



4.3.4 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 drought hazard in Gloucester County.

2022 HMP 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 federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2015 and 2021.
- The County's 2019 5-year American Community Survey population was considered when determining its exposure and vulnerability to the drought hazard.

4.3.4.1 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 (NOAA 2012). Gloucester County is located in the Southern Climate Division.

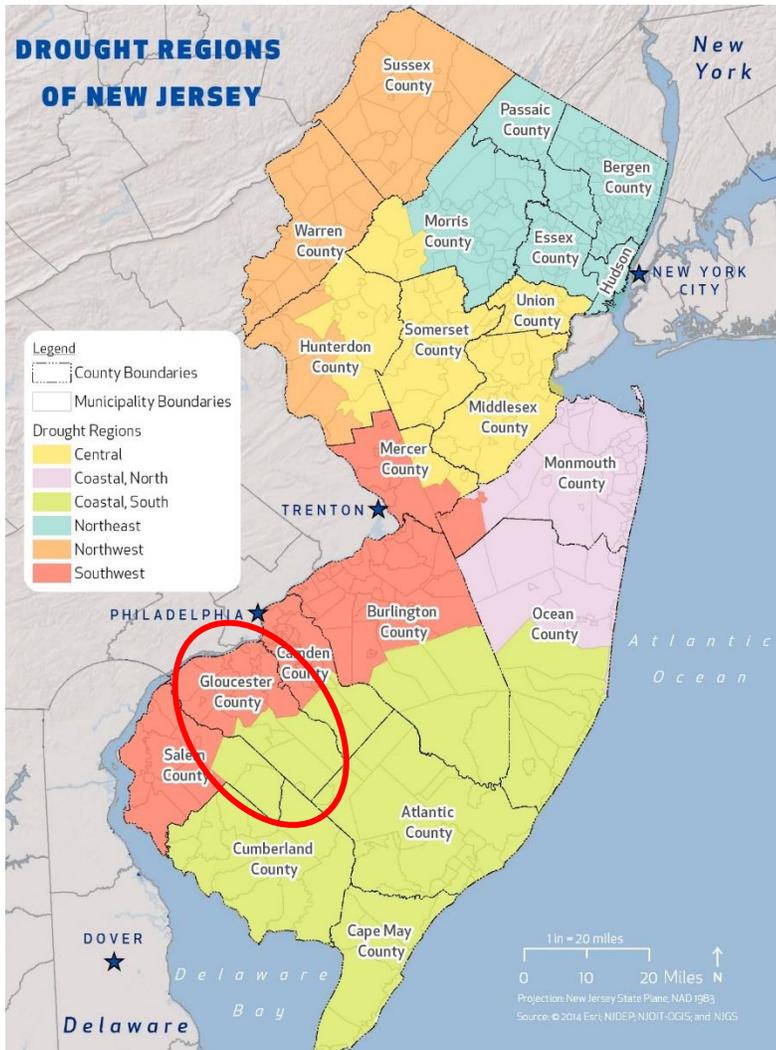
Drought regions allow New Jersey to respond to changing conditions without imposing restrictions on areas not experiencing water supply shortages. New Jersey is divided into six drought regions that are based on regional similarities in water supply sources and rainfall patterns (Hoffman and Domber 2003). 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.

Error! Reference source not found.5.4.4-1 shows the drought regions of New Jersey. Gloucester County is



located in both the Southwest, and the Coastal, South Drought Regions. Figure 4.3.4-1 shows the drought regions of New Jersey with Gloucester County circled in red.

Figure 4.3.4-1. Drought Regions of New Jersey



Source: NJOEM 2019

Note: The red circle indicates the location of Gloucester County

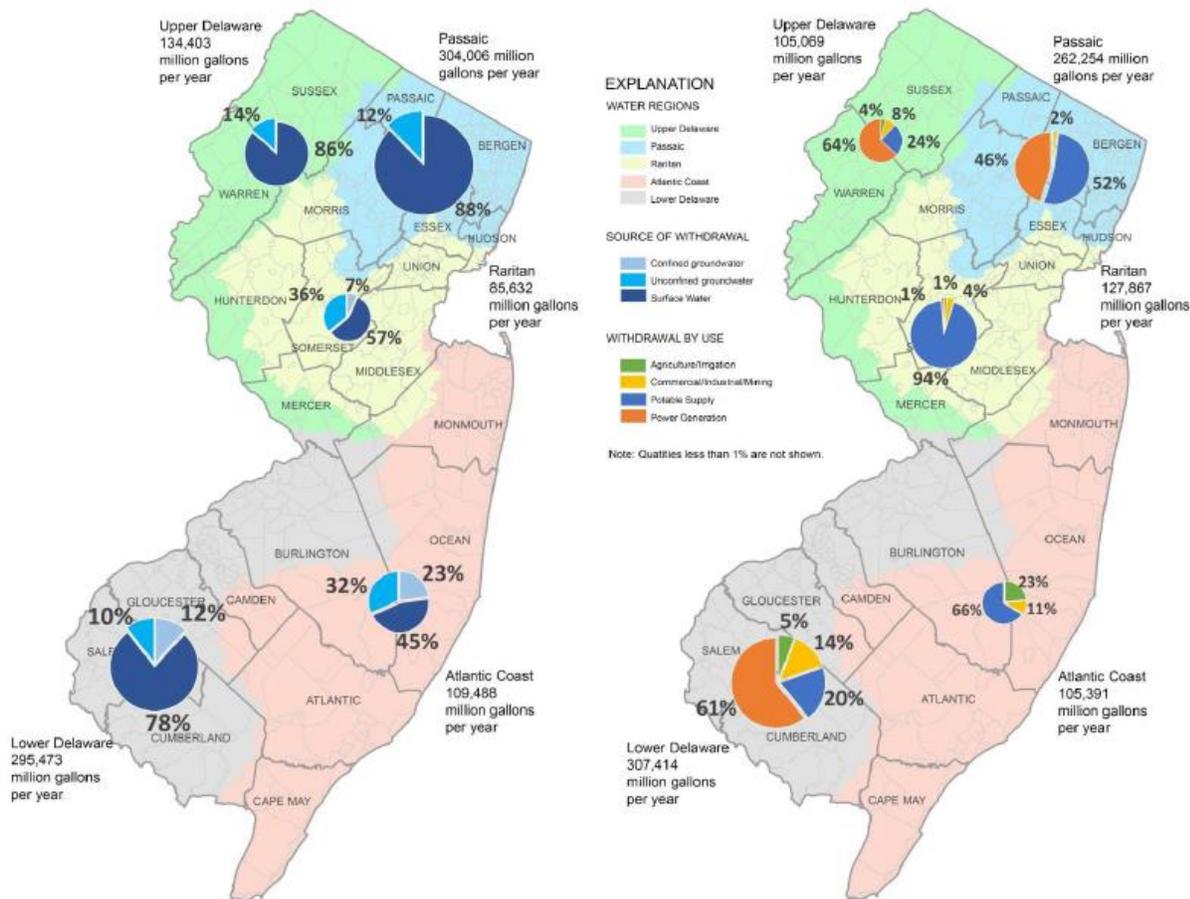
Surface waters in New Jersey provide much of the water used for drinking supplies, as well as for recreation, fishing, tourism, and commercial uses (NJDEP No Date). The state is divided into five water regions based upon watershed management area, and HUC11 (Hydrologic Unit Code). Gloucester County is located within both the Lower Delaware and Atlantic Coast water regions; refer to Figure 4.3.4-2. In terms of annual water withdrawal by sector in the Lower Delaware Region, the majority is for power generation, with a small percent of surface water used for potable water supply. By comparison, in the Atlantic Coast region, the majority of water withdrawals is for potable water supply, followed by agricultural and commercial uses. Water use trends, like withdrawal trends, vary from month to month with water use typically peaking during summer months



when outdoor and irrigation demands are high (NJDEP 2017). According to the NJDEP, major water supply sources available to the Southwest Drought Region and northern portion of Gloucester County include the Delaware River Basin and unconfined ground water, and rivers as a minor source. For the Coastal South Drought Region and southern portion of Gloucester County, major water sources include unconfined ground water, and minor sources include rivers and the New Jersey Reservoir.

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.

Figure 4.3.4-2. Water Regions, Sources and Withdrawal by Sector in New Jersey



Source: NJDEP 2016

Over 1.2 billion gallons of potable water are used in New Jersey each day, with 88 percent of the state’s population receiving its drinking water from public community water systems (NJDEP 2016). A public water



system is defined as a water system that pipes water for human consumption that has at least 15 service connections or regularly serves at least 25 individuals 60 days or more a year. About half the state's population receives its drinking water from surface water, the rest from ground water.

Gloucester County is also home to a large agricultural industry which is heavily reliant on existing water resources. According to the USDA Agricultural Census, as of 2017 the county has 580 farms which total 49,381 acres of land within Gloucester County. The average size of each farm is approximately 85 acres which is a 12 percent increase since the 2012 Agricultural Census (USDA 2017). The total market value of products sold by farms located in Gloucester County is roughly 102 million dollars while the average market value of products sold by each farm is 176,644 dollars on an annual basis. The majority of farms, that is 42 percent of all farms have a sales value of less than \$2,500 while 96 have an annual value of \$100,000 or more. Most sales of farms located in the county are from grain and vegetable production while a small fraction of sales stem from livestock and poultry products. Because this industry is heavily reliant on water, it is critical to examine the County vulnerability to drought to reduce any loss of income from farming.

According to the Washington Township Water Conservation Guide, the Raritan Aquifer is the most productive aquifer; it is relied on heavily for most South Jersey communities, which is causing stress because water is being removed faster than it can regenerate, especially with the inability for rain to penetrate the dry soils. This is a delicate situation because, while the Raritan is at risk for pollution or saltwater intrusion, taking too much water from the Cohansey can negatively impact streams and lakes. All of these various phenomena can have significant impact on Gloucester County over time (Mazziotti 2018).

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 (NOAA 2021). 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 4.3.4-1 lists the PDSI classifications. At the one end of the spectrum, 0 is used as normal and drought is indicated by negative numbers. 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 4.3.4-1 (University of Nebraska, Lincoln. 2013).



Table 4.3.4-1. 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

Watches, Warnings and Emergencies

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 2021).

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) (FEMA 2021).

FEMA Major Disasters and Emergency Declarations

Between 1954 and 2021, the State of New Jersey experienced two FEMA declared drought-related 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, Gloucester County has been included in both declarations (FEMA 2021).

Table 4.3.4-2. FEMA DR and EM Declarations for Drought Events in Gloucester County, 1954 to 2020

FEMA Declaration Number	Date(s) of Event	Declaration Date	Event Type
EM-3083	October 19, 1980	October 19, 1980	Water Shortage
DR-205	August 18, 1965	August 18, 1965	Water Shortage

Source: FEMA 2021

U.S. Department of Agriculture Disaster Declarations

Agriculture-related drought disasters are quite common. One-half to two-thirds of the counties in the U.S. have been designated as disaster areas in each of the past several years. The USDA Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2012 and 2021, Gloucester County has been included in six USDA declarations related to drought as summarized in Table 4.3.4-3 (USDA 2021). Although USDA disasters were declared, there are no USDA records for historical losses from 2012-2020 (USDA 2021).

Table 4.3.4-3. USDA Disaster Declarations for Gloucester County 2012-2021

Declaration	Event Date	Declaration Date	Event Description
S3487	June 28, 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
S3932	July 16, 2015	September 29, 2015	Excessive Heat and Drought
S3930	April 1, 2015	November 4, 2015	Excessive Heat and Drought
S4071	April 1, 2016	September 19, 2016	Combined effects of freeze, excessive heat, and drought
S4425	June 24, 2018	October 31, 2018	Excessive heat and drought conditions
S4602	August 15, 2019	January 10, 2020	Drought

Source: USDA 2021



Drought Events

For the 2022 HMP update, four events have impacted Gloucester County since the last hazard mitigation plan, that is between 2015 and 2021. These events have been identified and are listed in Table 4.3.4-4.

Table 4.3.4-4. Drought Incidents in Gloucester County, 2015 to 2021

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Gloucester County Designated?	Description
July 7- July 13, 2020	Drought	NA	NA	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Gloucester County from July 7 – July 13, 2020.
September 17 – December 9, 2019	Drought	NA	NA	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Gloucester County from September 17 – September 23, 2019, D1 or "moderate drought" from September 24 – October 28, 2019, and then back to D0 or "abnormally dry" between October 29 – December 9, 2019.
July 17 – 30, 2018	Drought	NA	NA	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Gloucester County from July 17 – July 30, 2018.
December 12, 2017 – February 12, 2018	Drought	NA	NA	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Gloucester County from December 12, 2017 - February 12, 2018.
August 30, 2016 – April 3, 2017	Drought	NA	NA	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Gloucester County from August 30 – September 12, 2016, D1 or "moderate drought" from September 13 – October 3, 2016, and then back to D0 or "abnormally dry" between October 4 – November 14, 2016, , D1 or "moderate drought" from November 15, 2016 – March 13, 2017, and D0 or "abnormally dry" between March 14 – April 3, 2017.
June 28 – August 1, 2016	Drought	NA	NA	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Gloucester County from June 28 – August 1, 2016.
May 3 – May 9, 2016	Drought	NA	NA	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Gloucester County from May 3 – May 9, 2016.
September 1 – October 5, 2015	Drought	NA	NA	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Gloucester County from September 1 – October 5, 2015
May 26, 2015 – June 1, 2015	Drought	NA	NA	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Gloucester County from May 26 -June 1, 2015

Source: NOAA NCEI 2021. USDA 2021, NDMC 2021, nj.com. FEMA 2021, NJOEM 2019

Probability of Future Occurrences

Based upon risk factors for and past occurrences, it is likely that droughts will occur across New Jersey and Gloucester County in the future. In addition, as temperatures increase (see climate change impacts), the probability for future droughts will likely increase as well. Therefore, it is likely that droughts will occur in New Jersey of varied severity in the future.



It is estimated that Gloucester 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.

According to the US Drought Monitor, the long term projections show that precipitation will increase in the region, which is contradictory to the statement that drought events will increase. However, it is important to note that while precipitation will increase, that is likely due to extreme preceptory events in shorter periods of time. At the same time, the number of drought events will also increase due to the longer periods of no rain. This gives a better understanding of how precipitation can increase at the same time, frequency of droughts also increases.

In Section 4.4 (Hazard Ranking), the identified hazards of concern for Gloucester 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 Steering Committee and Planning Committee, the probability of occurrence for drought in the County is considered 'occasional' (between 10 and 100 percent annual chance of occurring).

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.

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]) (R. K. Pachauri and L. A. 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. 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 (Runkle 2017). 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 percent increase. By 2050, annual precipitation in New Jersey could increase by 4 percent to 11 percent (Horton et al. 2015). By the end of this century, heavy precipitation events are projected to occur two to five times more often and with more intensity (Huang 2017) than in the last century. New Jersey will experience more intense rain events, less snow,



and more rainfalls (Fan 2014). 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).

Droughts along with extreme precipitation have been an increasingly recurring phenomenon over the past decades. Precipitation has increased over time, which is counterintuitive given drought events are also projected to increase. However, this follows the trend of increased extreme weather. With isolated precipitation, in between long stretches of dry weather, wildfires, riverine flooding, and degraded water supply can all happen at the same time and therefore can put communities, especially those that live along a river, susceptible to structural flood damage along with potential degraded water supply due to the receding water table that cannot get replenished from such extreme precipitation. The county is thus vulnerable to droughts, especially along the Delaware River, where the temperatures increase dramatically and severe runoff from dry soils can cause degraded water supply (Cornell University 2021).

4.3.4.2 Vulnerability Assessment

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

Impact on Life, Health and Safety

The entire population of Gloucester County is exposed to drought events (population of 291,165 people, according to the 2015-2019 American Community Survey 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.

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 2021)

Surface water supplies are affected more quickly during droughts than groundwater sources; however, groundwater supplies generally take longer to recover. In addition to 158 suppliers of groundwater throughout Gloucester County, the following list provides the surface water suppliers for Gloucester County (NJDEP 2021):

- DEPTFORD TWP MUA
- EAST GREENWICH TWP WATER DEPT
- GLASSBORO WATER DEPARTMENT



- NJ AMERICAN WATER – HARRISON
- NJ AMERICAN WATER – BRIDGEPORT
- NJ AMERICAN WATER – LOGAN
- MANTUA TOWNSHIP MUA
- MONROE TWP MUA
- NATIONAL PARK WATER DEPARTMENT
- PITMAN WATER DEPARTMENT
- WEST DEPTFORD TWP WATER DEPT
- WOODBURY CITY W DEPT
- WOODBURY HEIGHTS W UTILITY
- AQUA NJ - WOOLWICH

As previously stated, drought conditions can cause shortages in water for human consumption. Droughts can also lead to reduced local firefighting capabilities. The drought hazard is a concern for Gloucester County because the County's water is supplied by both surface water and groundwater. In the short-term, surface water supplies are affected more quickly during droughts than groundwater sources.

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. Gloucester County's overall score is 0.1675, indicating that its communities have low social vulnerability, though impacts from a drought event could severely impact parts of the community (CDC 2021).

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). Therefore, all assets in and adjacent to, the WUI zone, including population, structures, critical facilities, lifelines, and businesses are considered vulnerable to wildfire. Refer Section 4.3.15 for the Wildfire risk assessment.

Impact on Critical Facilities

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. Critical facilities in and adjacent to the wildfire hazard areas are considered vulnerable to wildfire.

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 2021).

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 (NJ Department of Environmental Protection 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 (NC State University 2013).

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 (IPCC 2016). Based on the 2017 Census of Agriculture, there were 518 farms in Gloucester County, a 1 percent decline from the 2012 reports. The average farm size was 85 acres. Gloucester County farms had a total market value of products sold of \$94.9 million in crop sales and \$7.6 million in livestock sales. Table 4.3.4-5 summarizes the acreage of agricultural land exposed to the drought hazard.

Table 4.3.4-5. Agricultural Land in Gloucester County in 2017

Number of Farms	Land in Farms (acres)	Total Cropland (percent)	Pastureland (percent)	Irrigated Land (acres)
580	49,381	72	5	8,732

Source: USDA 2017
(D) Withheld to avoid disclosing data for individual farms

Impact on the Environment

Droughts can impact the environment because these events can trigger wildfires, increase insect infestations, and exacerbate the spread of disease (IPCC 2016). 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 plants and animals. If water is not getting into the soils, the ground will dry up and become unstable. Unstable soils increase the risk of erosion and loss of topsoil (NC State University 2013).

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 Gloucester County. The New Jersey Water Supply Plan indicates seasonal outdoor water use is rising 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. Gloucester County has experienced population growth since 2010, based on 2015-2019 Community Survey information. The Boroughs of Woolrich, East Greenwich Township, and Borough of Glassboro have experienced the greatest percentage of growth since 2010; greater than 5 percent each. Increases in population may create greater strain on water resources in those communities, throughout Gloucester County and the region as a whole.

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 a greater stress on the water supply during a drought event. In terms of the agricultural industry for Gloucester County, there has been a 1 percent decline in the number of farms since the 2012 USDA report.