5.4.3 Extreme Temperature

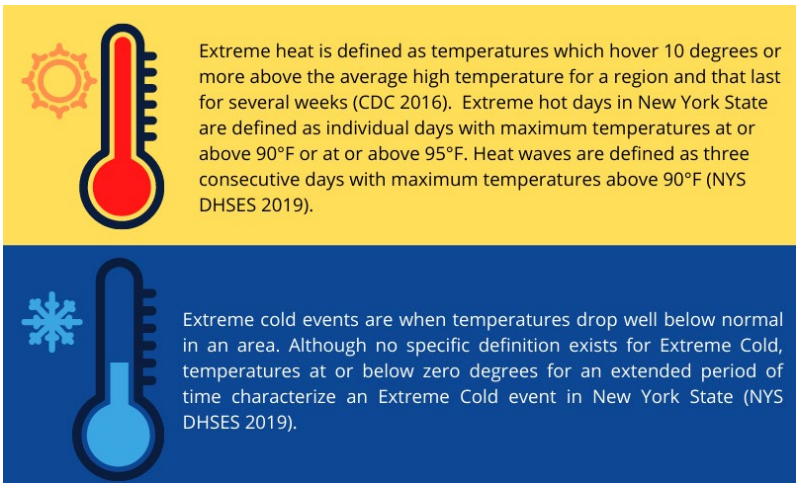
This section provides a profile and vulnerability assessment for the extreme temperature hazard for Tompkins County.

The hazard profile is organized as follows:	The vulnerability assessment is organized as follows:
• Description • Extent • Previous Occurrences and Losses • Probability of Future Occurrences • Climate Change Impacts	• Impact on Life and Safety • Impact on General Building Stock • Impact on Community Lifelines • Impact on Economy • Impact on Environment • Cascading Impacts on Other Hazards • Future Change that may Impact Vulnerability • Changes Since 2014 HMP • Identified Issues

5.4.3.1 Hazard Profile

This section provides profile information including description, extent, location, previous occurrences and losses, and the probability of future occurrences for the extreme temperatures hazard.

Description



In Tompkins 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 upon what the population is accustomed. According to the Northeast Regional Climate Center (NRCC), the hottest day on record in Tompkins County was 103°F in 1936 and the coldest temperature on record in the County was -25°F in 1961. Looking at data from the last 10 years (2010 to 2020), the warmest temperature recorded as 98°F in 2011 and the coldest temperature recorded was -22°F in 2015 (NRCC 2020).

Extent

Extreme Cold

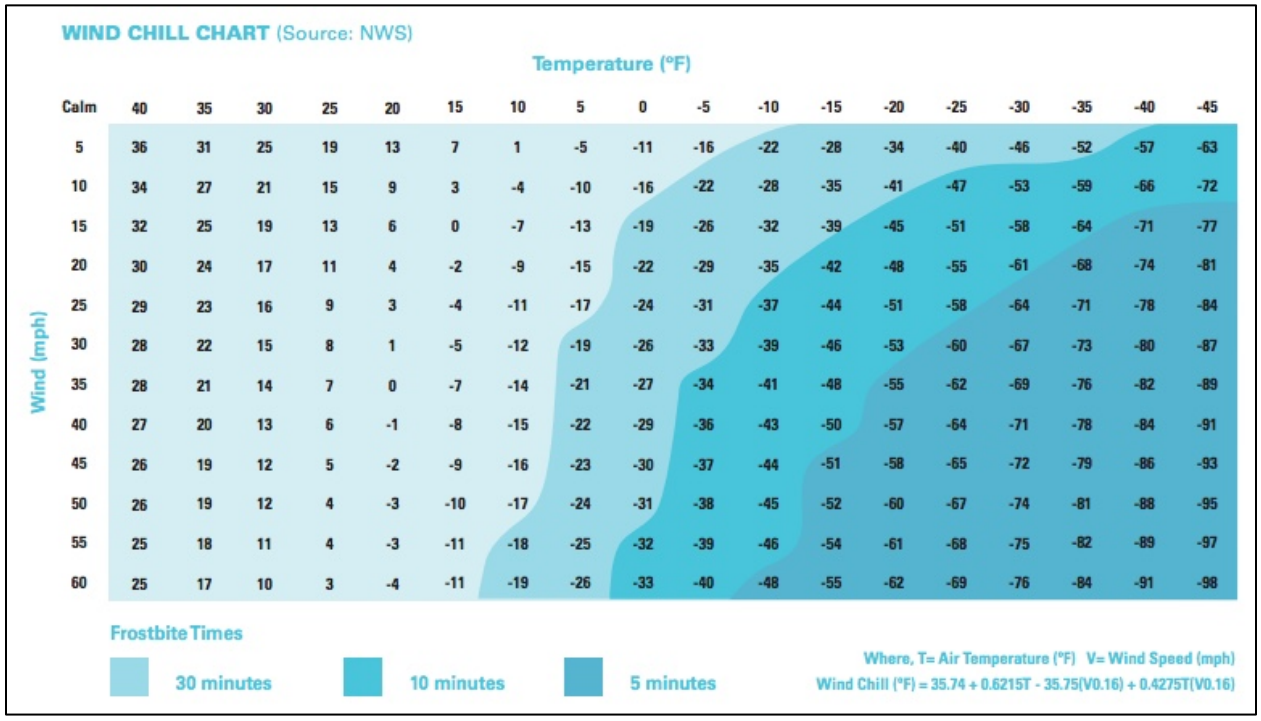
The extent (severity or magnitude) of extreme cold temperatures generally is measured through the Wind Chill Temperature (WCT) Index. The WCT Index uses advances in science, technology, and computer modeling to provide an accurate, understandable, and useful formula for calculating the dangers from wind chill. For details regarding the WCT Index, refer to: http://www.nws.noaa.gov/om/winter/windchill.shtml. The WCT Index is presented in Figure 5.4.3-1.

Wind Chill
At a Glance

The wind chill is how cold it actually feels on your skin when the wind is factored in. It may also be referred to as the "feels-like" temperature. Bitterly cold wind chills increase your risk of developing frostbite and hypothermia.

Source: The Weather Channel (2019)

Figure 5.4.3-1. NWS WCT Index



Source: NYS DHSES, 2019

The National Weather Service (NWS) provides alerts when Wind Chill indices approach hazardous levels. Table 5.4.3-1 explains these alerts.

Table 5.4.3-1. National Weather Service Alerts for Extreme Cold

Alert	Criteria
Wind Chill Advisory	NWS issues a wind chill advisory when seasonably cold wind chill values, but not extremely cold values are expected or occurring.

Alert	Criteria
Wind Chill Watch	NWS issues a wind chill watch when dangerously cold wind chill values are possible.
Wind Chill Warning	NWS issues a wind chill warning when dangerously cold wind chill values are expected or occurring.

Source: NWS 2018

Extreme Heat

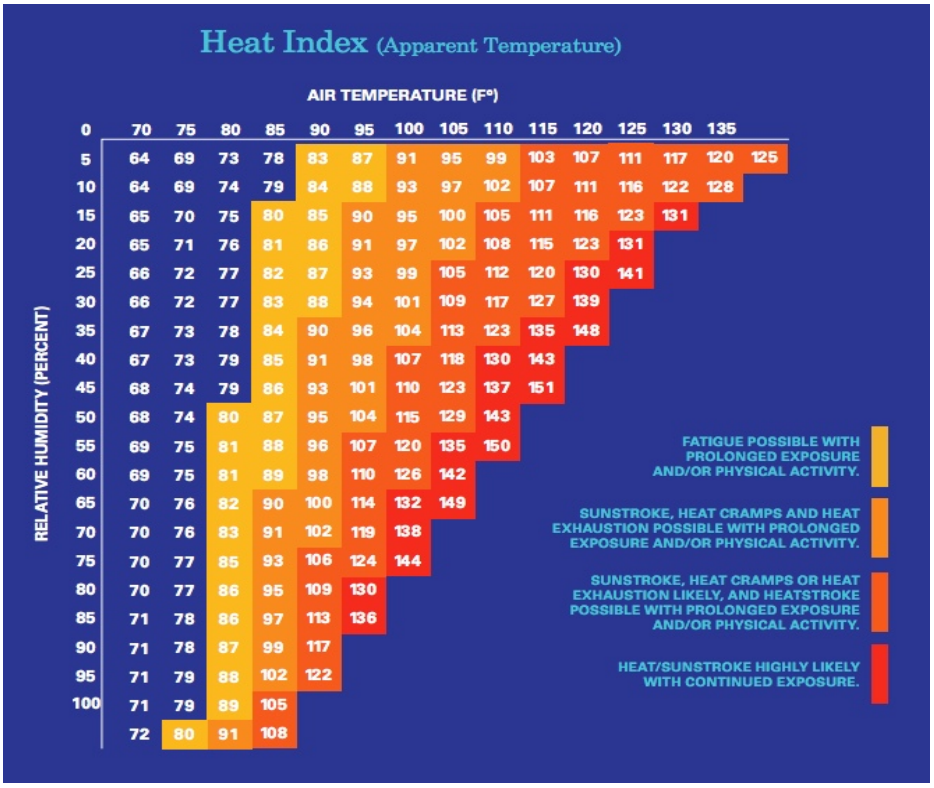
The extent of extreme heat temperatures is measured through the Heat Index, identified in Figure 5.4.3-2. The Heat Index was created by the NWS to accurately measure apparent temperature of the air as it increases with the relative humidity. Temperature and relative humidity are needed to determine the Heat Index. This provides a measure of how temperatures feel; however, the values are devised for shady, light wind conditions. Exposure to full sun can increase the index by up to 15 degrees (NYS DHSES 2019).

Relative Humidity
At a Glance

Relative humidity is the amount of moisture in the air at a certain temperature compared to what the air can "hold" at that temperature…it is measured as a percentage or ratio of the amount of water vapor in a volume of air RELATIVE to a given temperature and the amount it can hold at that given temperature. Warm air can hold more moisture than cold air.

Source: M°lekule.com, 2018

Figure 5.4.3-2. Heat Index Chart



Source: NYS DHSES, 2019

The NWS provides alerts when Heat Indices approach hazardous levels. Table 5.4.3-2 explains these alerts.

Table 5.4.3-2. National Weather Service Alerts

Alert	Criteria
Heat Advisory	Criteria for a Heat Advisory in New York 95-104 °F. The heat index has to remain at or above criteria for a minimum of 2 hours. Heat advisories are issued by county when any location within that county is expected to reach criteria.
Excessive Heat Watch	Issued when Heat Warning criteria is possible (50-79%) 1 to 2 days in advance
Excessive Heat Warning	Criteria for an Excessive Heat Warning is a heat index of 105 °F or greater that will last for 2 hours or more. Excessive Heat Warnings are issued by county when any location within that county is expected to reach criteria.

Source: NWS, 2020

Location

According to the New York State Hazard Mitigation Plan (2019), excessive temperatures can occur anywhere within the State of New York, including Tompkins County. Excessive heat incidents are widespread, even if there are localized cooler areas. The State has varied summers. Warmer conditions are experienced in the south, whereas more mild conditions experienced elsewhere in the State. Extreme cold temperatures occur throughout the County, typically during the winter months.

The Town of Caroline, Danby, and Newfield have higher levels of forest cover, compared to Lansing, Enfield, Groton, and Ulysses which have increased levels of active agricultural land with less forest cover (Tompkins County Comprehensive Plan). Municipalities with less tree cover tend to experience warmer weather, regardless of levels of urban/ rural

The State is divided into 10 different climate divisions: Western Plateau, Eastern Plateau, Northern Plateau, Coastal, Hudson Valley, Mohawk Valley, Champlain Valley, St. Lawrence Valley, Great Lakes, and Central Lakes. Tompkins County is located within the Central Lakes Climate Division. Within the Central Lakes Climate Division, Tompkins County varies greatly in climate and temperatures. The northern portion of the county is located along Cayuga Lake and experiences a relatively warm and drier climate whilst the southern portion of the county which tends to be more rough, forested terrain and as such has damper and cooler characteristics.

Previous Occurrences and Losses

Extreme temperature events occur each year in Tompkins County. Between 1954 and May 2020, New York State was not included in any major disaster (DR) or emergency (EM) declarations due to extreme temperatures (heat or cold). However, during the same time period, FEMA included Tompkins County in two winter storm-related declarations which included severe winter storm, snowstorm, snow, ice storm, winter storm, or blizzard (Table 5.4.3-3.). Extreme cold temperatures are often associated with these disaster types.

Table 5.4.3-3. Winter Storm Related Disaster (DR) and Emergency (EM) Declarations 1954-2020

Disaster Number	Incident Duration	Declaration Date	Incident Type	Title
DR-4322	March 14-- March 15, 2017	7/12/2017	Snow	Severe Winter Storm and Snowstorm
EM-3107	March 13-- March 17, 1993	3/17/1993	Snow	Severe Blizzard

Source: FEMA 2020
DR Major Disaster Declaration (FEMA)
EM Emergency Declaration (FEMA)
FEMA Federal Emergency Management Agency

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is also authorized to designate counties as disaster areas to make emergency loans available to agricultural producers suffering losses. Between 2012 and 2020, Tompkins County was included in the following seven USDA declarations involving extreme temperatures:

- S3249 – March 2012 – Frosts and Freezes
- S3252 – April 2012 – Excessive Snow and Freezes
- S3594 – May 2013 – Freeze and Frost
- S3666 – December 2013 – Freeze
- S3672 – March 2014 – Freeze
- S3886 – January 2015 -- Frost, Freeze, and Excessive Snow
- S4052 – February 2016 – Unseasonably Warm

Information regarding specific details of extreme temperature in Tompkins County is scarce; therefore, previous occurrences and losses associated with extreme temperature events are limited. To identify the events in the county, the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) Storm Events database was queried for events that occurred between 2012 and 2020. The 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 negative 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 negative 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.

Table 5.4.3-4 summarizes extreme temperature events that occurred in Tompkins County between 2012 and 2020. For events prior to 2012, refer to Appendix E (Supplementary Data).

Table 5.4.3-4. Extreme Temperature Events in Tompkins County, 2012 to 2020

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Event Details
March 17, 2012	Heat	N/A	N/A	Central New York experienced record warm temperatures as a result of a jet stream pushing farther north than typical. Binghamton and Syracuse climate record stations saw the warmest March on record by more than 12 degrees. In Tompkins County, temperatures were in the 70s and reached the 80s in warmer valley locations.

Source(s): NYS DHSES 2019; FEMA 2020; NWS 2020; NOAA-NCEI 2020
Note: Many sources were consulted to provide an update of previous occurrences and losses; event details and loss/impact information may vary and has been summarized in the above table.
FEMA Federal Emergency Management Agency
NOAA-NCEI National Oceanic Atmospheric Administration – National Centers for Environmental Information
NWS National Weather Service
NYSDHSES New York State Department of Homeland Security and Emergency Services
N/A Not Applicable

Climate Change Impact

Heat Waves, defined as extreme temperature heat events with three or more consecutive days with maximum temperatures at or above 90 ˚F, are expected to increase in duration and frequency (Table 5.4.6-10). Extreme cold events, defined both as the number of days per year with minimum temperature at or below 32 ˚F and those at or below 0 ˚F, are expected to decrease as average temperatures rise (NYSERDA 2014). With the increase in temperatures, heat waves will become more frequent and intense, increasing heat-related illness and death and posing new challenges to the energy system, air quality and agriculture. Table 5.4.3-5 displays the projected changes in these events and includes the minimum, central range and maximum days per year.

Table 5.4.3-5. Changes in Extreme Events in NYSERDA Region 3 (Elmira) – Heat Waves and Drought Conditions

Event Type (2020s)	Low Estimate (10th Percentile)	Middle Range (25th to 75th Percentile)	High Estimate (90th Percentile)
Days over 90 degrees Fahrenheit (°F) (10 days)	15	17-21	23
# of Heat Waves (1 heat waves)	2	2 to 3	3
Duration of Heat Waves (4 days)	4	4 to 5	5
Days below 32°F (155 days)	119	122 to 130	134

Source: NYSERDA 2014

Probability of Future Occurrences

Tompkins County will continue to experience extreme temperatures annually that could coincide with or

induce secondary hazards, such as human health impacts, hail, snow, ice or wind storms, thunderstorms, drought, and utility failures. These events include significant presidentially declared events as well as others reported and documented by NOAA.

Table 5.4.3-6 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. These events include significant presidentially declared events as well as others reported and documented by NOAA.

Table 5.4.3-6. Probability of Occurrences of Extreme Temperature Events

Hazard Type	Number of Occurrences Between 1996 and 2020	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	% chance of occurrence in any given year
Cold/Wind Chill	12	0.50	2.08	0.48	48%
Excessive Heat	1	0.04	25.00	0.04	4%
Extreme Cold/Wind Chill	2	0.08	12.50	0.08	8%
Heat	3	0.13	8.33	0.12	12%
TOTAL	**18**	**0.75**	**1.39**	**0.72**	**72%**

Source: NOAA NCEI 2020
Note: Probability was calculated using the available data provided in the NOAA-NCEI storm events database. For extreme temperature events, reporting begins at 1996.

Based on historical records and input from the Planning Partnership, the probability of occurrence for extreme temperatures in Tompkins County is considered high. Historical data from the Cornell Climate Smart Farming tool indicates that the general pattern with extreme heat days is unclear, as depicted below. Rather than a gradual increase since 1950, the histogram shows a wave-like pattern, where the years with extreme heat days increases and decreases approximately every 30 years. However, general projections show that, under projections where emissions continue to rise, the current number of days over 90F hovering between 0 and 20 can increase to 50 to 75 days a year.

Figure 5.4.3-3 Climate Projections based on High Emissions Scenario

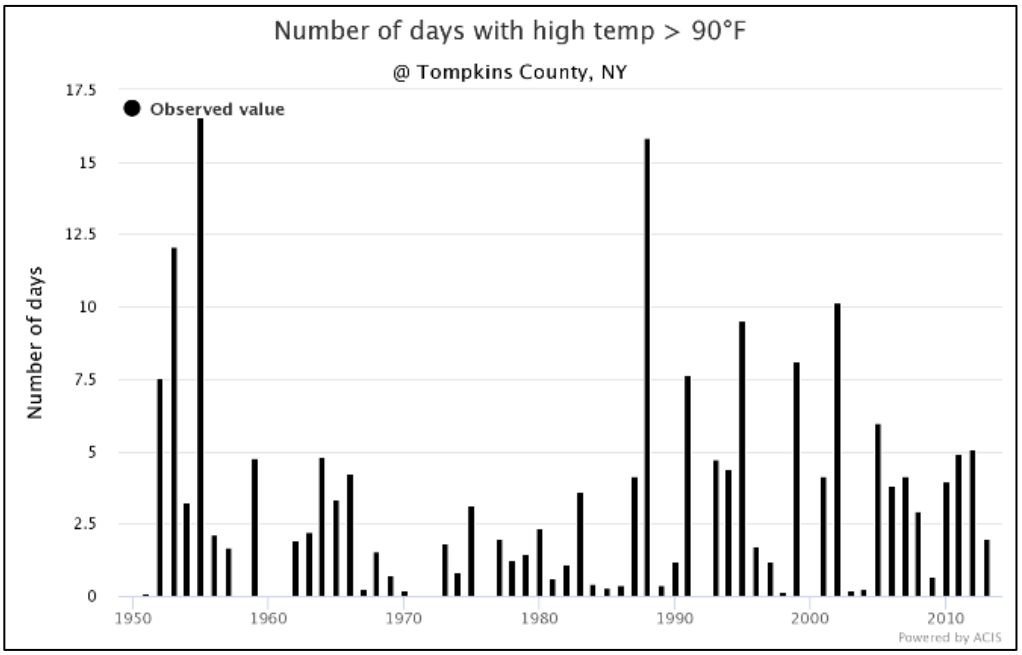
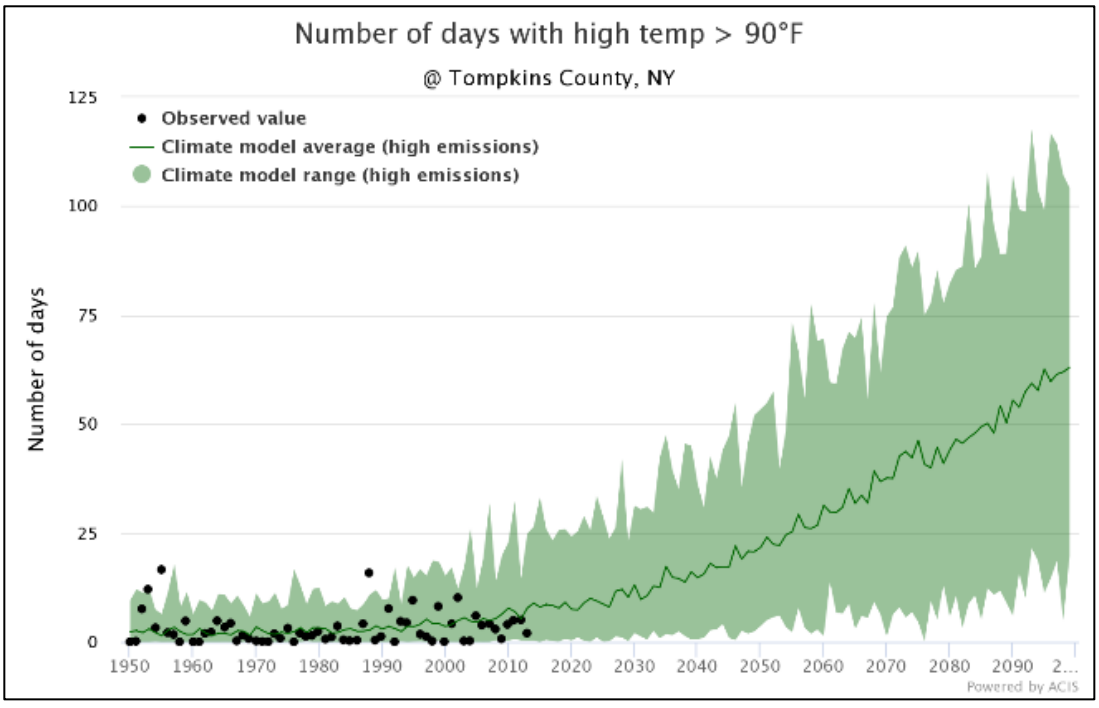


Figure 5.4.3-4 Historical Number of Days over 90°F



5.4.3.2 Vulnerability Assessment

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

Impact on Life, Health and Safety

The entire population of Tompkins County is exposed to extreme temperature events (population of 102,962 people, according to the 2014-2018 American Community Survey population estimates). Extreme temperature events have potential health impacts including injury and death.

According to the 2018 ACS 5-Year Population Estimate, persons that are most vulnerable to extreme temperature events are those over 65-years old (The Town of Ithaca has the greatest number of people over the age of 65, i.e., 2,029 people total. The Town of Ulysses has the greatest concentration of people over the age of 65, i.e., 27.4-percent of its total population) under 5-years old, those of low-income that cannot afford proper heating and cooling or have difficulty accessing transportation and medical care; and those with a disability. The homeless and residents of low-income whose housing may be less able to withstand extreme temperatures (e.g., homes with poor insulation and inefficient heating). There are a total of 17,500 persons living in poverty in the County (ACS 2018). In Tompkins County, areas with the highest concentration of population below the poverty level, with potentially fewer resources to protect against extreme temperatures are located in the Town of Dryden (17-percent of its total population). The City of Ithaca has the greatest number of persons living below the poverty level (9,631 persons total). Other groups vulnerable to extreme temperatures include individuals with underlying medical conditions, those that have a difficulty in communicating, including non-native speakers and those with intermittent internet and cellular service and also and the general public who may overexert during work or exercise during extreme heat events or experience hypothermia during extreme cold events (CDC 2020).

> Individuals most vulnerable to extreme weather events include those: Over 65 years old, under 5 years old, with low-income, homeless, with a disability, with underlying medical conditions, with difficulty communicating.

Overall, 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. Tompkins County's overall score is 0.3493, indicating that its communities have low to moderate vulnerability (CDC 2016). This score indicates that most County residents will have enough resources to respond to extreme temperature events. Refer to Section 4 (County Profile) that displays the densities of all the vulnerable populations in Tompkins County.

In addition to vulnerable populations, 30-percent of all deaths caused by fire 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). Homeless encampments in greater Tompkins County report a high rate of cooking/heating fires in the colder months. Furthermore, power outages occur more frequently during extreme cold events. Individuals powering their homes with generators are subjected to carbon monoxide poisoning if proper ventilation procedures are not followed (NYC 2019). Improperly connected portable generators are capable of 'back feeding' power lines which may cause injury or death to utility workers attempting to restore power and may damage house wiring and/or generators.

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 (through a range of methods), 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 a noted in Section 4 (County Profile), which summarizes the building inventory in Tompkins 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 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.

The 2019 New York City Hazard Mitigation Plan states that older buildings following less stringent building codes are more vulnerable to drafts during extreme cold events due to cracks and leaks in the walls (NYC 2019). Roof damage can also occur due to excessive snow fall and extreme temperature change. Extreme heat may also be damaging to older structures. Further, structures with glass exposed to sunlight and structures exposed to heat on all four sides are more susceptible to damages, including interior damages from overheating (NYC 2019).

Impact on Community Lifelines

All community lifeline critical facilities in the County are exposed to the extreme temperature hazard. Impacts to critical facilities that are buildings will experience similar issues 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.

The 2019 New York City Hazard Mitigation Plan indicates that transportation infrastructure may experience damages from extreme temperature events. This is particularly the case with ground transportation systems at risk of cracking, buckling, or sagging due to high temperatures (NYC 2019). This can cause disruptions to essential services that travel along these routes to provide services to the community.

Impact on Economy

Extreme temperature events also impact the economy, including loss of business function and damage to and/or loss of business 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 or telecommunications). Disruptions in public transportation service will also impact the economy for both commuters and customers alike.

Impact on the Environment

Extreme temperature events can have a major impact on the environment. For example, freezing and warming weather patterns create changes in natural processes. An excess amount of snowfall and earlier warming periods may affect natural processes such as flow within water resources (USGS 2020). Likewise, rain-on-snow events also exacerbate runoff rates with warming winter weather. Extreme heat events can have particularly negative impacts on aquatic systems, contributing to fish kills, aquatic plant die offs, and increased likelihood of harmful algal blooms.

Cascading Impacts to Other Hazards

Extreme temperature events can exacerbate the drought hazard and increase the potential risk of wildfires for the County. For example, extreme heat events may accelerate evaporation rates, drying out the air and soils. Extreme heat can also dry out terrestrial species, making them more susceptible to catching fire. Refer to Sections 5.4.2 and 5.4.10 for more information about the impacts of drought and wildfires, respectively.

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

As discussed in Section 4, areas targeted for future growth and development have been identified across Tompkins County. 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.

Projected Changes in Population

According to population projections from the Cornell Program on Applied Demographics, Tompkins County will experience a continual population increase from 2020 through 2040 (over 6,040 people in total by 2040). The U.S. Census Bureau also shows that the population in Tompkins County has increased 0.6-percent between 2010 and 2019 (U.S. Census Bureau 2020). An increase in the population throughout Tompkins County will also increase the number of persons exposed to extreme temperature events. Refer to Section 4 (County Profile), for additional discussion on population trends.

Change of Vulnerability Since the 2014 HMP

Overall, extreme temperature events will continue to impact the entire County. 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.

Identified Issues

- While extreme temperatures affect vulnerable populations as noted in this section, it is noted that urban areas may be inordinately affected not only due to the density of the elderly, youth, and low income population less equipped to address potential health impacts, but furthermore, urban areas may experience profound economic consequences due to the effect of extreme temperatures on not only infrastructure but on the economy of the area.
- Prolonged extreme heat events can lead to drought conditions and impact the drinking water supply for residents.
- Extreme temperature events can damage aging infrastructure and buildings as highways and roads are damaged by excessive heat as the asphalt softens, and roadways can be damaged from extreme cold temperatures causing frost heaving of road infrastructure.
- The increase in population in the rural areas might strain utility systems in affected portions of the County due to larger demand.

- The number of homeless in Tompkins County could pose an increased health risk to those without proper shelter during extreme temperature events. In order to quantify the number of homeless.
- A review of available tax assessor data may inform policy makers of areas where the age of housing may indicate areas in need of updated insulation and efficient heating and cooling measures.