



4.3.5 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 Essex County.

2020 HMP Update Changes

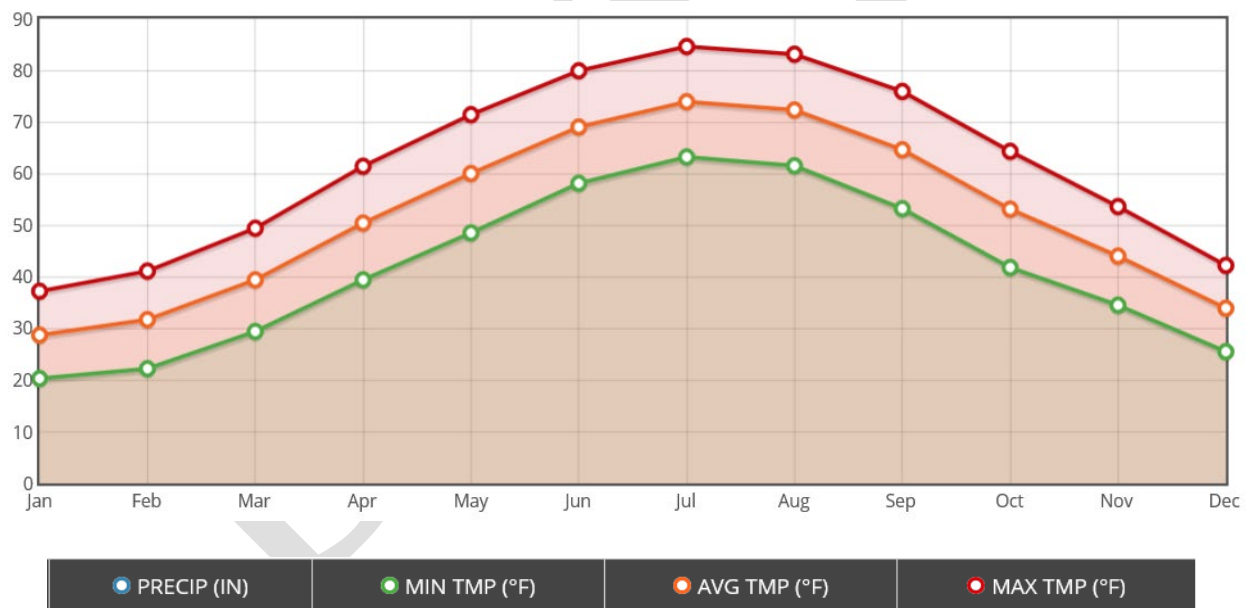
- All subsections have been updated using best available data.
- Previous occurrences are updated with events that occurred between 2014 and 2019.

4.3.5.1 Profile

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 4.3.5-1 shows the average low and high temperatures each month at the Essex Falls station in Essex County.

Figure 4.3.5-1. Average Temperatures at Essex Falls



Source: NWS 2018a

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 0°F or below (Centers of Disease Control and Prevention [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 (Centers for Disease Control and Prevention [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. (National Weather Service [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 and Tebaldi 2004).

Urbanized areas and urbanization creates 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 discontinuous areas with qualifying densities (U.S. Census 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 (U.S. Environmental Protection Agency [EPA] 2009).

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 °F and 5.4°F warmer than its surrounding areas. In the evening, the difference in air temperatures can be as high as 22°F. 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 50°F to 90°F 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 2010 and 2011).

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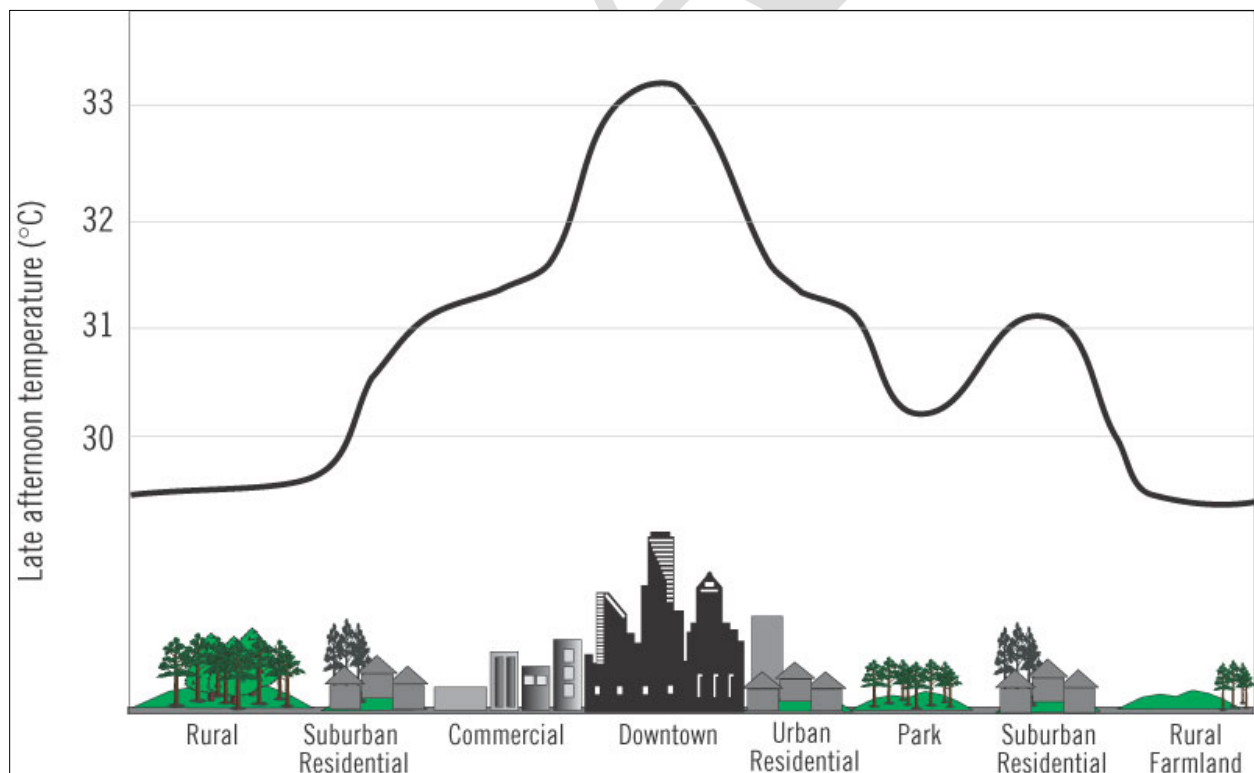
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Figure 4.3.5-2 below illustrates an urban heat island profile. The graphic demonstrates that heat islands are typically most intense over dense urban areas. Further, vegetation and parks within a downtown area may help reduce heat islands (U.S. EPA 2019).

Figure 4.3.5-2. Urban Heat Island Profile



Source: EPA 2019
°C degrees Celsius

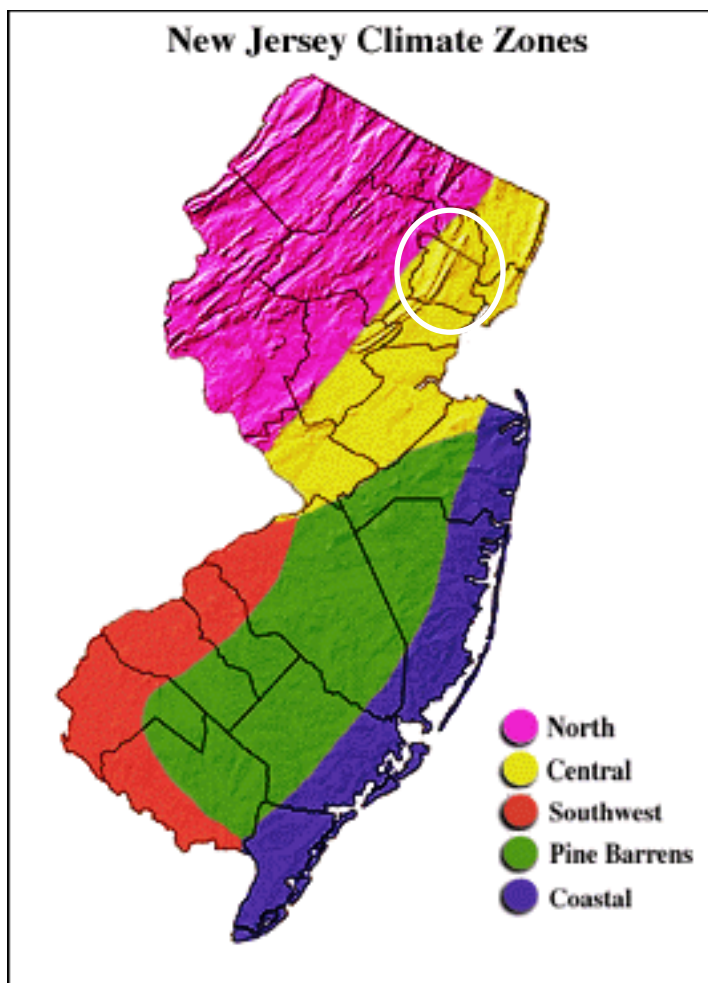


Location

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). Figure 4.3.5-3 depicts these regions. A majority of Essex County is located within the Central Climate Region with the northwestern corner located in the Northern Climate Region.

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 with large amounts of pollutants produced by the high volume of traffic and industrial establishments. 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 n.d.).

Figure 4.3.5-3. Climate Regions of New Jersey



Source: ONJSC Rutgers University, Date Unknown



Note: The white circle indicates the location of Essex County. The County is located in the Central Climate Zone of New Jersey.

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with extreme temperatures throughout New Jersey and Essex 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. The number of very hot days has been above average since the early 2000's. However, declines in the number of extreme cold days have occurred since the early 1990's (NOAA NCEI 2019).

FEMA Major Disasters and Emergency Declarations

Between 1954 and March 15, 2019, neither Essex County nor the State of New Jersey were 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 Essex County in six winter storm-related DR or EM declarations classified as one or a combination of the following disaster types that may have had associated extreme cold temperatures: severe winter storm, snowstorm, snow, ice storm, winter storm, and blizzard (Table 4.3.5-1).

Table 4.3.5-1. Winter Weather Related Disaster (DR) and Emergency (EM) Declarations 1954-2019

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-1954	December 26-27-2010	February 4, 2011	Snow: Severe Winter Storm and Snowstorm
DR-4264	January 22-24, 2016	March 14, 2016	Severe Storm(s): Severe Winter Storm and Snowstorm
DR-4368	March 6-7, 2018	June 8, 2018	Severe Storm(s): Severe Winter Storm and Snowstorm

Source: FEMA 2019

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.



Extreme temperature events that have impacted Essex County between 2014 and 2019 are identified in Table 5.4.5-2. Please see Section 9 (Jurisdictional Annexes) for available information regarding impacts and losses to each municipality.

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Table 4.3.5-2. Extreme Temperature Events in Essex County, 2014 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Description
August 12-13, 2016	Excessive Heat	N/A	N/A	High pressure over the western Atlantic Ocean ushered in hot and humid air northward across the area. On August 12, hot temperatures along with high humidity resulted in a heat index of 107 at Newark International Airport at 4 pm and a heat index up to 105°F at Caldwell Airport. On August 13, hot temperatures along with high humidity resulted in a heat index of 108 at both Newark International Airport and Caldwell Airport.

Source: NOAA-NCDC 2019; NWS 2019

°F degrees Fahrenheit

N/A Not applicable

Note: With documentation for New Jersey and Essex County being so extensive, not all sources have been identified or researched; therefore, Table 4.3.5-2 may not include all events that have occurred or impacted the County.



Probability of Future Occurrences

It is anticipated that Essex County will continue to experience extreme temperatures annually that may coincide with or induce secondary hazards such as snow, hail, ice or wind storms, thunderstorms, drought, human health impacts, and utility failures. Table 5.4.6-5 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.

Based on these historical records and input from the Steering Committee and Planning Committee, the probability of occurrence for extreme temperatures in Essex County is considered “frequent”. Refer to Section 4.4. (Hazard Ranking) for more information.

Table 4.3.5-3. Probability of Occurrences of Extreme Temperature Events

Hazard Type	Number of Occurrences Between 1950 and April 2019	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years)	Probability of event Occurring in Any Given Year	% Chance of Occurring in Any Given Year
Cold/Wind Chill	0	0	0	0	0
Excessive Heat	6	0.09	11.7	0.09	8.6
Extreme Cold/Wind Chill	0	0	0	0	0
Heat	0	0	0	0	0
Total	6	0.09	11.7	0.09	8.6

Source: NOAA-NCEI 2019

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

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.

Average annual temperatures have increased by 3°F in New Jersey over the past century (NOAA NCEI 2019). 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 (CATF 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). According to a recent state-level analysis, by the middle of the 21st century an estimated 70 percent of summers in this region are anticipated to be hotter than what we now recognize as the warmest summer on record (NOAA NCEI 2019).



4.3.5.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed and vulnerable. For the extreme temperature hazard, the entire County is exposed. The following discusses Essex County's vulnerability, in a qualitative nature, to the extreme temperature hazard.

Impact on Life, Health and Safety

The entire population of Essex County is exposed to extreme temperature events (population of 800,401 people, according to the 2013-2017 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 (CDC), 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).

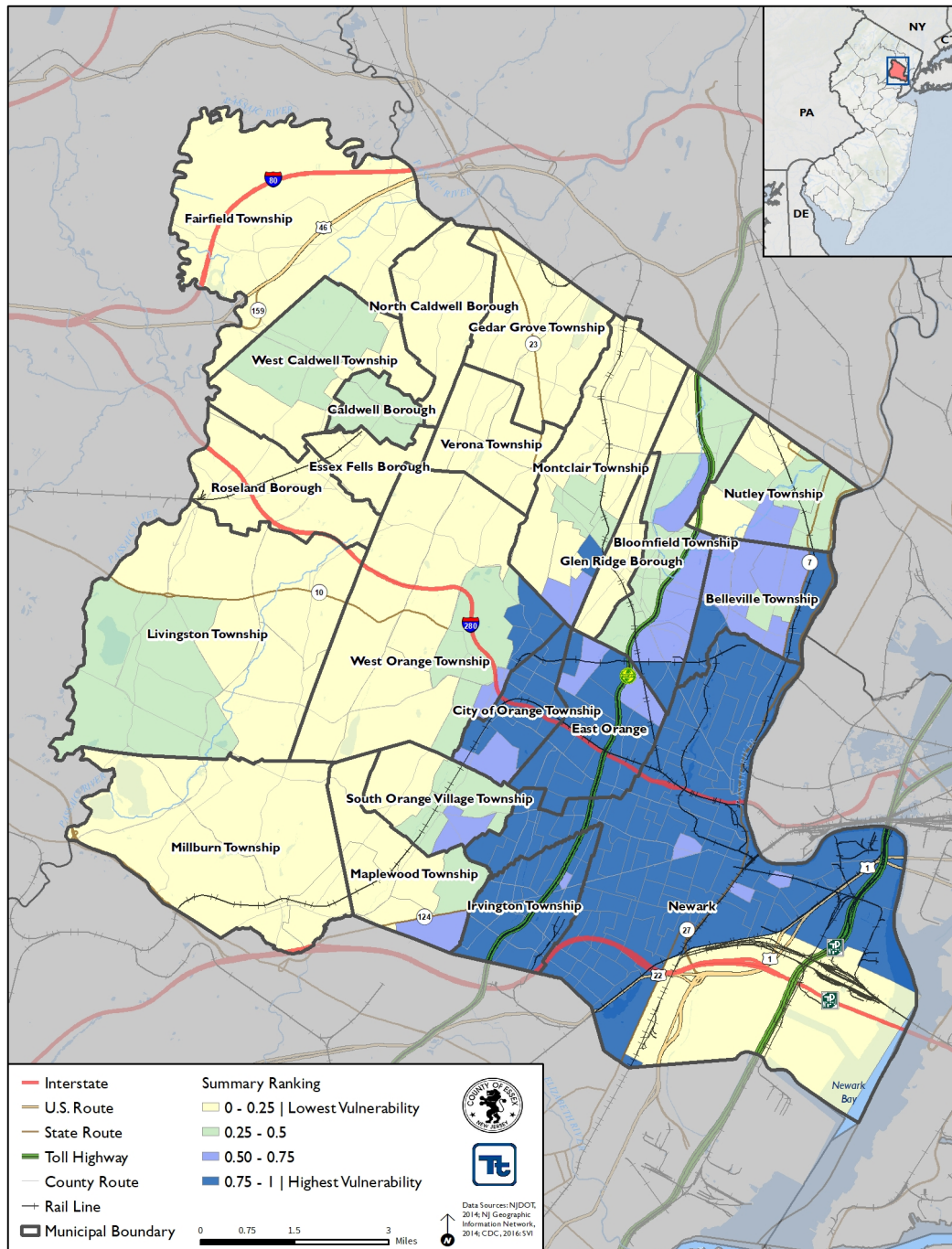
In Essex County, each municipality has areas of high concentration of elderly population (over 100 persons per square mile) with higher concentrations located in the more urban, densely populated areas of the County. Refer to Figure 3-X in Section 3 (County Profile) that displays the densities of populations over 65 in Essex County.

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 Essex County, areas with the highest concentration of population below the poverty level are located around the Cities of East Orange and Newark and Townships of Irvington and Orange. Refer to Figure 3-X in Section 3 (County Profile) that displays the densities of low-income populations in Essex County.

The 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 throughout the Cities of East Orange and Newark and the Townships of Irvington and Orange have been ranked in the highest vulnerability category with values between 0.75 and 1.0; Census tract 92 in the City of Newark has the highest social vulnerability with a ranking of 1.0. These Census tracts in these communities might be more susceptible to impacts from extreme temperatures. Figure 4.3.5-4 below displays the CDC 2016 SVI.



Figure 4.3.5-4. CDC's Social Vulnerability Index 2016



Risk of structural fire in the winter months is elevated, although winter home fires only account for 8 percent of fires within the U.S., approximately 30 percent of all fire deaths occur in the winter months. Cooking, and heat sources too close to combustible materials are leading factors in winter home fires (U.S. Fire Administration 2018). Often times, power outages occur during extreme cold events. Individuals powering their homes with generators are subjected to carbon monoxide poisoning if proper ventilation procedures are not followed. Improperly connected portable generators are capable of 'back feeding' power lines which may cause injury or



death to utility works attempting to restore power and may damage house wiring and/or generators (NJOEM 2019).

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 can significantly reduce the risk of temperature-related deaths.

Impact on General Building Stock

All buildings are exposed to the extreme temperature hazard. Refer to Section 3 (County Profile), which summarizes the building inventory in Essex 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.

Impact on Critical Facilities

All critical facilities in the County are exposed to the extreme temperature hazard. Impacts to critical facilities that are buildings 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.

In 2019, the North Jersey Transportation Planning Authority (NJTPA) released a report for the Passaic River Basin that discusses climate change including extreme heat and impacts to transportation infrastructure. Impacts associated with extreme heat events on bridges, culverts, facilities, rail, roads and transit rolling stock include stress, sagging, thermal expansion and system failure. Refer to the NJTPA study which assessed the level of vulnerability (as measured by criticality, sensitivity and adaptive capacity) of transportation assets in the Passaic River Basin which includes portions of Essex County (NJTPA 2019).

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). Disruptions in public transportation service will also impact the economy for both commuters and customers alike.

Extreme temperature events can impact agriculture yields. Based on information from the 2017 Census of Agriculture, 22 farms were present in Essex County, encompassing 191 acres of total farmland. The total market value of agricultural products from Essex County farms was withheld to avoid disclosing data for individual farms. The 2017 Census indicated that 11 farm operators reported farming as their primary occupation (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, building design considerations (e.g. Leadership in Energy and Environmental Design [LEED]), 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, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). Population increases in 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. NJTPA includes high population growth forecasts as one criterion to prioritize transportation adaptation strategies. Refer to Section 3 (County Profile) for a detailed discussion on population change in Essex County.

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.

Change of Vulnerability Since the 2015 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 and transportation systems if they are not properly maintained and do not adapt to the changing environment.