4.3.2 Drought

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

Drought can be defined or grouped into four categories:

- Meteorological drought is a measure of departure of precipitation from normal, defined solely by reference to relative degree of dryness. Because of climatic differences, dryness considered a drought at one location of the country may not be considered drought at 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 groundwater or reservoir levels, and other parameters. Agricultural drought occurs when not enough water is 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 below-normal surface or subsurface water supply resulting from periods of precipitation shortfalls (including snowfall). Hydrological drought is related to effects of precipitation shortfalls on stream flows and water levels in reservoirs, lakes, and groundwater.
- Socioeconomic drought is associated with supply and demand of an economic good, with elements of meteorological, hydrological, and agricultural drought categories. This differs from the aforementioned types of drought because its occurrence depends on supply and demand to identify or classify droughts. Supplies of many economic goods such as water, silage, food grains, fish, and hydroelectric power depend on weather. Socioeconomic drought occurs when demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply (National Drought Mitigation Center ([NDMC] 2017).

Drought can affect many sectors of an economy and can reach beyond an area undergoing physical drought. Because water is essential for producing goods and providing services, drought can reduce crop yield, increase fire hazard, lower water levels, and damage wildlife and fish habitats. Further consequences include reductions in crop yields, rangeland, and forest productivity that may cause lower incomes of farmers and agribusinesses; increase in prices of food and timber; increase in unemployment; reduction of tax revenues as expenditures decline; increase in crime, foreclosures, and migration; and depletion of disaster relief funds. The many impacts of drought can be categorized as economic, environmental, or social.

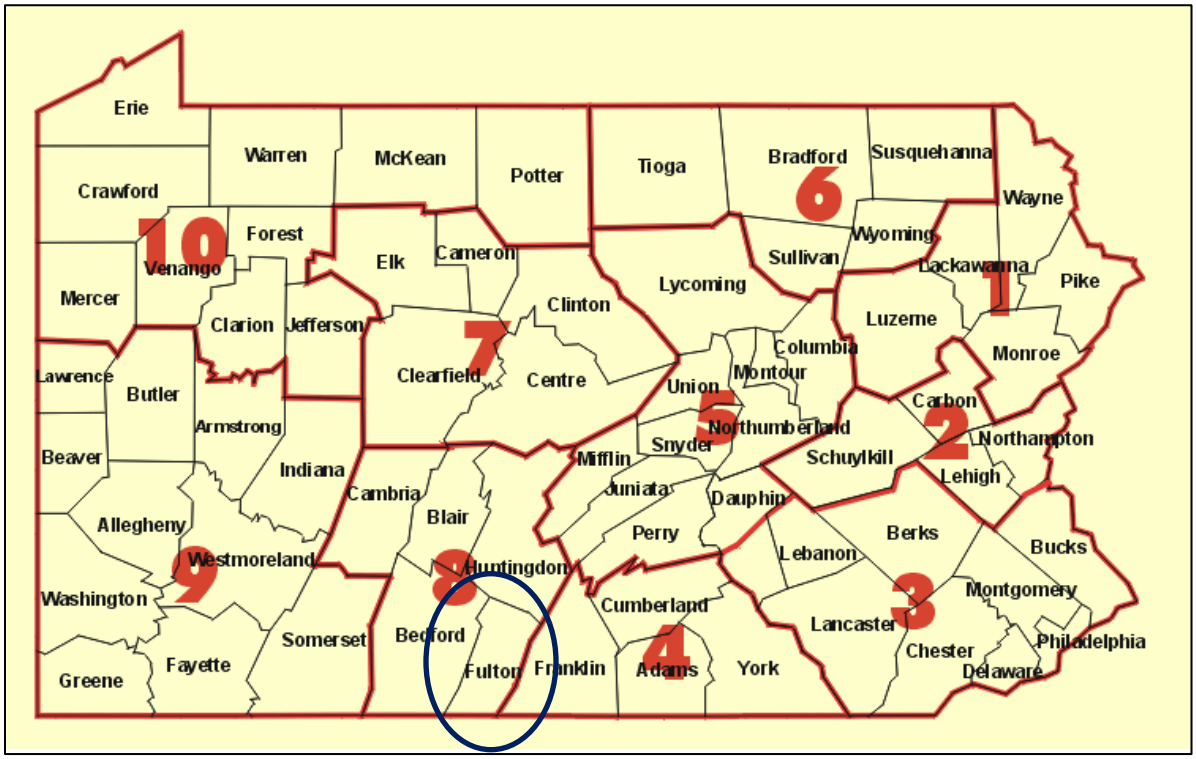
4.3.2.1 Location and Extent

Droughts are regional in scope and may affect the entirety of Fulton County rather than only individual municipalities within the county. Droughts may also concurrently affect counties near Fulton County, or even the entire Commonwealth. Generally, areas along waterways will reveal drought conditions later than areas away from waterways.

Climate divisions are regions within a state that are climatically homogenous. The National Oceanic and Atmospheric Administration (NOAA) has divided the United States into 359 climate divisions. NOAA has a map of these climate divisions nationally across the country (NOAA 2019). The boundaries of these divisions typically coincide with County boundaries, except in the western United States where they are based largely on drainage basins (National Weather Service [NWS] 2005).

According to NOAA, Pennsylvania includes 10 climate divisions: Pocono Mountains, East Central Mountains, Southeastern Piedmont, Lower Susquehanna, Middle Susquehanna, Upper Susquehanna, Central Mountains, South Central Mountains, Southwest Plateau, and Northwest Plateau Climate Division (National Climatic Data Center [NCDC] 2012). Figure 4.3.2-1 shows the climate divisions of Pennsylvania. Fulton County is within the South Central Mountains climate division.

Figure 4.3.2-1 Climate Divisions of Pennsylvania



Source: *NWS 2005*
Notes: Highlight added.
The climate divisions for Pennsylvania are:
1 = Pocono Mountains; 2 = East Central Mountains; 3 = Southeastern Piedmont; 4 = Lower Susquehanna; 5 = Middle Susquehanna; 6 = Upper Susquehanna; 7 = Central Mountains; 8 = South Central Mountains; 9 = Southwest Plateau; 10 = Northwest Plateau

Particularly at locations where citizens rely on wells for drinking water, water supplies are vulnerable to effects of drought and thus can impact the severity of a drought. Residents depending on well water can more easily handle short-term droughts without major inconveniences than can populations that rely on surface water. However, longer-term droughts inhibit groundwater aquifers from recharging and can thus extend the problems of well owners for an indeterminate amount of time. Fulton County residents who depend on private domestic wells have this greater "hidden vulnerability" to droughts. According to the U.S. Geological Survey (USGS) National Water Information System, the average daily domestic self-supplied groundwater withdrawals of fresh water in Fulton County was 0.73 million gallons (Mgal) per day in 2015, serving roughly 12,176 residents for a total of roughly 65 gallons per person (dependent on well water) per day (USGS 2019).

Table 4.3.2-1 lists the number of reported domestic wells within each municipality of Fulton County. The well data were obtained from the Pennsylvania Groundwater Information System (PaGWIS). PaGWIS is maintained by Pennsylvania Department of Conservation and Natural Resources (PA DCNR) and relies on voluntary submissions of well data recorded by well drillers; as a result, it is not a complete database of all domestic wells in the county. It is, however, the most complete dataset of domestic wells available.

Table 4.3.2-1. Domestic Wells in Fulton County

Municipality	Number of Reported Domestic Wells	Municipality	Number of Reported Domestic Wells
Ayr Township	223	Taylor Township	151
Belfast Township	145	Thompson Township	112
Bethel Township	212	Todd Township	107
Brush Creek Township	133	Union Township	131
Dublin Township	152	Valley-Hi Borough	3
Licking Creek Township	189	Wells Township	101
McConnellsburg Borough	0	**Fulton County**	**1,685**

Source: PA DCNR 2019

In addition to domestic wells in the county, residents may also receive their water from municipal water providers. According to the Pennsylvania Department of Environmental Protection (PA DEP) Drinking Water Reporting System, Fulton County has four community water systems for potable water: the Wells Tanner Water System, Belfast Township Municipal Authority, McConnellsburg Borough Municipal Authority, and the Leisure Living Retirement Home. Table 4.3.2-2 summarizes information for each community water system in Fulton County.

Table 4.3.2-2. Community Water Systems in Fulton County

Facility Name	Service Area	Population Served	Water Sources	Source Pumping Capacity (gpd)
McConnellsburg Borough Municipal Water Authority	McConnellsburg Borough, Ayr Township, Todd Township	2,000	Wells, Springs, Reservoirs	36,000-576,000
Belfast Township Municipal Authority	Belfast Township	276	Groundwater – one spring	340,000
Wells Tannery Water Authority	Village of Wells Tannery (Wells Township)	95	Groundwater - two wells	10,080-14,400
Leisure Living Retirement Home	Leisure Living Retirement Home (Fort Littleton)	40	Groundwater – one well	14,000

Source: PA DEP 2019

4.3.2.2 Range of Magnitude

Effects of droughts vary depending on their severity, timing, duration, and location. Some droughts may exert their greatest impact on agriculture, while others may have stronger effects on water supply or recreational activities. Droughts can adversely affect the following water resources significantly:

- Public water supplies for human consumption
- Rural water supplies for livestock consumption and agricultural operations
- Water quality
- Natural soil water or irrigation water for agriculture
- Water for forests and for fighting forest fires
- Water for navigation and recreation

PA DEP and Pennsylvania Emergency Management Agency (PEMA) manage and describe water supply droughts according to the following three conditions of drought, as defined in the Commonwealth of Pennsylvania 2018 Standard Hazard Mitigation Plan (PA HMP):

- Drought Watch: A period to alert government agencies, public water suppliers, water users, and the public regarding potential for future drought-related problems. Drought watches are invoked when three or more drought indicators are present for a county or group of counties. The focus is on increased monitoring, awareness, and preparation for response in the event that conditions worsen. A request for voluntary water conservation is issued. The objective of voluntary water conservation measures during a drought watch is to reduce water use by 5 percent within the affected areas. Due to varying conditions, individual water suppliers or municipalities may propose more stringent conservation actions.
- Drought Warning: This is a drought stage involving a coordinated response to imminent drought conditions and potential water supply shortages through concerted voluntary conservation measures to avoid or reduce shortages, relieve stressed sources, develop new sources, and, if possible, forestall the need to impose mandatory water use restrictions. The objective of voluntary water conservation measures during a drought warning is to reduce overall water use by 10 to 15 percent within the affected areas. Because of varying conditions, individual water suppliers or municipalities may propose more stringent conservation actions.
- Drought Emergency: This stage is a phase of concerted management operations to marshal all available resources to respond to actual emergency conditions, to avoid depletion of water sources, to assure at least minimum water supplies to protect public health and safety, to support essential and high propriety water uses and to avoid unnecessary economic dislocations. It is possible during this phase to impose mandatory restrictions on It is possible during this phase to impose mandatory restrictions on non-essential water uses that are provided in the Pennsylvania Code (Chapter 119), if deemed necessary and if ordered by the Governor of Pennsylvania. The objective of water use restrictions (mandatory or voluntary) and other conservation measures during this phase is to reduce consumptive water use in the affected area by 15 percent, and to reduce total use to the extent necessary to preserve public water system supplies, to avoid or mitigate local or area shortages and to assure equitable sharing of limited supplies.
- Local Water Rationing: Although not a drought phase, local municipalities may, with the approval of the PA Emergency Management Council, implement local water rationing to share a rapidly dwindling or severely depleted water supply in designated water supply service areas. These individual water rationing plans, authorized through provisions of the Pennsylvania Code (Chapter 120), will require specific limits on individual water consumption to achieve significant reductions in use. Under both mandatory restrictions imposed by the Commonwealth and local water rationing, procedures are provided for granting of variances to consider individual hardships and economic dislocations (PEMA 2018).

Pennsylvania uses five parameters to assess drought conditions: precipitation deficits, stream flows, reservoir storage levels, groundwater levels, and a measure of soil moisture. These are described in detail below:

- Precipitation Deficits: Because rainfall provides the basis for ground and surface water resources, measuring the difference in precipitation from the normal (30-year average) tends to be the earliest indicator that a drought is possible in an area. PA DEP will compare the cumulative precipitation for varying time periods (minimum of 3 months, maximum of 12 months) each month against the normal, 30-year average value for each same timer-period. Any duration that has less than the normal is considered to have a deficit, represented by a percentage less than the normal precipitation. Table 4.3.2-3 lists the drought conditions (defined in the PA HMP and noted above) that are indicated by various precipitation deficit percentages (PEMA 2018).

Table 4.3.2-3. Precipitation Deficit Drought Indicators for Pennsylvania

Duration of Deficit Accumulation (months)	Drought Watch (deficit as percent of normal precipitation)	Drought Warning (deficit as percent of normal precipitation)	Drought Emergency (deficit as percent of normal precipitation)
3	25	35	45
4	20	30	40
5	20	30	40
6	20	30	40
7	18.5	28.5	38.5
8	17.5	27.5	37.5
9	16.5	26.5	36.5
10	15	25	35
11	15	25	35
12	15	25	35

Source: PEMA 2018

Table 4.3.2-4 lists normal monthly and annual precipitation from 1981 to 2010 (the most current three-decade data available) at the two NOAA weather stations in Fulton County. Data from the NOAA weather stations are available through the National Centers for Environmental Information (NCEI), which compiles monthly and annual normal total precipitation (inches) data retrieved from both NWS Cooperative Network (COOP) and Principal Observation (First-Order) locations throughout the United States.

Table 4.3.2-4. Normal Monthly and Annual Precipitation (total in inches) from 1981 to 2010 at NOAA Weather Stations in Fulton County

Station Name	January	February	March	April	May	June	July	August	September	October	November	December	ANNUAL
Everett	2.58	2.39	3.22	3.81	4.01	3.61	3.54	3.11	3.41	2.94	3.20	2.80	38.62
Saxton 1 W	2.61	2.46	3.40	3.48	4.00	3.60	3.86	3.13	3.45	3.03	3.46	2.88	39.36

Source: NCEI 2014

- Stream Flows: Stream flows, which typically lag up to 2 months behind normal precipitation amounts in signaling a drought, offer the second earliest indication of drought conditions. PA DEP uses 61 USGS-maintained stream gauges throughout the Commonwealth as its drought monitoring network, computing 30-day average stream flow values for each stream gauge based on the entire period of record for each gauge. The USGS Drought status is determined from stream flows based on exceedances rather than percentages. The various stages of drought watch, warning, and emergency conditions are indicated, respectively, by 75 percent, 90 percent, and 95 percent exceedances of 30-day average flows (PEMA 2018). The National Weather Service tracks stream gages throughout the Commonwealth and provides real time information.
- Groundwater Levels: Groundwater levels for each day are used to calculate the average level of the preceding 30 days. This 30-day value is compared to the values derived from historical records yielding

a percentile indicating how much time the groundwater levels have been below the historical average levels. The USGS also maintains a network of groundwater monitoring wells, just recently upgraded to at least one well in each county. Groundwater is used to indicate drought status in a manner similar to stream flows. Groundwater level exceedances of 75, 90 and 95 percent are used to indicate watch, warning and emergency status. In this case, it is the 30-day average depth to groundwater that is measured and monitored, again in relation to long-term 30-day averages based on the period of record for each county well (PEMA 2018).

- Soil Moisture: Soil moisture is measured using an algorithm calibrated for relatively homogeneous regions that measures dryness based on temperature and precipitation in the area, which is information provided by the National Oceanic and Atmospheric Administration (NOAA). This generates a value called the Palmer Drought Severity Index (PDSI), which is compiled by the Climate Prediction Center of the National Weather Service on a weekly basis. A PDSI of -4.00 or less indicates a drought emergency; a value between -3.00 and -3.99 indicates a drought warning, and a value between -2.00 and -2.99 indicates a drought watch (PEMA 2018).
- Reservoir Storage Levels: Water level storage in several large public water supply reservoirs (especially three New York City reservoirs in the Upper Delaware River Basin) is the fifth indicator that the PA DEP uses for drought monitoring. Depending on the total quantity of storage and the length of the refill period for the various reservoirs, PA DEP uses varying percentages of storage draw down to indicate the three drought stages for each of the reservoirs (PEMA 2018).

Table 4.3.2-5 lists PDSI classifications. The PDSI uses 0 to reflect normal status, and negative numbers indicate droughts. For example, 0 is no drought, -2 is moderate drought, and -4 is extreme drought. Positive numbers signify excess precipitation (NDMC 2013).

Table 4.3.2-5. Palmer Drought Severity Index (PDSI) Classifications

Severity Category	PDSI Value	Drought Status
Extremely wet	4.0 or more	None
Very wet	3.0 to 3.99	None
Moderately wet	2.0 to 2.99	None
Slightly wet	1.0 to 1.99	None
Incipient wet spell	0.5 to 0.99	None
Near normal	0.49 to -0.49	None
Incipient dry spell	-0.5 to -0.99	None
Mild drought	-1.0 to -1.99	None
Moderate drought	-2.0 to -2.99	Watch
Severe drought	-3.0 to -3.99	Warning
Extreme drought	-4.0 or less	Emergency

Source: NDMC 2013; PEMA 2013

Availability and management of water supply are discussed in the 2009 Pennsylvania State Water Plan (PA DEP 2009b), a joint effort by the Statewide Water Resources Committee and PA DEP. In 2009, the PA DEP Secretary approved an updated State Water Plan to guide management of Pennsylvania's water resources over a 15-year planning horizon. As a functional planning tool for all Pennsylvania municipalities, counties, and regional planning partnerships, the State Water Plan profiles drought and resource constraints and encourages implementation of new technology and use policies to facilitate reduced water uses and resource demands at critical peak times. The State Water Plan provides inventories of water availability as well as an assessment of current and future water use demands and trends. It also offers strategies for improving management of water resources and waterway corridors that aim to reduce damages from extreme drought and flooding conditions (PA DEP 2009b).

4.3.2.3 Past Occurrence

Historical information has been drawn from many sources regarding previous occurrences and losses associated with drought events throughout Pennsylvania and Fulton County. Because so many sources were reviewed for the purpose of developing this plan, loss and impact information pertaining to many events could vary depending on the source. Therefore, accuracy of cited monetary values is based only on the available information identified during research for this plan.

According to NOAA's NCEI storm events database, Fulton County underwent four drought events between January 1, 1950, and October 19, 2017: October 1997, December 1998, July 1999, and August 1999. No Commonwealth-wide crop or property losses were reported because of the droughts; statewide losses would have included damages in other counties.

Since 1930, the Commonwealth of Pennsylvania has undergone 10 significant droughts. Since 1955, the Commonwealth has undergone 12 drought events that resulted in a Governor's proclamation or a Federal Emergency Management Agency (FEMA)-declared disaster or emergency. Fulton County was included in one of these events, and full details are available in PEMA's Pennsylvania Disaster History list. In addition to these events, between 1980 and 2016, PA DEP indicated that Fulton County has undergone 28 drought watch declarations, 11 drought warning declarations, and 12 drought emergency declarations (PEMA 2018).

According to FEMA, between 1954 and 2017, Pennsylvania underwent one drought-related disaster (DR) or emergency (EM) classified as one or a combination of the following disaster types: drought or water shortage. Because these disaster types generally cover a wide region of the Commonwealth, this single disaster may have impacted many counties. However, not all counties were included in the disaster declaration. FEMA, PEMA, and other sources indicate that Fulton County has not been declared a disaster area as a result of a drought-related event (FEMA 2017).

Based on all sources researched, drought events between 1895 and 2017 that have affected Fulton County are identified in Table 4.3.2-6. However, not all sources have been identified or researched, and therefore Table 4.3.2-6 may not include all events that have occurred throughout the county.

Table 4.3.2-6. Past Occurrences of Drought Events from 1895 to 2017

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts / PDSI Value
September 1895 – May 1896	Drought	N/A	N/A	-4.81 in January 1896
November 1908 – March 1909	Drought	N/A	N/A	-4.38 in January 1909
November 1909 – December 1909	Drought	N/A	N/A	-3.99 in November 1909
November 1910 – December 1910	Drought	N/A	N/A	-3.53 in December 1910
November 1922 – April 1923	Drought	N/A	N/A	-4.29 in December 1922
July 1930 – July 1931	Drought	N/A	N/A	-7.13 in January 1931
November 1931 – February 1932	Drought	N/A	N/A	-3.95 in December 1931
November 1953 – February 1954	Drought	N/A	N/A	-4.1 in February 1954
October 1963 – December 1963	Drought	N/A	N/A	-4.12 in December 1963
October 1964 – December 1964	Drought	N/A	N/A	-3.77 in December 1964
June 1965 – February 1967	Drought	N/A	N/A	-5.32 in August 1966
July – September 1965	Drought	DR-206	N/A	-3.68 in August 1965
April 1969 – June 1969	Drought	N/A	N/A	-3.74 in May 1969
November 1980 – April 1982	Drought Emergency	N/A	N/A	Not listed
April – December 1985	Drought Watch	N/A	N/A	Not listed
July – August 1988	Drought Watch	N/A	N/A	Not listed
August – December 1988	Drought Warning	N/A	N/A	Not listed
March – May 1989	Drought Watch	N/A	N/A	Not listed
June – July 1991	Drought Warning	N/A	N/A	Not listed
July 1991	Drought	N/A	Yes	Governor Robert P. Casey – Governor's Proclamation

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts / PDSI Value
July 1991 – April 1992	Drought Emergency	N/A	N/A	Not listed
April – September 1992	Drought Warning	N/A	N/A	Not listed
September – December 1995	Drought Watch	N/A	N/A	Not listed
July – November 1997	Drought Watch	N/A	N/A	Not listed
October 1997	Drought	N/A	N/A	No losses identified.
December 1998	Drought	N/A	N/A	No losses identified.
December 1998	Drought Watch	N/A	N/A	Not listed
January – March 1999	Drought Warning	N/A	N/A	Not listed
March – June 1999	Drought Watch	N/A	N/A	Not listed
June – July 1999	Drought Warning	N/A	N/A	Not listed
July 1999	Drought	N/A	Yes	Governor Tom Ridge – Governor's Proclamation, Individual Assistance, Hazard Mitigation Grant Program – Amended to include all 67 counties for an agricultural disaster
July – September 1999	Drought Emergency	N/A	N/A	Not listed
July 1999	Drought	N/A	N/A	No losses identified
August 1999	Drought	N/A	N/A	No losses identified
September 1999 – May 2000	Drought Watch	N/A	N/A	Not listed
August – December 2001	Drought Watch	N/A	N/A	Not listed
December 2001 – February 2002	Drought Warning	N/A	N/A	Not listed
February 2002	Drought and Water Shortage	N/A	Yes	Governor Mark S. Schweiker – Governor's Proclamation
February – November 2002	Drought Emergency	N/A	N/A	Not listed
November – December 2002	Drought Watch	N/A	N/A	Not listed
April – June 2006	Drought Watch	N/A	N/A	Not listed
August 2007 – January 2008	Drought Watch	N/A	N/A	Not listed
September – November 2010	Drought Warning	N/A	N/A	Not listed
August – September 2011	Drought Watch	N/A	N/A	Not listed
June – July 2015	Drought Watch	N/A	N/A	Not listed
August 2016 – February 2017	Drought Watch	N/A	N/A	Not listed

Sources: NRCC 2019; PEMA 2013; NCEI 2017; PA DEP 2017b

Notes:
FEMA Federal Emergency Management Agency
N/A Not applicable
PDSI Palmer Drought Severity Index

Table 4.3.2-7 lists the crop loss insurance payments on claims from Fulton County caused by drought events since 1948.

Table 4.3.2-7. Crop Loss Insurance Claims Due to Drought, 1948 to 2016

Crop Year	Total Claims	Crop Year	Total Claims
1948 - 1988	$0	2003	$0
1989	$0	2004	$3,515.00
1990	$0	2005	$110,145,90
1991	$0	2006	$142,677.50
1992	$0	2007	$277,016.26
1993	$174,284.75	2008	$150,567.70
1994	$20,030.60	2009	$91,795.80
1995	$30,481.25	2010	$540,299.22

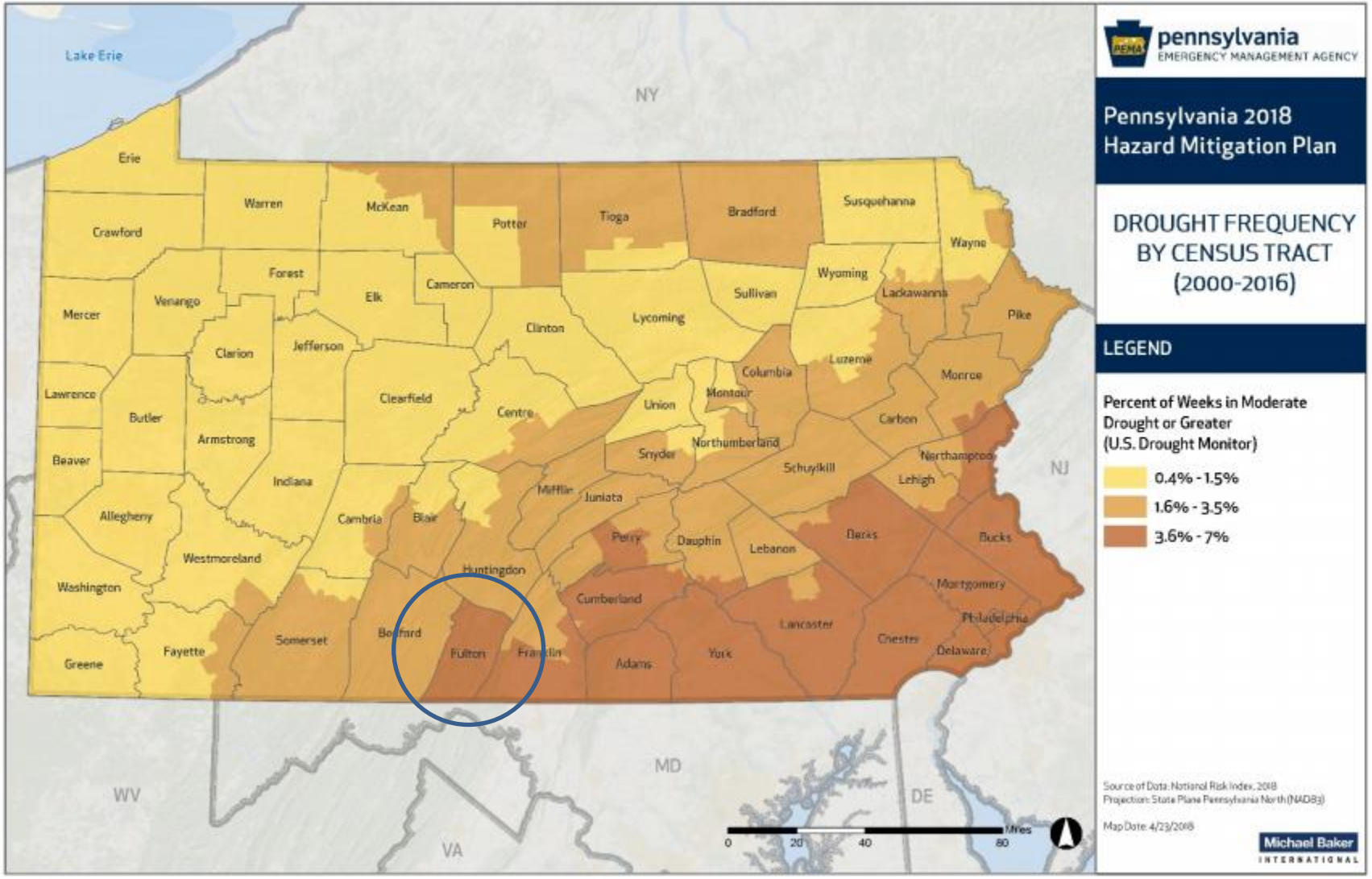
Crop Year	Total Claims	Crop Year	Total Claims
1996	$0	2011	$780,798.00
1997	$181,766.60	2012	$70,962.50
1998	$58,165.00	2013	$24,512.60
1999	$378,377.50	2014	$226,101.15
2000	$0	2015	$75,156.45
2001	$126,945.14	2016	$506,787.24
2002	$496,344,87	**Total**	**$4,466,732.44**

Source: U.S. Department of Agriculture (USDA) 2019a

4.3.2.4 Future Occurrence

Frequency of droughts is difficult to forecast. Based on data from a 16 year period, Fulton County underwent severe or extreme drought conditions less than 7 percent of the time (illustrated on Figure 4.3.2-2). Based on the drought conditions listed in Table 4.3.2-6, future occurrences of drought events are considered *likely*, as defined by the Risk Factor Methodology probability criteria (described in Section 4.4).

Figure 4.3.2-2. Percent of weeks that areas have been in moderate drought or greater



Source: PEMA 2018 (highlight added)

4.3.2.5 Vulnerability Assessment

To understand risk, a community must evaluate assets exposed and vulnerable within the identified hazard area. For the drought hazard, all of Fulton County has been identified as the hazard area. Therefore, all assets (population, structures, critical facilities, and lifelines) described in the county Profile (Section 2) are potentially vulnerable to a drought. This section evaluates and estimates potential impacts of the drought hazard on Fulton County in the following subsections:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impacts on (1) life, health, and safety; (2) general building stock and critical facilities; (4) economy; (5) environment; and (6) future growth and development
- Effects of climate change on vulnerability

Overview of Vulnerability

Fulton County is vulnerable to drought. Assets at particular risk include any open land or structures along the wildland-urban interface (WUI) that could become vulnerable to the wildfire hazard caused by extended periods of low rain and high heat, usually associated with drought. In addition, water supply resources could be impacted by extended periods of low rain. Finally, vulnerable populations could be particularly susceptible to the drought hazard and cascading impacts because of age, health conditions, and limited ability to mobilize to shelter, cooling, and medical resources.

Impact on Life, Health, and Safety

Drought conditions can cause a shortage of water available for human consumption and can reduce local firefighting capabilities. Social impacts of a drought include mental and physical stress, public safety threats (increased threat from forest/grass fires), health threats, conflicts among water users, reduced quality of life, and inequities in distribution of impacts and disaster relief. The infirm, young, and elderly are particularly susceptible to drought and extreme temperatures, sometimes associated with drought conditions, due to their age, health conditions, and limited ability to mobilize to shelters, cooling, and medical resources. Impacts on the economy and environment may have social implications as well (New York State Disaster Preparedness Commission [NYSDPC] 2011). For the purposes of this plan, the entire population of the county is considered vulnerable to drought events.

Impact on General Building Stock and Critical Facilities

A drought is not expected to directly affect any structures, and all are expected to be operational during a drought event. However, droughts contribute to conditions conducive to wildfires. Risk to life and property is greatest in regions where forested areas adjoin urbanized areas (high-density residential, commercial, and industrial), also known as the WUI. Therefore, all assets in and adjacent to the WUI zone, including population, structures, critical facilities, lifelines, and businesses, are considered vulnerable to wildfire. Section 4.3.12 of this HMP addresses the wildfire hazard in Fulton County.

Impact on the Economy

Drought events impact the economy, including loss of business function and damage and loss of inventory. Industries that rely on water for business may be impacted the hardest (e.g., agriculture). Even though a majority of businesses will still be operational, they may be impacted aesthetically. A prolonged drought can exert serious direct and indirect economic impacts on a community or across the county. Economic impacts may include:

- Losses from crop, livestock, timber, and aquaculture production and associated businesses.
- Losses from recreation providers and associated businesses.
- Losses related to the increased costs resulting from increased energy demand and from shortages caused by reduced hydroelectric generation capacity.

- Revenue losses for federal, state, and local governments from a reduced tax base and for financial institutions from defaults and postponed payments.
- Long-term loss of economic growth and development.

Loss estimates are based on lost agricultural revenues statewide. Table 4.3.2-8 below the annual market value of all agricultural products sold, as documented in the 2012 USDA Census of Agriculture. If the county would lose its agricultural yield due to drought, total losses could amount to over $12 million.

Table 4.3.2-9 details the potential losses associated with County livestock by providing livestock totals for the county and their associated market value. Livestock, poultry, and associated products have a potential loss value of more than $63 million (USDA 2017).

Table 4.3.2-8. Estimated County Losses Relating to Agricultural Crop Production

Crops	Inventory	Market Value of Agricultural Products
Grains, oilseeds, dry beans, dry peas	$5,065,000	**$12,253,000**
Vegetables, melons, potatoes, sweet potatoes	$337,000	
Fruits, tree nuts, berries	$197,000	
Nursery, greenhouse, floriculture, sod	$138,000	
Cultivated Christmas trees, short rotation woody crops	$137,000	
Other crops and hay	$6,380,000	

Source: USDA 2017

Table 4.3.2-9. Estimated County Losses Relating to Agricultural Livestock Production

Livestock and Poultry	Inventory	Market Value of All Livestock, Poultry, and Their Products
Poultry and eggs	$3,161,000	**$63,562,000**
Cattle and calves	$7,337,000	
Milk from cows	$24,872,000	
Hogs and pigs	$27,744,000	
Sheep, goats, wool, mohair, milk	$147,000	

Source: USDA 2017

Impact on the Environment

As summarized in the PA HMP (2018), the National Drought Mitigation Center at the University of Nebraska-Lincoln identified the following as environmental impacts from droughts:

- Damage to animal species in the form of reduced water and feed availability, degradation of fish and wildfire habitat, migration and concentration issues (too many or too few animals in a given area), stress to endangered species, and loss of biodiversity
- Lower water levels in reservoirs, lakes, and ponds
- Reduced stream flow
- Loss of wetlands
- Increased groundwater depletion, land subsidence, and reduced groundwater recharge
- Water quality impacts like salinity, water temperature increases, pH changes, dissolved oxygen, or turbidity
- Loss of biodiversity
- Loss of trees
- Increased number and severity of fires
- Reduced soil quality and erosion issues

- Increased dust or pollutants

Future Growth and Development

Areas targeted for potential future growth and development within the next 5 to 10 years have been identified across the county (further discussed in Section 2.4 of this HMP). Exposure of any new development and new residents to the drought hazard is anticipated.

Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation but also by type, frequency, and intensity of weather events. Both globally and at the local level, climate change can alter prevalence and severity of weather extremes such as droughts. While predicting changes in drought events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating effects of future climate change on human health, society, and the environment (U.S. Environmental Protection Agency [EPA] 2006).

According to the Pennsylvania Climate Impacts Assessment 2015 Update, the likelihood for drought will decrease by the middle of the 21st century as months with above-normal precipitation increase but drying of surface soil across the coterminous United States in all seasons is still projected due to enhanced evapotranspiration. Soil moisture at root depth of crops is more useful for estimating agricultural drought. Resolution constraints and lack of detailed evapotranspiration process representation lead to lower confidence in projections with the soil moisture budget being less constrained (Wehner et al. 2017).