4.3.5 Flood, Flash Flood, Ice Jam

This section provides a profile and vulnerability assessment of the flood hazard in Fulton County. Floods are one of the most common natural hazards in the United States and are the most prevalent type of natural disaster occurring in Pennsylvania. The Federal Emergency Management Agency's (FEMA) definition of flooding is "a general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from the overflow of inland or tidal waters or the rapid accumulation of runoff of surface waters from any source" (FEMA 2019).

Most floods fall into three categories: riverine, coastal, and shallow (FEMA 2015a). Other types of floods may include ice jam floods, flash floods, stormwater floods, alluvial fan floods, dam failure floods, and floods associated with local drainage or high groundwater (as indicated in the previous flood definition). For the purpose of this plan and as deemed appropriate by the Steering Committee, riverine, flash, ice jam, and stormwater flooding are the main flood types of concern for Fulton County. These types of floods are further discussed below.

Riverine Floods

Riverine floods are the most common flood type and occur along a channel. Channels are defined features on the ground that carry water through and out of a watershed. They may be called rivers, creeks, streams, or ditches. When a channel receives too much water, the excess water flows over its banks and inundates low-lying areas. These floods usually occur after heavy rains, heavy thunderstorms, or snowmelt, and can be slow or fast-rising, and generally develop over a period of hours to days (FEMA 2015a, Illinois Association for Floodplain and Stormwater Management 2006).

Flash Floods

According to the National Weather Service (NWS), flash floods are a rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within 6 hours of the causative event (e.g., intense rainfall, dam failure, or ice jam) (NWS 2018).

Flash floods can occur very quickly and with very little warning. This type of flood can be deadly because it produces rapid rises in water levels and has devastating flow velocities. Urban areas are more susceptible to flash floods because a high percentage of the surface area is impervious (NWS 2018). Time elapsed before flash flooding occurs may vary in different parts of the country. Ongoing flooding can intensify to flash flooding where intense rainfall results in a rapid surge of rising flood waters (NWS 2018). A flash flood can have a dangerous wall of roaring water that carries rocks, mud, and other debris, and can sweep away most things in its path. Flash floods usually result from intense storms dropping large amounts of rain within a brief period with little or no warning and can reach their peak within only a few minutes. They normally occur in the summer during the thunderstorm season. The most severe flooding conditions usually occur when direct rainfall is augmented by snowmelt. If the soil is saturated, frozen, rock, or clay, stream flow may increase because of inability of the soil to absorb additional precipitation (NWS 2018).

Ice Jam Floods

An ice jam is an accumulation of ice that acts as a natural dam and restricts flow of a body of water. Ice jams occur when warm temperatures and heavy rains cause rapid snow melt. The melting snow, combined with the heavy rain, causes frozen rivers to swell. The rising water breaks the ice layers into large chunks, which float downstream and often pile up near narrow passages and obstructions (bridges and dams). Ice jams may build up

to a thickness great enough to raise the water level and cause flooding (Northeast States Emergency Consortium [NESEC] Date Unknown, U.S. Army Corps of Engineers [USACE] 2002).

Ice jams are of two different types: freeze-up and break-up. Freeze-up jams occur in the early to mid-winter when floating ice may slow or stop due to a change in water slope as it reaches an obstruction to movement. Break-up jams occur during periods of thaw, generally in late winter and early spring. The ice cover break-up is usually associated with a rapid increase in runoff and corresponding river discharge caused by a heavy rainfall, snowmelt, or warmer temperatures (USACE 2002).

Dam Failure Floods

A dam is an artificial barrier that can impound water, wastewater, or any liquid-borne material for the purpose of storage or control of water (FEMA 2018). Dams are man-made structures built across a stream or river that impound water and reduce flow downstream (FEMA 2018). They are built for purposes of power production, agriculture, water supply, recreation, and flood protection. Dam failure is catastrophic type of failure characterized by the sudden, rapid, and uncontrolled release of impounded water, or the likelihood of such an uncontrolled release (FEMA 2018). Dams can fail for one or a combination of the following reasons:

- Overtopping caused by floods that exceed capacity of the dam (inadequate spillway capacity)
- Deliberate acts of sabotage (terrorism)
- Structural failure of materials used in dam construction
- Movement and/or failure of the foundation supporting the dam
- Settlement and cracking of concrete or embankment dams
- Piping and internal erosion of soil in embankment dams
- Inadequate or negligent operation, maintenance, and upkeep
- Earthquake (liquefaction/landslides) (FEMA 2019)

Flooding can occur when a dam fails or breaks, which can cause flooding conditions similar to flash floods. Dam failures can cause an increase of flow which can affect low-lying areas downstream of the dam.

Flooding caused by dam failure is addressed in Section 4.3.1 of this plan.

4.3.5.1 Location and Extent

Flooding in Pennsylvania is typically associated with abnormally high and intense rainfall amounts. It can also be caused by sudden snowmelt, landslides, or dam failures (PEMA 2018). In Pennsylvania, flooding usually occurs in the summer; however, flooding has occurred during the winter months as well.

Floodplains are found in lowland areas adjacent to rivers, streams, creeks, lakes, or other bodies of water that become inundated during a flood. The size of a floodplain depends on the recurrence interval of a given flood. A 1 percent annual chance floodplain is smaller than the floodplain associated with a flood that has a 0.2 percent annual chance of occurring (PEMA 2018). Floodplain maps of each Fulton County jurisdiction are available at the end of this profile. These maps show locations of both the 1 percent chance annual floodplain and the 0.2 percent chance annual floodplain.

Flooding is the most significant natural hazard in Fulton County. The Potomac River is less than 2 miles away from the county's most southern border, and the county is home to numerous small creeks and tributaries. Fulton County has two lakes of mentionable size: Cowans Gap Lake and Meadow Grounds Lake. Two-thirds of Fulton County's streams flow into the Potomac River Basin. The Potomac drainage area includes 14,679 square miles

in the four states of Maryland, Pennsylvania, Virginia, and West Virginia as well as in the District of Columbia. Fulton County lies in the Conococheague/Antietam sub-basin of the Potomac River.

Additionally, about one-third of the county's streams flow into the Juniata River, which is a sub-basin of the Susquehanna River Basin. The Juniata sub-basin encompasses a 3,406-square-mile area and includes Huntingdon and Blair Counties and portions of Somerset, Bedford, Franklin, Perry, Juniata, Snyder, Mifflin, Centre, Cambria, and Fulton Counties. A very small portion of the county is also within the Wills Creek/Evitts Creek/Town Creek sub-basin.

Table 4.3.5-1 lists total land areas within the 1 percent and 0.2 percent annual chance flood zones calculated via a spatial analysis referencing the February 2011 Digital Flood Insurance Rate Map (DFIRM).

Table 4.3.5-1. Total Land Areas in the 1 percent and 0.2 percent Annual Chance Flood Zones (Square Miles)

Municipality	NFIP-Participating Community	Total Area (Square Miles)	1% Flood Event Hazard Area		0.2% Flood Event Hazard Area	
			Area (Square Miles)	% of Total	Area (acres)	% of Total
Ayr Township	X	46.4	4.0	8.5%	4.0	8.5%
Belfast Township	X	50.4	5.3	10.5%	5.3	10.5%
Bethel Township	X	37.1	2.1	5.7%	2.1	5.7%
Brush Creek Township	X	54.6	2.7	4.9%	2.7	4.9%
Dublin Township	X	37.1	3.9	10.6%	3.9	10.6%
Licking Creek Township	X	44.5	4.4	9.9%	4.4	9.9%
McConnellsburg Borough	X	0.4	0.0	1.6%	0.0	1.8%
Taylor Township	X	32.5	2.5	7.8%	2.5	7.8%
Thompson Township	X	37.9	5.5	14.5%	5.5	14.5%
Todd Township	X	29	1.4	5.0%	1.4	5.0%
Union Township	X	30.5	1.5	4.8%	1.5	4.8%
Valley-Hi Borough		0.4	0.2	37.9%	0.2	37.9%
Wells Township	X	37.5	2.1	5.5%	2.1	5.5%
Fulton County (Total)		**438.3**	**35.5**	**8.1%**	**35.6**	**8.1%**

Source: FEMA 2011
Note: Areas listed include areas of inland waterways

In accordance with the 1978 Pennsylvania Stormwater Management Act (Act 167), counties are required to prepare stormwater management plans on a watershed-by-watershed basis that provide for improved management of stormwater impacts associated with development of land. In December 2008, Fulton County developed and implemented Phase I of the Act 167 County-Wide Plan Stormwater Management Plan. This phase of the plan includes the Scope of Study – Establishing procedures used to prepare the plan. These procedures are determined by an overall survey of:

- Specific watershed characteristics and hydrologic conditions
- Stormwater-related problems and significant obstructions
- Alternative measures for control
- Goals, objectives, solution strategies, and estimated costs for Phase 2 of the plan.

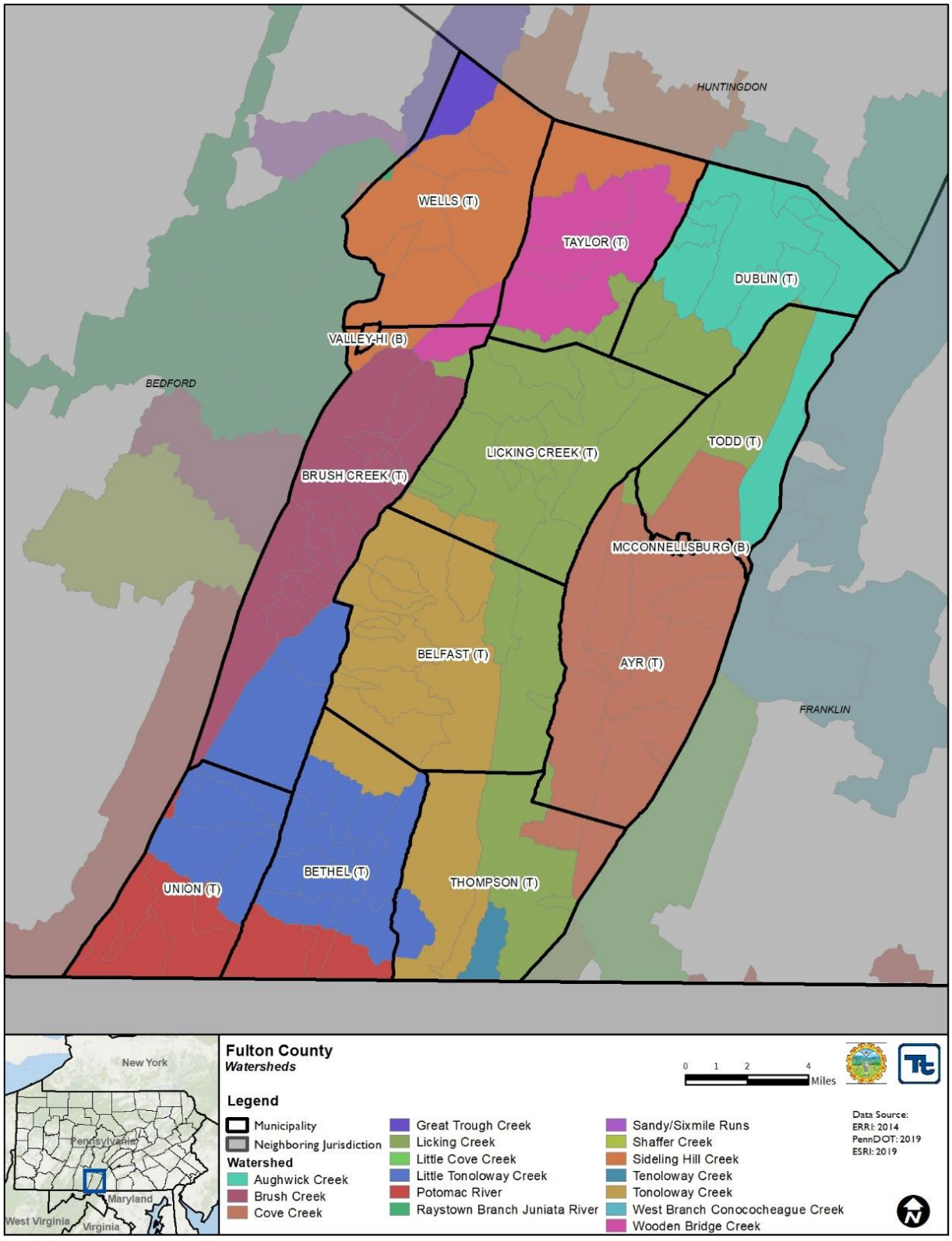
In June 2010, Fulton County published Phase II of the Act 167 County-Wide Plan Stormwater Management Plan. The Phase II Stormwater Management Plan includes stormwater runoff modeling for each watershed in Fulton County. The plan identifies the following PADEP-designated watersheds and associated streams for which Act 167 studies were prepared (Table 4.3.5-2).

Table 4.3.5-2. PA DEP-Designated Watersheds Identified in Act 167 Stormwater Management Plan.

Susquehanna River Watershed	Potomac River Watershed
Aughwick Creek	Licking Creek
Wooden Bridge Creek	Little Tonoloway Creek
Sideling Hill Creek	Tonoloway Creek
Bush Creek	Cove Creek
Great Trough Creek	Potomac River

Source: Fulton County Act 167 Plan, 2010

Figure 4.3.5-1. PA DEP-Designated Watersheds



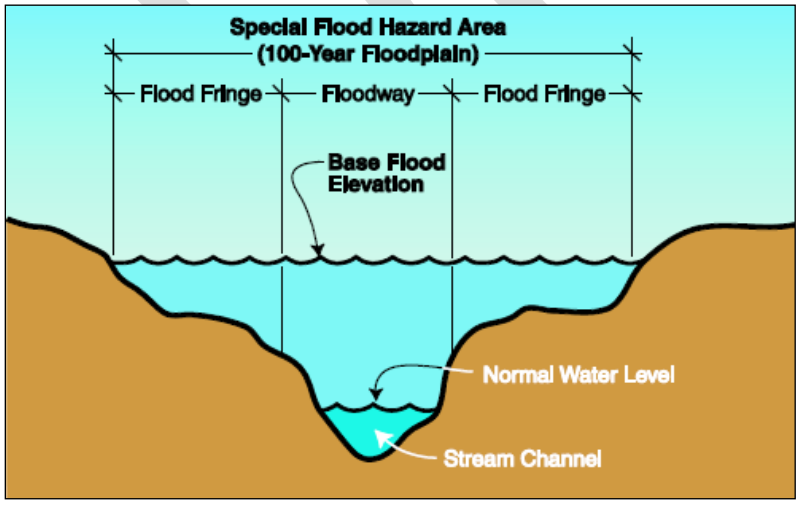
FEMA Regulatory Flood Zones

According to FEMA, flood hazard areas are defined as areas on a map shown to be inundated by a flood of a given magnitude. These areas are determined by use of statistical analyses of records of river flow, storm tides, and rainfall; information obtained through consultation with the community; floodplain topographic surveys; and hydrologic and hydraulic analyses. Flood hazard areas are delineated on FEMA's Flood Insurance Rate Maps (FIRM), which are official maps of a community on which the Federal Insurance and Mitigation Administration has delineated both Special Flood Hazard Areas (SFHA) and the risk premium zones applicable to the community. These maps identify SFHAs, location of a specific property in relation to the SFHA, the base flood elevation (BFE) (1 percent annual chance) at a specific site, the magnitude of a flood hazard within a specific area, undeveloped coastal barriers where flood insurance is not available, and regulatory floodways and floodplain boundaries (1 percent and 0.2 percent annual chance floodplain boundaries) (FEMA 2011). Fulton County's FIRMs can be accessed online via the FEMA Flood Map Service Center (https://msc.fema.gov/portal/home).

The land area covered by flood waters of the base flood is the SFHA on a FIRM. It is the area where the NFIP's floodplain management regulations must be enforced, and the area where mandatory purchase of flood insurance applies. This regulatory boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities because many communities have maps showing the extent of the base flood and likely depths that will occur.

The 1 percent annual chance flood is referred to as the base flood. As defined by NFIP, the BFE on a FIRM is the elevation of a base flood event, or a flood that has a 1 percent chance of occurring in any given year. The BFE describes the exact elevation of the water that will result from a given discharge level, which is one of the most important factors used in estimating potential damage within a given area. A structure within a 1 percent annual chance floodplain has a 26 percent chance of undergoing flood damage during the term of a 30-year mortgage (FEMA 2003). The 1 percent annual chance flood is a regulatory standard used by federal agencies and most states to administer floodplain management programs. The 1 percent annual chance flood is used by NFIP as the basis for insurance requirements nationwide. FIRMs also depict 0.2 percent annual chance flood designations (FEMA 2003). Figure 4.3.5-2 depicts the SFHA, the BFE, the flood fringe, and the floodway areas of a floodplain for the 1 percent annual chance flood.

Figure 4.3.5-2. Floodplain Diagram

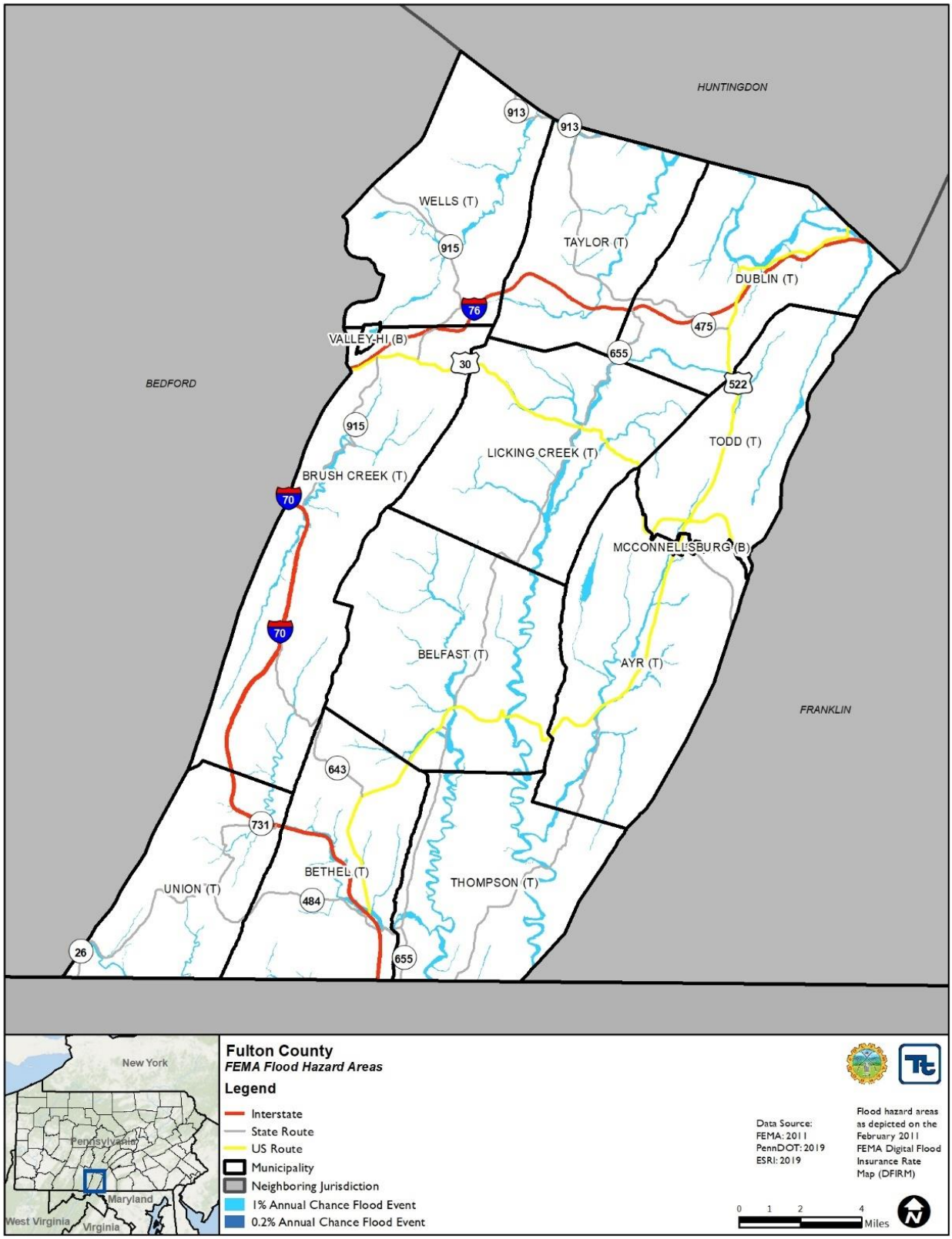


Source: PEMA 2018

The SFHA serves as the primary regulatory boundary used by FEMA and Pennsylvania. DFIRM, FIRMs, and other flood hazard information can be referenced to identify the expected spatial extent of flooding from a 1 percent annual chance event and 0.2 percent annual chance event.

At the time this plan was written, February 2011 DFIRMs were considered the best available and were used for the risk analysis. Figure 4.3.5-3 illustrates FEMA flood zones in Fulton County. Maps of each municipality's flood zones are shown at the end of this profile.

Figure 4.3.5-3. FEMA Floodplains in Fulton County



While the FIRMs provide a creditable source to document extent and location of the flood hazard, accuracy of data reflected on these maps has limitations. Notably, FIRMs are based on existing hydrological conditions at the time of map preparation. FIRMs are not set up to account for possible changes in hydrology over time.

Flood Insurance Study

In addition to FIRM and DFIRMs, FEMA also provides Flood Insurance Studies (FIS) of entire counties and individual jurisdictions. These studies aid in administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. They are narrative reports of countywide flood hazards, including descriptions of flood areas studied and engineered methods used, principal flood problems, flood protection measures, and graphic profiles of flood sources (FEMA 2011). The countywide FIS for Fulton County was last completed in 2011, at the same time as the DFIRM revisions.

Ice Jam Hazard Areas

Ice jams are common in northeastern United States, and the Commonwealth of Pennsylvania is not an exception. The ice jam database, maintained by the Ice Engineering Group at the USACE Cold Regions Research and Engineering Laboratory (CRREL), currently consists of over 18,000 records from across the United States. According to the USACE-CRREL, Fulton County underwent or may have been impacted by three historical ice jam incidents between 1780 and 2019 (USACE 2019). Ice jams have formed along Tonoloway Creek. Historical events are further mentioned in the "Previous Occurrences" section of this hazard profile.

4.3.5.2 Range of Magnitude

Both localized and widespread floods are considered hazards when people and property are affected. Injuries and deaths can occur when people are swept away by flood currents, or bacteria and disease are spread by moving or stagnant flood waters. Most property damage results from inundation by sediment-filled water. A large amount of rainfall over a short period of time can result in flash floods. Small amounts of rain can cause flooding in areas with frozen soil or saturated soils from a previous event, or if the rain is concentrated in areas with impervious surfaces (PEMA 2018).

Several factors determine the severity of floods, including intensity and duration, topography, ground cover, and rate of snowmelt. Water runoff is greater in areas with steep slopes and little or no vegetative ground cover. Many areas in Pennsylvania have relatively steep slopes that promote quick surface water runoff. Most storms track from west to east; however, some originate in the Great Lakes or the Atlantic Ocean (PEMA 2018).

Rainfall in Pennsylvania is about average for the eastern United States. Amounts of precipitation can be divided into the following six categories:

- Very light rain – precipitation rate of <0.01 inch per hour
- Light rain – precipitation rate between 0.01 inch and 0.04 inch per hour
- Moderate rain – precipitation rate between 0.04 inch and 0.16 inch per hour
- Heavy rain – precipitation rate between 0.16 inch and 0.63 inch per hour
- Very heavy rain – precipitation rate between 0.63 inch and 2 inches per hour
- Extreme rain – precipitation rate greater than 2 inches per hour (PEMA 2018)

Severity of a flood depends not only on the amount of water that accumulates within a period of time, but also on the land's ability to manage this water. One element is the size of rivers and streams in an area, but an equally important factor is the land's absorbency. When it rains, soil acts as a sponge. When the land is saturated or

frozen, infiltration into the ground slows, and any more water that accumulates must flow as runoff (Harris 2008).

In the case of riverine or flash flooding, once a river reaches flood stage, the flood extent or severity categories used by NWS include minor flooding, moderate flooding, and major flooding. Each category has a definition based on property damage and public threat:

- Minor Flooding – minimal or no property damage, but possibly some public threat or inconvenience.
- Moderate Flooding – some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary.
- Major Flooding – extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations are necessary (NWS 2016).

Fulton County's worst flood was associated with Hurricane Agnes in 1972. The county underwent widespread flooding and flash flooding. The damage was so severe that the county was declared a major disaster area in June 1972. Specific information on damages due to Hurricane Agnes were unavailable for this update. Another significant flooding scenario mirrors the January 1995 flooding. Several inches of rain poured down on several inches of snow that had already fallen. Many homes reported basement and first-floor flooding. Some homes were severely damaged, one of which could not be repaired. Several businesses were damaged as well. A local car dealership had most of its inventory of vehicles floating down the creek. The County Commissioners filed a Declaration of Disaster for this incident. As a result, municipalities and homeowners gained assistance through low-interest loans offered by FEMA.

4.3.5.3 Past Occurrence

Many sources provided historical information regarding previous occurrences and losses associated with flooding events throughout the State of Pennsylvania and Fulton County. With so many sources reviewed for the purpose of this Hazard Mitigation Plan (HMP), loss and impact information regarding many events could vary depending on the source. Therefore, accuracy of monetary figures discussed is based only on available information identified during research for this HMP.

According to the National Oceanic and Atmospheric Administration's National Center for Environmental Information (NOAA-NCEI) storm event database, Fulton County underwent 17 flood events between January 1, 1950, and June 1, 2018 (the dates for which data are available). Total property damages as a result of these flood events were estimated at $15,000,000. This total also includes damages to other counties.

Between 1954 and 2019, the Commonwealth of Pennsylvania underwent 51 FEMA-declared, flood-related disaster declarations (DR) or emergencies classified as one or a combination of the following disaster types: flood, flash flooding, severe storms, hurricanes, and high wind. Typically, these disasters covered a wide region of the State; therefore, they may have impacted many counties. However, not all counties were included in the disaster declarations (FEMA 2019). Fulton County was included in 10 of the declarations, as listed in Table 4.3.5-3.

Based on all sources researched, known flooding events resulting in property damages that have affected Fulton County and its municipalities are listed in Table 4.3.5-3. No deaths or injuries caused by flooding have been recorded in Fulton County. With flood documentation for the Commonwealth of Pennsylvania so extensive, not all sources have been identified or researched. Therefore, Table 4.3.5-3 may not include all events that have occurred throughout the county.

Table 4.3.5-3. Flooding Events between 1972 and 2019 in Fulton County

Date of Event	Event Type	Location	FEMA Declaration Number (if applicable)	County Designated?	Losses/Impacts
6/23/1972	Hurricane/Flood	Fulton County	DR-340	Y	Hurricane Agnes. Eligible for individual and public assistance.
7/1974	Flash Flood	Fulton County	N/A	Y	Ft. Littleton Scout Camp.
9/26/1975	Flood	Fulton County	DR-485	Y	Eligible for individual and public assistance.
1/19/2006-2/1/2006	Flood	Fulton County	DR-1093	Y	Eligible for individual and public assistance.
1/19/1996	Flash Flood	Fulton County	N/A	N/A	Countywide impact.
1/19/1996	Flood	Fulton County	N/A	N/A	Regional impact.
6/20/1996	Flash Flood	Fulton County	N/A	N/A	Road flooding occurred along Route 522 about 5 miles south of McConnellsburg.
7/19/1996	Flash Flood	Fulton County	N/A	N/A	Countywide impact.
8/14/1996	Flash Flood	Fulton County	N/A	N/A	Heavy rains flooded the road south of Harrisonville.
9/06/1996	Flash Flood	Fulton County	N/A	N/A	Northern parts of Fulton County were hit with heavy rains from the remnants of Hurricane Fran.
9/13/1996	Flash Flood	Fulton County	N/A	N/A	Thunderstorms dropped up to 8 inches of rain in 4 hours in McConnelsburg, flooding roads across the county. Fifty new and 20 used cars were swept away from Fulton Motors in McConnellsburg. Two homes were destroyed and 80 were damaged.
7/02/1997	Flash Flood	Fulton County	N/A	N/A	Heavy rains flooded roads and small streams in McConnellsburg. A car dealer moved cars to prevent damage.
11/07/1997	Flash Flood	Fulton County	N/A	N/A	Regional impact.
5/01/2003	Flash Flood	Fulton County	N/A	N/A	15,000 in property damage. Heavy rainfall of between 3 and 6 inches within 2 hours produced flash flooding in southern Fulton County. Most of the flooding occurred between the towns of Needmore and Big Cove. Portions of Route 522, Barnett's Run Road, Hess Road, and Gem Bridge Road were closed due to flooding. A significant amount of culvert and road damage occurred on Gem Bridge Road. Between 30 and 35 loads of shale and 150 tons of rock were hauled in for repair to roadways. A mudslide along Route 655 near Quarry Hill required extensive cleanup. One family briefly evacuated their home due to rising water in the yard and basement.
9/08/2004-09/09/2004	Flood	Fulton County	DR-1555	Y	Severe storms and flooding associated with Tropical Depression Frances. Major disaster declaration declared on 09/19/2004 for Individual Assistance.
9/17/2004-10/01/2004	Severe Storms/Flooding	Fulton County	DR-1557	Y	Tropical Depression Ivan. Governor Edward G. Rendell; AS OF 10/19/04 - Presidential - Major Disaster (Individual Assistance and Public Assistance).

Date of Event	Event Type	Location	FEMA Declaration Number (if applicable)	County Designated?	Losses/Impacts
9/9/2004	Flood	Fulton County	N/A	N/A	4½ inches of rainfall at the northern tier of the county to 8 inches in Buck Valley, resulting in road closures, fallen branches, and sporadic telephone interruptions. Roads impacted included SR 484, SR 2004, SR 4008, US 522.
9/17/2004	Flood	Fulton County	N/A	N/A	Regional impact.
9/28/2004	Flood	Fulton County	N/A	N/A	The remnants of Hurricane Jeanne moved northeast along the east slopes of the Appalachians during Tuesday, September 28, eventually moving off the mid-Atlantic Coast by early Tuesday evening. However, a large plume of tropical moisture northwest of the system produced widespread heavy rainfall across south central Pennsylvania during Tuesday, with rainfall amounts of 2 to 4 inches. This rainfall, combined with excessively wet soil and swollen rivers from the remnants of two antecedent tropical systems, produced mainly minor flooding across portions of south central Pennsylvania, with several road closures and some basement flooding reported.
9/17/2004-10/1/2004	Hurricane/Flood	Fulton County	DR-1557	Y	Pennsylvania Tropical Depression Ivan. Eligible for individual and public assistance.
8/29/2005-10/1/2005	Hurricane/Flood	Fulton County	EM-3235	Y	Pennsylvania Hurricane Katrina Evacuation. Eligible for public assistance.
6/2006	Flood	Fulton County	N/A	Y	Governor Edward G. Rendell; Presidential - Major Disaster for Individual Assistance, Public Assistance, and Hazard Mitigation.
3/5/2008	Flood	Fulton County	N/A	N/A	Heavy rain and flooding caused several road closures: - PA 655 N & S of US 30 - Licking Creek Township - Thompson Township - Todd Township Water rescue activated. Area impacted was in Dublin Township.
5/23/2009	Flood	Fulton County	N/A	N/A	Severe weather/flooding—vehicle with two occupants stranded. Area impacted was in Belfast Township and included Pleasant Ridge Rd. (RT 655) 1 mile off Great Cove Rd. (RT 522).
1/25/2010	Flood	Fulton County	N/A	N/A	Heavy rain caused flooding and closed several roads in the county. Route 522 North (Great Cove Road) between Route 30 and Hustontown was closed, along with Route 655. Dublin Mills Road and Witter Road in Taylor Township were also closed.
3/13/2010	Flood	Fulton County	N/A	N/A	Heavy rainfall between 1 and 3 inches combined with snowmelt to produce areal flooding. The flooding closed a portion of Dublin Mills Road along Sideling Hill Creek in the far northern part of the county near the Fulton Huntingdon line.
8/26/2011	Hurricane/Flood	Fulton County	N/A	N/A	Governor's Proclamation for Hurricane Irene. Applicable to entire state (i.e., no specific counties designated).
9/3/2011-10/15/2011	Hurricane/Flood	Fulton County	EM-3340	Y	Remnants of Tropical Storm Lee. Eligible for public assistance.

Date of Event	Event Type	Location	FEMA Declaration Number (if applicable)	County Designated?	Losses/Impacts
10/26/2012	Hurricane/Flood	Fulton County	N/A	N/A	Governor's Proclamation for Hurricane Sandy. Applicable to entire state (i.e., no specific counties designated).
10/26/2012-11/8/2012	Hurricane/Flood	Fulton County	EM-3356/DR-4099	Y	Hurricane Sandy. Eligible for Public Assistance.
06/01/2018	Flash Flood	McConnellsburg	N/A	N/A	Reservoir Road a Cloverleaf Court was flooded and impassable.
06/01/2018	Flash Flood	McConnellsburg	N/A	N/A	Great Cove Creek was out of its banks and flowing over a bridge on Confederate Road.
05/03/2019	Flood	Harrisonville	N/A	N/A	Flooding caused Black Bear Road to be shut down until 06/02/2019.

Sources: NCEI 2019; FEMA 2019

DR *Federal Disaster Declaration*
EM *Emergency Management*
EMA *Emergency Management Agency*
FEMA *Federal Emergency Management Agency*
NCEI *National Centers for Environmental Information*
NOAA *National Oceanic Atmospheric Administration*
N/A *Not applicable/not available*
SBA *Small Business Administration*
US *United States*

Based on review of the CRREL database, Table 4.3.5-4 lists the ice jam events that have occurred in or near the county between 1780 and 2019. Events listed below that occurred outside of the county were included because they were close enough to the county borders to cause possible flooding impacts on Fulton County. Information regarding losses associated with these reported ice jams was limited.

Table 4.3.5-4. Ice Jam Events in Fulton County between 1780 and 2019

City (Additional Geographic Identifier)	River	Jam Date	Water Year	Gage Number	Impact
Needmore (Belfast Township)	Tonoloway Creek	1/5/1990	1990	01613050	Maximum annual gage height of 4.49 feet due to an ice jam reported at USGS gage Tonoloway Creek near Needmore, at 0745 hours on January 5, 1990. Estimated average daily discharge 20 cfs.
Needmore (Belfast Township)	Tonoloway Creek	2/2/1981	1981	01613050	Ice jam reported on February 2, 1982 (average daily discharge 20 cfs compared to 0.7 cfs previous day) and February 11, 1982 (average daily discharge 61 cfs compared to 2.5 cfs previous day) at USGS gage Tonoloway Creek near Needmore. No stages given. Maximum annual gage height of 6.38 feet due to ice jam reported on February 20, with average daily discharge of 181 cfs (compared to 23 cfs previous day).
Needmore (Belfast Township)	Tonoloway Creek	2/13/1971	1971	01613050	The estimated water discharge was 100 cfs. Maximum gage height was 7.37 feet.
Outside Fulton County					
Gapsville (Bedford County)	Brush Creek	2/27/1936	1936	1561000	USGS did not record a gage height on February 27, 1936, on Brush Creek at Gapsville, PA, due to backwater from ice.
Sylvan (Franklin County)	Licking Creek	1/15/40	1940	1613500	Maximum annual gage height of 8.60 feet, affected by backwater from ice, reported at USGS gage Licking Creek near Sylvan, on January 15, 1940.
Three Springs (Huntingdon County)	Aughwick Creek	2/24/1979	1979	1564500	No stage reported, average daily discharge 1340 cfs (140 cfs previous day).
Three Springs (Huntingdon County)	Aughwick Creek	1/22/1959	1959	1564500	Maximum annual gage height of 11.4 feet, affected by backwater from ice, reported at USGS gage Aughwick Creek near Three Springs, on January 22, 1959. Bankfull stage 6 feet. Discharge not determined; maximum for year.
Orbisonia (Huntingdon County)	Aughwick Creek	2/28/1935	1935	1564000	USGS recorded a gage height of 9.2 feet on February 28, 1935 on Augwick Creek near Orbisonia, PA, due to backwater from ice.

Source: USACE 2019

Notes:

Although events were reported for Fulton County, information pertaining to every event was not easily ascertainable; therefore, this table may not list all ice jams in the County.

cfs Cubic feet per second

CRREL Cold Regions Research and Engineering Laboratory

USGS U.S. Geological Survey

4.3.5.4 Future Occurrence

Floods are described in terms of their extent (including the horizontal area affected and the vertical depth of flood waters) and the related probability of occurrence. The NFIP uses historical records to determine the probability of occurrence for different extents of flooding. The probability of occurrence is expressed in percentages as the chance of a flood of a specific extent occurring in any given year.

The NFIP recognizes the 1 percent annual chance flood, also known as the *base flood*, as the standard for identifying properties subject to federal flood insurance purchase requirements. A 1 percent annual chance flood is a flood that has a one percent chance of occurring over a given year. The DFIRMs identify areas subject to the 1 percent and 0.2 percent annual chance flooding. Areas subject to 2 percent and 10 percent annual chance events are not shown on maps; however, water surface elevations associated with these events are included in the flood source profiles contained in the Flood Insurance Study Report. Table 4.3.5-5 shows a range of flood recurrence intervals and associated probabilities of occurrence.

Table 4.3.5-5. Recurrence intervals and associated probabilities of occurrence

Flood Recurrence Interval	Chance of Occurrence in Any Given Year (%)	Flows
5 year	20	Mild
10 year	10	Light
25 year	4	Light to Moderate
50 year	2	Moderate
100 year	1	Heavy to Extreme
500 year	0.2	Extreme

Given the history of flood events that have impacted Fulton County, future flooding events of varying degrees are likely to occur. The fact that the elements required for flooding exist and that major flooding has occurred throughout the county in the past suggests that many people and properties are at risk from the flood hazard in the future.

For the 2019 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of flooding events for Fulton County. Information from NOAA-NCEI storm events database, FEMA, Pennsylvania State Climatologist, and the CRREL ice jam database were used to identify the number of flood events that occurred between 1950 and 2019. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics as well as the annual average number of events and the estimated percent chance of an incident occurring in a given year.

Table 4.3.5-6. Probability of Future Flooding Events

Hazard Type	Number of Occurrences Between 1972 and 2019	Recurrence Interval (in Years) (# Years/Number of Events)	Percent Chance of Occurrence in Any Given Year
Flash Flood	12	4.0	25%
Flood	21	2.2	46%
Ice Jam	3	10.0	10%
Total	36	1.3	75%

Sources: NOAA-NCEI 2019; USACE 2019; Fulton County 2019

It is estimated that Fulton County will continue to experience direct and indirect impacts of flooding events annually that may induce secondary hazards such as infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents, and inconveniences. Therefore, the future occurrence of floods in Fulton County has been adjusted and characterized as *likely*, when taking into consideration flash flooding, as defined by the Risk Factor Methodology probability criteria (see Section 4.4).

4.3.5.5 Vulnerability Assessment

To understand risk, a community must evaluate the assets exposed and vulnerable within the identified hazard area. For the flood hazard, the 1- and 0.2-percent annual chance flood events were examined. The following section discusses potential flood impacts, including:

- Impacts on (1) life, health, and safety; (2) general building stock and critical facilities; (3) the economy; (4) the environment; and (5) future growth and development
- Effect of climate change on vulnerability
- Further data collections that will assist in understanding this hazard over time.

The 1- and 0.2-percent annual chance flood events were examined to evaluate Fulton County's flood risk. Polygons representing the 1- and 0.2-percent annual chance events from the FEMA Risk Map products dated February 18, 2011, were used to estimate exposure. Figure 4.3.5-3 presented earlier in this section illustrates the flood boundaries used for the vulnerability assessment. The 1-percent annual chance flood depth grid generated for the FEMA Risk Map program was imported into FEMA's HAZUS-MH v4.2 riverine flood model to estimate potential losses.

Impact on Life, Health, and Safety

Impacts of flooding on life, health, and safety depend on several factors, including severity of the event and whether adequate warning time is provided to residents. Assumedly, the population living in or near floodplain areas that could be impacted by a flood would be exposed. However, exposure should not be limited only to those who reside within a defined hazard zone, but everyone who may be affected by a hazard event (e.g., people are at risk while traveling in flooded areas, or their access to emergency services is compromised during an event); the degree of that impact varies and is not strictly measurable.

In order to estimate the number of exposed individuals to the hazard, the total population for each municipality was divided by the number of residential buildings to establish an average population per residential structure that intersects the FEMA delineated floodplain. Table 4.3.5-7 lists the estimated population located within the 1 percent annual chance flood zone by municipality. Use of this approach resulted in an estimate of 114 people within the 1 percent annual chance floodplain (1.8%), and 114 people within the 0.2 percent annual chance floodplain. The 0.2 percent annual chance floodplain is a relatively small area and does not intersect with any structures. Limitations of these analyses are recognized, and thus results are used only to provide a general estimate.

Table 4.3.5-7. Estimated Fulton County Population Exposed to the 1 percent and 0.2 percent Flood Hazard (2010 Census)

Municipality	U.S. Census 2010 Population	Estimated Population Exposed			
		1-percent Annual Chance Flood*	% of Total	0.2-percent Annual Chance Flood*	% of Total
Ayr Township	1,942	18	0.9%	18	0.9%
Belfast Township	1,448	8	0.6%	8	0.6%
Bethel Township	1,508	6	0.4%	6	0.4%
Brush Creek Township	819	5	0.6%	5	0.6%
Dublin Township	1,264	9	0.7%	9	0.7%
Licking Creek Township	1,703	33	1.9%	33	1.9%
McConnellsburg Borough	1,220	6	0.5%	6	0.5%
Taylor Township	1,118	12	1.1%	12	1.1%
Thompson Township	1,098	0	0.0%	0	0.0%
Todd Township	1,527	1	0.1%	1	0.1%
Union Township	706	0	0.0%	0	0.0%
Valley-Hi Borough	15	0	0.0%	0	0.0%
Wells Township	477	16	3.3%	16	3.3%
Fulton County	**14,845**	**114**	**0.8%**	**114**	**0.8%**

Sources: U.S. Census 2010, FEMA 2011
Note: % Percent
** Estimated population exposed is calculated by the total population for each municipality was divided by the number of residential buildings to establish an average population per residential structure which intersects the FEMA delineated floodplain. Limitations of these analyses are recognized, and thus results are used only to provide a general estimate.*

The table above shows that less than 1 percent of the total county population is exposed to the 1 percent annual chance flood event, and the 0.2 percent annual chance flood event. Licking Creek Township has the largest portion of its population within the 1 and 0.2 percent annual chance event floodplains—1.9 percent of the population. For this HMP, potential population exposed is used as a guide for planning purposes.

Of the population exposed, the most vulnerable include the economically disadvantaged and the population over the age of 65. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on net economic impact on their families. The population over the age of 65 is also more vulnerable because they are more likely to seek or need medical attention that may not be available because of isolation during a flood event, and they may have more difficulty evacuating.

Using 2010 U.S. Census data, HAZUS-MH v4.2 estimates potential sheltering needs based on a 1 percent annual chance flood event. During the 1 percent flood event, HAZUS-MH v4.2 estimates 586 people will be displaced, and 0 people will seek short-term sheltering, representing less than 1 percent of the Fulton County population seeking short-term shelter. These statistics, by municipality, are listed in Table 4.3.5-8. The estimated displaced population and number of persons seeking short-term sheltering differ from the number of persons exposed to the 1 percent annual chance flood. The Flood Technical Manual for HAZUS 4.2 explains the assumptions made for the displacement and sheltering values generated through the flood model: “Because the Flood Model does not address flooding, such as flash flooding or long-duration flooding, HAZUS assumes that the local authorities

will have time to alert the residents and evacuate directly from the areas that will flood. This means any portion of a census block that is flooded initially is assumed to have all of the residents removed from the area. Ultimately, the level of damage within the General Building Stock (GBS) and the characteristics of the population will determine how many people require short-term sheltering (FEMA, 2018)." This methodology may overestimate the number of displaced populations. Limitations of these analyses are recognized, and thus results are used only to provide a general estimate.

Table 4.3.5-8. Estimated Population Displaced or Seeking Short-Term Shelter from the 1 percent Annual Chance Flood Event

Municipality	U.S. Census 2010 Population	1-Percent Annual Chance Event	
		Displaced Population*	Persons Seeking Short-Term Sheltering
Ayr Township	1,942	72	0
Belfast Township	1,448	83	0
Bethel Township	1,508	29	0
Brush Creek Township	819	16	0
Dublin Township	1,264	67	0
Licking Creek Township	1,703	145	0
McConnellsburg Borough	1,220	7	0
Taylor Township	1,118	30	0
Thompson Township	1,098	89	0
Todd Township	1,527	22	0
Union Township	706	5	0
Valley-Hi Borough*	15	0	0
Wells Township	477	21	0
Fulton County	**14,845**	**586**	**0**

Source: HAZUS-MH v4.2
**Note: The population displaced and seeking shelter was calculated using 2010 U.S. Census data, which is the default demographic database for HAZUS-MH v4.2. If a flood hazard area intersects any portion of a census block, it is assumed that local authorities will have time to alert and residents and evacuate directly from the areas that will flood. This means any portion of a census block that is flooded initially is assumed to have all of the residents removed from the area.*

Total number of injuries and casualties resulting from typical riverine flooding is generally limited because of advance weather forecasting, blockades, and warnings. Therefore, injuries and deaths generally are not anticipated if proper warning occurs and precautions are in place. Warning time for flash flooding is often limited. Flash flood events are frequently associated with other natural hazard events such as earthquakes, landslides, or severe weather, which limits their predictability and compounds the hazard. Populations without adequate warning of the event are highly vulnerable to this hazard. Ongoing mitigation efforts should help to avoid the most likely cause of injury—persons trying to cross flooded roadways or channels. Mitigation action items addressing this issue are included in Section 6 (Mitigation Strategies) of this plan.

Cascading impacts may also include exposure to pathogens such as mold. After flood events, excess moisture and standing water contribute to growth of mold in buildings. Mold may present a health risk to building occupants, especially those with already compromised immune systems such as infants, children, the elderly, and pregnant women. The degree of impact will vary and is not strictly measurable. Molds can grow in as short

a period as 24-48 hours in wet and damaged areas of buildings that have not been properly cleaned. Very small mold spores can easily be inhaled, creating potential for allergic reactions, asthma episodes, and other respiratory problems. Buildings should be properly cleaned and dried out to safely prevent mold growth (Centers for Disease Control and Prevention [CDC] 2015).

Molds and mildews are not the only public health risk associated with flooding. Flood waters can be contaminated by pollutants such as sewage, human and animal feces, pesticides, fertilizers, oil, asbestos, and rusting building materials. Common public health risks associated with flood events also include:

- Unsafe food
- Contaminated drinking and washing water and poor sanitation
- Mosquitos and animals
- Carbon monoxide poisoning
- Secondary hazards associated with re-entering/cleaning flooded structures
- Mental stress and fatigue.

Current loss estimation models such as HAZUS-MH are not equipped to measure public health impacts. The best level of mitigation for these impacts is to be aware that they can occur, educate the public on prevention, and be prepared to deal with these vulnerabilities in responding to flood events.

Impact on General Building Stock

After consideration of the population exposed and vulnerable to the flood hazard, the built environment was evaluated. Exposure to the flood hazard includes those buildings within the flood zone. Potential damage is the modeled loss that could occur to the exposed inventory, including structural and content value.

To estimate replacement cost value exposure and number of structures in the hazard area, default dasymetric building stock data from HAZUS-MH v4.2 and the building footprint layer from the county were used. Replacement cost values of the dasymetric Census blocks with their centroids in the floodplain were totaled. Table 4.3.5-9 lists building stock exposure per municipality, Table 4.3.5-10 lists building stock exposure by watershed, and Table 4.3.5-11 lists building stock potential loss to the 1 percent annual chance flood event.

In total, 93 structures, or 1.1 percent of the building stock, are within the 1 and 0.2 percent annual chance flood zones. Approximately $63 million of building/contents are within the 1 and 0.2 percent annual chance flood zones in Fulton County. This represents approximately 2.8 percent of the county's total general building stock replacement value inventory ($2.2 billion).

Potential damage estimated to the Fulton County general building stock inventory associated with the 1 percent annual chance flood exceeds $16 million. Estimated building stock potential loss estimates per municipality are listed in Table 4.3.5-11

Table 4.3.5-9. Estimated General Building Stock Exposure to the 1 Percent Annual Chance Flood Event

Municipality	Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed							
			Number of Buildings - 1-percent Annual Chance Flood	% of Total	RCV - 1-percent Annual Chance Flood	% of Total	Number of Buildings - 0.2-percent Annual Chance Flood	% of Total	RCV - 0.2-percent Annual Chance Flood	% of Total
Ayr Township	1,139	328,056,000	13	1.1%	$3,427,000	1.0%	13	1.1%	$3,427,000	1.0%
Belfast Township	740	181,485,000	7	0.9%	$8,024,000	4.4%	7	0.9%	$8,024,000	4.4%
Bethel Township	853	243,010,000	9	1.1%	$21,466,000	8.8%	9	1.1%	$21,466,000	8.8%
Brush Creek Township	519	110,481,000	4	0.8%	$2,226,000	2.0%	4	0.8%	$2,226,000	2.0%
Dublin Township	697	153,284,000	7	1.0%	$3,377,000	2.2%	7	1.0%	$3,377,000	2.2%
Licking Creek Township	881	203,625,000	19	2.2%	$7,709,000	3.8%	19	2.2%	$7,709,000	3.8%
McConnellsburg Borough	538	276,419,000	4	0.7%	$0	0.0%	4	0.7%	$0	0.0%
Taylor Township	697	141,644,000	16	2.3%	$4,002,000	2.8%	16	2.3%	$4,002,000	2.8%
Thompson Township	572	155,461,000	0	0.0%	$12,207,000	7.9%	0	0.0%	$12,207,000	7.9%
Todd Township	858	298,975,000	3	0.3%	$942,000	0.3%	3	0.3%	$942,000	0.3%
Union Township	421	106,265,000	1	0.2%	$0	0.0%	1	0.2%	$0	0.0%
Valley-Hi Borough	29	5,827,000	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Wells Township	292	58,946,000	10	3.4%	$0	0.0%	10	3.4%	$0	0.0%
Fulton County	**8,236**	**2,263,478,000**	**93**	**1.1%**	**63,380,000**	**2.8%**	**93**	**1.1%**	**$63,380,000**	**2.8%**

Source: HAZUS-MH v4.2; FEMA 2011
Notes:
% Percent
RCV Replacement cost value (structure and contents)

Table 4.3.5-10. Estimated General Building Stock Exposure by Watershed to the 1 Percent and 0.2 Percent Annual Chance Flood Events

Watershed	Total Number of Buildings	1% Annual Chance Flood Boundary		0.2% Annual Chance Flood Boundary	
		Number of Buildings	% of Total	Number of Buildings	% of Total
Aughwick Creek	498	9	1.8%	9	1.8%
Brush Creek	359	3	<1%	3	<1%
Cove Creek	2196	18	<1%	18	<1%
Great Trough Creek	5	0	<1%	0	<1%
Licking Creek	1833	20	1.1%	20	1.1%
Little Tonoloway Creek	918	9	<1%	9	<1%
Potomac River	459	2	<1%	2	<1%
Sideling Hill Creek	487	25	5.1%	25	5.1%
Tenoloway Creek	61	0	<1%	0	<1%
Tonoloway Creek	1019	6	<1%	6	<1%
West Branch Conococheague Creek	21	0	<1%	0	<1%
Wooden Bridge Creek	380	1	<1%	1	<1%
Fulton County (Total)	**8236**	**93**	**1.1%**	**93**	**1.1%**

Source: FEMA 2011, ERRI 2014

Table 4.3.5-11. Estimated General Building Stock Potential Loss to the 1 Percent Annual Chance Flood Event

Municipality	Total Replacement Cost Value	All Occupancies		Residential		Commercial		Agricultural, Industrial, Religious, Education, and Government	
		Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total
Ayr Township	$328,056,000	$1,221,000	0.4%	$1,067,000	0.3%	$19,000	0.0%	$135,000	0.0%
Belfast Township	$181,485,000	$2,114,000	1.2%	$1,178,000	0.6%	$523,000	0.3%	$413,000	0.2%
Bethel Township	$243,010,000	$1,745,000	0.7%	$533,000	0.2%	$582,000	0.2%	$630,000	0.3%
Brush Creek Township	$110,481,000	$393,000	0.4%	$266,000	0.2%	$42,000	0.0%	$85,000	0.1%
Dublin Township	$153,284,000	$1,452,000	0.9%	$830,000	0.5%	$227,000	0.1%	$395,000	0.3%
Licking Creek Township	$203,625,000	$3,066,000	1.5%	$1,962,000	1.0%	$912,000	0.4%	$192,000	0.1%
McConnellsburg Borough	$276,419,000	$92,000	0.0%	$27,000	0.0%	$47,000	0.0%	$18,000	0.0%
Taylor Township	$141,644,000	$1,362,000	1.0%	$576,000	0.4%	$684,000	0.5%	$102,000	0.1%
Thompson Township	$155,461,000	$3,517,000	2.3%	$3,002,000	1.9%	$350,000	0.2%	$165,000	0.1%
Todd Township	$298,975,000	$571,000	0.2%	$135,000	0.0%	$66,000	0.0%	$370,000	0.1%
Union Township	$106,265,000	$222,000	0.2%	$222,000	0.2%	$0	0.0%	$0	0.0%
Valley-Hi Borough	$5,827,000	$1,000	0.0%	$1,000	0.0%	$0	0.0%	$0	0.0%
Wells Township	$58,946,000	$317,000	0.5%	$210,000	0.4%	$2,000	0.0%	$105,000	0.2%
Fulton County	**$2,263,478,000**	**$16,073,000**	**0.7%**	**$10,009,000**	**0.4%**	**$3,454,000**	**0.2%**	**$2,610,000**	**0.1%**

Source: HAZUS-MH v4.2
Note: % Percent

NFIP Statistics

In addition to total building stock modeling, individual data available regarding flood policies, claims, repetitive loss (RL) properties, and severe repetitive loss (SRL) properties were analyzed. According to Section 1361A of the National Flood Insurance Act (NFIA), as amended, 42 *United States Code* (U.S.C.) 4102a, the definition of an SRL property is a residential property covered by an NFIP flood insurance policy, and for which at least one of the following sets of claim payments have occurred:

- At least four NFIP claim payments (including building and contents) over $5,000 each, with the cumulative amount of these claims payments exceeding $20,000
- At least two separate claims payments (building payments only), with the cumulative amount of the building portion of these claims payments exceeding the market value of the building

Moreover, for both of the above, at least two of the referenced claims must have occurred within any 10-year period and must have been submitted separately on dates more than 10 days apart.

An RL property is defined by FEMA's Flood Mitigation Assistance (FMA) Program as an NFIP-insured structure that incurred flood-related damage on two occasions, and for which the cost of repair equaled or exceeded 25 percent of the market value of the structure at the time of each such flood.

Fulton County has 1 RL property throughout the county. Table 4.3.5-12 summarizes NFIP policies and claims for Fulton County.

Table 4.3.5-12. NFIP Policies, Claims, and Repetitive Loss Statistics

Municipality	# Policies (1)	# Claims (Losses) (1)	# Repetitive Loss Properties (1)	Total Loss Payments (2)
Ayr Township	9	0	0	$0
Belfast Township	7	0	0	$0
Bethel Township	2	0	0	$0
Dublin Township	3	0	0	$0
Licking Creek Township	8	6	1	$125,427
McConnellsburg Borough	1	0	0	$0
Taylor Township	1	4	0	108,623
Thompson Township	1	0	0	$0
Wells Township	2	4	0	22,882
Fulton County	34	14	1	$282,492.26

Source: FEMA 2018, FEMA 2019
Notes:
(1) Policies, claims, RL, and SRL statistics provided by FEMA, and are current as of February 28, 2019. Communities with SRL properties are noted in the column. The number of claims represents claims closed by September 11, 2019.
(2) Total building and content loss information was collected from the claims file provided by FEMA: http://bsa.nfipstat.fema.gov/reports/1040.htm#42.

Impact on Critical Facilities

Critical services during and after a flood event may not be available if critical facility structures are directly damaged or transportation routes to access these critical facilities are impacted. Roads that are blocked or damaged can isolate residents and can prevent access throughout the planning area, including for emergency

service providers needing to get to vulnerable populations or to make repairs. Major roadways that may be impacted by the 1-percent annual chance flood event include I-70, I-76 US-30, US-522 PA-26, PA-643, PA-731, PA-913, PA-915, and PA-928. Bridges washed out or blocked by floods or debris also can cause isolation. Water and sewer systems can be flooded or backed up, causing health problems. Floodwaters can get into drinking water supplies, causing contamination. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers, and streams. Table 4.3.5-13 lists critical facilities and utilities within the 1 percent annual chance flood boundary. There are no critical facilities located within the 0.2 percent annual chance flood boundary in Fulton County.

Table 4.3.5-13. Critical Facilities and Utilities Within the 1 percent Annual Chance Flood Boundary

Municipality	Facility Types						
	Communication	Dam	Hazmat	Post Office	Potable Water	Substation	Wastewater Pump
Ayr Township	0	0	0	0	0	0	0
Belfast Township	0	0	0	0	1	0	0
Bethel Township	1	0	0	0	0	0	1
Brush Creek Township	0	0	0	0	0	0	0
Dublin Township	0	1	0	0	0	0	0
Licking Creek Township	0	0	1	0	0	1	0
Mcconnellsburg Borough	0	0	0	0	0	0	0
Taylor Township	0	0	0	2	0	1	0
Thompson Township	0	0	0	0	0	0	0
Todd Township	0	0	0	0	0	0	0
Union Township	0	0	0	0	0	0	0
Valley-Hi Borough	0	0	0	0	0	0	0
Wells Township	0	0	0	0	0	0	0
Fulton County	**1**	**1**	**1**	**2**	**1**	**2**	**1**

Source: Fulton County 2019, FEMA 2011

Impact on the Economy

Flood events can significantly impact the local and regional economy. This includes but is not limited to building damages and associated tax loss, impacts to utilities and infrastructure, agricultural losses, business interruption, and effects on tourism. In areas that are directly flooded, commercial and industrial building repairs/renovations may be necessary, disrupting associated services.

Flooding can cause extensive damage to public utilities and disruptions to delivery of services. Loss of power and communications may occur, and drinking water and wastewater treatment facilities may be temporarily out of operation. As presented above, several critical facilities and utilities are exposed and potentially vulnerable to the 1- and 0.-2 percent annual chance flood events.

Debris management may also be a large expense after a flood event. HAZUS-MH v4.2 estimates the amount of debris generated during a flood event. The model breaks down debris into three categories: (1) finishes (dry wall, insulation, etc.), (2) structural (wood, brick, etc.), and (3) foundations (concrete slab and block, rebar, etc.). These distinctions are necessary because of the different types of equipment needed to handle debris. Table 4.3.5-14 summarizes the debris estimates to result from a 1-percent annual chance flood event. Notably, this table lists estimated debris generated by riverine flooding only and does not include additional potential damage and debris possibly generated by force of wind that may be associated with storm events that cause flooding.

Table 4.3.5-14. Estimated Debris Generated from the 1 Percent Annual Chance Flood Event

Municipality	1% Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Ayr Township	79	56	9	14
Belfast Township	141	86	23	32
Bethel Township	90	47	20	23
Brush Creek Township	34	21	5	8
Dublin Township	123	67	23	33
Licking Creek Township	195	130	27	38
McConnellsburg Borough	4	3	0	0
Taylor Township	74	48	10	15
Thompson Township	374	179	108	88
Todd Township	9	5	1	3
Union Township	30	12	9	9
Valley-Hi Borough	0	0	0	0
Wells Township	28	16	6	7
Fulton County	**1,180**	**670**	**240**	**269**

Source: HAZUS-MH v4.2

Impact on the Environment

As discussed, floodplains serve beneficial and natural functions on ecological/environmental, social, and economic levels. Areas in the floodplain that typically provide these natural functions and benefits are wetlands, riparian areas, sensitive areas, and habitats for rare and endangered species. To determine the exposure of natural and beneficial land in Fulton County to the flood hazard, the acreage of wetlands and forested land were calculated. To determine exposure of natural and beneficial land in Fulton County to the flood hazard, acreages of wetlands and forested land were calculated. Table 4.3.5-15 lists the results of these calculations.

Table 4.3.5-15. Area of Natural and Beneficial Land Within the Floodplain

Wetlands	Area in the 1 percent Annual Chance Floodplain (Square Miles)	Area in the 0.2 percent Annual Chance Floodplain (Square Miles)
Wetlands	0.57	0.57
Forest	229.4	229.4

Sources: USGS National Land Cover Data (NLCD) 2019, FEMA 2011

Flooding can cause a wide range of environmental impacts, including but not limited to erosion and loss of vegetation and habitats. These impacts, in turn, may lead to decreased protection of the waterbody from adjacent land uses and to degraded water quality. Moreover, floods may generate large amounts of tree and construction debris, disperse household hazardous waste into the fluvial system, and contaminate water supplies and wildlife habitats with extremely toxic substances. Long-duration floods could exacerbate environmental problems because cleanup likely would be delayed and contaminants could remain in the environment for a longer period of time. Cleanup after a flood raises additional environmental concerns. The volume of debris to be collected, the extent to which public utilities (water supply systems and sewer operations) have been damaged, and the quantity of agricultural and industrial pollutants entering water bodies might present additional issues (Montz and Tobin 1997, Rubin 2013).

Future Growth and Development

As discussed in Section 2.4, areas targeted for future growth and development have been identified across the county. Any areas of growth could be impacted by the flood hazard if within identified hazard areas. The county intends to discourage development within vulnerable areas and to encourage higher regulatory standards on the local level.

Effect of Climate Change on Vulnerability

As discussed earlier, annual precipitation amounts in the region are projected to increase, primarily in the form of heavy rainfalls, which have the potential to affect drinking water, increase the risk to flash flooding and riverine flooding, and flood critical transportation corridors and infrastructure. Increases in precipitation may alter and expand the floodplain boundaries and runoff patterns, resulting in populations, buildings, and critical facilities and infrastructure that were previously outside the floodplain. This increase in exposure would result in an increased risk to life and health, an increase in structural losses, a diversion of additional resources to response and recovery efforts, and an increase in business closures affected by future flooding events due to loss of service or access.

Additional Data and Next Steps

A HAZUS-MH riverine flood analysis of Fulton County was based on the most current and best available data, including building and critical facility inventories, and FEMA DFIRM. For future plan updates, more accurate exposure and loss estimates may be produced by updating the default general building stock inventory in HAZUS-MH with a countywide inventory based on countywide available footprints and associated building attributes, and conducting the loss estimates at the structure level.

Section 6 (Mitigation Strategy) of this HMP includes discussions of specific mitigation actions addressing improved data collection, and further vulnerability analysis.

Figure 4.3.5-4. Ayr Township Municipal Flood Map

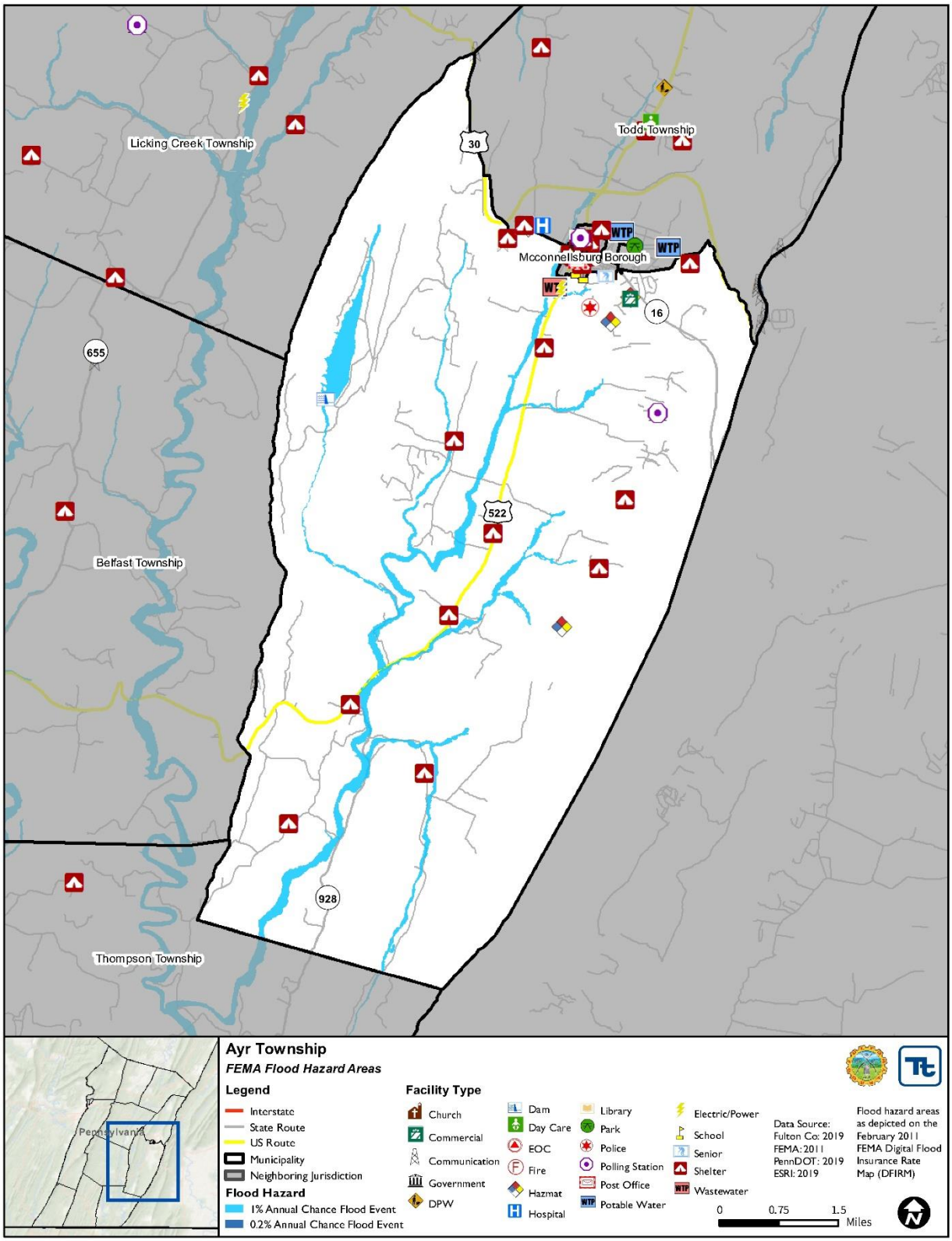


Figure 4.3.5-5. Belfast Township Municipal Flood Map

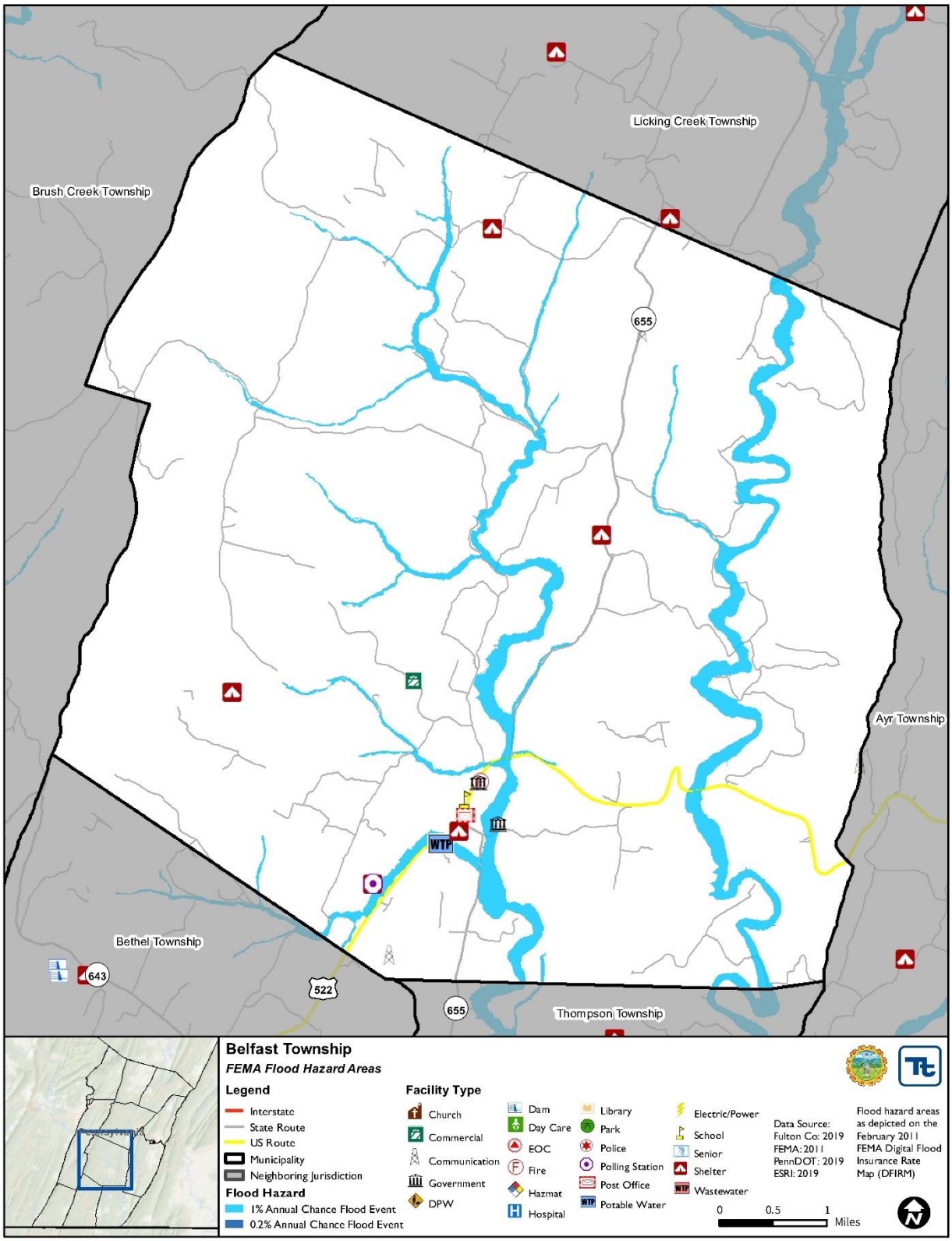


Figure 4.3.5-6. Bethel Township Municipal Flood Map

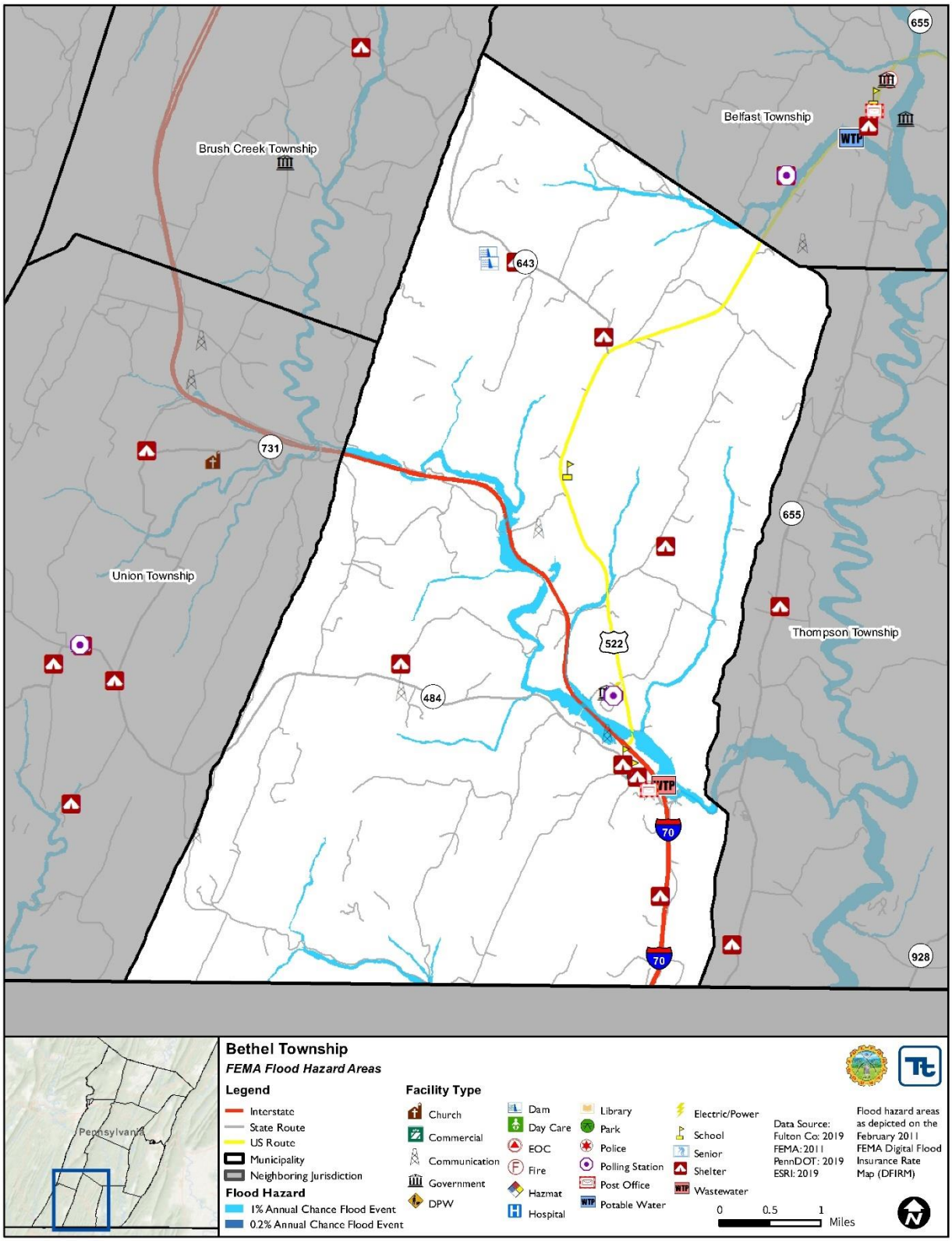


Figure 4.3.5-7. Brush Creek Township Municipal Flood Map

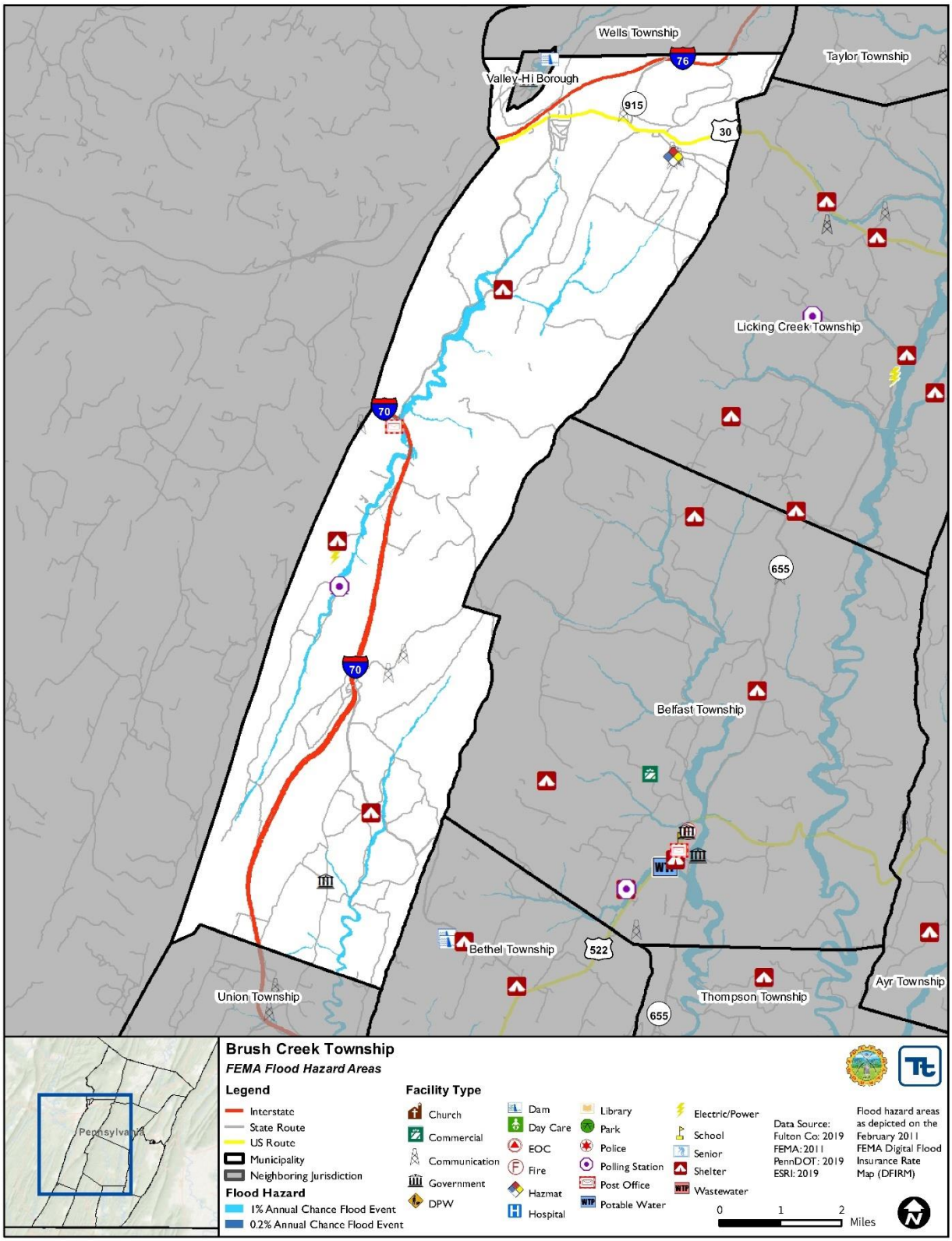


Figure 4.3.5-8. Dublin Township Municipal Flood Map

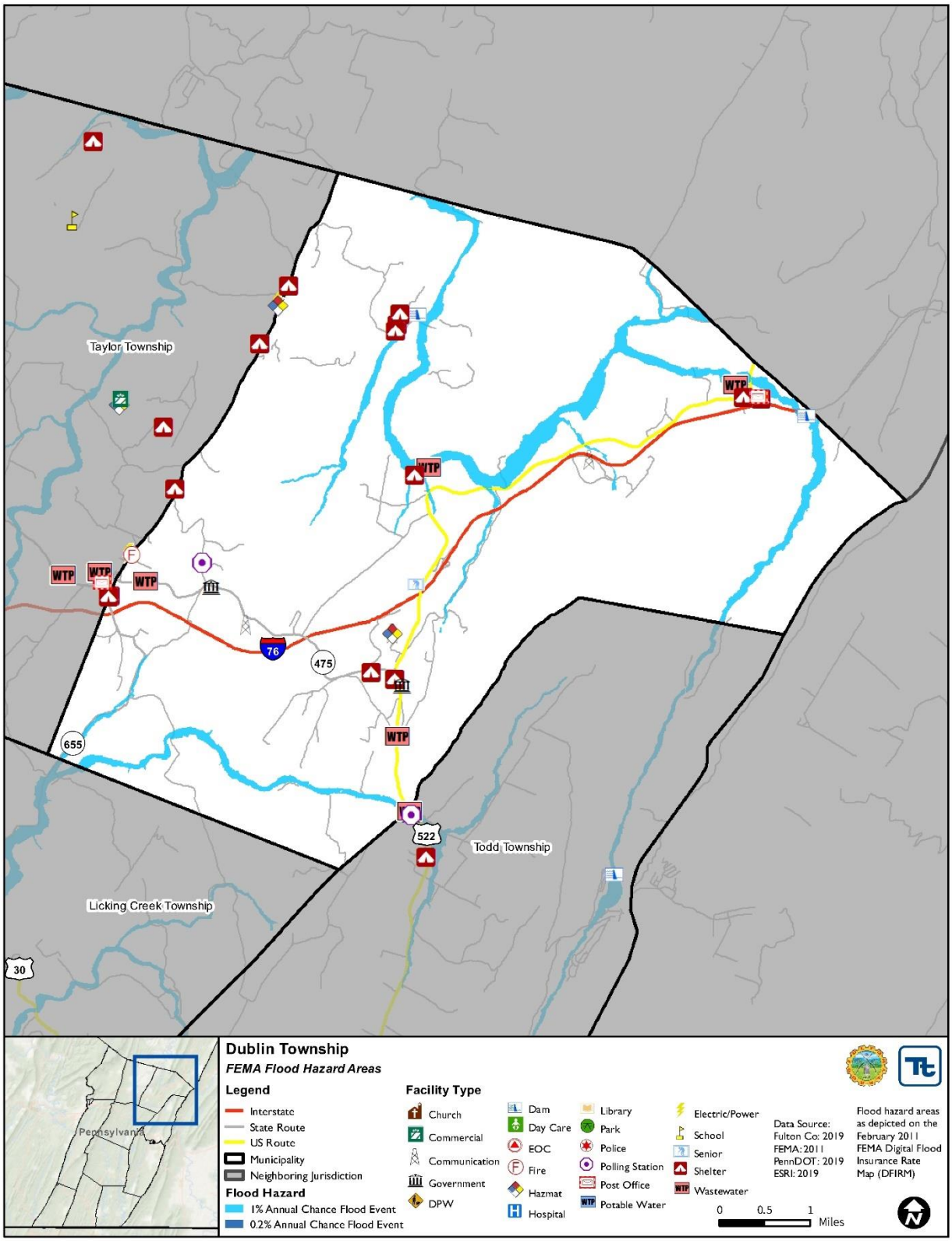


Figure 4.3.5-9. Licking Creek Township Municipal Flood Map

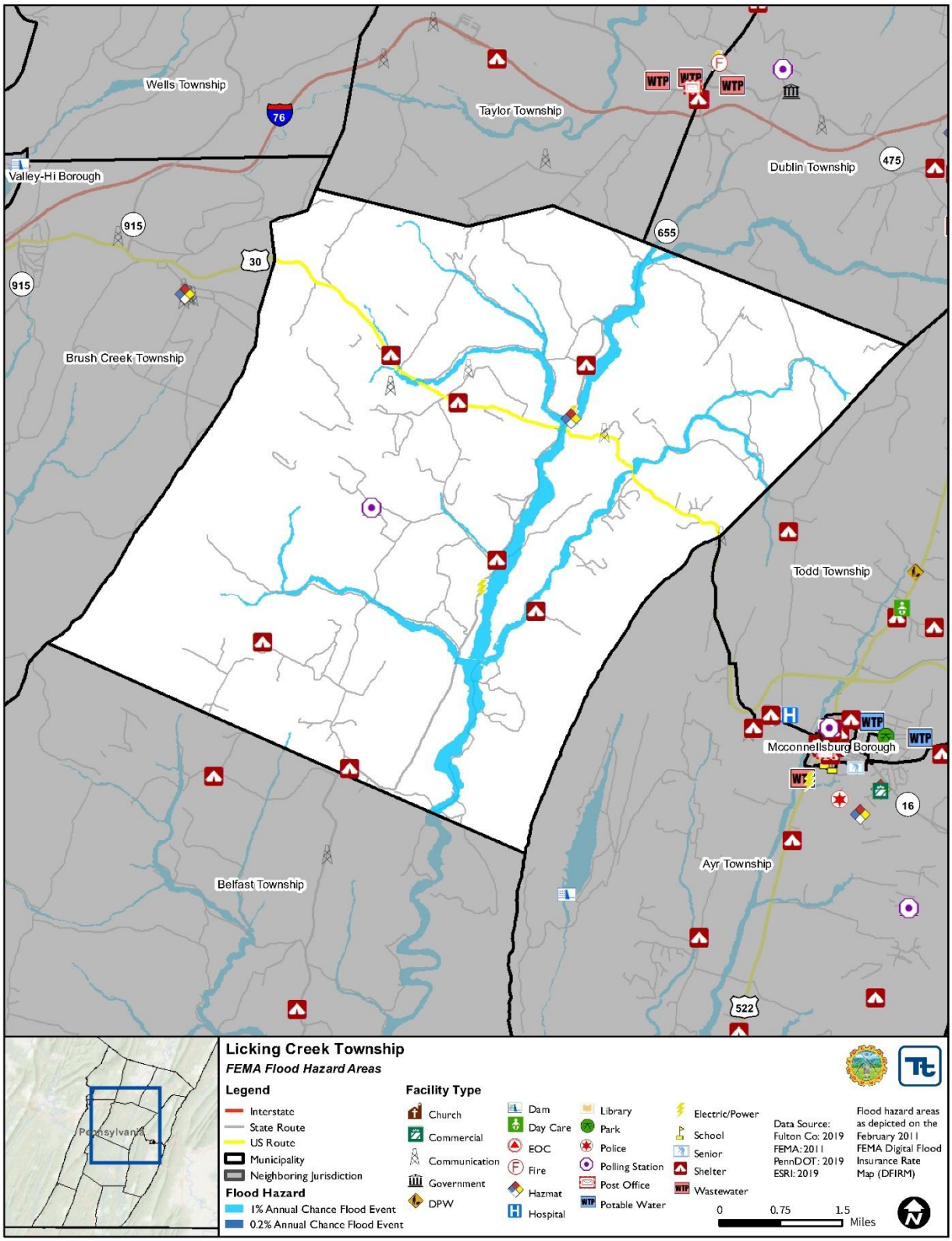


Figure 4.3.5-10. McConnellsburg Borough Municipal Flood Map

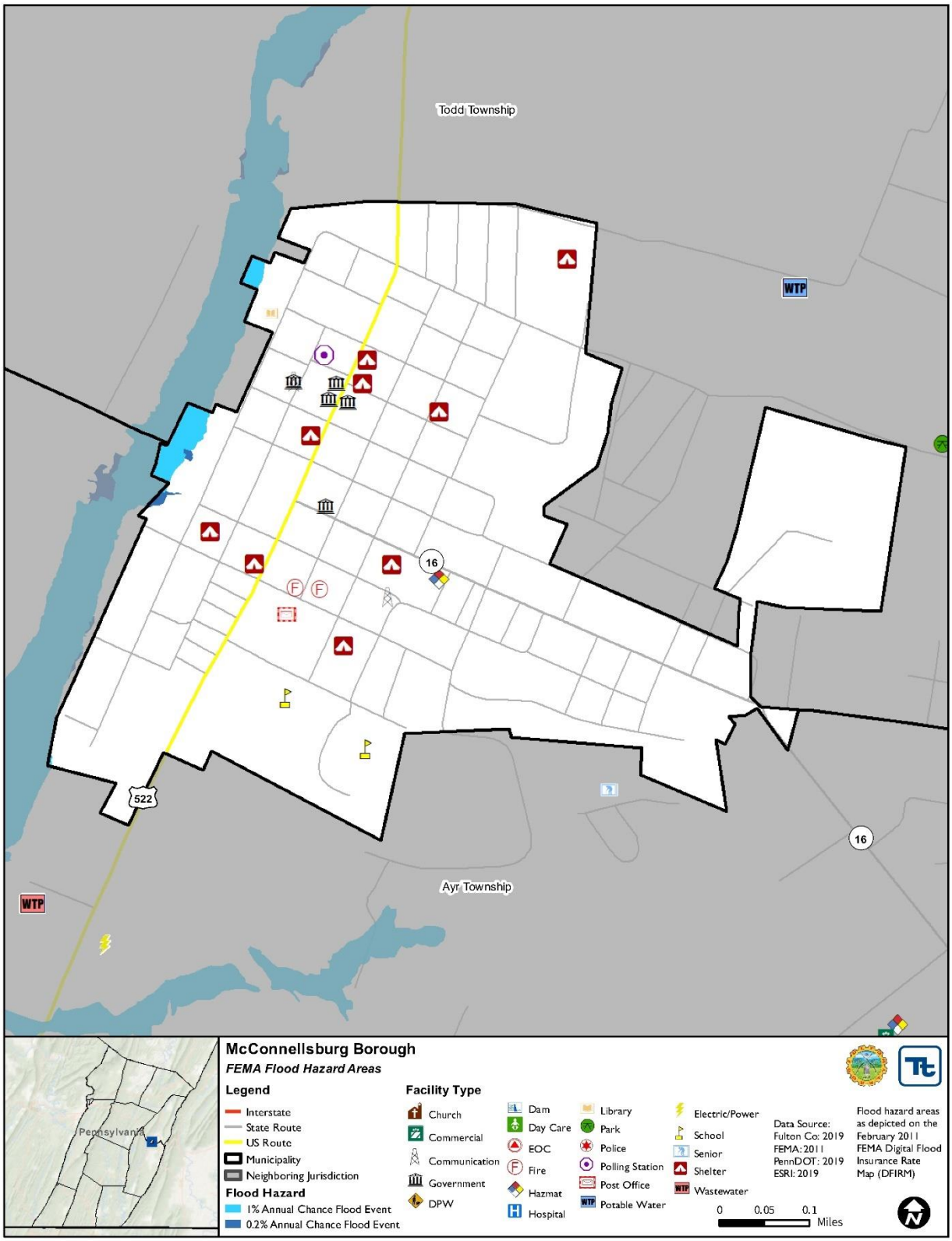


Figure 4.3.5-11. Taylor Township Municipal Flood Map

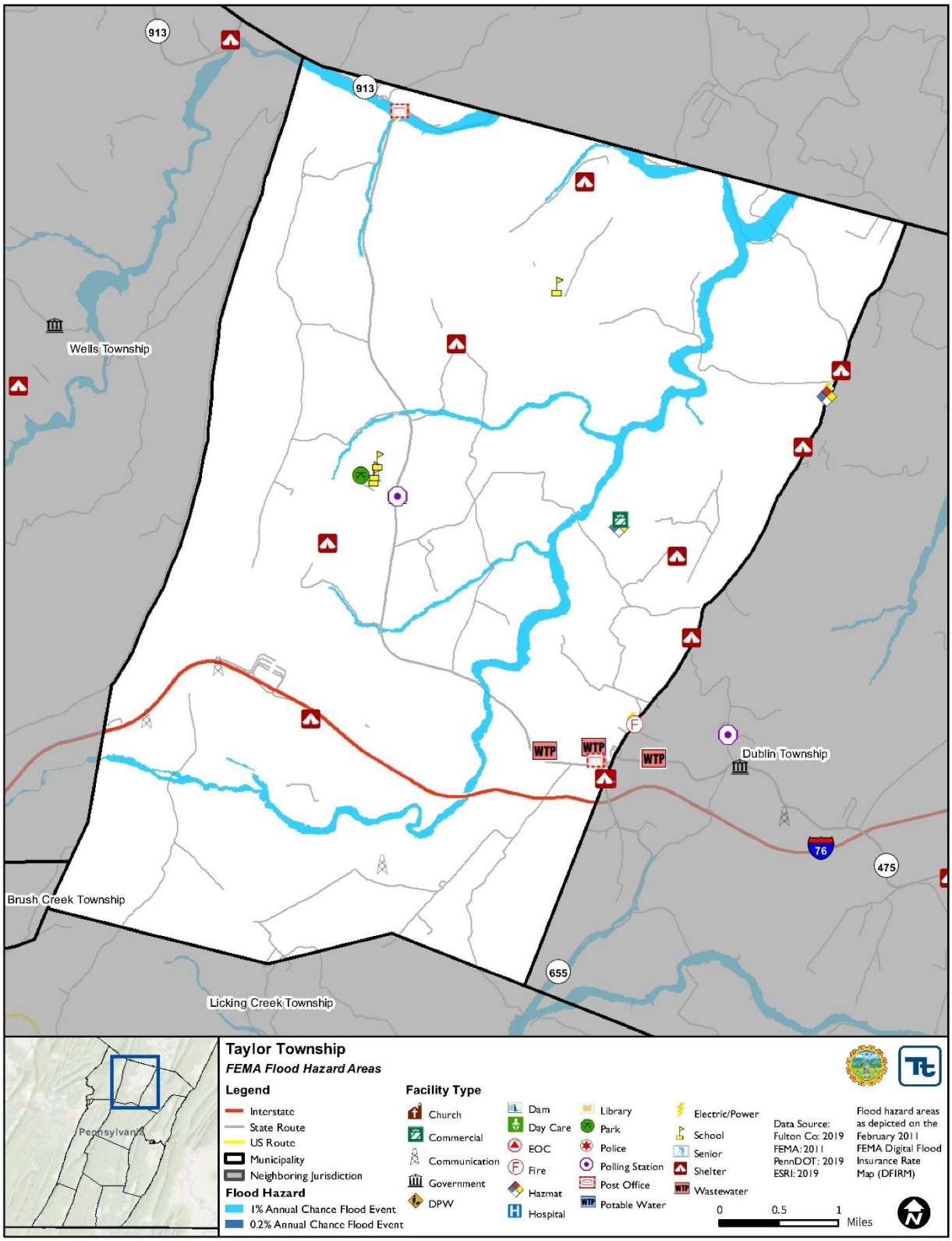


Figure 4.3.5-12. Thompson Township Municipal Flood Map

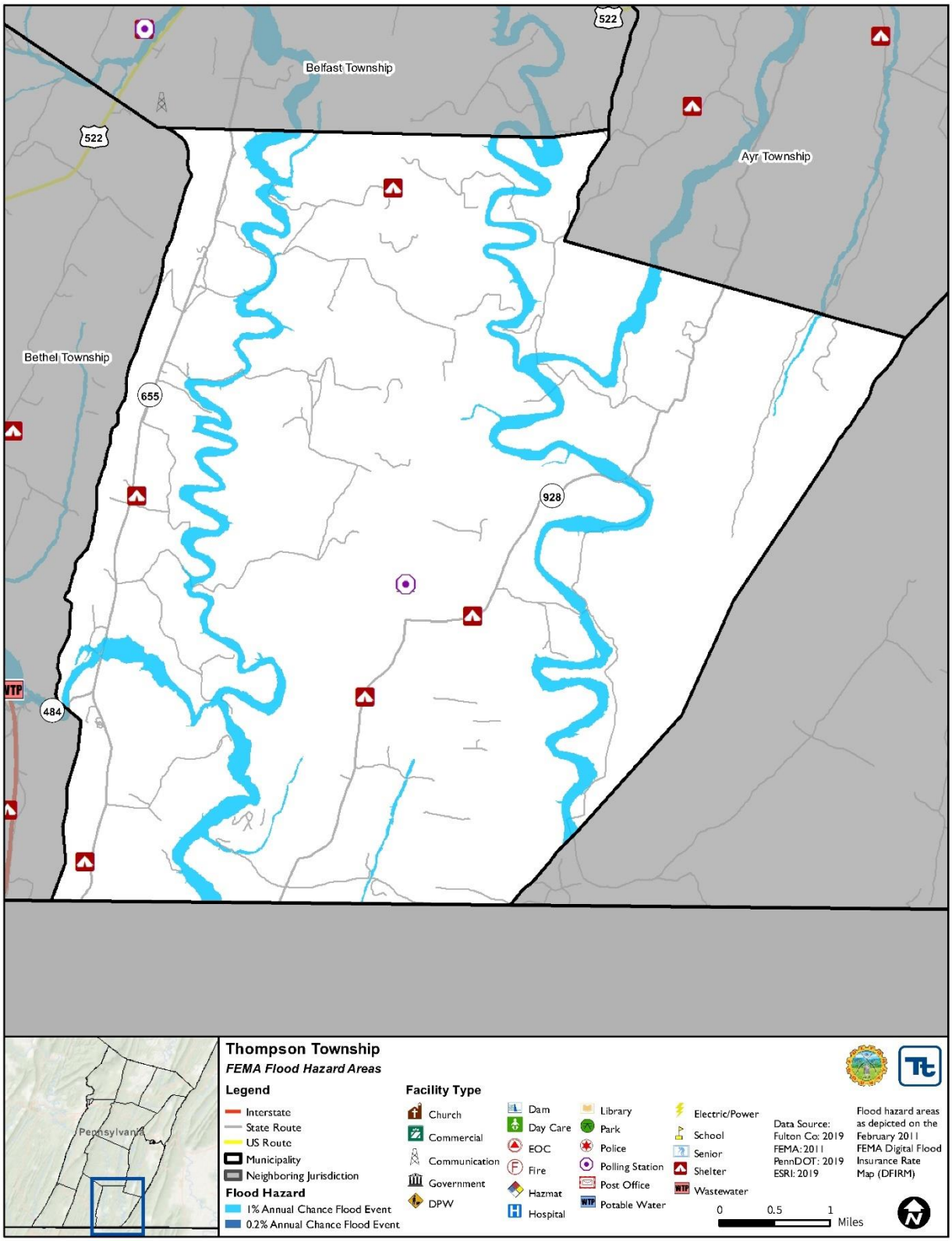


Figure 4.3.5-13. Todd Township Municipal Flood Map

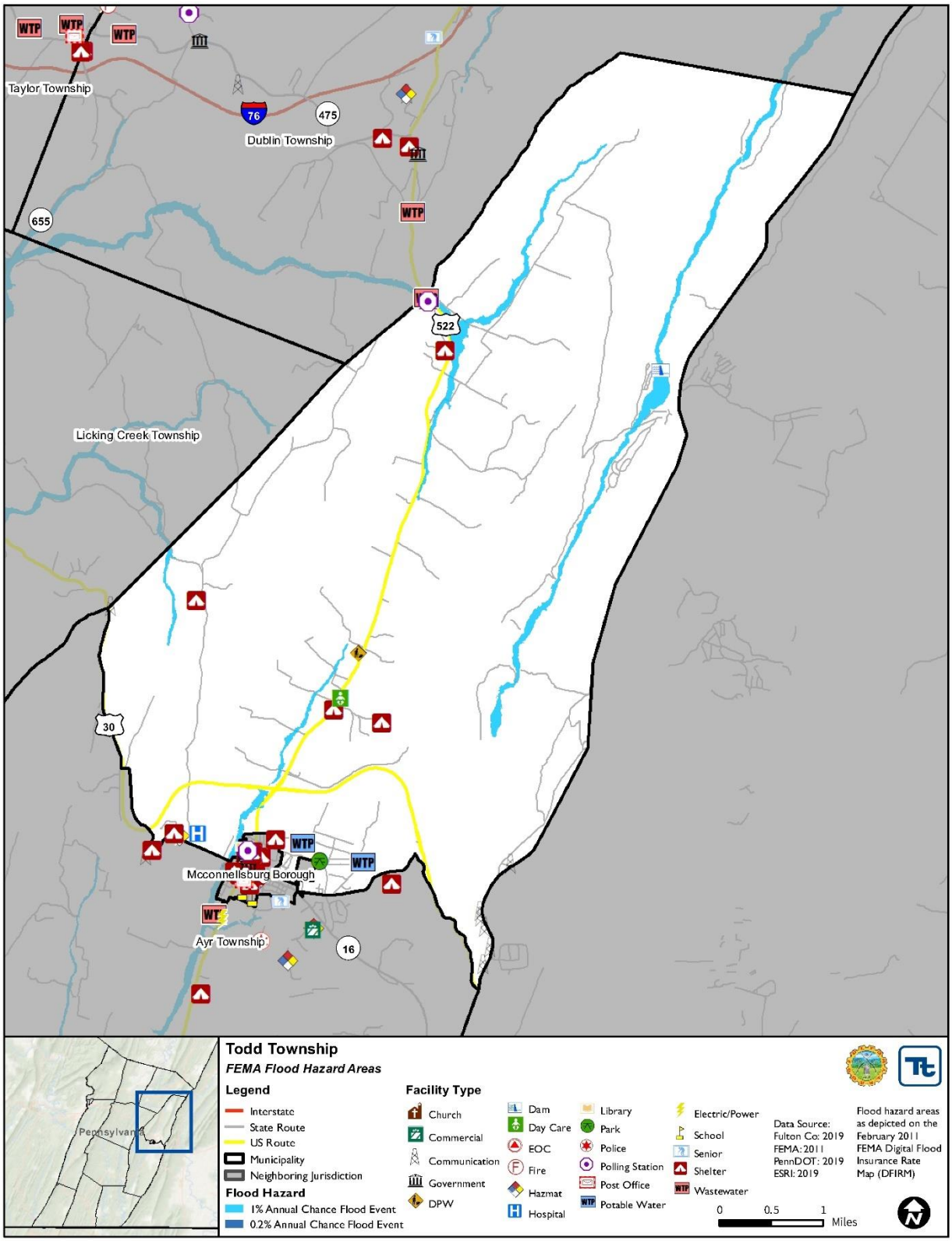


Figure 4.3.5-14. Union Township Municipal Flood Map

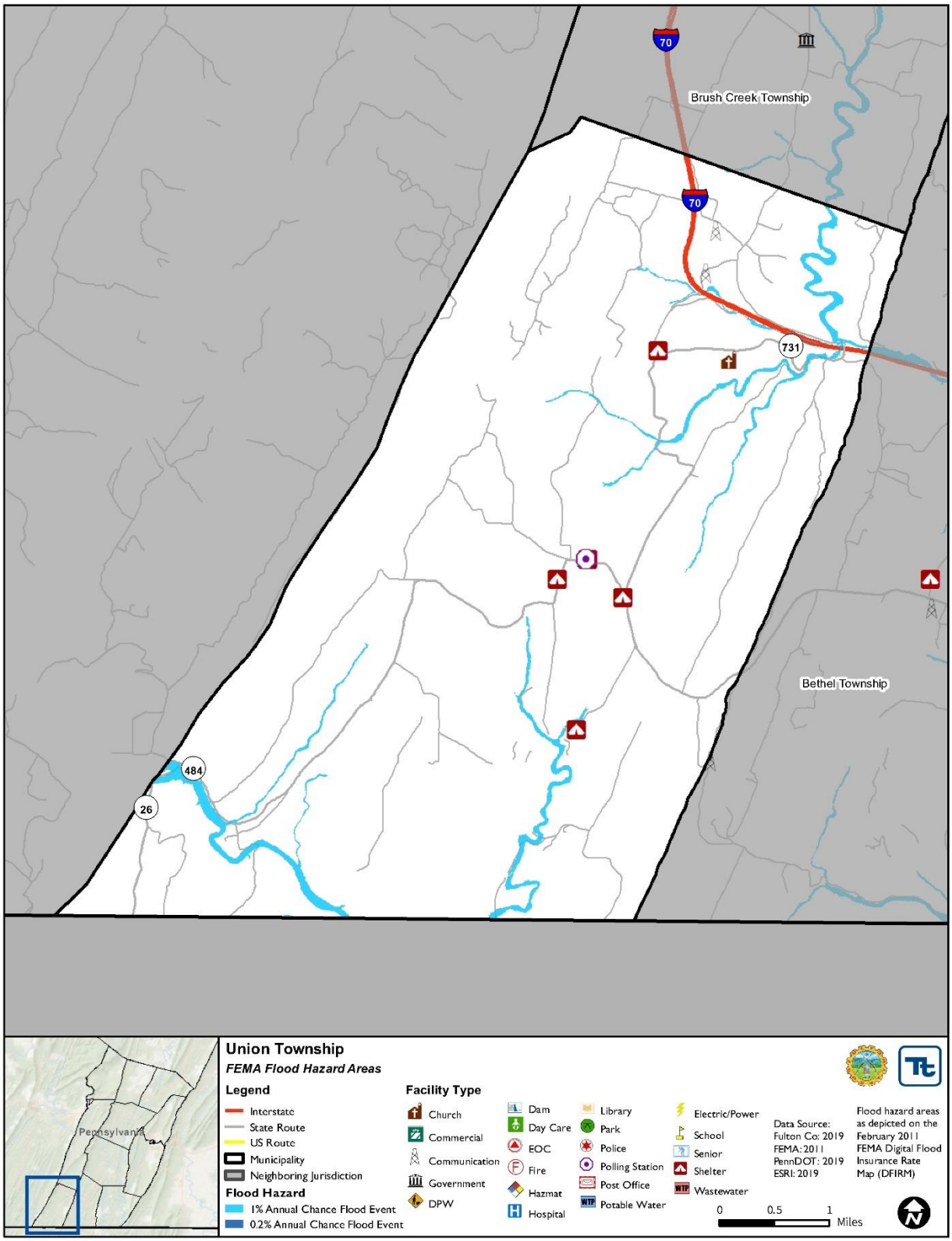


Figure 4.3.5-15. Valley-Hi Borough Municipal Flood Map

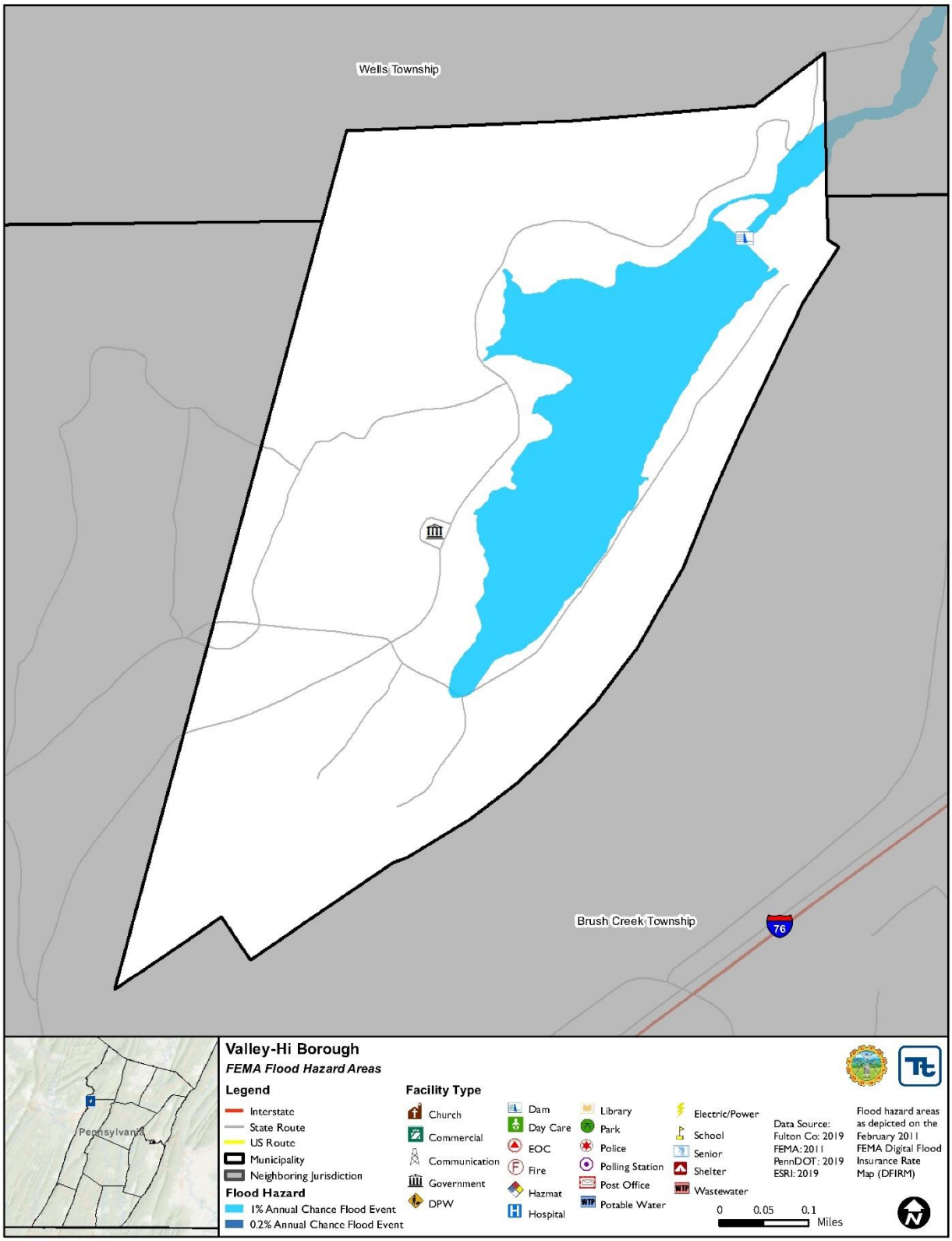


Figure 4.3.5-16. Wells Township Municipal Flood Map