4.3.3 DROUGHT

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 drought hazard in Mercer County.

2021 HMP Update Changes

- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2015 and 2020.
- The County's 2018 5-year ACS population was considered when determining its exposure and vulnerability to the drought hazard.

Profile

Hazard Description

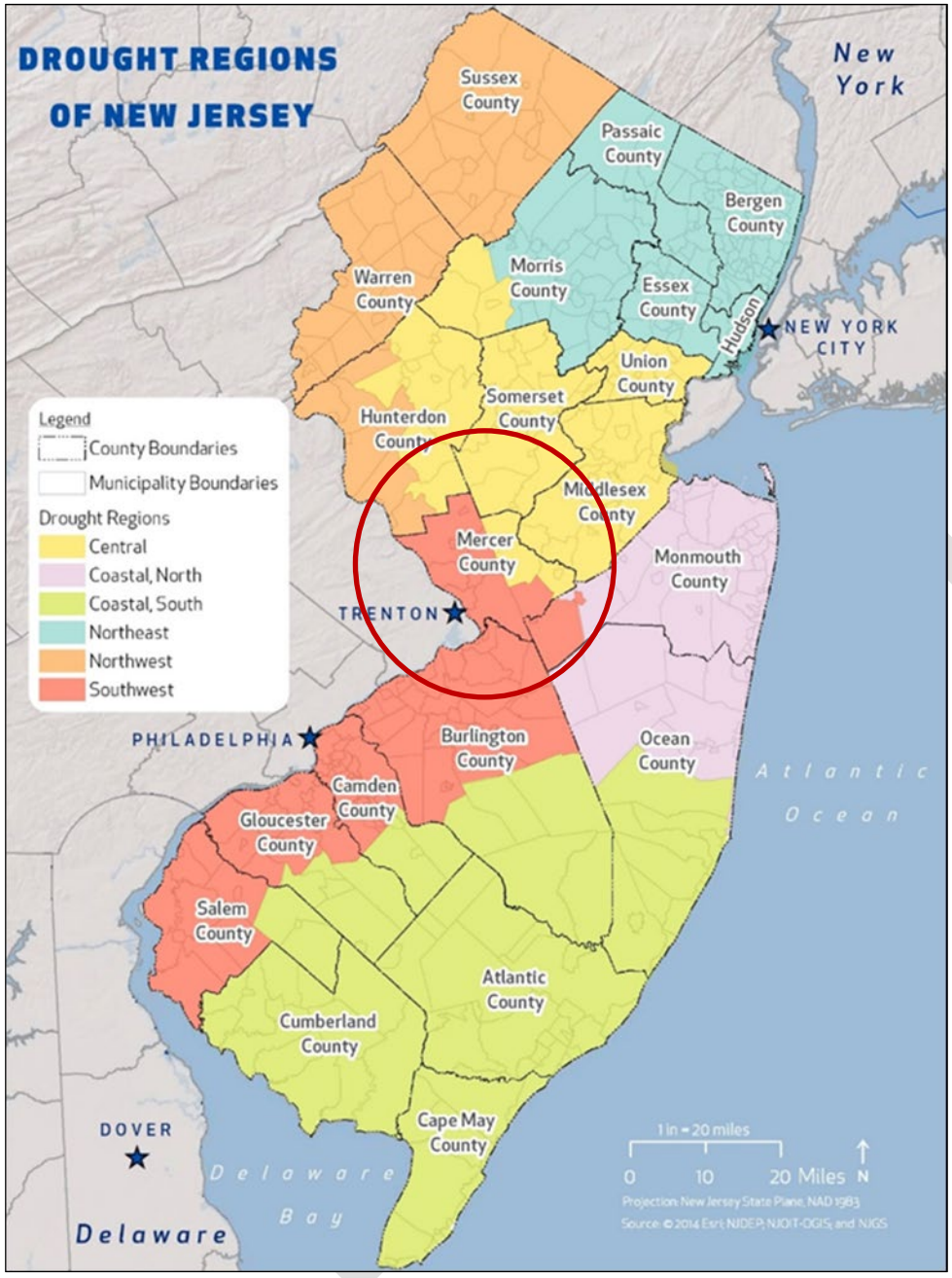
Drought is a period characterized by long durations of below normal precipitation. Drought conditions occur in virtually all climatic zones, yet characteristics of drought vary significantly from one region to another, relative to normal precipitation within respective regions. Drought can affect agriculture, water supply, aquatic ecology, wildlife, and plant life. Drought is a temporary irregularity in typical weather patterns and differs from aridity, which reflects low rainfall within a specific region and is a permanent feature of the climate of that area.

Location

Climate divisions are regions within a state that are climatically homogenous. The National Oceanic and Atmospheric Administration (NOAA) has divided the U.S. into 359 climate divisions. The boundaries of these divisions typically coincide with the county boundaries, except in the western U.S., where they are based largely on drainage basins (U.S. Energy Information Administration, Date Unknown). According to NOAA, New Jersey is made up of three climate divisions: Northern, Southern, and Coastal; Mercer County is located along the border of the Northern and Southern Climate Divisions (NOAA 2012).

Drought regions allow New Jersey to respond to changing conditions without imposing restrictions on areas not experiencing water supply shortages. New Jersey is divided into six drought regions that are based on regional similarities in water supply sources and rainfall patterns (Hoffman and Domber, 2003). Mercer County is located in the Northwest and Central Drought Regions (Hoffman and Domber, 2003) (see Figure 4.3.3-1). These regions were developed based upon hydro-geologic conditions, watershed boundaries, municipal boundaries, and water supply characteristics. Drought region boundaries are contiguous with municipal boundaries because during a water emergency, the primary enforcement mechanism for restrictions is municipal police forces.

Figure 4.3.3-1. Drought Regions of New Jersey

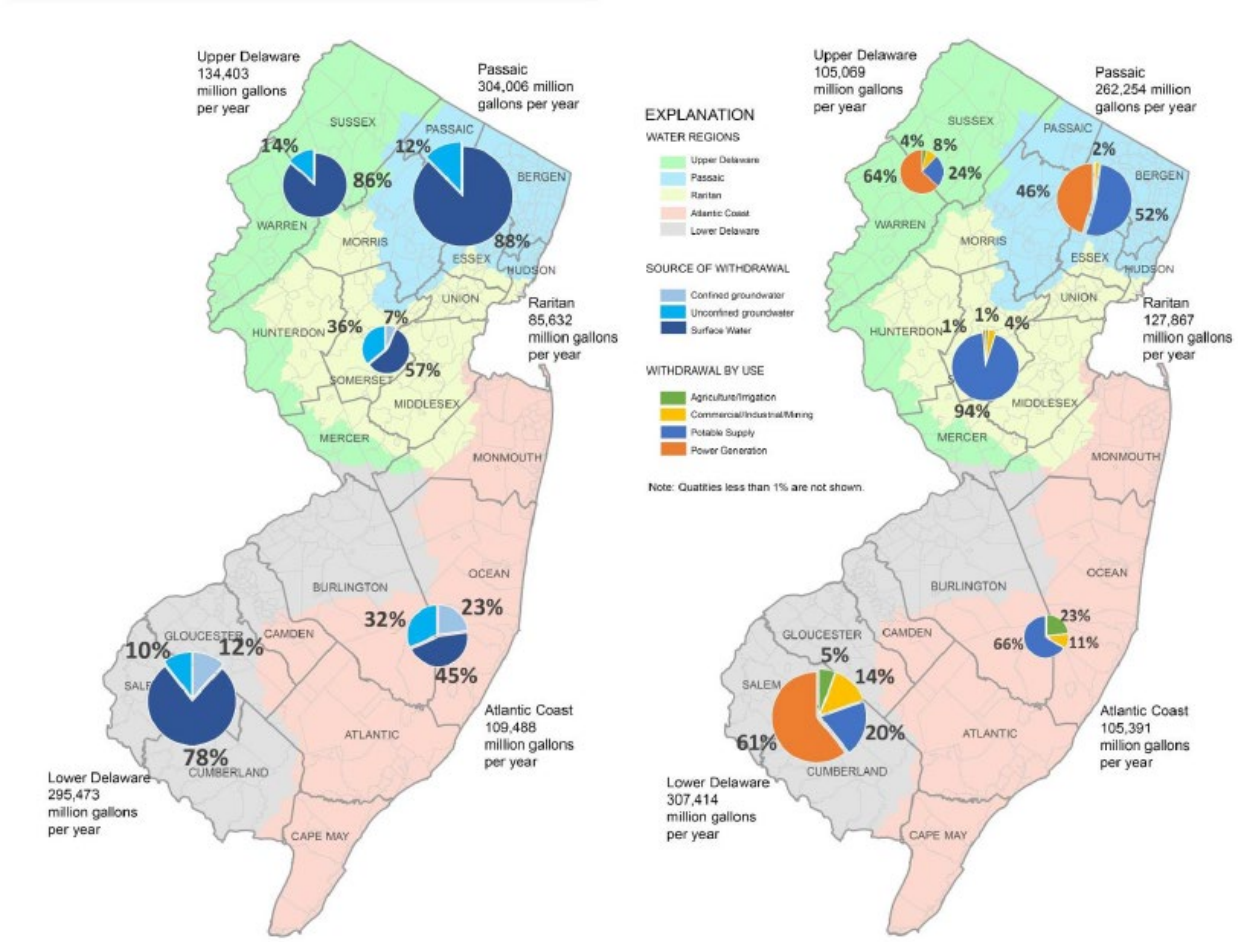


Source: *NJOEM 2019*

Note: *The red circle indicates the location of Mercer County. The County is located within the Southwest and Central Drought Regions of New Jersey.*

There are five water regions across the State (compiled from HUCH11 Watershed Management Areas). Mercer County is located in the Upper Delaware, Lower Delaware, and Raritan water regions. Refer to Figure 4.3.3-2 for the sources and withdrawals for each region (NJDEP 2017).

Figure 4.3.2-2. Water Regions, Sources and Withdrawal by Sector in New Jersey



Source: NJDEP 2017

According to the 2017 Census of Agriculture, Mercer County is home to 323 farms covering 25,230 acres. Roughly 1,008 acres are irrigated (USDA 2017). Farms are considered to be at a higher risk for drought impacts than other types of land use. Table 4.3.2-1. shows the agricultural land use area within Mercer County jurisdictions.

Table 4.3.2-1. Agricultural Land Use Area by Jurisdiction

Jurisdiction	Total Area (Acres)	Agriculture	
		Area (Acres)	Percent of Total Area
East Windsor (Twp)	10,019	1,963	19.6%
Ewing (Twp)	9,784	448	4.6%
Hamilton (Twp)	25,469	1,940	7.6%
Hightstown (B)	810	5	0.6%
Hopewell (B)	464	54	11.6%
Hopewell (Twp)	37,430	9,091	24.3%

Jurisdiction	Total Area (Acres)	Agriculture	
		Area (Acres)	Percent of Total Area
Lawrence (Twp)	14,063	1,490	10.6%
Pennington (B)	624	0	0.0%
Princeton	11,784	434	3.7%
Robbinsville (Twp)	13,168	2,649	20.1%
Trenton (C)	4,893	2	0.0%
West Windsor (Twp)	16,801	2,214	13.2%
Mercer County (Total)	**145,308**	**20,289**	**14.0%**

Source: NJDEP 2019 (the 2015 LULC Updated edition)
Note: B = Borough; T = Town; Twp = Township; % = Percent

Extent

The severity of a drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts. The State of New Jersey uses a multi-index system that takes advantage of some of these indices to determine the severity of a drought or extended period of dry conditions.

Palmer Drought Severity Index

The Palmer Drought Severity Index is commonly used by drought monitoring agencies for drought reporting. The PDSI is primarily based on soil conditions. Soil with decreased moisture content is the first indicator of an overall moisture deficit. Table 4.3.2-2 lists the PDSI classifications. Zero is used to define normal conditions and negative numbers define drought conditions. For example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The PDSI also reflects excess precipitation using positive numbers; however, this is not shown in Table 4.3.2-2 (National Drought Mitigation Center [NDMC] 2013).

Table 4.3.2-2. Palmer Drought Category Descriptions

Category	Description	Possible Impacts	Palmer Drought Index
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting and growth of crops or pastures; fire risk above average. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered.	-1.0 to -1.99
D1	Moderate drought	Some damage to crops and pastures; fire risk high; streams, reservoirs, or wells low; some water shortages developing or imminent; voluntary water-use restrictions requested.	-2.0 to -2.99
D2	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed.	-3.0 to -3.99
D3	Extreme drought	Major crop or pasture losses; extreme fire danger; widespread water shortages or restrictions.	-4.0 to -4.99
D4	Exceptional drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies.	-5.0 or less

Source: NDMC 2013

The Division of Water Supply and Geoscience within the NJDEP, regularly monitors various water supply conditions within the state based on the different Water Supply Regions. The water supply conditions aid the Department in declaring the regions as being within one of the four stages of water supply drought, Normal, Drought Watch, Drought Warning, and Drought Emergency.

- A ***Drought Watch*** is an administrative designation made by the Department when drought or other factors begin to adversely affect water supply conditions. A Watch indicates that conditions are dry but not yet significantly so. During a drought Watch, the Department closely monitors drought indicators (including precipitation, stream flows and reservoir and ground water levels, and water demands) and consults with affected water suppliers.
- A ***Drought Warning*** represents a non-emergency phase of managing available water supplies during the developing stages of drought and falls between the Watch and Emergency levels of drought response. The aim of a Drought Watch is to avert a more serious water shortage that would necessitate declaration of a water emergency and the imposition of mandatory water use restrictions, bans on water use, or other potentially drastic measures.
- A ***Drought Emergency*** can only be declared by the governor. While drought warning actions focus on increasing or shifting the supply of water, efforts initiated under a water emergency focus on reducing water demands. During a water emergency, a phased approach to restricting water consumption is typically initiated. Phase I water use restrictions typically target non-essential, outdoor water use (NJDEP Division of Water Supply and Geoscience 2018).

Previous Occurrences and Losses

Precipitation variability, coupled with concentrated population centers, can produce wide fluctuations in water availability and demands. The State and County have experienced several episodes of drought that have resulted in water shortages of varying degrees (e.g., mid-1960's, early to mid-1980's and 2001-2002) (NJDEP 2017).

Federal Disaster Declarations

Between 1954 and 2021, the State of New Jersey experienced two FEMA declared drought-related major disasters (DR) or emergencies (EM) classified as a water shortage. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Of those two declarations, Mercer County has been included in both declarations (FEMA 2021).

Table 4.3.2-3. FEMA DR and EM Declarations Since 2008 for Drought Events in Mercer County

FEMA Declaration Number	Date(s) of Event	Date of Declaration	Event Type
DR-205	August 18, 1965	August 8, 1967	Drought: Water Shortage
EM-3083	October 19, 1980	May 21, 1983	Drought: Water Shortage

Source: FEMA 2021

USDA Disaster Declarations

Agriculture-related drought disasters are quite common. 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. Mercer County was included in declarations in 2015 and 2016; refer to Table 4.3.3-4.

Table 4.3.3-4. USDA Agriculture Disaster Declarations, 2015 to 2021

Year	Designation number	Description	Losses
2015	S3930	Excessive Heat and Drought	$80,491.80 for All Other Crops
2016	S4071	Combined effects of freeze, excessive heat, and drought	$7,908 for Corn $98,079.75 for Soybeans
2016	S4165	Drought	

Source: USDA 2021

Table 4.3.3-5 summarizes the drought events identified in Mercer County from 2015 to 2021. Refer to Appendix E (Risk Assessment Supplement) for details on drought events that have impacted Mercer County prior to 2015.

Table 4.3.3-5. Drought Incidents in Mercer County, 2015 to 2021

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Mercer County Designated?	Description
September 23, 2015 – March 1, 2016	Drought	N/A	N/A	A drought watch was issued for Mercer County.
July 25 – October 18, 2016	Drought	N/A	N/A	A drought watch was issued for Mercer County.
October 11, 2016	Drought	N/A	N/A	A drought warning was issued in New Jersey
November 17, 2016	Drought	N/A	N/A	Water conservation was urged in northern New Jersey.
October 2, 2017	Drought	N/A	N/A	Leaves were reported to have turned brown rather than the usual fall colors in Mercer County.
March 9 – August 15, 2017	Drought	N/A	N/A	New Jersey's Department of Environmental Protection issued a drought watch and warning.
January 10, 2018	Drought	N/A	N/A	Low reservoirs were reported in northern New Jersey.
September 24 – December 2, 2019	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Mercer County from September 17 – October 14, 2019; D1 or "moderate drought" status from October 15–28, 2019; and D0 or "abnormally dry" from October 29 – December 2, 2019.
March 17 – 23, 2020	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Mercer County from March 17 – 23, 2020
July 7 – 13, 2020	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Mercer County from July 7 – 13, 2020.

Source: NOAA NCEI 2021, USDA 2021, NDMC 2021, FEMA 2021, US Drought Monitor 2021

Probability of Future Occurrences

Based on the historical occurrences for drought, it is likely that droughts will occur across New Jersey and Mercer County in the future. Drought affects groundwater sources but not as quickly as surface water supplies. In addition, as temperatures increase (see climate change impacts), the probability for future droughts will likely increase as well.

It is estimated that Mercer County will continue to experience direct and indirect impacts of drought and its impacts on occasion, with the secondary effects causing potential disruption or damage to agricultural activities and creating shortages in water supply within communities.

In Section 4.4, the identified hazards of concern for Mercer 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 drought in the County is considered 'frequent'. The ranking of the drought hazard for individual municipalities is presented in the jurisdictional annexes.

Climate Change Impacts

Water resources are important to both society and ecosystems. Humans depend on reliable, clean supply of drinking water to sustain their health. Water is also needed for agriculture, energy production, navigation, recreation, and manufacturing. These water uses put pressure on water resources and are most likely to be worsened by climate change in the future.

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.

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 (Office of the New Jersey State Climatologist 2020), which is faster than the rest of the Northeast region (2° F [1.1° C]) (Melillo et al. 2014) and the world (1.5° F [0.8° C]) (IPCC 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 et al. 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 et al. 2017). New Jersey can also expect that by the middle of the 21st century, 70% of summers will be hotter than the warmest summer experienced to date (Runkle et al. 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.

As temperatures increase, Earth's atmosphere can hold more water vapor which leads to a greater potential for precipitation. Currently, New Jersey receives an average of 46 inches of precipitation each year (Office of the New Jersey State Climatologist 2020). Since the end of the twentieth century, New Jersey has experienced slight increases in the amount of precipitation it receives each year, and over the last 10 years there has been a 7.9% increase. By 2050, annual precipitation in New Jersey could increase by 4% to 11% (Horton et al. 2015). By the end of this century, heavy precipitation events are projected to occur two to five times more often (Walsh et al. 2014) and with more intensity (Huang et al. 2017) than in the last century. New Jersey will experience more intense rain events, less snow, and more rainfalls (Fan et al. 2014, Demaria et al. 2016, Runkle et al. 2017). Also, small decreases in the amount of precipitation may occur in the summer months, resulting in greater potential for more frequent and prolonged droughts (Trenberth 2011).

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. The following discusses Mercer County's vulnerability, in a qualitative nature, to the drought hazard.

Impact on Life, Health and Safety

The entire population of Mercer County is exposed to drought events (population of 367,92 people, according to the 2015-2019 ACS population estimates). Drought conditions can cause a shortage of potable water for human consumption, both in quantity and quality. A decrease in available water may also impact power generation and availability to residents.

The Centers for Disease Control and Prevention's (CDC) 2018 Social Vulnerability Index (SVI) ranks U.S. Census tracts on socioeconomic status, household composition and disability, minority status and language, and housing and transportation. Mercer County's overall score is 0.558, indicating that its communities have a moderate to high level social vulnerability (CDC 2018). The highest concentrations of vulnerability in Mercer County are concentrated in the City of Trenton and East Windsor Township.

Public health impacts may include an increase in heat-related illnesses, waterborne illnesses, recreational risks, limited food availability, and reduced living conditions. Vulnerable populations could be particularly susceptible to the drought hazard and cascading impacts due to age, health conditions, and limited ability to mobilize to shelter, cooling and medical resources. Other possible impacts to health due to drought include increased recreational risks; effects on air quality; diminished living conditions related to energy, air quality, and sanitation and hygiene; compromised food and nutrition; and increased incidence of illness and disease. Health implications of drought are numerous. Some drought-related health effects are short-term while others can be long-term (CDC 2020).

Surface water supplies are affected more quickly during droughts than groundwater sources; however, groundwater supplies generally take longer to recover. According to the NJ Drinking Water Watch List, there are 13 suppliers of water to Mercer County (NJ Drinking Water Watch 2020). All suppliers provide water from groundwater sources. The EPA classifies water suppliers into three major categories: community water systems, non-transient non-community water systems, transient non-community water systems.

- ***Community Water System*** **(CWS):** A public water system that supplies water to the same population year-round.
- ***Non-Transient Non-Community Water System*** **(NTNCWS)**: A public water system that regularly supplies water to at least 25 of the same people at least six months per year. Some examples are schools, factories, office buildings, and hospitals which have their own water systems.
- ***Transient Non-Community Water System*** **(TNCWS)**: A public water system that provides water in a place such as a gas station or campground where people do not remain for long periods of time (EPA 2020).

Overall, in Mercer County, two sources are transient non-community water suppliers, one is a non-transient non-community supplier, one is a community supplier, and 10 are non-public water supplies. There are County residents and organizations that rely on wells for their water supply needs. While this number may still be lower than the actual drinking water well count for the County, it still demonstrates the importance of well water to residents.

Impact on General Building Stock

No structures are anticipated to be directly affected by a drought event. However, droughts contribute to conditions conducive to wildfires and reduce fire-fighting capabilities. Risk to life and property is greatest in those areas where forested areas adjoin urbanized areas (high density residential, commercial and industrial) also known as the wildfire urban interface (WUI) or where areas are made up of species that are highly susceptible to erupting into wildfire events. Therefore, all assets in and adjacent to the WUI zone and wildfire fuel hazard

areas, including population, structures, critical facilities, lifelines, and businesses are considered vulnerable to wildfire. Refer to Section 4.3.13 for the Wildfire risk assessment.

Impact on Critical Facilities and Lifelines

As mentioned, drought events generally do not impact buildings; however, droughts have the potential to impact agriculture-related facilities and critical facilities that are associated with water supplies such as potable water used with fire-fighting services. The impacts droughts cause to agricultural-related facilities is particularly important to Mercer County due to its high amount of acreage devoted to farmland. Critical facilities and community lifelines located in and adjacent to the wildfire hazard areas are also considered vulnerable to drought.

Water systems and thus distribution to the population may also be impacted by other hazards such as extreme weather events. A good example is Superstorm Sandy where storm surge damaged critical water supply infrastructure along the coast and high winds impacted energy distribution across the State which in turn impacted the ability to supply water. As a result, NJDEP has developed new guidance aimed to ensure that repairs, reconstruction, new facilities and operations/maintenance are focused on enhancing the resilience of critical infrastructure (NJDEP 2017).

Impact on the Economy

Drought can produce a range of impacts that span many economic sectors and can reach beyond an area experiencing physical drought. As previously discussed, water withdrawals are not only used for potable water but for use in the commercial/industrial/mining sectors and power generation. When a state of water emergency is declared by the Governor (when a potential or actual water shortage endangers the public health, safety and welfare), the NJDEP may impose mandatory water restrictions and require specific actions to be taken by water suppliers. According to the New Jersey Water Supply Plan, a water emergency seeks to cause as little disruption as possible to commercial activity and employment (NJDEP 2017).

A prolonged drought can have a serious economic impact on a community. One impact of drought is its impact on water supply. When drought conditions persist with little to no relief, water restrictions may be put into place by local or state governments. These restrictions may include placing limitations on when or how frequent lawns can be watered, car washing services, or any other recreational/commercial outdoor use of water supplies. In exceptional drought conditions, watering of lawns and crops may not be an option. If crops are not able to receive water, farmland will dry out and crops will die. This can lead to crop shortages, which, in turn, increases the price of food.

Increased demand for water and electricity can also result in shortages and higher costs for these resources. Industries that rely on water for business could be impacted the most (e.g., landscaping businesses). Although most businesses will still be operational, they may be impacted aesthetically. These aesthetic impacts are most significant within the recreation and tourism industry. Moreover, droughts within another area could impact the food supply and price of food for residents within the County.

Direct impacts of drought include reduced crop yield, increased fire hazard, reduced water levels, and damage to wildlife and fish habitat. The many impacts of drought can be listed as economic, environmental, or social. Direct and indirect losses include the following:

- Damage to crop quality and crop losses.
- Insect infestation leading to crop and tree losses.
- Plant diseases leading to loss of agricultural crops and trees.
- Reduction in outdoor activities.

- Increased risk of brush fires and wildfires due to dried crops, grasses, and dying trees.

When a drought occurs, the agricultural industry is most at risk in terms of economic impact and damage. For example, crops may not mature leading to a lessened crop yield, wildlife and livestock may become undernourished, land values could decrease, and ultimately there could be a financial loss for the farmer. Based on the 2017 Census of Agriculture, there were 323 farms in Mercer County, a 19-percent increase from the 2012 reports. The median farm size was 78 acres. Mercer County farms had a total market value of products sold of approximately $24.9-million in crop sales and $4.9-million in livestock sales. Table 4.3.2-5 summarizes the acreage of agricultural land exposed to the drought hazard.

Table 4.3.2-5. Agricultural Land in Mercer County in 2017

Number of Farms	Land in Farms (acres)	Total Cropland (acres)	Harvested Cropland (acres)	Irrigated Land (acres)
323	25,230	15,790	12,724	1,008

Source: USDA 2017

Impact on the Environment

Droughts can impact the environment because these events can trigger wildfires, increase insect infestations, and exacerbate the spread of disease (NOAA 2020). Droughts will also impact water resources that are relied upon by aquatic and terrestrial species. Ecologically sensitive areas, such as wetlands, can be particularly vulnerable to drought periods because they are dependent on steady water levels and soil moisture availability to sustain growth. As a result, these types of habitats can be negatively impacted after long periods of dryness (NJDEP 2017).

Droughts also have the potential to lead to water pollution due to the lack of rainwater to dilute any chemicals in water sources. Contaminated water supplies may be harmful to plans and animals. If water is not getting into the soils, the ground will dry up and become unstable for plant species. Maintaining stability prevents erosion and treefall that is susceptible to catching fire and starting wildfire events (North Carolina State University 2020).

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 3 (County Profile), areas targeted for future growth and development have been identified across Mercer County. The New Jersey Water Supply Plan indicates seasonal outdoor water use is rising statewide and is attributable to continued suburbanization and increases in residential and commercial lawn and landscape maintenance. Changes in water demands by commercial/industrial users will depend on future development of this water type use and how effectively efficiency techniques are implemented (NJDEP 2017).

Projected Changes in Population

Potable water use is the second largest water use sector and largest consumptive use in New Jersey. As such, population projections, per capital water use and percent non-residential water use by water system are important factors to consider when assessing future water needs. According to the 2019 5-year population estimates from the ACS, the population of Mercer County (i.e., 367,922 persons) has increased by approximately 0.4-percent since 2010. Even though the population has only slightly increased, any changes in the distribution of the population can impact the source of water resources required to sustain the user demand of each household, agricultural operation, and business operation.

Climate Change

As discussed above, most studies project that the State of New Jersey will see an increase in average annual temperatures. Additionally, the State is projected to experience more frequency droughts which may affect the availability of water supplies, primarily placing an increased stress on the population and their available potable water. Agricultural needs may increase if the climate grows warmer but may decrease if more efficient irrigation techniques are adopted broadly or if precipitation increases. A decrease in water supply, or increase in water supply demand, may increase the County's vulnerability to structural fire and wildfire events. Critical water-related service sectors may need to adjust management practices and actively manage resources to accommodate for future changes.

Vulnerability Change Since the 2016 HMP

When examining the change in the County's vulnerability to drought events from the 2016 HMP to this update, it is important to look at each entity that is exposed and vulnerable. The total population across the County has experienced a slight increase, which can place increased stress on the water supply during a drought event. The number of farm operations has increased since the 2012 USDA report by nearly 20-percent, which may increase the overall stress on the water supply during a drought event.