



5.4.1 Drought

This section provides a profile and vulnerability assessment of the drought hazard.

5.4.1.1 Hazard Profile

This section presents profile information: description, location and extent, previous occurrences and losses, and probability of future occurrences.

Description

Drought is a period characterized by long durations of below normal precipitation. Drought is a temporary irregularity and differs from aridity since the latter is restricted to low rainfall regions and is a permanent feature of climate. Drought conditions occur in virtually all climatic zones yet its characteristics vary significantly from one region to another, since it is relative to the normal precipitation in that region. Drought can affect agriculture, water supply, aquatic ecology, wildlife, and plant life.

There are four different ways that drought can be defined or grouped:

- **Meteorological** drought is a measure of departure of precipitation from normal. It is defined solely on the relative degree of dryness. Due to climatic differences, what might be considered a drought in one location of the country may not be a drought in another location.
- **Agricultural** drought links various characteristics of meteorological (or hydrological) drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential 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. Agricultural drought is defined in terms of soil moisture deficiencies relative to water demands of plant life, primarily crops.
- **Hydrological** drought is associated with the effects of periods of precipitation shortfalls (including snowfall) on surface or subsurface water supply. It occurs when these water supplies are below normal. It is related to the effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels.
- **Socioeconomic** drought is associated with the supply and demand of an economic good with elements of meteorological, hydrological, and agricultural drought. This differs from the aforementioned types of drought because its occurrence depends on the time and space processes of supply and demand to identify or classify droughts. The supply of many economic goods depends on weather (for example water, forage, food grains, fish, and hydroelectric power). Socioeconomic drought occurs when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply (National Drought Mitigation Center 2014).

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 Date Unknown). The New York State Department of Environmental Conservation (NYSDEC) and the New York State Drought Management Task Force identifies droughts in the following four stages:

- **Normal** is considered the standard moisture soil levels found throughout New York State



- **Drought Watch** is the first stage of drought. This stage is declared by the NYSDEC and is intended to give advance notice of a developing drought. As this stage, the general public is urged to conserve water. Public water purveyors and industries are urged to update and begin to implement individual drought contingency plans.
- **Drought Warning** is the second stage of drought. This stage is also declared by the NYSDEC and is a notice of impending and imminent severe drought conditions. A warning declaration includes stepping up public awareness and increasing voluntary conservation. Public water supply purveyors and industries are urged to continue to implement local drought contingency plans. Federal, state and local water resources agencies are notified to prepare for emergency response measures.
- **Drought Emergency** is the third stage of drought. This stage is declared by the NYS DHSES, based upon recommendation of the Task Force. It is a notice of existing severe and persistent drought conditions. An emergency declaration is a notice for local water resources agencies to mandate conservation and implement other emergency response measures. A continuing and worsening drought emergency may result in the New York State governor declaring a drought disaster. It is a notice of the most severe and persistent drought conditions. At this stage, a significant proportion of communities in the impacted area likely are unable to respond adequately.

New York State applies two methodologies to identify the different drought stages. The most commonly used indicator is the Palmer Drought Severity Index (PDSI), which is primarily based on soil conditions. Soil with decreased moisture content is the first indicator of an overall moisture deficit. The second methodology applied in New York State, created by the NYSDEC, is known as the State Drought Index (SDI).

According to the National Integrated Drought Information System (NIDIS), the Palmer Drought Severity Index (PDSI) was developed in 1965, and indicates prolonged and abnormal moisture deficiency or excess. It uses temperature and precipitation data to calculate water supply and demand, incorporates soil moisture, and is considered most effective for assessing moisture conditions in unirrigated cropland. The PDSI primarily indicates long-term drought and has been used extensively as a signal to initiate drought relief (NIDIS 2014).

Table 5.4.1-2 lists the Palmer Classifications. 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. For example, 2 is moderate rainfall (National Drought Mitigation Center [NDMC] 2013).

Table 5.4.1-1. PDSI Classifications

Palmer Classifications	
4.0 or more	Extremely wet
3.0 to 3.99	Very wet
2.0 to 2.99	Moderately wet
1.0 to 1.99	Slightly wet
0.5 to 0.99	Incipient wet spell
0.49 to -0.49	Near normal
-0.5 to -0.99	Incipient dry spell
-1.0 to -1.99	Mild drought
-2.0 to -2.99	Moderate drought
-3.0 to -3.99	Severe drought
-4.0 or less	Extreme drought

Source: NDMC 2013

The SDI evaluates drought conditions more comprehensively by determining whether numerous indicators reach dire thresholds. It compares the following four parameters to historical or “normal” values to evaluate drought conditions: stream flows, precipitation, lake and reservoir storage levels, and groundwater levels. The



State’s Drought Management Task Force uses those factors along with water use, duration of the dry period, and season to assess drought within different areas of the State. The data acquired are compared to critical threshold values to indicate a normal or changeable drought condition. The indicators are weighted regionally to reflect the different circumstances within each drought management region (NYS DHSES 2014, NYSDEC 2013). Table 5.4.1-3 lists the SDI index range within the Normal stage and the three drought stages.

Table 5.4.1-2. State Drought Index Range of Values

Drought Stage	Drought Index Range
Normal	100 to 150
Watch	75 to 100
Warning	50 to 70
Emergency	0 to 50

Source: NYS DHSES, 2013

In Monroe County, the greatest agricultural impact of drought would be due to insufficient water for consumption by and cooling of farm animals. Table 5.4.1-3 shows the typical water consumption for a number of animals common to Monroe County farms.

Table 5.4.1-3. Typical Water Consumption of Animals

Animal	Water Consumption, Typical	
	(Gallons per Day)	(liter per day)
Chickens/100	6	23
Cow, Dry	15	57
Milking Cows	35	130
Dairy Calves (1-4 months)	2.4	9
Dairy Heifers (5 - 24 months)	6.6	25
Dry Cows	9.3	41
Hog	4	15
Horse, Steer	12	45
Pig, feeder	1.1 - 2	9-May
Sheep	2	7.5
Turkeys/100	20	75

Source: King 2015

Some farms have access to Monroe County Water Authority for tank loads during emergency situations. Many dairy operations on the west side of Monroe County are on well water, while many horse operations in the County are on public water service. In cases of emergency, tank loads can be dumped into wells or on-site water tanks can be delivered. A minority of crop farmers in Monroe County have irrigation and access to an emergency water source.

Location

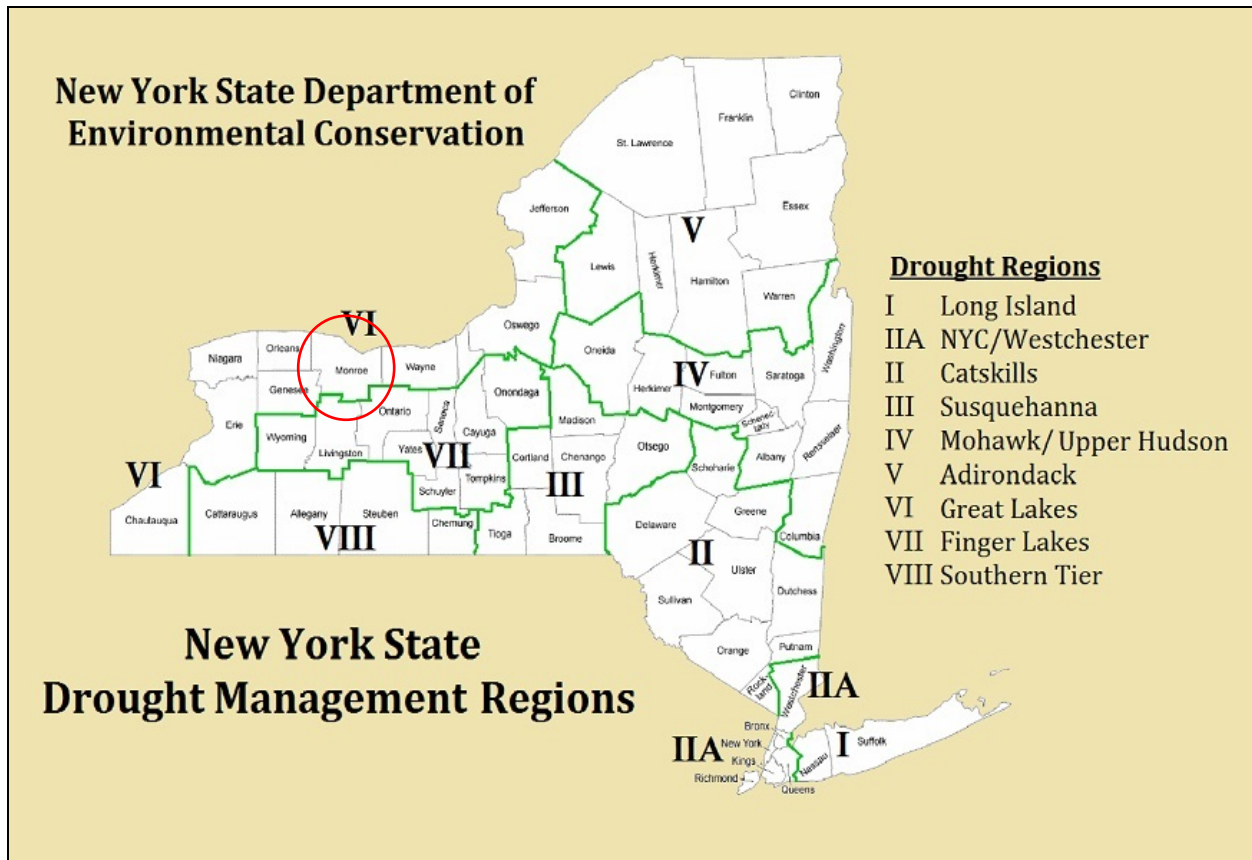
New York State is divided into nine drought management regions based roughly on drainage basin and county lines. NYSDEC monitors precipitation, lake and reservoir levels, stream flow, and groundwater level on a monthly basis within each region, and more frequently during periods of drought. NYSDEC uses these data to





assess the condition within each region, which can range from “normal” to “drought disaster” (NYSDEC 2013). Monroe County is identified as NYSDEC Drought Management Region 6, the Great Lakes Drought Region (Figure 5.4.1-1).

Figure 5.4.1-1. NYSDEC Drought Management Regions of New York State



Source: NYSDEC 2015

Note: The red circle indicates the location of Monroe County.

Previous Occurrences and Losses

Many sources provide historical information regarding previous occurrences and losses associated with drought events throughout New York State and Monroe County. Information about loss and impact resulting from each of many events can vary depending on the source. Notably, monetary amounts cited in this section on drought derive solely from information obtained during research for this HMP.

Between 1954 and 2015, FEMA declared that New York State underwent one drought-related disaster (DR) or emergency (EM) classified a water shortage. Generally, drought-related disasters affect a wide region of the State and thus may have impacted many counties. However, Monroe County was not included in the disaster declaration.

United States Department of Agriculture (USDA) crop losses provide another indicator of the severity of previous events. Additionally, crop losses can have a significant impact on the economy by reducing produce sales and purchases. Such impacts may have long-term consequences, particularly if crop yields are low the following years as well. USDA records indicate that Monroe County has experienced crop losses from drought events. Details are provided in the table immediately below:



Table 5.4.1-4. USDA Crop Losses from Drought in Monroe County

Year	Crop Type	Losses
2012	Cabbage	\$ 1,787.00
2012	Cabbage	\$ 223,381.00
2012	Corn	\$ 3,847.00
2012	Corn	\$ 149.00
2012	Fresh Market Sweet Corn	\$ 4,169.00
2012	Oats	\$ 1,312.00
2012	Potatoes	\$ 5,334.00
2012	Processing Beans	\$ 5,308.00
2012	Soybeans	\$ 17,010.00
2012	Soybeans	\$ 22,910.00
2012	Sweet Corn	\$ 41,015.00
2012	Sweet Corn	\$ (3,315.00)
2011	Cabbage	\$ 33,683.00
2011	Corn	\$ 36,664.00
2011	Corn	\$ 91,415.00
2011	Processing Beans	\$ 26,790.00
2011	Soybeans	\$ 1,605.50
2011	Soybeans	\$ 51,947.00
2007	All Other Crops	\$ 29,769.00
2007	All Other Crops	\$ 1,699.00
2007	All Other Crops	\$ 33,969.00
2007	All Other Crops	\$ 59,772.00
2007	All Other Crops	\$ 32,778.00
2007	All Other Crops	\$ 47,469.00
2007	All Other Crops	\$ 1,824.00
2005	All Other Crops	\$ 9,435.00
2005	All Other Crops	\$ 2,158.00
2005	All Other Crops	\$ 3,368.00
2005	All Other Crops	\$ 5,970.00
2005	All Other Crops	\$ 2,234.00
2005	All Other Crops	\$ 16,620.00
2005	All Other Crops	\$ 16,016.00
2003	All Other Crops	\$ 341.00
2003	All Other Crops	\$ 10,692.00
2002	All Other Crops	\$ 28,559.00
2002	All Other Crops	\$ 8,564.00
2002	All Other Crops	\$ 50,906.00
2002	All Other Crops	\$ 32,366.00
2002	All Other Crops	\$ 24,208.00
2002	All Other Crops	\$ 27,163.00
2002	Fresh Market Sweet Corn	\$ 1,456.00
2001	All Other Crops	\$ 14,082.00
2001	All Other Crops	\$ 11,937.00
2001	All Other Crops	\$ 19,395.00
2001	All Other Crops	\$ 77.00
1999	All Other Crops	\$ 2,090.00
1999	All Other Crops	\$ 2,414.00
1997	All Other Crops	\$ (863.00)
1997	All Other Crops	\$ 1,102.00
1996	All Other Crops	\$ 3,815.00
1995	All Other Crops	\$ 1,988.00
1995	All Other Crops	\$ 3,790.00
1994	All Other Crops	\$ (5,935.00)
1994	All Other Crops	\$ 6,688.00
1993	All Other Crops	\$ (1,688.00)



Year	Crop Type	Losses
1993	All Other Crops	\$ 13,441.00

Source: USDA 2015

Based on all sources researched, Table 5.4.1-5 identifies known drought events between 1988 and 2015 that have affected Monroe County and its municipalities. Not all sources have been identified or researched; therefore, Table 5.4.1-5 may not include all events that have occurred throughout the county and region.



Table 5.4.1-5. Drought Events in Monroe County between 1988 and 2015.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
July 2013	Nearing Drought Conditions	N/A	No	In mid-July, the County had only received 15.13 inches of rainfall, 2.28 below normal. USDA crop losses in 2013 for Monroe County totaled \$11,033 on account of two claims due to drought.
June thru September, 2012	Drought / Excessive Heat	N/A	No	<p>According to the U.S. Drought Monitor, conditions varied between a D1-D4, or ‘moderate drought,’ status across Monroe County for nearly three months. On June 2, USDA included Monroe County as a Contiguous County to a “Drought / Excessive Heat” Disaster Declaration (S3427). Just over three weeks later on June 26, Monroe County was included as a primary County in USDA Disaster Declaration (S3441) for Drought. According to the U.S. Drought Monitor, conditions varied between a D1-D4 status and ‘moderate drought’ across Monroe County from July through September of that year.</p> <p>USDA crop losses in 2012 for Monroe County totaled \$322,907 on account of 12 reported losses due to drought. The greatest losses came from the cabbage crop, which had \$225,168 in losses from two claims due to drought conditions.</p>
July 26 – August 16 th , 2011	Moderate Drought	N/A	No	<p>According to the U.S. Drought Monitor, conditions held at a D0, or “abnormally dry” status across all of Monroe County in late July and early August. Almost the entire County was declared to be in a D1-D4 status or ‘moderate drought’ on August 2nd and August 9th.</p> <p>USDA crop losses in 2011 for Monroe County totaled \$242,104 on account of six reported losses due to drought. The greatest losses came from the corn crop, which had \$ 128,079 in losses from two claims due to the dry conditions.</p>
August – October, 2007	Severe Drought	N/A	No	<p>The U.S. Drought Monitor (Sept. 24, 2007) reported conditions at a ‘D2’ status or ‘severe drought’ across the lakeshore counties from Erie and Niagara east through Orleans, Genesee, Monroe and Wayne counties. In Monroe County, the City of Rochester’s total of 8.05 inches was 51% of the normal 15.80 inches of rainfall for the entire five month growing season (May1 – Sept. 24) (NWS “The Lake Breeze,” Fall 2007, and NWS Buffalo Office “Drought Statement,” 9.24.07).</p> <p>In the middle of July, the National Drought Monitor raised Rochester’s drought status to abnormally dry and, on July 30, elevated the City’s status to moderate drought.</p> <p>This event prompted water conservation measures throughout the region, and an early shut-down for the State’s canal system (The Times Union, 10.9.07). USDA crop losses in 2007 for Monroe County totaled \$207,280 on account of Drought.</p>



Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
May 2007	Severe Drought	N/A	No	May 2007 was the driest month in the City of Rochester’s recorded history. The City received less than a quarter of an inch of rain (0.24 of an inch), and reached 90 degrees or warmer on two days (Democrat & Chronicle, 6.2.07). The Palmer Index in the month of May was -2.75, indicating a severe drought for the month.
May 2006	Drought	N/A	No	The NWS reported 2006 was the driest stretch in spring for the City of Rochester since 1977 (23 consecutive dry days). The U.S. Drought Monitor reported some areas reached a ‘D0’ drought level, or abnormally dry conditions (Democrat & Chronicle, 5.12.06).
April 2005	Nearing Drought Conditions	N/A	No	Only 0.04 inches of rain fell from April 4 – 19 (Democrat & Chronicle, 5.30.07). USDA crop losses in 2005 for Monroe County totaled \$55,801 on account of seven claims due to Drought.
Summer 2002	Drought Conditions	N/A	No	July, August and September of 2002 all had well below normal rainfall, and temperatures averaging three to six degrees above normal. USDA crop losses in 2002 for Monroe County totaled \$173,322 on account of seven claims due to Drought.
August 10, 1999	Severe Drought	N/A	No	The U.S. Department of Agriculture declared all of New Jersey and 34 counties in New York as agricultural disaster areas in August, 1999 for what President Clinton described as a “severe drought”. The declaration made farmers in these areas eligible for emergency, low-interest loans because of losses due to excessive heat and drought” (USDA “News Release No. 0329.99” August 10, 1999). The declared counties in New York included Monroe County. USDA crop losses in 1999 for Monroe County totaled \$4,504 on account of two claims due to Drought.
1988	Drought	N/A	No	The Monroe County Water Authority imposed water restrictions on the Rochester area in 1988 partially due to drought conditions (Democrat & Chronicle, 9.29.07).

Sources: USDA 2015; U.S. Drought Monitor 2015; The Democrat and Chronical Various Articles; NWS Buffalo 2007; The Times Union 2007.

FEMA Federal Emergency Management Agency

N/A Not applicable

NRCC Northeast Regional Climate Center

NWS National Weather Service

USDA U.S. Department of Agriculture



Probability of Future Events

Based upon risk factors for and past occurrences, it is likely that droughts will occur across New York State and Monroe 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 the State and County of varied severity in the future.

It is estimated that Monroe 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 5.3, the identified hazards of concern for Monroe 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’ (likely to occur within 25 years, as presented in Table 5.3-3).

Climate Change Impacts

According to the 2014 New York State HMP update, rising summer temperatures, along with little change in summer rainfall, are projected to increase frequency of short-term droughts. This scenario will lead to impacts on the natural and managed ecosystems across New York State. Water management and hydrology are also affected (NYS DHSES 2014).

Climate change is beginning to affect both people and resources in New York State, and these impacts are projected to continue growing. Impacts related to increasing temperatures and sea level rise are already evident within the State. *Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation* (ClimAID) was undertaken to provide decision-makers with information on the State’s vulnerability to climate change, and to facilitate development of adaptation strategies informed by both local experience and scientific knowledge (New York State Energy Research and Development Authority [NYSERDA] 2011).

Each region in New York State, as defined by ClimAID, has attributes that will be affected by climate change. Monroe County is part of geographical Region 1, Western New York and the Great Lakes Plain. Some of the issues in this region, affected by climate change, include: relatively low rainfall and increased summer drought risk, high-value crops could need irrigation, and improved conditions for grapes projected (NYSERDA 2014).

Temperatures and precipitation amounts are expected to increase throughout the State, as well as within Region 1. The State’s temperature is expected to rise between 2.0 and 3.4 degrees Fahrenheit (°F) by the 2020s, between 4.1 and 6.8 °F by the 2050s, and between 5.3 and 10.1 °F by the 2080s. The lower ends of these ranges assume lower greenhouse gas emissions scenarios, and the higher ends of these ranges assume higher greenhouse gas emission scenarios. By the end of the century, the greatest warming is projected to be in the northern parts of the State. (NYSERDA 2014).

Within Region 1, temperatures are anticipated to increase between 3.7 and 7.3 °F by the 2050s, and between 4.2 and 12.0 °F by the 2080s (baseline of 47.7°F). Precipitation totals will increase between 0 and 10% by the 2050s, and between 0 and 15% by the 2080s (baseline of 37 inches). Table 5.4.1-5 lists projected seasonal precipitation changes within the Western New York and Great Lakes Plain ClimAID Region (NYSERDA 2014).



Table 5.4.1-6. Projected Seasonal Precipitation Change in Region 1, 2050s (% change)

Winter	Spring	Summer	Fall
5 to +15	0 to +15	-10 to +10	-5 to +10

Source: NYSERDA, 2011

Annual temperatures have been rising throughout New York State since the start of the 20th century. State average temperatures have increased by approximately 0.6 °F since 1970, with winter warming exceeding 1.1 °F per decade. Extreme heat events are likely to increase throughout New York State, and short-duration warm season droughts will become more common.

With the increase in temperatures, heat waves will become more frequent and intense as shown in Table 5.4.8.5 below. Heat waves, defined as three or more consecutive days with maximum temperatures at or above 90 °F. Summer droughts are projected to increase under these conditions, affecting water supply, agriculture, ecosystems, and energy projects (NYSERDA 2014).

Table 5.4.1-7. Extreme Event Projections for Region 1 - Rochester

Middle Range (25th to 75th Percentile)	2020s	2050s	2080's
Days over 90 °F (8 days)	14 to 17	22 to 34	27 to 57
# of Heat Waves (0.7 heat waves)	2 to 2	3 to 4	3 to 8
Duration of Heat Waves (4 days)	4 to 4	4 to 5	5 to 6
Days below 32 °F (133 days)	103 to 111	84 to 96	68 to 88
Days over 1" Rainfall (5 days)	5 to 5	5 to 5	5 to 6
Days over 2" Rainfall (0.6 days)	0.6 to 0.7	0.6 to 0.8	0.6 to 0.9

Source: NYSERDA, 2014

By the end of the 21st century, the number of droughts is likely to increase, as the effect of higher temperatures on evaporation is likely to outweigh the increase in precipitation. Droughts in the northeast U.S. have been associated with local and remote modes of multi-year ocean-atmosphere variability that are unpredictable and may change with climate change. Changes in distribution of precipitation throughout the year and in timing of snowmelt could increase frequency of droughts (NYSERDA 2011).



5.4.1.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable within the identified hazard area. Regarding the drought hazard, all of Monroe County has been identified as the hazard area. Therefore, all assets within the County (population, structures, critical facilities, and lifelines), as described in the County Profile (Section 4), are vulnerable to a drought. The following factors are addressed in subsequent text that evaluates and estimates potential impacts of the drought hazard on the County:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health, and safety of residents; (2) general building stock; (3) critical facilities; (4) economy; and (5) future growth and development
- Effect of climate change on vulnerability
- Change of vulnerability as compared to that presented in the 2011 Monroe County Hazard Mitigation Plan
- Further data acquisitions that will increase understanding of this hazard over time.

Overview of Vulnerability

Drought is a significant concern to Monroe County, mainly due to its impact on public health, natural resources, and agriculture. Estimated losses are difficult to quantify; however, drought events can impact Monroe County's population and economy. Assets at particular risk would include areas used for agricultural purposes (farms and cropland). During the last HMP period of record, drought in other Counties and regions affected Monroe County, including the 2007 persistent shortage of rainfall along the Mohawk Valley and in Western New York. This dry period reduced the amount of water available to maintain sufficient navigational depth in some sections of the NYS Canal System, which was forced to close commercial traffic one week early that October, impacting local food supply and trade markets. That closure also impacted water-based recreational markets, affecting the local economy. Year round recreation and tourism in Monroe County from snow skiing to boating and other activities rely on water.

In addition, water supply resources could be impacted by extended periods of below average rain. The County's public water supply is lake fed, but rural populations are served by private wells and are significantly affected by periods of diminished groundwater resources. Particularly susceptible to the drought hazard and cascading impacts are populations vulnerable because of age, health conditions, limited ability to mobilize to shelter, and limited accessibility to cooling and medical resources.

Potential drought impacts are agricultural, hydrologic, and socioeconomic. The sequence of these impacts highlights the differences among them. When a drought begins, the agricultural sector is typically the first to be affected due to its heavy dependence on stored soil water. During dry periods, soil water can deplete quickly. If precipitation deficiencies continue, people who depend on other sources of water will begin to feel impacts of the shortage. Those who rely on surface water (for example, reservoirs and lakes) and subsurface water (for example, groundwater) are usually the last to be affected. A short-term drought that persists for 3 to 6 months may have little impact on these sectors, depending on characteristics of the hydrologic system and intensity of water use (NYS DHSES 2014).

Because agriculture and related sectors, including forestry, fisheries, and water activities, rely on surface and subsurface water supplies, they are vulnerable to numerous economic impacts. Droughts often result in loss of crop yields and livestock production, increased issues with insect infestations, increased forest diseases, and



reduced growth. Forest and grass fires also increase substantially during extended drought periods, posing higher levels of risk to human and wildlife populations, as well as to property (NYS DHSES 2014).

Loss of income is another factor in assessment of impacts of drought. Examples of income loss include reduced income for farmers, and for retailers and others who provide goods and services to farmers. The recreation and tourism industries may also undergo a loss of income because of increased costs of food, energy, and other products as supplies decrease. Some local shortages of certain goods trigger the need to import goods from outside the affected region. Reduced water supply affects use of rivers and other water bodies. Hydropower production may also be impacted by drought (NYS DHSES 2014).

Environmental losses from drought include damages to plant and animal species, wildfire habitat, and air and water quality; forest and grass fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some impacts may be short-term and others may linger for longer periods of time. If changes in climate intensify, environmental impacts and losses may become more significant. Wildfire habitat may be degraded through loss of wetlands, lakes, and vegetation. Increased soil erosion can lead to a more permanent loss of biological productivity of landscapes. However, quantifying environmental losses is difficult (NYS DHSES 2014).

Social impacts primarily involve public safety, health, conflicts among water users, reduced quality of life, and inequities in distribution of impacts and disaster relief. Many economic and environmental effects induce social impacts as well (NYS DHSES 2014).

Data and Methodology

Data were acquired from the following sources: HAZUS-MH, USDA, NOAA-NCDC, Monroe County, and the Planning Committee. Insufficient data were available to model the long-term potential impacts of a drought on the county. Over time, additional data will be obtained to allow better analysis of this hazard. Available information and a preliminary assessment appear below.

Impact on Life, Health, and Safety

The entire population of Monroe County is vulnerable to drought events. According to the 2010 U.S. Census, the county had a population of 744,344. Drought conditions can affect people's health and safety, including health problems related to low water flows and poor water quality, and health problems related to dust. Droughts also can lead to loss of human life (NDMC 2014). Other possible impacts on health from 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).

As previously stated, drought conditions can cause shortages of water for human consumption. Droughts can also lead to reduced local firefighting capabilities. The drought hazard is a concern for Monroe County because rural populations within the County rely upon private water supply from local groundwater resources.

The 2014 New York HMP states that between 2010 and 2012, Monroe County had 50% or more land area undergoing drought for 22 weeks during an abnormally dry period, and for 10 weeks during a drought-moderate period (NYS DHSES 2014).



Impact on General Building Stock

A drought event is not expected to directly affect any structures. However, droughts contribute to conditions conducive to wildfires and reduce fire-fighting capabilities. Risk to life and property is greatest within those areas where forested areas adjoin urbanized areas (high-density residential, commercial, and industrial) or wildland urban interface (WUI). Therefore, all assets within and adjacent to the WUI zone—including population, structures, critical facilities, lifelines, and businesses—are considered vulnerable to wildfire.

Impact on Critical Facilities

Water supply facilities may be affected by short supplies of water. As mentioned, drought events generally do not impact buildings; however, droughts can impact agriculture-related facilities and critical facilities associated with potable water supplies. Also, those critical facilities in and adjacent to the WUI zone are considered vulnerable to wildfire.

Impact on the Economy

Drought causes many economic impacts on agriculture and related sectors (forestry, fisheries, and waterborne activities). In addition to losses in yields in crop and livestock production, drought is associated with increased insect infestations, plant diseases, and wind erosion. Drought can lead to other losses because so many sectors are affected—losses that include reduced income for farmers and reduced business for retailers and others who provide goods and services to farmers. This leads to unemployment, increased credit risk for financial institutions, capital shortfalls, and loss of tax revenue. Prices for food, energy, and other products may also increase as supplies decrease (NYS DHSES 2014).

When a drought occurs, the agricultural industry is most at risk for economic impact and damage. During droughts, crops do not mature, which results in smaller crop yield, undernourishment of wildlife and livestock, decreases in land values, and ultimately financial loss to the farmer (FEMA 1997). The agricultural sector in New York State encompasses more than 34,000 farms that occupy approximately one-quarter of the State's land area and contribute \$4.5 billion annually to the State's economy. A large majority of the State's agriculture is rain-fed without irrigation. But summer precipitation is currently not sufficient to fully meet crop water needs during most years (NYSERDA 2011).

Table 5.4.1-6 summarizes direct and indirect losses to agricultural producers, livestock producers, timber producers, fishery producers, and tourism (NYS DHSES 2011).



Table 5.4.1-8. Impacts on the Economy

Losses to Agricultural Producers	Losses to Livestock Producers	Losses to Timber Producers
Annual and perennial crop losses	Reduced productivity of rangeland	Losses from wildland fires
Damage to crop quality	Reduced milk production	Losses from tree disease
Income loss for farmers due to reduced crop yields	Forced reduction of foundation stock	Losses from insect infestation
Reduced productivity of cropland (wind erosion, long-term loss of organic matter, etc.)	High cost/unavailability of water for livestock	Impaired productivity of forest land
Insect infestation	Cost of new or supplemental water resource development (wells, dams, pipelines)	Direct loss of trees, especially young ones
Plant disease	High cost/unavailability of feed for livestock	Transportation Industry
Wildlife damage to crops	Increased feed transportation costs	Loss from impaired navigability of streams, rivers, and canals
Increased irrigation costs	High livestock mortality rates	Decline in food production/disrupted food supply
Cost of new or supplemental water resource development (wells, dams, pipelines)	Disruption of reproduction cycles (delayed breeding, more miscarriages)	Increase in food prices
Loss from Fishery Production	Decreased stock weights	Increased importation of food (higher costs)
Damage to fish habitat	Increased predation	
Loss of fish and other aquatic organisms due to decreased flows	Grass fires	
Loss to Recreation and Tourism Industry	Energy-related Effects	Water Suppliers
Loss to manufacturers and sellers of recreational equipment	Increased energy demand and reduced supply because of drought-related power curtailments	Revenue shortfalls and/or windfall profits
Losses related to curtailed activities: hunting and fishing, bird watching, boating, etc.	Costs to energy industry and consumers associated with substituting more expensive fuels (oil) for hydroelectric power	

Source: NYSRPC, 2011

Based on the 2012 Census of Agriculture, 475 farms were present in Monroe County, encompassing 98,676 acres of total farmland. The average farm size was 208 acres. Monroe County farms had a total market value of products sold of \$90.580 million (\$81.342 million in crops including nursery and greenhouse; and \$9.238 million in livestock, poultry, and related products), averaging \$190,696 per farm. The Census indicated that 317 farm operators reported farming as their primary occupation (USDA 2012). Table 5.4.1-7 lists the acreage of agricultural land exposed to the drought hazard.

Table 5.4.1-9. Agricultural Land in Monroe County in 2012

Number of Farms	Land in Farms (acres)	Total Cropland (acres)	Harvested Cropland (acres)	Total Cropland Used Only For Pasture/Grazing (acres)
475	98,676	79,522	72,795	959

Source: USDA 2012

In 2012, the top three agricultural products sold in Monroe County were grains, oilseeds, dry beans, and dry peas at \$40.6 million; vegetables, melons, potatoes, and sweet potatoes at \$23.3 million; and Nursery, greenhouse, floriculture, and sod at \$9.5 million. Monroe County was the fourth highest ranked in the State



for its sales in cut Christmas trees and short rotation woody crops, and for its total acreage of crop items for all harvested vegetables (USDA 2012).

If the average production (dollar value) per crop type could be identified on a per acre basis, loss estimates could be developed based on assumed percent damage that could result from a drought. If a drought impacted 40 percent of the agricultural products sold from Monroe County farms, based on 2012 market values, this would be a loss of \$36.2 million. This figure does not include how the tourism industry and local jobs are impacted.

A prolonged drought can have a serious economic impact on a community. Increased demand for water and electricity may result in shortages and higher costs for these resources (FEMA 2005, New York State 2004). Industries that rely on water for business may 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/price of food for residents within the county.

Future Growth and Development

As discussed in Section 4, areas targeted for future growth and development have been identified across Monroe County. Future growth could affect the amount of potable water available due to a drain on available water resources. Other areas that could be impacted include agriculture and recreational facilities such as golf courses, farms, and nurseries. Areas targeted for potential future growth and development within the next 5 years have been identified across the county at the municipal level. Refer to the jurisdictional annexes in Volume II of this HMP.

Change of Vulnerability

An examination of change in the county's vulnerability to drought events from the 2011 HMP to this update must scrutinize each exposed and vulnerable entity. Total population across the county has changed, as indicated by a comparison of the 2000 U.S. Census with the 2010 U.S. Census.

Regarding the agricultural industry within Monroe County, from 2007 to 2012, the number of farms decreased by 19% (585 to 475 farms), and land within farms decreased by 26% (133,041 to 98,676 acres). The county also underwent an 8% decrease in the average size of farms—from 227 acres in 2007 to 208 acres in 2012. However, the county underwent a 25% increase in market value of products sold—from more than \$72 million in 2007 to more than \$90 million in 2012. Therefore, due to this increase in market values of products sold, the county's potential crop loss due to drought may increase overall (USDA Census of Agriculture, 2012).

Additional Data and Next Steps

For the Plan Update, any additional information regarding localized concerns and past impacts will be acquired and analyzed. These data will be developed to support future revisions to the plan. Attempts at mitigation could include extensions of current New York State, Monroe County, and local efforts. The lead state agency for drought preparedness is the NYSDEC.