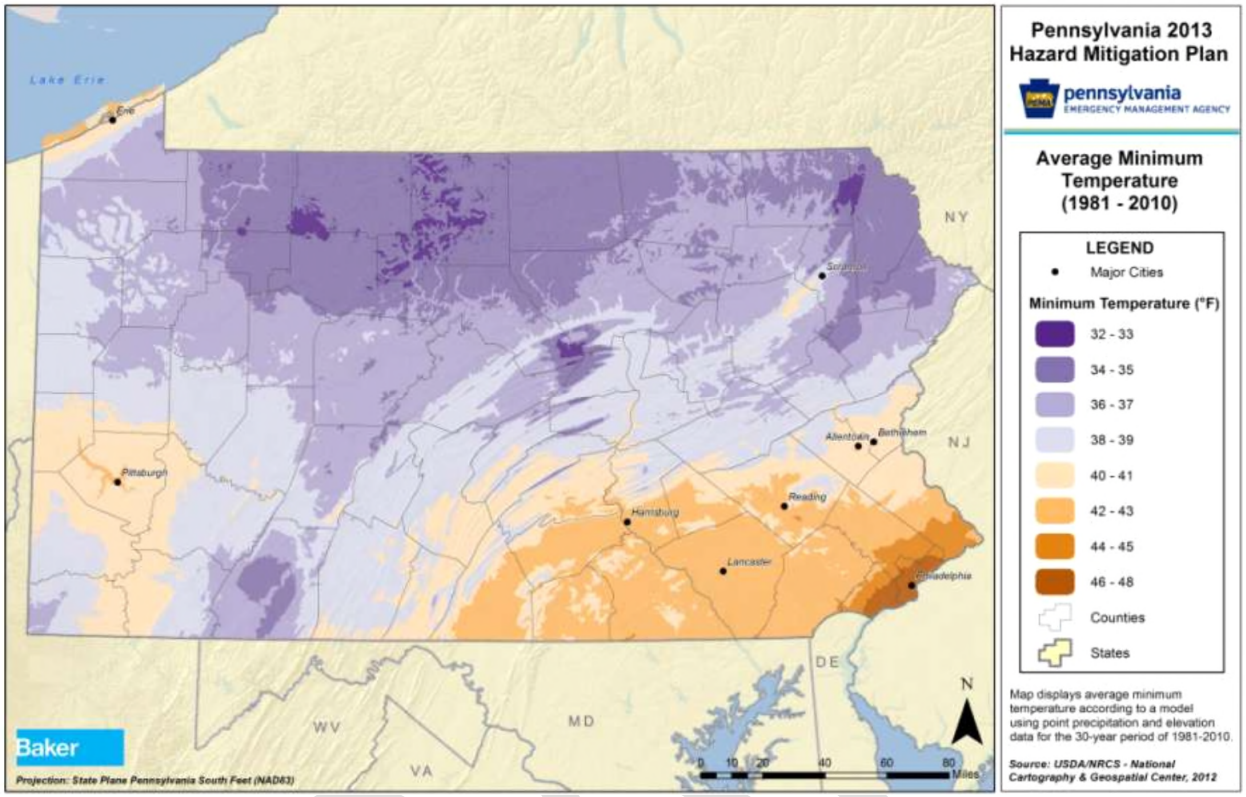
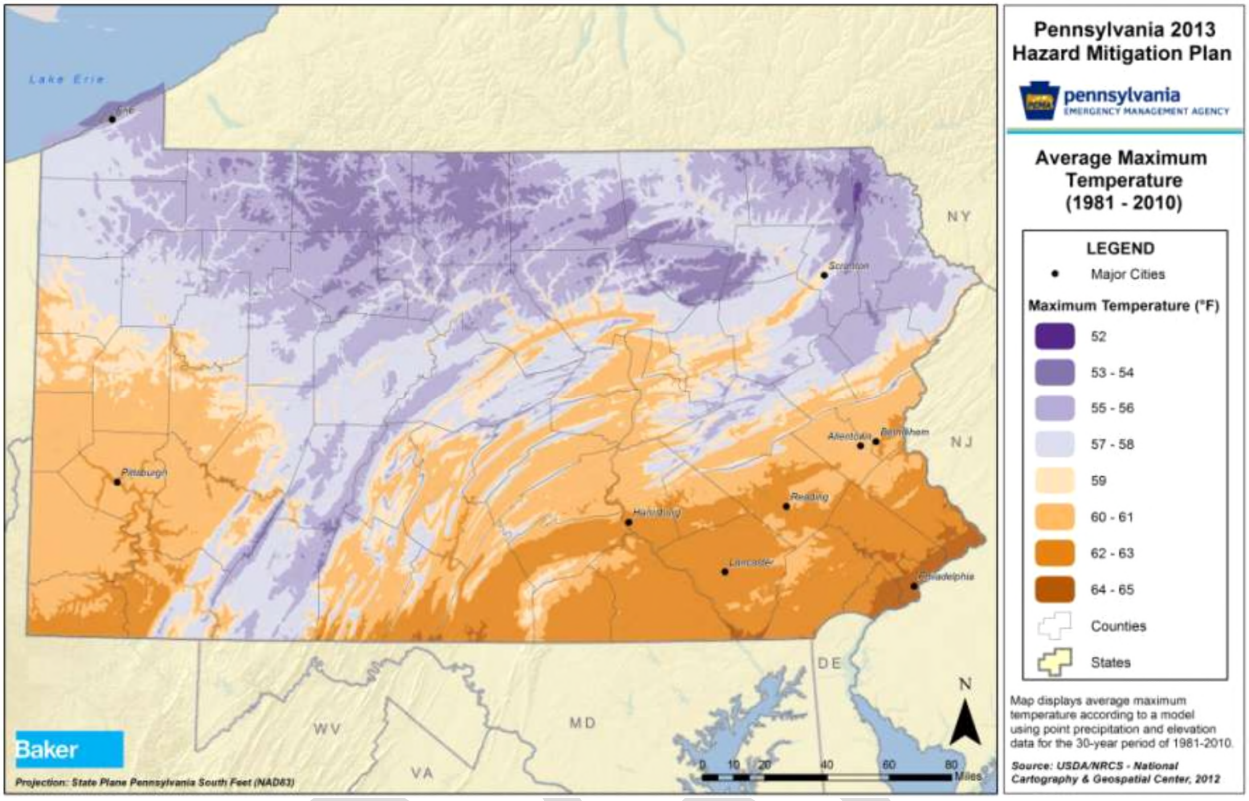


Figure 4.3.6-2. Average Maximum Temperature (1981-2010)

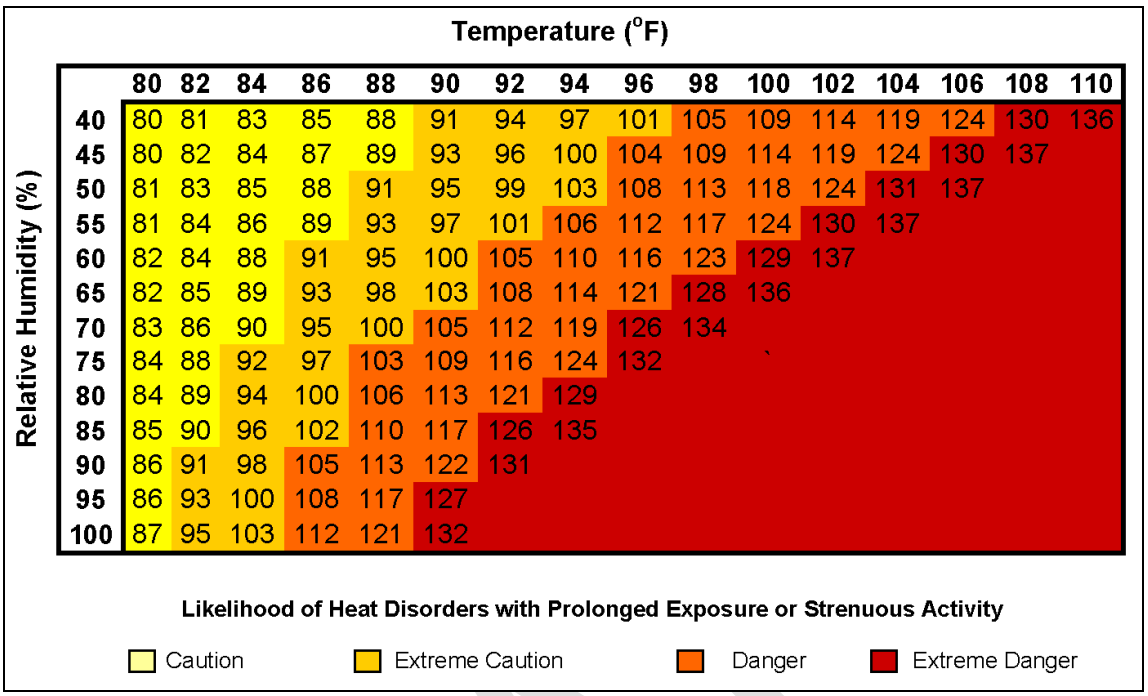


Extent

Extreme Heat

NOAA's heat alert procedures are based mainly on Heat Index values. The Heat Index is given in degrees Fahrenheit. The Heat Index is a measure of how hot it really feels when relative humidity is factored in with the actual air temperature. To find the Heat Index temperature, the temperature and relative humidity need to be known. Once both values are known, the Heat Index will be the corresponding number with both values (Figure 4.3.6-3). The Heat Index indicated the temperature the body feels. It is important to know that the Heat Index values are devised for shady, light wind conditions. Exposure to full sunshine can increase heat index values by up to 15°F. Strong winds, particularly with very hot dry air, can also be extremely hazardous (NWS 2013).

Figure 4.3.6-3. NWS Heat Index Chart



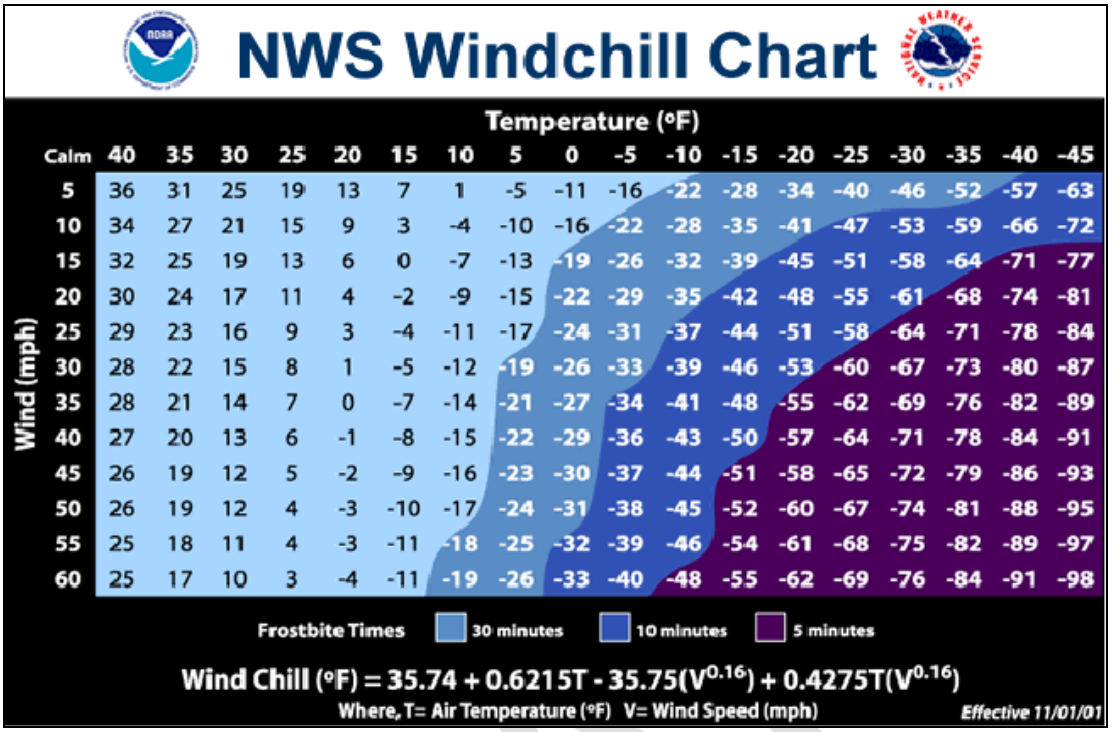
Source: NWS 2015
°F degrees Fahrenheit
% percent

Extreme Cold

The extent (severity or magnitude) of extreme cold temperatures are generally measured through the Wind Chill Temperature (WCT) Index. Wind Chill Temperature is the temperature that people and animals feel when outside and it is based on the rate of heat loss from exposed skin by the effects of wind and cold. As the wind increases, the body is cooled at a faster rate causing the skin's temperature to drop (NWS Date Unknown).

On November 1, 2001, the NWS implemented a new WCT Index. It was designed to more accurately calculate how cold air feels on human skin. The table below shows the new WCT Index. The WCT Index includes a frostbite indicator, showing points where temperature, wind speed, and exposure time will produce frostbite to humans. Figure 4.3.6-4 shows three shaded areas of frostbite danger. Each shaded area shows how long a person can be exposed before frostbite develops (NWS Date Unknown).

Figure 4.3.6-4. NWS Wind Chill Index



Source: NWS Date Unknown
°F degrees Fahrenheit
mph miles per hour

Range of Magnitude

Extreme temperatures can cause a range of impacts to communities that include health impacts, transportation, agriculture, and energy.

Meteorologists can accurately forecast extreme temperature event development and the severity of the associated conditions with several days lead time. These forecasts provide an opportunity for public health and other officials to notify vulnerable populations. For heat events, the NWS issues excessive heat outlooks when the potential exists for an excessive heat event in the next three to seven days. Watches are issued when conditions are favorable for an excessive heat event in the next 24 to 72 hours. Excessive heat warning/advisories are issued when an excessive heat event is expected in the next 36 hours (NWS 2013d). Winter temperatures may fall to extreme cold readings with no wind occurring. Currently, the only way to headline very cold temperatures is with the use of the NWS-designated Wind Chill Advisory or Warning products. When actual temperatures reach Wind Chill Warning criteria with little to no wind, extreme cold warnings may be issued (NWS Date Unknown).

Cold temperatures can be dangerous to humans and animals exposed to the cold. Without heat and shelter, cold temperatures can lead to hypothermia, frostbite, and even death. As stated above, cold temperatures are typically measured through the Wind Chill Temperature index. The values represent what the temperature actually feels like to humans and animals under cold, windy conditions. The effect of cold temperatures will vary by individual (CDC 2012).

Extremely high temperatures cause heat stress which can be divided into four categories (Figure 4.3.6-5). Each category is defined by apparent temperature which is associated with a heat index value that captures the

combined effects of dry air temperature and relative humidity on humans and animals. Major human risks for these temperatures include heat cramps, heat syncope, heat exhaustion, heatstroke, and death. Although the figure below serves as a guide for various danger categories, the impacts of high temperatures will vary from person to person based on age, health and other factors. The elderly and very young are most vulnerable to health-related impacts of extreme temperatures (PA HMP 2013).

Figure 4.3.6-5. Adverse Effects of Prolonged Exposures to Heat on Individuals

Category	Heat Index	Health Hazards
Extreme Danger	130 °F – Higher	Heat Stroke / Sunstroke is likely with continued exposure.
Danger	105 °F – 129 °F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Extreme Caution	90 °F – 105 °F	Sunstroke, muscle cramps, and/or heat exhaustions possible with prolonged exposure and/or physical activity.
Caution	80 °F – 90 °F	Fatigue possible with prolonged exposure and/or physical activity.

Source: NWS 2009

Past Occurrence

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

Based on the Midwestern Regional Climate Center (MRCC) data, Table 4.3.6-1 presents the extreme cold (minimum) and hot (maximum) temperature records for the weather stations located in Pike County between 1895 and 2016.

Table 4.3.6-1.MRCC Temperature Extremes

Station Name	Average Maximum (°F)	Average Minimum (°F)	Highest Max (°F)	Date	Lowest Minimum (°F)	Date
Hawley 1 E	59	35	100	8/26/1948	-31	1/21/1994
Matamoras	61	38	102	7/3/1966	-18	1/13/1981

Source: MRCC 2016

Note: There may be some potential problems with the data collected at the stations. The values of the all-time records for stations with brief histories are limited in accuracy and could vary from nearby stations with longer records. Although the data sets have been through quality control, there is still a need for more resources to quality control extremes. The record sets are for single stations in the cooperative observer network and are limited to the time of operation of each station under one coop number. The records for a place may need to be constructed from several individual station histories. Some of the data may vary from NWS records due to NWS using multiple stations and additional sources like record books (MRCC, Date Unknown).

Between 1954 and 2016, Pennsylvania has not been included in major disaster (DR) or emergency (EM) declarations as a result of extreme temperatures (FEMA 2016). Agriculture-related disaster declarations are quite common. One-half to two-thirds of the counties in the U.S. have been designated as disaster areas in each of the past several years. The USDA Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2012 and 2016, Pennsylvania has been included in 25 USDA declarations related to extreme temperatures. Pike County has been included in three of these declarations.

- S3487 – June – November 2012 - The combined effects of drought, high winds (derecho), hail, excessive heat, excessive rain, flash flooding, Hurricane Sandy, snowstorm, and Nor'easter
- S3696 – December 2013-April 2014 – Freeze
- S3930 – April-September 2015 – Excessive heat and drought

Table 4.3.6-2 discusses extreme temperature events that occurred in Pike County. Between 1950 and 2016, Pike County has experienced 113 extreme temperature events (Pennsylvania State Climatologist 2016; NOAA-NCEI 2016). However, details for all events were not readily available. As stated above, many sources were researched for historical information regarding extreme temperature events; however, the table below many not include all extreme temperature events that have impacted Pike County.

Table 4.3.6-2. Extreme Temperature Events in Pike County, 1950 to 2016

Date(s) of Event	Event Type	Description
October 4, 1996	Cold/Wind Chill	A very cold air mass moved into central New York State and northeastern Pennsylvania. Widespread freeze conditions were observed. In Pike County, the Hawley weather station recorded a low of 25°F on October 4th.
January 17, 1997	Cold/Wind Chill	An arctic air mass moved into northeast Pennsylvania and lasted for two days. Air temperatures dropped to near zero over much of the region. During the day, readings only reached single digits and lower teens. At night, temperatures ranged from -5°F to -15°F. In addition to the cold temperatures, strong winds impacted the area as well. Wind chills of -35° to -55°F were common over the northern tier of the Commonwealth. In Pike County, the Hawley weather station recorded a low of 6°F on the 17th.
September 28-29, 2000	Extreme Cold/Wind Chill	A widespread freeze occurred across central New York State and northeastern Pennsylvania. Temperatures below 30 degrees were observed. In Pike County, at the Hawley weather station, temperature lows of 28°F and 34°F were recorded for those dates.
August 1-10, 2001	Heat	The first nine days of August included a significant heat wave. Locations in northeast Pennsylvania reported temperatures in the upper 90s to lower 100s. Numerous high temperature records were set during this time. The heat wave peaked on the 9th when many locations saw temperatures above 100°F. In Pike County, between August 7th and 9th, temperatures were in the low to mid 90s. At the Hawley NWS weather station, temperatures ranged from 92°F to 94°F, with the highest temperature recorded on August 9th. At the Matamoras weather station, temperatures during this time period ranged from 93°F to 99°F, with the highest temperature recorded on August 10th.
January 10, 2004	Cold/Wind Chill	Cold temperatures moved into northeast Pennsylvania bringing cold temperatures of below zero to most locations. In Pike County, at the Hawley weather station, the maximum temperature for the 10th was 6°F and the minimum temperature was -8°F. The County had approximately $5,000 in property damage from this event.
January 15-16, 2004	Cold/Wind Chill	Cold temperatures and winds of 15 to 25 mph impacted northeastern Pennsylvania. The combination of the cold and wind produced wind chill values of -15°F to -35°F. Many schools were closed due to the temperatures. The temperatures also caused problems with cars and busses. Some residences and businesses had damage from frozen pipes. In Pike County, the maximum temperatures for these two days ranged from 7°F to 9°F and the minimum temperatures ranged from -3°F to -6°F (recorded at the Hawley weather station). Damages in the county were approximately $10,000 form this event.
December 14, 2005	Cold/Wind Chill	Arctic cold air caused morning temperatures to be below zero, with most between -5°F and -10°F. Temperatures in Pike County ranged from 0°F to -11°F.
July 21-23, 2011	Excessive Heat	For three days, high temperatures across parts of northeastern Pennsylvania rose above the 90s. In Pike County, temperatures across the county reached well into the 90s. At the Hawley weather station, temperatures ranged from 87°F to 95°F.
January 6-7, 2014	Arctic Air	An arctic airmass moved over central New York State and northeast Pennsylvania producing dangerously cold wind chill values as low as -30°F. In Pike County, -8°F

Date(s) of Event	Event Type	Description
		was recorded at the Hawley weather station.
February 14, 2016	Cold Temperatures	Arctic air spread across parts of central New York State and northeast Pennsylvania. This produced record low temperatures in some locations. A maximum low of -11°F was recorded at the Hawley weather station.

Sources: NOAA NCEI 2016; NWS 2016; Pennsylvania State Climatologist 2016

Future Occurrence

Extreme temperature events occur each year throughout Pike County. It is estimated that the county will continue to experience temperature extremes annually that may induce secondary hazards such as potential snow, hail, ice or wind storms, thunderstorms, drought, human health impacts, utility failures, and transportation accidents.

For the 2017 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of extreme temperature events for Pike County. Information from NOAA-NCEI storm events database and Pennsylvania State Climatologist were used to identify the number of extreme temperature 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 100-percent chance of an extreme temperature event occurring in any given year in Pike County.

Table 4.3.6-3. Probability of Future Extreme Temperature 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
Extreme Temperature	113	1.74	0.58	1.71	100%

Sources: NOAA-NCEI 2016; Pennsylvania State Climatologist 2016

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

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For the extreme temperature events, the entire County has been identified as the hazard area. Therefore, all assets in the County (population, structures, critical facilities and lifelines), as described in the County Profile (Section 2), are vulnerable. The following text evaluates and estimates the potential impact of extreme temperatures on Pike County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety of residents, (2) general building stock, (3) critical facilities (4) economy and (5) future growth and development
- Effect of climate change on vulnerability
- Further data collections that will assist understanding of this hazard over time

Overview of Vulnerability

Extreme temperatures generally occur for a short period of time but can cause a range of impacts, particularly to vulnerable populations that may not have access to adequate cooling or heating. This natural hazard can also cause impacts to agriculture (crops and animals), infrastructure (e.g., through pipe bursts associated with freezing, power failure) and the economy.

Data and Methodology

Data was collected from USDA, NOAA-NCDC, Pennsylvania State Climatologist, Pike County, and the Planning Committee sources. Insufficient data was available to model the long-term potential impacts of extreme temperature on the County. Over time, additional data will be collected to allow better analysis for this hazard. Available information and a preliminary assessment are provided below.

Impact on Life, Health, and Safety

For the purposes of this HMP, the entire population of Pike County is exposed to extreme temperature events.

Extreme temperature events have potential health impacts including injury and death. According to the Centers for Disease Control and Prevention, populations most at risk to extreme cold and heat events include the following: 1) the elderly, who are less able to withstand temperatures extremes due to their age, health conditions and limited mobility to access shelters; 2) infants and children up to four years of age; 3) individuals who are physically ill (e.g., heart disease or high blood pressure), 4) low-income persons that cannot afford proper heating and cooling; and 5) the general public who may overexert during work or exercise during extreme heat events or experience hypothermia during extreme cold events (CDC, 2006).

Meteorologists can accurately forecast extreme heat event development and the severity of the associated conditions with several days of lead time. These forecasts provide an opportunity for public health and other officials to notify vulnerable populations, implement short-term emergency response actions and focus on surveillance and relief efforts on those at greatest risk. Adhering to extreme temperature warnings can significantly reduce the risk of temperature-related deaths.

Impact on General Building Stock

All of the building stock in the County is exposed to the extreme temperature hazard. Refer to Section 2 which summarizes the building inventory in Pike County. Extreme heat generally does not impact buildings. Losses may be associated with the overheating of heating, ventilation, and air conditioning (HVAC) systems. Extreme cold temperature events can damage buildings through freezing/bursting pipes and freeze/thaw cycles. Additionally, manufactured homes (mobile homes) and antiquated or poorly constructed facilities may have inadequate capabilities to withstand extreme temperatures.

Impact on Critical Facilities

All critical facilities in the County are exposed to the extreme temperature hazard. Impacts to critical facilities are the same as described for general building stock. Additionally, it is essential that critical facilities remain operational during natural hazard events. Extreme heat events can sometimes cause short periods of utility failures, commonly referred to as “brown-outs”, due to increased usage from air conditioners, appliances, etc. Similarly, heavy snowfall and ice storms, associated with extreme cold temperature events, can cause power interruption as well. Backup power is recommended for critical facilities and infrastructure.

Impact on the Economy

Extreme temperature events also have impacts on the economy, including loss of business function and damage/loss of inventory. Business-owners may be faced with increased financial burdens due to unexpected repairs caused to the building (e.g., pipes bursting), higher than normal utility bills or business interruption due to power failure (i.e., loss of electricity, telecommunications).

The agricultural industry is most at risk in terms of economic impact and damage due to extreme temperature events. Extreme heat events can result in drought and dry conditions and directly impact livestock and crop production. Based on the 2012 Census of Agriculture, there were 50 farms in Pike County, with a total of 28,260 acres of land in farms. The average farm size was 565 acres. Pike County's farms had a total market value of products sold of over $2.9 million, averaging over $59,000 per farm. The Census indicated that 17 of farm operators reported farming as their primary occupation (USDA 2012).

An extreme heat event could result in drought conditions and have a serious impact on a community. During an extreme temperature event, there may be an increased demand for water and electricity which may lead to shortages and a higher cost for these resources.

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. Any areas of growth could be potentially impacted by the extreme temperature hazard because the entire County is exposed and potentially vulnerable.

Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of extremes such as extreme temperature events. While predicting changes of extreme temperature 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).

Additional Data and Next Steps

For future plan updates, the County can track data on extreme temperature events, obtain additional information on past and future events, particularly in terms of any injuries, deaths, shelter needs, pipe freeze, agricultural losses and other impacts. This will help to identify any concerns or trends for which mitigation measures should be developed or refined. In time, quantitative modeling of estimated extreme heat and cold events may be feasible as data is gathered and improved.