# 7. DROUGHT

## 7.1 HAZARD PROFILE

### 7.1.1 Hazard Description

Drought is a deficiency in precipitation over an extended period, usually a season or more, resulting in a water shortage causing adverse impacts on vegetation, animals, or people. It is a normal, recurrent feature of climate that occurs in virtually all climate zones, from very wet to very dry. Drought is a temporary aberration from normal climatic conditions and can vary significantly from one region to another. Human factors, such as water demand and water management, can exacerbate the impact that a drought has on a region (NIDIS 2020).

Anomalies of precipitation and temperature may last from several months to several decades. How long they last depends on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on the global scale (NIDIS n.d.).

There are five different ways that drought can be defined or grouped (NDMC n.d.):

- ***Meteorological drought*** is a measure of the departure of precipitation from normal. It is defined solely by the relative degree of dryness. Due to climatic differences, what might be considered a drought in one location may not be a drought in another location.
- ***Agricultural drought*** links drought to agricultural impacts, focusing on precipitation shortages, evapotranspiration, soil water deficits, reduced ground water or reservoir levels, and other parameters. It occurs when there is not enough water available for a particular crop to grow at a particular time.
- ***Hydrological drought*** is defined by stream flows and reservoir, lake, and groundwater levels being below normal levels due to precipitation shortfalls.
- ***Socioeconomic drought*** occurs when the demand for an economic good exceeds supply because of a weather-related shortfall in water supply. The supply of many economic goods depends on the weather (for example water, forage, food grains, fish, and hydroelectric power).
- ***Ecological drought*** is a prolonged and widespread deficit in naturally available water supplies that create multiple stresses across ecosystems.

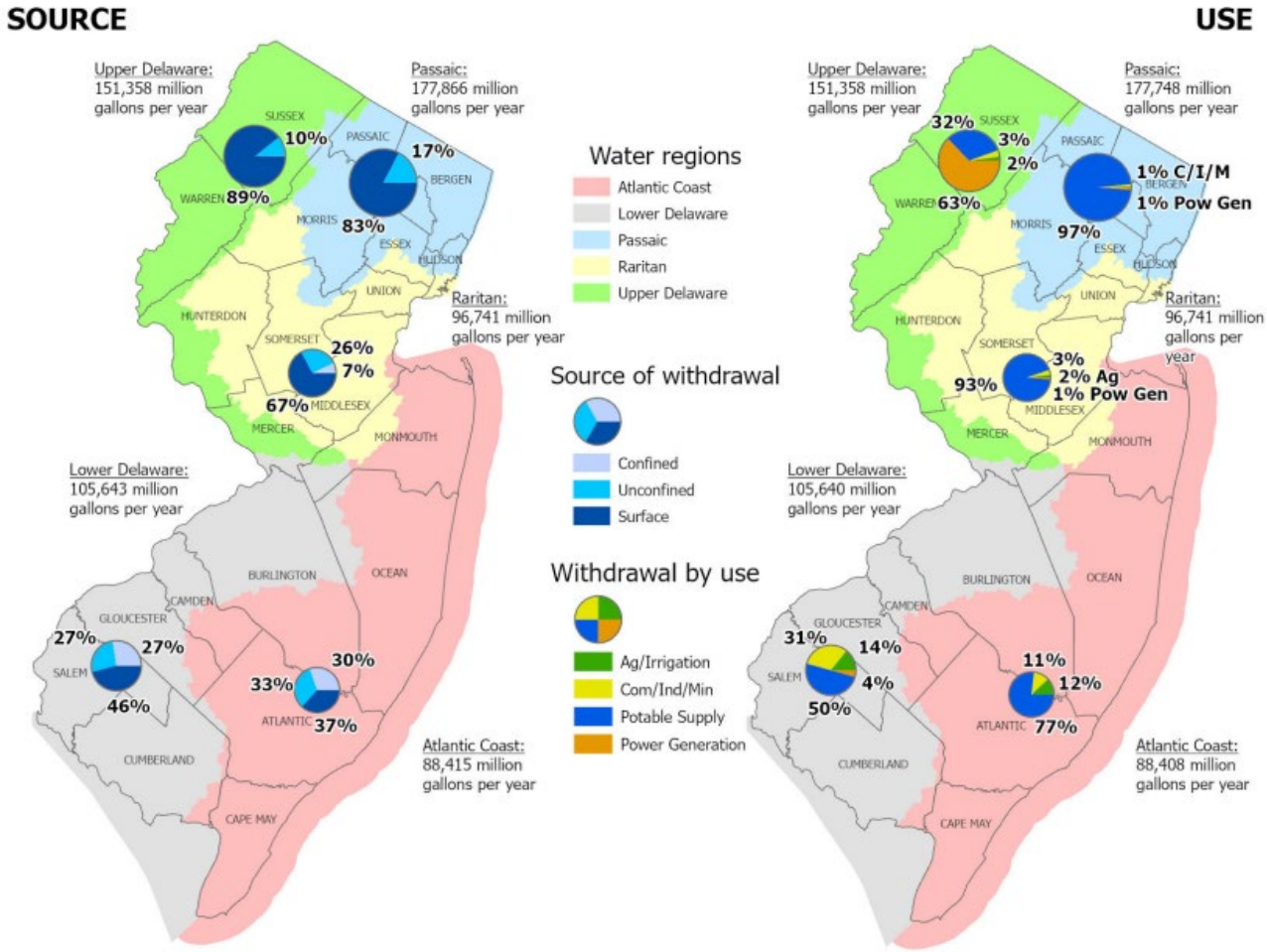
Water in hydrologic storage systems (e.g., reservoirs, rivers) is often used for multiple and competing purposes (e.g., flood control, irrigation, recreation, navigation, hydropower, or wildlife habitat), further complicating the sequence and quantification of impacts. Competition for water in these storage systems escalates during drought and conflicts between water users increase significantly (NDMC n.d.).

### 7.1.2 Water Supply and Water Use

#### Sources and Uses

New Jersey is divided into five water regions based on watershed management area and hydrologic unit codes (see Figure 7-1). Passaic County is located within the Passaic water region, with a small portion of the County falling within the Upper Delaware Region. Both of those regions get most of their water from surface water sources.

Figure 7-1. New Jersey Water Regions, Sources, and Withdrawals by Sector




*Source: (NJDEP 2024)*

In the Passaic water region, almost all of the water withdrawn is for potable water supply, with very small amounts for power generation and commercial, industrial or mining purposes. In contrast, the majority of water withdrawal in the Upper Delaware water region is for power generation, followed by potable supply. Water use trends, like withdrawal trends, vary from month to month with water use typically peaking during summer when outdoor and irrigation demands are high (NJDEP 2024).

Passaic County's agricultural industry is heavily reliant on water resources. According to the U.S. Department of Agriculture (USDA) Agricultural Census, as of 2022 the County had 99 farms covering 1,830 acres of land. Table 7-1 summarizes agricultural land in Passaic County.

Table 7-1. Agricultural Land in Passaic County

| Number of Farms | Land in Farms (acres) | Total Cropland (acres) | Irrigated Land (acres) |
|---|---|---|---|
| 99 | 1,830 | 412 | 127 |

*Source: USDA 2022*

The average size of each farm is 18 acres, which is a 13 percent decrease since the 2017 Agricultural Census. The total market value of products sold annually by farms in Passaic County is $4.6 million, an average of $47,301 per farm. About half of the farms (49 percent) have annual sales of less than $2,500; 5 percent have annual sales of $100,000 or more. Most sales from farms in the County are from crop production; only a small fraction of sales stems from livestock and poultry products (USDA 2022).

### Suppliers

Over 1.2 billion gallons of potable water are used in the State of New Jersey each day, with 88 percent of the State's population receiving its drinking water from public community water systems. 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 (NJDEP 2024).

## 7.1.3 Location

New Jersey is divided into six drought regions that are based on regional similarities in water supply sources and rainfall patterns (see Figure 7-2). These regions were developed based upon hydro-geologic conditions, watershed boundaries, municipal boundaries, and water supply characteristics. Passaic County is located in the Northeast Region. According to the NJDEP, rivers and reservoirs are major supply sources in this region and unconfined groundwater is a minor supply source (NJDEP 2023). Drought region boundaries are contiguous with municipal boundaries because during a water emergency, the primary enforcement mechanism for restrictions is municipal police forces (NJDEP 2022).

## 7.1.4 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 (NIDIS 2023). The State of New Jersey uses a multi-index system that takes advantage of multiple indices to determine the severity of a drought or extended period of dry conditions (NJDEP 2024).

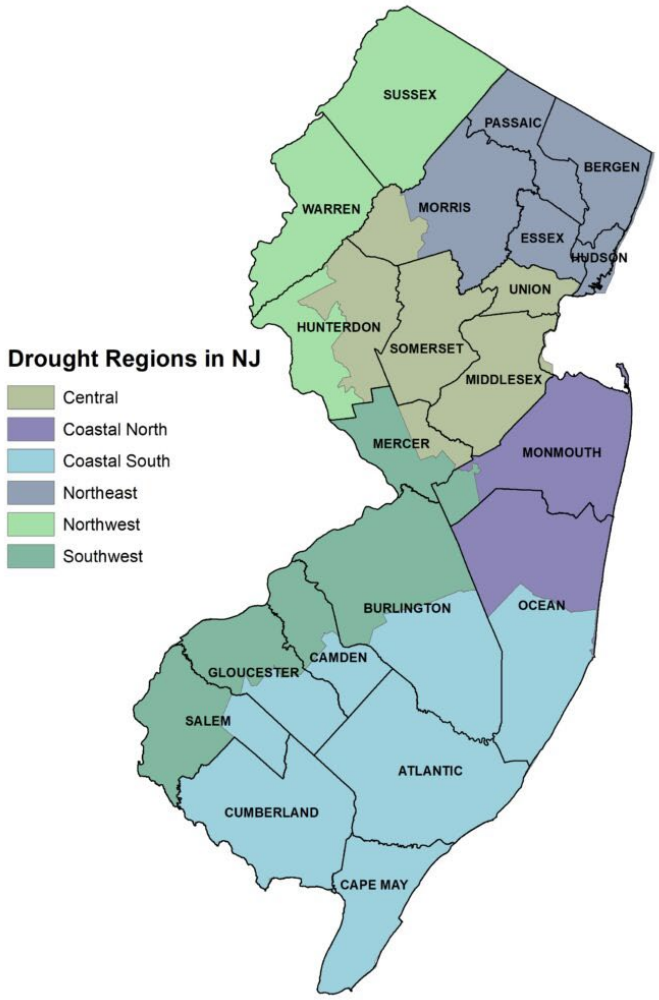
### U.S. Drought Monitor

The U.S. Drought Monitor uses five classifications for drought: abnormally dry (D0), moderate drought (D1), severe drought (D2), extreme drought (D3), and exceptional drought (D4). Table 7-2 describes these drought categories. Moderate and severe droughts have short-term impacts, typically last less than six months, and primarily affect agriculture and grasslands. Extreme and exceptional droughts have longer term impacts and typically last longer than six months and affect hydrology and ecology (NIDIS 2023).

### Palmer Drought Severity Index

The Palmer Drought Severity Index (PDSI) 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 7-3 lists the PDSI classifications. At one end of the spectrum, zero 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 (NCAR 2023).

Figure 7-2. New Jersey Drought Regions




*Source: NJDEP*

Table 7-2. U.S. Drought Monitor Classifications

| Category | Description | Possible Impacts |
|---|---|---|
| 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. |
| 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. |
| D2 | Severe drought | Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed. |
| D3 | Extreme drought | Major crop or pasture losses; extreme fire danger; widespread water shortages or restrictions. |
| D4 | Exceptional drought | Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies. |

*Source: (NIDIS 2023)*

Table 7-3. Palmer Drought Category Descriptions

| Palmer Drought Index | Description | Palmer Drought Index | Description |
|---|---|---|---|
| 4.0 or more | Extremely wet | -0.99 to -0.5 | Incipient dry spell |
| 3.0 to 3.99 | Very wet | -1.99 to -1.0 | Mild drought |
| 2.0 to 2.99 | Moderately wet | -2.99 to -2.0 | Moderate drought |
| 1.0 to 1.99 | Slightly wet | -3.99 to -3.0 | Severe drought |
| .05 to 0.99 | Incipient wet spell | -4.0 or less | Extreme drought |
| -0.49 to 0.49 | Near norm | | |

*Source: (NDMC 2023)*

### Watches, Warnings, and Emergencies

New Jersey's Division of Water Supply and Geoscience monitors water supply conditions in the state based on the five water supply regions(see Figure 7-1). The water supply conditions aid NJDEP in declaring the regions as being at one of the following stages of drought (NJDEP 2024):

- ***Normal Conditions*** indicate no drought conditions are present. There is routine monitoring of water supply and meteorological indicators.
- A ***Drought Watch*** is issued when drought or other factors begin to adversely affect water supply conditions. A watch indicates that conditions are dry but not significantly so. During a drought watch, NJDEP closely monitors drought indicators (including precipitation, stream flows, reservoir and ground water levels, and water demand) and consults with affected water suppliers. 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 Warning*** represents a non-emergency phase of managing water supplies during the developing stages of drought. Under a drought warning, the commissioner of the NJDEP may order water purveyors to develop alternative sources of water or transfer water from areas of the state with more water to those with less. While mandatory water use restrictions are not imposed, the general public is strongly urged to use water sparingly in affected areas.
- A ***Drought Emergency*** can only be declared by the governor. Efforts initiated under a water emergency focus on reducing water demand. A phased approach to restricting water consumption is typically initiated. Phase I water use restrictions typically target non-essential, outdoor water use.

## 7.1.5 Previous Occurrences

### FEMA Major Disaster and Emergency Declarations

Passaic County has been included in two major disaster (DR) or emergency (EM) declarations for drought-related events (FEMA 2024). Table 7-3 lists these declarations.

### USDA Declarations

The U.S. Secretary of Agriculture can designate counties as disaster areas to make emergency loans from the USDA to producers suffering losses in those counties and contiguous counties. Between 2019 and 2023, Passaic County was included in two USDA drought-related agricultural disaster declarations, as listed in Table 7-4.

Table 7-4. FEMA Declarations for Drought Events in Passaic County

| Event Date | Declaration Date | Declaration Number | Description |
|---|---|---|---|
| August 18, 1965 | August 18, 1965 | DR-205-NJ | Water Shortage |
| October 19, 1980 | October 19, 1980 | EM-3083-NJ | Water Shortage |

*Source: FEMA 2023*

Table 7-5. USDA Declarations for Drought Events in Passaic County (2019 to 2023)

| Event Date | USDA Declaration Number | Description |
|---|---|---|
| July 1, 2022, to August 19, 2022 | S5345 | Drought and Excessive Heat |
| August 9, 2022 | S5306 | Drought |

*Source: USDA 2024*

## Previous Events

Known hazard events that impacted Passaic County between August 2019 and December 2023 are discussed in Table 7-5. For events prior to 2019, refer to the 2020 Passaic County HMP.

Table 7-6. Drought Events in Passaic County (2019 to 2023)

| Event Date | FEMA Declaration Number | Passaic County Included in Declaration? | Location Impacted | Description |
|---|---|---|---|---|
| September 24 -October 28, 2019 | N/A | N/A | County-wide | The County was in D0 drought status. |
| March 17-30, 2020 | N/A | N/A | County-wide | The County was in D0 drought status. |
| June 30-August 10, 2020 | N/A | N/A | County-wide | The County was in D0 drought status. |
| May 4-June 7, 2021 | N/A | N/A | County-wide | The County was in D0 drought status. |
| February 1-March 21, 2022 | N/A | N/A | County-wide | The County was in D0 drought status. |
| March 22-April 11, 2022 | N/A | N/A | County-wide | The County was in D0 drought status. |
| July 5, 2022-January 31, 2023 | USDA S5406 | Yes | State-wide | From July 5 to August 8, 2022, the County was in D0 drought status. A Drought Watch was issued on August 9, 2022. Stream flow and ground water levels fell below normal for most of the state and some reservoirs showed steep rates of decline. The county re-entered D0 drought status on October 25, 2022, and exited drought status on January 30, 2023. |
| April 4-May 1, 2023 | N/A | N/A | County-wide | The County was in D0 drought status. |
| June 6-July 17, 2023 | N/A | N/A | County-wide | From June 6 to July 10, 2023, the County was in D0 drought status. From June 20 to July 3, 2022, the County was in D1 drought status. The County re-entered D0 drought status on July 4 and exited drought status on July 17, 2023. |

*Source: National Drought Mitigation Center 2023, US Drought Monitor 2023, FEMA 2023, NOAA NCEI 2023*

## 7.1.6 Probability of Future Occurrences

### Probability Based on Previous Occurrences

Information from the NCEI Storm Events Database, the State of New Jersey 2024 All-Hazard Mitigation Plan, and FEMA were used to identify the number of events that occurred between 1950 and 2023. Table 7-6 provides calculated probability of future drought events in Passaic County based on this past history. The National Weather Service Climate Prediction Center can provide seasonal outlooks for droughts that last for three-month increments (NIDIS n.d.).

Based on risk factors for past occurrences, it is likely that droughts of varied severity will occur across the State of New Jersey and Passaic County in the future. The probability of occurrence for drought in the County is considered “occasional.”

Table 7-7. Future Occurrence of Drought Events in Passaic County

| Hazard Type | Number of Occurrences Between 1950 and 2023 | % Chance of Occurrence in Any Given Year |
|---|---|---|
| Drought | 20 | 27% |

*Source: NOAA-NCEI 2024; FEMA 2024; NJOEM 2024*

### Effect of Climate Change on Future Probability

The pressure on water resources due to diverse water demands are likely to be worsened by future climate change. Warming is projected by the end of the 21st century. Increases in the number of extremely hot days and decreases in the number of extremely cold days are projected to accompany the overall warming. According to state-level analysis, by the middle of the 21st century an estimated 70 percent of summers in the northeast region are anticipated to be hotter than what the current warmest summers on record (National Centers for Environmental Information 2022). These trends will affect the probability and frequency of dry conditions that could lead to drought events in Passaic County.

## 7.1.7 Cascading Impacts on Other Hazards

Drought increases conditions that may trigger fires in the County, such as dead and dying trees, and grasses. Additionally, droughts can lead to the following (NIDIS 2019):

- Long-term damage to crop quality and crop losses
- Insect infestation leading to crop losses and reduced tree canopy
- Reduction in the ability to perform outdoor activities, which could result in loss of tourism and recreation

# 7.2 VULNERABILITY AND IMPACT ASSESSMENT

All of Passaic County has been identified as the hazard area for drought, so all assets (population, structures, critical facilities, and lifelines) are potentially vulnerable to this hazard. A qualitative assessment was conducted to evaluate the assets exposed to this hazard and its potential impacts.

## 7.2.1 Life, Health, and Safety

### Overall Population

For this plan, the entire population of the County (519,986) is considered vulnerable to drought events. Drought can cause a shortage of water for human and can reduce local firefighting capabilities. Social impacts of drought include mental and physical stress, public safety threats (increased threat from forest/grass fires), health threats, conflicts among water users, and reduced quality of life. Public health impacts may include increased 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 (Centers for Disease Control and Prevention 2021).

### Socially Vulnerable Population

Socially vulnerable populations may be especially susceptible to drought based on their physical and financial ability to react or respond during a drought. The infirm, young, and elderly are particularly susceptible to drought due to their age, health conditions, and limited ability to mobilize to shelters, cooling, and medical resources.

Without a quantitative assessment of potential impacts of a drought on socially vulnerable populations, the Planning Partners can best assess mitigate options through an understanding of the general numbers and locations of such populations across Passaic County. Section 3.6.3 provides detailed data on socially vulnerable populations within the planning area. Table 7-7 summarizes highlights of this information. For planning purposes, it is reasonable to assume that percentages and distribution of socially vulnerable populations affected by a drought will be similar to the countywide numbers.

Table 7-8. Distribution of Socially Vulnerable Populations by Municipality

| | Countywide Total | | Municipality Highest in Category | | Municipality Lowest in Category | |
|---|---|---|---|---|---|---|
| Category | Number | Percent | Number | Percent | Number | Percent |
| | | | Paterson | North Haledon | Prospect Park | Passaic |
| Population Over 65 | **78,440** | **15.1%** | **18,141** | **24.6%** | **625** | **9.0%** |
| | | | Paterson | Passaic, Prospect Park | Bloomingdale | Bloomingdale |
| Population Under 5 | **33,502** | **6.4%** | **12,442** | **8.3%** | **247** | **3.2%** |
| Non-English- | | | Paterson | Passaic | Bloomingdale, Ringwood | Ringwood |
| Speaking Population | **68,953** | **13.3%** | **34,885** | **22.4%** | **104** | **0.9%** |
| Population With | | | Paterson | Prospect Park | Bloomingdale | Pompton Lakes |
| Disability | **46,707** | **9.0%** | **12,756** | **14.3%** | **588** | **7.2%** |
| Population Below | | | Paterson | Paterson | Ringwood | Ringwood |
| Poverty Level | **68,995** | **13.3%** | **37,143** | **23.5%** | **262** | **2.2%** |
| Households Below | | | Paterson | Paterson | North Haledon | Ringwood |
| ALICE Threshold | **62,752** | **35%** | **33,284** | **67%** | **745** | **22%** |

## 7.2.2 General Building Stock

No structures are anticipated to be directly affected by a drought. However, droughts contribute to conditions conducive to wildfires and reduce fire-fighting capabilities. Refer to Chapter 13 for the wildfire risk assessment.

## 7.2.3 Community Lifelines and Other Critical Facilities

Droughts generally do not impact buildings, but they have the potential to impact agriculture-related facilities, critical facilities, and lifelines that are associated with water supplies, such as potable water systems. Critical facilities and lifelines in and adjacent to wildfire hazard areas are also considered vulnerable to drought.

## 7.2.4 Economy

Drought can produce a range of impacts that span many economic sectors and can reach beyond an area experiencing physical drought. Water withdrawals are used for potable water, for the commercial, industrial, and mining sectors, and for power generation. If a water emergency is declared for the state, the NJDEP may impose mandatory water restrictions and require specific actions to be taken by water suppliers. In these cases, the state seeks to cause as little disruption as possible to commercial activity and employment (New Jersey Department of Environmental Protection 2017).

A prolonged drought can have a serious economic impact on a community. 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 (North Carolina 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.

## 7.2.5 Natural, Historic and Cultural Resources

### Natural

Droughts can exacerbate conditions conducive to wildfires, increase insect infestations, and exacerbate the spread of disease (Intergovernmental Panel on Climate Change 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 (New Jersey Department of Environmental Protection 2017).

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. 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 (North Carolina State University 2013).

Drought affects groundwater sources, but generally not as quickly as surface water supplies. Groundwater supplies generally take longer to recover. Reduced precipitation during a drought means that groundwater supplies are not replenished at a normal rate. This can lead to a reduction in groundwater levels. Reduced replenishment of groundwater affects streams also. Much of the flow in streams comes from groundwater, especially during the

summer when there is less precipitation and after snowmelt ends. Reduced groundwater levels mean that even less water will enter streams when steam flows are lowest (NJDEP 2021).

### Historic

The primary impacts on historic resources from drought would be an increased risk of wildfires, which could threaten these assets, and impacts on structure foundations from the shrink-swell cycle of expansive soils.

### Cultural

Prolonged drought and seasonal aridity can exacerbate soil deflation and erosion, potentially uncovering previously buried archaeological sites (USDA Forest Service 2018). This exposure increases the vulnerability of these sites to further damage and loss, posing a significant threat to the preservation of cultural heritage (USDA Forest Service 2018).

## 7.3 FUTURE CHANGES THAT MAY AFFECT RISK

### 7.3.1 Potential or Planned Development

Areas targeted for future growth and development have been identified across Passaic County. The State of 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 demand by commercial/industrial users will depend on future development of this water type use and how effectively efficiency techniques are implemented (New Jersey Department of Environmental Protection 2017).

### 7.3.2 Projected Changes in Population

Projected population increases in Passaic County can exacerbate the impacts of drought in several ways. A larger population will lead to higher demand for water for residential, agricultural, and industrial uses, straining existing water supplies and making management during drought conditions more challenging (NEEF 2024). This increased demand will also put additional pressure on water infrastructure, leading to more frequent breakdowns and maintenance issues, complicating water distribution. With more people relying on the same water sources, the risk of water shortages during prolonged dry periods increases, leading to stricter water use restrictions and competition for limited resources. Additionally, increased population density can lead to more development and urbanization, reducing natural landscapes that help recharge groundwater and maintain ecological balance, further reducing water availability during droughts. Overall, the projected population growth in Passaic County will likely intensify the challenges associated with managing water resources and mitigating the impacts of drought.

The New Jersey Department of Labor and Workforce Development produced population projections by County for 2029 and 2034. According to these projections, Passaic County is projected to have an increase in population in the upcoming years. These projections include a population of 536,100 by 2029 and 542,500 by 2034 (State of New Jersey 2017).

### 7.3.3 Climate Change

Most studies project that the State of New Jersey will experience more frequent 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 future changes.

### 7.3.4 Other Identified Conditions

The State of New Jersey is expected to see an increase in the occurrence of droughts, which could impact the availability of water supplies and place added strain on the population and their access to clean drinking water. A decrease in water supply, or an increase in demand for water, may heighten the County's susceptibility to structural fires and wildfires. Consequently, it may be necessary for critical water-related service sectors to modify their management strategies and proactively allocate resources to adapt to forthcoming shifts.