4.3.6 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 Gloucester County.

2022 Plan Update Changes

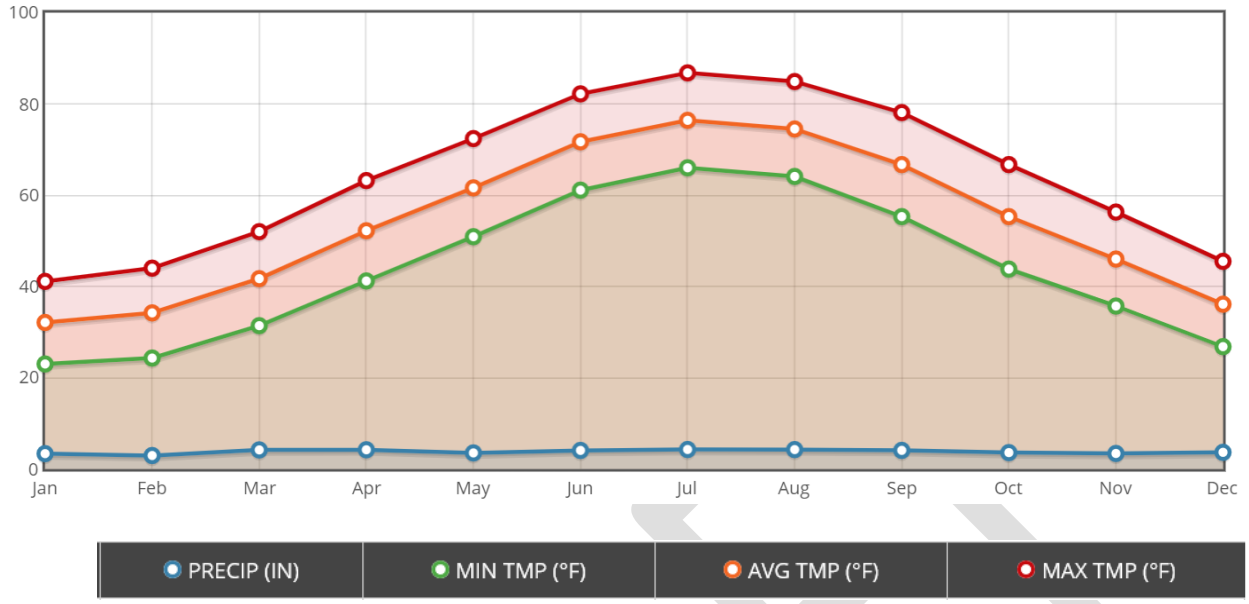
- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, probability of future occurrence, and climate change impacts.
- New and updated figures from other federal and state agencies are incorporated.
- Previous occurrences are updated with events that occurred between 2015 and 2021.
- A vulnerability assessment section is completed for the extreme temperature hazard. Available information and a preliminary assessment are used to complete this section. The vulnerability assessment directly follows the hazard profile.

4.3.6.1Profile

Hazard Description

Extreme temperature includes both heat and cold events that can have significant direct impacts to human health and commercial/agricultural businesses and primary and secondary effects on infrastructure (e.g., burst pipes and power failure). Distinguishing characteristics of "extreme cold" or "extreme heat" vary by location, based on the conditions to which the population is accustomed. Figure 4.3.6-1 shows the average low and high temperatures each month at the Hammonton Station in Atlantic County (no stations are located within Gloucester County).

Figure 4.3.6-1. Average Temperatures at Hammonton Station



Source: NWS 2021

Extreme Cold

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 (CDC 2007). 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).

Extreme Heat

Extreme heat is defined as temperatures which hover 10 degrees or more above the average high temperature for a region and that last for several weeks (CDC 2016). A heat wave is defined as a period of abnormally and uncomfortably hot and unusually humid weather. Typically, a heat wave lasts two or more days (NWS 2009). 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 2004).

Urbanized areas and urbanization create an exacerbated type of risk during an extreme heat event, compared to rural and suburban areas. As defined by the U.S. Census, urban areas are classified as all territory, population, and housing units located within urbanized areas and urban clusters. The term urbanized area denotes an

urban area of 50,000 or more people. Urban areas under 50,000 people are called urban clusters. The U.S. Census delineates urbanized area and urban cluster boundaries to encompass densely settled territory, which generally consists of:

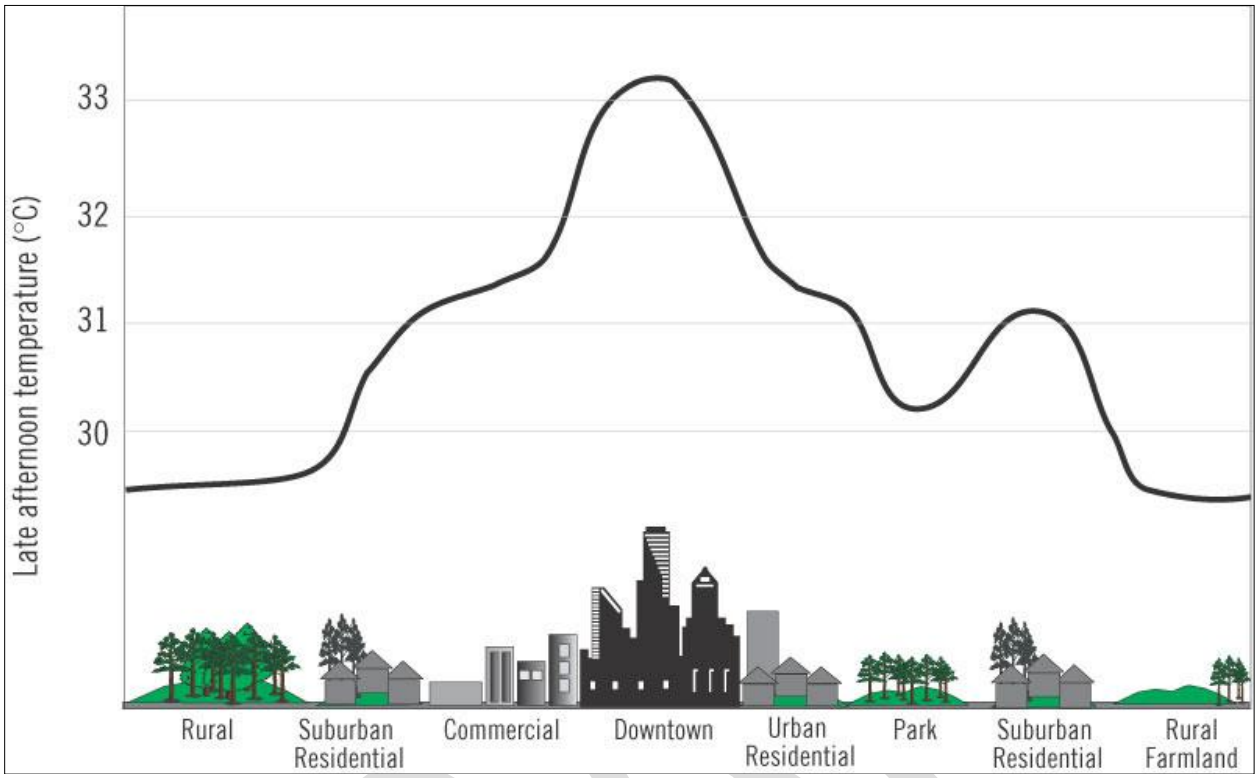
- A cluster of one or more block groups or census blocks each of which has a population density of at least 1,000 people per square mile at the time.
- Surrounding block groups and census blocks each of which has a population density of at least 500 people per square mile at the time.
- Less densely settled blocks that form enclaves or indentations or are used to connect discontiguous areas with qualifying densities (U.S. Census Bureau 2010).

As these urban areas develop and change, so does the landscape. Buildings, roads, and other infrastructure replace open land and vegetation. Surfaces that were once permeable and moist are now impermeable and dry. These changes cause urban areas to become warmer than the surrounding areas. This forms an 'island' of higher temperatures (EPA 2019).

The term 'heat island' describes built up areas that are hotter than nearby rural areas. The annual mean air temperature of a city with more than one million people can be between 1.8 ºF and 5.4ºF warmer than its surrounding areas. In the evening, the difference in air temperatures can be as high as 22ºF. Heat islands occur on the surface and in the atmosphere. On a hot, sunny day, the sun can heat dry, exposed urban surfaces to temperatures 50ºF to 90ºF hotter than the air. Heat islands can affect communities by increasing peak energy demand during the summer, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and death, and water quality degradation (EPA 2019).

The figure below illustrates an urban heat island profile. The graphic demonstrates that heat islands are typically most intense over dense urban areas. Further, vegetation and parks within a downtown area may help reduce heat islands (U.S. EPA 2019).

Figure 4.3.6-2. Urban Heat Island Profile



Source: EPA 2019
°C: degrees as Centigrade

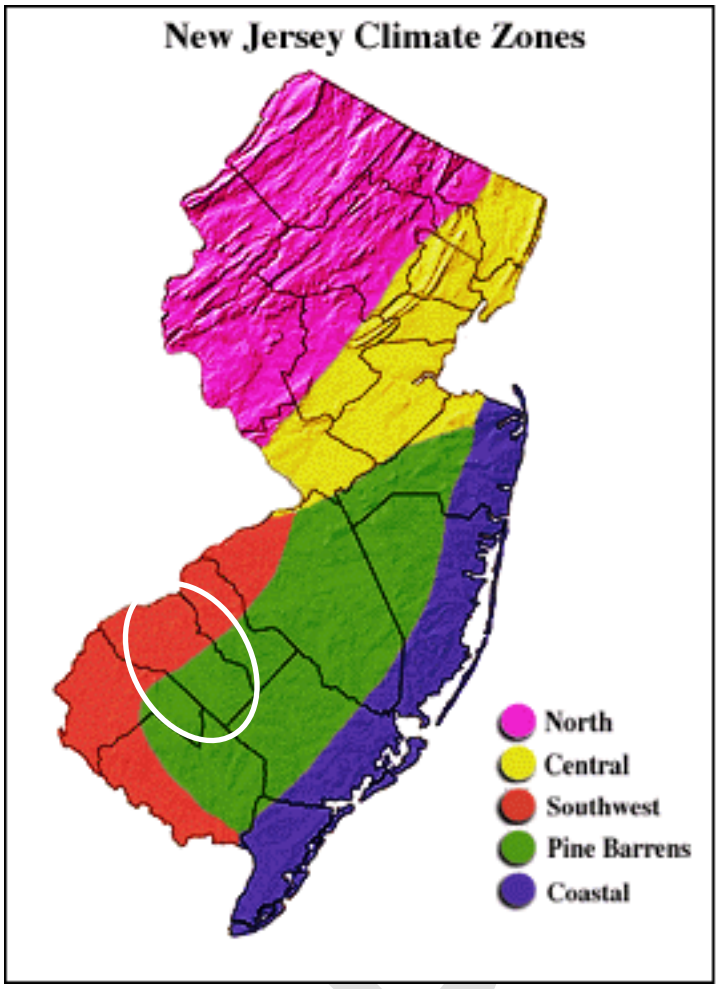
Location

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 2021). Figure 4.3.6-3 depicts these regions. A majority of Gloucester County is located within the Southwest Climate Region with the southern section located in the Pine Barrens Region.

The Southwest Climate Region is located along the southwestern border stretching from Trenton all the way to the Delaware Bay. The region is relatively suburban with pockets of urbanized areas, especially in the central region along the Delaware River, across from Philadelphia. Due to the proximity to the Delaware Bay, this region adds a maritime influence on the climate, having some of the highest average daily temperatures as well as higher nighttime temperatures. In general, the region is drier than other parts of the state, and given its more inland characteristics, is not prone to major coastal storms. That being said, the region does have significant humidity during the summer, and making the high temperatures feel even hotter than recorded (Rutgers University 2019).

As for the Pine Barrens Zone which covers the southeastern portion of the county, unlike its neighboring Southwest Region, has relatively low temperatures due to solar radiation absorbed during the day and radiated back into space during the night. Compared to its surrounding regions, Pine Barrens Zone is 15-20 degrees cooler. In general, the region has porous and sandy soils which allow water to be absorbed quickly, causing the zone to be relatively dry, making it vulnerable to forest fires.

Figure 4.3.6-3. Climate Regions of New Jersey



Source: ONJSC Rutgers University, Date Unknown
Note: The white oval indicates the location of Gloucester County. The County is located in the Southwest and Pine Barrens Zone.

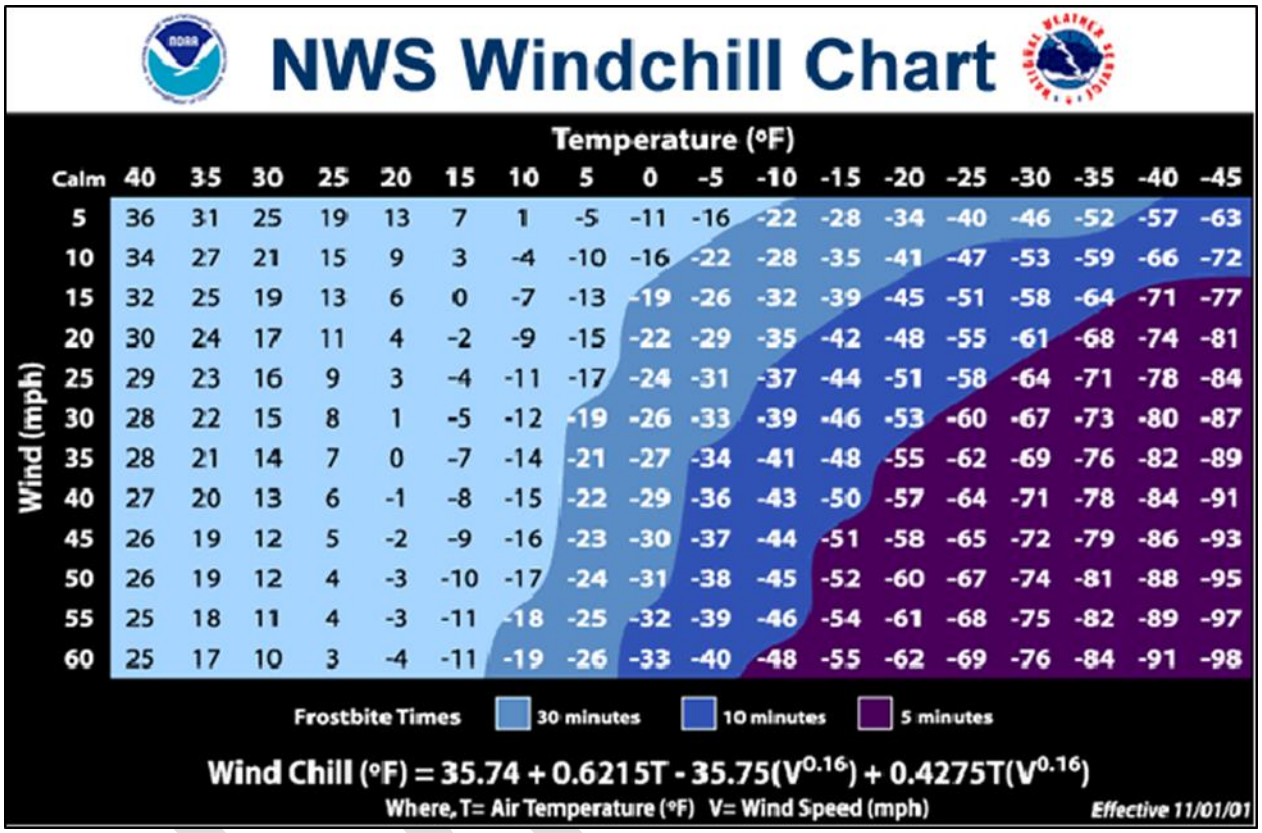
Extent

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 2021).

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 2021).

Figure 4.3.6-4 NWS Wind Chill Index

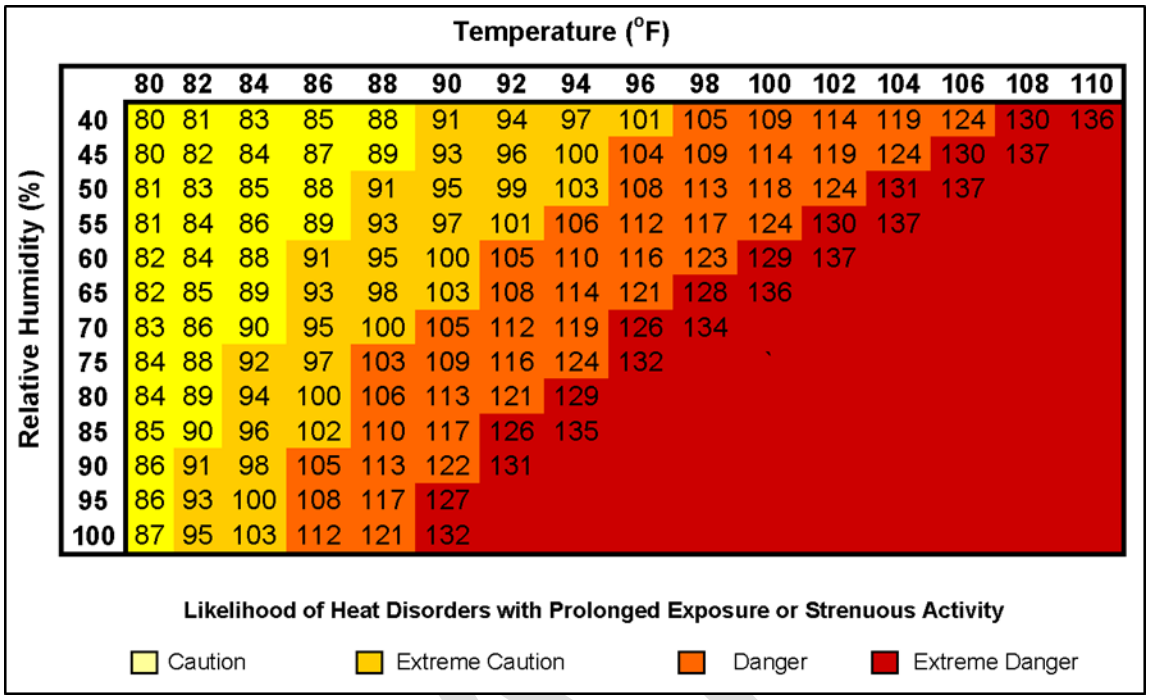


Source: NWS 2021
°F degrees Fahrenheit
mph miles per hour

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 4.3.6-5). The Heat Index indicates the temperature the body feels. Adverse effects of prolonged exposure to heat are displayed in Figure 4.3.6-6. 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 2021).

Figure 4.3.6-5 NWS Heat Index



Source: NWS 2013
°F degrees Fahrenheit
% percent

Figure 4.3.6-6 Adverse Effects of Prolonged Exposure 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 2021
°F degrees Fahrenheit

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 2021). 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 2021).

Previous Occurrences and Losses

Weather variability, coupled with concentrated population centers, can produce wide fluctuations in temperatures. The State and County have experienced multiple episodes of extreme temperatures, both hot and cold, that have resulted in cascading effects and even utility failure (Gloucester County 2016).

Many sources provided historical information regarding previous occurrences and losses associated with extreme temperatures throughout New Jersey and Gloucester County; therefore, the loss and impact information for many events could vary depending on the source. The accuracy of monetary figures discussed is based only on the available information in cited sources.

New Jersey has been experiencing an increase in extreme temperatures across the State. Historically, there has been an increase in temperature during the warmest months in New Jersey, with the majority of the extreme heat months occurring after 1990. Conversely, the months which set records for extreme cold temperatures tended to occur prior to 1930.

FEMA Major Disasters and Emergency Declarations

Between 1954 and 2020, neither Gloucester County or the State of New Jersey was not included in any major disaster (DR) or emergency (EM) declarations due to extreme temperatures. However, during the same time period, the Federal Emergency Management Agency (FEMA) included Gloucester County in six winter storm-related DR or EM declarations classified as one or a combination of the following disaster types: severe winter storm, snowstorm, snow, ice storm, winter storm, and q (FEMA 2021).

Table 4.3.6-1. Winter Weather Related Disaster (DR) and Emergency (EM) Declarations 1954-2021

Declaration	Event Date	Declaration Date	Event Description
EM-3106	March 13-17, 1993	March 17, 1993	Snow: Severe Blizzard
DR-1088	January 7-12, 1996	January 13, 1996	Snow: Blizzard of 96 (Severe Snow Storm)
EM-3181	February 16-17, 2003	March 20, 2003	Snow: Snow
EM-1889	February 5-6, 2010	March 23, 2010	Severe Winter Storm and Snowstorm
DR-1873	December 19 - 20, 2009	February 5, 2010	Snowstorm

Source: FEMA 2021

U.S. Department of Agriculture Disaster Declarations

Agriculture-related heat/ cold disasters are quite common. Usually, they occur along with other weather events such as drought, winter storms, frosts, and even flooding. Overall, it is difficult to separate the agricultural loss caused by extreme temperatures from their partner weather events (drought, winter storm, etc.). However, on

a cumulative scale these events can cause significant damage and as a result have been recorded as USDA disasters. Table 4.3.6-2 lists the disaster declarations related to extreme temperatures within Gloucester County between 2012 and 2021.

Table 4.3.6-2 USDA Disaster Declarations for Gloucester County 2012-2021

Declaration	Event Date	Declaration Date	Event Description
S4748	April 6- May 15, 2020	August 28, 2020	Severe freeze and frost. No agricultural loss was reported.
S4425	June 24 – July 21, 2018	April 31, 2018	Excessive heat and drought conditions. No agricultural loss was reported.
S4071	April 1 - September 9, 2016	October 5, 2016	Combined effects of freeze, excessive heat, and drought. No agricultural loss was reported.
S3930	April 1 – September 29, 2015	November 4, 2015	Excessive Heat and Drought. No agricultural loss was reported.
S3932	July 16 - September 29, 2015	November 4, 2015	Excessive Heat and Drought. No agricultural loss was reported.
S3487	June 28 – November 8, 2012	February 14, 2013	The combined effects of drought, high winds (Derecho), hail, excessive heat, excessive rain, flash flooding, Hurricane Sandy, snowstorm, and Nor'easter. No agricultural loss was reported.

Source: USDA 2021

Extreme Temperature Events

The National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) Storm Events database records and defines extreme temperature events as follows:

- Cold/Wind Chill is reported in the NOAA-NCEI database when a period of low temperatures or wind chill temperatures reach or exceed locally or regionally defined advisory conditions (typical value is -18 °F or colder).
- Excessive Heat is reported in the NOAA-NCEI database whenever heat index values meet or exceed locally or regionally established excessive heat warning thresholds.
- Extreme Cold/Wind Chill is reported in the NOAA-NCEI database when a period of extremely low temperatures or wind chill temperatures reaches or exceeds locally or regionally defined warning criteria (typical value around -35 °F or colder).
- Heat is reported in the NOAA-NCEI database whenever heat index values meet or exceed locally or regionally established advisory thresholds.

For this 2022 Plan Update, known extreme temperature events that have impacted Gloucester County between 2015 and 2020 are identified in Table 4.3.6-3. With extreme temperature documentation for New Jersey and Gloucester County being so extensive, not all sources have been identified or researched. Therefore, Table 4.3.6-3 may not include all events that have occurred in the County. Please see Section 9 for detailed information regarding impacts and losses to each municipality.

Table 4.3.6-3 Extreme Temperature Events in Gloucester County, 2015 to 2021

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Gloucester County Designated?	Location	Description
January 7, 2015	Cold/wind Chill	N/A	No	Gloucester County	The arrival of an arctic air mass brought one of the coldest mornings of the month of January to most of New Jersey. Morning low temperatures were mainly in the single numbers above zero. In addition, gusty northwest winds continued into the morning and lowest hourly wind chill factors reached around degrees below zero throughout the state.
February 13, 2015	Cold/wind Chill	N/A	No	Gloucester County	Northwest winds that persisted into the morning of the 13th combined with an arctic air mass to produce wind chill factors of around 10 degrees below zero and low temperatures in the positive single numbers throughout most of New Jersey. Multiple deaths were recorded across the state.
February 15, 2015	Cold/wind Chill	N/A	No	Gloucester County	The combination of strong to high winds and an approaching arctic air mass-produced wind-chill factors of 10 to 15 degrees below zero during the first half of the day on the 15th in New Jersey. Many municipalities declared code blues. Plumbers were swamped with frozen pipe calls. Some say it was the busiest they have been in over 20 years. Shelters were full. Even oil lines were freezing. Some homes ran out of heating oil.
February 20, 2015	Cold/wind Chill	N/A	No	Gloucester County	The arrival of another arctic air mass brought some of the lowest wind chills as well as the lowest temperatures of the winter season to New Jersey on the 20th and 21st. As far as wind chill factors went, the first half of the day on the 20th was colder with wind chill factors as low as around 20 degrees below zero during the morning. Actual low temperatures were around zero. 2 degrees above zero was recorded in Sewell (Gloucester County).
February 24, 2015	Cold/wind Chill	N/A	No	Gloucester County	Unlike the two previous arctic outbreaks earlier this month, this one was not accompanied by strong winds during the first half of the day. Air and wind chill temperatures were nearly the same. Morning low temperatures averaged 25 to 35 degrees colder than normal. 2 degrees above zero was recorded in South Harrison (Gloucester County).
June 12, 2015	Heat	N/A	No	Gloucester County	An unseasonably hot and humid air mass caused high temperatures to reach the lower to mid-90s in southwest New Jersey on the 12th. Combined with relatively high dew points, peak hourly heat index values reached the upper 90s. The heat forced some schools, especially those without air conditioning, to dismiss children early.
June 23, 2015	Heat	N/A	No	Gloucester County	Unseasonably hot and humid weather occurred across southern New Jersey on the 23rd with high temperatures reaching into the lower to mid-90s and afternoon heat indices of around 100 degrees F. This air mass provided the necessary energy for a strong to severe squall line of thunderstorms that moved through the southern half of the state during the very late afternoon and early evening.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Gloucester County Designated?	Location	Description
July 19, 2015	Excessive Heat	N/A	No	Gloucester County	Unseasonably hot and humid weather affected most of New Jersey on the 19th and 20th. High temperatures in most areas reached into the lower to mid-90s both days. The 19th was slightly hotter and more humid overall. The combination of heat and humidity brought afternoon heat index values as high as 100 degrees F to 105 degrees F on the 19th. These were some of the highest heat index values of the entire summer. A dissipating cold front on the 20th brought slightly drier air into the region during the afternoon of the 20th and heat index values peaked around 100 degrees F A re-enforcing cold frontal passage on the 21st brought even cooler and drier air into the area and by the 22nd all high temperatures were less than 90 degrees in New Jersey.
February 14, 2016	Cold/wind Chill	N/A	No	Gloucester County	Bitter cold temperatures and strong northwest winds associated with an Arctic outbreak combined to create dangerous wind chill temperatures across the entire northeast quadrant of the county beginning Saturday morning, February 13th into Sunday afternoon, February 14th. Below zero minimum temperatures were common along and north of the I-78 corridor. Wind chill values at this same time ranged from -46 degrees at High Point to 10 degrees above zero near the waters of the back bays near the coast. The lowest wind chill values were reported at the following locations during the early morning hours of February 14th.
July 1, 2018	Excessive Heat	N/A	No	Gloucester County	Temperatures in the middle to upper 90s and dew points in the upper 60s to lower 70s led to excessive heat across New Jersey. Heat indices reached 111 degrees at the Somerset ASOS at 3 pm on July 3rd.

Source: NOAA-NCEI 2021 NWS 2021, FEMA 2021
°F degrees Fahrenheit

Probability of Future Occurrences

It is anticipated that Gloucester County will continue to experience extreme temperatures annually that may coincide with or induce secondary hazards such as snow, hail, ice or windstorms, thunderstorms, drought, human health impacts, and utility failures. Table 4.3.6-4 shows the annual number of events, recurrence interval, annual probability, and annual percent chance of occurrence for the hazards associated with extreme temperatures and reported in the NOAA-NCEI Storm Events Database.

Table 4.3.6-4 Probability of Occurrences of Extreme Temperature Events

Hazard Type	Number of Occurrences Between 1950 and 2020	% Chance of Occurring in Any Given Year
Cold/Wind Chill	25	36%
Excessive Heat	24	34%
Extreme Cold/Wind Chill	2	3%
Heat	61	87%
TOTAL	**112**	**100%**

Source: NOAA-NCEI 2021
Note: Probability was calculated using the available data provided in the NOAA-NCDC storm events database.

Based on these historical records and input from the Steering Committee, the probability of occurrence for extreme temperatures in Gloucester County is considered "occasional" (10-100 percent chance of annual occurrence) (Section 4.4 Hazard Ranking).

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.

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.

Climate change includes major changes in temperature, precipitation, or wind patterns, which occur over several decades or longer. Due to the increase in greenhouse gas concentrations since the end of the 1890s, New Jersey has experienced a 3.5° F (1.9° C) increase in the State's average temperature (ONJSC 2021) which is faster than the rest of the Northeast region (2° F [1.1° C]) (Melillo 2014) and the world (1.5° F [0.8° C]) (Meyer 2014). This warming trend is expected to continue. By 2050, temperatures in New Jersey are expected to increase by 4.1 to 5.7° F (2.3° C to 3.2° C) (Horton 2015). Thus, New Jersey can expect to experience an average annual temperature that is warmer than any to date (low emissions scenario) and future temperatures could be as much as 10° F (5.6° C) warmer (high emissions scenario) (Runkle 2017). New Jersey can also expect that

by the middle of the 21st century, 70 percent of summers will be hotter than the warmest summer experienced to date (Runkle 2017). The increase in temperatures is expected to be felt more during the winter months (December, January, and February), resulting in less intense cold waves, fewer sub-freezing days, and less snow accumulation.

4.3.6.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed and vulnerable. For the extreme temperature hazard, the entire county has been identified as exposed; therefore, all assets are potentially vulnerable. The following text estimated potential impacts of extreme temperatures on Gloucester County.

Impact on Life, Health and Safety

For the purposes of this HMP, the entire population of Gloucester County is exposed to extreme temperature events (population of 291,165 people, according to the 2019 American Community Survey population estimates). 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 with chronic medical conditions (e.g., heart disease, 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 2017a).

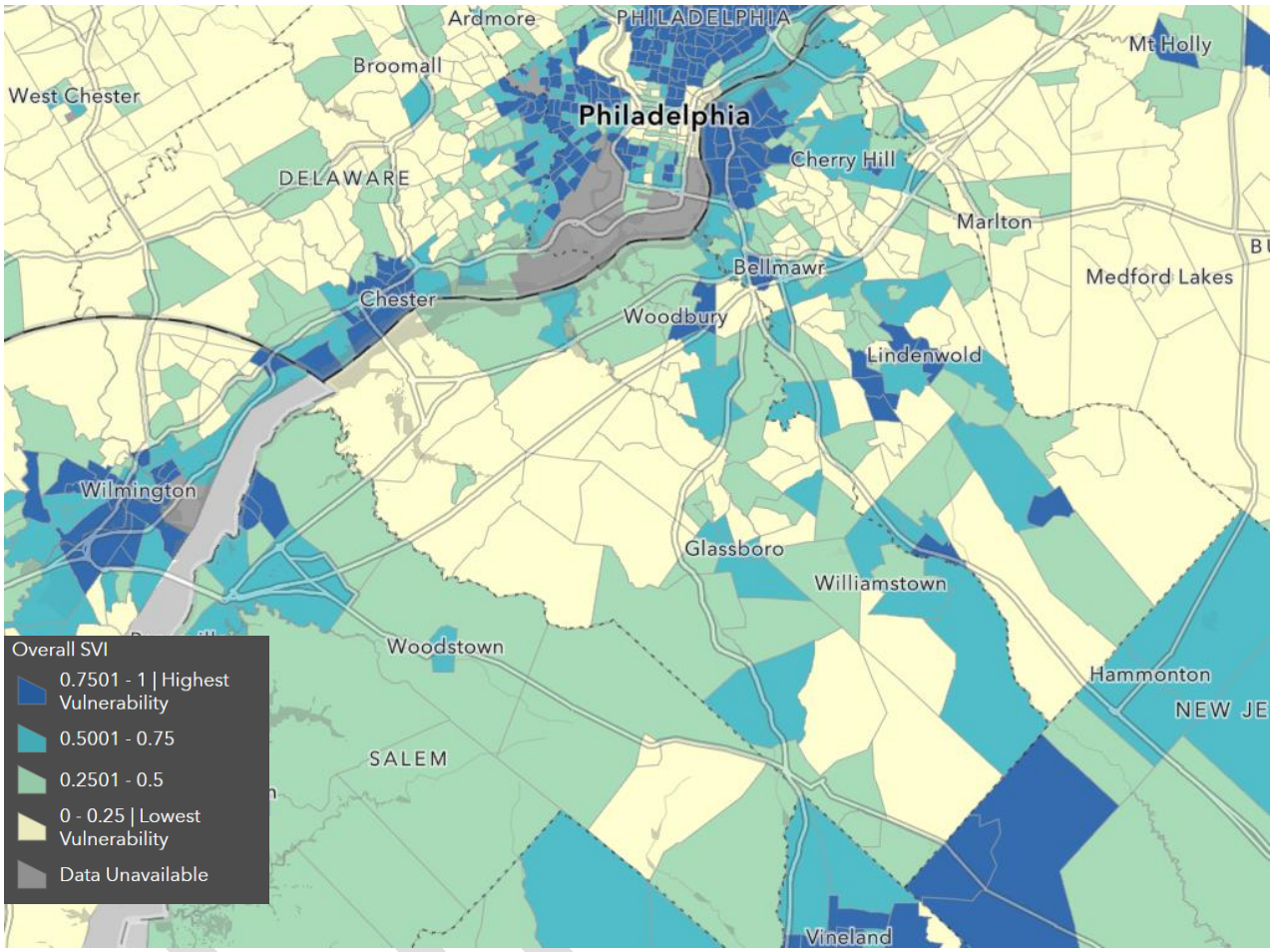
In Gloucester County, each municipality has areas of high concentration of elderly population (over 100 persons per square mile) with higher concentrations located in the more urban, densely populated areas of the County. Such urbanized areas include Glassboro, Monroe, and communities located along the Delaware River and New Jersey Turnpike. As a relatively suburban county, Gloucester County is fortunate to have areas of greenery which decrease the overall county's vulnerability to heat waves. However, as the county increases development, preservation of such spaces can become more difficult thus increasing the population's vulnerability, especially elderly to increased extreme temperature events.

Residents with low incomes might not have access to housing or their housing can be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply). In Gloucester County, while the general composition of the population is middle to upper middle class, 6.2 percent are below the poverty line, most of which live in the more urbanized areas of the county. Refer to Figure 4-11 in Section 3 (County Profile) that displays the densities of low-income populations in Gloucester County (U.S. Census Bureau 2010).

The Centers for Disease Control's (CDC) 2016 Social Vulnerability Index (SVI) ranks U.S. Census Tracts on socioeconomic status, household composition and disability, minority status and language, and housing and transportation. Census Tracts in Woodbury have been ranked in the highest vulnerability category with values between 0.75 and 1.0; Census Tract 5010.02 in Woodbury has the highest social vulnerability with a ranking of

0.93. Such Census Tracts in these communities might be more susceptible to impacts from extreme temperatures. The figure below displays the CDC 2016 SVI.

Figure 4.3.6-7. CDC's Social Vulnerability Index 2016



Source: CDC 2021

In addition, safety issues include not only health-related impacts, but domicile impacts as home fires occur more often in winter than any other season (FEMA 2020).

Meteorologists can accurately forecast extreme heat and cold 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 and conducting appropriate mitigation and preparation measures can significantly reduce the risk of temperature-related deaths.

Impact on General Building Stock

All the building stock in the county is exposed to the extreme temperature hazard. Refer to Section 3 (County Profile), which summarizes the building inventory in Gloucester County. Extreme heat generally does not impact buildings; however, elevated summer temperatures increase the energy demand for cooling. Losses can 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, as well as increasing vulnerability to home fires. Additionally, manufactured homes (mobile homes) and antiquated or poorly constructed facilities can have inadequate capabilities to withstand extreme temperatures.

4.3.6.3 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 and other energy-intensive appliances. Similarly, heavy snowfall and ice storms, associated with extreme cold temperature events, can cause power interruption. Backup power is recommended for critical facilities and infrastructure. Additionally, designating and developing emergency cooling or heating facilities can also enhance the resilience and safety of communities.

Impact on Economy

Extreme temperature events also have impacts on the economy, including loss of business function and damage to and loss of inventory. Business-owners can 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). In response to such vulnerabilities to the existing utility infrastructure, in July 2014 the State has established the New Jersey Energy Resilience Bank ("ERB" or the "Bank"), the first public infrastructure bank in the nation to focus on energy resilience (State of New Jersey 2021). The ERB is a direct and innovative approach to address significant energy infrastructure vulnerabilities arising in the aftermath of Superstorm Sandy. Utilizing $200 million through New Jersey's second Community Development Block Grant-Disaster Recovery (CDBG-DR) allocation, the ERB supports the development of distributed energy resources at critical facilities throughout the state that will enable them to remain operational during future outages.

Based on information from the 2017 Census of Agriculture, 580 farms were present in Gloucester County, encompassing 191 acres of total farmland. The average farm size was 85 acres. The total market value of agricultural products from Gloucester County farms was $176,644 (USDA 2017).

Future Changes that May Impact Vulnerability

Understanding future changes that impact vulnerability in the county can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The county considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development.
- Projected changes in population.
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

Projected Development and Change in Population

The ability of new development to withstand extreme temperature impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. New development will change the landscape where buildings, roads, and other infrastructure potentially replace open land and vegetation. Surfaces that were once permeable and moist are now impermeable and dry. These changes cause urban areas to become warmer than the surrounding areas forming (heat islands as described above). Specific areas of recent and new development are indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 (Jurisdictional Annexes) of this plan.

According to population projections from the State of New Jersey Department of Labor and Workforce Development, Gloucester County will experience an increase in population between 2010 and 2030 by 30.4 percent and is projected to continue to lead the state's population growth in the next two decades. Population change is not expected to have a measurable effect on the overall vulnerability of the county's population over time. However, drastic increases less densely populated areas of the County may require utility system upgrades to keep up with utility demands (e.g., water, electric) during extreme temperature events to prevent increased stresses on these systems. Additionally, by increasing development, green space preservation will need to continue to be a priority to mitigate increased heat islands. Refer to Section 3 (County Profile) for a detailed discussion on population changes.

Climate Change

As discussed above, most studies project that the State of New Jersey will see an increase in average annual temperatures. As the climate warms, extreme cold events might decrease in frequency, while extreme heat events might increase in frequency; the shift in temperatures could also result in hotter extreme heat events. With increased temperatures, vulnerable populations could face increased vulnerability to extreme heat and its associated illnesses, such as heatstroke and cardiovascular and kidney disease. Additionally, as temperatures rise, more buildings, facilities, and infrastructure systems may exceed their ability to cope with the heat. Thus, building efficiency and upgrading heating and cooling technology/HVAC will become an increasingly important issue for businesses and homeowners over the coming years.

Change of Vulnerability Since the 2016 HMP

Overall, the entire county remains vulnerable to extreme temperatures. As existing development and infrastructure continue to age, they can be at increased risk to failed utility systems (e.g., HVAC) if they are not properly maintained or upgraded. Similarly, an increase in the elderly population remaining in the county increases the vulnerable population.