4.0 RISK ASSESSMENT

A risk assessment analyzes "the potential for damage, loss, or other impacts created by the interaction of hazards with community assets" (FEMA, 2013). This risk assessment section contains information on identified hazards that threaten Adams County and the surrounding region and the vulnerability of the area as it relates to the county's assets.

4.1 Update Process Summary

Earlier versions of this plan recognized that hazards and vulnerabilities have the potential to grow as the county grows. In 2005, Adams County profiled the following hazards:

- flooding,
- tornadoes and windstorms,
- other severe weather,
- fires
- hazardous materials releases,
- nuclear incidents, and
- terrorism.

In the 2010 update, the county updated the names of most hazards in the original mitigation plan and the organization of the profiles to match PEMA guidance. The 2010 update also saw the addition of drought, dam failure, earthquakes, subsidence, and hailstorms. Planners again updated the hazard list to match Commonwealth guidance in 2015 and added extreme temperatures, invasive species, hurricane, tropical storm, Nor'easter, pandemic and infectious disease, and transportation accidents to the plan.

The planning committee utilized the list of hazards from the 2015 version as its starting point for the 2020 risk assessment. Hazard names and definitions remain consistent with those listed in the PEMA standard operating guideline, and the committee opted to add one hazard: landslide. The committee included this hazard because of the recognition that not all geologic hazards stem from subsidence or sinkholes; further, the committee wanted to capture concerns about erosion in a profile. The addition of landslide brings the total number of hazard profiles to 18 (13 natural and six human-caused).

Committee members evaluated each hazard with a hazards worksheet that asked for perceptions of risks from the identified hazards as well as whether committee members felt

impacts from those hazards have increased, decreased, or remained constant for their jurisdictions. The county's consultant utilized this data, as well as information gleaned from the public participation survey, to inform updated profiles for each hazard. The county's consultant also integrated social vulnerability data, where appropriate, into the profiles.

Each profile contains a standard vulnerability assessment in which the county ranked the hazards per seven criteria: frequency, response, onset, magnitude, business impacts, human impacts, and potential property damage. These rankings yielded an overall vulnerability "score" that enabled a ranked list (see Section 4.4). Additionally, where applicable, the county's consultant utilized scholarly research and other reference materials (cited appropriately throughout) to estimate losses from each hazard (and these estimates and their methodologies are unique to the hazards).

4.2 Hazards Identification

§201.6(c)(2)(i)	[The risk assessment shall include a] description of the…location and extent of all-natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

Pennsylvania's disaster history helps provide direction on the identification of hazards and their significance, both at the state and local level. PEMA maintains a historical log of all disasters that have occurred in the Commonwealth dating back to 1955. An analysis of the past occurrences of each hazard is the first step toward predicting the future susceptibility to that hazard. By noting the hazards of the past, Adams County and its municipalities will be able to better understand and prepare for future natural and human-caused disasters.

4.2.1 Table of Presidential Disaster Declarations

Under the Stafford Act, two forms of presidential action authorize federal disaster assistance dollars. **Presidential Emergency Declarations** are intended to spur activities that will protect property and strengthen public safety to lessen impacts or avoid a catastrophic event. **Presidential Disaster Declarations** are made as a result of a disaster event and provide supplemental coordination and financial assistance beyond the ability of state and local governments (McCarthy, 2011). Because of the difference in these declarations, a single event may qualify for both kinds of declarations.

There is no financial threshold for an Emergency Declaration, but there are thresholds for Presidential Disaster Declarations established under the Stafford Act: a state and a county

threshold. These thresholds are based on a formula that uses the population of the jurisdiction (as recorded in the decennial Census) times a set per capita indicator. When reviewing a state request for major disaster assistance, figures of $1.39 per capita for states and $3.50 per capita for counties is used as an indicator that the disaster is of a size that it might warrant federal assistance. Using those figures, damages exceeding $17,656,306.81 in Pennsylvania, or $354,924.50 in Adams County would warrant a Presidential Disaster Declaration.

Table 4.2.1-1 displays the Presidential Disaster Declarations that have affected Adams County from 1955 to 2019.

Table 4.2.1-1

LIST OF DISASTER DECLARATIONS, ADAMS COUNTY			
Declaration	*Name*	*Incident Period*	*Declaration Declared*
DR-4506	PA Covid-19	01/20/2020-Present	03/30/2020
EM-3441	PA Covid-19	01/20/2020-Present	03/13/2020
DR-4374	MD Severe Storms and Flooding (Adams was contiguous county)	05/15/2018-05/19/2018	06/25/2018
DR-4267	PA Severe Winter Storm and Snowstorm	01/22/2016-01/23/2016	03/23/2016
EM-3356	PA Hurricane Sandy	10/26/2012-11/08/2012	10/29/2012
DR-4030	PA Tropical Storm Lee	09/03/2011-10/15/2011	09/12/2011
EM-3340	PA Remnants of Tropical Storm Lee	09/03/2011-10/15/2011	09/08/2011
DR-1898	PA Severe Winter Storms and Snowstorms	02/05/2010-02/11/2010	04/16/2010
DR-1649	PA Severe Storms, Flooding, and Mudslides	06/23/2006-07/10/2006	06/30/2006
EM-3235	PA Hurricane Katrina Evacuation	08/29/2005-10/01/2005	09/10/2005
EM-3180	PA Snowstorm	02/14/2003-02/19/2003	03/14/2003
DR-1120	PA Flooding	06/12/1996-06/19/1996	06/18/1996
DR-1093	PA Flooding	01/19/1996-02/01/1996	01/21/1996
DR-1085	PA Blizzard	01/06/1996-01/12/1996	01/13/1996
DR-1015	PA Winter Storm, Severe Storm	01/04/1994-02/25/1994	03/10/1994
EM-3105	PA Severe Snowfall and Winter Storm	03/13/1993-03/17/1993	03/16/1993
DR-523	PA Severe Storms, Flooding	10/20/1976	10/20/1976
DR-485	PA Severe Storms, Heavy Rains, and Flooding	09/26/1975	09/26/1975
DR-340	PA Tropical Storm Agnes	06/23/1972	06/23/1972

4.2.2 Summary of Hazards

The following table lists the hazards considered by the remainder of this risk assessment.

HAZARDS IDENTIFICATION	
Hazard	*Description*
Natural Hazards	
Drought	Drought is a natural climatic condition which occurs in virtually all climates, the consequence of a natural reduction in the amount of precipitation experienced over a long period, usually a season or more in length.
Earthquake	An earthquake is the motion or trembling of the ground produced by sudden displacement of rock, usually within the upper 10-20 miles of the Earth's crust.
Extreme Temperature	Extreme cold temperatures drop well below what is considered normal for an area during the winter months and often accompany winter storm events. Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months.
Flood, Flash Flood, Ice Jam	Flooding is the temporary condition of partial or complete inundation of normally dry land, and it is the most frequent and costly of all hazards in Pennsylvania
Hailstorm	Precipitation in the form of small balls or lumps, usually consisting of concentric layers of clear ice and compact snow.
Hurricane, Tropical Storm, Nor'easter	Hurricanes, tropical storms, and Nor'easters are any closed circulation developing around a low-pressure center.
Invasive Species	Invasive species are organisms that are not indigenous to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health.
Landslide/Erosion	A landslide is the downward and outward movement of slope-forming soil, rock, and vegetation reacting to the force of gravity. Erosion is the gradual destruction or diminution of something.
Pandemic and Infectious Disease	A pandemic occurs when infection from a new strain of a certain disease, to which most humans have no immunity, substantially exceeds the number of expected cases over a given period. Such a disease may or may not be transferable between humans and animals.
Subsidence, Sinkhole	Sinkholes are underground voids caused by water passing through naturally-occurring fractures in water-soluble bedrock.
Tornado, Windstorm	Tornadoes are violent windstorms characterized by a twisting funnel-shaped cloud extending to the ground. Windstorms can occur during severe thunderstorms, winter storms, coastal storms, or tornados.
Wildfire	Wildfires are raging, uncontrolled fires that spread rapidly through vegetative fuels, exposing and possibly consuming structures.
Winter Storm	Winter storms may include snow, sleet, freezing rain, or a mi13 of these wintry forms of precipitation, and can range from moderate snowfall or ice events to blizzards that last for several days.
Technological Hazards	
Dam Failure	Dams are barriers preventing the flow of water or loose solid materials. Dam failure can occur with little warning, and cause loss of life and property, environmental damage, and loss of purpose of the dam (e.g., water supply, hydropower, etc.).
Environmental Hazards: Hazardous Materials Release	A hazardous materials release can contaminate air, water, and soils, possibly resulting in death and/or injuries.
Nuclear Incident	Nuclear incidents refer to events involving the release of significant levels of radioactivity or exposure of workers or the general public to radiation.
Human-Caused Hazards	
Terrorism	Terrorism refers to the use of force against persons or property with the intent to intimidate or coerce, and includes threats, assassination, kidnapping, hijacking, bombings or bomb threats, cyber-attacks, and use of chemical, biological, nuclear, and radiological weapons.

HAZARDS IDENTIFICATION	
Hazard	*Description*
Transportation Accident	Transportation accidents can result from any form of air, rail, water, or road travel, and can cause regional impacts such as hazardous materials releases or disruption in critical supply/access routes.

4.3 Hazard Profiles

The following profiles detail each hazard considered by this plan, which includes discussion on how the hazard impacts the area. Within each profile, research and historical data inform the following elements.

- **Hazard Overview:** Defines the hazard and presents a summary table of the hazard.
- **Location and Extent:** Identifies the physical places in the county that are vulnerable to the hazard and the severity of a hazard in a given location.

§201.6(c)(2)(i)	A description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

- **Range and Magnitude:** Describes impacts on different topics such as health, the environment, or infrastructure that may result from the hazard as well as specific populations that may be vulnerable.

§201.6(c)(2)(ii)	A description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. All plans approved after October 1, 2008, must also address NFIP-insured structures that have been repetitively damaged by floods.

- **Past Occurrences:** Summarizes significant past events related to the hazard.

§201.6(c)(2)(i)	A description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

- **Future Occurrences:** Describes the probability of future occurrence of the hazard under consideration.

§201.6(c)(2)(ii)(A)	The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas.

- **Vulnerability Assessment:** Outlines the methods used for loss amounts (of deaths, injury, and property damage depending on available information) and estimates based on historical information and vulnerable populations, structures, and infrastructure. Also, details methods for calculating the probability and severity of each hazard.

§201.6 (c)(2)(ii)(B)	An estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate.
§201.6(c)(2)(iii)	For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

The following sections provide more detail on the hazards identified above. Hazard profiles appear in the following order.

- 4.3.1 Drought
- 4.3.2 Earthquake
- 4.3.3 Extreme Temperature
- 4.3.4 Flood, Flash Flood, Ice Jam
- 4.3.5 Hailstorm
- 4.3.6 Hurricane, Tropical Storm, Nor'easter
- 4.3.7 Invasive Species
- 4.3.8 Landslide
- 4.3.9 Pandemic and Infectious Disease
- 4.3.10 Subsidence, Sinkhole
- 4.3.11 Tornado, Wind Storm
- 4.3.12 Wildfire
- 4.3.13 Winter Storm
- 4.3.14 Dam Failure
- 4.3.15 Environmental Hazards: Hazardous Materials Releases
- 4.3.16 Nuclear Incidents
- 4.3.17 Terrorism
- 4.3.18 Transportation Accidents

4.0 RISK ASSESSMENT

4.3.1 Drought

Drought is a natural climatic condition which occurs in virtually all climates, the consequence of a natural reduction in the amount of precipitation experienced over a long period, usually a season or more in length.			
Period of Occurrence:	Droughts can occur at any point in time.	**Hazard Index Ranking:**	14-Low
Warning Time:	12-24 Hours	**State Risk Ranking:**	2.0-Medium
Type of Hazard:	Natural	**Disaster Declarations:**	DR-206 (Pennsylvania Water Shortage, 1965)

"Drought" is a period of abnormally dry weather, which persists long enough to produce a serious hydrological imbalance. Drought is a term used in relation to who or what is affected by the lack of moisture. Drought can be a result of multiple causes, including global weather patterns that produce persistent, upper-level high-pressure systems with warm, dry air, resulting in less precipitation. Droughts develop slowly; typically, they are already underway when officially identified. There are several types of droughts (Sears, 2017, p. 138).

- **Meteorological Drought:** Differences from the streamflow precipitation amounts. Because not every area receives the same amount of rainfall, a drought in one place might not be considered a drought in another.
- **Agricultural Drought:** Moisture deficiency seriously injurious to crops, livestock, or other agricultural commodities. Parched crops may wither and die. Pastures may become insufficient to support livestock. The effects of agricultural droughts are difficult to measure because many variables may impact production during the same growing season.
- **Hydrological Drought**: Reduction in groundwater, lake and reservoir levels, depletion of soil moisture, and a lowering of the groundwater table. Consequently, there is a decrease in groundwater discharge to streams and lakes. Prolonged hydrological drought will affect the water supply.
- **Socioeconomic Drought:** A lack of water that begins to affect people's daily lives.

Precipitation falls in uneven patterns across the country; the amount of precipitation at a particular location varies from year to year, but over years, the average amount is fairly constant. The amount of rain and snow also varies with the seasons. Even if the total amount of rainfall for a year is about average, rainfall shortages can occur during a period when moisture is critically necessary for plant growth, such as in the early summer. When little or no rain falls, soils can dry out, and plants can die. When rainfall is less than normal for several weeks, months, or years the flow of streams and rivers declines, water levels in lakes and reservoirs fall, and the depth to water in wells increases. If dry weather persists and water-supply problems develop, the dry period can become a drought (USGS, n.d.).

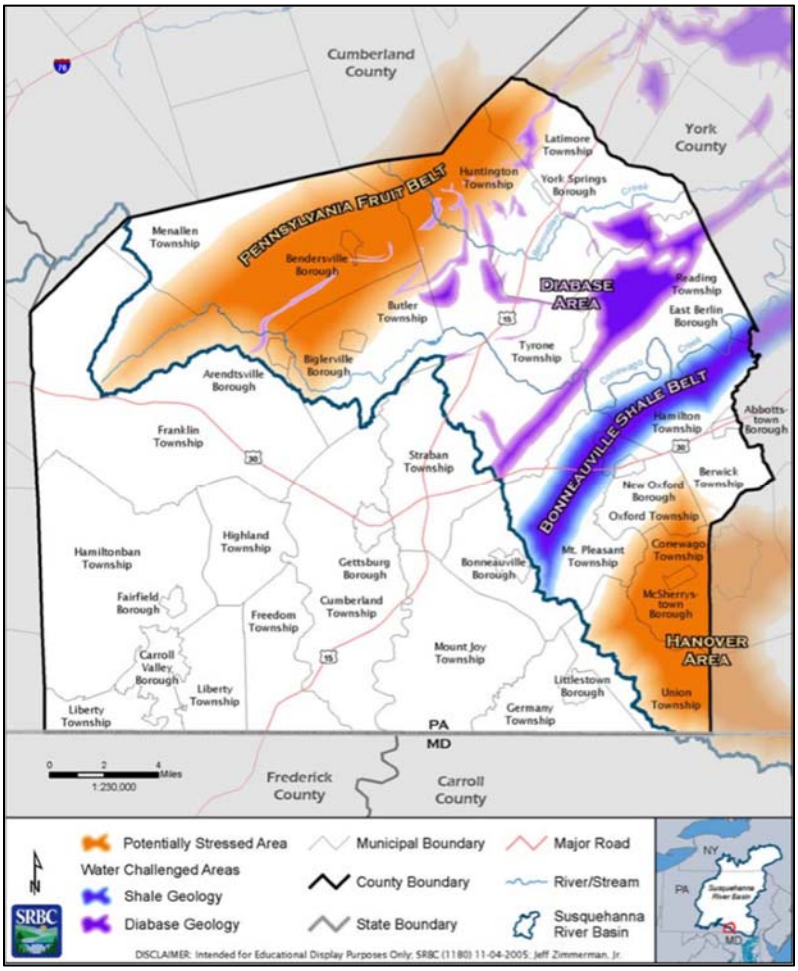
This hazard is of particular concern in Pennsylvania due to the presence of farms as well as water-dependent industries and recreation areas across the Commonwealth. A prolonged drought could severely impact these sectors of the local economy, as well as residents who depend on wells for drinking water and other personal uses (PEMA, 2018).

4.3.1.1 Location and Extent

Droughts are often regional phenomena, so they typically impact all communities in an area relatively uniformly. Drought often occurs across several jurisdictions, with large areas of the state or region experiencing the effects of the drought at the same time. The geographic extent of drought can range from localized areas of Pennsylvania to the entire Mid-Atlantic region.

Though drought can occur in all areas of Adams County, some areas are more susceptible than others. In Adams County, the Pennsylvania Fruit Belt and the southeastern Hanover area are at a higher risk of adverse effects. These areas lack the water resources necessary for public and industrial water use. Affected areas include all or portions of Bendersville Borough, Biglerville Borough, McSherrystown Borough, Butler Township, Conewago Township, Huntington Township, and Union Township. Figure 4.3.1.1-1 below highlights the areas of Adams County most likely to experience adverse effects due to drought.

Figure 4.3.1.1-1



Droughts are typically measured using the Palmer Drought Severity Index (PDSI). The PDSI is used to indicate prolonged and abnormal moisture deficiencies or excesses and is an important climatological tool for evaluating the scope and severity of periods of abnormally dry or wet weather (National Weather Service, 2005). Table 4.3.1.1-1 details the PDSI.

Table 4.3.1.1-1

PALMER DROUGHT SEVERITY INDEX	
Palmer Value	*Drought Condition*
4.0+	Extremely Moist
3.0 to 3.9	Very Moist
2.0 to 2.9	Unusually Moist
-1.9 to 1.9	Near Normal
-2.0 to -2.9	Moderate Drought
-3.0 to -3.9	Severe Drought
-4.0 or less	Extreme Drought

In addition to the PDSI, the Crop Moisture Index (CMI) calculates the change in moisture available from week to week, which gives a short-term status of agricultural moisture (National Weather Service, 2005). Table 4.3.1.1- below describes the Crop Moisture Index.

Table 4.3.1.1-2

CROP MOISTURE INDEX	
Crop Moisture Index Value	*Drought Condition*
3.0 and up	Excessively Wet
2.0 to 2.9	Wet
1.0 to 1.9	Moist
-0.9 to 0.9	Slightly Dry/ Favorable Moist
-1.0 to -1.9	Abnormally Dry
-2.0 to -2.9	Excessively Dry
-3.0 or less	Severely Dry

In addition to the above severity scales, the National Drought Mitigation Center has developed the U.S. Drought Monitor. The Drought Monitor is a map that is updated weekly using data from the previous week to show areas of the U.S. that are in a drought. Table 4.3.1.1-3 lists the U.S. Drought Monitor classifications of drought.

Table 4.3.1.1-3

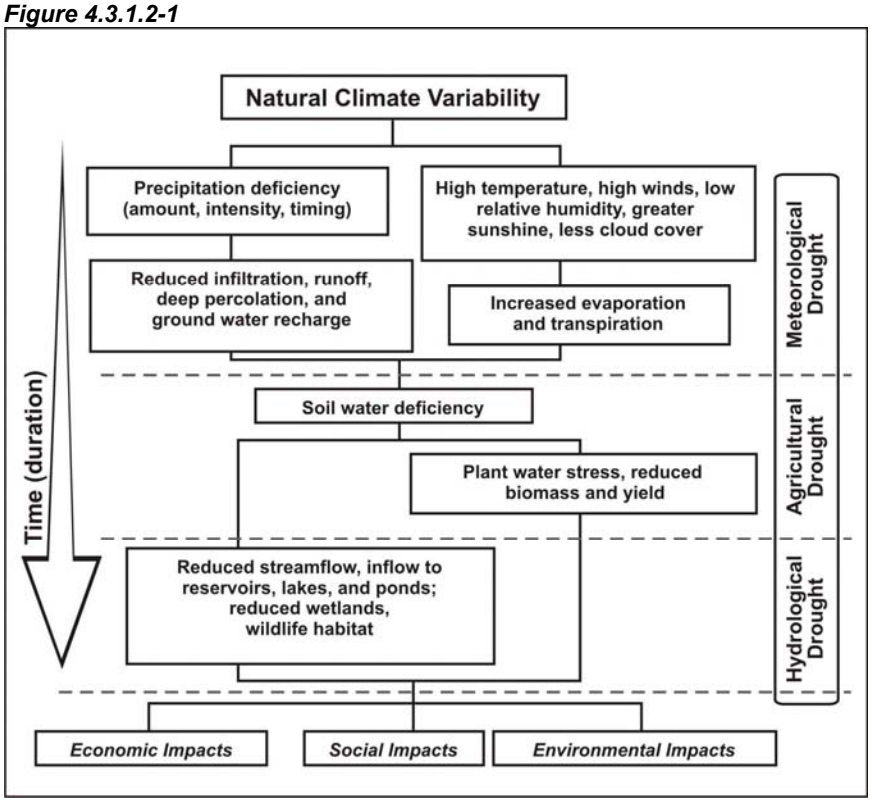
U.S. DROUGHT MONITOR CLASSIFICATION			
Category	*Description*	*Possible Impacts*	*Palmer Drought Severity Index*
D0	Abnormally Dry	Going into drought: • Short-term dryness slowing planting, growth of crops or pastures Coming out of drought • Some lingering water deficits • Pastures or crops not fully recovered	-1.0 to -1.9
D1	Moderate Drought	• Some damage to crops, pastures • Streams, reservoirs, or wells low, some water shortages developing or imminent • Voluntary water-use restrictions requested	-2.0 to -2.9
D2	Severe Drought	• Crop or pasture losses likely • Water shortages common • Water restrictions imposed	-3.0 to -3.9
D3	Extreme Drought	• Major crop/pasture losses • Widespread shortages or restrictions	-4.0 to -4.9
D4	Exceptional Drought	• Exceptional and widespread crop/pasture losses • Shortages of water in reservoirs, streams, and wells creating water emergencies	-5.0 or less

4.3.1.2 Range of Magnitude

Droughts are the second most likely disasters to come with a multi-billion dollar economic effect, with the average billion-dollar drought costing $9.5 billion (NOAA, 2019). This estimate takes into consideration physical damage to structures and material assets, time element losses, vehicles and boats, offshore energy platforms, agricultural assets (crops, livestock, timber), and disaster restoration costs. The effects of a drought can vary depending on the duration, severity, location, and month they occur. Even short-term droughts, when coupled with extreme temperatures, can be devastating.

As droughts progress, they typically progress through four stages: meteorological drought, agricultural drought, hydrological drought, and socioeconomic drought (see above). Figure 4.3.1.2-1 below shows these phases and their contributors.

Figure 4.3.1.2-1



According to the phases of drought figure above, droughts progress from meteorological to agricultural, then to hydrological. Meteorological droughts include periods of high temperature and wind, low humidity, and low cloud cover. These conditions, over time, cause a deficiency of soil water. Soil water deficiency is a characteristic trait of agricultural drought. In the presence of the meteorological conditions listed above, plants become water-stressed, and crop yields

suffer. Continued moisture deficiency eventually leads to hydrologic drought, characterized by reduced streamflow, reservoir levels, and wetlands. This level of drought leads to economic, environmental, and social impacts.

The economic impacts of drought are primarily related to agriculture and water utilities. Farmers lost income when drought decreases or destroys their crops, increasing the amount of water and feed for livestock, and when they need to expend resources on irrigating otherwise self-sufficient fields. Additionally, water companies may need to add water supplies or increase their usage of current water supplies.

Droughts affect the environment in many ways. Wildlife habitats, particularly wetlands, can be damaged or eliminated during drought. Decreased water supply for wildlife can lead to migration or disease in wild animals. Periods of drought also affect soil quality. Social impacts of drought include health issues related to water availability and quality, threats to public safety due to increased forest fire risk, reduced incomes, and fewer recreational activities. Populations most impacted by the social effects of drought include those who work in the agricultural sector and those that primarily rely on well-water.

According to the U.S. Drought Monitor, there are possible impacts from each level of drought, which appear in the graphic below.

D0 Abnormally Dry	*Going into drought:* • short-term dryness slowing planting, growth of crops or pastures *Coming out of drought:* • some lingering water deficits • pastures or crops not fully recovered
D1 Moderate Drought	• Some damage to crops, pastures streams, reservoirs, or wells low, some water shortages developing or imminent • Voluntary water-use restrictions requested
D2 Severe Drought	• Crop or pasture losses likely • Water shortages common • Water restrictions imposed
D3 Extreme Drought	• Major crop/pasture losses Widespread water shortages or restrictions
D4 Exceptional Drought	• Exceptional and widespread crop/pasture losses • Shortages of water in reservoirs, streams, and wells creating water emergencies

Table 4.3.1.2-1 below gives the number of wells in each municipality in Adams County via data collected by the Pennsylvania Groundwater Information System (PaGWIS). It is important to note that PaGWIS relies on voluntary data submission. Therefore it is not a complete list of all wells in the county.

Table 4.3.1.2-1

ADAMS COUNTY WELLS BY MUNICIPALITY					
Municipality	*Wells*	*Total Population*	*Municipality*	*Wells*	*Total Population*
Abbottstown	15	952	Franklin	983	4,883
Arendtsville	9	847	Freedom	983	815
Bendersville	3	746	Germany	463	2,702
Biglerville	29	1,154	Hamilton	399	2,534
Bonneauville	12	2,119	Hamiltonban	353	2,095
Carroll Valley	362	3,894	Highland	186	920
East Berlin	17	1,559	Huntington	413	2,362
Fairfield	17	538	Latimore	404	2,589
Gettysburg	154	7,627	Liberty	267	1,326
Littlestown	64	4,439	Menallen	659	3,528
McSherrystown	0	3,044	Mount Joy	339	3,684
New Oxford	37	2,142	Mount Pleasant	354	4,677
York Springs	5	797	Oxford	360	5,527
Berwick	323	2,191	Reading	402	5,781
Butler	479	2,577	Straban	480	4,938
Conewago	166	7,116	Tyrone	408	2,141
Cumberland	528	6,187	Union	297	5,781

4.3.1.3 Past Occurrence

According to the NCEI database, there have been four instances of drought in Adams County, none of which caused any injuries, deaths, or damages to property or crops. Table 4.3.1.3-1 below lists the recorded droughts in Adams County.

Table 4.3.1.3-1

DROUGHT OCCURRENCES IN ADAMS COUNTY		
Date	*Property Damage*	*Crop Damage*
10/31/1997	$0.00	$0.00
12/15/1998	$0.00	$0.00
07/01/1999	$0.00	$0.00
08/01/1999	$0.00	$0.00

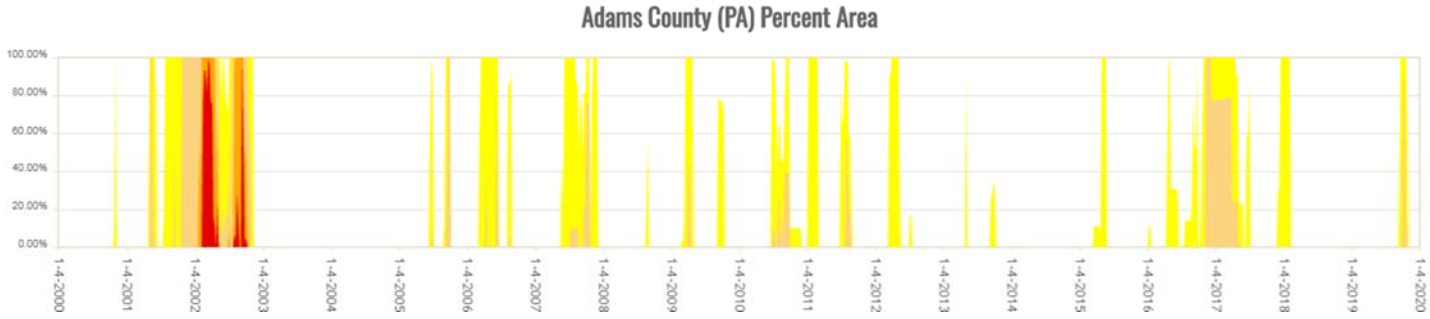
There have been four additional instances of droughts that were declared disasters by the Governor of Pennsylvania (but not recorded in the NCEI database) in 1955, 1995, 1999, and 2002. In 1991, another drought led to Adams County residents receiving Small Business Loan Funds.

The above tables and narratives do not provide data on crop losses, though drought-related agricultural impacts seem plausible. Adams County received a USDA Secretarial Designation in 2016 for drought impacts running between May and December of that year (USDA FSA, n.d.). Aggregated 2016 data from EWG's *Farm Subsidies Database* is available,

and it covers at least S4165 for the drought incident, S4141 for a freeze and frost incident, and other potential small claims. However, seven Adams County farmers received $94,859 worth of disaster assistance program benefits in 2016 for one or both of these events. Of that total, $91,096 were under the miscellaneous category, which consists of the crop disaster, quality losses, and non-insured assistance programs, and the remaining $3,763 was under the "Livestock Disaster/Emergency" category, which includes the livestock compensation and livestock emergency assistance programs (EWG, n.d.).

The U.S. Drought Monitor, kept by the University of Nebraska-Lincoln, provides more detailed information about drought since 2000. Figure 4.3.1.3-2 below is a graphical representation of the time and severity of droughts presented in Adams County between 2000 and 2019.

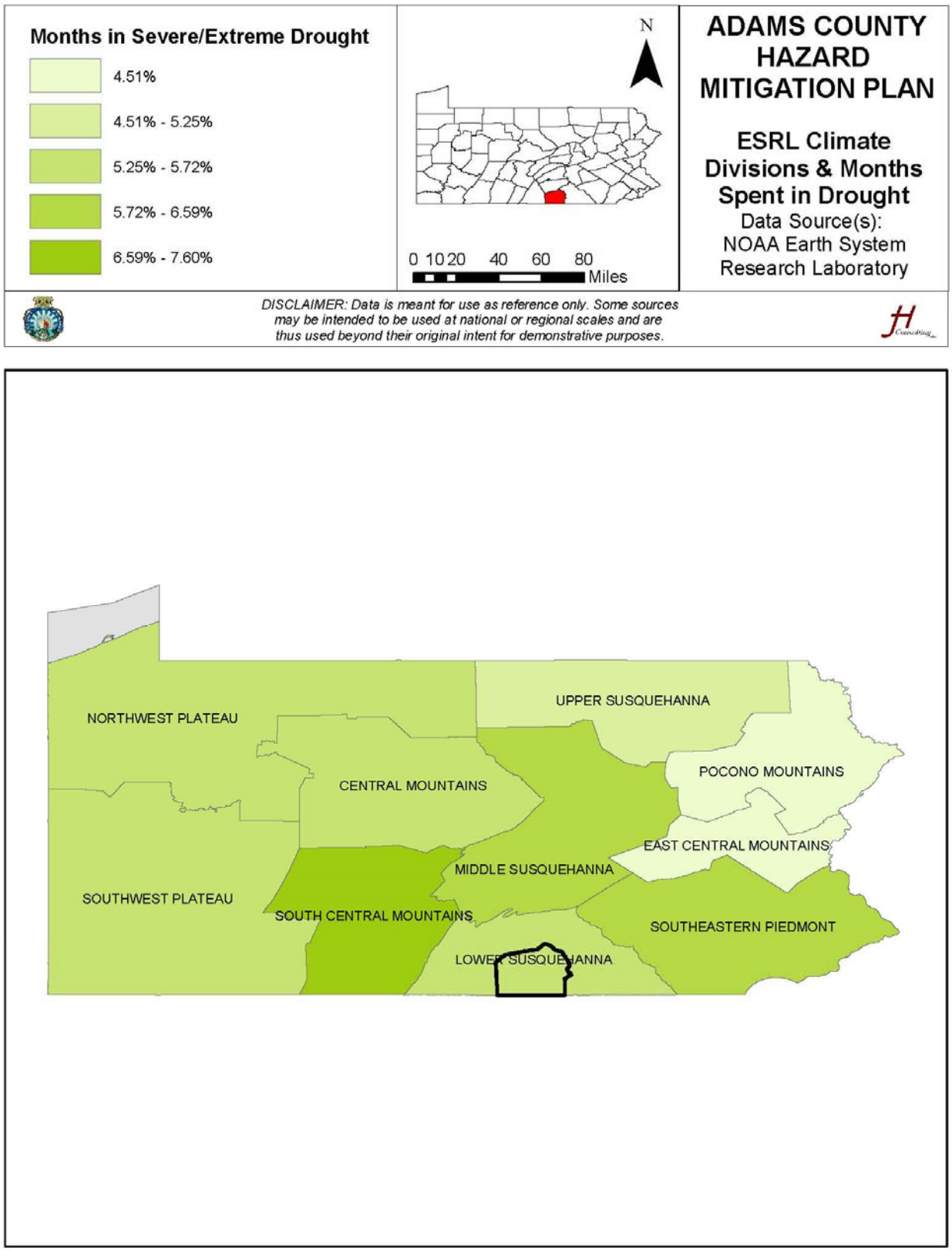
Figure 4.3.1.3-2



4.3.1.4 Future Occurrence

Though it is difficult to anticipate exactly where drought conditions will occur in the future, Adams County can estimate the chances of experiencing drought conditions generally. NOAA's Earth System Research Laboratory (ESRL) has divided the U.S. into "climate divisions." ESRL further maintains data for each of these areas, including the historical Palmer Drought Severity Index (PDSI) values for all months between 1895 and 2018. Adams County's climate division, Lower Susquehanna, experienced drought conditions (i.e., incipient, mild, moderate, severe, or extreme drought per the PDSI) in 42.74% of the months between 1895 and 2018. The region experienced severe or extreme drought conditions (defined per the PDSI values in the table above) during 5.72% of the months (i.e., 85 out of 1,488 months). The following map displays this information graphically and compares it to the remainder of Pennsylvania.

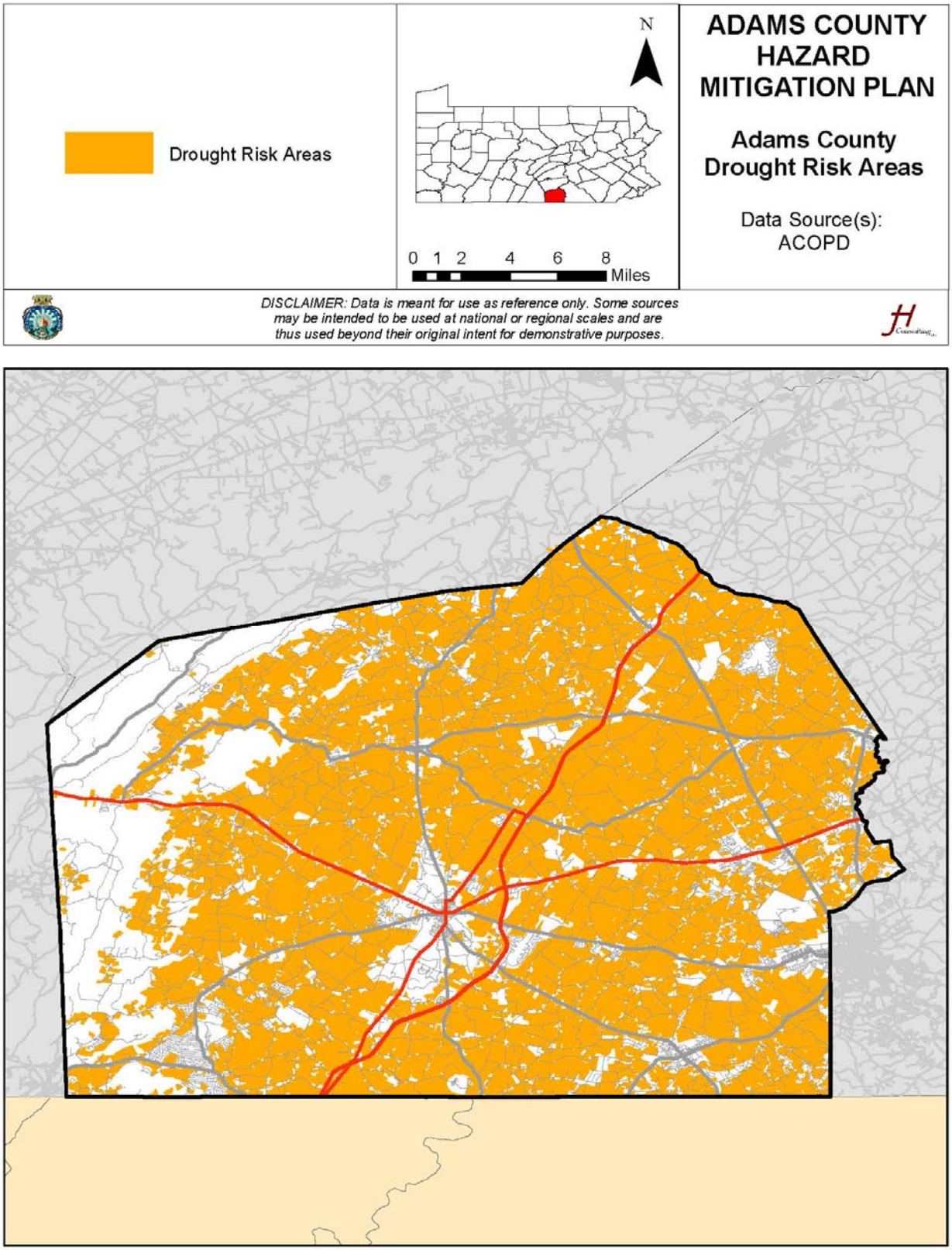
Figure 4.3.1.4-1



Future droughts in Adams County have the potential to cause widespread socioeconomic damages. A severe, prolonged drought can cause compromised quality and quantity of potable water, compromised food and nutrition, diminished living conditions, recreational risks, and increased disease incidence (CDC, 2010). The effects of social vulnerability are exacerbated by drought, which is a concern for Huntington and Tyrone Townships. These municipalities are located in potentially water-stressed areas and are ranked by the CDC as some of the most socially vulnerable (CDC, 2016).

Droughts also have the potential to harm Adams County's economy. The Fruit Belt is particularly vulnerable to drought due to its location in a potentially water-stressed area. The Adams County Fruit Belt includes 65% of the tree fruit acreage in Pennsylvania and is the leading producer of apples (and peaches) in Pennsylvania (Adams County Office of Planning and Development, 2016). The Fruit Belt contributes $5.8 million to Adams County's economy and is expected to increase over the next ten years. Figure 4.3.1.4-2 depicts drought-prone areas in Adams County.

Figure 4.3.1.4-2



4.3.1.5 Vulnerability Assessment

This section summarizes the vulnerability to Adams County from drought. Adams County conducted an online survey for the public to share its thoughts on hazard vulnerabilities. Table 4.3.1.5-1 presents the results of that survey regarding a drought.

Table 4.3.1.5-1

PUBLIC SENTIMENT, DROUGHT – ADAMS COUNTY					
Hazard	*Level of Concern*				*Total Responses*
	Not at All	*Somewhat*	*Concerned*	*Very*	
Drought	31 (21.23%)	74 (50.68%)	34 (23.29%)	7 (4.79%)	146
In the past ten years, do you remember this hazard occurring in your community?				68 (46.58%)	146
Have you noticed an increase or decrease in the occurrences or intensity of this hazard? (141 responses)				37 (26.24%)	INCREASE
				95 (67.38%)	NO CHANGE
				9 (6.38%)	DECREASE

The Fruit Belt is the most drought vulnerable area in Adams County. Because of its location in a water-stressed area and its social vulnerability implications, it would bear the greatest burden of drought. Table 4.3.1.5-2 below further describes Adams County's vulnerability to drought.

Table 4.3.1.5-2

DROUGHT VULNERABILITY SUMMARY			
Category	*Points*	*Description*	*Notes*
Frequency	2	Low	There have been four drought events since 1997, for an average of 0.18 events per year.
Response	3	1 Week	Droughts are typically long-lasting events that require a prolonged response.
Onset	1	Over 24 hours	Droughts are prolonged events, and conditions gradually progress for weeks or months.
Magnitude	5	N/A	A drought would affect the entire region, including surrounding counties and states. Each area of Adams County would be affected.
Business	1	Less than 24 hours	Droughts will most heavily affect the agricultural industry in Adams County. The overall economy would be slightly affected but still operational.
Human	1	Minimum	Typically, there are no casualties attributed to drought. Past drought events have not caused any injuries or deaths.
Property	1	Less than 10%	Personal property loss due to drought is typically minimal.
Total	**14**	**Low**	

4.0 RISK ASSESSMENT

4.3.2 Earthquake

HIGHEST HIGH MEDIUM LOW LOWEST	An earthquake is a movement or shaking of earth's tectonic plates.			
	Period of Occurrence:	Earthquakes can occur at any time	**Hazard Index Ranking:**	11-Low
	Warning Time	Less than 12 hours	**State Hazard Ranking:**	1.9-Low
	Type of Hazard:	Natural	**Disaster Declarations:**	N/A

Earth is composed of four major layers: the inner core (innermost layer), outer core, mantle, and crust (outermost layer). Many tectonic plates that are slowly moving, sliding past, and bumping into one another are the primary components of the crust layer. The edges of these tectonic plates are called fault lines, which is where most earthquakes originate. The rough edges of the tectonic plates become lodged against each other; when the plate has moved enough, the edges become dislodged, causing an earthquake. The epicenter of the earthquake is the location directly above the ruptured fault.

An earthquake is the motion or trembling of the ground produced by sudden displacement of rock, usually within the upper 10-20 miles of the Earth's crust. Earthquakes result from crustal strain, volcanism, landslides, or the collapse of underground caverns. Earthquakes can affect hundreds of thousands of square miles, cause damage to property measured in the tens of billions of dollars, result in loss of life and injury to hundreds of thousands of persons, and disrupt the social and economic functioning of the affected area. The failure and collapse of structures due to ground shaking, which is dependent upon amplitude and duration of the earthquake, has been the cause of most property damage due to earthquakes (FEMA, 1997).

4.3.2.1 Location and Extent

Earthquake intensity ranges from "small to feel" and violent incidents that cause significant damage. The U.S. Geological Survey (USGS) uses the Modified Mercalli Intensity (MMI) scale to measure the intensity of earthquakes. The MMI scale characterizes the intensity

of an earthquake at a given location by the severity of ground shaking at that location and the effects of the shaking on people, human-made structures, and the landscape. Two other common ways to measure earthquakes include the Richter scale and peak ground acceleration (PGA).

- **Richter Scale:** The Richter scale, developed in 1935, measures the scale and severity of an earthquake. The magnitude of an earthquake can range between 0 and 10. The effects of an earthquake can extend far beyond the site of its occurrence.
- **Peak Ground Acceleration:** PGA is "the maximum ground acceleration that occurred during an earthquake at a location. PGA is equal to the amplitude of the largest absolute acceleration recorded on an accelerogram at a site during a particular earthquake" (Douglas, 2003).

Figure 4.3.2.1-1 below outlines the MMI scale and compares it to the Richter (magnitude) scale.

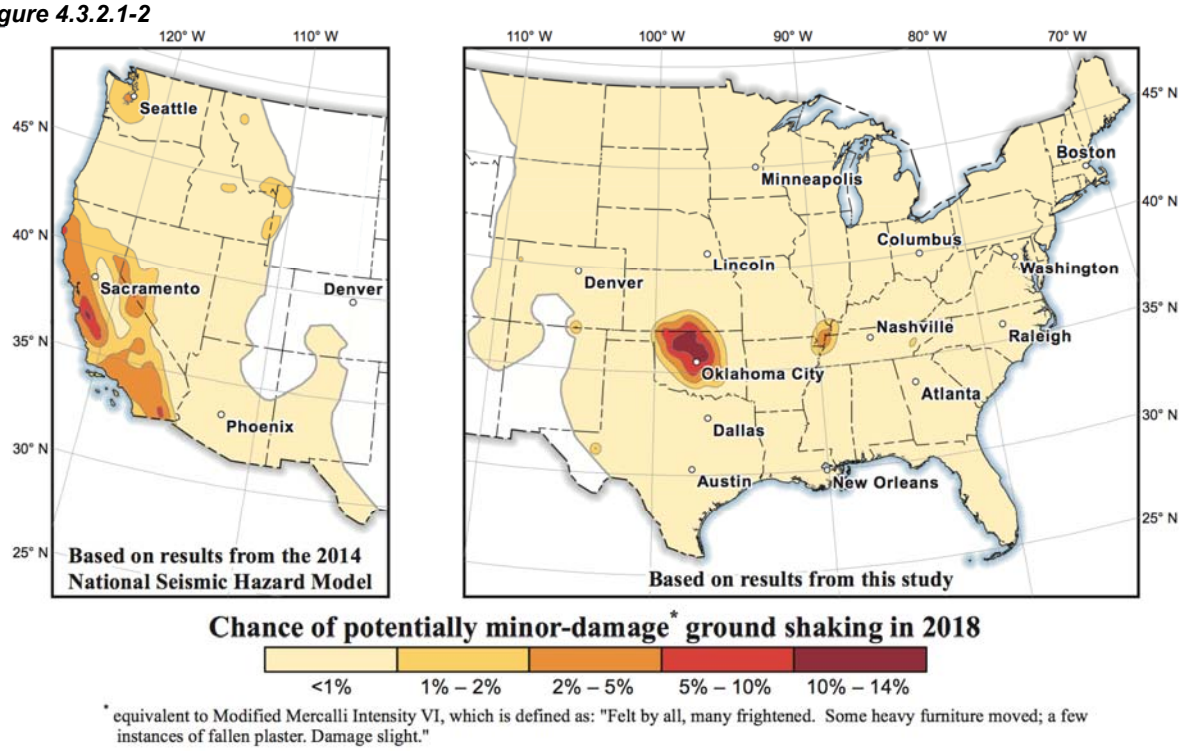
Figure 4.3.2.1-1

MODIFIED MERCALLI AND MAGNITUDE SCALE COMPARISON		
Modified Mercalli Scale		*Magnitude Scale*
I	Felt by few people under especially favorable conditions.	1.5
II	Felt by few persons at rest, especially on upper floors of buildings.	2.0 2.5
III	Felt quite noticeably indoors, especially on upper floors of buildings. Many do not recognize it as an earthquake. Standing vehicles may rock slightly. Vibration feels like passing truck.	3.0
IV	During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation of a heavy truck striking building; standing vehicles rock noticeably.	3.5
V	Felt by nearly everyone; many awakened. Some dishes and windows broken. Unstable objects overturned.	4.0 4.5
VI	Felt by all; many frightened. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.	5.0
VII	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by vehicle drivers.	5.5
VIII	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse; damage great in poorly built structures; fall of chimneys, factory stacks, columns, monuments, and walls. Heavy furniture overturned. Disturbs	6.0
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations. Underground pipes broken.	6.5 7.0
X	Some well-built wooden structures are destroyed; most masonry and frame structures with foundations destroyed; train rails bent.	7.5
XI	Few, if any, masonry structures remain standing. Bridges destroyed. Underground pipelines taken out of service. Train rails bent greatly.	8.0
XII	Damage total. Waves seen on ground surfaces. Lines of sight and level are distorted. Objects thrown into the air.	8.5

The area of greatest seismic activity in the United States is along the Pacific Coast, in the states of California and Alaska; however, as many as 40 states have moderate earthquake risk. On the East Coast, many residents remember the 2011 earthquake with an epicenter in Louisa County, Virginia. Many local officials on the East Coast are concerned with earthquake

risk emanating from the central United States. Generally, the number of earthquakes in the central U.S. has increased over the past decade (USGS, n.d.). From 1973 to 2008, there were approximately 25 earthquakes per year of magnitude three or larger. Since 2009, that number has increased to 362 per year. Earthquakes in the immediately surrounding region are typically small (less than 3.0 magnitude). The largest recorded earthquake with an epicenter in Pennsylvania was 4.6 in 1994. Figure 4.3.2.1-2 below is a map produced by the U.S. Geological Survey showing probable damage due to earthquakes.

Figure 4.3.2.1-2



As shown in the map above, the northeastern United States, and thus Adams County, has a less than 1% chance of experiencing minor property damage due to earthquakes.

4.3.2.2 Range of Magnitude

Damage from earthquakes varies widely by magnitude. Earthquakes with a magnitude at or above 6.0 on the MMI scale can cause significant, widespread damage to buildings, utilities, and transportation infrastructure. The direct effects of earthquakes include, but are not limited to, shaking and ground rupture, landslides, fires, soil liquefaction, tsunami, floods, and general property damage.

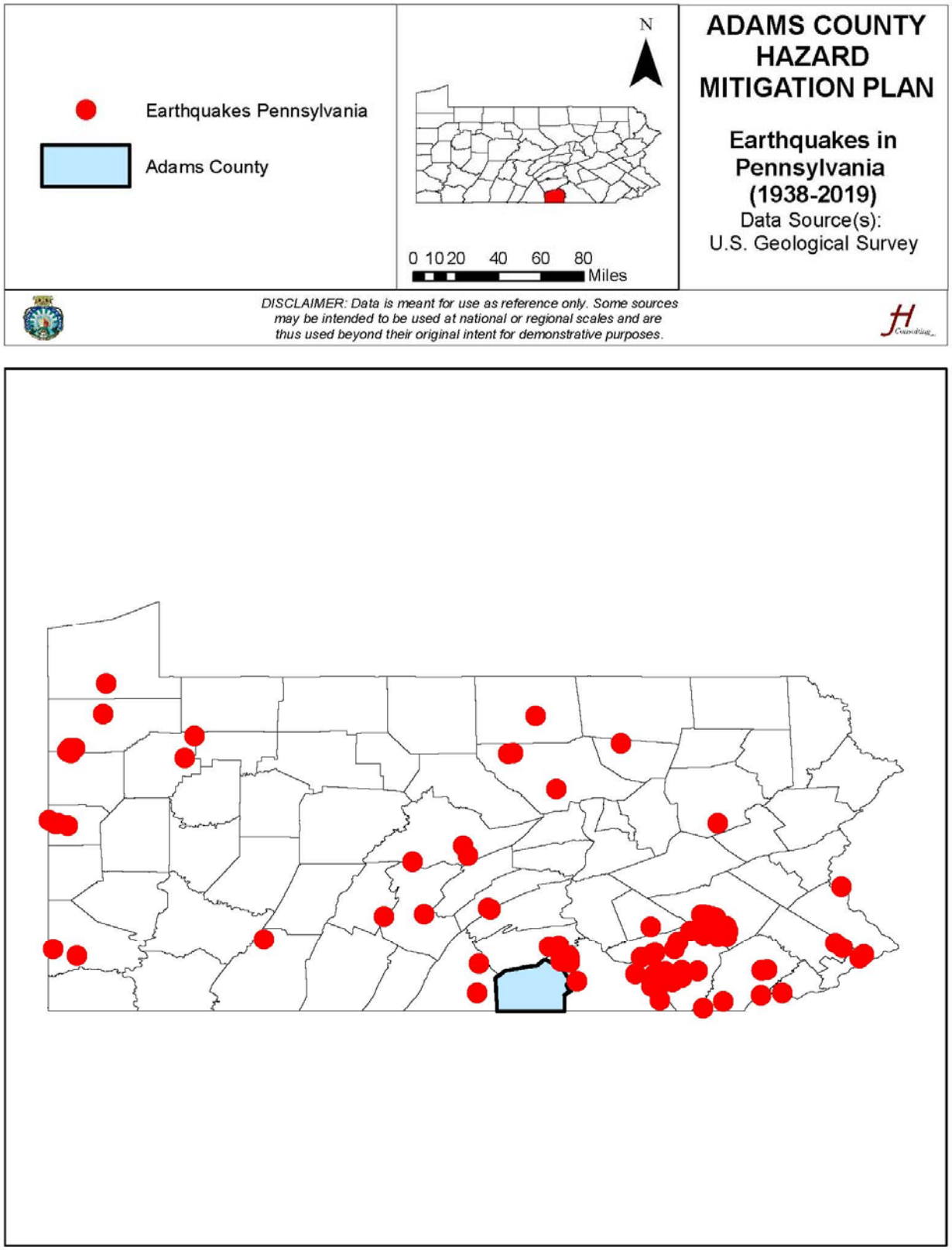
Cascading effects can include structural damage and utility and communication system

outages. The risk of fire also increases after an earthquake due to potentially-damaged gas pipelines and electrical lines. The greatest human risk during an earthquake is structure movement and collapse. Contents within structures may fall or fail and injure or kill the people inside.

4.3.2.3 Past Occurrence

The USGS keeps records of all earthquakes reported in the United States. There have been 126 earthquakes in Pennsylvania since 1938 (USGS, n.d.), with an average magnitude of 2.0 on the Richter scale. There have been no earthquakes with epicenters in Adams County, but there have been 36 small (generally less than 3.0 magnitude) earthquakes in the surrounding Cumberland, Franklin, and York Counties (with the largest being a 3.05 magnitude event on June 3, 2010, in northwestern York County. Figure 4.3.2.3-1 shows the earthquakes with epicenters in Pennsylvania (1938-2019).

Figure 4.3.2.3-1



4.3.2.4 Future Occurrence

Because there are no major faults located near Pennsylvania, future earthquakes in Adams County will most likely be small in magnitude and cause minimal, if any, damage. A worst-case scenario would be an earthquake of 6.0 magnitude or greater occurring in or near Adams County. Such an event would cause widespread damage to structures, utility services (especially underground water and gas pipelines), and transportation infrastructure.

4.3.2.5 Vulnerability Assessment

This section summarizes the vulnerability to Adams County from an earthquake. Adams County conducted an online survey for the public to share its thoughts on hazard vulnerabilities. Table 4.3.2.5-1 presents the results of that survey regarding earthquakes.

Table 4.3.2.5-1

PUBLIC SENTIMENT, EARTHQUAKE – ADAMS COUNTY					
Hazard	*Level of Concern*				*Total Responses*
	Not at All	*Somewhat*	*Concerned*	*Very*	
Earthquake	86 (59.31%)	53 (36.55%)	6 (4.14%)	0 (0.00%)	145
In the past ten years, do you remember this hazard occurring in your community?				45 (30.82%)	146
Have you noticed an increase or decrease in the occurrences or intensity of this hazard? (140 responses)				29 (20.71%)	INCREASE
				110 (78.57%)	NO CHANGE
				1 (0.71%)	DECREASE

Nationally, earthquakes cause $6.1 billion in damages each year. In Pennsylvania, there are fewer incidents than the national average, so this figure is much lower. According to the USGS, earthquakes cause less than $1 million in damages in Adams County. Table 4.3.2.5-2 below describes the vulnerability of Adams County to earthquakes.

Table 4.3.2.5-2

EARTHQUAKE VULNERABILITY SUMMARY			
Category	*Points*	*Description*	*Notes*
Frequency	2	Low	There have been no earthquakes with epicenters in Adams County, and very few felt earthquakes in the area.
Response	1	Less than half a day	Earthquakes felt in Adams County are usually small and result in minimal damage. They do not require an extended response.
Onset	4	Less than 6 hours	Earthquakes can happen at any time and occur spontaneously.
Magnitude	1	Less than 10%	Earthquakes in Adams County have not caused significant damage, and affect less than 10% of land area
Business	1	Less than 24 hours	Damage from earthquakes is minimal and would not affect the county's economy.
Human	1	Minimum	Human impacts from earthquakes are minimal in Adams County. There are no recorded injuries or deaths attributed to earthquakes.
Property	1	Less than 10%	Property damage from earthquakes in Adams County has been minimal.
Total	**11**	**Low**	

4.0 RISK ASSESSMENT

4.3.3 Extreme Temperatures

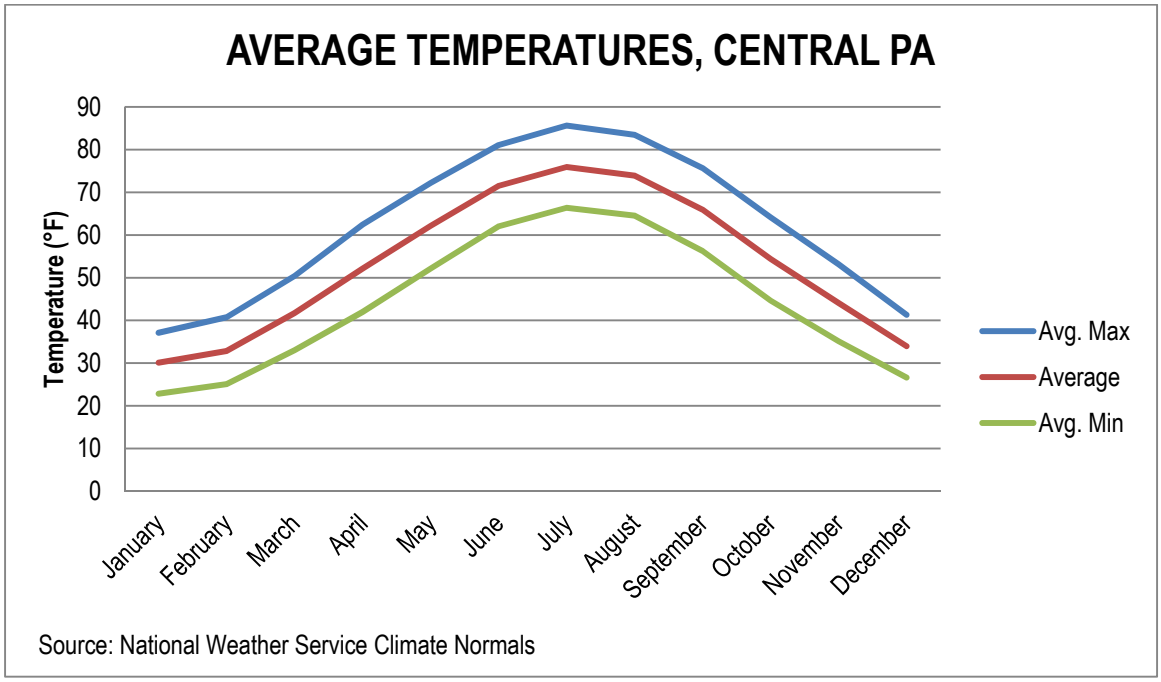
HIGHEST HIGH MEDIUM LOW LOWEST	Extreme temperatures are those 10° F or more above the average high or below the average low for an area.			
	Period of Occurrence:	June-September (Heat) December-February (Cold)	**Hazard Index Ranking:**	15-Low
	Warning Time:	12-24 Hours	**State Risk Ranking:**	2.3-Medium
	Type of Hazard:	Natural	**Disaster Declarations:**	N/A

For the 2020 update, extreme temperatures include both heat and cold events. Extreme cold temperatures drop well below normal for an area (typically 10° F or more) during the winter months and often accompany winter storm events. Combined with high wind speeds, such temperatures in Pennsylvania can be life-threatening to those exposed for extended periods. Extreme heat includes temperatures that hover 10° F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined (PEMA, 2013).

4.3.3.1 Location and Extent

Temperatures vary widely over a year, but each season has an average temperature range. The National Oceanic and Atmospheric Administration (NOAA) generates monthly "normal" reports from its different stations. Figure 4.3.3.1-1 below shows the average minimum and maximum temperatures for central Pennsylvania.

Figure 4.3.3.1-1



As shown in the figure, temperatures are typically highest from June to August and lowest from November to February. *Extreme* temperatures are those 10 degrees above or below the high or low temperature. For example, extremely cold temperatures for Adams County would be below approximately 12° F in January, and above approximately 96° F in July would constitute an extremely hot temperature.

Extreme temperatures affect each jurisdiction in Adams County equally. Although the temperatures may vary slightly across the county, the average of the county's temperatures and the extent of extremes are very similar. The National Weather Service, in collaboration with local partners, issues several heat-related products as conditions warrant. Descriptions of those products are in Table 4.3.3.1-2 below.

Table 4.3.3.1-2

NATIONAL WEATHER SERVICE TEMPERATURE-RELATED PRODUCTS	
Product	*Description*
Excessive Heat Warning	Issued within 12 hours of extremely dangerous heat conditions. Issued when the maximum heat index temperature is expected to be 105°F or higher for at least two days and night time air temperatures will not drop below 75°.
Excessive Heat Watch	Issued when conditions are favorable for an excessive heat event in the next 24 to 72 hours. Officials use a watch when the risk of a heatwave has increased, but its occurrence and timing is still uncertain.

NATIONAL WEATHER SERVICE TEMPERATURE-RELATED PRODUCTS	
Product	*Description*
Heat Advisory	Issued within 12 hours of the onset of extremely dangerous heat conditions. This Advisory is issued when the maximum heat index temperature is expected to be 100°F or higher for at least two days, and nighttime temperatures will not drop below 75°.
Excessive Heat Outlook	Issued when the potential exists for an excessive heat event in the next 3-7 days. It provides information to those who need considerable lead time to prepare for an event.
Frost Advisory	Issued when temperatures, winds, and sky cover are favorable for frost development. Frost advisories are most likely when temperatures are less than or equal to 36 degrees.
Freeze Watch	Freeze Watches are issued a few days ahead of a cold front in which temperatures are expected to be 29-32 degrees.
Freeze Warning	Freeze Warnings are issued when low temperatures are expected to be 29-32 degrees.
Hard Freeze Watch	Hard Freeze Watches are issued days ahead of a cold front in which temperatures are expected to be 28 degrees or less.
Hard Freeze Warning	Hard Freeze Warnings issued when temperatures are expected to be 28 degrees or less

4.3.3.2 Range of Magnitude

Extreme temperatures tend to affect the population's health rather than infrastructure. The extent of damage to infrastructure consists of broken pipes and cracks in the pavement due to expansion/contraction during extreme cold events and power outages during both extreme heat and cold events.

Extreme heat can impact health in a variety of ways. High temperatures can trigger a variety of heat stress conditions such as heat stroke, heat exhaustion, heat cramps, sunburn, and heat rash. These conditions are exacerbated by high relative humidity. High humidity reduces the ability of sweat to evaporate from the skin, reducing the body's ability to cool itself. Prolonged exposure to heat can necessitate medical intervention; in extreme cases, prolonged exposure could cause death. Since 1999, 508 people have died of heat-related illnesses in Pennsylvania (CDC, 2019). The table below outlines the possible heat disorders for people in high-risk groups (i.e., children, elderly, etc.).

Table 4.3.3.2-1

HEAT RISKS	
Heat Index	*Possible Heat Disorders for People in High-Risk Groups*
80°F-90°F	Fatigue possible with prolonged exposure to physical activity
90°F -105°F	Sunstroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity
105°F -130°F	Sunstroke, heat cramps, or heat exhaustion likely, and heatstroke possible with prolonged exposure and/or physical activity
130°F +	Heat/Sunstroke highly likely with continued exposure
Source: https://nws.weather.gov/blog/nwsdesmoines/2014/06/06/iowa-heat-awareness-day-june-5-2014-2/	

Like extreme heat, extreme cold temperatures can cause serious human impacts. When exposed to cold temperatures, the human body begins to lose heat faster than it can be produced. Prolonged exposure to such temperatures will use up the entirety of the body's stored energy, causing cold-related illnesses such as hypothermia, frostbite, trench foot, and chilblains (CDC, 2018).

Individuals most likely to experience the negative effects of extreme heat include those 65 years and older, children younger than two, and people with chronic diseases (CDC, 2018). These individuals should limit outdoor activity during the warmest parts of the day and wear appropriate clothing and sun protection. Those most susceptible to cold include older adults, children, people who remain outdoors for extended periods, and those who use alcohol or illicit drugs. These individuals, to the extent possible, should minimize time spent outdoors and dress in appropriate clothing that minimizes skin exposure to the cold. The following maps show concentrations of the elderly (i.e., 65 and over) as well as children (i.e., 18 and under) in Adams County.

Figure 4.3.3.2-2

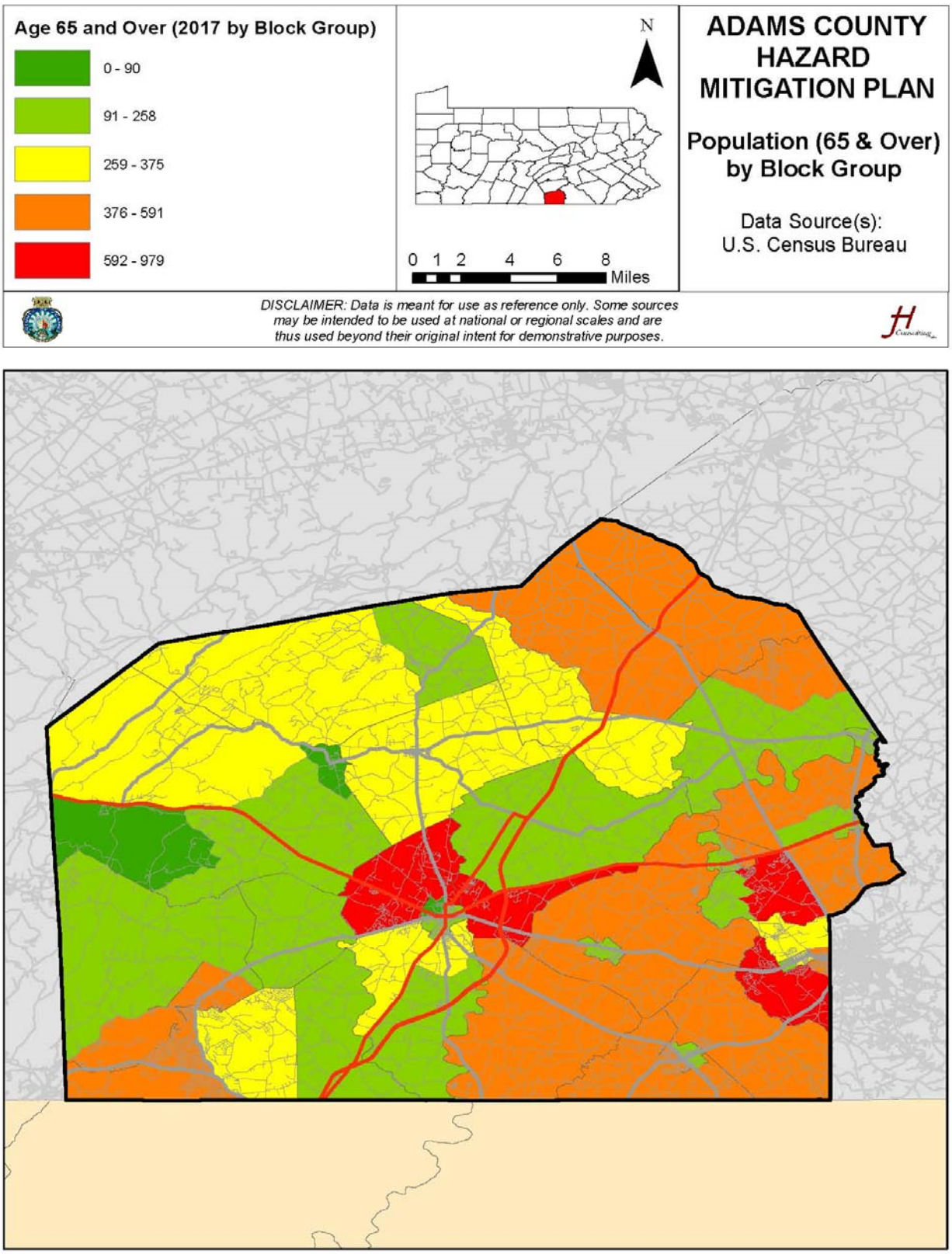
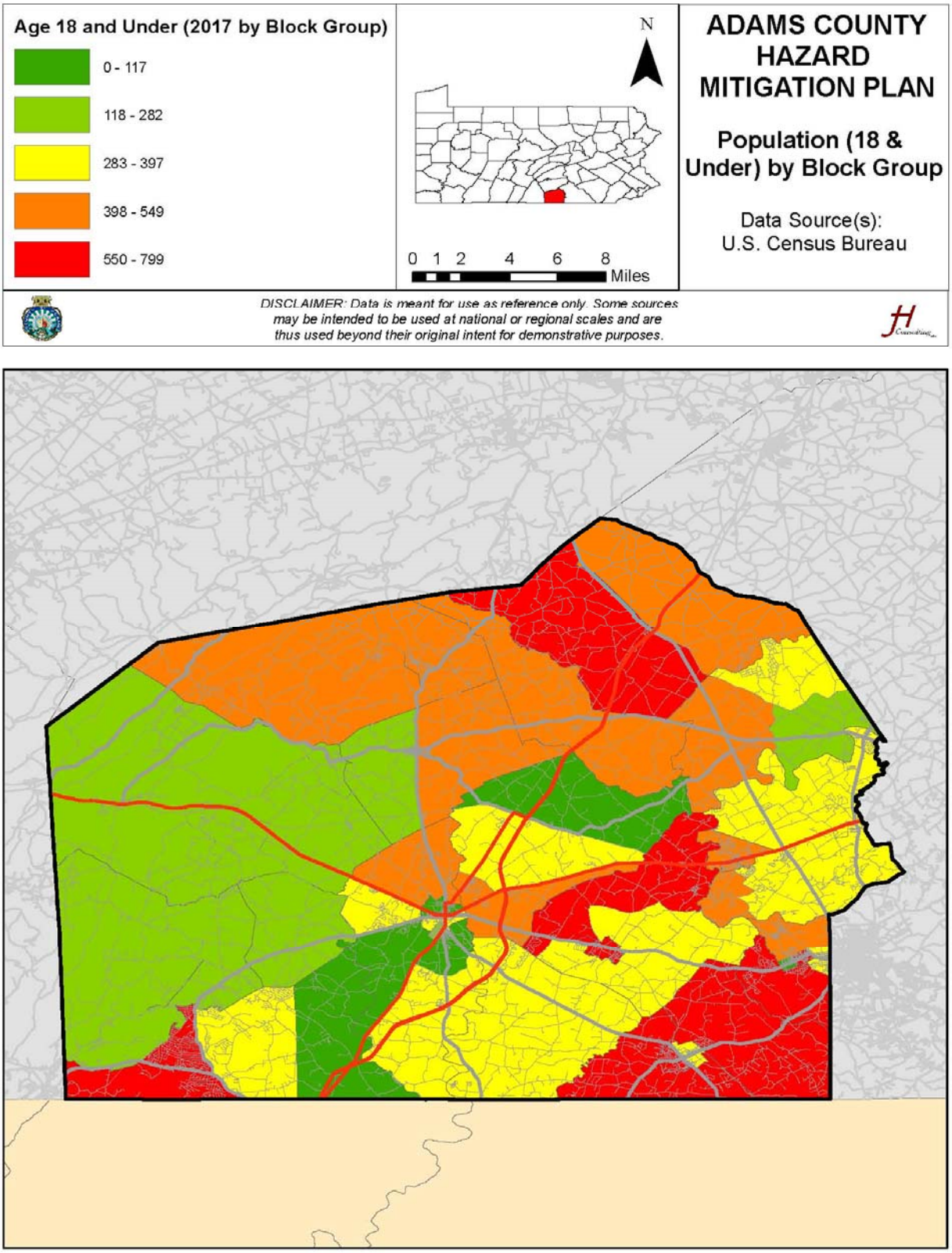
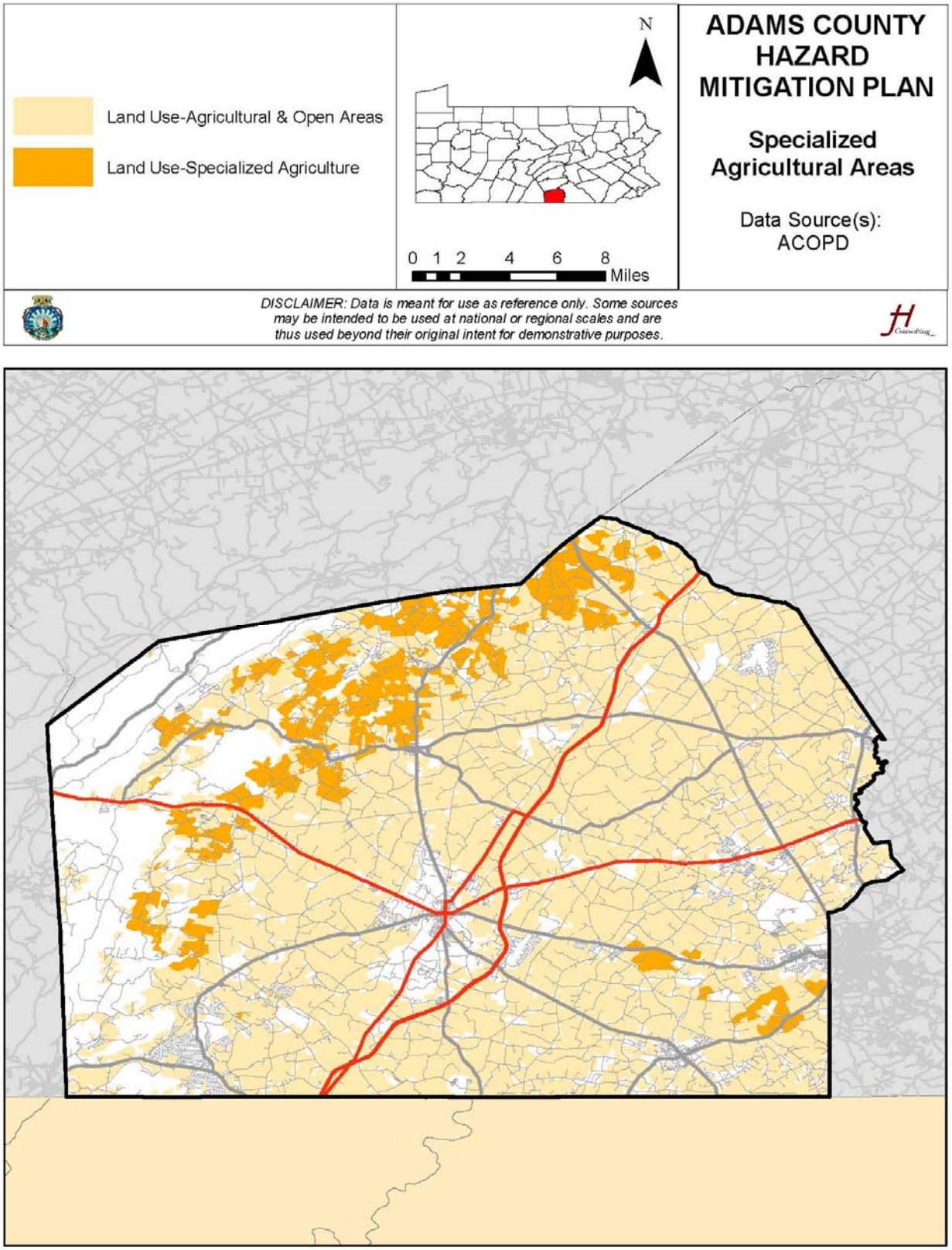


Figure 4.3.3.2-3



Adams County's agricultural industry is also susceptible to the effects of extreme heat and cold events, particularly if these events occur earlier or later in the year than expected. Fruit trees are particularly susceptible to cold weather; apple buds die at temperatures between -25 and -32 degrees Fahrenheit, while peach buds are even more sensitive to cold temperatures (Cornell, 2018). Figure 4.3.3.2-4 highlights the agricultural areas of Adams County, which would experience significant impacts of extreme temperatures.

Figure 4.3.3.2-4



4.3.3.3 Past Occurrence

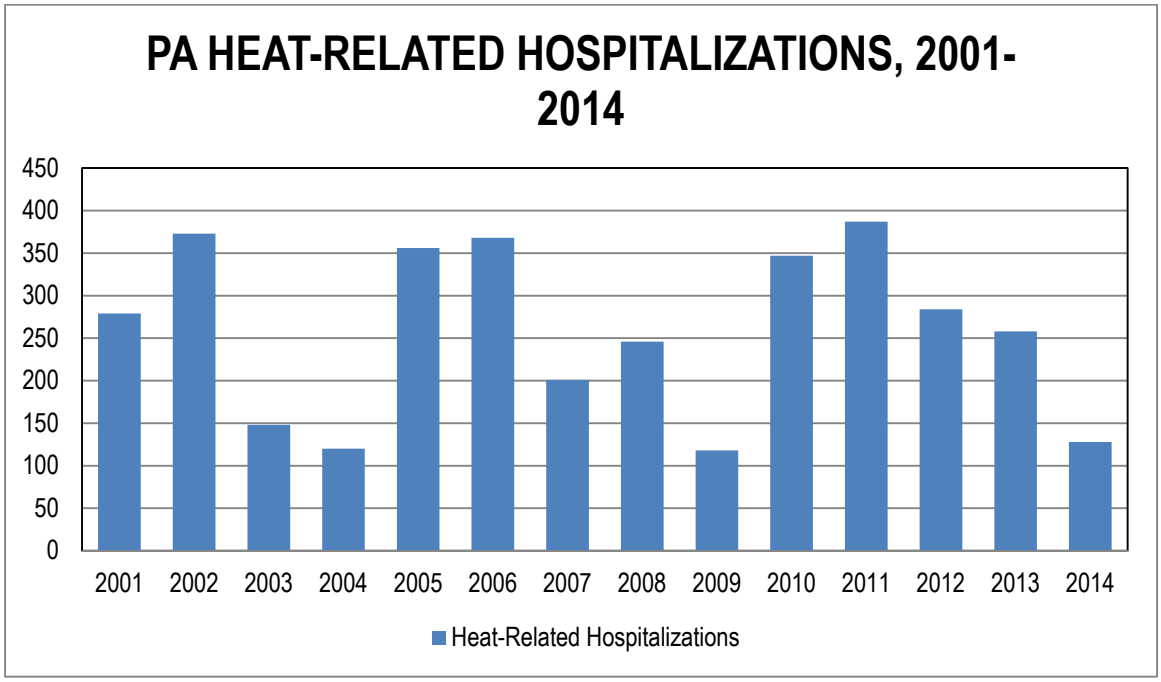
The National Centers for Environmental Information's database keeps detailed records of past weather events. There have been ten incidences of extreme temperatures in Adams County since 1999. Table 4.3.3.3-1 describes these incidents.

Table 4.3.3.3-1

EXTREME TEMPERATURE EVENTS IN ADAMS COUNTY, 1999-2019						
Location	*Date*	*Type*	*Deaths*	*Injuries*	*Property Damage*	*Crop Damage*
Adams (Zone)	7/5/1999	Heat	0	0	$0.00	$0.00
Adams (Zone)	7/17/2006	Heat	0	0	$0.00	$0.00
Adams (Zone)	7/18/2006	Heat	0	0	$0.00	$0.00
Adams (Zone)	7/31/2006	Heat	0	0	$0.00	$0.00
Adams (Zone)	8/1/2006	Heat	0	0	$0.00	$0.00
Adams (Zone)	2/5/2007	Extreme Cold/wind Chill	0	0	$0.00	$0.00
Adams (Zone)	7/21/2011	Excessive Heat	0	0	$0.00	$0.00
Adams (Zone)	2/15/2015	Extreme Cold/wind Chill	0	0	$0.00	$0.00
Adams (Zone)	7/25/2016	Excessive Heat	0	0	$0.00	$0.00
Adams (Zone)	7/2/2018	Excessive Heat	0	0	$0.00	$0.00
		TOTALS	**0**	**0**	**$0.00**	**$0.00**

The Pennsylvania Department of Health maintains a database of hospital admissions for heat-related illnesses. Figure 4.3.3.3-2 below shows the number of heat-related hospitalizations in the state from 2001 to 2014. Years with a recorded extreme heat event (for example, 2006 and 2011) generally had more heat-related hospitalizations than years with no recorded heat event.

Figure 4.3.3.3-2



4.3.3.4 Future Occurrence

Adams County has experienced ten extreme temperature events in the past 20 years; thus, the county has approximately a 50% chance of experiencing an extreme temperature event on any given year. Extreme heat events will likely occur during summer months (June to September), and extreme cold events likely occur during winter months (December to February).

4.3.3.5 Vulnerability Assessment

This section summarizes the vulnerability to Adams County from extreme temperatures. Adams County conducted an online survey for the public to share its thoughts on hazard vulnerabilities. Table 4.3.3.5-1 presents the results of that survey regarding extreme temperature.

Table 4.3.3.5-1

PUBLIC SENTIMENT, EXTREME TEMPERATURE – ADAMS COUNTY					
Hazard	*Level of Concern*				*Total Responses*
	Not at All	*Somewhat*	*Concerned*	*Very*	
Extreme Temperature	48 (32.65%)	58 (39.46%)	32 (21.77%)	9 (6.12%)	147
In the past ten years, do you remember this hazard occurring in your community?				64 (43.84%)	146
Have you noticed an increase or decrease in the occurrences or intensity of this hazard? (142 responses)				71 (50.00%)	INCREASE
				68 (47.89%)	NO CHANGE
				3 (2.11%)	DECREASE

Table 4.3.3.5-2 summarizes Adams County's vulnerability to extreme temperature events.

Table 4.3.3.5-2

EXTREME TEMPERATURES VULNERABILITY SUMMARY			
Category	*Points*	*Description*	*Notes*
Frequency	3	May or may not occur	There have been ten extreme temperature events in Adams County since 1999, for an average of 0.5 events per year. This suggests that there is approximately a 50% chance of an extreme temperature event occurring in any given year.
Response	1	Less than one day	Extreme temperatures would not require an elevated response.
Onset	1	Over 24 hours	Extreme temperature events develop over a few days or weeks and occur during the warmest and coolest months.
Magnitude	5	N/A	Extreme temperature events would affect the entire region, not just Adams County.
Business	1	Less than 24 hours	The county's economy would not typically be affected by extreme temperature events.
Human	3	Medium	Although no injuries or deaths occurred due to extreme temperatures in Adams County, extreme heat is responsible for more deaths in PA than all other natural hazards combined.
Property	1	Less than 10% of property	Extreme heat does not typically affect the property. Damages from the extreme cold would be minimal.
Total	**15**	**Low**	

4.0 RISK ASSESSMENT

4.3.4 Flood, Flash Flood, Ice Jam

HIGHEST HIGH MEDIUM LOW LOWEST	Flooding is the temporary condition of partial or complete inundation of normally dry land, and it is the most frequent and costly of all hazards in Pennsylvania			
	Period of Occurrence:	Floods typically occur after prolonged periods of precipitation.	**Hazard Index Ranking:**	19-Medium
	Warning Time:	12-24 Hours	**State Risk Ranking:**	3.4-Highest
	Type of Hazard:	Natural	**Disaster Declarations:**	DR-485 DR-523 DR 1093 DR-1120 DR-1649 DR-3340 DR-4030 DR-4374 EM-3356

Flooding is the temporary condition of partial or complete inundation of normally dry land, and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. Generally, flooding occurs when precipitation occurs over a given river basin for an extended period. Flash flooding is usually a result of heavy localized precipitation falling in a short period over a given location, often along mountain streams and in urban areas where much of the ground is covered by impervious surfaces. The severity of a flood event is dependent upon a combination of stream and river basin topography and physiography, hydrology, precipitation and weather patterns, present soil moisture conditions, the degree of vegetative clearing as well as the presence of impervious surfaces in and around flood-prone areas (PEMA, 2018).

Winter flooding can include ice jams which occur when warm temperatures and heavy rain cause snow to melt rapidly. Snowmelt combined with heavy rains can cause frozen rivers to swell, which breaks the ice layer on top of a river. The ice layer often breaks into large chunks, which float downstream, piling up in narrow passages and near other obstructions such as bridges and dams. All forms of flooding can damage infrastructure (PEMA, 2018).

4.3.4.1 Location and Extent

The depth of floodwaters and the probability of occurrence were used to describe floods

in the past. As such, "100-year flood," "500-year flood," and similar terminology, was used when describing floods. Unfortunately, the public logically assumed a flood that a "100-year" flood happens every 100 years or a "500-year" flood happens every 500 years. A better representation of flood risk is the percent chance of a flood happening in a given year. So, a 100-year flood is a flood level that has a 1% chance of occurring in any given year; a 500-year flood has a 0.5% chance of occurring in any given year, and so on.

When structures experience more than one loss due to flooding, they can become repetitive loss or severe repetitive loss properties. The Flood Mitigation Assistance (FMA) grant and the National Flood Insurance Program (NFIP) both track losses due to flooding. Each program defines repetitive loss and severe repetitive loss properties slightly differently. Table 4.3.4.1-1 provides both definitions of repetitive loss and severe repetitive loss properties.

Table 4.3.4.1-1

REPETITIVE LOSS AND SEVERE REPETITIVE LOSS DEFINITIONS		
Program	*Repetitive Loss*	*Severe Repetitive Loss*
Flood Mitigation Assistance (FMA) Grant	*A Repetitive Loss (RL) property is a structure covered by a contract for flood insurance made available under the NFIP that:* Has incurred flood-related damage on two occasions, in which the cost of the repair, on the average, equaled or exceeded 25% of the market value of the time of each such flood event; At the time of the second incidence of flood-related damage, the contract for flood insurance contains increased cost of compliance coverage.	(a) Is covered under a contract for flood insurance made available under the NFIP; and (b) Has incurred flood-related damage i. For <u>which 4 or more separate claims payments</u> (includes building and contents) have been made under flood insurance coverage with the amount of each such claim exceeding $5,000, and with the cumulative amount of such claim's payments exceeding $20,000, or ii. For which <u>at least 2 separate claims payments</u> (includes only building) have been made under such coverage, with the cumulative amount of such claims exceeding the market value of the insured structure.
National Flood Insurance Program (NFIP)	A Repetitive Loss (RL) property is any insurable building for which two or more claims of more than $1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period since 1978.	A single-family property (consisting of 1 to 4 residences) that is covered under flood insurance by the NFIP and has incurred flood-related damage for which 4 or more separate claims payments have been paid under flood insurance coverage, with the amount of each claim payment exceeding $5,000 and with a cumulative amount of such claims payments exceeding $20,000; or for which at least 2 separate claims payments have been made with the cumulative amount of such claims exceeding the reported value of the property.

According to the Pennsylvania Emergency Management Agency, there are seven severe repetitive loss properties and thirty-five repetitive loss properties in Adams County. Tables 4.3.4.1-2 and 4.3.4.1-3 respectively list the municipality, losses, and payments associated with these properties.

Table 4.3.4.1-2

ADAMS COUNTY SEVERE REPETITIVE LOSS PROPERTIES							
Community Name (Jurisdiction)	*Occupancy*	*Zone*	*Losses*	*Building Payments*	*Contents Payments*	*Total Paid*	*Average Payment*
Reading Township	Single Family	A	3	$89,166.78	$14,917.80	$104,084.58	$34,694.86
Reading Township	Single Family	AE	5	$71,957.54	$26,106.63	$98,064.17	$19,612.83
Reading Township	Single Family	A12	4	$110,815.32	$14,805.53	$125,620.85	$31,405.21
Reading Township	Single Family	A12	6	$86,561.93	$12,913.26	$99,475.19	$16,579.20
Reading Township	Single Family	AE	4	$74,403.66	$0.00	$74,403.66	$18,600.92
Reading Township	Single Family	C	5	$185,238.39	$22,406.54	$207,644.93	$41,528.99
Reading Township	Single Family	A	6	$168,743.83	$22,940.33	$191,684.16	$31,947.36

Table 4.3.4.1-3

ADAMS COUNTY REPETITIVE LOSS PROPERTIES							
Community Name (Jurisdiction)	*Occupancy*	*Zone*	*Losses*	*Building Payments*	*Contents Payments*	*Total Paid*	*Average Payment*
Abbottstown Borough	Assmd Condo	AE	2	$9,978.18	$9,549.72	$19,527.90	$9,763.95
Butler Township	Single Family	X	7	$37,427.80	$11,602.24	$49,030.04	$7,004.29
Carroll Valley Borough	Single Family	AE	2	$17,131.70	$1,462.70	$18,594.40	$9,297.20
Cumberland Township	Single Family	C	3	$37,000.00	$6,627.04	$43,627.04	$14,542.35
Cumberland Township	Other Residential	X	2	$52,794.01	$0.00	$52,794.01	$26,397.01
East Berlin Borough	Single Family	B	2	$19,996.70	$944.55	$20,941.25	$10,470.63
East Berlin Borough	Single Family	EMG	2	$2,141.20	$2,242.90	$4,384.10	$2,192.05
Franklin Township	Single Family	A	2	$29,261.39	$0.00	$29,261.39	$14,630.70
Gettysburg Borough	Assmd Condo	B	3	$285,812.73	$0.00	$285,812.73	$95,270.91
Gettysburg Borough	Single Family	A04	2	$34,577.87	$10,000.00	$44,577.87	$22,288.94
Gettysburg Borough	2-4 Family	B	3	$17,481.63	$104.92	$17,586.55	$5,862.18
Hamilton Township	Single Family	A12	2	$8,822.63	$13,542.08	$22,364.71	$11,182.36
Hamilton Township	Single Family	A12	2	$70,787.30	$9,254.08	$80,041.38	$40,020.69
Hamilton Township	Single Family	X	2	$35,393.37	$19,845.00	$55,238.37	$27,619.19
Highland Township	Other-Non-residential	A	7	$152,650.48	$48,505.66	$201,156.14	$28,736.59

ADAMS COUNTY REPETITIVE LOSS PROPERTIES							
Community Name (Jurisdiction)	*Occupancy*	*Zone*	*Losses*	*Building Payments*	*Contents Payments*	*Total Paid*	*Average Payment*
Mount Pleasant Township	Single Family	AE	2	$6,494.54	$0.00	$6,494.54	$3,247.27
Oxford Township	2-4 Family	X	2	$11,619.56	$4,836.84	$16,456.40	$8,228.20
Reading Township	Single Family	C	2	$9,710.58	$41,154.67	$50,865.25	$25,432.63
Reading Township	Single Family	A	2	$75,188.24	$0.00	$75,188.24	$37,594.12
Reading Township	Single Family	A	3	$89,166.78	$14,917.80	$104,084.58	$34,694.86
Reading Township	Single Family	B	4	$14,826.76	$3,929.46	$18,756.22	$4,689.06
Reading Township	Single Family	AE	5	$71,957.54	$26,106.63	$98,064.17	$19,612.83
Reading Township	Single Family	A12	3	$33,651.93	$11,850.04	$45,501.97	$15,167.32
Reading Township	Single Family	A12	4	$110,815.32	$14,805.53	$125,620.85	$31,405.21
Reading Township	Single Family	A12	6	$86,561.93	$12,913.26	$99,475.19	$16,579.20
Reading Township	Single Family	A12	4	$44,216.92	$22,971.58	$67,188.50	$16,797.13
Reading Township	Single Family	AE	6	$29,270.00	$21,057.53	$50,327.53	$8,387.92
Reading Township	Single Family	A12	4	$20,475.42	$4,677.36	$25,152.78	$6,288.20
Reading Township	Single Family	AE	4	$74,403.66	$0.00	$74,403.66	$18,600.92
Reading Township	Single Family	C	5	$25,840.96	$12,656.48	$38,497.44	$7,699.49
Reading Township	Single Family	A12	5	$84,913.58	$1,069.91	$85,983.49	$17,196.70
Reading Township	Single Family	C	5	$185,238.39	$22,406.54	$207,644.93	$41,528.99
Reading Township	Single Family	A	6	$168,743.83	$22,940.33	$191,684.16	$31,947.36
Reading Township	Single Family	A12	3	$19,807.52	$7,760.52	$27,568.04	$9,189.35
Reading Township	Single Family	A	3	$47,073.84	$5,356.81	$52,430.65	$17,476.88

All of Adams County's severe repetitive loss properties and 18 (51%) repetitive loss properties are located in Reading Township.

4.3.4.2 Range of Magnitude

Hazards associated with flooding can be primary, secondary, or tertiary. Typically, primary hazards are those that occur due to contact with water. Secondary effects are those

that occur because of flooding, such as the disruption of services, or health impacts. Tertiary effects are continued effects, such as the change in the position of river channels. Table 4.3.4.2-1 provides examples of each of these effects.

Table 4.3.4.2-1

EFFECTS OF FLOODING	
Type	*Description*
Primary Effects	• With higher velocities, streams can transport larger particles as suspended load. Such large particles include not only rocks and sediment, but, during a flood, could include such large objects as automobiles, houses, and bridges. • Floodwaters can accomplish massive amounts of erosion. Such erosion can undermine bridge structures, levees, and buildings, causing their collapse. • Water entering human-built structures cause water damage. Even with minor flooding of homes, furniture is ruined, floors and walls are damaged, and anything that comes in contact with the water is likely to be damaged or lost. Flooding of automobiles usually results in damage that cannot easily be repaired. • The high velocity of floodwaters allows the water to carry more sediment as a suspended load. When the floodwaters retreat, velocity is generally much lower, and sediment is deposited. After the retreat of the floodwaters, everything is usually covered with a thick layer of stream deposited mud, including the interior of buildings. • Flooding of farmland usually results in crop loss. Livestock, pets, and other animals are often carried away and drown. • Humans that get caught in the high-velocity floodwaters can drown in the water. • Floodwaters can concentrate garbage, debris, and toxic pollutants that can cause the secondary effects of health hazards.
Secondary Effects	**Disruption of services -** • Drinking water supplies may become polluted, especially if sewerage treatment plants are flooded. This may result in disease and other health effects. • Gas and electrical service may be disrupted. • Transportation systems may be disrupted, resulting in shortages of food and clean-up supplies.
Tertiary Effects	• The location of river channels may change as the result of flooding, new channels develop, leaving the old channels dry. • Sediment deposited by flooding may destroy farmland (although silt deposited by floodwaters could also help to increase agricultural productivity). • Jobs may be lost due to the disruption of services, destruction of business, etc. • Insurance rates may increase. • Destruction of wildlife habitat.
Source: https://www.tulane.edu/~sanelson/Natural_Disasters/floodhaz.htm	

4.3.4.3 Past Occurrence

The National Center for Environmental Information's Storm Event Database keeps records of severe weather events in the United States. Table 4.3.4.3-1 below describes the NCEI flood events in Adams County since 1996.

Table 4.3.4.3-1

FLOOD EVENTS IN ADAMS COUNTY, 1996-2019						
Location	*Date*	*Type*	*Deaths*	*Injuries*	*Property Damage*	*Crop Damage*
Adams (Zone)	1/19/1996	Flood	0	0	$0.00	$0.00
Adams (Zone)	5/16/2003	Flood	0	0	$0.00	$0.00
Adams (Zone)	12/11/2003	Flood	0	0	$0.00	$0.00
Adams (Zone)	2/6/2004	Flood	0	0	$0.00	$0.00
Adams (Zone)	9/17/2004	Flood	0	0	$0.00	$0.00
Adams (Zone)	9/28/2004	Flood	0	0	$0.00	$0.00
Adams (Zone)	3/28/2005	Flood	0	0	$0.00	$0.00
Adams (Zone)	4/2/2005	Flood	0	0	$0.00	$0.00
Countywide	6/28/2006	Flood	0	0	$0.00	$0.00
New Oxford	4/15/2007	Flood	0	0	$0.00	$0.00
Fountain Dale	3/5/2008	Flood	0	0	$0.00	$0.00
Orrtanna	1/25/2010	Flood	0	0	$10,000.00	$0.00
Fountain Dale	3/10/2011	Flood	0	0	$0.00	$0.00
Peach Glen	9/23/2011	Flood	0	0	$0.00	$0.00
Trust	10/29/2012	Flood	0	0	$0.00	$0.00
Trust	1/31/2013	Flood	0	0	$0.00	$0.00
Trust	10/10/2013	Flood	0	0	$0.00	$0.00
Trust	3/30/2014	Flood	0	0	$0.00	$0.00
Trust	4/30/2014	Flood	0	0	$0.00	$0.00
Trust	5/16/2014	Flood	0	0	$0.00	$0.00
Heidlersburg	7/22/2018	Flood	1	0	$0.00	$0.00
		TOTALS	**1**	**0**	**$10,000.00**	**$0.00**

There have been 21 flood events in Adams County over the past 23 years. Of these floods, only one caused reported property damage, one caused a death, and none caused any reported crop damage. The average property damage due to flooding, based on NCEI data, is $476 per event.

January 2010 Floods

In January of 2010, heavy rainfall between one and four inches produced widespread flooding across much of central Pennsylvania. Snow and ice melt contributed to enhanced runoff, especially across higher elevations. Between three and four inches of rain caused widespread flooding that occurred in Tom's Creek and Middle Creek in the Orrtanna area in Adams County. Officials closed over 75 roads due to flooding throughout the county. The most affected areas were along Conewago Creek, including Table Rock and East Berlin. This event caused 10,000 in property damage, making it the most significant flood in the county.

July 2018

On July 22, 2019, there were floods across southern Pennsylvania. After days of

downpours, flooding prompted water rescues from homes and vehicles in several areas and the closure of dozens of roads in the area. One person was reported missing during the flood; the Adams County Coroner told local news sources that they were swept away after exiting their vehicle in an attempt to walk to safety.

There have been 26 flash flood events in Adams County since 1996. Table 4.3.4.3-2 below details these flash flood events.

Table 4.3.4.3-2

FLASH FLOOD EVENTS IN ADAMS COUNTY, 1996-2019						
Location	*Date*	*Type*	*Deaths*	*Injuries*	*Property Damage*	*Crop Damage*
Countywide	1/19/1996	Flash Flood	0	0	$0.00	$0.00
Gettysburg	6/18/1996	Flash Flood	0	0	$0.00	$0.00
Biglerville	6/20/1996	Flash Flood	0	0	$0.00	$0.00
Gettysburg	9/6/1996	Flash Flood	0	0	$0.00	$0.00
Countywide	12/13/1996	Flash Flood	0	0	$0.00	$0.00
North Portion	9/11/1997	Flash Flood	0	0	$0.00	$0.00
West Portion	11/7/1997	Flash Flood	0	0	$0.00	$0.00
Countywide	1/8/1998	Flash Flood	0	0	$0.00	$0.00
Countywide	3/21/1998	Flash Flood	0	0	$0.00	$0.00
Countywide	9/16/1999	Flash Flood	0	0	$20,000.00	$0.00
Biglerville	9/1/2000	Flash Flood	0	0	$20,000.00	$0.00
York Springs	6/21/2003	Flash Flood	0	0	$0.00	$0.00
Gettysburg	9/23/2003	Flash Flood	0	0	$0.00	$0.00
Biglerville	6/14/2004	Flash Flood	0	0	$0.00	$0.00
Heidlersberg	7/7/2005	Flash Flood	0	0	$0.00	$0.00
Bonneauville	8/7/2005	Flash Flood	0	0	$0.00	$0.00
Gettysburg	6/25/2006	Flash Flood	0	0	$0.00	$0.00
Countywide	6/27/2006	Flash Flood	1	0	$0.00	$0.00
Mummasburg	8/12/2010	Flash Flood	0	0	$10,000.00	$0.00
Wenksville	4/16/2011	Flash Flood	0	0	$0.00	$0.00
Arendtsville	4/28/2011	Flash Flood	0	0	$0.00	$0.00
East Berlin	9/11/2011	Flash Flood	0	0	$64,000.00	$0.00
Greenmount	9/23/2011	Flash Flood	0	0	$0.00	$0.00
Greenmount	9/27/2011	Flash Flood	0	0	$0.00	$0.00
Gettysburg	9/18/2012	Flash Flood	0	0	$0.00	$0.00
Biglerville	8/20/2015	Flash Flood	0	0	$0.00	$0.00
Littlestown	7/5/2019	Flash Flood	0	0	$0.00	$0.00
Whitehall	7/5/2019	Flash Flood	0	0	$0.00	$0.00
		TOTALS	**1**	**0**	**$114,000.00**	**$0.00**

Of the 26 flash flood events in Adams Count over the past 23 years, four have caused reported property damage, and none caused reported crop damage. The average property damage caused by flash floods is $4,384 per event. The most significant event occurred in

September of 2011, caused by the remnants of Tropical Storm Lee.

September 2011

In September of 2011, the remnants of Tropical Storm Lee caused significant flood and flash flood activity near and to the east of the Susquehanna Valley. The storm caused between five and twelve inches of rainfall in areas of Adams County. Several roads were closed, and responders performed water rescues in the East Berlin region. Approximately 60 structures reported major damage, and 64 reported minor damage. This event caused $63,850 in damage to public property and was the most significant flash flood event in Adams County.

October 2019

On October 31, 2019, flash flooding affected several counties in southern Pennsylvania. Multiple roads, including parts of Interstate 83, closed due to flooding, and vehicles could not navigate the floodwaters. During this event, runoff in Gettysburg left 2 feet of water in the basement of a historic home on Baltimore Street, and nearly 50,000 customers throughout Pennsylvania lost power during this rain.

The above tables and narratives do not provide data on crop losses, though local officials know of weather-related agricultural impacts. Adams County received three USDA Secretarial Designations in 2018 for excessive moisture, heavy rain, and flood/flash flood incidents, S4356, S4445, and S4465 (USDA FSA, n.d.). Aggregated 2018 data from EWG's *Farm Subsidies Database* reports that Adams County farmers received $80,738 worth of disaster assistance program benefits in 2018. Of that total, $74,066 were under the "Miscellaneous" category (which includes the crop disaster, quality losses, and non-insured assistance programs), and the remaining $6,672 was under the "Livestock Disaster/Emergency" category (which consists of the livestock compensation and livestock emergency assistance programs) (EWG, n.d.).

4.3.4.4 Future Occurrence

Floods can occur at any time but are most likely to occur from March to September. A potential worst-case flood scenario would be periods of heavy rain falling in areas already inundated with water, areas with inadequate stormwater management systems, and areas located near water sources (i.e., rivers, lakes, streams, and ponds). Areas located in a floodplain or floodway will likely be the most significantly impacted by future events.

4.3.4.5 Vulnerability Assessment

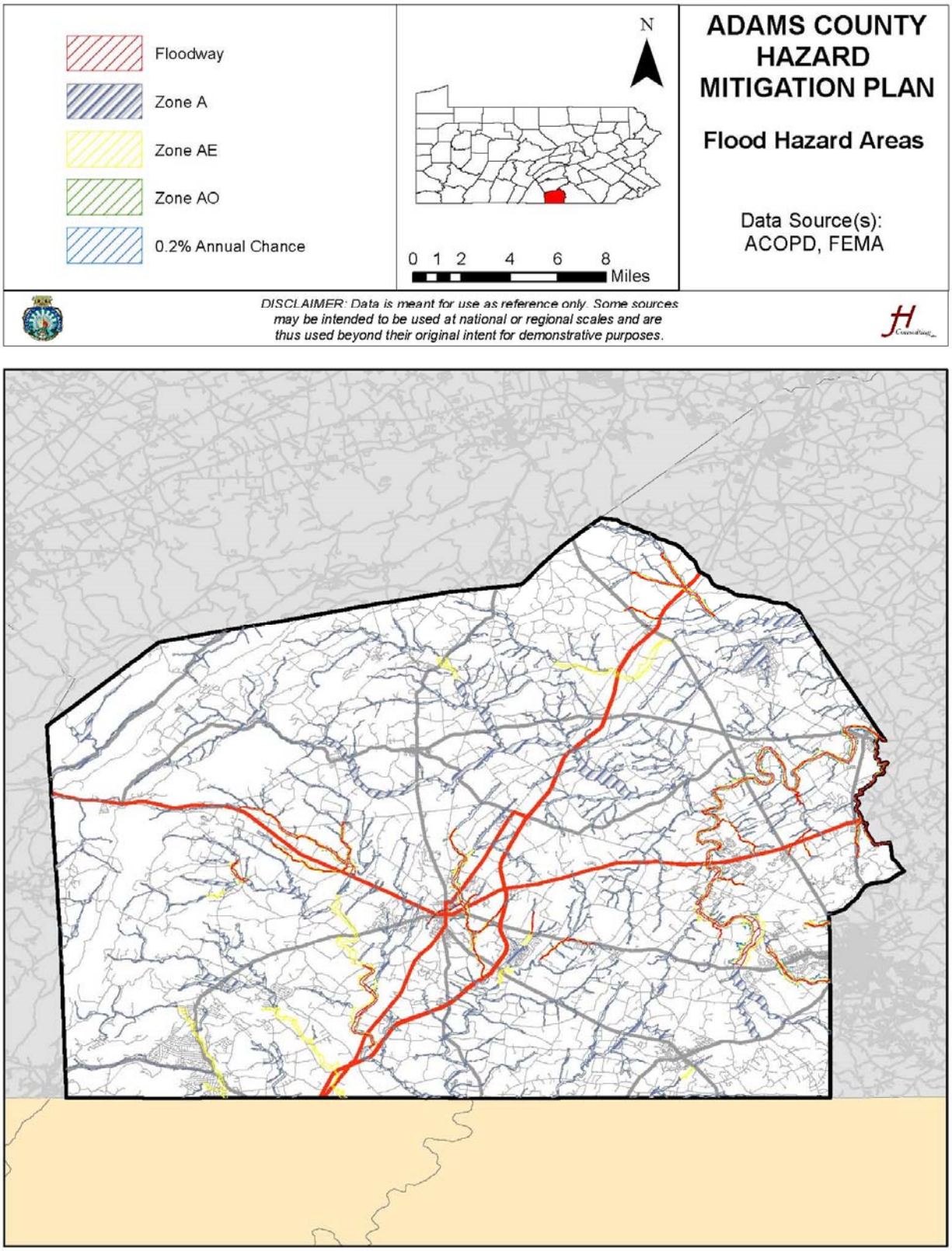
This section summarizes the vulnerability to Adams County from flooding. Adams County conducted an online survey for the public to share its thoughts on hazard vulnerabilities. Table 4.3.4.5-1 presents the results of that survey regarding flooding.

Table 4.3.4.5-1

PUBLIC SENTIMENT, FLOOD, FLASH FLOOD, ICE JAM – ADAMS COUNTY					
Hazard	*Level of Concern*				*Total Responses*
	Not at All	*Somewhat*	*Concerned*	*Very*	
Flood, Flash Flood, Ice Jam	43 (29.25%)	56 (38.10%)	33 (22.45%)	15 (10.20%)	147
In the past ten years, do you remember this hazard occurring in your community?				78 (53.42%)	146
Have you noticed an increase or decrease in the occurrences or intensity of this hazard? (139 responses)				60 (43.17%)	INCREASE
				77 (55.40%)	NO CHANGE
				2 (1.44%)	DECREASE

Given the presence of special flood hazard areas and the availability of building footprint data from the Adams County Office of Planning and Development, planners examined the structures that could see future flood impacts. Figure 4.3.4.5-2 shows the special flood hazard area at the county level. See Appendix D for flood maps at the municipal level (that also identify potentially-impacted critical facilities).

Figure 4.3.4.5-2



Based on past occurrences, Adams County can expect to experience at least one flood or flash flood event in any given year. Table 4.3.4.5-3 gives an overview of Adams County's vulnerability to flooding and flash flooding.

Table 4.3.4.5-3

FLOOD, FLASH FLOOD, ICE JAM VULNERABILITY SUMMARY			
Category	*Points*	*Description*	*Notes*
Frequency	5	Excessive	There have been 47 flood and flash flood events in Adams County in the past 23 years, for an average of 2 events per year.
Response	3	1 Week	Emergency response to flooding can last up to a week, with longer responses corresponding to more significant events.
Onset	4	Less than 6 hours	While storm and rain systems can be predicted multiple days in advance, but the extent of flooding in a given area cannot.
Magnitude	2	Limited	Weather systems can affect a large portion of the county. However, flooding typically only affects less than ¼ of the total land area at a time.
Business	2	1 Week	A significant flood event could impact the county's economy for up to a week while the affected jurisdiction recovers.
Human	1	Minimum	Flooding typically does not have significant human health impacts.
Property	2	10-25% of property affected	A single flooding incident, while significant, will typically affect between 10 and 25% of property in Adams County
Total	**19**	**Medium**	

4.0 RISK ASSESSMENT

4.3.5 Hailstorm

Hailstorms occur when ice crystals form within a low-pressure front due to the rapid rise of warm air into the upper atmosphere and the subsequent cooling of the air mass. Frozen droplets gradually accumulate on the ice crystals until, having developed sufficient weight, they fall as precipitation in the form of balls or irregularly-shaped masses of ice greater than 0.75 inches in diameter (FEMA, 1997).			
Period of Occurrence:	Hailstorms can occur at any time but are most prevalent from March-September	**Hazard Index Ranking:**	13-Low
Warning Time	12-24 Hours	**State Risk Ranking:**	1.9-Low
Type of Hazard:	Natural	**Disaster Declarations:**	N/A

Merriam Webster defines hail as precipitation in the form of small balls or lumps, usually consisting of concentric layers, of clear ice and compact snow. It forms when updrafts from thunderstorms are strong enough to carry water droplets upwards into temperatures low enough to freeze the droplets into balls of ice. When the thunderstorm's updraft subsides, or the hailstones grow too heavy for the draft to support, they fall to the ground and can cause damage.

4.3.5.1 Location and Extent

Hailstorms are not limited to a particular area of Adams County, and forecast technology can predict neither their duration nor intensity. Because thunderstorm updrafts produce hail, seasons with a high frequency of thunderstorms have a higher potential for hailstorms to form. Warmer months (March-September) are more likely to produce thunderstorms, thus more likely to produce hail.

The TORRO Hailstorm Intensity Scale, outlined in Table 4.3.5.1-1 below, measures hailstorm intensity (Voss Law Firm, n.d.).

Table 4.3.5.1-1

TORRO HAILSTORM INTENSITY SCALE			
TORRO Intensity	*Intensity Category*	*Diameter (mm)*	*Typical Damage Impacts*
H0	Hard Hail	2	No Damage
H1	Potentially Damaging	5-15	Slight damage to plants, crops
H2	Significant	10-20	Significant damage to fruit, crops, vegetation
H3	Severe	20-30	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	25-40	Widespread glass damage, vehicle bodywork damage
H5	Destructive	30-50	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	40-60	Bodywork of grounded aircraft dented, brick walls pitted
H7	Destructive	50-75	Severe roof damage, risk of serious injuries
H8	Destructive	60-90	Severe damage to aircraft bodywork
H9	Super Hailstorms	75-100	Extensive structural damage. Risk of severe or fatal injuries to persons caught in the open
H10	Super Hailstorms	>100	Extensive structural damage. Risk of severe or fatal injuries to persons caught in the open

4.3.5.2 Range of Magnitude

Hail is typically pea to marble-sized (H0-H3 on the TORRO scale), but significant thunderstorms can produce much larger hail. The largest hailstone measured in the U.S. was 7.9 inches (200 mm) in diameter from a thunderstorm in Vivian, South Dakota, in 2010. In Adams County, the largest recorded hailstones were 1.75 (44.45 mm) inches in diameter, which would be an H5-H6 storm on the TORRO Scale. Hail of this size occurred on several occasions:

- three times in 2008 in Fairfield, York Springs, and Heidlersburg;
- once in 2004 in Bonneauville;
- twice in 2000 in Bermudian and Littlestown; and
- once each in 1991, 1989, 1987, and 1980 at various locations in Adams County.

Extreme hailstorms can cause significant damage. One of the most significant impacts would be crop damage. Hailstorms typically occur from March to September, which is the primary growing season for most crops. Hail damage to crops can cause torn leaves, broken stalks, and plants stripped bare.

In addition to crop damage, hail can damage vehicles and structures. Vehicle damage includes dents and windshield/glass damage. Total costs for vehicle damages can be between $2,500 and $7,000 per vehicle, depending on the extent of the damage. Hail damage to structures includes cracked and broken shingles, bent roof vents and pipes, and broken windows.

4.3.5.3 Past Occurrences

According to the National Centers for Environmental Information, there were 42 hail events in Adams County between 1980 and 2019, causing $15,000 in damages. Table 4.3.5.3-1 outlines these occurrences.

Table 4.3.5.3-1

HAIL EVENTS IN ADAMS COUNTY, 1980-2019					
Location	*Date*	*Time*	*Size*	*Property Damage*	*Crop Damage*
Adams County	4/9/1980	18:30	1.75 in.	$0.00	$0.00
Adams County	5/12/1980	17:30	1.75 in.	$0.00	$0.00
Adams County	5/23/1987	12:40	1.75 in.	$0.00	$0.00
Adams County	5/23/1988	14:25	1.00 in.	$0.00	$0.00
Adams County	6/6/1989	14:45	1.75 in.	$0.00	$0.00
Adams County	5/13/1991	13:07	1.75 in.	$0.00	$0.00
Berlin	8/11/1993	17:50	0.75 in.	$0.00	$0.00
Fairfield	8/11/1993	18:40	1.75 in.	$0.00	$0.00
Bristol	6/29/1994	12:30	0.75 in.	$0.00	$0.00
Abbottstown	5/29/1995	15:33	0.75 in.	$0.00	$0.00
Biglerville	6/4/1996	15:00	0.75 in.	$0.00	$0.00
Heidlersburg	6/11/1996	13:00	N/A	$0.00	$0.00
Heidlersburg	6/11/1996	22:00	N/A	$0.00	$0.00
New Oxford	6/14/1996	18:07	0.75 in.	$0.00	$0.00
Gettysburg	6/24/1996	12:00	N/A	$0.00	$0.00
Biglerville	4/8/1998	14:38	0.75 in.	$0.00	$0.00
Zora	5/10/2000	13:58	0.75 in.	$0.00	$0.00
Bermudian	5/24/2000	13:20	1.75 in.	$0.00	$0.00
Littlestown	5/24/2000	14:20	1.75 in.	$0.00	$0.00
Fairfield	9/14/2000	19:30	0.75 in.	$0.00	$0.00
Fairfield	5/2/2002	14:43	0.75 in.	$0.00	$0.00
New Oxford	5/26/2002	15:20	1.25 in.	$0.00	$0.00
New Oxford	5/27/2002	20:10	1.00 in.	$0.00	$0.00
McSherrystown	6/19/2002	17:00	1.00 in.	$0.00	$0.00
Gettysburg	6/1/2004	12:29	0.88 in.	$0.00	$0.00
Bonneauville	8/19/2004	17:50	1.75 in.	$0.00	$0.00
New Oxford	8/7/2005	16:30	1.00 in.	$0.00	$0.00
Abbottstown	8/7/2005	16:35	1.00 in.	$0.00	$0.00
Cashtown	7/4/2006	12:20	0.75 in.	$0.00	$0.00
Bendersville	7/18/2006	15:50	0.75 in.	$0.00	$0.00
Fairfield	8/25/2007	16:55	0.88 in.	$0.00	$0.00
Gettysburg	6/10/2008	18:20	1.00 in.	$0.00	$0.00
Fairfield	6/23/2008	19:12	1.75 in.	$0.00	$0.00
York Springs	7/27/2008	11:35	1.75 in.	$0.00	$0.00
Heidlersburg	7/27/2008	11:45	1.75 in.	$0.00	$0.00
East Berlin	8/2/2008	13:10	0.75 in.	$0.00	$0.00
Cashtown	8/10/2008	13:35	1.00 in.	$0.00	$0.00
Gettysburg	6/9/2009	14:15	0.88 in.	$0.00	$0.00
McSherrystown	6/4/2010	18:40	1.00 in.	$10,000.00	$0.00
Guldens Station	8/18/2011	21:00	1.00 in.	$0.00	$0.00

HAIL EVENTS IN ADAMS COUNTY, 1980-2019					
Location	*Date*	*Time*	*Size*	*Property Damage*	*Crop Damage*
Trust	6/29/2012	3:20	0.88 in.	$5,000.00	$0.00
New Oxford	7/18/2012	14:15	1.0 in.	$0.00	$0.00
East Berlin	6/21/2016	7:02	1.00 in.	$0.00	$0.00
McSherrystown	2/25/2017	14:50	1.00 in.	$0.00	$0.00
Abbottstown	5/10/2018	16:23	1.00 in.	$0.00	$0.00
Gettysburg	5/15/2018	16:31	1.00 in.	$0.00	$0.00
Gettysburg	5/15/2018	16:40	1.00 in.	$0.00	$0.00
			TOTALS	**$15,000.00**	**$0.00**

June 4, 2010

In June 2010, hail caused $10,000 in property damage in Conewago Township and McSherrystown. Severe thunderstorms produced significant wind damage and hail with a one-inch diameter in the late afternoon and evening. The event caused extensive damage to an apartment complex in Conewago Township.

June 29, 2012

On June 29, 2012, hail caused $5,000 in property damage. The event developed during a thunderstorm that produced nickel-sized hail and damaging winds across the southern portion of Pennsylvania.

May 10, 2018

In May 2018, a significant hailstorm caused serious damage to crops in northern Adams County. The hailstorm lasted approximately ten minutes and included H3 to H4 (quarter-sized) hail. Fruit growers in the area reported to the Gettysburg Times that hail caused damage to trees, leaves, branches, and fruit.

4.3.5.4 Future Occurrence

Hailstorm events historically occur nearly annually in Adams County. Nationally, hailstorms are most likely to occur from March to September; however, in Adams County, all past events have occurred between April and August. A potential worst-case hailstorm scenario for the county would be a storm carrying hail larger than two inches (or an H5 on the TORRO Scale) over a regional area. A hailstorm of this magnitude would have a detrimental impact, particularly on farmland. Adams County is home to 1,146 farms (166,227 farm acres) and is the fifth leading producer of total crops in Pennsylvania. Adams County is Pennsylvania's leading producer of fruits, tree nuts, and berries.

4.3.5.5 Vulnerability Assessment

This section summarizes the vulnerability to Adams County from hail. Adams County conducted an online survey for the public to share its thoughts on hazard vulnerabilities. Table 4.3.5.5-1 presents the results of that survey regarding hailstorm.

Table 4.3.5.5-1

PUBLIC SENTIMENT, HAILSTORM – ADAMS COUNTY					
Hazard	*Level of Concern*				*Total Responses*
	Not at All	*Somewhat*	*Concerned*	*Very*	
Hailstorm	33 (22.60%)	77 (52.74%)	32 (21.92%)	4 (2.74%)	146
In the past ten years, do you remember this hazard occurring in your community?				50 (34.25%)	146
Have you noticed an increase or decrease in the occurrences or intensity of this hazard? (137 responses)				15 (10.95%)	INCREASE
				121 (88.32%)	NO CHANGE
				1 (0.73%)	DECREASE

Historically, in Adams County, hail has not caused significant damage. All of Adams County, including all critical infrastructure, is vulnerable to the effects of hail, and the economic impact of a severe and widespread hailstorm has the potential to be significant. Table 4.3.5.5-2 below further describes Adams County's vulnerability to hail events.

Table 4.3.5.5-2

HAILSTORM VULNERABILITY SUMMARY			
Category	*Points*	*Description*	*Notes*
Frequency	4	High	There have been 42 hail events in Adams County in the past 39 years, for an average of 1.1 events per year.
Response	2	One day	Hailstorms do not require a prolonged response.
Onset	2	12-24 hours	Thunderstorms that produce hail are typically forecasted 12-24 hours before their onset.
Magnitude	2	Limited	Past hailstorms caused $15,000 in reported damages (NCEI), for an average of $357 per event.
Business	1	Less than 24 hours	Typical hailstorms in Adams County have not disrupted the county's economy.
Human	1	Minor	No are no reported injuries or deaths due to hail in Adams County.
Property	1	Less than 10%	Hailstorms in Adams County have been brief and localized. Less than 10% of the property is affected.
Totals	**13**	**Low**	

4.0 RISK ASSESSMENT

4.3.6 Hurricane, Tropical Storm, Nor'easter

HIGHEST HIGH MEDIUM LOW LOWEST	Hurricanes, tropical storms, and Nor'easters are closed circulations developing around a low-pressure center.			
	Period of Occurrence:	June-November	**Hazard Index Ranking:**	15-Low
	Warning Time:	More than 24 hours	**State Risk Ranking:**	2.6-High
	Type of Hazard:	Natural	**Disaster Declarations:**	EM-3356 DR-4030 EM-3340 DR-3235 DR-340

Hurricanes, tropical storms, and nor'easters are "cyclones," and as such are any closed circulation developing around a low-pressure center in which the winds rotate counter-clockwise (in the Northern Hemisphere) and whose diameter averages 10-30 miles across. While most of Pennsylvania does not suffer the devastating impacts cyclonic systems can have on coastal regions, many areas in the commonwealth are subject to the primary damaging forces associated with these storms, including high-level sustained winds, heavy precipitation, and tornadoes. The majority of hurricanes and tropical storms form in the Atlantic Ocean, Caribbean Sea, and the Gulf of Mexico during the official Atlantic hurricane season (June through November) (PEMA, 2018).

4.3.6.1 Location and Extent

Coastal areas are the most adversely-impacted by tropical storm events. Because of Pennsylvania's proximity to the coast, the state's counties are at high risk for a hurricane, tropical storm, and Nor'easter events. Adams County, in particular, could be among the most heavily impacted counties in the state due to its southeastern location and a short distance to the ocean. The eastern-most point of Adams County is approximately 70 miles from the northern Chesapeake Bay, 95 miles from the Delaware Bay, and 152 miles from the Atlantic coast.

The Saffir-Simpson hurricane wind scale measures the wind speed of hurricanes and estimates potential property damage. Category 3 and above storms are "major" hurricanes due

to their potential for significant loss of life and property damage. Table 4.3.6.1-1 below outlines the Saffir-Simpson scale.

Table 4.3.6.1-1

SAFFIR-SIMPSON HURRICANE WIND SCALE		
Category	*Sustained Wind Speed*	*Damage*
1	74-95 mph 64-82 knots	Very dangerous winds will produce some damage. Well-constructed frame homes could have damage to roofs, shingles, vinyl siding, and gutters. Large branches of trees will snap, and shallowly rooted trees may topple, Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph 83-95 knots	Extremely dangerous winds will cause extensive damage. Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near0total power loss is expected with outages that could last from several days to weeks.
3 (Major)	111-129 mph 96-112 knots	Devastating damage will occur. Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees till be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days after the storm passes
4 (Major)	130-156 mph 113-136 knots	Catastrophic damage will occur. Well-built frame homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (Major)	157+ mph 137+ knots	Catastrophic damage will occur. A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Thunderstorms typically accompany hurricanes and tropical storms. Thunderstorms are rain-bearing storms that produce lightning, and often occur independently of a cyclone event. Even with Adams County's relative proximity to the Atlantic Ocean, the types of events characterized by this profile most-readily present as thunderstorms (and most of those fall below the intensity measured by the Saffir-Simpson scale).

4.3.6.2 Range of Magnitude

Hurricanes and tropical storms produce a variety of negative effects, including flooding, storm surge, high wind, and tornadoes. Heavy rains are responsible for major flooding in areas where the storm initially strikes and can span hundreds of miles from where the storm originally made landfall. Large, slow-moving storms produce more rainfall than smaller, faster-moving storms.

High wind, thunderstorms, and tornadoes also accompany hurricane and tropical storm

events. As with heavy rain, larger storms and storms with higher wind speeds are more likely to produce tornadoes and wind damage.

4.3.6.3 Past Occurrence

Cyclones have impacted Adams County several times in the past, including Hurricane Sandy and Tropical Storms Lee and Agnes.

Hurricane Sandy (2012)

Hurricane Sandy was the deadliest and most destructive hurricane of the 2012 Atlantic hurricane season and the second-costliest hurricane on record at the time. Sandy formed in the central Caribbean on October 22 and intensified into a hurricane as it moved north across Jamaica, Cuba, and the Bahamas. Sandy moved northeast of the United States until turning west toward the Mid-Atlantic coast on October 28. Sandy made landfall as a post-tropical cyclone near Brigantine, New Jersey, with 70-knot maximum sustained winds. Because of its massive size, Sandy drove a catastrophic storm surge into the New York and New Jersey coastlines.

The highest recorded storm-total rainfall amount obtained in Pennsylvania for the storm was 7.94 inches in Bedford County, west of Adams County. An unconfirmed report of 8.15 inches was reported at Hanover in York County (adjacent to Adams County). Heavy rain brought widespread flooding to Adams County. Road closures began near noon on October 29, with significant flooding by 3:00 p.m. Wind damage was also significant, with gusts measured between 60 and 65 mph, causing downed trees and utility wires, and closed roads.

Tropical Storm Lee (2011)

Tropical Storm Lee began in the Caribbean Sea during the last week of August 2011. Lee slowly moved northward toward the Louisiana coastline by September 3. After landfall, Lee progressed northward through the Southeast into the Mid-Atlantic region. Rain fell in the Mid-Atlantic over areas that had exceptionally wet summer (including rains from Hurricane Irene less than two weeks before). This led to flooding along the Susquehanna River in Pennsylvania.

Tropical Storm Lee significantly impacted Adams County. Widespread flooding caused over 40 road closures in Adams County, including US 15, US 30, and Route 94. Responders performed water rescues in the East Berlin area, and 124 structures reported damage. In Fairfield and Gettysburg, thunderstorm winds estimated at 60 mph knocked down numerous trees and utility wires.

Tropical Storm Agnes (1972)

Agnes was the first named storm of the 1972 Atlantic hurricane season. The storm formed as a tropical depression on June 14, over the Yucatan Peninsula. The storm moved northward and made landfall as a hurricane near Panama City, Florida, on June 19. It then moved north into Georgia and South Carolina before re-entering the Atlantic Ocean and making landfall again near New York City as a strong tropical storm. Agnes dropped between seven and ten inches of rain across the Mid-Atlantic region, with some areas experiencing up to 16 inches.

Historical Listing: Thunderstorms

Cyclone events can also cause an increase in thunderstorm activity. Adams County experiences thunderstorm events each year. There have been 232 thunderstorm wind and lightning events in Adams County since 1955, for an average of 3.6 events per annum. These events have caused one reported death, $200 in crop damage, and $1,059,500 in property damage.

Table 4.3.6.2-1

THUNDERSTORM EVENTS IN ADAMS COUNTY, 1955-2019						
Location	*Date*	*Event Type*	*Deaths*	*Injuries*	*Property Damage*	*Crop Damage*
Adams County (Zone)	10/30/1955	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	6/11/1958	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	6/11/1958	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	9/28/1967	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	7/19/1969	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	7/27/1969	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	7/15/1970	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	7/15/1970	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	6/5/1973	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	9/4/1973	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	6/27/1978	Thunderstorm Wind	0	0	$0.00	$0.00

THUNDERSTORM EVENTS IN ADAMS COUNTY, 1955-2019						
Location	*Date*	*Event Type*	*Deaths*	*Injuries*	*Property Damage*	*Crop Damage*
Adams County (Zone)	8/1/1979	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	6/29/1980	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	8/10/1980	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	8/11/1980	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	9/17/1980	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	7/20/1981	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	7/21/1983	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	7/12/1985	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	6/30/1987	Thunderstorm Wind	1	0	$0.00	$0.00
Adams County (Zone)	9/17/1987	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	9/17/1987	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	7/11/1988	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	8/6/1988	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	8/6/1988	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	8/6/1988	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	8/15/1988	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	8/15/1988	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	11/16/1989	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	11/20/1989	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	11/20/1989	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	5/10/1990	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	6/8/1990	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	6/8/1990	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	6/18/1990	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	6/18/1990	Thunderstorm Wind	0	0	$0.00	$0.00

THUNDERSTORM EVENTS IN ADAMS COUNTY, 1955-2019						
Location	*Date*	*Event Type*	*Deaths*	*Injuries*	*Property Damage*	*Crop Damage*
Adams County (Zone)	7/5/1990	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	7/9/1990	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	8/29/1990	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	8/29/1990	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	4/9/1991	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	4/9/1991	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	5/6/1991	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	5/6/1991	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	7/7/1991	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	11/22/1991	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	2/14/1992	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	6/24/1992	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	6/24/1992	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	8/28/1992	Thunderstorm Wind	0	0	$0.00	$0.00
Adams County (Zone)	8/28/1992	Thunderstorm Wind	0	0	$0.00	$0.00
New Oxford	8/11/1993	Thunderstorm Wind	0	0	$0.00	$0.00
Gettysburg	8/17/1993	Thunderstorm Wind	0	0	$0.00	$0.00
New Oxford	8/28/1993	Thunderstorm Wind	0	0	$0.00	$0.00
Gettysburg	9/2/1993	Thunderstorm Wind	0	0	$0.00	$0.00
York Springs	6/29/1994	Thunderstorm Wind	0	0	$0.00	$0.00
Gettysburg	7/6/1994	Thunderstorm Wind	0	0	$500,000.00	$0.00
New Oxford	4/9/1995	Thunderstorm Wind	0	0	$0.00	$0.00
Aspers	6/11/1995	Thunderstorm Wind	0	0	$0.00	$0.00
Hampton	7/6/1995	Thunderstorm Wind	0	0	$0.00	$0.00
East Berlin	7/10/1995	Thunderstorm Wind	0	0	$0.00	$0.00
Fairfield	7/16/1995	Thunderstorm Wind	0	0	$0.00	$0.00
Gettysburg	10/5/1995	Thunderstorm Wind	0	0	$0.00	$0.00
Gettysburg	11/11/1995	Thunderstorm Wind	0	0	$0.00	$0.00
Aspers	5/11/1996	Thunderstorm Wind	0	0	$0.00	$0.00
Biglerville	6/14/1996	Thunderstorm Wind	0	0	$0.00	$0.00
Biglerville	6/20/1996	Thunderstorm Wind	0	0	$0.00	$0.00
Gettysburg	6/24/1996	Thunderstorm Wind	0	0	$0.00	$0.00
Shippensburg	6/24/1996	Thunderstorm Wind	0	0	$0.00	$0.00
York Springs	7/30/1996	Thunderstorm Wind	0	0	$0.00	$0.00
Abbottstown	9/28/1996	Thunderstorm Wind	0	0	$0.00	$0.00

THUNDERSTORM EVENTS IN ADAMS COUNTY, 1955-2019						
Location	*Date*	*Event Type*	*Deaths*	*Injuries*	*Property Damage*	*Crop Damage*
Gettysburg	10/18/1996	Thunderstorm Wind	0	0	$0.00	$0.00
Biglerville	6/18/1997	Thunderstorm Wind	0	0	$0.00	$0.00
York Springs	7/28/1997	Thunderstorm Wind	0	0	$0.00	$0.00
Fountain Dale	5/29/1998	Thunderstorm Wind	0	0	$0.00	$0.00
Cashtown	5/31/1998	Thunderstorm Wind	0	0	$0.00	$0.00
Gettysburg	6/16/1998	Thunderstorm Wind	0	0	$0.00	$0.00
Littlestown	3/3/1999	Thunderstorm Wind	0	0	$35,000.00	$0.00
Gettysburg	5/12/1999	Thunderstorm Wind	0	0	$10,000.00	$0.00
Gettysburg	5/13/2000	Thunderstorm Wind	0	0	$4,000.00	$0.00
Gettysburg	6/2/2000	Thunderstorm Wind	0	0	$2,000.00	$0.00
Biglerville	6/21/2000	Thunderstorm Wind	0	0	$2,000.00	$0.00
Gettysburg	6/25/2000	Lightning	0	0	$30,000.00	$0.00
Gettysburg	7/14/2000	Thunderstorm Wind	0	0	$5,000.00	$0.00
Countywide	3/13/2001	Thunderstorm Wind	0	0	$1,000.00	$0.00
East Berlin	4/9/2001	Thunderstorm Wind	0	0	$0.00	$0.00
Biglerville	6/12/2001	Thunderstorm Wind	0	0	$0.00	$0.00
Gettysburg	6/12/2001	Thunderstorm Wind	0	0	$0.00	$0.00
Gettysburg	6/20/2001	Thunderstorm Wind	0	0	$0.00	$0.00
East Berlin	7/1/2001	Thunderstorm Wind	0	0	$0.00	$0.00
Fountain Dale	7/10/2001	Thunderstorm Wind	0	0	$0.00	$0.00
Gettysburg	8/13/2001	Thunderstorm Wind	0	0	$0.00	$0.00
Edgegrove	9/24/2001	Thunderstorm Wind	0	0	$0.00	$0.00
Cashtown	4/14/2002	Thunderstorm Wind	0	0	$1,000.00	$0.00
New Oxford	4/28/2002	Thunderstorm Wind	0	0	$0.00	$0.00
Fairfield	5/2/2002	Thunderstorm Wind	0	0	$0.00	$0.00
Gettysburg	6/27/2002	Thunderstorm Wind	0	0	$0.00	$0.00
McSherrystown	9/27/2002	Thunderstorm Wind	0	0	$0.00	$0.00
Gettysburg	7/6/2003	Thunderstorm Wind	0	0	$0.00	$0.00
Gettysburg	7/21/2003	Thunderstorm Wind	0	0	$0.00	$0.00
York Springs	7/21/2003	Thunderstorm Wind	0	0	$5,000.00	$0.00
East Berlin	7/21/2003	Thunderstorm Wind	0	0	$10,000.00	$0.00
Gettysburg	8/26/2003	Thunderstorm Wind	0	0	$0.00	$0.00
York Springs	5/7/2004	Thunderstorm Wind	0	0	$0.00	$0.00
Biglerville	6/14/2004	Thunderstorm Wind	0	0	$5,000.00	$0.00
Gettysburg	6/17/2004	Thunderstorm Wind	0	0	$0.00	$0.00
Biglerville	7/14/2004	Thunderstorm Wind	0	0	$0.00	$0.00
Cashtown	8/19/2004	Thunderstorm Wind	0	0	$0.00	$0.00
Arendtsville	6/6/2005	Thunderstorm Wind	0	0	$0.00	$0.00
Biglerville	6/6/2005	Thunderstorm Wind	0	0	$0.00	$0.00
Biglerville	6/6/2005	Thunderstorm Wind	0	0	$0.00	$0.00
Fairfield	6/6/2005	Thunderstorm Wind	0	0	$0.00	$0.00
Gettysburg	6/6/2005	Thunderstorm Wind	0	0	$0.00	$0.00
New Oxford	8/7/2005	Thunderstorm Wind	0	0	$0.00	$0.00
Bonneauville	8/7/2005	Thunderstorm Wind	0	0	$0.00	$0.00
Biglerville	11/29/2005	Thunderstorm Wind	0	0	$5,000.00	$0.00
Biglerville	7/4/2006	Thunderstorm Wind	0	0	$0.00	$0.00
Gettysburg	7/4/2006	Thunderstorm Wind	0	0	$0.00	$0.00
York Springs	7/18/2006	Thunderstorm Wind	0	0	$0.00	$0.00
Gettysburg	7/18/2006	Thunderstorm Wind	0	0	$0.00	$0.00

THUNDERSTORM EVENTS IN ADAMS COUNTY, 1955-2019						
Location	*Date*	*Event Type*	*Deaths*	*Injuries*	*Property Damage*	*Crop Damage*
East Berlin	7/27/2006	Thunderstorm Wind	0	0	$0.00	$0.00
York Springs	7/27/2006	Thunderstorm Wind	0	0	$0.00	$0.00
McKnightstown	6/8/2007	Thunderstorm Wind	0	0	$0.00	$0.00
McSherrystown	6/8/2007	Thunderstorm Wind	0	0	$0.00	$0.00
McKnightstown	6/13/2007	Thunderstorm Wind	0	0	$0.00	$0.00
Greenmount	6/13/2007	Thunderstorm Wind	0	0	$0.00	$0.00
New Oxford	8/3/2007	Thunderstorm Wind	0	0	$0.00	$0.00
McSherrystown	8/3/2007	Thunderstorm Wind	0	0	$0.00	$0.00
Fairfield	8/25/2007	Thunderstorm Wind	0	0	$0.00	$0.00
Arendtsville	6/23/2008	Thunderstorm Wind	0	0	$2,500.00	$0.00
Biglerville	6/23/2008	Thunderstorm Wind	0	0	$2,500.00	$0.00
East Berlin	7/27/2008	Thunderstorm Wind	0	0	$0.00	$0.00
East Berlin	8/2/2008	Thunderstorm Wind	0	0	$0.00	$0.00
Gettysburg	8/7/2008	Thunderstorm Wind	0	0	$0.00	$0.00
Cashtown	8/10/2008	Thunderstorm Wind	0	0	$1,000.00	$0.00
New Oxford	8/11/2009	Thunderstorm Wind	0	0	$10,000.00	$0.00
Table Rock	8/21/2009	Thunderstorm Wind	0	0	$5,000.00	$200.00
Biglerville	4/8/2010	Thunderstorm Wind	0	0	$5,000.00	$0.00
Cashtown	5/14/2010	Thunderstorm Wind	0	0	$0.00	$0.00
New Oxford	5/27/2010	Thunderstorm Wind	0	0	$ 5,000.00	$0.00
Wenksville	6/4/2010	Thunderstorm Wind	0	0	$ 5,000.00	$0.00
McSherrystown	6/4/2010	Thunderstorm Wind	0	0	$75,000.00	$0.00
McSherrystown	6/4/2010	Thunderstorm Wind	0	0	$50,000.00	$0.00
Orrtanna	7/25/2010	Thunderstorm Wind	0	0	$5,000.00	$0.00
Gardners	7/25/2010	Thunderstorm Wind	0	0	$5,000.00	$0.00
Greenmount	8/16/2010	Thunderstorm Wind	0	0	$5,000.00	$0.00
York Springs	8/16/2010	Thunderstorm Wind	0	0	$5,000.00	$0.00
Two Taverns	9/22/2010	Thunderstorm Wind	0	0	$5,000.00	$0.00
New Oxford	9/22/2010	Thunderstorm Wind	0	0	$5,000.00	$0.00
Abbottstown	4/16/2011	Thunderstorm Wind	0	0	$5,000.00	$0.00
Biglerville	4/28/2011	Thunderstorm Wind	0	0	$5,000.00	$0.00
Biglerville	4/28/2011	Thunderstorm Wind	0	0	$5,000.00	$0.00
Bermudian	4/28/2011	Thunderstorm Wind	0	0	$5,000.00	$0.00
Fairfield	5/26/2011	Thunderstorm Wind	0	0	$5,000.00	$0.00
Fairfield	6/9/2011	Thunderstorm Wind	0	0	$5,000.00	$0.00
Fairfield	9/14/2011	Thunderstorm Wind	0	0	$5,000.00	$0.00
Gettysburg	9/14/2011	Thunderstorm Wind	0	0	$5,000.00	$0.00
Fairfield Airport	4/26/2012	Thunderstorm Wind	0	0	$3,000.00	$0.00
Bendersville	5/27/2012	Thunderstorm Wind	0	0	$5,000.00	$0.00
York Springs	7/5/2012	Thunderstorm Wind	0	0	$5,000.00	$0.00
McKnightstown	7/18/2012	Thunderstorm Wind	0	0	$5,000.00	$0.00
Hampton	8/3/2012	Thunderstorm Wind	0	0	$5,000.00	$0.00
Berlin Junction	8/3/2012	Thunderstorm Wind	0	0	$5,000.00	$0.00
Round Top	9/1/2012	Thunderstorm Wind	0	0	$0.00	$0.00
Sells Station	9/1/2012	Thunderstorm Wind	0	0	$5,000.00	$0.00
Round Top	9/7/2012	Thunderstorm Wind	0	0	$5,000.00	$0.00
Fairfield Airport	9/8/2012	Thunderstorm Wind	0	0	$5,000.00	$0.00
Bendersville	9/8/2012	Thunderstorm Wind	0	0	$5,000.00	$0.00
York Springs	9/8/2012	Thunderstorm Wind	0	0	$5,000.00	$0.00

THUNDERSTORM EVENTS IN ADAMS COUNTY, 1955-2019						
Location	*Date*	*Event Type*	*Deaths*	*Injuries*	*Property Damage*	*Crop Damage*
Berlin Junction	6/13/2013	Thunderstorm Wind	0	0	$2,000.00	$0.00
Orrtanna	6/25/2013	Thunderstorm Wind	0	0	$5,000.00	$0.00
Virginia Mills	6/25/2013	Thunderstorm Wind	0	0	$2,000.00	$0.00
Biglerville	6/28/2013	Thunderstorm Wind	0	0	$2,000.00	$0.00
York Springs	6/30/2013	Thunderstorm Wind	0	0	$5,000.00	$0.00
Gettysburg	7/19/2013	Thunderstorm Wind	0	0	$5,000.00	$0.00
Iron Springs	9/12/2013	Thunderstorm Wind	0	0	$2,000.00	$0.00
Fairfield Airport	9/12/2013	Thunderstorm Wind	0	0	$2,000.00	$0.00
Granite Hill	11/1/2013	Thunderstorm Wind	0	0	$0.00	$0.00
Virginia Mills	11/18/2013	Thunderstorm Wind	0	0	$0.00	$0.00
Gettysburg	11/18/2013	Thunderstorm Wind	0	0	$0.00	$0.00
Brush Run	11/18/2013	Thunderstorm Wind	0	0	$0.00	$0.00
Virginia Mills	6/18/2014	Thunderstorm Wind	0	0	$1,000.00	$0.00
McKnightstown	6/18/2014	Thunderstorm Wind	0	0	$2,000.00	$0.00
Bonneauville	6/18/2014	Thunderstorm Wind	0	0	$2,000.00	$0.00
East Berlin	6/18/2014	Thunderstorm Wind	0	0	$2,000.00	$0.00
Fountain Dale	7/8/2014	Thunderstorm Wind	0	0	$2,000.00	$0.00
Orrtanna	7/8/2014	Thunderstorm Wind	0	0	$1,000.00	$0.00
Gettysburg	7/8/2014	Thunderstorm Wind	0	0	$0.00	$0.00
Virginia Mills	7/13/2014	Thunderstorm Wind	0	0	$0.00	$0.00
Granite Hill	7/13/2014	Thunderstorm Wind	0	0	$1,000.00	$0.00
Greenmount	7/13/2014	Thunderstorm Wind	0	0	$1,000.00	$0.00
Virginia Mills	9/2/2014	Thunderstorm Wind	0	0	$1,000.00	$0.00
Bendersville	9/2/2014	Thunderstorm Wind	0	0	$500.00	$0.00
Granite	5/27/2015	Thunderstorm Wind	0	0	$1,000.00	$0.00
Seven Stars	6/8/2015	Thunderstorm Wind	0	0	$1,500.00	$0.00
Littlestown	6/8/2015	Thunderstorm Wind	0	0	$20,000.00	$0.00
Arendtsville	6/20/2015	Thunderstorm Wind	0	0	$1,000.00	$0.00
Bendersville	6/20/2015	Thunderstorm Wind	0	0	$500.00	$0.00
Bridgeport	7/9/2015	Thunderstorm Wind	0	0	$2,000.00	$0.00
Gettysburg	8/4/2015	Thunderstorm Wind	0	0	$2,000.00	$0.00
Five Pts	9/4/2015	Thunderstorm Wind	0	0	$8,000.00	$0.00
Littlestown	10/9/2015	Thunderstorm Wind	0	0	$1,000.00	$0.00
Biglerville	6/5/2016	Thunderstorm Wind	0	0	$2,000.00	$0.00
Knoxlyn	6/21/2016	Thunderstorm Wind	0	0	$3,000.00	$0.00
Fairfield	7/25/2016	Thunderstorm Wind	0	0	$6,000.00	$0.00
Fairfield	8/16/2016	Thunderstorm Wind	0	0	$4,000.00	$0.00
Gettysburg	8/16/2016	Thunderstorm Wind	0	0	$2,000.00	$0.00
Irishtown	10/30/2016	Thunderstorm Wind	0	0	$5,000.00	$0.00
Bendersville	6/19/2017	Thunderstorm Wind	0	0	$3,000.00	$0.00
Aspers	6/19/2017	Thunderstorm Wind	0	0	$5,000.00	$0.00
York Springs	6/19/2017	Thunderstorm Wind	0	0	$2,000.00	$0.00
Aspers	8/4/2017	Thunderstorm Wind	0	0	$0.00	$0.00
York Springs	8/4/2017	Thunderstorm Wind	0	0	$0.00	$0.00
York Springs	8/4/2017	Thunderstorm Wind	0	0	$0.00	$0.00
Cashtown	9/5/2017	Thunderstorm Wind	0	0	$0.00	$0.00
Cashtown	9/5/2017	Thunderstorm Wind	0	0	$0.00	$0.00
Granite Hill	5/12/2018	Thunderstorm Wind	0	0	$4,000.00	$0.00
East Berlin	5/15/2018	Thunderstorm Wind	0	0	$4,000.00	$0.00

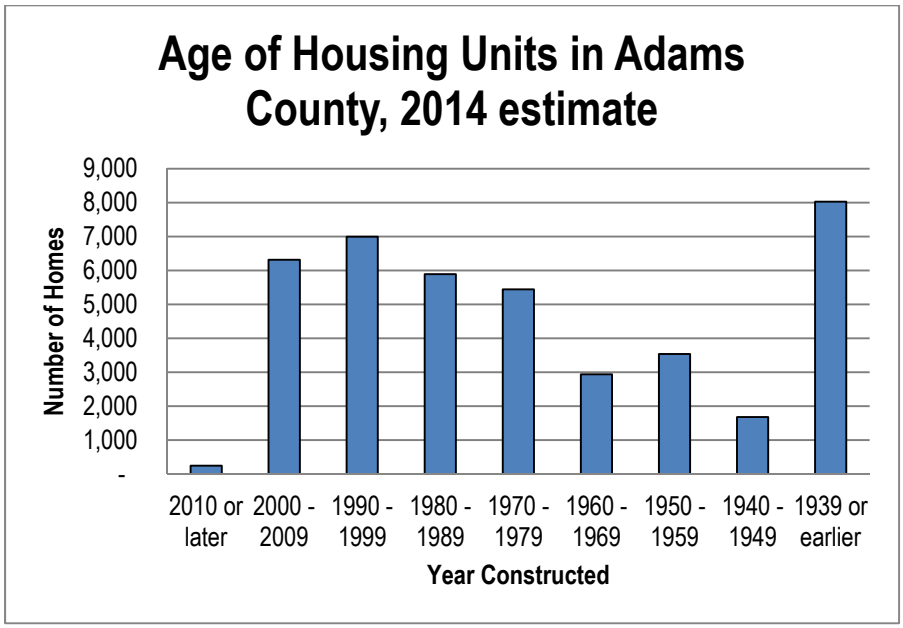
THUNDERSTORM EVENTS IN ADAMS COUNTY, 1955-2019						
Location	*Date*	*Event Type*	*Deaths*	*Injuries*	*Property Damage*	*Crop Damage*
Fairfield Airport	6/24/2018	Thunderstorm Wind	0	0	$2,000.00	$0.00
Fairfield Airport	6/24/2018	Thunderstorm Wind	0	0	$1,000.00	$0.00
Bonneauville	8/17/2018	Thunderstorm Wind	0	0	$8,000.00	$0.00
Trust	5/19/2019	Thunderstorm Wind	0	0	$8,000.00	$0.00
McSherrystown	5/29/2019	Thunderstorm Wind	0	0	$4,000.00	$0.00
Fairfield Airport	6/2/2019	Thunderstorm Wind	0	0	$1,000.00	$0.00
New Oxford	6/29/2019	Thunderstorm Wind	0	0	$3,000.00	$0.00
Fairfield	6/29/2019	Thunderstorm Wind	0	0	$3,000.00	$0.00
Virginia Mills	6/29/2019	Thunderstorm Wind	0	0	$4,000.00	$0.00
Heintzleman	7/2/2019	Thunderstorm Wind	0	0	$4,000.00	$0.00
Two Taverns	7/2/2019	Thunderstorm Wind	0	0	$4,000.00	$0.00
Littlestown	7/2/2019	Thunderstorm Wind	0	0	$0.00	$0.00
Heidlersburg	7/21/2019	Thunderstorm Wind	0	0	$3,000.00	$0.00
Gettysburg	10/31/2019	Thunderstorm Wind	0	0	$0.00	$0.00
		TOTALS	**1**	**0**	**$1,059,500.00**	**$200.00**

4.3.6.4 Future Occurrence

Future cyclone events in Adams County will likely involve damages similar to those experienced by past events. Generally, flooding and high wind accompany these types of storms and damages in Adams County would be the result of these effects.

Historic buildings are more susceptible to cyclone events than more recently-constructed structures. Adams County, and particularly Gettysburg, contains a high number of these historical structures. Figure 4.3.6.4-1 shows the number of homes in Adams County by year constructed.

Figure 4.3.6.4-1



4.3.6.5 Vulnerability Assessment

This section summarizes the vulnerability to Adams County from cyclone events. Adams County conducted an online survey for the public to share its thoughts on hazard vulnerabilities. Table 4.3.6.5-1 presents the results of that survey regarding cyclone events.

Table 4.3.6.5-1

PUBLIC SENTIMENT, HURRICANE, TROPICAL STORM, NOR'EASTER – ADAMS COUNTY					
Hazard	*Level of Concern*				*Total Responses*
	Not at All	*Somewhat*	*Concerned*	*Very*	
Hurricane, Tropical Storm, Nor'easter	23 (15.54%)	81 5(4.73%)	31 (20.95%)	13 (8.78%)	148
In the past ten years, do you remember this hazard occurring in your community?				74 (50.68%)	146
Have you noticed an increase or decrease in the occurrences or intensity of this hazard? (141 responses)				40 (28.37%)	INCREASE
				98 (69.50%)	NO CHANGE
				3 (2.13%)	DECREASE

Table 4.3.6.5-2 describes Adams County's vulnerability to cyclone events.

Table 4.3.6.5-2

HURRICANE, TROPICAL STORM, NOR'EASTER VULNERABILITY SUMMARY			
Category	*Points*	*Description*	*Notes*
Frequency	2	Low (Cyclone events only)	There have been three Atlantic cyclone events in the past 47 years, for an average of 0.06 events per year. There have been 232 thunderstorm events since 1955, for an average of 3.6 events per year.
Response	3	1 Week	Coastal areas will require a more involved emergency response than Adams County. The county's response would involve a response to flooding and high wind events.
Onset	1	Over 24 hours	Cyclone events' paths can be generally mapped more than 24 hours before landfall.
Magnitude	5	N/A	All areas of the county would be affected by these events. Some areas will experience more negative effects than others, but overall
Business	1	Less than 24 hours	The effects of cyclone events are similar to those of flooding. The county economy would not be suspended in the event of these events.
Human	1	Minimum/Minor Injuries	Human impact due to hurricanes and tropical storms would involve very few if any, human impacts.
Property	2	10-25% of property affected	Cyclone events typically affect the entire county, but only a few areas sustain damages. Those areas more prone to flooding, and those near water sources such as streams and lakes are most likely to experience damages.
Total	**15**	**Low**	

4.0 RISK ASSESSMENT

4.3.7 Invasive Species

HIGHEST HIGH MEDIUM LOW LOWEST	A species that is not native to a specific location and that has a tendency to spread to a degree believed to cause damage to the environment, human economy, or human health.			
	Period of Occurrence:	Can occur at any time	**Hazard Index Ranking:**	16-Medium
	Warning Time:	None	**State Risk Ranking:**	2.1-Medium
	Type of Hazard:	Natural	**Disaster Declarations:**	N/A

An invasive species is a species that is not indigenous to the ecosystem under consideration and whose introduction causes or is likely to harm the local economy, environment, or human health. These species can be any organism: plant, fish, invertebrate, mammal, bird, disease, or pathogen. Infestations may not necessarily impact human health but can create a nuisance or agricultural hardships by destroying crops, defoliating populations of native plant and tree species, or interfering with ecological systems (PEMA, 2018).

4.3.7.1 Location and Extent

The Governor's Invasive Species Council of Pennsylvania (PISC), the lead organization for invasive species threats at the Commonwealth level, recognizes two classes of invasive species: aquatic and terrestrial. Aquatic invasive species are non-native viruses, invertebrates, fish, and aquatic plants that threaten the diversity or abundance of native species, the ecological stability of the infested waters, human health and safety, or commercial, agricultural, or recreational activities dependent on such waters. The U.S. Fish and Wildlife Service notes that ships, boats, barges, aquaculture, aquatic recreation such as fishing, water gardening, seaplanes, connected waterways, etc. may spread aquatic invasive species (FWS, 2017). In Adams County, aquatic invasive species would most likely impact lakes.

Terrestrial invasive species include non-native arthropods, vascular plants, or pathogens that complete their life cycle on land. Their introduction is similar to that of aquatic invasive species in that it is likely to cause economic or environmental harm or harm to human health. It is simplistic to say that potential impact areas are "those on land" based on the definition.

Rather, heavily forested and agricultural areas may be more at risk to terrestrial invasive species.

4.3.7.2 Range of Magnitude

When enough individuals of a species are present to form a breeding population, they can become an invasive species. The range of environmental impacts varies widely. Aggressive species can reduce biodiversity by crowding out or actively harming native species. Secondary impacts of invasive species go beyond causing animal, plant, and human health and cause harm to and affect entire ecosystems, particularly those that affect forests. Forests in Pennsylvania protect watersheds, promote carbon absorption, stabilize slopes, and prevent soil erosion.

A potential worst-case scenario for Adams County would be a significant infestation of a species that affects agricultural communities, such as plum pox or gypsy moth. Both of these species target forests and agricultural ecosystems, which are integral to the county's economy. In a recent study for Adams County, a consultant noted: "the ability to control or mitigate impacts, if not events, has increased substantially through research that has resulted in precision in dealing with these events" (The Chesapeake Group, 2016, p. 7). Through cooperation, farmers share information, provide assistance, etc. Without this collaboration, the viability of the fruit belt or other agricultural activities could be subject to heightened impacts from invasive species.

4.3.7.3 Past Occurrence

PISC has identified current and potential threats in Pennsylvania. Table 4.3.7.3-1 lists the aquatic invasive species in Pennsylvania.

Table 4.3.7.3-1

PENNSYLVANIA AQUATIC INVASIVE SPECIES	
Amphibians and Reptiles	Red-Eared Slider
	Yellow-Bellied Slider
Fishes, Diseases, Invertebrates	Northern Snakehead
	European Rudd
	Tubenose Goby
	Asian Carp
	Eurasian Ruffe
	Flathead Catfish
	Round Goby
	Sea Lamprey
	West Nile Virus

PENNSYLVANIA AQUATIC INVASIVE SPECIES	
Fishes, Diseases, Invertebrates (cont.)	Viral Hemorrhagic Septicemia
	Spring Viremia of Carp
	Quagga Mussel
	Zebra Mussel
	Asian Clam
	Rusty Crayfish
	Spiny Waterflea
	Fishhook Waterflea
Mammals and Birds	Nutria
	Mute Swans
	Canada Goose
Submerged Aquatic Plants	Wild Taro
	Hydrilla
	Curly Leaf Pondweed
	Alligator Weed
	Water Chestnut
	Eurasian Watermilfoil
	Giant Salvinia
	East Indian Hygrophila
	Limnophila Sessiliflora
	Carolina Fanwort
	Parrot Feather
	Brazilian Waterweed
	Water Spinach
	Didymo
	Hydrilla
Terrestrial Aquatic Plants	Narrow Leaved Cattail
	Japanese Hops
	Giant hogweed
	Japanese Knotweed
	Common Reed
	Purple Loosestrife
	Giant Knotweed
	Hybrid Cattail

The Pennsylvania Department of Conservation and Natural Resources has organized efforts to combat invasive aquatic species in the state by performing voluntary boat and trailer checks. Boats, motors, and trailers provide an attachment point for these species, and when attached, they can spread to multiple locations. The Pennsylvania Sea Grant is also promoting the control of invasive species in the state, specifically hydrilla (*Hydrilla verticillata*) and red-eared slider turtles.

The PISC has also identified current and potential terrestrial invasive species in Pennsylvania. Table 4.3.7.3-2 below lists these species.

Table 4.3.7.3-2

PENNSYLVANIA TERRESTRIAL INVASIVE SPECIES	
Human and Animal Pathogens	Avian Influenza
	Smallpox
	West Nile Virus
	Foot and Mouth Disease
	Botulism
	Plague
	Salmonellosis
	Brucellosis
	Anthrax
	Glanders
	Q Fever
	Chronic Wasting Disease
	Bovine Spongiform Encephalopathy
Plant Pathogens	Chrysanthemum White Rust
	Dutch Elm Disease
	Sudden Oak Death
	Potato Wart
	White Pine Blister
	European Stone Fruit Yellows
	Plum Pox Virus
	Ralstonia Blight
	Ring Rot
Birds	European Starling
	Monk Parakeet
	Pigeons
	House Sparrows
Insects and Other Invertebrates	Japanese Beetle
	Pine Shoot Beetle
	Emerald Ash Borer
	Exotic Bark Barer
	Asian Longhorned Beetle
	Siren Wood Wasp
	Spotted Lanternfly
	Gypsy Moth
	Brown Marmorated Stink Bug
	Hemlock Wooly Adelgid
	Elongate Hemlock Scale
	Beech Bark Scale
	Varroa Mite
	Tracheal Mite
	Non-Native Earthworms
	Potato Cyst Nematode
	Golden Nematode
	Soybean Cyst Nematode
	Giant African Snail
Mammals	Norway Rat
	House Mouse
	13-Lined Ground Squirrel
	Feral Swine
Vascular Plants	Tropical Soda Apple
	Beach Vitex

PENNSYLVANIA TERRESTRIAL INVASIVE SPECIES	
Vascular Plants (cont.)	Benghal Dayflower
	Rosary Pea
	Cagon Grass
	Kudzu
	Goatsure
	Multiflora Rose
	Johnsongrass
	Garlic Mustard
	Mile-A-Minute
	Canada Thistle
	Asiatic Bittersweet
	Japanese Knotweed
	Tree of Heaven
	Purple Loosestrife
	Japanese Hops
	Common Reed

Plum Pox Virus, 1999

In September of 1999, there was an outbreak of plum pox virus in Adams, Franklin, York, and Cumberland Counties. Eradication of the virus necessitated the destruction of more than 1,600 acres of commercial orchards and homeowner trees. This infestation resulted in a loss of $50 million in crop damage, in addition to the loss of fruit production in the affected areas.

4.3.7.4 Future Occurrence

The probability of future occurrence for invasive species threats is increasing due to the trend toward a “global society” with frequent regional, nationwide, and international travel. Expanded global trade has created opportunities for organisms to be transported and to establish themselves in new countries and regions. Additionally, changing weather patterns may contribute to the establishment of nonnative species by shifting the climate to allow invasive species in previously inhospitable areas. Adams County, as a tourist destination, may see the introduction of invasive species from benign visitors.

The Chesapeake Group, in the local study cited above, concluded that the fruit belt in Adams County would remain healthy and viable for the foreseeable future and play a role in the region’s economy. As such, high-priority future vulnerability could be to those areas most involved in fruit-based agriculture.

4.3.7.5 Vulnerability Assessment

This section summarizes the vulnerability to Adams County from invasive species. Adams County conducted an online survey for the public to share its thoughts on hazard vulnerabilities. Table 4.3.7.5-1 presents the results of that survey regarding invasive species.

Table 4.3.7.5-1

PUBLIC SENTIMENT, INVASIVE SPECIES – ADAMS COUNTY					
Hazard	*Level of Concern*				*Total Responses*
	Not at All	*Somewhat*	*Concerned*	*Very*	
Invasive Species	17 (11.56%)	62 (42.18%)	41 (27.89%)	27 (18.37%)	147
In the past ten years, do you remember this hazard occurring in your community?				64 (41.78%)	146
Have you noticed an increase or decrease in the occurrences or intensity of this hazard? (142 responses)				69 (48.59%)	INCREASE
				69 (48.59%)	NO CHANGE
				4 (2.82%)	DECREASE

Table 4.3.7.5-2 below outlines Adams County's vulnerability to invasive species.

Table 4.3.7.5-2

INVASIVE SPECIES VULNERABILITY SUMMARY			
Category	*Points*	*Description*	*Notes*
Frequency	2	Low	Significant infestation events are rare in Adams County, but there is one event on record.
Response	1	Less than one day	While devastating, an invasive species infestation would not likely require a response from traditional emergency personnel.
Onset	1	Over 24 hours	An invasive species infestation takes weeks or months to rise to a level that warrants a response.
Magnitude	3	25-50% of land area affected	Invasive species typically cover a significant portion of land, such as entire orchards, forests, or waterways.
Business	4	More than 30 days	Invasive species infestations can take time to develop. The time it takes each species to form an invasive colony varies by species.
Human	2	Low	Most invasive species do not cause human health impacts. Those that do appear in this plan as a pandemic or infectious disease outbreak.
Property	3	25-50% of land area affected	Invasive species typically do the most harm to agricultural property, such as crops.
Total	**16**	**Medium**	

4.0 RISK ASSESSMENT

4.3.8 Landslide

HIGHEST HIGH MEDIUM LOW LOWEST	A landslide is the downward and outward movement of slope-forming soil, rock, and vegetation reacting to the force of gravity. Erosion is the gradual destruction or diminution of something.			
	Period of Occurrence:	Landslides can occur at any time	**Hazard Index Ranking:**	8-Lowest
	Warning Time:	Landslides can develop slowly over time, or suddenly	**State Risk Ranking:**	2.2-Medium
	Type of Hazard:	Natural	**Disaster Declarations:**	DR-1649

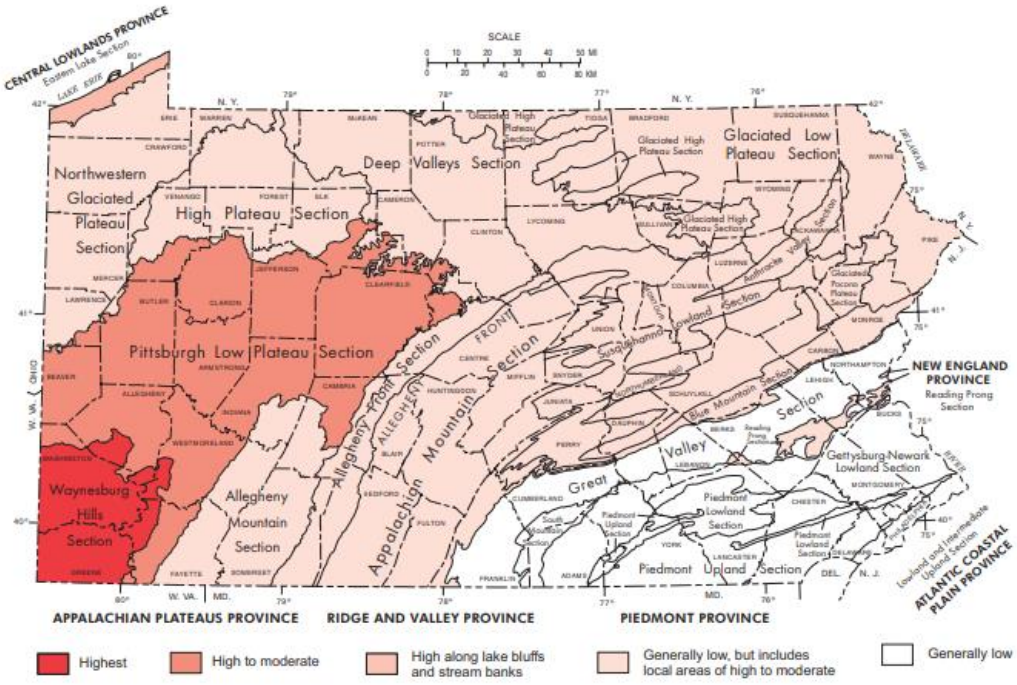
A landslide is the downward and outward movement of slope-forming soil, rock, and vegetation reacting to the force of gravity. Landslides can be triggered by both natural and human-caused changes in the environment, including heavy rain, rapid snowmelt, steepening of slopes due to construction or erosion, earthquakes, and changes in groundwater levels. Mudflows, mudslides, rockfalls, rockslides, and rock topples are all forms of a landslide. Areas that are generally prone to landslide hazards include previous landslide areas, the bases of steep slopes, the bases of drainage channels, developed hillsides, and areas recently burned by forest and brush fires (PEMA, 2018).

4.3.8.1 Location and Extent

Pennsylvania's Department of Conservation and Natural Resources (DCNR) classifies landslides by the type of material involved and the type of movement. Additional criteria include the rate of movement and the water content of the material, as these are commonly related.

Southwestern Pennsylvania has the highest concentration of landslides. The risk of landslide outside this area is low, and many occur in loose soil and on steep slopes. Bedrock landslides can occur where weak rock layers or fractures provide slip surfaces, such as roads that have sections cut from rock or soil. In Adams County, as well as other communities in eastern Pennsylvania, landslides may result from construction activities. Figure 4.3.8.1-1 shows the overall risk of landslide in Pennsylvania.

Figure 4.3.8.1-1



Soil erosion is the process by which the land's surface is worn away by the action of wind, water, ice, and gravity (PADEP, 2012). Natural (or geologic) erosion has been occurring at a (typically) low rate since the earth's formation and is the primary factor in the creation of the earth's topography we recognize today. Water-generated erosion is the type of erosion that typically occurs fastest, and is most severe.

4.3.8.2 Range of Magnitude

Most landslides in Pennsylvania are moderate to slow-moving, and damage structures and property rather than people. Landslide events can damage transportation routes, utilities, and buildings, and pollute various waterways. By volume, sediment is the greatest pollutant to the surface waters of Pennsylvania (PADEP, 2012). Excessive sedimentation is associated with increased turbidity and reduced light penetration in water sources. Overall, this reduced the number and type of organisms present in the water. Large volumes of sediment also have the potential to fill lakes and reservoirs and clog stream channels.

In the United States, between 25 and 50 deaths each year result from landslides and debris flow. Health hazards associated with these events include: rapidly moving water and debris that can lead to trauma, broken utility lines that can result in injury or illness, and disrupted transportation ways that can endanger travelers and limit access to healthcare.

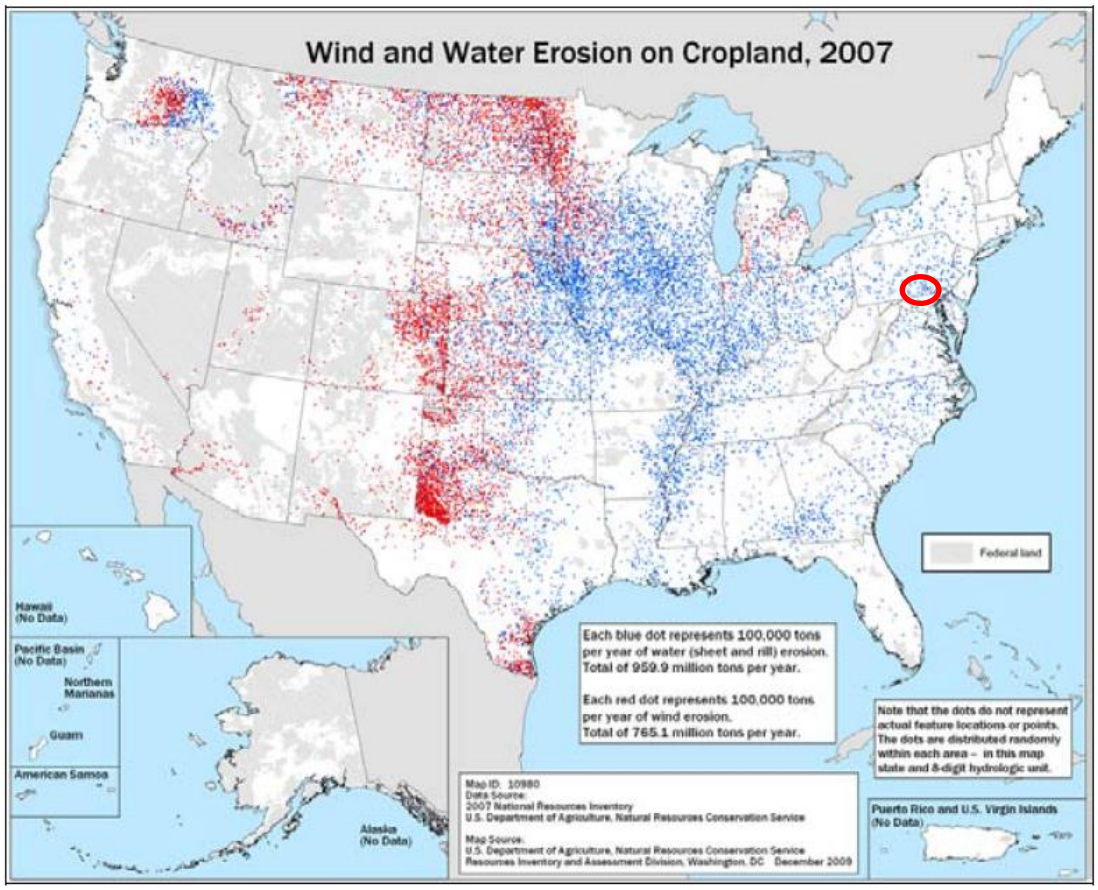
The Penn State Extension service defines three primary types of soil erosion in Pennsylvania: sheet erosion, rill erosion, and gully formation (2018). Sheet erosion is unlikely, but rill erosion and gully formation are prominent. Rill erosion occurs when the "concentrated flow" of runoff forms rivulets that carry soil off of a field. Gully formation occurs when high volume flow concentrates in an area. Anecdotally, Adams County's planning committee sees rill erosion and gully formation when concentrated and intense rain falls over the area.

4.3.8.3 Past Occurrence

The U.S. Geological Service maintains the U.S. Landslide Registry, a database of landslides in the United States. There are no noted landslides in Adams County. The nearest recorded landslides were in York and Cambria Counties. Adams County did receive a Public Assistance disaster declaration in 2006 (DR 1649). The declaration was for severe storms, flooding, and mudslides between June 23 and July 10, 2006. However, the impact of that series of events was largely flooding in Adams County.

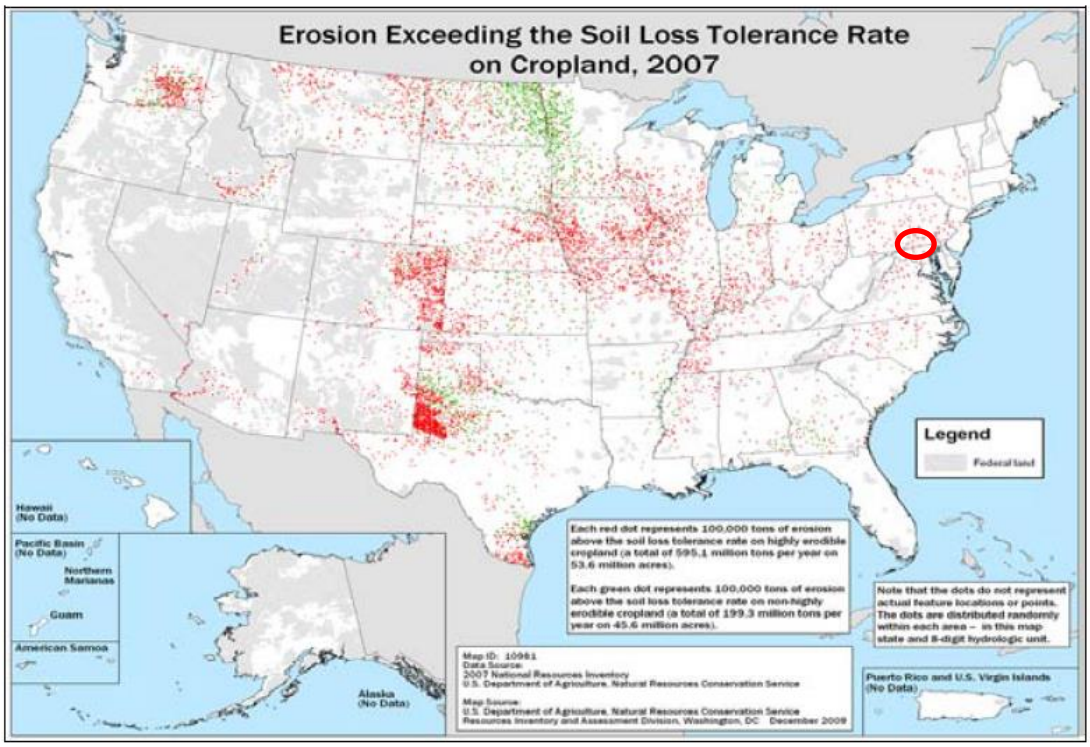
The USDA's Natural Resource Conservation Service compiled data on soil erosion of cropland in 2007. That report found that, between 1982 and 2007, soil erosion on cropland throughout the nation decreased by approximately 43% from 3.06 billion tons per annum to 1.73 billion tons (NRCS PA, 2007). The report included the following graphics. In each case, the red circle highlights the general Adams County region.

Figure 4.3.8.3-1



The Adams County region includes numerous “blue dots” indicating erosion. According to the report, blue dots represent instances of 100,000 tons of water erosion per year. Figure 4.3.8.3-2 shows instances of erosion that exceed the soil loss toleration rate on cropland. In this graphic, red dots represent 100,000 tons of erosion over the loss toleration rate, and there are red dots in the Adams County region.

Figure 4.3.8.3-2



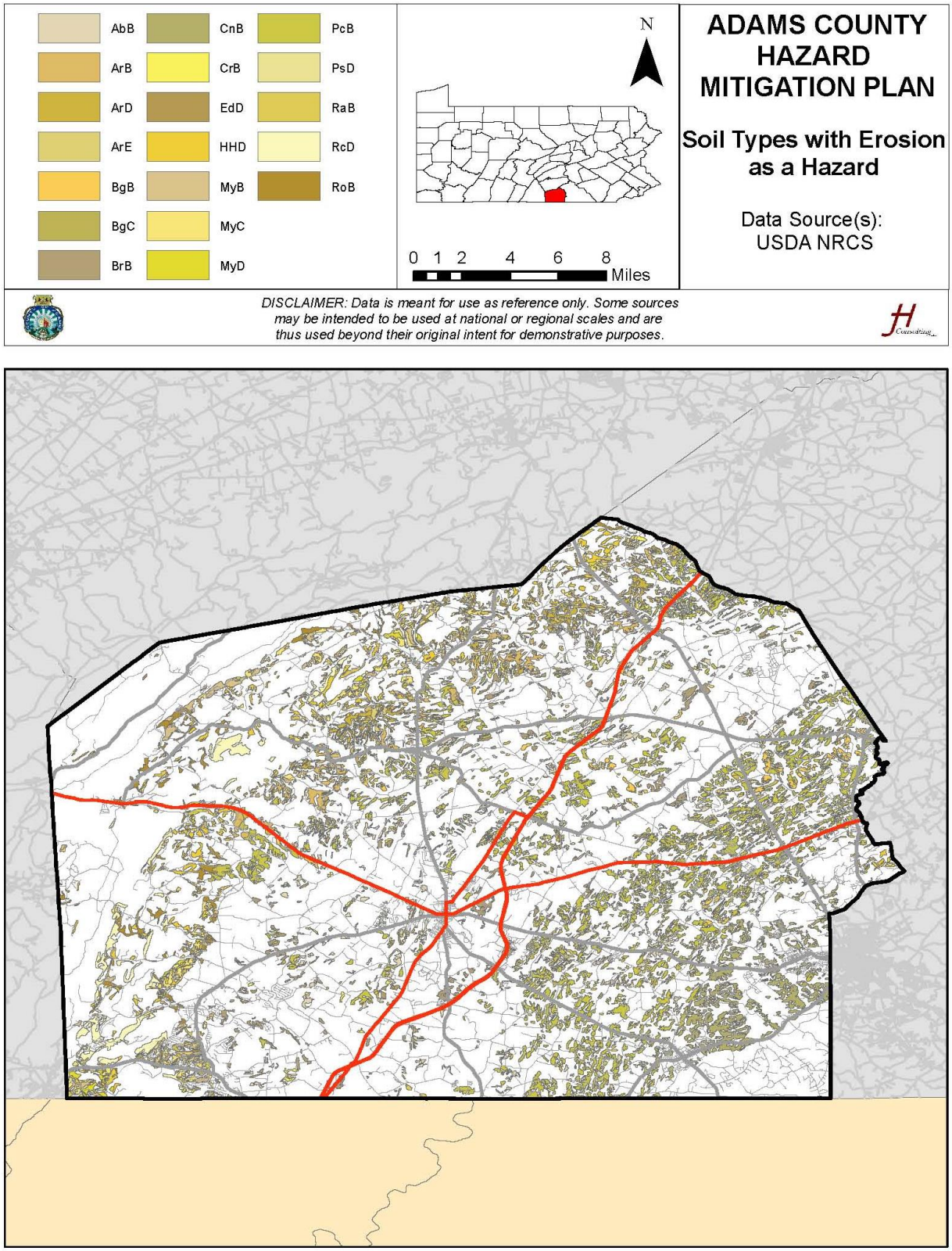
Adams County faces another unique impact from erosion. PennLive reported that erosion was impacting the landscape at the Gettysburg National Military Park. Visitors from throughout the world visit the park annually, and human foot traffic has impacted the area. DeJesus (2017) writes, “Generations of visitors have in their exploration transformed the landscape from its natural state, carving the hillside with paths devoid of vegetation and eroded down to packed earth.” According to the article, the National Park Service is working to address the issue in several ways.

4.3.8.4 Future Occurrence

Land development is increasing the number of landslides and the economic effects of the few natural slides that occur. Major construction with large excavations and fills located in hilly areas creates an increased potential for landslides. Erosion may also occur in construction areas, but other instances occur following heavy rains, etc. In those instances, impacted areas are usually those along creeks and streams as well as low-lying dips or gullies leading off of elevated areas. The Adams County Conservation District supports and enforces erosion and sediment control efforts to minimize erosion (to the extent possible). Figure 4.3.8.4-1 is a map of Adams County that identifies soil types (Source: USGS). Generally, these soil types list erosion

as a major hazard. It is significant that many other soil types (not highlighted on the following figure) also list erosion as a hazard, but they note that planting grasses (or the presence of grasses as legumes) as a suitable means of controlling erosion.

Figure 4.3.8.4-1



4.3.8.5 Vulnerability Assessment

Table 4.3.8.5-1 shows Adams County's vulnerability to landslides.

Table 4.3.8.5-1

LANDSLIDE VULNERABILITY SUMMARY			
Category	*Points*	*Description*	*Notes*
Frequency	1	None	There have been no recorded landslide events in Adams County.
Response	2	1 day	Response to a landslide event will be short. Landslides do not require an extended traditional emergency response.
Onset	1	Over 24 hours	Most landslides in Pennsylvania are slow-moving and occur over time.
Magnitude	1	Localized	Landslides are localized events. Unlike the weather, which affects entire regions, the land area affected by a landslide is concentrated.
Business	1	Less than 24 hours	A landslide in Adams County would not likely cause interruption on the county's economy.
Human	1	Minimum	Landslides do not typically cause human health impacts. Their effects are limited to land and property.
Property	1	Less than 10% of property affected	Landslides do not affect significant amounts of property.
Total	**8**	**Lowest**	

4.0 RISK ASSESSMENT

4.3.9 Pandemic and Infectious Diseases

HIGHEST HIGH MEDIUM LOW LOWEST	A pandemic occurs when infection from a new strain of a certain disease, to which most humans have no immunity, substantially exceeds the number of expected cases over a given period. Such a disease may or may not be transferable between humans and animals.			
	Period of Occurrence:	Can occur at any time	**Hazard Index Ranking:**	16-Medium
	Warning Time:	More than 24 hours	**State Risk Ranking:**	2.0-Medium
	Type of Hazard:	Natural	**Disaster Declarations:**	EM-3441 (Covid-19) DR-4506 (Covid-19)

In 2016, pandemic and infectious diseases accounted for three of the top ten causes of death worldwide. Microorganisms such as bacteria, viruses, fungi, or parasites, cause these diseases and pass directly or indirectly from one person to another (Baylor College of Medicine, n.d.). Humans can also become infected from an infected animal that harbors a pathogenic organism.

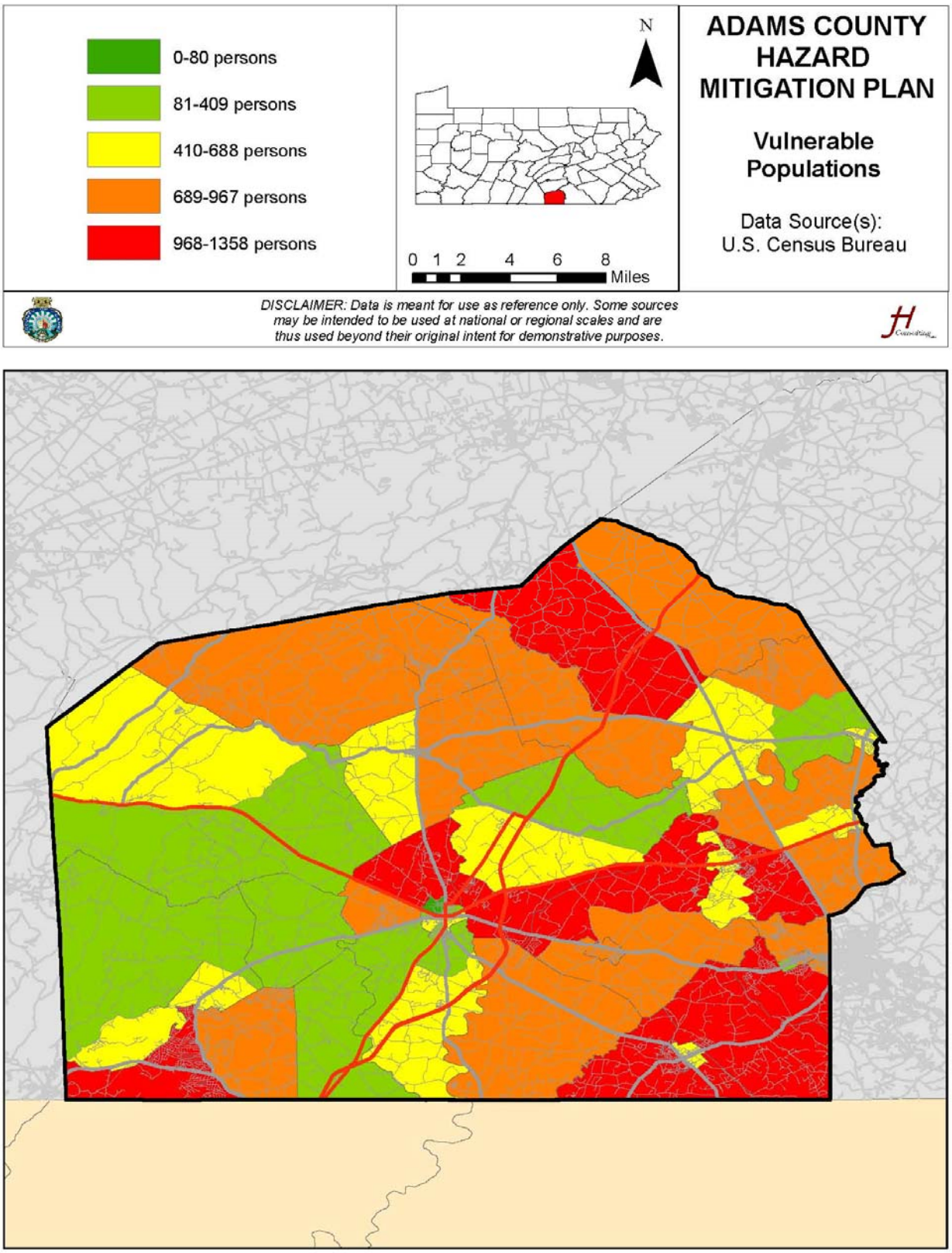
4.3.9.1 Location and Extent

According to the Center for Disease Control and Prevention (CDC), there are three widely accepted "levels" of disease presence.

- ***Endemic*** refers to the baseline level of a particular disease in a population or area. This level is not necessarily the desired level, but the observed level.
- ***Epidemic*** refers to an increase in the number of cases of a disease above the usual level in that population or area. Epidemics may result from an increase of the disease's virulence, presence of a disease in a new outbreak, enhanced disease transmission, increased susceptibility among exposed persons, or increased exposure to the disease-causing agent. Note that, while the term "epidemic" originally only included infectious diseases, some non-infectious health conditions (such as obesity and the opioid misuse) have reached epidemic status in the United States.
- ***Pandemic*** refers to an epidemic that has spread over several countries or continents, typically affecting a large number of people.

An epidemic or pandemic would affect all areas of Adams County, but certain sub-sections of the population would be more affected than others. Those most vulnerable are children, the elderly, and individuals with chronic illnesses. Figure 4.3.9.2-1 shows the distribution of age-related vulnerable populations (i.e., combined totals of those 18/under and 65/over).

Figure 4.3.9.2-1



4.3.9.2 Range of Magnitude

The extent of illness caused by a communicable or infectious disease depends on both the person infected and the pathogen infecting them. For example, the influenza virus usually circulates from November to March and affects up to 20% of Americans. Unlike seasonal influenza, pandemic strains of the flu virus are easily circulated and affect healthy individuals. Table 4.3.9.2-1 outlines the difference between seasonal and pandemic influenza.

Table 4.3.9.2-1

Seasonal Flu	Flu Pandemic
Outbreaks occur every year, usually in winter.	This occurs only rarely (only four times since 1918).
Caused by influenza viruses that are similar to those already affecting people.	Caused by a new influenza virus that people have not been exposed to before.
Healthy adults usually not at risk for serious complications.	Healthy adults may be at increased risk for serious complications.
Hospitals and healthcare providers can usually meet public needs.	Hospitals and healthcare providers may be overwhelmed and difficult to access.
The vaccine is available at the beginning of the flu season.	A vaccine would probably not be available in the early stages of a pandemic.
It causes an average of 36,000 deaths each year in the United States.	The number of deaths could be significantly higher. In the 1918 pandemic, approximately 675,000 people died in the United States.
Generally does not have a severe impact on daily life.	May have a severe impact on daily life, including widespread restrictions on travel, closings of schools and businesses, and cancellation of public events.

Pandemics are further exacerbated by the fact that healthcare resources can become scarce during an event. The number of cases and a reduced number of caregivers can overload jurisdictions or healthcare systems. Furthermore, preventative measures, such as vaccinations or prophylactic medication, may be in short supply or unavailable.

Fortunately, there are vaccines for several communicable diseases. Table 4.3.9.2-2 below shows vaccination rates among Adams County Kindergarteners and 7th graders for age-appropriate immunizations for school years 2015/2016, 2016/2017, 2017/2018, and 2018/2019. The 2018/2019 data also includes 12th graders.

Table 4.3.9.2-2

ADAMS COUNTY VACCINATION RATES, 2015-2019

2018/2019 School Year

Grade	Total Students Enrolled	DTaP/DTP/DT 4 Doses or More	Polio 4 Doses or More	MMR 2 Doses or More	HepB 3 Doses or More	Varicella Had Disease	Varicella 2 Doses	Tdap/ Td 1 Dose	MCV 1 Dose	MCV 2 Doses	Medical Exempt	Religious Exempt	Philoso-phical Exempt	Provisional Enrollment	Denied Admission
Kindergarten	1,100	1,073	1,076	1,076	1,076	1	1,072				3	8	12	18	-
Percent		97.5%	97.8%	97.8%	97.8%	0.1%	97.5%				0.3%	0.7%	1.1%	1.6%	
7th Grade	1,195	1,181	1,179	1,179	1,175	5	1,177	1,170	1,171		9	12	8	10	-
Percent		98.8%	98.7%	98.7%	98.3%	0.4%	98.5%	97.9%	98.0 %		0.8%	1.0%	0.7%	0.8%	
12th Grade	1,260	1,256	1,252	1,255	1,258	50	1,203	1,252	15	1,229	11	10	10	1	-
Percent		99.7%	99.4%	99.6%	99.8%	4.0%	95.5%	99.4%	1.2%	97.5 %	0.9%	0.8%	0.8%	0.1%	
Totals	3,555	3,510	3,507	3,510	3,509	56	3,452	2,422	1,186	1,229	23	30	30	29	-
Percent		98.7%	98.6%	98.7%	98.7%	1.6%	97.1%	98.65 %	48.3 %	97.5 %	0.6%	0.8%	0.8%	0.8%	
Number of Schools Reporting	32														

2017/2018 School Year

Grade	Total Students Enrolled	DTaP/DTP/DT 4 Doses or More	Polio 3 Doses or More	MMR 2 Doses or More	HepB 3 Doses or More	Varicella Had Disease	Varicella 2 Doses	Tdap/ Td 1 Dose	MCV 1 Dose	Medical Exempt	Religious Exempt	Philoso-phical Exempt	Provisional Enrollment	Denied Admission
Kindergarten	884	854	850	856	862	5	853			8	10	11	15	-
Percent		96.61%	96.15%	96.83%	97.51%	0.57%	96.49%	0.00%	0.00%	0.90%	1.13%	1.24%	1.70%	
7th Grade	1,157	1,127	1,126	1,127	1,129	19	1,123	1,120	1,121	14	18	9	8	-
Percent		97.41%	97.32%	97.41%	97.58%	1.64%	97.06%	96.80 %	96.89%	1.21%	1.56%	0.78%	0.69%	
Totals	2,041	1,981	1,976	1,983	1,991	24	1,976	1,120	1,121	22	28	20	23	-
Percent		97.06%	96.82%	97.16%	97.55%	1.18%	96.82%	54.88 %	54.92%	1.08%	1.37%	0.98%	1.13%	
Number of Schools Reporting	23													

ADAMS COUNTY VACCINATION RATES, 2015-2019 (cont.)

2016/2017 School Year

Grade	Total Students Enrolled	DTaP/DTP/DT 4 Doses	Polio 3 Doses	MMR 2 Doses	HepB 3 Doses	Varicella Had Disease	Varicella 2 Doses	Tdap/ Td 1 Dose	MCV 1 Dose	Medical Exempt	Religious Exempt	Philoso-phical Exempt	Provisional Enrollment	Denied Admission
Kindergarten	1,348	1,271	1,306	1,255	1,303	9	1,238			12	4	24	106	-
Percent		94.29%	96.88%	93.10%	96.66%	0.67%	91.84%	0.00%	0.00%	0.89%	0.30%	1.78%	7.86%	
7th Grade	1,456	1,442	1,444	1,441	1,435	16	1,421	1,271	1,259	13	10	11	186	-
Percent		99.04%	99.18%	98.97%	98.56%	1.10%	97.60%	87.29 %	86.47%	0.89%	0.69%	0.76%	12.77%	
Totals:	2,804	2,713	2,750	2,696	2,738	25	2,659	1,271	1,259	25	14	35	292	-
Percent		96.75%	98.07%	96.15%	97.65%	0.89%	94.83%	45.33 %	44.90%	0.89%	0.50%	1.25%	10.41%	
Number of Schools Reporting	25													

2015/2016 School Year

Grade	Total Students Enrolled	DTaP/DTP/DT 4 Doses	Polio 3 Doses	MMR 2 Doses	HepB 3 Doses	Varicella Had Disease	Varicel la 2 Doses	Tdap/ Td 1 Dose	MCV 1 Dose	Medical Exempt	Religious Exempt	Philoso-phical Exempt	Provisional Enrollment	Denied Admission
Kindergarten	1,156	1,116	1,130	1,117	1,126	5	1,108			6	5	15	50	1
Percent		96.54%	97.75%	96.63%	97.40%	0.43%	95.85 %	0.00%	0.00%	0.52%	0.43%	1.30%	4.33%	
7th Grade	1,143	1,135	1,139	1,136	1,129	16	1,123	1,038	1,028	6	11	6	112	-
Percent		99.30%	99.65%	99.39%	98.78%	1.40%	98.25 %	90.81 %	89.94%	0.52%	0.96%	0.52%	9.80%	
Totals	2,299	2,251	2,269	2,253	2,255	21	2,231	1,038	1,028	12	16	21	162	1
Percent		97.91%	98.70%	98.00%	98.09%	0.91%	97.04 %	45.15 %	44.72%	0.52%	0.70%	0.91%	7.05%	
Number of Schools Reporting	25													

As shown in the table above, most children in Adams County's school system received a vaccine to protect them from applicable communicable diseases. In each year, the percent of children vaccinated against these agents is typically above 85%, which is typically sufficient to provide community (i.e., herd) immunity to those who are not vaccinated.

4.3.9.3 Past Occurrence

Table 4.3.9.3-1 lists the four most recent pandemic influenza events. The 1918 Spanish Influenza outbreak remains the worst-case pandemic on record, with the number of deaths dramatically decreasing with each event.

Table 4.3.9.3-1

PREVIOUS WORLDWIDE PANDEMIC EVENTS		
Date	*Pandemic Name/Subtype*	*Worldwide Deaths*
1918-1920	Spanish Flu / H1N1	50 million
1957-1958	Asian Flu / H2N2	1-3 million
1968-1969	Hong Kong Flu / H3N2	1 million
2009-2010	Swine Flu / A/H1N1	25,174
2020-Present	COVID-19	Final estimate unknown (at the time of writing)

H1N1 Epidemic of 2009

The most recent pandemic influenza event was the H1N1 (or swine flu) epidemic in 2009. The CDC monitored the spread of the disease on a near-daily basis. The H1N1 flu was relatively mild for most people, but the virus spread with unprecedented speed; more than 700 schools in the United States closed, and many hospitals quarantined infected individuals. The first pediatric death from the H1N1 flu in Pennsylvania occurred in Adams County in 2009, and approximately 70% of people hospitalized due to the H1N1 virus in the United States belonged to a high-risk group.

COVID-19 Pandemic

In the latter stages of the 2020 mitigation plan update, Adams County responded to the COVID-19 pandemic. The ACDES decided to not include specific details of that incident in this plan because the response was active upon the conclusion of the update. Details will likely feature more heavily in the next plan update.

The Pennsylvania Department of Health (PADoH) maintains county-specific records of the 74 state-specific reportable communicable diseases. Table 2.3.9.3-1 below outlines the

number of cases of these communicable in Adams County.

Table 2.3.9.3-1

COMMUNICABLE DISEASES IN ADAMS COUNTY, 2013-2017						
Communicable Disease	*2017 Count*	*2016 Count*	*2015 Count*	*2014 Count*	*2013 Count*	*Average*
Campylobacter	19	11	21	18	10	15.8
Chicken Pox (Varicella)	6	ND*	ND*	0	ND*	3
Cryptosporidiosis	7	8	ND*	ND*	ND*	7.5
Giardiasis	ND*	6	ND*	ND*	ND*	6
Haemophilus influenzae	ND*	ND*	0	ND*	ND*	0
Hepatitis A	0	0	0	0	0	0
Hepatitis B, Acute	0	0	0	ND*	0	0
Hepatitis B, Chronic	0	ND*	ND*	7	ND*	3.5
Lyme Disease	144	86	116	91	48	97
Neisseria meningitidis	0	0	0	0	0	0
Pertussis	ND*	5	ND*	0	0	1.67
Salmonellosis	16	17	23	18	14	17.6
Shiga toxin-producing *E. coli*	ND*	ND*	ND*	0	8	4
Shigellosis	0	ND*	ND*	ND*	ND*	0
Tuberculosis	0	0	ND*	ND*	0	0
* Not displayed when the count is between 1 and 4 to avoid potential identification of individual cases **Source:** PA Dept. of Health, Bureau of Communicable Diseases						

Of the diseases experienced in Adams County, there are vaccines for chickenpox, pertussis, and Hepatitis B. Because most children in Adams County received vaccinations, the number of cases of these diseases should not significantly increase.

4.3.9.4 Future Occurrence

Seasonal influenza activity peaks every winter, generally from December to February (CDC, 2018). Other communicable diseases that occur regularly in Adams County include campylobacter, chickenpox, cryptosporidiosis, giardiasis, chronic hepatitis B, Lyme disease, pertussis, salmonellosis, and Shiga toxin-producing *E. coli.*

The Mayo Clinic recommends several strategies for decreasing the risk of contracting an infection. These strategies include hand washing, getting recommended vaccinations, staying home when ill, preparing foods safely, practicing safe sex, traveling wisely, and not sharing personal items (Mayo Clinic, 2019).

4.3.9.5 Vulnerability Assessment

Table 4.3.9.5-1 below shows Adams County's vulnerability to a pandemic or infectious disease.

Table 4.3.9.5-1

PANDEMIC AND INFECTIOUS DISEASE RISK SUMMARY			
Category	*Points*	*Description*	*Notes*
Frequency	5	Excessive	Adams County can expect a seasonal outbreak of infectious disease every year.
Response	3	Medium	Pandemic and infectious disease events occur over a longer period than other hazards and may require a prolonged response.
Onset	1	Over 24 hours	While one person can become ill in less than a day, the onset of a pandemic is slow and takes place over weeks or months.
Magnitude	1	Localized	A pandemic would affect less than 10% of land area in Adams County. Its impacts are limited to human health.
Business	2	1 Week	Pandemic events can cause a shortage in the workforce when employees are absent due to illness.
Human	3	Medium	By nature, pandemic and infectious diseases cause adverse human impacts. Depending on the extent of the pathogen, there may or may not be deaths associated with the event.
Property	1	Less than 10% of property affected	Pandemic events primarily affect human health, not property.
Total	**16**	**Medium**	

4.0 RISK ASSESSMENT

4.3.10 Subsidence, Sinkhole

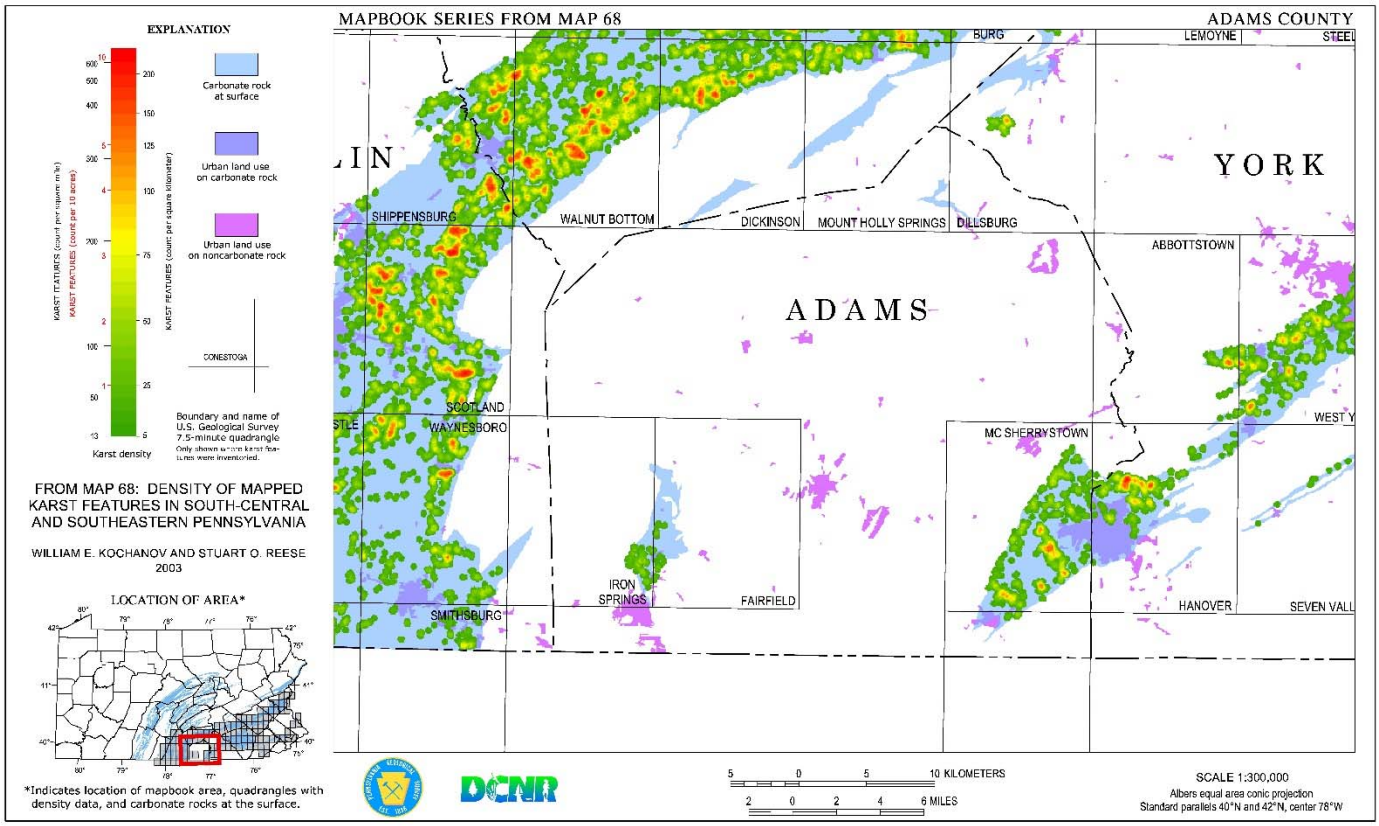
HIGHEST HIGH MEDIUM LOW LOWEST	Sinkholes are underground voids caused by water passing through naturally-occurring fractures in water-soluble bedrock.			
	Period of Occurrence:	Sinkholes can occur at any time	**Hazard Index Ranking:**	12-Low
	Warning Time:	Over 24 hours	**State Risk Ranking:**	1.7-Low
	Type of Hazard:	Natural	**Disaster Declarations:**	N/A

Subsidence is a natural geologic process that commonly occurs in areas with underlying limestone bedrock and other rock types that are soluble in water. Water passing through naturally-occurring fractures dissolves these materials and leaves underground voids. Eventually, overburden on top of the voids causes a collapse which can damage structures with low strain tolerances. This collapse can take place slowly over time or quickly in a single event. Karst topography describes a landscape that contains characteristic structures such as sinkholes, linear depressions, and caves. In addition to natural processes, human activity such as water, natural gas, and oil extraction can cause subsidence and sinkhole formations (PEMA, 2018).

4.3.10.1 Location and Extent

Karst topography is a type of landscape where dissolving bedrock has created sinkholes, sinking streams, caves, and springs. Figure 4.3.10.1-1 shows karst topography in Adams County.

Figure 4.3.10.1-1



Sinkholes are common in areas with karst topography. As the rock dissolves, spaces and caverns can develop underground. The land above these spaces stays intact until the underground space gets too big for the land to support, at which time a sudden collapse of the land can occur.

While most sinkholes are naturally-occurring, some new sinkholes can be attributed to human land-use practices. Development can change the pattern of water drainage, and the weight of construction can trigger an underground collapse of supporting material. Additionally, pumping groundwater for irrigation or water supply and improper management of stormwater runoff can produce new sinkholes in sinkhole-prone areas.

4.3.10.2 Range of Magnitude

Sinkholes and areas of subsidence can vary in shape, proximity to development, and the period over which they occur. Events can result in minor elevation changes or deep, gaping holes in the earth's surface. Events can cause significant damage in populated areas, particularly to underground utility systems, transportation systems, property, and structures.

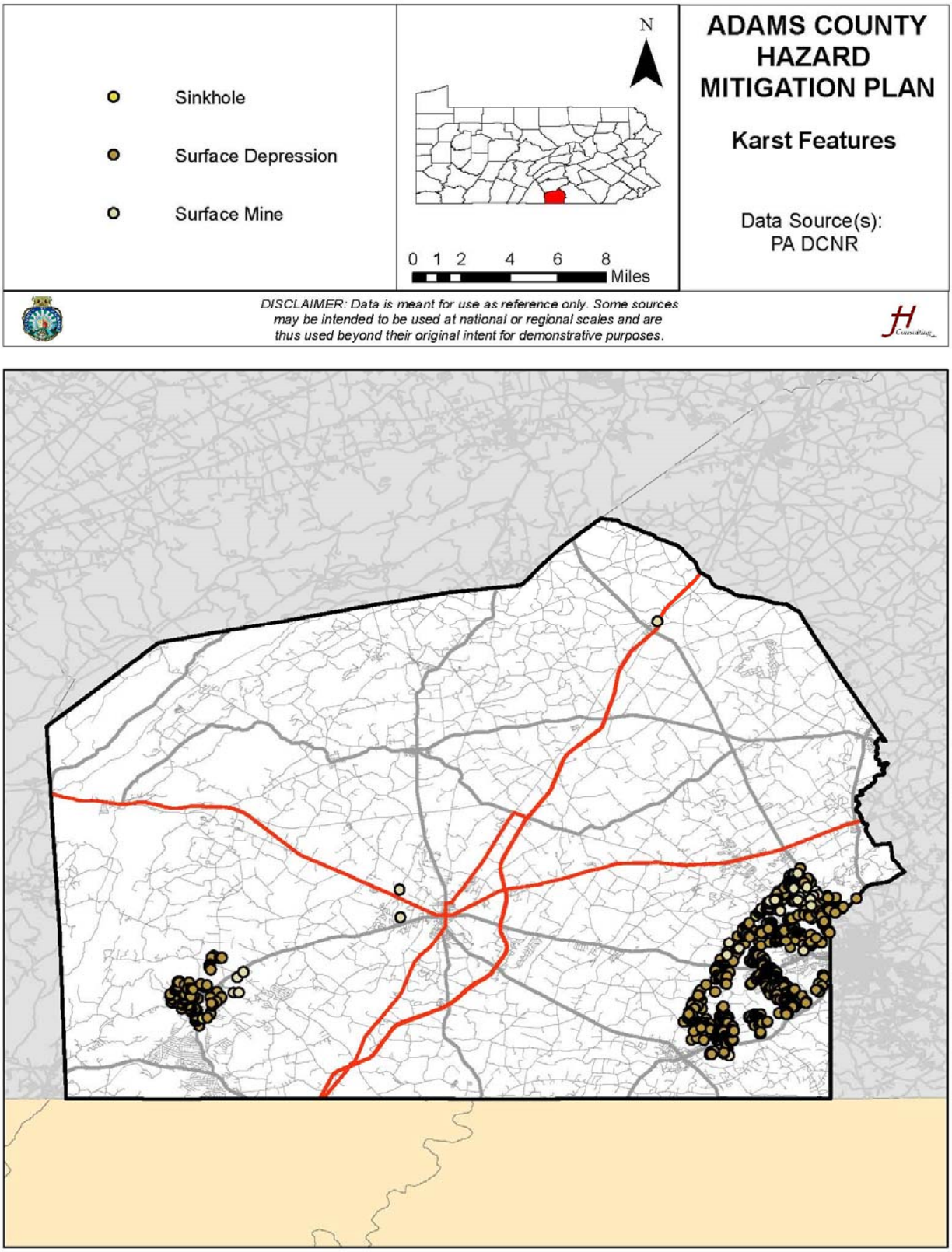
There are a few measures that can reduce the overall vulnerability to subsidence and

sinkholes. Municipal governments may determine guidelines for construction in high-subsidence areas. A community can reduce its vulnerability to subsidence or sinkholes by implementing solutions such as land use controls, insurance programs, subsidence-resistant designs, or in the case of mine-related subsidence, conduct selective support or mine filling. If a sinkhole occurs on private property, it is normally the responsibility of the property owner to initiate repairs. Homeowners' insurance often does not cover damages attributed to sinkholes. Since 1987, sinkhole insurance has been available within Pennsylvania and may serve to eliminate the financial burdens placed on the homeowner.

4.3.10.3 Past Occurrence

The Pennsylvania Department of Conservation and Natural Resources conducted a partial inventory of Karst features throughout the Commonwealth. There are 31 identified sinkholes and 788 surface depressions throughout Adams County (PADCNR, 2016). Additionally, DCNR staff indicated that small sinkholes occur more frequently across the state, but cause limited damage. Figure 4.3.10.3-1 graphically depicts Karst features in Adams County.

Figure 4.3.10.3-1



4.3.10.4 Future Occurrence

Based on geologic conditions and past surface depressions, sinkholes and subsidence are possible in all areas of the county, but much more likely to occur in the following municipalities.

- Carroll Valley Borough
- Conewago Township
- Fairfield Borough
- Franklin Township
- Germany Township
- Hamiltonban Township
- Huntington Township
- Latimore Township
- Littlestown Township
- McSherrystown Borough
- Union Township
- York Springs Borough

Municipalities could minimize the potential for sinkhole development through proper maintenance and updating of water utility lines. Zoning laws can also regulate development within the high Karst areas.

4.3.10.5 Vulnerability Assessment

This section summarizes the vulnerability to Adams County from subsidence. Adams County conducted an online survey for the public to share its thoughts on hazard vulnerabilities. Table 4.3.10.5-1 presents the results of that survey regarding subsidence and sinkholes.

Table 4.3.10.5-1

PUBLIC SENTIMENT, SUBSIDENCE, SINKHOLE – ADAMS COUNTY					
Hazard	*Level of Concern*				*Total Responses*
	Not at All	*Somewhat*	*Concerned*	*Very*	
Subsidence, Sinkhole	54 (36.73%)	50 (34.01%)	35 (23.81%)	8 (5.44%)	147
In the past ten years, do you remember this hazard occurring in your community?				24 (16.44%)	146
Have you noticed an increase or decrease in the occurrences or intensity of this hazard? (137 responses)				26 (18.98%)	INCREASE
				107 (78.10%)	NO CHANGE
				4 (2.92%)	DECREASE

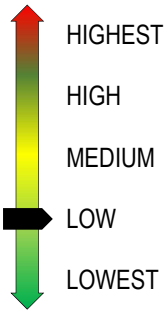
Table 4.3.10.5-2 shows Adams County's vulnerability to subsidence and sinkholes.

Table 4.3.10.5-2

SUBSIDENCE, SINKHOLE VULNERABILITY SUMMARY			
Category	*Points*	*Description*	*Notes*
Frequency	5	Excessive	There are 31 sinkholes and 788 surface depressions in Adams County.
Response	1	Less than half a day	Sinkholes typically do not require a traditional emergency response.
Onset	1	Over 24 hours	Areas of subsidence and sinkhole can develop slowly, over weeks.
Magnitude	2	Limited	Sinkholes are prevalent in Adams County. However, they affect less than 25% of the land area in the county.
Business	1	Less than 24 hours	Sinkholes typically do not impact the county's economic activity.
Human	1	Minimum	Sinkholes and subsidence do not usually cause human impacts. Damages are related primarily to land and property.
Property	1	Less than 10%	Sinkholes and subsidence affect small areas and do not affect more than 10% of property in the county.
Total	**12**	**Low**	

4.0 RISK ASSESSMENT

4.3.11 Tornado, Wind Storm



Tornadoes are violent windstorms characterized by a twisting funnel-shaped cloud extending to the ground. Wind storms can occur during severe thunderstorms, winter storms, coastal storms, or tornados.			
Period of Occurrence:	Tornadoes can occur at any time but are most likely to occur during thunderstorms from March to September.	**Hazard Index Ranking:**	14-Low
Warning Time:	Little to no warning time	**State Risk Ranking:**	2.2-Medium
Type of Hazard:	Natural	**Disaster Declarations:**	N/A

A wind storm can occur during severe thunderstorms, winter storms, coastal storms, or tornadoes. Straight-line winds, such as a downburst, have the potential to cause wind gusts that exceed 100 miles per hour. Based on 40 years of tornado history and over 100 years of hurricane history, FEMA identifies western and central Pennsylvania as being more susceptible to higher winds than eastern Pennsylvania (FEMA, 1997). There are six types of severe wind: straight-line wind, downbursts, macrobursts, microbursts, gust fronts, and derechos.

- **Straight-line Wind:** A term used to define any thunderstorm wind that is not associated with rotation, and it mainly differentiates storm-associated winds from tornadic winds
- **Downburst:** The general term for all localized strong wind events caused by a strong downdraft within a thunderstorm
- **Macroburst:** An outward burst of strong winds at or near the surface with a diameter larger than 2.5 miles and occurs when a strong downdraft reaches the surface
- **Microburst:** A small, concentrated downburst that produces an outward burst of strong winds near the surface; microbursts are small and short-lived, with a diameter less than 2.5 miles and lasting only 5-10 minutes
- **Gust Front:** The leading edge of rain-cooled air that clashes with warmer thunderstorm inflow, characterized by a wind shift, temperature drop, and gusty winds ahead of a thunderstorm.
- **Derecho:** A widespread, long-lived wind storm associated with a band of rapidly moving showers or thunderstorms; a typical derecho consists of numerous microbursts and

downbursts. An event with wind speeds of at least 58 mph and a diameter of 240 miles can be classified as a derecho.

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground. Tornadoes are most often generated by thunderstorm activity (but sometimes result from hurricanes or tropical storms) when cool, dry air intersects and overrides a layer of warm, moist air, forcing the warm air to rise rapidly. The damage caused by a tornado is a result of high wind velocities and wind-blown debris. According to the National Weather Service, tornado wind speeds can range between 30 to more than 300 miles per hour and are more likely to occur during the spring and early summer months (March through June) in the late afternoon and early evening. Most tornadoes are a few dozen yards wide and touch down briefly, but even small, short-lived tornadoes can inflict tremendous damage. Destruction ranges from minor to catastrophic depending on the intensity, size, and duration of the storm.

4.3.11.1 Location and Extent

The Beaufort Wind Scale, which was developed in 1805 by Sir Francis Beaufort, measures wind. It assigns force categories to winds based on its effects on either land or water. Table 4.3.11.1-1 below describes the Beaufort scale.

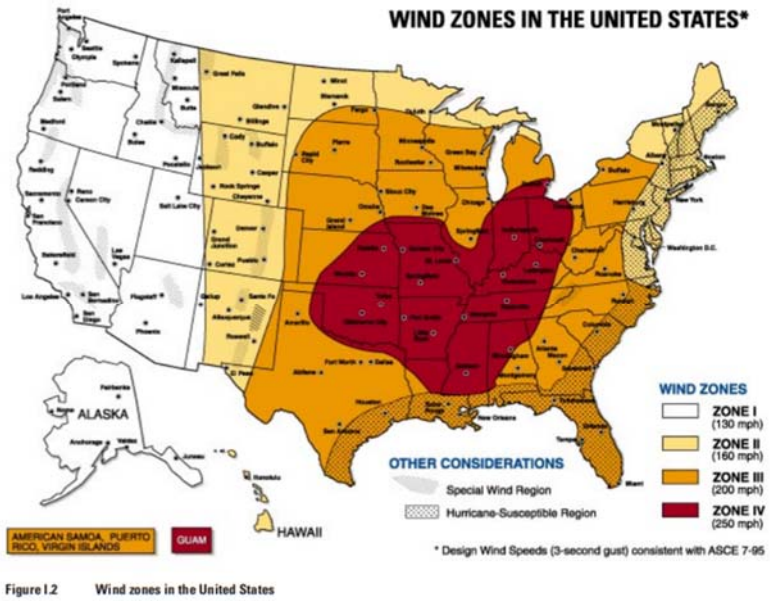
Table 4.3.11.1-1

BEAUFORT WIND SCALE				
Force	*Wind (Knots)*	*WMO Classification*	*Appearance of Wind Effects*	
			On Water	*On Land*
0	Less than 1	Calm	Sea surface smooth and mirror-like	Calm, smoke rises vertically
1	1-3	Light Air	Scaly ripples, no foam crests	Smoke drift indicates wind direction, still wind vanes
2	4-6	Light Breeze	Small wavelets, crests glassy, no breaking	Wind felt on face, leaves rustle, vanes begin to move
3	7-10	Gentle Breeze	Large wavelets, crests begin to break, scattered whitecaps	Leaves and small twigs constantly moving, light flags extended
4	11-16	Moderate Breeze	Small waves 1-4 ft. becoming longer, numerous whitecaps	Dust, leaves, and loose paper lifted, small tree branches move
5	17-21	Fresh Breeze	Moderate waves 4-8 ft. taking longer form, many whitecaps, some spray	Small trees in leaf begin to sway
6	22-27	Strong Breeze	Larger waves 8-13 ft., whitecaps common, more spray	Larger tree branches moving, whistling in wires
7	28-33	Near Gale	Sea heaps up, waves 13-19 ft., white foam streaks off breakers	Whole trees moving, resistance felt walking against the wind

BEAUFORT WIND SCALE				
Force	*Wind (Knots)*	*WMO Classification*	*Appearance of Wind Effects*	
			On Water	*On Land*
8	34-40	Gale	Moderately high (18-25 ft.) waves of greater length, edges of crests begin to break into spindrift, foam blown in streaks	Twigs broken off trees, generally impedes progress
9	41-47	Strong Gale	High waves (23-32 ft.), the sea begins to roll, dense streaks of foam, a spray may reduce visibility	Slight structural damage occurs, slate blows off roofs
10	48-55	Storm	Very high waves (29-41 ft.) with overhanging crests, sea white with densely blown foam, heavy rolling, lowered visibility	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	56-63	Violent Storm	Exceptionally high (37-52 ft.) waves, foam patches cover the sea, visibility more reduced	N/A
12	64+	Hurricane	Air filled with foam, waves over 45 ft., sea completely white with driving spray, visibility greatly reduced	N/A

FEMA's wind zone map classifies wind zones in the United States. As shown in Figure 4.3.11.1-2 below, Adams County is located in Zones II and III, indicating structures should be able to withstand wind speeds of 160 to 200 miles per hour or a 12 on the Beaufort scale.

Figure 4.3.11.1-2



Tornadoes occur around the world, but the United States is a major hotspot, with an average of over 1,200 tornadoes each year. Canada, who experiences the second-most tornadoes, experiences approximately 100 tornadoes per year. States in the southern United States are more likely than the rest of the nation to experience tornado events. Even so, Pennsylvania experiences an average of 16 tornadoes per year.

Meteorological professionals measures tornadoes using the Enhanced Fujita (EF) scale, which became operational in 2007. The EF scale, adapted from the original Fujita scale, assigns ratings to tornadoes based on their wind speed and related damage. When tornado damage is surveyed, it is compared to a list of damage indicators and degrees of damage, which help estimate the range of wind speeds produced by the tornado. Table 4.3.11.1-3 below shows the EF scale categories and their respective wind speeds.

Table 4.3.11.1-3

EF SCALE		
EF Rating	*3 Second Gust (MPH)*	*Possible Damage*
0	65-85	Broken branches, shallow-rooted trees pushed over, some chimney damage
1	86-110	Surface damage to roofs, mobile homes pushed off foundation, moving vehicles pushed off the road
2	111-135	Frame houses have roof torn off, mobile homes completely destroyed, train boxcars overturned, large trees snapped or uprooted, smaller debris turned into missiles
3	136-165	Roofs completely tore off well-constructed buildings, along with some walls, majority of trees uprooted, trains overturned, vehicles lifted off the ground
4	166-200	Well-constructed houses are completely destroyed; structures with weak foundations blown away; vehicles could be thrown; large debris become flying missiles
5	Over 200	Most structures severely damaged or completely destroyed; vehicles can become flying missiles

4.3.11.2 Range of Magnitude

Wind and tornado events have the potential to cause significant damage to both residential and agricultural areas of Adams County. Residential areas of the county could experience structure damage, including lost roofing and siding, and broken garage doors. Mobile homes are especially at risk during wind events, as even anchored homes can be damaged with wind gusts over 80 miles per hour (69 knots). Figure 4.3.11.2-1 shows the general locations of mobile homes in Adams County.

Figure 4.3.11.2-1

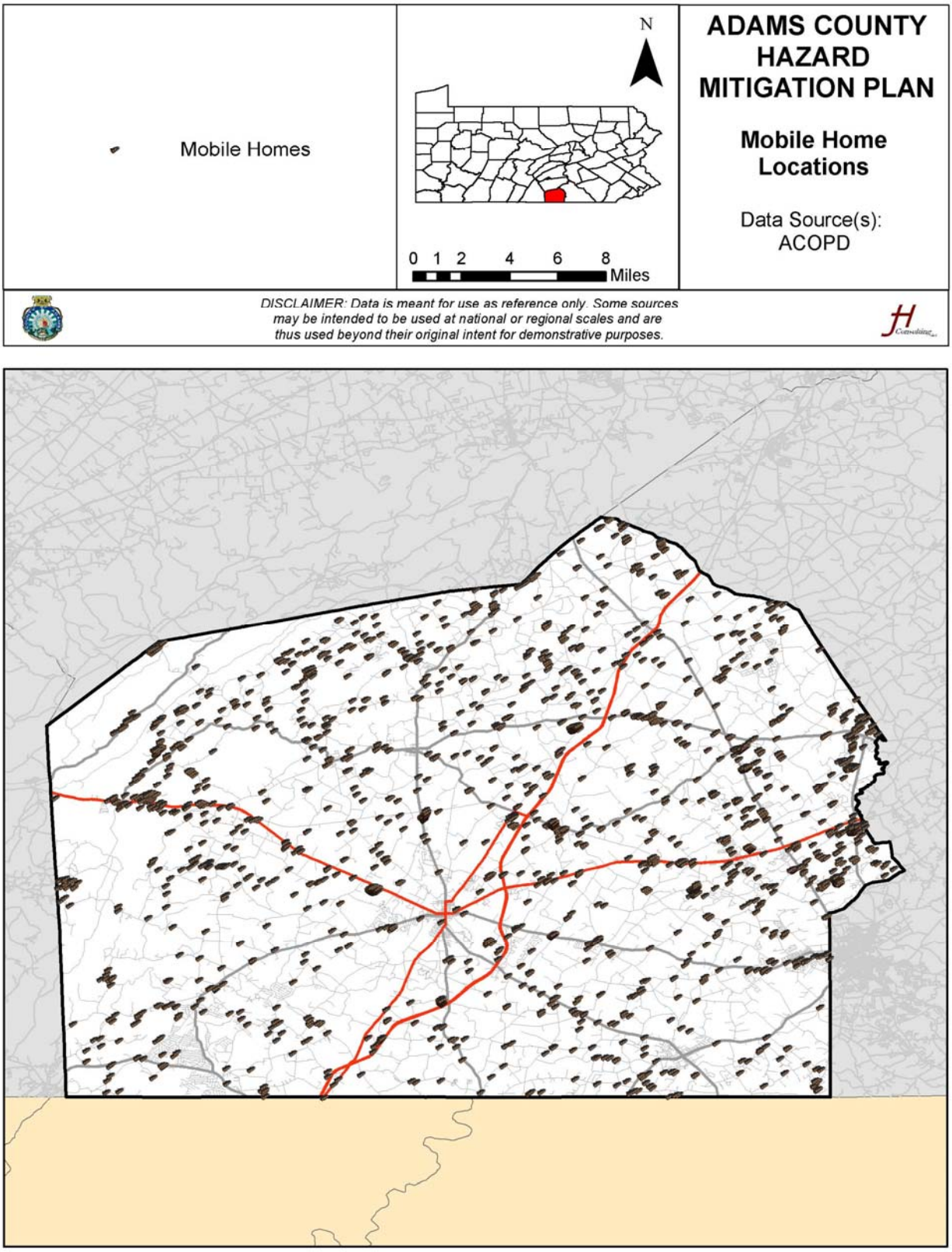
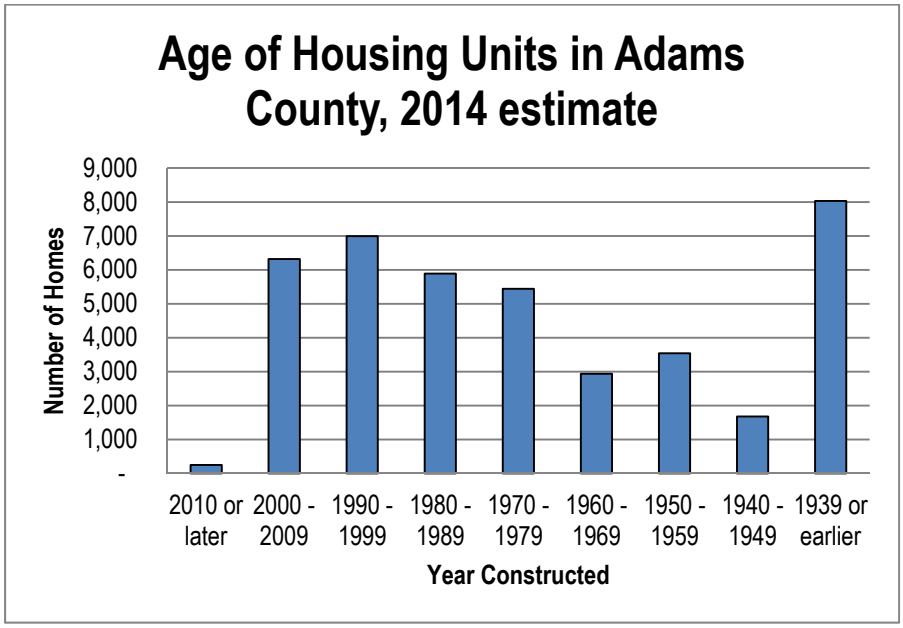


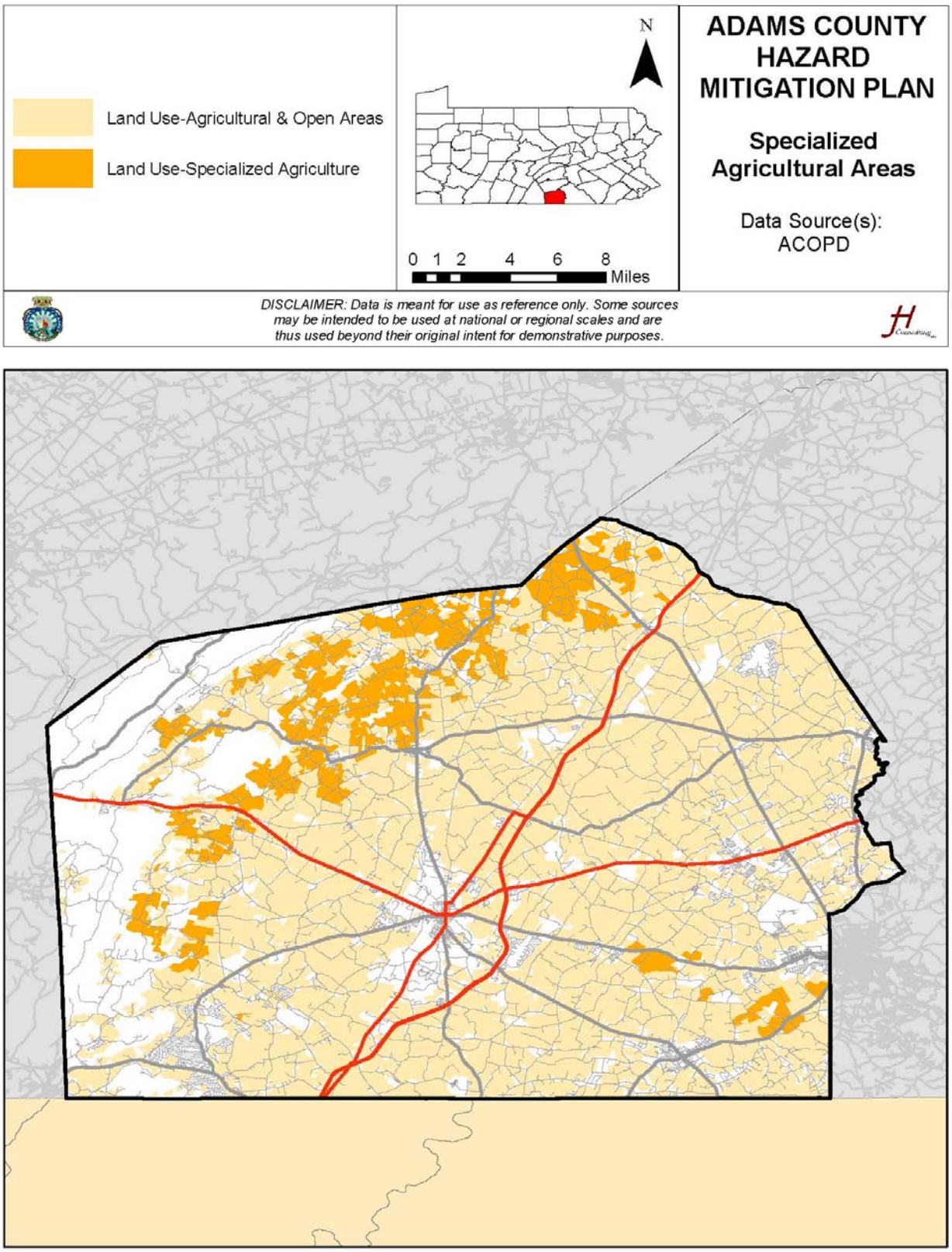
Figure 4.3.11.2-2 also appears in Section 4.3.6 (Hurricane, Tropical Storm, Nor'easter Hazard Profile), but it is relevant to the severe wind discussion. Structures built before 1950 are typically "pre-code" structures, meaning they may not be able to withstand the wind speeds that newer structures can withstand.

Figure 4.3.11.2-2



Agricultural communities in Adams County could also experience crop damage in addition to structural damage. Crop damage from wind and tornado events can include broken branches and plants, uprooted trees and plants, soil movement and erosion, and dispersal of seeds. As noted elsewhere in this plan, Figure 4.3.11.2-3 shows the areas with agriculture as the principal land use.

Figure 4.3.11.2-3



4.3.11.3 Past Occurrence

The National Center for Environmental Information's Storm Event Database contains information regarding past wind and tornado events (since 1950). Tables 4.3.11.3-1 and 4.3.11.3-2 list these events, along with their damages.

Table 4.3.11.3-1

WIND EVENTS, ADAMS COUNTY, 1950-2019									
Location	*Date*	*Time*	*Time Zone*	*Type*	*Magnitude*	*Deaths*	*Injuries*	*Property Damage*	*Crop Damage*
Adams (Zone)	9/16/1999	16:00	EST	High Wind	60 kts.	0	0	0.00K	0.00K
Adams (Zone)	9/29/1999	20:00	EST	High Wind	60 kts.	0	0	0.00K	0.00K
Adams (Zone)	4/9/2000	6:00	EST	High Wind	58 kts. M	0	0	0.00K	0.00K
Adams (Zone)	12/12/2000	4:00	EST	High Wind	N/A	0	0	13.90K	0.00K
Adams (Zone)	2/10/2001	2:00	EST	High Wind	N/A	0	0	5.55K	0.00K
Adams (Zone)	3/9/2002	19:30	EST	High Wind	50 kts. E	0	0	0.00K	0.00K
Adams (Zone)	3/21/2002	18:30	EST	High Wind	50 kts. E	0	0	0.00K	0.00K
Adams (Zone)	11/13/2003	5:00	EST	High Wind	60 kts. EG	0	0	0.00K	0.00K
Adams (Zone)	12/1/2006	18:00	EST-5	High Wind	45 kts. ES	0	0	0.00K	0.00K
Adams (Zone)	12/31/2008	8:00	EST-5	High Wind	50 kts. EG	0	0	5.00K	0.00K
Adams (Zone)	2/12/2009	1:00	EST-5	High Wind	50 kts. EG	0	0	25.00K	0.00K
Adams (Zone)	2/25/2011	9:00	EST-5	High Wind	58 kts. MG	0	0	0.00K	0.00K
Adams (Zone)	8/28/2011	1:00	EST-5	Strong Wind	43 kts. EG	0	0	10.00K	0.00K
Adams (Zone)	10/29/2012	15:00	EST-5	High Wind	56 kts. MG	0	0	0.00K	0.00K
Adams (Zone)	4/3/2016	0:00	EST-5	High Wind	52 kts. EG	0	0	1.00K	1.00K
Adams (Zone)	3/2/2018	8:00	EST-5	High Wind	52 kts. EG	0	0	0.00K	0.00K
Adams (Zone)	2/24/2019	13:00	EST-5	High Wind	52 kts. EG	0	0	0.00K	0.00K
					TOTAL	**0**	**0**	**$60,450**	**$1,000**

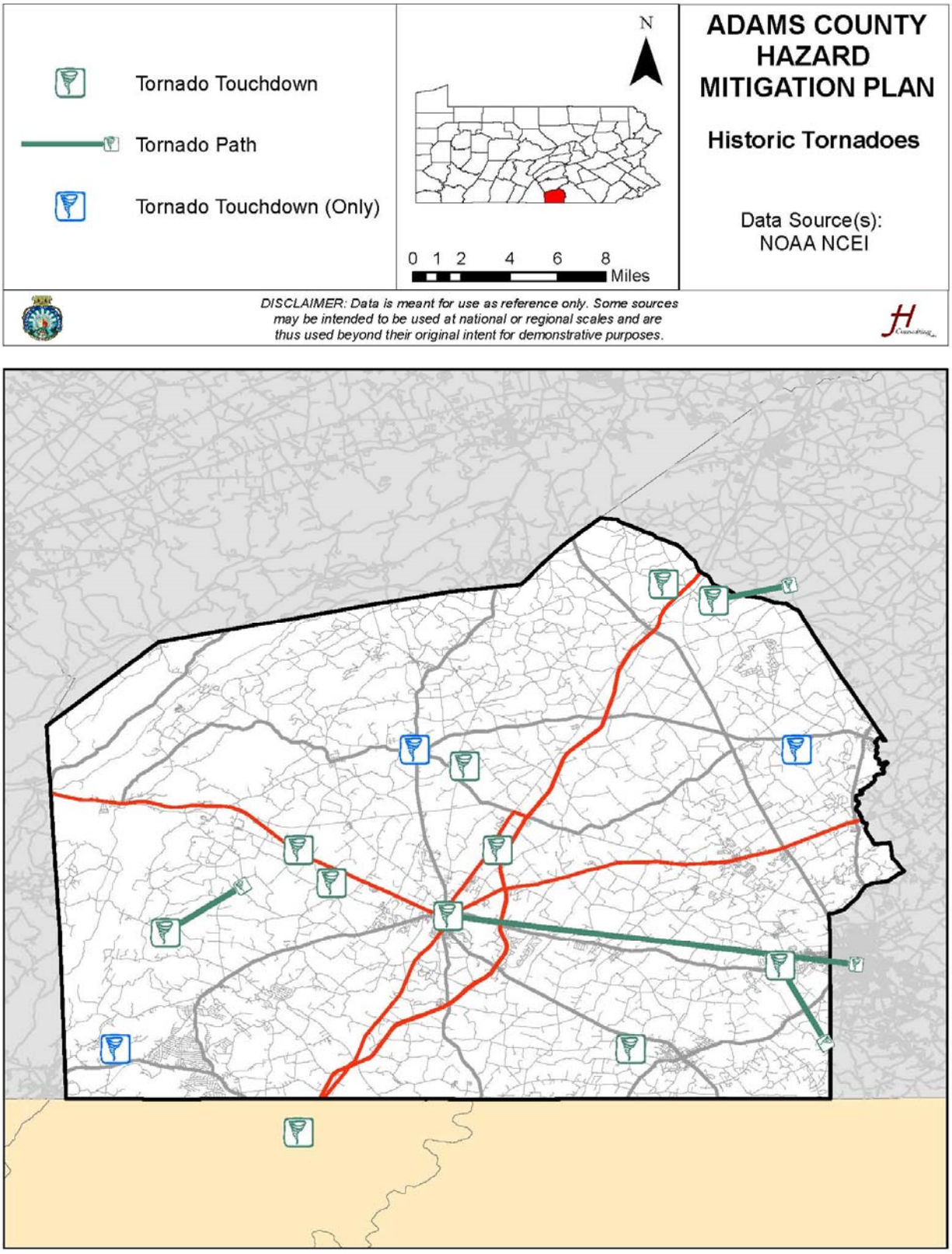
There were 17 wind events in Adams County from 1999 to 2019, for an 85% annual chance of an event on any given year. Six of the 17 recorded events (35%) caused property damage, and the average damage for all 17 was $3,555.

Table 4.3.11.3-2

TORNADO EVENTS, ADAMS COUNTY, 1950-2018									
Location	*Date*	*Time*	*Time Zone*	*Type*	*Magnitude*	*Deaths*	*Injuries*	*Property Damage*	*Crop Damage*
Adams (Zone)	3/30/1951	15:00	CST	Tornado	F1	0	0	2.50K	0.00K
Adams (Zone)	4/25/1954	16:30	CST	Tornado	F2	0	0	25.00K	0.00K
Adams (Zone)	9/16/1971	14:45	CST	Tornado	F1	0	0	25.00K	0.00K
Adams (Zone)	3/21/1976	11:30	CST	Tornado	F2	0	0	25.00K	0.00K
Adams (Zone)	8/28/1978	14:30	CST	Tornado	F2	0	0	2.50K	0.00K
Adams (Zone)	6/7/1980	17:00	CST	Tornado	F2	0	0	2.500M	0.00K
Adams (Zone)	6/7/1980	17:00	CST	Tornado	F3	0	0	250.00K	0.00K
McKnightstown	6/24/1996	16:45	EST	Tornado	F1	0	0	0.00K	0.00K
McKnightstown	7/19/1996	13:35	EST	Tornado	F1	0	0	0.00K	0.00K
York Springs	9/6/1996	19:00	EST	Tornado	F1	0	0	0.00K	0.00K
Table Rock	4/1/1998	12:30	EST	Tornado	F1	0	0	0.00K	0.00K
Heidlersburg	3/3/1999	20:30	EST	Tornado	F0	0	0	25.00K	0.00K
Littlestown	8/20/1999	18:00	EST	Tornado	F1	0	0	0.00K	0.00K
Fountain Dale	8/30/2005	23:22	EST	Tornado	F1	0	0	0.00K	0.00K
Gettysburg	8/30/2005	23:38	EST	Tornado	F1	0	0	0.00K	0.00K
Seven Stars	8/30/2005	23:40	EST	Tornado	F1	0	0	0.00K	0.00K
					TOTAL	**0**	**0**	**$357,500**	**$0**

There have been 16 tornadoes in Adams County since 1951. These events have caused $357,500 in damages over the past 68 years, for an average of $22,300 per event. Figure 4.3.11.3-3 shows a map of historical tornado paths.

Figure 4.3.11.3-3



4.3.11.4 Future Occurrence

Future wind and tornado events will affect each area of Adams County differently. In the northern portion of the county, the agricultural industry would be heavily affected. Fruit, fruit trees, and crops account for a significant portion of the county's economy, and all are vulnerable to the effects of windstorms and tornadoes.

Central and southeastern Adams County is more residential and would be affected by wind and tornado events differently. These areas would likely experience structure, tree, and utility damage.

4.3.11.5 Vulnerability Assessment

This section summarizes the vulnerability to Adams County from severe wind. Adams County conducted an online survey for the public to share its thoughts on hazard vulnerabilities. Table 4.3.11.5-1 presents the results of that survey regarding severe wind.

Table 4.3.11.5-1

PUBLIC SENTIMENT, TORNADO, WINDSTORM – ADAMS COUNTY					
Hazard	*Level of Concern*				*Total Responses*
	Not at All	*Somewhat*	*Concerned*	*Very*	
Tornado, Windstorm	17 (11.64%)	56 (38.36%)	58 (39.73%)	15 (10.27%)	146
In the past ten years, do you remember this hazard occurring in your community?				72 (49.32%)	146
Have you noticed an increase or decrease in the occurrences or intensity of this hazard? (139 responses)				45 (32.37%)	INCREASE
				91 (65.47%)	NO CHANGE
				3 (2.16%)	DECREASE

The table below shows the outcome of the vulnerability assessment for Adams County.

Table 4.3.11.5-2

TORNADO, WIND STORM VULNERABILITY SUMMARY			
Category	*Points*	*Description*	*Notes*
Frequency	3	Medium	There have been 33 events in Adams County in 68 years, for an average of 0.48 events per year, or a 48% chance per year of an event.
Response	2	1 Day	Tornado events would likely require an intense response for the first 24-hours. Operations beyond one day would likely transition to recovery efforts.
Onset	4	Less than 6 hours	While thunderstorms that produce tornadoes and windstorms are predicted days before the event, tornadoes and wind events occur spontaneously.
Magnitude	1	Localized	Tornado and wind events are highly localized and affect less than 10% of the land area.
Business	1	Less than 24 hours	Tornado and wind events are unlikely to cause prolonged, widespread economic impacts.
Human	2	Low (Some injuries)	Widespread human impacts during tornados are unlikely. Individuals can be significantly harmed by debris and structural damage.
Property	1	Less than 10% of property affected	Again, tornado and wind events are highly localized. While individuals may experience significant property damage, less than 10% of all property in Adams County is likely to be damaged in these events.
Total	**14**	**Low**	

4.0 RISK ASSESSMENT

4.3.12 Wildfire

HIGHEST HIGH MEDIUM LOW LOWEST	Wildfires are uncontrolled fires that spread rapidly through vegetative fuels, exposing and possibly consuming structures.			
	Period of Occurrence:	Most common in Spring and Fall	**Hazard Index Ranking:**	15-Low
	Warning Time:	Wildfires can occur at any time, with no warning	**State Risk Ranking:**	2.4-Medium
	Type of Hazard:	Natural	**Disaster Declarations:**	N/A

A wildfire is a raging, uncontrolled fire that spreads rapidly through vegetative fuels, exposing and possibly consuming structures. Wildfires often begin unnoticed and can spread quickly, creating dense smoke that is visible for miles. Wildfires can occur at any time of the year but mostly occur during long, dry, hot spells. Any small fire in a wooded area, if not quickly detected and suppressed, can get out of control. Human carelessness, negligence, and ignorance cause most wildfires. In some instances, lightning strikes can precipitate spontaneous combustion. Wildfires in Pennsylvania can occur in fields, grass, brush, and forests. 99% of wildfires in Pennsylvania are a direct result of people, often caused by debris burns (PEMA, 2018).

4.3.12.1 Location and Extent

Adams County experiences several fires each year, most of which are easily controlled by local fire departments and do not reach the threshold for inclusion as a “wildfire.” Like all other fires, wildfires require three conditions to start: an available fuel source (including dried leaves or grass), dry conditions (including low relative humidity), and an ignition source. The first two conditions typically occur in Pennsylvania in the spring and fall, when trees are bare, and sunlight can warm the ground and dry surface fuels.

The National Fire Danger Rating System is a system that allows fire officials to estimate current fire danger for a given area based on available fuels, weather, topography, and risks.

- **Low:** When the fire danger is “low,” fuels do not ignite easily, and a more intense heat source is needed to start fires. Dry grasslands may burn easily, but wood fires will spread slowly, and control of fires is typically not difficult.

- **Moderate:** When the fire danger is "moderate," fires can start from accidental causes, but the number of fire starts is generally low. If a fire does start on open, dry grassland, it can spread quickly on windy days. Most wood fires spread slowly or moderately. The average fire intensity will be moderate, except in heavy concentrations of fuel. Fires are still not likely to become serious and are typically easy to control.
- **High:** When the fire danger is "high," fires can start easily from most fuel sources. Unattended campfires and brush fires are likely to escape and can spread easily. Fires can become serious and difficult to control unless they are extinguished when they are still small.
- **Very High:** When the fire danger is "very high," fires will start easily from most fuel sources, spread rapidly, and quickly increase in intensity following ignition. These fires can be difficult to control and will often become much larger and longer-lasting than fires in lower categories.
- **Extreme:** When fire danger reaches "extreme," fires of all types can start quickly and burn intensely. All fires are potentially serious and can spread quickly with intense burning. Small fires become larger much faster than at the "very high" level. Long-distance fire spotting is likely. These fires can become dangerous and often last for several days.

4.3.12.2 Range of Magnitude

A major cause of forest fires in Pennsylvania is debris burning. These fires typically start small but are spread by wind to dead grass and leaves bordering woodlands. The number and severity of wildfires depend on external factors such as drought, human activity, wind activity, and the amount of available fuel. Wildfires can burn less than one acre up to hundreds of acres of land.

An area of concern for wildfires is the Michaux State Forest, located in Adams, Cumberland, and Franklin Counties. The forest contains more than 85,000 acres used for recreation, wood products, and timber and water resources. Fires in the forest can have a severe impact on the well-being of residents and the local economy. Response to wildfires in the forest would be difficult, as much of the area is rural and rugged.

4.3.12.3 Past Occurrence

From 2015 to 2018, 724 wildfires burned 4,962 acres in Pennsylvania. The most common cause of these fires was debris burning. PA DNR maintains records of wildfires by

forest districts. Table 4.3.12.3-1 lists the wildfires in District 1 (which includes all of Adams County) from 1979 to 2019.

Table 4.3.12.3-1

WILDFIRES IN PA DNR DISTRICT 1, 1979-2019						
Year	*Spring*		*Fall*		*Total*	
	# Fires	*Acres*	*# Fires*	*Acres*	*# Fires*	*Acres*
1979	37	54.8	22	21.6	59	76.4
1980	19	48.8	43	99.1	62	147.9
1981	82	254.8	69	77.5	151	332.3
1982	39	28.9	10	11.6	49	40.2
1983	8	4.7	13	13.3	21	17.7
1984	20	45.0	12	81.8	32	126.8
1985	70	120.9	9	10.6	79	131.5
1986	65	124.3	2	2.1	67	126.4
1987	94	89.9	50	77.3	144	164.2
1988	49	74.2	46	65.3	95	139.5
1989	80	91.7	6	3.4	86	95.1
1990	34	125.4	17	33.8	51	159.2
1991	44	43.1	24	63.3	68	106.4
1992	40	81.4	5	0.5	45	81.9
1993	6	14.4	4	4.8	10	18.9
1994	10	71.6	6	20.4	16	92.0
1995	22	256.6	4	1.0	26	257.6
1996	5	17.3	2	4.1	7	21.4
1997	12	7.9	21	6.4	33	14.3
1998	6	15.5	39	118.0	45	133.5
1999	15	82.6	30	116.8	45	199.4
2000	8	17.0	13	16.1	21	33.1
2001	37	11.4	42	229.5	79	240.9
2002	5	34.8	10	24.9	15	59.7
2003	3	1.7	1	3.0	4	4.7
2004	0	0.0	2	0.7	2	0.7
2005	18	92.4	3	23.3	21	115.7
2006	25	89.5	7	13.9	32	103.4
2007	10	15.6	12	29.4	22	45.0
2008	9	16.4	2	3.6	11	20.0
2009	18	52.7	3	1.9	21	54.5
2010	7	3.8	11	5.6	18	9.4
2011	4	1.3	5	11.0	9	12.3
2012	18	23.3	0	0.0	18	23.3
2013	9	12.3	5	2.3	14	14.6
2014	3	53.8	7	2.5	13	56.2
2015	21	22.4	7	5.8	28	28.2
2016	22	23.6	17	17.1	39	40.7
2017	18	43.6	2	6.2	20	49.8
2018	11	16.9	1	0.1	12	17.0
2019	15	21.3	9	8.4	24	29.7
Source: http://www.docs.dcnr.pa.gov/cs/groups/public/documents/document/dcnr_20033433.pdf						

There have been 1,590 fires that burned 5,201.9 acres in Region 1 from 1979 to 2018. The yearly average number of fires in this region is 39.75, and the average number of acres burned per year is 130.

4.3.12.4 Future Occurrence

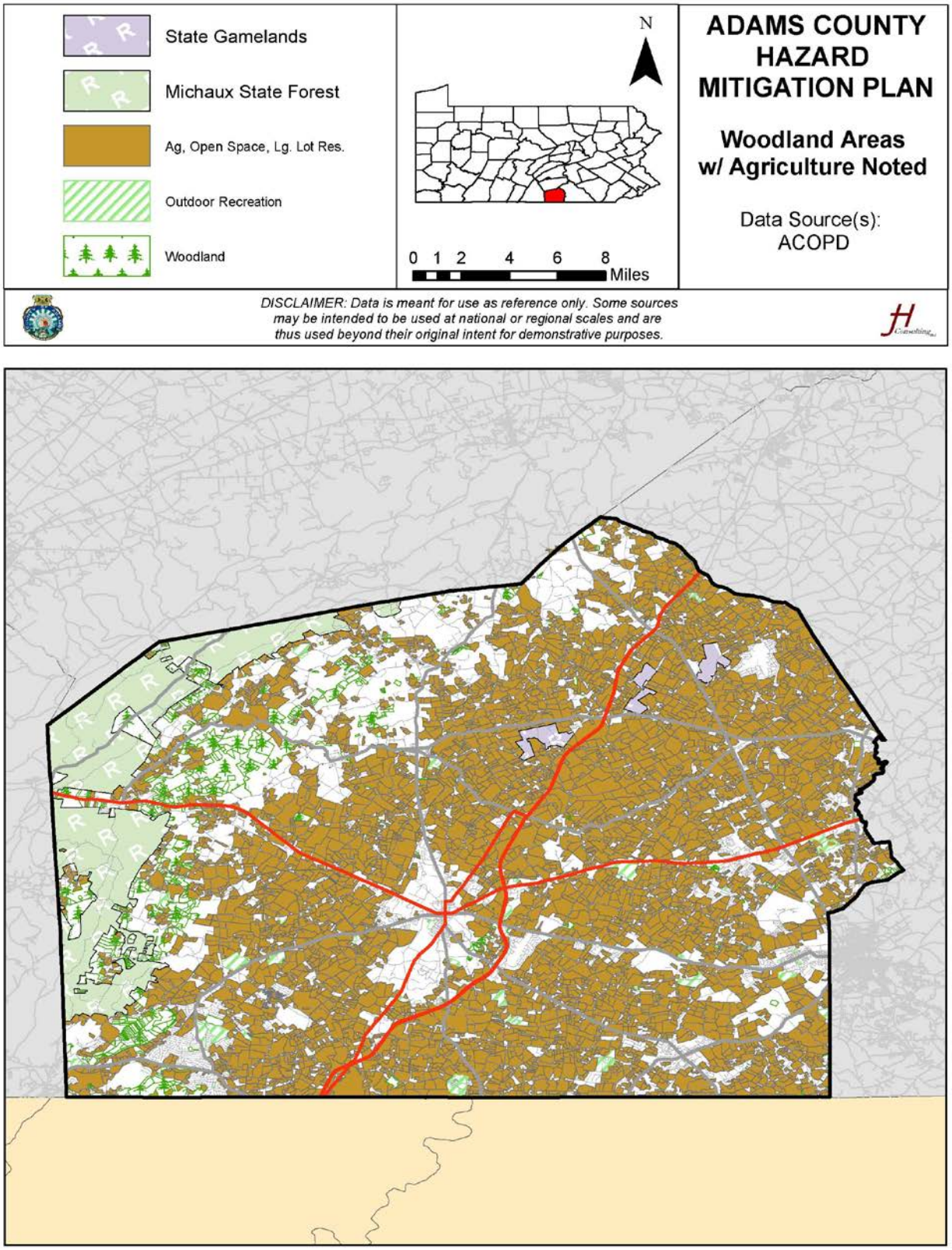
Weather conditions, including extreme heat and drought, increase the likelihood of fires escalating to the level of "wildfire." Any fire left unattended or mismanaged has the potential to become a wildfire. However, the likelihood of a fire attaining a significant size and intensity is unpredictable and varies based on environmental conditions.

As stated in 4.3.12.1, humans cause 99% of wildfires. The probability of a wildfire occurring in wildfire-prone areas would increase in areas with a significant amount of human activity due to an increase in debris burning, equipment use, power lines, and campfires.

Scholars refer to an area called the "wildland-urban interface," or WUI, when discussing wildfire risk. Radeloff and colleagues (2005) defined the WUI as "…the area where houses meet or intermingle with undeveloped wildland vegetation" (citing the USDA and USDI, 2001, p. 800). Critically, the WUI does not recognize an area where wildfires are more or less prone to occur. Rather, they identify areas that can expect higher wildfire-related damages should an incident occur. It is difficult to understand that the WUI, even in a single county, is not a place, per se, but conditions that exist. Thus, the WUI can be a rural subdivision in a wooded or vegetative area or three to four homes on an open range (wildlandfirersg.org, 2020).

Figure 4.3.12.4-1 depicts land use in Adams County, and it highlights the state forest as well as various fuel types. For Adams County, though WUI areas exist throughout the county, the priority areas form an arc in the western portion of the county roughly along the Michaux State Forest.

Figure 4.3.12.4-1



4.3.12.5 Vulnerability Assessment

This section summarizes the vulnerability to Adams County from wildfire. Adams County conducted an online survey for the public to share its thoughts on hazard vulnerabilities. Table 4.3.12.5-1 presents the results of that survey regarding wildfire.

Table 4.3.12.5-1

PUBLIC SENTIMENT, WILDFIRE – ADAMS COUNTY					
Hazard	*Level of Concern*				*Total Responses*
	Not at All	*Somewhat*	*Concerned*	*Very*	
Wildfire	42 (28.57%)	60 (40.82%)	35 (23.81%)	10 (6.80%)	147
In the past ten years, do you remember this hazard occurring in your community?				9 (6.16%)	146
Have you noticed an increase or decrease in the occurrences or intensity of this hazard? (134 responses)				21 (15.67%)	INCREASE
				111 (82.84%)	NO CHANGE
				2 (1.49%)	DECREASE

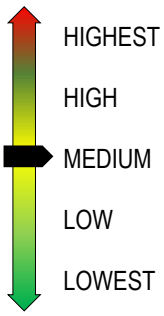
Table 4.3.12.5-2 shows Adams County's vulnerability to wildfires.

Table 4.3.12.5-2

WILDFIRE VULNERABILITY SUMMARY			
Category	*Points*	*Description*	*Notes*
Frequency	5	Excessive	Adams County can expect to experience at least one wildfire per year.
Response	2	1 Day	Wildfires in this region are typically small and can be easily contained.
Onset	4	Less than 6 hours	Wildfire conditions are predicted easily, but fires themselves occur with no notice.
Magnitude	1	Localized	The average wildfire burns 3.27 acres, which is less than 10% of the land area.
Business	1	Less than 24 hours	Most wildfires in Adams County are small and would not affect the local economy.
Human	1	Minimum (minor injuries)	Generally, the risk of injury or death due to wildfire is low. First responders to the event may experience negative health effects.
Property	1	Less than 10% of property	The average wildfire in Adams County would burn less than 10% of the county's land area.
Total	**15**	**Low**	

4.0 RISK ASSESSMENT

4.3.13 Winter Storm



Winter storms may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation, and can range from moderate snowfall or ice events to blizzards that last for several days.			
Period of Occurrence:	Winter storms occur during cold months, typically November to February	**Hazard Index Ranking:**	17-Medium
Warning Time:	More than 24 hours	**State Risk Ranking:**	3.1-High
Type of Hazard:	Natural	**Disaster Declarations:**	DR-4267 DR-1898 DR-3105 DR-1015 EM-3180 DR-1085 EM-3105

Winter storms may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation. A winter storm can range from a moderate snowfall or ice event over a few hours to blizzard conditions with wind-driven snow that lasts for several days. Low temperatures and heavy or blowing snow accompany many winter storms, which can severely impair visibility and disrupt transportation. The Commonwealth of Pennsylvania has a long history of severe winter weather (NOAA, 2009).

4.3.13.1 Location and Extent

While there are widely-accepted scales to characterize other natural disasters, there is no such scale that describes winter storms. Paul Kocin and Louis Uccellini of the National Weather Service developed the Northeast Snowfall Impact Scale (NESIS) in 2004 to characterize and rank snowstorms in the northeastern United States. NESIS scores are a function of the area affected by the snowstorm, the amount of snow, and the number of people living in the path of the storm. Figure 4.3.13.1-1 below shows the NESIS formula.

Figure 4.3.13.1-1

$$NESIS = \sum_{n=4}^{n=30} \left[\frac{n}{10} \left(\frac{A_n}{A_{mean}} \right) + \left(\frac{P_n}{P_{mean}} \right) \right] \qquad (1)$$

where:

n = snowfall category {4 for > 4", 10 for > 10", 20 for > 20", 30 > 30"}

A_n = *area of snowfall greater than or equal to category n (mi^2)*

P_n = *population affected by snowfall greater than category n (2000 census)*

A_{mean} = *mean area of >10" snowfall within the 13-state Northeast region (91,000 mi^2)*

P_{mean} = *mean population affected by snowfall >10" within the 13-state Northeast region (35.4 million)*

The formula above calculates the NESIS raw score, which ranges from around one for smaller storms to over ten for extreme storms. This raw score is then converted to one of five NESIS categories. The largest NESIS values result from storms producing heavy snowfall over large areas that include major metropolitan centers. Table 4.3.13.1-2 below visually describes the NESIS scale.

Table 4.3.13.1-2

NESIS SCALE		
Category	*NESIS Value*	*Description*
1	1.0-2.499	Notable
2	2.5-3.99	Significant
3	4.0-5.99	Major
4	6.0-9.99	Crippling
5	10.0+	Extreme

4.3.13.2 Range of Magnitude

Winter storms can bring snow, sleet, freezing rain, and ice, and last for hours or days. They have serious impacts on utility services in affected communities. Heavy snow accumulation on power lines can cause them to fail, leaving citizens without power. Additionally, heavy snow and ice buildup on roadways can further exacerbate the issue by making roads difficult to impossible to traverse. Power interruption, coupled with impassable roads, can leave communities with no electricity service for multiple days.

4.3.13.3 Past Occurrence

The NOAA Storm Event Database maintains records of winter storms in Adams County.

These 62 events appear in Table 4.3.13.3-1 below.

Table 4.3.13.3-1

WINTER STORM EVENTS IN ADAMS COUNTY, 1996-2019						
Location	*Date*	*Type*	*Injuries*	*Deaths*	*Property Damage*	*Crop Damage*
Adams (ZONE)	1/7/1996	Blizzard	0	0	$0.00	$0.00
Adams (ZONE)	1/12/1996	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	11/28/1996	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	2/13/1997	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	1/15/1998	Ice Storm	0	0	$0.00	$0.00
Adams (ZONE)	1/2/1999	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	1/8/1999	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	1/14/1999	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	3/14/1999	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	1/25/2000	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	1/30/2000	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	2/13/2000	Ice Storm	0	0	$0.00	$0.00
Adams (ZONE)	2/18/2000	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	12/13/2000	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	1/20/2001	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	3/4/2001	Heavy Snow	0	0	$5,000.00	$0.00
Adams (ZONE)	1/6/2002	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	12/5/2002	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	12/10/2002	Ice Storm	0	0	$0.00	$0.00
Adams (ZONE)	12/25/2002	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	1/2/2003	Ice Storm	0	0	$0.00	$0.00
Adams (ZONE)	2/6/2003	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	2/16/2003	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	12/5/2003	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	1/25/2004	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	2/6/2004	Ice Storm	0	0	$0.00	$0.00
Adams (ZONE)	2/24/2005	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	3/1/2005	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	12/9/2005	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	12/16/2005	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	2/12/2006	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	2/13/2007	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	3/16/2007	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	12/13/2007	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	12/15/2007	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	2/1/2008	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	2/12/2008	Ice Storm	0	0	$0.00	$0.00
Adams (ZONE)	1/6/2009	Ice Storm	0	0	$2,000.00	$0.00
Adams (ZONE)	1/27/2009	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	12/19/2009	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	2/5/2010	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	2/9/2010	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	1/26/2011	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	2/1/2011	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	2/21/2011	Heavy Snow	0	0	$0.00	$0.00

WINTER STORM EVENTS IN ADAMS COUNTY, 1996-2019						
Location	*Date*	*Type*	*Injuries*	*Deaths*	*Property Damage*	*Crop Damage*
Adams (ZONE)	10/29/2011	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	3/6/2013	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	12/14/2013	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	1/5/2014	Ice Storm	0	0	$0.00	$0.00
Adams (ZONE)	1/20/2014	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	2/3/2014	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	2/4/2014	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	2/13/2014	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	11/25/2014	Heavy Snow	0	0	$0.00	$0.00
Adams (ZONE)	1/22/2016	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	3/13/2017	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	2/7/2018	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	3/20/2018	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	11/15/2018	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	2/11/2019	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	2/20/2019	Winter Storm	0	0	$0.00	$0.00
Adams (ZONE)	3/3/2019	Winter Storm	0	0	$0.00	$0.00
		TOTALS	**0**	**0**	**$7,000.00**	**$0.00**

February 2003

From February 14-19, 2003, the east coast of the United States and Canada experienced a monumental winter storm, which has come to be known as the Blizzard of 2003 or the Presidents' Day Storm II. This storm spread heavy snowfall across major cities in the Northeastern and Mid-Atlantic states, including Pennsylvania. Twenty-two to 30 inches of snow fell across south-central Pennsylvania, including much of the Susquehanna Valley. The heavy snow forced many schools, businesses, and roadways to close for at least one to two days.

February 2010

A major winter storm affected the entire U.S. Mid-Atlantic region in the first week of February 2010. Snowfall began on February 4 and continued until the 7th. Southern Pennsylvania experienced between 15 and 30 inches of snowfall, causing schools, roadways, and businesses to close.

January 2016

On January 22, 2016, Adams County experienced a significant winter storm. According to the Evening Sun, between 24 and 30 inches of snow fell throughout the county. Main roads were dangerous, and many secondary roads were impassable to those without all-wheel drive vehicles. The Pennsylvania Department of Transportation restricted trailers from major roads,

including interstates 78, 81, 83, and 283, and the post offices throughout most of the county suspended operations for the day.

The above tables and narratives do not provide data on crop losses, though local officials are aware of winter weather-related agricultural impacts. Adams County received USDA Secretarial Designations in 2012 (February) and 2016 (February through April) for freeze and frost impacts (USDA FSA, n.d.). The EWG *Farm Subsidies Database* reports that 23 farmers received disaster assistance payouts at a combined total of $224,723 in 2012, presumably largely under designation S3373. Of those payouts, $8,425 were under the "Miscellaneous" category, which includes the crop disaster, quality losses, and non-insured assistance programs. Under the "Supplement Revenue Assistance Payments" program, Adams County farmers received $216,298 (EWG, n.d.).

The aggregated 2016 data from EWG's database is also available, but it seemingly covers two designations: S4141 for the aforementioned freeze and frost incident as well as S4165 for drought conditions running May through December (USDA FSA, n.d.). However, seven Adams County farmers received $94,859 worth of disaster assistance program benefits in 2016 for one or both of these events. Of that total, $91,096 were under the miscellaneous category referenced above, and the remaining $3,763 was under the "Livestock Disaster/Emergency" category (which consists of the livestock compensation and livestock emergency assistance programs) (EWG, n.d.).

4.3.13.4 Future Occurrence

There have been 62 winter storm events in Adams County since 1996, for an average of 2.7 events per year. Damages reported were minimal: one storm caused $5,000 in property damage while another caused $2,000. Future events in Adams County will likely cause road closures or impassible routes, along with utility interruptions. During severe winter storms, these impacts could last for multiple days.

4.3.13.5 Vulnerability Assessment

This section summarizes the vulnerability to Adams County from winter weather. Adams County conducted an online survey for the public to share its thoughts on hazard vulnerabilities. Table 4.3.13.5-1 presents the results of that survey regarding winter storms.

Table 4.3.13.5-1

PUBLIC SENTIMENT, WINTER STORM – ADAMS COUNTY					
Hazard	*Level of Concern*				*Total Responses*
	Not at All	*Somewhat*	*Concerned*	*Very*	
Winter Storm	17 (11.56%)	67 (45.58%)	51 (34.69%)	12 (8.16%)	147
In the past ten years, do you remember this hazard occurring in your community?				120 (82.19%)	146
Have you noticed an increase or decrease in the occurrences or intensity of this hazard? (139 responses)				44 (31.65%)	INCREASE
				87 (62.59%)	NO CHANGE
				8 (5.76%)	DECREASE

It is assumed that older buildings are at a higher risk of damage from winter storms than newer structures. Additional information on construction type and building codes of the time would allow a more thorough analysis of structure vulnerability. Figure 4.3.13.5-2 shows the 2014 estimated age of structures in Adams County.

Figure 4.3.13.5-2

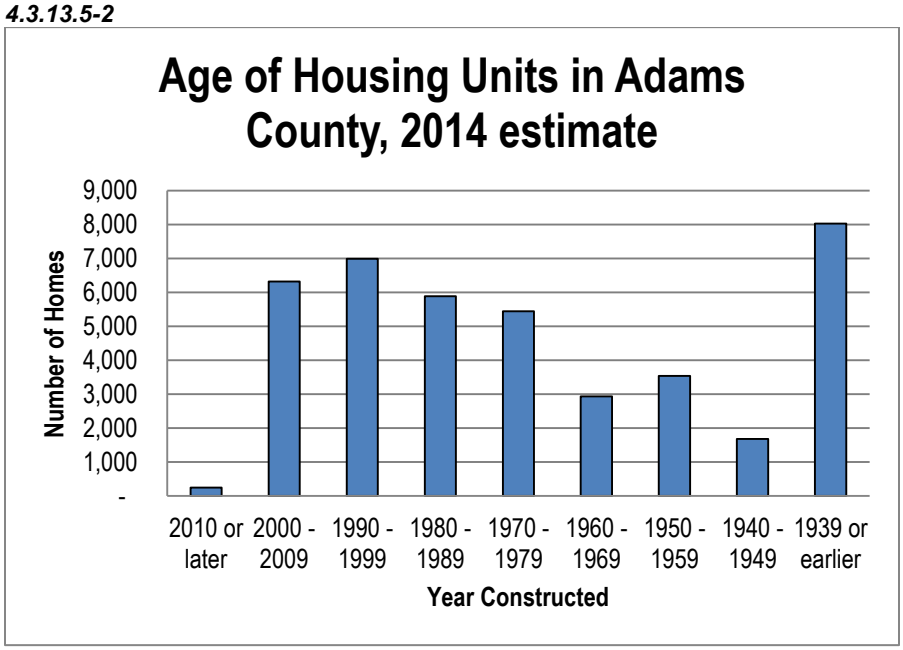


Table 4.3.13.5-3 shows Adams County's vulnerability to winter storms. Due to the frequency of past events and high annual probability, winter storms are likely to continue affecting Adams County.

Table 4.3.13.5-3

WINTER STORM VULNERABILITY SUMMARY			
Category	*Points*	*Description*	*Notes*
Frequency	5	Excessive	There have been 62 events since 1996, for an average of 2.7 events per year. It can be assumed that Adams County will experience a winter storm nearly every year.
Response	3	1 Week	Winter storms can last for multiple days, requiring an extended response.
Onset	1	Over 24 hours	Winter storms can be predicted more than one day in advance, giving citizens and emergency personnel time to prepare for the event.
Magnitude	4	More than 50% of land area	Winter storms would affect all areas of the county, although some areas may experience worse conditions than others,
Business	2	1 Week	Winter storm events can interrupt utilities and communication for several days. The county's economy would be interrupted during this time.
Human	1	Minimum	Winter storms on their own are not likely to cause human injuries or deaths. Human impacts would be due to traffic accidents or extreme temperatures that accompany winter storms.
Property	1	Less than 10%	Winter storms can cause slight property damage, such as roof collapse and utility interruptions. These would likely affect less than 10% of property in the county.
Total	**17**	**Medium**	

4.0 RISK ASSESSMENT

4.3.14 Dam Failure

A dam is a barrier preventing the flow of water or loose solid materials (such as snow or soil). Dam failure is the failure of that barrier.			
Period of Occurrence:	Dam failures can occur at any time; some may occur with little warning.	**Hazard Index Ranking:**	12-Low
Warning Time	None	**State Risk Ranking:**	2.4-Medium
Type of Hazard:	Human-Caused	**Disaster Declarations:**	N/A

A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but immense damage and loss of life are possible in downstream communities when such events occur. Aging infrastructure, hydrologic, hydraulic and geologic characteristics, population growth, and design and maintenance practices should be considered when assessing dam failure hazards. The failure of the South Fork Dam, located in Johnstown, Pennsylvania, was the deadliest dam failure ever experienced in the United States. It took place in 1889 and resulted in the Johnstown Flood, which claimed 2,209 lives. Today there are approximately 3,200 dams and reservoirs throughout Pennsylvania (PEMA, 2018).

4.3.14.1 Location and Extent

Figure 4.3.14.1-1 below shows the National Inventory of Dams (NID) list of dams coded by their hazard potential.

Figure 4.3.14.1- 1

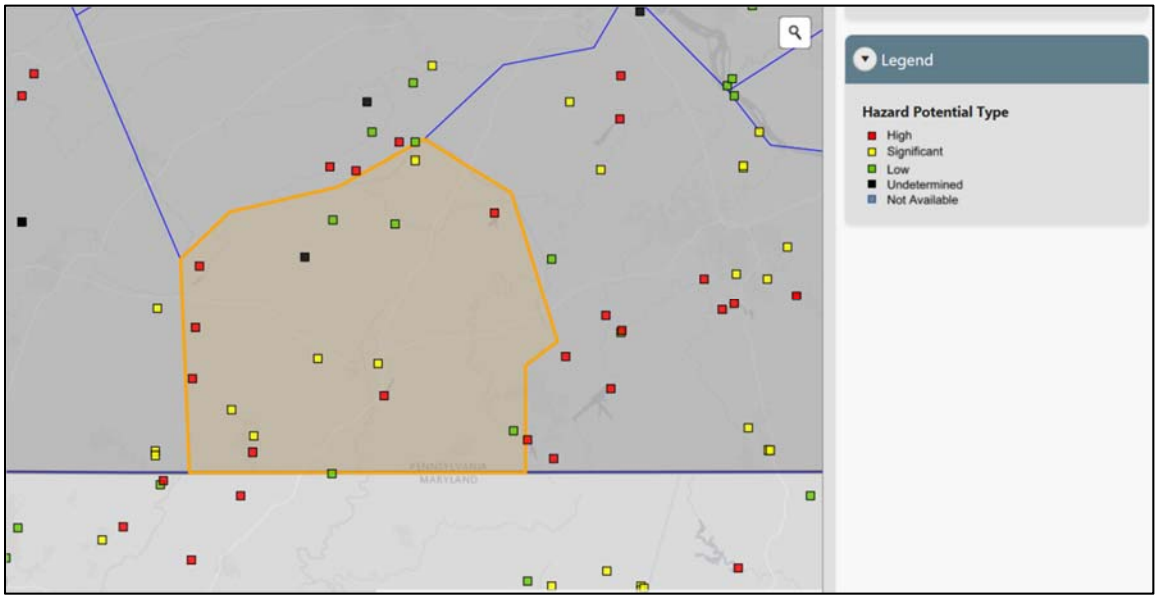


Table 4.3.14.1-2 includes all dams located in Adams County, as well as their location, hazard potential, height, and storage capacity. Of the 16 dams in Adams County, eight are high hazard potential, four are significant hazard potential, and three are low hazard potential. The remaining dams are not classified. Antietam Dam, located in York County, is included in this profile due to the location of its inundation area (which includes Hamiltonban Township).

Table 4.3.14-2

LIST OF DAMS IN ADAMS COUNTY				
Dam	*Location*	*Hazard Potential (FEMA)*	*NID Height (in feet)*	*NID Storage (in acre-feet)*
Antietam	Hamiltonban Township	High[1]	70	866
Baugher	Huntington Township	Low	18	55
Carbaugh Run	Franklin Township	High	35	365
Granite Lake Dam	Straban Township	Significant[2]	16	32.5
Highland Farms Dam	Latimore Township	Significant	28	48
Irrigation Pond	Menallen Township	Low[3]	26	17
Lake Heritage	Mount Joy Township	High	53	2,966
Lake Meade	Reading/Latimore Township	High	42	5,330
Lawrence Baker	West Manheim Township, York	High	75	7,895

[1] "Dams assigned the high potential classification are those where failure or misoperation will probably cause loss of human life" (FEMA, 2004, p. 6).
[2] "Dams assigned the significant hazard potential classification are those dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, and can impact other concerns" (FEMA, 2004, p. 5).
[3] "Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses" (FEMA, 2004, p. 5).

LIST OF DAMS IN ADAMS COUNTY				
Dam	*Location*	*Hazard Potential (FEMA)*	*NID Height (in feet)*	*NID Storage (in acre-feet)*
Sheppard Dam	County			
Long Pine Run	Franklin Township	High	112	7,490
Mountainview Orchards Pond	Arendtsville	Unknown	25	68
Section F (Lake May)	Carroll Valley Borough	High	22	271
Section K	Carroll Valley Borough	Significant	12	89
Sheppard	Union Township	Low	23	89
Sheppard Meyers Dam	West Manheim Township, York County	High	38	1,213
Williams Dam	Hamiltonban Township	Significant	39	25

Pennsylvania's Department of Environmental Protection is responsible for regulating the construction and maintenance of high hazard dams. Pennsylvania State Code requires dam emergency action plans (EAPs) for all Category 1, Category 2, and Category 3 dams. The EAPs are drafted according to PEMA's EAP guidelines and reviewed by the dam owner, dam operator, and county emergency management coordinators for counties affected by the dam's failure. Table 4.3.14.1-3 below shows the EAP information for dams located in and affecting Adams County.

Table 4.3.14-3

EAP STATUS OF DAMS IN ADAMS COUNTY			
Dam	*EAP Available (Y/N)*	*EAP Required (Y/N)*	*EAP Last Updated*
Antietam	Yes	Yes	05/23/2016
Baugher	No	No	N/A
Carbaugh Run	Yes	Yes	11/24/2015
Granite Lake Dam	Yes	Yes	09/08/2008
Highland Farms Dam	Yes	Yes	03/01/2000
Irrigation Pond	No	No	N/A
Lake Heritage	Yes	Yes	05/01/2010
Lake Meade	Yes	Yes	04/01/2014
Lawrence Baker Sheppard Dam (York Co.)	Yes	Yes	01/07/2015
Long Pine Run	Yes	Yes	05/19/2013
Mountainview Orchards Pond	No	No	N/A
Section F (Lake May)	Yes	Yes	11/25/20009
Section K	No	Yes	N/A
Sheppard	No	No	N/A
Sheppard Meyers Dam (York Co.)	Yes	Yes	04/17/2015
Williams Dam	No	Yes	N/A

Complete dam failure can cause significant damage for its inundation area, or the total area that would flood in the event of dam failure. Dam failures lead to several negative economic and environmental impacts. Economic impacts include the cost of rebuilding structures and infrastructure in the inundation areas, as well as lost revenue from industry related to the dam. Dam failures can result in the pollution of surface or groundwater, air, and soil, as well as damage to or destruction of environmentally sensitive areas.

4.3.14.2 Range of Magnitude

There are multiple degrees of dam failure, with the most severe being catastrophic. Sudden, rapid, and uncontrolled release of impounded water characterizes catastrophic failures. Catastrophic failures have the potential to cause significant damage to communities located downstream. There are eight high and four significant hazard dams in Adams County. Complete failure of any of these dams would result in severe adverse effects and potential loss of life in the area downstream of the dam.

Depending on their abruptness, dam failures may or may not leave enough time for evacuation of people or property. Failures caused by overtopping or piping can occur slowly. These types of failures would leave the most evacuation time. Failures due to structural damage or maintenance issues can be gradual or abrupt. In the case of an abrupt failure, evacuation may not be possible.

In addition to economic losses due to damaged infrastructure, the failure of dams used for water supply would leave its communities without a source of potable water. The primary function of five of the dams affecting Adams County is water supply (Antietam, Carbaugh Run, Lawrence Baker Sheppard, Long Pine Run, and Sheppard Meyers).

4.3.14.3 Past Occurrences

The National Performance of Dams Program at Stanford University monitors dam incidents and repairs, as well as incident consequences, for dams in the United States and around the world. While there have been no recorded dam failures or incidents in Adams County in the past, planning committee members noted a potentially critical issue with the New Oxford Dam. Additionally, there have been three significant dam failures in Pennsylvania in the past. Those instances are detailed below.

The Austin (Bayless) Dam was constructed in 1901 outside Austin, Pennsylvania, to supply water to the Bayless Paper Mill. While it stood, several foundation issues made the dam known as a safety concern. In September of 1911, less than two years after its construction, the

Austin Dam collapsed, killing 78 people and causing $3-6 million in damages (~$70-140 million today).

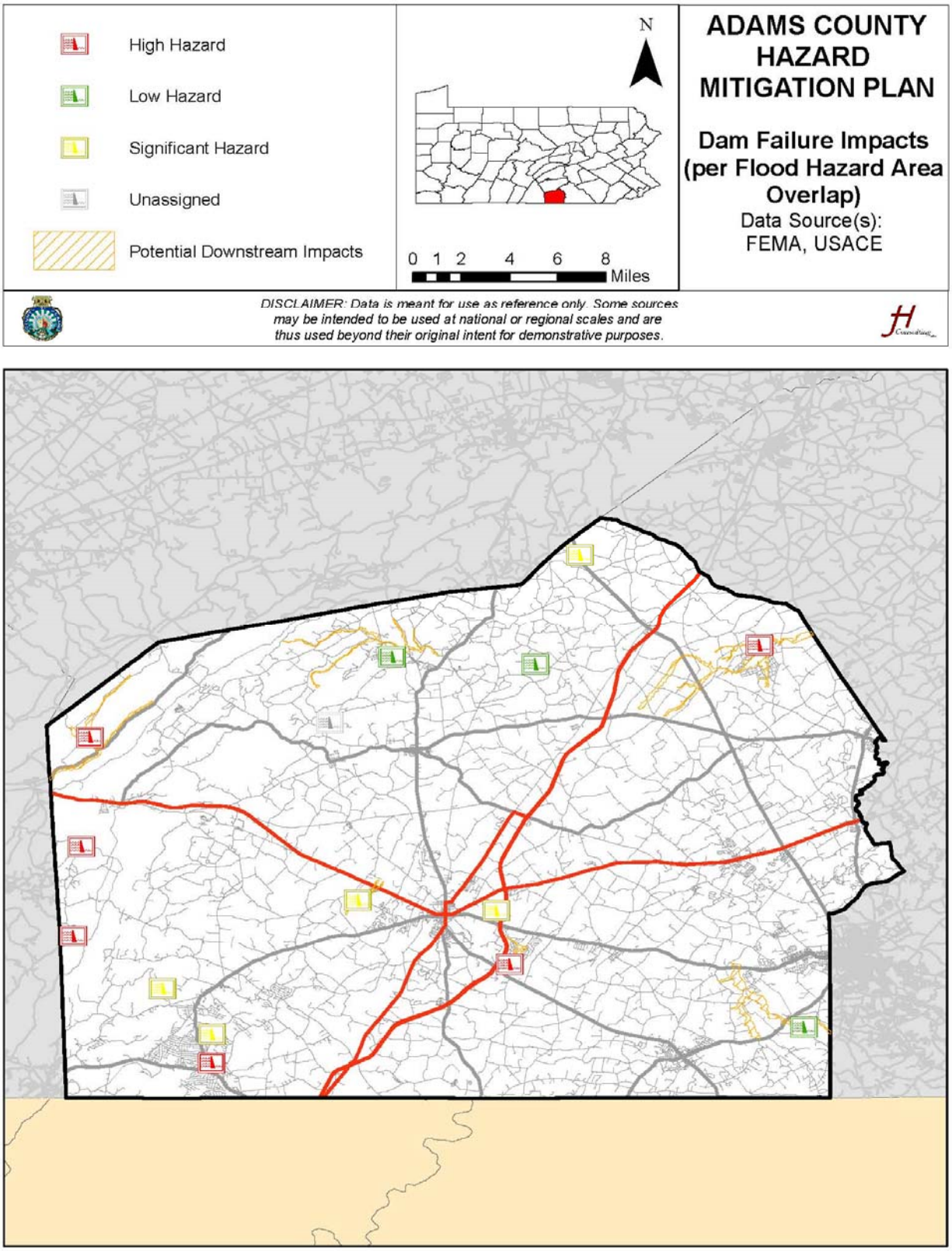
The Laurel Run Dam outside Johnstown was constructed from 1915 to 1918 to provide drinking and industrial water for the town. In 1943 and 1959, assessments found the dam to be structurally deficient but took no corrective action. In July of 1977, after a series of storms, the Laurel Run Dam failed. This incident caused over 40 deaths and $5.3 million in damages.

The Penn Forest Dam was constructed between 1956 and 1958 to supply water to the town of Bethlehem. The dam began experiencing problems in 1960, leading to corrective action. In July of 1994, the dam showed signs of seepage, indicating that the condition of the dam was deteriorating. Emergency response procedures were activated and maintained until January of 1995 when the reservoir returned to a safe level.

4.3.14.4 Future Occurrence

The failure of high hazard dams is unlikely in Adams County. All Category 1, 2, and 3 dams have up-to-date EAPs, and high-hazard dams are inspected on an annual basis. Figure 4.3.14.4-1 depicts areas of Adams County susceptible to dam failure.

Figure 4.3.14.4-1



4.3.14.5 Vulnerability Assessment

This section summarizes the vulnerability to Adams County from dam failure. Adams County conducted an online survey for the public to share its thoughts on hazard vulnerabilities. Table 4.3.14.5-1 presents the results of that survey regarding dam failure.

Table 4.3.14.5-1

PUBLIC SENTIMENT, DAM FAILURE – ADAMS COUNTY					
Hazard	*Level of Concern*				*Total Responses*
	Not at All	*Somewhat*	*Concerned*	*Very*	
Dam Failure	119 (81.51%)	21 (14.38%)	4 (2.74%)	2 (1.37%)	146
In the past ten years, do you remember this hazard occurring in your community?				2 (1.37%)	146
Have you noticed an increase or decrease in the occurrences or intensity of this hazard? (134 responses)				1 (0.75%)	INCREASE
				130 (97.01%)	NO CHANGE
				3 (2.24%)	DECREASE

All structures downstream of a dam are vulnerable to dam failure. Municipalities located in such areas include Hamiltonban Township, Huntington Township, Franklin Township, Straban Township, Latimore Township, Menallen Township, Mount Joy Township, Reading/Latimore Township, West Manheim Township York County, Arendtsville Borough, Carroll Valley Borough, and Union Township.

Table 4.3.14.5-2 below describes Adams County's vulnerability to dam failure.

Table 4.3.14.5-2

DAM FAILURE VULNERABILITY SUMMARY			
Category	*Points*	*Description*	*Notes*
Frequency	1	None	There have been no recorded dam failures in Adams County.
Response	3	1 Week	A complete dam failure is unlikely in Adams County. If an event did occur, it would require a significant emergency response.
Onset	3	6-12 Hours	In most cases, a dam would not fail without prior warning. As dams in Pennsylvania are regularly inspected, a sudden failure is unlikely.
Magnitude	1	Localized	For most dams in Adams County, a dam failure would be a localized event.
Business	1	Less than 24 hours	In the event of a dam failure, Adams County's economy would not be affected.
Human	2	Low (some injuries)	With High and Medium hazard potential dams, complete failure could cause injuries or death.
Property	1	Less than 10%	Dam failure in Adams County would likely affect small areas, and most property damage would be limited to the loss of the dam itself.
Total	**12**	**Low**	

4.0 RISK ASSESSMENT

4.3.15 Environmental Hazards: Hazardous Materials Release

HIGHEST HIGH MEDIUM LOW LOWEST	A hazardous materials release can contaminate air, water, and soils, possibly resulting in injuries or death.			
	Period of Occurrence:	Hazardous materials releases can occur at any time	**Hazard Index Ranking:**	17-Medium
	Warning Time:	None	**State Risk Ranking:**	2.5-High
	Type of Hazard:	Human-Caused	**Disaster Declarations:**	N/A

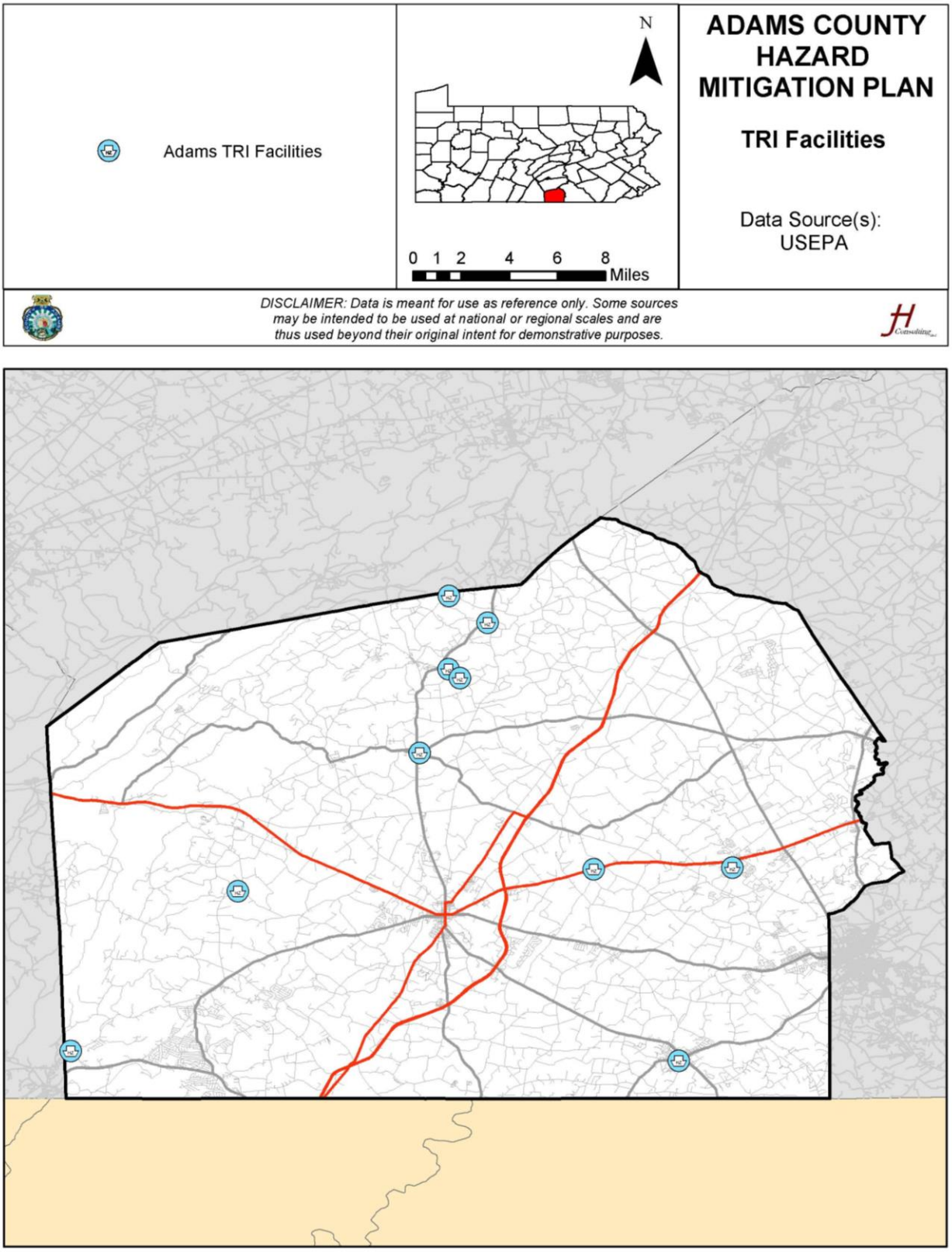
Hazardous materials are substances that, if released or misused, can pose a threat to the environment or health. When released, these materials can contaminate air, water, and soil, resulting in possible injuries or death. While often accidental, releases can occur as a result of human carelessness, intentional acts, or as cascading effects of natural hazards. Hazardous materials can include toxic chemicals, radioactive materials, infectious substances, and hazardous wastes. Such releases can affect nearby populations and contaminate critical or sensitive environmental areas (PEMA, 2018).

4.3.15.1 Location and Extent

Hazardous materials can be found in every community, as they are used in homes, hospitals, and factories, and are shipped daily via land, air, railways, and pipelines (FEMA, 2019). If released, these materials can damage the environment, critical infrastructure, property, and people.

The U.S. Environmental Protection Agency's (EPA) Toxic Release Inventory (TRI) tracks the management of certain chemicals that may pose a threat to human health and the environment. Industrial facilities must report how much of each chemical is recycled, combusted for energy recovery, treated for destruction, and disposed of or released on- and off-site. Adams County's ten TRI facilities are located throughout the county and shown in Figure 4.3.15.1-1. In 2017, these sites housed a combined 120,300 lbs. of waste and released an additional 221 lbs. of waste into the air and water.

Figure 4.3.15.1-1



In addition to the TRI, the EPA also tracks sites that have improperly handled hazardous materials. Through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), informally called Superfund, the EPA can clean contaminated sites. Table 4.3.15.1-2 below shows the name and locations of Adams County's Superfund sites, along with their contaminants and affected media.

Table 4.3.15.1-2

ADAMS COUNTY SUPERFUND SITES			
Site Name	*Jurisdiction*	*Contaminants*	*Media*
Hunterstown Road	Straban Township	1,1,1-Trichloroethane	Groundwater
		1,1,1- Trichloroethane	Groundwater
		1,1,2- Trichloroethane	Groundwater
		1,1-Dichloroethane	Groundwater
		1,1-Dichloroethene	Groundwater
		1,1- Dichloroethene	Groundwater
		1,1- Dichloroethene	Sediment
		1,1- Dichloroethene	Soil
		Antimony	Sediment
		Antimony	Soil
		Barium	Sediment
		Barium	Soil
		Chloroethene (Vinyl Chloride)	Groundwater
		Chloroethene (Vinyl Chloride)	Groundwater
		Chloroethene (Vinyl Chloride)	Sediment
		Chloroethene (Vinyl Chloride)	Soil
		Chromium	Sediment
		Chromium	Soil
		CIS-1,2- Dichloroethene	Groundwater
		Copper	Sediment
		Copper	Soil
		Lead	Sediment
		Lead	Soil
		Mercury	Sediment
		Mercury	Soil
		Toluene	Groundwater
Hunterstown Road	Straban Township	Trichloroethene	Groundwater
		Trichloroethene	Groundwater
Keystone	Union Township	1,1,1-Trichloroethane	Groundwater
		1,1,1- Trichloroethane	Groundwater
		1,1,1- Trichloroethane	Soil
		1,1,2,2-Tetrachloroethane	Groundwater
		1,1,2,2- Tetrachloroethane	Groundwater
		1,1,2- Trichloroethane	Groundwater
		1,1-Dichloroethane	Groundwater
		1,1- Dichloroethane	Groundwater
		1,1- Dichloroethane	Groundwater
		1,1- Dichloroethane	Soil
		1,1- Dichloroethene	Groundwater

ADAMS COUNTY SUPERFUND SITES			
Site Name	*Jurisdiction*	*Contaminants*	*Media*
Keystone (cont.)	Union Township	1,1- Dichloroethene	Groundwater
		1,2- Dichloroethane	Groundwater
		1,2- Dichloroethane	Groundwater
		1,2- Dichloroethene (cis and trans mixture)	Groundwater
		1,2- Dichloroethene (cis and trans mixture)	Soil
		1,4-Dioxane	Groundwater
		Aldrin	Groundwater
		Alpha-Hexachlorocyclohexane	Groundwater
		Aluminum	Groundwater
		Anthracene	Soil
		Antimony	Groundwater
		Aroclor 1248	Groundwater
		Arsenic	Groundwater
		Arsenic	Sediment
		Barium	Groundwater
		Barium	Groundwater
		Base neutral acids	Groundwater
		Benzene	Groundwater
		Benzoic Acid	Groundwater
		Benzoic Acid	Soil
		Beryllium	Groundwater
		Beryllium	Groundwater
		Beryllium	Sediment
		Beryllium	Soil
		Bis(2-ethylhexyl) phthalate	Groundwater
		Bis(2-ethylhexyl) phthalate	Groundwater
		Butyl-benzyl-phthalate	Soil
		Cadmium	Groundwater
		Carbon Disulfide	Groundwater
		Carbon Tetrachloride	Groundwater
		Chloroethane	Groundwater
		Chloroethane	Groundwater
		Chloroethene (Vinyl Chloride)	Groundwater
		Chloroethene (Vinyl Chloride)	Groundwater
		Chloroethene (Vinyl Chloride)	Leachate
		Chloroform	Groundwater
		Chromium	Groundwater
Keystone	Union Township	Chromium	Groundwater
		Chromium	Soil
		CHRYSENE	Soil
		Cis-1,2-dichloroethene	Groundwater
		Cis-1,2-dichloroethene	Leachate
		Cobalt	Groundwater
		Copper	Groundwater
		Copper	Groundwater
		Di-N-Octyl Phthalate	Soil
		Dichlorodifluoromethane	Groundwater
		Dichlorodifluoromethane	Groundwater
		DIELDRIN	Groundwater
		Diethyl Phthalate	Groundwater

ADAMS COUNTY SUPERFUND SITES			
Site Name	*Jurisdiction*	*Contaminants*	*Media*
Keystone (cont.)	Union Township	Diethyl Phthalate	Soil
		Dimethyl Phthalate	Soil
		Fluoroanthene	Soil
		Gamma-chlordane	Groundwater
		Heptachlor	Groundwater
		Heptachlor epoxide	Groundwater
		Indeno(1,2,3-CD)pyrene	Soil
		Iron	Groundwater
		Iron	Soil
		Lead	Groundwater
		Manganese	Groundwater
		Manganese	Groundwater
		Manganese	Soil
		Mercury	Groundwater
		Mercury	Groundwater
		Mercury	Groundwater
		Mercury	Soil
		Mercury	Surface Water
		Nickel	Groundwater
		Pentachlorophenol	Groundwater
		Phenanthrene	Soil
		Selenium	Groundwater
		Tetrachloroethene	Groundwater
		Tetrachloroethene	Groundwater
		Tetrachloroethene	Soil
		Tetrachloroethene	Leachate
		Trichloroethene	Groundwater
		Trichloroethene	Groundwater
		Trichloroethene	Leachate
		Trichloroethene	Groundwater
		Vanadium	Groundwater
		Zinc	Groundwater
		Zinc	Groundwater
Shrivers Corner	Straban Township	Chromium	Soil
		Lead	Soil
		Metals	Groundwater
		Volatile Organic Compounds	Groundwater
Shrivers Corner	Straban Township	Zinc	Sediment
Westinghouse Elevator Co. Plant	Cumberland Township	1,1,1- Trichloroethane	Free-phase NAPL
		1,1,1- Trichloroethane	Groundwater
		1,1-Dichloroethene	Groundwater
		Trichloroethene	Free-phase NAPL
		Trichloroethene	Groundwater
		Trichloroethene	Soil Gas

4.3.15.2 Range of Magnitude

With any hazardous material release, the severity of an incident depends on several

extenuating circumstances, including weather conditions, terrain, and compliance (or lack thereof) with codes, type of material released, and response time for emergency personnel. A hazardous material release can also include significant environmental impacts, which are listed below.

- Hydrologic Effects
  - Surface and groundwater contamination
  - Other effects on water quality such as changes in water temperature
  - Damage to streams, lakes, ponds, estuaries, and wetland ecosystems

- Air Quality Effects
  - Pollutants, smoke, and dust

- Loss of Quality in Landscape and Soil Quality
- Damage to Plant Communities
  - Loss of biodiversity
  - Damage to vegetation

- Damage to Animal Species
  - Animal fatalities
  - Degradation of wildlife and aquatic habitat
  - Pollution of drinking water for wildlife
  - Loss of biodiversity
  - Disease

As a general guideline, there are three levels of hazardous materials incidents, ranging from easily contained by local responders to those that require vast amounts of resources (NFPA, 2008).

- **Level 1:** An incident involving hazardous materials that can be contained, extinguished, and/or abated using resources immediately available to the public sector responders. Level 1 incidents present little risk to the environment and/or public health with containment and cleanup.
- **Level 2:** An incident that is beyond the capabilities of the first responders on the scene and could be beyond the public sector responders having jurisdiction. Level 2 incidents might require the services of a state or regional response team or other state or federal

assistance. This level can pose immediate and long-term risks to environmental and public health.

- **Level 3:** An incident that is beyond the capabilities of a single state or regional response team and requires additional assistance. Level 3 incidents can require resources from state and federal agencies and private industry. These incidents generally pose extreme, immediate, and/or long-term risks to the environment and public health.

With a hazardous materials release, there are several potentially exacerbating or mitigating circumstances that will affect its severity or impact. Mitigating conditions are precautionary measures taken in advance to reduce the impact of a release on the surrounding environment. Exacerbating conditions, characteristics that can enhance or magnify the effects of a hazardous material release include the following.

- **Weather conditions** affect how the hazard occurs and develops.
- **Micro-meteorological effects of buildings and terrain** alter the dispersion of hazardous materials.
- **Non-compliance with applicable codes and maintenance failures** can substantially increase the damage to the facility itself and surrounding buildings.

4.3.15.3 Past Occurrence

The Pipeline and Hazardous Materials Safety Administration (PHMSA) maintains a database of all hazardous materials incidents in the U.S. by air, highway, and railway transport. These incidents are summarized in Table 4.3.15.3-1.

Table 4.3.15.3-1

PHMSA INCIDENTS IN ADAMS COUNTY				
Incident Location	*Date*	*Hazard Class*	*Commodity Name*	*Mode of Transportation*
Reading Township	1/20/1994	8	Corrosive liquids, n.o.s.	Highway
Reading Township	5/19/1995	3	Resin solution, flammable	Highway
Gettysburg Borough	8/1/1995	9	Environmentally hazardous substances, liquid, n.o.s.	Highway
New Oxford Borough	1/18/1997	3	Gasoline includes gasoline mixed with ethyl alcohol, with not more than 10% alcohol	Highway
Reading Township	3/3/1997	8	Phosphoric acid solution	Highway

PHMSA INCIDENTS IN ADAMS COUNTY				
Incident Location	*Date*	*Hazard Class*	*Commodity Name*	*Mode of Transportation*
Reading Township	6/4/1997	3	Flammable liquids, n.o.s.	Highway
Hampton	6/27/1997	8	Ferric chloride, solution	Highway
Reading Township	7/7/1997	3	Ethanol or ethyl alcohol or ethanol solutions or ethyl alcohol solutions	Highway
Reading Township	7/23/1997	8	Sulfuric acid	Highway
Franklin Township	7/28/1997	8	Hypochlorite solutions with more than 5 percent but less than 16 percent available chlorine	Highway
Berwick Township	8/16/1997	3	Flammable liquids, n.o.s.	Highway
Cumberland Township	8/29/1997	3	Adhesives, containing a flammable liquid	Highway
Hilltown	9/8/1997	8	Corrosive liquid, acidic, inorganic, n.o.s.	Highway
Reading Township	1/9/1998	8	Cyclohexylamine	Highway
Reading Township	1/27/1998	3	Adhesives, containing a flammable liquid	Highway
Reading Township	2/26/1998	8	Potassium hydroxide, solution	Highway
Hilltown	3/12/1998	9	Hazardous waste, solid, n.o.s.	Highway
Mount Pleasant Township	3/17/1998	8	Hydrochloric acid, solution	Highway
Hilltown	4/15/1998	3	Flammable liquids, toxic, n.o.s.	Highway
Cumberland Township	5/23/1998	6.1	Dichloromethane	Highway
Berwick Township	6/8/1998	6.1	Tetrachloroethylene	Highway
Huntington Township	7/14/1998	3	Flammable liquids, n.o.s.	Highway
Huntington Township	8/1/1998	6.1	Organophosphorus pesticides, liquid, toxic	Highway
Huntington Township	8/21/1998	5.2	Organic peroxide type F, liquid	Highway
Gettysburg Borough	8/25/1998	6.1	Chloroform	Highway
Franklin Township	9/24/1998	8	Sodium hydroxide, solution	Air
Franklin Township	9/29/1998	3	Flammable liquids, n.o.s.	Air
Mount Pleasant Township	10/5/1998	3	Acetone	Highway
Hilltown	12/17/1998	3	Flammable liquids, n.o.s.	Highway
Plainview	1/22/1999	3	Resin solution, flammable	Highway

PHMSA INCIDENTS IN ADAMS COUNTY				
Incident Location	*Date*	*Hazard Class*	*Commodity Name*	*Mode of Transportation*
Berwick Township	3/25/1999	9	Hazardous substance, liquid or solid, n.o.s. or from-e, liquid or solid, n.o.s.	Highway
Reading Township	4/19/1999	5.1	Sodium nitrate	Highway
Hilltown	5/21/1999	9	Hazardous waste, solid, n.o.s.	Highway
Huntington Township	6/25/1999	9	Environmentally hazardous substances, liquid, n.o.s.	Highway
Reading Township	9/30/1999	3	Ethanol or ethyl alcohol or ethanol solutions or ethyl alcohol solutions	Highway
Reading Township	11/23/1999	3	Propionaldehyde	Rail
Union Township	1/20/2000	8	Ferric chloride, solution	Highway
Reading Township	2/2/2000	8	Sulfuric acid, fuming	Highway
Berwick Township	6/15/2000	8	Sulfuric acid	Highway
Reading Township	10/27/2000	8	Sulfuric acid	Highway
Gettysburg Borough	1/24/2001	4.1	Flammable solids, organic, n.o.s.	Air
East Berlin Borough	4/13/2001	3	Fuel oil (no. 1, 2, 4, 5, or 6)	Highway
Berwick Township	6/28/2001	9	Hazardous substance, liquid or solid, n.o.s. or from-e, liquid or solid, n.o.s.	Highway
Reading Township	9/13/2001	3	Ethylene glycol monoethyl ether acetate	Highway
Mount Pleasant Township	1/31/2002	5.2	Organic peroxide Type D, liquid	Highway
Mount Pleasant Township	4/28/2003	8	Corrosive liquids, n.o.s.	Highway
Hampton	8/1/2003	3	Fuel oil (no. 1, 2, 4, 5, or 6)	Highway
Mount Pleasant Township	9/4/2003	3	Paint including paint, lacquer, enamel, stain, shellac solutions, varnish, polish, liquid filler, and liquid lacquer base	Highway
New Oxford Borough	10/13/2003	8	Ferric chloride, solution	Highway
Mount Pleasant Township	10/27/2003	3	Amyl acetates	Highway
Berwick Township	11/10/2003	3	Butanedione	Highway
Mount Pleasant Township	12/23/2003	3	Resin solution, flammable	Highway

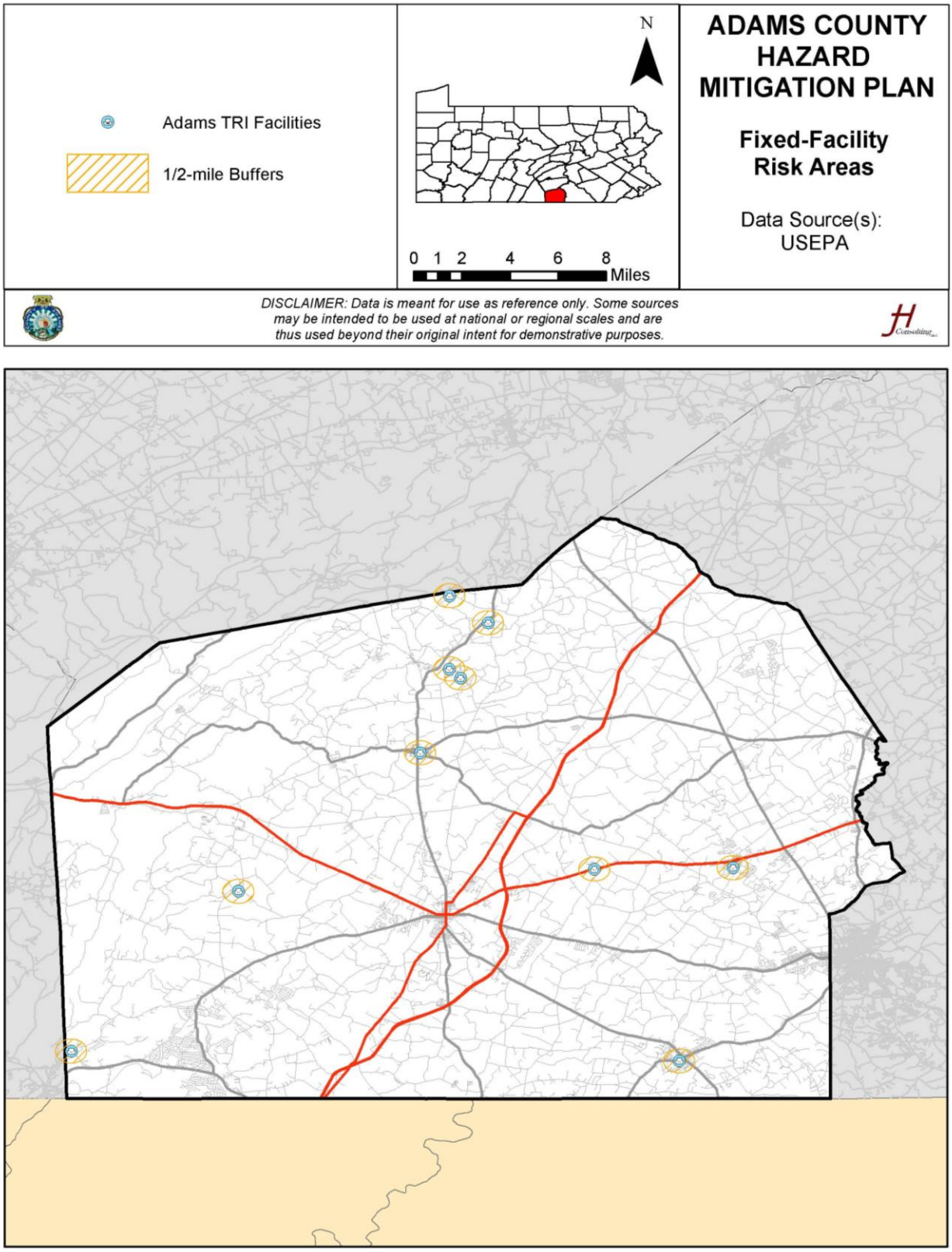
PHMSA INCIDENTS IN ADAMS COUNTY				
Incident Location	*Date*	*Hazard Class*	*Commodity Name*	*Mode of Transportation*
Mount Pleasant Township	1/8/2004	3	Paint including paint, lacquer, enamel, stain, shellac solutions, varnish, polish, liquid filler, and liquid lacquer base	Highway
Tyrone Township	1/20/2004	3	Acetone	Highway
Cumberland Township	3/19/2004	3	Tars, liquid including road oils and cutback bitumens	Highway
Mount Pleasant Township	4/29/2004	6.1	Organophosphorus pesticides, liquid, toxic	Highway
Gettysburg Borough	10/26/2005	2.2	Aerosols, non-flammable, (each not exceeding 1 l capacity)	Highway
Gettysburg Borough	4/7/2006	2	Fuel oil, diesel	Highway
Gettysburg Borough	5/16/2007	3	Isopropanol	Highway
Gettysburg Borough	12/24/2007	8	Corrosive liquids, n.o.s.	Highway
Gettysburg Borough	4/16/2009	N/A	N/A	Air
Gettysburg Borough	9/28/2009	3	Petroleum distillates, n.o.s. or petroleum products, n.o.s.	Highway
Gettysburg Borough	10/30/2010	3	Paint related material including paint thinning, drying, removing, or reducing compound	Highway
Gettysburg Borough	2/7/2011	5.1	Magnesium perchlorate	Highway
Littlestown Borough	7/24/2019	8	Hydrochloric acid	Highway

Of the 64 events listed above, most occurred in just three areas. Fourteen incidents occurred in Reading (Township), followed by Gettysburg with 11 incidents, and Mount Pleasant with eight. The most commonly-reported material classes reported in incidents were Class 3 (flammable liquids) and Class 8 (corrosive materials), which coincides with the most transported hazardous materials in the county. Additionally, the majority (92%) of the incidents occurred on a highway. Only 6.25% occurred within the airway mode, and an even smaller minority (1.5%) occurred on a railway.

4.3.15.4 Future Occurrence

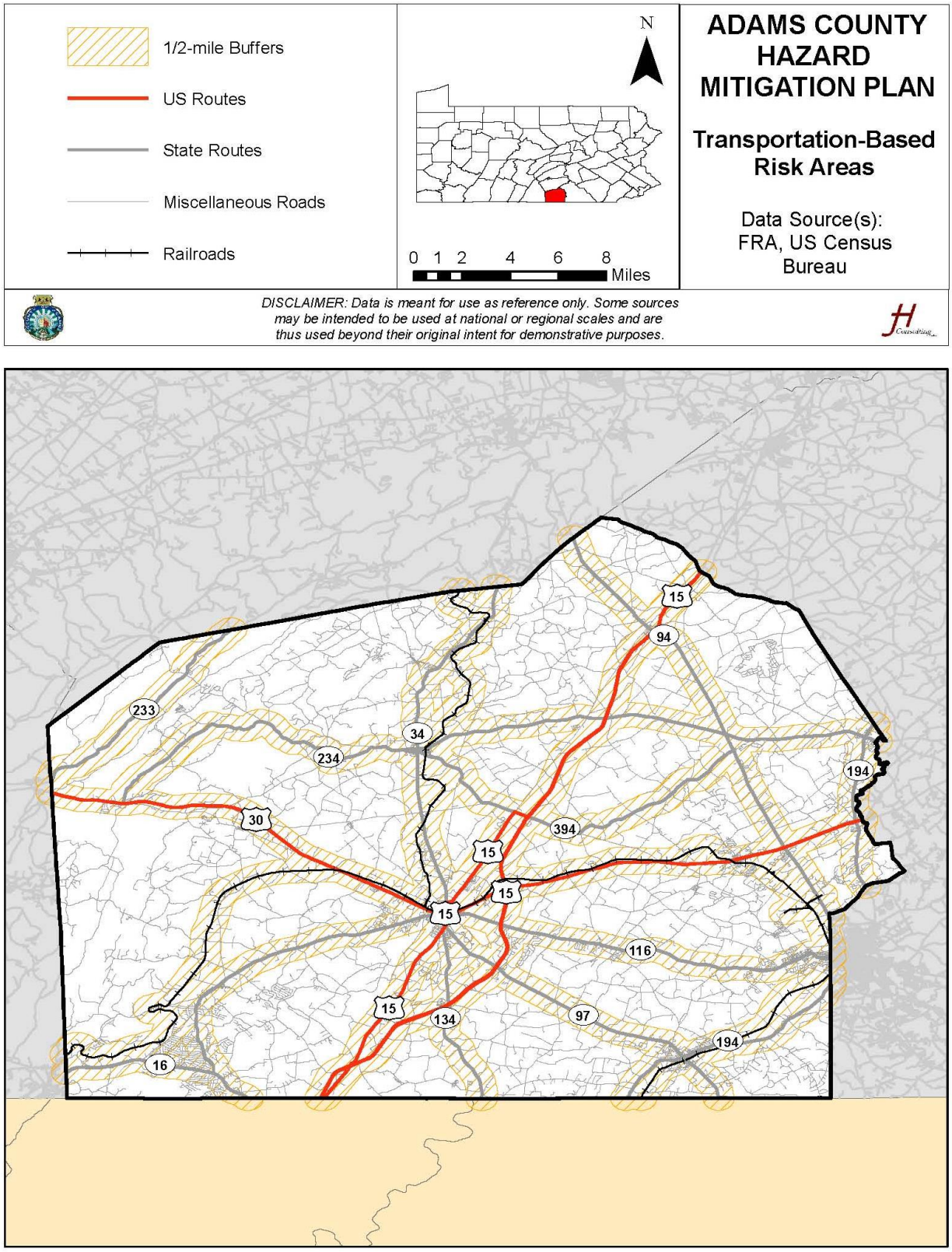
Future hazardous materials releases are most likely to occur during the transportation process, specifically during highway transport. Releases could also occur from TRI facilities or Superfund sites. Figure 4.3.15.4-1 depicts these sites (with half-mile buffers).

Figure 4.3.15.4-1



Based on previous incidents and the county's most recent commodity flow study, future transportation-based hazardous material releases will most likely involve Class 3 hazardous materials transported by truck. 481,453,616.5 tons of hazardous materials are moved through the county by truck. Of these materials, 83% are Class 3 hazardous materials. Figure 4.3.15.4-2 depicts transportation routes in Adams County (with half-mile buffers).

Figure 4.3.15.4-2



4.3.15.5 Vulnerability Assessment

This section summarizes the vulnerability to Adams County from hazardous materials. Adams County conducted an online survey for the public to share its thoughts on hazard vulnerabilities. Table 4.3.15.5-1 presents the results of that survey regarding hazardous materials releases.

Table 4.3.15.5-1

PUBLIC SENTIMENT, ENVIRONMENTAL HAZARDS: HAZARDOUS MATERIALS RELEASE – ADAMS COUNTY					
Hazard	*Level of Concern*				*Total Responses*
	Not at All	*Somewhat*	*Concerned*	*Very*	
Hazardous Materials Release	26 (17.69%)	51 (34.69%)	45 (30.61%)	25 (17.01%)	147
In the past ten years, do you remember this hazard occurring in your community?				32 (21.92%)	146
Have you noticed an increase or decrease in the occurrences or intensity of this hazard? (137 responses)				25 (18.25%)	INCREASE
				109 (79.56%)	NO CHANGE
				3 (2.19%)	DECREASE

Table 4.3.15.5-2 below describes Adams County's vulnerability to hazardous materials releases.

Table 4.3.15.5-2

ENVIRONMENTAL HAZARDS: HAZARDOUS MATERIALS RELEASE VULNERABILITY SUMMARY			
Category	*Points*	*Description*	*Notes*
Frequency	5	Excessive	There have been 64 transportation-based incidents since 1994, for an average of 2.56 events per year.
Response	2	1 Day	A hazardous material event would require an emergency response but would be unlikely to last longer than 24 hours.
Onset	5	N/A	Hazardous materials releases can occur at any time, with no warning.
Magnitude	1	Localized	Most incidents in Adams County are transportation-based and affect only a small area of the county.
Business	1	Less than 24 hours	Most likely, a hazardous materials release would not interrupt the county's economy for an extended period.
Human	2	Low (some injuries)	While not all hazardous materials incidents will cause injuries, there is potential that negative human health effects will occur.
Property	1	Less than 10% of property	Again, hazardous materials incidents are localized and would affect a small amount of property.
Total	**17**	**Medium**	

4.0 RISK ASSESSMENT

4.3.16 Nuclear Incidents

HIGHEST HIGH MEDIUM LOW LOWEST	Nuclear incidents refer to events involving the release of significant levels of radioactivity or exposure of workers or the general public to radiation.			
	Warning Time	None	**Hazard Index Ranking:**	21-High
	Period of Occurrence:	Nuclear incidents can occur at any time	**State Risk Ranking:**	2.4-Medium
	Type of Hazard:	Human-Caused	**Disaster Declarations:**	N/A

Nuclear incidents generally refer to events involving the release of significant levels of radioactivity or exposure of workers or the general public to radiation (FEMA, 1997). The primary concern following such an incident is the extent of the radiation. The inhalation or ingestion of radioactive isotopes, which can cause acute health effects (e.g., death, burns, severe impairment), chronic health effects (e.g., cancer), and psychological effects (FEMA, 1997) is also a concern.

4.3.16.1 Location and Extent

In a nuclear power plant, the “fuel” is an isotope of either uranium or plutonium. The isotope undergoes fission (i.e., splitting) to produce energy, which heats water and turns steam-driven turbine generators. In addition to energy, split fuel creates radioactive fission products, which are the cause of concern during nuclear accidents. Officials classify nuclear accidents into three categories:

- **Criticality Incidents:** Involve loss of control of nuclear assemblies or power reactors
- **Loss-of-Coolant Incidents:** Occur whenever a reactor’s coolant system experiences a break or opening large enough that the coolant inventory cannot be maintained by the make-up system
- **Loss-of-Containment Incidents:** Involve the release of radioactivity from materials such as tritium, fission products, plutonium, and natural, depleted, or enriched uranium. Points of release have been containment vessels at fixed facilities or damaged packages during transportation accidents.

The Nuclear Regulatory Commission established a list of emergency response communications to be used in case of a nuclear incident.

Figure 4.3.16.1-1

NUCLEAR EMERGENCY RESPONSE COMMUNICATIONS		
Communication	*Description*	*Purpose*
Notification of Unusual Event (NOUE)	Events are in progress or have occurred, which indicate a potential degradation of the level of safety of the plant or indicate a security threat to facility protection has been initiated. No releases of radioactive material requiring offsite response or monitoring are expected unless further degradation of safety systems occurs	To assure that the first step in future response has been carried out, to bring the operations staff to a state of readiness and to provide systematic handling of unusual event information and decision-making.
Alert	Events are in progress or have occurred which involve an actual or potential substantial degradation of the level of safety of the plant or a security event that involves probable life-threatening risk to site personnel or damage to site equipment because of hostile actions. Any releases are expected to be limited to small fractions of the Environmental Protection Agency (EPA)	To assure that emergency personnel is readily available to respond if the situation becomes more serious or to perform confirmatory radiation monitoring if required, and provide offsite authorities current information on plant status and parameters.
Site Area Emergency (SAE)	Events are in progress or have occurred which involve actual or likely major failures of plant functions needed for the protection of the public or hostile action that results in intentional damage or malicious acts; 1) toward site personnel or equipment that could lead to the likely failure of or; 2) that prevent effective access to, equipment needed for the protection of the public. Any releases are not expected to result in exposure levels that exceed EPA PAG exposure levels beyond the site boundary.	To assure that emergency response centers are staffed, to assure that monitoring teams are dispatched, to assure that personnel required for evacuation of near-site areas are at duty stations if the situation becomes more serious, to provide consultation with offsite authorities, and to provide updates to the public through government authorities.
General Emergency	Events are in progress or have occurred which involve actual or imminent substantial core degradation or melting with potential for loss of containment integrity or hostile action that results in an actual loss of physical control of the facility. Releases can be reasonably expected to exceed EPA PAG exposure levels offsite for more than the immediate site area.	To initiate predetermined protective actions for the public, to provide continuous assessment of information from the licensee and offsite organizational measurements, to initiate additional measures as indicated by actual or potential releases, to provide consultation with offsite authorities, and to provide updates for the public through government authorities.

There are five nuclear facilities in Pennsylvania: Beaver Valley, Limerick, Peach Bottom, Susquehanna, and Three Mile Island, which closed in September 2019. Adams County is in the ingestion exposure pathway emergency planning zone (EPZ) (i.e., within 50 miles) of the Three

Mile Island and Peach Bottom facilities.

4.3.16.2 Range of Magnitude

Human exposure as a result of a reactor accident can be in three ways: total or partial exposure as a result of proximity to the radiation source, external contamination, and internal contamination (Christodouleas et al., 2011). In previous incidents, only plant workers or emergency personnel involved in the aftermath experienced substantial total- or partial-body exposure. External contamination occurs when the fission products settle on human beings, thereby exposing skin or internal organs. Internal contamination is the primary mechanism through which large populations around a reactor accident can be exposed to radiation, and occurs when fission products are ingested or inhaled or enter the body through open wounds.

4.3.16.3 Past Occurrence

There are 437 nuclear power plants in operation around the world. There have been five major nuclear accidents in the past: (a) Kyshtym, Russia in 1957, (b) Windscale Pules, the United Kingdom in 1957, (c) Three Mile Island, Pennsylvania in 1979, (d) Chernobyl, Ukraine in 1986, and (e) Fukushima, Japan in 2011.

In the United States, officials often consider the incident at Three Mile Island the most serious incident in commercial nuclear power plant operating history, though multiple studies showed that the small radioactive release had no detectable health effects on plant workers or the public. The Chernobyl incident was also significant, and Ukrainian officials still monitor an exclusion zone around the area. The City of Pripyat stands deserted and serves as a symbol of Chernobyl's aftermath. Scientists around the world study the exclusion zone, and the magnitude of the impacts associated with the incident are debated. Modern technology and research practices have enabled on-going monitoring of and research on impact areas following the Fukushima incident in Japan, though long-term impacts are not yet readily available.

4.3.16.4 Future Occurrence

The probability of future events is unlikely. However, if an event were to occur, Adams County, as a support community, would likely host displaced persons. Gettysburg High School is a reception center, and the Gettysburg Area School Complex is a decontamination center for a future incident at the Three Mile Island facility. Such an event is unlikely since Three Mile Island is no longer in operation.

4.3.16.5 Vulnerability Assessment

This section summarizes the vulnerability to Adams County from nuclear incidents. Adams County conducted an online survey for the public to share its thoughts on hazard vulnerabilities. Table 4.3.16.5-1 presents the results of that survey regarding nuclear incidents.

Table 4.3.16.5-1

PUBLIC SENTIMENT, NUCLEAR INCIDENTS – ADAMS COUNTY					
Hazard	*Level of Concern*				*Total Responses*
	Not at All	*Somewhat*	*Concerned*	*Very*	
Nuclear Incidents	58 (39.46%)	65 (44.22%)	16 (10.88%)	8 (5.44%)	147
In the past ten years, do you remember this hazard occurring in your community?				1 (0.68%)	146
Have you noticed an increase or decrease in the occurrences or intensity of this hazard? (136 responses)				4 (2.94%)	INCREASE
				119 (87.50%)	NO CHANGE
				13 (9.56%)	DECREASE

Table 4.3.16.5-2 shows Adams County's vulnerability to nuclear incidents.

Table 4.3.16.5-2

NUCLEAR INCIDENT VULNERABILITY SUMMARY			
Category	*Points*	*Description*	*Notes*
Frequency	2	Low	There has been one nuclear incident in Pennsylvania near Adams County. The potential for a future nuclear incident is low (given historical precedent and the current operational status of Three Mile Island).
Response	5	More than one month	Emergency response to a significant nuclear incident could span months, with some operations extending years.
Onset	4	Less than 6 hours	Nuclear incidents may occur with little to no warning.
Magnitude	3	Critical	A future event at Peach Bottom could potentially affect the eastern half of Adams County (within the 50-mile ingestion zone).
Business	3	At least 2 weeks	An incident at Peach Bottom that impacts eastern Adams County could impact business operations to some degree for an extended period.
Human	1	Minimum (minor injuries)	Based on the past event at Three Mile Island, the human population will not be adversely affected by a nuclear incident.
Property	3	25-50% of property	A future event at Peach Bottom could affect the eastern half of Adams County, including property (within the 50-mile ingestion zone).
Total	**21**	**High[1]**	

[1] Adams County continues to participate in bi-annual exercises with FEMA and the NRC; despite the decommissioning of the Three Mile Island plant, the county plans to continue participation as long as the exercises are on-going. The county lies within the 50-mile ingestion zone of the Peach Bottom plant, which necessitates planning (but to a lesser extent than for areas in the emergency planning zone).

The ranking for nuclear incidents is high because of the mechanism used to calculate ranks (e.g., magnitude listed as critical per the amount of land area impacted). The on-going drills coupled with public education strategies in Section 6.0 are sufficient to mitigate nuclear incident risks (to the extent possible) in Adams County.

4.0 RISK ASSESSMENT

4.3.17 Terrorism

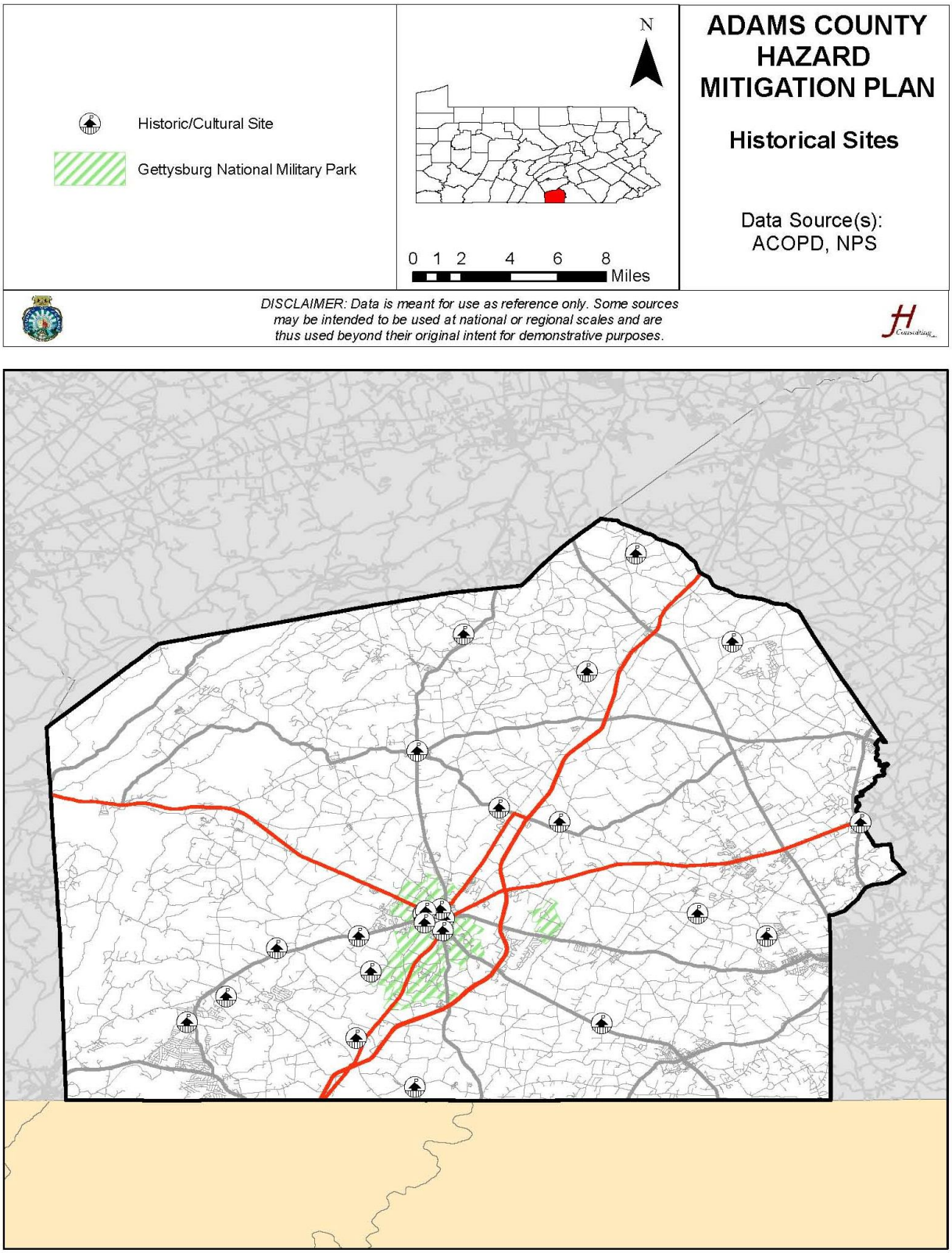
HIGHEST HIGH MEDIUM LOW LOWEST	Terrorism refers to the use of force against persons or property with the intent to intimidate or coerce, and includes threats, assassination, kidnapping, hijacking, bombings or bomb threats, cyber-attacks, and use of chemical, biological, nuclear, and radiological weapons.			
	Warning Time	None	**Hazard Index Ranking:**	14-Low
	Period of Occurrence:	Acts of terrorism can occur at any time	**State Risk Ranking:**	2.0-Medium
	Type of Hazard:	Human-Caused	**Disaster Declarations:**	N/A

Terrorism is the use of force or violence against persons or property with the intent to intimidate or coerce. Acts of terrorism include threats of terrorism, assassinations, kidnappings, hijackings, bomb scares and bombings, cyber-attacks (computer-based), and the use of chemical, biological, nuclear, and radiological weapons (FEMA, 2009). Increasingly, cyberattacks have become a more pressing concern for governments across America.

4.3.17.1 Location and Extent

High-risk targets for terrorism include military and civilian government facilities, international airports, large cities, and high-profile landmarks. Terrorists might also target large public gatherings, water and food supplies, utilities, and corporate centers. Adams County is home to national military monuments (e.g., Gettysburg National Military Park), high-profile landmarks (e.g., the Eisenhower National Historic Site), and large public gatherings. Figure 4.3.17.1-1 below shows the locations of high profile historical sites in the county.

Figure 4.3.17.1-1



The Federal Bureau of Investigation (FBI) classifies terrorism into international and domestic terrorism. International terrorism includes violent acts committed by individuals or groups associated with designated foreign terrorist organizations. Domestic terrorism includes acts carried out by individuals or groups associated with U.S.-based movements that support extremist ideologies.

4.3.17.2 Range of Magnitude

The severity of a terrorism incident depends on the method used, the proximity of a device to people, animals, or other assets and duration of the incident. Terrorists use several methods of attack, including the following.

- **Explosions:** Explosive devices are one of the most common weapons used by terrorists. Materials and information on how to make explosive devices are widely available and these devices are easily carried and detonated.
- **Biological Threats:** Biological threats are organisms or agents that can kill or incapacitate people, and are dispersed by contaminating food or water sources, infecting animals, or spraying them into the air as aerosols.
- **Chemical Threats:** Chemical agents are poisonous vapors, aerosols, liquids, and solids that have toxic effects on people, animals, or plants. Chemical agents are potentially lethal, but often difficult to deliver in lethal concentrations and difficult to produce or acquire.
- **Nuclear Blasts:** All nuclear devices cause deadly effects, including blinding light, intense heat, nuclear radiation, and fires. Nuclear devices can range from small devices carried by individuals to long-range nuclear weapons launched by hostile nations.
- **Radiological Dispersion Devices (RDD):** Terrorist use of an RDD, often called a “dirty bomb,” is more likely than that of a nuclear explosive device. RDDs spread sub-lethal amounts of radiation over a general area with materials commonly used in medicine, agriculture, industry, and research.

A potential worst-case scenario for Adams County would be a terrorist attack at the Gettysburg National Military Park. The park holds historical and cultural significance and attracts approximately one million tourists each year.

4.3.17.3 Past Occurrence

Adams County has experienced terrorist threats in the past. From 2004 to 2009, there

were 26 terrorist incidents reported to PIERS (Pennsylvania's Emergency Incident Reporting System), including nine bomb threats, 11 suspicious packages or devices, and six miscellaneous incidents. The Pennsylvania Emergency Management Agency no longer uses the PIERS system to collect incident information, so terrorism events since 2009 have not been formally collected. Local news sources have reported the following incidents since 2009. These incidents are shown in Table 4.3.17.3-1.

Table 4.3.17.3-1

TERRORISM THREATS ADAMS COUNTY PA			
Date	*Location*	*Threat Location*	*Type of Threat*
November 2019	Gettysburg Borough	Workplace	Bomb Threat
October 2019	Gettysburg Borough	Workplace	Bomb Threat
April 2019	Gettysburg Borough	Law Enforcement Agency	Bomb Threat
April 2019	Gettysburg Borough	Local Prison	Threat
January 2019	Cumberland Township	Human Resources Building	Bomb Threat
February 2018	Fairfield Borough	School	Bomb Threat
November 2017	Gettysburg Borough	Public Event	Bomb Threat
May 2016	Gettysburg Borough and New Oxford Borough	Schools	Bomb Threat

4.3.17.4 Future Occurrence

Planners cannot predict terrorist events in the same way that they can natural hazard occurrences and risk areas. Terrorism can also take many forms and involves a range of political and personal agendas. Potentially vulnerable areas include the Gettysburg National Military Park, the Eisenhower National Historic Site, critical facilities (e.g., water plants), and infrastructure (e.g., local electricity grid hardware).

4.3.17.5 Vulnerability Assessment

This section summarizes the vulnerability to Adams County from terrorism. Adams County conducted an online survey for the public to share its thoughts on hazard vulnerabilities. Table 4.3.17.5-1 presents the results of that survey regarding terrorism.

Table 4.3.17.5-1

PUBLIC SENTIMENT, TERRORISM – ADAMS COUNTY					
Hazard	*Level of Concern*				*Total Responses*
	Not at All	*Somewhat*	*Concerned*	*Very*	
Terrorism	40 (27.03%)	56 (37.84%)	31 (20.95%)	21 (14.19%)	148
In the past ten years, do you remember this hazard occurring in your community?				2 (1.37%)	146
Have you noticed an increase or decrease in the occurrences or intensity of this hazard? (134 responses)				23 (17.16%)	INCREASE
				110 (82.09%)	NO CHANGE
				1 (0.75%)	DECREASE

Table 4.3.17.5-2 shows Adams County's vulnerability to terrorism.

Table 4.3.17.5-2

TERRORISM VULNERABILITY SUMMARY			
Category	*Points*	*Description*	*Notes*
Frequency	1	None	While there have been threats of terrorism, there have been no acts of terrorism in Adams County.
Response	2	1 day	With most terrorism incidents, an emergency response would be necessary for a short period.
Onset	4	Less than 6 hours	Terrorism incidents cannot be predicted or forecasted like some natural hazards. The onset of terrorism
Magnitude	1	Localized	Acts of terrorism typically target specific places or events. While significant, an event would affect a small land area.
Business	1	Less than 24 hours	Depending on the event, the local economy could be affected for a prolonged period.
Human	4	High	In the event of a terrorist event, there will likely be multiple severe injuries or deaths.
Property	1	Less than 10% of property	Again, acts of terrorism are specific to a set target and would not cause widespread property damage.
Total	**14**	**Low**	

4.0 RISK ASSESSMENT

4.3.18 Transportation Accidents

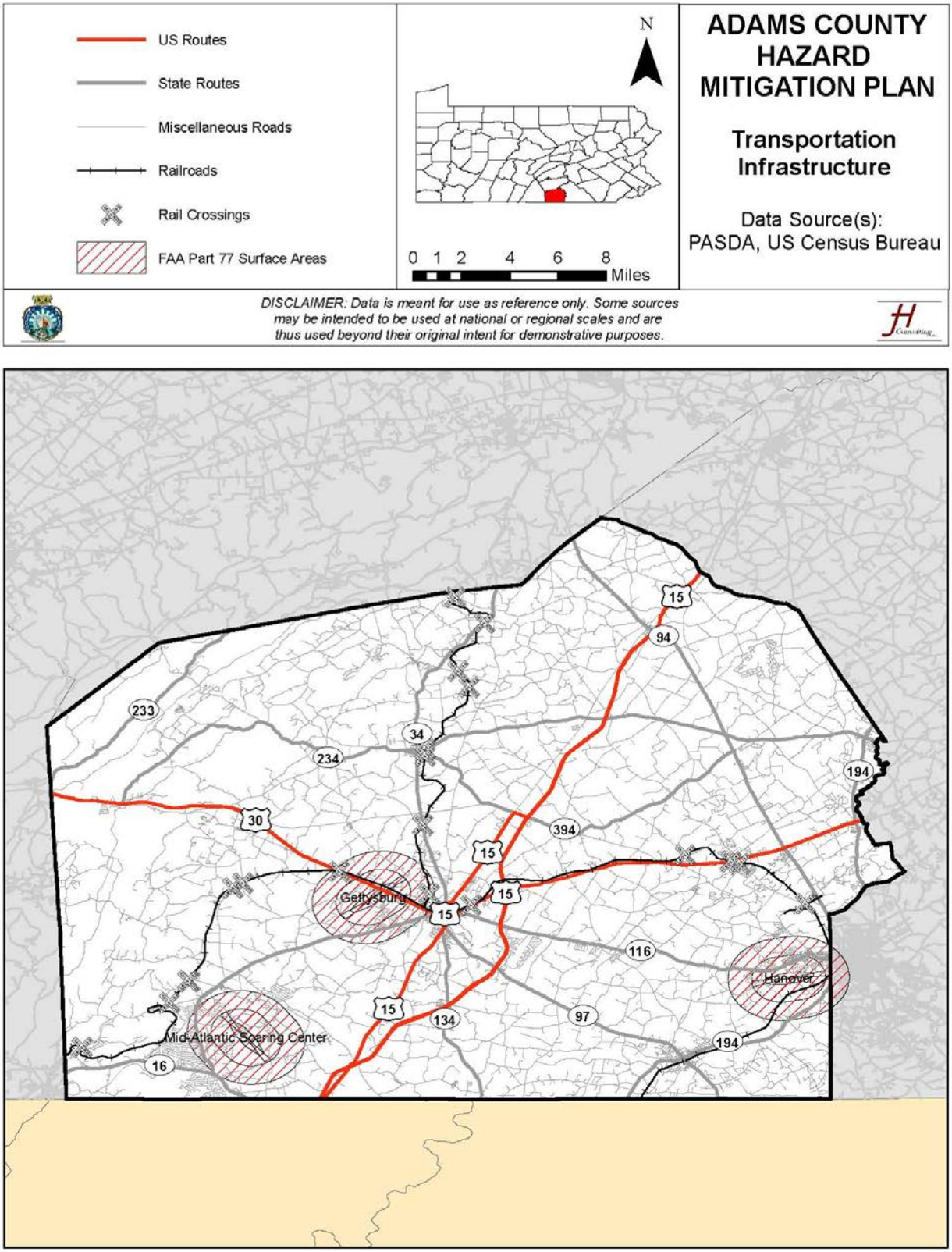
HIGHEST HIGH MEDIUM LOW LOWEST	Transportation accidents can result from any form of air, rail, water, or road travel, and can cause regional impacts such as hazardous materials releases or disruption in critical supply/access routes.			
	Warning Time	None	**Hazard Index Ranking:**	16-Medium
	Period of Occurrence:	Transportation accidents can occur at any time.	**State Risk Ranking:**	2.4-Medium
	Type of Hazard:	Human-Caused	**Disaster Declarations:**	N/A

Transportation accidents can result from any form of air, rail, water, or road travel. It is unlikely that small accidents would significantly impact the larger community. However, certain accidents could have secondary regional impacts such as a hazardous materials release or disruption in critical supply/access routes, especially along vital transportation corridors or at critical junctions. Traffic congestion, in certain circumstances, can also be hazardous. Traffic congestion is a condition that occurs when traffic demand approaches or exceeds the available capacity of the road network (PEMA, 2018).

4.3.18.1 Location and Extent

For this plan, transportation accidents are incidents involving highway, air, and rail travel. The county is home to two significant transportation routes: US 15 and US 30. Two rail lines are operating in the county which transport freight, including hazardous materials. The CSX line runs east-west through Gettysburg, and the Gettysburg and Northern Railroad line runs from Gettysburg north to Mount Holly Springs. Finally, while there are no public passenger airports in the county, there are four private airports: the Gettysburg Airport and Travel Center, Mid-Atlantic Soaring Center, Hanover Airport, and Southern Adams County Heliport. Figure 4.3.18.1-1 depicts the transportation infrastructure of Adams County.

Figure 4.3.18.1-1



The Pennsylvania Department of Transportation (PennDOT) defines seven roadway crash types (2018).

- **Non-Collision:** A harmful event that does not involve a collision, such as a fire, explosion, or overturn
- **Angle:** A crash in which two vehicles on opposite roadways collide at an intersection, driveway, or ramp
- **Rear-End:** A crash in which vehicles traveling in the same direction on the same road collide
- **Head-On:** A crash in which vehicles traveling in opposite directions, on the same road collide
- **Sideswipe:** A crash between two vehicles in which the sides of the vehicles engage
- **Hit Fixed Object:** A collision in which a vehicle hits a stationary object on or adjacent to the roadway
- **Hit Pedestrian:** A collision between a motor vehicle and any person not in or upon the vehicle

Rail transportation accidents are generally one of three types (Federal Railway Administration, 2010).

- **Derailment:** An accident on a railway in which a train leaves the rails
- **Collision:** An accident in which a train strikes something such as another train or highway motor vehicle
- **Other:** Accidents caused by other circumstances like obstructions on rails, fire, or explosion

The Federal Aviation Administration's (FAA's) guideline on aircraft accident and incident notification, investigation, and reporting defines an aircraft accident as, "an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and until all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage. All aspects of the exceptions to substantial damage (see "Substantial Damage") should be considered before making a final substantial damage determination that would classify the occurrence as an accident" (8020.11D, 2018, p. 2).

4.3.18.2 Range of Magnitude

At a minimum, transportation accidents result in damage to vehicles and minor injuries to passengers and drivers. At worst, significant transportation accidents can result in death or serious injury, extensive property damage, traffic congestion, and temporary business interruption. Most car accidents in Adams County result in injury or property damage only. On average, less than 1.5% of car accidents result in a fatality.

The effects of a transportation accident are exacerbated if the vehicles (either motor vehicles or trains) are carrying hazardous materials. An accident of this nature would cause environmental and human harm in addition to property damage from the accident. See Section 4.3.15 for more information.

4.3.18.3 Past Occurrence

PennDOT provides annual accident reports that show the number of car accidents per county. Table 4.3.18.3 below shows the accidents in Adams County from 2003 to 2018.

Table 4.3.18.3-1

CAR ACCIDENTS IN ADAMS COUNTY				
Year	*Fatal Injury Crashes*	*Injury Crashes*	*Property Damage Only Crashes*	*Yearly Total*
2018	15	424	605	1,044
2017	5	426	571	1,002
2016	15	402	601	1,018
2015	14	394	582	990
2014	6	452	568	1,026
2013	5	489	569	1,063
2012	13	444	538	995
2011	12	286	578	1,076
2010	14	473	520	1,007
2009	21	566	571	1,158
2008	21	485	528	1,034
2007	17	525	519	1,061
2006	16	468	490	974
2005	25	505	495	1,025
2004	15	546	534	1,095
2003	23	536	526	1,085
TOTAL	**222**	**6,997**	**8,190**	**15,609**
AVERAGE	**14.80**	**466.47**	**546.00**	**1,041.60**

The Federal Railroad Administration (FRA) provides county-specific information about railway accidents in the United States. Table 4.3.18.4 shows train accidents that occurred from 2010 to 2019.

Table 4.3.18.3-2

FRA TEN-YEAR ACCIDENT OVERVIEW, ADAMS COUNTY PA											
Category	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*TOTAL*
Total Accidents/Incidents	2	1	1	1	1	0	1	1	2	3	13
Train Accidents (not at Grade-Crossings)	0	0	0	0	0	0	0	0	0	1	1
Hazmat Releases	0	0	0	0	0	0	0	0	0	0	0
Highway-Rail Incidents	1	0	1	0	0	0	0	0	1	1	4
Other Accidents/Incidents	1	1	0	1	1	0	1	1	1	1	9

Aviation accidents are the least frequent type of transportation accidents. Most involve small aircraft and result in few if any injuries. Despite their relative rarity, there have been two aircraft accidents in Adams County. In 2014, two people were killed in a small plane crash near Biglerville. In 2016, another small plane crashed into a tree in Cumberland Township, and responders were able to remove the pilot safely.

Adams County's hazard mitigation planning committee reported several issues associated with transportation accidents. In many municipalities, the central business district includes densely-constructed areas and potentially heavy pedestrian traffic. Thus, these areas have speed limits. Drivers routinely exceed speed limits, creating hazards. Some municipalities have a town square, and artifacts in the center of the square have been damaged by drivers not aware of the obstruction. Adams County is also an area frequented by tourists (i.e., drivers that may not be familiar with the area).

4.3.18.4 Future Occurrence

Based on the number of past occurrences, the likelihood of a transportation accident occurring in Adams County is extremely likely. Most accidents will likely involve motor vehicles, through a train or airplane accident is possible. As Adams County's population increases and its industry expands, its traffic volume will likely follow suit. Based on this and past occurrences, transportation accidents are highly likely, and will primarily occur on highways.

4.3.18.5 Vulnerability Assessment

This section summarizes the vulnerability to Adams County from transportation accidents. Adams County conducted an online survey for the public to share its thoughts on

hazard vulnerabilities. Table 4.3.18.5-1 presents the results of that survey regarding transportation accidents.

Table 4.3.18.5-1

PUBLIC SENTIMENT, TRANSPORTATION ACCIDENT – ADAMS COUNTY					
Hazard	*Level of Concern*				*Total Responses*
	Not at All	*Somewhat*	*Concerned*	*Very*	
Transportation Accident	26 (17.57%)	51 (34.46%)	43 (29.05%)	28 (18.92%)	148
In the past ten years, do you remember this hazard occurring in your community?				51 (34.91%)	146
Have you noticed an increase or decrease in the occurrences or intensity of this hazard? (138 responses)				46 (33.33%)	INCREASE
				92 (66.67%)	NO CHANGE
				0 (0.00%)	DECREASE

Table 4.3.18.5-2 shows Adams County's vulnerability to transportation accidents.

Table 4.3.18.5-2

TRANSPORTATION ACCIDENT VULNERABILITY SUMMARY			
Category	*Points*	*Description*	*Notes*
Frequency	5	Excessive	Adams County can expect to experience multiple vehicle accidents and at most likely, a train accident in any given year.
Response	1	Less than half a day	Transportation accidents do not require a prolonged emergency response. Typical accidents are resolved in less than half a day.
Onset	5	N/A	Transportation accidents cannot be predicted or forecasted like natural hazards.
Magnitude	1	Localized	Traffic patterns may be interrupted, but transportation accidents typically only affect a small portion of the county
Business	1	Less than 24 hours	A transportation accident would not typically interrupt the county's economy.
Human	2	Low (Some injuries)	Depending on the severity of the accident, there may be some injuries. Most are not significant, but a few instances may involve multiple severe injuries.
Property	1	Less than 10% of property	Transportation accidents typically involve a small amount of property, which is far less than 10% of property in Adams County.
Total	**16**	**Medium**	

4.4 Hazard Vulnerability Summary

One of the components of a risk assessment is the probability of a hazard occurring and its potential severity should it occur. This process helps to identify which hazards pose the most significant threat to Adams County and participating municipalities.

4.4.1 Methodology

Historical occurrences, not worst-case scenarios, inform all calculations. In cases with no historical occurrences, planners derived estimates from other available data sources, which vary across hazards. Table 4.4.1-1 describes the ranking categories used to determine the overall vulnerability of Adams County to the hazards outlined in the hazard mitigation plan.

Table 4.4.1-1

VULNERABILITY CONSIDERATIONS							
	Frequency	*Response*	*Onset*	*Magnitude*	*Business*	*Human*	*Property*
1	None	Less than half a day	Over 24 hours	Localized (Less than 10% of land area affected)	Less than 24 hours	Minimum (minor injuries)	Less than 10% of property affected
2	Low	1 day	12-24 hours	Limited (10-25% of land area affected)	1 week	Low (some injuries)	10-25% of property affected
3	Medium	1 week	6-12 hours	Critical (25-50% of land area affected)	At least 2 weeks	Medium (multiple severe injuries)	25-50% of property affected
4	High	1 month	Less than 6 hours	Catastrophic (More than 50% of land area affected)	More than 30 days	High (multiple deaths)	More than 50% of property affected
5	Excessive	More than one month	N/A	N/A	N/A	N/A	N/A

"Frequency" refers to the number of times a hazard has occurred in a specific period based on available historical data. Planners calculate the figure by dividing the total number of occurrences by the length of time the data is available. Thus, four occurrences over ten years equal 0.4 occurrences per year. Table 4.4.1-2 describes the frequency and its corresponding category.

Table 4.4.1-2

FREQUENCY			
Value	*Score*	*Description*	*Definition*
.76 - >1.0	5	Excessive	Will occur during a year
.51 - .75	4	High	Likely to occur in a year
.26 - .50	3	Medium	May or may not occur in a year
0 - .25	2	Low	Unlikely to occur in a year
0	1	None	So unlikely that it can be assumed it will not occur in a year

The remaining vulnerability categories in Table 4.4.1-1 are largely qualitative (again based on historical occurrences). Planners estimated the appropriate value for each, and the profiles in Section 4.3 include a table listing each criterion with a determination of its score. Each hazard received a composite score corresponding to category numbers in the far left column of Table 4.4.1-1. Hazards received scores between 7 (i.e., all seven categories at a value of one) and 35 (i.e., all seven categories at a value of five). The list below represents the overall ranges by which Adams County ranked all of the hazards in the plan.

Range of Points (Score)	*Hazard Ranking*
7 - 10	Lowest
11 - 15	Low
16 - 20	Medium
21 - 25	High
26 - 30	Highest

4.4.2 Ranking Results

Using this methodology, Table 4.4.2-1 lists the ranking for each of the hazards identified in the risk assessment (in descending order from the highest point total to the lowest).

Table 4.4.2-1

HAZARD RANKING RESULTS								
Hazard	*Frequency*	*Response*	*Onset*	*Magnitude*	*Business*	*Human*	*Property*	*Ranking*
Nuclear Incidents	2	5	4	3	3	1	3	**21**
Flood, Flash Flood, Ice Jam	5	3	4	2	2	1	2	**19**
Winter Storm	5	3	1	4	2	1	1	**17**
Env. Haz.: Hazardous Materials Release	5	2	5	1	1	2	1	**17**
Invasive Species	2	1	1	3	4	2	3	**16**
Pandemic and Infectious Disease	5	3	1	1	2	3	1	**16**
Transportation Accidents	5	1	5	1	1	2	1	**16**
Hurricane, Tropical Storm, Nor'easter	2	3	1	5	1	1	2	**15**
Extreme Temperature	3	1	1	5	1	3	1	**15**
Wildfire	5	2	4	1	1	1	1	**15**
Tornado, Wind Storm	3	2	4	1	1	2	1	**14**
Terrorism	1	2	4	1	1	4	1	**14**

HAZARD RANKING RESULTS								
Hazard	*Frequency*	*Response*	*Onset*	*Magnitude*	*Business*	*Human*	*Property*	*Ranking*
Drought	2	3	1	5	1	1	1	**14**
Hailstorm	4	2	2	2	1	1	1	**13**
Dam Failure	1	3	3	1	1	2	1	**12**
Subsidence, Sinkhole	5	1	1	2	1	1	1	**12**
Earthquake	2	1	4	1	1	1	1	**11**
Landslide	1	2	1	1	1	1	1	**8**

Based on these results, there is one "High" risk hazard, six "Medium" risk hazards, 10 "Low" risk hazards, and one "Lowest" risk hazards.

4.4.3 Potential Loss Estimates

Potential loss estimates for hazard events help a community understand the monetary value of what might be at stake during a hazard event. Estimates are *potential* in that they generally represent losses that could occur in a countywide hazard scenario. In site-specific (or localized) events, losses may be lower, while regional events may yield higher estimates.

In previous versions of this hazard mitigation plan, planners typically characterized loss estimates as "replacement value," "contents value," "functional loss," and "displacement cost." While these categories remain valid, planners have migrated toward a case-by-case description of loss based on historical occurrences, scholarly research, etc. The various hazard losses below will indicate the appropriate sources, as well as note whether the loss is historical, modeled, or predicted.

Drought

Planners calculated a predictive loss estimate for drought. The USDA maintains data about agricultural activities through five-year censuses. Table 4.4.3-1 is from the 2007, 2012, and 2017 efforts.

Table 4.4.3-1

USDA CENSUS OF AGRICULTURE DATA – ADAMS COUNTY					
Year	*Farms*	*Land in Farms (acres)*	*Harvested Cropland (acres)*	*Average Harvested Cropland per Farm (acres)*	*Market Value of Agricultural Products Sold*
2007	1,289	174,595	107,626	117.37	$168,343,000
2012	1,188	171,305	112,966	128.22	$201,742,000
2017	1,146	166,227	114,458	129.04	$181,122,000

Source: https://www.nass.usda.gov/AgCensus/index.php

There can be no correlation drawn between the presence of farms and drought risk; however, the market value of agricultural products sold provides evidence of total agricultural economic activity exposed to losses from droughts (an average of $183,735,700). Data on historical occurrences shows no crop damage (or lacks estimates of loans or other assistance provided for crop losses). For planning purposes, utilizing research on average crop yield losses provides the basis for a mathematical loss calculation. Kuwayama (2019) focused on corn and soybeans and found that a week of drought in non-irrigating counties results in average crop yield reductions ranging from 0.1% to 1.2%. The average market value of agricultural products sold annually (i.e., across 52 weeks) suggests an average weekly value of approximately $3,533,400 (for a potential exposure ranging from $3,533 to $42,400). In 2017, the U.S. Department of Agriculture designated Adams County as a "natural disaster area from drought" from May 1 through December 10 (just over seven months) (AgFax, 2017). Combining these calculations suggests a range of exposure of $98,900 to $1,187,200 per drought.

Earthquake

Planners utilized the HAZUS-MH program from the Federal Emergency Management Agency to produce a modeled loss estimate. The scenario depicts a 5.0 earthquake located at the county seat of Gettysburg. The following tables describe the expected building damages by occupancy type and the building-related economic loss estimates. Tables 4.4.3-1 and 4.4.3-2 highlight expected building damage and economic losses from an earthquake event.

Table 4.4.3-2

ADAMS COUNTY EXPECTED BUILDING DAMAGE BY OCCUPANCY (HAZUS)										
	None		*Slight*		*Moderate*		*Extensive*		*Complete*	
	Count	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*
Agriculture	192.83	0.73	77.82	0.94	67.23	1.33	24.06	1.42	6.06	1.35
Commercial	1,079.89	4.09	430.21	5.21	466.98	9.23	201.79	11.89	27.13	12.76
Education	26.45	0.10	11.79	0.14	14.74	0.29	6.90	0.41	2.12	0.47
Government	46.06	0.17	17.67	0.21	21.54	0.43	9.87	0.58	2.86	0.64
Industrial	403.74	1.53	137.63	1.67	150.98	2.98	62.51	3.68	16.15	3.61
Other Residential	1925.46	7.29	851.71	10.31	958.57	18.94	413.54	24.36	91.72	20.49
Religion	128.18	0.49	43.75	0.53	34.83	0.69	14.37	0.85	3.87	0.87
Single-family	22,608.16	85.60	6,688.59	80.98	3,345.82	66.11	964.67	56.82	267.75	59.81
TOTAL	**26,411**		**8,259**		**5,061**		**1,698**		**448**	

Table 4.4.3-3

ADAMS COUNTY HAZUS BUILDING-RELATED ECONOMIC LOSS ESTIMATES (MILLIONS OF DOLLARS)							
Category	*Area*	*Single-family*	*Other Residential*	*Commercial*	*Industrial*	*Others*	*Total*
Income Losses	Wage	0.0000	9.0484	24.8826	1.2028	2.5674	**37.7012**
	Capital-related	0.0000	3.8446	23.1636	0.7124	0.4746	**28.1952**
	Rental	10.4687	10.6801	10.9385	0.3977	0.9955	**33.4805**
	Relocation	36.8203	5.6707	16.3753	2.1660	7.5740	**68.6063**
	Subtotal	47.2890	29.2438	75.3600	4.4789	11.6115	**167.9832**
Capital Stock Losses	Structural	59.1859	20.3474	23.4387	6.6529	10.0040	**119.6286**
	Non-structural	200.1881	75.5719	65.5213	22.1922	24.1059	**387.5794**
	Content	75.9591	20.0901	35.3348	15.2420	14.6783	**161.3043**
	Inventory	0.0000	0.0000	0.9865	3.0185	0.3927	**4.3977**
	Subtotal	335.3328	116.0094	125.2813	47.1056	49.1809	**672.9100**
	TOTAL	**382.62**	**145.25**	**200.64**	**51.58**	**60.79**	**840.89**

Extreme Temperature

There are no historical financial losses available for the ten extreme temperature events in Adams County from 2009 to 2018. However, using statewide data, planners constructed a per-incident historical loss estimate. In Pennsylvania, there were 79 events with $985,000 in recorded property damage between 2009 and 2018. This data yields an average of $12,468 per event.

Flood, Flash Flood, Ice Jam

Planners can calculate several loss estimates for flooding. The NFIP records of claims paid database serves as a historical loss estimate. Table 4.4.3-4 shows the total amount of claims paid in each municipality, according to CIS.

Table 4.4.3-4

FLOODING CLAIMS PAID, ADAMS COUNTY		
Community	*Participation Status*	*Total Amount of Paid Claims*
Abbottstown Borough	Participating	$47,628.00
Arendtsville Borough	Participating	$878.00
Bendersville Borough	Participating	$0.00
Berwick Township	Participating	$0.00
Biglerville Borough	Participating	$12,089.00
Bonneauville Borough	Participating	$4,549.00
Butler Township	Participating	$22,392.00
Carroll Valley Borough	Participating	$134,505.00
Conewago Township	Participating	$7,457.00

FLOODING CLAIMS PAID, ADAMS COUNTY		
Community	*Participation Status*	*Total Amount of Paid Claims*
Cumberland Township	Participating	$1,590,214.00
East Berlin Borough	Participating	$294,890.00
Fairfield Borough	Participating	$5,699.00
Franklin Township	Participating	$84,425.00
Freedom Township	Participating	$111,026.00
Germany Township	Participating	$0.00
Gettysburg Borough	Participating	$662,204.00
Hamilton Township	Participating	$355,480.00
Hamiltonban Township	Participating	$0.00
Highland Township	Participating	$0.00
Huntington Township	Participating	$0.00
Latimore Township	Participating	$0.00
Liberty Township	Participating	$2,347.00
Littlestown Borough	Participating	$0.00
McSherrystown Borough	Participating	$0.00
Menallen Township	Participating	$68,901.00
Mt. Joy Township	Participating	$8,038.00
Mt. Pleasant Township	Participating	$53,257.00
New Oxford Borough	Not Participating	N/A
Oxford Township	Participating	$31,036.00
Reading Township	Participating	$2,216,339.00
Straban Township	Participating	$89,800.00
Tyrone Township	Participating	$0.00
Union Township	Participating	N/A
York Springs Borough	Participating	$12,566.00

As with earthquakes, planners can compile modeled losses from floods to buildings in Adams County with the HAZUS-MH program. The following tables outline the expected building damages by occupancy and type and the building-related economic losses. Table 4.4.3-5 shows building damage by occupancy.

Table 4.4.3-5

EXPECTED BUILDING DAMAGE BY OCCUPANCY												
	1-10		*11-20*		*21-30*		*31-40*		*41-50*		*>50*	
Occupancy	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*
Agricultural	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
Commercial	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
Education	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
Government	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
Industrial	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
Religion	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
Residential	24	33%	34	47%	6	8%	5	7%	2	3%	1	1%
TOTAL	**24**		**34**		**6**		**5**		**2**		**1**	

Table 4.4.3-6 shows the expected building damage by building type.

Table 4.4.3-6

EXPECTED BUILDING DAMAGE BY BUILDING TYPE												
	1-10		*11-20*		*21-30*		*31-40*		*41-50*		*>50*	
Building Type	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*
Concrete	0	0%	0	0%	0	0%	0	0	0	0%	0	0%
Manufactured Housing	0	0%	0	0%	0	0%	0	0	0	0%	0	0%
Masonry	6	43%	5	36%	2	14%	1	7	0	0%	0	0%
Steel	0	0%	0	0%	0	0%	0	0	0	0%	0	0%
Wood	18	31%	29	50%	4	7%	4	7	2	3%	1	2%

Table 4.4.3-7 shows building-related economic losses as either direct building losses or business interruption losses.

Table 4.4.3-7

BUILDING-RELATED ECONOMIC LOSS ESTIMATES (MILLIONS OF DOLLARS)						
Category	*Area*	*Residential*	*Commercial*	*Industrial*	*Others*	*Total*
Building Loss	Building	15.51	1.66	0.77	0.34	**18.27**
	Content	6.70	6.32	1.77	1.72	**16.51**
	Inventory	0.00	0.07	0.22	0.06	**0.34**
	Subtotal	22.21	8.05	2.76	2.11	**35.13**
Business Interruption	Income	0.10	5.88	0.07	0.84	**6.89**
	Relocation	4.12	0.99	0.05	0.30	**5.45**
	Rental Income	1.18	0.70	0.00	0.06	**1.94**
	Wage	0.25	6.11	0.10	5.33	**11.79**
	Subtotal	5.64	13.68	0.22	6.53	**26.07**
	TOTAL	**27.85**	**21.73**	**2.98**	**8.64**	**31.60**

NCEI storm event data also supplements the flooding analysis by enabling the calculation of per-incident historical losses. There have been 21 flood events in Adams County over the past 23 years. Of these floods, only one caused reported property damage, one caused a death, and none caused any reported crop damage. The average property damage due to flooding, based on NCEI data, is $476 per event. Of the 26 flash flood events in Adams Count over the past 23 years, four have caused reported property damage, and none caused reported crop damage. The average property damage caused by flash floods is $4,384 per event.

Hailstorm

Hail is among the costliest weather disasters nationally. Given robust historical records, planners can calculate per-incident historical loss estimates. According to the NOAA's NCEI

storm events database, 6,045 major hailstorms caused $1.8 billion in property and crop damage in the U.S. in 2017. These figures suggest high potential, per-storm impacts of nearly $298,000.

Specifically, in Adams County, 42 historical events resulted in approximately $15,000 of property damage (and $0 in crop damage, despite evidence of storms impacting crops) (NCEI, n.d.). Local data suggests an average, per-storm impact of approximately $357.00.

Hurricane, Tropical Storm, Nor'easter

Cyclone events, as well as severe thunderstorms, can impact all areas of Adams County. According to NCEI storm event records, 231 thunderstorm events caused $1,059,500 in property damage along with $200.00 in crop damage between 1955 and 2019. Significantly, all reported losses occurred after 1994 (resulting in a total of 176 events over 25 years). These figures suggest historical, per-incident losses of approximately $60,200.

Invasive Species

Documented historical occurrences also enable the calculation of a historical, per-incident loss estimate. The 1999 plum pox infestation noted in Section 4.3.7 resulted in $50 million in losses across four counties, including Adams, for an average of $12,500,000 per county.

Planners could also calculate a predictive loss estimate. The Chesapeake Group produced a report that detailed the fruit belt industry in southeastern Pennsylvania, including Adams County. The document outlining the industry in Adams County includes an "impact model." That report noted that the fruit belt contributed approximately $580 million to the Adams County economy. The report also cites approximately 20,000 acres of tree fruit in the historic South Mountain Fruit Belt of Adams County (for an economic impact of approximately $29,000 per acre). The previously-noted 1999 plum pox infestation impacted 1,600 acres in four counties (for an average of 400 acres per county). At an economic impact of $29,000/acre, an infestation impacting 400 acres could yield $11,600,000 in potential economic losses (for the year in which the infestation occurred).

Landslide

Using scholarly research, Adams County calculated a predictive loss estimate stemming from erosion. Telles, Guimaraes, Carmela, and Dechen (2011) compiled a meta-analysis of studies that examined the costs of soil erosion. That analysis cited 16 studies in the United

States, and within those studies, researchers reported an on-site average of $182.17 estimated dollars/year loss (per ton of lost soil).

The landslide profile in Section 4.3.8 indicated multiple areas within Adams County where 100,000 tons of erosion occurred within a given year (NRCS PA, 2007). Using the research-derived figure per ton results in a predictive loss estimate of $18,217,000 annually.

Pandemic and Infectious Disease

Losses based on historical health-related incidents are difficult to estimate. According to a study by Molinari et al. (2007), seasonal influenza results in a substantial economic impact, estimated, in part, at $16.3 billion in lost earnings. By population, Adams County represents 0.03% of the United States population. Since seasonal influenza primarily impacts the human population, using Adams County's composition of the U.S. as a multiplier (i.e., 0.0003) and applying it to the potential economic impact, lost earnings in the county could reach $4,829,000 each year (a predictive loss estimate).

Although that number appears high, it equates to approximately $74.67 per year for each person listed by the U.S. Census Bureau as "in civilian labor force" for the county. Public health emergencies rarely affect structures. They affect people, and at times, the operations of critical facilities, businesses, and other community assets.

Subsidence, Sinkhole

To estimate exposures to subsidence and sinkholes, planners dissolved point features of known sinkholes into a shapefile in a GIS database, and then selected building footprints that intersected the newly-created shapefile. This operation yielded seven impacted buildings. Planners then utilized parcel ID numbers to compile aggregated and average exposure values. The seven impacted properties generated a total exposure (i.e., land plus building value) of $16,713,700, with an average of $2,387,671 per property. When extracting the building values out of the total figures, the aggregate exposure is $11,309,300, with an average of $1,615,614 per structure.

Tornado, Wind Storm

NCEI storm event records enable historical, per-incident loss estimates for both severe wind events and tornadoes. The 17 wind events occurring between 1999 and 2019 resulted in a reported $60,450 property damage and $1,000 crop damage. The average property damage per severe wind event was $3,555.

Further, Adams County experienced 16 tornadoes between 1951 and 2005, and these events resulted in combined estimated property damage of $357,500. The historic tornadoes in the county accounted for an average of $22,300 per incident.

Wildfire

Adams County compiled a predictive loss estimate for wildfires based on National Interagency Fire Center (2019) data alongside the Pennsylvania Department of Conservation and Natural Resources (DCNR) data. According to the DCNR, 1,590 fires burned 5,201.9 acres in Region 1 (which includes all of Adams County) between 1979 and 2018. The average annual number of fires in this region was 39.75, with an average acreage of 130. Further, the National Interagency Fire Center notes that firefighters may incur an average of $203 worth of suppression costs (based on federal agency expenditures – i.e., forest service, department of interior agencies, etc.) per acre burned. Based on the Pennsylvania DCNR figures, Region 1 could expect to incur $26,390 of losses per fire and $1,049,000 per year.

Winter Storm

Like the other severe weather hazards presented in this plan, historical data from the National Centers for Environmental Information enable the calculation of historical, per-incident loss estimates. Adams County experienced 62 winter weather events between 1996 and 2019. These incidents (combined) yielded a reported $7,000 in property damage. The incidents suggest an average of $113 in property losses per incident, which is likely too low to be useful. Within the data, one incident accounted for $5,000 of the losses, while another incident accounted for the remaining $2,000. Using these figures across two incidents, a more accurate winter weather historical loss estimate would be $3,500 per incident.

Dam Failure

The Stanford University National Performance of Dams Program (NPDP) reports 92 dam-related incidents in Pennsylvania with an associated “total economic loss” of $209,325,000 (combined). These figures suggest an average historical, per-incident loss of $23,258,333. (Note: of the 92 incidents, nine had accompanying economic loss figures. Of those nine, five were $0.00.)

Environmental Hazards: Hazardous Materials Release

The U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) provides loss data for some incidents. The Adams County PHMSA data included 28 incidents that occurred between 2000 and 2019; 12 (42.86%) incidents included reported "damages." Those reported damages were $208,421, or an average of $17,370 per incident. Another perspective on these estimated losses would be an average of approximately $10,970 per year.

Nuclear Incidents

Estimating losses from nuclear incidents has notoriously been difficult. Specifically, scholars have conducted significant research on the 1979 Three Mile Island incident that serves as perhaps the best historical loss estimates for the Adams County area. "Losses" in these studies have ranged from direct dollar losses to social and psychological confidence losses in addition to environmental losses. The numbers associated with these estimates vary widely.

For this plan, planners utilized a scholarly article from Sagara, Fujimoto, and Fukuda (1998) that identified the total loss for state and county governments at $90,000. That article further identified one state government and seven county governments surrounding the plant site. The loss estimate divided by the eight contributing governments yields a historical loss estimate of $11,250 for governmental purposes (i.e., not an economic, environmental, etc. loss).

Terrorism

Adams County focused its terrorism loss estimate on tourism impacts given the risks identified in Section 4.3.17. Enders and Olson wrote, in a study measuring the economic costs of terrorism, that a consistent finding across researching examining the connections between terrorism and tourism is that large countries experience minimal tourism losses from terrorism (2012). Enders and Olson cited a 2003 Sloboda article that estimated total terrorism-related tourism losses in the United States at $56 million between the first Gulf War and 2012. The Enders and Olson article cites a 1992 piece by Enders, Sandler, and Parise that estimated continental Europe's tourism losses from terrorism at 29.6% of a year's worth of tourism revenues.

Though comparing the research-generated figure for continental Europe to local tourism revenues in Adams County could not reasonably be accurate, it does provide a predicted loss that can be helpful to planners. The Gettysburg & Adams County Chamber of Commerce reported that visitors (i.e., tourists) spent $691.2 million in Gettysburg and Adams County in

2016. Calculations using the European estimate yield a potential loss of $204,595,200 in tourism revenues per terrorist event.

Transportation Accidents

PennDOT reported that in 2017, "the economic loss due to traffic crashes was $1,414 to every man, woman, and child in Pennsylvania" (2018, p. 8). Further, that report cited an average cost of $3,278 in property damage per crash. The historical incident data presented in Section 4.3.18 above notes an average of 1,042 crashes per year in Adams County. These figures, then, suggest a predictive loss estimate of $3,415,676 per year.

4.4.4 Future Development and Vulnerability

Understanding the risk Adams County faces from future events is an important consideration of vulnerability. This section examines various demographic and other trends in Adams County to contextualize future risk to the hazards identified later in this plan.

Population

Hazard Mitigation Relevance: People are some of the most important assets in a community. Understanding population trends and concentrations assists in describing current and future vulnerability, as well as in the design of outreach and to target preparedness, response, and mitigation actions. Also, understanding where people reside or visit in a community informs the appropriate locations for mitigation projects (FEMA, 2013).

Adams County's population has steadily increased since 1990. However, the Center for Rural Pennsylvania maintains its classification of Adams County as a "rural" county. The center defines rural as a population density within the area less than the statewide average density of 284 persons per square mile (rural.palegislature.us/demographics_rural_urban.html). Given the Census Bureau's 2018 estimate of 106,541, Adams County's population density is 205 persons per square mile. (Neighboring Cumberland and York Counties are "urban.")

The Adams County Office of Planning and Development expects the county's population to continue a steady increase. Between the 1990 and 2010 decennial Censuses, the population increased by 29.6% (from 78,274 to 101,407). Census estimates for 2018 show a 5.1% increase. The county expects an 18.2% increase through 2040, bringing the county's population to 125,880. Figure 4.4.4-1 presents the office of planning and development's projections.

Figure 4.4.4-1

POPULATION DATA and PROJECTIONS
Municipalities of Adams County, Pennsylvania

	Population					Projections		
	1990	2000	2010	2015 Est.	2018 Est.	2020	2030	2040
Abbottstown	539	905	1,011	1,018	1,023	1,027	1,043	1,128
Arendtsville	693	848	952	952	952	952	956	1,057
Bendersville	560	576	641	651	651	654	692	762
Biglerville	993	1,101	1,200	1,207	1,211	1,214	1,227	1,341
Bonneauville	1,282	1,378	1,800	1,802	1,805	1,806	1,847	2,346
Carroll Valley	1,457	3,291	3,876	3,925	4,006	4,042	4,227	4,789
East Berlin	1,175	1,365	1,521	1,523	1,523	1,524	1,530	1,751
Fairfield	524	486	507	509	511	512	521	577
Gettysburg	7,025	7,490	7,620	7,680	7,688	7,707	7,785	8,258
Littlestown	2,974	3,947	4,434	4,565	4,678	4,745	5,001	5,295
McSherrystown	2,769	2,691	3,038	3,053	3,068	3,076	3,109	3,301
New Oxford	1,617	1,696	1,783	1,792	1,792	1,794	1,804	1,909
York Springs	547	574	833	833	833	833	843	911
TOTAL: Boros	*22,155*	*26,348*	*29,216*	*29,510*	*29,741*	*29,886*	30,586	33,423
Berwick	1,831	1,818	2,389	2,466	2,494	2,524	2,677	3,293
Butler	2,514	2,678	2,567	2,650	2,710	2,750	2,912	3,131
Conewago	4,532	5,709	7,085	7,369	7,645	7,801	8,585	9,511
Cumberland	5,431	5,718	6,162	6,779	6,976	7,201	8,219	8,984
Franklin	4,126	4,590	4,877	4,985	5,045	5,092	5,303	5,839
Freedom	692	844	831	846	851	856	883	975
Germany	1,949	2,269	2,700	2,833	2,905	2,962	3,198	3,588
Hamilton	1,760	2,044	2,530	2,630	2,684	2,726	2,959	3,468
Hamiltonban	1,872	2,216	2,372	2,403	2,430	2,446	2,538	2,862
Highland	815	825	943	968	982	992	1,062	1,232
Huntington	1,989	2,233	2,369	2,417	2,452	2,476	2,599	2,866
Latimore	2,209	2,528	2,580	2,644	2,679	2,706	2,813	3,104
Liberty	938	1,063	1,237	1,278	1,330	1,356	1,483	1,613
Menallen	2,700	2,974	3,515	3,728	3,802	3,882	4,246	4,632
Mount Joy	2,848	3,232	3,670	3,827	3,920	3,990	4,311	4,899
Mount Pleasant	4,076	4,420	4,693	4,938	5,030	5,124	5,550	6,010
Oxford	3,437	4,876	5,517	5,628	6,149	6,324	7,171	6,790
Reading	3,828	5,106	5,780	5,933	6,019	6,085	6,471	7,224
Straban	4,565	4,539	4,928	5,044	5,110	5,161	5,399	5,915
Tyrone	1,829	2,273	2,298	2,343	2,365	2,384	2,478	2,787
Union	2,178	2,989	3,148	3,180	3,222	3,243	3,325	3,734
TOTAL: Twps	*56,119*	*64,944*	*72,191*	*74,890*	*76,800*	*78,081*	84,183	92,457
Adams County	**78,274**	**91,292**	**101,407**	**104,400**	**106,541**	**107,967**	**114,769**	**125,880**

Office of PLANNING and DEVELOPMENT

Source: US Census Bureau Decennial Census;
ACOPD - Estimates March 2019, Projections last revised December 2019

Education, Business Development, Transportation, and Other Development

Hazard Mitigation Relevance

- (Economic and Business Development) Describing economic and business development trends helps to assess dependencies between economic sectors and the infrastructure needed to support them (FEMA, 2013).
- (Transportation) The transportation infrastructure is a key community asset, particularly in the response and recovery phases. Ensuring open arterial routes helps with emergency response, the movement of life-saving (or sustaining) supplies, etc. Identifying key transportation assets and understanding their potential vulnerabilities can inform projects designed to support their continuity in emergencies.
- (Land Use) Land use descriptions inform discussions of risk and vulnerability. For example, flooding may exist as a high risk, but may not correlate with high vulnerability in open or unpopulated forested areas. Further, understanding land use may identify valuable areas where natural features can provide protective functions that reduce the magnitude of hazard events (FEMA, 2013). *Proposed* land uses can inform discussions about the types of assets that future hazard occurrences could impact.

Development in Adams County has centered historically on those areas with abundant transportation access. According to the county's office of planning and development, much of the future land use continues this trend (Explore Adams, https://adamsgis.maps.arcgis.com/apps/MapSeries/index.html?appid=a0194d4c547e4bdfbdf6c16712ee2ef4). The areas at crossroads in boroughs are "mixed-use." Numerous areas near Abbottstown, Bendersville, East Berlin, Gettysburg, Littlestown, McSherrystown, New Oxford, Straban, and York Springs appear as "employment centers," indicating those areas as targeted for general economic development. Areas just east of Gettysburg (toward New Oxford Borough and Oxford Township) are the only areas with anticipated commercial development, owing largely to the crossroads of US 15 and US 30.

The county anticipates residential development in the southern, central, and eastern areas of the county. Medium-low density residential development areas are throughout those areas. Areas of medium density residential development appear along the US 30 corridor as well. Significantly, local officials realize the value of maintaining the rural nature of Adams County. The county's comprehensive plan contains a "growth management plan" that identifies designated growth areas. Many other comprehensive plans in the county reference the county plan and remain consistent with it. Growth areas in the eastern portions of the county focus on the Boroughs of Abbottstown, Bonneauville, East Berlin, Littlestown, McSherrystown, and New Oxford, and include portions of Berwick, Conewago, Germany, Hamilton, Mount Pleasant, Oxford, Reading, and Union Townships. Other smaller growth areas are in the Hampton area, at SR 94 and SR 394; in the Green Springs area east of SR 94 near the county line at Hanover; and Lake Meade.

Growth in the central portion of the county emanates outward from the Gettysburg area, with additional development associated with York Springs and several interchanges along US

15. Development near Gettysburg includes the US 15-US 30 interchange and Lake Heritage areas, with smaller growth areas at US 15/Bus 15 at Fairplay south of Gettysburg; at the Black Horse area west of the borough and north of SR 116; near Mummasburg northwest of Gettysburg Borough; and in the Hunterstown area (at the SR 394/US 15 interchange). Growth areas near Gettysburg include portions of Cumberland, Franklin, Freedom, Highland, Mount Joy, Mount Pleasant, and Straban Townships. Growth in the York Springs/SR 234 interchange area includes parts of Huntington, Latimore, and Tyrone Townships.

The western portions of the county will likely see growth in and near the boroughs, primarily in Carroll Valley, with less growth in the Arendtsville, Bendersville, Biglerville, and Fairfield areas. The office of planning and development also identified small growth areas in Hamiltonban, Highland, and Liberty Townships.

Various municipalities maintain seven other comprehensive plans. Table 4.4.4-2 highlights goals, tools, and overlaps with the county's plan.

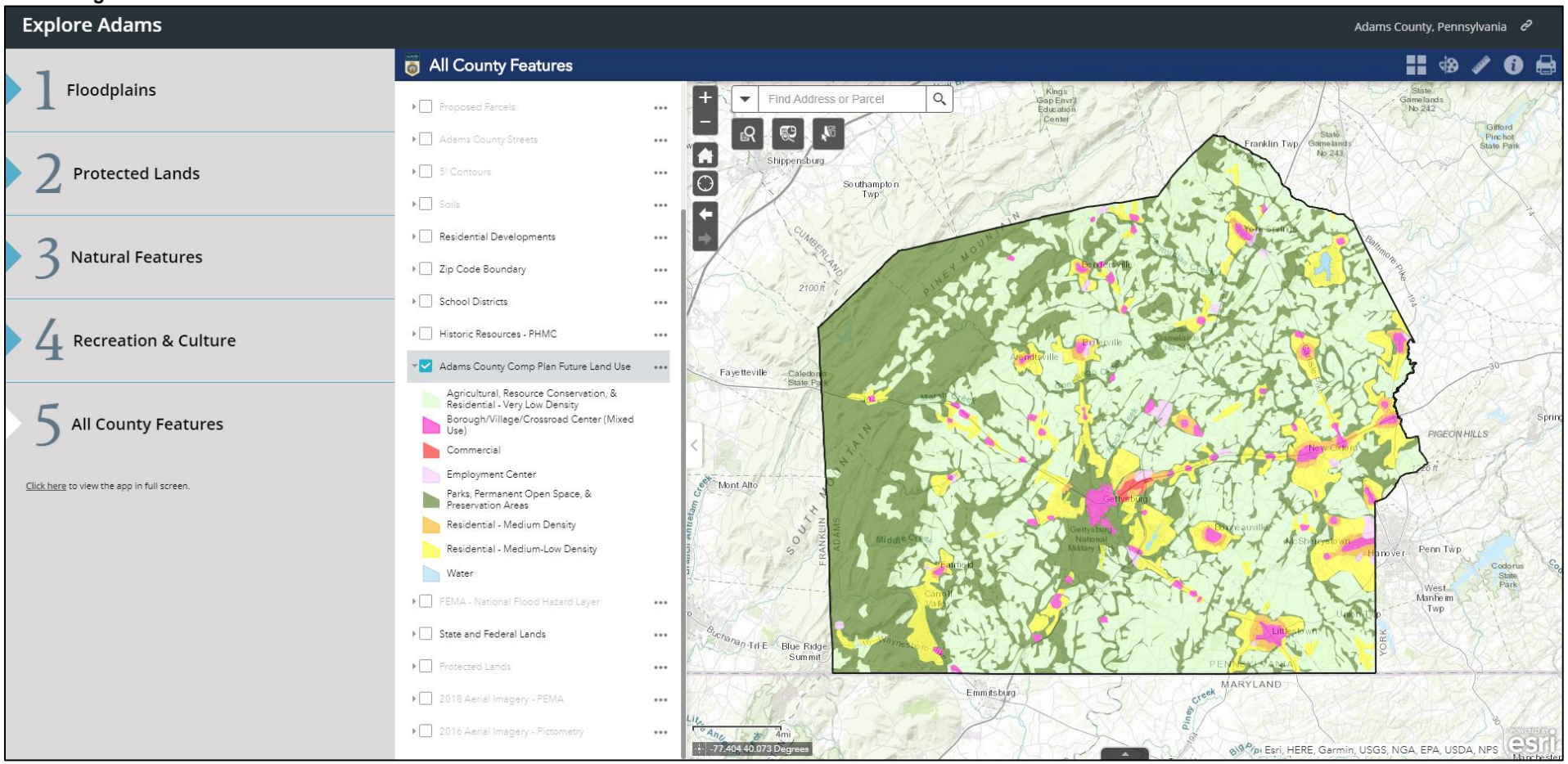
Table 4.4.4-2

OTHER COMPREHENSIVE PLANNING CONSIDERATIONS		
Plan (and Municipalities)	*Year Adopted*	*Goals, Tools, Overlaps*
Bonneauville-Mount Pleasant Joint Comprehensive Plan (Bonneauville Borough, Mount Pleasant Township)	2003	• Transfer of development rights program proposed to incentivize private developers to preserve farmland • Land use plan categories to direct development: public recreation and battlefield preservation, conservation corridors, agricultural preservation, land conservation • Consider development timing-monitor private sector growth trends to determine if growth areas should be expanded
(The) Borough of Carroll Valley Comprehensive Plan (Carroll Valley Borough)	2012	• Seek to designate areas or corridors within its limits as growth areas, consistent with the county's comprehensive plan • Growth areas evaluated by borough staff, committees, and elected officials to determine if changes to zoning designations, ordinances, rules, or regulations to ensure housing needs can be pursued • Evaluate the current zoning delineation and corresponding ordinances for areas that require modification to allow for business development
Central Adams Joint Comprehensive Plan (Cumberland Township, Gettysburg Borough, Straban Township)	2018	• Future land use areas depicted on Map B20

OTHER COMPREHENSIVE PLANNING CONSIDERATIONS		
Plan (and Municipalities)	*Year Adopted*	*Goals, Tools, Overlaps*
Conewago Township, Adams County Comprehensive Plan (Conewago Township)	2008	• Seeks to maintain consistency with county planning, particularly regarding east-west transportation corridors, while maintaining rural nature of township • Goals to concentrate development on the edges of towns and villages to ensure utility support
Eastern Adams Joint Comprehensive Plan and Route 194 Corridor Study (Abbottstown Borough, East Berlin Borough, Hamilton Township, New Oxford Borough, Oxford Township, Reading Township)	2012	• Designated growth areas established and included in Map 23 of the plan
Northwest Adams Joint Comprehensive Plan (Arendtsville Borough, Bendersville Borough, Biglerville Borough, Butler Township, Franklin Township, Menallen Township)	2010	• Designated growth areas and potential future growth areas established and intended to accommodate most of the region's residential growth in the next 10 to 20 years and shown on the future land use map (Map 9-5) • Growth areas contain 3.681 acres for potential development • Transfer of development rights program proposed to incentivize private developers to preserve farmland
Southeast Adams Joint Comprehensive Plan (Germany Township, Littlestown Borough, Union Township)	2008	• Designated growth areas and potential future growth areas established and shown on the future land use plan • Most growth within the region will occur within the designated growth area, and upon build-out, growth would then be accommodated in the potential future growth area

Figure 4.4.4-3, taken from Explore Adams (ACODP, n.d.), shows these future land use areas.

Figure 4.4.4-3

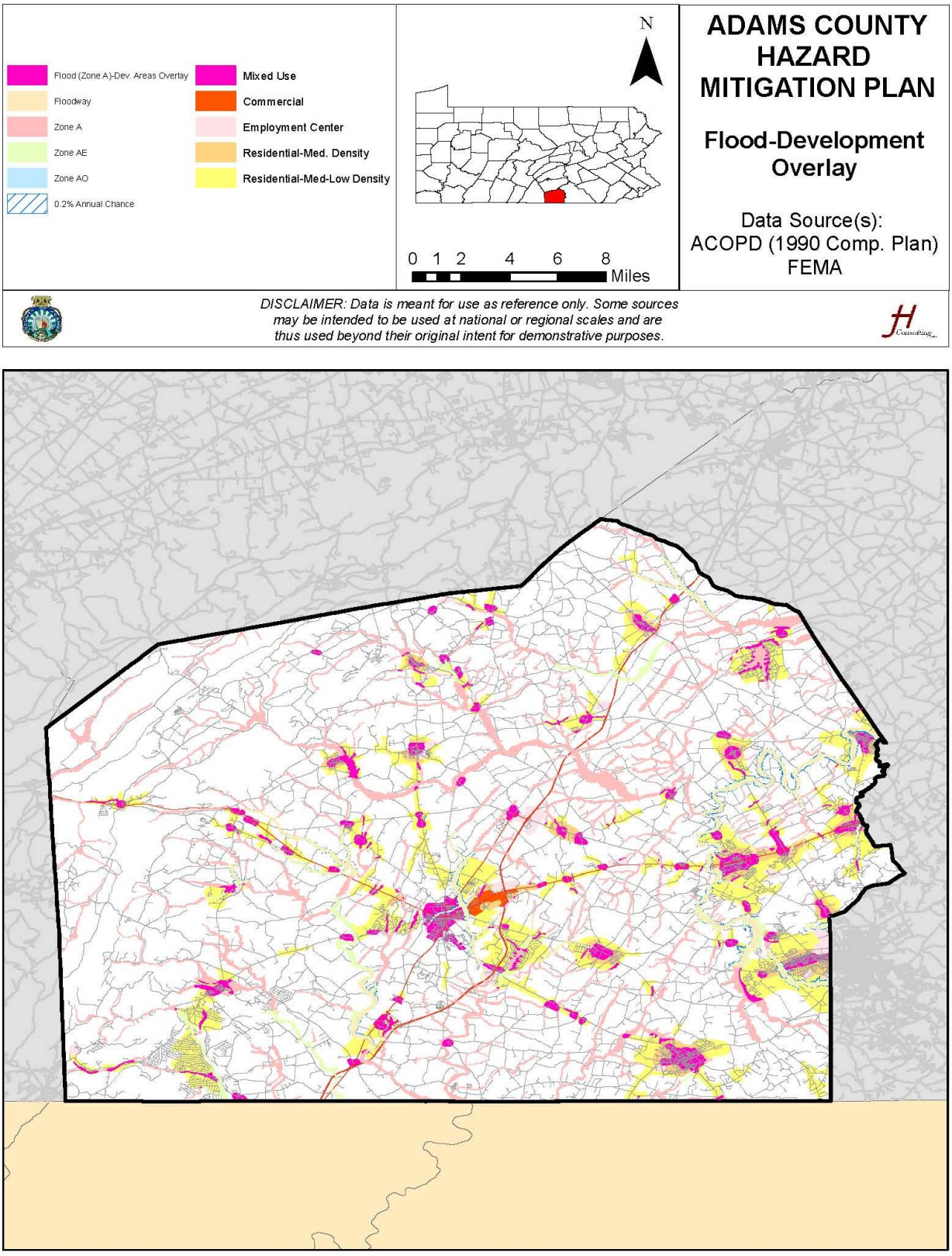

Explore Adams
Adams County, Pennsylvania
1 Floodplains
2 Protected Lands
3 Natural Features
4 Recreation & Culture
5 All County Features
Click here to view the app in full screen.
All County Features
Proposed Parcels
Adams County Streets
5' Contours
Soils
Residential Developments
Zip Code Boundary
School Districts
Historic Resources - PHMC
Adams County Comp Plan Future Land Use
Agricultural, Resource Conservation, & Residential - Very Low Density
Borough/Village/Crossroad Center (Mixed Use)
Commercial
Employment Center
Parks, Permanent Open Space, & Preservation Areas
Residential - Medium Density
Residential - Medium-Low Density
Water
FEMA - National Flood Hazard Layer
State and Federal Lands
Protected Lands
2018 Aerial Imagery - PEMA
2016 Aerial Imagery - Pictometry
Find Address or Parcel
Shippensburg
Southampton Twp
Franklin Twp
Fayetteville
Mont Alto
Gettysburg
Hanover
Penn Twp
West Manheim Twp
Emmitsburg
MARYLAND
PENNSYLVANIA
Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS

Planned Development and Hazard Areas

When planning for new development, this plan suggests that it is vital to consider areas where new development avoids damages from future hazardous events. The following maps identify areas targeted for development cross-referenced with various risk areas per the risk assessment in Section 4.0.

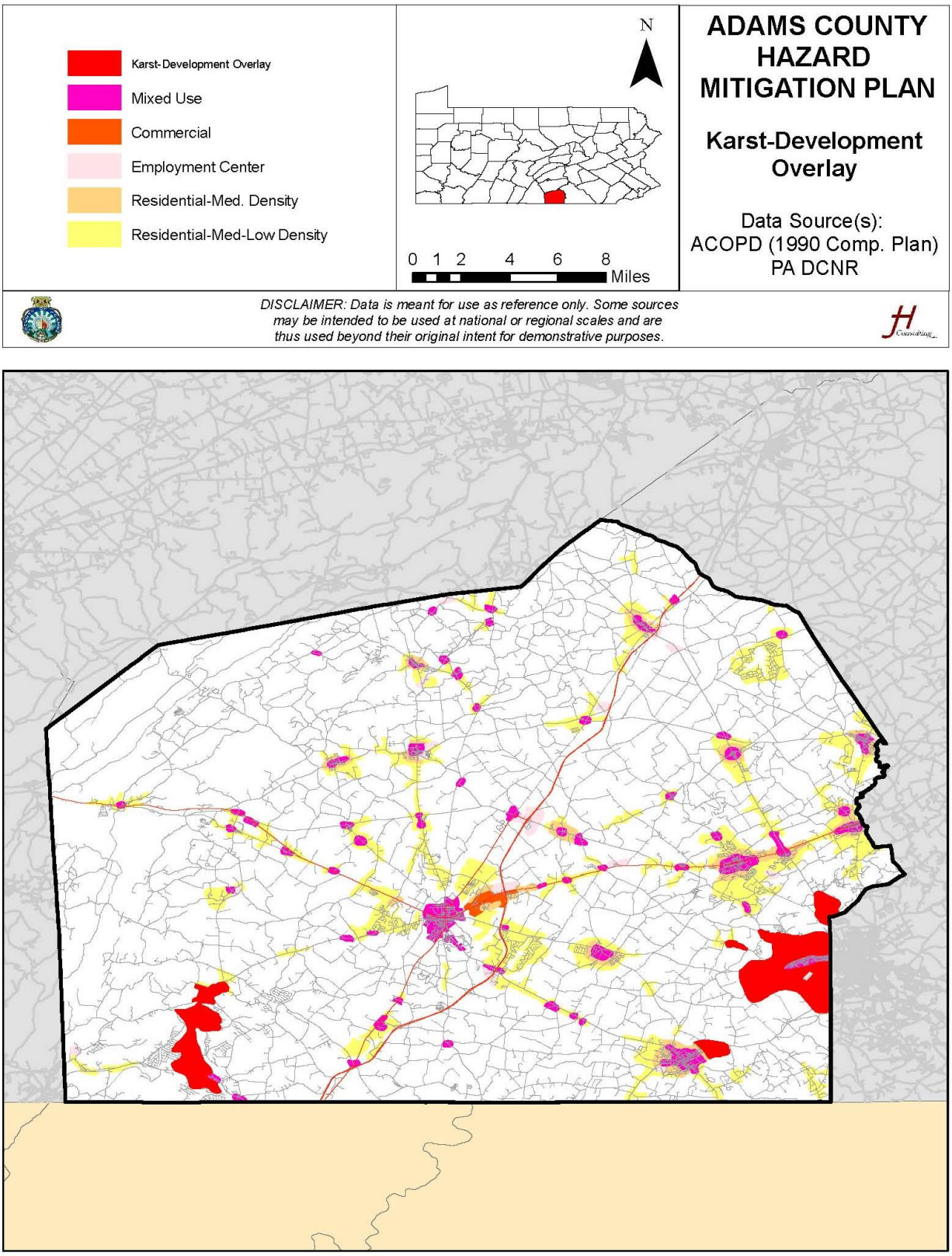
- Figure 4.4.4-4: Flood-Development Overlay
  - This figure shows those areas identified for future development in the 1990 comprehensive plan that intersection Zone A Special Flood Hazard Areas.
  - The primary mitigation action in these areas would be to maintain greenspace in flood-prone areas to the extent possible.
  - If building or upgrading in or near SFHAs, construction of livable or usable spaces about the base flood elevation (subject to local floodplain management ordinances) should be required.
  - Additionally, sharing information on the flooding risk and encouraging resident/employee protective actions in timely fashions can be beneficial.

Figure 4.4.4-4


Flood (Zone A)-Dev. Areas Overlay
Floodway
Zone A
Zone AE
Zone AO
0.2% Annual Chance
Mixed Use
Commercial
Employment Center
Residential-Med. Density
Residential-Med-Low Density
N
0 1 2 4 6 8
Miles
ADAMS COUNTY HAZARD MITIGATION PLAN
Flood-Development Overlay
Data Source(s):
ACOPD (1990 Comp. Plan)
FEMA
DISCLAIMER: Data is meant for use as reference only. Some sources may be intended to be used at national or regional scales and are thus used beyond their original intent for demonstrative purposes.

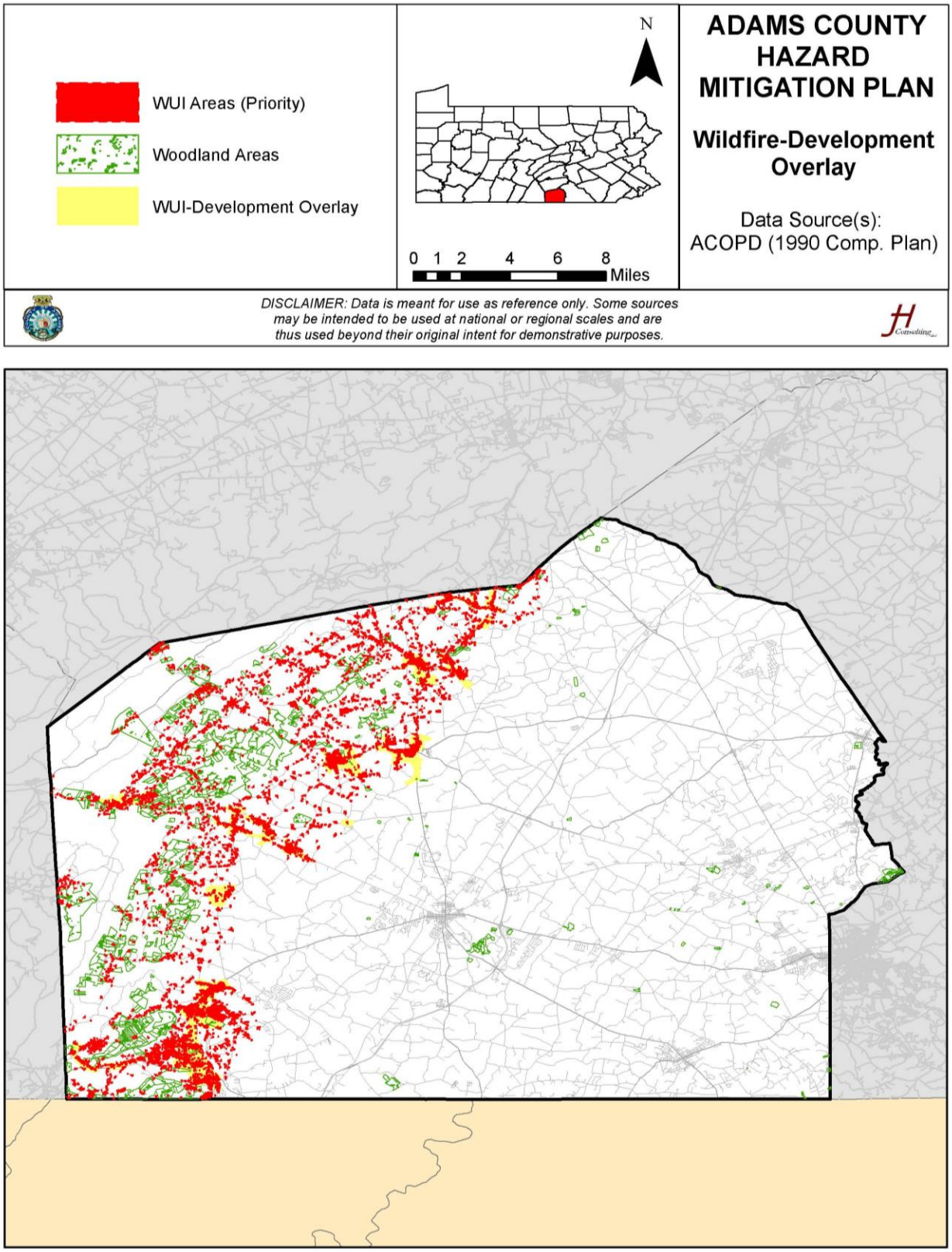
- Figure 4.4.4-5: Karst-Development Overlay
  - This figure shows those areas identified for future development in the 1990 comprehensive plan that lie above known Karst areas.
  - According to FEMA's 2013 booklet outlining mitigation ideas, access to information is a key mitigation strategy for subsidence-prone areas. Municipalities may consider sharing information on structural design ideas that can resist the loading associated with subsidence, etc.

Figure 4.4.4-5


Karst-Development Overlay
Mixed Use
Commercial
Employment Center
Residential-Med. Density
Residential-Med-Low Density
N
0 1 2 4 6 8
Miles
ADAMS COUNTY HAZARD MITIGATION PLAN
Karst-Development Overlay
Data Source(s):
ACOPD (1990 Comp. Plan)
PA DCNR
DISCLAIMER: Data is meant for use as reference only. Some sources may be intended to be used at national or regional scales and are thus used beyond their original intent for demonstrative purposes.

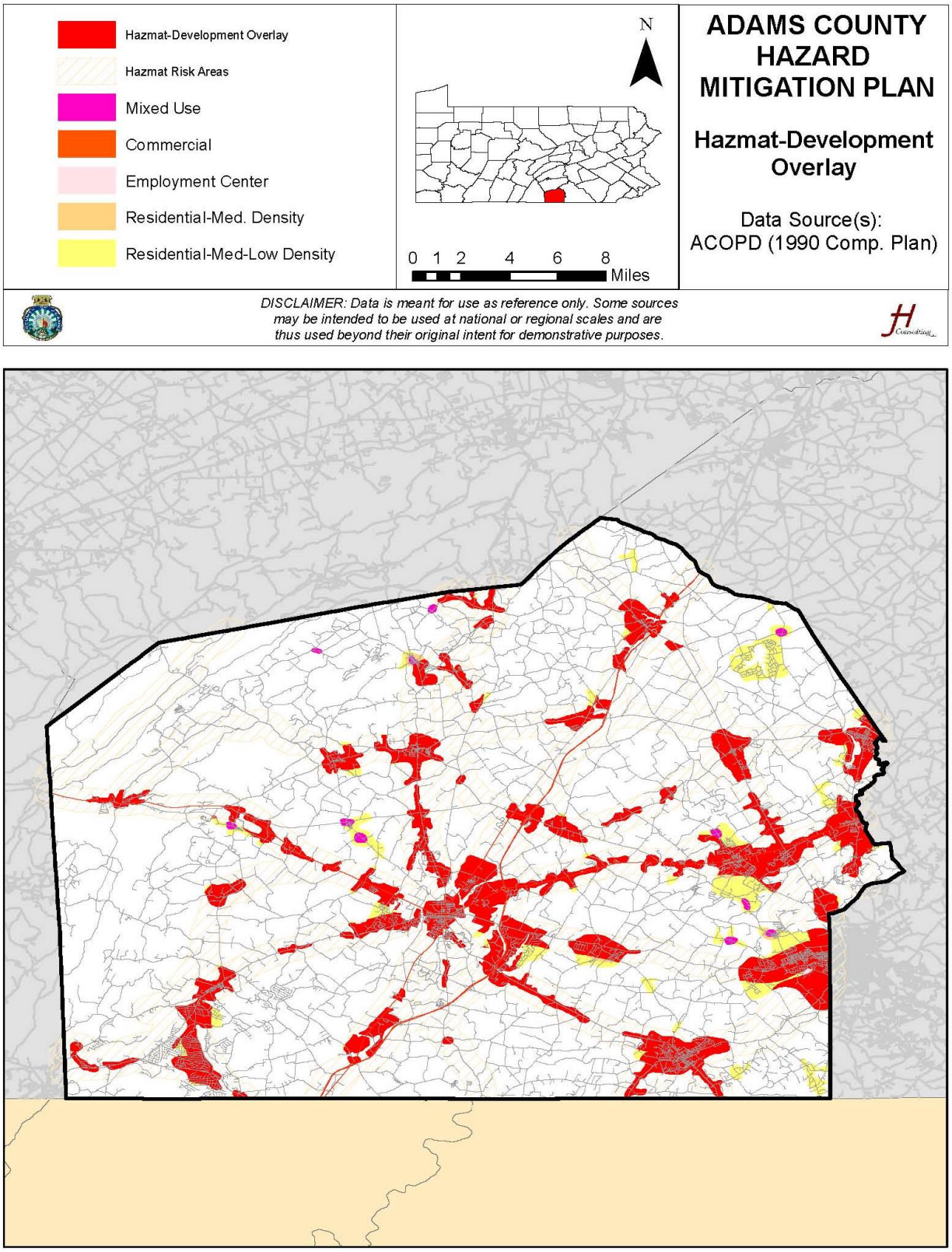
- Figure 4.4.4-6: Wildfire-Development Overlay
  - This figure shows building footprints within 2.4 kilometers (Radeloff et al., 2005) of woodland areas near the Michaux State Forest as well as the areas identified in the 1990 comprehensive plan for future development that surround them.
  - In these areas, municipal officials may consider wildland-urban interface codes that can regulate safer construction, the placement of signage and fire hydrants, vegetation management, etc. Municipalities may also consider participating in Firewise programs.
  - Residents or developers in these areas may use fire-resistant roofing and building materials in remodels, upgrades, and new construction. They may use functional shutters over windows.
  - Further, property owners may manage the vegetation on their properties, including safe disposal of yard and household waste; removing dead/dry leaves, twigs, needles, and other combustibles from roofs; creating a defensible space around structures; etc. (FEMA, 2013).

Figure 4.4.4-6


WUI Areas (Priority)
Woodland Areas
WUI-Development Overlay
N
0 1 2 4 6 8
Miles
ADAMS COUNTY HAZARD MITIGATION PLAN
Wildfire-Development Overlay
Data Source(s):
ACOPD (1990 Comp. Plan)
DISCLAIMER: Data is meant for use as reference only. Some sources may be intended to be used at national or regional scales and are thus used beyond their original intent for demonstrative purposes.

- Figure 4.4.4-7: Hazmat-Development Overlay
  - This figure shows hazardous material risk areas along with the areas identified in the 1990 comprehensive plan as “future development areas” that overlap them.
  - Developers and residents that build in these areas should have a plan to shelter-in-place. They may also find it beneficial to pre-plan an evacuation, to include the location to which they would evacuate (or have their employees evacuate).
  - Relationships with local industries (where fixed facilities are active) and jurisdictional fire departments may also be important to enhance access to early warnings, information on protective measures, etc.

Figure 4.4.4-7


Hazmat-Development Overlay
Hazmat Risk Areas
Mixed Use
Commercial
Employment Center
Residential-Med. Density
Residential-Med-Low Density
N
0 1 2 4 6 8
Miles
ADAMS COUNTY HAZARD MITIGATION PLAN
Hazmat-Development Overlay
Data Source(s):
ACOPD (1990 Comp. Plan)
DISCLAIMER: Data is meant for use as reference only. Some sources may be intended to be used at national or regional scales and are thus used beyond their original intent for demonstrative purposes.

Climate Change and Other Complicating Variables

Direct, calculable consequences of disasters can include fatalities, injuries, and damages to humans, animals, or property. Disasters do not end there; there are several indirect effects, tangible and intangible, associated with them. Some examples of these include loss of livelihood and income, loss of community and population, mental and psychosocial impacts, costs of rebuilding, repair or replacement, loss of inventory, wages and tax revenue, etc. (Coppola, 2015). All of these also have a cost associated with them, but it is much more difficult to assign a specific dollar value and quantify them accurately. For this plan, the primary focus of loss estimates will be the direct consequences of the given hazard.

Countless situations could occur that could result in a disruption to critical systems throughout Adams County. Loosely-related variables often considered *cascading hazards*, can complicate some hazards. For example, high winds may cause sporadic damage, but often do not become a significant countywide concern until a large number of residents are without power. In addition to weather-related power outages, cascading hazards in Adams County could include (but not be limited to) the following.

- Damage to infrastructure (i.e., roads, bridges, pipes, utility poles, etc.) and residences following flooding
- Flooding of downstream or protected areas in the event of a dam or levee failure
- Drinking water supply shortages and contamination following severe and prolonged drought conditions or floods
- Power outages, ruptured gas lines, etc. following earthquakes or severe weather
- Public health concerns following flooding conditions
- Population displacement before, during, or after an event that may be temporary or permanent

The complicating variables related to each hazard often appear in the hazard profiles. The information presented relates to worst-case scenario events; a single event may not always reach all impacts described. It is important, however, to understand that the impacts of hazards go beyond those seen immediately after the event. The effects of one event can last months or even years, especially where public health, social, economic, environmental, and infrastructure impacts are concerned.

Many natural hazards are related to the climate or weather, such as droughts, severe weather, and floods. There is an important distinction between weather and climate. Weather refers to the atmospheric conditions of a geographical region over a short period, such as days

or weeks. Climate, in contrast, refers to the atmospheric conditions of a geographical area over long periods, such as years or even decades (Keller & Devecchio, 2015, pp. 406-407). According to the U.S. Global Change Research Program, there are weather and climate changes already observed in the United States.

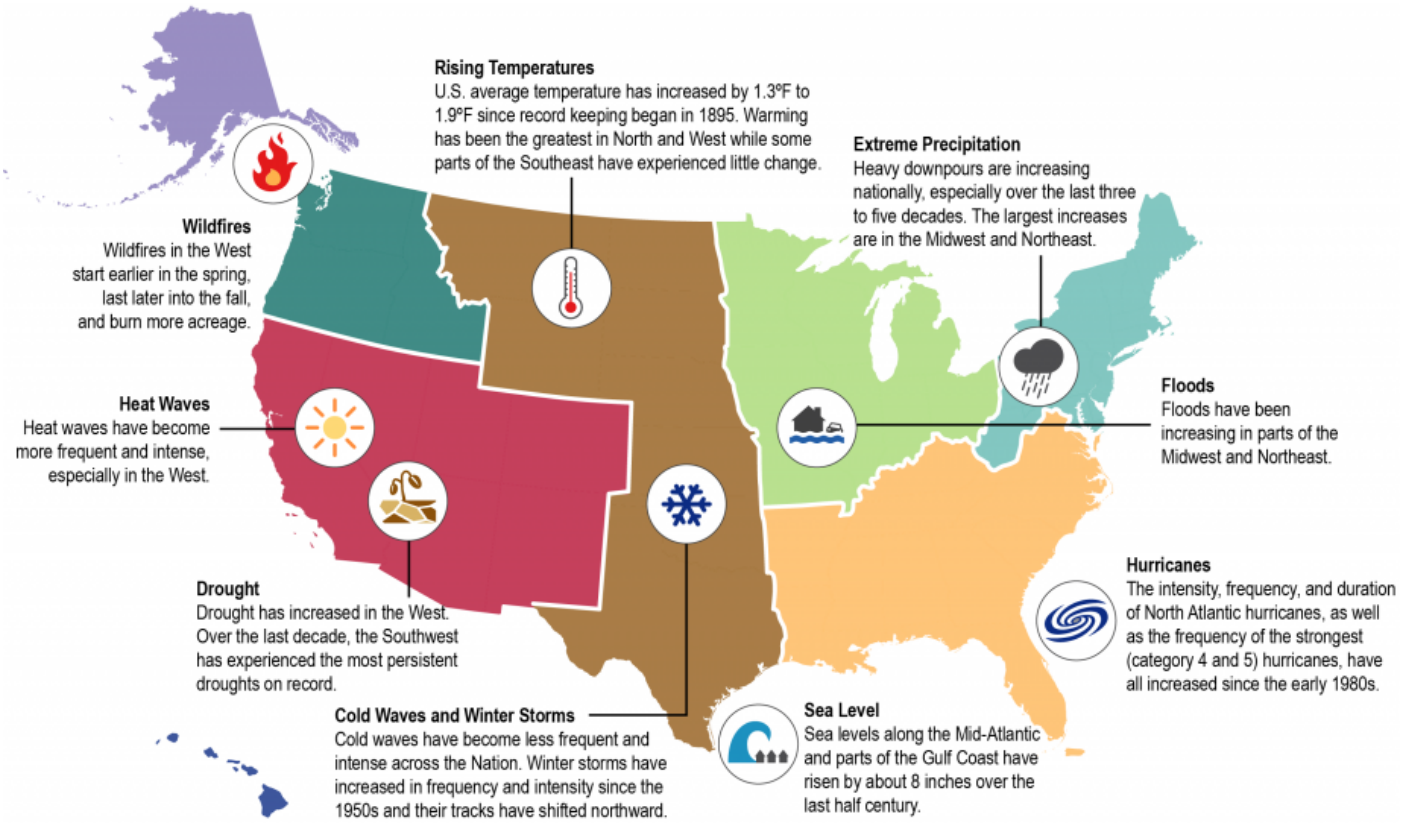
- Since recordkeeping began in 1895, the average U.S. temperature has increased by 1.3°F to 1.9°F, with most of the increase happening since 1970. Also, the first decade of the 2000s was the warmest on record.
- The average precipitation across the U.S. has increased since 1900, with some areas experiencing higher than the national average and some lower. Heavy downpours are increasing, especially over the last 30-50 years.
- Drought events have increased in the west. Changes in precipitation and runoff, combined with changes in consumption and withdrawal, have reduced surface and groundwater supplies in many areas.
- Some types of severe weather events have experienced changes. Heatwaves are more frequent and intense, and cold waves have become less frequent and intense overall.
- The intensity, frequency, and duration of North Atlantic hurricanes have increased since the early 1980s.

Climate change can have a significant impact on human health and the environment. The changes mentioned above can affect the environment by leading to changes in land use, ecosystems, infrastructure conditions, geography, and agricultural production. Extreme heat, poor air quality, reduced food and water supply and quality, changes in infectious agents, and population displacement can lead to public health concerns such as heat-related illnesses, cardiopulmonary illnesses, food, water, and vector-borne diseases and have consequences on mental health and stress (USGCRP, n.d.).

The National Climate Assessment (NCA) defined climate trends for national U.S. regions in 2014. The major trends are:

- wildfires and heat waves on the west coast,
- rising temperatures and increased severity and frequency of winter storms in the middle of the country,
- more rain and flooding in the Midwest and northeastern parts of the country, and
- an increase in sea levels in the mid-Atlantic with an increase of hurricane activity in the southeastern states.

The Intergovernmental Panel on Climate Change (IPCC) largely concurs with the above list (IPCC, n.d.). In Pennsylvania, the trend will likely be an increase in extreme precipitation, as noted in the graphic below.



<u>Public Health, Social Vulnerability, and Other General Vulnerability Indicators</u>

Vulnerability is the "measure of the propensity of an object, area, individual, group, community, country, or other entity to incur the consequences of a hazard" (Coppola, 2015, p. 33). Many aspects contribute to the vulnerability of a society; these can include income disparity, class, race or ethnicity, gender, age, disability, health, and literacy (Thomas & Phillips, 2013, pp. 2-3). Understanding the overall health status of the community is important in determining the vulnerability of the population to any given hazard; emergencies and disaster situations can exacerbate existing medical conditions. Vulnerable populations, populations of concern, or populations at risk are those individuals or groups of people who are more exposed to the risks of the impacts of a hazard because of their age, gender, income, occupation, disability, physical or mental health, literacy, religion, education, or ethnicity.

Some groups face several stressors related to both climate and non-climate factors. For example, people living in impoverished urban or isolated rural areas, floodplains, and other at-risk locations are more vulnerable not only to extreme weather and persistent climate change but also to social and economic stressors. Many of these stressors can occur simultaneously or consecutively. Over time, this accumulation of multiple, complex stressors is expected to become more evident as climate impacts interact with stressors associated with existing mental and physical health conditions and with other socioeconomic and demographic factors. Where appropriate (and where information is available), hazard profiles provide further vulnerability details.