



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 Essex County.

2020 HMP Update Changes

- All subsections have been updated using best available data.
- Previous occurrences were updated with events that occurred between 2014 and 2019.
- Information from the New Jersey Water Supply Plan 2017-2022 has been integrated.

4.3.3.1 Profile

Hazard Description

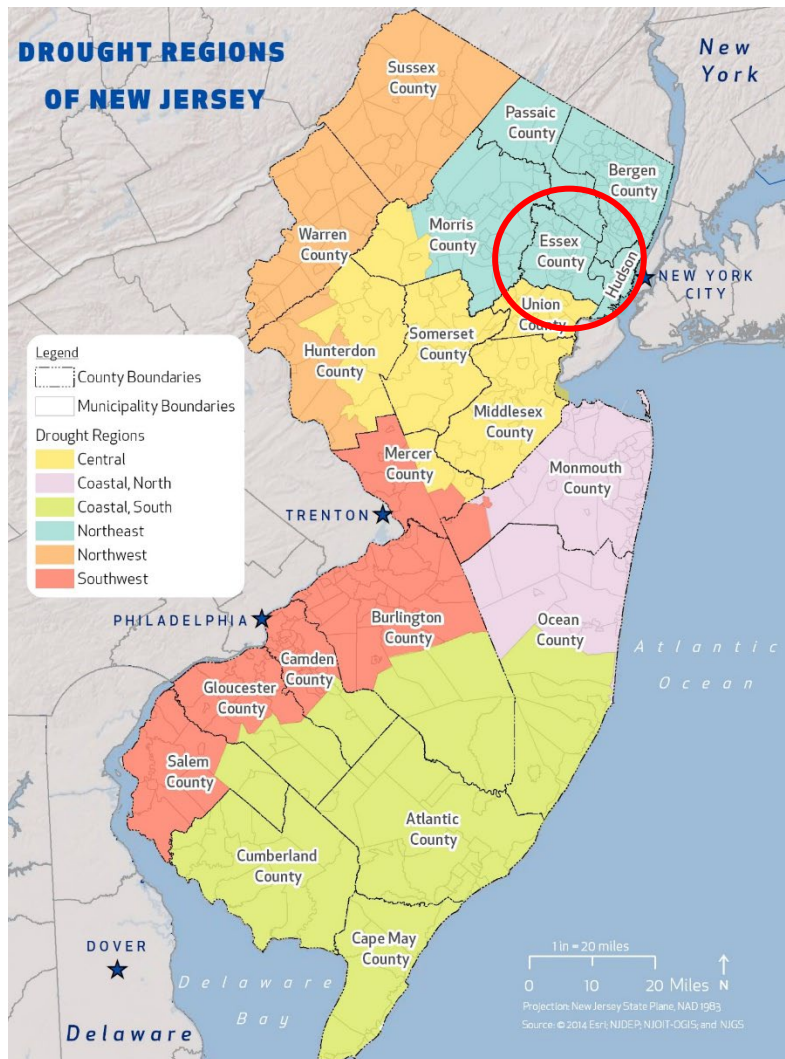
Drought is a period characterized by long durations of below normal precipitation. Drought conditions occur in virtually all climatic zones, yet characteristics of drought vary significantly from one region to another, relative to normal precipitation within respective regions. Drought can affect agriculture, 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). Essex County is located in the Northern 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. Figure 4.3.3-1 shows the drought regions of New Jersey. Essex County is located in the Northeast Drought Region.

Figure 4.3.3-1. Drought Regions of New Jersey



Source: NJOEM (State HMP) 2019

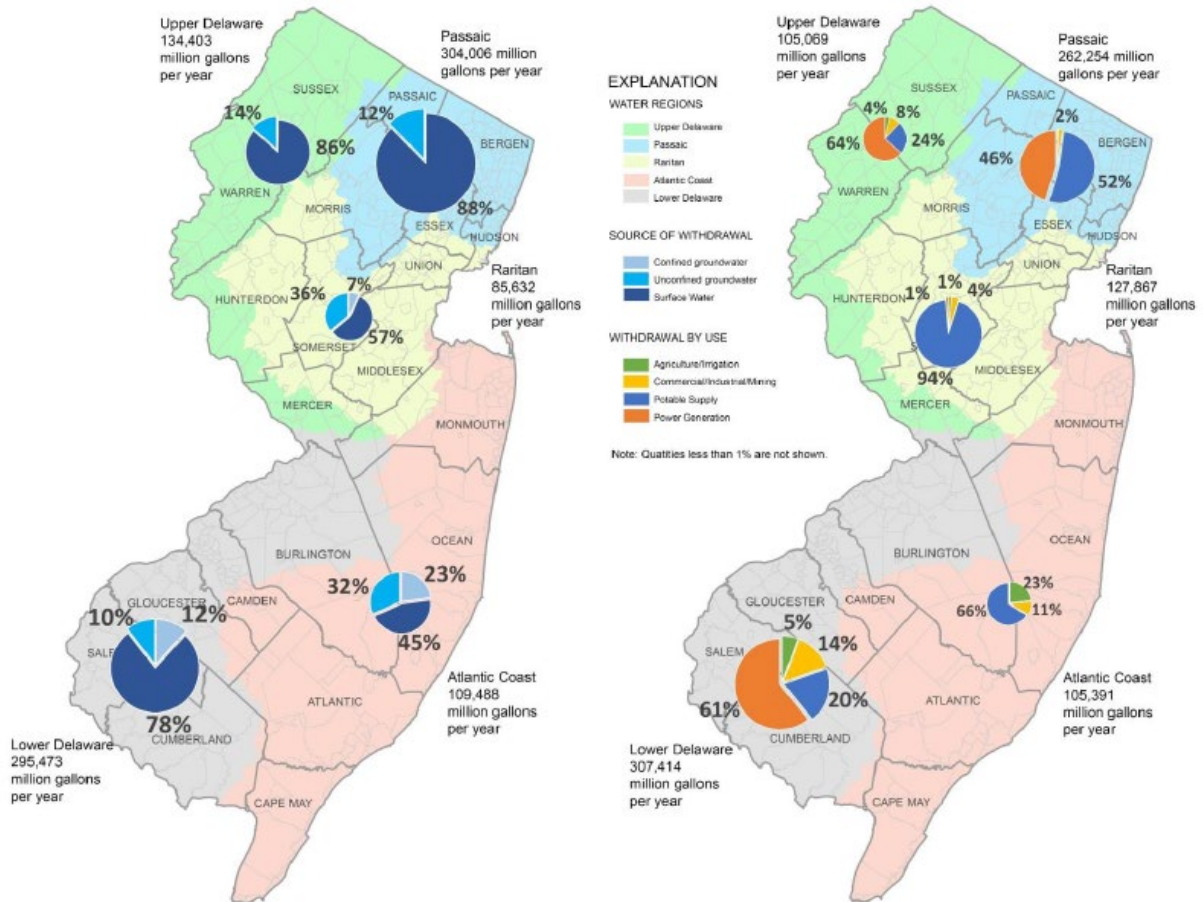
Note: The red circle indicates the location of Essex County. The County is located in the Northeast Region of New Jersey

There are five water regions across the State (compiled from HUCH11 Watershed Management Areas). Essex County is located in the Passaic and Raritan water regions; refer to Figure 4.3.3-2. The County’s water supply sources are from unconfined groundwater and surface water sources. In terms of annual water withdrawal by sector, the majority is for potable water supply, followed by power generation, then commercial/industrial/mining. Water use trends, similar to 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 Water Resources Baseline Topic Report, the City of Newark may approach or exceed the capacity of their reservoirs and more detailed evaluations are needed. In addition, the Central Passaic Buried Valley Aquifers that serve eastern Morris and western Essex Counties have been constrained and municipalities with significant growth may be affected (Together North Jersey 2013).



Figure 4.3.3-2. Water Regions, Sources and Withdrawal by Sector in New Jersey



Source: NJDEP 2017

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 4.3.3-1 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 4.3.3-1 (National Drought Mitigation Center [NDMC] 2013).



Table 4.3.3-1. 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

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).

Between 1954 and 2014, the State of New Jersey experienced two FEMA declared drought-related disasters (DR) or emergencies (EM) classified as a water shortage; DR-205 in 1965 and EM-3083 in 1980 were both



declared. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Essex County was included in both declarations (FEMA 2019); refer to Table 4.3.3-2. Drought events that have impacted Essex County between 2014 and 2019 are identified in Table 4.3.3-3. For events prior to 2014, refer to Appendix X (Risk Assessment Supplement). Please see Section 9 (Jurisdictional Annexes) for detailed information regarding impacts and losses to each municipality.

Table 4.3.3-2. FEMA Declarations Related to Drought

Declaration	Event Date	Declaration Date	Event Description
DR-205	August 18, 1965	August 8, 1967	Drought: Water Shortage
EM-3083	October 19, 1980	May 21, 1983	Drought: Water Shortage

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. In 2016, Essex County was included in declaration S4071 for the combined effects of freeze, excessive heat, and drought with no losses reported.

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Table 4.3.3-3. Drought Incidents in Essex County, 2014 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Description
September 9-December 1, 2014	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or “abnormally dry” status across Essex County from September 9 - December 1, 2014.
May 5-June 23 2015	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or “abnormally dry” status across Essex County from May 5 - May 25, D1 or “moderate drought” status from May 26 - June 1, and D0 or “abnormally dry” status from June 2 - June 23, 2015.
August 11, 2015-January 25, 2016	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or “abnormally dry” status across Essex County from August 11 – August 31, 2015 and D1 or “moderate drought” status from September 1, 2015 – January 25, 2016.
April 19, 2016-April 10, 2017	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0, or “abnormally dry” status across Essex County from April 19 - June 13, 2016, D1 or “moderate drought” status from June 14 - October 24, 2016, D2 or “severe drought” status from October 25, 2016 – January 23, 2017, D1 or “moderate drought” status from January 24 – March 20, 2017, and D0 or “abnormally dry” status from March 21 - April 10, 2017. In October of 2016, a CoCoRaHS reporter noted that lawns were stressed with numerous brown areas and slow growth, soils in surrounding fields and farms were dry and dusty, leaves were starting to change color and drop early, structures could be seen at the bottom of local reservoirs, forest fire and a drought watch was in effect for the county. A spokesman for the Department of Environmental Protection recommended that the public conserve water. Agricultural disaster S4071 was declared for the combined effects of freeze, excessive heat, and drought.
October 3-30, 2017	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or “abnormally dry” status across Essex County from October 3-30, 2017. Fall leaves were reported to be dropping early without changing color.
December 5, 2017 – February 12, 2018	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or “abnormally dry” status across Essex County from December 5, 2017 – February 12, 2018. Drinking water reservoirs were reported to be low.

Source: USDA 2019, NDMC 2019



Probability of Future Occurrences

Based on the historical occurrences for drought, Essex County can anticipate a range of drought from abnormally dry to severe, or D0 to D2, based on the Palmer Drought Category. 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 Essex 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 (Hazard Ranking), the identified hazards of concern for Essex 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’.

Climate Change Impacts

The climate of New Jersey is already changing and will continue to change over the course of this century. From 1900 to 2014 annual average temperatures in New Jersey have increased approximately 3°F (NOAA NCEI, 2017). In terms of winter temperatures, the northeast region has seen an increase in the average temperature of 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F, and by 2080 projections show an increase of 4°F to 7.5°F (Sustainable Jersey Climate Change Adaptation Task Force 2015). With an overall increase in temperature, drought conditions may become more frequent.

The future drought potential that New Jersey is modeled to experience indicates the State will experience more frequent but not necessarily more severe droughts. While all droughts impose some level of stress on water supplies, some will have long-term effects. If the projected more frequent droughts are spaced out over time, then New Jersey’s water supply systems should be capable of recovering between droughts. However, more frequent droughts raise the potential for sequential droughts that do not allow for recovery of reservoir levels or aquifer storage, resulting in a scenario where moderate droughts could have aggregate results that severely test our water supply capabilities (NJ Climate Adaptation Alliance, 2016).

As temperatures rise, people and animals will need more water to maintain their health and to thrive. Many economic activities, such as hydropower, raising livestock, and growing foods, will also require water. The amount of water available for these activities may be reduced as temperatures rise and if competition for water resources increases. As shown in the paragraph above, these trends will certainly affect the probability and frequency of dryer conditions that could lead to drought events in Essex County.

4.3.3.2 Vulnerability Assessment

To understand risk, a community must evaluate its assets that are exposed or vulnerable to the identified hazard. The following discusses Essex County’s vulnerability, in a qualitative nature, to the drought hazard.

Impact on Life, Health and Safety

The entire population of Essex County is exposed to drought events (population of 800,401 people, according to the 2013-2017 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 2012).

Essex County is supplied by both surface water and groundwater as shown on Figure 4.3.3-2. Surface water supplies are affected more quickly during droughts than groundwater sources; however, groundwater supplies generally take longer to recover. Table 4.3.3-4 summarizes the surface water drinking water suppliers for Essex County.

Table 4.3.3-4. Surface Water Source Drinking Water Suppliers in Essex County

Name	Population Served	Source Type
Belleville Water Dept	35,129	Surface Water Purchased
Bloomfield Water Department	47,315	Surface Water Purchased
Caldwell Water Dept	7,822	Surface Water Purchased
Cedar Grove Water Dept	12,900	Surface Water Purchased
East Orange Water Commission	75,000	Surface Water Purchased
Essex Fells Water Dept	2,200	Surface Water Purchased
Essex Fells Water Hilltop System	354	Surface Water Purchased
Fairfield Water Dept	7,400	Surface Water Purchased
Glen Ridge Water Dept	7,681	Surface Water Purchased
Livingston Twp Division of Water	27,391	Surface Water Purchased
Montclair Water Bureau	37,669	Surface Water Purchased
Newark Water Department	290,139	Surface Water
NJ American Water - Short Hills	217,230	Surface Water
North Caldwell - Hilltop	208	Surface Water Purchased
North Caldwell Water Dep	6,000	Surface Water Purchased
Nutley Water Dept	29,500	Surface Water Purchased
Orange Water Dept	30,134	Surface Water Purchased
Roseland Water Dept	5,300	Surface Water Purchased
South Orange Water Department	16,964	Surface Water Purchased
Verona Water Department	13,641	Surface Water Purchased
West Caldwell Water Department	10,759	Surface Water Purchased

Source: U.S. EPA 2019

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 4.3.10 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 potable water supplies. 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 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. Increased demand for water and electricity can 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.

Based on information from the 2017 Census of Agriculture, 22 farms were present in Essex County, encompassing 191 acres of total farmland. The average farm size was 9 acres. The total market value of agricultural products from Essex County farms was withheld to avoid disclosing data for individual farms. The 2017 Census indicated that 11 farm operators reported farming as their primary occupation (USDA 2017). Table 4.3.3-5 lists the acreage of agricultural land exposed to the drought hazard.

Table 4.3.3-5. Agricultural Land in Essex County in 2017

Number of Farms	Land in Farms (acres)	Total Cropland (acres)	Harvested Cropland (acres)	Total Cropland Used Only for Pasture/Grazing (acres)
22	191	60	48	12



Source: USDA 2017

Future Changes that May Impact Vulnerability

Understanding future changes that impact vulnerability in the County can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

Projected Development

As discussed in Section 3 (County Profile), areas targeted for future growth and development have been identified across Essex 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. According to population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). NJDEP assessed future water needs for public water systems factoring in future projected population growth for each municipality. The analysis suggests an additional 32 million gallons per day (mgd) (over 2015 rates) will be needed by 2020 to meet the anticipated growth in potable demand, 68 mgd by 2025, 103 mgd by 2030, 134 mgd by 2035, and 164 mgd by 2040 (NJDEP 2017).

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.

Change of Vulnerability Since the 2015 HMP

Overall, the entire County remains vulnerable to droughts. Statewide total water withdrawals, excluding power generation, have decreased from 1990 to 2015 due to reduced demands in the commercial/industrial/mining sectors. However, potable water withdrawal and demand continues to increase as population increases (NJDEP 2017). In terms of the agricultural industry, from 2007 to 2017, there was a 69% increase in number of farms (13 farms to 22 farms), and a 4% increase in land in farms (184 acres to 184 acres) in Essex County. This may suggest an increase in water withdrawals, typically with peaks in the summer months, for traditional agricultural uses like irrigation of crops, plants and animals as well as other horticultural uses.