5.4.4 Extreme Temperatures

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the extreme temperature hazard in Morris County.

2015 Plan Update Changes

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, probability of future occurrence, and potential change in climate and its impacts on the extreme temperature hazard is discussed. The extreme temperature hazard now contains both cold and heat events and is now located in Section 5 of the plan update.
- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2010 and 2014.
- A vulnerability assessment was conducted for the extreme temperature hazard and it now directly follows the hazard profile.

5.4.4.1 Profile

Hazard Description

Extreme temperature includes both heat and cold events, which can have significant impact to human health, commercial/agricultural businesses, and primary and secondary effects on infrastructure (e.g., burst pipes and power failures). What constitutes as extreme cold or extreme heat can vary across different areas of the U.S., 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] 2005). 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, 2000). 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. On average, excessive heat claims more lives each year than floods, lightning, tornadoes, and hurricanes combined (NOAA Date Unknown). In 2012, heat had the highest average of weather-related fatalities nationally; 155 fatalities reported, one of which was in the State of New Jersey (NOAA 2012).

Location

According to the ONJSC, New Jersey has five distinct climate regions. Elevations, latitude, distance from the Atlantic Ocean, and landscape (e.g. urban, sandy soil) produce distinct variations in the daily weather between each of the regions. The five regions include: Northern, Central, Pine Barrens, Southwest, and Coastal (ONJSC Rutgers University, Date Unknown). A majority of Morris County is located within the North Climate Region with the southeastern portion located in the Central Climate Region.

The Northern Region covers about one-quarter of New Jersey and consists mainly of elevated highlands and valleys which are part of the Appalachian Uplands. Being in the northernmost portion of the State, and with small mountains up to 1,800 feet in elevation, this Region normally exhibits a colder temperature regime than other climate regions of the State. This difference is most dramatic in winter when average temperatures in the Northern Region can be more than 10°F cooler than in the Coastal Zone (ONJSC Rutgers University 2014).

The Central Region has a northeast to southeast orientation, running from New York Harbor and the Lower Hudson River to the great bend of the Delaware River in the vicinity of Trenton. This region has many urban locations and the concentration of buildings and impervious surfaces tend to retain more heat; thereby, affecting the local temperatures. The observed nighttime temperatures in heavily developed areas of this region are typically warmer than surrounding suburban and rural areas due to the amount of asphalt, brick, and concrete. The northern edge of the Central Region is often the boundary between freezing and non-freezing precipitation during the winter months. Areas in the southern part of this region tend to have nearly twice as many days with temperatures above 90°F than other locations in the central portion of the State (ONJSC Rutgers University 2014).

Temperature extremes can occur throughout the entire State. In New Jersey, average days per year where temperatures reach 90°F or higher range from five days to over 30 days, depending on location. Morris County has an average of 14 to 18 days of temperatures in excess of 90°F; 2 days of temperatures in excess of 95°F; and 0.2 days of temperatures in excess of 100°F (ONJSC 2013).

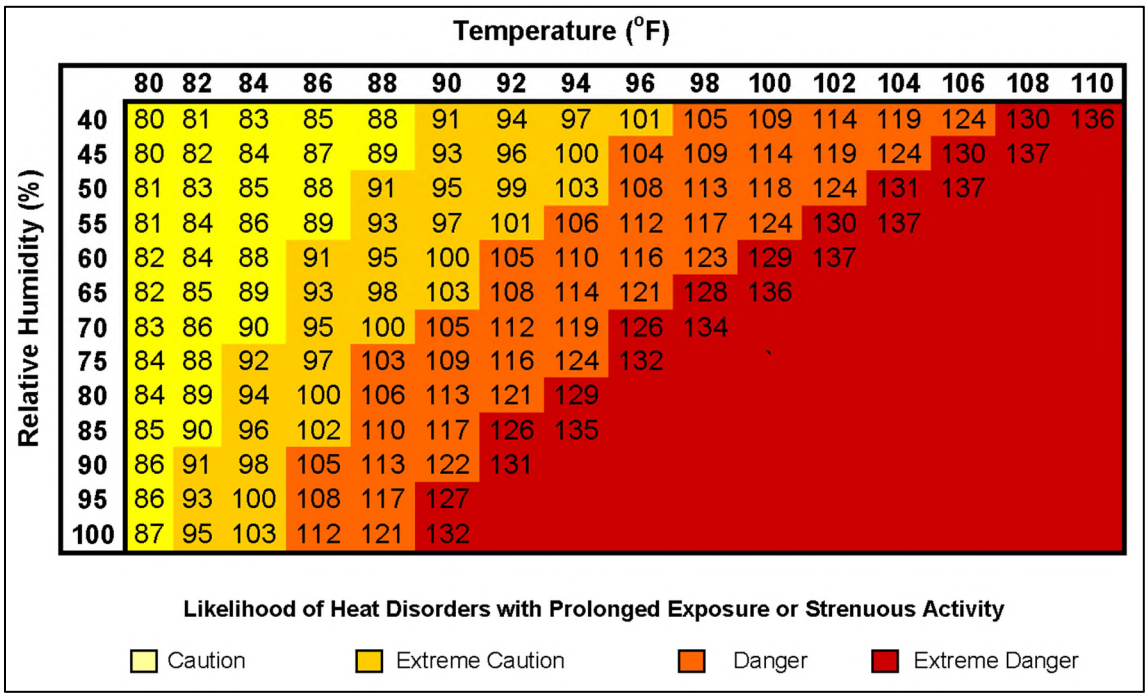
Average days per year when temperatures reached less than 32°F in New Jersey range from six days in the southern part of the State to over 45 days in northern New Jersey. Morris County has an average of 22 to 23 days of temperatures below 32°F; 2.2 to 4.8 days of temperatures below 0°F (ONJSC 2013).

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 5.4.4-1). 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 5.4.4-1. NWS Heat Index Chart



Source: NWS 2013
°F degrees Fahrenheit
% percent

Figure 5.4.4-2. 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.

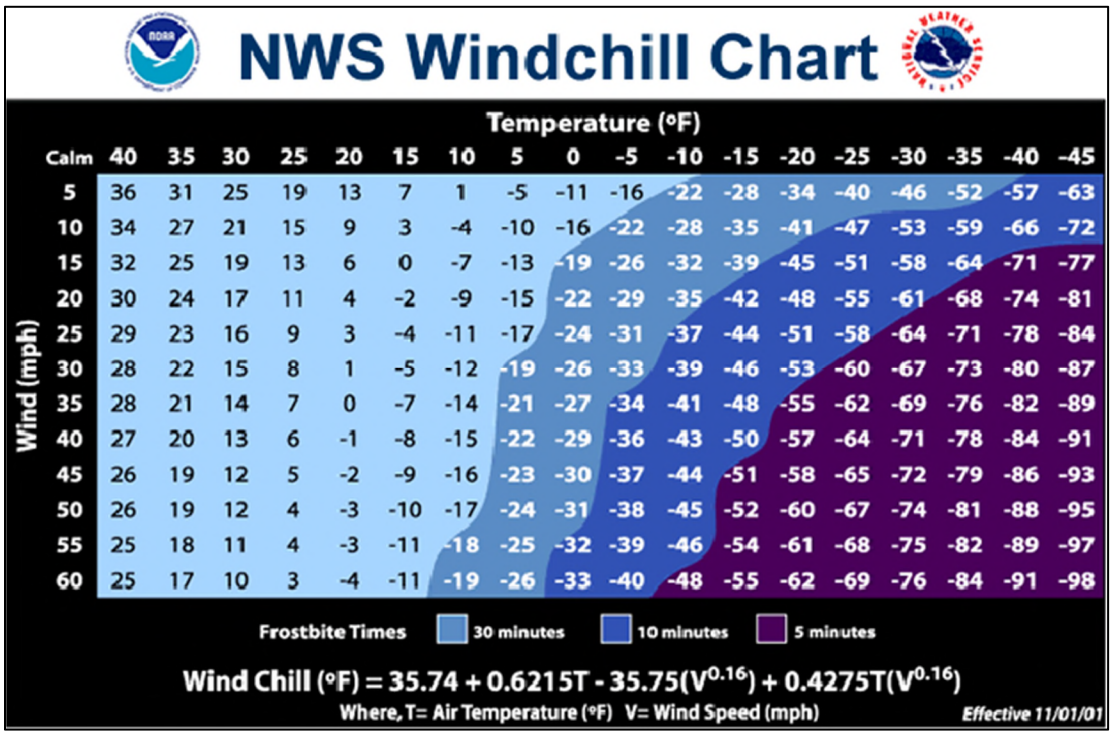
Source: NWS 2009
°F degrees Fahrenheit

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 5.4.4-3 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 5.4.4-3. NWS Wind Chill Index



Source: *NWS 2009b*
°F *degrees Fahrenheit*
mph *miles per hour*

Warning Time

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 2013). 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 (NOAA 2013).

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with extreme temperature events throughout the State and Morris 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.

The NWS Forecast Office operates an online annual temperature extremes database, known as "NOWData". The data set contains annual maximum and minimum temperature records for stations in the U.S. Each station has a cooperative observer system identification number (coop number). In the New York City Cooperative Area, there are over 25 stations, including three in Morris County (Boonton, Chatham and Pottersville). 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). Based on the NWS data, Table 5.4.4-1 presents the extreme cold (minimum) and hot (maximum) temperature records for the three weather stations located in Morris County between 2008 and 2014.

Table 5.4.4-1. MRCC Temperature Extremes

Station Name	Average Maximum (°F)	Average Minimum (°F)	Mean (°F)	Highest Max (°F)	Date	Lowest Minimum (°F)	Date
Boonton	64	44	53.6	102	7/8/2012	-0	1/23/2014
Chatham	64	43	53.5	104	7/19/2012	-3	1/18/2009
Pottersville	62	44	53.3	102	7/23/2011	1	1/4/2014

Source: MRCC 2014

Agriculture-related drought disasters 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 2014, New Jersey has been included in seven USDA declarations. Of those seven declarations, Morris County has been included in one as a result of drought conditions (S3487 in 2012).

For this 2015 Plan Update, known extreme temperature events that have impacted Morris County between 2008 and 2014 are identified in Appendix G. For events that occurred prior to 2008, see the 2010 Morris County HMP. Between 1954 and 2014, FEMA has not included the State of New Jersey in any temperature-related declarations. Please note that not all events that have occurred in Morris 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. Please see Section 9 for detailed information, if any, regarding impacts and losses to each municipality.

Probability of Future Occurrences

Extreme temperatures are expected to occur more frequently as part of regular seasons. Specifically, extreme heat will continue to impact New Jersey and its counties and, based upon data presented, will increase in the next several decades. As previously stated, several extreme temperature events occur each year in Morris County. It is estimated that the County will continue to experience these events annually.

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

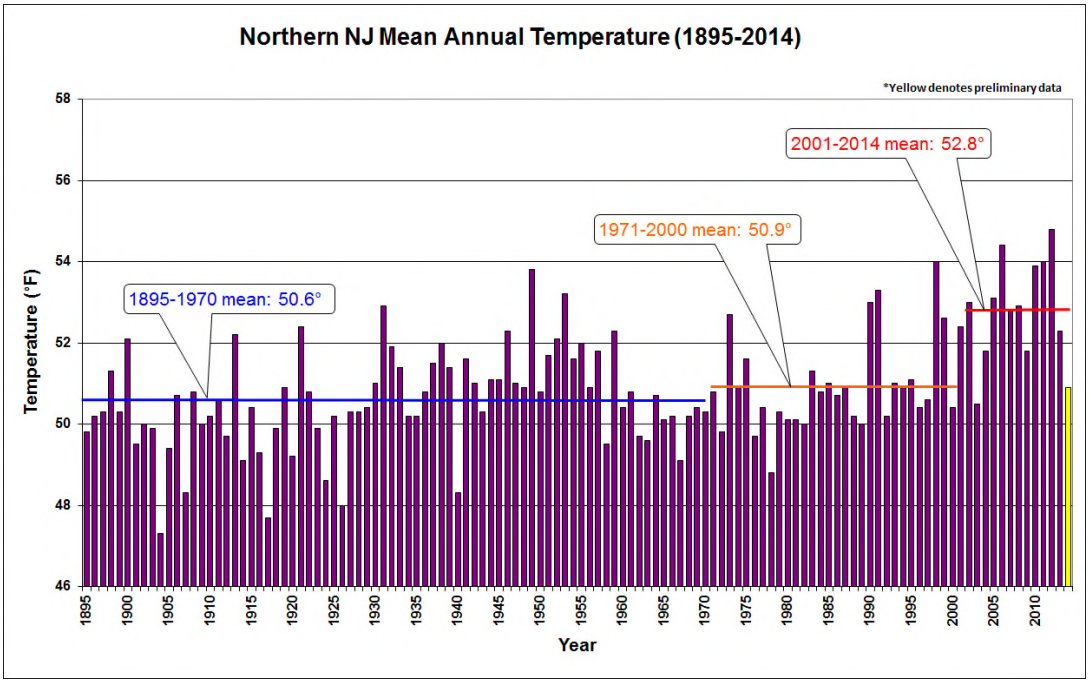
Climate Change Impacts

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes.

Temperatures in the Northeast United States have increased 1.5 degrees Fahrenheit (°F) on average since 1900. Most of this warming has occurred since 1970. The State of New Jersey, for example, has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and the most recent decade of 2001-2010 (ONJSC, 2011). Winter temperatures across the Northeast have seen an increase in average temperature of 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013).

Annual average temperatures have been rising in the northeastern United States since 1900, with the regional warming trend greater in the Northeast than in the United States as a whole. Data collected by ONJSC shows a statistically significant rise in average statewide temperature over the last 113 years. Since 1970, the average annual temperature in the Northeast has increased by 2°F. Average winter temperatures have increased by 4°F (Rutgers 2013). Over the next 100 years, temperatures across the Northeast are projected to increase, with larger increases under higher emissions scenarios to lower emissions scenarios, and greater increases in summer as compared to winter temperatures by the end of the century. In the Northeast, increases in annual average temperature above the baseline are expected to range from 1.5°F to 3°F by the 2020s, 3°F to 6°F by the 2050s, and from 3.5°F to 10°F by the 2080s, reflecting a range of emissions scenarios from low to high (Rutgers 2013). FIGURE illustrates the monthly mean temperatures in northern New Jersey from 1895 to 2015. As shown in this figure, the mean temperature for northern New Jersey has steadily increased. More recently, the yearly average for 2004 to 2013 have all been above the calculated normal for this climate division.

Figure 5.4.4-4. Monthly Mean Temperatures in Northern New Jersey, 1895 to 2015



5.4.4.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For extreme temperatures, the entirety of Morris County has been identified as exposed to this hazard. Therefore, all assets in the County (population, structures, critical facilities and lifelines), as described in the County profile, are exposed and potentially vulnerable. The following text evaluates and estimates the potential impact of extreme temperature on the 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
- Change of vulnerability as compared to that presented in the 2010 Morris County Hazard Mitigation Plan
- Further data collections that will assist understanding 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

At the time of this Plan, insufficient data is available to model the long-term potential impacts of extreme temperature on Morris 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 in Morris County is exposed to extreme temperature events. Refer to Section 4 for a summary of population statistics for the County.

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.

The increase in the number of extreme heat days will lead to more heat related illness. Also, with an increase in severe storms there will be an increase in stormwater runoff which may be polluted and sicken individuals (Kaplan and Herb 2012). The effect on public health will likely increase the need for vulnerable population planning and may place heavier burdens on the healthcare system.

Impact on General Building Stock

All of the building stock in the County is exposed to the extreme temperature hazard. Refer to Section 4 which summarizes the building inventory in Morris 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 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. See the Impact on the Economy section of the drought hazard profile (Section 5.4.2) for information regarding the impact on the agriculture as result of a drought in the County.

Future Growth and Development

As discussed in Sections 4 and 9, areas targeted for future growth and development have been identified across Morris County. Any areas of growth could be potentially impacted by the extreme temperature hazard because the entire County is exposed and vulnerable. Please refer to the specific areas of development indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 of this plan.

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).

Climate Change in New Jersey: Trends and Projections describes changes in temperature, precipitation, and sea level rise. Each section of the report summarizes observed recent changes in climate in New Jersey. Observations are based on recorded climate data collected by the ONJSC and other institutions, and on other reports summarizing climate change in the northeastern United States. Each section also presents a synthesis of the most current projections for future climate changes based on climate science modeling and techniques. The

projections reflect potential average climate over a span of future years (2020, 2050, and 2080). The projections in the report illustrate the potential climate changes that could impact the northeastern United States based on future emissions scenarios (A2, A1B, and B1 – high, medium, and low scenarios). Each emissions scenario would result in a range of potential climate outcomes in the State (Rutgers 2013).

In the coming years, most studies project that the State of New Jersey can expect an increase in average annual temperature, and steady or increasing amounts of precipitation with more rain in the winter. More frequent extreme events are likely, including heat waves, short-term droughts, and extreme precipitation events with subsequent flooding. Sea level rise in New Jersey is already occurring faster than the global average rate because of land subsidence and ground water withdrawal, and a continued rate of rise is expected to lead to more frequent and more severe coastal flooding events, including those associated with hurricane and tropical storms (Rutgers 2013).

Change of Vulnerability

Overall, the County's vulnerability has not changed and the entire County will continue to be exposed and vulnerable to the extreme temperature events.

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.