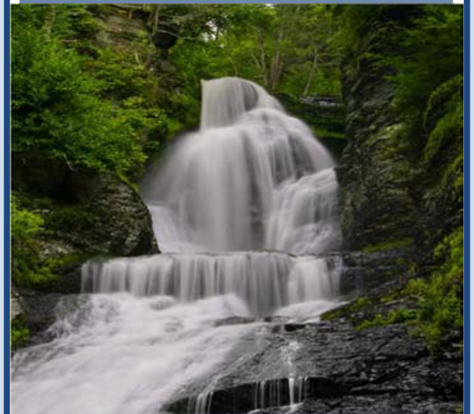
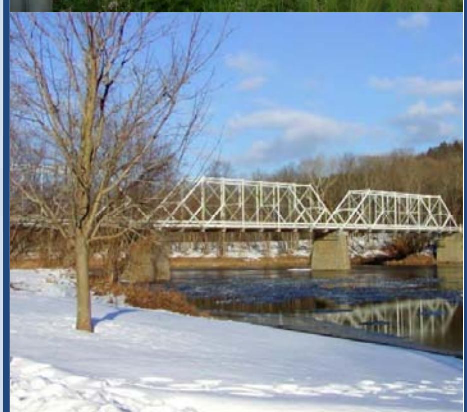
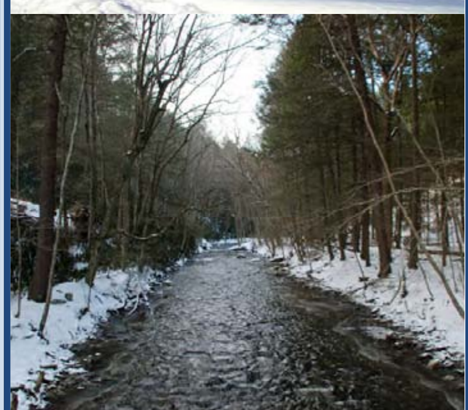



PIKE COUNTY HAZARD MITIGATION PLAN

2017 UPDATE

Prepared for:

Pike County Commissioners
Matthew Osterberg, Chairman
Richard Caridi, Vice-Chair
Steven Guccini, Commissioner

Prepared by:

TETRA TECH

6 Century Drive, Floor 3 | Parsippany, New Jersey

APPENDICES

CERTIFICATION OF ANNUAL REVIEW MEETINGS

The Pike County Hazard Mitigation Steering and Planning Committees have reviewed this Hazard Mitigation Plan (HMP) update. See Section 7 of this document for further details regarding this certification section. The Director of the Pike County Office of Community Planning and HMP Coordinator hereby certifies the review.

Year	Date of Meeting	Public Outreach Addressed?*	Signature
2013	N/A	N/A	To the best of the knowledge of the Pike County Steering Committee, no HMP progress reports were submitted from municipalities for the period of 2013 to 2016 although some mitigation actions were accomplished during this period and reported during the 2017 HMP planning process. Progress on actions is discussed in detail in Section 6.
2014	N/A	N/A	
2015	N/A	N/A	
2016	N/A	N/A	
2017			
2018			
2019			
2020			

** Confirm yes here annually, and describe on record of changes page.*

RECORD OF CHANGES

Date	Description of Change Made, Mitigation Action Completed, or Public Outreach Performed	Change Made By (Print Name)	Change Made By (Signature)
2013-2016	To the best of the knowledge of the Pike County Steering Committee, no HMP progress reports were submitted from municipalities for the period of 2013 to 2016 although some mitigation actions were accomplished during this period and reported during the 2017 HMP planning process. Progress on actions is discussed in detail in Section 6.	N/A	N/A

REMINDER: *Please attach all associated meeting agendas, sign-in sheets, handouts, and minutes.*

SECTION 1 INTRODUCTION

This section presents background information, describes the purpose, and defines the scope of the 2017 update of the Pike County Hazard Mitigation Plan (HMP).

1.1 BACKGROUND

Across the United States, natural and human-caused disasters have led to increasing levels of deaths, injuries, property damage, and interruptions of business and government services. The time, money, and effort spent to recover from these disasters exhausts resources, diverting attention from important public programs and private agendas.

Pike County, Pennsylvania, has experienced a significant number of statewide or County-specific disaster declarations since 1954. The emergency management community, citizens, elected officials, and other stakeholders in Pike County recognize the impact of disasters on their community and concluded that proactive efforts need to be taken to reduce the impact of natural and human-caused hazards.

"Hazard mitigation" describes actions taken to prevent or reduce the long-term risks to life and property caused by a hazard event. Pre-disaster mitigation actions are taken in advance of a hazard event and are essential to breaking the typical disaster cycle of damage, reconstruction, and repeated damage. With careful selection, mitigation actions can be long-term, cost-effective means of reducing the risk of loss.

The Pike County Hazard Mitigation Steering Committee, composed of Pike County and municipal officials, and the Planning Team, composed of Pike County officials, municipal representatives, emergency responders, representatives from state and federal agencies and utility companies, has updated this HMP. Through an open-bid process, Pike County contracted Tetra Tech, Inc. (Tetra Tech), to update the 2012 HMP.

The HMP update is the result of nine months of collaboration between the citizens and officials of the County and representatives from Tetra Tech to develop a pre-disaster, multi-hazard mitigation plan that will guide the County toward greater disaster resistance, while respecting the character and needs of the community.

1.2 PURPOSE

The purpose of this HMP is to minimize the effects that natural, technological, and man-made hazards have on the people, property, environment, and business operations within Pike County. This document exists to provide the background information and rationale for the mitigation actions that the Steering Committee, Planning Team and municipal representatives have chosen to implement across the County.

The document is governed by the Disaster Mitigation Act of 2000 (DMA 2000) and it's implementing regulations (Title 44 Code of Federal Regulations [CFR] §201.6, published February 26, 2002). Local jurisdictions must comply with the DMA 2000 and these regulations to remain eligible for funding and technical assistance from State and federal hazard mitigation programs.

1.3 SCOPE

The implementation actions within this HMP apply to Pike County and any municipalities within the County that adopt this HMP as their own. However, only those municipalities that have participated in the plan update process may adopt this plan and will remain eligible for State and federal hazard mitigation funding through the HMP. For the purpose of this plan, municipal participation was defined as completion and submission of an Evaluation of Identified Hazards Worksheet, Capability Assessment Survey, and Mitigation Strategy 5-Year Plan Review Worksheet and attendance by an official municipal representative at a planning or public meeting conducted as part of the planning process.

SECTION 2 COUNTY PROFILE

This section discusses the geography and environment, community facts, population and demographics, land use and development, and critical facilities in Pike County.

2.1 GEOGRAPHY AND ENVIRONMENT

Pike County is located in the far northeast corner of Pennsylvania (see Figure 2-1). The Delaware River serves as its entire border with New York State to the northeast and with New Jersey to the southeast. Lake Wallenpaupack and Wayne County make up the northwestern border, while Monroe County is at the southwestern border. With its 547 square miles, the county ranks forty-second out of the sixty-seven Commonwealth counties in terms of land mass.

Approximately 34.5 percent of Pike County is publicly owned. Included in this figure are close to 91,000 acres owned by the Commonwealth of Pennsylvania and over 17,000 acres owned by the Federal Government in the Delaware Water Gap National Recreation Area and a small amount (approximately 9 acres) in the Upper Delaware Scenic and Recreational River Corridor, all located within Pike County. These Federal properties are located along the Delaware River and are managed by the U.S. Department of Interior's National Park Service.

The County's location along the Upper Delaware River Corridor and the location of the Lackawaxen River, a major Delaware tributary which flows through the northern part of the County in Lackawaxen Township, both play a significant role in the Pike County's Hazard Mitigation planning efforts. Additionally, the County's strategic location near to the metropolitan centers in nearby New York and New Jersey also impact the human-made and societal hazards affecting the County.

All of Pike County's major watersheds are classified as "high quality" or "exceptional value." Pike County's watersheds are depicted in Figure 2-2.

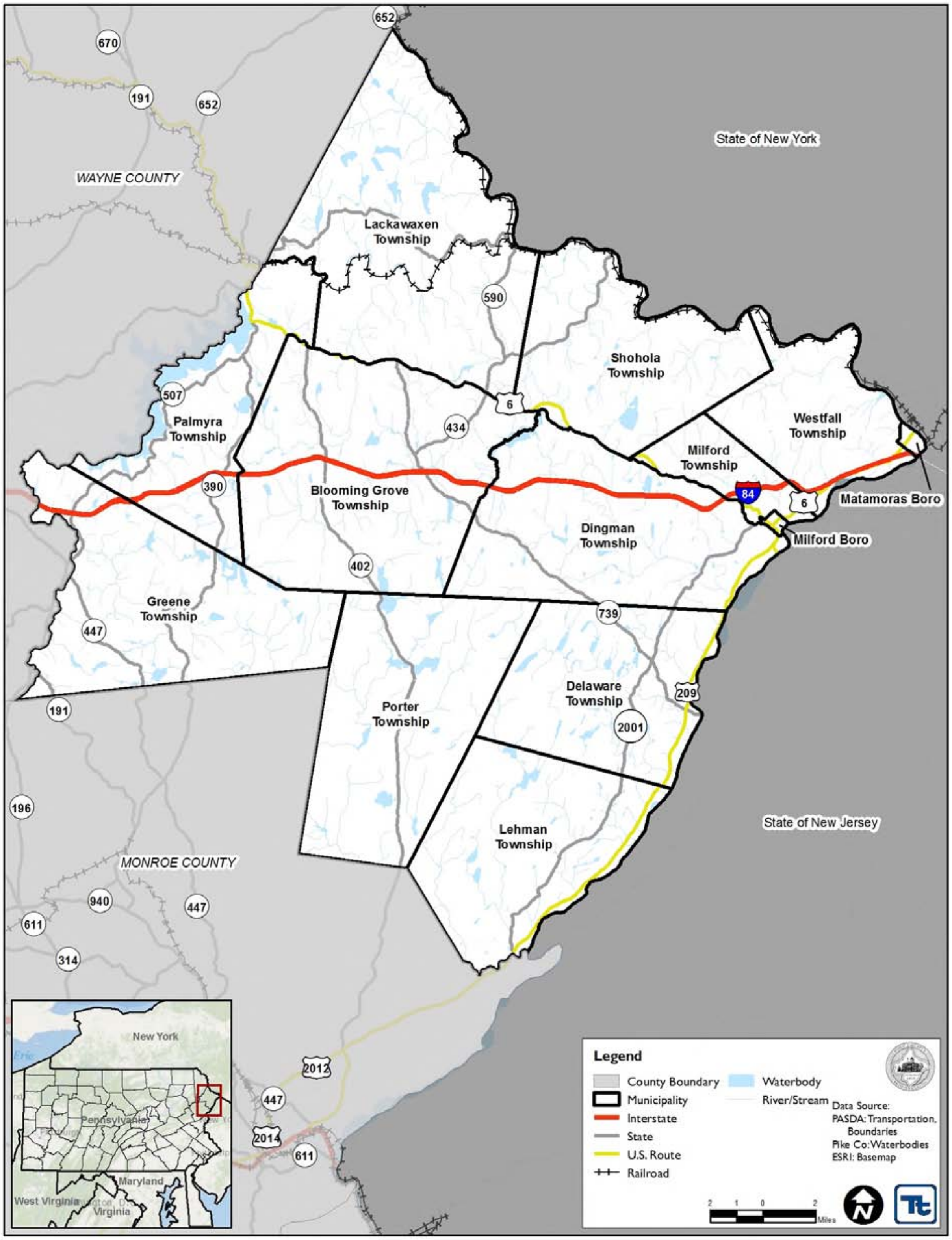
2.2 COMMUNITY FACTS

Pike County formed in 1814 when it separated from Wayne County. The County was named for Zebulon Montgomery Pike, who discovered Pike's Peak. He also was a General killed in the war of 1812. By the Act of April 1, 1836, a portion of Pike County was cut off to form part of Monroe County; otherwise, its boundaries remain as they were established by the Act of 1814. At the time it was formed, it included 5 townships. Today it contains 13 municipalities: Blooming Grove Township, Delaware Township, Dingman Township, Greene Township, Lackawaxen Township, Lehman Township, Matamoras Borough, Milford Borough, Milford Township, Palmyra Township, Porter Township, Shohola Township, and Westfall Township. The County Seat is Milford Borough.

The County's proximity to New York City and location along the Delaware River historically made it an important area for transportation of commodities and resources, particularly timber and stone. Today, recreation is the main industry in the County. With its many lakes, rivers, streams, state game and forest lands and the Delaware Water Gap National Recreation Area, it is estimated that the population of the county often doubles at times during the months from April to October. Hunting, fishing, biking, hiking, nature watching and canoeing are the major recreational attractions to the area.

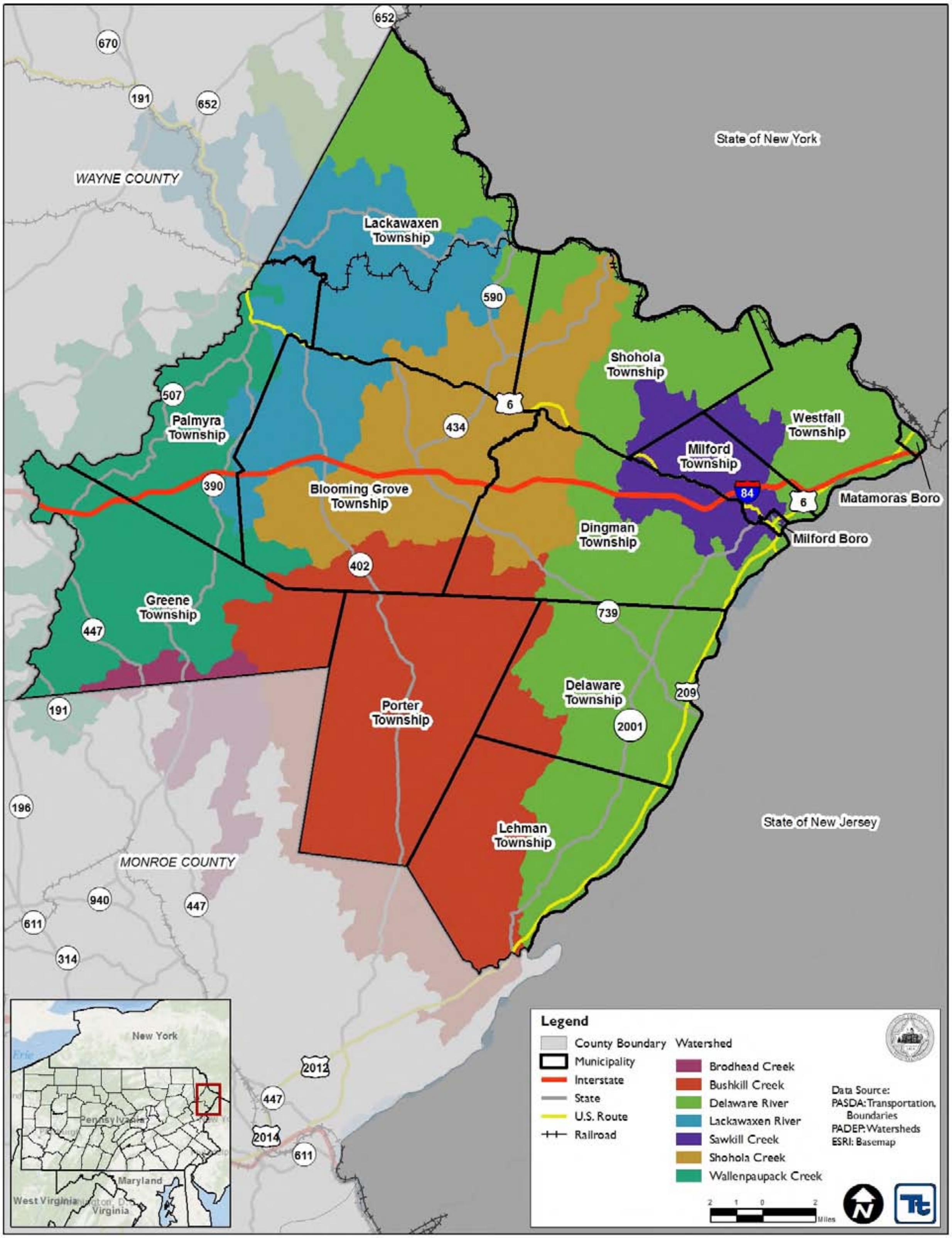
The largest recreation resource in Pike County is Lake Wallenpaupack which was created in 1926 when Pennsylvania Power and Light Company built a hydroelectric plant and dam on the Lackawaxen River. The Delaware River, Lackawaxen River and the large tracts of public land are also major eco-tourism attractions. Major employers in Pike County include school districts, government, and retailers.

Figure 2-1. Base Map of Pike County



Source: Pike County, 2016

Figure 2-2. Major Watersheds in Pike County



Source: PADEP 2011

2.3 POPULATION AND DEMOGRAPHICS

Pike County has been rated as one of the fastest growing Pennsylvania counties for several decades. Between 2000 and 2010 the County experienced a 23.9 percent population increase. This is lower than the population increase of 65.6 percent that took place between 1990 and 2000.

Pike County's increased population has primarily come from the migration of people from New York and New Jersey. The impetus for the migration of people has been the desire for lower home prices, less crime, and more open space. Over 72 percent of the County's workforce commute to jobs outside of Pike County (DCED, 2005). Many are commuting to the New York City / New Jersey metropolitan area.

According to the Pennsylvania Population Projections from the Center for Rural Pennsylvania, the population in Pike County is projected to decrease over the coming decades. Table 2-2 summarizes these projections for Pike County through July 2040.

Table 2-1. Population Projections for Pike County

Jurisdiction	July 1, 2020	July 1, 2030	July 1, 2040
Pike County (Total)	56,192	55,783	54,257

Source: The Center for Rural Pennsylvania, 2014

Changes in population or demographics may be used to identify higher-risk populations. Maintaining up-to-date data on demographics will allow Pike County to better assess magnitudes of hazards and develop more specific mitigation plans and strategies. Baseline demographic information about Pike County is listed in Table 2-2.

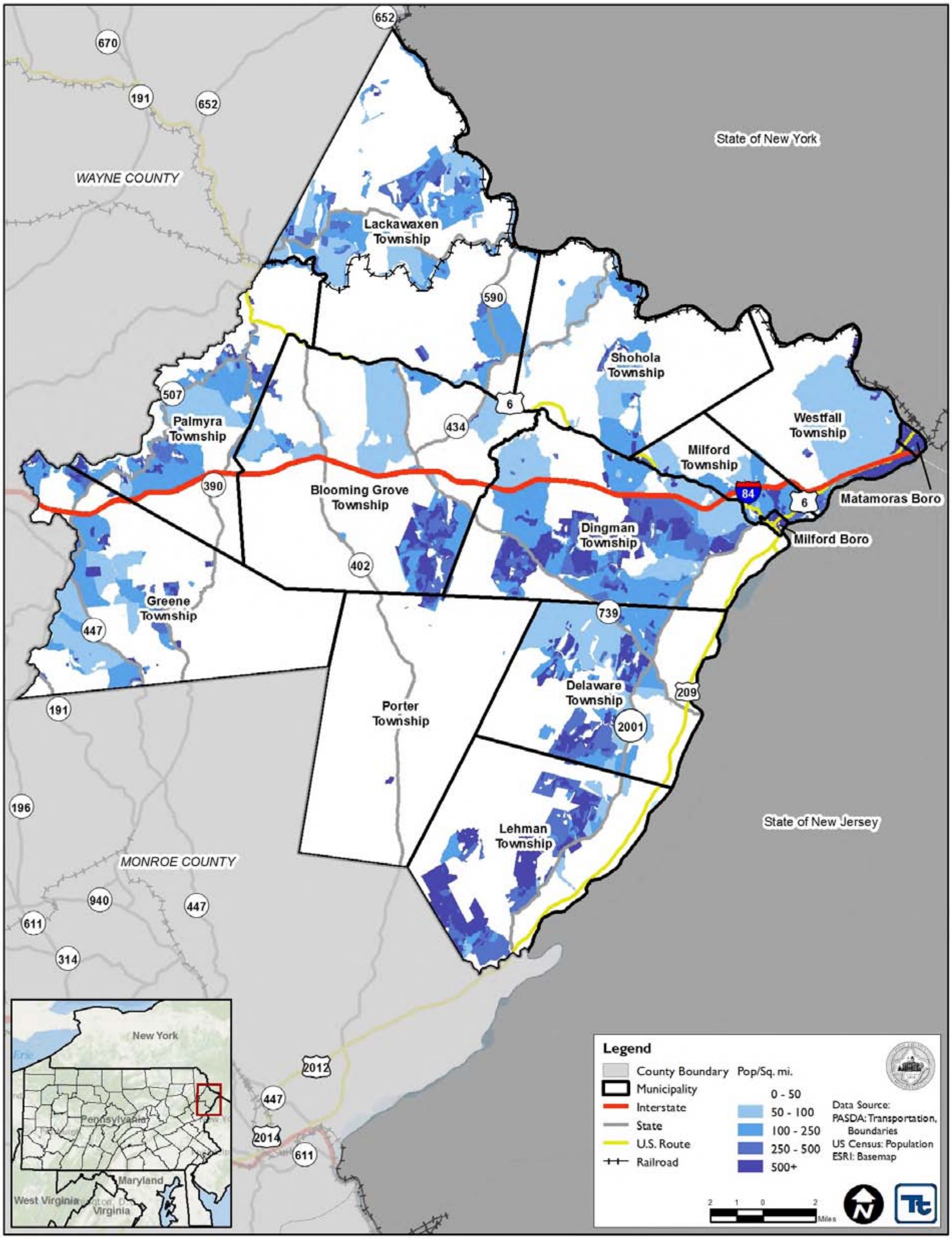
Table 2-2. Demographics

Demographics	2010 Census
Total population	57,369
Male	28,686
Female	28,683
Median age (years)	43.7
Under 5 years	2,823
18 years and over	44,011
65 years and over	9,303
Household population	56,891
Group quarters population	*478*

Source: U.S. Census Bureau 2010, General Population and Housing Characteristics, Pike County

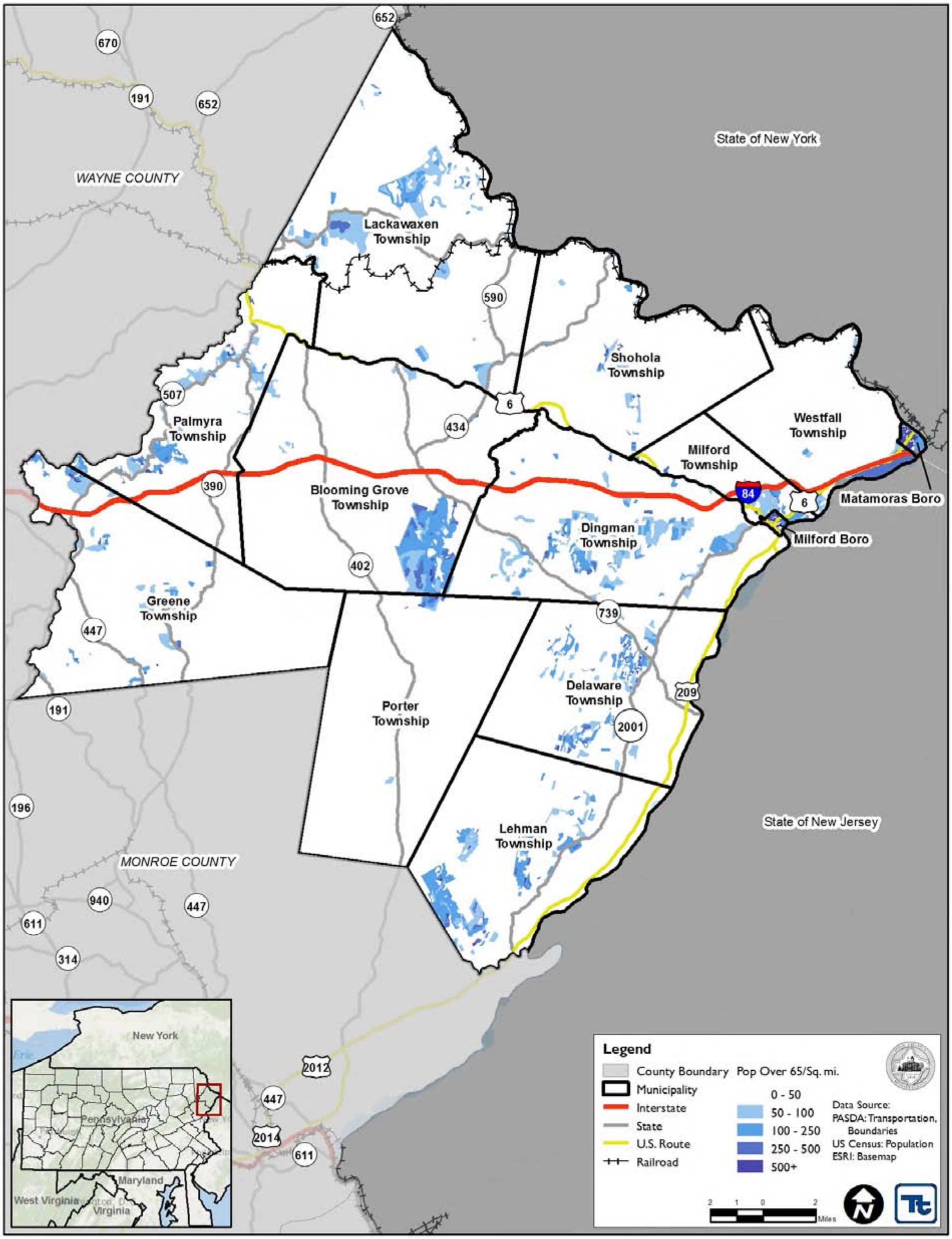
Pike County ranks as the 42nd most populous county in the Commonwealth of Pennsylvania. It has a relatively dense population (101.1 people per square mile [U.S. Census Bureau Quick Facts 2010]). A higher population density means that people are clustered in groups, rather than spread throughout the County. A higher population density facilitates dissemination of information, instructions, and resources to residents; however, centralization of population can also pose challenges, including (1) increased likelihood that a hazard will affect a significant number of people concurrently, (2) more rapid spread of diseases among people in close contact, and (3) more rapid spread of fires among structures located close to each other. Figure 2-3 illustrates population distribution in Pike County based on 2010 U.S. Census data.

Figure 2-3. Pike County 2010 Population Distribution



Source: U.S. Census Bureau 2010

Figure 2-4. Pike County Population Over 65 Years



Source: U.S. Census Bureau 2010; HAZUS-MH 3.1

Table 2-3. Race and Ethnicity

Race and Ethnicity	2010 Census
One race	56,160
White	50,856
Black or African American	3,322
American Indian and Alaska Native	176
Asian	597
Pacific Islander	16
Other	1,193
Two or more races	1,209
Hispanic or Latino	5,173

Source: U.S. Census Bureau 2010, General Population and Housing Characteristics, Pike County

Pike County has 38,482 residential structures. Many properties may be vulnerable to various natural hazards, particularly those located in defined hazard areas. Damage to residential properties is not only costly to repair or rebuild, but devastating to the displaced residents.

According to the U.S. Census, approximately 45 percent of the County's residential properties are vacant; most are due to a large number of second/vacation homes. Vacant buildings are particularly vulnerable to arson and criminal activity. Because vacant properties are not inhabited year round or may not be adequately maintained, many may be structurally deficient and at risk of collapse.

Approximately 15.4 percent of the County's population live in rented homes. Because renters are more transient than homeowners, communicating with renters may be more difficult than communicating with homeowners. Similarly, communicating with tourists would be harder during an emergency event. Refer to Table 2-4 which summarizes housing characteristics of residential properties in Pike County.

This environment presents many challenges for Pike County relevant to hazard mitigation. Currently, the local zoning officers and building inspectors address structural issues when property owners are conducting repairs/renovations. From an emergency management perspective, Pike County Emergency Management Agency maintains the 911 addresses of all structures, conducts outreach and shares information with the private communities, and knows the location of all State cabins in the County (individuals own the cabin but the land is owned by the State; cabins are often vacant throughout the year). Further, local Fire Departments pre-plan their jurisdiction each year to obtain an updated understanding of their residents, full-time/seasonal structures, etc.

Pike County and several municipalities identified new and enhanced communication strategies to ensure these populations receive proper information and notifications. These mitigation actions include and specifically target seasonal population and lakeside communities to increase rapport and educate on hazard mitigation. For example, Pike County Office of Community Planning will attend the Association of Community Association meetings. This association meets monthly to discuss common concerns among and across private communities and presents an opportunity for the County to learn how they may further assist (Section 6, Table 6-4, action PC-02). Porter Township identified a new action to develop a customized communication plan to convey risk in multiple formats due to unique conditions in their community (e.g., poor cell coverage, small off-grid cabins) (Section 6, Table 6-4, action PO-03). Refer to Section 6 (Table 6-4) for further details on the actions identified to utilize multiple outreach formats (e.g., social media, newsletters, and attendance at community association meetings) to further discuss hazard mitigation with all residents.

Table 2-4. Housing Characteristics

Housing Characteristics	2010 Census
Total housing units	38,482
Owner-occupied housing units	17,914
Renter-occupied housing units	3,269
Vacant housing units	17,299
Average household size	2.63
Housing units with a mortgage	12,489
Housing units (owned) without a mortgage	5,425

Source: U.S. Census Bureau

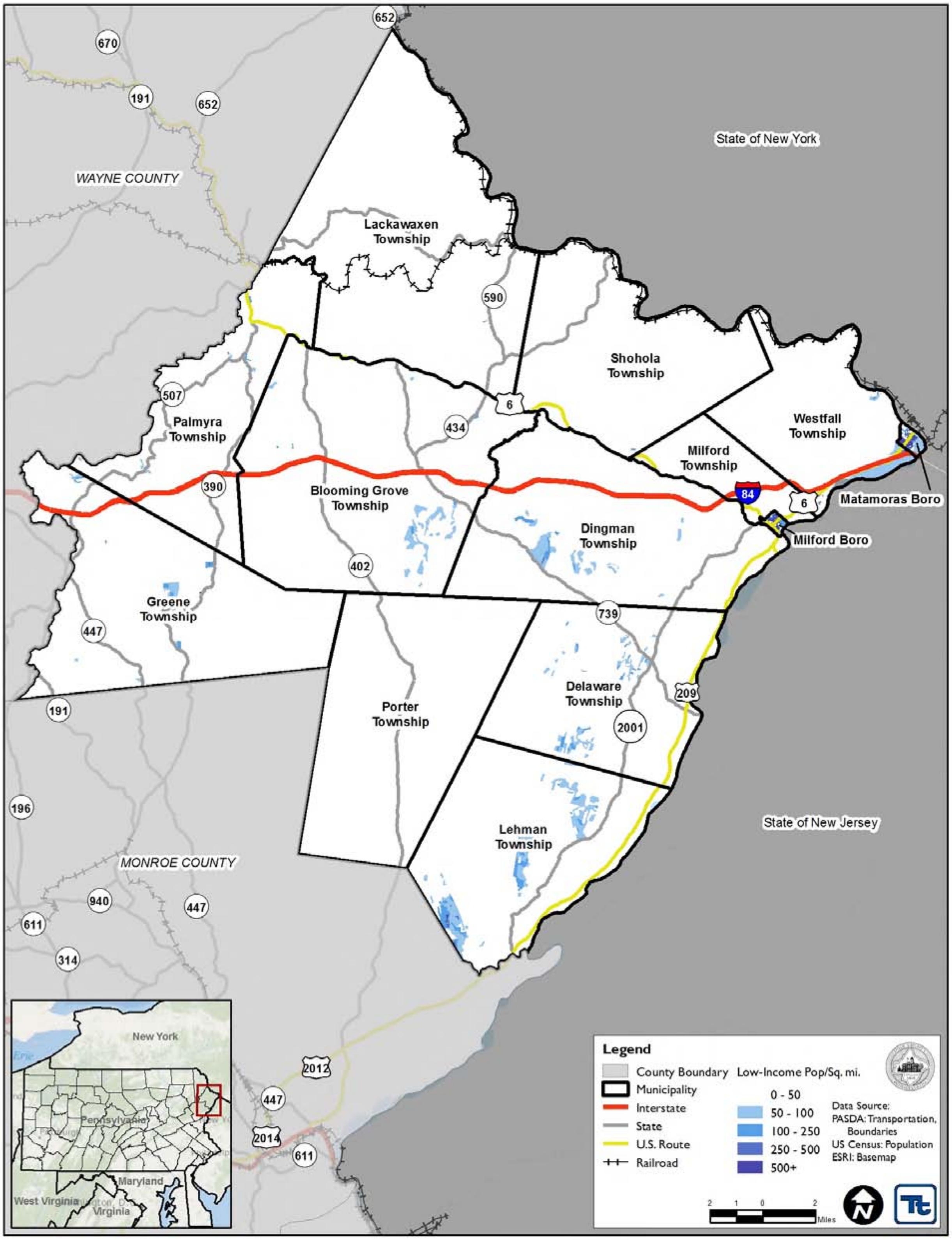
In 2014 (the most current data available), the median household income in the County was $58,906, which was higher than the Commonwealth of Pennsylvania's estimated median household income ($53,115). The County's 2014 estimated per capita income of $27,935 was lower than the Commonwealth's 2013 estimated per capita income of $28,912. Approximately 7.4 percent of families' incomes in Pike County were below poverty level, and 9.8 percent of its individuals' incomes were below poverty level. Emergency responders may have difficulty connecting with individuals within this economic bracket for several reasons, including less access to the Internet within these communities. Additionally, some low-income families and individuals may not own vehicles, and therefore could be a more vulnerable population during an evacuation. Table 2-5 summarizes economic characteristics of Pike County's population and population distribution of residents with incomes below the poverty level.

Table 2-5. Economic Characteristics

Economic Characteristics	2014 Data
Median household income in 2014	$58,906
Median family income in 2014	$68,118
Per capita income in 2014	$27,935
Families below poverty level	7.4%
Individuals below poverty level	9.8%

Source: U.S. Census Bureau Selected Economic Characteristics 2014 American Community Survey 5-Year Estimates, Pike County and Pennsylvania

Figure 2-5. Pike County Population Below the Poverty Level



Source: U.S. Census Bureau 2010; HAZUS-MH 3.1

2.4 LAND USE AND DEVELOPMENT

Pike County's existing land use patterns are greatly influenced and shaped by surrounding natural features such as mountains, valleys, and waterways. These features have largely determined locations of transportation corridors and development activities.

Over 95 percent of Pike County's land cover is undeveloped with almost 89 percent of this total devoted to forest and agricultural land uses (Figure 2-7). In addition, approximately 10 percent of the County is made up of water and wetlands.

Transportation systems within Pike County include highway and rail facilities. The County's highway system is formed around approximately 35 miles of Interstate Route 84. This road runs east to west across the center of the County. Access to I-84 is limited to six interchanges.

The County has become a commuter-shed for metropolitan New York and New Jersey via I-84, Routes 206 and 15, I-80, and mass transit which provide acceptable yet long commutes (Pike County Office of Community Planning, 2006). Most of the County's state routes are in need of repair and/or maintenance and were not designed to handle the increase in traffic volume being generated by the expanded population.

Pike County has identified areas of development in the County (Figure 2-6). The County is positioning these sites for development and will work with municipal, other public, nonprofit, and private-sector partners to plan and pursue these projects. These targeted sites are:

- Pike County Court House
- Delaware Plaza – Delaware Township
- PennDOT 4-4 Building – Blooming Grove Township
- Westfall Senior Apartments (94 units) – Westfall Township

Figure 2-6. Pike County New Development

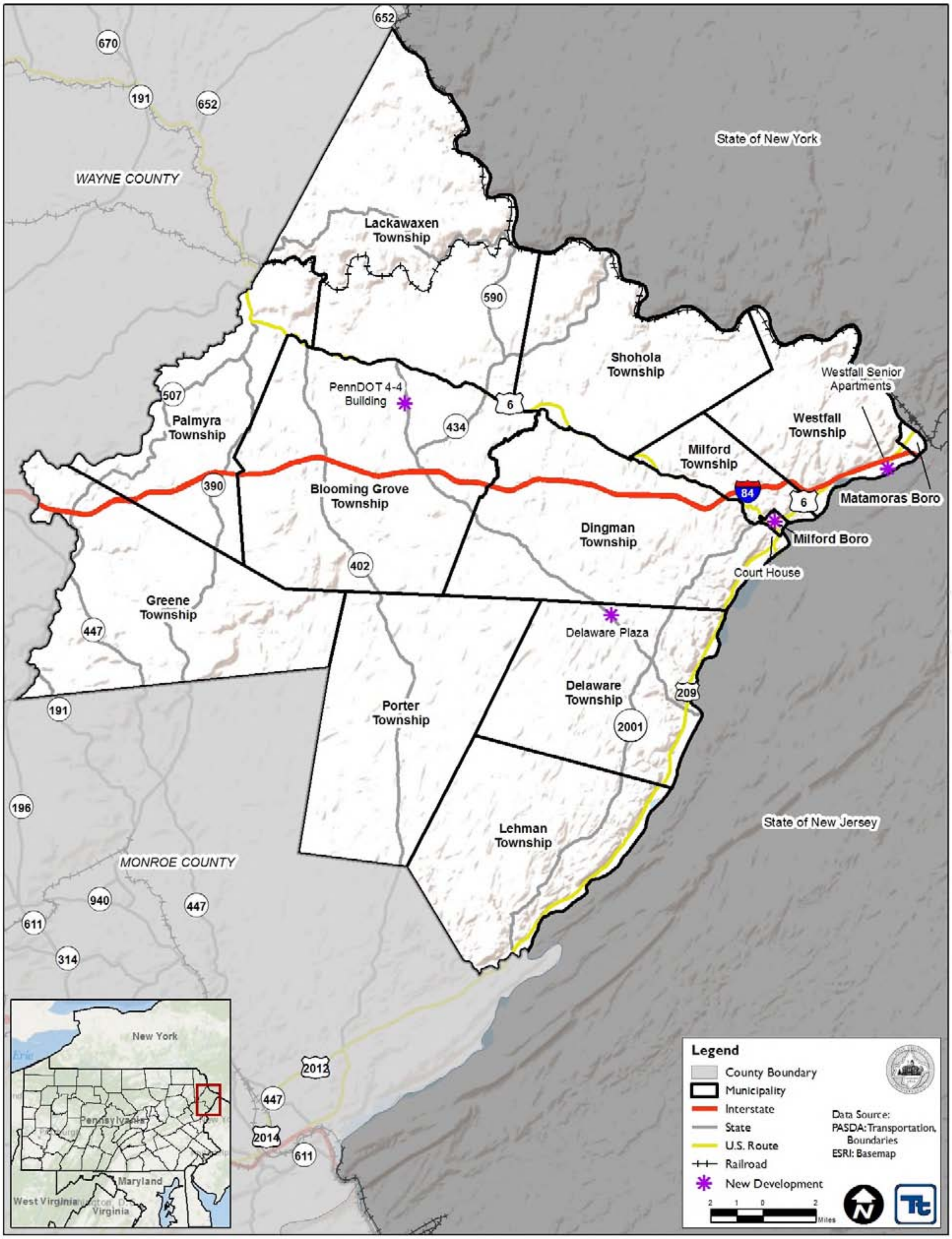
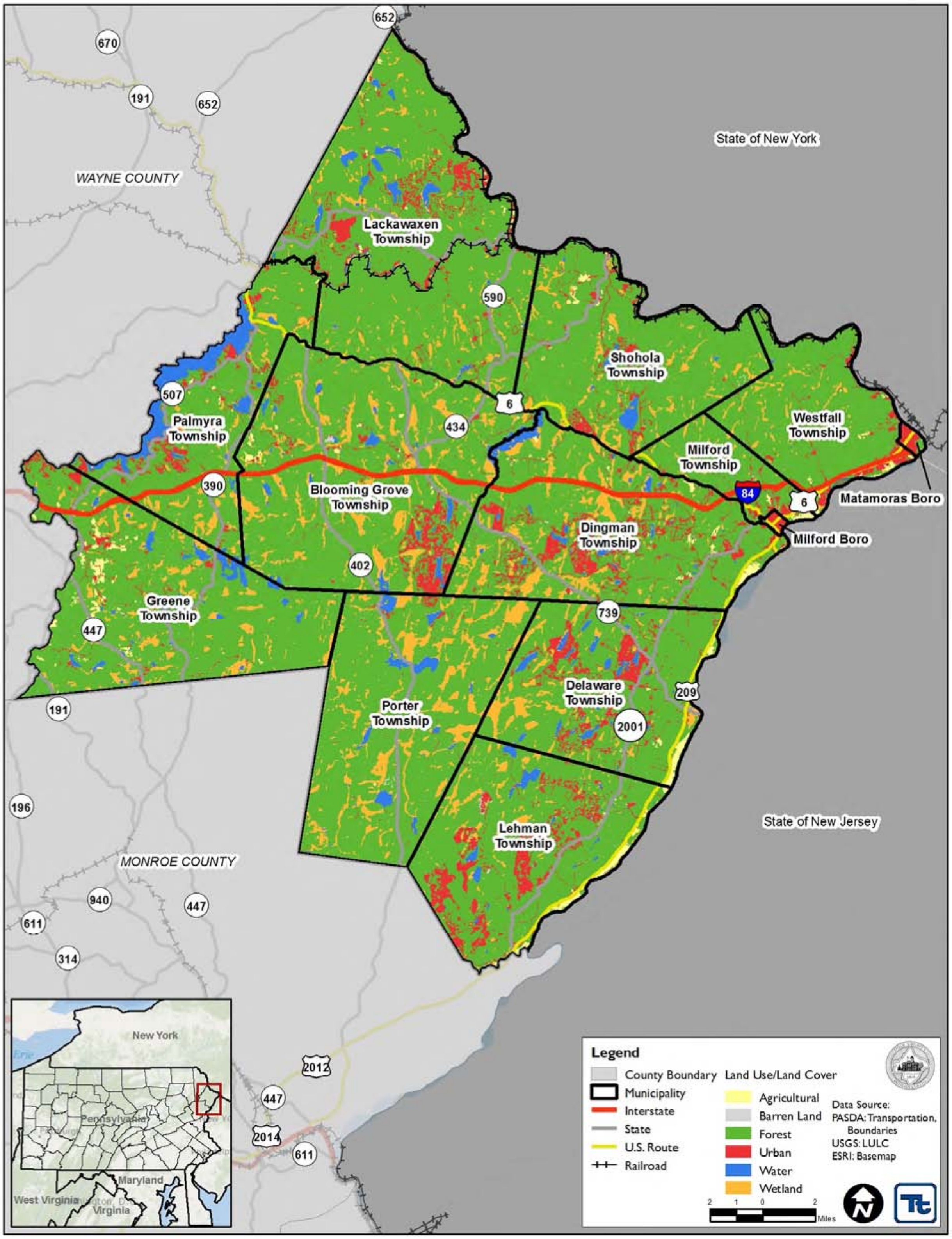


Figure 2-7. Pike County Land Use and Land Cover



Source: USGS National Land Cover Dataset

2.5 CRITICAL FACILITIES

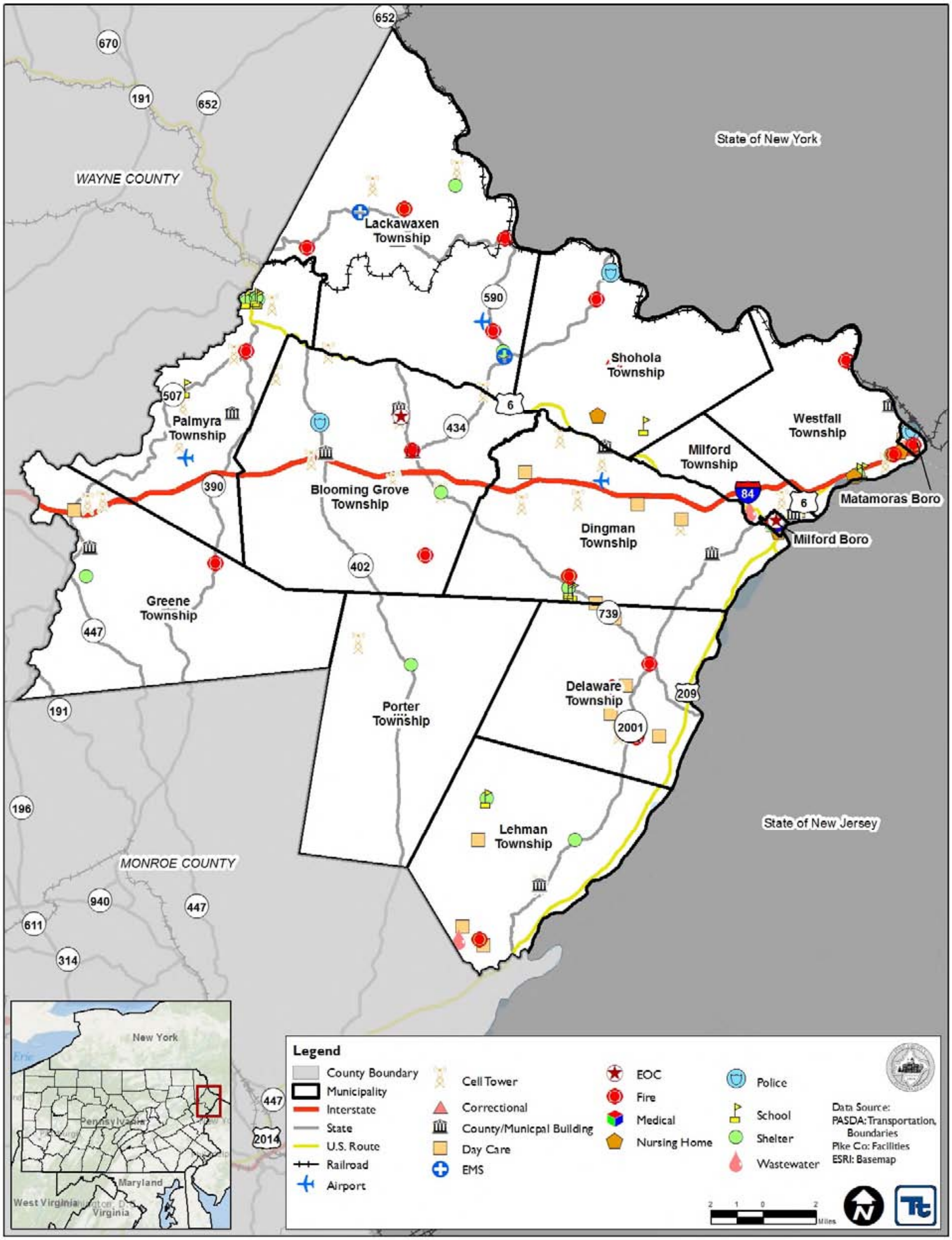
This section describes critical facilities in Pike County, including essential facilities, transportation systems, lifeline utility systems, and high-potential loss facilities. Transportation systems include roadways, bridges, tunnels, airways, and waterways. Lifeline utility systems include potable water, wastewater, oil, natural gas, electric power facilities, and emergency communication systems.

Critical facilities are those facilities considered critical to the health and welfare of the population, and that are especially important following a hazard. As defined for this HMP, critical facilities include essential facilities, transportation systems, lifeline utility systems, and high-potential loss facilities.

Essential facilities are a subset of critical facilities that include those facilities important to ensure full recovery following the occurrence of a hazard event. For the County risk assessment, this category was defined to include police, fire, Emergency Medical Services (EMS), schools, shelters, senior accommodations, and medical facilities.

A comprehensive inventory of critical facilities in the County was developed from various sources including input from representatives of the Steering Committee, Pike County, and participating municipal departments. The inventory of critical facilities presented in this section represents the current state of the effort at the time of publication of this HMP, and was used for the risk assessment presented in Section 4. Figure 2-8 identifies critical facilities and their approximate locations within Pike County.

Figure 2-8 Critical Facilities in Pike County



Source: Pike County, 2016

2.5.1 Essential Facilities

This section provides information on emergency facilities, hospital and medical facilities, shelters, schools, and senior care and living facilities.

Emergency Facilities

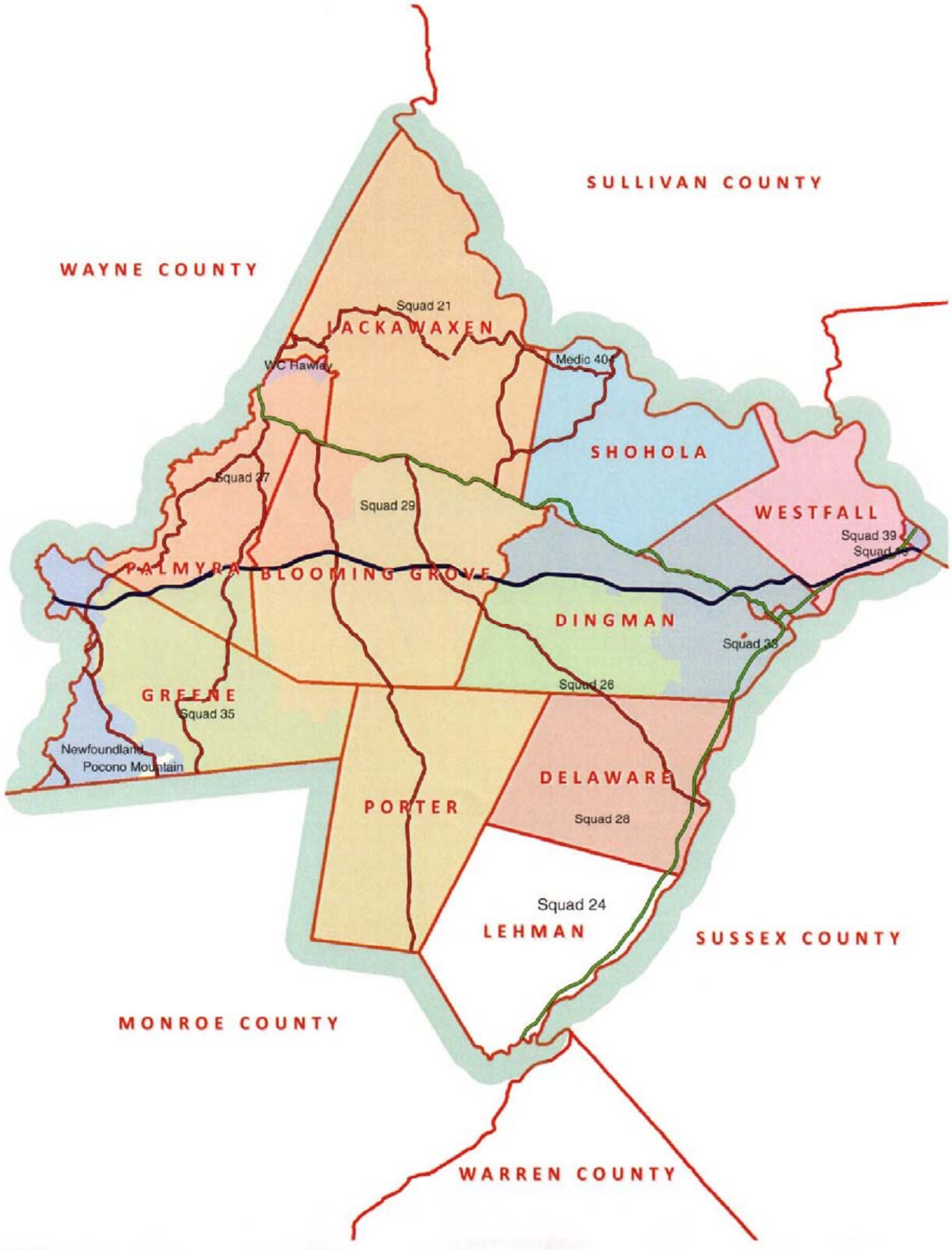
For the purposes of this HMP update, emergency facilities include police, fire, and emergency operation centers (EOC). Table 2-6 lists types of emergency facilities in each municipality and whether they have access to backup power. Figures 2-9 and 2-10 illustrate the EMS and fire facilities and service areas in Pike County.

Table 2-6. Emergency Facilities in Pike County

Municipality	EOC	Fire	Police
Blooming Grove Township	✓		✓*
Delaware Township	✓	✓	
Dingman Township		✓	
Greene Township			
Lackawaxen Township		✓	
Lehman Township		✓	
Matamoras Borough	✓	✓	✓
Milford Borough		✓	✓
Milford Township			
Palmyra Township			
Porter Township			
Shohola Township		✓	✓
Westfall Township	✓	✓	

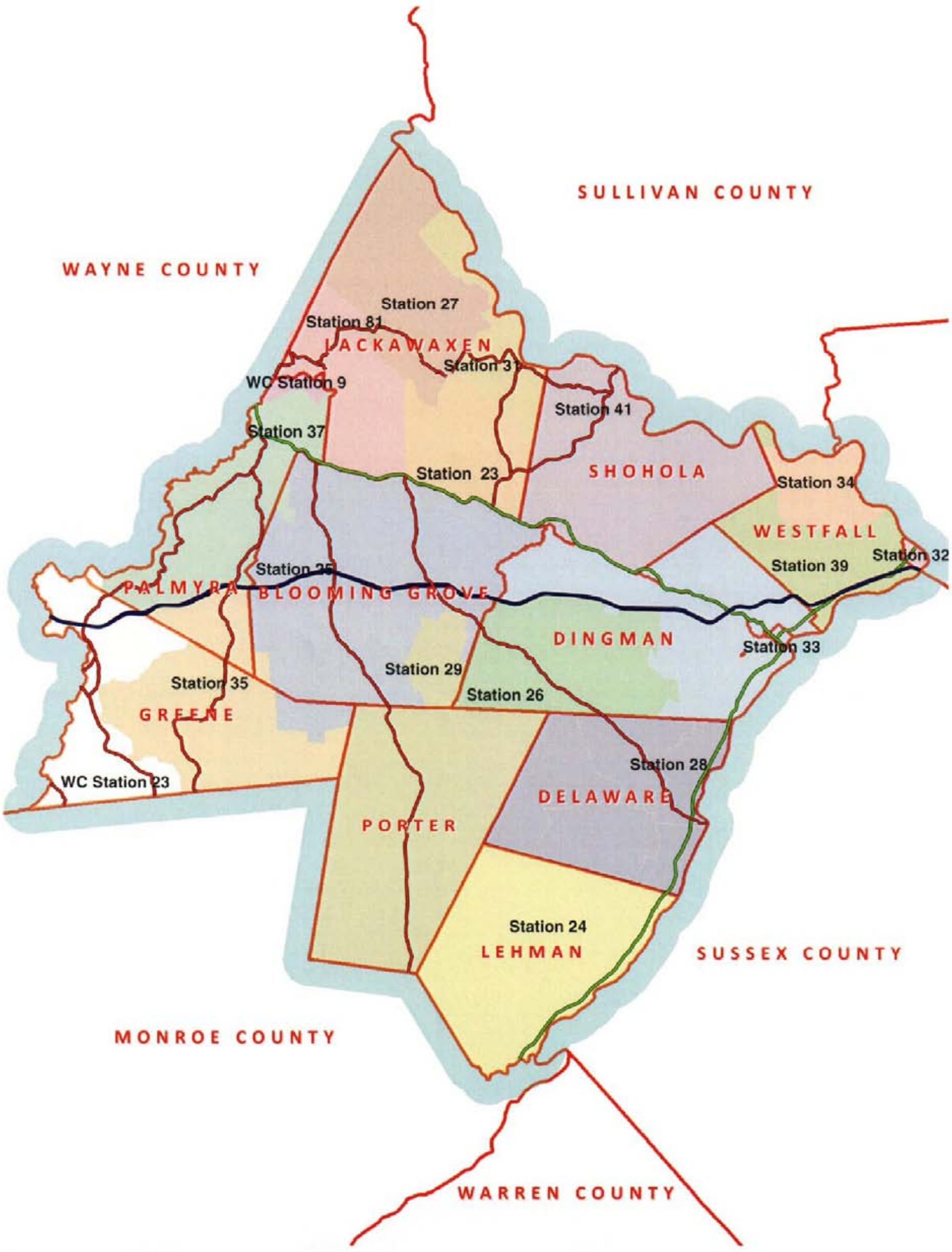
Sources: Pike County 2016
Notes:
Some municipalities may have multiple fire stations (i.e., fire substations). These are indicated on the map of critical facilities
✓ = *Facility is located in the identified municipality.*
✓ = *Facility is located in the identified municipality and has backup power.*
* *State Police*

Figure 2-9. EMS Facilities and Service Area in Pike County



Source: Pike County, 2016

Figure 2-10. Fire Stations and Service Area in Pike County



Source: Pike County, 2016

Hospital and Medical Centers

Table 2-7 below provides an inventory of hospitals and major medical facilities in Pike County. There following lists additional hospitals in the region that residents may access for 24-hour emergency/trauma services:

- Wayne Memorial, Honesdale, Pennsylvania
- Bon Secure Hospital, Port Jervis, New York
- Newton Memorial Hospital, Newton, New Jersey
- Commonwealth Hospital and Moses Taylor Hospital, Scranton, Pennsylvania

Table 2-7. Hospitals and Medical Centers in Pike County

Name	Address	Municipality	# Beds	Building Type	Backup Power
Milford Health and Wellness Center	111 East Catherine Street	Milford Borough	-	Medical Facility	Yes

Source: Pike County 2016
Note: - Data not available

Shelters

Table 2-8 provides an inventory of shelters in Pike County. Many shelters in Pike County are maintained by the American Red Cross (ARC), which coordinates with Pike County Emergency Services during an activation.

Table 2-8. Shelters in Pike County

Name	Address	Municipality	Building. Type	Backup Power	Capacity
Blooming Grove Twp Bldg	488 Rt 739	Blooming Grove Township	Government	Yes	125
Delaware Twp Municipal Bldg	116 Wilson Hill Rd	Delaware Township	Government	Yes	115
American Legion	SR 2001	Dingman Township	Non-profit	No	80
Dingman Delaware Elementary	1355 Rt 739	Dingman Township	School	Yes	700+
Dingman Delaware Primary	1375 Rt 739	Dingman Township	School	Yes	700+
Dingman Twp VFD	680 Log Tavern Rd	Dingman Township	Fire	Yes	125
Hemlock Grove United Methodist Church	491 Romerville Rd	Greene Township	Church	Yes	300
Central Volunteer Fire House	Westcolang Rd off 590 E	Lackawaxen Township	Fire	Yes	125
Greeley VFD	245 Rt 590	Lackawaxen Township	Fire	No	100
Masthope Mountain Community Lodge	196 Karl Hope Blvd	Lackawaxen Township	Community Center	Yes	275
Bushkill Fire House	124 Evergreen Dr	Lehman Township	Fire	Yes	150
East Stroudsburg HS North	HC 12 Box 690	Lehman Township	School	Yes	900+
Pocono Mountain Lake Estates	49 Pocono Mountain Lake Estates	Lehman Township	Community Center	Yes	300
Matamoras Fire Department	6th Ave and Ave Q	Matamoras Borough	Fire	Yes	150
Delaware Valley Elementary*	244 Rt 6 & 209	Matamoras	School	Yes	700+
Milford Fire Station #33	107 W Catharine St	Milford Borough	Fire	Yes	65
Paupack United Methodist Church	Rt 507 Box 335	Palmyra Township	Church	Yes	200

Name	Address	Municipality	Building. Type	Backup Power	Capacity
Wallenpaupack High School	2552 Route 6	Palmyra Township	School	Yes	900+
Wallenpaupack Middle School	139 Atlantic Ave	Palmyra Township	School	Yes	700+
Wallenpaupack North Intermediate School	187 Atlantic Ave	Palmyra Township	School	Yes	700+
Wallenpaupack North Primary School	158 Atlantic Ave	Palmyra Township	School	Yes	700+
Pickerel Inn	Rt 402 and Silver Lake Road	Porter Township	Accommodation	Yes	30
Shohola Elementary School	940 Twin Lakes Road	Shohola Township	School	-	500+
Delaware Valley MS/HS	252 Rt 6	Westfall Township	School	Yes	1,200+
Westfall VFD	101 Mountain Rd	Westfall Township	Fire	Yes	150

Source: Pike County 2016
Notes:
- Data not available
All shelters listed in the table are American Red Cross shelters with the exception of the location names noted with an asterisk (*).

Schools and Institutions of Higher Education

Table 2-9 lists schools and institutions of higher education in Pike County.

Table 2-9. Schools in Pike County

Name	Address	Municipality
Delaware Valley Administrative Office	236 Route 6 & 209	Westfall Township
Delaware Valley High School 11/12	252 Route 6 & 209	Westfall Township
Delaware Valley High School 9/10	256 Route 6 & 209	Westfall Township
Delaware Valley Middle School	258 Route 6 & 209	Westfall Township
Dingman Delaware Elementary School	1355 Route 739	Dingman Township
Dingman-Delaware Middle School	1365 Route 739	Dingman Township
Dingman Delaware Primary School	1375 Route 739	Dingman Township
East Stroudsburg North Campus	911 Bushkill Falls Rd	Lehman Township
Delaware Valley Elementary School	500 Avenue S	Matamoras Borough
Shohola Elementary School	940 Twin Lakes Road	Shohola Township
Wallenpaupack Area High School	2552 US-6	Palmyra Township
Wallenpaupack Area Middle School	139 Atlantic Ave	Palmyra Township
Wallenpaupack Elementary School	187 Atlantic Ave	Palmyra Township

Source: Pike County 2016

Senior Care and Senior Living Facilities

Table 2-10 lists the senior facilities in Pike County.

Table 2-10. Senior Facilities in Pike County

Name	Address	Municipality	Building. Type
Westfall Senior Apartments	Hulst Drive	Matamoras Borough	Nursing Home
Belle Reve Health Care Center	404 East Harford St	Milford Borough	Nursing Home
Twin Cedar's Senior Living	364 Little Walker Rd	Shohola Township	Nursing Home
Alliance Adult Living	1036 Pennsylvania Ave	Westfall Township	Nursing Home
Milford Senior Care & Rehabilitation Ctr	264 Route 6 & 209	Westfall Township	Nursing Home

Source: Pike County

2.5.2 Transportation Systems

This section presents available inventory data regarding roadways, airports, railways, and other public transportation systems in Pike County.

Highway, Roadways, and Associated Systems

Pike County does not have a mass transit system and relies on its roads and highway system to transport residents and visitors to and from the County; over 90 percent of the County's residents rely on an automobile to commute to work. The major roads and highways in the County include, I-84, Route 6, Route 209, Route 6/209, Route 739, Route 507, Route 390, SR 2001, Twin Lakes Road, Silver Lake Road, Log Tavern Road, and Bushkill Falls Road. These roads are all State roads and maintained by PennDOT. The majority of residential development in the County is within private communities, where it is the responsibility of the community to maintain the roadways (Pike County, 2006).

Airports

Airports can fall into two categories: public airports and private airports. Public airports include large commercial airports for major airplane carriers that are open to the public. Private airports are often used for small charter flights and private jets and airplanes. Military airports and restricted land zones are also identified as private airports.

There are no public airports located within Pike County; however, multiple private and international airports are located within the region: Mountain Bay Airport in Palmyra Township, Myer Airfield in Dingman Township, and Boehm Airfield in Lackawaxen Township. Stewart International Airport in Newburgh, NY, Lehigh Valley International Airport in Allentown, PA, Wilkes-Barre/Scranton International Airport in Avoca, PA, and multiple airports in New Jersey and New York also provide domestic and international travel (Pike, 2006).

Railways

Residents of the County have access to rail transit to New York City by way of the Metro-North Railroad from Port Jervis, NY. A Norfolk Southern line passes through the County, which provides interconnections to Binghamton, NY and New York City. The Stourbridge Line from Wayne County also passes through the County, providing limited commercial rail services (Pike, 2006).

Public Transportation

Pike County has a limited public transportation system. This includes taxi and van services, for both the public and senior citizens, and the Shortline Bus Line from Port Jervis, NY, Westfall Township, and Lords Valley, PA (Pike, 2006).

The Pike County Transportation Department has four programs for Pike County residents: Pike County Shared Ride Program; Medical Assistance Transportation Program; People with Disabilities Program; and transportation for the general public. The Shared Ride Program allows seniors of Pike County access to medical, financial and social services. The three senior centers at Blooming Grove, Lackawaxen and Bushkill are serviced. The Medical Assistance Transportation Program allows medical assistance recipients, regardless of age, access to medical and pharmacy needs. The People with Disabilities Program allows individuals 18 to 64 years of age access to the same services as the Shared Ride Program schedule. Pike County is also a participating County with Commuter Services of Pennsylvania.

2.5.3 Lifeline Utility Systems

This section presents potable water, wastewater, and energy resource utility system data. Because of heightened security concerns, only partial local utility lifeline data—sufficient to complete the analysis—have been obtained.

Potable Water Supply

The County relies solely on groundwater from private, community and municipal wells, and springs to meet its water demand (Pike, 2006). There are approximately 8,236 domestic wells in the County (PaGWIS, 2015). There are a few public community water services areas in Pike County; they are identified in Table 2-12.

Table 2-12. Potable Water Supply in Pike County

Facility Name	Address	Service Area	Owner
Matamoras Municipal Water Authority	304 Pennsylvania Ave, Matamoras Borough	Matamoras Borough; Portions of Westfall Township	Authority
Milford Water Authority	151 Old Owego Turnpike, Milford Borough	Milford Borough; Portions of Dingman Township and Milford Township	Authority
Pennsylvania American Water System	Southport Drive, Lehman Township	Westfall Walmart, Milford Landing Development, Staples Plaza	Private
Pennsylvania American Water System		Marcel and Squaw Hollow	

Source: Pike County Comprehensive Plan 2006, Pike County 2016

Wastewater Facilities

One public sewer service is located in Westfall Township. Wastewater facilities in Pike County are identified in Table 2-13.

Table 2-13. Wastewater Facilities in Pike County

Facility Name	Address	Service Area
Westfall Sewage Authority	Westfall Town Drive, Westfall Township	Westfall Township
Delaware Sewer	Wild Acres	Delaware Township
Pennsylvania American Water	Marcel Lakes Estates	Delaware Township

Sources: Pike County 2006, Pike County 2016

Energy Resources

Electric power is provided by three companies in Pike County (refer to Table 2014).

Table 2-14. Electric Service Providers in Pike County

Provider Name	Municipalities Served
Metropolitan Edison Company	Delaware Township, Dingman Township, Lehman Township
Pike County Light and Power	Matamoras Borough, Milford Borough, Milford Township, Westfall Township
Pennsylvania Power and Light - Electric Utilities	Blooming Grove Township, Greene Township, Lackawaxen Township, Palmyra Township, Porter Township, Shohola Township

Refer to Figure 4.3.19-1 (Utility Interruptions) for the location of utility sites, as well as the location of pipelines.

Communication Resources

Residents in Pike County may choose to use Sprint/Embarq, AT&T, Verizon, or other phone carriers for their local telephone and data service needs. PenTeleData is the predominant cable provider for Pike County; otherwise satellite service is available to Pike County residents.

2.5.4 High-Potential Loss Facilities

High-potential loss facilities include military installations, dams, levees, nuclear power plants, and hazardous materials (HAZMAT) facilities. There are no nuclear facilities or military installations located in the County. HAZMAT facilities and dams are described below.

HAZMAT Facilities

Pike County is home to two identified facilities that utilize, ship, or house chemicals considered hazardous. These facilities have been identified under the Superfund Amendments and Reauthorization Act (SARA) as exceeding the quantity threshold for reporting. These facilities are required to comply with regulations set forth by the federal SARA, and comply with reporting requirements specified in the Pennsylvania Hazardous Materials Emergency Planning and Response Act (Act 165). The County monitors these reporting requirements, as necessary, to ensure facility safety.

Dams

According to the Pennsylvania Department of Environmental Protection (PADEP), Pike County has 147 dams. A dam is included in the NID if (1) it is a "high" or "significant" hazard potential class dam, (2) it is a "low" hazard potential class dam that exceeds 25 feet in height and 15 acre-feet of storage, or (3) it is a "low" hazard potential class dam that exceeds 50 acre-feet of storage and 6 feet in height. PADEP also tracks dams that may not fall into these categories.

Table 2-15 defines the hazard potential classifications, as accepted by the NID Interagency Committee on Dam Safety. PA DEP also designates dams based on potential risk level; this classification is slightly more detailed than that of the NID and is presented in Table 2-16.

Table 2-15. NID Dam Hazard Potential Classifications

Hazard Potential Classification	Loss of Human Life	Economic, Environmental, and Lifeline Losses
Low	None expected	Low and generally limited to owner
Significant	None expected	Yes
High	Probable. One or more expected	Yes (but not necessary for this classification)

Table 2-16. Pennsylvania Dam Classification Definitions

Size Category		
Category	**Impoundment Storage (Acre-feet)**	**Dam Height**
A	Equal to or greater than 50,000	Equal to or greater than 100
B	Less than 50,000 but greater than 1,000	Less than 100 but greater than 40
C	Equal to or less than 1,000	Equal to or less than 40
Hazard Potential Category		
Category	**Population at Risk**	**Economic Loss**
1	Substantial (numerous homes or small businesses or a large business or school)	Excessive such as extensive residential, commercial, or agricultural damage, or substantial public inconvenience.
2	Few (a small number of homes or small businesses)	Appreciable such as limited residential, commercial, or agricultural damage, or moderate public inconvenience.
3	None expected (no permanent structures for human habitation or employment)	Significant damage to private or public property and short duration public inconvenience such as damage to storage facilities or loss of critical stream crossings.
4	None expected (no permanent structures for human habitation or employment)	Minimal damage to private or public property and no significant public inconvenience

Source: Commonwealth of Pennsylvania 2011

2.5.5 Other Critical Facilities

Table 2-17 lists other facilities identified by the County Steering Committee as critical to operations during a hazard event.

Table 2-17. Other Facilities in Pike County

Name	Municipality	Building Type
Blooming Grove Township Building	Blooming Grove Township	Municipal Building
Pike Co Conservation District	Blooming Grove Township	County Building
Pike Co Correctional Facility	Blooming Grove Township	Correctional
Pike Co Training Center	Blooming Grove Township	County Building
Antonia France	Delaware Township	Day Care
Camp Speers Eljabar YMCA	Delaware Township	Day Care

Name	Municipality	Building Type
Delaware Township Municipal Building	Delaware Township	Municipal Building
Little Acorns Daycare	Delaware Township	Day Care
Little Wonders	Delaware Township	Day Care
Annette Nelson	Dingman Township	Day Care
Dingman Township Building	Dingman Township	Municipal Building
Georgia Miner	Dingman Township	Day Care
Tami Kennedy	Dingman Township	Day Care
Greene Township Building	Greene Township	Municipal Building
Greentown Daycare	Greene Township	Day Care
Lackawaxen Ambulance - Bohemia	Lackawaxen Township	EMS
Lackawaxen Ambulance - Greeley	Lackawaxen Township	EMS
Lackawaxen Township Building	Lackawaxen Township	Municipal Building
Kathleen Conrad	Lehman Township	Day Care
Lehman Township Building	Lehman Township	Municipal Building
Lori Colfer	Lehman Township	Day Care
Wanda Shepard-Garner	Lehman Township	Day Care
Discover the Rainbow	Matamoras Borough	Day Care
Matamoras Borough Bldg	Matamoras Borough	Municipal Building
Milford Christian Day School	Matamoras Borough	Day Care
Center for Developmental Disabilities	Milford Borough	Day Care
Good Shepherd Childcare	Milford Borough	Day Care
Milford Borough Building	Milford Borough	Municipal Building
Pike Co Administration Bldg	Milford Borough	County Building
Pike Co Courthouse	Milford Borough	County Building
Sunshine Station III	Milford Borough	Day Care
Milford Hill Learning Center	Milford Township	Day Care
Milford Township Building	Milford Township	Municipal Building
Sunshine Station	Milford Township	Day Care
Palmyra Township Building	Palmyra Township	Municipal Building
Porter Township Building	Porter Township	Municipal Building
Pike Co Office of Comm. Plan/Workforce	Shohola Township	County Building
Shohola Township Building	Shohola Township	Municipal Building
Westfall Township Building	Westfall Township	Municipal Building

Source: Pike County 2016

SECTION 3 PLANNING PROCESS

A successful planning process builds partnerships and brings together members representing government agencies, the public, and other stakeholders to reach consensus on ways the community will prepare for and respond to those hazards most likely to occur. Applying a comprehensive and transparent process adds validity to the Hazard Mitigation Plan (HMP). Participants involved in the HMP planning process gained better understanding of problems and issues, and helped devise solutions and actions for the community—resulting in a revised set of common community values and widespread support for directing financial, technical, and human resources to agreed-upon actions.

The planning process was an integral part of updating the Pike County HMP. This section describes the planning process used to update the HMP, with participation from all 13 of the County's municipalities. This section also describes the hazard mitigation Steering Committee, Planning Team, meetings and documentation, public and stakeholder participation, multi-jurisdictional planning, and existing planning mechanisms implemented during the HMP update process. Additional details about the process of updating each section of this HMP appear at the beginnings of those sections.

3.1 UPDATE PROCESS AND PARTICIPATION SUMMARY

In accordance with the Disaster Mitigation Act of 2000 (DMA 2000) requirements, this plan documents the following topics:

- Planning process
- Hazard identification
- Risk assessment
- Mitigation strategy: goals, actions, and projects
- Formal adoption by the participating jurisdictions
- Pennsylvania Emergency Management Agency (PEMA) and Federal Emergency Management Agency (FEMA) approval

The PEMA All-Hazard Mitigation Planning Standard Operating Guide lays out the standard planning process in Pennsylvania to create and update HMPs (including this HMP), and is cited in Appendix A, under Authorities and References. Hazard vulnerabilities and the risk assessment are described in Section 4 (Risk Assessment), and the mitigation strategy is described in Section 6 (Mitigation Strategy) of this HMP.

Public participation and planning meetings served as the main forums for gathering information to update the HMP. The Steering Committee, Planning Team and Tetra Tech, Inc. (contract consultant) were afforded access to information in relevant and approved plans, policies, and procedures for Pike County. Opportunities for public participation included attending a public meeting, completing on-line surveys, and reviewing and commenting on the draft HMP update. To develop all sections of the HMP, meetings, surveys, e-mail correspondence, and teleconferences were used to solicit input from County, municipal, and other stakeholders, including members of the general public; most information received for this update came from Pike County, its municipalities, and the Steering Committee. Through this planning process, the County established a comprehensive approach to reduce effects of hazards on the County and its municipalities.

3.2 THE HAZARD MITIGATION PLANNING TEAM

Recognizing the need to manage risk within the County, and to meet the requirements of the DMA 2000, the Pike County Office of Community Planning led the update to the 2012 HMP. Mr. Michael Mrozinski, Director, developed a Steering Committee to provide guidance and direction to the planning effort, and to ensure the resulting document will be embraced both politically and by the constituency within the planning area. Mr. Mrozinski served as chair of the Steering Committee. He was supported by all members of the Steering Committee:

- Michael Mrozinski, Director, Pike County Office of Community Planning
- Brian Snyder, Community Planner, Pike County Office of Community Planning
- Sally Corrigan, Executive Director, Pike County Conservation District
- Tim Knapp, Director, Pike County Office of Emergency Management
- Robert Melvin, Chairman, Board of Supervisors, Westfall Township
- Alison Miskiman, Project Manager, Tetra Tech

The Steering Committee was charged with:

- Providing guidance and overseeing the planning process on behalf of the general planning partnership (Planning Team).
- Attending and participating in Steering Committee meetings.
- Assisting with the development and completion of certain planning elements, including:
    - Reviewing and updating the hazards of concern;
    - Developing a public and stakeholder outreach program;
    - Assuring the data and information used in the plan update process is best available;
    - Reviewing and updating the hazard mitigation planning goals and objectives;
    - Identifying and screening of appropriate mitigation strategies and activities;
    - Reviewing and updating plan maintenance procedures; and
- Reviewing and commenting on plan documents prior to submission to PEMA and FEMA.

A Planning Team was assembled to represent each of the municipalities participating in the HMP update, as well as invited stakeholders and members of the Steering Committee. Table 3-1 lists the Planning Team members invited to participate in the planning process. For a complete list of participants, through attendance at meetings, completion of worksheets, or submission of comments, please refer to Appendices C through E. Please note that the Steering Committee members are also part of the overall project Planning Team, fulfilling these responsibilities on behalf of Pike County; and participants representing multiple jurisdictions are listed more than once. Further, additional municipal representatives participated in the planning process.

Table 3-1. Planning Team Members

Entity	Name	Title
Blooming Grove Township	Nicholas Mazza	Chairman, Board of Supervisors
	Robert Palumbo	Emergency Management Coordinator
Delaware Township	Jeffrey Sheetz	Chairman, Board of Supervisors
	George Beodeker	Emergency Management Coordinator
Dingman Township	Tom Mincer	Chairman, Board of Supervisors
	William Mikulak	Emergency Management Coordinator
Greene Township	Edward Simon	Supervisor
	Allen Shiffler	Emergency Management Coordinator
Lackawaxen Township	Michael Mancino	Chairman, Board of Supervisors
	William Fallon	Emergency Management Coordinator
Lehman Township	Robert H. Rohner, Jr	Chairman, Board of Supervisors
	Edward Bland	Emergency Management Coordinator
Matamoras Borough	Joseph Sain	President, Matamoras Borough Council
	Thomas Oliver	Emergency Management Coordinator
Milford Borough	Patrick Beck	President, Milford Borough Council

Entity	Name	Title
	David E. Ruby	Emergency Management Coordinator
Milford Township	Gary M. Clark	Chairman, Board of Supervisors
	Robert DiLorenzo	Emergency Management Coordinator
Palmyra Township	Tom Simons	Chairman, Board of Supervisors
	Nick Spinelli	Emergency Management Coordinator
Porter Township	William Powell	Chairman, Board of Supervisors
	Robert Hellyer	Emergency Management Coordinator
Shohola Township	George P. Hoeper	Chairman, Board of Supervisors
	Clint Malzahn	Emergency Management Coordinator; Fire Chief
Westfall Township	Bob Melvin*	Chairman, Board of Supervisors
	Bob Ewbank	Emergency Management Coordinator
Pike County Board of Commissioners	Matthew Osterberg	Chairman
	Rich Caridi	Vice Chairman
	Steve Guccini	Commissioner
Pike County Commissioners Office	Gary Orben	Chief Clerk
Pike County Office of Community Planning	Michael Mrozinski*	Director
	Jessica Grohmann	Assistant Planning Director
	Brian Snyder*	Community Planner
Pike County Emergency Management Agency	Timothy Knapp*	Coordinator
Pike County Conservation District	Sally Corrigan*	Executive Director
Pike County Sheriff's Office	Philip Bueki	Sheriff
Pike County Public Safety	Bernie Swartwood	Director of Communications
Delaware Valley School District	John Bell	Superintendent
East Stroudsburg Area School District	Sharon Laverdue	Superintendent
Wallenpaupack Area School District	Michael Silsby	Superintendent
Pennsylvania Department of Conservation and Natural Resources	Lorne Possinger	Eastern Regional Recreation and Parks Advisor
	Tim Dugan	District Forester, Bureau of Forestry
	Mike Roche	Assistant Manager, Bureau of Forestry
Pennsylvania Department of Environmental Protection	Bob Pitcavage	Northeast Liaison
Pennsylvania Emergency Management Agency	Thomas Hughes	State Hazard Mitigation Officer
	Ernie Szabo	Mitigation Planner
	Anthony J. Camillocci	Eastern Area Office Representative
Pennsylvania Game Commission	Daniel Figured	Northeast Director
PennDOT District 4-4	Kenneth Thiele	Maintenance Manager for Pike County
Penn State Extension	Nancy Grotevant	Pocono District Extension Director
Pennsylvania Power & Light	Alana Roberts	Regional Affairs Director
Orange & Rockland Utilities	Thomas Brizzolara	Director Public Affairs
Pike Co Light & Power/Corning Gas	Matt Cook	Operations
Upper Delaware Council	Laurie Ramie	Executive Director
Upper Delaware Scenic & Recreational River	Kris Heister	Superintendent
PA Senate 20th District	Andrew Seder	Eastern District Field Representative
PA House of Representatives 139th District	Jill Gamboni	Outreach Specialist

Entity	Name	Title
PA House of Representatives 189th District	Kathleen Moran	Representative Aide
Brookfield Energy Partners	Katie Lester	Compliance Specialist
Delaware Water Gap National Recreation Area	John Donahue	Superintendent
Lake Wallenpaupack Watershed Management District	Nick Spinelli	Director
Twin and Walker Creeks Conservancy	Chet Dawson	President
Wayne County, Pennsylvania	Brian Smith	Chairman, Board of Commissioners
	Craig Rickard	Planning Director
Monroe County, Pennsylvania	John Moyer	Chairman, Board of Commissioners
	Christine Meinhart-Fritz	Planning Director
Warren County, New Jersey	Richard Gardner	Director, Board of Chosen Freeholders
	David Dech	Planning Director
Sussex County, New Jersey	Carl Lazzaro	Director, Board of Chosen Freeholders
	Autumn Sylvester	Planning Director
Sullivan County, New York	Luis Alvarez	Chairman, Legislature
	Freda Eisenberg	Planning Commissioner
Orange County, New York	L. Stephen Brescia	Chairman, Legislature
	David Church	Planning Commissioner

**Steering Committee Member*

The Planning Team acknowledged that important steps in developing a comprehensive HMP were identifying hazards that specifically affect Pike County, and assessing their likelihood of occurrence, along with potential damage to the people, property, and environment of the County. The Planning Team chose to focus on an all-hazards approach rather than to narrow the focus to natural disasters only.

As the contract consultant, Tetra Tech guided the Steering Committee and Planning Team through the HMP update planning process. More specifically, Tetra Tech was tasked with:

- Assisting with the organization of a Steering Committee and Planning Team;
- Assisting with the development and implementation of a public and stakeholder outreach program;
- Data collection;
- Facilitation and attendance at meetings;
- Assisting with the review, update and ranking of the hazards of concern, and hazard profiling and risk assessment;
- Assistance with the review and update of mitigation planning goals and objectives;
- Assistance with the review of progress of past mitigation strategies;
- Assistance with the screening of mitigation actions and the identification of appropriate actions;
- Assistance with the prioritization of mitigation actions; and
- Authoring of the draft and final HMP documents.

3.3 MEETINGS AND DOCUMENTATION

As noted, the Steering Committee and Planning Team partnered with Tetra Tech to aid in the update of the HMP. Tetra Tech assisted the County in drafting planning documents, preparing meeting materials, and facilitating meetings. The Steering Committee reviewed any documentation produced by Tetra Tech, provided validation, and acted as an advocate for the HMP update.

Table 3-2 lists meetings held by the Pike County Steering Committee and Planning Team as part of the process of updating the Pike County HMP.

Table 3-2. Public and Planning Meetings

Date	Description of Meeting
March 14, 2016	Kickoff meeting with PEMA representatives, including administrative and grant requirements overview.
August 19, 2016	Kickoff meeting with Pike County Office of Community Planning and Contract Consultant, Tetra Tech
September 2, 2016	First Steering Committee Meeting, including five-year plan review and update process, role of Steering Committee, project schedule, data collection, public and stakeholder outreach strategy and in-kind tracking.
September 10, 2015	Kickoff Meeting with Planning Team members, including five-year plan review and plan update process, evaluation of identified hazards, capability assessment, and mitigation strategy review.
October 5, 2016	Director of the Pike County Office of Community Planning presented the HMP update planning process at the Pike County Commissioner's public meeting and handed out the tri-fold brochure to encourage public and stakeholder participation.
October 28, 2016	Second Steering Committee Meeting, including continued data collection, hazards of concern and worksheet status.
November 4, 2016	Planning Team and public meeting to review five-year review and update process, draft hazard profile and risk assessment results, continued pubic involvement and next steps.
December 28, 2016	Third Steering Committee Meeting, including risk ranking and Steering Committee review of hazard profiles.
February 1, 2017	Fourth Steering Committee Meeting, including review of capability assessment, mitigation goals and objectives and 2012 mitigation actions
March 8, 2017	Mitigation Solutions Workshop to review capability assessment results, risk ranking results, mitigation goals, objectives, actions and current plan status with municipal representatives and stakeholders
March 8, 2017	Direct outreach and meetings with municipal representatives to complete worksheet and participation requirements, and mitigation project selection (Delaware Township, Palmyra Township, Shohola Township, Westfall Township).
March 30, 2017	Direct outreach and teleconference meeting with Lehman Township to complete worksheet and participation requirements, and mitigation project selection.
March 31, 2017	Direct outreach and meetings with municipal representatives to complete worksheet and participation requirements, and mitigation project selection (Blooming Grove, Dingman Township, Lackawaxen, Milford Borough, Porter Township, Westfall Township).
April 18, 2017	Direct outreach and teleconference meetings with Greene Township and Matamoras Borough to complete worksheets and participation requirements, and mitigation project selection.
April 21, 2017	Direct outreach and teleconference meeting with Milford Township to complete worksheets and participation requirements, and mitigation project selection.
April 24, 2017	Steering Committee Meeting to discuss plan maintenance strategy and discuss plan adoption procedures.
May 1, 2017	Draft HMP posted on the project website for public and Planning Team review
To be determined – upon receipt of APA designation	HMP adoption by County Commissioners

Notes: APA = Approval Pending Adoption; HMP = Hazard Mitigation Plan; PEMA = Pennsylvania Emergency Management Agency

Pike County's contractor, Tetra Tech, followed up each Steering Committee meeting with meeting notes that documented all agenda topics, decisions, and action items identified. The meeting minutes were shared among the Steering Committee. Documentation from all meetings is located in Appendix C.

Pike County residents were informed of the public meeting through various sources, including newspaper public notices and announcements on the Pike County main webpage and the Pike County HMP project website (http://www.pikecountypahmp.com/). The Risk Assessment meeting was advertised as a public meeting and residents attended and provided feedback for development of the HMP. Any subsequent supporting documentation provided by County residents will be included in Appendix E (Public and Stakeholder Documentation).

3.4 PUBLIC AND STAKEHOLDER PARTICIPATION

To maximize effectiveness of the HMP, the Planning Team fostered continual public and stakeholder engagement. Input was encouraged and collected through a variety of methods. Three worksheets/surveys—the Hazard/Risk Identification Survey, Capabilities Assessment Survey, and Mitigation Strategy 5-Year Plan Review Worksheet (Mitigation Review Worksheet)—were given to each municipality in Pike County. Of the 13 municipalities surveyed in Pike County, all returned a worksheet/survey so that their input could be reviewed and incorporated into the updated HMP.

The following entities with vested interest in development of the updated HMP were given the opportunity to participate in the planning process by attending a Planning Team or public meeting, or by offering comments on the project website: local, state, and federal agencies; neighboring jurisdictions (i.e., Monroe and Wayne Counties in Pennsylvania; Sussex and Warren Counties in New Jersey; and Orange and Sullivan Counties in New York); community leaders; educators; and other relevant private and nonprofit groups. Invitations to participate in meetings were sent to adjacent counties, and other relevant stakeholders identified by the County. Appendix E includes a copy of the Planning Team meeting invitation list and sample copies of invitation letters sent. Meeting invitations were also sent to all municipalities including elected officials and Emergency Management Coordinators. Additionally, direct outreach by phone or one-on-one meetings was conducted with municipalities who were unable to attend other meetings or who had questions about worksheets, participation requirements, the planning process, or mitigation project selection. All 13 municipalities in Pike County had representatives attending at least one meeting. For meetings in which the municipality could not attend, individual municipal support meetings were held as discussed in Section 3.5 below.

Through tri-fold brochures on display throughout the County and public notices published in the local newspapers, the above groups and the general public were invited to take on-line surveys, visit the project website, review the draft County HMP update and to send comments to the Pike County Office of Community Planning. In addition, a general public meeting was held during the planning process as listed in Table 3-2. Preceding the public meeting was a public notice inviting the general public to attend. Copies of the public notices, the tri-fold brochure, and other forms of public and stakeholder outreach are presented in Appendix E.

Section 3.5, entitled "Multi-Jurisdictional Planning," includes Table 3-2, showing overall municipal participation in the planning process.

As illustrated, the Steering Committee felt that jurisdictional and stakeholder participation was critical to the process. The Steering Committee met regularly to review the status of the HMP, the HMP itself, and strategies to involve the public. Because this particular HMP was an update, the Steering Committee felt that it was critical to allow adequate time for the public and stakeholders to review each section of the update; conducted via the project website.

3.5 MULTI-JURISDICTIONAL PLANNING

Pike County took a multi-jurisdictional approach to preparing its HMP, so that the HMP would apply to the County and all participating municipalities. The County was able to provide resources (e.g., data, geographic information system [GIS], etc.) to which the municipalities may not have had access. However, Pike County depended on municipal buy-in because the municipalities have the legal authority to enforce compliance with land use planning and development directives. Pike County, together with Tetra Tech, undertook an intensive effort to involve all 13 municipalities in the update process.

Each municipality was given the opportunity to participate in this process. Municipal officials and representatives were invited to attend Planning Team and public meetings, were provided worksheets to update the hazards of concern capabilities and mitigation strategy, and were asked to review and prioritize the mitigation actions. Municipal participation culminated in formal adoption of the HMP; copies of municipal adoption resolutions are in Appendix F. Table 3-3 indicates how each municipality participated in the planning process. In some cases, a municipality was unable to attend a Planning Team meeting; therefore, an individual follow-up meeting with each municipality was held by Pike County Steering Committee representatives to cover the meeting material and provide municipal support on the topics presented.

Table 3-3. Participation Matrix

Jurisdiction	Meetings					Worksheets				
	Planning Team Kick-Off Meeting	Individual Municipal Kick-Off Meeting	Risk Assessment Meeting (Public)	Mitigation Strategy Workshop	Municipal Support Meeting	Risk Assessment Survey Received	Capabilities Assessment Survey Received	Mitigation Review Worksheet Received	Updated Mitigation Strategy Received	2017 Plan Adoption Date
Pike County	X		X	X	X	X	X	X	X	TBD
Blooming Grove Township	X		X		X	X	X	X	X	TBD
Delaware Township	X		X	X	X	X	X	X	X	TBD
Dingman Township	X		X	X	X	X	X	X	X	TBD
Greene Township		X	X	X	X	X	X	X	X	TBD
Lackawaxen Township	X		X	X	X	X	X	X	X	TBD
Lehman Township	X		X	X	X	X	X	X	X	TBD
Matamoras Borough	X		X		X	X	X	X	X	TBD
Milford Borough		X	X		X	X	X	X	X	TBD
Milford Township		X	X		X	X	X	X	X	TBD
Palmyra Township	X		X	X	X	X	X	X	X	TBD
Porter Township		X	X	X	X	X	X	X	X	TBD
Shohola Township	X		X	X	X	X	X	X	X	TBD
Westfall Township	X		X	X	X	X	X	X	X	TBD

TBD = To be determined after plan is approved-pending adoption by FEMA Region 3.

Figure 3-1. Photograph of the Planning Team Kick-Off Meeting (September 10, 2016)

Figure 3-2. Photograph of the Risk Assessment Planning Team/Public Meeting (November 4, 2016)

SECTION 4 RISK ASSESSMENT

4.1 UPDATE PROCESS SUMMARY

In accordance with the FEMA Local Mitigation Planning Handbook, risk is the potential for damage, loss, or other impacts created by the interaction of natural hazards with community assets. Pike County's risk assessment is organized into the following sections:

- Section 4.2 outlines the hazard identification process for both natural and human-caused hazards of concern for further profiling and evaluation.
- Section 4.3 profiles the hazards of concern (location and extent, range of magnitude, past occurrence, and future occurrence) and assesses vulnerability.
- Section 4.4 summarizes the risk assessment methodology, ranking results, potential losses and future development and vulnerability.

The Steering Committee and Planning Team evaluated the 2012 HMP hazards of concern by examining the historic events that have taken place in the County since the last plan update and reviewing the Commonwealth's Hazard Mitigation Plan. In addition, the Steering Committee, Planning Team and stakeholders completed the risk assessment worksheet (Evaluation of Identified Hazards and Risk Worksheet). The worksheet listed hazards profiled in the 2012 HMP and requested that participants identify if the frequency of occurrence, magnitude of impact, and/or geographic extent of each hazard increased, decreased or did not change since the preparation of the 2012 HMP. The worksheet also provided the opportunity to assess hazards not profiled in the HMP to determine if those hazards should be included as part of the update. Responses from the survey reviewed by the Steering Committee to identify a list of hazards to profile in the 2017 HMP update, including five additional hazards of concern. The new hazards of concern are: extreme temperature; invasive species; landslide, lightning strike; and radon exposure. In addition, the environmental hazards profile was expanded to include pyrite. Each hazard profile also includes an additional subsection which discusses the effect of climate change on vulnerability. Refer to copies of the worksheets completed in Appendix D.

4.2 HAZARD IDENTIFICATION

4.2.1 Disaster Declarations

In reviewing and updating Pike County's hazards of concern, the Steering Committee and Planning Team reviewed additional information and historical records from a wide range of sources. The following discusses the Presidential Disaster and Emergency Declarations, Gubernatorial Disaster Declarations or Proclamations and Small Business Administration Disaster Declarations that have affected Pike County.

Presidential Disaster and Emergency Declarations are issued when it has been determined that state and local governments need assistance in responding to a disaster event. Table 4.2-1 identifies Presidential Disaster and Emergency Declarations issued between 1955 through August 2016 that have affected Pike County. Additional declarations beyond August 2016 can be found on the FEMA website at: https://www.fema.gov/disasters.

Table 4.2-1: Presidential Disaster and Emergency Declarations affecting Pike County

Declaration Number	Date	Event
4099	October, 2012	Hurricane Sandy
4025	September, 2011	Remnants of Hurricane Irene
1649	June, 2006	Severe Storms, Flooding, and Mudslides
1587	April, 2005	Severe Storms, Flooding, and Mudslides
3235	September, 2005	Proclamation of Emergency - Hurricane Katrina
1557	September, 2004	Tropical Depression Ivan
1219	June, 1998	Flooding, Severe Storms, and Tornadoes
1085	January, 1996	Blizzard
1093	January, 1996	Flooding
3105	March, 1993	Proclamation of Emergency - Blizzard
340	June, 1972	Flood (Agnes)
273	August, 1969	Drought
206	August, 1965	Drought
40	August, 1955	Flood (Diane)

In addition to these Presidentially-declared events, 30 events warranted Gubernatorial Disaster Declarations or Proclamations. Table 4.2-2 lists Gubernatorial Disaster Declarations or Proclamations that have been issued for Pike County between 1954 and 2016.

Table 4.2-2: Gubernatorial Disaster Declarations or Proclamations affecting Pike County

Date	Event
January, 2016	Proclamation of Emergency – Severe Winter Event
August, 2015	Proclamation of Emergency – High Winds, Severe Thunderstorms, Heavy Rains, Tornadoes and Flooding
January, 2015	Proclamation of Emergency – Severe Winter Event
February, 2014	Proclamation of Emergency – Severe Winter Weather

Date	Event
January, 2014	Proclamation of Emergency – Severe Cold Weather
October, 2012	Proclamation of Emergency – Hurricane Sandy
April, 2012	Proclamation of Emergency – Winter Storm
August, 2011	Proclamation of Emergency – Hurricane Irene
January, 2011	Proclamation of Emergency – Severe Winter Storm
February, 2010	Proclamation of Emergency – Winter Storm
April, 2007	Proclamation of Emergency - Severe Winter Storm
February, 2007	Proclamation of Emergency - Regulations
February, 2007	Proclamation of Emergency - Severe Winter Storm
September, 2006	Proclamation of Emergency - Tropical Depression Ernesto
June, 2006	Proclamation of Emergency – Summer Floods
April, 2005	Proclamation of Emergency – Severe Storms and Flooding
September, 2004	Proclamation of Emergency – Severe Storms, Heavy Rain, High Winds and Flooding associated with Hurricane Ivan
September, 2003	Hurricane Isabel / Henri - related storms and flooding
February, 2002	Drought and Water Shortage
September, 1999	Hurricane Floyd
July, 1999	Drought
April, 1997	Snowstorm
September, 1995	Drought
January, 1994	Severe Winter Storms
November, 1980	Drought Emergency
February, 1978	Blizzard
January, 1978	Heavy Snow
February, 1974	Truckers Strike
February, 1972	Heavy Snow
January, 1966	Heavy Snow

Pike County has also received Small Business Administration Disaster Assistance for a number of disaster events. A Small Business Administration Disaster Declaration qualifies communities for access to affordable, timely, and accessible financial assistance. Table 4.2-3 illustrates Small Business Administration Disaster Declarations issued for Pike County between 1954 and 2016.

Table 4.2-3: Small Business Administration Disaster Declarations affecting Pike County

Date	Event
April, 2007	Severe Storms and Flooding
July, 1991	Drought
February, 1981	Flash Flood (Matamoras)

Since 1955, declarations have been issued for various hazard events including hurricanes or tropical storms, severe winter storms, and flooding. A unique Presidential Emergency Declaration was issued in September, 2005. Through Emergency Declaration 3235, President George W. Bush declared that a state of emergency existed in the Commonwealth of Pennsylvania and ordered federal aid to supplement Commonwealth and local response efforts to help people evacuated from their homes due to Hurricane Katrina. All counties within the Commonwealth, including Pike County, were indirectly affected by Hurricane Katrina as a result of evacuee assistance.

4.2.2 Summary of Hazards

As part of the plan update process, the Steering Committee and Planning Team reviewed the hazards of concern detailed in the 2012 version of the plan as well as those identified in the State HMP. They also considered the history of hazard events occurring in Pike County, as well as events occurring after the completion of the 2012 version of the plan. This review of historical events included an evaluation of all emergency and disaster declarations in the Commonwealth, with a focus on those in which Pike County was designated for federal assistance.

Further, all jurisdictions participating in the plan update process were provided a *Hazard Identification/ Evaluation of Risk* worksheet to help identify the hazards—natural and non-natural—that each community believed posed significant risk to Pike County, including any that may not have been considered in either the 2012 version of the plan or the State HMP. Completed worksheets submitted by the municipalities are included in Appendix D. Following review of the 2012 hazards list and completion of the *Hazard Identification/ Evaluation of Risk* worksheet, additional hazards were considered in need of a risk assessment. The Steering Committee and Planning Team decided to keep all 2012 hazards of concern and add the following hazards: 1) extreme temperature; 2) invasive species; 3) landslide; 4) lightning; and 5) radon. Several additional non-natural hazards were identified by the Planning Team and stakeholders; however, they were not included because they are addressed in other plans or programs within the county (e.g., Pike County Emergency Management Plan).

Based on all available information and input from the municipalities, the Steering Committee and Planning Team selected the following natural and non-natural hazards for consideration in this plan.

Natural Hazards

- Drought
- Earthquake
- Extreme Temperature
- Flood, Flash Flood, Ice Jam
- Hurricane, Tropical Storm, Nor'Easter
- Invasive Species
- Landslide
- Lightning
- Pandemic
- Radon
- Tornado and Windstorm
- Wildfire
- Winter Storm

Non-Natural Hazards

- Dam Failure
- Drowning

- Environmental Hazards
- Nuclear Incidents
- Terrorism
- Transportation Accidents
- Urban Fire and Explosion
- Utility Interruption

These hazards have been profiled individually in Section 4.3 of this plan.

4.3 HAZARD PROFILES

The following sections profile and assess vulnerability for each hazard of concern. For each hazard, the profile includes: the hazard description; its location and extent; range of magnitude, past occurrence, future occurrence, and vulnerability assessment. The vulnerability assessment for each hazard includes: an overview of vulnerability and data and methodology used; the impact to life, health and safety; impact to general building stock and critical facilities; impact to the economy; impact to the environment; impact to future growth and development; and effect of climate change on vulnerability.

4.3.1 Dam Failure

Due to sensitivity issues, the Dam Failure profile can be found in Appendix I (Confidential).

4.3.2 Drought

This section provides a profile and vulnerability assessment of the drought hazard in Pike County. Drought is a period characterized by long durations of below normal precipitation. Drought conditions occur in virtually all climatic zones, yet characteristics of drought vary significantly from one region to another, relative to normal precipitation within respective regions. Drought can affect agriculture, water supply, aquatic ecology, wildlife, and plant life. Drought is a temporary irregularity in typical weather patterns and differs from aridity, which reflects low rainfall within a specific region and is a permanent feature of the climate of that area.

Drought can be defined or grouped in four categories:

- Meteorological drought is a measure of departure of precipitation from normal, defined solely by reference to relative degree of dryness. Because of climatic differences, dryness considered a drought at one location of the country may not be considered drought at another location.
- Agricultural drought links various characteristics of meteorological (or hydrological) drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, reduced groundwater or reservoir levels, and other parameters. Agricultural drought occurs when not enough water is available for a particular crop to grow at a particular time. Agricultural drought is defined in terms of soil moisture deficiencies relative to water demands of plant life, primarily crops.
- Hydrological drought is associated with below normal surface or subsurface water supply resulting from periods of precipitation shortfalls (including snowfall). Hydrological drought is related to effects of precipitation shortfalls on stream flows and water levels in reservoirs, lakes, and groundwater.
- Socioeconomic drought is associated with supply and demand of an economic good, with elements of meteorological, hydrological, and agricultural drought. This differs from the aforementioned types of drought because its occurrence depends on supply and demand to identify or classify droughts. Supplies of many economic goods such as water, silage, food grains, fish, and hydroelectric power depend on weather. Socioeconomic drought occurs when demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply (National Drought Mitigation Center [NDMC] 1985).

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

Scientists at this time do not know how to predict drought more than 1 month in advance for most locations. Predicting drought depends on the ability to forecast precipitation and temperature. Anomalies of precipitation and temperature may last from several months to several decades. How long they last depends on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and accumulated influence of weather systems on the global scale (NDMC Date Unknown).

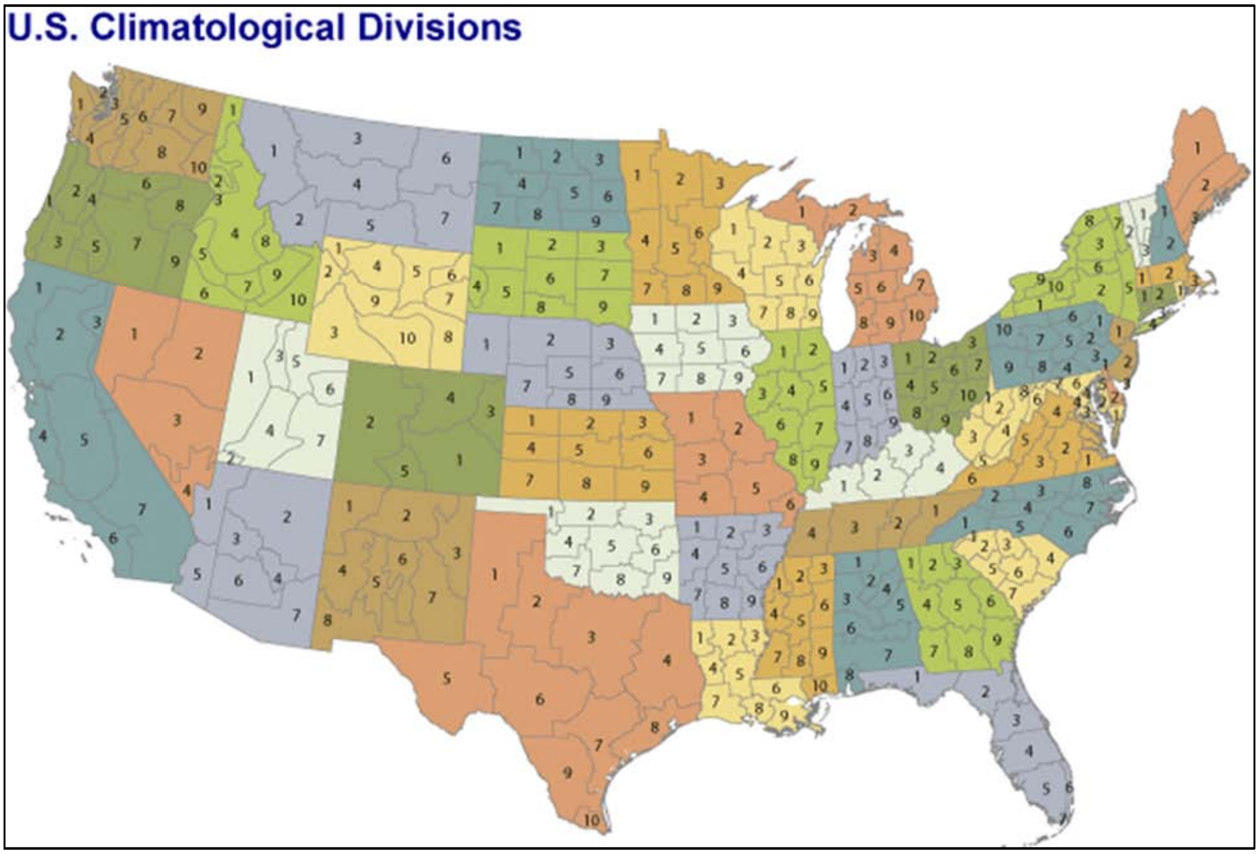
Location and Extent

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

Climate divisions are regions within a state that are climatically homogenous. The National Oceanic and Atmospheric Administration (NOAA) has divided the United States into 359 climate divisions. The boundaries of these divisions typically coincide with county boundaries, except in the western United States where they are based largely on drainage basins (Climate Prediction Center [CPC] 2005).

According to NOAA, Pennsylvania includes 10 climate divisions: Pocono Mountains, East Central Mountains, Southeastern Piedmont, Lower Susquehanna, Middle Susquehanna, Upper Susquehanna, Central Mountains, South Central Mountains, Southwest Plateau, and Northwest Plateau Climate Division (National Climatic Data Center [NCDC] 2015). Figure 4.3.2-1 shows the climate divisions throughout the United States, and Figure 4.3.2-2 shows the climate divisions of Pennsylvania. Pike County is within the Pocono Mountains climate division.

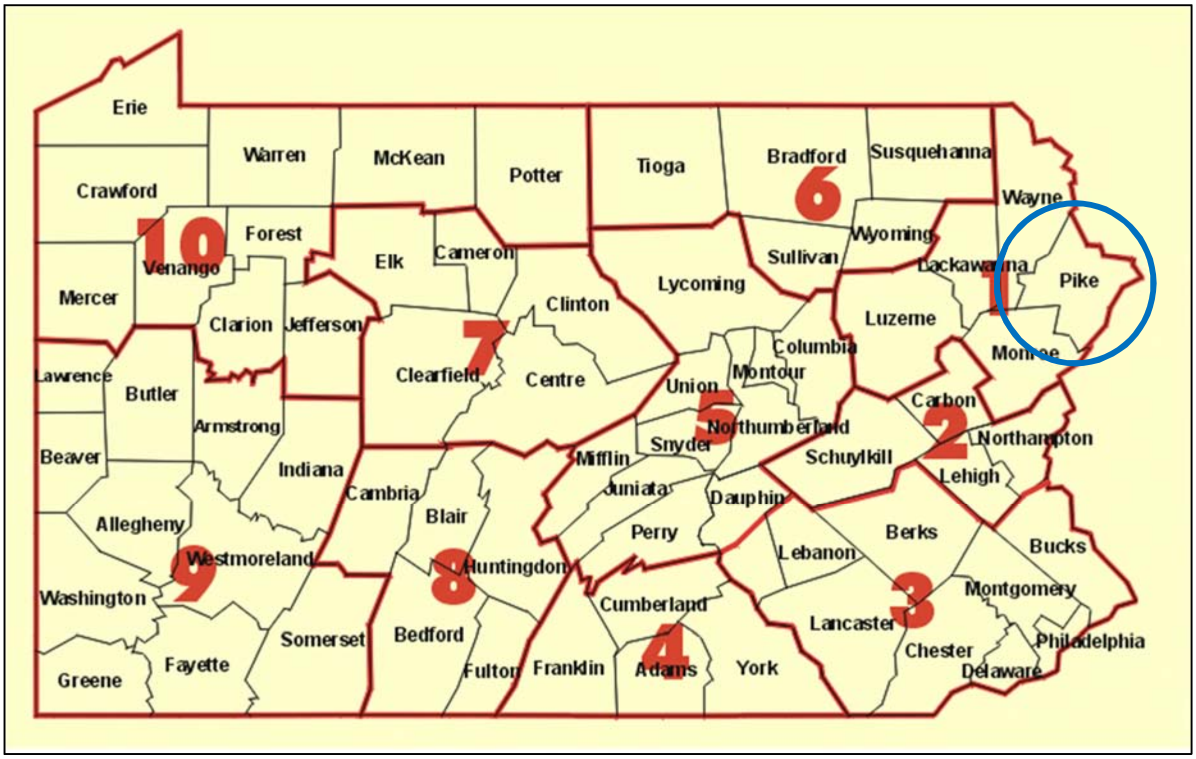
Figure 4.3.2-1. Climate Divisions in the United States



Source: NCDC 2012

Notes: Climate division names vary from state to state. The climate divisions for Pennsylvania are: 1 = Pocono Mountains; 2 = East Central Mountains; 3 = Southeastern Piedmont; 4 = Lower Susquehanna; 5 = Middle Susquehanna; 6 = Upper Susquehanna; 7 = Central Mountains; 8 = South Central Mountains; 9 = Southwest Plateau; 10 = Northwest Plateau

Figure 4.3.2-2. Climate Divisions of Pennsylvania



Source: CPC 2005

Note (1): The climate divisions for Pennsylvania are:
1 = Pocono Mountains; 2 = East Central Mountains; 3 = Southeastern Piedmont; 4 = Lower Susquehanna; 5 = Middle Susquehanna; 6 = Upper Susquehanna; 7 = Central Mountains; 8 = South Central Mountains; 9 = Southwest Plateau; 10 = Northwest Plateau

Note (2): The blue circle indicates the location of Pike County.

Particularly at locations where citizens rely on wells for drinking water, water supplies are vulnerable to effects of drought and thus can impact the severity of a drought. Residents depending on well water can more easily handle short-term droughts without major inconveniences than can populations that rely on surface water. However, longer-term droughts inhibit groundwater aquifers from recharging and can thus extend the problems of well owners for an indeterminate amount of time—Pike County residents who depend on private domestic wells have this greater "hidden vulnerability" to droughts.

According to the Pennsylvania Groundwater Information System (PaGWIS) there are 4,315 domestic private wells in Pike County. PaGWIS is maintained by Pennsylvania Department of Conservation and Natural Resources (DCNR) and relies on voluntary submissions of well record data by well drillers; as a result, it is not a complete database of all domestic wells in the County. It is, however, the most complete dataset of domestic wells available. Refer to the Vulnerability Assessment for further discussion.

In addition to domestic wells in the County, residents may also receive their water from municipal water providers. According to the U.S. Environmental Protection Agency (EPA), there are 38 community water systems in Pike County. These systems provide water year-round to over 41,000 people. Public water systems in the County procure their water from groundwater. Additionally, there are 214 non-transient or transient non-community water systems that provide water to over 51,000 people. Non-transient, non-community water systems provide water to the same people, but not year round (e.g. schools that have their own water system). Transient, non-community water systems do not consistently provide water to the same people (e.g. rest stops, campgrounds, gas stations). These systems all receive water from groundwater sources. Table 4.3.2-1 below provides information regarding the community water systems located within Pike County, as identified by the U.S. EPA.

Table 4.3.2-1. Community Water Systems in Pike County

Water System Name	Population Served	Primary Water Source Type
Aqua PA Fawn Lake Forest	6,533	Ground water
Aqua PA Tafton Wilson Hill	80	Ground water
Aqua PA Tanglewood Lakes	1,321	Ground water
Aqua PA Woodledge Village	58	Ground water
Crescent Lake North Comm Assoc	80	Ground water
Deerhaven White Beauty View Es	53	Ground water
Grampas Woods Estates	45	Ground water
Happy Hollow	89	Ground water
Hemlock Farms (Main)	8,321	Ground water
Hitching Post Assoc	90	Ground water
Killiam Tract	39	Ground water
Lake Wallenpaupack Estates POA	204	Ground water
Laurel Lane Development Assoc	179	Ground water
Laurel Woods Mobile Home Park	70	Ground water
Milford Senior Care	110	Ground water
Milford Water Authority	2,420	Groundwater under influence of surface water
Moon Valley Falls	120	Ground water
Muni Auth Of Boro Of Matamoras	2,900	Ground water
Oak Manor Estates	46	Ground water
Pawc All Seasons System	100	Ground water
Pawc Marcel Lakes	845	Ground water
Pawc Milford Landing	468	Ground water
Pawc Pocono Mtn Lake Forest	180	Ground water
Pawc Saw Creek Estates	6,833	Ground water
Pawc Wild Acres	2,943	Ground water
Pike County Correctional Facil	376	Ground water
Pine Ridge System	2,450	Ground water
Poc Mtn Lake Est Sect 1e	140	Ground water
Pocono Mtn Lake Estates Sect5a	150	Ground water
Pocono Ranch Lands Sect 4	225	Ground water
Rustic Acres Mhp	73	Ground water
Tamiment Resort	1,200	Ground water
Tanglewood Ski Aqua PA	690	Ground water
The Escape	1,100	Ground water
Tranquility Falls	121	Ground water
Twin Lakes Utilities Inc	300	Ground water
Wheatfield Village	35	Ground water

Water System Name	Population Served	Primary Water Source Type
White Sand Springs	40	Ground water

Source: U.S. EPA 2016

Range of Magnitude

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

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

Pennsylvania Department of Environmental Protection (PADEP) and Pennsylvania Emergency Management Agency (PEMA) manage water supply droughts in Pennsylvania according to the following four conditions of drought defined in the Commonwealth of Pennsylvania 2013 Standard Hazard Mitigation Plan (PA HMP):

- Drought Watch: A period to alert government agencies, public water suppliers, water users, and the public regarding potential for future drought-related problems. The focus is on increased monitoring, awareness, and preparation for response in the event that conditions worsen. A request for voluntary water conservation is issued. The objective of voluntary water conservation measures during a drought watch is to reduce water use by 5 percent within the affected areas. Because of varying conditions, individual water suppliers or municipalities may ask for more stringent conservation actions.
- Drought Warning: This is a drought stage involving a coordinated response to imminent drought conditions and potential water supply shortages through concerted voluntary conservation measures to avoid or reduce shortages, relieve stressed sources, develop new sources, and, if possible, forestall need to impose mandatory water use restrictions. The objective of voluntary water conservation measures during a drought warning is to reduce overall water use by 10 to 15 percent within the affected areas. Because of varying conditions, individual water suppliers or municipalities may ask for more stringent conservation actions.
- Drought Emergency: During this drought stage, water management entities marshal all available resources to respond to actual emergency conditions, avoid depletion of water sources, ensure at least minimum water supplies to protect public health and safety, support essential and high-priority water uses, and avoid unnecessary economic dislocations. If deemed necessary and if ordered by the Governor during this stage, imposition of mandatory restrictions on nonessential water usage could occur as provided for in 4 *Pa. Code* Chapter 119. Objectives of water use restrictions (mandatory or voluntary) and other conservation measures during a drought emergency are to reduce consumptive water use within the affected areas by 15 percent, and to reduce total use to the extent necessary to preserve public water system supplies, avoid or mitigate local or area shortages, and ensure equitable sharing of limited supplies.
- Local Water Rationing: This fourth condition of drought is not defined as a drought stage. Local municipalities may, with the approval of the Pennsylvania Emergency Management Council, implement local water rationing to share a rapidly dwindling or severely depleted water supply within designated water supply service areas. These individual water rationing plans, authorized through provisions of 4 *Pa. Code* Chapter 120, require specific limits on individual water consumption to achieve significant reductions in use. Under both mandatory restrictions imposed by the

Commonwealth and local water rationing practices, procedures are specified for granting variances in consideration of individual hardships and economic dislocations (PEMA 2013).

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

- Precipitation Deficits: As rainfall provides the basis for both groundwater and surface water resources, precipitation deficits are the earliest indicators of a potential drought. The National Weather Service (NWS) records "normal" monthly precipitation data for each county in Pennsylvania. These figures are generated from long-term monthly and decennial averages of precipitation, and are updated at the end of each decade based on the most recent 30 years. Monthly totals less than normal values represent precipitation deficits, which are then converted to percentages of the normal values. Table 4.3.3-3 lists the drought conditions (defined in the PA HMP and noted above) that are indicated by various precipitation deficit percentages (PEMA 2013).

Table 4.3.2-2. Precipitation Deficit Drought Indicators for Pennsylvania

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

Source: PEMA 2013

- Stream Flows: Stream flows, which typically lag up to 2 months behind precipitation normals in signaling a drought, offer the second earliest indication of drought conditions. PADEP uses 73 U.S. Geological Survey (USGS)-maintained stream gauges throughout the State as its drought monitoring network, computing 30-day average stream flow values for each stream gauge based on the entire period of record for each gauge. For example, the Tonoloway Creek gauge near Needmore has data records as far back as October 1965 from which the long-term, 30-day average, or normal, flows are now determined. Drought status is determined from stream flows based on exceedances rather than percentages. The various stages of drought watch, warning, and emergency conditions are indicated, respectively, by 75-, 90-, and 95-percent exceedances of 30-day average flows (PEMA 2013). Detailed descriptions of these data collection methods appear in the PA HMP.
- Reservoir Storage Levels: Water level storage in several large public water supply reservoirs is another indicator that PADEP uses for drought monitoring. Depending on total quantity of storage and length of the refill period for the various reservoirs, PADEP uses varying percentages of storage drawdown to indicate the three drought stages for each reservoir (PEMA 2013).
- Groundwater Levels: Groundwater levels can be an indicator of a developing drought, although low readings may lag up to 3 months behind drought-indicative precipitation readings. This lag occurs because storage of nearly 80 trillion gallons of groundwater throughout the Commonwealth disguises precipitation deficits before significant lack of groundwater recharge becomes noticeable (PEMA 2013).

USGS also maintains groundwater monitoring wells in each county throughout the Commonwealth. Groundwater measurements taken from these wells at exceedances of 75, 90, and 95 percent are used to indicate drought watch, warning, and emergency statuses, respectively. Within the USGS well network, the 30-day average depth-to-groundwater readings are analyzed in relation to long-term, 30-day averages based on the period of record for each county well (PEMA 2013).

- Soil Moisture: NOAA's Palmer Drought Severity Index (PDSI) provides soil moisture information for evaluating the scope, severity, and frequency of prolonged periods of abnormally dry or wet weather. The tool is frequently used to indicate availability of irrigation water supplies, reservoir levels, range conditions, amount of stock water, and forest fire potential. Although notably ineffective for monitoring short-term drought, the PDSI is effective for determining long-term droughts, and as such is most frequently used to delineate disaster areas (CPC 2005).

Table 4.3.2-3 lists PDSI classifications. The PDSI uses 0 to reflect normal status, and negative numbers indicate droughts. For example, 0 is no drought, -2 is moderate drought, and -4 is extreme drought. Positive numbers signify excess precipitation (NDMC 2013).

Table 4.3.2-3. Palmer Drought Severity Index (PDSI) Classifications

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

Source: NDMC 2013; PEMA 2013

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

Past Occurrence

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

According to the National Centers for Environmental Information (NCEI) Storm Events Database, Pike County underwent three drought events between January 1, 1950 and June 30, 2016. Overall, these events led to $200,000 in crop damages (NCEI 2016).

Since November 1980, PADEP indicated that Pike County has undergone 18 drought-watch declarations, 16 drought-warning declarations, and 13 drought-emergency declaration between November 1980 and August 2016 (PADEP 2016). Additionally, according to the Cornell Northeast Regional Climate Center (NRCC), Pike County is located within the Pocono Mountains Climate Division, which has experienced seven drought periods of two or more months within severe or extreme drought (NRCC 2016).

According to FEMA, between 1954 and 2016, Pennsylvania underwent one drought-related disaster (DR) or emergency (EM) classified as one or a combination of the following disaster types: drought or water shortage. Because these disaster types generally cover a wide region of the Commonwealth, this single disaster impacted many counties. However, not all counties were included in the disaster declaration. FEMA, PEMA, and other sources indicate that Pike County was included in the major disaster declaration (DR-206) as a result of a drought-related event (FEMA 2016).

Based on all sources researched, drought events between 1963 and 2016 that have affected Pike County are identified in Table 4.3.2-4. Please note that not all sources have been identified or researched, and therefore Table 4.3.2-4 may not include all events that have occurred throughout the County.

Table 4.3.2-4. Pike County Declared Drought Status from 1963 to 2016

Date	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts / PDSI Value	Source(s)
October – December 1963	Drought	N/A	N/A	Three month duration of severe to extreme drought conditions in the Pocono Mountains Climate Division, which includes Pike County. Lowest PDSI for the Climate Division was -3.64 recorded in October 1963	NRCC
August 1964 – April 1966	Water Shortage / Drought	DR-206	Yes	Twenty-one month duration of severe to extreme drought conditions in the Pocono Mountains Climate Division, which includes Pike County. Lowest PDSI for the Climate Division was -5.47 recorded in July 1965.	FEMA, NRCC
June – November 1966	Drought	N/A	N/A	Six month duration of severe to extreme drought conditions in the Pocono Mountains Climate Division, which includes Pike County. Lowest PDSI for the Climate Division was -4.29 recorded in August 1966	NRCC
January – February 1967	Drought	N/A	N/A	Two month duration of severe to extreme drought conditions in the Pocono Mountains Climate Division, which includes Pike County. Lowest PDSI for the Climate Division was -3.95 recorded in February 1967.	NRCC
1977	Drought	N/A	N/A	The Matamoras Municipal Water Authority was forced to drill several new wells when their original artesian wells began to dry up. For several weeks, water was pumped across the Delaware River Bridge from Port Jervis, New York into the Matamoras system.	Pike County HMP 2012
November 18, 1980 – April 20, 1982	Drought Emergency	N/A	N/A	According to the NRCC, there was a two month duration of severe to extreme drought conditions in the Pocono Mountains Climate Division, which includes Pike County, from December 1980 to January 1981. Lowest PDSI for the Climate Division during this time frame was -3.95 recorded in January 1981.	PADEP, NRCC
November 10, 1982 – February 8, 1983	Drought Warning	N/A	N/A	No impacts and/or losses identified for this event.	PADEP
February 8, 1983 – March 28, 1983	Drought Warning	N/A	N/A	No impacts and/or losses identified for this event.	PADEP
January 23, 1985 – April 26, 1985	Drought Warning	N/A	N/A	No impacts and/or losses identified for this event.	PADEP
April 26, 1985 – December 19, 1985	Drought Emergency	N/A	N/A	No impacts and/or losses identified for this event.	PADEP
July 7, 1988 - August 24, 1988	Drought Watch	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
August 24, 1988 - December 12, 1988	Drought Watch	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
June 28, 1991 - July 24, 1991	Drought Watch	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
July 24, 1991 - August 16, 1991	Drought Emergency	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
August 16, 1991 -	Drought	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike

Date	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts / PDSI Value	Source(s)
September 13, 1991	Emergency				County HMP 2012
September 13, 1991 - October 21, 1991	Drought Emergency	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
October 21, 1991 - January 16, 1992	Drought Emergency	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
January 17, 1992 - April 20, 1992	Drought Emergency	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
April 20, 1992 - June 23, 1992	Drought Warning	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
September 1, 1995 - September 20, 1995	Drought Warning	N/A	N/A	Lowest PDSI for the Pocono Mountains Climate Division was -3.64 recorded in September 1995	PADEP, NRCC, Pike County HMP 2012
September 20, 1995 - November 8, 1995	Drought Emergency	N/A	N/A	Lowest PDSI for the Pocono Mountains Climate Division was -3.64 recorded in September 1995	PADEP, NRCC, Pike County HMP 2012
November 8, 1995 - December 18, 1995	Drought Warning	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
August 1997	Drought	N/A	N/A	The impacted counties had approximately $1.4 million in crop damage. Pike County had approximately $200,000 in crop damage as a result of this drought event.	NCEI
December 3, 1998 - December 8, 1998	Drought Watch	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
December 8, 1998 - December 14, 1998	Drought Watch	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
December 14, 1998 - December 16, 1998	Drought Warning	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
December 16, 1998 - January 15, 1999	Drought Warning	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
January 15, 1999 - March 15, 1999	Drought Warning	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
March 15, 1999 - June 10, 1999	Drought Watch	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
June 10, 1999 - June 18, 1999	Drought Warning	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
June 18, 1999 - July 20, 1999	Drought Warning	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
July 20, 1999 - September 30,1999	Drought Emergency	N/A	N/A	The lowest PDSI for the Pocono Mountains Climate Division was -3.65 recorded in August 1999.	PADEP, NRCC, Pike County HMP 2012

Date	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts / PDSI Value	Source(s)
July 1999	Drought	N/A	N/A	Governor Tom Ridge – Governor's Proclamation, Individual Assistance, Hazard Mitigation Grant Program – Amended to include all 67 counties for an agricultural disaster.	PEMA
September 30, 1999 - December 16, 1999	Drought Watch	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
December 16, 1999 - Feb 25,2000	Drought Watch	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
Feb 25, 2000 - May 5, 2000	Drought Watch	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
August 24, 2001 - November 6, 2001	Drought Watch	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
November 6, 2001 - December 5, 2001	Drought Watch	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
December 5, 2001 - Feb 12, 2002	Drought Warning	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
Feb 12, 2002 - May 13, 2002	Drought Emergency	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
September 5, 2002 - November 7, 2002	Drought Watch	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
April 11, 2006 - June 30, 2006	Drought Watch	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
August 8, 2007 - September 5, 2007	Drought Watch	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
September 16, 2010 – November 10, 2010	Drought Warning	N/A	N/A	No impacts and/or losses identified for this event.	PADEP, Pike County HMP 2012
June 28, 2012 – November 8, 2012	Drought	N/A	N/A	The combined effects of drought, high winds, hail, excessive heat, excessive rain, flash flooding, Hurricane sandy, snowstorms, and Nor'Easters, led to the USDA disaster declaration (S3487) for Pike County.	USDA
2014	Drought	N/A	N/A	Drought conditions led to a USDA disaster declaration (S3759) for Pike County.	USDA
March 24, 2015 – June 17, 2015	Drought Watch	N/A	N/A	No impacts and/or losses identified for this event.	PADEP
June 17, 2015 – July 10, 2015	Drought Watch	N/A	N/A	No impacts and/or losses identified for this event.	PADEP
April – September 2015	Drought	N/A	N/A	Excessive heat and drought led to a USDA disaster declaration (S3930) for Pike County.	USDA
November 2016	Drought Warning/Watc	N/A	N/A	The PADEP declared a drought watch for Pike County on November 9th and the county is still under a drought watch as of November 23rd. The PADEP	PADEP

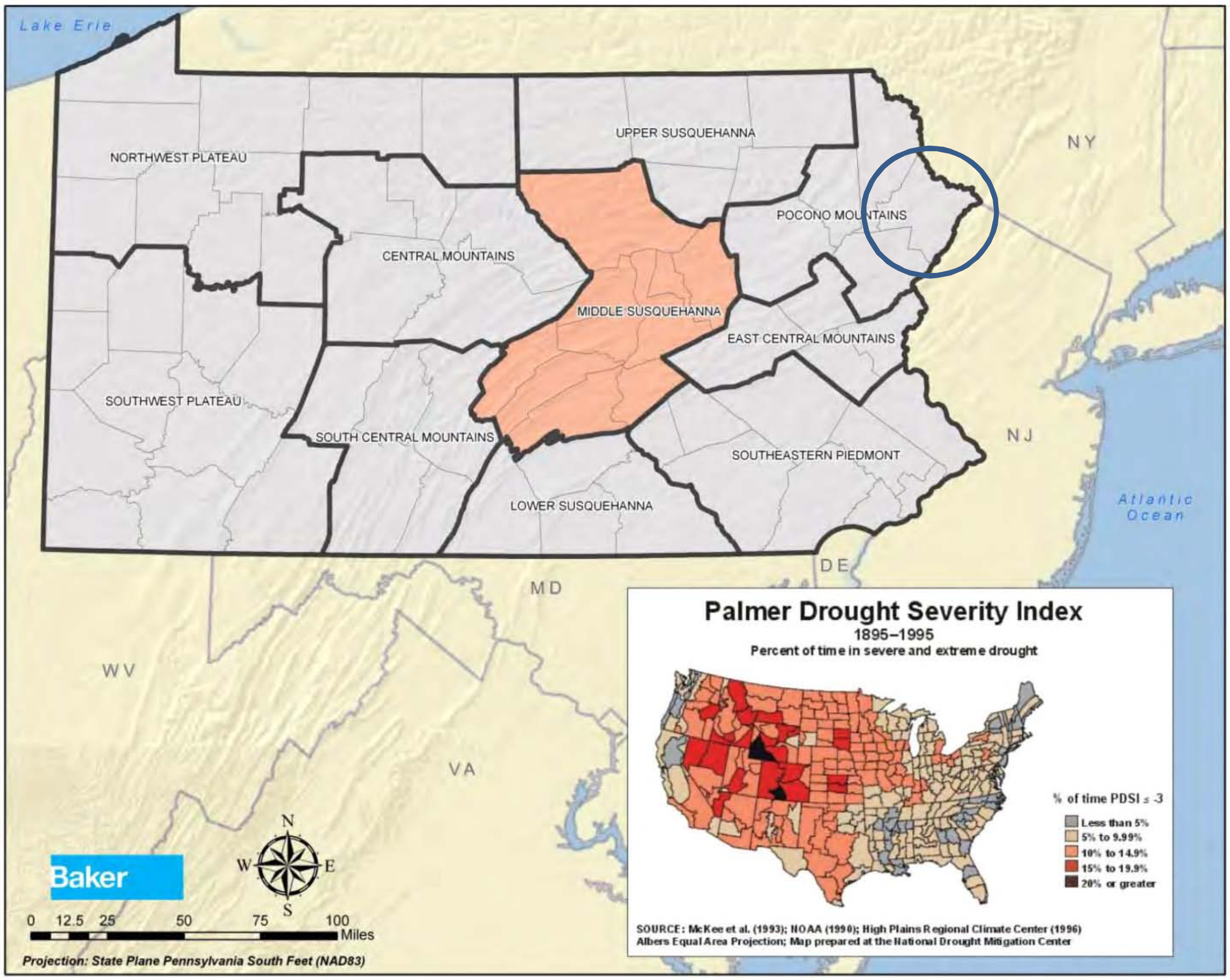
Date	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts / PDSI Value	Source(s)
	h			encourages those under a drought watch to reduce their nonessential water use by 5%.	

Sources: FEMA 2016; NCEI 2016; NRCC 2016; Pike County HMP 2012; PADEP 2016
FEMA Federal Emergency Management Agency
N/A Not applicable
NCEI National Centers for Environmental Information
NRCC Northeast Regional Climate Center
PADEP Pennsylvania Department of Environmental Protection
PDSI Palmer Drought Severity Index
PEMA Pennsylvania Emergency Management Agency
USDA U.S. Department of Agriculture

Future Occurrence

Based on the monthly Palmer Drought Severity Index, as computed by the National Centers for Environmental Information, the Pocono Mountains Climate Division (includes Pike County) was in extreme drought for 1.2% of the time and in severe drought for 3.4% of the time (based on data from January 1895 to November 2016). As presented in the 2013 Pennsylvania State Hazard Mitigation Plan, between 1895 and 1995, Pike County was in severe or extreme drought for less than 5 percent of the time period (see Figure 4.3.2-3). This is equivalent to a PDSI value less than or equal to -3.

Figure 4.3.2-3. Palmer Drought Severity Index for Pennsylvania (1895 to 1995)



Source: PEMA 2013

Note: The blue circle indicates the approximate location of Pike County

It is estimated that Pike County will continue to experience direct and indirect impacts of drought and its impacts on occasion, with secondary effects causing potential disruption or damage to agricultural activities and creating shortages in water supply within communities. For the 2017 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of drought events for Pike County. Information from PADEP, NOAA-NCEI storm events database, NRCC, and the 2012 County HMP were used to identify the number of drought events that occurred between 1950 and 2015. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimate percent chance of an incident occurring in a given year. Based on these statistics, there is an estimated 80.3-percent chance of a drought occurring in any given year in Pike County.

Table 4.3.2-5. Probability of Future Drought Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent Chance of occurrence in any given year
Drought	53	0.82	1.25	0.80	80.3%

Sources: Pike County HMP 2012; NOAA-NCEI 2016; NRCC 2016; PADEP 2016

The future occurrence of drought in Pike County can be considered *highly likely* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1). Due to the increasing demand for water by the increasing population base and the growing tourist population, droughts will continue to be a problem.

Vulnerability Assessment

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

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

Overview of Vulnerability

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

Data and Methodology

At the time this HMP was updated, insufficient data were available to model long-term potential impacts of a drought on Pike County. Over time, additional data will be collected to allow better analysis of this hazard. Preliminary assessments based on available data are provided below.

Impact on Life, Health, and Safety

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

All of Pike County's water supply is provided by groundwater, either through private wells, municipal water authorities or community water systems. There are two municipal water supply districts in Pike County (US Census GID, 2007). These districts serve residents in Matamoras and Milford Boroughs. Future droughts will quickly affect those systems relying on surface supplies while those on wells should be able to handle short-term droughts without any major problem. However, longer-term droughts which inhibit recharging of groundwater aquifers will extend the problems for water suppliers and well owners for an undetermined length of time. With a limited number of exceptions, few of the water systems in the County provide large storage capacity. Many of the small water systems operate with limited funds and little money is being invested for any improvements. As the county's population grows, more water is being removed from the aquifer. Unless significant improvements to the infrastructure are made to improve storage capability, many suppliers could find it increasing difficult to meet the demands over extended periods of below normal precipitation when the aquifer is not being adequately recharged.

Pike County residents that use private domestic wells are also vulnerable to droughts because their wells can dry up. There are 4,312 of these domestic wells in Pike County, with at least one in every municipality. Table 4.3.2-5 shows the number of domestic wells per municipality as collected by the Pennsylvania Groundwater Information System (PaGWIS). According to this dataset, residents in Dingman Township are the most vulnerable to the water supply issues related to droughts because of the high amount of wells that are reported there. It is important to note, however, that the well data collected by PaGWIS relies on voluntary submissions of well record data by well drillers; therefore, it is not a complete database of all domestic wells in the County.

Table 4.3.2-6. Number of Reported Domestic Wells in Pike County

Municipality	Number of Reported Domestic Wells	Municipality	Number of Reported Domestic Wells
Blooming Grove Township	122	Milford Borough	N/A
Delaware Township	516	Milford Township	178
Dingman Township	1,415	Palmyra Township	187
Greene Township	525	Porter Township	58
Lackawaxen Township	337	Shohola Township	330
Lehman Township	444	Westfall Township	152
Matamoras Borough	3	Unidentified Municipality	45
TOTAL	**4,312**		

Source: PaGWIS, 2016
N/A Information for this municipality was not reported

Impact on General Building Stock and Critical Facilities

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

Impact on the Economy

A prolonged drought can exert serious direct and indirect economic impacts on a community or across the County. A summary of impacts on the economy is presented in Table 4.3.2-6.

Table 4.3.2-7. Impacts on the Economy

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

Source: NYSDPC 2011
Note: Dark blue cell boxes indicate a new category of economic loss; all losses immediately underneath that category pertain to that loss type.

Loss estimates are based on lost agricultural revenues statewide. Table 4.3.2-7 below enumerates the County's farmland acreage exposure to the drought hazard, as well as the annual market value of all agricultural products sold, as documented in the 2012 USDA Census of Agriculture. If the County would lose its agricultural yield due to drought, total losses could amount to almost $2.97 million. Table 4.3.2-8 details potential losses associated with County livestock by providing livestock totals for the County and their associated market value. Livestock, poultry, and associated products have a potential loss value of nearly $259,000 (USDA 2012).

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

Impacted Farmland Acreage	Market Value Of All Agricultural Products
28,260	$2,965,000

Source: USDA 2012

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

Livestock and Poultry	Inventory	Market Value Of All Livestock, Poultry, and Their Products
Cattle and Calves	(D)	$259,000
Hogs and Pigs	N/A	
Sheep and Lambs	$5,000	
Layers	$2,175	
Poultry and Egg	$5,000	
Total	**$12,175**	

Source: USDA 2012
Note: Market value of livestock and poultry is provided only by total value and not available by category.
(D) – Amount omitted from report

According to the USDA, Pike County has experienced $0 in crop loss insurance payments on claims caused by drought events since 1948.

Impact on the Environment

As summarized in the PA HMP, environmental impacts of drought include:

- Hydrologic effects – lower water levels in reservoirs, lakes, and ponds; reduced streamflow; loss of wetlands; estuarine impacts; groundwater depletion and land subsidence; effects on water quality such as increases in salt concentration and water temperature
- Damage to animal species – lack of feed and drinking water; disease; loss of biodiversity; migration or concentration; and reduction and degradation of fish and wildlife habitat
- Damage to plant communities – loss of biodiversity; loss of trees from urban landscapes and wooded conservation areas
- Increased number and severity of fires
- Reduced soil quality
- Air quality effects – dust and pollutants
- Loss of quality in landscape through loss in plants and plant diversity
- Increase in nitrate levels, which can negatively affect health of pregnant women and children (PEMA 2013).

Future Growth and Development

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

Effect of Climate Change on Vulnerability

Climate is defined not just as average temperature and precipitation but also by type, frequency, and intensity of weather events. Both globally and at the local level, climate change can alter prevalence and severity of weather extremes such as droughts. While predicting changes in drought events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating effects of future climate change on human health, society, and the environment (U.S. Environmental Protection Agency [EPA] 2014).

The PADEP was directed by the Climate Change Act (Act 70 of 2008) to initiate a study of potential impacts of global climate change on the Commonwealth. The June 2009 Pennsylvania Climate Impact Assessment and October 2013 Pennsylvania Climate Impact Assessment Updates' main findings indicate that Pennsylvania is very likely to undergo increased temperatures in the 21st century. Increases in temperature will likely lead to increased evapotranspiration, and thus an increase in soil-moisture-related droughts throughout late spring and early fall. Pennsylvania's precipitation climate is projected to become more extreme in the future, with longer dry periods and greater intensity of precipitation (although the number of severe storms may in fact decrease). Most models project an increase in the maximum number of consecutive dry days in a year, a drought indicator (Shortle et al. 2009, 2013).

Future improvements in modeling smaller-scale climatic processes can be expected and will lead to improved understanding of how the changing climate will alter temperature, precipitation, storm frequency, and intensity in Pennsylvania. Understanding this information can help provide better indications of future drought events (Shortle et al. 2009).

4.3.3 Drowning

Drowning is death from suffocation, typically associated with swimming, fishing, boating or bridge accidents, or suicide. Every day, about ten people die from unintentional drowning. Of these, two are children aged 14 or younger. Drowning ranks fifth among the leading causes of unintentional injury death in the United States. From 2005-2014, there were an average of 3,536 fatal unintentional drownings (non-boating related) annually in the United States — about 10 deaths per day. An additional 332 people died each year from drowning in boating-related incidents. Drowning rates are particularly high for children ages 1-14. The Centers for Disease Control and Prevention (CDC) estimates that drowning is the second leading cause of injury death (after motor vehicle crashes) among children ages 1-14. (CDC 2016).

Drowning accidents can be categorized as unintentional, suicide, homicide, or undetermined depending on the circumstances (PA DOH, 2004). Unintentional drowning can be a significant hazard in communities with numerous water bodies (e.g. ponds, lakes, rivers, etc.) and extensive outdoor recreational activity. In addition, drowning accidents can occur in swimming pools at private residences as above ground pools such as “kiddie pools” and inflatable pools become more popular.

Location and Extent

Drowning can be a significant hazard in communities with numerous bodies of water (ponds, lakes, rivers, etc.) and extensive outdoor recreational activity. Pike County has been and continues to grow in popularity as a tourist destination. Water related recreational opportunities such as fishing, boating, and swimming are popular among visitors. Some of the most popular tourist destinations in Pike County are the Delaware Water Gap National Recreation Area waterfalls, Lake Wallenpaupack, , Pecks Pond (owned partially by the state) in Porter Township, two lakes at Promised Land State Park (Greene Township), and the Delaware River specifically in the Delaware Water Gap National Recreational Area. In addition to natural bodies of water, swimming pools are another location where drownings occur. Many swimming pools are located at residences and at hotels, resorts, and residential communities located throughout Pike County.

One of the most popular tourist destinations in the County is Lake Wallenpaupack where drownings have historically taken place. The Palmyra Township Beach is the only public beach on Lake Wallenpaupack; however, there are numerous other private properties surrounding the lake.

Drownings also have occurred in the Delaware River, where the danger stems from swift currents, deep holes, and sudden drop offs (NPS 2008). Milford Beach is a popular swimming location along the Delaware River and contains a federal boat launch in addition to its sand beach.

Range of Magnitude

By definition, drowning generally results in death. However, nonfatal drownings can cause brain damage that may result in long-term disabilities including memory problems, learning disabilities, and loss of basic nervous system functions. In a typical year, counties in Pennsylvania can range from having 0 to 100 drowning incidents and depend on factors such as the physical environment (access to water bodies) and a combination of social and cultural issues (wanting to learn how to swim and interest in recreational water-related activities).

Drowning is ranked seventh for the leading cause of injury death in Pennsylvania. Across the state, 33-percent of residents who died from drowning were under 20 years of age (PA DOH, 2004). Approximately 76-percent of drowning accidents in Pennsylvania from 2001 to 2005 have been unintentional, another fourteen percent were suicides, eight percent were from undetermined causes, and less than two percent were deemed homicides.

A worst case scenario for drowning occurred in July of 2009 when a man drowned when boating with family and friends in Lake Wallenpaupack. Numerous rescue teams from Pennsylvania, New York, and New Jersey, including the FBI, state police, state Fish & Boat Commission and area volunteer response teams assisted in the search for the body (News Eagle, July 24, 2009). It took a week to recover the body from the water because of cold water temperatures and the nature of the bottom of the lake. It was the second drowning in Lake Wallenpaupack that month.

Past Occurrence

There is no official federal, state, or county reporting system for drownings; however, the Pennsylvania Department of Health has a report of drowning deaths that occurred in Pike County between 1999 and 2014. Table 4.3.3-1 lists the number of deaths from drowning and submersion in the county. The data does not include information about the water bodies where the drownings occurred.

Table 4.3.3-1. Incidents of drowning and submersion that have occurred in Pike County

Years	Number of Deaths
1999	0
2000	0
2001	1
2002	2
2003	0
2004	1
2005	0
2006	3
2007	0
2008	0
2009	3
2010	0
2011	1
2012	0
2013	1
2014	2
TOTAL:	**14**

Source: PA DOH Enterprise Data Dissemination Informatics Exchange (EDDIE) 2016

According to the National Park Service, between 1980 and 2008 there have been 56 deaths due to drowning in the Upper Delaware River, which stretches from Wayne County to Milford. Twenty nine of those that drowned were swimming or wading and the average age was 28. The National Park Service report does not include the specific locations in the Upper Delaware River where the drownings occurred (Pike County HMP 2012).

Available details regarding drowning incidents that occurred in Pike County are discussed below:

- February 2006 – A boater went missing on the Delaware River in Westfall Township; a search was conducted and the body was recovered.
- April 2008 – A search was conducted on the Delaware River in Lehman Township for two boaters. The report is inconclusive as to the status of the boaters.
- May 2009 - A man's body was discovered near a dock in Lake Wallenpaupack.
- July 2009 - A mother of two wandered away from a beached boat and died of an accidental drowning in Lake Wallenpaupack.
- September 2009 - A Florida man drowned in Lake Wallenpaupack near the Seeley's Landing area.
- May 31, 2010 – A 31-year old man drowned while trying to swim across the Delaware River at Milford Beach.
- July 2016 – A man drowned in Westcolang Lake in Lackawaxen Township

Future Occurrence

It is impossible to predict when and where drowning may occur; however, given past occurrences of drownings in Pike County the majority have occurred in Lake Wallenpaupack or the Delaware River. During the warm summer months, as activities such as swimming, boating and fishing increase, and as such, so does the likelihood of drowning.

For the 2017 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of drowning events for Pike County. Information from the 2012 County HMP, the Pennsylvania Department of Health's Enterprise Data Dissemination Informatics Exchange (EDDIE) system and internet searches were used to identify the number of drought events that occurred between 1950 and 2015. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimate percent chance of an incident occurring in a given year. Based on these statistics, there is an estimated 94-percent chance of a drowning occurring in any given year in Pike County.

Table 4.3.2-5. Probability of Future Drowning Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent Chance of occurrence in any given year
Drowning	62	0.95	1.06	0.94	93.9%

Sources: Pike County HMP 2012; EDDIE 2016

Based on past occurrence and the popularity of Pike County as a tourist destination for water-related recreation, the future occurrence of drowning in Pike County can be considered *highly likely* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1).

Vulnerability Assessment

As tourism continues to increase in Pike County and number of visitors grows, drowning is likely to continue without mitigation actions in place. Municipalities that border Lake Wallenpaupack and the Delaware River are more vulnerable to drownings as their residents have easiest access to the water bodies. However, residents from other municipalities and from outside the County also frequent these natural assets.

In 2009, the rules for the Upper Delaware River, from Hancock, NY to Sparrowbush, NY (slightly upstream of Milford Beach) were changed to make wearing life jackets mandatory for people of all ages when river gage heights at Barryville or Callicoon surpass six feet. This may reduce risk of drowning hazards in the upper river valley Pike County municipalities that border the Delaware River, however, Milford Beach is situated below the area covered by those rules.

According to the Pennsylvania Fish & Boat Commission, all children 12 years of age and younger on all Commonwealth waters must wear a personal floatation device (PFD or life jacket) while underway on any boat 20-feet in length or less and on all canoes and kayaks. All boats must have a U.S. Coast Guard approved wearable PFD on board for each person. In addition, anyone towed behind a boat (regardless of age and activity), all personal watercraft operators and passengers, and sailboarders (wind surfers) must wear a life jacket. Further, in addition to PFDs, boats 16 feet and over must have a throwable device on board (excluding canoes and kayaks) (PA FBC, 2010).

In 2012, the Pennsylvania Fish & Boat Commission mandated that a person shall wear a U.S. Coast Guard-approved PFD during cold weather months (November 1st through April 30th) while underway or at anchor on boats less than 16 feet in length or any canoe or kayak to increase chance of survival in cold water (PA FBC, 2017).

4.3.4 Earthquake

An earthquake is sudden movement of the Earth's surface caused by release of stress accumulated within or along the edge of the Earth's tectonic plates, a volcanic eruption, or a manmade explosion (Shedlock and Pakiser 1997). Most earthquakes occur at the boundaries where the Earth's tectonic plates meet (faults); less than 10 percent of earthquakes occur within plate interiors. As plates continue to move and plate boundaries change geologically over time, weakened boundary regions become part of the interiors of the plates. These zones of weakness within the continents can cause earthquakes, which are a response to stresses that originate at the edges of the plate or in the deeper crust (Shedlock and Pakiser 1997).

According to the U.S. Geological Survey (USGS) Earthquake Hazards Program, an earthquake hazard is any disruption associated with an earthquake that may affect residents' normal activities. This category includes surface faulting, ground motion (shaking), landslides, liquefaction, tectonic deformation, tsunamis, and seiches. Each of these terms is defined below:

- Surface faulting: Displacement that reaches the Earth's surface during a slip along a fault. Commonly occurs with shallow earthquakes—those with an epicenter of less than 20 kilometers (km).
- Ground motion (shaking): Movement of the earth's surface from earthquakes or explosions. Ground motion or shaking is produced by waves generated by a sudden slip on a fault or sudden pressure at the explosive source, and that travel through the Earth and along its surface.
- Landslide: Movement of surface material down a slope.
- Liquefaction: A process by which water-saturated sediment temporarily loses strength and acts as a fluid, like the wet sand near the water at the beach. Earthquake shaking can cause this effect.
- Tectonic Deformation: Change in the original shape of a material caused by stress and strain.
- Tsunami: A sea wave of local or distant origin that results from large-scale seafloor displacements associated with large earthquakes, major sub-marine slides, or exploding volcanic islands.
- Seiche: Sloshing of a closed body of water, such as a lake or bay, from earthquake shaking (USGS 2012).

Ground shaking is the primary cause of earthquake damage to man-made structures. Damage can be increased when soft soils amplify ground shaking. Soils influence damage in different ways. Soft soils can amplify the motion of earthquake waves, producing greater ground shaking and increasing stresses on built structures on the land surface. Loose, wet, sandy soils also can cause damage when they lose strength and flow as a fluid when shaken, causing foundations and underground structures to shift and break (Stanford 2003).

The National Earthquake Hazard Reduction Program (NEHRP) developed five soil classifications (A to E) distinguished by soil shear-wave velocity that alters severity of an earthquake; each classification is listed in Table 4.3.4-1. Class A soils—hard rock—reduce ground motion from an earthquake, and Class E soils—soft soils—amplify and magnify ground shaking, and increase building damage and losses.

Figure 4.3.4-1. NEHRP Soil Classifications

Soil Classification	Description
A	Hard rock
B	Rock
C	Very dense soil and soft rock
D	Stiff soils
E	Soft soils

Source: Federal Emergency Management Agency (FEMA) 2013

The following sections discuss location and extent, range of magnitude, previous occurrence, future occurrence, and vulnerability assessment associated with the earthquake hazard in Pike County.

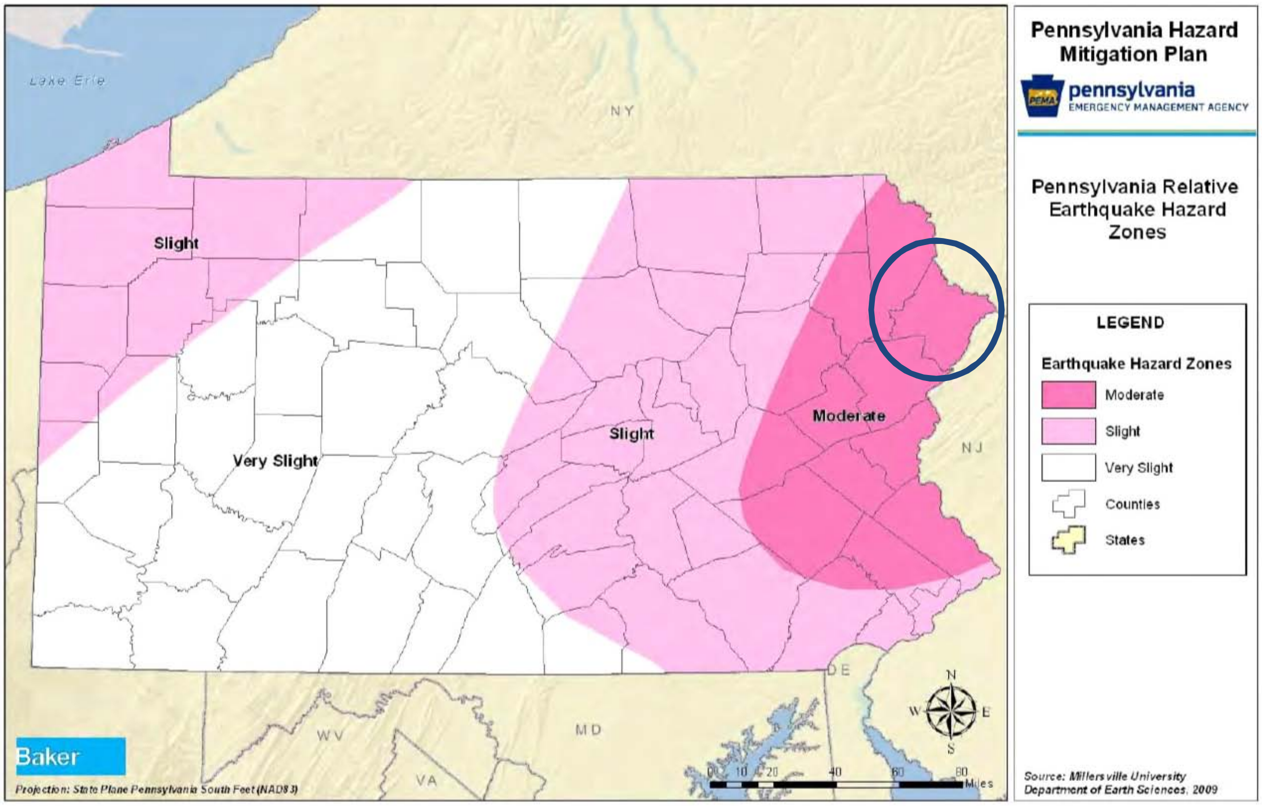
Location and Extent

Focal depth and geographic position of the epicenter of an earthquake commonly determine its location. Focal depth of an earthquake is the depth from the Earth's surface to the region where an earthquake's energy originates (the focus or hypocenter). The epicenter of an earthquake is the point on the Earth's surface directly above the hypocenter. Earthquakes usually occur without warning, and their effects can be felt in areas at great distances from the epicenter.

According to the Pennsylvania Bureau of Topographic and Geologic Survey, events that occur in the Commonwealth involve very small impact areas (less than 100 km in diameter). The most seismically active region in the Commonwealth is in southeastern Pennsylvania in the area of Lancaster County (Pennsylvania Emergency Management Agency [PEMA] 2013). Areas of Pennsylvania, including Pike County, may be subject to the effects of earthquakes with epicenters outside the Commonwealth.

Pennsylvania has three earthquake hazard area zones: very slight, slight, and moderate (shown on Figure 4.3.4-2) (PEMA 2013). Pike County is within the "moderate zone".

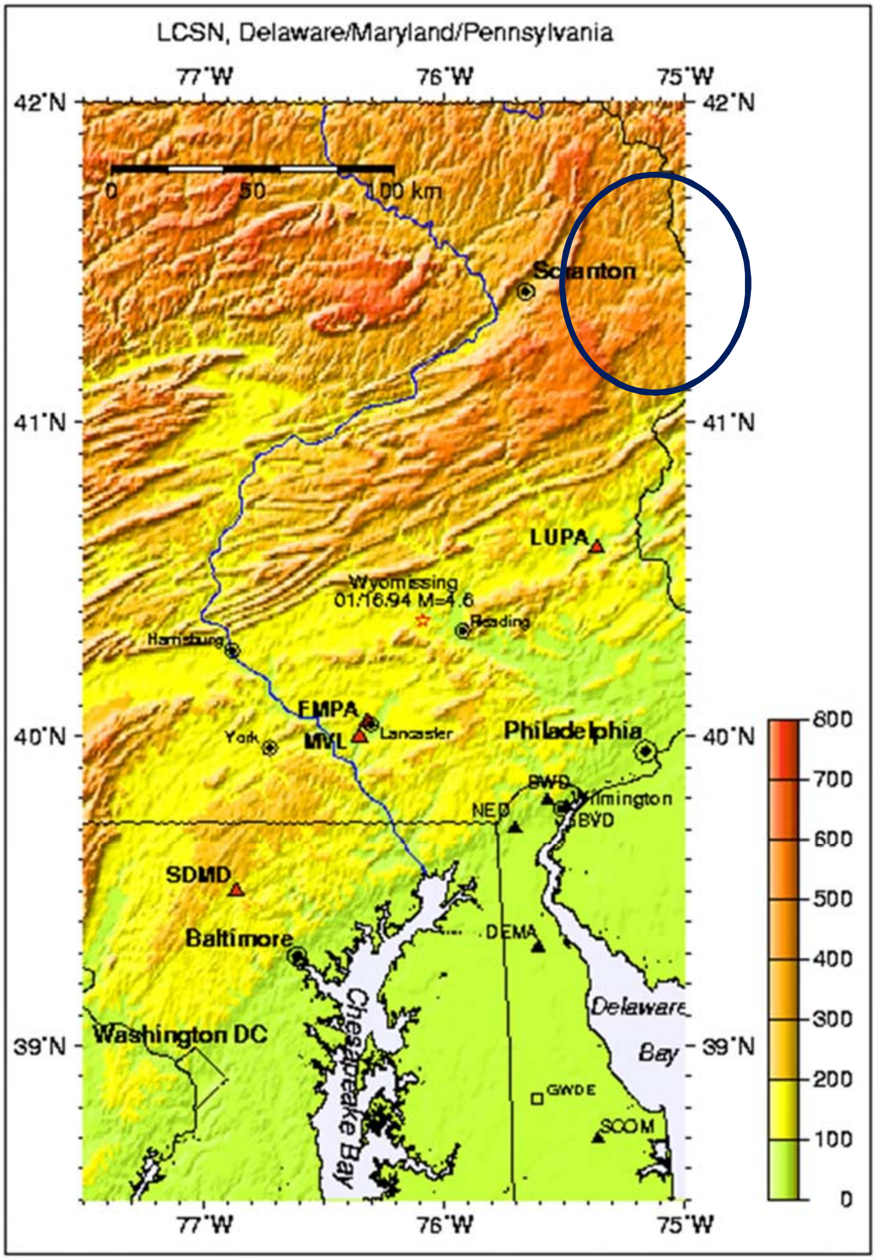
Figure 4.3.4-2. Pennsylvania Earthquake Hazard Zones



Source: PEMA 2013
Note: Pike County is within the blue oval on the map.

The Lamont-Doherty Cooperative Seismographic Network (LCSN) monitors earthquakes that occur primarily in the northeastern United States. Goals of the project are to compile a complete earthquake catalog for this region, assess earthquake hazards, and study causes of earthquakes in the region. LCSN operates 40 seismographic stations in the following seven states: Connecticut, Delaware, Maryland, New Jersey, New York, Pennsylvania, and Vermont. Figure 4.3.4-3 shows locations of seismographic stations in eastern Pennsylvania. The figure shows one station, Lehigh University station, is the closest station to Pike County. There is a station located in Basking Ridge, NJ as well. The network is composed of broadband and short-period seismographic stations (LCSN 2012).

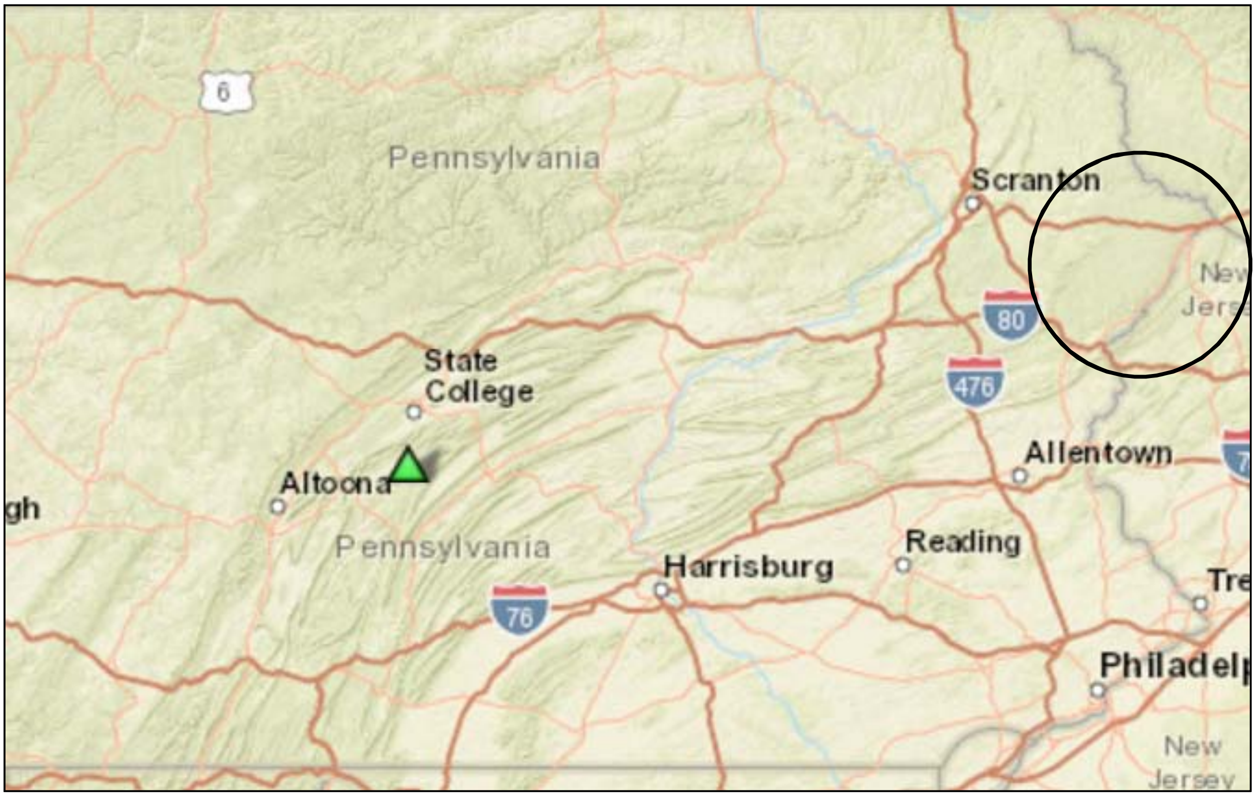
Figure 4.3.4-3. Lamont-Doherty Seismic Stations Locations in Eastern Pennsylvania



Source: LCSN 2006
Note: Pike County is within the oval on the map.

In addition to the Lamont-Doherty Seismic Stations, USGS operates a global network of seismic stations to monitor seismic activity. While no seismic stations are within Pike County, nearby stations are in State College, Pennsylvania. Figure 4.3.4-4 shows their locations.

Figure 4.3.4-4. USGS Seismic Stations



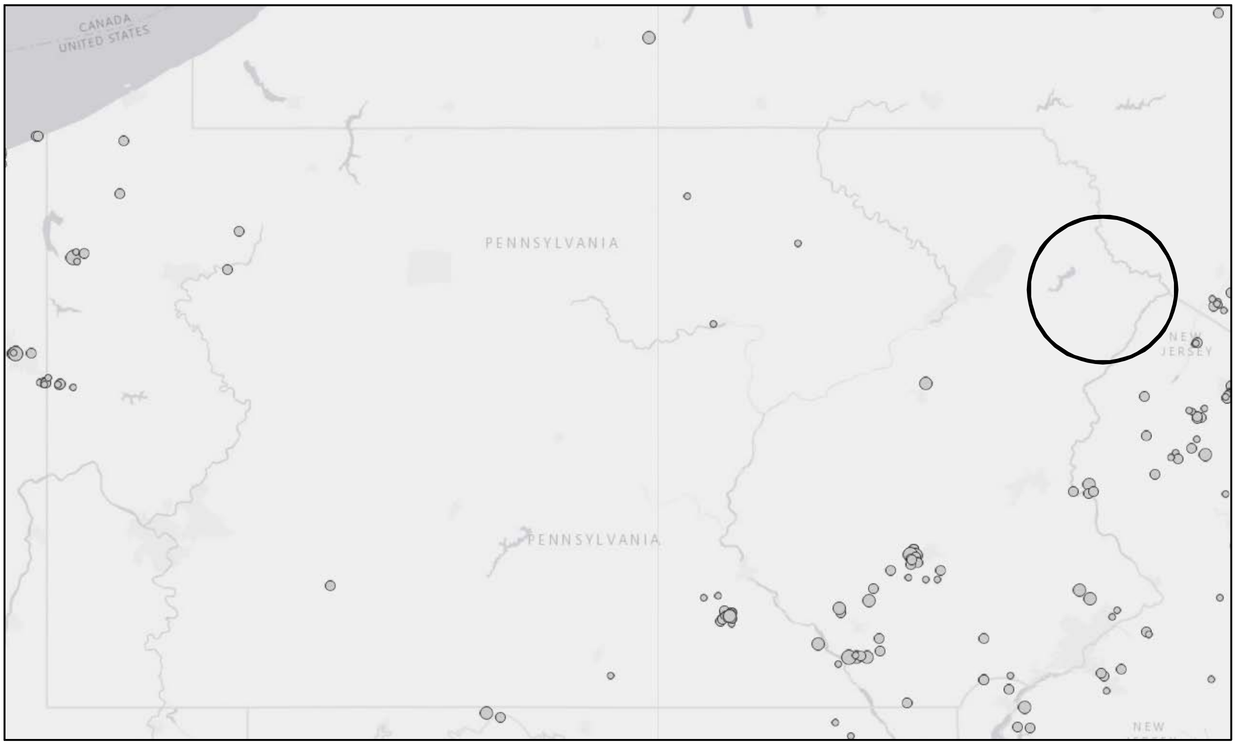
Source: USGS 2016

Note: Seismic station locations are indicated by green triangles, and Pike County is within the black oval.

The USGS provides the website *Did You Feel It?* (http://earthquake.usgs.gov/earthquakes/dyfi/) for citizens to report earthquake experiences and to share information regarding the earthquake and its effects. The website is intended to gather citizens' experiences during an earthquake and incorporate the information into detailed maps for illustrating shaking intensity and damage assessments (USGS 2016).

Earthquakes above a magnitude 5.0 can cause damage near their epicenters, and larger-magnitude earthquakes can cause damage over larger, wider areas. Earthquakes in Pennsylvania appear to be centered in the southeastern portion and northwestern corner of the Commonwealth. Figure 4.3.4-5 illustrates earthquake activity in Pennsylvania from 1950 to 2016, with Pike County circled in black. A discussion of previous occurrences of earthquakes in Pike County appears in the Previous Occurrence section (Section 4.3.4.3) of this profile.

Figure 4.3.4-5. Earthquake Epicenters in Pennsylvania, 1950 – 2016



Source: USGS 2016
Note: The black circle indicates the approximate location of Pike County.

Range of Magnitude

Seismic waves are vibrations from earthquakes that travel through the Earth and are recorded on instruments called seismographs. The magnitude or extent of an earthquake is a given value of the earthquake size, or amplitude of the seismic waves, as measured by a seismograph. The Richter magnitude scale (Richter scale) was developed in 1932 as a mathematical device to compare sizes of earthquakes. The Richter scale is the most widely known scale that measures magnitude of earthquakes. It has no upper limit and is not used to express damage. An earthquake in a densely populated area that results in many deaths and considerable damage may have the same magnitude and shock in a remote area that did not undergo any damage. Table 4.3.4-2 lists Richter scale magnitudes and corresponding earthquake effects associated with each magnitude. Based on historical data of earthquakes with a recorded intensity, little damage is expected from earthquake events. However, since the worst earthquake recorded in Pennsylvania was a magnitude 5.2, a worst case scenario for this hazard would be if an earthquake of similar magnitude occurred in Pike County or near the border in an adjacent county, causing mild damage in populated areas.

Table 4.3.4-1. Richter Scale Magnitudes

Richter Magnitude	Earthquake Effects
2.5 or less	Usually not felt, but can be recorded by seismograph
2.5 to 5.4	Often felt, but causes only minor damage
5.5 to 6.0	Slight damage to buildings and other structures
6.1 to 6.9	May cause a lot of damage in very populated areas
7.0 to 7.9	Major earthquake; serious damage

Richter Magnitude	Earthquake Effects
8.0 or greater	Great earthquake; can destroy communities near the epicenter

Source: PEMA 2013

The intensity of an earthquake is based on observed effects of ground shaking on people, buildings, and natural features, and varies with location. The Modified Mercalli Intensity (MMI) scale expresses the intensity of an earthquake and is a subjective measure that describes the strength of a shock felt at a particular location. The MMI scale expresses intensity of an earthquake's effects in a given locality according to a scale from I to XII. Descriptions of MMI scales appear in Table 4.3.4-2. Earthquakes that occur in Pennsylvania originate deep within the Earth's crust, and not on an active fault. No injury or severe damage from earthquake events has been reported in Pike County.

Table 4.3.4-2. Modified Mercalli Intensity Scale with Associated Impacts

Scale	Intensity	Description Of Effects	Corresponding Richter Scale Magnitude
I	Instrumental	Detected only on seismographs	<4.2
II	Feeble	Some people feel it	
III	Slight	Felt by people resting; feels like a truck rumbling by	
IV	Moderate	Felt by people walking	
V	Slightly Strong	Sleepers awake; church bells ring	<4.8
VI	Strong	Trees sway; suspended objects swing; objects fall off shelves	<5.4
VII	Very Strong	Mild alarm; walls crack; plaster falls	<6.1
VIII	Destructive	Moving cars uncontrollable; masonry fractures; poorly constructed buildings are damaged	<6.9
IX	Ruinous	Some houses collapse; ground cracks; pipes break open	
X	Disastrous	Ground cracks profusely; many buildings are destroyed; liquefaction and landslides are widespread	<7.3
XI	Very Disastrous	Most buildings and bridges collapse; roads, railways, pipes, and cables are destroyed; general triggering of other hazards occurs	<8.1
XII	Catastrophic	Total destruction; trees fall; ground rises and falls in waves	>8.1

Source: PEMA 2013

Seismic hazards are often expressed in terms of Peak Ground Acceleration (PGA) and Spectral Acceleration (SA). USGS defines PGA and SA as the following: "PGA is what is experienced by a particle on the ground. Spectral Acceleration (SA) is approximately what is experienced by a building, as modeled by a particle mass on a massless vertical rod having the same natural period of vibration as the building" (USGS 2012). Both PGA and SA can be measured in *g* (the acceleration caused by gravity) or expressed as a percent acceleration force of gravity (percent g). For example, at 100 percent g PGA (equivalent to 1.0 g) during an earthquake (an extremely strong ground motion), objects accelerate sideways at the same rate as when they drop from a ceiling. At 10 percent g PGA, ground acceleration is 10 percent that of gravity (New Jersey Office of Emergency Management [NJOEM] 2011). PGA and SA hazard maps provide insight into location-specific vulnerabilities (New York State Disaster Preparedness Commission [NYSDPC] 2011).

PGA is a common earthquake measurement that indicates three factors: (1) geographic area affected, (2) probability of an earthquake at each level of severity, and (3) strength of ground movement (severity) expressed in percent g. In other words, PGA expresses the severity of an earthquake and is a measure of how hard the earth shakes (or accelerates) in a given geographic area (NYSDPC 2011). Damage levels from an earthquake vary with intensity of ground shaking and with seismic capacity of structures, as noted in Table 4.3.4-3.

Table 4.3.4-3. Damage Levels Experienced in Earthquakes

Ground Motion Percentage	Explanation of Damages
1-2% g	Motions are widely felt by people; hanging plants and lamps swing strongly, but damage levels, if any, are usually very low.
Below 10% g	Usually causes only slight damage, except in unusually vulnerable facilities.
10-20% g	May cause minor-to-moderate damage in well-designed buildings, with higher levels of damage in poorly designed buildings. At this level of ground shaking, only unusually poor buildings would be subject to potential collapse.
20-50% g	May cause significant damage in some modern buildings and very high levels of damage (including collapse) in poorly designed buildings.
≥50% g	May causes higher levels of damage in many buildings, even those designed to resist seismic forces.

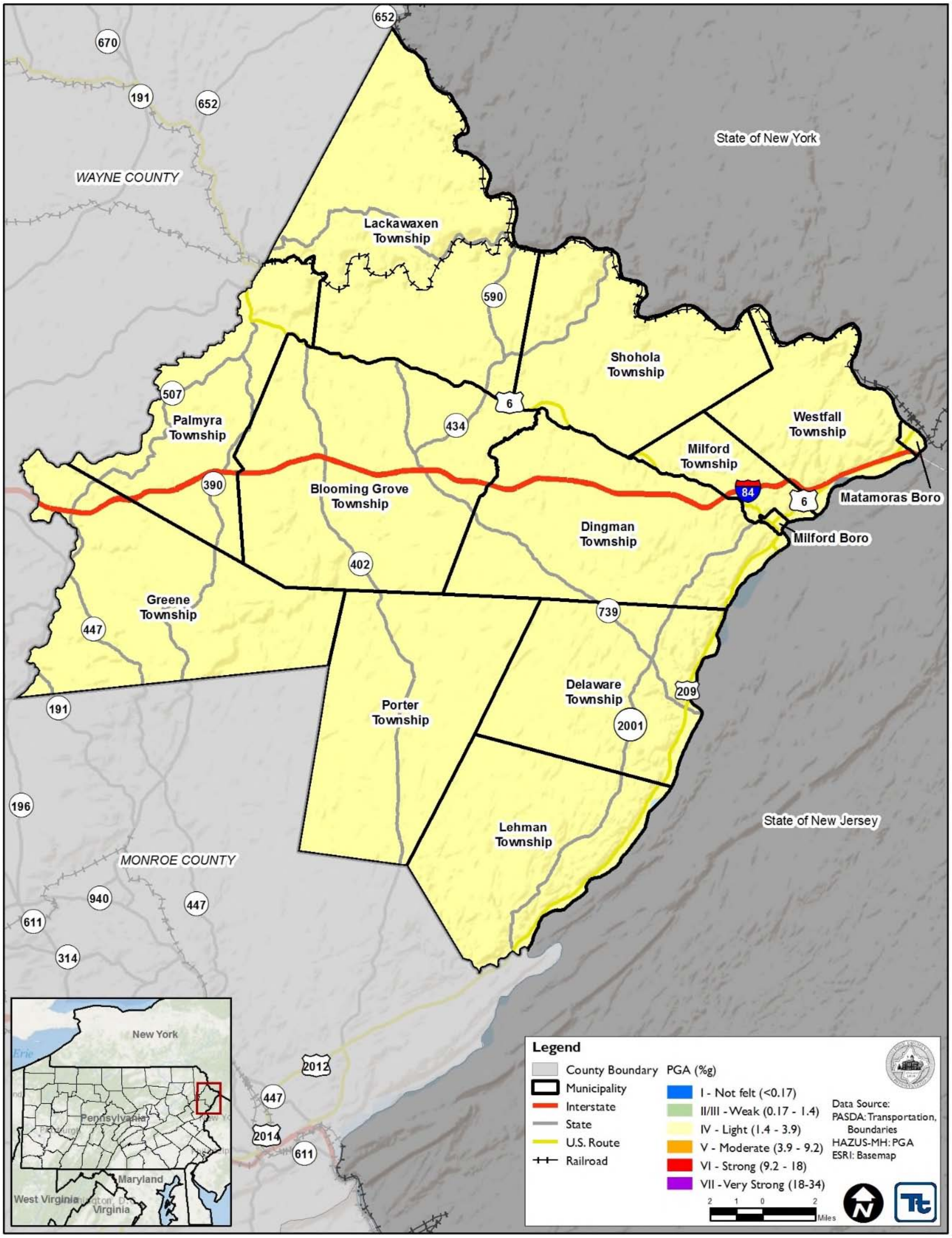
Source: NJOEM 2011
Note: % g Peak Ground Acceleration

National maps of earthquake shaking hazards have been produced since 1948. These maps provide information essential for creating and updating seismic design requirements for building codes, insurance rate structures, earthquake loss studies, retrofit priorities, and land use planning applied in the United States. Scientists frequently revise these maps to reflect new information and knowledge. Buildings, bridges, highways, and utilities built to meet modern seismic design requirements are typically able to withstand earthquakes better, with less damage and disruption. After thoroughly reviewing the studies, professional organizations of engineers update seismic-risk maps and seismic design requirements specified in building codes (Brown and others 2001).

To analyze the earthquake hazard in Pike County, a probabilistic assessment was conducted for the 100-, 500- and 2,500-year mean return periods (MRP) in Hazards U.S. – Multi-Hazard (HAZUS-MH) 3.0. A HAZUS analysis evaluates statistical likelihood that a specific event will occur and the consequences of that event. A 100-year MRP event is an earthquake with a 1-percent chance that the mapped ground motion levels (PGA) will be exceeded in any given year. A 500-year MRP event is an earthquake with a 0.2-percent chance that the mapped ground motion levels (PGA) will be exceeded in any given year. A 2,500-year MRP event (the worst-case scenario) is an earthquake with 0.04-percent chance that the mapped PGA will be exceeded in any given year.

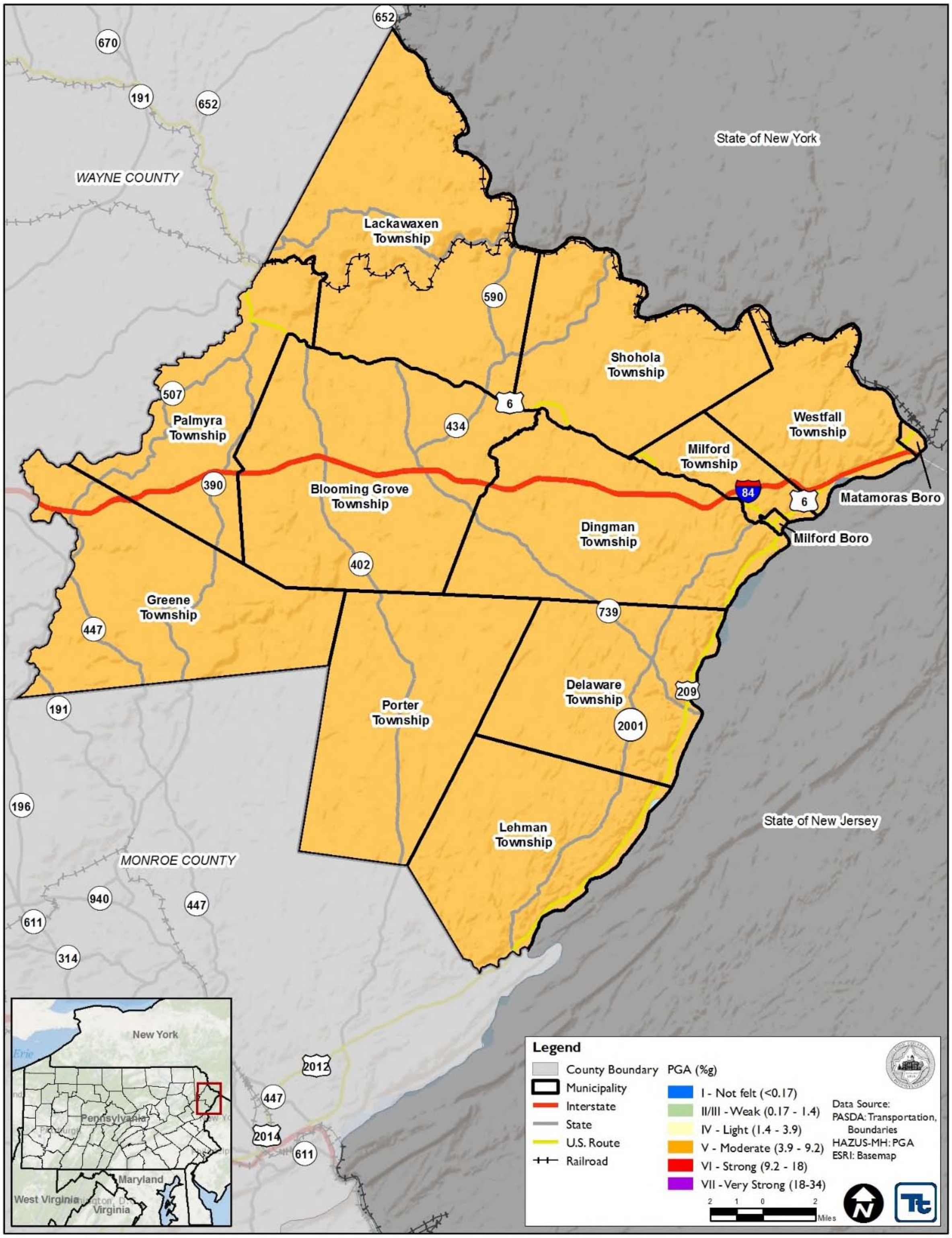
Figures 4.3.4-5 through 4.3.4-7 illustrate the geographic distribution of PGA (percent *g*) across Pike County for each event. Potential losses estimated by HAZUS-MH for the MRP and the associated PGA are discussed in the Vulnerability Assessment section (Section 4.3.4.5) of this profile.

Figure 4.3.4-6. Peak Ground Acceleration Modified Mercalli Scale in Pike County for a 100-Year MRP Earthquake Event



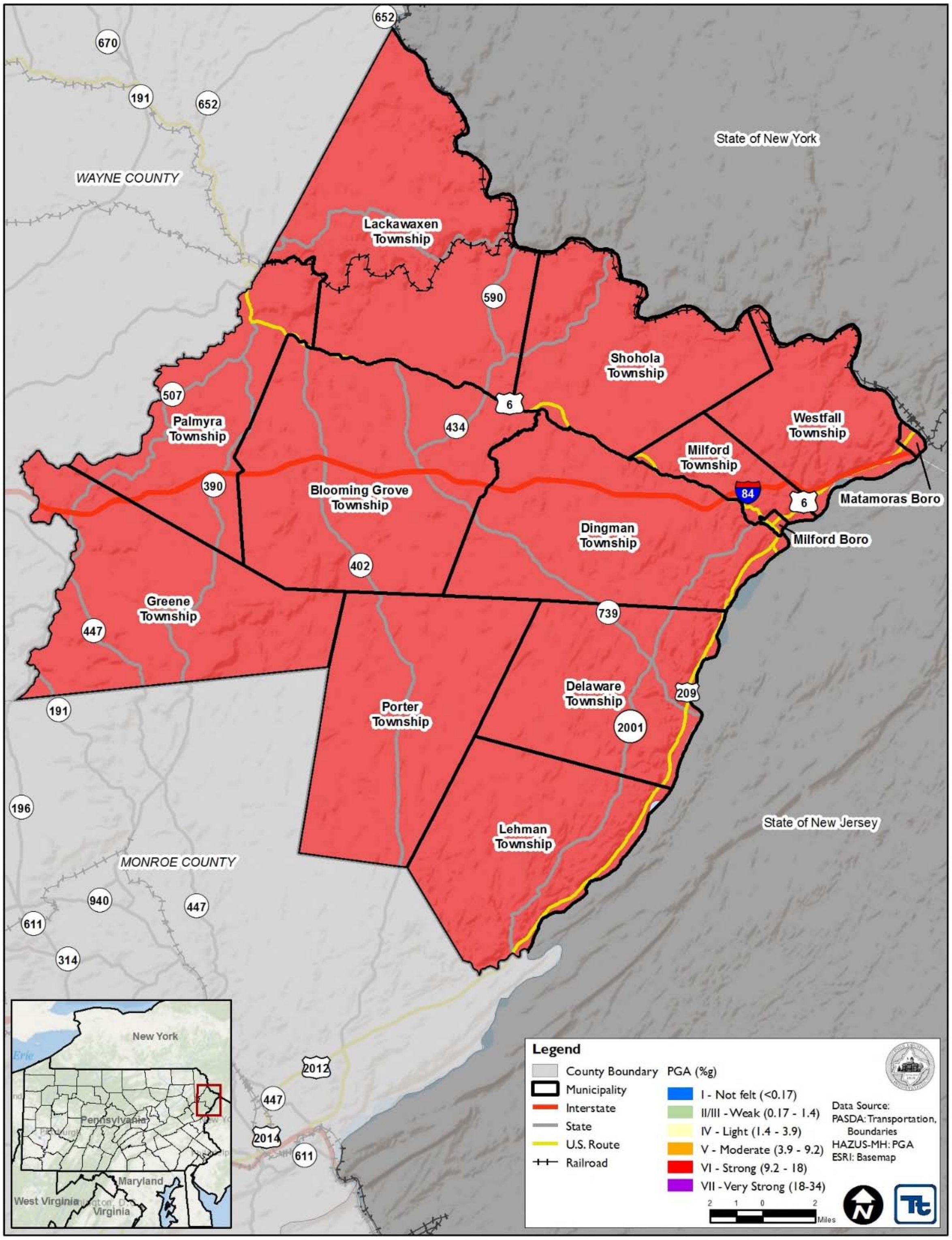
Source: HAZUS-MH 3.1
Note: The peak ground acceleration for the 100-year MRP is 1.5-1.6%g.

Figure 4.3.4-7. Peak Ground Acceleration Modified Mercalli Scale in Pike County for a 500-Year MRP Earthquake Event



Source: HAZUS-MH 3.1
Note: The peak ground acceleration for the 500-year MRP is 4.6-5.4%g.

Figure 4.3.4-8. Peak Ground Acceleration Modified Mercalli Scale in Pike County for a 2,500-Year MRP Earthquake Event

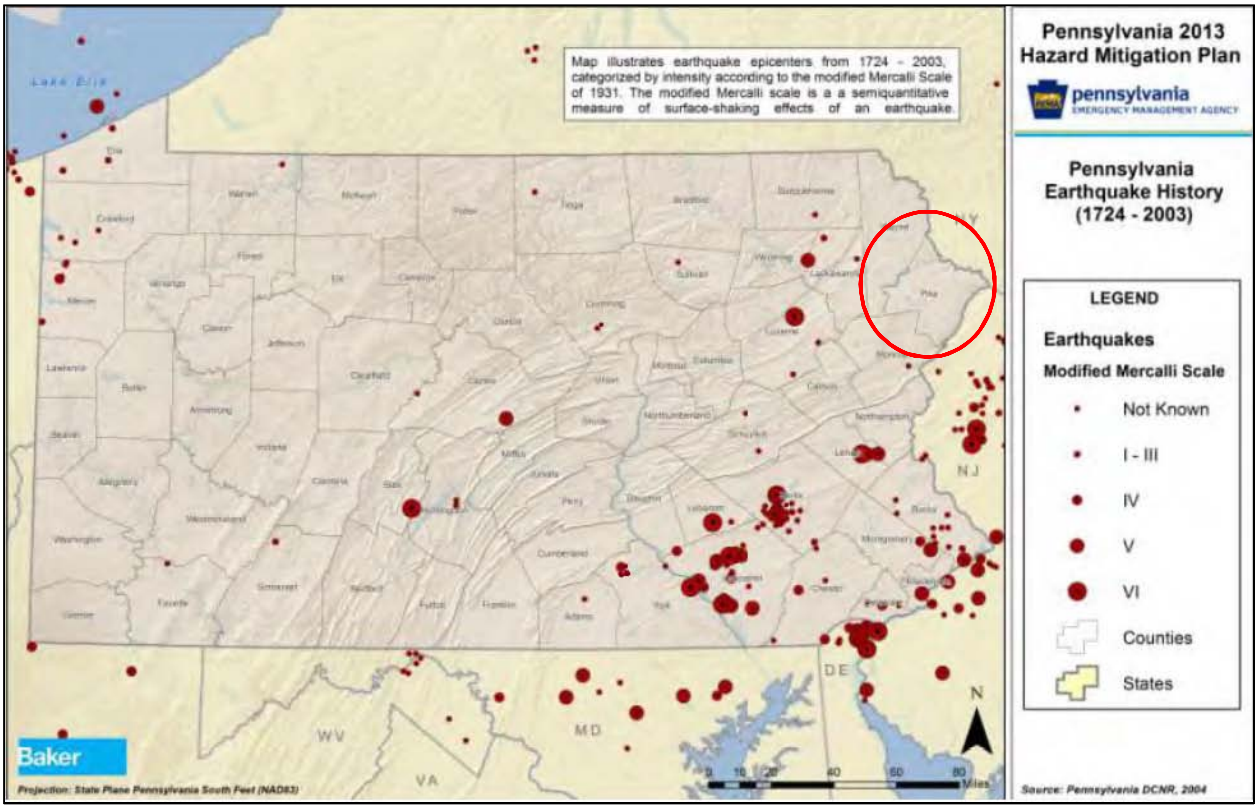


Source: *HAZUS-MH 3.1*
Note: *The peak ground acceleration for the 2,500-year MRP is 12.3-16.6%g.*

Past Occurrence

The historical record of earthquakes goes back approximately 200 years. In Pennsylvania, about 48 earthquakes have caused light damage since the Colonial period. Nearly half of these events had out-of-state epicenters (PEMA 2013, USGS 2014). Figure 4.3.4-9 is a map of earthquake epicenters in Pennsylvania from 1724 to 2003. No damages were reported in Pike County.

Figure 4.3.4-9. Earthquake Epicenters in Pennsylvania



Source: PEMA 2013
Note: Pike County is within the red circle.

According to the USGS, there have been no earthquake epicenters recorded in Pike County between 1724 and September 27, 2016. Recorded epicenters closest to Pike County were a 3.0 magnitude earthquake on April 27, 1974 in Luzerne County; and 1.0 on March 18, 2002, 1.3 on February 21, 2006, and 2.4 on February 16, 2006 in Sussex County, New Jersey (USGS 2016). PEMA's Pennsylvania Disaster History list includes no significant earthquake events in Pennsylvania, and no Federal Emergency Management Agency (FEMA) major disaster (DR) / emergency declarations (EM) have occurred for significant earthquake events in Pennsylvania (FEMA 2016). Additionally, according to the USGS "Did You Feel It", Pike County residents reported having felt the recent earthquakes that occurred in Sussex County (USGS 2016).

Historically, large earthquakes in eastern North America have occurred in three regions: (1) Mississippi Valley near the Town of New Madrid, Missouri; (2) St. Lawrence Valley region of Quebec, Canada; and (3) Charleston, South Carolina. In February 1925, one of the region's largest earthquakes on record occurred (magnitude near 7.0) with its epicenter in a region of Quebec. If a similar-magnitude earthquake would occur in the western part of the Quebec region, some moderate damage might be expected in one or more counties of Pennsylvania's northern tier. An earthquake with an estimated magnitude of about 7.5 occurred on August 31, 1886, in Charleston, South Carolina. The earthquake was felt in most of Pennsylvania. Since then, an earthquake with a magnitude of 5.8 occurred in Louisa County, Virginia; it was felt throughout Pennsylvania, causing evacuations, minor damage, and emergency infrastructure inspections (PEMA 2013).

Other earthquakes have occurred in east coast areas, including eastern Massachusetts, southeastern New York, and northern New Jersey. Moderate earthquakes occurred in southeastern New York and northern New Jersey, and were felt in eastern Pennsylvania. If an earthquake of magnitude 6.0 or greater would occur in that area, damage would likely result in easternmost counties of Pennsylvania, including Pike County.

Future Occurrence

Earthquakes cannot be predicted and may occur any time of the day or year. Major earthquakes are infrequent in the State and County and may occur only once every few hundred years or longer, but the consequences of major earthquakes may potentially be very high. Based on the historic record, the future probability of damaging earthquakes impacting Pike County is low.

According to the USGS earthquake catalog, between 1950 and 2015, there have been no earthquakes with epicenters in Pike County. Earthquakes have occurred outside of Pike County but it is unknown as to whether or not those events had direct or indirect impacts on County assets. Based on available historical data, future occurrences of earthquake events can be considered *unlikely* as defined by the Risk Factor Methodology probability criteria (refer to Section 4.4 of this plan).

Vulnerability Assessment

To understand risk, a community must evaluate which assets are exposed or vulnerable in the identified hazard area. The entire County has been identified as exposed to the earthquake hazard. Therefore, all assets in Pike County (population, structures, critical facilities, and lifelines) described in the County Profile (Section 2), are vulnerable. The following section provides an evaluation and estimation of the potential impact of the earthquake hazard on Pike County, including the following:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, safety, and health of residents; (2) general building stock; (3) critical facilities; (4) economy; (5) environment; and (6) future growth and development
- Effect of climate change on vulnerability
- Further data collections that will assist understanding of this hazard over time.

Overview of Vulnerability

Earthquakes usually occur without warning and can be felt in areas at great distance from their point of origin. Extent of damage depends on density of population, as well as building and infrastructure construction in the area shaken by the quake. Some areas may be more vulnerable than others based on soil type, age of buildings, and building codes in place. Compounding potential for damage is that, historically, Building Officials Code Administration (BOCA) in the northeastern United States was developed to address local concerns including heavy snow loads and wind; seismic requirements for design criteria are not as stringent compared to the West Coast's reliance on the more seismically-focused Uniform Building Code. Thus, a smaller earthquake in the northeastern United States can cause more structural damage than it would in the western part of the United States.

The entire population and general building stock inventory of the County are at risk for damage or loss from impacts of an earthquake. Potential losses associated with earth shaking were calculated for Pike County for the 100-, 500-, and 2,500-year MRP events. A summary of the data used and methodology applied for this assessment appears below, followed by impacts on population, existing structures, critical facilities, and the economy within Pike County.

Data and Methodology

A probabilistic assessment was conducted for the 100-, 500-, and 2,500-year MRP in HAZUS-MH 3.1 to analyze the earthquake hazard and provide a range of loss estimates for Pike County. The probabilistic method uses historical earthquake information from historical earthquakes and inferred faults, locations, and magnitudes, and computes probable ground-shaking levels that may be experienced during a recurrence period by Census tract. According to the New York City Area Consortium for Earthquake Loss Mitigation (NYCEM), probabilistic estimates are best for urban planning, land use, zoning, and seismic building code regulations (NYCEM 2003). The default assumption is a magnitude-7.0 earthquake for all return periods.

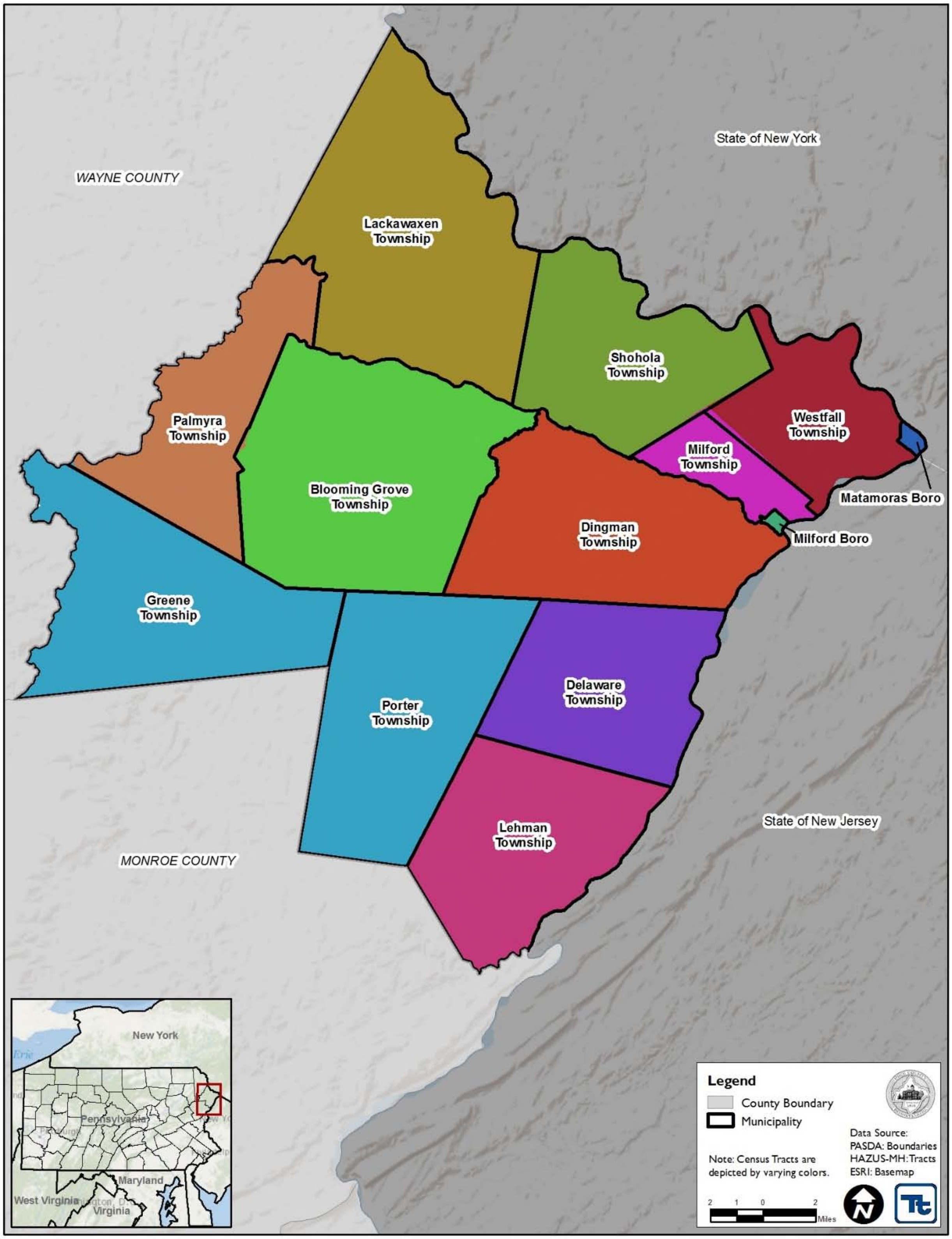
In addition to the probabilistic scenarios cited, an annualized loss run was conducted in HAZUS 3.1 to estimate annualized general building stock dollar losses within Pike County. The annualized loss methodology combines estimated losses associated with ground shaking for each return period, which are based on values from the USGS seismic probabilistic curves. Annualized losses are useful for mitigation planning because they provide a baseline that can be used to compare (1) the risk of one hazard across multiple jurisdictions, and (2) the degree of risk of all hazards for each participating jurisdiction.

As noted in the HAZUS-MH Earthquake User Manual, "Uncertainties are inherent in any loss estimation methodology. They arise in part from incomplete scientific knowledge concerning earthquakes and their effects upon buildings and facilities. They also result from the approximations and simplifications that are necessary for comprehensive analyses. Incomplete or inaccurate inventories of the built environment, demographics, and economic parameters add to the uncertainty. These factors can result in a range of uncertainty in loss estimates produced by the HAZUS Earthquake Model, possibly at best a factor of 2 or more." However, HAZUS potential loss estimates are acceptable for the purposes of this Hazard Mitigation Plan (HMP).

The occupancy classes available in HAZUS-MH 3.1 were condensed into the following categories to facilitate the analysis and presentation of results: residential, commercial, industrial, agricultural, religious, government, and educational. Residential loss estimates address both multi-family and single-family dwellings. Impacts on critical facilities and utilities were also evaluated.

HAZUS-MH 3.1 generates results at the Census-tract level. Boundaries of the U.S. Census tracts are not always coincident with municipal boundaries in Pike County. Results in subsequent tables are presented for the U.S. Census tracts, with the associated municipalities listed for each tract. Figure 4.3.4-10 below shows spatial relationships between U.S. Census tracts and municipal boundaries.

Figure 4.3.4-10. HAZUS-MH Census Tracts in Pike County



Source: HAZUS-MH 3.1

Impact on Life, Health, and Safety

Overall, the entire population of Pike County is exposed to the earthquake hazard event. According to the 2010 U.S. Census, Pike County had a population of 57,369 people. The impact of earthquakes on life, health, and safety depends on the severity of the event. Risks to public safety and loss of life from an earthquake in Pike County are minimal, with higher risk occurring in buildings as a result of damage to the structure, or people walking below building ornamentation and chimneys that may be shaken loose and fall as a result of the quake.

Populations considered most vulnerable are located in the built environment, particularly near unreinforced masonry construction. In addition, the vulnerable population includes the elderly (persons over the age of 65) and individuals living below the Census poverty threshold. These socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard, and locations and construction quality of their housing.

Residents may be displaced or require temporary to long-term sheltering as a result of the event. The number of people requiring shelter is generally less than the number displaced, as some displaced persons use hotels or stay with family or friends after a disaster event. HAZUS-MH 3.0 does not estimate any displaced persons or population that may require short-term sheltering as a result of the 100-year event. Table 4.3.4-4 summarizes the estimated sheltering needs for Pike County.

Table 4.3.4-4. Summary of Estimated Sheltering Needs for Pike County

Scenario	Displaced Households	Persons Seeking Short-Term Shelter
500-Year Earthquake	4	2
2,500-Year Earthquake	39	22

Source: HAZUS-MH 3.1

Structural building damage correlates strongly to the number of injuries and casualties from an earthquake event (NYCEM 2003). Furthermore, different sectors of the community would be exposed to the hazard depending on time of day of occurrence. For example, HAZUS considers that maximum residential occupancy occurs at 2:00 a.m.; educational, commercial, and industrial sectors maximum occupancy at 2:00 p.m.; and peak commute time at 5:00 p.m. Whether affected directly or indirectly, the entire population would have to deal with consequences of earthquakes to some degree. Business interruption could prevent people from working, road closures could isolate populations, and loss of functions of utilities could affect populations that suffered no direct damage from an event. HAZUS-MH 3.1 estimates no injuries or casualties in Pike County as a result of a 100-year MRP event. Table 4.3.4-5 summarizes estimated number of injuries, hospitalizations, and casualties as a result of the 500-year MRP event. Table 4.3.4-6 summarizes estimated number of injuries, hospitalizations, and casualties as a result of the 2,500-year MRP event.

Table 4.3.4-5. Estimated Number of Injuries, Hospitalizations, and Casualties from the 500-Year MRP Earthquake Event

Level of Severity	Time of Day		
	2:00 a.m.	2:00 p.m.	5:00 p.m.
Injuries	4	3	3
Hospitalization	1	0	0
Casualties	0	0	0

Source: HAZUS-MH 3.1

Table 4.3.4-6. Estimated Number of Injuries, Hospitalizations, and Casualties from the 2,500-Year MRP Earthquake Event

Level of Severity	Time of Day		
	2:00 a.m.	2:00 p.m.	5:00 p.m.
Injuries	28	24	20
Hospitalization	6	4	3
Casualties	1	1	1

Source: HAZUS-MH 3.1

Impact on General Building Stock

After consideration of the population exposed to the earthquake hazard, an evaluation of value of general building stock exposed to and damaged by the 100-, 500- and 2,500-year MRP earthquake events occurred. In addition, annualized losses were calculated by use of HAZUS-MH 3.1. The entire study area's general building stock is considered at risk and exposed to this hazard.

The HAZUS-MH 3.1 model estimates value of exposed building stock and loss (in terms of damage to exposed stock). The County Profile section of this HMP (Section 2) presents statistics on replacement values of general building stock (structure and contents).

A probabilistic model was run to estimate annualized dollar losses within Pike County by application of HAZUS-MH 3.1. Annualized losses are useful for mitigation planning because they provide a baseline that can be used to compare (1) risk of one hazard across multiple jurisdictions, and (2) degree of risk of all hazards within each participating jurisdiction. Notably, annualized loss does not predict losses in any particular year. Estimated earthquake annualized losses are approximately $130K per year (building and contents) within the County.

According to NYCEM, where earthquake risks and mitigation were evaluated in the New York, New Jersey, and Connecticut region, most damage and loss caused by an earthquake would directly or indirectly result from ground shaking (NYCEM 2003). NYCEM found a strong correlation between PGA and damage a building might undergo. The HAZUS-MH model is based on the best available earthquake science and aligns with these statements. HAZUS-MH 3.0 methodology and model were used to analyze the earthquake hazard for the general building stock within Pike County. Figure 4.3.4-6 through Figure 4.3.4-8 earlier in this profile illustrate the geographic distribution of PGA (*g*) across the County for the 100-, 500-, and 2,500-year MRP events.

In addition, according to NYCEM (NYCEM 2003), a building's construction determines how well it can withstand the force of an earthquake. The NYCEM report indicates that un-reinforced masonry buildings are most at risk during an earthquake because the walls are prone to collapse outward, whereas steel and wood buildings absorb more of the earthquake's energy. Additional attributes that affect a building's capability to withstand an earthquake's force include its age, number of stories, and quality of construction. HAZUS-MH considers building construction and age of buildings in its analysis. Default building ages and building types already incorporated into the inventory were used because the default general building stock was used for this HAZUS-MH analysis.

Potential building damage was evaluated by HAZUS-MH 3.1 across the following damage categories: none, slight, moderate, extensive, and complete. Table 4.3.4-7 provides definitions of these categories of damage for a light wood-framed building; definitions for other building types are included in the HAZUS-MH technical manual documentation. General building stock damage for these damage categories by occupancy class on a countywide basis is summarized for the 500- and 2,500-year events in Table 4.3.4-8.

Table 4.3.4-7. Example of Structural Damage State Definitions for a Light Wood-Framed Building

Damage Category	Description
Slight	Small plaster or gypsum-board cracks at corners of door and window openings and wall-ceiling intersections; small cracks in masonry chimneys and masonry veneer.
Moderate	Large plaster or gypsum-board cracks at corners of door and window openings; small diagonal cracks across shear wall panels exhibited by small cracks in stucco and gypsum wall panels; large cracks in brick chimneys; toppling of tall masonry chimneys.
Extensive	Large diagonal cracks across shear wall panels or large cracks at plywood joints; permanent lateral movement of floors and roof; toppling of most brick chimneys; cracks in foundations; splitting of wood sill plates or slippage of structure over foundations; partial collapse of room-over-garage or other soft-story configurations.
Complete	Structure may have large permanent lateral displacement, may collapse, or be in imminent danger of collapse because of the crippled wall failure or the failure of the lateral load resisting system; some structures may slip and fall off the foundations; large foundation cracks.

Source: FEMA 2012

Table 4.3.4-8. Estimated Buildings Damaged by General Occupancy for 500-year and 2,500-year MRP Earthquake Events

Category	Average Damage State									
	500-Year MRP					2,500-Year MRP				
	None	Slight	Moderate	Extensive	Complete	None	Slight	Moderate	Extensive	Complete
Residential	35,993 (93.7%)	958 (2.5%)	306 (<1%	37 (<1%)	4 (<1%)	31,380 (81.7%)	3,968 (10.3%)	1,608 (4.2%)	301 (<1%)	42 (<1%)
Commercial	707 (1.8%)	24 (<1%)	8 (<1%)	1 (<1%)	0 (0%)	571 (1.5%)	101 (<1%)	56 (<1%)	11 (<1%)	1 (<1%)
Industrial	202 (<1%)	6 (<1%)	2 (<1%)	0 (0%)	0 (0%)	163 (<1%)	28 (<1%)	17 (<1%)	3 (<1%)	0 (0%)
Education, Government, Religious, and Agricultural	160 (<1%)	5 (<1%)	1 (<1%)	0 (0%)	0 (0%)	132 (<1%)	21 (<1%)	12 (<1%)	2 (<1%)	0 (0%)

Source: HAZUS-MH 3.1

HAZUS-MH 3.1 estimates no damage to Pike County's general building stock as a result of a 100-year MRP event. Table 4.3.4-9 summarizes estimated building value (buildings and contents) for annualized loss, 500-, and 2,500-year MRP earthquake events. Damage loss estimates include structural and non-structural damage to buildings and loss of contents. Table 4.3.4-10 summarizes estimated value (buildings and contents) damaged by 500-, and 2,500-year MRP earthquake events.

Table 4.3.4-9. Estimated Building Value (Building and Contents) Damaged by the Annualized, 500-, and 2,500-Year MRP Earthquake Events

Municipality	Total Replacement Cost Value (Building and Contents)	Estimated Total Damages*			Percent of Total Building and Contents		
		Annualized Loss	500-Year	2,500-Year	Annualized Loss	500-Year	2,500-Year
Blooming Grove Township	$1,160,095,000	$9,943	$940,204	$8,262,952	<1%	<1%	<1%
Delaware Township	$1,496,677,000	$16,099	$1,391,456	$14,114,607	<1%	<1%	<1%
Dingman Township	$1,983,140,000	$20,685	$1,816,568	$17,810,638	<1%	<1%	<1%
Greene Township-Porter Township	$1,345,239,000	$11,812	$1,080,585	$9,774,890	<1%	<1%	<1%
Lackawaxen Township	$1,231,620,000	$10,119	$987,409	$8,149,543	<1%	<1%	<1%
Lehman Township	$1,992,003,000	$21,862	$1,843,282	$19,560,495	<1%	<1%	<1%
Matamoras Borough	$377,318,000	$4,401	$367,013	$3,855,277	<1%	<1%	1.0%
Milford Borough	$413,430,000	$5,214	$386,500	$4,469,173	<1%	<1%	1.1%
Milford Township	$672,467,000	$7,431	$587,203	$6,353,488	<1%	<1%	<1%
Palmyra Township	$1,244,033,000	$9,753	$946,874	$7,888,975	<1%	<1%	<1%
Shohola Township	$759,299,000	$7,544	$671,580	$6,297,048	<1%	<1%	<1%
Westfall Township	$383,781,000	$4,707	$379,989	$4,026,964	<1%	<1%	1.0%
Pike County (Total)	**$13,059,102,000**	**$129,570**	**$11,398,663**	**$110,564,051**	**<1%**	**<1%**	**<1%**

Source: HAZUS-MH 3.1
Notes:
Total amount is sum of damages for all occupancy classes (residential, commercial, industrial, agricultural, educational, religious, and government).
As stated at the beginning of the vulnerability analysis, HAZUS-MH 3.1 generates results at the Census-tract level. Boundaries of Census tracts are not always coincident with municipal boundaries in Pike County. Results in the table are for Census tracts, with associated municipalities listed for each tract. See Figure 4.3.4-9 for a visual breakdown of Census tracts.

Table 4.3.4-10. Estimated Value (Building and Contents) Damaged by the 500- and 2,500-Year MRP Earthquake Events

Municipality	Total Improved Value (Building and Contents)	Estimated Residential Damage		Estimated Commercial Damage	
		500-Year	2,500-Year	500-Year	2,500-Year
Blooming Grove Township	$1,160,095,000	$922,639	$8,069,267	$14,089	$151,778
Delaware Township	$1,496,677,000	$1,262,246	$12,551,230	$82,373	$994,134
Dingman Township	$1,983,140,000	$1,664,635	$15,990,275	$87,237	$1,018,970
Greene Township-Porter Township	$1,345,239,000	$1,011,947	$9,011,052	$47,530	$525,055
Lackawaxen Township	$1,231,620,000	$968,772	$7,956,673	$12,857	$130,234
Lehman Township	$1,992,003,000	$1,730,691	$18,119,467	$60,192	$766,878
Matamoras Borough	$377,318,000	$292,721	$2,966,815	$55,288	$656,757
Milford Borough	$413,430,000	$131,795	$1,391,758	$191,391	$2,316,248
Milford Township	$672,467,000	$443,418	$4,675,451	$110,440	$1,286,744
Palmyra Township	$1,244,033,000	$925,187	$7,662,456	$15,136	$157,062
Shohola Township	$759,299,000	$599,961	$5,483,587	$36,691	$410,009
Westfall Township	$383,781,000	$286,457	$2,915,012	$81,343	$962,760
Pike County (Total)	**$13,059,102,000**	**$10,240,470**	**$96,793,041**	**$794,566**	**$9,376,628**

Source: HAZUS-MH 3.1

Notes: As stated at the beginning of the vulnerability analysis, HAZUS-MH 3.1 generates results at the Census-tract level. Boundaries of Census tracts are not always coincident with municipal boundaries in Pike County. Results in the table are for Census tracts, with associated municipalities listed for each tract. See Figure 4.3.4-9 for a visual breakdown of Census tracts.

An estimated $11 million in damages would occur to buildings in the County during a 500-year earthquake event. This takes into account structural damage, non-structural damage, and loss of contents, representing less than 1 percent of total replacement value for general building stock in Pike County (total replacement value within the County would exceed $13 billion.) For the 2,500-year earthquake event, HAZUS-MH estimates more than $110 million in damages (<1 percent of the building stock). Residential and commercial buildings would undergo most damage from earthquake events. Earthquakes can cause secondary hazard events such as fires. According to the HAZUS-MH earthquake model, no fires are anticipated as a result of the 100-, 500-, or 2,500-year MRP events.

Impact on Critical Facilities

After consideration of general building stock exposed to and damaged by each earthquake event, critical facilities were evaluated. All critical facilities (essential facilities, transportation systems, lifeline utility systems, high-potential loss facilities, and user-defined facilities) in Pike County are considered exposed and vulnerable to the earthquake hazard. The Critical Facilities subsection of this HMP in Section 2 (County Profile) discusses the inventory of critical facilities in Pike County.

HAZUS-MH 3.1 estimates the probability that critical facilities may sustain damage as a result of the 100-, 500-, and 2,500-year MRP earthquake events. Additionally, HAZUS-MH estimates percent functionality of each facility days after the event. Table 4.3.4-11 (500-year MRP earthquake event) and Table 4.3.4-12 (2,500-year MRP earthquake event) list percent probabilities that critical facilities and utilities would sustain damages within the damage categories (column headings), and list percent functionalities after different numbers of days following those events (column headings). During and following a 100-Year MRP event, HAZUS-MH 3.1 estimates nearly 100% functionality of emergency facilities (police, fire, Emergency Medical Services [EMS], and medical facilities), schools, utilities, and specific facilities identified by Pike County as critical. Therefore, impact on critical facilities by a 100-year event would not be significant.

Table 4.3.4-11. Estimated Damage to and Loss of Functionality of Critical Facilities and Utilities in Pike County for the 500-Year MRP Earthquake Event

Name	Percent Probability of Sustaining Damage					Percent Functionality			
	None	Slight	Moderate	Extensive	Complete	Day 1	Day 7	Day 30	Day 90
Critical Facilities									
Medical	100	0	0	0	0	100	100	100	100
Police	99-100	<1	<1	0	0	99-100	100	100	100
Fire	99-100	<1	<1	0	0	99-100	100	100	100
EOC	99.7-99.8	<1	<1	0	0	100	100	100	100
School	99	<1	<1	0	0	99	100	100	100
Utilities									
Wastewater	100	0	0	0	0	100	100	100	100

Source: HAZUS-MH 3.1
Notes: EOC Emergency Operations Center

Table 4.3.4-12. Estimated Damage to and Loss of Functionality of Critical Facilities and Utilities in Pike County for the 2,500-Year MRP Earthquake Event

Name	Percent Probability of Sustaining Damage					Percent Functionality			
	None	Slight	Moderate	Extensive	Complete	Day 1	Day 7	Day 30	Day 90
Critical Facilities									
Medical	88	8	3	<1	<1	88	96	100	100
Police	67-83	11-18	5-11	0-3	<1	67-83	85-94	96-99	98-99
Fire	67-83	11-18	5-11	0-3	<1	67-83	84-94	96-99	98-99
EOC	79-82	12-13	6-7	0-1	<1	79-82	92-93	99	99
School	67-73	15-18	9-11	2-3	<1	67-73	84-88	96-97	98
Utilities									
Wastewater	47-64	29-39	6-13	0-1	<1	61-74	98-99	99-100	100

Source: HAZUS-MH 3.1
Notes: EOC Emergency Operations Center

Impact on Economy

Earthquakes also impact the economy, causing loss of business function, damage to inventory, relocation costs, wage loss, and rental loss during repair or replacement of buildings. A HAZUS-MH analysis estimated total economic loss associated with each earthquake scenario, including building- and lifeline-related losses (such as transportation and utility losses) based on available inventory (facility or geographic information system [GIS] point data only). Direct building losses are estimated costs to repair or replace damages to buildings. These losses are reported in the Impact on General Building Stock section presented earlier. Lifeline-related losses include costs of direct repair to transportation and utility systems, and are reported in terms of probability of reaching or exceeding a specified level of damage caused by a given level of ground motion. Additionally, economic loss includes business interruption losses associated with inability to operate a business as a result of damage sustained during the earthquake, as well as temporary living expenses for those displaced. These losses are discussed below.

Significantly, for a 500-year event, HAZUS-MH 3.1 estimates that the County would incur approximately $3.8 million in income losses (wage, rental, relocation, and capital-related losses) in addition to structural, non-structural, and content building stock losses ($11.41 million). For a 2,500-year event, HAZUS-MH estimates that the County would incur approximately $25 million in income losses, and approximately $111 million in structural, non-structural and content building stock losses.

The HAZUS-MH analysis did not take into account damage to roadway segments. However, these features assumedly would undergo damage as a result of ground failure, and an earthquake event thus would interrupt regional transportation and distribution of materials. According to HAZUS-MH Earthquake User Manual, losses to the community resulting from damages to lifelines could be much greater than costs of repair (FEMA 2012).

Earthquake events can significantly damage road bridges; this is important because they often provide the only access to certain neighborhoods. Because softer soils can generally follow floodplain boundaries, bridges that cross watercourses should be considered vulnerable. A key factor in degree of vulnerability is age of a facility, which helps indicate the standards the facility was built to achieve.

HAZUS-MH Earthquake User's Manual also estimates volume of debris that may be generated as a result of an earthquake event to enable the study region to prepare and rapidly and efficiently manage debris removal and disposal. Debris estimates are divided into two categories: (1) reinforced concrete and steel that require special equipment to break up before transport, and (2) brick, wood, and other debris that can be loaded directly onto trucks with bulldozers (FEMA 2012).

No debris would be generated as a result of a 100-year earthquake event. HAZUS-MH 3.1 estimates generation of more than 8,500 tons of debris by a 500-year MRP event, and nearly 50,000 tons by a 2,500-year MRP event. Table 4.3.4-13 summaries estimated debris generated by 500- and 2,500-year MRP earthquake events.

Table 4.3.4-13. Estimated Debris Generated by 500- and 2,500-year MRP Earthquake Events

	500-Year		2,500-Year	
Municipality	**Brick/Wood (tons)**	**Concrete/ Steel (tons)**	**Brick/Wood (tons)**	**Concrete/ Steel (tons)**
Blooming Grove Township	672	126	3,193	893
Delaware Township	867	174	4,399	1,422
Dingman Township	1,081	221	5,433	1,770
Greene Township-Porter Township	706	142	3,437	1,068
Lackawaxen Township	738	137	3,391	929
Lehman Township	1,201	243	6,224	2,049
Matamoras Borough	220	52	1,109	456
Milford Borough	190	66	986	668
Milford Township	262	87	1,326	819
Palmyra Township	651	122	3,029	833
Shohola Township	429	89	2,102	703
Westfall Township	242	62	1,255	575
Pike County (Total)	**7,259**	**1,522**	**35,885**	**12,186**

Source: HAZUS-MH 3.1
Notes: As stated at the beginning of the vulnerability analysis, HAZUS-MH 3.1 generates results at the Census-tract level. Boundaries of Census tracts are not always coincident with municipal boundaries in Pike County. Results in the table are for Census tracts, with associated municipalities listed for each tract. See Figure 4.3.4-9 for a visual breakdown of Census tracts

Impact on the Environment

Earthquakes can lead to numerous, widespread, and devastating environmental impacts. These impacts may include but are not limited to:

- Induced flooding or landslides
- Poor water quality
- Damage to vegetation
- Breakage in sewage or toxic material containments.

Secondary impacts can include train derailments, roadway damages, spillage of hazardous materials (HazMat), and utility interruption.

Future Growth and Development

As discussed in Section 2.4 of this HMP, areas targeted for future growth and development have been identified across the County. Human exposure and vulnerability to earthquake impacts in newly developed areas are anticipated to be similar to those current within the County. Current building codes require seismic provisions that should render new construction less vulnerable to seismic impacts than older, existing construction that may have been built to lower construction standards.

Effect of Climate Change on Vulnerability

Impacts of global climate change on earthquake probability are unknown. Some scientists say that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the Earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity according to research into prehistoric earthquakes and volcanic activity. National Aeronautics and Space Administration (NASA) and USGS scientists found that retreating glaciers in southern Alaska might be opening the way for future earthquakes (NASA 2004).

Secondary impacts of earthquakes could be magnified by climate change. Soils saturated by repetitive storms could undergo liquefaction during seismic activity as a result of the increased saturation. Dams storing increased volumes of water as a result of changes in the hydrograph could fail during seismic events. No current models are available to estimate these impacts.

Additional Data and Next Steps

Ground shaking is the primary cause of earthquake damage to man-made structures, and soft soils amplify ground shaking. One contributor to site amplification is velocity at which rock or soil transmits shear waves (S-waves). The National Earthquake Hazards Reduction Program (NEHRP) developed five soil classifications defined by their shear-wave velocity that alter severity of an earthquake. These soil classifications range from A to E, whereby A represents hard rock that reduces ground motions from an earthquake and E represents soft soils that amplify and magnify ground shaking and increase building damage and losses. When this soil information becomes available, it may be incorporated into HAZUS-MH to further refine the County's vulnerability assessment.

A HAZUS-MH earthquake analysis was conducted for Pike County by use of the default model data. Additional data needed to further refine and enhance the County's vulnerability assessment includes identifications of unreinforced masonry critical facilities and privately-owned buildings (i.e., residences) via local knowledge and/or pictometry/orthophotos. Use of soil type data can also lead to more accurate estimates of potential losses to the County. These buildings may not withstand earthquakes of certain magnitudes, and plans to provide emergency response/recovery efforts for these properties can be established. Further mitigation actions include training of County and municipal personnel to provide post-hazard event rapid visual damage assessments, increase of County and local debris management and logistic capabilities, and revised regulations to prevent additional construction of non-reinforced masonry buildings.

4.3.5 Environmental Hazards

For the purposes of this HMP update, the environmental hazards section primarily focuses on hazardous material release and pollution, fire from oil and gas well drilling, and the acidic drainage from the exposure of pyritic rock in Pike County. Hazardous material releases can occur at facilities or along transportation routes. These releases can result in injury or death and contaminate air, water and soils. Activities associated with oil and gas well drilling can cause fire and pollute streams and drinking water. New to this HMP update is stream and groundwater contamination from exposing pyritic rock during road construction and/or other developments resulting in acidic drainage into the environment. Another concern is the application of salt and brine to roads to de-ice during winter months which can also potentially lead to groundwater contamination. This section provides a profile and vulnerability assessment of the environmental hazards in Pike County.

Hazardous Materials Release

Hazardous materials fall into several categories, such as flammable and combustible materials, compressed gases, explosive and blasting agents, radioactive materials, oxidizing materials, poisons, and corrosive liquids. Hazardous materials incidents are generally unintentional, and associated with transportation accidents or accidents at fixed facilities such as spills. However, hazardous materials can be released as a criminal or terrorist act. Any release can result in injury and death and may contaminate air, water and/or soils.

Product release into the local environment can be generated from a fixed facility or at any location along a route of travel, and may be the result of carelessness, technical failure, external incidents, or an intentional act against the facility or container. Volatility of products stored or transported, along with potential impact on a local community, may increase the risk of intentional acts against a facility or transport vehicle. Release of certain products considered HazMat can immediately and adversely impact the general population, ranging from inconvenience of evacuations to personal injury and even death. Moreover, any release can compromise the local environment through contamination of soil, groundwater, or local flora and fauna. Although explosions are often associated with environmental hazards (resulting from loss of containment of HazMat), explosions are profiled under Section 4.3.13 – Urban Fire and Explosion in this HMP update.

Oil and Gas Wells

Marcellus Shale-related activities consist of the extraction of natural gas from the Marcellus Shale formation via horizontal drilling and a process known as “hydraulic fracturing” that pumps water, mixed with sand and potentially hazardous chemicals, into the shale formation under high pressure to fracture the shale around the well, allowing natural gas to flow freely. Upon completion of the hydraulic fracturing process, the used water, often referred to as “frac fluid,” must be treated to remove chemicals and minerals (Pennsylvania Department of Environmental Protection [PADEP] 2015). Active drilling has not yet commenced in Pike County; however, extensive drilling is currently being conducted as near as 30 miles west of Pike County in the Susquehanna River Basin. One reason for the delay in drilling operations in Pike County is the current temporary hold on drilling in the parts of the Delaware River Basin that drain to special-protection waters, an area which includes Pike County. The Delaware River Basin Commission (DRBC) has not yet approved final regulations for gas drilling within the Delaware River Basin, although regulations are in final draft form and a public comment period has been completed. Thus, the DRBC, at any point, could approve regulations and drilling could proceed within the Delaware River Basin and Pike County (USGS 2014).The Utica Shale underlies a significant portion of Pennsylvania as well and is also a source of natural gas. In the subsurface, Utica Shale is located a few thousand feet below the Marcellus Shale. The Utica Shale is currently receiving a lot of attention because it is yielding large amounts of natural gas, natural gas liquids and crude oil to wells drilled in eastern Ohio and western Pennsylvania (King from Geology.com). According to PA DCNR, there is one well in Pike County penetrating the Utica Shale formation or deeper (PA DCNR, Accessed 2017). There is no active drilling into the Utica Shale formation in Pike County.

Pike County has three conventional wells; two are active dry hole wells and one is a plugged dry hole well (PADEP 2016). Dry hole wells are completed wells that are not productive of oil and/or gas. Plugged wells are non-productive wells that have been filled with cement (PADEP 2014). Marcellus Shale drilling may increase the potential for environmental issues within Pennsylvania. Drilling and pipelines could affect water quality and quantity, during both hydraulic fracturing and wastewater treatment phases of the drilling process (Penn State University 2011). All oil and gas exploration and drilling in the State is regulated under all or part of the state oil and gas laws, the Clean Streams Law, the Dam Safety and Encroachments Act, the Solid Waste Management Act, the Water Resources Planning Act, and the Worker and Community Right to Know Act. The Delaware River Basin Commission also regulates oil and gas (unconventional gas drilling) within the Delaware River Basin. PADEP is responsible for reviewing and issuing drilling permits, inspecting drilling operations, and responding to complaints about water quality problems. PADEP inspectors conduct routine and unannounced inspections of drilling sites and wells statewide (PADEP 2015).

Pyrite

Pyrite, or iron sulfide, also known as ‘fools gold’ is one of the most common sulfide minerals. Because of its high sulfur content, when exposed to the atmosphere or water, pyrite forms sulfuric acid. These acidic conditions inhibit plant growth ay the surface and if water infiltrates into the pyrite-laden rock, the resulting oxidation can acidify the water enabling it to dissolve metals in adjacent rocks such as copper, zinc, aluminum, manganese, and silver. The occurrence of acid drainage depends on numerous factors, including rock type, mineralogy, geochemistry, geologic structure (e.g., fractures, joints, and faults), changing the water table, surface and sub-surface hydrology, extent of geologic weathering, and depositional environments. If the drainage is uncontrolled, the acidic and metal-bearing water can drain into and contaminate streams and/or migrate into the groundwater (Hudson et. al, 1999 from AGI; and PADCNR, 2006).

Location and Extent

Hazardous Materials Release

Facilities that use, manufacture, or store hazardous materials in Pennsylvania must comply with both Title III of the Federal Superfund Amendments and Reauthorization Act (SARA), also known as the Emergency Planning and Community Right-to-Know Act (EPCRA), and the Commonwealth's reporting requirements under the Hazardous Materials Emergency Planning and Response Act (1990-165), as amended. The community right-to-know reporting requirements keep communities abreast of the presence and release of chemicals at individual facilities. EPCRA was designed to ensure that state and local communities are prepared to respond to potential chemical accidents through Local Emergency Planning Committees (LEPCs). LEPCs are charged with developing emergency response plans for SARA Title III facilities; these plans cover the location and extent of hazardous materials, establish evacuation plans, response procedures, methods to reduce the magnitude of a materials release, and establish methods and schedules for training and exercises.

Because SARA Title III facilities are covered under their own unique planning process and are continually evaluated through the LEPC, this HMP will focus on the Environmental Protection Agency (EPA)-identified hazardous materials sites. This dataset, publicly available at https://www3.epa.gov/enviro/, includes a number of materials facilities. Using this dataset will help to provide a more complete picture of the risk of hazardous materials releases in the County.

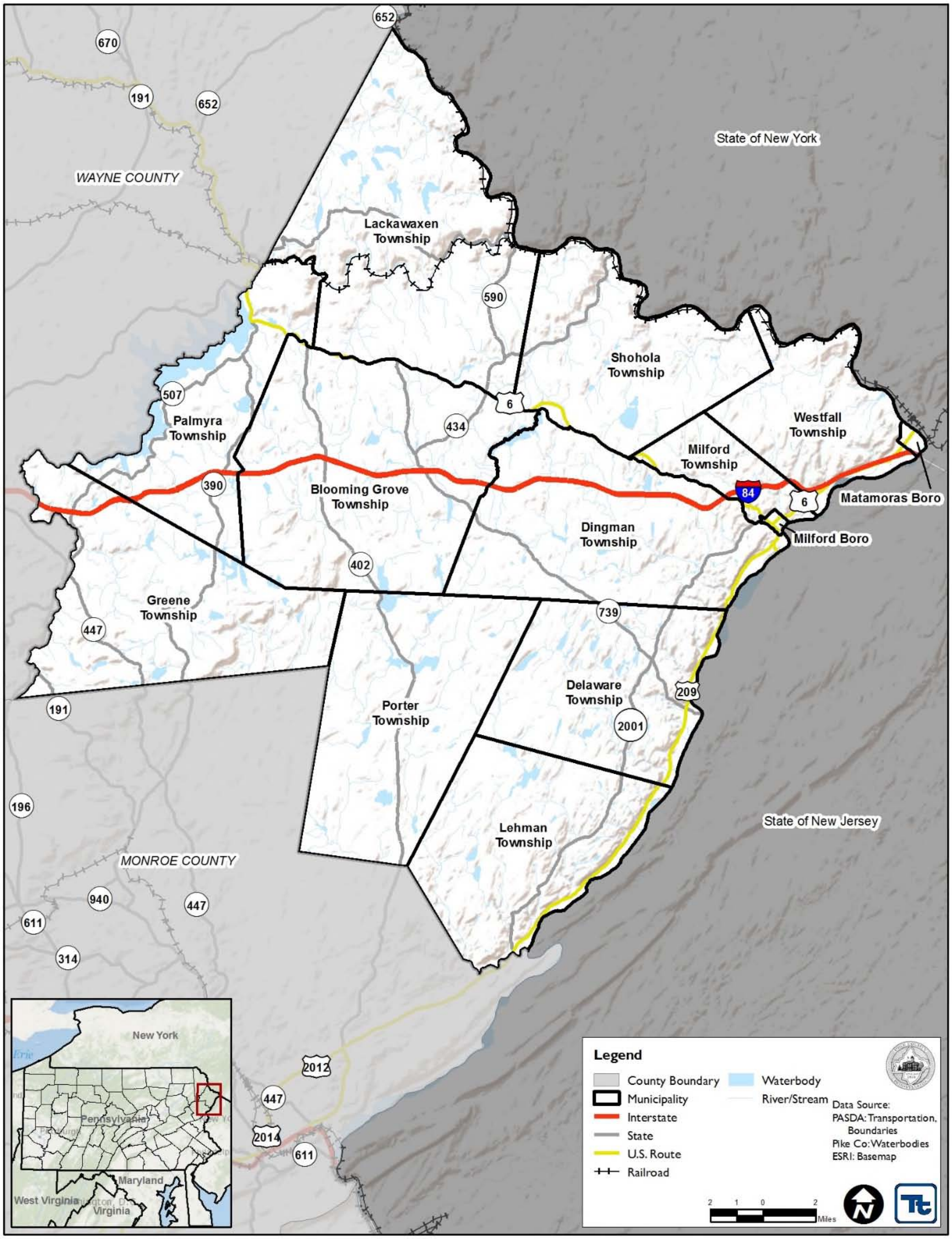
Pike County has 63 EPA-regulated facilities located throughout the county. Several of these facilities are located in close proximity to population centers that could be affected should a major accident or spill occur (EPA 2016). In addition to the EPA-regulated facilities, there are two natural gas transmission lines [Columbia Gas and Tennessee Gas (Kinder Morgan)] that cross the County and pose a threat of hazardous material release (PHMSA 2016). A third transmission line will be constructed by Tennessee Gas in 2017-2018.

The U.S. Department of Transportation (DOT) categorizes HazMat into the following nine classes based on chemical characteristics posing risk:

- Class 1: Explosives
- Class 2: Gases
- Class 3: Flammable liquids
- Class 4: Flammable solids
- Class 5: Oxidizers and organic pesticides
- Class 6: Poisons and etiologic materials
- Class 7: Radioactive materials
- Class 8: Corrosives
- Class 9: Miscellaneous.

Pike County has a few highly traveled highways and a railway network that pose a risk for hazardous material incidents. These networks transport hazardous material daily, on Interstate 84, US Route 6, US Route 209, PA 402, and PA 739. These major roads pass through the more populous areas. Similarly, rail lines pass through residential areas and near Matamoras Borough where larger numbers of people could be vulnerable should a serious accident occur in these places. These major transportation routes are shown in Figure 4.3.5-1.

Figure 4.3.5-1. Major Roadways Used to Transport Hazardous Materials in Pike County



Source: Pike County 2016

Based on past occurrences, hazardous material releases within Pike County have been accidental and have not been considered terrorist or criminal acts. While past occurrences have not been deemed intentional, an intentional release of any of these products in large quantity would pose a threat to the local population, economy, and environment resulting in lost revenue, injuries, and deaths.

Oil and Gas Wells

Since 2005, natural gas exploration activities in the Marcellus Shale Formation have increased significantly in the Commonwealth of Pennsylvania. According to maps produced by PADEP, in 2008, 195 Marcellus Shale wells were drilled; two years later, in 2010, 1,386 Marcellus Shale wells had been drilled. This number has decreased recently. Between 2014 and 2015, a total of 2,159 wells were drilled in Pennsylvania; however, none are located in Pike County (PennState University 2015). Most drilling has occurred in the northern-central and southwestern portions of the State, with highest numbers of 2015 Marcellus Shale drilling permits issued in Bradford, Susquehanna, Greene, and Washington Counties.

Figure 4.3.5-2 shows the extent of the Marcellus Shale Formation. Pike County lies completely within the shale formation, so it may be vulnerable to shale drilling in the near future. Additionally, there are active and abandoned oil/gas wells in three of the 13 municipalities in Pike County, though none are Marcellus Shale wells. Two of the existing wells are active dry hole wells and one is a plugged dry hole well. Figure 4.3.5-3 shows the location of these wells.

Figure 4.3.5-4 illustrates the approximate extent of Utica Shale in Pennsylvania. This map shows that Utica Shale Formation occurs in Pike County's subsurface or outcrop formations (PADCNR, 2011). As noted, there is no known Utica-Shale formation drilling in Pike County.

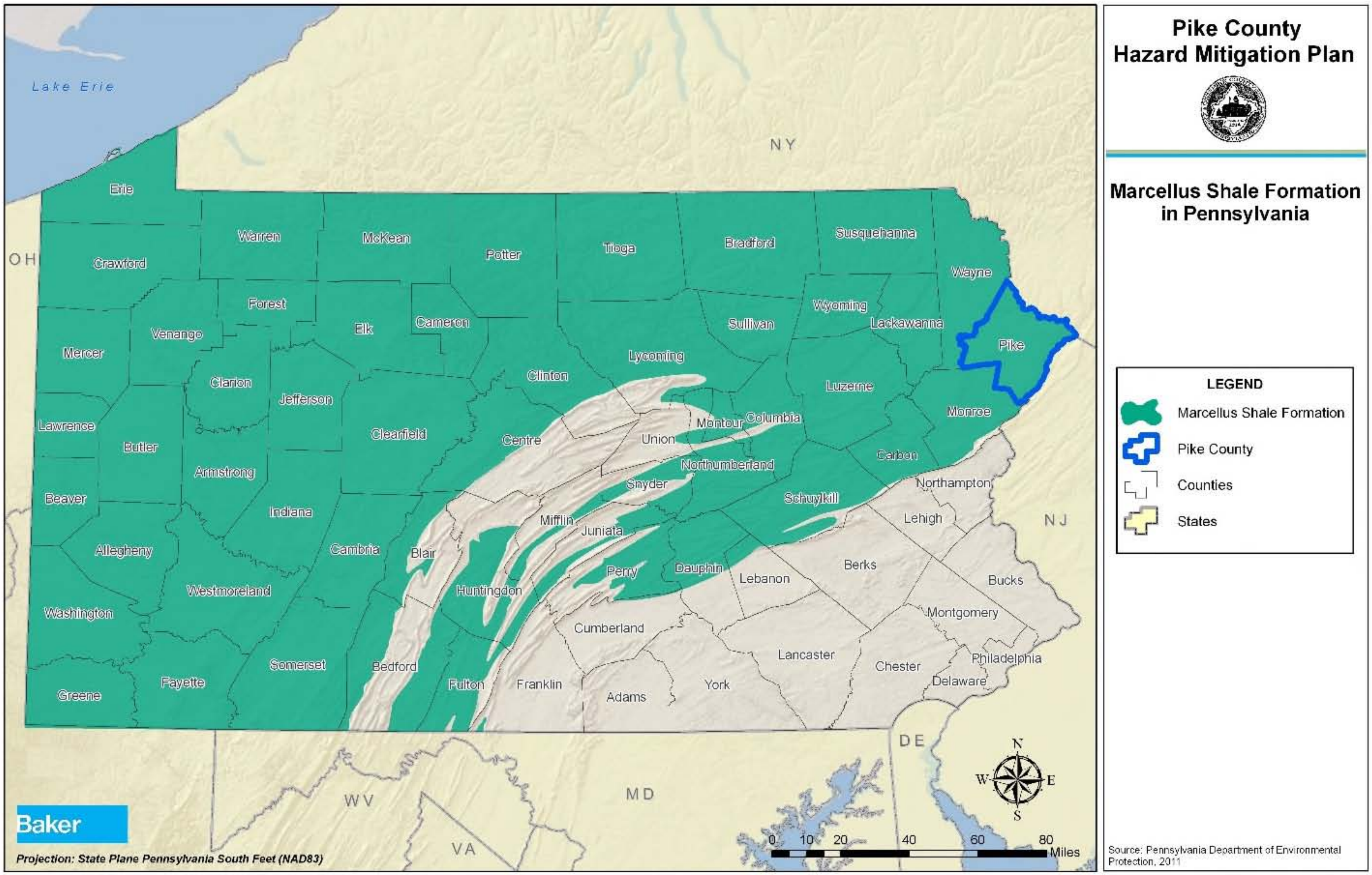
Pyrite

The presence of sulfide-bearing rock formations and isolated occurrences of sulfide deposits in Pennsylvania depends on a wide variety of factors including the rock's depositional and structural history, its mineralogy and geochemistry, and present surface and subsurface hydrologic and geochemical environment. As noted, most cases of acidic drainage in Pennsylvania involves iron sulfide minerals, such as pyrite, and its exposure to air to create iron oxides and acidic water. Coal-bearing rocks of Pennsylvania are a source of acidic drainage.

Figure 4.3.5-5 illustrates geologic units containing potentially significant acid-producing sulfide minerals. Pike County is not identified on this map as containing these geologic units (Pennsylvania Geological Survey, 2005).

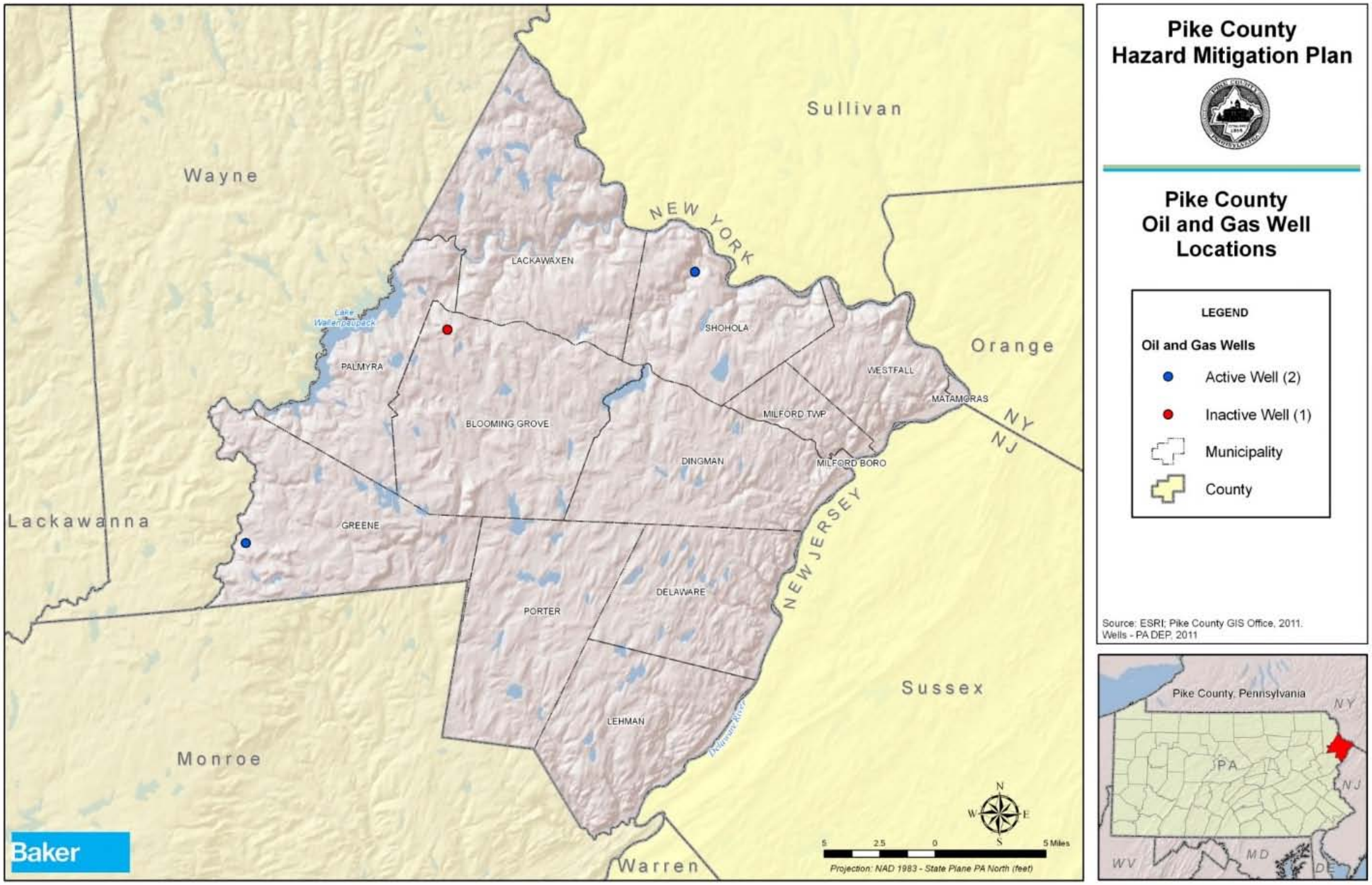
However, construction activities have uncovered pyrite in borings in Pike County (Pocono Record, 2016). According to the Pennsylvania Geological Survey, the only reliable way to anticipate acidic drainage is by conducting site-specific assessments. Pre-site investigation data is often available from previous studies, including college theses, consultant reports, geologic survey reports, aerial photographs, existing geophysical surveys, and the like. There is, however, no substitute for site specific information including interviews with local residents, geologic logs of borings, analysis of site geochemistry (water and rock), and other sources of information.

Figure 4.3.5-2. Map of Marcellus Shale Formation in Pennsylvania



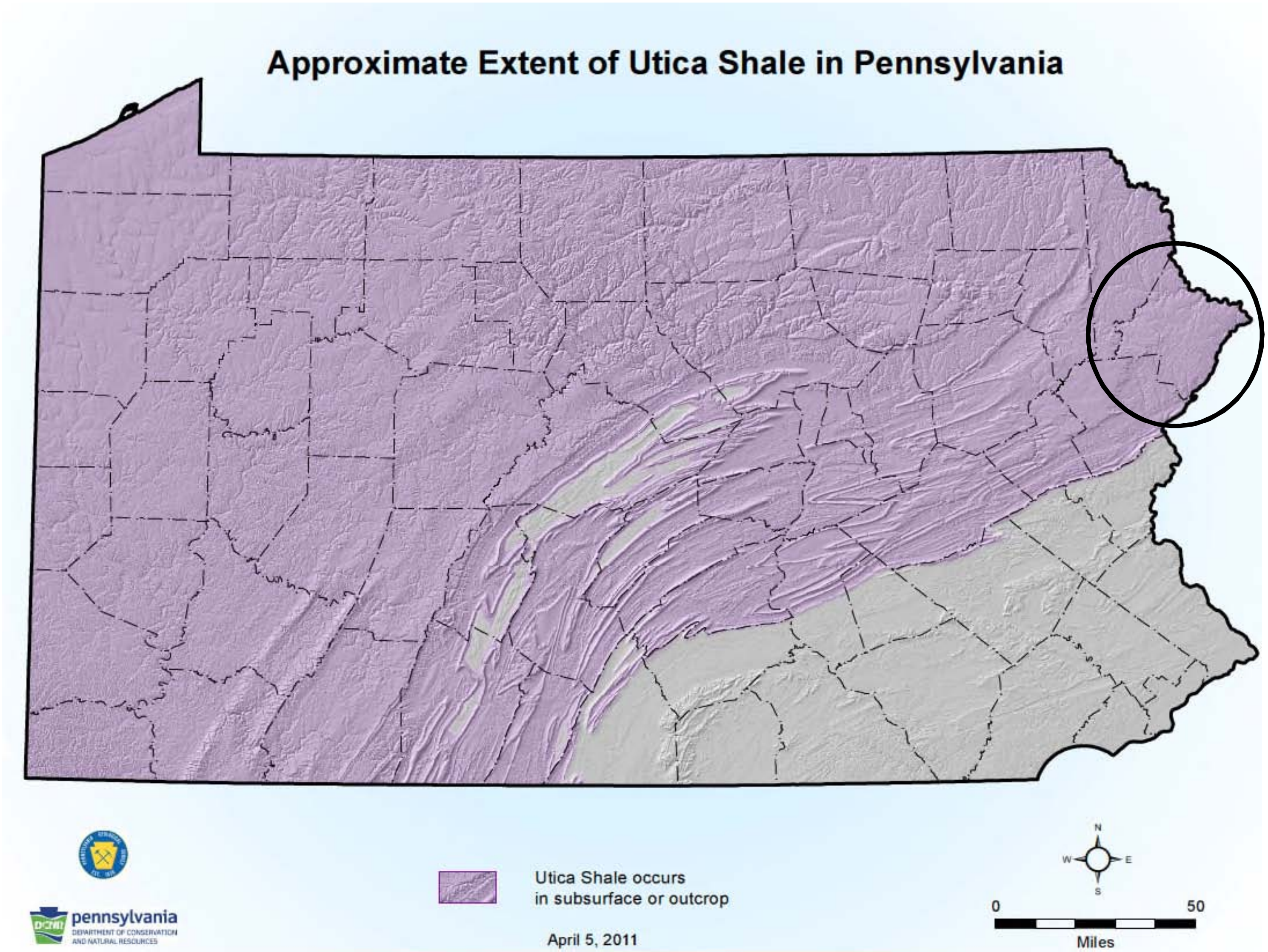
Source: PA DEP, 2011

Figure 4.3.5-3. Oil and Gas Well Locations in Pike County



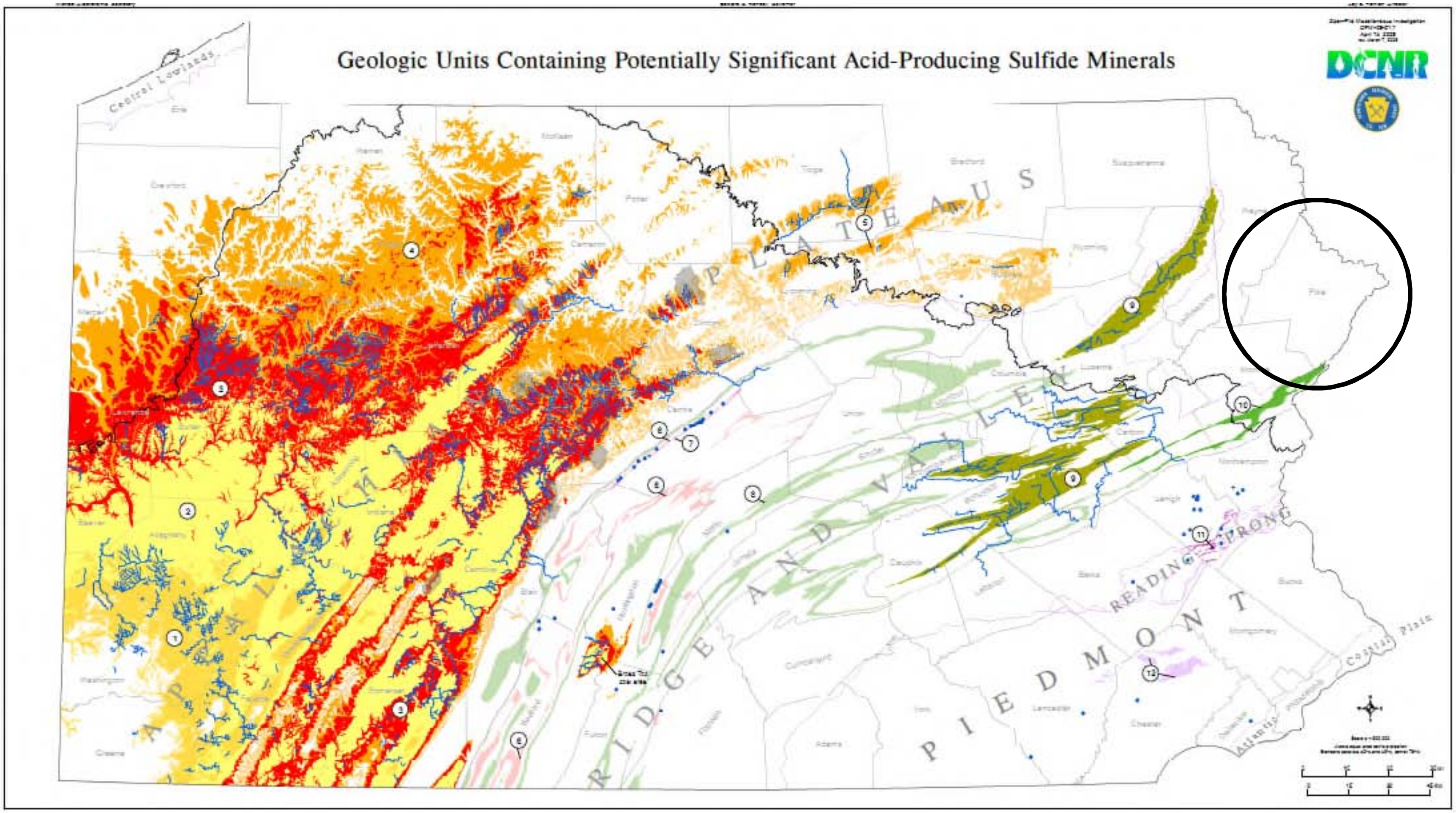
Source: PADEP 2011

Figure 4.3.5-4. Approximate Extent of Utica Shale in Pennsylvania



Source: PA DCNR, 2011
Note: The black circle marks the location of Pike County.

Figure 4.3.5-5. Geologic Units Containing Potentially Significant Acid-Producing Sulfide Minerals



Source: Pennsylvania Geological Survey, 2005
Note: The black circle marks the location of Pike County.

Range of Magnitude

Environmental hazard incidents within Pike County could range from minor petroleum spills to large, facility-based incidents that could lead to loss of life and property, and damage to the environment and the economy. Severity of an incident varies with type of material released and distances and related response times for emergency response teams. Areas within closest proximity to the releases are generally at greatest risk, yet depending on the agent, a release can travel great distances or persist over a long time (e.g., nuclear radiation), resulting in far-reaching effects on people and the environment.

Hazardous Materials Release

A hazardous material release, accidental or intentional, can be exacerbated or mitigated by specific circumstances surrounding the event. Exacerbating conditions are characteristics that can enhance or magnify effects of a hazard. Mitigating conditions, on the other hand, are characteristics of the target and its physical environment that can reduce effects of a hazard. These conditions include:

- Weather conditions – affect how the hazard develops.
- Micro-meteorological effects of buildings and terrain – alter dispersion of materials.
- Shielding in the form of sheltering-in-place – protects people and property from harmful effects.
- Non-compliance with applicable codes (e.g., fire and building codes) and maintenance failures (e.g., fire protection and containment features) – can substantially increase damage to a facility and to surrounding buildings.
- Geographic location of hazardous material site – if occurring within a Special Flood Hazard Area (SFHA), a materials release could cause larger-scale water contamination during a flood incident, or a flood incident could compromise production and storage of hazardous chemicals. Stormwaters and floodwaters can also move toxic chemicals swiftly across great distances.
- The application of salt or brine to de-ice roads.

At the lower end of the range of magnitude, a small amount of hazardous materials released in a remote area can trigger an evacuation of the area around the spill and a cleanup effort. The worst case scenario for a hazardous material release occurred in January 1995 when 1,000 gallons of diesel fuel was spilled after a Conrail freight train derailed near Parkers Glen in Shohola Township (PEIRS, 2002-2009).

Oil and Gas Wells and Pipelines

Oil and gas well drilling and oil and gas-containing pipelines can exert a variety of effects on the environment. Abandoned oil and gas wells not properly plugged can contaminate groundwater and consequently drinking water wells. Surface waters and soil are sometimes polluted by brine (a salty wastewater product of oil and gas well drilling), by oil spills at a drilling site, or by a pipeline breach. These events can spoil public drinking water supplies and significantly harm vegetation and aquatic animals.

In order to extract natural gas, hydraulic fracking must be implemented along with drilling wells. Wells are drilled first and then are cased in to protect groundwater from natural gas or other substances. Next, to fracture the shale around the well, the drillers pump the fracking water, which is a mix of water, sand and chemicals, into the well to force natural gas extraction. Natural gas well fires occur when natural gas is ignited at a well site. Often, these fires erupt during drilling when a spark from machinery or equipment ignites the gas. The initial explosion and resulting flames can seriously injure or kill individuals in the immediate area. These fires are often difficult to extinguish due to the intensity of the flame and abundance of the fuel source.

Although there are no active Utica or Marcellus Shale gas wells in the County, there are two other active wells. A possible worst-case scenario for oil and gas well incidents in Pike County would be if one of these wells in the County were to experience a blowout. This would potentially cause an explosion and could lead to contamination of water supplies for nearby well-dependent populations.

Past Occurrences

Hazardous Materials Release

With some exceptions, the majority of hazardous material release incidents over the years has involved petroleum product spills along the highways or has involved the railroad. Most of these are the result of collisions or derailments and have a limited impact on people and the environment. The number and quantity of hazardous materials being produced, stored and transported continue to increase each year in Pennsylvania. Reporting requirements from the State changed in 2007, allowing State agencies to categorize incidents as something other than “Hazardous Materials.” For instance, a vehicle collision resulting in a spill of petroleum products (e.g., gasoline, motor oil) may be reported as a vehicle accident instead of a HazMat release. In the case of an explosion, the explosive event may not be the primary incident. Rather, the incident may be based on events that led up to an explosion.

There have been a total of 184 incidences of hazardous material releases in Pike County from 2002 to 2016 (Pike County HMP 2012; Pike County 2016). According to the U.S. Department of Transportation (USDOT) Pipeline and Hazardous Materials Safety Administration (PHMSA), which provides an incident report database for information on incidents throughout the United States, there have been 10 incidents (all highway) between 2002 and 2016 (PHMSA 2016). Additionally, EPA TRI records indicate that there have been a total of 1,561 pounds of chemicals released from fixed sites in Pike County between 2001 and 2008. For the years 2009 to 2015, there is no data for TRI facilities in Pike County (EPA 2016).

Table 4.3.5-1 provides a description of hazardous material events that occurred in Pike County from 1978 to 2015. Most of the incidences happened during transit, but a few occurred at fixed sites. Additionally, Pike County indicated that between 2010 and 2016 (as of October 5, 2016), there have been 137 hazardous material incidents reported in the County (Pike County 2016).

Table 4.3.5-1. Previous Hazardous Materials Incidents in Pike County

Date	Location	Material Involved	Type of Incident/Details
January 1978	Westfall Township	Acetaldehyde	Conrail freight train derailed north of Mill Rift; one derailed tank car containing acetaldehyde began leaking and required the evacuation of several residences along the Delaware River in both Pennsylvania and New York.
December 1990	Milford Township	Carbon bisulfate	A Yellow freight tractor-trailer jack-knifed on icy Route 84 west of the Milford exit. One tandem trailer, carrying twelve 55-gallon drums of Carbon bisulfate overturned spilling cargo. Emergency officials closed portions of Route 84 for up to 12 hours to allow for safe clean up
February 1992	Milford Township	Natural Gas	The odor of natural gas forced the evacuation of 54 patients at the former Milford Head Trauma center (Facility has since closed and is now the location of Belle-Reve).
November 1993	Milford Township	Non-toxic substance	One lane of Route 84 westbound near the Milford exit was closed for a period of time, while emergency officials investigated a material leaking from a tractor-trailer. Material was later identified as a non-toxic substance
August 1994	Westfall Township	Chlorine gas	A chlorine gas leak occurred at Matamoras Municipal Water Authority Well #5 in Westfall Township. One individual was taken to the hospital for treatment.

Date	Location	Material Involved	Type of Incident/Details
January 1995	Shohola Township	Diesel fuel	The lead locomotive of a Conrail freight train derailed in Shohola Township in the area near Parkers Glen. The derailment resulted in the unit, turning on its side, releasing close to 1000 gallons of diesel fuel
August 1999	Palmyra Township	Various substances	A tractor-trailer parked at the Route 390 exit of Route 84 was reported to be leaking something. Trailer was carrying a mixed load of hazardous waste material. TEEM Environmental responded and cleaned up two leaking drums – one a flammable material, the other a non-toxic polymer, similar to glue
December 1999	Dingman Township	Flammable solution	A tractor-trailer accident along Route 84 in Dingman Township resulted in at least twelve 400-lb containers of a highly flammable solution to leak. TEEM Environmental provided clean up.
02/13/2002	Porter Township	Unknown	Unknown
05/05/2002	Dingmans Ferry	Unknown	Storage tank leaking due to heat expansion
05/21/2002	Dingman Township	Diesel fuel	Diesel fuel spill; Transportation County was Schneider National and cleanup was carried out by PennDOT and My Place Towing
06/26/2002	Porter Township	Unknown	Unknown
07/20/2002	Delaware Township	Pesticide	Pesticide spill during spraying of repellent
11/28/2002	Matamoras Borough	Gasoline	Motor vehicle accident occurred resulting in 40 gallons of gasoline spilling on the ground at a gas station
01/14/2003	Delaware Township	Gasoline	Less than 55 gallons of petroleum product spilled; limited impact on environment, soils or waterways
02/20/2003	Blooming Grove Township	Kerosene	A residential storage tank leaked about 75 gallons of kerosene; cleanup by a private contractor
04/03/2003	Milford Borough	Dye tear gas	Dye tear gas packs detonated in the Wayne Bank; building was vented after emergency units responded; no injuries reported
05/22/2003	Greene Township	Diesel fuel	Motor vehicle accident occurred on Interstate 84 involving a tractor trailer; the saddle tank on the trailer ruptured, spilling about 120 gallons of diesel fuel; cleanup by a private contractor, and no injuries reported
10/01/2003	Blooming Grove Township	Diesel fuel	A multi-vehicle accident took place on interstate 84 involving a tractor trailer; the saddle tank ruptured on the trailer and approximately 100 gallons of diesel fuel spilled. cleanup by a private contractor, and no injuries reported
11/06/2003	Delaware Township	Gasoline	Less than 55 gallons of petroleum product spilled; limited impact on environment, soils or waterways
12/19/2003	Milford Township	Diesel fuel	An unknown source leaked 70 gallons of diesel fuel onto gravel; some fuel spilled into a drain leading to a local stream that is part of the Milford Water Authority watershed protection area; cleanup provided by TEEM Environmental
06/02/2004	Dingman Township	Diesel fuel	Less than 55 gallons of petroleum product spilled; limited impact on environment, soils or waterways; cleanup provided by PennDOT
07/13/2004	Westfall Township	Diesel fuel	A diesel fuel tank was punctured, spilling 70 gallons of fuel onto a roadway; cleanup provided by local emergency units
01/12/2005	Milford Township	Diesel fuel	On Interstate 84, the saddle tank of a tractor-trailer ruptured, spilling about 125 gallons of diesel fuel; cleanup by a private contractor, and no injuries reported
02/14/2005	Dingman Township	Diesel fuel	Unknown quantity of diesel fuel spilled onto ground from an overturned tractor-trailer; cleanup provided by a

Date	Location	Material Involved	Type of Incident/Details
			private contractor
05/23/2005	Matamoras Borough	Natural Gas	Maintenance crew ruptured a gas line, releasing natural gas; leak was secured by the local gas company without incident; no injuries reported
05/25/2005	Palmyra Township	Heating oil	A delivery truck spilled an unknown amount of heating oil onto the ground; Lake Wallenpaupack may have received some of the spill; cleanup provided by a private contractor
05/27/2005	Palmyra Township	Unknown	A chemical spilled from a tractor-trailer at a rest stop on Interstate 84; no injuries reported
06/02/2005	Blooming Grove Township	Diesel fuel	Less than 55 gallons of petroleum product spilled; limited impact on environment, soils or waterways; cleanup provided by local emergency units
06/03/2005	Palmyra Township	Diesel fuel	Less than 55 gallons of petroleum product spilled; limited impact on environment, soils or waterways; cleanup provided by a private contractor
12/28/2005	Westfall Township	Diesel fuel	Accident involving a tractor-trailer occurred on Interstate 84; the saddle tank ruptured on the trailer, and an unknown amount of diesel fuel spilled onto the roadway; cleanup coordinated by emergency crews
01/05/2006	Westfall Township	Caustic soda	Water system was inadvertently contaminated with caustic soda; a teacher, student and the principal of the Delaware Valley School District, Middle School received minor burn injuries; DEP is monitoring the situation
02/14/2006	Blooming Grove Township	Diesel fuel	Less than 55 gallons of petroleum product spilled; limited impact on environment, soils or waterways; cleanup provided by local emergency units
03/02/2006	Blooming Grove Township	Diesel fuel	A tractor-trailer was jacknified and about 250 gallons of diesel fuel were spilled; cleanup provided by Lords Valley Towing
04/25/2006	Matamoros Borough	Natural Gas	A gas line was ruptured at a construction site causing a release of natural gas; the local gas company secured the release without incident
06/08/2006	Palmyra Township	Diesel fuel	Less than 55 gallons of petroleum product spilled; limited impact on environment, soils or waterways; cleanup provided by local emergency units
06/12/2006	Dingman Township	Asphalt	Asphalt Spill; Clean up by Datom Products
06/14/2006	Matamoros Borough	Gasoline	Less than 55 gallons of petroleum product spilled; limited impact on environment, soils or waterways; cleanup provided by local emergency units
08/02/2006	Lehman Township	Diesel fuel	Less than 55 gallons of petroleum product spilled; limited impact on environment, soils or waterways; cleanup provided by local emergency units
09/21/2006	Blooming Grove Township	Diesel fuel	A fuel tank on a tractor-trailer was punctured by road debris, spilling an indeterminate amount of diesel fuel on a berm; cleanup was provided by a private contractor and no injuries were reported
10/01/2006	Dingman Township	Diesel fuel	Less than 55 gallons of petroleum product spilled; limited impact on environment, soils or waterways; cleanup provided by local emergency units
11/15/2006	Greene Township	Diesel fuel	Less than 55 gallons of petroleum product spilled; limited impact on environment, soils or waterways; cleanup provided by local emergency units
12/09/2006	Lehman Township	Diesel fuel	Less than 55 gallons of petroleum product spilled; limited impact on environment, soils or waterways; cleanup provided by local emergency units
02/02/2007	Dingman Township	Liquid oxygen	A truck transporting liquid oxygen started to leak; emergency units secured the leak

Date	Location	Material Involved	Type of Incident/Details
05/14/2007	Matamoras Borough	Natural gas	A main gas line was ruptured at a construction site and caused a natural gas release; Orange and Rockland Gas Company secured the release without incident
05/31/2007	Lehman Township	Propane	Propane release occurred; the release was secured by local emergency units and no injuries were reported
06/04/2007	Blooming Grove Township	X-ray development acid	A van transporting x-ray development acid was reported to be on fire; cleanup was organized by emergency units and no injuries were reported
07/27/2007	Westfall Township	Hydraulic Oil	Less than 55 gallons of petroleum product spilled; limited impact on environment, soils or waterways; cleanup provided by local emergency units
08/04/2007	Blooming Grove Township	Gasoline	A vehicle accident on the McConnell Spillway resulted in an unknown amount of gasoline spilling; cleanup coordinated by emergency units and no injuries were reported
08/11/2007	Greene Township	Diesel fuel	Less than 55 gallons of petroleum product spilled; limited impact on environment, soils or waterways; cleanup provided by local emergency units
09/07/2007	Blooming Grove Township	Diesel fuel	Less than 55 gallons of petroleum product spilled; limited impact on environment, soils or waterways; cleanup provided by local emergency units
10/19/2007	Dingman Township	Diesel fuel	A tractor-trailer spilled approximately 70 gallons of diesel fuel; cleanup coordinated by emergency units
12/11/2007	Blooming Grove Township	Diesel fuel	A saddle tank ruptured on a tractor-trailer spilling an unknown quantity of diesel fuel onto a roadway; cleanup was coordinated by emergency units
05/23/2008	Delaware Township	Gypsy Moth spray	After Gypsy Moth spraying occurred, tank washout activities caused an undetermined amount of spray to be released into the Wild Acres Lake
08/03/2008	Westfall Township	Gasoline	Gasoline spilled but had a limited impact on environment, soils or waterways; cleanup provided by local emergency units
08/11/2008	Palmyra Township	Gasoline	A vehicle was driven into a pond and resulted in spilling unknown quantities of gasoline and oil; cleanup coordinated by the State Police
11/05/2008	Dingman Township	Natural gas	A Columbia Gas Company transmission line exploded, causing a natural gas release and for Interstate 84 to close; Columbia Gas Company secured the release without incident
04/28/2009	Palmyra Township	Toxic/Infectious Substance	A leak of an unknown chemical substance occurred at a rest stop on Interstate 84; local fire units responded and cleanup was coordinated by TEEM Environmental
09/17/2011	Blooming Grove Township	Diesel Fuel	80 gallons of diesel fuel was cleaned up in Blooming Grove Township
04/14/2014	Milford Township	Diesel Fuel	40 gallons of diesel fuel was cleaned up at an exit along I-84 in Milford Township
11/5/2015	Palmyra Township	Combustible Liquid Spill	While delivering chemical into an above ground storage tank, the hose ruptured and discharged between 23 and 30 gallons. The product went on to the stone and soil and then under the storage tank.
07/07/2015	Westfall Township	Gasoline Release	20 gallons of gasoline was cleaned up in Westfall Township
07/22/2015	Delaware Township	Gasoline	40 gallons of gasoline was cleaned up in Delaware Township
01/12/2016	Greene Township	Diesel Fuel	150 gallons of diesel fuel was cleaned up in Greene Township on I-84 as a result of a vehicle accident
03/26/2016	Palmyra	Gasoline	Gasoline was dumped in a storm drain; 5 gallons of gasoline was cleaned up
04/26/2016	Blooming Grove	Gasoline	15 gallons of gasoline was cleaned up

Date	Location	Material Involved	Type of Incident/Details
	Township		
06/03/2016	Blooming Grove Township	Diesel Fuel	65 gallons of diesel fuel was cleaned up
06/05/2016	Palmyra Township	Gasoline	A spill at a gas station led to a clean-up of 15 gallons of gasoline at the Promised Land Truck Stop in Palmyra Township
07/22/2016	Delaware Township	Gasoline	40 gallons of gasoline was cleaned up
09/25/2016	Greene Township	Gasoline	A fuel spill at a gas station led to the clean-up of 10 gallons of fuel

Source: 2012 Pike County HMP; PHSMA 2016; North American Hazmat Situations and Deployments Map 2016; Pike County 2016

Oil and Gas Wells

Environmental incidents including water contamination and fire spurring from oil and gas well drilling have occurred numerous times in Pennsylvania over the past century. Being that there is very little oil and gas well drilling in Pike County and no Marcellus shale drilling, there have been no past occurrences of oil and gas well accidents in Pike County. However, there have been many natural gas incidents occurring in nearby counties as gas companies rush to develop the natural gas deposits from Marcellus Shale. Most recently, in April 2011, a large spill occurred in Bradford County during fracking operations, and seven families were asked to evacuate their homes. An unknown amount of contaminated fluids spilled from the well, and reportedly contaminated a local creek that runs into the Susquehanna River. In Clearfield County in 2010, high gas pressure during the fracking process caused a rupture that discharged polluted water and explosive gas for sixteen hours. Though the drilling took place in a remote area at least a mile from any homes and no one was injured, it was still a major accident where the drilling process went out of control (Pike County HMP 2012).

Pyrite

Pyrite was found in borings collected for the expansion of SR 2001 (Milford Road) in Lehman Township in Pike County. The Route 2001 road improvement project was temporarily put on hold because of pyrite's discovery and debate resulted as to where to dispose of the rock (Pocono Record, 2016). As of January 2017, PennDOT has applied for a permit from PA DEP to treat the rock at two road sites in Lehman Township; the proposal also includes a groundwater monitoring plan. The permit is still in technical review (Pocono Record, 2017).

Future Occurrence

Because of the wide scope of definition of environmental hazards, ranging from a small spill to a large release of a highly volatile or toxic hazardous materials, incidents can and will happen at any time. Additionally, the County is home to over 60 EPA-regulated facilities. Although these facilities follow applicable safety and health regulations and best practices, proximities of the facilities to population centers is a concern for the county. Additionally, hazardous materials are transported along the highways and railroads in the county, making transportation accidents involving hazardous materials a concern for the county as well.

As for oil and gas well incidents, it is difficult to predict when and where these hazards will arise. Stringent monitoring through the PADEP will reduce the likelihood of potential impacts to the community and environment. Incidents involving oil and gas wells are expected to remain relatively low; however, it may increase if development of Marcellus Shale progresses in Pike County. Pike County started a Marcellus Shale Task Force in October 2010 which will help the county begin to plan for future impacts of Marcellus Shale on the region.

For the 2017 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of environmental hazard incidents for Pike County. Information from 2012 Pike County HMP, data provided by Pike County, the Right-to-Know Network, and PHSMA were used to identify the number of environmental hazard incidents that occurred between 1950 and 2015. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimate percent chance of an incident occurring in a given year. Based on these historic statistics, there is an estimated 100-percent chance of a hazardous release (fixed site or in-transit) occurring in any given year, while oil and gas incidents has a 0-percent chance of occurring due to the lack of active oil and gas wells located in Pike County.

Table 4.3.5-2. Probability of Future Environmental Hazard Incidents

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Hazardous Materials Release (fixed and in-transit)	183	2.83	0.36	1.0	100%
Oil and Gas Incidents	0	0	0	0	0%

Source: Pike County HMP 2012; Right-to-Know Network 2016; PHMSA 2016; Pike County 2016

While hazardous materials incidents in Pike County have occurred in the past, they are generally considered difficult to predict. Smaller incidents, such as fuel spills, will affect the county many times each year, most likely during refilling of home heating oil tanks, and may not be reported. Although the county does not anticipate severe releases on any regular basis, possibility of this should not be discounted. Based on Risk Factor Methodology Probability Criteria, the likelihood of future environmental hazard incidents occurring within Pike County remains at *highly likely*.

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed and vulnerable to the identified hazard. For environmental hazards, all of Pike County is exposed to the hazard. Therefore, all assets in the county (population, structures, critical facilities and lifelines), as described in the County Profile (Section 2), are exposed and potentially vulnerable to the release of hazardous substances. The following text evaluates and estimates the potential impact of the hazardous substances hazard on the county including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety of residents, (2) general building stock, (3) critical facilities, (4) economy, and (5) future growth and development
- Effect of climate change on vulnerability
- Change of vulnerability as compared to that presented in the 2012 Pike County HMP
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

Facilities that produce, use, or ship HazMat within the Commonwealth of Pennsylvania are required to comply with regulations set forth within the federal SARA and the Emergency Planning and Community Right to Know Act (EPCRA), and the Commonwealth of Pennsylvania reporting requirements under the Hazardous

Materials Emergency Planning and Response Act (Act 165). According to the 2013 State HMP, Pike County has three SARA Title III facilities (Pennsylvania State HMP 2013).

As stated above, Pike County has a few highly traveled highways and a railway network that pose a risk for hazardous material incidents. These networks transport hazardous material daily, on Interstate 84, US Route 6, US Route 209, PA 402, and PA 739. These major roads pass through the more populous areas. Similarly, rail lines pass through residential areas and boroughs where larger numbers of people could be vulnerable should a serious accident occur in these places.

Data and Methodology

To determine potential impact on Pike County, a 0.25-mile buffer was placed around the identified major roadways, as well as a 0.5-mile radius around each SARA Type III facility to define the hazard area. Populations and features of the built environment within this area may be directly or indirectly affected by an environmental hazard. The hazard area was overlaid upon the 2010 U.S. Census population data in Geographic Information System (GIS) (U.S. Census 2010). U.S. Census blocks are not consistent with these boundaries; blocks with their centroids within the hazard area were determined to be affected. A qualitative discussion is included regarding oil and gas wells in Pike County.

Impact on Life, Health, and Safety

Environmental hazards most significantly impact the residential population in Pike County. The majority of incidents reported in the County were related to (1) petroleum spills, which may be the result of motor vehicle incidents; and (2) other chemical releases and spills. Table 4.3.5-3 lists estimated Pike County populations vulnerable to environmental hazard areas.

Table 4.3.5-3. Estimated Pike County Populations Vulnerable to Environmental Hazard Areas

Municipality	Total Population	Population within ¼ mile of major roadways	Percent Population	Population within vulnerability radii of SARA Facility	Percent Population
Blooming Grove Township	4,819	297	6.2%	0	0%
Delaware Township	7,396	471	6.4%	0	0%
Dingman Township	11,926	402	3.4%	394	3.3%
Greene Township	3,956	756	19.1%	0	0%
Lackawaxen Township	4,994	648	13.0%	0	0%
Lehman Township	10,663	0	0.0%	0	0%
Matamoras Borough	2,469	1,904	77.1%	0	0%
Milford Borough	1,021	1,003	98.2%	0	0%
Milford Township	1,530	792	51.8%	179	11.7%
Palmyra Township	3,312	1,263	38.1%	0	0%
Porter Township	485	6	1.2%	0	0%
Shohola Township	2,475	216	8.7%	0	0%
Westfall Township	2,323	1,003	43.2%	0	0%
Pike County (Total)	**57,369**	**8,761**	**15.3%**	**573**	**<1%**

Source: U.S. Census 2010; Pike County 2015; EPA 2017
Notes:

%	*Percent*
SARA	*Superfund Amendments and Reauthorization Act*

Impact on General Building Stock, Critical Facilities, and Economy

While buildings and critical facilities may be present within the hazard area, estimating direct damage to these structures and facilities would be difficult. However, damages to the surrounding environment can result in indirect impacts, such as temporary loss of function due to hazard response or damage in the area.

Economic losses from environmental hazards and explosion incidents range from non-recordable to those exceeding millions of dollars. Impacts on the local economy from a single incident are almost impossible to measure because of complexities of predicting losses of work, revenue, and future business.

There are approximately 35 miles of Interstate Route 84 that crosses east to west across the County from the Delaware River at the Matamoras - Westfall border to the Wayne County border at Greene Township. This road is a major route from the New England states west. It is a vulnerable corridor for hazardous waste accidents as many materials, including high level radioactive waste are transported through the corridor. Other potential sources of hazardous materials include two natural gas transmission lines that cross the County, each with a compressor station, the two SARA facilities within the County, each containing chlorine gas, and several fuel dispensing facilities with large bulk tanks containing either fuel oil, diesel fuel, kerosene, or propane.

Regarding railroad transport of hazardous materials, Norfolk Southern took over operation of approximately 26 miles of its Southern Tier Route along the Delaware River from Conrail in 1999. A January 2001 listing of the top 50 commodities showed that approximately 6,000 car loads of hazardous materials were transported along this line in the previous 12 months – liquefied petroleum amounted to 1,900 car loads. In January 2005, Norfolk Southern leased this line to the Central New York Railroad, which is owned by the New York, Susquehanna and Western Railroad. This railroad has plans to improve the track conditions with hope of increasing traffic. It appears that more trains may now be using the line than have used it for many years thus making populations that live along the lines vulnerable to hazardous material accidents.

Jurisdictions that are home to EPA-identified hazardous material facilities should be considered vulnerable to releases from these fixed facilities. Westfall Township has the most hazardous materials facilities with two, followed by Delaware Township and Milford Township which each host one facility. Lackawaxen, Palmyra, Shohola, Blooming Grove, Greene, Porter, Lehman, and Delaware townships have much lower relative vulnerability to fixed hazardous materials incidents because they have no hazardous material facilities although communities that border a site would be vulnerable (Pike County HMP 2012).

Populations in and around the communities that are home to EPA-identified hazardous material sites are more vulnerable to facility releases, particularly those within 1.5 miles of the facility. According to the EPA Envirofacts database, Pike County does not have any TRI, TSCA or Superfund sites (EPA 2016). Jurisdictions without fixed hazardous materials facilities in general do not have vulnerable structures or critical facilities. However, it is important to note that even if a jurisdiction houses no hazardous materials sites, it may be vulnerable to a release event occurring in an adjacent municipality.

Transportation of hazardous materials also increases risk of hazardous material releases to those jurisdictions through which carriers pass. Transportation carriers must have response plans in place to address accidents, otherwise the local emergency response team will step in to secure and restore the area. Quick response minimizes the volume and concentration of hazardous materials that disperse through air, water and soil. Populations living within ¼ mile of major highways and railways should also be considered more vulnerable in the event of a transportation incident involving hazardous materials. For more information on the numbers of addressable structures located within ¼ mile of major highways and railways, please see Section 4.3.14.5.

There are two natural gas transmission pipelines that bisect the County. They are displayed in figured 4.3.19-1. Breaks in the pipelines could result in hazardous material releases as well as explosions and utility interruptions. Municipalities most vulnerable to pipeline accidents include Westfall, Milford, Dingman, Delaware, Lehman, Shohola, and Lackawaxen Township.

Oil and Gas Wells and Pipelines

Although there are only two oil or gas wells in Pike County, all 13 communities in Pike County are vulnerable on some level, directly or indirectly, to environmental hazards resulting from oil and gas well and pipeline activity. Surface waters closest to well sites are most vulnerable to damage and oil and gas industry workers are most likely to be affected by gas well fires.

In addition, well drilling and operation poses a threat to groundwater resources. One of the greatest fears of residents in Marcellus Shale counties is that groundwater will become contaminated as a result of developing the natural gas deposits. Groundwater is currently the sole source of drinking water in Pike County according to a watershed specialist from the Pike County Conservation District and the majority of Pike County residents obtain their groundwater from wells drilled into bedrock (Kane, 2009). Private water supplies such as domestic drinking water wells in the vicinity of oil and gas wells are at risk of contamination from brine and other pollutants including methane which can pose a fire hazard. Ideally vulnerability of private drinking well owners would be established by comparing distance of drinking water wells to known oil and gas well locations but this data is not available at this time. Private drinking water is largely unregulated and information on these wells is submitted to the Pennsylvania Topographic and Geologic Survey by water well drillers. Therefore the existing data is largely incomplete and/or inaccurate (PaGWIS). Table 4.3.5-4 shows the number of oil wells, gas wells, and domestic drinking water wells by jurisdiction.

Table 4.3.5-4. Number of oil wells, gas wells and domestic drinking water wells by jurisdiction

Municipality	Oil and Gas Wells				Domestic Drinking Water Wells
	Active	Abandoned	Inactive	Plugged	
Blooming Grove Township	0	0	0	1	219
Delaware Township	0	0	0	0	989
Dingman Township	0	0	0	0	2,783
Greene Township	1	0	0	0	985
Lackawaxen Township	0	0	0	0	528
Lehman Township	0	0	0	0	1,053
Matamoras Borough	0	0	0	0	19
Milford Borough	0	0	0	0	104
Milford Township	0	0	0	0	195
Palmyra Township	0	0	0	0	345
Porter Township	0	0	0	0	153
Shohola Township	1	0	0	0	498
Westfall Township	0	0	0	0	281
Pike County (TOTAL)	**2**	**0**	**0**	**1**	**8,168**

Source: PAGWIS, PADEP
Note: 87 domestic wells did not have an associated municipality in the attribute table.

Impact on the Environment

As discussed above, environmental hazards and explosion incidents discussed above can profoundly affect the surrounding environment. Contamination of soil, and surface water and groundwater supplies, can result in many direct impacts on surrounding populations and ecosystems. Local flora and fauna within hazard areas are also at risk. The application of salt to de-ice roads may impact groundwater and contaminate potable drinking water sources near major highway corridors and state highway routes in the County.

Future Growth and Development

As discussed in Section 2.4, areas targeted for future growth and development have been identified across Pike County. Any areas of growth could be impacted by environmental hazards if within identified hazard areas discussed throughout Section 4.3 of this HMP. The County intends to discourage development within vulnerable areas and SFHAs, or to encourage higher regulatory standards on the local level.

Effect of Climate Change on Vulnerability

Environmental hazard incidents are human-caused hazard; however, as noted, their release may be the result from natural hazard events. Climate change may potentially increase the frequency and magnitude of flood and severe weather events which may lead to an increased release of hazardous materials at both fixed sites and in-transit.

Change of Vulnerability

Overall, Pike County remains vulnerable to hazards materials release events. As the oil and gas industry continues to grow, the County may become more vulnerable to any impacts from the industry.

Additional Data and Next Steps

For the HMP update, any additional information regarding localized concerns and past impacts will be collected and analyzed. This data will be developed to support future revisions to the plan. Mitigation efforts could include building on existing Pennsylvania, Pike County, and local efforts.

4.3.6 Extreme Temperature

This section provides a profile and vulnerability assessment of the extreme temperature hazard in Pike County. Extreme temperature includes both heat and cold events, which can have a significant impact to human health, commercial/agricultural businesses and primary and secondary effects on infrastructure (e.g., burst pipes and power failure). What constitutes "extreme cold" or "extreme heat" can vary across different areas of the country, based on what the population is accustomed to.

Extreme cold events are when temperatures drop well below normal in an area. In regions relatively unaccustomed to winter weather, near freezing temperatures are considered "extreme cold." Extreme cold temperatures are generally characterized in temperate zones by the ambient air temperature dropping to approximately 0ºF or below (Centers of Disease Control and Prevention [CDC] 2013). Extremely cold temperatures often accompany a winter storm, which can cause power failures and icy roads. Although staying indoors as much as possible can help reduce the risk of car crashes and falls on the ice, individuals may also face indoor hazards. Many homes will be too cold—either due to a power failure or because the heating system is not adequate for the weather. The use of space heaters and fireplaces to keep warm increases the risk of household fires and carbon monoxide poisoning (CDC 2007).

Conditions of extreme heat are defined as summertime temperatures that are substantially hotter and/or more humid than average for a location at that time of year (CDC 2009). An extended period of extreme heat of three or more consecutive days is typically called a heat wave and is often accompanied by high humidity (NWS 2005). There is no universal definition of a heat wave because the term is relative to the usual weather in a particular area. The term heat wave is applied both to routine weather variations and to extraordinary spells of heat which may occur only once a century (Meehl and Tebaldi 2004). A basic definition of a heat wave implies that it is an extended period of unusually high atmosphere-related heat stress, which causes temporary modifications in lifestyle and which may have adverse health consequences for the affected population (Robinson 2013). A heat wave is defined has three consecutive days of temperatures ≥90°F.

Extreme heat is the number one weather-related cause of death in the U.S. In a ten-year average of weather fatalities across the nation from 2006 to 2015, excessive heat claimed more lives each year than floods, lightning, tornadoes, and hurricanes. In 2015, heat claimed 45 lives, with four occurring in Pennsylvania (NWS 2015).

Location and Extent

Location

Pike County is susceptible to extreme temperatures in the summer and winter seasons and they can occur anywhere in the County. Average minimum temperatures in Pike County ranged from 34°F to 38°F (Figure 4.3.6-1) and average maximum temperatures range from 55°F to 61°F (Figure 4.3.6-2) (PA HMP 2013). The average high temperature in July is 83.6°F and the average low temperature in January is 15.3°F (Sterlings Best Places 2016).

Figure 4.3.6-1. Average Minimum Temperature (1981-2010)

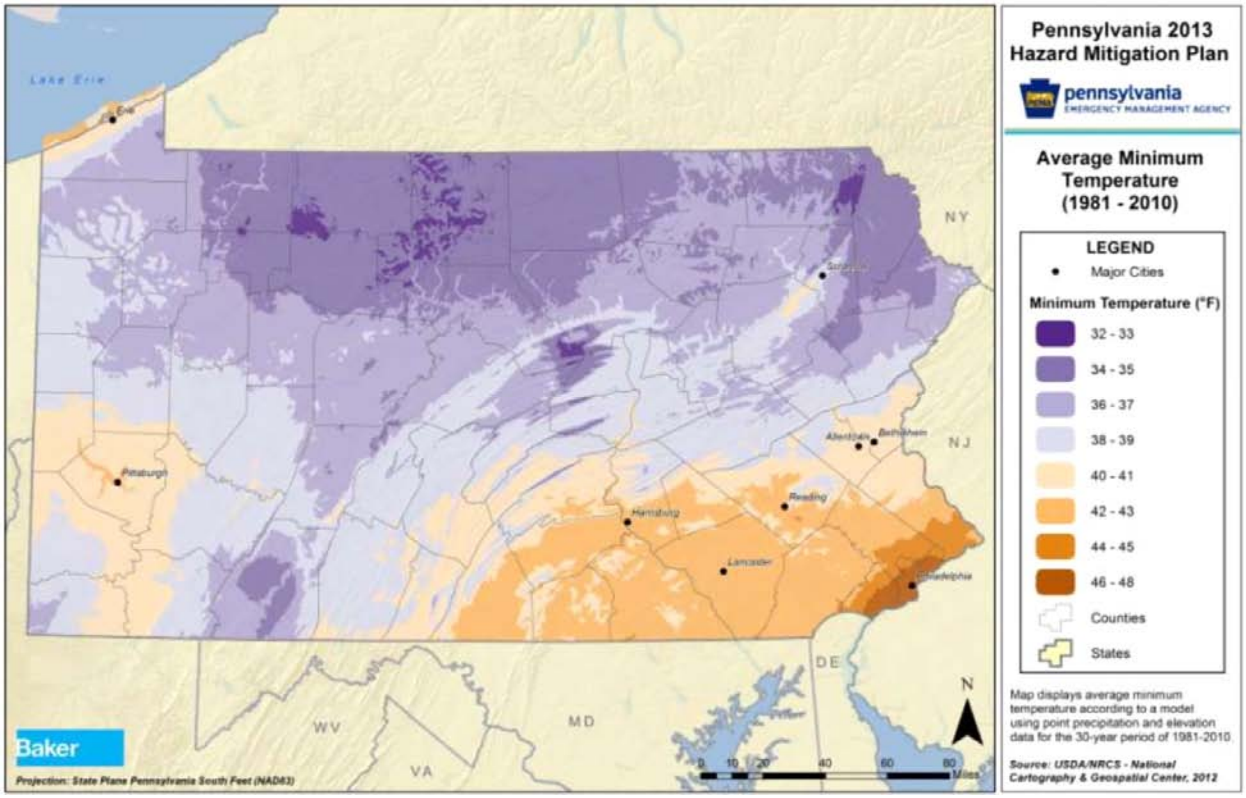
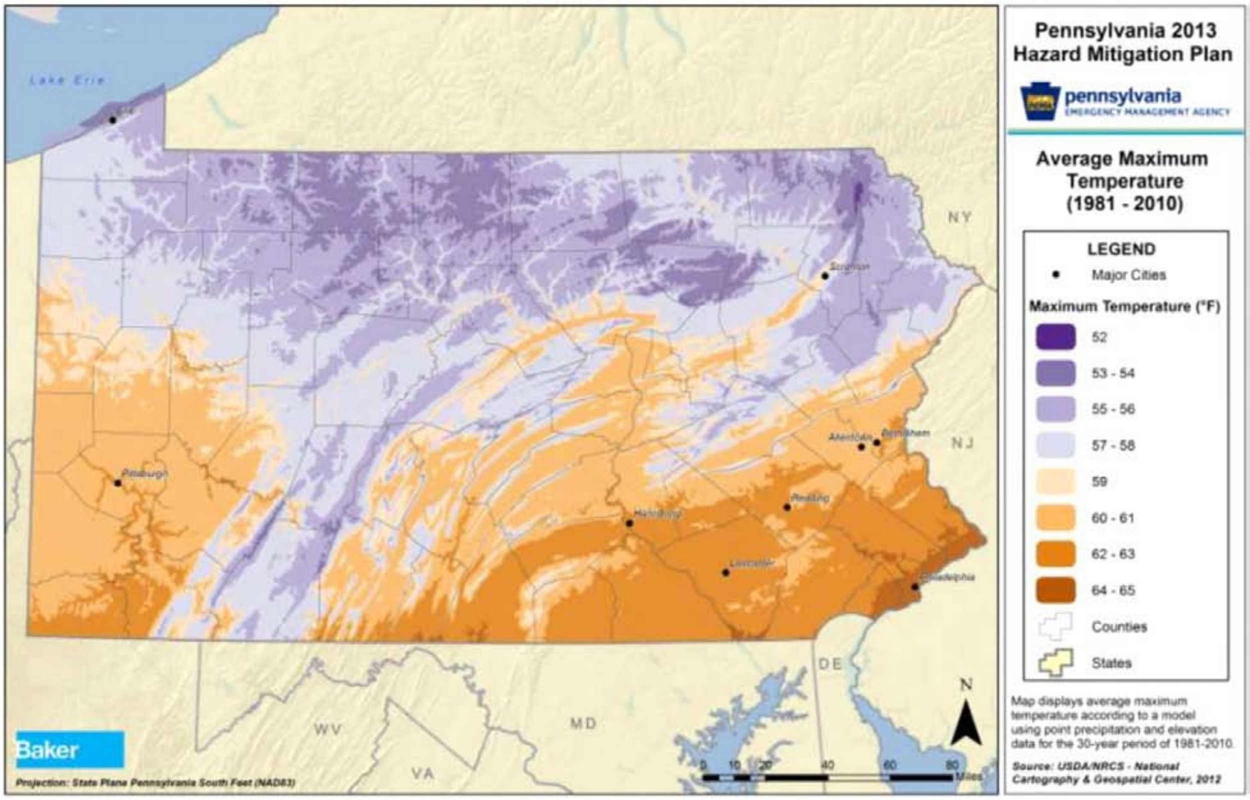


Figure 4.3.6-2. Average Maximum Temperature (1981-2010)



Extent

Extreme Heat

NOAA's heat alert procedures are based mainly on Heat Index values. The Heat Index is given in degrees Fahrenheit. The Heat Index is a measure of how hot it really feels when relative humidity is factored in with the actual air temperature. To find the Heat Index temperature, the temperature and relative humidity need to be known. Once both values are known, the Heat Index will be the corresponding number with both values (Figure 4.3.6-3). The Heat Index indicated the temperature the body feels. It is important to know that the Heat Index values are devised for shady, light wind conditions. Exposure to full sunshine can increase heat index values by up to 15°F. Strong winds, particularly with very hot dry air, can also be extremely hazardous (NWS 2013).

Figure 4.3.6-3. NWS Heat Index Chart

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution   Extreme Caution   Danger   Extreme Danger

Source: NWS 2015
°F degrees Fahrenheit
% percent

Extreme Cold

The extent (severity or magnitude) of extreme cold temperatures are generally measured through the Wind Chill Temperature (WCT) Index. Wind Chill Temperature is the temperature that people and animals feel when outside and it is based on the rate of heat loss from exposed skin by the effects of wind and cold. As the wind increases, the body is cooled at a faster rate causing the skin's temperature to drop (NWS Date Unknown).

On November 1, 2001, the NWS implemented a new WCT Index. It was designed to more accurately calculate how cold air feels on human skin. The table below shows the new WCT Index. The WCT Index includes a frostbite indicator, showing points where temperature, wind speed, and exposure time will produce frostbite to humans. Figure 4.3.6-4 shows three shaded areas of frostbite danger. Each shaded area shows how long a person can be exposed before frostbite develops (NWS Date Unknown).

Figure 4.3.6-4. NWS Wind Chill Index

NWS Windchill Chart

Temperature (°F)

Wind (mph) / Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes | 10 minutes | 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Source: NWS Date Unknown
°F degrees Fahrenheit
mph miles per hour

Range of Magnitude

Extreme temperatures can cause a range of impacts to communities that include health impacts, transportation, agriculture, and energy.

Meteorologists can accurately forecast extreme temperature event development and the severity of the associated conditions with several days lead time. These forecasts provide an opportunity for public health and other officials to notify vulnerable populations. For heat events, the NWS issues excessive heat outlooks when the potential exists for an excessive heat event in the next three to seven days. Watches are issued when conditions are favorable for an excessive heat event in the next 24 to 72 hours. Excessive heat warning/advisories are issued when an excessive heat event is expected in the next 36 hours (NWS 2013d). Winter temperatures may fall to extreme cold readings with no wind occurring. Currently, the only way to headline very cold temperatures is with the use of the NWS-designated Wind Chill Advisory or Warning products. When actual temperatures reach Wind Chill Warning criteria with little to no wind, extreme cold warnings may be issued (NWS Date Unknown).

Cold temperatures can be dangerous to humans and animals exposed to the cold. Without heat and shelter, cold temperatures can lead to hypothermia, frostbite, and even death. As stated above, cold temperatures are typically measured through the Wind Chill Temperature index. The values represent what the temperature actually feels like to humans and animals under cold, windy conditions. The effect of cold temperatures will vary by individual (CDC 2012).

Extremely high temperatures cause heat stress which can be divided into four categories (Figure 4.3.6-5). Each category is defined by apparent temperature which is associated with a heat index value that captures the combined effects of dry air temperature and relative humidity on humans and animals. Major human risks for these temperatures include heat cramps, heat syncope, heat exhaustion, heatstroke, and death. Although the figure below serves as a guide for various danger categories, the impacts of high temperatures will vary from person to person based on age, health and other factors. The elderly and very young are most vulnerable to health-related impacts of extreme temperatures (PA HMP 2013).

Figure 4.3.6-5. Adverse Effects of Prolonged Exposures to Heat on Individuals

Category	Heat Index	Health Hazards
Extreme Danger	130 °F – Higher	Heat Stroke / Sunstroke is likely with continued exposure.
Danger	105 °F – 129 °F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Extreme Caution	90 °F – 105 °F	Sunstroke, muscle cramps, and/or heat exhaustions possible with prolonged exposure and/or physical activity.
Caution	80 °F – 90 °F	Fatigue possible with prolonged exposure and/or physical activity.

Source: NWS 2009

Past Occurrence

Many sources provided historical information regarding previous occurrences and losses associated with extreme temperature events throughout Pike County. With so many sources reviewed for the purpose of this HMP, loss and impact information for many events could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

Based on the Midwestern Regional Climate Center (MRCC) data, Table 4.3.6-1 presents the extreme cold (minimum) and hot (maximum) temperature records for the weather stations located in Pike County between 1895 and 2016.

Table 4.3.6-1.MRCC Temperature Extremes

Station Name	Average Maximum (°F)	Average Minimum (°F)	Highest Max (°F)	Date	Lowest Minimum (°F)	Date
Hawley 1 E	59	35	100	8/26/1948	-31	1/21/1994
Matamoras	61	38	102	7/3/1966	-18	1/13/1981

Source: MRCC 2016

Note: There may be some potential problems with the data collected at the stations. The values of the all-time records for stations with brief histories are limited in accuracy and could vary from nearby stations with longer records. Although the data sets have been through quality control, there is still a need for more resources to quality control extremes. The record sets are for single stations in the cooperative observer network and are limited to the time of operation of each station under one coop number. The records for a place may need to be constructed from several individual station histories. Some of the data may vary from NWS records due to NWS using multiple stations and additional sources like record books (MRCC, Date Unknown).

Between 1954 and 2016, Pennsylvania has not been included in major disaster (DR) or emergency (EM) declarations as a result of extreme temperatures (FEMA 2016). Agriculture-related disaster declarations are quite common. One-half to two-thirds of the counties in the U.S. have been designated as disaster areas in each of the past several years. The USDA Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2012 and 2016, Pennsylvania has been included in 25 USDA declarations related to extreme temperatures. Pike County has been included in three of these declarations.

- S3487 – June – November 2012 - The combined effects of drought, high winds (derecho), hail, excessive heat, excessive rain, flash flooding, Hurricane Sandy, snowstorm, and Nor'easter
- S3696 – December 2013-April 2014 – Freeze
- S3930 – April-September 2015 – Excessive heat and drought

Table 4.3.6-2 discusses extreme temperature events that occurred in Pike County. Between 1950 and 2016, Pike County has experienced 113 extreme temperature events (Pennsylvania State Climatologist 2016; NOAA-NCEI 2016). However, details for all events were not readily available. As stated above, many sources were researched for historical information regarding extreme temperature events; however, the table below many not include all extreme temperature events that have impacted Pike County.

Table 4.3.6-2. Extreme Temperature Events in Pike County, 1950 to 2016

Date(s) of Event	Event Type	Description
October 4, 1996	Cold/Wind Chill	A very cold air mass moved into central New York State and northeastern Pennsylvania. Widespread freeze conditions were observed. In Pike County, the Hawley weather station recorded a low of 25°F on October 4th.
January 17, 1997	Cold/Wind Chill	An arctic air mass moved into northeast Pennsylvania and lasted for two days. Air temperatures dropped to near zero over much of the region. During the day, readings only reached single digits and lower teens. At night, temperatures ranged from -5°F to -15°F. In addition to the cold temperatures, strong winds impacted the area as well. Wind chills of -35° to -55°F were common over the northern tier of the Commonwealth. In Pike County, the Hawley weather station recorded a low of 6°F on the 17th.
September 28-29, 2000	Extreme Cold/Wind Chill	A widespread freeze occurred across central New York State and northeastern Pennsylvania. Temperatures below 30 degrees were observed. In Pike County, at the Hawley weather station, temperature lows of 28°F and 34°F were recorded for those dates.
August 1-10, 2001	Heat	The first nine days of August included a significant heat wave. Locations in northeast Pennsylvania reported temperatures in the upper 90s to lower 100s. Numerous high temperature records were set during this time. The heat wave peaked on the 9th when many locations saw temperatures above 100°F. In Pike County, between August 7th and 9th, temperatures were in the low to mid 90s. At the Hawley NWS weather station, temperatures ranged from 92°F to 94°F, with the highest temperature recorded on August 9th. At the Matamoras weather station, temperatures during this time period ranged from 93°F to 99°F, with the highest temperature recorded on August 10th.
January 10, 2004	Cold/Wind Chill	Cold temperatures moved into northeast Pennsylvania bringing cold temperatures of below zero to most locations. In Pike County, at the Hawley weather station, the maximum temperature for the 10th was 6°F and the minimum temperature was -8°F. The County had approximately $5,000 in property damage from this event.
January 15-16, 2004	Cold/Wind Chill	Cold temperatures and winds of 15 to 25 mph impacted northeastern Pennsylvania. The combination of the cold and wind produced wind chill values of -15°F to -35°F. Many schools were closed due to the temperatures. The temperatures also caused problems with cars and busses. Some residences and businesses had damage from frozen pipes. In Pike County, the maximum temperatures for these two days ranged from 7°F to 9°F and the minimum temperatures ranged from -3°F to -6°F (recorded at the Hawley weather station). Damages in the county were approximately $10,000 form this event.
December 14, 2005	Cold/Wind Chill	Arctic cold air caused morning temperatures to be below zero, with most between -5°F and -10°F. Temperatures in Pike County ranged from 0°F to -11°F.
July 21-23, 2011	Excessive Heat	For three days, high temperatures across parts of northeastern Pennsylvania rose above the 90s. In Pike County, temperatures across the county reached well into the 90s. At the Hawley weather station, temperatures ranged from 87°F to 95°F.
January 6-7, 2014	Arctic Air	An arctic airmass moved over central New York State and northeast Pennsylvania producing dangerously cold wind chill values as low as -30°F. In Pike County, -8°F

Date(s) of Event	Event Type	Description
		was recorded at the Hawley weather station.
February 14, 2016	Cold Temperatures	Arctic air spread across parts of central New York State and northeast Pennsylvania. This produced record low temperatures in some locations. A maximum low of -11°F was recorded at the Hawley weather station.

Sources: NOAA NCEI 2016; NWS 2016; Pennsylvania State Climatologist 2016

Future Occurrence

Extreme temperature events occur each year throughout Pike County. It is estimated that the county will continue to experience temperature extremes annually that may induce secondary hazards such as potential snow, hail, ice or wind storms, thunderstorms, drought, human health impacts, utility failures, and transportation accidents.

For the 2017 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of extreme temperature events for Pike County. Information from NOAA-NCEI storm events database and Pennsylvania State Climatologist were used to identify the number of extreme temperature events that occurred between 1950 and 2015. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimate percent chance of an incident occurring in a given year. Based on these statistics, there is an estimated 100-percent chance of an extreme temperature event occurring in any given year in Pike County.

Table 4.3.6-3. Probability of Future Extreme Temperature Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Extreme Temperature	113	1.74	0.58	1.71	100%

Sources: NOAA-NCEI 2016; Pennsylvania State Climatologist 2016

Based on available historical data, the future occurrence of extreme temperatures can be considered *likely* as defined by the Risk Factor Methodology probability criteria (refer to Section 4.4).

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For the extreme temperature events, the entire County has been identified as the hazard area. Therefore, all assets in the County (population, structures, critical facilities and lifelines), as described in the County Profile (Section 2), are vulnerable. The following text evaluates and estimates the potential impact of extreme temperatures on Pike County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety of residents, (2) general building stock, (3) critical facilities (4) economy and (5) future growth and development
- Effect of climate change on vulnerability
- Further data collections that will assist understanding of this hazard over time

Overview of Vulnerability

Extreme temperatures generally occur for a short period of time but can cause a range of impacts, particularly to vulnerable populations that may not have access to adequate cooling or heating. This natural hazard can also cause impacts to agriculture (crops and animals), infrastructure (e.g., through pipe bursts associated with freezing, power failure) and the economy.

Data and Methodology

Data was collected from USDA, NOAA-NCDC, Pennsylvania State Climatologist, Pike County, and the Planning Committee sources. Insufficient data was available to model the long-term potential impacts of extreme temperature on the County. Over time, additional data will be collected to allow better analysis for this hazard. Available information and a preliminary assessment are provided below.

Impact on Life, Health, and Safety

For the purposes of this HMP, the entire population of Pike County is exposed to extreme temperature events.

Extreme temperature events have potential health impacts including injury and death. According to the Centers for Disease Control and Prevention, populations most at risk to extreme cold and heat events include the following: 1) the elderly, who are less able to withstand temperatures extremes due to their age, health conditions and limited mobility to access shelters; 2) infants and children up to four years of age; 3) individuals who are physically ill (e.g., heart disease or high blood pressure), 4) low-income persons that cannot afford proper heating and cooling; and 5) the general public who may overexert during work or exercise during extreme heat events or experience hypothermia during extreme cold events (CDC, 2006).

Meteorologists can accurately forecast extreme heat event development and the severity of the associated conditions with several days of lead time. These forecasts provide an opportunity for public health and other officials to notify vulnerable populations, implement short-term emergency response actions and focus on surveillance and relief efforts on those at greatest risk. Adhering to extreme temperature warnings can significantly reduce the risk of temperature-related deaths.

Impact on General Building Stock

All of the building stock in the County is exposed to the extreme temperature hazard. Refer to Section 2 which summarizes the building inventory in Pike County. Extreme heat generally does not impact buildings. Losses may be associated with the overheating of heating, ventilation, and air conditioning (HVAC) systems. Extreme cold temperature events can damage buildings through freezing/bursting pipes and freeze/thaw cycles. Additionally, manufactured homes (mobile homes) and antiquated or poorly constructed facilities may have inadequate capabilities to withstand extreme temperatures.

Impact on Critical Facilities

All critical facilities in the County are exposed to the extreme temperature hazard. Impacts to critical facilities are the same as described for general building stock. Additionally, it is essential that critical facilities remain operational during natural hazard events. Extreme heat events can sometimes cause short periods of utility failures, commonly referred to as “brown-outs”, due to increased usage from air conditioners, appliances, etc. Similarly, heavy snowfall and ice storms, associated with extreme cold temperature events, can cause power interruption as well. Backup power is recommended for critical facilities and infrastructure.

Impact on the Economy

Extreme temperature events also have impacts on the economy, including loss of business function and damage/loss of inventory. Business-owners may be faced with increased financial burdens due to unexpected repairs caused to the building (e.g., pipes bursting), higher than normal utility bills or business interruption due to power failure (i.e., loss of electricity, telecommunications).

The agricultural industry is most at risk in terms of economic impact and damage due to extreme temperature events. Extreme heat events can result in drought and dry conditions and directly impact livestock and crop production. Based on the 2012 Census of Agriculture, there were 50 farms in Pike County, with a total of 28,260 acres of land in farms. The average farm size was 565 acres. Pike County's farms had a total market value of products sold of over $2.9 million, averaging over $59,000 per farm. The Census indicated that 17 of farm operators reported farming as their primary occupation (USDA 2012).

An extreme heat event could result in drought conditions and have a serious impact on a community. During an extreme temperature event, there may be an increased demand for water and electricity which may lead to shortages and a higher cost for these resources.

Future Growth and Development

Areas targeted for potential future growth and development within the next 5 years have been identified across Pike County. Refer to Section 2.4 of this HMP. Any areas of growth could be potentially impacted by the extreme temperature hazard because the entire County is exposed and potentially vulnerable.

Effect of Climate Change on Vulnerability

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

Additional Data and Next Steps

For future plan updates, the County can track data on extreme temperature events, obtain additional information on past and future events, particularly in terms of any injuries, deaths, shelter needs, pipe freeze, agricultural losses and other impacts. This will help to identify any concerns or trends for which mitigation measures should be developed or refined. In time, quantitative modeling of estimated extreme heat and cold events may be feasible as data is gathered and improved.

4.3.7 Flood, Flash Flood, Ice Jam

This section provides a profile and vulnerability assessment of the flood hazard in Pike County. Floods are one of the most common natural hazards in the United States and are the most prevalent type of natural disaster occurring in Pennsylvania. Over 94 percent of the State's municipalities have been designated as flood-prone areas. Both seasonal and flash floods have been causes of millions of dollars in annual property damages, loss of lives, and disruption of economic activities (Pennsylvania Emergency Management Agency [PEMA] 2013).

The Federal Emergency Management Agency's (FEMA) definition of flooding is "a general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from the overflow of inland or tidal waters or the rapid accumulation of runoff of surface waters from any source" (FloodSmart.gov 2015).

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

Riverine Floods

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

Flash Floods

According to the National Weather Service (NWS), flash floods are a rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within 6 hours of the causative event (e.g., intense rainfall, dam failure, or ice jam) (NWS 2015).

Flash floods can occur very quickly and with very little warning. This type of flood can be deadly because it produces rapid rises in water levels and has devastating flow velocities. Urban areas are more susceptible to flash floods because a high percentage of the surface area is impervious (Pennsylvania Emergency Management Agency [PEMA] 2013). Time elapsed before flash flooding occurs may vary in different parts of the country. Ongoing flooding can intensify to flash flooding where intense rainfall results in a rapid surge of rising flood waters (NWS 2015). A flash flood can have a dangerous wall of roaring water that carries rocks, mud, and other debris, and can sweep away most things in its path. Flash floods usually result from intense storms dropping large amounts of rain within a brief period with little or no warning, and can reach their peak within only a few minutes. They normally occur in the summer during the thunderstorm season. The most severe flooding conditions usually occur when direct rainfall is augmented by snowmelt. If the soil is saturated or frozen, stream flow may increase because of inability of the soil to absorb additional precipitation (FEMA 2008).

Ice-Jam Floods

An ice jam is an accumulation of ice that acts as a natural dam and restricts flow of a body of water. Ice jams occur when warm temperatures and heavy rains cause rapid snow melt. The melting snow, combined with the heavy rain, causes frozen rivers to swell. The rising water breaks the ice layers into large chunks, which float downstream and often pile up near narrow passages and obstructions (bridges and dams). Ice jams may build up to a thickness great enough to raise the water level and cause flooding (Northeast States Emergency Consortium [NESEC] Date Unknown, U.S. Army Corps of Engineers [USACE] 2002).

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

Dam Failure Floods

A dam is an artificial barrier that can impound water, wastewater, or any liquid-borne material for the purpose of storage or control of water (FEMA 2010). Dams are man-made structures built across a stream or river that impound water and reduce flow downstream (FEMA 2003). They are built for purposes of power production, agriculture, water supply, recreation, and flood protection. Dam failure is any malfunction or abnormality outside of the design that adversely affects a dam's primary function of impounding water (FEMA 2011). Dams can fail for one or a combination of the following reasons:

- Overtopping caused by floods that exceed capacity of the dam (inadequate spillway capacity)
- Prolonged periods of rainfall and flooding
- Deliberate acts of sabotage (terrorism)
- Structural failure of materials used in dam construction
- Movement and/or failure of the foundation supporting the dam
- Settlement and cracking of concrete or embankment dams
- Piping and internal erosion of soil in embankment dams
- Inadequate or negligent operation, maintenance, and upkeep
- Failure of upstream dams on the same waterway
- Earthquake (liquefaction/landslides) (FEMA 2010).

Flooding can occur when a dam fails or breaks, producing effects similar to flash floods. Areas most susceptible to effects of floods are low-lying areas near water or downstream from a dam (FEMA 2011).

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

Location and Extent

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

Floodplains are found in lowland areas adjacent to rivers, streams, creeks, lakes, or other bodies of water that become inundated during a flood. The size of a floodplain depends on the recurrence interval of a given flood. A 1-percent annual chance floodplain is smaller than the floodplain associated with a flood that has a 0.2-percent annual chance of occurring (PEMA 2013). Floodplain maps of each Pike County jurisdiction are available at the end of this profile. These maps show locations of both the 1-percent chance annual floodplain and the 0.2-percent chance annual floodplain.

Pike County's biggest flooding threat remains along the Delaware River corridor and portions of the Lackawaxen River. Other major creeks within the County include the East Branch Wallenpaupack, Shohola, Billings, and Blooming Grove Creek. Lake Wallenpaupack also comprises a portion of the County's western border and is prone to flooding. It was also noted that Broadhead Road in Lehman Township is prone to flooding.

Most municipalities in Pike County have flood-prone areas because they are located along streams, creeks, or lakes. In addition, community development of the floodplain has resulted in frequent flooding. For inland areas, excess water from snowmelt or rainfall accumulates and overflows onto stream banks and adjacent floodplains.

Table 4.3.7-1 lists total land areas within the 1-percent and 0.2-percent annual chance flood zones calculated via a spatial analysis referencing the 2000 Digital Flood Insurance Rate Map (DFIRM).

Table 4.3.7-1 Total Land Areas in the 1-Percent and 0.2-Percent Annual Chance Flood Zones (Acres)

Municipality	NFIP-Participating Community	Total Area (acres)	1% Flood Event Hazard Area		0.2% Flood Event Hazard Area	
			Area (acres)	% of Total	Area (acres)	% of Total
Blooming Grove Township	Yes	49,458	3,973	8.0%	3,973	8.0%
Delaware Township	Yes	29,210	2,459	8.4%	2,459	8.4%
Dingman Township	Yes	38,493	5,783	15.0%	5,992	15.6%
Greene Township	Yes	39,581	4,610	11.6%	4,610	11.6%
Lackawaxen Township	Yes	51,955	3,283	6.3%	3,283	6.3%
Lehman Township	Yes	32,205	3,949	12.3%	3,949	12.3%
Matamoras Borough	Yes	509	250	49.2%	839	164.9%
Milford Borough	Yes	321	117	36.4%	123	38.2%
Milford Township	Yes	7,931	314	4.0%	327	4.1%
Palmyra Township	Yes	25,249	6,769	26.8%	6,769	26.8%
Porter Township	Yes	38,699	10,370	26.8%	10,370	26.8%
Shohola Township	Yes	30,101	1,855	6.2%	1,892	6.3%
Westfall Township	Yes	19,302	1,848	9.6%	2,473	12.8%
Pike County (Total)	**-**	**363,014**	**45,580**	**12.6%**	**47,058**	**13.0%**

Source: FEMA 2000
Note: Areas listed include areas of inland waterways

In accordance with the 1978 Pennsylvania Stormwater Management Act (Act 167), counties are required to prepare stormwater management plans on a watershed-by-watershed basis that provide for improved management of stormwater impacts associated with development of land. In 2010, Pike County developed and implemented Phase I of the Act 167 County Wide Plan Stormwater Management Plan. This phase of the Plan includes the Scope of Study—establishing procedures for use in preparing the Plan. These procedures are determined by an overall survey of:

- Specific watershed characteristics and hydrologic conditions

- Stormwater-related problems and significant obstructions
- Alternative measures for control
- Goals, objectives, solution strategies, and estimated costs for Phase 2 of the Plan.

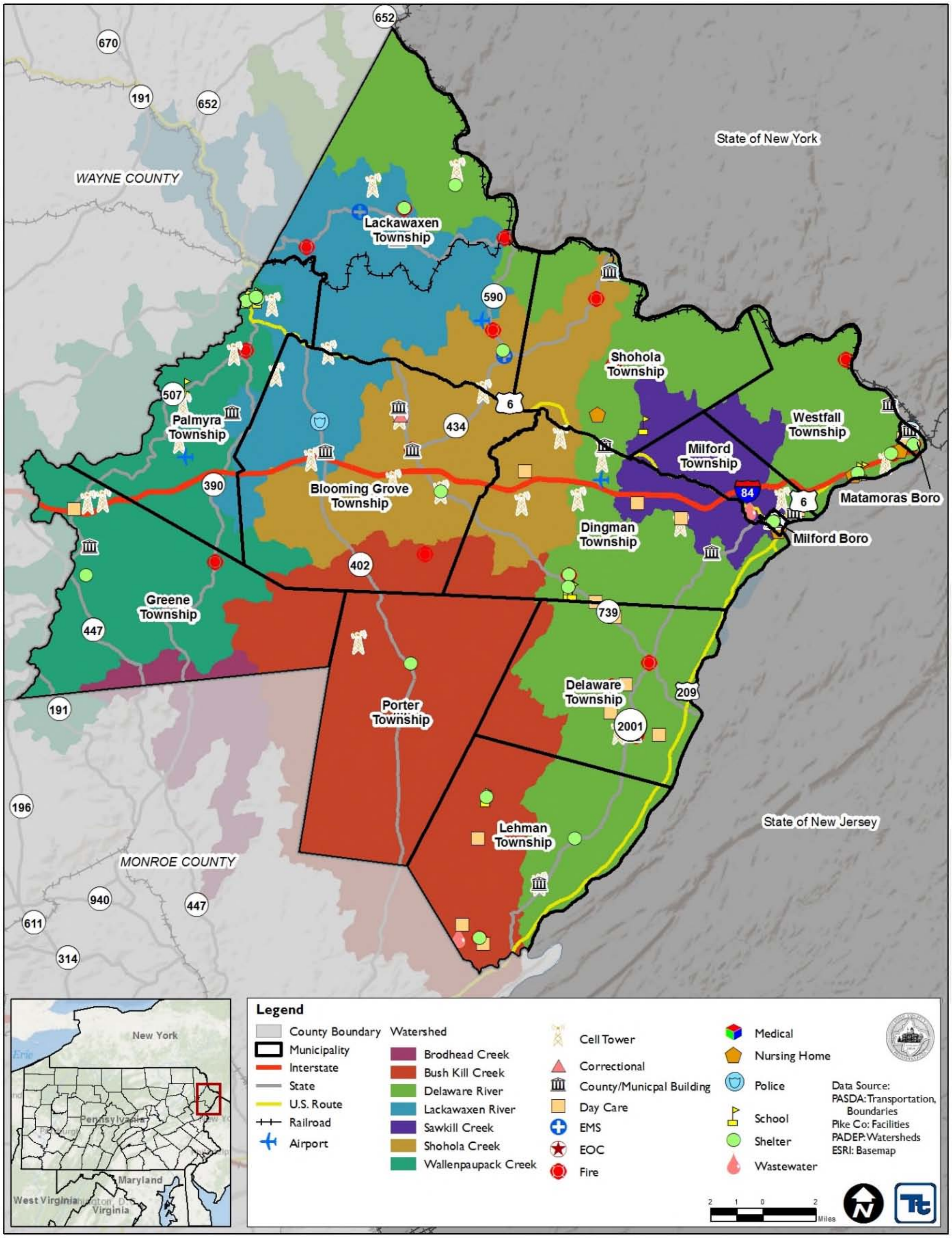
Pike County's draft Stormwater Management Plan is dated July 2010. Figure 4.3.7-1 shows PADEP-designated watersheds with critical facilities in Pike County.

The 2000 FEMA FIS for Pike County also documents the major flooding problems in the County, including areas along the Delaware River that flood at any point during the year (FEMA FIS 2000). Additionally, there are several floodprone areas in the Sawkill Creek Watershed area and Delaware Township. The Sawkill Creek Watershed is located in the eastern portion of Pike County and is contained within five municipalities: Dingman Township, Milford Borough, Milford Township, Shohola Township, and Westfall Township. The Sawkill Creek drains a watershed area of approximately 25 square miles and includes the following primary tributaries: Savantine Creek, Pinchot Brook, Dimmick Meadow Brook, Vantine Brook, and Sloat Brook. Areas of flooding were identified in the Sawkill Creek Watershed Act 167 Stormwater Management Plan. Township Road 428 in Milford Township floods during heavy rains. Pinchot Brook floods onto the roadway. It appears that this happens due to an undersized culvert for the stream crossing. The other floodprone area is associated with the entrance of Country Club Woods development. The roads serving this area were constructed on severe slopes which has led to erosion and flooding problems where the primary subdivision road intersects State Route 2011.

In the 1994 Act 167 Lackawaxen River Watershed Stormwater Management Plan for Wayne, Pike and Lacakawana Counties, the following areas of Pike County were identified as locations of flooding problems:

- State Route 4004 in Blooming Grove Township
- Kimbles Road (T 367) along Decker Creek and adjacent wetland

Figure 4.3.7-1. PADEP-Designated Watersheds with Critical Facilities



Source: PADEP

Delaware Township has noted the following floodprone areas:

- High Ridge Road lies within a depression between Glen Brook Drive and Spring Drive. Numerous homes discharge stormwater into this low-lying area and there is a possible wetland located on the east side of the road. Excessive stormwater from nearby residences collects in the low-lying areas due to a lack of discharge system or method of conveyance. Ponding occurs around nearby homes and there have been reports of basement flooding.
- Ponding occurs in the front yard of a home on Wild Acres Drive. This road runs east to west and the grade of the area slopes gently downward to the north. The low point and area of ponding at the home exists on the south side of the roadway. An 18" HDPE culvert exists under the driveway of the home; however, it has been improperly installed which results in the ponding of the front yard.
- Silver Lake Road (SR 2004) parallels Dingmans Creek, which flows through a small pool area on the west side of the road. At this location, it meets up with an unnamed tributary draining from a wetland area on the east side of Silver Lake Road. Due to undersized culverts under Silver Lake Road, Dingmans Creek overtops the roadway during high water events.
- Along Ridge Road in Pocono Mountain Lake Forest, a driveway travels through a low lying area and water ponds and overtops the roadway during periods of high water and cuts off entry to the house.
- Chestnut Ridge runs east/west and crosses Hornbeck's Creek at 30° angle approximately 0.75 miles from the intersection with Milford Rd (SR 2001). Hornbeck's Creek is conveyed under the roadway via a smooth bore metal culvert (made from a railway tanker) with a 90" diameter. The southern bank is high and retained by a stacked-stone wall on the north side of Chestnut Ridge Rd. The northern bank is lower in elevation and allows the stream to overflow its banks and enter the yard of a residence to the east of the culvert. After flowing through the yard the water crosses Chestnut Ridge Road east of the residence and flows under the road via an 18"HDPE culvert, thence through a possible wetland/wet-meadow area where it returns to Hornbeck's Creek. During times of high water this 18" culvert has inadequate capacity and water overtops the road.
- Silver Lake Road runs parallel to the southern shoreline of Nyce Lake. Near the southeastern corner of the impoundment there exists a large concrete overflow tunnel with two gate valves of unknown size. A large (approximately 100 foot wide) spillway also exists approximately 80 feet north of the concrete overflow tunnel. This area of the roadway tends to floods.

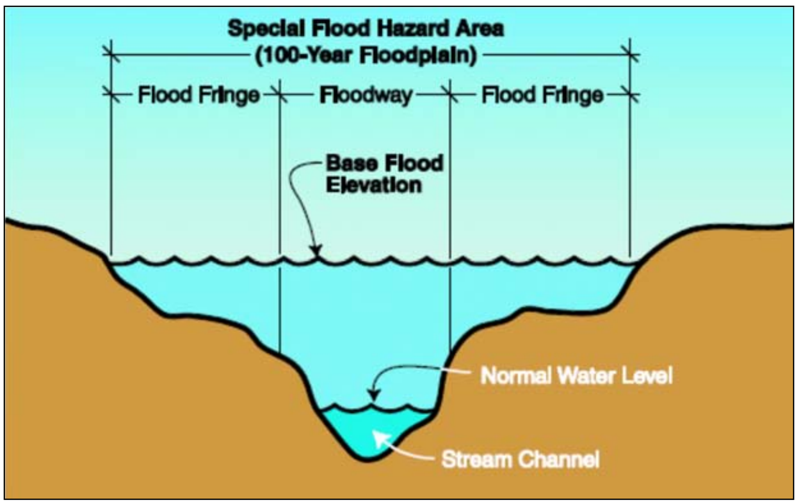
FEMA Regulatory Flood Zones

According to FEMA, flood hazard areas are defined as areas on a map shown to be inundated by a flood of a given magnitude. These areas are determined by use of statistical analyses of records of river flow, storm tides, and rainfall; information obtained through consultation with the community; floodplain topographic surveys; and hydrologic and hydraulic analyses. Flood hazard areas are delineated on FEMA's Flood Insurance Rate Maps (FIRM), which are official maps of a community on which the Federal Insurance and Mitigation Administration has delineated both Special Flood Hazard Areas (SFHA) and the risk premium zones applicable to the community. These maps identify SFHAs, location of a specific property in relation to the SFHA, the base flood elevation (BFE) (1-percent annual chance) at a specific site, the magnitude of a flood hazard within a specific area, undeveloped coastal barriers where flood insurance is not available, and regulatory floodways and floodplain boundaries (1-percent and 0.2-percent annual chance floodplain boundaries) (FEMA 2003, 2005, 2008). Pike County's FIRMs can be accessed online via the FEMA Flood Map Service Center (https://msc.fema.gov/portal).

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

The 1-percent annual chance flood is referred to as the base flood. As defined by NFIP, the BFE on a FIRM is the elevation of a base flood event, or a flood which has a 1-percent chance of occurring in any given year. The BFE describes the exact elevation of the water that will result from a given discharge level, which is one of the most important factors used in estimating potential damage within a given area. A structure within a 1-percent annual chance floodplain has a 26-percent chance of undergoing flood damage during the term of a 30-year mortgage. The 1-percent annual chance flood is a regulatory standard used by federal agencies and most states to administer floodplain management programs. The 1-percent annual chance flood is used by NFIP as the basis for insurance requirements nationwide. FIRMs also depict 0.2-percent annual chance flood designations (FEMA 2003). Figure 4.3.7-2 depicts the SFHA, the base flood elevation, the flood fringe, and the floodway areas of a floodplain for the 1-percent annual chance flood.

Figure 4.3.7-2. Floodplain Illustration

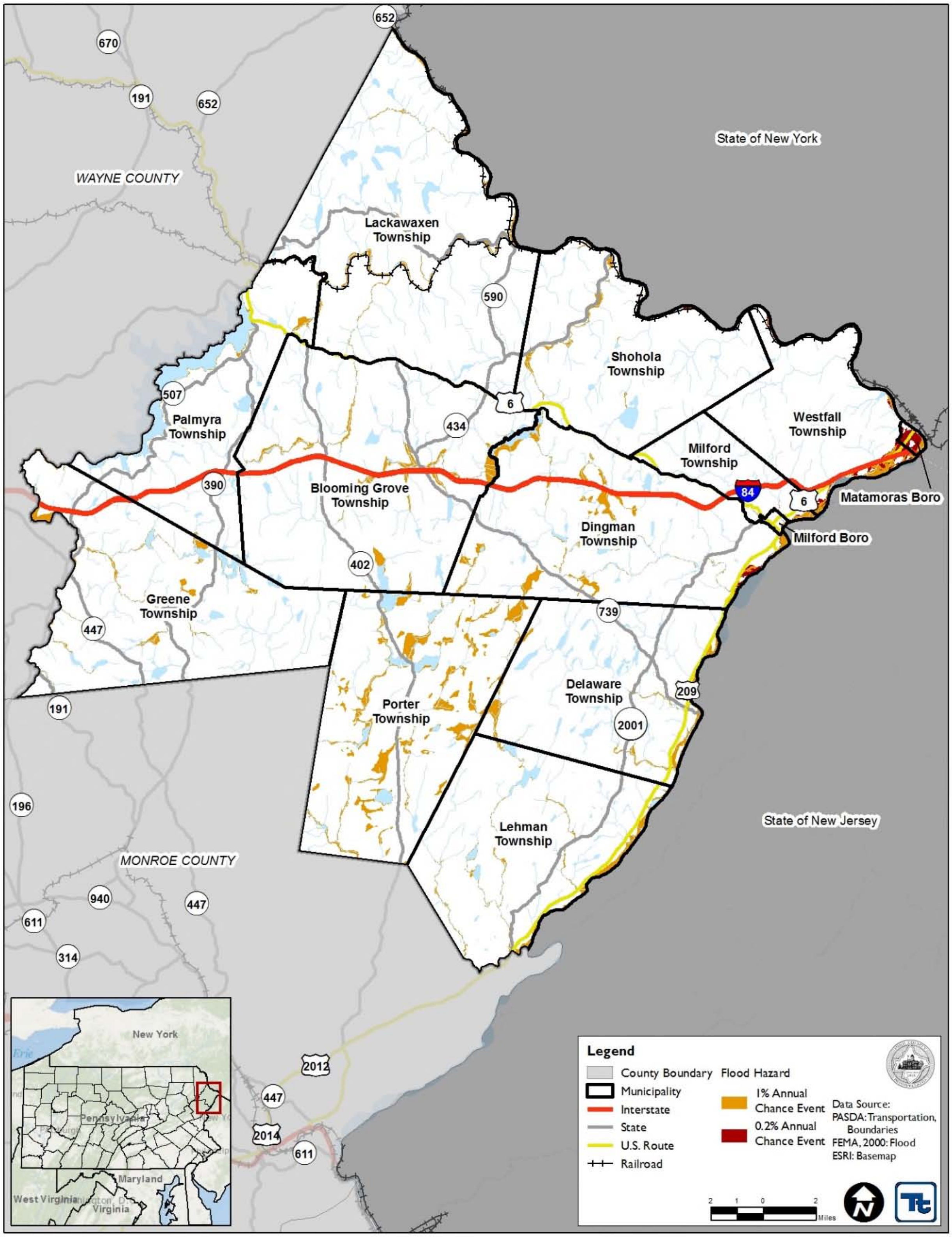


Source: PEMA 2013

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

At the time this Plan was written, the August 2015 DFIRMs were considered the best available, and were used for the risk analysis. Figure 4.3.6-3 illustrates NFIP flood zones in Pike County. Maps of each municipality's flood zones are shown at the end of this profile.

Figure 4.3.7-3. NFIP Floodplains in Pike County



Source: FEMA 2000

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

Flood Insurance Study

In addition to FIRM and DFIRMs, FEMA also provides Flood Insurance Studies (FIS) of entire counties and individual jurisdictions. These studies aid in administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. They are narrative reports of countywide flood hazards, including descriptions of flood areas studied and engineered methods used, principal flood problems, flood protection measures, and graphic profiles of flood sources (FEMA 2008). The countywide FIS for Pike County was last completed in 2000, at the same time as the DFIRM revisions.

Ice-Jam Hazard Areas

Ice jams are common in northeastern United States, and the Commonwealth of Pennsylvania is not an exception. The Ice Jam Database, maintained by the Ice Engineering Group at the USACE Cold Regions Research and Engineering Laboratory (CRREL), currently consists of over 19,000 records from across the United States. According to the USACE-CRREL, Pike County underwent or may have been impacted by three historical ice jam incidents between 1784 and 2015 (USACE 2015). Ice Jams have formed along Delaware River and Shohola Creek. Historical events are further mentioned in the "Previous Occurrences" section of this hazard profile.

Range of Magnitude

Both localized and widespread floods are considered hazards when people and property are affected. Injuries and deaths can occur when people are swept away by flood currents, or bacteria and disease are spread by moving or stagnant floodwaters. Most property damage results from inundation by sediment-filled water. A large amount of rainfall over a short period of time can result in flash floods. Small amounts of rain can cause flooding in areas with frozen soil or saturated soils from a previous event, or if the rain is concentrated in areas with impervious surfaces (PEMA 2013).

Several factors determine severity of floods, including intensity and duration, topography, ground cover, and rate of snowmelt. Water runoff is greater in areas with steep slopes and little or no vegetative ground cover. Many areas in Pennsylvania have relatively steep slopes that promote quick surface water runoff. Most storms track from west to east; however, some originate in the Great Lakes or the Atlantic Ocean (PEMA 2013).

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

- Very light rain – precipitation rate of <0.01 inch per hour
- Light rain – precipitation rate between 0.01 inch and 0.04 inch per hour
- Moderate rain – precipitation rate between 0.04 inch and 0.16 inch per hour
- Heavy rain – precipitation rate between 0.16 inch and 0.63 inch per hour
- Very heavy rain – precipitation rate between 0.63 inch and 2 inches per hour
- Extreme rain – precipitation rate greater than 2 inches per hour (PEMA 2013).

Severity of a flood depends not only on the amount of water that accumulates within a period of time, but also on the land's ability to manage this water. One element is the size of rivers and streams in an area; but an equally important factor is the land's absorbency. When it rains, soil acts as a sponge. When the land is saturated or frozen, infiltration into the ground slows, and any more water that accumulates must flow as runoff (Harris 2001).

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

- Minor Flooding – minimal or no property damage, but possibly some public threat or inconvenience.
- Moderate Flooding – some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary.
- Major Flooding – extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations are necessary (NWS 2011).

A worst case scenario for flooding occurred in September 2004, following a very wet August that included some rain from the remnants of Tropical Storm Bonnie and Tropical Depression Charley. Remnants of Hurricane Frances dumped an average of 3 inches in the county on September 8th. On September 18th, Tropical Depression Ivan dumped 4 to 5 inches of rain over an already saturated county causing widespread damage. Rainfall for August and September averaged over 20 inches across the county. In addition to the damage caused by runoff, many streams flooded. Rainfall in the headwaters of the Delaware River was such that both the Lackawaxen River and Delaware River rose above flood stage causing the evacuation of many low lying areas, including portions of Westfall Township, Matamoras Borough, and Lackawaxen Township. Pike County qualified for both Public Assistance and Individual Assistance as part of the Presidential Declaration of Major Disaster. Over 300 property owners applied for Individual Assistance. Many roads remained closed for weeks while repairs were made. Particularly hard hit were Shohola, Lackawaxen, Palmyra, Greene, Dingman, Delaware and Lehman Townships. Two county-owned bridges – one in Shohola Township and one in Lehman Township - sustained major damage. A portion of the Twin Lakes road was washed away.

Past Occurrence

Pike County has a long history of flooding events. While flooding is often localized to streets and small neighborhoods, the County has historically experienced periodic storm events that affect multiple communities over a large area. Past building practices often resulted in homes being constructed in the FEMA designated floodplains, exacerbating flooding problems within certain communities.

There are gauges at Barryville (BRYN6) and Matamoras/Port Jervis (MTMP1) which are used to monitor hydrologic conditions on the Delaware River. The National Weather Service uses flood categories as forecast points which describe the severity of flood impacts in the river/stream reach. Table 4.3.7-2 summarizes the flood categories in feet at each of these gauges; and Table 4.3.7-3 summarizes the top historic crests at these locations.

Table 4.3.7-2. Flood Categories at the Barryville (BRYN6) and Matamoras/Port Jervis (MTMP1) Gages

Flood Category	Flood Category Definition	Barryville (in feet)	Matamoras/ Port Jervis (in feet)
Major Flood Stage	Life-threatening and extensive inundation of structures and roads; significant evacuations are expected at this stage.	26	27
Moderate Flood Stage	Inundation of buildings usually begins at this stage; roads are likely to be closed and some areas cut off (evacuations may be necessary).	22	24

Flood Category	Flood Category Definition	Barryville (in feet)	Matamoras/ Port Jervis (in feet)
Flood Stage	Gage height above which a rise in water surface level begins to create a hazard to lives, property or commerce; issuance of flood warnings is linked to flood stage.	17	18
Action Stage	Level where the NWS needs to take some type of mitigation action in preparation for possible significant hydrologic activity	15	16

Source: NWS 2015; NWS 2017

Table 4.3.7-3. Historic Crests at the Barryville (BRYN6) and Matamoras/Port Jervis (MTMP1) Gages

Barryville		Matamoras/Port Jervis	
Feet	**Date**	**Feet**	**Date**
28.97	June 28, 2006	26.60	February 12, 1981
26.40	August 19, 1955	25.50	March 8, 1904
24.80	April 30, 2005	23.91	August 19, 1955
24.09	September 18, 2004	23.10	October 10, 1903
23.19	May 23, 1942	21.47	June 28, 2006
22.18	January 20, 1996	20.52	April 3, 2005
20.90	February 11, 1981	19.52	September 18, 2004
20.07	March 22, 1948	18.50	March 7, 1923
20.06	June 29, 1973	18.37	January 20, 1996
19.28	March 15, 1986		

Source: NWS 2017

According to the National Oceanic and Atmospheric Administration's National Climatic Data Center (NOAA NCDC) storm event database, Pike County experienced 22 flood events between January 1, 1950, and June 30, 2016 (the date range of data availability). Total property damages as a result of these flood events were estimated at $52,195,000. This total also includes damages to other counties.

Between 1954 and 2016, the Commonwealth of Pennsylvania underwent 33 FEMA-declared, flood-related disaster declarations (DR) or emergencies classified as one or a combination of the following disaster types: severe storms, mudslides, flash flooding, tropical storms, tropical depressions, high winds, and rains. Typically, these disasters covered a wide region of the State; therefore, they may have impacted many counties. However, not all counties were included in the disaster declarations (FEMA 2016). Pike County was included in six of the declarations, as listed in Table 4.3.7-.

Based on all sources researched, known flooding events that have affected Pike County and its municipalities, resulting in property damages, are listed in Table 4.3.6-4. No injuries or fatalities caused by flooding have been recorded in Pike County. With flood documentation for the Commonwealth of Pennsylvania so extensive, not all sources have been identified or researched. Therefore, Table 4.3.6-4 may not include all events that have occurred throughout the County.

Table 4.3.7-4. Flooding Events between 1950 and 2016 in Pike County

Date of Event		Event Type	Location	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
August 1955		Remnants of Hurricanes Connie and Diane	Countywide	DR-40	No	The remnants of Hurricanes Connie and Diane caused flooding in Pike County as a result of heavy rains. Both storms moved through the area less than one week apart. After a relatively dry summer, the two storms dumped closed to 20 inches of rain over a wide area with some areas receiving more. The results were devastating, particularly along the Lackawaxen and Delaware Rivers and the many streams.
August 1969		Severe Storms and Flooding	Countywide	DR-273	Yes	N/A
June 1972		Remnants of Hurricane Agnes	Countywide	DR-355	No	The remnants of Hurricane Agnes produced very heavy rains across most of Pennsylvania including Pike County. There was some minor flooding within the county.
February 1981		Ice Jams	Matamoras, Westfall	N/A	N/A	A series of ice jams along both the Lackawaxen and Delaware. Rivers caused significant flooding. Significant property damage occurred in Matamoras, Westfall and Lackawaxen and Port Jervis, NY. One Matamoras resident lost her life. Telephone and natural gas service were lost when lines that crossed the Delaware River were taken down or ruptured. (A near repeat occurred in 1982). Residents were eligible for SBA loans to rebuild.
November 27, 1993		Flash/Flash Flood	Eastern Pennsylvania	N/A	N/A	General rainfall totals of 2.50 to 3.50 inches occurred throughout eastern Pennsylvania with numerous locations receiving 4.00 to 5.00 inches.
September 27, 1994		Flash/Flash Flood	Countywide	N/A	N/A	The worst damage was along the Sawkill Creek. Three households along the creek had to be evacuated in Milford.
January 19, 1996		Severe Storms and Flooding / Flash Flood	Countywide	DR-1093	Yes	According to the Pennsylvania State Climatologist, the county had $23 million in damages from this event.
September 8, 1996		Flash Flood	Milford	N/A	N/A	Serious street flooding was reported in Milford. Also, local law enforcement officials had to rescue 500 to 700 people from the agricultural fairgrounds as flood waters rapidly reached a depth of one to two feet.
May 31-June 2, 1998		Severe Storms, Tornadoes and Flooding	Countywide	DR-1219	Yes	N/A
September 16, 1999		Flood	Countywide	N/A	N/A	Water was seen rushing down hillsides where numerous road washouts were reported.
July 16,		Urban/Small	Countywide	N/A	N/A	Minor flooding was reported in the southern portion of the county

Date of Event		Event Type	Location	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
2000		Stream Flood				due to heavy thunderstorm rains.
June 26, 2002		Flash Flood	Shohola	N/A	N/A	Localized heavy thunderstorm rains caused numerous road washouts in Shohola Township. A state of emergency was declared in the township due to the washouts and also to trees and wires blocking the roads. According to the Pennsylvania State Climatologist, the county had $70,000 in damages from this event.
June 21, 2003		Flash Flood	Milford and Dingman Townships	N/A	N/A	State route 739 washed out in Dingman Township. Heavy rain fell during the afternoon into the evening of the 21st. Radar estimated 2 to 3 inches of rain fell. Rain also fell on the 20th making the ground saturated. According to the Pennsylvania State Climatologist, the county had $20,000 in damages from this event.
May 12, 2004		Flash Flood	Pecks Pond	N/A	N/A	Pecks Pond, Pike County. Flash flood – 2 to 3 feet of water on Route 402.
August 12, 2004		Flash Flood	Shohola	N/A	N/A	Shohola, Pike County. Flash Flood – Numerous road washouts from flash flooding reported in the towns of Shohola, Lackawaxen, Porter, and Blooming Grove. This included the settlements of Lords Valley and Pecks Pond. According to the Pennsylvania State Climatologist, the county had $1 million in damages from this event.
August 30, 2004		Flash Flood	Milford	N/A	N/A	Heavy rain caused numerous roads to flood just west of Milford. Rainfall amounts were 1.5 to 3 inches. According to the Pennsylvania State Climatologist, the county had $5,000 in damages from this event.
September 8-9, 2004		Severe Storms and Flooding Associated with Tropical Depression Frances	Countywide	DR-1555	Yes	N/A
September 18, 2004		Flash Flood (Tropical Depression Ivan)	Countywide	DR-1557	Yes	Rainfall amounts were 4 to 7 inches which started on the 16th and continued into the 18th. This rain was from the remnants of hurricane Ivan. Most creeks and streams went out of their banks. In addition, the Delaware and Lackawaxen Rivers had major flooding. About a dozen rescues were performed. Over 100 roads were closed. The entire village of Newfoundland was evacuated. 6 bridges were closed. 2 businesses were closed. According to the Pennsylvania State Climatologist, the county had $15 million in damages from this event.
April 2, 2005		Severe Storms and Flooding	Pike County and Southern Wayne	DR-1587	Yes	Lackawaxen River at Hawley rose to its flood stage of 11 feet and crested, which was the fourth highest crest on record. The high crest was partially due to Lake Wallenpaupack making high releases. This

Date of Event		Event Type	Location	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
			County			was the second highest flood of record and the highest in almost 50 years.
April 3, 2005		Flash Flood	Countywide	DR-1555	Yes	Storm from the Ohio Valley brought 2 to 4 inches of rain. Rivers and streams already had high flows due to rainstorm and snowmelt. Numerous roads, bridges and buildings were damaged. All streams and creeks were out of their banks. A state of emergency was declared in Matamoras. 100 homes were damaged. 15 homes had damage to the foundations and were condemned.
October 8, 2005		Flash Flood	Southeastern Pike County	N/A	N/A	Streams and creeks went out of their banks. Many roads were closed. 6 to 10 inches of rain fell in this area.
June 28, 2006		Flood	Milford	DR-1649	Yes	Major flooding occurred along the Delaware River from Matamoras, PA and Port Jervis, NY south through the eastern border of Pike County.
March 11, 2011		Flash Flood	Dingmans Ferry	N/A	N/A	Rainfall amounts ranged from 1.5 to 2 inches, with isolated amounts over 3 inches in Pike County resulting in road flooding throughout the County.
August 26-30, 2011 September 3-October 5, 2011		Hurricane Irene Tropical Storm Lee	Countywide	DR-4025 DR-4030	Yes No	Hurricane Irene and Tropical Storm Lee are two recent storm events that impacted Pike County resulting in rainfall and flooding. Hurricane Irene made landfall in the United States on August 27, 2011. It was downgraded to a tropical storm as it headed north and remnants of it affected Pike County with rainfall on August 28th. Tropical Storm Lee developed as a tropical disturbance in the Gulf of Mexico and was a particularly large and slow-moving storm. By the time it reached Pennsylvania, the storm had lost its tropical characteristics and merged with an upper level trough positioned over the eastern third of the US. The storm then stalled over Pennsylvania, bringing rainfall to the region. While both storm events brought rainfall and flooding to Pike County, neither Hurricane Irene nor Tropical Storm Lee resulted in flooding and damages that surpassed other major storm events that have impacted Pike County and resulted in worst case scenarios or record flood levels. According to the Pike County EMA, the results of the two storms were minor in comparison to other storms that have affected the County. Hurricane Irene resulted in more of an impact to Pike County than Tropical Storm Lee. Many homes had flooded basements as a result of sump pump failure from periods of utility interruption during Irene. There were approximately 120 structures which were classified as minor, affected, or inaccessible

Date of Event		Event Type	Location	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
						due to damages resulting from the storm. No homes or businesses were destroyed or suffered major damage that would render the structures inhabitable for an extended period of time. In addition, while there was some damage to municipal roads and some municipal property, no public buildings or treatment facilities were damages. There were however a few bridges or private culverts that were damaged by Irene. According to the Pike County EMA, there were few, if any reports of damage from Tropical Storm Lee. The rainfall was not as steady as it was with Hurricane Irene. Damages that did occur from Lee were only additional damage to roads that were already damaged by Hurricane Irene.
August 22, 2014		Flash Flood	Lackawaxen	N/A	N/A	Flash flood waters rushed into Woodloch Pines Resort near Hawley. Several parts of the resort were flooded after heavy rains.

Sources: NOAA-NCEI 2016; FEMA 2016; Pike County HMP 2012; Pennsylvania State Climatologist 2016

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

Ice jams are a frequent occurrence on the Delaware River near Pike County and on the Lackawaxen River. There are no official local, state, or federal databases that track occurrences of ice jams; however, news articles have recorded several events. As mentioned above in Table 4.3.7-4, a February 1981 flood event was the result of a series of ice jams on the Lackawaxen and Delaware Rivers. In February of 1988, a 10-mile ice jam was reported on the Delaware River stretching from Dingmans Ferry to just north of Milford (The Morning Call, 1988). Backwater flooding occurred just north of the ice jam. In January of 1999, an ice jam that formed in New York moved down the Delaware River and lodged south of Milford (The Morning Call, 1999). It resulted in minor flooding.

Based on review of the CRREL database, Table 4.3.7-5 lists the ice-jam events that have occurred in or near the County between 1780 and 2015. Events listed below that occurred outside of the County were included because they were close enough to the County borders to cause possible flooding impacts on Pike County. Information regarding losses associated with these reported ice jams was limited.

Table 4.3.7-5. Ice Jam Events in Pike County between 1780 and 2015

City (Additional Geographic Identifier)	River	Jam Date	Water Year	Gage Number	Impact
Shohola	Shohola Creek	2/26/1926	1926	1432500	Discharge 800 cfs affected by ice
Bushkill	Delaware River	2/5/1970	1970	Unknown	An ice jam was reported on the Delaware River two miles north of Bushkill. The water level rose 10 feet above normal but no flooding had occurred.
Matamoras	Delaware River	1/1/1981	1981	Unknown	A midwinter ice jam was reported at Port Jervis followed by the spring break-up, causing flooding in Matamoras
Matamoras	Delaware River	2/15/1981	1981	Unknown	An ice jam and heavy rain event led to the evacuation of 4,000 people. In Matamoras, 44 businesses and 400 homes were damaged. A woman's body was found outside her home after she drowned from this event. This event also impacted Port Jervis is New York State. The flooding caused $3.5 million in damages.

Source: CRREL 2016; New York Times 1981

Notes:

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

cfs Cubic feet per second

CRREL Cold Regions Research and Engineering Laboratory

USGS U.S. Geological Survey

Future Occurrence

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

The NFIP recognizes the 1-percent annual chance flood, also known as the *base flood*, as the standard for identifying properties subject to federal flood insurance purchase requirements. A one-percent annual chance flood is a flood which has a one percent chance of occurring over a given year. The DFIRMs identify areas subject to the 1- and 0.2-percent-annual-chance flooding. Areas subject to 2- and 10-percent annual chance events are not shown on maps; however, water surface elevations associated with these events are included in the flood source profiles contained in the Flood Insurance Study Report. Table 4.3.7-6 shows a range of flood recurrence intervals and associated probabilities of occurrence.

Table 4.3.7-6. Recurrence intervals and associated probabilities of occurrence

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

Source: Pike County HMP 2012

Based on the historic and more recent flood events in Pike County, it is clear that the County has a high probability of flooding for the future. The fact that the elements required for flooding exist and that major flooding has occurred throughout the County in the past, whether major or minor, suggests that many people and properties are at risk from the flood hazard in the future.

For the 2017 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of flooding events for Pike County. Information from NOAA-NCEI storm events database, FEMA, Pennsylvania State Climatologist and the CRREL ice jam database were used to identify the number of flood events that occurred between 1950 and 2015. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimate percent chance of an incident occurring in a given year. Based on these statistics, there is an estimated 57.6-percent chance of flood event occurring in any given year in Pike County.

Table 4.3.7-7. Probability of Future Flooding Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Flash Flood	12	0.18	5.50	0.18	18.2%
Flood	13	0.20	5.08	0.20	19.7%
Ice Jam	13	0.20	5.08	0.20	19.7%

Sources: NOAA-NCEI 2016; CRREL 2016; Pennsylvania State Climatologist 2016

It is estimated that Pike County will continue to experience direct and indirect impacts of flooding events annually that may induce secondary hazards such as coastal erosion, storm surge in coastal areas, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents and inconveniences. Therefore the future occurrence of floods in Pike County has been adjusted and characterized as *highly likely,* when taking into consideration flash flooding, as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1).

Vulnerability Assessment

To understand risk, a community must evaluate the assets exposed or vulnerable within the identified hazard area. For the flood hazard, the 1-percent (100-year) and 0.2-percent (500-year) annual chance flood events are examined. The following sections evaluate and estimate potential impact of flooding in Pike County, presenting:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on (1) life, health, and safety; (2) general building stock; (3) critical facilities; (4) the economy; (5) the environment; and (6) future growth and development
- Effects of climate change on vulnerability
- Impact on the environment
- Further data collections that will assist in understanding this hazard over time.

Overview of Vulnerability

Flood is a significant concern for Pike County. To assess risk, exposures to the 1- and 0.2-percent annual chance flood events were examined, and potential losses were calculated for the 1- percent annual chance flood event. The flood hazard exposure and loss estimate analysis is presented below.

Data and Methodology

The 1- and 0.2-percent annual chance flood events were examined to evaluate Pike County's risk from and vulnerability to the flood hazard. Polygons representing the 1- and 0.2-percent annual chance events from the DFIRM dated October 2000 were used to estimate exposure. Figure 4.3.6-3 shown earlier in this section illustrates the flood boundaries used for this vulnerability assessment. A 1-percent annual chance flood depth grid was generated for use in HAZUS-MH 3.1 to estimate potential losses within the County. The DFIRM data from 2000 and elevation data from the County were used to develop the depth grid.

The version of the HAZUS-MH model applied to conduct Pike County's vulnerability assessment uses 2010 U.S. Census demographic data. Pike County's current spatial data do not support a countywide HAZUS-MH general building stock update at this time; therefore, the dasymetric census block configuration from HAZUS-MH was used.

To estimate exposure to the building stock, default dasymetric building stock data from HAZUS-MH 3.1 was used for replacement cost value and number of structures within the hazard area. Data from HAZUS-MH are at the census block level and are calculated by use of 2014 RS Means valuations.

Impact on Life, Health, and Safety

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

Cascading impacts may also include exposure to pathogens such as mold. After flood events, excess moisture and standing water contribute to growth of mold in buildings. Mold may present a health risk to building occupants, especially those with already compromised immune systems such as infants, children, the elderly, and pregnant women. The degree of impact will vary and is not strictly measurable. Molds can grow in as short a period as 24-48 hours in wet and damaged areas of buildings that have not been properly cleaned. Very small mold spores can easily be inhaled, creating potential for allergic reactions, asthma episodes, and other respiratory problems. Buildings should be properly cleaned and dried out to safely prevent mold growth (Centers for Disease Control and Prevention [CDC] 2015).

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

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

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

To estimate the population exposed to the 1-percent annual chance flood event, the FEMA DFIRM floodplain boundaries were overlaid upon the 2010 U.S. Census population data in Geographic Information Systems (GIS). Census blocks are not consistent with boundaries of the floodplain, and gross overestimate or underestimate of exposed population can occur via use of the centroid or intersect of the Census block with these zones. Limitations of these analyses are recognized, and thus results are used only to provide a general estimate.

The 2010 Census blocks with their centroids located in the flood boundaries were used to calculate the estimated population exposed to this hazard. Table 4.3.7-8 lists the estimated population located within the 1-percent annual chance flood zone by municipality. Use of this approach resulted in an estimate of 514 people within the 1-percent annual chance floodplain (less than 1%), and 3,246 people within the 0.2-percent annual chance floodplain (5.7 percent)

Table 4.3.7-8. Estimated Pike County Population Exposed to the 1- and 0.2-Percent Flood Hazard (2010 Census)

Municipality	Total Population	1-Percent Annual Chance Event		0.2-Percent Annual Chance Event	
		Population in Hazard Area	Percent Population in Boundary	Population in Hazard Area	Percent Population in Boundary
Blooming Grove Township	4,819	31	<1%	31	<1%
Delaware Township	7,396	25	<1%	25	<1%
Dingman Township	11,926	186	1.6%	186	1.6%
Greene Township	3,956	56	1.4%	56	1.4%
Lackawaxen Township	4,994	13	<1%	13	<1%
Lehman Township	10,663	6	<1%	6	<1%
Matamoras Borough	2,469	18	<1%	1,953	79.1%
Milford Borough	1,021	18	1.8%	18	1.8%
Milford Township	1,530	18	1.2%	18	1.2%

Municipality	Total Population	1-Percent Annual Chance Event		0.2-Percent Annual Chance Event	
		Population in Hazard Area	Percent Population in Boundary	Population in Hazard Area	Percent Population in Boundary
Palmyra Township	3,312	0	0.0%	0	0.0%
Porter Township	485	58	12.0%	58	12.0%
Shohola Township	2,475	73	2.9%	73	2.9%
Westfall Township	2,323	12	<1%	809	34.8%
Pike County (Total)	**57,369**	**514**	**<1%**	**3,246**	**5.7%**

Sources: U.S. Census 2010, FEMA 2000
Note: % Percent

The table above shows that less than 1 percent of the total County population is exposed to the 1-percent annual chance flood event, and that approximately 5.7 percent of the total County population is exposed to the 0.2-percent annual chance flood event. Porter Township has the largest portion of its population within the 1-percent annual chance event floodplain—12 percent of the population, while Matamoras Borough has the largest population within 0.2-percent annual chance events; 79.1 percent of its population is exposed. For this project, potential population exposed is used as a guide for planning purposes.

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

Using 2010 U.S. Census data, HAZUS-MH 3.1 estimates potential sheltering needs based on a 1-percent annual chance flood event. During the 1-percent flood event, HAZUS-MH 3.1 estimates 1,865 households will be displaced, and 854 people will seek short-term sheltering, representing 1.5 percent of the Pike County population seeking short-term shelter. These statistics, by municipality, are listed in Table 4.3.6-7. The estimated displaced population and number of persons seeking short-term sheltering differ from the number of persons exposed to the 1-percent annual chance flood (Table 4.3.6-9), because the displaced population numbers take into consideration that not all residents will be significantly impacted enough to be displaced or to require short-term sheltering during a flood event.

Table 4.3.7-9. Estimated Population Displaced or Seeking Short-Term Shelter from the 1-Percent Annual Chance Flood Event

Municipality	Total Population (2010 U.S. Census)	1-Percent Annual Chance Event	
		Displaced Households	Persons Seeking Short-Term Sheltering
Blooming Grove Township	4,819	52	2
Delaware Township	7,396	52	14
Dingman Township	11,926	216	31
Greene Township	3,956	118	18
Lackawaxen Township	4,994	141	16
Lehman Township	10,663	278	184
Matamoras Borough	2,469	224	130
Milford Borough	1,021	127	62
Milford Township	1,530	53	25
Palmyra Township	3,312	36	5
Porter Township	485	16	0
Shohola Township	2,475	81	8
Westfall Township	2,323	471	359
Pike County (Total)	**57,369**	**1,865**	**854**

Source: HAZUS-MH 3.1
Note: The population displaced and seeking shelter was calculated using 2010 U.S. Census data.

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

Impact on General Building Stock

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

To estimate replacement cost value exposure and number of structures in the hazard area, default dasymetric building stock data from HAZUS-MH 3.1 were used. Replacement cost values of the dasymetric Census blocks with their centroids in the floodplain were totaled. Table 4.3.6-10 lists building stock exposure per municipality, and Table 4.3.6-9 lists number of exposed structures per watershed.

In total, 519 structures, or 1.4-percent of the building stock, are within the 1-percent annual chance flood zone; and 1,727 structures, or 4.5-percent of the building stock, are within the 0.2-percent flood zone. Approximately $189 million of building/contents are within the 1-percent annual chance flood zone in Pike County. This represents approximately 1.4-percent of the County's total general building stock replacement value inventory ($13 billion). Also, an estimated $658 million of building/contents is within the 0.2-percent annual chance flood zone (5.0-percent of the County's total).

As discussed in the Methodology section, Pike County's current spatial data did not support a countywide HAZUS-MH general building stock update. Therefore, the HAZUS-MH flood model estimated potential damages to buildings in Pike County using the dasymetric dataset. Development of the dasymetric dataset involved removing homogeneous undeveloped areas (such as areas covered by bodies of water, parks, or forests) from the Census blocks. Cumulative building exposure is distributed only in developed sub-Census Block areas. As a result, more accurate flood loss determinations were produced using this dataset. Potential damage estimated to the Pike County general building stock inventory associated with the 1-percent annual chance flood exceeds $2.9 billion. Building stock potential loss estimates per municipality are listed in Table 4.3.6-12.

Table 4.3.7-10. Estimated General Building Stock Exposure to the 1-Percent Annual Chance Flood Event

Municipality	Total # Buildings	Total RCV (Structure and Contents)	Total (All Occupancies)							
			1-Percent Annual Chance Event				0.2-Percent Annual Chance Event			
			# Buildings	% Total	Total RCV (Structure and Contents	% Total	# Buildings	% Total	Total RCV (Structure and Contents	% Total
Blooming Grove Township	3,998	$1,160,095,000	22	<1%	$4,649,000	<1%	22	<1%	$4,649,000	<1%
Delaware Township	4,253	$1,496,677,000	11	<1%	$4,622,000	<1%	11	<1%	$4,622,000	<1%
Dingman Township	5,480	$1,984,820,000	223	4.1%	$78,611,000	4.0%	223	4.1%	$78,611,000	4.0%
Greene Township	3,275	$956,640,000	72	2.2%	$18,329,000	1.9%	72	2.2%	$18,329,000	1.9%
Lackawaxen Township	4,562	$1,231,170,000	5	<1%	$1,590,000	<1%	5	<1%	$1,590,000	<1%
Lehman Township	5,995	$1,992,003,000	5	<1%	$1,538,000	<1%	5	<1%	$1,538,000	<1%
Matamoras Borough	972	$377,318,000	6	<1%	$1,882,000	<1%	781	80.3%	$304,862,000	80.8%
Milford Borough	718	$413,430,000	14	1.9%	$6,256,000	1.5%	14	1.9%	$6,256,000	1.5%
Milford Township	784	$670,787,000	7	<1%	$3,150,000	<1%	7	<1%	$3,150,000	<1%
Palmyra Township	3,981	$1,244,483,000	4	<1%	$1,272,000	<1%	4	<1%	$1,272,000	<1%
Porter Township	912	$388,599,000	93	10.2%	$38,300,000	9.9%	93	10.2%	$38,300,000	9.9%
Shohola Township	2,311	$759,299,000	46	2.0%	$13,378,000	1.8%	46	2.0%	$13,378,000	1.8%
Westfall Township	1,175	$383,781,000	11	<1%	$15,013,000	3.9%	444	37.8%	$181,394,000	47.3%
Pike County (Total)	**38,416**	**$13,059,102,000**	**519**	**1.4%**	**$188,590,000**	**1.4%**	**1,727**	**4.5%**	**$657,951,000**	**5.0%**

Source: HAZUS-MH 3.1; FEMA 2000
Notes:
% Percent
RCV Replacement cost value (structure and contents)

Table 4.3.7-11. Estimated General Building Stock Exposure by Watershed to the 1- and 0.2-Percent Annual Chance Flood Events

Watershed	Total Number of Buildings	1% Annual Chance Flood Boundary		0.2% Annual Chance Flood Boundary	
		Number of Buildings	% of Total	Number of Buildings	% of Total
Brodhead Creek	192	0	0.0%	0	0.0%
Bushkill Creek	6,788	98	1.4%	98	1.4%
Delaware River	15,273	193	1.3%	1,401	9.2%
Lackawaxen River	2,781	27	1.0%	27	1.0%
Sawkill Creek	2,139	30	1.4%	30	1.4%
Shohola Creek	4,484	95	2.1%	95	2.1%
Wallenpaupack Creek	6,759	76	1.1%	76	1.1%
Pike County (Total)	**38,416**	**519**	**1.4%**	**1,727**	**4.5%**

Source: FEMA 2000, Eastern Pennsylvania Coalition for Abandoned Mine Reclamation (EPCAMR) 2014; HAZUS-MH 3.1

Table 4.3.7-12. Estimated General Building Stock Potential Loss to the 1-Percent Annual Chance Flood Event

Municipality	Total Replacement Cost Value	1% Annual Chance Event							
		All Occupancies		Residential		Commercial		Industrial, Religious, Education and Government	
		Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total
Blooming Grove Township	$1,160,095,000	$114,611	<1%	$105,249	<1%	$5,528	<1%	$3,834	<1%
Delaware Township	$1,496,677,000	$135,830	<1%	$131,741	<1%	$2,848	<1%	$1,241	<1%
Dingman Township	$1,984,820,000	$538,317	<1%	$510,619	<1%	$22,209	<1%	$5,489	<1%
Greene Township	$956,640,000	$388,458	<1%	$374,412	<1%	$8,882	<1%	$5,164	<1%
Lackawaxen Township	$1,231,170,000	$340,619	<1%	$330,303	<1%	$6,884	<1%	$3,432	<1%
Lehman Township	$1,992,003,000	$462,309	<1%	$444,218	<1%	$14,144	<1%	$3,947	<1%
Matamoras Borough	$377,318,000	$73,740	<1%	$56,103	<1%	$15,989	<1%	$1,648	<1%
Milford Borough	$413,430,000	$95,052	<1%	$51,230	<1%	$32,096	<1%	$11,726	<1%
Milford Township	$670,787,000	$75,168	<1%	$67,705	<1%	$4,222	<1%	$3,241	<1%
Palmyra Township	$1,244,483,000	$286,405	<1%	$285,121	<1%	$480	<1%	$804	<1%
Porter Township	$388,599,000	$179,652	<1%	$176,133	<1%	$2,173	<1%	$1,346	<1%
Shohola Township	$759,299,000	$262,190	<1%	$198,864	<1%	$29,110	<1%	$34,216	<1%
Westfall Township	$383,781,000	$305,954	<1%	$223,545	<1%	$70,659	<1%	$11,750	<1%
Pike County (Total)	**$13,059,102,000**	**$3,258,305**	**<1%**	**$2,955,243**	**<1%**	**$215,224**	**<1%**	**$87,838**	**<1%**

Source: HAZUS-MH 3.1
Note: % Percent

To further enhance the risk assessment, FEMA Region III provided the total exposure in the floodplain (TEIF) for Pike County. This data utilizes best available data including the 2010 U.S. Census geography and 2012 RS Means valuations. This data is used in lieu of the average annualized loss study. This data indicates the total exposure in the floodplain for Pike County is $397,925,522. Table 4.3.6-13 below lists the TEIF for each municipality.

Table 4.3.7-13. 2010 TEIF Results by Municipality for Pike County

Municipality	TEIF 2010
Blooming Grove Township	$23,968,400
Delaware Township	$26,087,021
Dingman Township	$58,050,910
Greene Township	$32,241,499
Lackawaxen Township	$20,740,483
Lehman Township	$87,273,241
Matamoras Borough	$6,317,334
Milford Borough	$12,391,436
Milford Township	$9,699,122
Palmyra Township	$29,460,299
Porter Township	$27,608,216
Shohola Township	$13,933,447
Westfall Township	$50,154,115
Pike County (Total)	**$397,925,522**

Source: FEMA Region III

NFIP Statistics

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

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

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

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

Pike County has three RL (one non-residential and two single family) and one SRL (single family) properties spread across two municipalities. Table 4.3.6-14 categorizes numbers of RL and SRL properties by municipality and by occupancy class (non-residential or residential).

Table 4.3.7-14. Summary of Repetitive Loss Properties by Municipality

Municipality	Repetitive Loss Properties					Severe Repetitive Loss Properties				
	2-4 Family	Assumed Condo	Non Residential	Other Residential	Single Family	2-4 Family	Assumed Condo	Non Residential	Other Residential	Single Family
Blooming Grove Township	0	0	0	0	0	0	0	0	0	0
Delaware Township	0	0	0	0	0	0	0	0	0	0
Dingman Township	0	0	0	0	1	0	0	0	0	0
Greene Township	0	0	0	0	0	0	0	0	0	0
Lackawaxen Township	0	0	0	0	0	0	0	0	0	0
Lehman Township	0	0	0	0	0	0	0	0	0	0
Matamoras Borough	0	0	0	0	0	0	0	0	0	0
Milford Borough	0	0	0	0	0	0	0	0	0	0
Milford Township	0	0	0	0	0	0	0	0	0	0
Palmyra Township	0	0	0	0	0	0	0	0	0	0
Porter Township	0	0	0	0	0	0	0	0	0	0
Shohola Township	0	0	0	0	0	0	0	0	0	0
Westfall Township	0	0	1	0	1	0	0	0	0	1
Pike County (Total)	**0**	**0**	**1**	**0**	**2**	**0**	**0**	**0**	**0**	**1**

Source: PEMA 2016

Note: Repetitive loss property totals do not include severe repetitive loss properties.

Table 4.3.7-15 summaries NFIP policies and claims for Pike County.

Table 4.3.7-15. NFIP Policies, Claims, and Repetitive Loss Statistics

Municipality	# Policies (1)	# Claims (Losses) (1)	# Repetitive Loss Properties (1)	Total Loss Payments (2)
Blooming Grove Township	10	2	0	$40,387
Delaware Township	11	5	0	$7,347
Dingman Township	18	11	1 RL	$66,551
Greene Township	19	0	0	$0
Lackawaxen Township	35	21	0	$560,999
Lehman Township	22	13	0	$41,675
Matamoras Borough	68	53	0	$646,547
Milford Borough	11	5	0	$0
Milford Township	11	6	0	$43,149
Palmyra Township	9	1	0	$3,785
Porter Township	1	7	0	$22,281
Shohola Township	11	4	0	$5,777
Westfall Township	93	77	3 RL / 1 SRL	$1,421,843
Pike County (Total)	**319**	**205**	**4 RL / 1 SRL**	**$2,860,341**

Source: FEMA 2016
Notes:
(1) Policies, claims, RL, and SRL statistics provided by FEMA, and are current as of August 31, 2016. Communities with SRL properties are noted in the column. The number of claims represents claims closed by August 31, 2016.
(2) Total building and content loss information was collected from the claims file provided by FEMA: http://bsa.nfipstat.fema.gov/reports/1040.htm#42.
FEMA Federal Emergency Management Agency
PEMA Pennsylvania Emergency Management Agency
RL Repetitive loss
SRL Severe repetitive loss

Impact on Critical Facilities

In addition to consideration of general building stock at risk, risk of flood to critical facilities and utilities was evaluated. HAZUS-MH was used to estimate potential for flood loss to critical facilities exposed to the flood risk. Using depth/damage function curves, HAZUS estimates percent of damage to building and contents of critical facilities. HAZUS-MH estimates that few emergency and utility facilities within the County would be nonfunctional for more than 1 day, and most would undergo relatively minimal damages.

To address impacts on short-term functionality of critical facilities and utilities by a hazard during a disaster event, other facilities of neighboring municipalities may have to increase support response functions. Mitigation planning should consider means to reduce impacts on critical facilities and utilities, and ensure that sufficient emergency and school services remain functional when a significant event occurs. Actions addressing shared services agreements are included in Section 6 (Mitigation Strategy) of this Plan.

Table 4.3.7-16 lists critical facilities and utilities within the 1-percent annual change flood boundary. Table 4.3.7-17 lists critical facilities and utilities within the 0.2 percent annual change flood boundary.

Table 4.3.7-16. Critical Facilities and Utilities Within the 1-Percent Annual Chance Flood Boundary

Municipality	Facility Types	
	Fire Station	Shelter
Blooming Grove Township	0	0
Delaware Township	0	0
Dingman Township	0	1
Greene Township	0	0
Lackawaxen Township	0	0
Lehman Township	0	1
Matamoras Borough	0	0
Milford Borough	0	0
Milford Township	0	0
Palmyra Township	0	0
Porter Township	0	0
Shohola Township	0	0
Westfall Township	1	1
Pike County (Total)	**1**	**3**

Source: Pike County 2016, FEMA 2000

Table 4.3.7-17. Critical Facilities and Utilities Within the 0.2-Percent Annual Chance Flood Boundary

Municipality	Facility Types							
	Daycare Facility	Fire Station	Municipal Building	Nursing Home	Police Station	School	Shelter	Wastewater Facility
Blooming Grove Township	0	0	0	0	0	0	0	0
Delaware Township	0	0	0	0	0	0	0	0
Dingman Township	0	0	0	0	0	1	0	0
Greene Township	0	0	0	0	0	1	0	0
Lackawaxen Township	0	0	0	0	0	0	0	0
Lehman Township	0	0	0	0	0	0	0	0
Matamoras Borough	1	0	1	0	1	1	1	0
Milford Borough	0	0	0	0	0	0	0	0
Milford Township	0	0	0	0	0	0	0	0
Palmyra Township	0	0	0	0	0	0	0	0
Porter Township	0	0	0	0	0	0	0	0
Shohola Township	0	0	0	0	0	0	0	0

Municipality	Facility Types							
	Daycare Facility	Fire Station	Municipal Building	Nursing Home	Police Station	School	Shelter	Wastewater Facility
Westfall Township	0	1	1	2	0	0	1	0
Pike County (Total)	**1**	**1**	**2**	**2**	**1**	**1**	**3**	**1**

Source: Pike County 2016, FEMA 2000

Impact on the Economy

For impact on the economy, estimated losses from a flood event are considered. Losses include but are not limited to general building stock damages, agricultural losses, business interruption, and impacts on tourism and tax base within Pike County. Damages to general building stock can be quantified by use of HAZUS-MH as discussed above. Other economic components such as loss of facility use, functional downtime, and social economic factors are less susceptible to measurement with a high degree of certainty. For the purposes of this analysis, general building stock damages are discussed further.

Flooding can cause extensive damage to public utilities and disruptions in delivery of services. Loss of power and communications may occur, and drinking water and wastewater treatment facilities may be temporarily out of operation. Flooded streets and road blocks make it difficult for emergency vehicles to respond to calls for service. Floodwaters can wash out sections of roadway and bridges.

Direct building losses are estimated costs to repair or replace damage caused to buildings. Estimated potential damage to general building stock inventory associated with the 1-percent flood is approximately $190 million, which represents 1.4 percent of the County's overall total general building stock inventory. These dollar value losses from the County's total building inventory replacement value, in addition to damages to roadways and infrastructure, would impact the local economy.

HAZUS-MH estimates the amount of debris generated from a 1-percent annual chance flood event. The model breaks down debris into three categories because of the different types of equipment needed to handle debris: (1) finishes (dry wall, insulation, etc.), (2) structural (wood, brick, etc.), and (3) foundations (concrete slab and block, rebar, etc.). Table 4.3.6-16 summarizes the debris HAZUS-MH 3.1 estimates to result from a 1-percent annual chance flood event—32,000+ tons of debris. Notably, this table lists estimated debris generated only by riverine flooding, and does not include additional potential damage and debris possibly generated by force of wind.

Table 4.3.7-18. Estimated Debris Generated from the 1-Percent Annual Chance Flood Event

Municipality	1% Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Blooming Grove Township	520	103	229	188
Delaware Township	23	12	6	5
Dingman Township	518	85	258	174
Greene Township	1,309	308	529	472
Lackawaxen Township	1,839	358	818	664
Lehman Township	536	288	138	111

Municipality	1% Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Matamoras Borough	6,407	1,068	2,945	2,393
Milford Borough	5,241	959	2,546	1,736
Milford Township	392	74	172	146
Palmyra Township	86	18	38	30
Porter Township	99	95	1	3
Shohola Township	2,160	386	962	812
Westfall Township	13,046	2,221	6,412	4,413
Pike County (Total)	**32,175**	**5,975**	**15,053**	**11,147**

Source: HAZUS-MH 3.1

Impact on the Environment

As discussed, floodplains serve beneficial and natural functions on ecological/environmental, social, and economic levels. Areas in the floodplain that typically provide these natural functions and benefits are wetlands, riparian areas, sensitive areas, and habitats for rare and endangered species. Floods, however, can also lead to negative impacts on the environment. Loss of riparian buffers, land use change within a watershed, and introduction of non-natural contaminants may be environmental issues when floods occur (Montz and Tobin 1997, Rubin 2013).

To determine exposure of natural and beneficial land in Pike County to the flood hazard, acreages of wetlands and forested land were calculated. Table 4.3.7-19 lists results of these calculations.

Table 4.3.7-19. Acreage of Natural and Beneficial Land Within the Floodplain

Wetlands	Area in the 1-Percent Annual Chance Floodplain (acres)	Area in the 0.2-Percent Annual Chance Floodplain (acres)
Wetlands	15,649	15,664
Forest	10,020	10,274

Sources: USGS National Land Cover Data (NLCD) 2014, FEMA 2000

The basic environmental impact of major flooding is morphological, and shape of a river valley is often determined more by a catastrophic event than a long, gradual, methodical process. This is a primary factor in formation of natural habitat for flora and fauna, and may influence habitats beyond the river corridor (Hickey and Salas 1995).

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

Future Growth and Development

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

Effect of Climate Change on Vulnerability

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

PADEP was directed by the Climate Change Act (Act 70 of 2008) to initiate a study of potential impacts of global climate change on the Commonwealth. The June 2009 Pennsylvania Climate Impact Assessment's main findings indicate that Pennsylvania is very likely to undergo increased temperatures in the 21st century. An increase in variability of temperature and precipitation may lead to increased frequency and/or severity of storm events. Summer floods and general stream flow variability are projected to increase due to increased variability in precipitation. Even with the anticipated increase in winter precipitation as rain rather than snow, increased winter temperatures and a reduced snowpack may decrease rain-on-snow events and thus major flooding events in Pennsylvania. This conclusion, however, remains speculative until further studies can validate it. Future improvements in modeling smaller-scale climatic processes are expected, and will lead to improved understanding of how the changing climate will alter temperature, precipitation, storms, and flood events in Pennsylvania (Shortle et al. 2009).

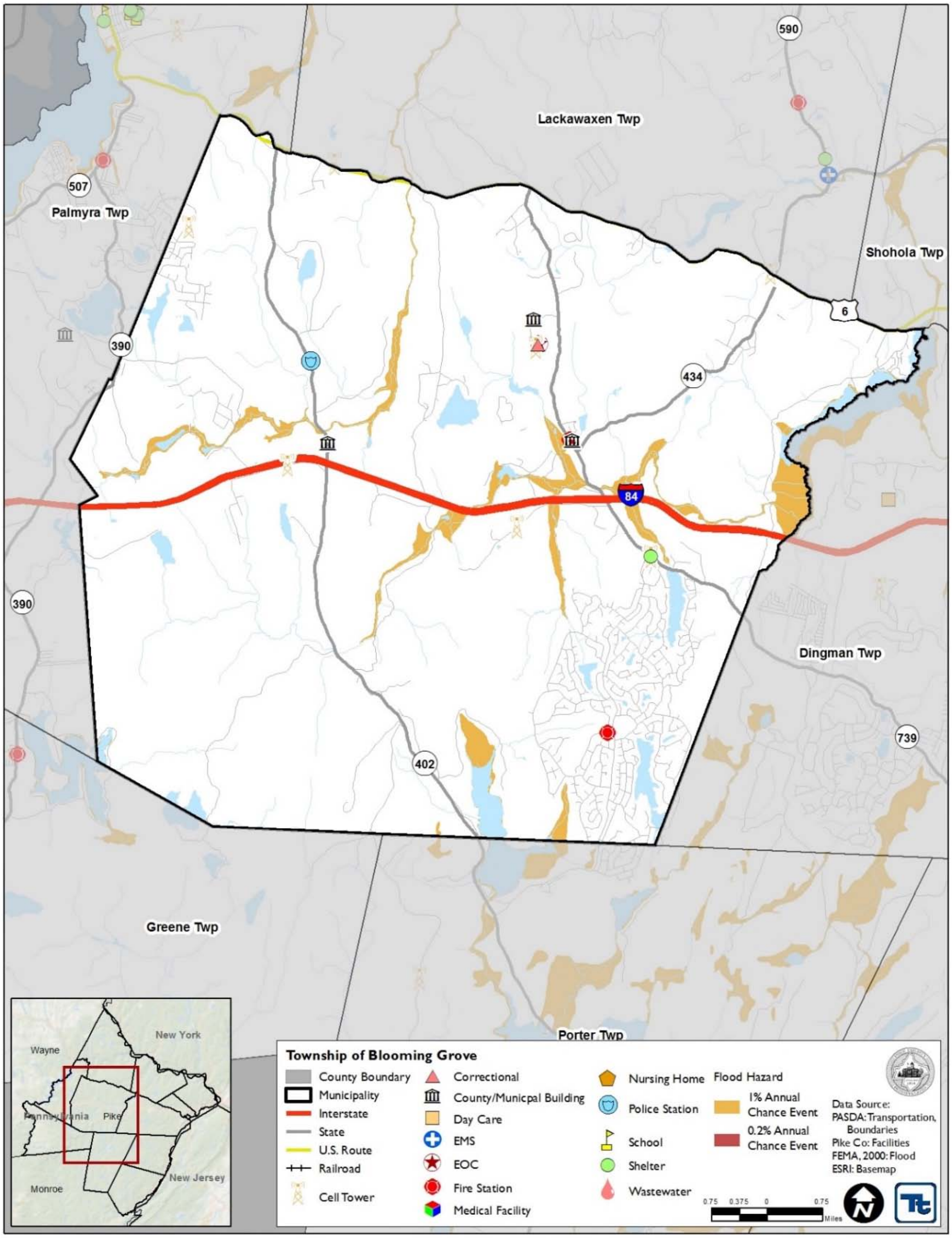
Additional Data and Next Steps

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

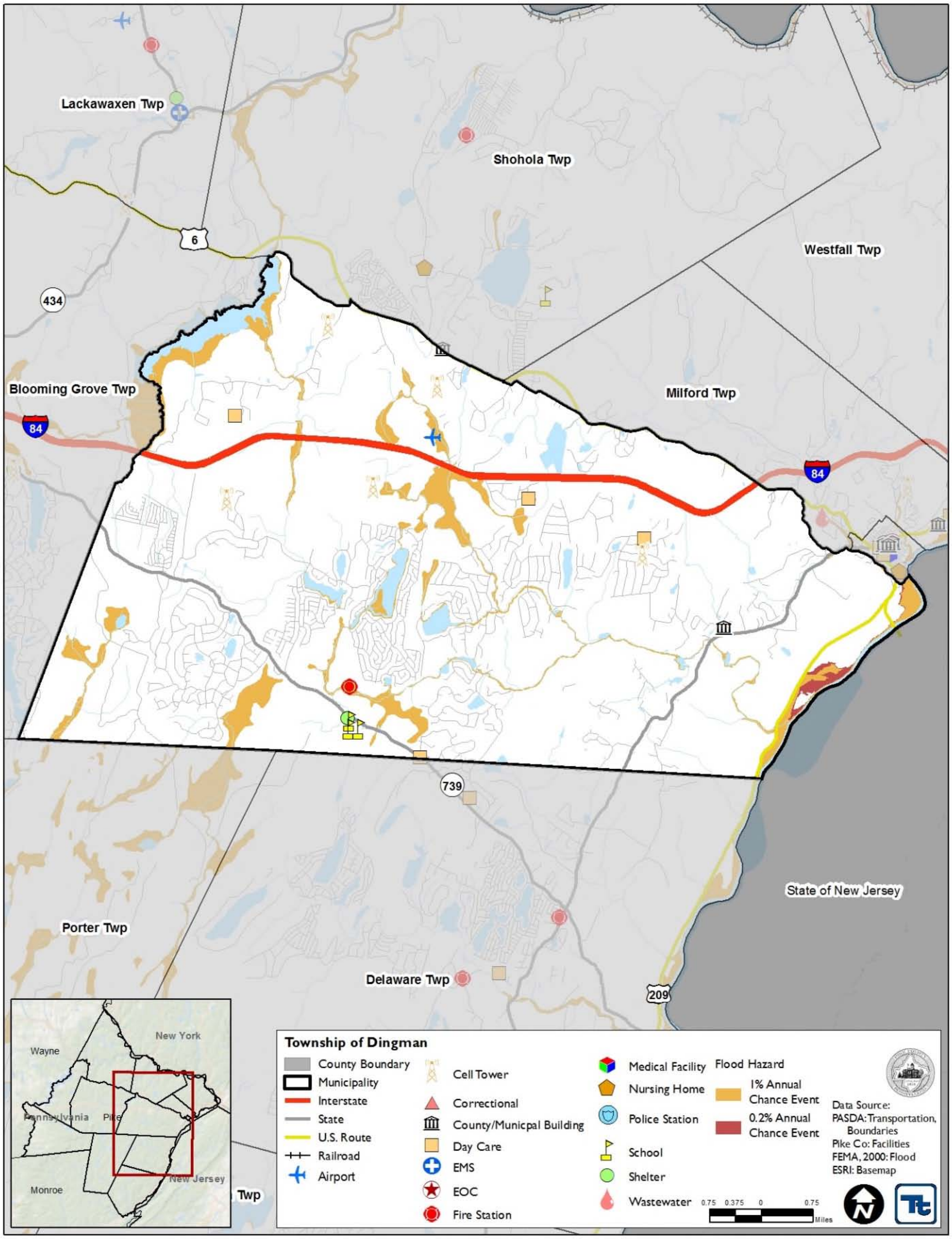
Section 6 (Mitigation Strategy) of this HMP includes discussions of specific mitigation actions addressing improved data collection, and further vulnerability analysis.

MUNICIPAL FLOODPLAIN MAPS

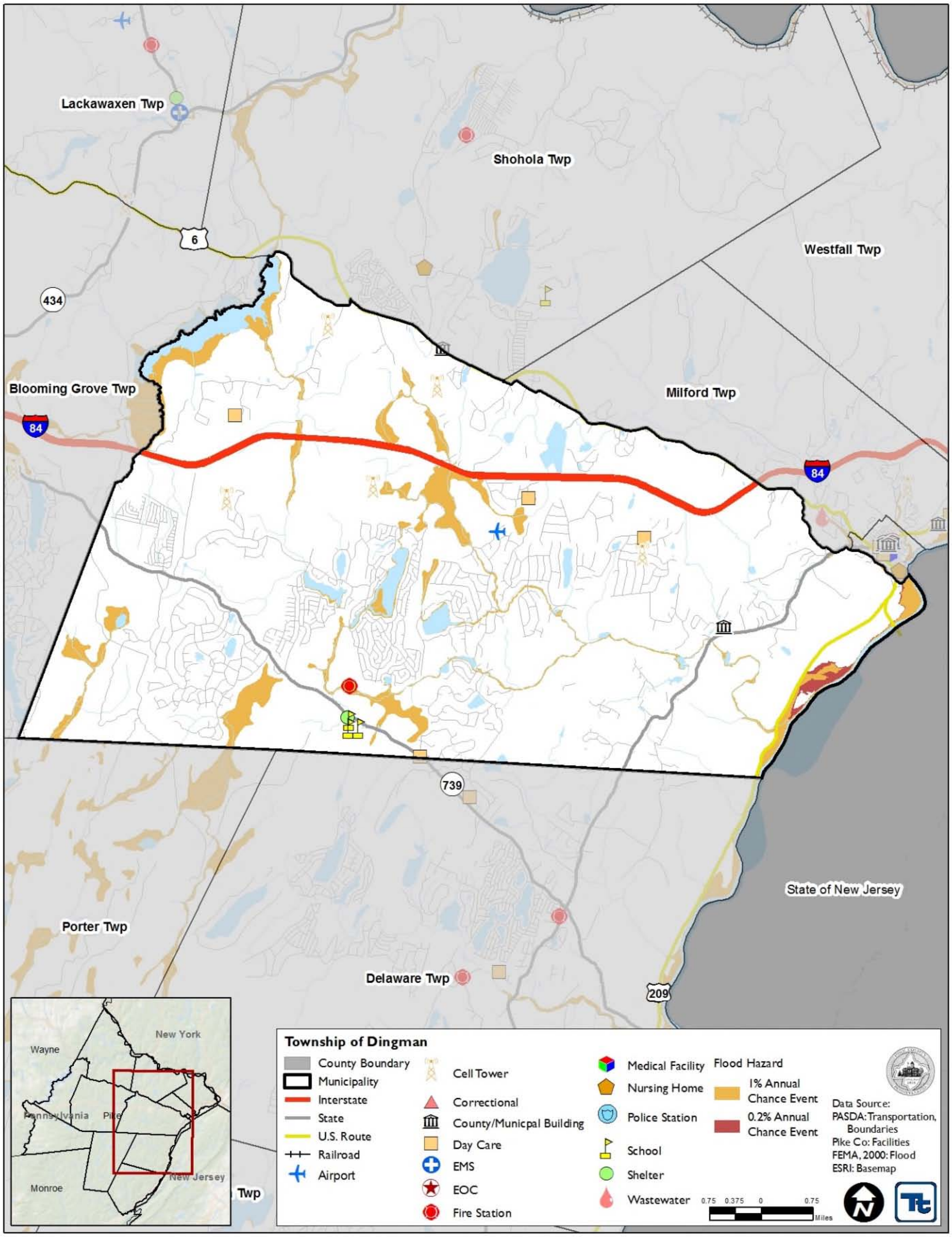
Blooming Grove Township



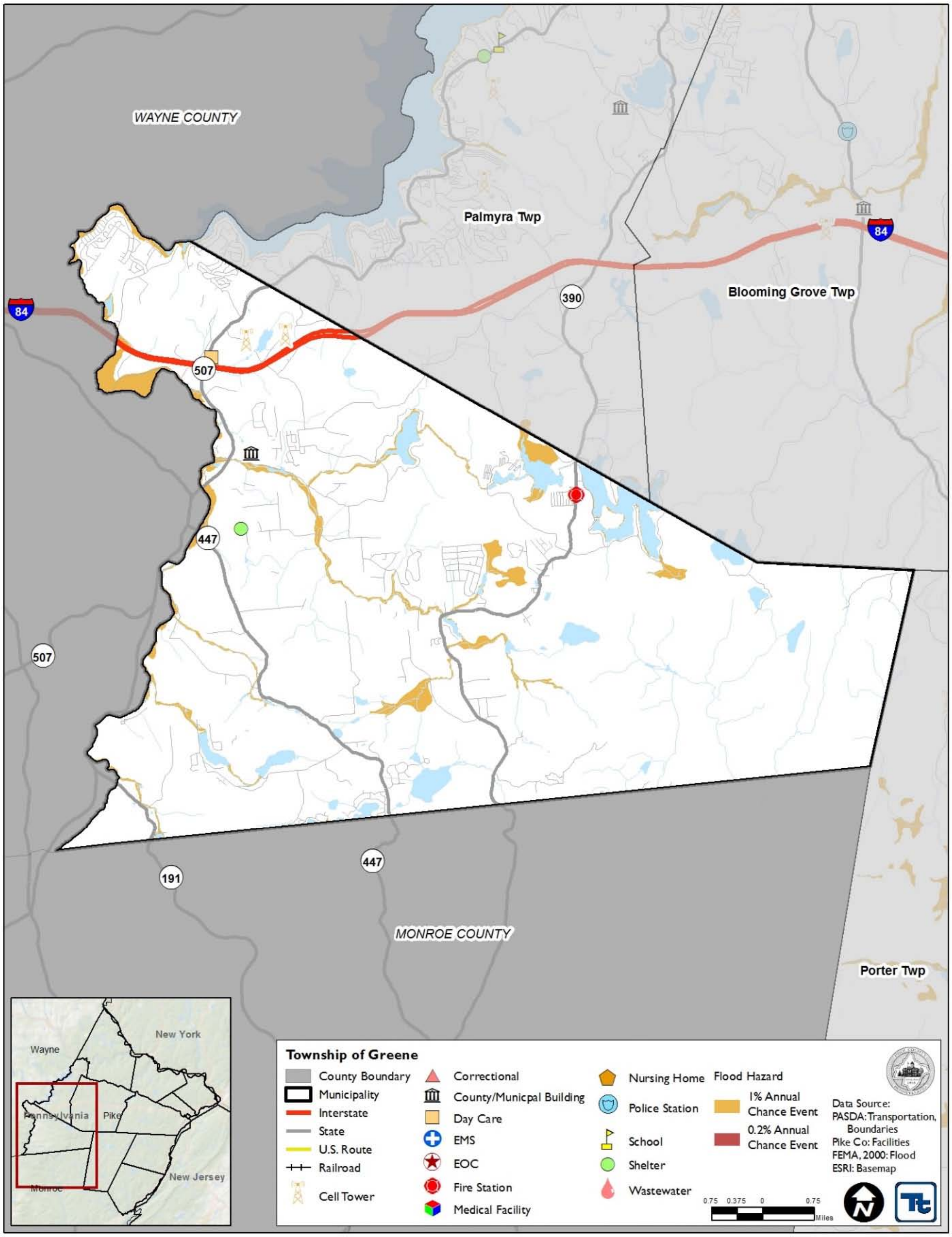
Delaware Township



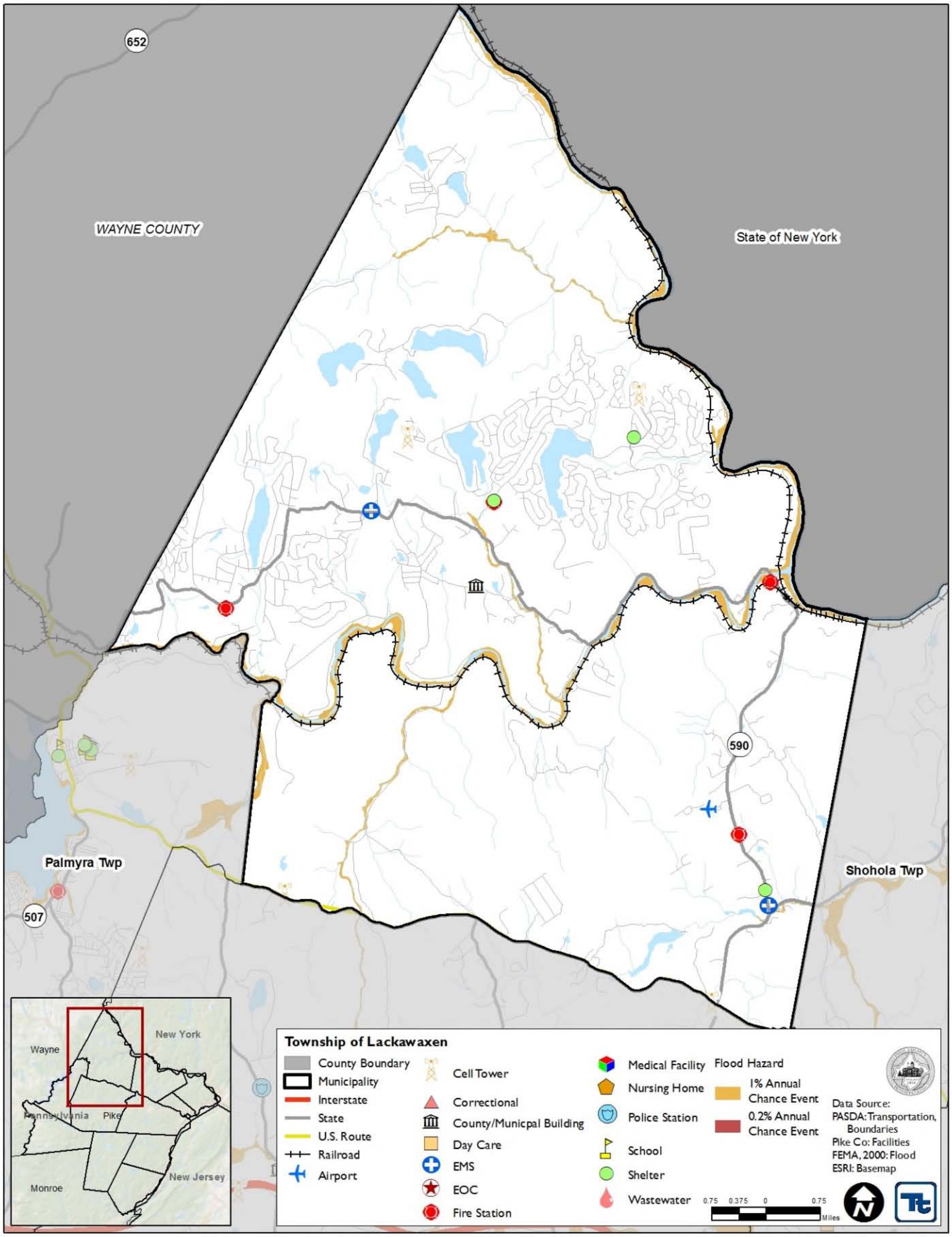
Dingman Township



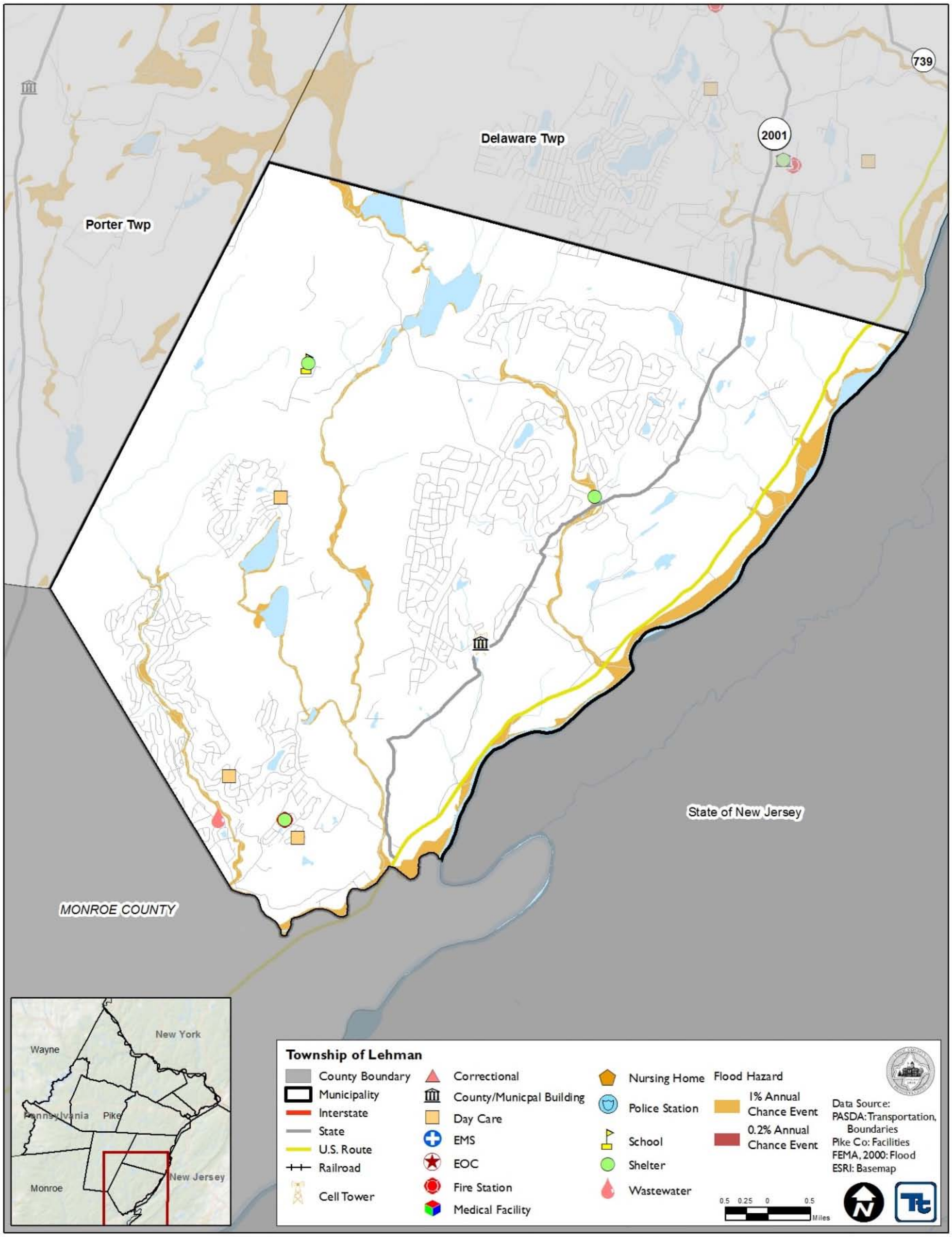
Greene Township



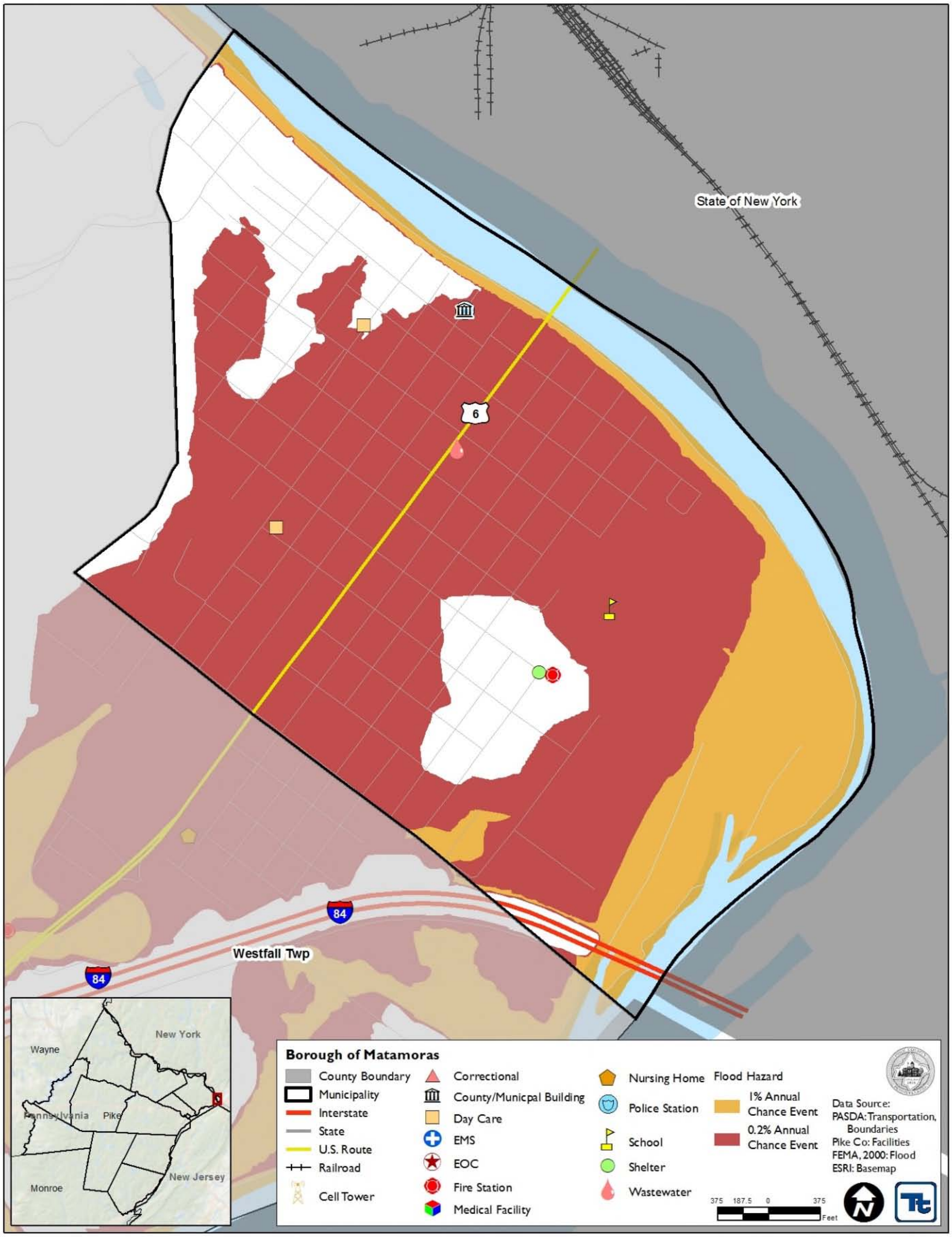
Lackawaxen Township



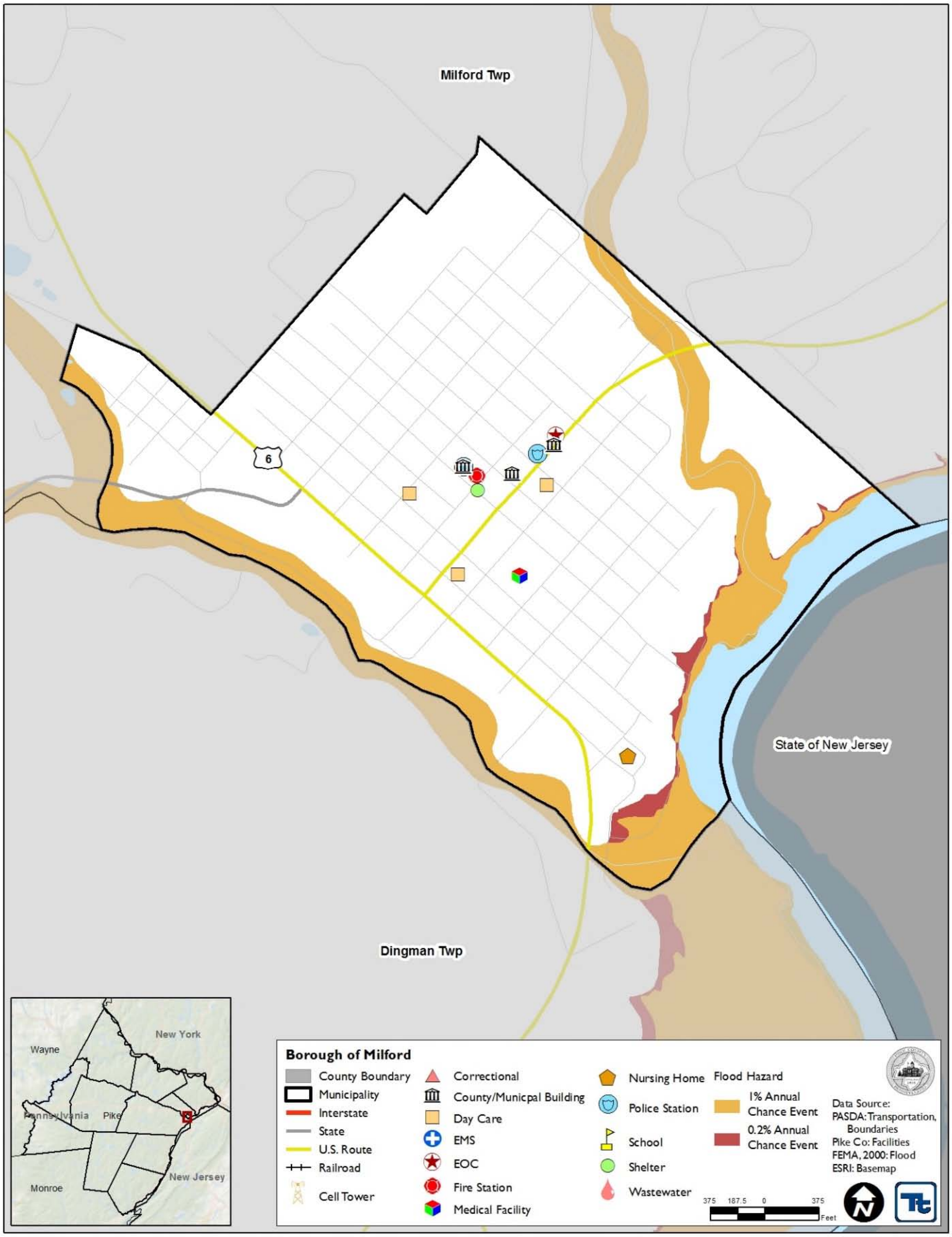
Lehman Township



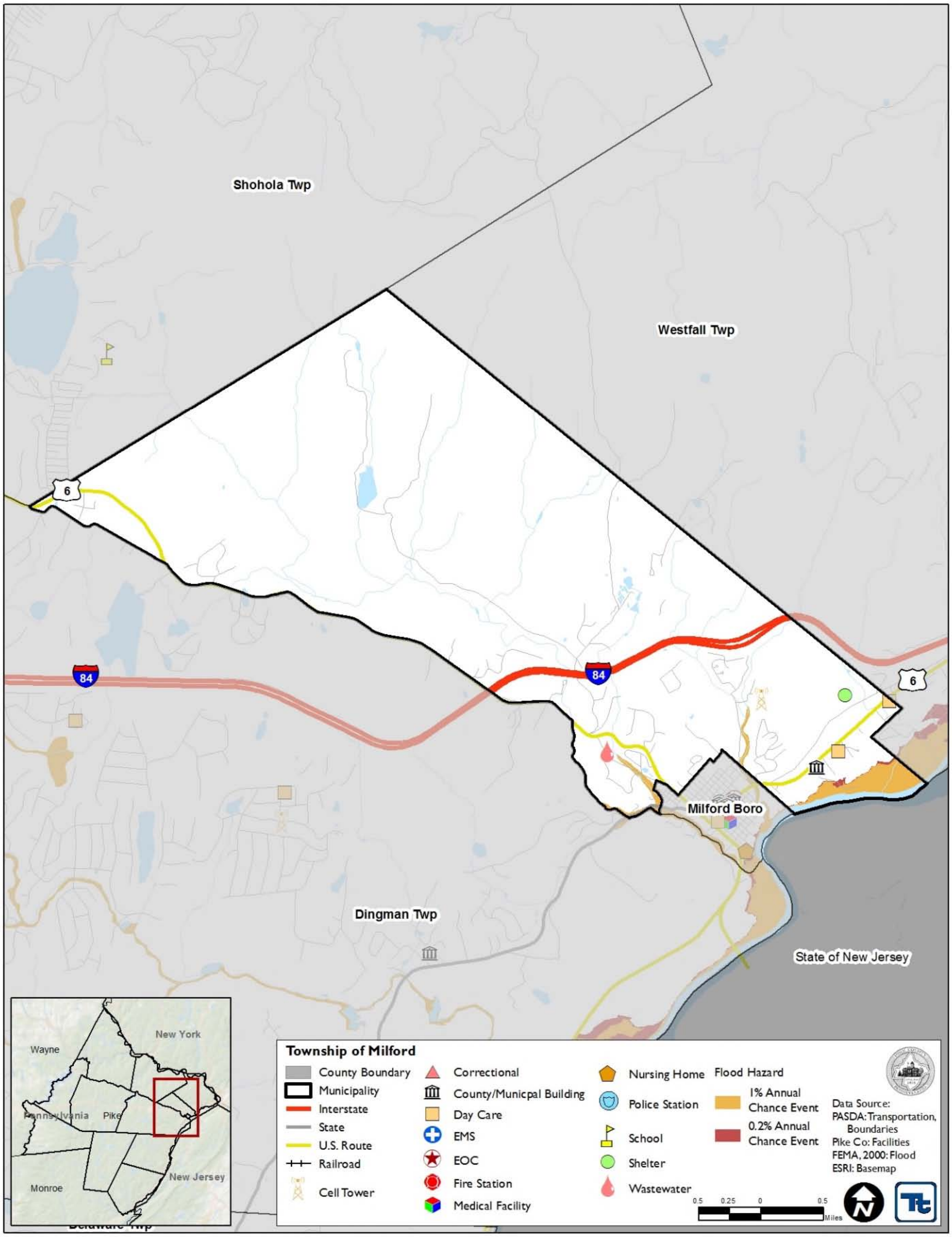
Matamoras Borough



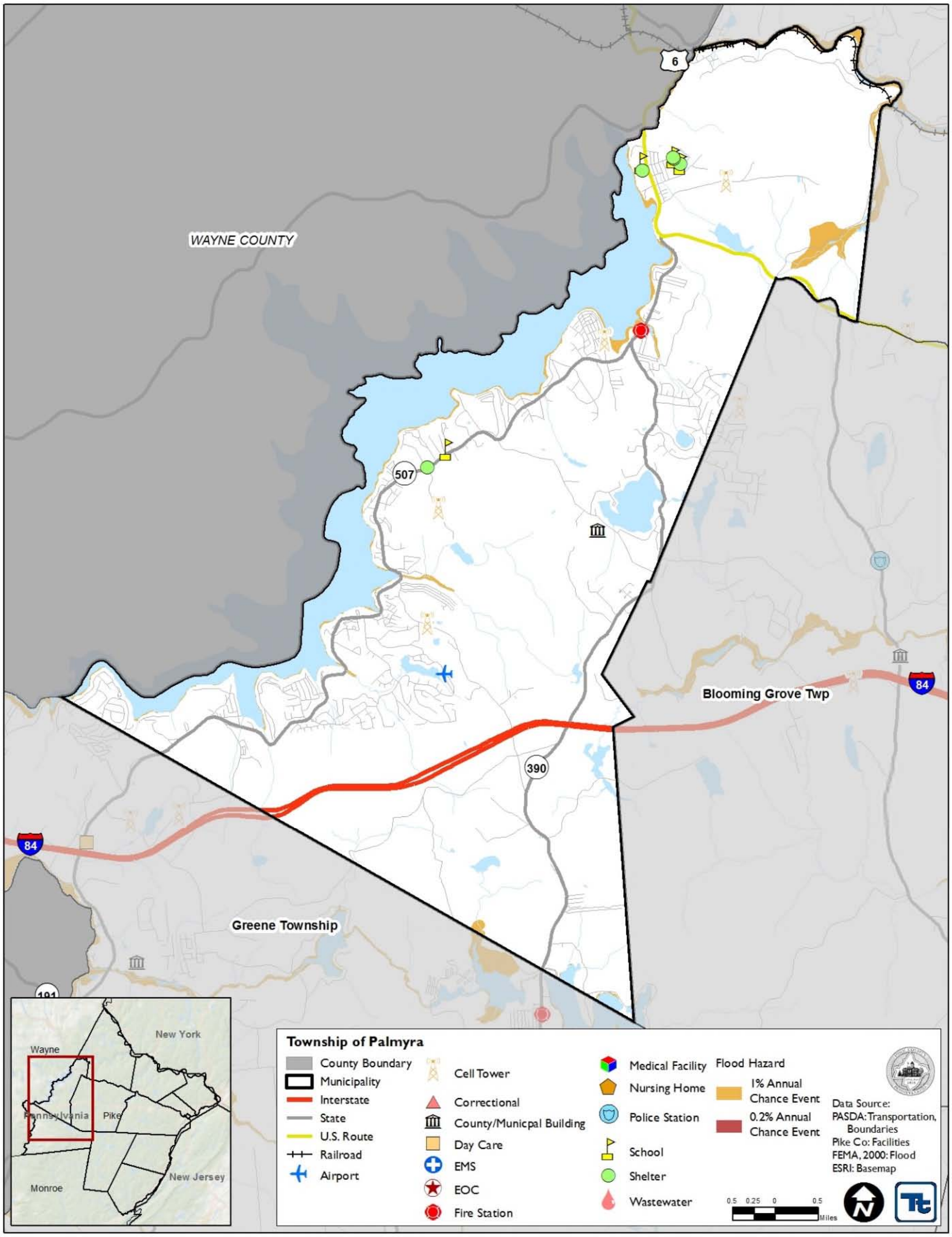
Milford Borough



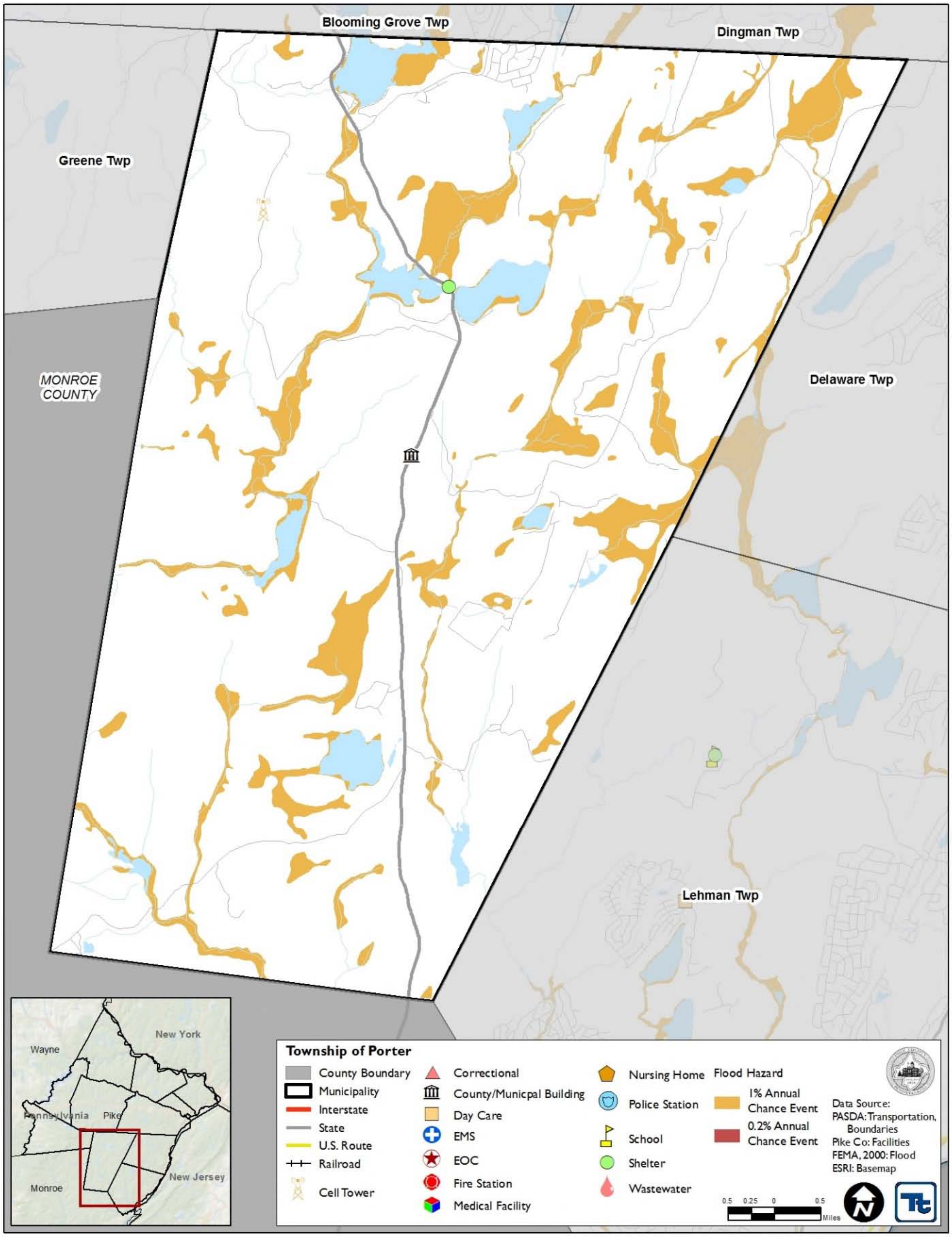
Milford Township



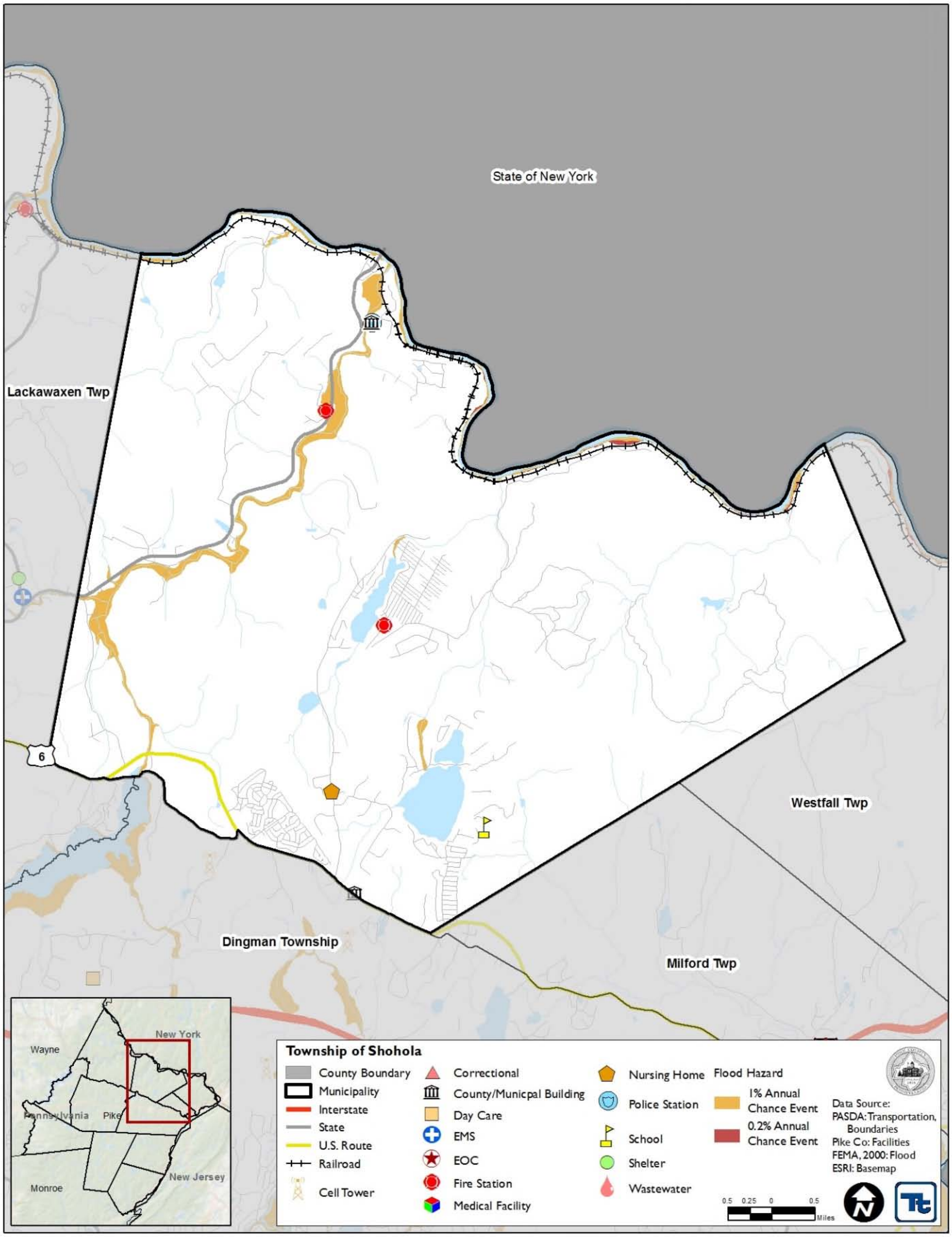
Palmyra Township



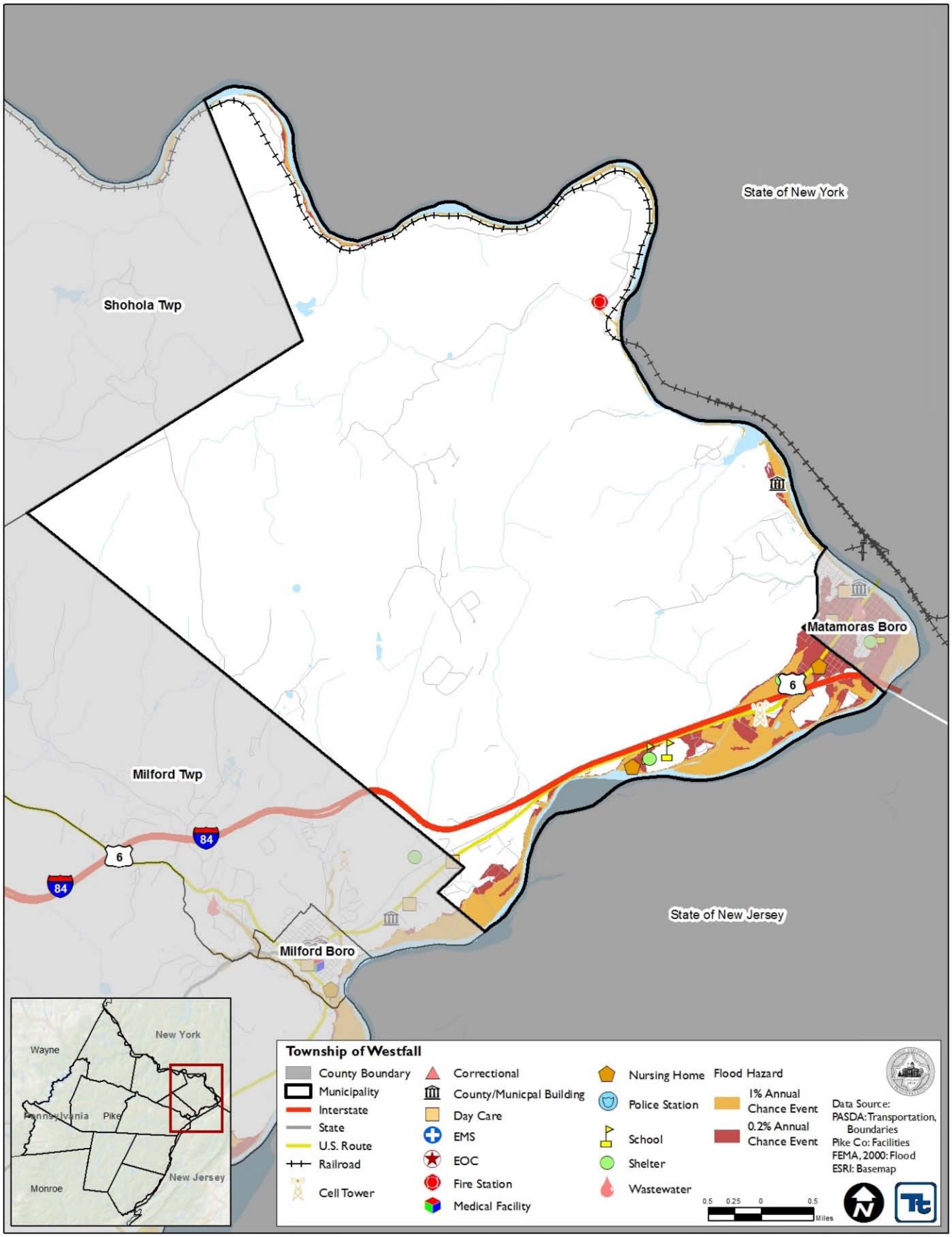
Porter Township



Shohola Township



Westfall Township



4.3.8 Hurricane, Tropical Storm, Nor'Easter

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the hurricane, tropical storm and Nor'Easter hazard in Pike County.

Hurricanes and Tropical Storm

A tropical cyclone is a rotating, organized system of clouds and thunderstorms that originates over tropical or sub-tropical waters and has a closed low-level circulation. Tropical depressions, tropical storms, and hurricanes are all considered tropical cyclones. These storms rotate counterclockwise around the center in the northern hemisphere and are accompanied by heavy rain and strong winds (NWS 2013a). Almost all tropical storms and hurricanes in the Atlantic basin (which includes the Gulf of Mexico and Caribbean Sea) form between June 1 and November 30 (hurricane season). August and September are peak months for hurricane development (NOAA 2013a). Over a two-year period, the U.S. coastline is struck by an average of three hurricanes, one of which is classified as a major hurricane. Hurricanes, tropical storms, and tropical depressions pose a threat to life and property. These storms bring heavy rain, storm surge, and flooding (NOAA 2013b).

A tropical storm system is characterized by a low-pressure center and numerous thunderstorms that produce strong winds and heavy rain (winds are at a lower speed than hurricane-force winds, therefore categorized as a tropical storm instead of a hurricane). Tropical storms strengthen when water evaporated from the ocean is released as the saturated air rises, resulting in condensation of water vapor contained in the moist air. They are fueled by a different heat mechanism than other cyclonic windstorms such as Nor'Easters and polar lows. The characteristic that separates tropical cyclones from other cyclonic systems is that at any height in the atmosphere, the center of a tropical cyclone will be warmer than its surroundings; a phenomenon called "warm core" storm systems (NOAA 2013b).

A hurricane is a tropical storm that attains hurricane status when its wind speed reaches 74 or more miles per hour (mph). Tropical systems may develop in the Atlantic between the Lesser Antilles and the African coast, or may develop in the warm tropical waters of the Caribbean and Gulf of Mexico. These storms may move up the Atlantic Coast of the United States and impact the Eastern Seaboard, or move into the United States through the states along the Gulf Coast, bringing wind and rain as far north as New England, before moving offshore and heading east.

Nor'Easters

A Nor'Easter is a cyclonic storm that moves along the East Coast of North America. It is called a Nor'Easter because the damaging winds over coastal areas blow from a northeasterly direction. Nor'Easters can occur any time of the year, but are most frequent and strongest between September and April. These storms usually develop between Georgia and New Jersey within 100 miles of the coastline and typically move from southwest to northeast along the Atlantic Coast of the United States (NOAA 2013b).

In order to be called a Nor'Easter, a storm must have the following conditions, as per the Northeast Regional Climate Center (NRCC):

- Must persist for at least a 12-hour period
- Have a closed circulation
- Be located within the quadrilateral bounded at 45°N by 65°W and 70°W and at 30°N by 85°W and 75°W

- Show general movement from the south-southwest to the north-northeast
- Contain wind speeds greater than 23 miles per hour (mph)

A Nor'Easter event can cause storm surges, waves, heavy rain, heavy snow, wind, and coastal flooding. Nor'Easters have diameters that can span 1,200 miles, impacting large areas of coastline. The forward speed of a Nor'Easter is usually much slower than a hurricane, so with the slower speed, a Nor'Easter can linger for days and cause tremendous damage to those areas impacted. Approximately 20 to 40 Nor'Easters occur in the northeastern United States every year, with at least two considered severe (Storm Solution, 2014). The intensity of a Nor'Easter can rival that of a tropical cyclone in that, on occasion, it may flow or stall off the mid-Atlantic coast resulting in prolonged episodes of precipitation, coastal flooding, and high winds.

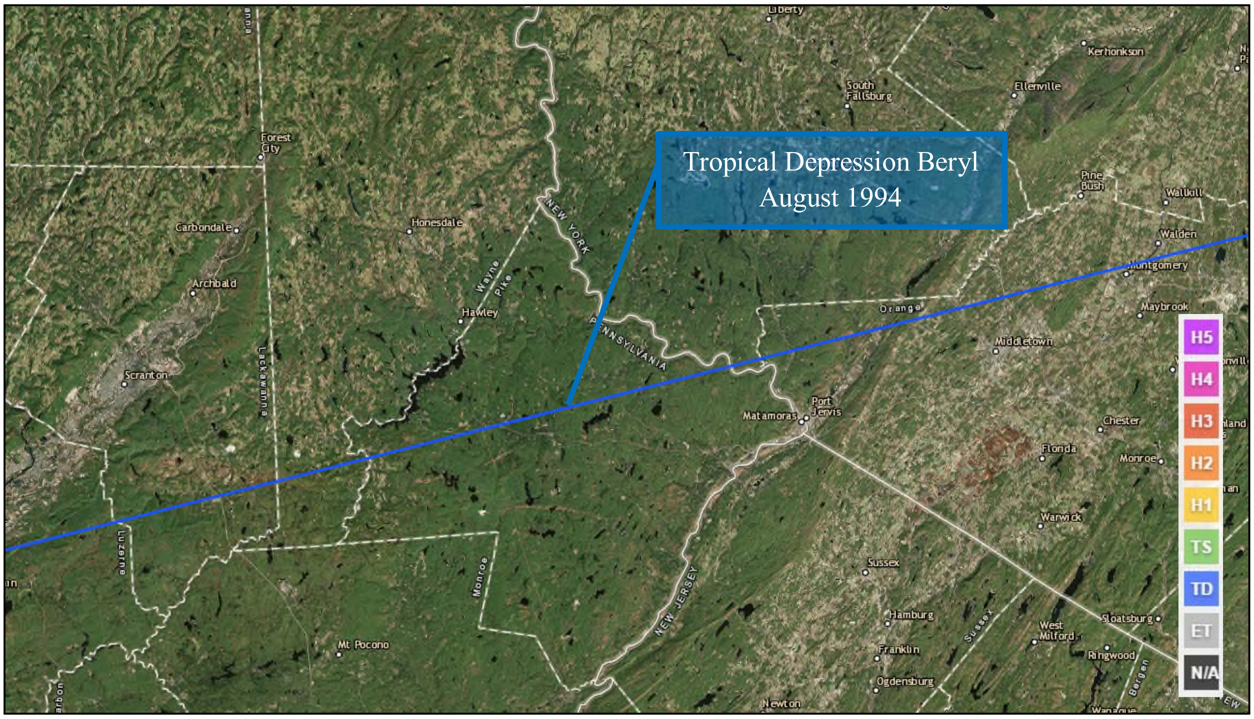
Location and Extent

While Pike County is not located along the Atlantic Coast, hurricanes, tropical storms and Nor'Easters can track inland, bringing heavy rainfall, snow and strong winds. These storms are regional events that can impact very large areas hundreds to thousands of miles across over the life the storm. Therefore, all communities within Pike County are equally subject to the impacts of hurricanes, tropical storms, and Nor'Easters. Areas in Pike County which are subject to flooding, wind, and winter storm damage are particularly vulnerable.

Tropical Storm and Hurricane Tracks

NOAA's Historical Hurricane Tracks tool is a public interactive mapping application that displays Atlantic Basin and East-Central Pacific Basin tropical cyclone data. This interactive tool catalogs tropical cyclones that have occurred from 1842 to 2015 (latest date available from data source). Between 1842 and 2015, 19 events classified as either a hurricane, tropical storm, or tropical depression tracked within 65 nautical miles of Pike County. Figure 4.3.8-1 displays tropical cyclone tracks for Pike County that tracked with 65 nautical miles between 1990 and 2015 (only one event – Tropical Depression Beryl in 1994). Please note that this figure does not show Tropical Storm Irene or Lee because those storms did not pass within 65 nautical miles of Pike County. Nor does it show Hurricane Sandy, as that storm system was classified as an "Extratropical" system, not as a tropical depression, tropical storm, or hurricane, when it passed through the region. However, these and other events severely impacted the county with strong winds, power outages, and other damage. Refer to the "Previous Events and Losses" section for further information regarding hurricane and tropical storm events that impacted Pike County.

Figure 4.3.8-1. Historical Tropical Storm and Hurricane Tracks 1990 to 2015



Source: NOAA 2016

NWS issues hurricane and tropical storm watches and warnings. These watches and warnings are issued or will remain in effect after a tropical cyclone becomes post-tropical, when such a storm poses a significant threat to life and property. The NWS allows the National Hurricane Center (NHC) to issue advisories during the post-tropical stage. The following are the definitions of the watches and warnings:

- *Hurricane/Typhoon Warning* is issued when sustained winds of 74 mph or higher are expected somewhere within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the warning is issued 36 hours in advance of the anticipated onset of tropical storm-force winds. The warning can remain in effect when dangerously high water or combination of dangerously high water and waves continue, even though winds may be less than hurricane force.
- *Hurricane Watch* is issued when sustained winds of 74 mph or higher are possible within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the hurricane watch is issued 48 hours prior to the anticipated onset of tropical storm-force winds.
- *Tropical Storm Warning* is issued when sustained winds of 39 to 73 mph are expected somewhere within the specified area within 36 hours in association with a tropical, subtropical, or post-tropical storm.
- *Tropical Storm Watch* is issued when sustained winds of 39 to 73 mph are possible within the specified area within 48 hours in association with a tropical, sub-tropical, or post-tropical storm (NWS 2013b).

Nor'Easters

Nor'Easters are typically regional events, with most events impacting a large area of Pennsylvania. In many cases, surrounding states and even the northeast region of the United States can be affected by a single event. Coastal communities and other low-lying areas are particularly vulnerable to Nor'Easters. With Pike County's proximity to the Delaware River and the Atlantic Ocean, the county is exposed to the direct and indirect impacts of Nor'Easter events.

Range of Magnitude

The following provides details regarding the range of magnitude for hurricanes, tropical storms, and Nor'Easters.

Hurricane and Tropical Storm

The extent of a hurricane is categorized in accordance with the Saffir-Simpson Hurricane Scale. The Saffir-Simpson Hurricane Wind Scale is a 1-to-5 rating based on a hurricane's sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous and require preventative measures (NOAA 2009). Table 4.3.8-1 represents this scale, which is used to estimate the potential property damage and flooding expected when a hurricane makes landfall.

Table 4.3.8-1. The Saffir-Simpson Hurricane Scale

Category	Wind Speed (mph)	Expected Damage
1	74-95	Very dangerous winds will produce some damage: Homes with well-constructed frames could have damage to roof, shingles, vinyl siding, and gutters. Large tree branches will snap and shallow-rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110	Extremely dangerous winds will cause extensive damage: Homes with well-constructed frames could sustain major roof and siding damage. Many shallow-rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (major)	111-129	Devastating damage will occur: Homes with well-built frames may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (major)	130-156	Catastrophic damage will occur: Homes with well-built frames 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	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.

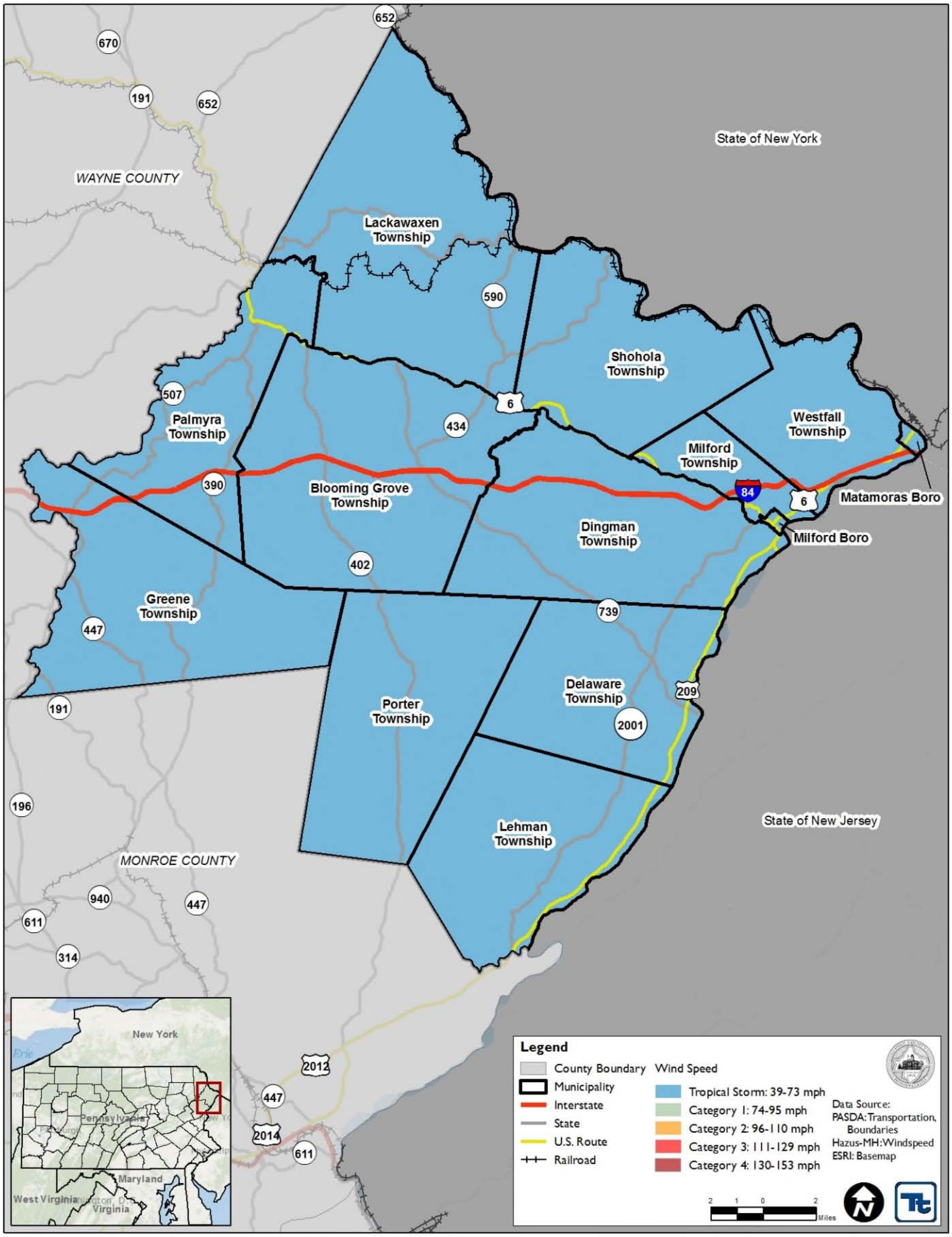
Source: NOAA 2009
mph Miles per hour
> Greater than

Mean Return Period

In evaluating the potential for hazard events of a given magnitude, a MRP is often used. The MRP provides an estimate of the magnitude of an event that may occur within any given year based on past recorded events. MRP is the average period of time, in years, between occurrences of a particular hazard event, equal to the inverse of the annual frequency of exceedance (Dinicola 2009).

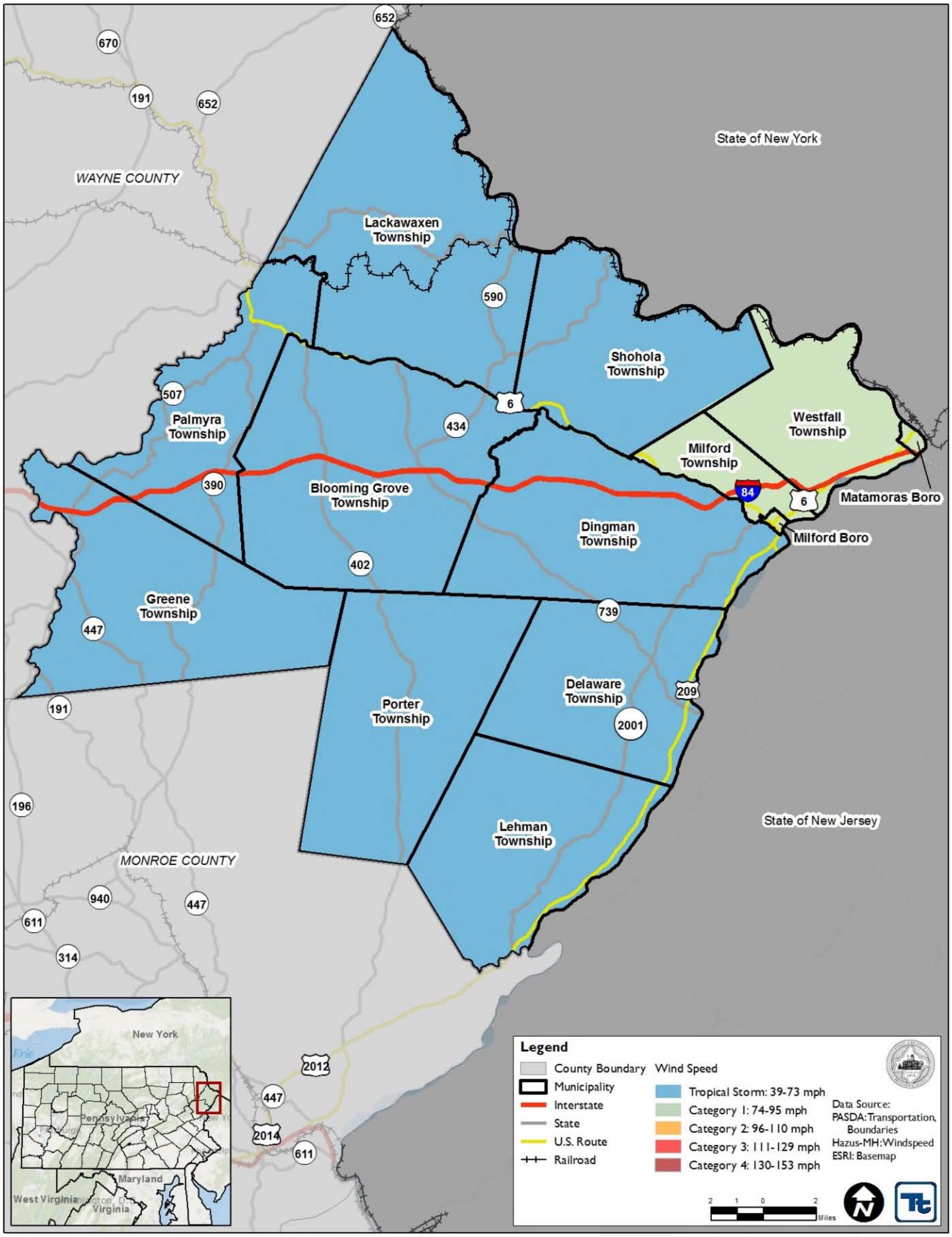
Figure 4.3.8-2 and Figure 4.3.8-3 display the estimated maximum 3-second gust wind speeds that can be anticipated in the study area associated with the 100- and 500-year MRP events. These peak wind speed projections were generated using HAZUS-MH model runs. The maximum 3-second gust wind speeds for Pike County are 54 to 58 mph (Tropical Storm), for the 100-year MRP event. The maximum 3-second gust wind speeds for Pike County are 66 to 76 mph (Tropical Storm to Category 1), for the 500-year MRP event. The storm tracks for the 100- and 500-year event were not available in HAZUS-MH 3.1; a HAZUS-acknowledged error in this version that will be addressed in the future. The associated impacts and losses from these 100-year and 500-year MRP hurricane events are discussed later in the Vulnerability Assessment subsection.

Figure 4.3.8-2. Wind Speeds for the 100-Year Mean Return Period Event



Source: HAZUS-MH 3.1

Figure 4.3.8-3. Wind Speeds for the 500-Year Mean Return Period Event



Source: *HAZUS-MH 3.1*

Nor'Easter

The extent of a Nor'Easter can be classified by meteorological measurements and by evaluating its societal impacts. NOAA's National Climatic Data Center (NCDC) is currently producing the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from 1 to 5. It is based on the spatial extent of the storm, the amount of snowfall, and the interaction of the extent and snowfall totals with population (based on the 2000 Census). The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA-NCDC 2016). Table 4.3.8-2 presents the five RSI ranking categories.

Table 4.3.8-2. RSI Ranking Categories

Category	Description	RSI Value
1	Notable	1-3
2	Significant	3-6
3	Major	6-10
4	Crippling	10-18
5	Extreme	18.0+

Source: NOAA-NCDC 2016
Note: RSI = Regional Snowfall Index

Past Occurrence

The National Oceanic and Atmospheric Administration's Coastal Services Center maintains records of all coastal storms occurring in the United States since the 1850s. Table 4.3.8-3 lists all coastal storms having centers of circulation that pass through or within 65 nautical miles of Pike County. Typically when these storms reach Pike County, they have lost their hurricane speed winds, so structural damage is usually not as bad as what coastal communities' experience.

Table 4.3.8-3. Tropical Cyclone Events Located Within 65 Nautical Miles of Pike County

Year	Event	Strength In/Near Pike County
1863	Not Named	Tropical Storm
1863	Not Named	Tropical Storm
1866	Not Named	Extra-Tropical Storm
1867	Not Named	Extra-Tropical Storm
1878	Not Named	Category 1 Hurricane
1878	Not Named	Category 1 Hurricane
1888	Not Named	Tropical Storm
1893	Not Named	Tropical Storm
1903	Not Named	Tropical Storm
1915	Not Named	Tropical Storm
1929	Not Named	Extra-Tropical Storm
1945	Not Named	Extra-Tropical Storm
1949	Not Named	Tropical Storm
1952	Able	Tropical Storm
1972	Agnes	Tropical Storm
1979	David	Tropical Storm
1988	Chris	Tropical Storm
1994	Beryl	Tropical Depression

Source: NOAA 2016

Between 1954 and 2016, FEMA issued a disaster (DR) or emergency (EM) declaration for the Commonwealth of Pennsylvania for 15 tropical cyclone-related events, classified as one or a combination of the following disaster types: hurricane, tropical storm, severe storms, flooding, and tropical depression. Of those events, Pike County has been included in five hurricane and tropical storm-related declarations during this time period (EM and DR) (FEMA 2016). Table 4.3.8-4 lists FEMA DR and EM declarations from 1955 to 2016 for this HMP update.

Table 4.3.8-4. FEMA DR and EM Declarations for Hurricane and Tropical Storm Events in Pike County

FEMA Declaration Number	Date(s) of Event	Event Type	Location
DR-340	June 1972	Tropical Storm Agnes	67 counties including Pike County
DR-1555	September 8-9, 2004	Severe Storms and Flooding associated with Tropical Depression Frances	67 counties including Pike County
DR-1557	September 17-October 1, 2004	Tropical Depression Ivan	67 counties including Pike County
DR-4025	August 26-30, 2011	Hurricane Irene	14 counties including Pike County
DR-4099	October 26-November 8, 2012	Hurricane Sandy	18 counties including Pike County

Source: FEMA 2016

It is important to note that a number of hurricane, tropical storm, and nor'easter events have impacted the County without tracking through or near it; these storm events include Hurricanes Agnes (1972), Floyd (1999), Henri/Isabel (2003), Diane (1955), Tropical Depression Ivan (2004), and Hurricane Sandy (2012). Additionally, the County recently experienced impacts of two other large storm events, Hurricane Irene and Tropical Storm Lee. Primary impacts of these two storms were related to flooding and little damage occurred as a result of wind. Details regarding both storms is as follows:

Hurricane Irene and Tropical Storm Lee are two recent storm events that impacted Pike County resulting in rainfall and flooding. Hurricane Irene made landfall in the United States on August 27, 2011. It was downgraded to a tropical storm as it headed north and remnants of it affected Pike County with rainfall on August 28th. Tropical Storm Lee developed as a tropical disturbance in the Gulf of Mexico and was a particularly large and slow-moving storm. By the time it reached Pennsylvania, the storm had lost its tropical characteristics and merged with an upper level trough positioned over the eastern third of the US. The storm then stalled over Pennsylvania, bringing rainfall to the region (Pike County HMP 2012).

While both storm events brought rainfall and flooding to Pike County, neither Hurricane Irene nor Tropical Storm Lee resulted in flooding and damages that surpassed other major storm events that have impacted Pike County and resulted in worst case scenarios or record flood levels. According to the Pike County EMA, the results of the two storms were minor in comparison to other storms that have affected the County. Hurricane Irene resulted in more of an impact to Pike County than Tropical Storm Lee. Many homes had flooded basements as a result of sump pump failure from periods of utility interruption during Irene. There were approximately 120 structures which were classified as minor, affected, or inaccessible due to damages resulting from the storm. No homes or businesses were destroyed or suffered major damage that would render the structures inhabitable for an extended period of time. In addition, while there was some damage to municipal roads and some municipal property, no public buildings or treatment facilities were damaged. There were however a few bridges or private culverts that were damaged by Irene. According to the Pike County EMA, there were few, if any reports of damage from Tropical Storm Lee. There were no utility interruptions in Pike County during Tropical Storm Lee and the rainfall was not as steady as it was with Hurricane Irene. Damages that did occur from Lee were only additional damage to roads that were already damaged by Hurricane Irene (Pike County HMP 2012).

For this 2017 HMP update, hurricane, tropical storm and Nor'Easters events, including FEMA disaster declarations, which have impacted Pike County are identified in Table 4.3.8-5. Because documentation for these types of events is so extensive, not all sources have been identified or researched. Therefore, Table 4.3.8-5 may not include all events that occurred throughout the county.

Table 4.3.8-5. Hurricane, Tropical Storm and Nor'Easter Events Impacting Pike County

Date	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts	Source(s)
August 1955	Hurricanes Connie and Diane	N/A	N/A	The remnants of Hurricanes Connie and Diane caused flooding in Pike County as a result of heavy rains. Both storms moved through the area less than one week apart. After a relatively dry summer, the two storms dumped closed to 20 inches of rain over a wide area with some areas receiving more. The results were devastating, particularly along the Lackawaxen and Delaware Rivers and the many streams.	Pike County HMP
June 1972	Hurricane Agnes	DR-340	Yes	The remnants of Hurricane Agnes produced very heavy rains across most of Pennsylvania including Pike County. There was some minor flooding within the county.	Pike County HMP
September 8-9, 2004	Severe Storms and Flooding Associated with Tropical Depression Frances	DR-1555	Yes	N/A	FEMA
September 18, 2004	Flood/Flash Flood (Tropical Depression Ivan)	DR-1557	Yes	Rainfall amounts were 4 to 7 inches which started on the 16th and continued into the 18th. This rain was from the remnants of hurricane Ivan. Most creeks and streams went out of their banks. In addition, the Delaware and Lackawaxen Rivers had major flooding. About a dozen rescues were performed. Over 100 roads were closed. The entire village of Newfoundland was evacuated. 6 bridges were closed. 2 businesses were closed. According to the Pennsylvania State Climatologist, the county had $15 million in damages from this event.	FEMA, NOAA-NCEI, Pike County HMP
August 26-30, 2011 September 3-October 5, 2011	Hurricane Irene Tropical Storm Lee	DR-4025 DR-4030	Yes No	Hurricane Irene and Tropical Storm Lee are two recent storm events that impacted Pike County resulting in rainfall and flooding. Hurricane Irene made landfall in the United States on August27, 2011. It was downgraded to a tropical storm as it headed north and remnants of it affected Pike County with rainfall on August 28th. Tropical Storm Lee developed as a tropical disturbance in the Gulf of Mexico and was a particularly large and slow-moving storm. By the time it reached Pennsylvania, the storm had lost its tropical characteristics and merged with an upper level trough positioned over the eastern third of the US. The storm then stalled over Pennsylvania, bringing rainfall to the region. While both storm events brought rainfall and flooding to Pike County, neither Hurricane Irene nor Tropical Storm Lee resulted in flooding and damages that surpassed other major storm events that have impacted Pike County and resulted in worst case scenarios or record flood levels.	Pike County HMP 2012

Date	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts	Source(s)
				According to the Pike County EMA, the results of the two storms were minor in comparison to other storms that have affected the County. Hurricane Irene resulted in more of an impact to Pike County than Tropical Storm Lee. Many homes had flooded basements as a result of sump pump failure from periods of utility interruption during Irene. There were approximately 120 structures which were classified as minor, affected, or inaccessible due to damages resulting from the storm. No homes or businesses were destroyed or suffered major damage that would render the structures inhabitable for an extended period of time. In addition, while there was some damage to municipal roads and some municipal property, no public buildings or treatment facilities were damaged. There were however a few bridges or private culverts that were damaged by Irene. According to the Pike County EMA, there were few, if any reports of damage from Tropical Storm Lee. There were no utility interruptions in Pike County during Tropical Storm Lee and the rainfall was not as steady as it was with Hurricane Irene. Damages that did occur from Lee were only additional damage to roads that were already damaged by Hurricane Irene.	
October 28, 2011	Nor'Easter / Winter Storm	N/A	N/A	An early season winter storm brought wet snow across northeast Pennsylvania. Snow amounts varied depending on elevation. More than a foot of snow fell in the Poconos. In Pike County, snowfall totals across the county averaged around 12 inches.	NOAA-NCEI
October 26-November 8, 2012	Hurricane Sandy	DR-4099	Yes	Hurricane Sandy brought high winds and locally heavy rains to northeast Pennsylvania. Peak sustained winds ranged from 30 to 40 mph with frequent gusts between 50 and 60 mph. The hardest hit area was the higher terrain areas, especially in the Poconos. Peak gusts were between 60 and 70 mph in the Poconos and other higher mountains of northeast Pennsylvania. The winds knocked down numerous trees and power lines, leaving approximately 110,000 people without power during the height of the storm. Pike County and the southern half of Wayne County were the hardest hit, with almost 60,000 people without power. In addition to the winds, rain was locally heavy and generally caused minor flooding. In Pike County, the high winds knocked down numerous trees and power lines throughout the county. There were numerous road closures throughout the county, including Interstate 84 and many state roads. Peak sustained winds were estimated at close to 40 mph with peak wind gusts measured at 75 mph, mainly over the southeast portion of the county. During the height of the storm, approximately 31,000 customers were without power and it took up to a week for power to be fully restored	FEMA, NOAA-NCEI

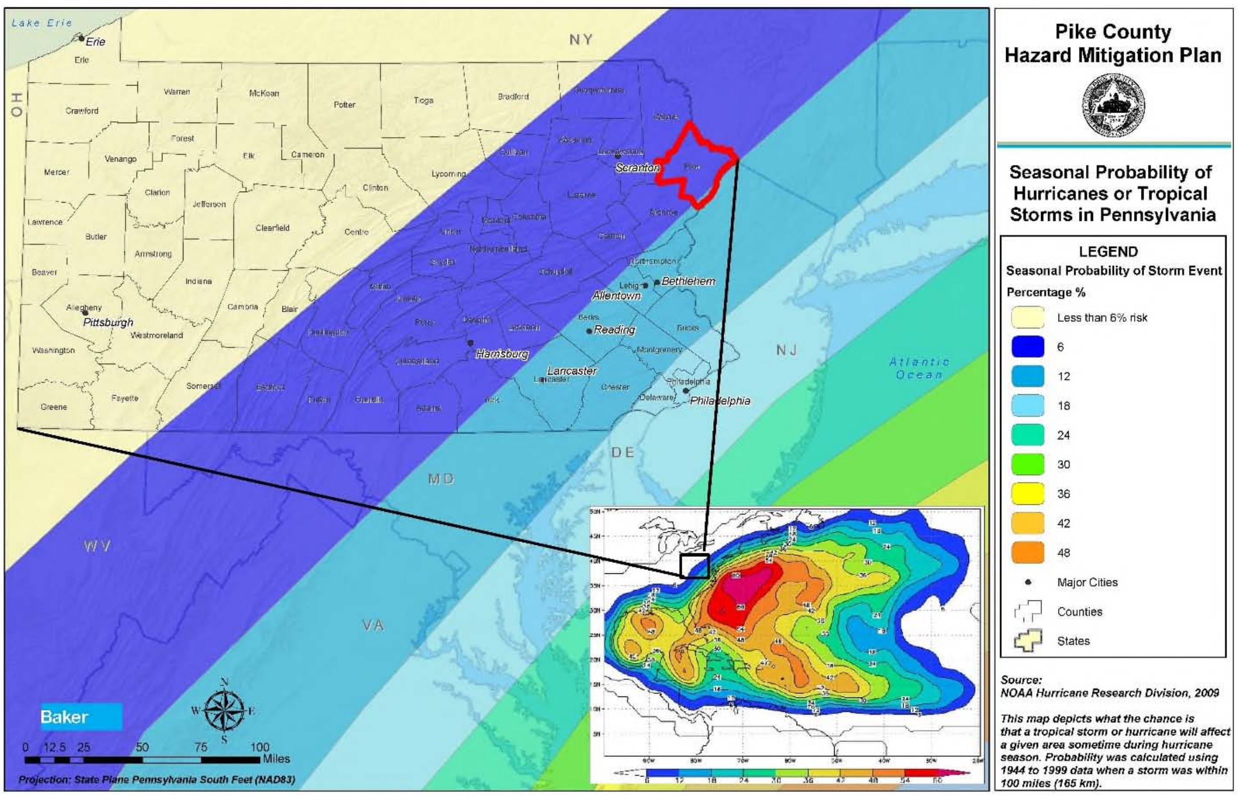
Date	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts	Source(s)
				across the county.	
November 26, 2014	Nor'Easter	N/A	N/A	A Nor'Easter made its way up the east coast, bringing heavy snow to northeast Pennsylvania. In Pike County, snowfall totals ranged from six to 10 inches, with the highest amount of 10 inches recorded in the Town of Milford.	NOAA-NCEI

Sources: NOAA-NCEI 2016; FEMA 2016; Pike County HMP 2012
DR Federal Disaster Declaration
EM Emergency Management
EMA Emergency Management Agency
FEMA Federal Emergency Management Agency
NCEI National Centers for Environmental Information
NOAA National Oceanic Atmospheric Administration
N/A Not applicable / not available
SBA Small Business Administration

Future Occurrence

Although hurricanes and tropical storms can cause flood events consistent with 1 percent- and 2 percent- level frequency, their probability of occurrence is measured relative to wind speed. The National Oceanic and Atmospheric Administration Hurricane Research Division published the map included as Figure 4.3.8-4 showing the chance that a tropical storm or hurricane will affect a given area during the entire Atlantic hurricane season spanning from June to November. Note that this figure does not provide information on the probability of various storm intensities. However, based on historical data between 1944 and 1999, this map reveals there is approximately a 6 to12 percent chance of experiencing a tropical storm or hurricane event between June and November of any given year in the County (Pike County HMP 2012).

Figure 4.3.8-4. Seasonal Probability of a Hurricane or Tropical Storm affecting Pike County



Source: NOAA Hurricane Research Division, 2009

For the 2017 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of hurricane, tropical storm and Nor'Easters events for Pike County. Information from NOAA-NCEI storm events database, FEMA, and a NOAA Historical Hurricane Tracks search were used to identify the number of events that occurred between 1950 and 2015. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimate percent chance of an incident occurring in a given year.

Table 4.3.8-6. Probability of Future Hurricane, Tropical Storm and Nor'Easter Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Extra-Tropical Storms	1	0.02	66.00	0.02	1.5
Tropical Depression	4	0.06	16.50	0.06	6.1
Tropical Storm	8	0.12	8.25	0.12	12.1
Hurricanes (all categories)	0	0.00	0	0	0
Nor'Easter	2	0.03	33.00	0.03	3.0

Source: NHC 2016; NOAA-NCEI 2016; FEMA 2016

It is estimated that Pike County will continue to experience direct and indirect impacts of hurricanes, tropical storms and Nor'Easters annually that may induce secondary hazards such as flooding, extreme wind, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents, and inconveniences. Therefore the future occurrence of hurricanes, tropical storms and Nor'Easters in Pike County can be characterized as *possible* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1).

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable to the identified hazard. For the hurricane and tropical storm hazard, all of Pike County has been identified as exposed. Therefore, all assets in the county (population, structures, critical facilities, and lifelines), as described in the County Profile (Section 4), are at risk. The following text evaluates and estimates the potential impact of the hurricane and tropical storm hazard on the county including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health, and safety of residents, (2) general building stock, (3) critical facilities, (4) economy, and (5) future growth and development
- Effect of climate change on vulnerability
- Change of vulnerability as compared to that presented in the 2012 Pike County HMP
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

There are many similarities between Nor'Easter and hurricane events. Both types of events can bring high winds and heavy rainfalls or severe winter weather events, resulting in similar impacts on the population, structures, and the economy.

The high winds and air speeds often result in power outages, disruptions to transportation corridors and equipment, loss of workplace access, significant property damage, injuries and loss of life, and the need to shelter and care for individuals impacted by the events. A large amount of damage can be inflicted by trees, branches, and other objects that fall onto power lines, buildings, roads, vehicles, and, in some cases, people.

The entire inventory of the county is at risk of being damaged or lost due to impacts of hurricanes, tropical storms and Nor'Easters. Certain areas, infrastructure, and types of buildings are at greater risk than others due to proximity to flood waters, falling hazards, and their manner of construction. Potential losses associated with high winds were calculated for Pike County for the 100-year and 500-year MRP wind events.

Data and Methodology

After reviewing historic data, the HAZUS-MH methodology and model were used to analyze the wind hazard for Pike County. Data and tools used to assess this hazard include data from FEMA's HAZUS-MH 3.1 wind model, professional knowledge, information provided by the Planning Committee.

A probabilistic scenario was run for Pike County for annualized losses and the 100- and 500-year MRPs in HAZUS-MH. Maximum peak gust wind speeds for these MRPs are displayed on Figures 4.3.4-2 and 4.3.8-3.

HAZUS-MH contains data on historic hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps for the area. Surface roughness and vegetation data support the modeling of wind force across various types of land surfaces. Impacts to life, health, and safety and structures are discussed below using the methodology described above. An updated critical facility inventory was used in the evaluation of this hazard.

Impact on Life, Health and Safety

For the purposes of this HMP, the entire population of Pike County (57,369 people) is exposed to hurricanes and tropical storm events (U.S. Census, 2010). Residents may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings and debris carried by high winds can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. HAZUS-MH estimates no households will be displaced and temporary shelter will not be required as a result of the 100- and 500-year MRP events.

Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions based on the major economic impact to their family and may not have funds to evacuate. The population over the age of 65 is also more vulnerable and, physically, they may have more difficulty evacuating. The elderly are considered most vulnerable because they require extra time or outside assistance during evacuations and are more likely to seek or need medical attention which may not be available due to isolation during a storm event. Please refer to Section 4 for the statistics of these populations.

Impact on General Building Stock

After considering the population exposed to the hurricane hazard, the value of general building stock exposed to and damaged by 100- and 500-year MRP hurricane wind events was considered. Potential damage is the modeled loss that could occur to the exposed inventory, including damage to structural and content value based on the wind-only impacts associated with a tropical storm hurricane. The entire study area is considered at risk to the wind hazard. Please refer to Section 4 (County Profile) which presents the total exposure value for general building stock by occupancy class for Pike County.

Expected building damage was evaluated by HAZUS-MH across the following wind damage categories: no damage/very minor damage, minor damage, moderate damage, severe damage, and total destruction. Table 4.3.8-7 summarizes the definition of the damage categories.

Table 4.3.8-7. Description of Damage Categories

Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
No Damage or Very Minor Damage Little or no visible damage from the outside. No broken windows, or failed roof deck. Minimal loss of roof over, with no or very Limited water penetration.	≤2%	No	No	No	No	No
Minor Damage Maximum of one broken window, door or garage door. Moderate roof cover loss that can be covered to prevent additional water entering the building. Marks or dents on walls requiring painting or patching for repair.	>2% and ≤15%	One window, door, or garage door failure	No	<5 impacts	No	No
Moderate Damage Major roof cover damage, moderate window breakage. Minor roof sheathing failure. Some resulting damage to interior of building from water.	>15% and ≤50%	> one and ≤ the larger of 20% & 3	1 to 3 panels	Typically 5 to 10 impacts	No	No
Severe Damage Major window damage or roof sheathing loss. Major roof cover loss. Extensive damage to interior from water.	>50%	> the larger of 20% & 3 and ≤50%	>3 and ≤25%	Typically 10 to 20 impacts	No	No
Destruction Complete roof failure and/or, failure of wall frame. Loss of more than 50% of roof sheathing.	Typically >50%	>50%	>25%	Typically >20 impacts	Yes	Yes

Source: HAZUS-MH Hurricane Technical Manual

Table 4.3.8-8 summarizes the building value (structure only) damage estimated for the 100- and 500-year MRP hurricane wind-only events. Damage estimates are reported for the county's probabilistic HAZUS-MH model scenarios. The data shown indicates total losses associated with wind damage to building structure.

Table 4.3.8-8. Estimated Building Value (Structure Only) Damaged by the 100-Year and 500-Year MRP Hurricane-Related Winds

Municipality	Total Improvement Value (Structure Only)	Estimated Total Damages*			Percent of Total Building Improvement Value		
		Annualized Loss	100-Year	500-Year	Annualized Loss	100-Year	500-Year
Blooming Grove Township	$768,042,000	$4,523	$93,340	$458,268	<1%	<1%	<1%
Delaware Township	$973,607,000	$8,509	$36,243	$1,029,901	<1%	<1%	<1%
Dingman Township	$1,287,496,000	$10,319	$54,850	$1,403,863	<1%	<1%	<1%
Greene Township	$624,259,000	$3,897	$75,851	$348,282	<1%	<1%	<1%
Lackawaxen Township	$816,292,000	$3,639	$65,256	$499,744	<1%	<1%	<1%
Lehman Township	$1,303,700,000	$10,046	$22,779	$1,005,961	<1%	<1%	<1%
Matamoras Borough	$237,231,000	$2,577	$255	$443,427	<1%	<1%	<1%
Milford Borough	$224,907,000	$1,102	$825	$152,478	<1%	<1%	<1%
Milford Township	$414,595,000	$2,215	$9,188	$340,218	<1%	<1%	<1%
Palmyra Township	$824,628,000	$5,105	$131,205	$457,693	<1%	<1%	<1%
Porter Township	$255,805,000	$1,542	$27,648	$140,112	<1%	<1%	<1%
Shohola Township	$488,962,000	$3,808	$29,727	$552,051	<1%	<1%	<1%
Westfall Township	$238,350,000	$1,595	$1,914	$262,005	<1%	<1%	<1%
Pike County (Total)	**$8,457,874,000**	**$58,878**	**$549,080**	**$7,094,001**	**<1%**	**<1%**	**<1%**

Source: HAZUS-MH 3.1

**The Total Damages column represents the sum of damages for all occupancy classes (residential, commercial, industrial, agricultural, educational, religious and government) based on improvement value.*

Table 4.3.8-9. Estimated Residential and Commercial Building Value (Structure Only) Damaged by the 100-Year and 500-Year MRP Hurricane-Related Winds

Municipality	Total Improvement Value (Structure Only)	Estimated Residential Damage		Estimated Commercial Damage	
		100-Year	500-Year	100-Year	500-Year
Blooming Grove Township	$768,042,000	$93,340	$457,069	$0	$965
Delaware Township	$973,607,000	$36,243	$1,022,507	$0	$4,697
Dingman Township	$1,287,496,000	$54,850	$1,395,210	$0	$4,967
Greene Township	$624,259,000	$75,851	$344,445	$0	$2,896

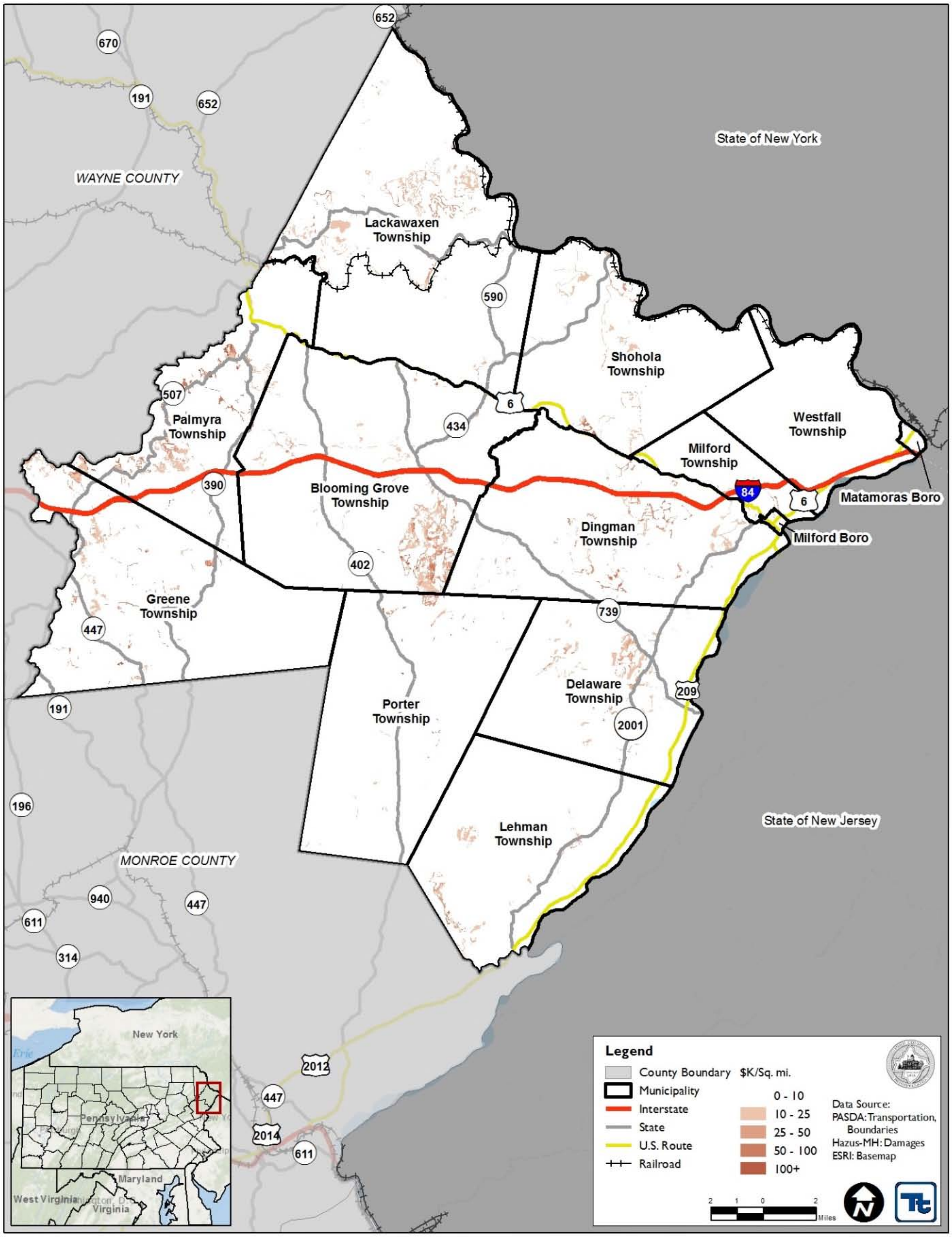
Municipality	Total Improvement Value (Structure Only)	Estimated Residential Damage		Estimated Commercial Damage	
		100-Year	500-Year	100-Year	500-Year
Lackawaxen Township	$816,292,000	$65,256	$498,468	$0	$875
Lehman Township	$1,303,700,000	$22,779	$999,481	$0	$3,598
Matamoras Borough	$237,231,000	$255	$437,568	$0	$4,367
Milford Borough	$224,907,000	$825	$139,082	$0	$9,999
Milford Township	$414,595,000	$9,188	$331,981	$0	$6,287
Palmyra Township	$824,628,000	$131,205	$456,068	$0	$1,129
Porter Township	$255,805,000	$27,648	$139,258	$0	$388
Shohola Township	$488,962,000	$29,727	$547,637	$0	$2,252
Westfall Township	$238,350,000	$1,914	$256,180	$0	$5,173
Pike County (Total)	**$8,457,874,000**	**$549,080**	**$7,024,955**	**$0**	**$47,593**

Source: HAZUS-MH 3.1

The total damage to buildings (structure only) for all occupancy types across Pike County is estimated to be $549K for the 100-year MRP wind-only event, and approximately $7 million for the 500-year MRP wind-only event. The majority of these losses are to the residential building category. Refer to Figures 4.3.8-4 and 4.3.8-5 that illustrate the density estimated building loss across Pike County for these two events.

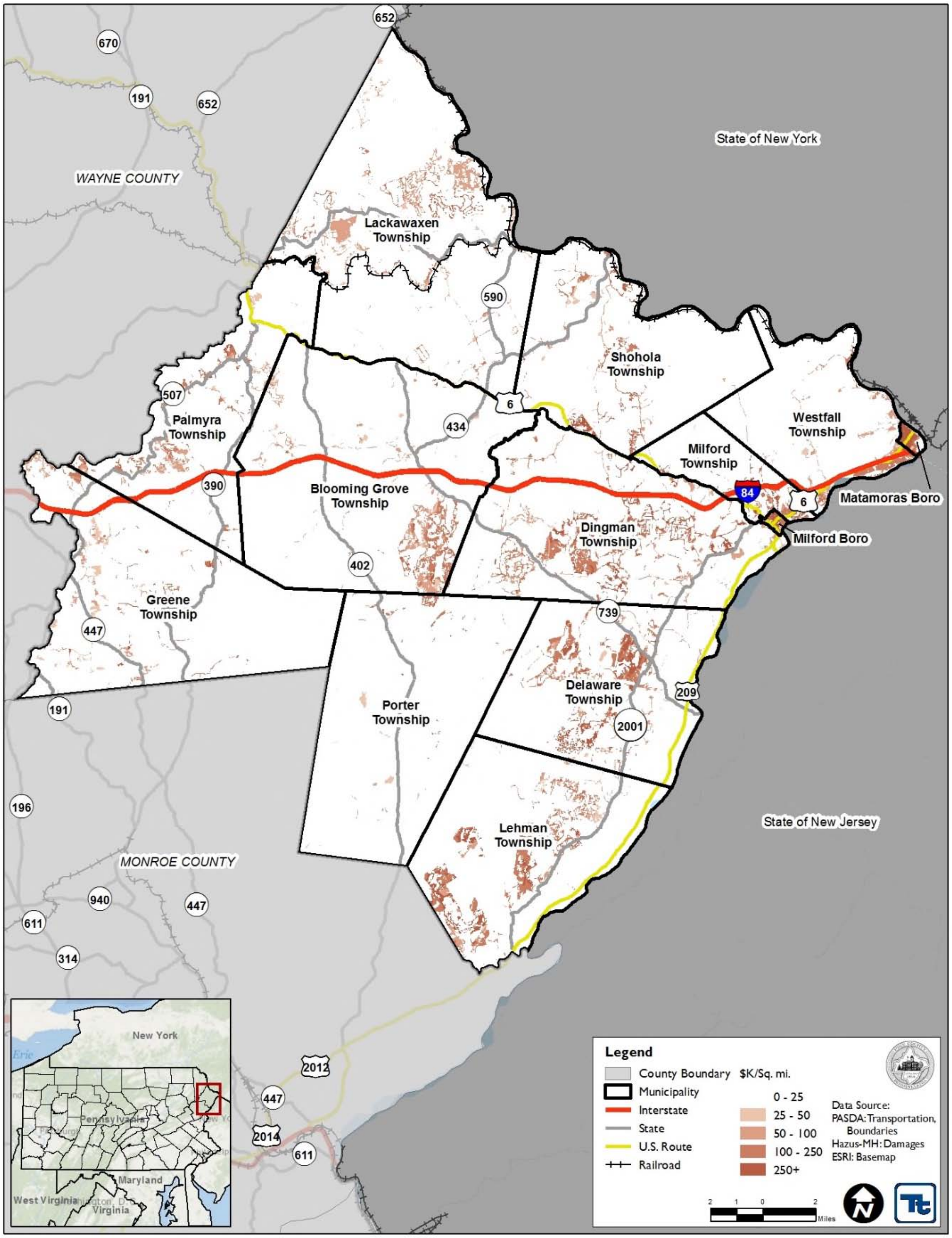
Because of differences in building construction, residential structures are generally more susceptible to wind damage than commercial and industrial structures. The damage counts include buildings damaged at all severity levels from minor damage to total destruction. Total dollar damage reflects the overall impact to buildings at an aggregate level.

Figure 4.3.8-5. Density of Losses for Structures (All Occupancies) for the 100-Year MRP Wind Event



Source: HAZUS-MH 3.1

Figure 4.3.8-6. Density of Losses for Structures (All Occupancies) for the 500-Year MRP Wind Event



Source: HAZUS-MH 3.1

Impact on Critical Facilities

Overall, all critical facilities are exposed to the wind hazard associated with hurricane and tropical storm events. HAZUS-MH estimates the probability that critical facilities (i.e., medical facilities, fire/EMS, police, EOC, schools, and user-defined facilities such as shelters and municipal buildings) may sustain damage as a result of 100-year and 500-year MRP wind events. Additionally, HAZUS-MH estimates the loss of use for each facility in number of days. Due to the sensitive nature of the critical facility dataset, individual facility estimated loss is not provided.

HAZUS-MH estimates no damage to the critical facilities as a result of the 100-year event.

Table 4.3.8-10 summarizes the percent probability that each facility type may experience damage as a result of the 500-year MRP event. HAZUS-MH estimates no damage to the critical facilities as a result of the 100-year event.

Table 4.3.8-10. Estimated Impacts to Critical Facilities for the 500-Year Mean Return Period Hurricane-Related Winds

Facility Type	500-Year Event				
	Loss of Days	Percent-Probability of Sustaining Damage			
		Minor	Moderate	Severe	Complete
EOC	0	0-1	0	0	0
Medical	0	2	1	0	0
Police	0	0-1	0	0	0
Fire	0	0	0	0	0
Schools	0	0-1	0	0	0

Source: HAZUS-MH 3.1

Impact on Economy

Hurricanes and tropical storms also impact the economy, including: loss of business function (e.g., tourism, recreation), damage to inventory, relocation costs, wage loss and rental loss due to the repair/replacement of buildings. HAZUS-MH estimates the total economic loss associated with each storm scenario (direct building losses and business interruption losses). Direct building losses are the estimated costs to repair or replace the damage caused to the building. This is reported in the "Impact on General Building Stock" subsection discussed earlier. Business interruption losses are the losses associated with the inability to operate a business because of the wind damage sustained during the storm or the temporary living expenses for those displaced from their home because of the event.

For the 100-year MRP wind event, HAZUS-MH estimates less than $1,000 in business interruption costs (income loss, relocation costs, rental costs and lost wages) and no inventory losses. For the 500-year MRP wind only event, HAZUS-MH estimates approximately $13K in business interruption losses for the County, which includes loss of income, relocation costs, rental costs and lost wages, and no inventory losses.

Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. Utility infrastructure (power lines, gas lines, electrical systems) could suffer damage and impacts can result in the loss of power, which can impact business operations and can impact heating or cooling provision to the population.

HAZUS-MH 3.1 also estimates the amount of debris that may be produced a result of the 100- and 500-year MRP wind events. Table 4.3.8-11 summarizes the estimated debris by municipality. Because the estimated debris production does not include flooding, this is likely a conservative estimate and may be higher if multiple impacts occur.

According to the HAZUS-MH Hurricane User Manual: '*The Eligible Tree Debris columns provide estimates of the weight and volume of downed trees that would likely be collected and disposed at public expense. As discussed in Chapter 12 of the HAZUS-MH Hurricane Model Technical Manual, the eligible tree debris estimates produced by the Hurricane Model tend to underestimate reported volumes of debris brought to landfills for a number of events that have occurred over the past several years. This indicates that that there may be other sources of vegetative and non-vegetative debris that are not currently being modeled in HAZUS. For landfill estimation purposes, it is recommended that the HAZUS debris volume estimate be treated as an approximate lower bound. Based on actual reported debris volumes, it is recommended that the HAZUS results be multiplied by three to obtain an approximate upper bound estimate. It is also important to note that the Hurricane Model assumes a bulking factor of 10 cubic yards per ton of tree debris. If the debris is chipped prior to transport or disposal, a bulking factor of 4 is recommended. Thus, for chipped debris, the eligible tree debris volume should be multiplied by 0.4*'.

Table 4.3.8-11. Debris Production for 100- and 500-Year Mean Return Period Hurricane-Related Winds

Municipality	Brick and Wood (tons)		Concrete and Steel (tons)		Tree (tons)		Eligible Tree Volume (cubic yards)	
	100 Year	500 Year	100 Year	500 Year	100 Year	500 Year	100 Year	500 Year
Blooming Grove Township	0	1	0	0	0	0	0	0
Delaware Township	0	13	0	0	0	0	0	0
Dingman Township	0	20	0	0	0	0	0	0
Greene Township	0	3	0	0	0	0	0	0
Lackawaxen Township	0	4	0	0	0	0	0	0
Lehman Township	0	8	0	0	0	0	0	0
Matamoras Borough	0	16	0	0	0	0	0	0
Milford Borough	0	5	0	0	0	0	0	0
Milford Township	0	17	0	0	0	0	0	0
Palmyra Township	0	0	0	0	0	0	0	0
Porter Township	0	0	0	0	0	0	0	0
Shohola Township	0	21	0	0	0	0	0	0
Westfall Township	0	16	0	0	0	0	0	0
Pike County (Total)	**0**	**124**	**0**	**0**	**0**	**0**	**0**	**0**

Source: HAZUS-MH 3.1

Effect of Climate Change on Vulnerability

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

Change of Vulnerability

Pike County and its municipalities continue to be vulnerable to the hurricane and tropical storm hazard. However, the main difference between the 2017 HMP update and the original 2012 HMP is the lack of quantitative risk assessment. This plan update utilized population and general building stock data in HAZUS-MH version 3.1's hurricane model to estimate wind losses for a probabilistic 100- and 500-year MRP event. The original 2012 HMP discussed the vulnerability of mobile homes to extreme wind events, and included the number of mobile homes per municipality.

Overall, this vulnerability assessment uses a more accurate and updated building inventory which provides more accurate estimated exposure and potential losses for Pike County.

Future Growth and Development

As discussed and illustrated in Section 2, areas targeted for future growth and development have been identified across the county. Any areas of growth could be potentially impacted by the Hurricane, Tropical Storm, Nor'Easter hazard because the entire Planning Area is exposed and potentially vulnerable to the impacts associated with these events.

Additional Data and Next Steps

Over time, Pike County may obtain additional data to support the analysis of this hazard. Data that will support the analysis would include additional detail on past hazard events and impacts, building footprints and specific building information such as details on protective features (for example, hurricane straps).

4.3.9 Invasive Species

This is a new section and hazard to the Pike County HMP and provides a profile and vulnerability assessment for the invasive species hazard.

Location and Extent

An invasive species is a species that is not indigenous to a given ecosystem and that, when introduced to a non-native environment, is likely to cause economic or environmental harm, or pose a hazard to human health. The Commonwealth of Pennsylvania plays host to a number of invasive pathogens, insects, plants, invertebrates, fish, and higher mammals. These species have largely been introduced by the actions of humans. Common pathways for invasive species threats include unintentional release of species, the movement of goods and equipment that may unknowingly harbor species, smuggling, ship ballast, hull fouling, and escape from cultivation (PISC, 2010). Invasive species threats are generally divided into two main subsets:

- *Aquatic Invasive Species* are nonnative 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, agriculture, aquaculture, or recreational activities dependent on such waters.
- *Terrestrial Invasive Species* are nonnative arthropods, vascular plants, higher vertebrates, or pathogens that complete their lifecycle on land instead of in an aquatic environment and whose introduction does or is likely to cause economic or environmental harm or harm to human health.

The Commonwealth of Pennsylvania HMP discusses a number of identified invasive species impacting the Commonwealth. For the purpose of this HMP update and as identified by the Pike County Steering Committee, the following will be discussed further:

- Eurasian Watermilfoil
- Emerald Ash Borer
- Purple Loosestrife
- Hemlock Woolly Adelgid
- Japanese Knotweed
- Gypsy moth
- Phragmites
- Didymo
- Zebra Mussel

Additionally, Pike County identified ticks and mosquitos as a concern due to the diseases they can carry and spread. Please refer to Section 4.3.13 (Pandemic) for details regarding diseases spread by ticks and mosquitos. The location and extent of invasive threats depends on the preferred habitat of the species as well as the species' ease of movement and establishment. The presence of invasive species has been reported throughout Pike County.

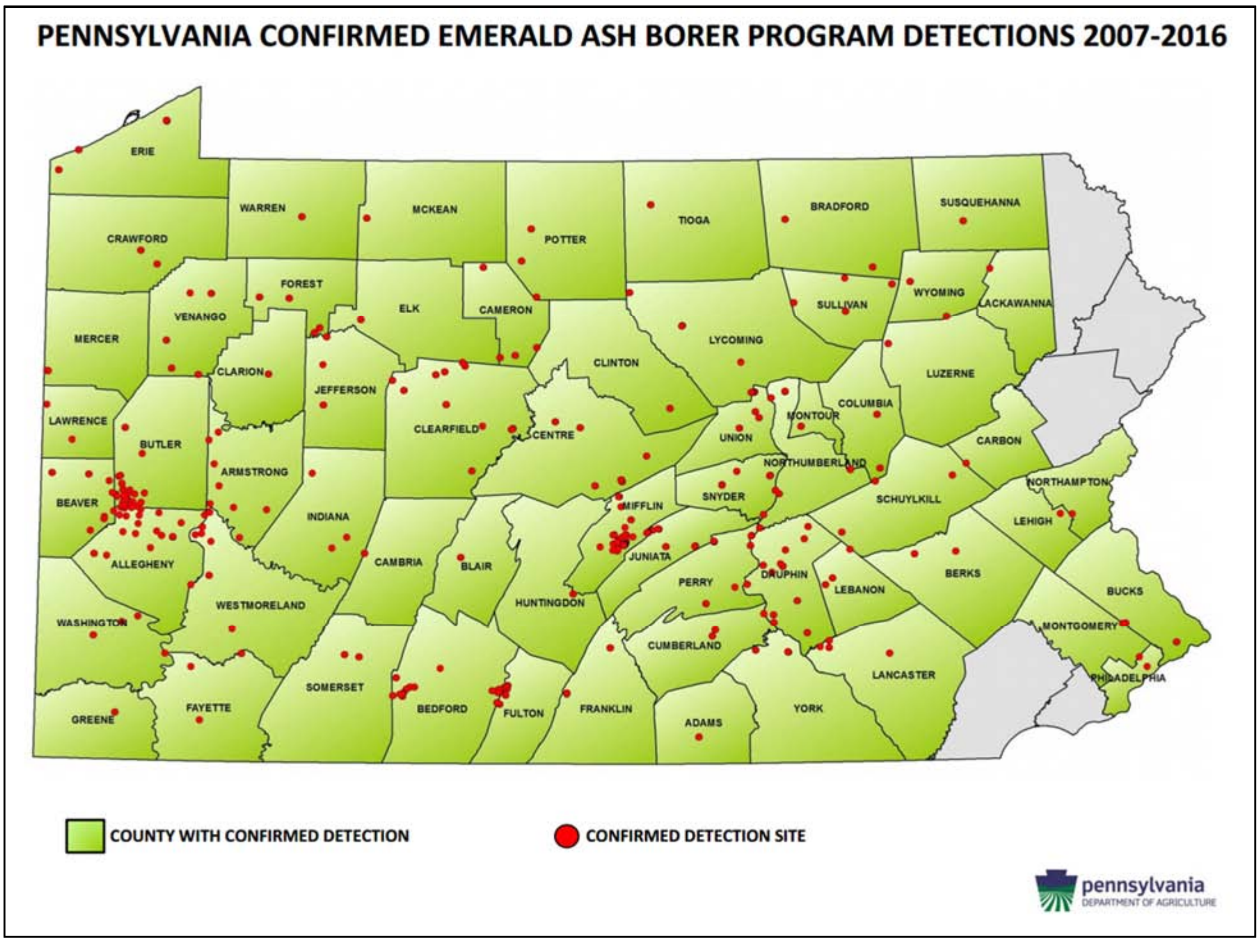
Eurasian Watermilfoil

Eurasian watermilfoil is native to Europe, Asia and northern Africa. It was accidentally introduced into the U.S. sometime between the late 1800s and 1940s, either from the aquarium trade or attached to boats. It is a submerged aquatic invasive plant that has stems that grow up to the water's surface, usually 10 feet in length but can grow as much as 30 feet. Watermilfoil is found in lakes, ponds and other aquatic environments where stagnant to slow moving water is found. Once watermilfoil becomes established, the dense mats of leaves block light, leading to a decline in the abundance of native plants. It can also reduce habitat for fish pawning and breeding and impact recreational uses (DCNR No Date). In Pike County, milfoil has been observed in Pecks Pond (DCNR 2001).

Emerald Ash Borer

The emerald ash borer (EAB) is a half-inch long metallic green beetle. Larvae of this beetle feed under the bark of ash trees. Their feeding eventually girdles and kills branches and entire trees. It was detected for the first time in Pennsylvania in late June 2007. EAB adults were identified in Cranberry Township in Butler County (DCNR 2016). EAB is currently quarantined throughout Pennsylvania and has been confirmed in at least 22 counties. Pike County has been included in the quarantine. The quarantine was established to slow the spread of EAB by the Pennsylvania Department of Agriculture. It makes it illegal to move out of the Commonwealth all hardwood firewood, ash trees of any size, ash saw logs, limbs, branches, stumps or roots (DCNR 2011). Between 2007 and 2016, EAB has been confirmed in nearly all counties of Pennsylvania; however, EAB has not been confirmed in Pike County (PA Department of Agriculture 2016).

Figure 4.3.9-1. Pennsylvania Confirmed Emerald Ash Borer Program Detections, 2007 to 2016



Source: PA Department of Agriculture 2016

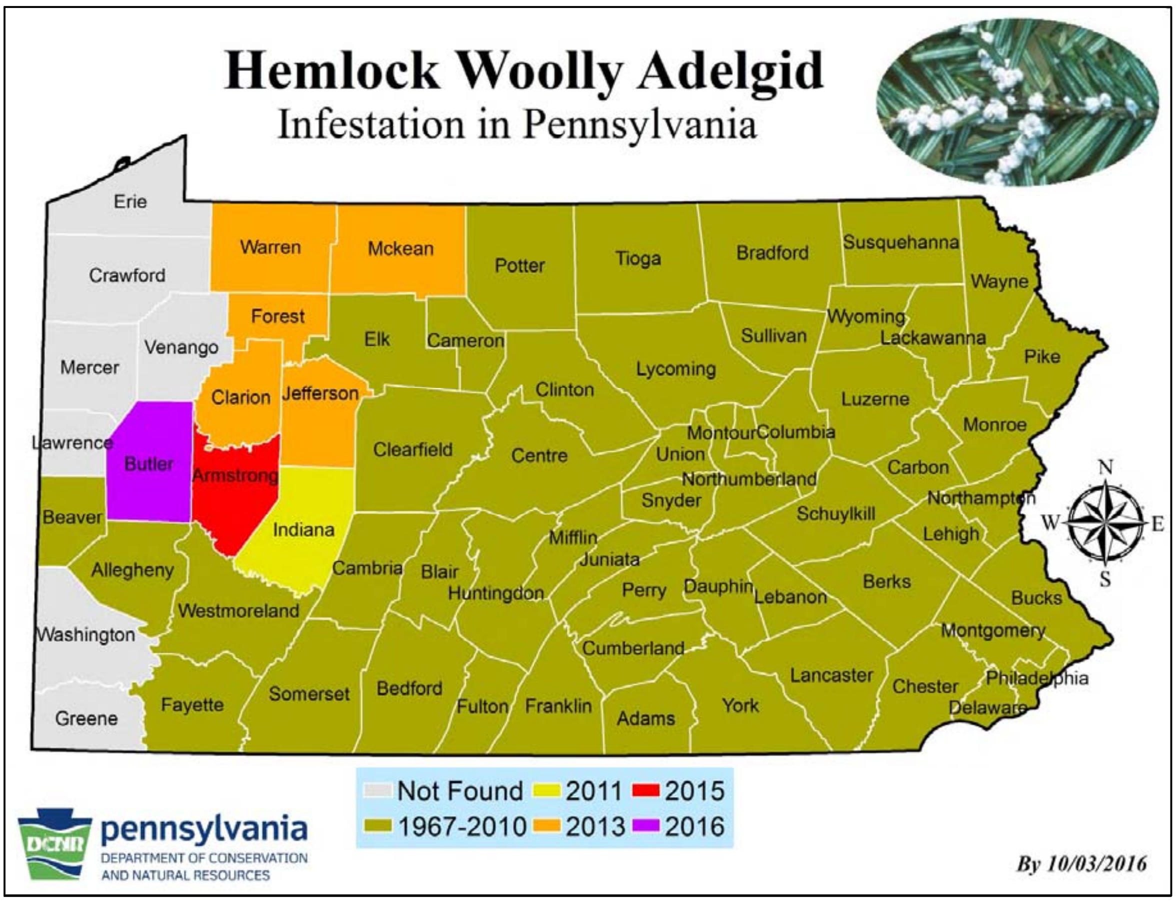
Purple Loosestrife

Purple loosestrife is a perennial herb with square, woody stems, which grow anywhere from four to 10 feet high. Magenta-colored flower spikes are present throughout much of the summer. It prefers open wetlands and is capable of invading freshwater wet meadows, tidal and non-tidal marshes, river and stream banks, pond edges, reservoirs and ditches. Purple loosestrife was first introduced to North America in the early 1800s as an ornamental. It outcompetes native plants including some federally endangered species. This species reduces habitat for waterfowl, clog waterways, disrupt nutrient cycling and collect debris, eventually displacing an entire wetland (DCNR No Date).

Hemlock Woolly Adelgid

The hemlock woolly adelgid, is a serious pest of Eastern hemlock in the northeastern states. This insect was first reported in southeastern Pennsylvania in the late 1960s and has spread to both ornamental and forest hemlocks. Adelgids are small, soft-bodied insects that are closely related to aphids. The hemlock woolly adelgid sucks sap from the young branches which results in premature needle drop and branch dieback. Some trees die within four years while others persist in a weakened state for many years. As of October 2016, Pike County is infested by hemlock woolly adelgid (DCNR 2016).

Figure 4.3.9-2. Hemlock Woolly Adelgid Infestation in Pennsylvania



Source: DCNR 2016

Japanese Knotweed

Japanese Knotweed is an herbaceous perennial with straight, hollow stems and grows three to 12 feet tall. The plant's greenish white flowers bloom from August to October. It was introduced to North America for ornamental use and for forage and erosion control in the late 1800s. Japanese Knotweed is capable of quickly forming dense stands and crowd out natural vegetation. Thickets of knotweed can clog small waterways and displace streamside vegetation, increasing bank erosion and lowering the quality of riparian habitat for fish and wildlife (DCNR No Date).

Gypsy Moth

The gypsy moth (*Lymantria dispar*) is a non-native insect from France that was introduced to Massachusetts in 1869. It is now established in 19 states, including Pennsylvania. Its caterpillar (larva) stage eats the leaves of a large variety of trees. A sample of some of the many species it eats includes oak, maple, apple, crabapple, aspen, willow, birch, mountain ash, pine and spruce. The populations of gypsy moths rise and fall in cycles. When populations are high, thousands of acres of trees can be damaged. In Pennsylvania, it was first discovered in Luzerne and Lackawanna Counties in 1932. A total of 4.3 million acres were defoliated in the Commonwealth during the historical peak year in 1990. Suppression programs have been carried out by the Pennsylvania Bureau of Forestry since 1968 to minimize the impacts of the gypsy moth. In 2016, Pike County was included in the gypsy moth suppression program (DCNR 2016). The County worked with the DCNR in a joint effort to spray for gypsy moth caterpillars in certain residential areas within Pike County. The insecticide was applied by aircraft, flying approximately 50 feet above the treetops (Pike County Conservation District 2016).

The USDA has a gypsy moth program that regulates the movement of gypsy moth host material from infested areas to other areas of the country. This program is a federal-state partnership that prevents the establishment of gypsy moths in areas of the United States that are not contiguous to current regulated states and counties. Figure 4.3.9-2 illustrates the quarantine areas of the United States. Pike County is located within a gypsy moth quarantine area.

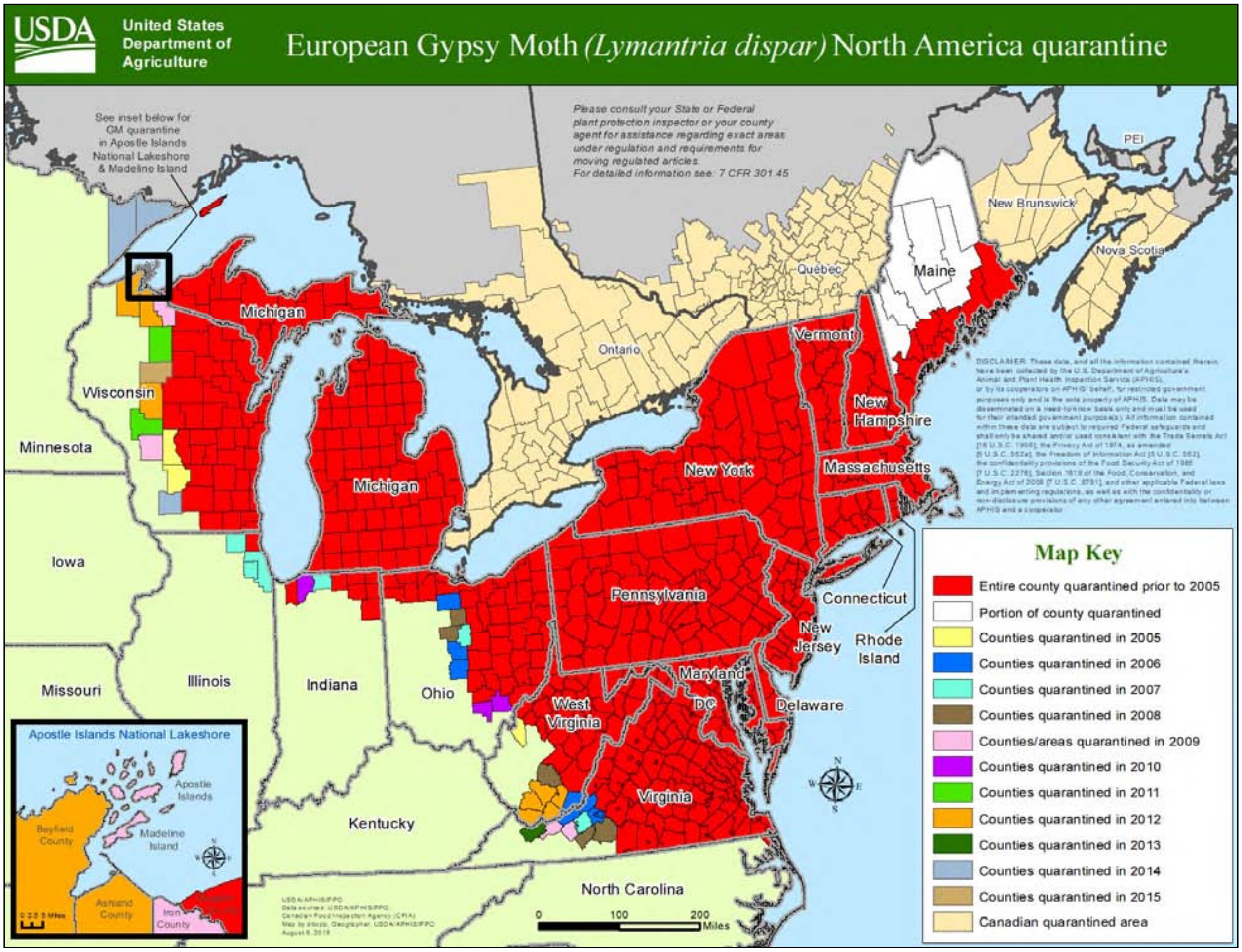
Phragmites

A major threat to the natural habitat of many swamps, lakes and wetlands throughout Pike County is the presence of a common reed (*Phragmites austrailis*); known as phragmites. Runoff from roads inputs nutrients into these areas that allows this species, among others, to colonize and thrive. This invasive species can alter the hydrology of the wetland and degrade and alter habitats (PHNP 2011).

Didymo

Large blooms of an invasive aquatic alga *Didymosphenia geminata* (also known as Didymo or "Rock Snot") have been seen throughout the 200-mile non-tidal portion of the Delaware River and several tributaries. Rock Snot is not a public health hazard, however, this invasive crowds or smothers more biologically valuable algae growing on the riverbed, and altering the physical and biological conditions within a stream (Sanchez, 2013).

Figure 4.3.9-3. Gypsy Moth Quarantine Areas in the United States



Source: USDA 2015

Zebra Mussel

The zebra mussel (*Dreissena polymorpha*) was accidentally introduced to the Great Lakes in the 1980's and has been spreading in Pennsylvania's waters. Zebra mussels grow on hard surfaces including the shells of native mussels, and in high densities can starve and suffocate native mussels by covering their shells completely. Zebra mussels are not as abundant in flowing waters as in lakes, but in rivers, such as the Hudson River (NY), they are persisting many years after their initial invasion (PHNP 2011).

According to the Pike County Natural Heritage Inventory, this species has been spotted in the Delaware River Watershed is not yet known in Pike County, but must be watched for its disastrous effects on ecosystems and economies (PHNP 2011).

Pennsylvania has a Noxious Weed law that prevents the propagation, sale, or transport of thirteen weed species within the Commonwealth. This includes purple loosestrife identified as a concern for Pike County. The Pennsylvania Fish and Boat Commission maintains a list of Aquatic Invasive Species that are prohibited from possession, sale, barter, or distribution within the Commonwealth (PA Code 58.71.6). This list includes the zebra mussel.

Range of Magnitude

The magnitude of invasive species threats ranges from nuisance to widespread killer and is generally amplified when the ecosystem or host species is already stressed, such as in times of drought. The already weakened state of the native ecosystem causes it to more easily succumb to an infestation. Some invasive species are not considered an agricultural pest and do not harm humans. However, other species can cause significant changes in the composition of an ecosystem. For example, EAB has 99% mortality rate for any ash tree it infects. Other species can clog waterways, smother native plants, and impact animals (PA HMP 2013).

There is a wide range of environmental impacts caused by invasive species. The aggressive nature of many invasive species can cause significant reductions in biodiversity by crowding out native species. This can affect the health of individual host organisms as well as the overall well-being of the affected ecosystem. Beyond causing human, animal, and plant harm, there are secondary impacts of invasive species that go beyond harm to host species and ecosystems, particular in the case of invasive species that attack forests. Pennsylvania's forests prevent soil degradation and erosion, protect watersheds, stabilize slopes, and absorb carbon dioxide emissions. The key role of forests in the hydrologic system means that if forest land is wiped out, the effects of erosion and flooding will be amplified. There is also an impact on agricultural harvests like honey. As a state with strong agricultural population, invasive species remain a hazard for the economic livelihood of the state (PA HMP 2013).

An example of a possible worst-case scenario for invasive species is the increase in population of hemlock woolly adelgid and their destruction to the Eastern hemlock population. Without this tree species, streams may increase in temperature, impacting the native brook trout; destroy wildlife cover; and impact forest aesthetics and recreational opportunities.

Past Occurrence

Based on all sources researched, Pike County has been impacted by Hemlock Woolly Adelgid, Purple Loosestrife, Japanese Knotweed, Watermilfoil, Gypsy Moth, Phragmites and Rock Snot with growing concern over Zebra Mussels. However, specific occurrences and quantified losses were not identified for these invasive species in Pike County.

Future Occurrence

According to the PISC, the probability of future occurrence for invasive species threats is on the rise because of the growing volume of transported goods, increasing technology, efficiency and speed of transportation and expanding international trade agreements. Expanded global trade has created opportunities for many organisms to be transported to, and establish themselves, in new countries and regions. Furthermore, climate change is contributing to the introduction of new invasive species. As maximum and minimum seasonal temperatures change, pests are able to establish themselves in previously inhospitable climates. This also gives introduced species an earlier start and increases the magnitude of their growth. This may shift the dominance of ecosystems in the favor of nonnative species (Pennsylvania State Hazard Mitigation Plan 2013).

Based on historical documentation, increased incidences of infestation throughout Pennsylvania and the overall impact of changing climate trends, it is estimated that Pike County and all its jurisdictions will continue to experience the impacts of invasive species that may induce secondary hazards and health threats to the County population if they are not prevented, controlled or eradicated effectively.

Future occurrences of invasive species can be considered *highly likely* as defined by the Risk Factor Methodology probability criteria (further discussed in Section 4.4).

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For invasive species, Pike County has been identified as the hazard area. Therefore, all assets in Pike County, as described in the County Profile section, are vulnerable to invasive species. The following text evaluates and estimates the potential impact of infestation on the County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety of residents, (2) general building stock, (3) critical facilities, (4) economy, and (5) future growth and development
- Effect of climate change on vulnerability
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

Invasive species is a significant concern to Pike County, mainly due to its impact on natural resources. Estimated losses are difficult to quantify; however invasive species can impact Pike County's population and economy. Direct impacts of invasive species have cascading indirect impacts. As vegetation dies or becomes stressed/weakened by pests such as hemlock woolly adelgid, EAB or gypsy moth, there is an increase in available fuel and increase in high intensity wildfires. As species composition changes due to invasive species, whole fire regimes can shift. Physical stresses on trees may also affect how street trees respond to physical stresses caused by other natural hazards such as hurricanes, drought and ice storms.

Data and Methodology

Due to a lack of quantifiable loss information, a qualitative assessment was conducted to evaluate the assets exposed to this hazard and the potential impacts associated with this hazard.

Impact on Life, Health and Safety

The entire population of Pike County is vulnerable to infestation.

Impact on General Building Stock and Critical Facilities

No structures are anticipated to be directly affected by infestation. However, structures can be indirectly affected by the collapse of infested Ash or Hemlock trees. Falling trees can cause damage to nearby structures and powerlines.

Impact on Economy and Environment

The impact invasive species has on the economy and estimated dollar losses are difficult to measure and quantify. Costs associated with the activities and programs implemented to conduct surveillance and address invasive species have not been quantified in available documentation. Not only do invasive species have a negative impact on the natural native environment but may impact the fishing, boating, and tourism economies in Pike County as well.

Impact of Future Growth and Development

Areas targeted for potential future growth and development within the next 5 years have been identified across the County (further discussed in Section 2.4 of this HMP). Any areas of growth could be potentially impacted by the invasive species hazard because the entire planning area is exposed and potentially vulnerable.

Effect of Climate Change on Vulnerability

Climate change is contributing to the introduction of new invasive species. As maximum and minimum seasonal temperatures change, invasive species are able to establish themselves in previously inhospitable climates. Evidence suggests that a changing climate will further increase the likelihood of invasive species impacting natural areas and that the consequences of those invasive species may be magnified. Warming temperatures also gives invasive species an earlier start and increases the magnitude of their growth (PA HMP 2013; U.S. Forest Service 2016).

Additional Data and Next Steps

For the HMP update, any additional information regarding localized concerns and past impacts will be collected and analyzed. This data will be developed to support future revisions to the plan. Mitigation efforts could include building on existing Pennsylvania, Pike County, and local efforts.

4.3.10 Landslide

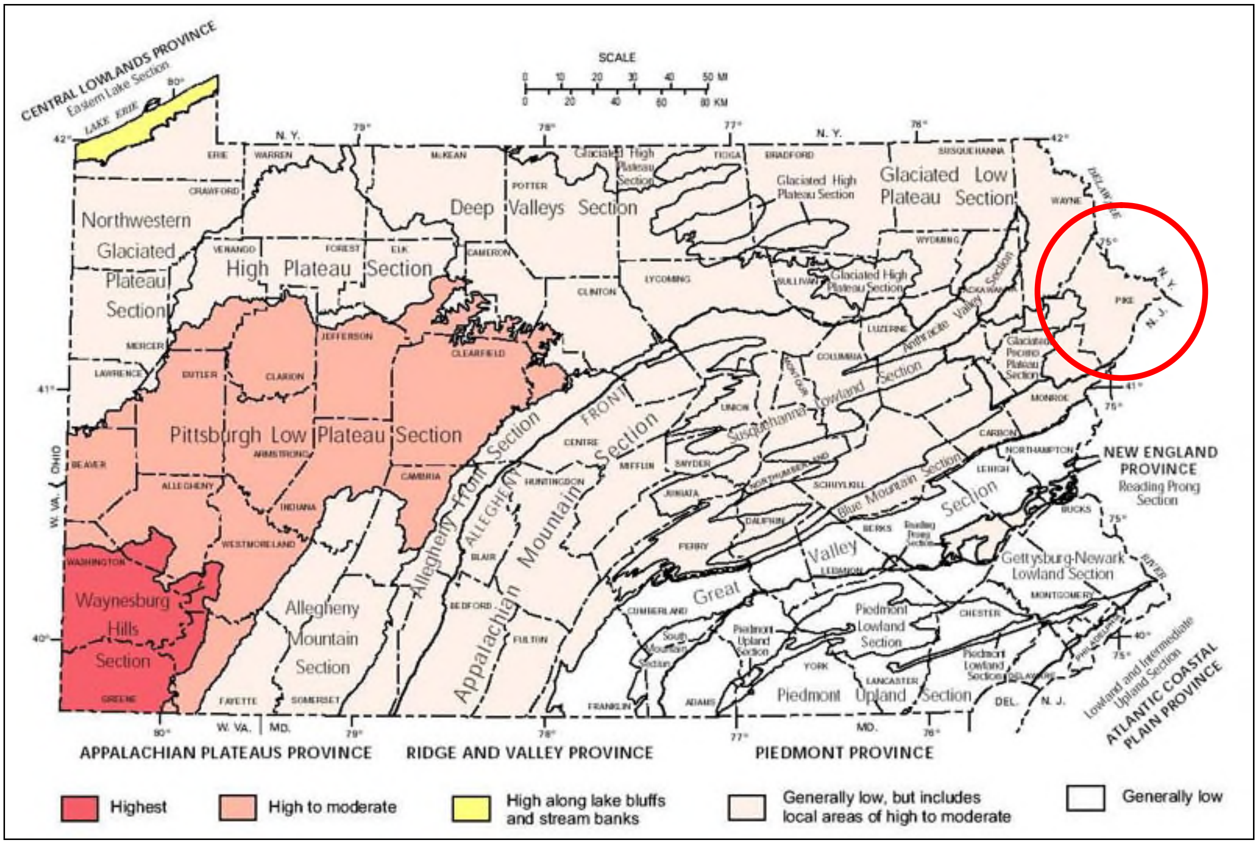
This section provides a profile and vulnerability assessment of the landslide hazard in Pike County. According to the U.S. Geological Survey (USGS), the term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows (USGS 2016). Landslides are classified by type of material involved and the type of movement. In addition, they are classified at the rate of movement and the water content of the material. Movement rates range from inches over many years to many feet per second (DCNR 2001).

Location and Extent

The entire U.S. experiences landslides, with 36 states having moderate to highly severe landslide hazards. Expansion of urban and recreational developments into hillside areas exposes more people to the threat of landslides each year. According to the USGS, Pike County has high landslide potential. For a figure displaying the landslide potential of the conterminous United States, please refer to http://pubs.usgs.gov/fs/2005/3156/2005-3156.pdf (USGS 2005).

Rockfalls and other slope failures occur in areas of Pennsylvania with moderate to steep slopes; however, most of Pennsylvania has areas susceptible to landslides. The southwestern area of Pennsylvania has the highest concentration of landslides (PA HMP 2013; DCNR 2016). According to DCNR, most major and minor highways have sections cut in rock or soil that can lead to slope failure. Steep mountain slopes across Pennsylvania have experienced debris avalanches associated with extreme rainfall or rain-on-snow events. Additionally, urban and rural land development is increasing the number of landslide occurrences. Major highway construction with large excavations and fills creates potential for landslides (DCNR 2016). Figure 4.3.10-1 shows the landslide susceptible areas across the Commonwealth. Pike County is noted as having a generally low susceptibility to landslides but includes local areas of high to moderate susceptibility.

Figure 4.3.10-1. Areas of Pennsylvania Susceptible to Landslides



Source: DCNR 2016

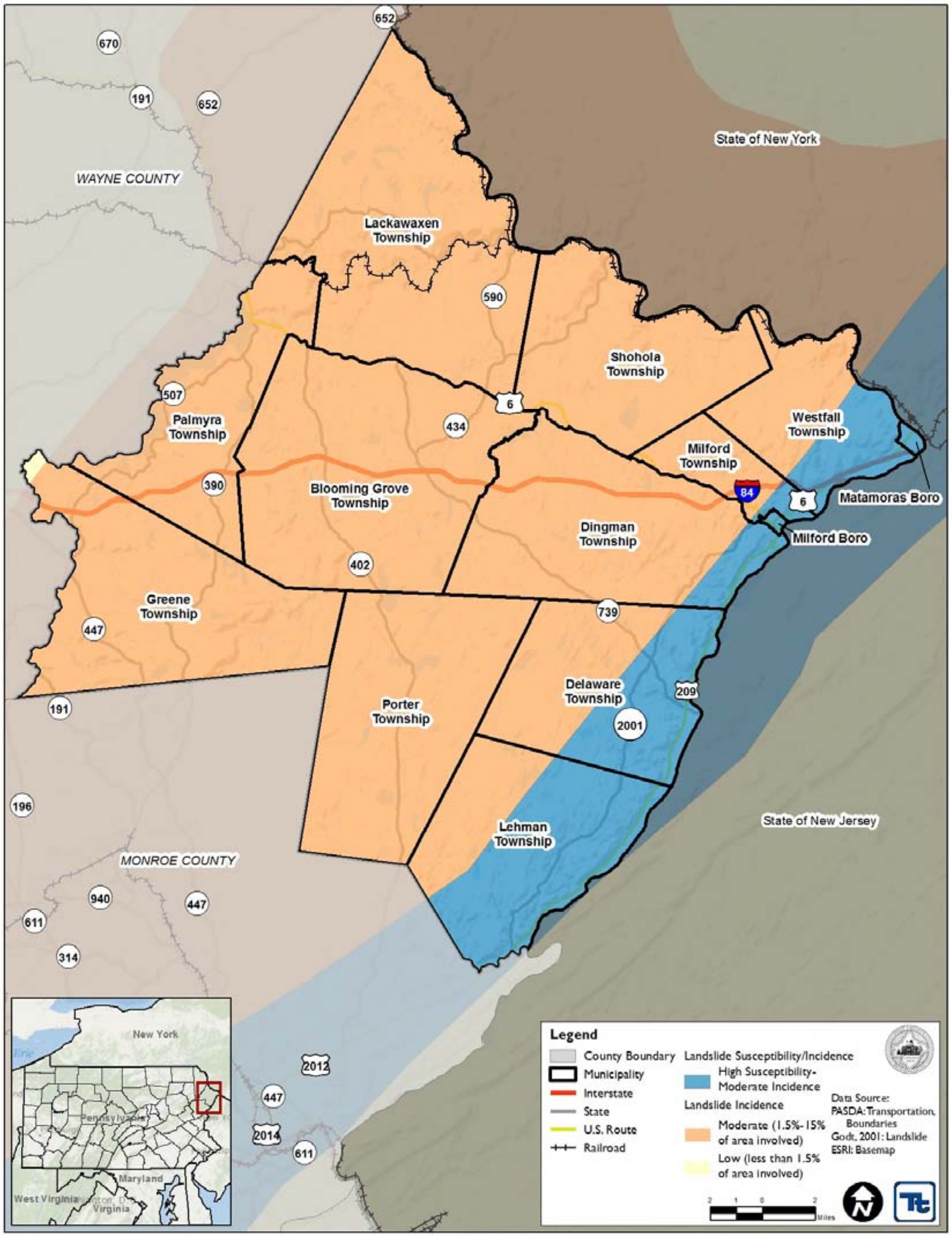
Note: The red circle indicates the approximate location of Pike County. Pike County is shown has having a generally low susceptibility to landslides but includes local areas of high to moderate susceptibility.

To determine the extent of a landslide hazard, the affected areas need to be identified and the probability of the landslide occurring within some time period needs to be assessed. Natural variables that contribute to the overall extent of potential landslide activity in any particular area include soil properties, topographic position and slope, and historical incidence. Predicting a landslide is difficult, even under ideal conditions and with reliable information. As a result, the landslide hazard is often represented by landslide incidence and/or susceptibility, as defined below:

- Landslide incidence is the number of landslides that have occurred in a given geographic area. High incidence means greater than 15% of a given area has been involved in landsliding; medium incidence means that 1.5 to 15% of an area has been involved; and low incidence means that less than 1.5% of an area has been involved (Radbruch-Hall 1982).
- Landslide susceptibility is defined as the probable degree of response of geologic formations to natural or artificial cutting, to loading of slopes, or to unusually high precipitation. It can be assumed that unusually high precipitation or changes in existing conditions can initiate landslide movement in areas where rocks and soils have experienced numerous landslides in the past. Landslide susceptibility depends on slope angle and the geologic material underlying the slope. Landslide susceptibility only identifies areas potentially affected and does not imply a time frame when a landslide might occur. High, medium, and low susceptibility are delimited by the same percentages used for classifying the incidence of landsliding (Radbruch-Hall 1982).

According to the Landslide Incidence and Susceptibility GIS layer from National Atlas as shown in Figure 4.3.10-2, the eastern portion of Pike County is located in the High-Susceptibility/Moderate-Incidence zone (Godt 2001). For the purposes of this planning effort, the High-Susceptibility/Moderate-Incidence zone is considered the hazard area. The remainder of the County is located in the Moderate Incidence zone, with a small portion of Green Township in the Low Incidence zone. According to Pike County records, the most recent landslides occurred in the Townships of Shohola, Westfall, Dingman, and Delaware.

Figure 4.3.10-2. Landslide Hazard Area in Pike County



Range of Magnitude

Landslides have the potential to damage transportation routes, utilities, and buildings. They can also create travel delays and other side effects. Fortunately, deaths and injuries caused by landslides are rare in Pennsylvania, and most landslides in the Commonwealth are moderate to slow moving, damaging things rather than people. Almost all of the known deaths caused by landslides have occurred when rockfalls or other slides along highways have involved vehicles. Storm-induced debris flows are the only other type of landslide likely to cause death and injuries. As residential and recreational development increases on and near steep mountain slopes, the hazards from these events will also increase (PA HMP 2013).

According to DCNR, the Pennsylvania Department of Transportation and large municipalities incur substantial costs due to landslide damage and to extra construction costs for new roads in known landslide-prone areas. One PA DOT estimate in 1991 showed an average of $10 million per year in landslide repair contracts across the Commonwealth and a similar amount in mitigation costs for grading projects (DCNR 2014).

The impact of landslides on the environment depends on the size and specific location of the event. In general, impacts include:

- Changes to topography
- Damage or destruction of vegetation
- Potential diversion or blockage of water in the vicinity of streams, rivers, etc.
- Increased sediment runoff both during and after event (PA HMP 2013).

Pike County's worst-case scenario is for a landslide to occur during or after a heavy rain event in the area of major transportation routes (Interstate 84, US Route 209, and US Route 6). A landslide on these roads could lead to road closures and damages and cut off access to emergency response vehicles.

Past Occurrence

Outside of impacts to important transportation routes, landslide history is not documented as completely (if at all) as other hazards, primarily because landslides are not always seen, and therefore historical landslide occurrences in Pike County are not well known. Information provided by Pike County Office of Community Planning identified the following landslide events:

- 2007 – State Route 1005 in Shohola Township - $775,000 in damages
- 2009 – T397 in Shohola Township - $500,000 in damages
- August and September 2011 – Intense rain from Hurricane Irene and Tropical Storm Lee led to numerous roadway washouts leading to long-term closures throughout the Delaware Water Gap National Recreation Area. This included roadways in portions of Pike County.
- 2014 – State Route 434 in Shohola Township - $3 million in damages
- 2015 – State Route 1013 in Westfall Township - $2 million in damages
- 2015 – State Route 2002 in Delaware Township - $1.25 million in damages

Between 1954 and 2016, FEMA issued a disaster (DR) or emergency (EM) declaration for Pennsylvania for one geological hazard-related event, classified as severe storms, flooding and mudslide. This declaration did not include Pike County (FEMA 2016).

Future Occurrence

Based upon risk factors and past occurrences, it is likely that landslides will continue to occur in Pike County in the future. However, severity of the landslides can vary depending on type and location of event. Landslide probabilities are largely a function of surface geology, but are also influenced by both weather and human activities. Mismanaged, intense development in steeply sloped areas could increase the frequency of landslide occurrence. Periods of intense rain or snowmelt can also increase the risk of landslides.

For the 2017 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of landslide events for Pike County. Information provided by Pike County was used to identify the number of landslide events that occurred between 1950 and 2015. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimate percent chance of an incident occurring in a given year. Based on these statistics, there is an estimated 9.1-percent chance of a landslide event occurring in any given year in Pike County.

Table 4.3.10-1. Probability of Future Lanslide Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Landslide	6	0.09	11.00	0.09	9.1%

Sources: Pike County 2016

Based on available historical data, the future occurrence of landslides can be considered *possible* as defined by the Risk Factor Methodology probability criteria (refer to Section 4.4).

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the hazard area identified. The following section discusses potential impact of the landslide hazard on Pike County, including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on (1) life; (2) health and safety; (3) general building stock; (4) critical facilities, economy; and (5) future growth and development
- Effect of climate change on vulnerability
- Additional data and next steps.

Overview of Vulnerability

Vulnerability to ground failure hazards is a function of location, soil type, geology, type of human activity, use, and frequency of events. Effects of landslides on people and structures can be reduced by total avoidance of hazard areas or by restricting, prohibiting, or imposing conditions on hazard-zone activity. Local governments can reduce effects of landslides through land use policies and regulations. Individuals can reduce their exposure to hazards by educating themselves on the past hazard history of the site and by making inquiries to planning and engineering departments of local governments (National Atlas 2007).

Overall, 13.6 percent (or 76.9 square miles) of Pike County is located within the High-Susceptibility/Moderate-Incidence hazard area. Only a small area of Greene Township is located in the Low

Incidence area, with the remainder of the County located in the Moderate Incidence Area. For the purposes of this assessment, the High Susceptibility/Moderate-Incidence area is considered the hazard zone. Refer to Figure 4.3.10-2 earlier in this section. Further information regarding these hazard areas is presented below.

Data and Methodology

Unlike for flood, wind, and earthquake hazards, no standard loss estimation models have been developed for the landslide hazard. In an attempt to estimate Pike County's vulnerability, the Geology — Landslide Incidence and Susceptibility geographic information system (GIS) layer from the National Atlas was used to coarsely define the general landslide susceptible area ("approximate hazard area") (Figure 4.3.10-1). Limitations of this analysis are recognized, and results are used only to provide a general estimate. Over time, additional data will be collected to allow better analysis of this hazard. Available information and a preliminary assessment are provided below.

According to Radbruch-Hall and others, the Landslide Incidence and Susceptibility GIS layer from National Atlas:

> "….was prepared by evaluating formations or groups of formations shown on the geologic map of the United States (King and Beikman 1974) and classifying them as having high, medium, or low landslide incidence (number of landslides) and being of high, medium, or low susceptibility to landsliding. Thus, those map units or parts of units with more than 15 percent of their area involved in landsliding were classified as having high incidence; those with 1.5 to 15 percent of their area involved in landsliding, as having medium incidence; and those with less than 1.5 percent of their area involved, as having low incidence. This classification scheme was modified where particular lithofacies are known to have variable landslide incidence or susceptibility. In continental glaciated areas, additional data were used to identify surficial deposits that are susceptible to slope movement. Susceptibility to landsliding was defined as the probable degree of response of the areal rocks and soils to natural or artificial cutting or loading of slopes or to anomalously high precipitation. High, medium, and low susceptibility are delimited by the same percentages used in classifying the incidence of landsliding. For example, it was estimated that a rock or soil unit characterized by high landslide susceptibility would respond to widespread artificial cutting by some movement in 15 percent or more of the affected area. We did not evaluate the effect of earthquakes on slope stability, although many catastrophic landslides have been generated by ground shaking during earthquakes. Areas susceptible to ground failure under static conditions would probably also be susceptible to failure during earthquakes" (Radbruch-Hall 1982).

To estimate exposure to the building stock, the default dasymetric building stock data from Hazards U.S. (HAZUS) – Multi-Hazard (MH) 3.1 was used for replacement cost value. Data from HAZUS-MH is at the census block level and is calculated by use of 2015 RS Means valuations. To estimate the number of structures within the hazard area, the default dasymetric building stock data from HAZUS-MH was also used.

Impact on Life, Health, and Safety

As discussed above, 13.6 percent of Pike County is located in the High-Susceptibility/Moderate-Incidence hazard area. Therefore, the County's population (U.S. Census 2010 population of 57,369) within this area is considered exposed to this hazard; however, based on the historic record, landslide events tend to be localized events. Landslide events can cause both direct and indirect (impact on buildings) damage to the County's population.

To estimate populations within the hazard area, the hazard area boundary (shown in Figure 4.3.10-1) was overlaid upon the 2010 U.S. Census population data (U.S. Census 2010). Census blocks with their centers (centroids) within the boundary of the landslide incidence hazard area were used to calculate the estimated population considered exposed to this hazard. The U.S. Census blocks do not align exactly with the hazard area, and thus these estimates should be considered for planning purposes only. Additionally, the hazard area boundary is only available at the municipal level and more detailed breakdowns are not available; this presents another reason to only use these estimates for planning purposes.

Table 4.3.10-2 lists populations exposed by municipality (U.S. Census 2010). The population downslope of the landslide hazard areas is particularly vulnerable to this hazard. Due to the nature of U.S. Census block data, it is difficult to determine demographics of populations vulnerable to mass movements of geological material. Using this approach, 18,162 people (31.7 percent of the population) are located in the High-Susceptibility/Moderate-Incidence hazard area. Please note while reviewing the table that exposure rates do not equate to actual potential impacts. Although an entire jurisdiction may be located in a high-susceptibility area, as noted, most landslide events are localized. Therefore, while a large number of residents may have a high exposure risk to landslide events, few residents will actually be significantly impacted.

Table 4.3.10-2. Estimated Pike County Population Vulnerable to the Landslide Hazard Area

Municipalities	Total Population (2010 U.S. Census)	High-Susceptibility/Moderate-Incidence Landslide Hazard Area	
		Population Exposed	Percent Total
Blooming Grove Township	4,819	0	0.0%
Delaware Township	7,396	3,208	43.4%
Dingman Township	11,926	148	1.2%
Greene Township	3,956	0	0.0%
Lackawaxen Township	4,994	0	0.0%
Lehman Township	10,663	8,686	81.5%
Matamoras Borough	2,469	2,469	100.0%
Milford Borough	1,021	1,021	100.0%
Milford Township	1,530	592	38.7%
Palmyra Township	3,312	0	0.0%
Porter Township	485	0	0.0%
Shohola Township	2,475	0	0.0%
Westfall Township	2,323	2,038	87.7%
Pike County (Total)	**57,369**	**18,162**	**31.7%**

Sources: United States Census 2010, Godt 2001

Impact on General Building Stock

Similar to the population, the building stock data are presented by census block. For this analysis, the HAZUS-MH 3.1 dasymetric census blocks were used (refer to Section 4.1 for more information). In general, the built environment within the High-Susceptibility/Moderate-Incidence landslide incidence zone and the population, structures, and infrastructure downslope are vulnerable to this hazard. Using the default general building stock, the replacement cost values of the U.S. Census blocks with their centroids in the hazard area were totaled. Approximately $3.6 billion in replacement cost is located in the High-Susceptibility/Moderate-

Incidence hazard area (27.3 percent); or an estimated 9,747 structures. Table 4.3.10-3 lists building stock exposure per municipality.

Table 4.3.10-3. Estimated General Building Stock Exposure to the Landslide Hazard Area

Municipality	Total Number of Buildings	Total Replacement Value (Structure and Contents)	High Susceptibility/Moderate Incidence Landslide Hazard Area			
			# Buildings	Percent Total	RCV Exposed	Percent Total
Blooming Grove Township	3,998	$1,160,095,000	0	0.0%	$0	0.0%
Delaware Township	4,253	$1,496,677,000	1,901	44.7%	$665,159,000	44.4%
Dingman Township	5,480	$1,984,820,000	94	1.7%	$54,293,000	2.7%
Greene Township	3,275	$956,640,000	0	0.0%	$0	0.0%
Lackawaxen Township	4,562	$1,231,170,000	0	0.0%	$0	0.0%
Lehman Township	5,995	$1,992,003,000	4,700	78.4%	$1,532,437,000	76.9%
Matamoras Borough	972	$377,318,000	972	100.0%	$377,318,000	100.0%
Milford Borough	718	$413,430,000	718	100.0%	$413,430,000	100.0%
Milford Township	784	$670,787,000	367	46.8%	$196,594,000	29.3%
Palmyra Township	3,981	$1,244,483,000	0	0.0%	$0	0.0%
Porter Township	912	$388,599,000	0	0.0%	$0	0.0%
Shohola Township	2,311	$759,299,000	0	0.0%	$0	0.0%
Westfall Township	1,175	$383,781,000	995	84.7%	$326,285,000	85.0%
Pike County (Total)	**38,416**	**$13,059,102,000**	**9,747**	**25.4%**	**$3,565,516,000**	**27.3%**

Source: HAZUS-MH 3.1; Pike County; Godt, 2001
Notes:
% Percent
RCV Replacement cost value (structure and contents)

Critical Facilities and the Economy

To estimate exposure, the approximate hazard area was overlaid upon the essential and municipal facilities. In addition to critical facilities, a significant amount of infrastructure can be exposed to mass movements of geological material:

- *Roads* – Access to major roads is crucial to life-safety after a disaster event and to response and recovery operations. Landslides can block egress and ingress on roads, isolating neighborhoods, posing traffic problems, and causing delays of public and private transportation. This can result in economic losses for businesses.
- *Bridges* – Landslides can significantly impact road bridges. Mass movements can knock out bridge abutments or significantly weaken the soil supporting them, rendering them hazardous for use.
- *Power Lines* – Power lines are generally elevated above steep slopes; but the towers supporting them can be subject to landslides. A landslide could trigger failure of the soil underneath a tower, causing it to collapse and ripping down the lines. Power and communication failures due to landslides can create problems for vulnerable populations and businesses.
- *Rail Lines* – Similar to roads, rail lines are important for response and recovery operations after a disaster. Landslides can block travel along the rail lines, which would become especially

troublesome, because detouring a rail line would not be as easy as detouring a local road or highway.

Several other types of infrastructure may also be exposed to landslides, including water and sewer infrastructure. At this time, all critical facilities, infrastructure, and transportation corridors within the hazard areas are considered vulnerable until more information becomes available. Table 4.3.10-4 lists critical facilities located in the High-Susceptibility/Moderate-Incidence hazard area.

Table 4.3.10-4. Critical Facilities in the High-Susceptibility/Moderate-Incidence Landslide Hazard Area

	Facility Types											
Municipality	**Cell Tower**	**County Building**	**Daycare**	**Emergency Operation Center**	**Fire Station**	**Medical Facility**	**Municipal Building**	**Nursing Home**	**Police Station**	**School**	**Shelter**	**Wastewater Facility**
Blooming Grove Township	0	0	0	0	0	0	0	0	0	0	0	0
Delaware Township	1	0	2	0	2	0	1	0	0	0	1	0
Dingman Township	0	0	0	0	0	0	0	0	0	0	0	0
Greene Township	0	0	0	0	0	0	0	0	0	0	0	0
Lackawaxen Township	0	0	0	0	0	0	0	0	0	0	0	0
Lehman Township	1	0	2	0	1	0	1	0	0	0	2	1
Matamoras Borough	0	0	2	0	1	0	1	0	1	1	1	1
Milford Borough	0	2	3	1	1	1	1	1	2	0	1	0
Milford Township	1	0	2	0	0	0	1	0	0	0	1	0
Palmyra Township	0	0	0	0	0	0	0	0	0	0	0	0
Porter Township	0	0	0	0	0	0	0	0	0	0	0	0
Shohola Township	0	0	0	0	0	0	0	0	0	0	0	0
Westfall Township	1	0	0	0	1	0	1	2	0	4	3	0
Pike County (Total)	**4**	**2**	**12**	**1**	**6**	**1**	**6**	**3**	**3**	**5**	**9**	**2**

Sources: Pike County, Godt 2001

Geologic hazards can impose direct and indirect impacts on society. Direct costs include actual damage sustained by buildings, property, and infrastructure. Indirect costs, such as cleanup costs, business interruption, loss of tax revenues, reduced property values, and loss of productivity are difficult to measure. Additionally, ground failure threatens transportation corridors, fuel and energy conduits, and communication lines (USGS 2003). Estimated potential damages to general building stock can be quantified as discussed above. For the purposes of this analysis, general building stock damages are discussed further.

A landslide event alters the landscape. In addition to changes in topography, vegetation and wildlife habitats may be damaged or destroyed, and soil and sediment runoff will accumulate downslope, potentially blocking waterways and roadways and impacting quality of streams and other water bodies. Additional environmental impacts include loss of forest productivity. Considering both landslide hazard areas, the entire building stock is potentially exposed to a landslide event. These dollar value losses to Pike County's total building inventory would impact Pike County's tax base and the local economy.

All major roadways and transportation routes located in, and downslope of, the High-Susceptibility/Moderate-Incidence zone may be vulnerable to a landslide event.

Future Growth and Development

Areas targeted for potential future growth and development within the next five years have been identified across Pike County. Refer to Section 2.4 of this HMP for further details. New development within the High-Susceptibility/Moderate-Incidence landslide hazard areas are considered exposed to these risks.

Effect of Climate Change on Vulnerability

Climate is defined not just as average temperature and precipitation but also by type, frequency, and intensity of weather events. Both globally and at the local scale, climate change could alter prevalence and severity of extremes such as severe storms, including those that may bring intense or prolonged precipitation (U.S. Environmental Protection Agency [EPA] 2006). An increase in rainfall intensity and duration will saturate the soil, potentially erode the local landscape, and impair slope stability, leading to an increase of landslide events in Pike County.

While predicting changes in these types of events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment (EPA 2006). Potential effects of climate change on Pike County's vulnerability to landslide events must be considered as understanding of impacts of regional climate change increases.

Additional Data and Next Steps

More detailed landslide susceptibility zones can be generated so that communities can more accurately identify high hazard areas. A pilot study conducted for Schenectady County, New York, (described in the 2011 Draft New York State Hazard Mitigation Plan) developed higher-resolution landslide susceptibility zones. The methodology included use of the Natural Resource Conservation Services (NRCS) Digital Soil Survey soil units and their associated properties, including the American Association of State Highway and Transportation Officials (AASHTO) rating, liquid limit, hydrologic group, percentage of silt and clay, erosion potential, and slope, derived from high-resolution digital elevation models. Identifying historical damages to buildings and infrastructure incurred from landslides will also help with loss estimates and future modeling efforts, given a margin of uncertainty. Furthermore, research on rainfall thresholds for forecasting landslide potential may also be an option for Pike County.

4.3.11 Lightning

This section provides a profile and vulnerability assessment of the lightning hazard in Pike County. Lighting is a rapid discharge of electrical energy in the atmosphere. The clap of thunder is the result of a shock wave created by the rapid heating and cooling of the air in the lightning channel. All thunderstorms produce lightning and are very dangerous. It ranks as one of the top weather killers in the United States and kills approximately 50 people and injures hundreds each year. Lightning can occur anywhere there is a thunderstorm (NOAA 2014).

Location and Extent

Lightning can occur anywhere in Pike County. It can occur with all thunderstorms, making the entire county susceptible to the impacts of lightning. Different geographic areas may experience varying event frequencies, but in all cases, lighting strikes and associated fatalities occur primarily during the summer months.

According to the 2013 Commonwealth of Pennsylvania State Hazard Mitigation Plan, most lightning flashes occur in southwestern Pennsylvania; however, eastern and southeastern portions of the Commonwealth are at greater risk for death, injury or damage to lightning than central and north-central due to high population density (PA HMP 2013).

Range of Magnitude

Lightning causes an average of 55-60 fatalities and 400 injuries each year in the United States and costs more than $1 billion in insured losses every year (NWS 2010). Many case histories show observed heart damage, inflated lungs, and brain damage in lightning-related fatalities. Many who have survived lightning strikes reported loss of consciousness, amnesia, paralysis, and burns. Death and injury to livestock and other animals; thousands of forest and brush fires; and damage to buildings, communications systems, power lines, and electrical systems are also the result of lightning (PA HMP 2013).

Between 1959 and 2014, Pennsylvania ranked ninth among all states in the United States for the number of lightning deaths with 133 deaths. This represents approximately 3% of all fatalities that occurred throughout the United States over this time frame (NWS 2015). Damages to property and crops as a result of lightning events totaled over $15.5 million in Pennsylvania (NOAA NCEI 2016).

The worst-case scenario for lightning strikes would be a strike in a large group of people, such as at an outdoor sporting event, in Pike County (PEMA 2013). Numerous injuries or deaths could occur.

Past Occurrence

A lightning "event" is defined as a lightning strike which results in fatality, injury, and/or property or crop damage. The following table provides information regarding lightning events that occurred in Pike County between 1950 and 2016. Please note that not all lightning events that have occurred in Pike County are included due to the extent of documentation and the fact that not all sources may have been identified or researched. Loss and impact information could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP update.

Table 4.3.11-1. Lightning Events in Pike County, 1950 to 2016

Date	Location	Fatalities	Injuries	Property Damage ($)
July 8,	Shohola	0	0	Lightning struck a tree and apparently traveled through its root system

Date	Location	Fatalities	Injuries	Property Damage ($)
1994	Township			into a home in Shohola Township. It proceeded to blow up a television and engulfed a bedroom in flames. About 30 fire fighters prevented further damage to the house. Overall, this event caused approximately $5,000 in property damage.
July 26, 1994	Delaware Township	0	0	Lightning struck a tree near a Delaware Township house and jumped to its television antenna and entered the house. This triggered a fire which heavily damaged a bedroom with heat and the remainder of the house had smoke damage. Overall, this event caused approximately $17,000 in property damage.
July 1, 1995	Dingmans Ferry	0	0	Lightning struck and charred the steeple of the Holy Trinity Lutheran Church in Dingmans Ferry.
June 11, 2000	Milford	0	0	Pike County courthouse was damaged by a lightning strike
June 1, 2004	Milford	0	0	$20,000 – lightning downed lines in the Town

Sources: NOAA National Centers for Environmental Information 2016

Future Occurrence

Lightning can be expected in any severe storm event. While injuries or fatalities caused by lightning strikes are rare, lightning events severe enough to be reported can be expected at least once every two years. It is estimated that the County will continue to experience lightning events annually. For the 2017 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of lightning events for Pike County. Information from NOAA-NCEI storm events database was used to identify the number of lightning strike events that occurred between 1950 and 2015. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimate percent chance of an incident occurring in a given year. Based on these statistics, there is an estimated 7.6-percent chance of a lightning strike event occurring in any given year in Pike County.

Table 4.3.11-2. Probability of Future Lightning Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Lightning	5	0.08	13.2	0.08	7.6%

Sources: NOAA-NCEI 2016

Based on available historical data, the future occurrence of lightning strikes can be considered *possible* as defined by the Risk Factor Methodology probability criteria (refer to Section 4.4).

Vulnerability Assessment

To understand risk, a community must evaluate the assets that are exposed or vulnerable in the identified hazard area. For lightning events, all of Pike County has been identified as the hazard area. Therefore, all assets (population, structures, critical facilities, and lifelines), as described in Section 2, are potentially vulnerable. This section evaluates and estimates the potential impact of lightning strike events on Pike County including the following subsections:

- Overview of vulnerability
- Data and methodology used for the evaluation

- Impact on (1) life; (2) health and safety; (3) general building stock; (4) critical facilities, (5) economy; and (6) future growth and development
- Effect of climate change on vulnerability
- Additional data and next steps.

Overview of Vulnerability

Evaluation of National Climatic Data Center lightning data for Pike County, along with data from the current and previous versions of the PA HMP, show that while the absolute number of lightning events has changed for individual municipalities, the basic pattern of vulnerability across the County has remained relatively consistent.

The potential for lightning strikes will continue to exist for all municipalities. The direct and indirect losses associated with these events include injury and loss of life, damage to structures and infrastructure, agricultural losses, utility failure (power outages), and stress on community resources.

Pike County is a StormReady county. This designation is obtained through participation in the NWS StormReady Program, which includes the following six guidelines met by the County:

- Communication – A 24-hour warning point (WP) must be fully staffed at all times, and a County Emergency Operations Center (EOC) must be established.
- NWS Information Reception – At least four redundant systems must be in place at the WP to receive weather warnings.
- Hydrometeorological Monitoring – At least four methods of monitoring hydrometeorological data must be available.
- Local Warning Dissemination – At least four redundant systems must be in place to notify the County of severe weather warnings, and there must be National Weather Radio-Specific Area Messaging Encoding receivers in public facilities.
- Community Preparedness – The County must present at least four annual weather safety talks, spotters and dispatchers must be trained biennially, and the County must host or co-host NWS spotter training annually.
- Administration – The County must also meet a number of administrative criteria that include formal hazardous weather operations planning, biennial visits of the County Emergency Management Coordinator (EMC) to the NWS office, and annual visits by an NWS official to the County.

Meeting the criteria of the StormReady program results in a decrease in vulnerability to all severe weather events, including lightning strikes.

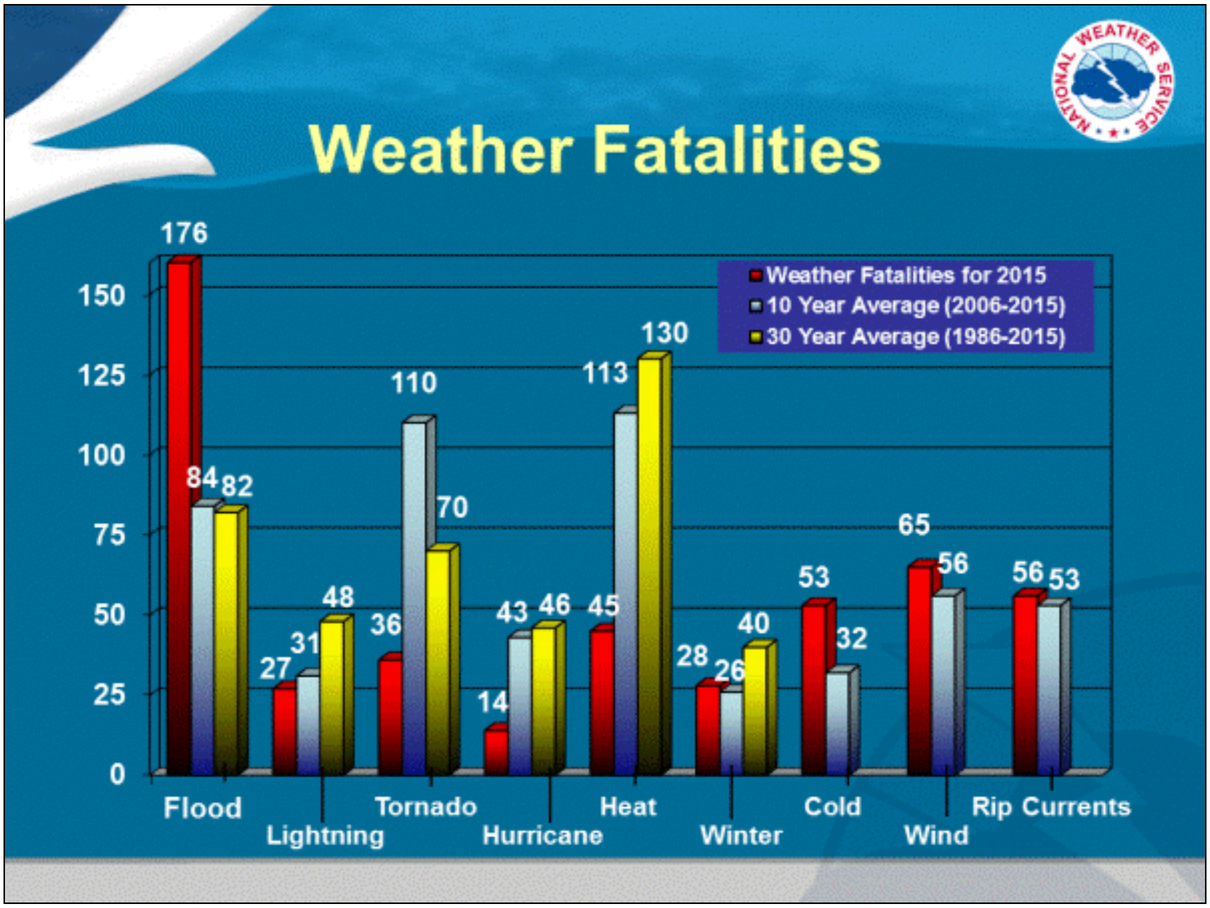
Data and Methodology

The NOAA, NWS, NCDC, and local resources were used to collect and analyze lightning impacts on Pike County.

Impact on Life, Health, and Safety

Across the United States, the 10-year average (2006 to 2015) for fatalities caused by lightning is 31, while the 30-year average (1986 to 2015) is 52 (NOAA 2016). Figure 4.3.1-1 illustrates these statistics. According to NOAA NCEI, there have been no fatalities or injuries associated with lightning strike events from 1950 to 2016 (NOAA NCEI 2016).

Figure 4.3.11-1. Weather Fatalities in the United States



Source: NOAA 2016

The entire population of the County is considered exposed to the lightning hazard. Lightning strikes in Pennsylvania occur primarily during the summer months. In general, population and building density have a correlation with hazard vulnerability and loss. The more-developed areas of Pike County are at greater risk to lightning strikes than others because of the greater population density. Populations located outdoors are considered at risk and more vulnerable to a lightning strike compared to those inside a shelter. Moving to a lower-risk location will decrease a person's vulnerability.

Impact on General Building Stock, Critical Facilities, and the Economy

For the purposes of this HMP, the entire general building stock and all infrastructure of Pike County are considered exposed to the lightning strike hazard. In general, developed areas in the County are at greater risk than more rural areas others due to population and structure density. Taller buildings can act as lightning rods; therefore, they naturally have experienced greater vulnerability and loss during past lightning strike events (PEMA 2013).

The precise vulnerability of lightning strikes will depend on a facility's height in relation to surrounding buildings, as well as the absence or presence of a lightning rod or other lightning channeling technology on the structure. According to the PA HMP, fire departments, schools, and police departments are the most vulnerable to lightning strikes. Food and agriculture facilities that raise livestock may also be more vulnerable to lightning strikes as these animals tend to shelter under trees in storm situations. It is important to note that most of the food and agriculture-related critical facilities are privately owned farms that may own sizeable herds of livestock; however, the Commonwealth critical facilities list does not indicate which of the farms own herds. Finally, if entertainment and recreation facilities include outdoor recreation spaces with wide-open spaces, there may be added lightning strike vulnerability (PEMA 2013).

According to NOAA's Technical Paper titled *Lightning Fatalities, Injuries, and Damage Reports in the United States from 1959 - 1994*, monetary losses for lightning events range from less than $50 to greater than $5 million (larger losses associated with forest fires with homes destroyed and crop loss) (NOAA 1997). Lightning can be responsible for damages to buildings; cause electrical, forest, and/or wildfires; and damage infrastructure such as power transmission lines and communication towers. Agricultural losses caused by lightning and lightning-resulting fires can be devastating.

The 2013 State HMP estimated jurisdictional losses for the 21 counties most vulnerable to lightning strike, including Pike County. Using GIS, losses for the County were estimated to total over $2.7 million. Note that losses due to lightning strikes will differ based on the magnitude of the event and the lightning protection measures on a given facility (PA HMP 2013).

Future Growth and Development

Areas targeted for potential future growth and development within the next 5 years have been identified across Pike County; refer to Section 2.4 of this HMP. New development is anticipated to be exposed to the lightning strike hazard.

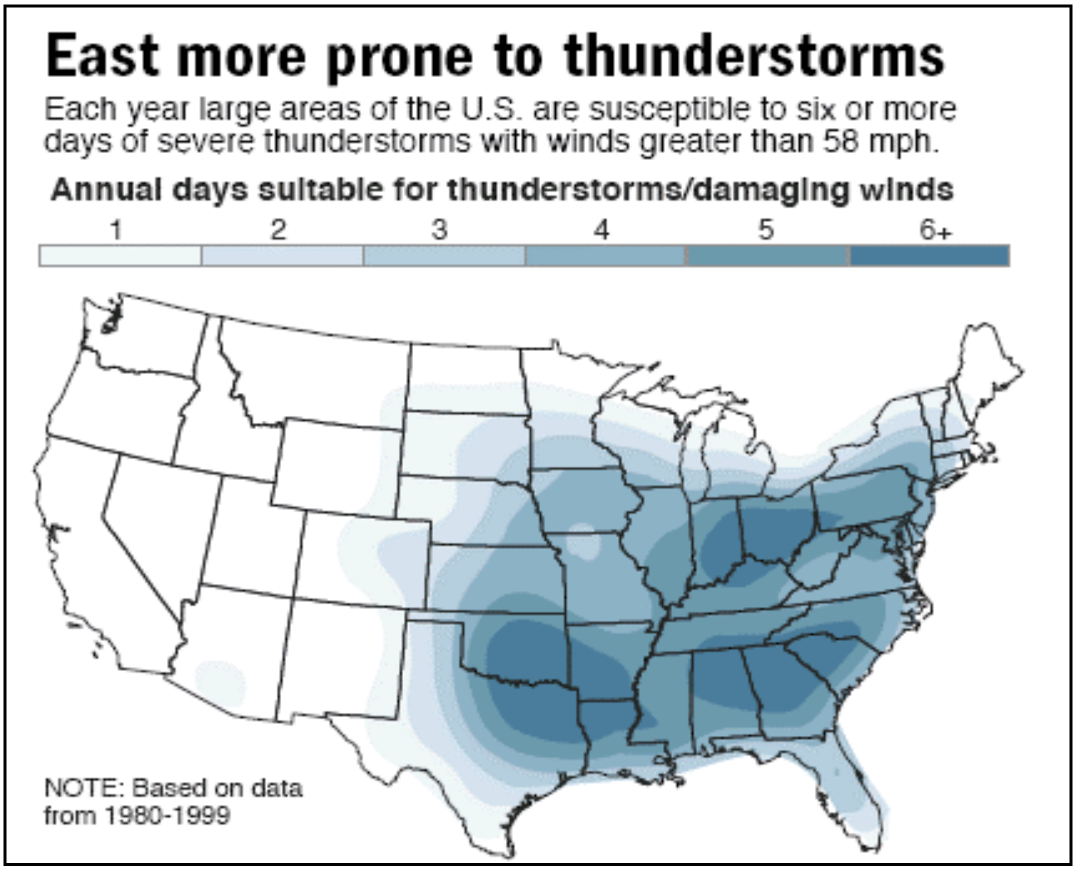
Effect of Climate Change on Vulnerability

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

As the climate changes, temperatures and the amount of moisture in the air will both increase, thus leading to an increase in the severity of thunderstorms which can lead to derechos (or fast-moving windstorm/thunderstorm that moves across a great distance characterized by damaging winds) and tornadoes. Studies have shown that an increase in greenhouse gases in the atmosphere would significantly increase the number of days that severe thunderstorms occur in the southern and eastern United States (NASA 2013). As prepared by the NWS, Figure 4.3.1-2 identifies those areas, particularly within the eastern U.S., that are more prone to thunderstorms, including Pennsylvania.

National Aeronautics and Space Administration (NASA) scientists suggest that the U.S. will face more severe thunderstorms in the future, with deadly lightning, damaging hail, and the potential for tornadoes in the event of climate change. A recent study conducted by NASA predicts that smaller storm events like thunderstorms will also be more dangerous due to climate change.

Figure 4.3.11-2. Annual Days Suitable for Thunderstorms/Damaging Winds



Source: Borenstein, 2007
mph miles per hour

Additional Data and Next Steps

The assessment above identifies vulnerable populations and potential structural and economic losses associated with the lightning strike hazard. Research performed at NOAA and other private organizations is ongoing to improve warning and threat information for the public. The continued collection of additional/actual loss data specific to the Plan participants will further enhance Pike County's vulnerability assessment.

4.3.12 Nuclear Incident

Nuclear hazards and incidents generally refer to incidents involving (1) a release of significant levels of radioactive materials or (2) exposure of workers or the general public to radiation. Primary concerns following a nuclear incident or accident are the impact on public health from direct exposure to a radioactive plume; inhalation of radioactive materials; ingestion of contaminated food, water, and milk; and long-term exposure to deposited radioactive materials in the environment that may lead to either acute (radiation sickness or death) or chronic (cancer) health effects.

The nuclear industry has adopted pre-determined, site-specific Emergency Action Levels (EAL). The EALs provide the framework and guidance for observing, addressing, and classifying the severity of site-specific incidents and conditions that are communicated to off-site emergency response organizations (Nuclear Regulatory Commission [NRC] 2008). Additional EALs specifically deal with issues of security, such as threats of airborne attack, hostile action within the facility, or attack on the facility. These EALs ensure that appropriate notifications of a security threat will occur in a timely manner.

The NRC encourages the use of Probabilistic Risk Assessments (PRA) to estimate quantitatively the potential risk to public health and safety considering the design, operations, and maintenance practices at nuclear power plants. PRAs typically focus on accidents that can severely damage the core and that may challenge containment. Federal Emergency Management Agency (FEMA), Pennsylvania Emergency Management Agency (PEMA), and county governments have formulated Radiological Emergency Response Plans to prepare for radiological emergencies at the five nuclear power-generating facilities in the Commonwealth of Pennsylvania. These plans include a Plume Exposure Pathway Emergency Planning Zone (EPZ) (an area with a radius of 10 miles from each nuclear power facility), and an Ingestion Exposure Pathway EPZ (an area with a radius of 50 miles from each facility).

Location and Extent

There are five nuclear power generation stations located in the Commonwealth; however, none are located within Pike County limits. The County is located within the 50-mile Ingestion Exposure Pathway EPZ of the Susquehanna Nuclear Power Plant located in Luzerne County and Indian Point Power Plant located in Buchanan, New York. Should an accident occur at either facility, the area within the Ingestion Exposure Pathway EPZ could receive some radioactive contamination. The Indian Power Plant is set to close by 2021. Figure 4.3.8-1 provides visual representation of where Pike County falls in the Plume Exposure Pathway EPZ and Ingestion Exposure Pathway EPZ of nuclear power plants.

Figure 4.3.12-1. Pike County Jurisdictions in the 50-Mile Ingestion Exposure Pathway Zone

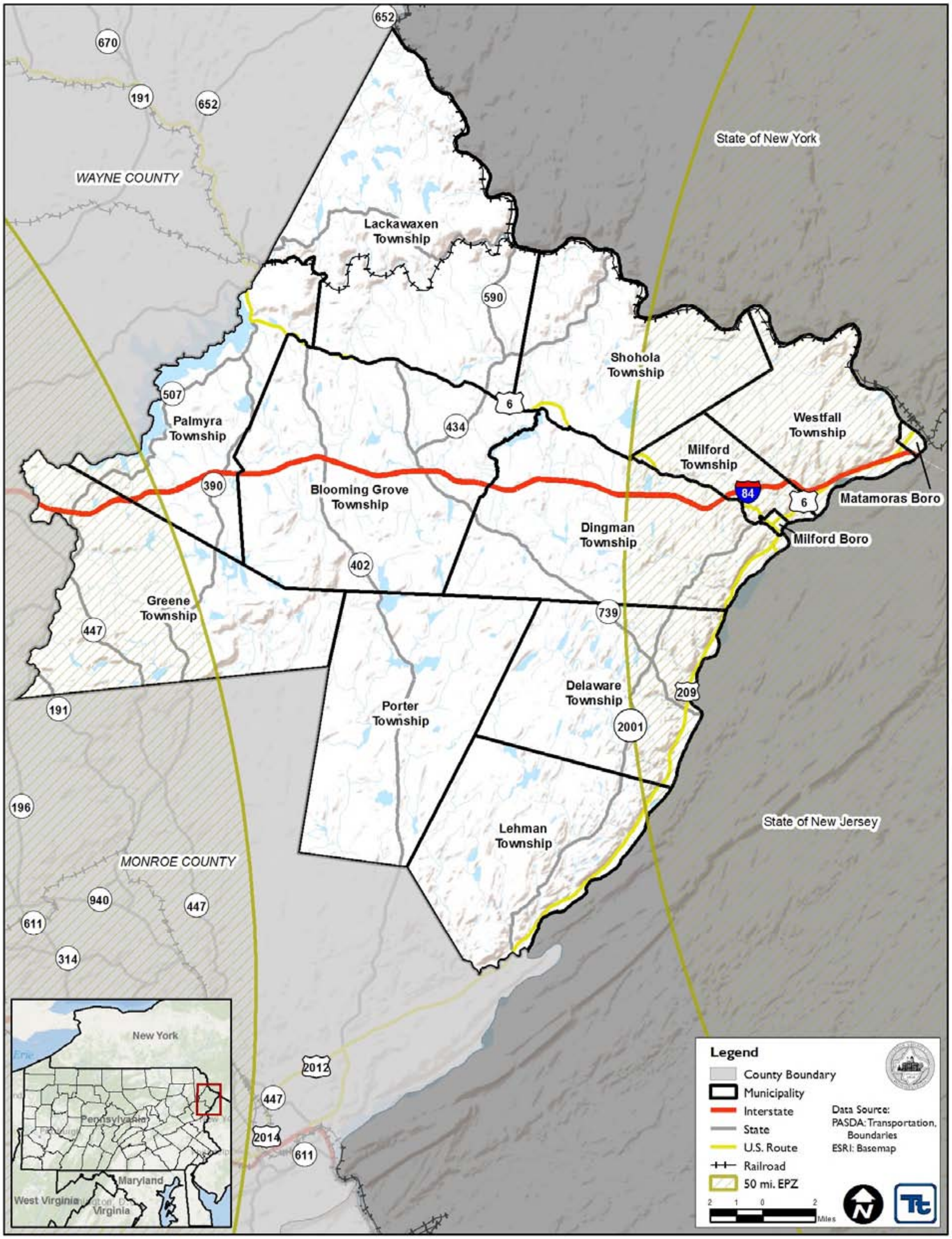


Table 4.3.12-1 lists the jurisdictions in Pike County that are located within the 50-mile EPZs for Susquehanna Steam Electric Station and Indian Point Power Plant.

Table 4.3.12-1. Pike County Jurisdictions in the 50-Mile Ingestion Exposure Pathway Zones

Jurisdiction	50-Mile Ingestion Exposure Pathway Zone – Susquehanna	50-Mile Ingestion Exposure Pathway Zone – Indian Point
Blooming Grove Township	No	No
Delaware Township	No	Yes
Dingman Township	No	Yes
Greene Township	Yes	No
Lackawaxen Township	No	No
Lehman Township	No	Yes
Matamoras Borough	No	Yes
Milford Borough	No	Yes
Milford Township	No	Yes
Palmyra Township	Yes	No
Porter Township	No	No
Shohola Township	No	Yes
Westfall Township	No	Yes

The U.S. Department of Energy transports used nuclear fuel to the repository by rail and road, inside sealed containers. The used fuel may be shipped along specified highway routes. Rail is used to transport nuclear waste as well (Nuclear Energy Institute 2016). A concern for Pike County is the transportation of spent nuclear fuel rods from Indian Point. The County indicated that these fuel rods are transported in unmarked containers via rail every few years and pose a hazardous materials in-transit threat to Pike County.

Range of Magnitude

Plume Exposure Pathway EPZ refers to whole-body external exposure to radiation from a radioactive plume and from deposited materials and inhalation exposure from the passing radioactive plume. The duration of primary exposures could range in length from hours to days. The Plume Exposure Pathway EPZ does not reach Pike County. The 50-mile Ingestion Exposure Pathway EPZ refers to exposure primarily from ingestion of water or foods such as milk and fresh vegetables that have been contaminated with radiation. This kind of exposure can stem from any of the three categories of nuclear accident. Although the 50-mile Ingestion EPZs include only portions of Pike County (refer to Figure 4.3.12-1 and Table 4.3.12-1), impacts are anticipated across the entire County.

Nuclear facility accidents are classified into three categories, and exposure to radiation can stem from any of the three:

- Criticality accidents: Involves loss of control of nuclear assemblies or power reactors.
- Loss-of-coolant accidents: Occurs whenever a reactor coolant system experiences a break or opening large enough so that the coolant inventory in the system cannot be maintained by the normally operating make-up system.
- Loss-of-containment accidents: Involves 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.

In accordance with regulations specified by FEMA and NRC, each facility is required to notify jurisdictional agencies of an incident or occurrence within that facility. NRC uses four classification levels for nuclear incidents (NRC 2008). PEMA and facility owners with whom PEMA coordinates use the following notification levels based on an internal trigger:

- Unusual Event: Incidents are occurring or have occurred that indicate potential degradation in the level of safety of the plant. No release of radioactive material requiring off-site response or monitoring is expected unless further degradation occurs.
- Alert: Incidents are in process or have occurred that involve actual or potential substantial degradation in the level of safety of the plant. Any releases of radioactive material from the plant are expected to be limited to a small fraction of the U.S. Environmental Protection Agency (EPA) Protective Action Guides (PAG).
- Site Area Emergency: Incidents are in process or have occurred that resulted in actual or likely major failures of plant functions needed for protection of the public. Any releases of radioactive material are not expected to exceed EPA PAGs except near the site boundary.
- General Emergency: Incidents are in process or have occurred that have caused actual or imminent substantial core damage or melting of reactor fuel with potential for loss of containment integrity. Radioactive releases during a general emergency can reasonably be expected to exceed the EPA PAGs over more than the immediate site area.

After a nuclear incident, the primary concern is the effect on the health of the population near the incident. The duration of primary exposure could range in length from hours to months depending on the proximity to the point of radioactive release. External radiation and inhalation and ingestion of radioactive isotopes can cause acute health effects (e.g. death, severe health impairment), chronic health effects (e.g. cancers) and psychological effects.

Potential environmental impacts specific to the 50-mile Ingestion Exposure Pathway EPZ, and therefore of most concern to Pike County, include the long-term effects of radioactive contamination in the environment and in agricultural products. Pike County can expect some radioactive contamination in very small amounts in the case of a nuclear incident. This is not a significant concern in terms of external exposure and immediate health risks, but even a small amount of radiation will require the protection of the food chain, particularly milk supplies. Small amounts of radiation ingested over time could lead to future health issues. As a result, in the case of a nuclear incident, foodstuffs, crops, milk, livestock feed and forage, and farm water supplies will need to be protected from and tested for contamination. Additionally, spills and releases of radiologically active materials from accidents can result in the contamination of soil and public water supplies.

The worst-case scenario nuclear incidents for Pike County would be if a General Emergency occurred at Indian Point Power Plant that leaked sufficient radiation to create longer-term damage in the form of contaminated water, soil, and food supplies in the county. In addition, New York State residents may enter Pike County in search of a new residence or for medical care thus overwhelming existing community facilities and services.

Past Occurrence

Pennsylvania is home to the only recorded nuclear emergency in the United States. In 1979, the Three Mile Island Nuclear Generating Station declared a general emergency following an internal system failure. Repercussions from this event were swift, with sweeping changes to NRC oversight that included assignment of responsibility to FEMA for outside support. Growth in the nuclear power industry immediately slowed, with the number of facilities decreasing over the next decade. In addition, public confidence in the nuclear industry decreased considerably.

While reports show conflicting information regarding medical impacts on the residential population following the disaster, costs of the cleanup phase of this incident exceeded $1 billion. No FEMA disaster declarations have since occurred regarding nuclear emergencies in Pennsylvania.

Future Occurrence

Pennsylvania is home to the only nuclear power plant General Emergency in the nation. Since the Three Mile Island incident, nuclear power has become significantly safer and is one of the most heavily regulated industries in the nation. Despite the knowledge gained since then, there is still the potential for a similar accident to occur again at one of the five nuclear generating facilities in the Commonwealth. The Nuclear Energy Agency of the Organization for Economic Co-Operation and Development notes that studies estimate the chance of protective barriers in a modern nuclear facility at less than one in 100,000 per year (Pike County HMP 2012).

Across the United States, a number of *Unusual Event* and *Alert* classification level events occur each year at the 100+ nuclear facilities that warrant notification of local emergency managers. Of these, *Alert* emergencies occur less frequently. For example, in 1997, there were forty notifications of *Unusual Events* and three *Alert* events nationwide. Based on historical events, *Site Area Emergency* and *General Emergency* incidents are very rare (Pike County HMP 2012). Based on available historical data and the lack of nuclear incident events impacting Pike County, the future occurrence of nuclear incident events can be considered *unlikely* as defined by the Risk Factor Methodology probability criteria (refer to Section 4.4).

Vulnerability Assessment

Effects from a radiological incident at a fixed facility would vary depending on the product released (type of radiation), amount of radiation released, current weather conditions, and time of day. The priority following an incident at any of the facilities within the Commonwealth of Pennsylvania is the life and safety of all individuals within the area impacted. Secondary to health and safety would be effects on critical infrastructure, environment, property, and the economy.

Contamination of agriculture, livestock, and production can lead to loss of commerce with other regions of the State, country, and even the world. Recently, many countries halted imports of products from Japan for fear of contamination following the tsunami-related nuclear incident at the Fukishima Power Plant. This loss in revenue compounded losses that Japan and its region were already encountering following the initial disaster.

Impacts within the affected area can include loss of utility service, contamination of local crops and livestock, loss of residential property due to measurable quantities of nuclear materials, and increased risk to health and wellbeing of individuals within the area.

Only portions of Pike County are located within the Ingestion Pathway EPZ of the Susquehanna Steam Electric Station or Indian Point Power Plant. Thus those municipalities more vulnerable to the contamination effects of nuclear incidents include Palmyra and Greene Townships for the Susquehanna Steam Electric Station and Shohola, Westfall, Milford, Dingman, Delaware, and Lehman Townships and Matamoras and Milford Boroughs for the Indian Point Power Plant. The number of structures and critical facilities within the 50 mile EPZ of each power plant is displayed in Table 4.3.8-2.

Table 4.3.12-2. Structures and Critical Facilities with the 50 mile EPZ of Power Plants.

Municipality	Addressable Structures in 50 mile EPZ of Indian Point Power Plant (NY)	Total Critical Facilities in 50 mile EPZ of Indian Point Power Plant (NY)	Addressable Structures in 50 mile EPZ of Susquehanna Power Plant (PA)	Total Critical Facilities in 50 mile EPZ of Susquehanna Power Plant (PA)
Blooming Grove Township	0	0	0	0
Delaware Township	1,021	3	0	0
Dingman Township	1,906	4	0	0
Greene Township	0	0	2,834	5
Lackawaxen Township	0	0	0	0
Lehman Township	0	0	0	0
Matamoras Borough	972	8	0	0
Milford Borough	718	13	0	0
Milford Township	784	6	0	0
Palmyra Township	0	0	707	0
Porter Township	0	0	0	0
Shohola Township	231	1	0	0
Westfall Township	1,175	13	0	0
Pike County (Total)	**6,807**	**48**	**3,541**	**5**

Source: HAZUS MH v3.1

As stated in Section 4.3.8.2, the County's primary vulnerability to nuclear incidents comes in the form of food, soil, and water contamination. In terms of vulnerable land, the approximately 28,000 acres of farmland is vulnerable to radiological contamination in a nuclear incident. In 2007, the market value of all agricultural products of these farms totaled approximately $3 million. While unlikely that all agricultural products would be lost in the event of a nuclear incident, the County can expect some portion to be lost. Time of year also impacts the vulnerability and losses estimated for a nuclear incident; an incident that occurs during the prime growing and harvesting season will have a larger impact on the County.

It is important to note that the entire County, not just the areas in the EPZ may be impacted based on the flow of goods and services and where residents get their food supply. Water contamination is also a concern in nuclear incidents. Public water suppliers that operate in or provide water to the County, coupled with the County's 8,255 domestic drinking water wells, are all vulnerable to the effects of a nuclear incident.

4.3.13 Pandemic

Pandemics are large-scale disease outbreaks, defined by how the disease spreads, not by how many fatalities are associated with it. A pandemic outbreak has several recognizable characteristics, including rapid, large-scale (potentially global) spread; overloaded healthcare systems; inadequate medical supplies; medical supply shortages; and a disrupted economy and society (Flu.gov 2015). Pandemics typically result from infectious diseases. An infectious disease, as defined by the World Health Organization (WHO), is caused by pathogenic organisms (e.g., bacteria, viruses, fungus, or parasites) that spread from one person to another, whether through direct or indirect contact. Zoonotic disease, a type of infectious disease, occurs when animals transmit a disease to humans (WHO 2015). Although any infectious disease can reach pandemic levels, influenza (flu) has the greatest likelihood of causing the next pandemic.

Of particular concern to Pike County are arthropod-borne viruses (arboviruses), which are viruses that are maintained in nature through biological transmission between susceptible hosts (mammals) and blood-feeding arthropods (mosquitos and ticks). More than 100 arboviruses can cause disease in humans; over 30 have been identified as human pathogens in the western hemisphere (New Jersey Department of Health and Senior Services 2008). Pike County has been impacted by various past and present infestations including: high population of mosquitoes (mosquito-borne diseases) and deer ticks (tick-borne diseases).

Mosquito-borne diseases are diseases that are spread through the bite of an infected female mosquito. Diseases of concern to Pike County include West Nile Virus. More recently, there has been an outbreak of Zika virus in the United States which is another mosquito-borne disease and a concern for the Commonwealth. Additionally, tick-borne diseases are bacterial or viral illnesses that spread to humans through infected ticks. Ticks become infected by microorganisms when feeding on small infected mammals (mice and voles). People who spend a lot of time outdoors have a greater risk of being bitten by an infected tick and becoming infected themselves. It is possible to be infected with more than one tick-borne disease at a time. Tick-borne diseases, including Lyme disease, are a major concern to Pike County.

In addition to arboviruses, Pike County has been impacted by influenza outbreaks in the past five years. Most recently, Pike County has been monitoring the Ebola virus, measles and Zika; however, there have been no cases in the County. For the purpose of this HMP update, the following diseases will be discussed in further detail: mosquito-borne (West Nile Virus), tick-borne (Lyme), influenza, measles, Ebola, and Zika.

West Nile Virus

West Nile Virus (WNV) encephalitis is a mosquito-borne viral disease, which can cause an inflammation of the brain. WNV is commonly found in Africa, West Asia, the Middle East and Europe. For the first time in North America, WNV was confirmed in New York City during the summer and fall of 1999. Since 2004, a continent-wide WNV epidemic flares up in the summer and continues into the fall as infected mosquitos spread the virus from birds to horses, humans and other animals (Pennsylvania Department of Health 2013).

Tick-Borne Diseases

Ticks can be infected with bacteria, viruses, or parasites. One of the more common tick-borne diseases in the Northeast is Lyme disease. Lyme disease is an illness caused by infection with the bacterium *Borrelia burgdorferi*, which is carried by infected ticks. Symptoms include fever, fatigue, headache, muscle aches, joint pain, a bull's eye rash may appear, and other symptoms that can be mistaken for viral infections, such as influenza or infectious mononucleosis. Pennsylvania has led the nation in confirmed cases of Lyme disease for three straight years and for the first time deer ticks have been found in each of Pennsylvania's 67 counties. In

2014, there were 7,400 cases of Lyme disease in the Commonwealth (Pennsylvania Department of Health 2016).

Influenza

The risk of a global influenza pandemic has increased over the last several years. This disease is capable of claiming thousands of lives and adversely affecting critical infrastructure and key resources. An influenza pandemic has the ability to reduce the health, safety, and welfare of the essential services workforce; immobilize core infrastructure; and induce fiscal instability.

Pandemic influenza is different from seasonal influenza (or "the flu") because outbreaks of seasonal flu are caused by viruses that are already among people. Pandemic influenza is caused by an influenza virus that is new to people and is likely to affect many more people than seasonal influenza. In addition, seasonal flu occurs every year, usually during the winter season, while the timing of an influenza pandemic is difficult to predict. A severe pandemic could change daily life for a time, including limitations on travel and public gatherings (Barry-Eaton District Health Department 2013).

At the national level, the CDC's Influenza Division has a long history of supporting the WHO and its global network of National Influenza Centers (NIC). With limited resources, most international assistance provided in the early years was through hands-on laboratory training of in-country staff, the annual provision of WHO reagent kits (produced and distributed by CDC), and technical consultations for vaccine strain selections. The Influenza Division also conducts epidemiologic research including vaccine studies and serologic assays and provides international outbreak investigation assistance (CDC 2011).

Measles

Measles is caused by a virus and is normally passed through direct contact and through the air. The virus infects the mucous membranes and then spreads throughout the body. It is highly contagious and considered a very serious disease. In 1980, before widespread vaccination, measles caused an estimated 2.6 million deaths each year. It still remains as one of the leading causes of death among young children. In 2013, approximately 145,700 people died, worldwide, from measles, with a majority of deaths being children under age 5 (World Health Organization 2015).

More recently, in 2015, 178 people from 24 states and Washington D.C. were reported to have measles, with one measles-related death. In recent years, the number of cases of measles has been on the rise as more parents elect not to vaccinate their children. Most of these cases were part of a large, ongoing outbreak linked to an amusement park in California. The United States experienced a record number of measles during 2014, with 644 cases from 24 states reported (New Jersey Department of Health 2015).

Ebola

Ebola, previously known as Ebola hemorrhagic fever, is a rare and deadly disease caused by infection with one of the Ebola virus strains. According to the CDC, the 2014 Ebola epidemic is the largest in history affecting multiple countries in West Africa. Two imported cases, including one death, and two locally-acquired cases in healthcare workers have been reported in the United States. The CDC and partners are taking precautions to prevent the further spread of Ebola in the United States (CDC 2016a).

Zika Virus

Zika virus is a generally mild illness that is spread primarily through the bite of an infected mosquito. Zika virus can spread through sexual contact from a partner who has been infected with Zika virus. Although less common, Zika virus can also be spread from a mother to baby during pregnancy or during the time of birth or through blood transfusion (Pennsylvania Department of Health 2016).

The current outbreak began in May 2015 in Brazil which led to reports of a neurological disease called Guillain-Barré syndrome and pregnant women giving birth to babies with birth defects such as microcephaly. The outbreak has spread to numerous countries and areas, prompting the Centers for Disease Control and Prevention (CDC) to issue travel notices to regions where the Zika virus transmission is ongoing. In response to the emerging disease, Pennsylvania has created a Zika Response Plan (Pennsylvania Department of Health 2016).

Location and Extent

Pandemic events cover a wide geographic area and can affect large populations; this can include multiple countries or continents. Size and extent of an infected population depends on how easily the illness is spread, mode of transmission, and amount of contact between infected and uninfected individuals. Locations with higher density populations are more susceptible to pandemic outbreaks, as the disease can be transmitted more easily, with the exception of Lyme disease. Additionally, vulnerable populations, especially the young and the elderly (who have weaker immune systems), are at greater risk for both contracting a disease and suffering fatal or severe consequences. Flu most frequently spreads through the air or by touch; when an infected person coughs, infected droplets go into the air or onto their hands, facilitating transmission of the disease to other people (WHO 2015).

When a pandemic or disease outbreak occurs, WHO and other public health institutions begin tracking the disease outbreak, treatment, and more. Ebola was a significant pandemic concern for American public health officials in 2014; however, the disease has primarily remained in Africa to date. Should a pandemic take hold in the United States, the Centers for Disease Control and Prevention (CDC) and the National Institutes of Health (NIH) would be actively involved in managing the outbreak and treatment of the disease.

Influenza viruses with the potential to reach pandemic levels include the avian influenza A (H5N1) and avian influenza H7N9 (CDC 2015). Several years ago, the swine influenza (H1N1) was of particular concern. H1N1 was first detected in people in the United States in April 2009. On June 11, 2009, WHO signaled that a pandemic of 2009 H1N1 flu was underway (CDC 2009).

Although Ebola and Zika are still recognized as global health threats, Pike County is primarily concerned with the possibility of a pandemic flu outbreak and tick-borne diseases due to the presence of summer camps and sources of outdoor recreation in the County.

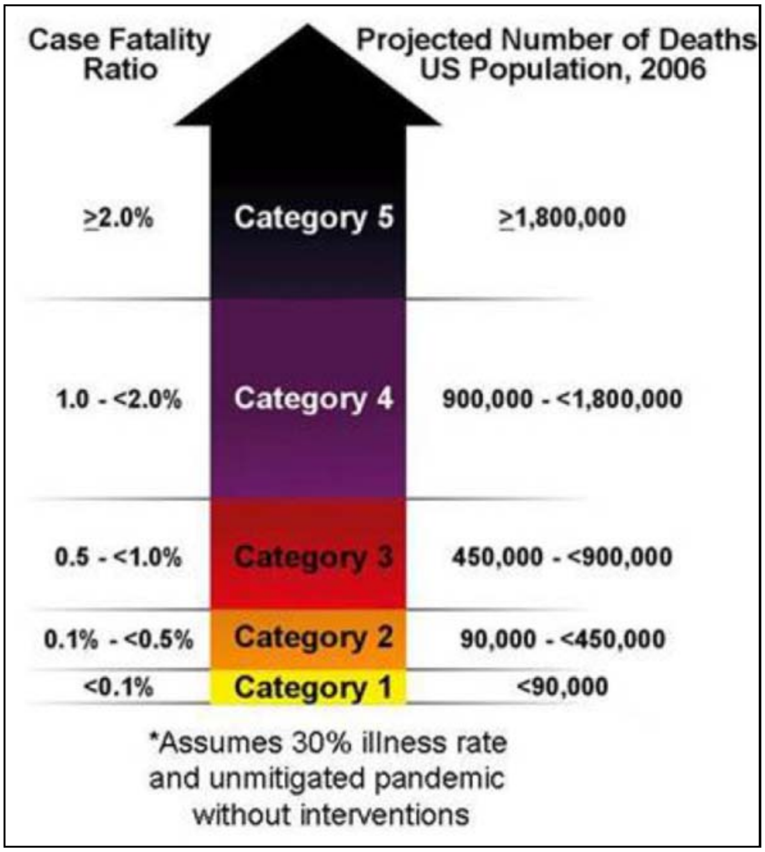
Range of Magnitude

Severity of a pandemic depends on a number of factors, as indicated above. These include aggressiveness of the disease, ease of transmission, and factors associated with the impacted community (e.g., access to medical care, demographic data, and population density). Advancements in medical technologies have greatly reduced the number of deaths caused by influenza, the disease most likely to reach pandemic scale in Pennsylvania. Consequently, global effects of various influenza outbreaks have declined over the past century. High-risk populations considered more vulnerable to various pandemic diseases are described in the vulnerability assessment.

The severity and length of the next pandemic cannot be predicted. Based on previous pandemics and without medications or vaccines available, it is estimated that a severe pandemic could cause almost 2 million deaths in the United States, more than 9 million hospitalizations, and more than 90 million people ill (New Jersey Department of Health [NJDOH] 2012).

The CDC and Prevention Community Strategy for Pandemic Influenza Mitigation guidance introduced a Pandemic Severity Index (PSI), which uses the case fatality ratio as the critical driver for categorizing the severity of a pandemic. The index is designed to estimate the severity of a pandemic on a population to allow better forecasting of the impact of a pandemic, and to enable recommendations on the use of mitigation interventions that are matched to the severity of influenza pandemic. Pandemics are assigned to one of five discrete categories of increasing severity (Category 1 to Category 5) (CDC 2016b). Figure 4.3.13-1 illustrates the five categories of the PSI.

Figure 4.3.13-1. Pandemic Severity Index



Source: CDC 2016b

WHO described a series of pandemic phases in 1999 and revised these in 2005 and 2009 to provide a global framework and aid in pandemic preparedness and response planning. In addition to facilitating implementation of preparedness recommendations, the phases also help provide greater understanding of when an event is considered to have reached pandemic levels. The six phases are shown on Figure 4.3.13-2 below and are described as follows:

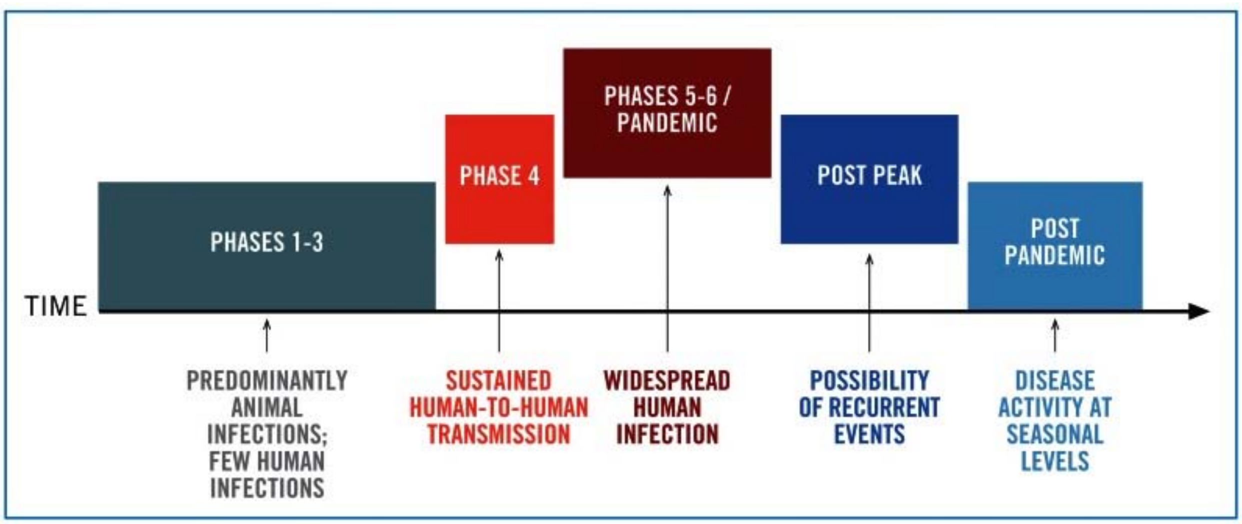
- Phase 1: No viruses circulating among animals have been reported among humans.
- Phase 2: An animal influenza virus circulating among domesticated or wild animals has caused known infection in humans and is now considered a potential pandemic threat.
- Phase 3: An animal or human-animal influenza reassortment virus has caused sporadic cases or small clusters of disease in people but has not resulted in human-to-human transmission sufficient to sustain

community-level outbreaks. Limited human-to-human transmission may occur under some circumstances, such as close contact between an infected person and an unprotected caregiver.

- Phase 4: Verified human-to-human transmission of an animal or human-animal influenza reassortment virus is able to cause "community-level outbreaks." The ability to cause sustained disease outbreaks in a community marks a significant upwards shift in the risk of a pandemic. Any country that suspects or has verified such an event should urgently consult with WHO so that the situation can be jointly assessed and a decision made by the affected country if implementation of a rapid pandemic containment operation is warranted. Phase 4 indicates a significant increase in risk of a pandemic but does not necessarily mean that a pandemic is a forgone conclusion.
- Phase 5: There has been human-to-human spread of the virus into at least two countries in one WHO region. While most countries will not be affected at this stage, the declaration of Phase 5 is a strong signal that a pandemic is imminent, and that the time to finalize the organization, communication, and implementation of the planned mitigation measures is short.
- Phase 6: The pandemic phase is characterized by community-level outbreaks in at least one other country in a different WHO region, in addition to the criteria defined in Phase 5. Phase 6 indicates a global pandemic is underway.

Conclusion of Phase 6 leads to the post-peak period, wherein pandemic levels decrease in most countries with surveillance capabilities. Despite a decrease in activity, countries still must be prepared for additional waves of the pandemic. Pandemic waves can be separated by a period of months, leading to a long recovery time to guarantee entry of the pandemic into the post-pandemic phase (WHO 2009).

Figure 4.3.13-2. Pandemic Influenza Phases



Source: WHO 2009

A worst-case scenario would be entry of the United States into a Phase 6-designation of an influenza or other pandemic, whereby local community outbreaks would occur in Pike County. This would affect most of the population, causing significant numbers of fatalities and disrupting normal living conditions. The most likely scenario is a seasonal flu or a Phase 3- or 4-designation. In these cases, a few residents might get sick, but most of the County would not be directly impacted.

Mosquito-Borne Diseases

Since it was discovered in the western hemisphere, WNV has spread rapidly across North America, affecting thousands of birds, horses and humans. WNV swept from the New York City region in 1999 to almost all of the continental U.S., seven Canadian provinces and throughout Mexico and parts of the Caribbean by 2004 (USGS 2016). The CDC has a surveillance program for WNV. Data is collected on a weekly basis and reported for five categories: wild birds, sentinel chicken flocks, human cases, veterinary cases and mosquito surveillance (CDC 2011).

For Zika virus, the CDC is tracking the spread of the virus in the United States and around the world. On January 22, 2016, CDC activated its Emergency Operations Center (EOC) to respond to outbreaks of Zika occurring in the Americas and increased reports of birth defects and Guillain-Barré syndrome in areas affected by Zika. On February 8, 2016, CDC elevated its EOC activation to a Level 1, the highest level (CDC 2016c).

Tick-Borne Diseases

Lyme disease is the most commonly reported vector-borne illness in the U.S. In 2009, it was the fifth most common nationally notifiable disease. In 2014, 96% of Lyme disease cases in the U.S. were reported from 14 states, which included Pennsylvania (CDC 2015). Between 2000 and 2014, there were 625 confirmed cases of Lyme disease in Pike County (CDC 2015). The Yale School of Public Health mapped Lyme disease risk for the northeast United States. According to their work, Pike County is at high risk for Lyme disease in humans (Yale School of Public Health 2014).

Typical symptoms include fever, headache, fatigue, and a characteristic skin rash called erythema migraines. If left untreated, infection can spread to joints, the heart, and the nervous system. Patients with Lyme disease are frequently misdiagnosed with chronic fatigue syndrome, fibromyalgia, multiple sclerosis, and various psychiatric illnesses, including depression. Misdiagnosis with these other diseases may delay the correct diagnosis and treatment as the underlying infection progresses unchecked.

Influenza, Measles and Ebola

The exact size and extent of an infected population depends on how easily the illness will spread, the mode of transmission, and the amount of contact between infected and uninfected individuals. The transmission rates of pandemic illnesses are often higher in more densely populated areas. The Ebola virus is spread to others through direct contact; it is not spread through the air like influenza.

Pandemic flu should not be confused with seasonal flu. Seasonal flu is a less severe concern because of its regularity of occurrence and predictability. The following Table 4.3.13-1 lists key differences between pandemic and seasonal flus.

Table 4.3.13-1. Seasonal Flu vs Pandemic Flu

Pandemic Flu	Seasonal Flu
Rarely happens (three times in 20th century).	Happens annually and usually peaks in January or February.
People have little or no immunity because they have no previous exposure to the virus.	Usually some immunity built up from previous exposure.
Healthy people may be at increased risk for serious complications.	Usually only people at high risk, not healthy adults, are at risk of serious complications.
Healthcare providers and hospitals may be overwhelmed.	Healthcare providers and hospitals can usually meet public and patient needs.
Vaccine probably would not be available in the early stages of a pandemic.	Vaccine available for annual flu season.
Effective antivirals may be in limited supply	Adequate supplies of antivirals are usually available.
Number of deaths could be high (U.S. death toll during the	Seasonal flu-associated deaths in the U.S. over 30 years

Pandemic Flu	Seasonal Flu
1918 pandemic was approximately 675,000).	ending in 2007 have ranged from about 3,000 per season to about 49,000 per season.
Symptoms may be more severe	Symptoms include fever, cough, runny nose, and muscle pain.
May cause major impact on the general public, such as widespread travel restrictions and school or business closings.	Usually causes minor impact on the general public; some schools may close and sick people are encouraged to stay home.
Potential for severe impact on domestic and world economy.	Manageable impact on domestic and world economy.

Source: Flu.gov 2015

Approximately 12,470 Americans died from H1N1 within a roughly 1-year period from April 2009 to April 2010 (CDC, 2010). Between October 2014 and late May 2015, 6.4% of deaths were attributable to pneumonia and influenza—below the epidemic threshold of 6.6% (an epidemic occurs when incidence rate exceeds expected rate but is not at the magnitude of a pandemic) (CDC FluView 2015).

Past Occurrence

The following section provides information regarding past occurrences of pandemic events.

West Nile Virus

West Nile Virus arrived in the United States in 1999 and was first detected in Pike County in 2000 when mosquito pools, dead birds and/or horses tested positive for the virus. Since then, the number of positive counties in Pennsylvania, human cases, and West Nile deaths has fluctuated with the temperature and precipitation each year. Table 4.3.13-2 illustrates the virus's overall cases, human cases, and mortality from 2001-2010. In Pike County, there have been birds and mosquitoes that have tested positive for the virus, however no positive human cases and therefore no human deaths.

Table 4.3.13-2. Previous West Nile Virus occurrences in Pike County from 2001-2016

Year	Number Of Positive Cases	Positive Human Cases	Human Deaths
2001	1	0	0
2002	4	0	0
2003	13	0	0
2004	1	0	0
2005	0	0	0
2006	1	0	0
2007	1	0	0
2008	0	0	0
2009	0	0	0
2010	0	0	0
2011	1	0	0
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	0	0
2016	0	0	0

Source: PA West Nile Control Project 2016

Tick-Borne Diseases

Pennsylvania has led the nation in confirmed cases of Lyme disease for three straight years and for the first time deer ticks have been found in each of Pennsylvania's 67 counties. Table 4.3.13-3 shows the number of reported cases of Lyme disease in Pike County from 2000 to 2014.

Table 4.3.13-3. Previous Lyme Disease Occurrences in Pike County from 2000-2014

Year	Number Of Reported Cases
2000	14
2001	14
2002	22
2003	46
2004	48
2005	46
2006	27
2007	57
2008	44
2009	37
2010	18
2011	19
2012	13
2013	39
2014	51

Source: Pennsylvania Department of Health 2016

Influenza

The United States Department of Health and Human Services estimates that influenza pandemics have occurred for at least 300 years at unpredictable intervals. There have been several pandemic influenza outbreaks over the past 100 years. A list of events worldwide is shown in Table 4.3.13-4.

Table 4.3.13-4. List of previous significant outbreaks of influenza over the past century

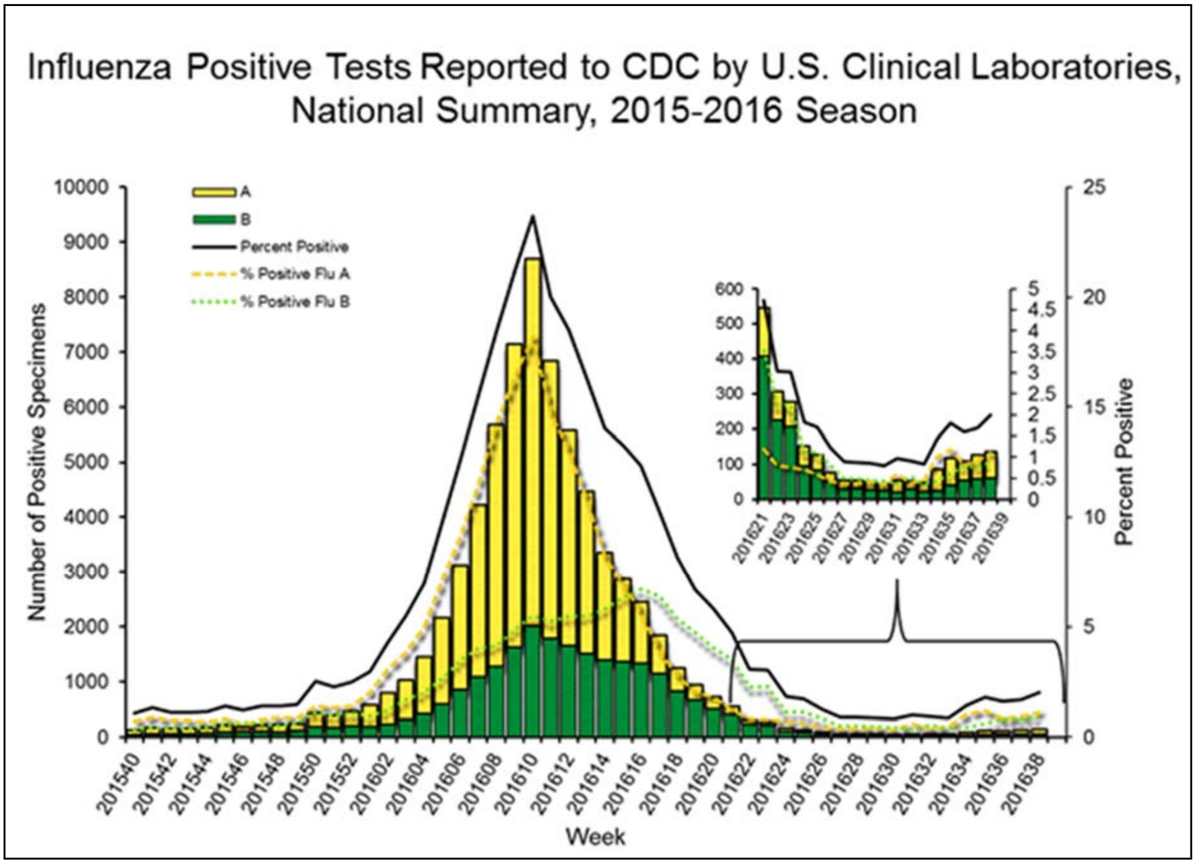
Date	Pandemic Name/Subtype	Worldwide Deaths (Approximate)
1918-1920	Spanish Flu / H1N1	50 million
1957-1958	Asian Flu / H2N2	1.5-2 million
1968-1969	Hong Kong Flu / H3N2	1 million
2009-2010	Swine Flu / 2009 H1N1	18,036

Source: Global Security, 2009; World Health Organization, 2009

Deaths occurred in the United States as a result of the Spanish Flu, Asian flu, and Hong Kong Flu outbreaks. The Spanish Flu claimed 500,000 lives in the United States, and there were 350,000 cases in Pennsylvania – 150,000 were in Philadelphia alone. Most deaths resulting from the Asian flu occurred between September 1957 and March 1958; there were about 70,000 deaths in the United States and approximately 15% of the population of Pennsylvania was affected. The first cases of the Hong Kong Flu in the U.S. were detected in September 1968 with deaths peaking between December 1968 and January 1969 (Global Security, 2009). More recently, 43 cases of 2009 H1N1 have been confirmed in Pike County resulting in 1 death.

Epidemiologists and public health officials consistently track the rate of influenza or influenza-like-illnesses (ILI) to monitor potential pandemic threats. This also allows them to provide annual data on ILI seasonal outbreaks. Figure 4.3.13-3 below shows the biweekly national number of cases of ILI during the 2015-2016 season, distinguishing each type of ILI by a unique color.

Figure 4.3.13-3. ILI Cases in the United States, 2015-2016 Season



Source: CDC Weekly Flu 2016d

In the mid-Atlantic region, which includes the State of Pennsylvania and Pike County, the following numbers of positive ILI tests were reported:

- A (H1) – 0
- A (Unable to subtype) – O
- A (H3) – 6
- 2009 N1N1 – 0
- A (Subtyping not performed) – 0
- B – 0
- N3N2v – 0 (CDC 2016e)

The Pennsylvania Department of Health maintains an influenza surveillance data archive that provides summaries for each influenza season, dating back to 2005/2006. Table 4.3.13-5 shows the number of reported cases of influenza in Pike County from 2005 to 2015.

Table 4.3.13-5. Reported Influenza Cases in Pike County, 2005-2015

Year	Number Of Reported Cases
2005	32
2006	5
2007	36
2008	38
2009	76
2010	28
2011	7
2012	92
2013	68
2014	71
2015	103
TOTAL	**556**

Source: Pennsylvania Department of Health 2016

Measles

According to the CDC, in 2014, the United States experienced a record number of measles cases, with 667 cases reported in 27 states. That was the greatest number of cases since measles elimination was documented in 2000. In 2015, 189 people from 24 states were reported to have measles. Recently, from January 2 to September 10, 2016, there were 54 reports cases in 16 states (Alabama, Arizona, California, Colorado, Connecticut, Florida, Georgia, Hawaii, Illinois, Massachusetts, Minnesota, New York, North Carolina, Tennessee, Texas, and Utah). The most recent outbreak, which occurred in 2015, was linked to an amusement park in California. The outbreak likely started from a traveler who became infected overseas with measles, then visited the amusement park while infectious; however, no source was identified (CDC 2016f). There were reported cases of measles in Pennsylvania during this outbreak (CDC 2015).

Ebola

The first outbreak of Ebola occurred in 1976 in Zaire (Democratic Republic of the Congo). Since then, there has been additional outbreaks and known cases identified. The most recent being the 2014 outbreak which was the largest Ebola outbreak in West Africa. In the United States, there were two imported cases, one death and two locally acquired cases in healthcare workers have been reported.

Table 4.3.13-6 lists the outbreaks of Ebola since it was first identified in 1976.

Table 4.3.13-6. List of Previous Significant Outbreaks of Ebola

Date(s)	Country Impacted	Reported Number of Human Cases	Reported Number (%) of Deaths Among Cases
1976	Zaire	318	280 (88%)
1995	DRC	315	250 (79%)
2000-2001	Uganda	425	224 (53%)
2001-2002	Republic of Congo	57	43 (75%)
2007	DRC	264	187 (71%)
2007	Western Uganda	149	37 (25%)
2014	West Africa	27,000*	11,000* (41%)

Source: *CDC 2016*
* *As of July 18, 2015*
DRC *Democratic Republic of the Congo*

Zika Virus

Outbreaks of Zika virus disease have been recorded in Africa, the Americas, Asia and the Pacific. Zika virus was first identified in Uganda in 1947 in monkeys through a network that monitored yellow fever. It was later identified in humans in 1952 in Uganda and the United Republic of Tanzania. From the 1960s to 1980s, human infections were found in Africa and Asia, typically accompanied by mild illness. The first large outbreak of disease caused by Zika infection was reported from the Island of Yap (Federated States of Micronesia) in 2007. In July 2015, Brazil reported an association between Zika virus infection and Guillain-Barré syndrome and in October 2015, Brazil reported an association between Zika virus infection and microcephaly (WHO 2016). In the United States, as of September 28, 2016, there have been 3,625 reported cases of Zika virus. This includes 129 cases in Pennsylvania, all travel-associated; however, no cases have been identified in Pike County (CDC 2016g).

Future Occurrence

Predicting the future occurrences of pandemics is difficult; however, based on the history of occurrences in Pike County, it is likely that the County will be impacted by certain diseases in the future. Additionally, an increase in population and population density in the County has the potential to increase exposure and susceptibility of its residents to outbreaks. Infected mosquitos and ticks will continue to inhabit and impact the County.

Future occurrences of pandemic West Nile Virus are unclear. Instances of the virus have been generally decreasing due to aggressive planning and eradication efforts, but some scientists suggest that as global temperatures rise and extreme weather conditions occur due to climate change, the range of the virus in the United States will grow (Epstein 2001).

Tick-borne diseases including Lyme disease will continue to impact the northeast United States, Pennsylvania and Pike County due to its natural environment. Each year, the number of cases increases. Research continues to address concerns of the disease (CDC 2014). Climate has been linked to one of the factors that influence the transmission, distribution, and incidence of Lyme disease. Studies have provided evidence that climate change has also contributed to the expanded range of ticks, increasing the potential risk of Lyme disease (EPA 2016).

As with West Nile Virus, the precise timing of pandemic influenza is uncertain. Based on historical events, Pike County is expected to experience pandemic influenza outbreaks approximately every 11 to 41 years. The precise timing of pandemic influenza is uncertain, but occurrences are most likely when the Influenza Type A virus makes a dramatic change, or antigenic shift, that results in a new or "novel" virus to which the population has no immunity. This emergence of a novel virus is the first step toward a pandemic (US Health and Human Services 2009).

Adults and children who contracted measles during the most recent outbreak were reported to have not been vaccinated against the disease or they did not know if they were ever vaccinated. For every 1,000 children who get measles, one to three of them will die from the disease (Connell 2015). If the number of vaccinations for measles decreases, there may be an increase number of reported cases.

For the 2017 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of pandemic events for Pike County. Information from the CDC, Pennsylvania Department of Health, and Pennsylvania West Nile Virus Control Program were used to identify the number of disease occurrences and pandemic events that occurred between 1950 and 2015. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimate percent chance of an incident occurring in a given year. Based on these statistics, there is an estimated 100-percent chance of a pandemic event or an occurrence of a disease occurring in any given year in Pike County.

Table 4.3.13-7. Probability of Future Occurrences of Disease Outbreak in Pike County

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
West Nile Virus	0	0.00	0	0	0%
Lyme Disease	491	7.55	0.13	1.0	100%
Influenza	556	8.55	0.12	1.0	100%
Measles	0	0.00	0	0	0%
Ebola	0	0.00	0	0	0%
Zika	0	0.00	0	0	0%

Source: Pennsylvania Department of Health 2016; Pennsylvania West Nile Virus Control Program 2016

Based on previous occurrences of the various diseases, pandemics and outbreaks of the different diseases will continue to occur. However, it is uncertain as to the future of these diseases and their impacts on Pike County. Future pandemics may also emerge from other diseases, especially invasive pathogens that County residents do not have natural immunity to. Overall, the probability of future pandemic events are considered *highly likely* as defined by the Risk Factor Methodology probability criteria (refer to Section 4.4).

Vulnerability Assessment

Depending on characteristics of the disease/virus, certain population groups can be at higher risk of infection. Regarding seasonal influenza, about 60% of hospitalizations and 90% of flu-related deaths occur among people 65 and older. However, during the relatively recent H1N1 pandemic, 90% of hospitalizations and 87% of H1N1-related deaths occurred in people younger than 65. As with seasonal flu, people with underlying health conditions faced a much higher probability of contracting H1N1. Schools, convalescent centers, and other institutions are highly conducive to faster transmission of pandemic diseases (CDC 2010). Section 2 of this Plan provides information on vulnerable populations in Pike County.

Should a pandemic reach Pike County, the County's doctors and other health professionals should expect to see additional outpatient visits. There are no hospitals located within the County so if a pandemic that would require hospitalization were to occur, Pike County residents would have to rely on facilities either in Port Jervis, NY, Newton, NJ, Stroudsburg, PA, Bartonsville, PA, Honesdale, PA or Scranton, PA.

In addition, if a pandemic were to affect a nearby county, Pike County may expect to see an influx of people entering the County. This will increase the vulnerability of Pike County's current residents.

Pike County also experiences high tourism, particularly from more metropolitan areas. Tourists entering the County could be carrying a virus which may spread to current residents and cause a potential outbreak.

Effect of Climate Change on Vulnerability

The relationship between climate change and infectious diseases is somewhat controversial. The notion that rising temperatures will increase the number of mosquitoes that can transmit malaria or other diseases among humans (rather than just shift their range) has been the subject of debate over the past decade. Some believe that climate change may affect the spread of disease, while others are not convinced. However, many researchers point out that climate is not the only force at work in increasing the spread of infectious diseases into the future. Other factors, such as expanded rapid travel and evolution of resistance to medical treatments, are already changing the ways pathogens infect people, plants, and animals. As climate change potentially accelerates, it is likely to work synergistically with many of these factors, especially in populations increasingly subject to massive migration and malnutrition (Harmon 2010).

4.3.14 Radon Exposure

Radon is a natural gas that cannot be seen, smelled, or tasted. It is a noble gas that originates from natural radioactive decay of uranium and thorium. It is a large component of the natural radiation to which humans are exposed, and can pose a serious threat to public health when it accumulates in poorly ventilated residential and occupation settings. According to the U.S. Environmental Protection Agency (EPA) (EPA 402-R-03-003: EPA Assessment), radon is estimated to cause approximately 21,000 lung cancer deaths per year, second only to smoking as the leading cause of lung cancer (EPA 2003). An estimated 40 percent of the homes in Pennsylvania are believed to have elevated radon levels (Pennsylvania Department of Environmental Protection [PADEP] 2014). This section provides a profile and vulnerability assessment of the radon exposure hazard.

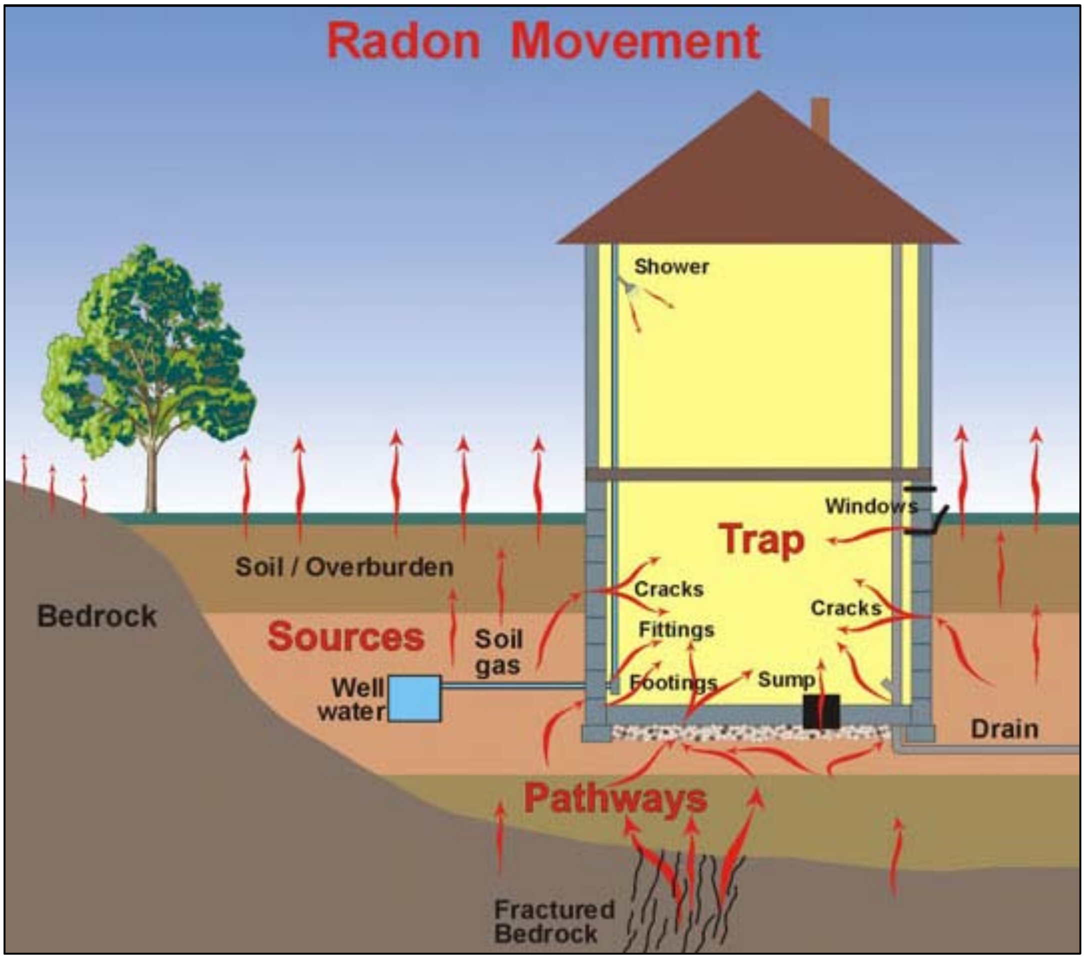
Location and Extent

Radioactivity caused by airborne radon has been recognized for many years as an important component in the natural background radioactivity exposure of humans. Not until the 1980s were the wide geographic distribution of elevated radon levels in houses and the possibility of extremely high radon concentrations in houses recognized. In 1984, routine monitoring of employees leaving the Limerick nuclear power plant near Reading, Pennsylvania, showed that readings from one employee frequently exceeded expected radiation levels, yet only natural, nonfission-product radioactivity was detected on him. Radon levels in his home were detected around 2,500 picoCuries per liter (pCi/L), much higher than the 4 pCi/L guideline set by EPA or even the 67 pCi/L limit for uranium miners. As a result of this event, the Reading Prong section, a physiographic province of Pennsylvania, where this person lived became the focus of the first large-scale radon scare in the world (PA HMP 2013).

Radon (Rn-222), which has a half-life of 3.8 days, is a widespread hazard. The distribution of radon correlates with the distribution of radium (Ra-226), its immediate radioactive parent, and with uranium, its original ancestor. Because of the short half-life of radon, the distance radon atoms travel from their parent before they decay is generally limited to extents of feet or tens of feet (PA HMP 2013). Figure 4.3.10-1 illustrates radon entry points into a home. Three sources of radon in houses are now recognized:

- Radon in soil air that flows into the house
- Radon dissolved in water from private wells and exsolved during water usage (This source is rarely a problem in Pennsylvania.)
- Radon emanating from uranium-rich building materials, such as concrete blocks or gypsum wallboard (This source also is not known to be a problem in Pennsylvania) (PA HMP 2013).

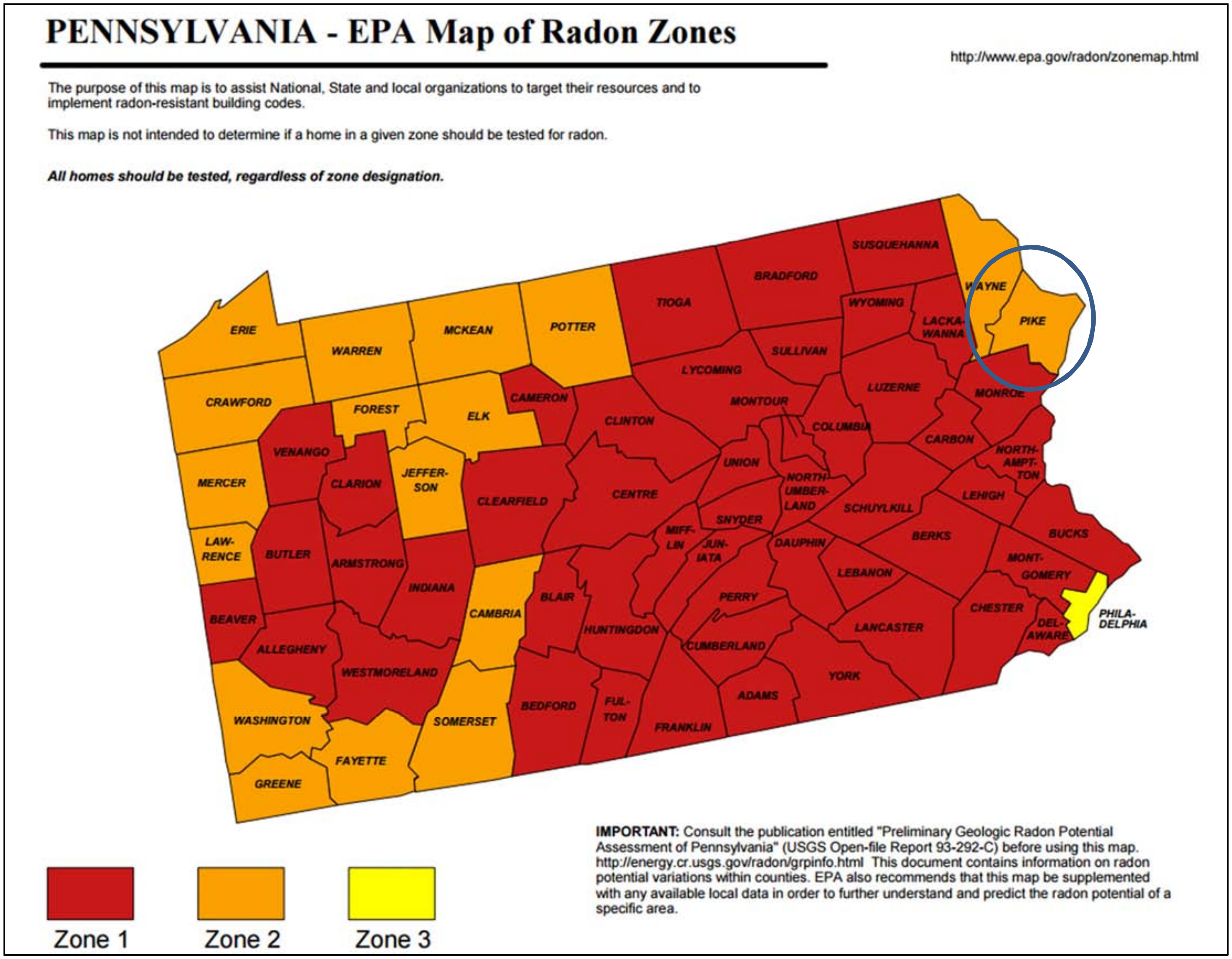
Figure 4.3.14-1. Sketch of Radon Entry Points into a House



Sources: PEMA 2010; Arizona Geological Survey 2006

Each county in Pennsylvania is classified as having a low (Zone 3), moderate (Zone 2), or high (Zone 3) radon hazard potential (Refer to Figure 4.3.14-2). A majority of counties across the Commonwealth, particularly counties in eastern Pennsylvania, have a high hazard potential. According to the EPA map of radon zones, Pike County is located in Zone 2 (counties with predicted average indoor radon screening levels from 2 to 4 pCi/L).

Figure 4.3.14-2. EPA Radon Zones in Pennsylvania



Source: *EPA 2016*

Note: *Pike County is identified by a blue circle. The figure indicates that Pike County is located in EPA Radon Zone 2 (moderate).*

High radon levels were initially thought to be exacerbated in tightly sealed houses, although it is now recognized that rates of air flow into and out of houses, plus the location of air inflow and the radon content of air in the surrounding soil, are key factors affecting radon concentrations. Air must be drawn into a house to compensate for outflows of air caused by a furnace, fan, thermal "chimney" effect, or wind effects. If the upper part of the house is tight enough to impede influx of outdoor air (radon concentration generally below 0.1 pCi/L), an appreciable fraction of the air may be drawn in from the soil or fractured bedrock through the foundation and slab beneath the house, or through cracks and openings for pipes, sumps, and similar features. Soil gas typically contains between a few hundred to a few thousand pCi/L of radon; therefore, even a small rate of soil gas inflow can lead to elevated radon concentrations in a house (PA HMP 2013).

Radon concentration in soil gas depends on a number of soil properties, the importance of which are still being evaluated. In general, 10 to 50 percent of newly formed radon atoms escape the host mineral of their parent radium and gain access to the air-filled pore space. The radon content of soil gas clearly tends to be higher in soils containing higher levels of radium and uranium, especially if the radium occupies a site on or near the surface of a grain from which the radon can easily escape. The amount of pore space in the soil and its permeability for air flow, including cracks and channels, are important factors determining radon concentration in soil gas and its rate of flow into a house. Soil depth and moisture content, mineral host and form for radium, and other soil properties may also be important. Fractured zones may supply air having radon concentrations similar to those in deep soil for houses built on bedrock (PA HMP 2013).

Areas where houses have high levels of radon can be divided into three groups in terms of uranium content in rock and soil:

- Areas of very elevated uranium content (above 50 parts per million [ppm]) around uranium deposits and prospects: Although very high levels of radon can occur in these areas, the hazard normally is restricted to within a few hundred feet of the deposit. In Pennsylvania, these localities occupy an insignificant area.
- Areas of common rock having higher than average uranium content (5 to 50 ppm): In Pennsylvania, these rock types include granitic and felsic alkali igneous rocks and black shales. High uranium values in rock or soil and high radon levels in houses in the Reading Prong are associated with Precambrian granitic gneisses commonly containing 10 to 20 ppm uranium, but locally containing more than 500 ppm uranium. Elevated uranium occurs in black shales of the Devonian Marcellus Formation and possibly the Ordovician Martinsburg Formation in Pennsylvania. High radon values are locally present in areas underlain by these formations.
- Areas of soil or bedrock that have normal uranium content but properties that promote high radon levels in houses: This group is incompletely understood at present. Relatively high soil permeability can lead to high radon concentrations, the clearest example being houses built on glacial eskers. Limestone-dolomite soils also appear to be predisposed for high radon levels in houses, perhaps because of the deep clay-rich residuum where radium is concentrated by weathering on iron oxide or clay surfaces, coupled with moderate porosity and permeability. The importance of carbonate soils is indicated by exceedance of 4 pCi/L in 93 percent of a sample of houses built on limestone-dolomite soils near State College, Centre County, and exceedance of 20 pCi/L in 21 percent of that sample of houses, even though uranium levels in the underlying bedrock are all within the normal range of 0.5 to 5 ppm (PA HMP 2013).

Range of Magnitude

Exposure to radon is the second leading cause of lung cancer after smoking. Radon exposure is the number one cause of lung cancer among nonsmokers. Radon is responsible for approximately 21,000 lung cancer deaths every year, approximately 2,900 of which occur among people who have never smoked. Lung cancer is the only known effect on human health from exposure to radon in air and, thus far, no evidence indicates that children are at greater risk of lung cancer than adults. The main hazard is actually from the radon daughter products (polonium-218, lead-214, bismuth-214), which may become attached to lung tissue and induce lung cancer by their radioactive decay. Table 4.3.10-1 lists the following information for smokers and nonsmokers: (1) cancer risks from exposure to radon at various levels, (2) comparisons of lung cancer risks from radon exposure to comparable cancer risks from other hazards, and (3) action thresholds (PA HMP 2013).

Table 4.3.14-1. Radon Risk for Smokers and Nonsmokers

Radon Level (pCi/L)	Cancer Rate per 1,000 People with Lifetime Exposure	Comparative Cancer Risk of Radon Exposure	Action Threshold
SMOKERS			
20	About 260 people could get lung cancer	250 times the risk of drowning	Fix Structure
10	About 150 people could get lung cancer	200 times the risk of dying in a home fire	
8	About 120 people could get lung cancer	30 times the risk of dying in a fall	
4	About 62 people could get lung cancer	5 times the risk of dying in a car crash	
2	About 32 people could get lung cancer	6 times the risk of dying from poison	Consider fixing structure between 2 and 4 pCi/L
1.3	About 20 people could get lung cancer	(Average indoor radon level)	Reducing radon levels below 2 pCi/L is difficult
0.4	About 3 people could get lung cancer	(Average outdoor radon level)	
NONSMOKERS			
20	About 36 people could get lung cancer	35 times the risk of drowning	Fix Structure
10	About 18 people could get lung cancer	20 times the risk of dying in a home fire	
8	About 15 people could get lung cancer	4 times the risk of dying in a fall	
4	About 7 people could get lung cancer	The risk of dying in a car crash	
2	About 4 people could get lung cancer	The risk of dying from poison	Consider fixing structure between 2 and 4 pCi/L
1.3	About 2 people could get lung cancer	(Average indoor radon level)	Reducing radon levels below 2 pCi/L is difficult
0.4	-	(Average outdoor radon level)	

Note: Risk may be lower for former smokers.
* Lifetime risk of lung cancer deaths from U.S. Environmental Protection Agency (EPA) Assessment of Risks from Radon in Homes (EPA 402-R-03-003).
** Comparison data calculated using the Centers for Disease Control and Prevention's 1999-2001 National Center for Injury Prevention and Control Reports.

Source: EPA 2016

The worst-case scenario for radon exposure would be a large area of tightly sealed homes in Pike County provided residents high levels of exposure over a prolonged period of time without the resident being aware. This worst-case scenario exposure could then lead to a large number of people with cancer attributed to radon exposure. The most likely scenario is a single household exposed to a very low concentration of radon, with no adverse health effects.

Past Occurrence

Current data on abundance and distribution of radon as it affects individual houses in the Commonwealth of Pennsylvania in general is considered incomplete and potentially biased (PA HMP 2013). Pike County is not an exception. The EPA has estimated that the national average indoor radon concentration is 1.3 pCi/L and the level for action is 4.0 pCi/L; however they have estimated that the average indoor concentration in Pennsylvania basements is about 7.1 pCi/L and 3.6 pCi/L on the first floor (PADEP 2016).

In 2015, a groundwater study was conducted by the USGS in collaboration with the Pike County Conservation District. The purpose of this study was to characterize the chemical quality of groundwater from shallow freshwater aquifers used by private residential homes and business supply wells in the County prior to gas drilling. As part of this study, 80 private wells were sampled in 2015 and analyzed for major ions, metals, dissolved gases, gross alpha- and gross-beta radioactivity, dissolved and suspended solids, oil and grease, total coliform, and determination of radon-222, dissolved nutrients, and additional major ions. As results become available from the Pike County Conservation District, they will be included in Pike County's HMP update.

The PADEP Bureau of Radiation Protection provides information for homeowners on how to test for radon in their houses. If a test results in radon concentrations over 4.0 pCi/L, then the Bureau works to help the homeowners make repairs to their houses to mitigate against high radon levels. The total number tests reported to the Bureau since 1990 and their results are provided by zip code on the Bureau's website and are summarized in Table 4.3.10-2 below for Pike County. However, this information is only provided if over 30 tests total were reported in order to best approximate the average for the area (PADEP 2016).

In Pike County, all zip codes had reported results from a sufficient number of tests to allow the Bureau to report the findings, which are shown in the table below. Please note that the PADEP does not post public results unless a zip code has had at least 30 tests conducted. The PADEP only publishes the average and maximum results for a zip code; it does not offer a range of results for a zip code, municipality, or region. The PADEP Radon Division recommends that all homeowners test for radon, regardless of test results within their respective zip codes. Despite a low average text result within a zip code, many homes in that zip code may have elevated radon levels.

Table 4.3.10-2. Radon Level Tests and Results by Pike County Zip Codes

ZIP Code	Location	Area in Home	Number of Tests	Maximum Result (pCi/L)	Average Result (pCi/L)
18336	Matamoras	Basement	188	44.4	4.1
		First Floor	63	11.4	1.6
18337	Milford	Basement	1,682	111.7	5.1
		First Floor	511	36.3	2.6
18428	Lords Valley (Blooming Grove Township)	Basement	1,816	89.0	4.6
		First Floor	739	40.1	2.5
18328	Delaware Township	Basement	1,106	70.7	4.6
		First Floor	491	23.1	2.2
18426	Greentown (Greene Township)	Basement	804	119.5	5.1
		First Floor	226	12.0	2.0
18428	Hawley (Lackawaxen Township)	Basement	1816	89.0	4.6
		First Floor	739	40.1	2.5
18324	Bushkill (Lehman Township)	Basement	1,195	456.0	5.5
		First Floor	437	73.2	2.8
18451	Paupack (Palmyra Township)	Basement	143	56.6	5.5
		First Floor	40	10.5	2.1
18458	Shohola Township	Basement	306	55.3	4.5
		First Floor	106	16.4	2.0

Source: PADEP 2016
Notes: pCi/L picoCuries per liter

Future Occurrence

Radon exposure is inevitable, given present soil, geologic, and geomorphic factors across Pennsylvania. Residents who live in developments within areas where radon levels previously have been found significantly high will continue to be more susceptible to exposure. However, new incidents of concentrated exposure may occur with future development or deterioration of older structures. Exposure can be limited by conducting proper testing within both existing and future developments, and implementing appropriate mitigation measures (PEMA 2013). As part of a 2014 initiative, EPA's "Test, Fix, Save a Life" radon action campaign strives to highlight radon testing and mitigation as a simple and affordable step to significantly reduce risk for lung cancer. Through this initiative, the "Test, Fix, Save a Life" mantra specifies activities and facts for the public regarding radon poisoning, as indicated below:

- Test: All homes with or without basements should be tested for radon. Affordable do-it-yourself radon test kits are available online and at home improvement and hardware stores, or you can hire a qualified radon tester.
- Fix: EPA recommends taking action to fix radon levels at or above 4.0 pCi/L and contacting a qualified radon-reduction contractor. In most cases, a system with a vent pipe and fan is used to reduce radon. Addressing high radon levels often costs the same as other minor home repairs.
- Save a Life: 21,000 Americans die from radon-related lung cancer each year. By decreasing elevated levels in a home, residents can help prevent lung cancer while creating a healthier home (EPA 2014).

Based on available data and the fact that radon is present across Pike County, future occurrences of radon exposure can be considered *highly likely* as defined by the Risk Factor Methodology probability criteria (further discussed in Section 4.4).

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed or vulnerable within the identified hazard area. The following section discusses potential impacts of the radon exposure hazard on Pike County, including:

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

Overview of Vulnerability

Radon exposure is of particular concern in Pike County because of the County's location within EPA Radon Zone 2 (moderate potential). While structural factors (such as building construction and engineered mitigation measures) can influence the level of radon exposure, all residents and structures within Pike County are potentially vulnerable to radon.

Data and Methodology

The 2010 U.S. Census data for Pike County was referenced to support an evaluation of assets exposed to this hazard and potential impacts associated with this hazard. In accordance with the 2013 Pennsylvania State Hazard Mitigation Plan, an average radon mitigation system cost of $1,200 was applied to 20 percent of the building stock to evaluate economic vulnerability (PEMA 2013).

Impact on Life, Health, and Safety

For the purposes of this plan, the entire population of the County is assumed exposed to radon. Radon is responsible for approximately 21,000 lung cancer deaths every year, approximately 2,900 of which occur among people who have never smoked. Lung cancer is the only known effect on human health from exposure to radon in air, and thus far, no evidence indicates that children are at greater risk of lung cancer than are adults (EPA 2010).

Impact on General Building Stock and Critical Facilities

While the entire general building stock and critical facility inventory in the County is exposed to radon, radon does not result in direct damage to structures and facilities. Rather, engineering methods installed to mitigate human exposure to radon in structures results in economic costs described in in this section. The 2013 Pennsylvania State HMP notes that Pike County has 26 State critical facilities located in zip codes with average high radon test results (PEMA 2013).

Impact on the Economy

The EPA has concluded that an average radon mitigation system costs $1,200. EPA also states that current state surveys indicate one home in five has elevated radon levels. Based on this information, radon loss estimation is factored by assuming that 20 percent of the residential buildings within High Potential (Level 1) counties have elevated radon levels, and each would require a radon mitigation system installed at the EPA-estimated average of $1,200 (PEMA 2013). Therefore, within Pike County, estimated radon mitigation costs for residential structures could exceed $5.2 million. However, this costs could be higher based on the number of households in the County with radon levels exceeding 4 pCi/L.

Impact on the Environment

Radon exposure exerts minimal environmental impacts. Because of the relatively short half-life of radon, it tends to affect only living and breathing organisms such as humans or pets that are routinely within contained areas (basement or house) where the gas is released (PEMA 2013).

Future Growth and Development

Areas targeted for potential future growth and development within the next 5 years have been identified across the County (further discussed in Section 2.4 of this HMP). Any new land development will be exposed to this hazard. Measures to reduce human exposure to radon in structures are readily available and can be incorporated during new construction at significantly lower cost and greater effectiveness than retrofitting existing structures to implement these measures.

Effect of Climate Change on Vulnerability

According to the EPA's *Climate Change and Indoor Air* Quality contractor report, the primary factors that influence radon entry into a home include: radon content of the soil; pressure differential between the interior of the home and the soil; the air exchange rate for the home; the moisture content surrounding the home; and the presence and size of entry pathways. These factors can be affected by climate change to different degrees. Climate change may also affect the depositional environment within the home resulting in changes to the delivered dose by radon decay products. Additionally, the EPA stated that the relative concentration of radon to its decay products, and the ability to deliver dose, is impacted by numerous factors including building ventilation rate, decay product attachment to aerosols, and particle deposition rate on surface. All these factors could be impacted by housing as well as behavioral changes driven directly or indirectly by climate change. For example, the increased use of ceiling fans could increase deposition of radon decay products and reduce the delivered radon-related doses to the lungs (EPA 2010).

Additional Data and Next Steps

The assessment above identifies human health and economic losses associated with this hazard of concern; however, these estimates are based on national epidemiological statistics and generalized estimates of costs to mitigate structures in Pike County. Because specific structural conditions affect human exposure to radon, direct radon measurements within facilities are necessary to properly assess the level of health risk and indicate the need for mitigation measures. Furthermore, EPA recommends consideration of radon exposure risk and installation of mitigation measures as appropriate during all new construction.

4.3.15 Terrorism

Terrorism is defined in the Code of Federal Regulations (CFR) as "the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives" (Title 28 CFR §0.85 2015). Terrorism is less about causing physical damage and injuries (and fatalities) as it is about creating and spreading fear. This fear may result in a change in key policy or business operations to cease. Terrorism may include the use of weapons of mass destruction (WMD), including chemical, biological, radiological, nuclear, and high-yield explosive weapons; armed attacks; industrial sabotage; cyber terrorism; and other means. These categories can be further subcategorized or attacks can involve multiple categories, especially when considering the means and purpose behind the event.

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

Location and Extent

An important consideration in evaluating terrorism hazards is the existence of facilities, landmarks, or other buildings of international, national, or regional importance. While Pike County has many notable landmarks from a local historic perspective, there are no sites which are considered significant landmarks in terms of national or international importance.

Nonetheless, terrorism can take many forms and terrorists have a wide range of personal, political, or cultural agendas. Therefore, there is no location that is not a potential terrorist target. Two types of terrorist activity are particularly relevant to Pike County: agroterrorism and intentional hazardous material releases. Agroterrorism is the direct, intentional, generally covert contamination of food supplies or introduction of pests and/or disease agents to crops and livestock. Approximately 3-percent of Pike County's land area is dedicated to agriculture.

Several major transportation routes and two large gas transmission pipelines traverse the County; making intentional hazard material releases a potential threat to citizens and the environment. This hazard is addressed in Section 4.3.4. In addition, there are several bridges that connect Pike County to the New York – New Jersey metropolitan area that could be considered potential targets.

Although Pike County does not have a large number of facilities that could be considered targets, it does have the type of facilities that are considered, including school complexes, shopping areas, government buildings, including jails, water distribution systems and dams, power plants and communications systems. A complete list of critical facilities is included in Appendix E.

In addition, all bridges and railways (discussed in Section 4.3.17) across the County are considered potential targets.

Furthermore, the threat of a nuclear attack is rare but should not be eliminated. There are still several countries in the world with nuclear capability and other nations continue to try to obtain that capability. Any areas that are identified as high risk areas or target areas would experience the direct effects of the weapon, including blast, radiation, extreme temperatures, wind and light which is brighter than the sun. Depending on the size of the device, there could be total destruction within a 4-mile radius of the blast. Any survivors within a 20- mile radius can expect residual effects including fires, flooding, loss of power, fuel and water shortages, plus the release of other hazardous materials that may be in the area. People close to the blast would be killed. As the distance increases, more people will survive, however, people that do survive the initial blast may die due to an increase in exposure to gamma rays.

Because of Pike County's location and proximity to the New York metropolitan area, should a major attack occur, Pike County should expect to receive some exposure from radioactive fallout. Pike County should also expect to see an influx of people from the New York metropolitan area seeking safety.

Range of Magnitude

Any acts of terrorism can occur anywhere, at any time of day. The National Terrorism Advisory System (NTAS) communicates information about terrorist threats by providing detailed information to the public, government agencies, first responders, airports and other transportation hubs, and the private sector. When a threat arises, the Secretary of Homeland Security announces an NTAS Alert and shares the news with the public. The alert may include specific information about the nature of the threat, including the geographic region, mode of transportation, or critical infrastructure potentially affected, as well as steps that individuals and communities can take to protect themselves and help prevent, mitigate, or respond to the threat. The alert indicates whether the threat is elevated or imminent. Elevated threats are those that include no specific information about the timing or location. Imminent threats are threats believed to be impending, or occurring very soon. The alerts will be posted on-line on multiple government websites (which websites may vary dependent on the threat) and released to the news media for distribution. U.S. Department of Homeland Security (DHS) will also distribute alerts through its social media channels (DHS 2015).

Terrorism refers to the use of WMDs, including biological, chemical, nuclear, and radiological weapons; arson, incendiary, explosive, and armed attacks; industrial sabotage and intentional hazardous materials releases; and "cyber-terrorism." Within these general categories, however, there are many variations. Particularly in the area of biological and chemical weapons, there are a wide variety of agents and ways for them to be disseminated. Terrorist methods can take many forms, including:

- Agri-terrorism
- Arson/incendiary attack
- Armed attack
- Biological agent
- Chemical agent
- Cyber-terrorism (or computer-based attacks)
- Conventional bomb or bomb threat
- Hazardous material release (intentional)
- Nuclear bomb
- Radiological agent

In Pike County, terrorist attacks could vary from a mere threat to an individual facility, to the use of a high-yield explosive or other device in a highly populated area.

Past Occurrence

Pike County has never suffered an international terrorist attack. However, Pike County has experienced domestic terrorism incidents. Table 4.3.15-1 displays terrorism incidents reported to PEIRS between 2002 and 2009. The most common terroristic threat was bomb threats. In addition to the events identified in the table below, Pike County indicated that between 2010 and 2016 (as of October 5, 2016), 48 incidents identified as suspicious activities in the County (Pike County 2016).

Table 4.3.15-1. Terrorism Incidents/Suspicious Activity in Pike County from 2002 to 2009

Date	Location	Type
02/08/2002	Lehman Township	Bomb Threat
02/14/2003	Palmyra Township	Bomb Threat
06/11/2003	Palmyra Township	Bomb Threat
12/18/2003	Palmyra Township	Bomb Threat
10/28/2004	Palmyra Township	School Bomb Threat
03/29/2006	Lehman Township	School Bomb Threat
04/05/2006	Lehman Township	School Bomb Threat
05/10/2006	Westfall Township	Bomb Threat
05/30/2006	Palmyra Township	Suspicious Activity
09/11/2006	Lehman Township	School Bomb Threat
07/02/2007	Dingman Township	Suspicious Device
12/29/2007	Blooming Grove Township	Suspicious Device
02/21/2008	Lehman Township	Terroristic Threat

Source: PEIRS, 2002-09

Future Occurrence

Based on historical events, Pike County can expect to experience several terrorist threats or suspicious activities each year; however, few will result in an actual terrorist incident. Previous events in the County have not resulted in what are considered significant terrorist attacks; the severity of a future incident cannot be predicted with a sufficient level of certainty. Based on the recent incident events, the future occurrence of terrorism in Pike County can be considered *possible* as defined by the Risk Factor Methodology probability criteria (refer to Section 4.4).

Vulnerability Assessment

The probability of Pike County becoming a terrorist target should remain relatively low, however, because of its proximity to other more vulnerable areas its vulnerability and potential for secondary impacts is increased. The County may experience some serious issues with influx of people from the more metropolitan areas to the east in situations of terrorism and/or nuclear threats to these areas. This influx of population in these critical situations would stress the facilities of the County and its municipalities.

Since the probability of terrorism occurring cannot be quantified in the same way as that of many natural hazards, it is not possible to assess vulnerability in terms of likelihood of occurrence. Instead, vulnerability is assessed in terms of specific assets. By identifying potentially at-risk terrorist targets in a community, planning efforts can be put in place to reduce the risk of attack. All communities in Pike County are vulnerable on some level, directly or indirectly, to a terrorist attack. However, communities where the previously mentioned potential targets are located should be considered more vulnerable. Site-specific assessments should be based on the relative importance of a particular site to the surrounding community or population. Threats that are known to exist and vulnerabilities include:

- <u>Inherent vulnerability</u>:
  - Visibility – How aware is the public of the existence of the facility?
  - Utility – How valuable might the place be in meeting the objectives of a potential terrorist?
  - Accessibility – How accessible is the place to the public?
  - Asset mobility – is the asset's location fixed or mobile?

- Presence of hazardous materials – Are flammable, explosive, biological, chemical and/or radiological materials present on site? If so, are they well secured?
- Potential for collateral damage – What are the potential consequences for the surrounding area if the asset is attacked or damaged?
- Occupancy – What is the potential for mass casualties based on the maximum number of individuals on site at a given time?

- Tactical vulnerability:

  Site Perimeter
  - Site planning and Landscape Design – Is the facility designed with security in mind – both site-specific and with regard to adjacent land uses?
  - Parking Security – Are vehicle access and parking managed in a way that separates vehicles and structures?

  Building Envelope
  - Structural Engineering – Is the building's envelope designed to be blast-resistant? Does it provide collective protection against chemical, biological and radiological contaminants?

  Facility Interior
  - Architectural and Interior Space Planning – Does security screening cover all public and private areas?
  - Mechanical Engineering – Are utilities and HVAC systems protected and/or backed up with redundant systems?
  - Electrical Engineering – Are emergency power and telecommunications available? Are alarm systems operational? Is lightning sufficient?
  - Fire Protection Engineering – Are the building's water supply and fire suppression systems adequate, code-compliant and protected? Are on-site personnel trained appropriately? Are local first responders aware of the nature of the operations at the facility?
  - Electronic and Organized Security – Are systems and personnel in place to monitor and protect the facility?

Pike County is involved in a Regional Catastrophic Planning Team which includes counties in New York and New Jersey in the New York City metropolitan area. The counties involved in the initiative correspond to the U.S. Census Bureau's New York-Newark-Bridgeport, NY-NJ-CT-PA Combined Statistical Area (CSA) and include the largest city in the United States (New York), the two largest cities in New Jersey (Newark and Jersey City), and Bridgeport, Connecticut. Pike County is the only participating Pennsylvania County. The team offers planning support for COOP and COG plans, debris management plans, shelter plans, logistical planning, mass fatality planning, and mass casualty planning. Through Pike County's involvement in the group, the County is able to plan for evacuation and sheltering needs if a terroristic incident were to occur.

4.3.16 TORNADOES AND WINDSTORMS

This section provides a profile and vulnerability assessment of the tornado and windstorm hazard. The wind hazard includes various types of wind events, including windstorms and tornados, which are defined below.

Wind is air moving from high to low pressure. It is the rough horizontal movement of air (as opposed to an air current) caused by uneven heating of the Earth's surface. It occurs at all scales, from local breezes generated by heating of land surfaces and lasting tens of minutes, to global winds resulting from solar heating of the Earth (Federal Emergency Management Agency [FEMA] 1997). Types of damaging winds include straight-line winds, downdrafts, downbursts, microbursts, gust fronts, derecho, bow echoes, and hook echoes, described as follows:

- **Straight-line Wind** is any thunderstorm wind not associated with rotation (e.g., tornadic winds). Straight-line winds are movements of air from areas of higher pressure to areas of lower pressure—the greater the difference in pressure, the stronger the winds.
- A **Downdraft** is a small-scale column of air that rapidly sinks toward the ground and usually results in a downburst.
- A **Downburst** is a strong downdraft with horizontal dimensions larger than 2.5 miles, resulting in an outward burst or damaging winds on or near the ground. It is usually associated with thunderstorms, but can occur with rain storms too weak to produce thunder.
- A **Microburst** is a small, concentrated downburst that produces an outward burst of damaging winds near the surface. It is typically short-lived, lasting only 5 to 10 minutes, with maximum wind speeds of up to 168 miles per hour (mph).
- A **Gust Front** is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. It is characterized by a wind shift, temperature drop, and gusty winds ahead of a thunderstorm (National Severe Storms Laboratory [NSSL] Date Unknown).
- A **Derecho** is a widespread and long-lived windstorm associated with thunderstorms that are often curved (Johns and others 2011). The two major influences on the atmospheric circulation are differential heating between the equator and the poles, and rotation of the planet (Federal Emergency Management Agency [FEMA] 1997).
- A **Bow Echo** is a radar echo that is linear but bent outward in a bow shape. Damaging straight-line winds often occur near the center of a bow echo (crest). Bow echoes can be more than 300 kilometers long, last for several hours, and produce extensive swaths of wind damage at the ground (NSSL Date Unknown).
- A **Hook Echo** is a radar echo that is the most recognized and well-known radar signature for a tornadic supercell. This "hook-like" feature occurs when the strong counter-clockwise winds circling the mesocyclone (rotating updraft) are strong enough to wrap precipitation around the rain-free updraft area of the storm (NSSL 2016).

High winds other than tornados occur in all parts of the United States. Areas where wind speeds are highest are coastal regions from Texas to Maine and the Alaskan coast; however, speeds of exposed winds in mountain areas can be at least as high as those along the coast (FEMA 1997, Robinson 2013). Wind begins with differences in air pressures. A wind's rough horizontal movement of air is caused by uneven heating of the Earth's surface. Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the Earth. Effects from high winds can include downed trees and power lines, and damaged roofs and windows. Table 4.3.16-1 lists wind classifications used by the National Weather Service (NWS).

Table 4.3.16-1. NWS Wind Descriptions

Descriptive Term	Sustained Wind Speed (mph)
Strong, dangerous, or damaging	≥40
Very windy	30-40
Windy	20-30
Breezy, brisk, or blustery	15-25
Light, or light and variable wind	5-15 or 10-20
None	0-5

Source: *NWS 2011*
Notes:
mph *Miles per hour*
NWS *National Weather Service*

Extreme windstorm events are associated with extra-tropical and tropical cyclones, winter cyclones, severe thunderstorms, and accompanying mesoscale offspring such as tornados and downbursts. Winds vary from 0 mph at ground level to 200 mph in the upper atmospheric jet stream at 6 to 8 miles above the Earth's surface (FEMA 1997).

A type of windstorm that occurs often during rapidly-moving thunderstorms is a derecho, a long-lived windstorm associated with a rapidly moving squall line of thunderstorms. It produces straight-line wind gusts of at least 58 mph, and often isolated gusts exceeding 75 mph. As a result, trees generally fall and debris is blown in one direction. To be considered a derecho, these conditions must continue along a path of at least 240 miles. Derechos are more common in the Great Lakes and Midwest regions of the United States, though, on occasion, can persist into the mid-Atlantic and northeast United States (Office of the New Jersey State Climatologist [ONJSC] Rutgers University 2013).

Tornados are nature's most violent storms and can cause fatalities and devastate neighborhoods in seconds. A tornado appears as a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 250 mph. Damage paths can be greater than 1 mile wide and 50 miles long. Tornados typically develop from either a severe thunderstorm or hurricane as cool air rapidly overrides a layer of warm air. Tornados typically move at speeds between 30 and 125 mph, and can generate internal winds exceeding 300 mph. The lifespan of a tornado rarely is longer than 30 minutes (FEMA 1997). High wind velocity and wind-blown debris, along with lightning or hail, cause the damage from tornados. Destruction from tornados depends on the size, intensity, and duration of the storm. Tornados cause the greatest damage to structures that are light, such as residential and mobile homes, and tend to remain localized during impact (Northern Virginia Regional Commission [NVRC] 2006).

The following sections discuss location and extent, range of magnitude, previous occurrences, future occurrences, and vulnerability assessment associated with the wind and tornado hazard within Pike County.

Location and Extent

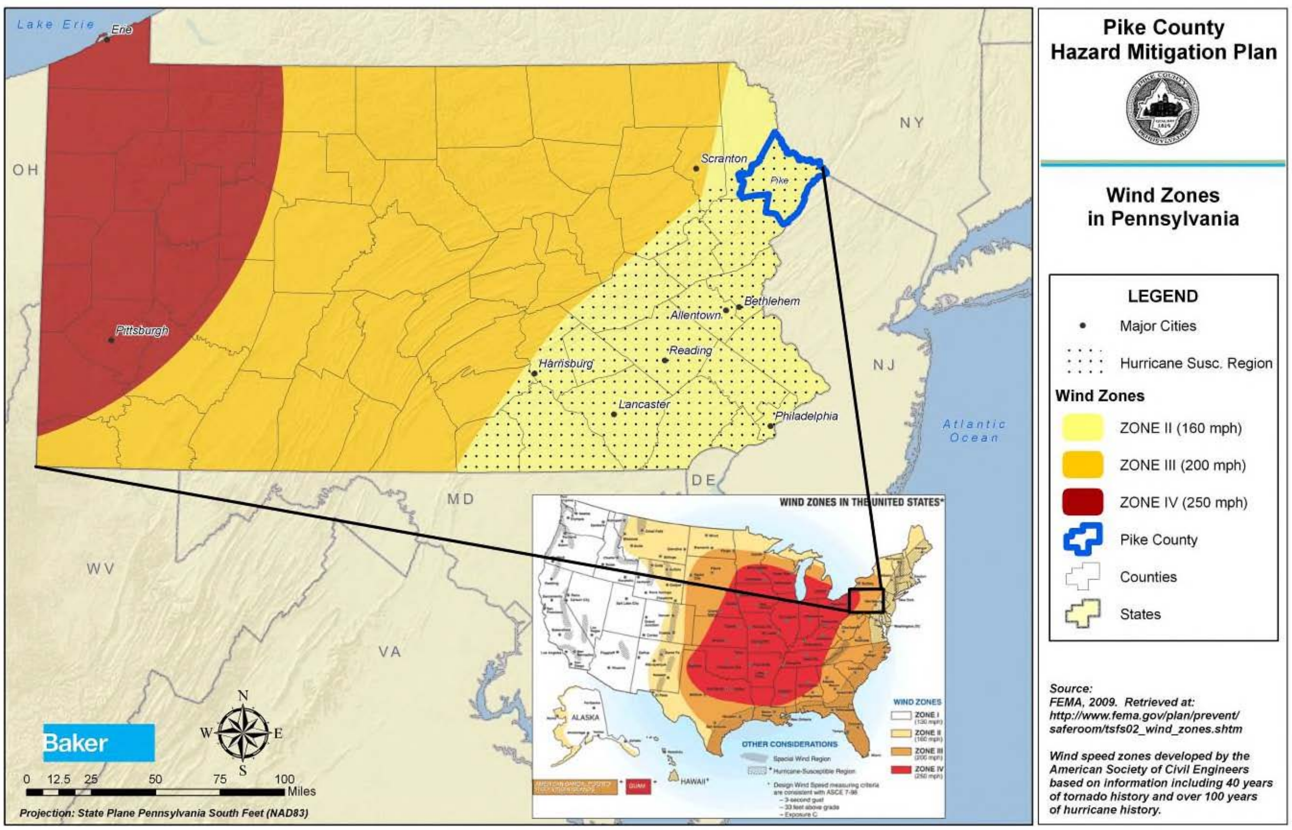
Tornadoes and windstorms can occur throughout Pike County though events are usually localized. However, severe thunderstorms may result in conditions favorable to the formation of numerous or long-lived tornadoes. Tornadoes can occur at any time during the day or night, but are most frequent during late afternoon into early evening, the warmest hours of the day, and most likely to occur during the spring and early summer months of March through June. Tornado movement is characterized in two ways: direction and speed of spinning winds, and forward movement of the tornado, also known as the storm track. The forward motion of the tornado path can be a few hundred yards or several hundred miles in length. The width of tornadoes can vary greatly, but generally range in size from less than 100 feet to over a mile in width. Some tornadoes never touch the ground and are short-lived, while others may touch the ground several times. Straight-line winds and windstorms occur on a region-wide scale

(Pennsylvania Emergency Management Agency [PEMA] 2013). While such winds usually accompany tornadoes, straight-lined winds are caused by the movement of air from areas of higher pressure to areas of lower pressure. Stronger winds are the result of greater differences in pressure. Windstorms are generally defined with sustained wind speeds of 40 mph or greater lasting for one hour or longer, or winds of 58 mph or greater for any duration.

Windstorms

Figure 4.3.16-3 illustrates the ways in which the frequency and strength of windstorms affect the United States, and the general location of the most wind activity. This figure is based on 40 years of tornado history and 100 years of hurricane history collected by FEMA. States located in Wind Zone IV have undergone the greatest number of tornados and the strongest tornados (NVRC 2006). Pike County is within Wind Zone II, where wind speeds can be as high as 160 mph. Table 4.3.16-2 describes the areas within the various wind zones of the United States.

Figure 4.3.16-1. Wind Zones in the United States



Source: Pike County HMP 2012

Table 4.3.16-2. Wind Zones in the United States

Wind Zones	Areas Affected
Zone I (130 mph)	All of Washington, Oregon, California, Idaho, Utah, and Arizona. Western parts of Montana, Wyoming, Colorado, and New Mexico. Most of Alaska, except the east and south coastlines.
Zone II (160 mph)	Eastern parts of Montana, Wyoming, Colorado, and New Mexico. Most of North Dakota. Northern parts of Minnesota, Wisconsin, and Michigan. Western parts of South Dakota, Nebraska, and Texas. All New England States. Eastern parts of New York, Pennsylvania, Maryland, and Virginia. Washington DC.
Zone III	Areas of Minnesota, South Dakota, Nebraska, Colorado, Kansas, Oklahoma, Texas,

Wind Zones	Areas Affected
(200 mph)	Louisiana, Mississippi, Alabama, Georgia, Tennessee, Kentucky, Pennsylvania, New York, Michigan, and Wisconsin. Most or all of Florida, Georgia, South Carolina, North Carolina, Virginia, and West Virginia. All of American Samoa, Puerto Rico, and Virgin Islands.
Zone IV (250 mph)	Mid United States, including all of Iowa, Missouri, Arkansas, Illinois, Indiana, and Ohio, and parts of adjoining states of Minnesota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, Louisiana, Mississippi, Alabama, Georgia, Tennessee, Kentucky, Pennsylvania, Michigan, and Wisconsin. Guam.
Special Wind Region	Isolated areas in the following states: Washington, Oregon, California, Idaho, Utah, Arizona, Montana, Wyoming, Colorado, and New Mexico. The borders between Vermont and New Hampshire; between New York, Massachusetts, and Connecticut; between Tennessee and North Carolina.
Hurricane Susceptible Region	Southern United States coastline from Gulf Coast of Texas eastward to include entire State of Florida. East coastline from Maine to Florida, including all of Massachusetts, Connecticut, Rhode Island, Delaware, and Washington DC. All of Hawaii, Guam, American Samoa, Puerto Rico, and Virgin Islands.

Source: FEMA 2010
Note: mph Miles per hour

Tornados

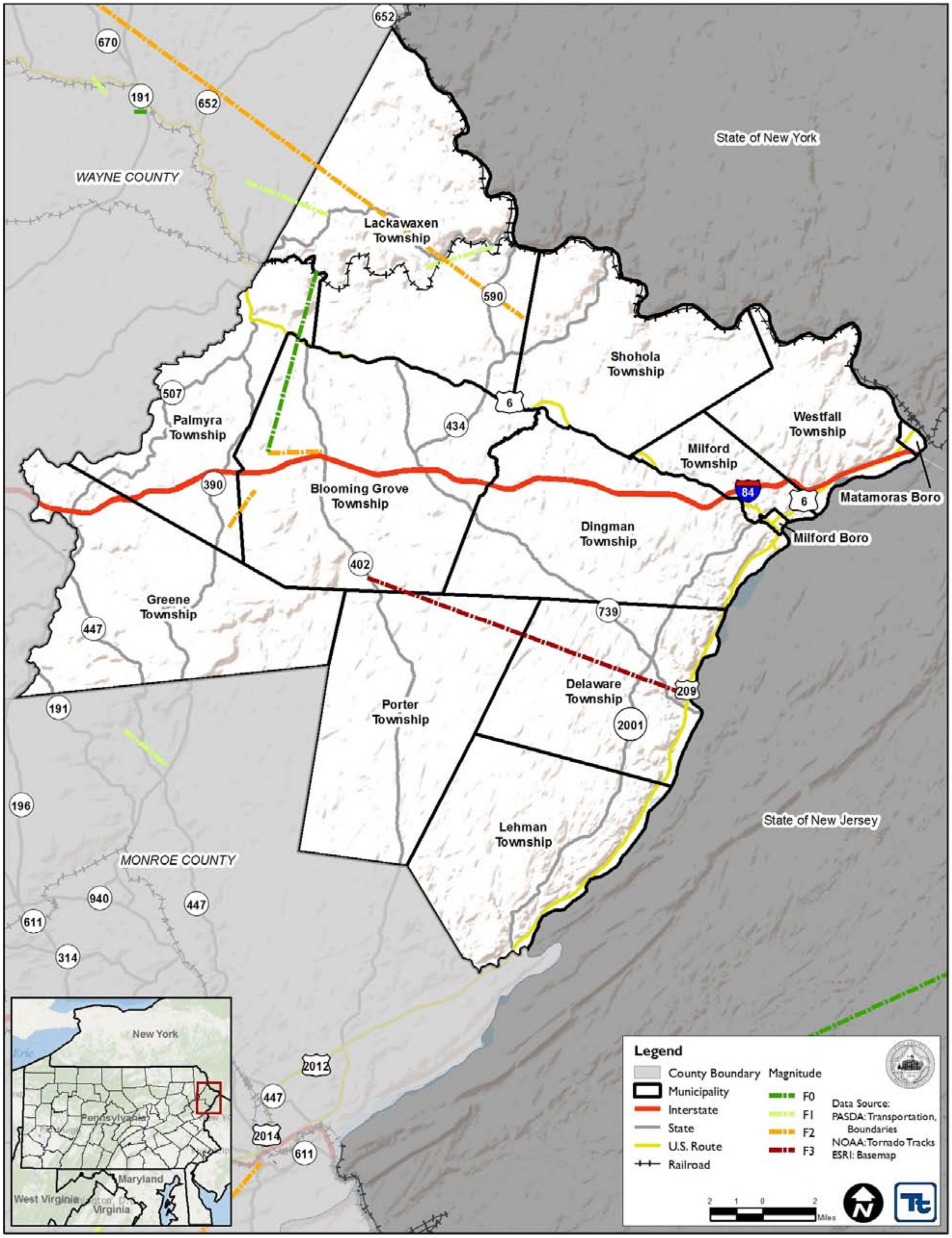
The United States undergoes more tornados than any other country—in a typical year, approximately 1,000. The peak of the U.S. tornado season is April through June, with the highest concentration of tornados in the central United States, although tornados can occur at any time of year (NWS 2011). Tornados tend to strike in the afternoons and evening, the warmest hours of the day, with approximately 80 percent of all tornados striking between noon and 9:00 p.m. (PEMA 2013).

Tornado movement is characterized in two ways: direction and speed of the spinning winds, and forward movement of the tornado and storm track. Rotational wind speeds of the vortex can range from 100 to more than 250 mph. Speed of forward motion can be 0 to 45 or 50 mph. Therefore, some estimates of maximum velocity of tornados (combination of ground speed, wind speed, and upper winds) are about 300 mph. Forward motion of the tornado path can be a few hundred yards or several hundred miles in length. Widths of tornados can vary greatly, but widths generally range from less than 100 feet to more than a mile. Some tornados never touch the ground and are short-lived, while others may touch the ground several times.

While the extent of tornado damage is usually localized, extreme winds of this vortex can be among the most destructive on Earth when they move through populated, developed areas. The Commonwealth of Pennsylvania underwent an average of 15 tornado events annually between 1981 and 2010.

Figure 4.3.16-2 depicts that tornado activity has occurred throughout the entire County.

Figure 4.3.16-2. Tornadoes that have touched down in Pike County between 1950 and 2014



Range of Magnitude

Windstorms are generally defined as sustained wind speeds of 40 mph or greater, lasting for 1 hour or longer, or winds of 58 mph or greater for any duration. A tornado's magnitude is classified according to the Enhanced Fujita Scale (EF Scale), further discussed below.

Magnitude or severity of a tornado was originally categorized according to the Fujita Scale (F Scale) or the Pearson Fujita Scale introduced in 1971, based on a relationship between the Beaufort Wind Scales (B-Scales) (measure of wind intensity) and the Mach number scale (measure of relative speed). The F Scale is used to rate the intensity of a tornado by examining the damage caused by the tornado after it has passed over a man-made structure (Tornado Project Date Unknown). The F Scale categorizes each tornado by intensity and area, and is divided into six categories—F0 (Gale) to F5 (Incredible) (Edwards 2013).

Although the F Scale has been in use for more than 30 years, it has limitations. The primary limitations are lack of Damage Indicators (DI), no account of construction quality and variability, and no definitive correlation between damage and wind speed. These limitations have led to inconsistent rating of tornados and, in some cases, overestimates of tornado wind speeds. The limitations encouraged and induced development of the Enhanced Fujita Scale (EF Scale). The Texas Tech University Wind Science and Engineering (WISE) Center, along with a forum of nationally renowned meteorologists and wind engineers from across the country, developed the EF Scale (NWS 2016).

The EF Scale became operational on February 1, 2007. It is used to assign tornados a rating based on estimated wind speeds and related damage. When tornado-related damage is surveyed, it is compared to a list of DIs and Degrees of Damage (DOD), which help better estimate the range of wind speeds produced by the tornado. From that, a rating is assigned, similar to that of the F Scale, with six categories from EF0 to EF5, representing increasing degrees of damage. The EF Scale was revised from the original F Scale to reflect better examinations of tornado damage surveys. This scale was developed with consideration to the designs of most structures (NWS 2016). Table 4.3.16-3 details each of the six categories of the EF Scale.

Table 4.3.16-3. Enhanced Fujita Damage Scale

EF Scale Number	Intensity Phrase	Wind Speed (mph)	Type of Damage Done
EF0	Light tornado	65–85	Light damage. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	Moderate tornado	86-110	Moderate damage. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	Significant tornado	111-135	Considerable damage. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	Severe tornado	136-165	Severe damage. Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	Devastating tornado	166-200	Devastating damage. Well-constructed houses and whole-frame houses completely leveled; cars thrown, and small missiles generated.
EF5	Incredible tornado	>200	Incredible damage. Strong-frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air over distances exceeding 100 meters (109 yards); high-rise buildings undergo significant structural deformation; incredible phenomena occur.

Source: NWS 2016 *Note: mph = Miles per hour*

The EF Scale takes into account more variables than the original F Scale in assigning a wind speed rating to a tornado. The EF Scale incorporates 28 DIs, such as building type, structures, and trees. There are eight DODs for each DI, ranging from the beginning of visible damage to complete destruction of the DI. Table 4.3.16-4 lists the 28 DIs, with a description of construction typical for each DI. Each DOD in every category is assigned an estimated expected wind speed, a lower boundary of wind speed, and an upper boundary of wind speed.

Table 4.3.16-4. EF Scale Damage Indicators

Number	Damage Indicator	Abbreviation	Number	Damage Indicator	Abbreviation
1	Small barns, farm outbuildings	SBO	15	School – 1-story elementary (interior or exterior halls)	ES
2	One- or two-family residences	FR12	16	School – junior or senior high school	JHSH
3	Single-wide mobile home	MHSW	17	Low-rise (1-4 story) building	LRB
4	Double-wide mobile home	MHDW	18	Mid-rise (5-20 story) building	MRB
5	Apartment, condominium, townhouse (3 stories or less)	ACT	19	High-rise (over 20 stories)	HRB
6	Motel	M	20	Institutional building (hospital, government. or university)	IB
7	Masonry apartment or motel	MAM	21	Metal building system	MBS
8	Small retail building (fast food)	SRB	22	Service station canopy	SSC
9	Small professional (doctor office, branch bank)	SPB	23	Warehouse (tilt-up walls or heavy timber)	WHB
10	Strip mall	SM	24	Transmission line tower	TLT
11	Large shopping mall	LSM	25	Free-standing tower	FST
12	Large, isolated ("big box") retail building	LIRB	26	Free-standing pole (light, flag, luminary)	FSP
13	Automobile showroom	ASR	27	Tree – hardwood	TH
14	Automotive service building	ASB	28	Tree – softwood	TS

Source: Storm Prediction Center (SPC) 2006

Events after February 2007 are classified based on the EF Scale. Previous occurrences and losses associated with historical tornado events, described in the Past Occurrences section of this hazard profile (Section 4.3.16.3), are classified based on the F Scale.

Figure 4.3.16-1, above, shows wind speed zones developed by the American Society of Civil Engineers based on information including 40 years of tornado history and over 100 years of hurricane history. It identifies wind speeds that could occur across the United States to be used as the basis for design and evaluation of the structural integrity of shelters and critical facilities. According to the figure, Pike County falls within Zone III, meaning design wind speeds for shelters and critical facilities should be able to withstand a 3-second gust up to 160 mph, regardless of whether the gust is the result of a tornado, hurricane, tropical storm, or windstorm event. Therefore, these structures should be able to withstand speeds experienced in an EF3 tornado.

Since tornado events are typically localized, environmental impacts are rarely widespread. However, where these events occur, severe damage to plant species is likely. This includes loss of trees and an increased threat of wildfire in areas where dead trees are not removed. Hazardous material facilities should meet design requirements for the wind zones identified in Figure 4.3.16-1 in order to prevent release of hazardous materials into the environment.

A worst case scenario for tornados occurred on May 31, 1998 when within about a 3 hour stretch from 7 to 10 pm, four different tornadoes affected the County. Pike County was included in a Presidential Disaster Declaration for Individual Assistance for these tornadoes. These tornadoes included:

- An F1 tornado touched down on the border of Pike County and Wayne County in the Greene Township area. Damage was limited to numerous downed trees.
- An F2 tornado touched down in Blooming Grove Township in the Madden Road area. Damage included downed trees, blocked roads and severe structural damage to one house.
- An F2 tornado touched down in the Greene Township area of Promised Land State Park. Damage included thousands of downed trees, blocked roads and downed utility lines and poles. Many homes received minor damage. Numerous cabins within the state park were either damaged or destroyed.
- An F3 tornado touched down in Porter Township along Rt. 402 near Pecks Pond. This storm traveled the greatest distance and eventually ended in Delaware Township near Camp Speers. It downed thousands of trees and power lines, blocking numerous roads, damaged vehicles and damaged or destroyed numerous houses and buildings. Particularly hard hit was the Blue Heron Lake area, where thirteen homes were damaged with four being totally destroyed. Numerous houses in Marcel Lake Estates also received some type of damage. Estimated damage for this F3 tornado was $1 million (NCDC, 2011).

Past Occurrence

Tornadoes have occurred in all seasons and all regions of Pennsylvania, but the northern, western, and southeastern portions of the Commonwealth have been struck more frequently. A list of tornado events that have occurred in Pike County between 1950 and 2016 is shown in Table 4.3.16-5 with an associated Fujita Tornado Scale magnitude. A map showing the approximate location of previous events is included in Figure 4.3.16-2.

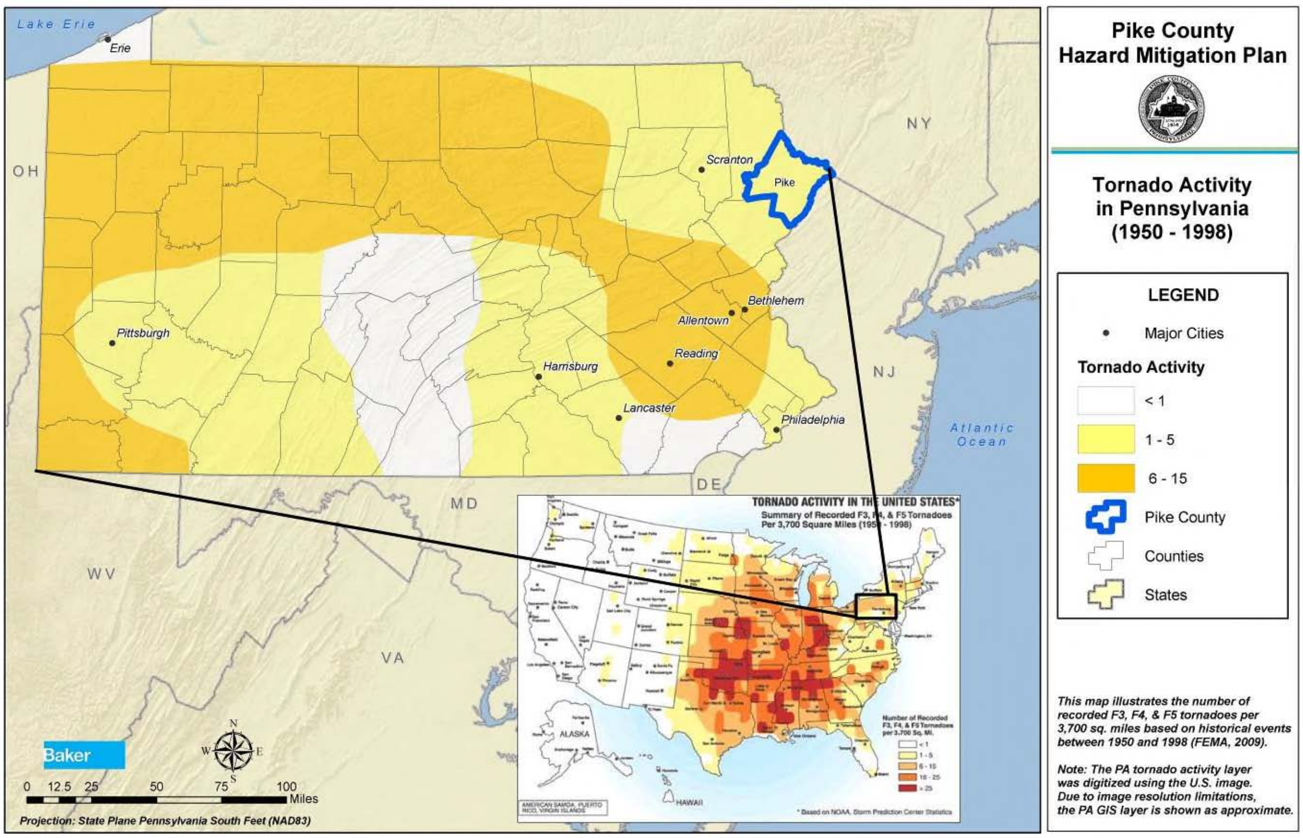
Table 4.3.16-5. Previous Tornado Events between 1950 and 2016 in Pike County

Location	Date	Estimated Length	Estimated Width	Magnitude	Estimated Property Damage ($)**
*Sullivan County, NY	11/16/80	1.50 miles	200 yards	F1	$25,000,000
Blooming Grove	05/31/98	2.00 miles	550 yards	F2	$200,000
Blooming Grove	05/31/98	3.00 miles	200 yards	F2	$400,000
Pecks Pond	05/31/98	20.00 miles	200 yards	F3	$1,000,000
Greentown	05/31/98	0.30 miles	30 yards	F0	$40,000
Kimbles	12/01/06	7.00 miles	100 yards	F0	$20,000

Location	Date	Estimated Length	Estimated Width	Magnitude	Estimated Property Damage ($)**
Rowland	12/01/06	5.00 miles	200 yards	F1	$20,000
*Wayne County	07/23/10	3.00 miles	100 yards	F1	$50,000
*Wayne County	07/23/10	17.00 miles	400 yards	F2	$100,000

Sources: NOAA-NCEI 2016; SPC 2016
Note:
**Tornado did not originate in Pike County but tracked into the County*
***Estimated property damage totals represent the total as a result of the entire event and does not only represent Pike County loss if the tornado tracked into other counties.*

Figure 4.3.16-3. Number of Recorded F3, F4, & F5 Tornadoes per 3,700 sq. miles Based on Historical Events, 1950-1998



Source: Pike County HMP, 2012

Pike County also has record of a June 1999 storm that crossed Pike County producing a small tornado that downed trees and utility lines from Lake Wallenpaupack to Matamoras along Route 6. Structural damage occurred in Blooming Grove Township, Shohola Township, Dingman Township, Milford Borough and Matamoras. Information about the track, length, width, and property damage from the tornado is not available (Pike County HMP 2012).

Windstorm events may be the result of thunderstorms, hurricanes, tropical storms, winter storms, or nor'easters. There have been 17 high wind events (with wind speeds greater than 50 knots) recorded in Pike County since 1950. The highest wind speed recorded in the County occurred on July 23, 2010 producing 70 knot winds. A list of events greater than 50 knots that have occurred since 1950 is shown in Table 4.3.16-6.

Table 4.3.16-6. Previous Windstorm Events Greater than 50 knots in Pike County between 1950 and 2015

Location	Date	Estimated Wind Speed (knots)	Estimated Property Damage ($)
Countywide	09/02/1990	53	N/A
Countywide	02/17/1998	55	30,000
Countywide	05/18/2000	60	N/A
Tafton	06/02/2000	55	N/A
Countywide	12/12/2000	52	450,000
Tamiment	04/09/2001	52	N/A
Rowland	08/03/2001	60	N/A
Lackawaxen	03/10/2002	60	N/A
Lackawaxen	06/26/2002	60	50,000
Milford	07/21/2003	55	20,000
Countywide	10/15/2003	60	700,000
Countywide	11/13/2003	58	190,000
Milford	05/27/2005	60	5,000
Dingmans Ferry	08/03/2006	60	6,000
Milford	08/03/2006	60	5,000
Paupack	06/21/2007	83	N/A
Lackawaxen	07/23/2010	70	50,000
Countywide	02/18/2011	50	100,000
Countywide	5/26/2011	50	N/A
Countywide	6/9/2011	50	N/A
Countywide	7/29/2011	50	N/A
Countywide	10/29/2011	65	100,000
Countywide	6/22/2012	50	N/A
Countywide	7/23/2012	50	N/A
Countywide	7/26/2012	50	N/A
Countywide	4/10/2013	50	N/A
Countywide	7/2/2014	50	N/A
Countywide	7/7/2014	50	N/A
Countywide	7/8/2014	50	N/A
Countywide	8/21/2014	50	N/A
Countywide	8/21/2014	50	N/A

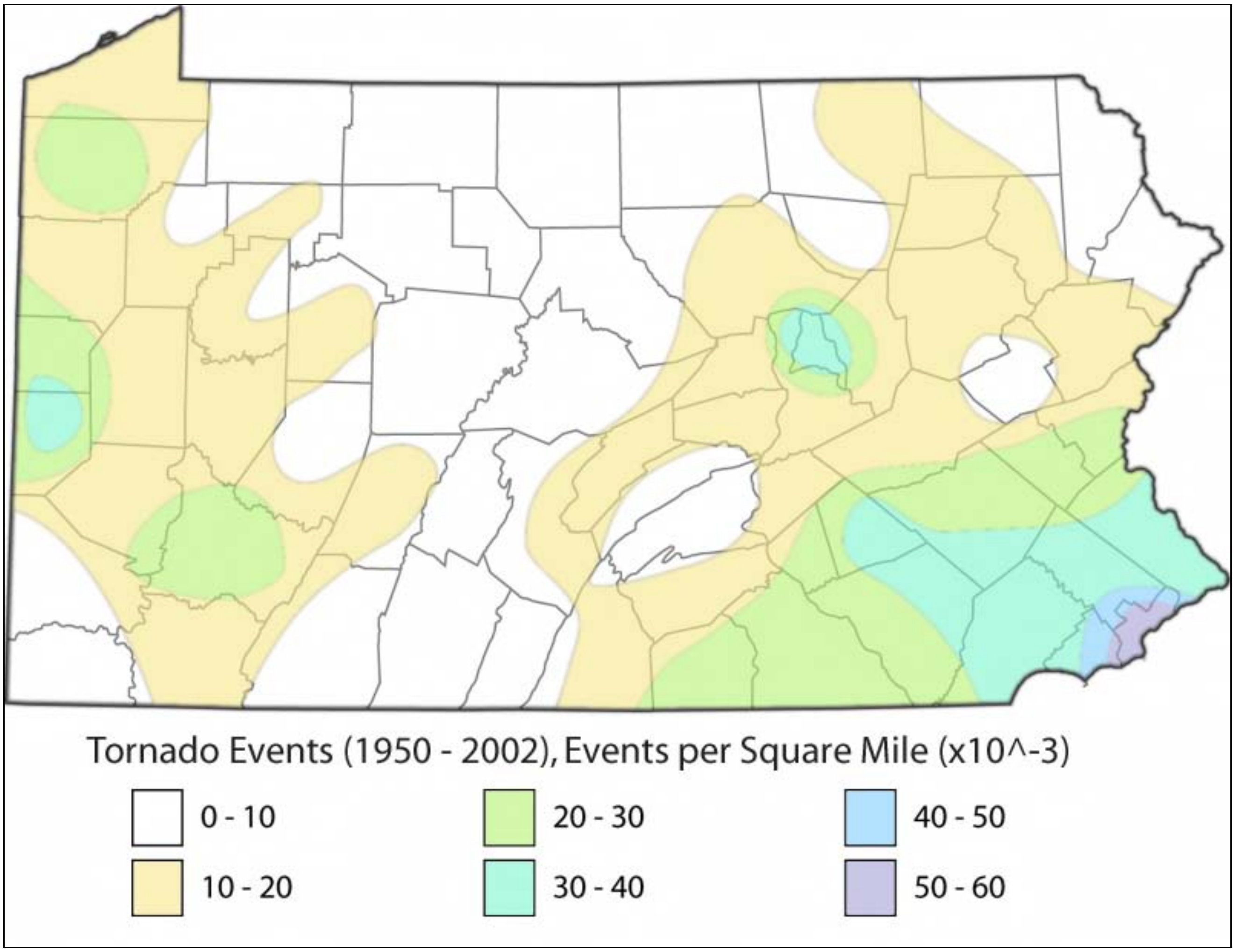
Source: NOAA-NCDC 2016; SPC 2016
N/A Not Available

Future Occurrence

According to the National Weather Service, the Commonwealth of Pennsylvania has an annual average of 10 tornadoes with two related deaths. While the chance of being hit by a tornado is small, the damage that results when the tornado arrives is devastating. An F4 tornado can carry wind velocities of 200 mph, resulting in a force of more than 100 pounds per square foot of surface area. This is a "wind load" that exceeds the design limits of most buildings.

Using events collected between 1950 and 2002, Figure 4.3.16-4 shows the number of total tornado events per square mile across Pennsylvania from the State Climatologist. The figure shows that a majority of Pike County experienced a lower frequency of tornado events than the southwest and southern portions.

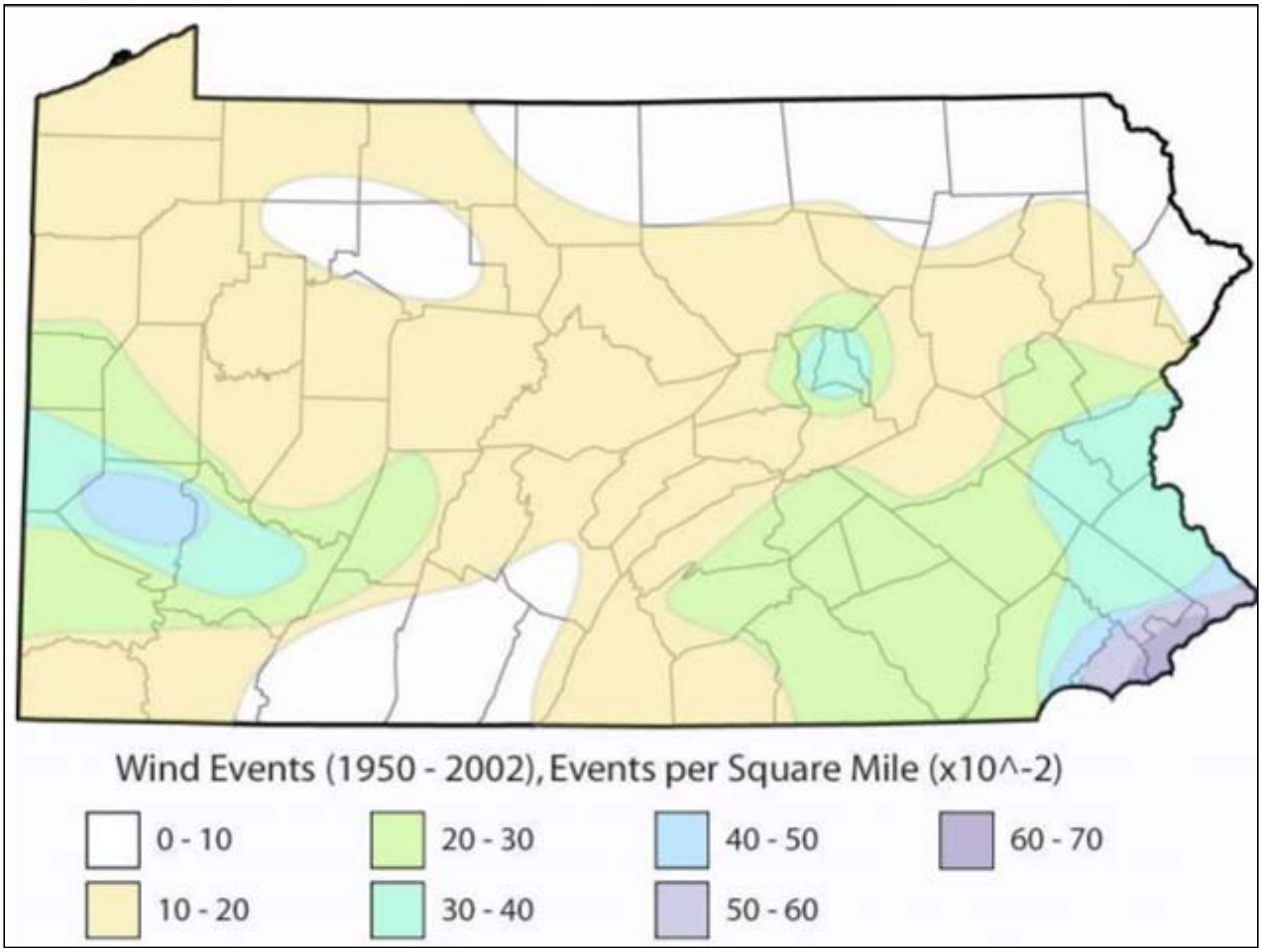
Figure 4.3.16-4. Total Tornado Events Per Square Mile in Pennsylvania



Source: Pennsylvania State Climatologist 2016

Similar to tornadoes, the Pennsylvania State Climatologist used historical data between 1950 and 2002 to show the number of wind events per square mile in the Commonwealth. The figure shows that a majority of Pike County experienced a lower frequency of events than the southwest and southern portions of the county.

Figure 4.3.16-5. Wind Events Per Square Mile in Pennsylvania



Source: Pennsylvania State HMP 2013

For the 2017 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of tornado and windstorm events for Pike County. Information from NOAA-NCEI storm events database, the Pennsylvania State Climatologist, the 2012 Pike County HMP, and the Storm Predication Center were used to identify the number of tornado and wind events that occurred between 1950 and 2015. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimate percent chance of an incident occurring in a given year. Based on these statistics, there is an estimated nearly 100-percent chance of a windstorm event occurring in any given year in Pike County.

Table 4.3.16-7. Probability of Future Tornado and Windstorm Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Tornado (all scales)	10	0.15	6.60	0.15	15.2%
Wind (greater than 50 knots)	64	0.98	1.03	0.97	96.9%

Sources: NOAA-NCEI 2016; SPC 2016; Pennsylvania State Climatologist 2016

Windstorms, straight line winds and winds associated with a severe thunderstorm occur on a more frequent basis. Based on available historical data, the future occurrence of tornadoes and windstorms can be considered *highly likely* as defined by the Risk Factor Methodology probability criteria (refer to Section 4.4).

Vulnerability Assessment

To understand risk, a community must evaluate which assets are exposed or vulnerable in the identified hazard area. The entire County has been identified as the hazard area for tornado and other windstorm events. Therefore, all assets in the County (population, structures, critical facilities, and lifelines), as described in the County Profile (Section 2), are vulnerable. The following text evaluates and estimates potential impacts of strong winds on the County, including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impacts on: (1) life, health, and safety of residents; (2) general building stock; (3) critical facilities; (4) economy; (5) environment; and (6) future growth and development
- Effect of climate change on vulnerability

Overview of Vulnerability

High winds and air speeds of a severe windstorm event, including winds in a tornado, can result in power outages, disruptions to transportation corridors and equipment, loss of workplace access, significant property damage, injuries and loss of life, and need to shelter and care for individuals affected by the events. A large amount of damage can be inflicted by trees, branches, and other objects that fall onto power lines, buildings, roads, vehicles, and in some cases, people. The risk assessment for tornados and windstorms evaluates available data for a range of storms included in this hazard category.

The entire inventory of Pike County is at risk of damage or loss via impacts of tornados and windstorms. The age, conditions, and building quality of homes can make structures more susceptible to damage from high winds. The greatest threat will be from severe windstorms that often accompany thunderstorms and the potential from damage from downed trees. Areas such as Matamoras and Milford boroughs have many old trees that are very susceptible to wind damage. As the population of the county has increased, many new homes have been built in densely wooded areas, increasing the potential for structural damage, injury and/or death.

Data and Methodology

A qualitative assessment on potential impacts to life, health and safety; buildings, critical facilities and the economy are summarized below. Refer to Section 4.3.8 (Hurricane, Tropical Storm and Nor'Easter) for further details on estimated potential losses as a result of the 100- and 500-year mean return period wind events using HAZUS-MH.

Impact on Life, Health, and Safety

Impacts of a tornado or windstorm on life, health, and safety depend on several factors, including severity of the event and whether adequate warning time was provided to residents. Assumedly, the entire County's population (U.S. Census 2010 population of 57,369 people) is exposed to this hazard.

Residents may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings, and debris carried by high winds can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and locations and construction quality of their housing. As a result of the 100- and 500-year MRP events, HAZUS-MH estimates that zero people would be displaced and zero people may require temporary shelter.

Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions based on the major economic impact on their family, and may not have funds to evacuate. The population over the age of 65 is also more vulnerable and, physically, they may have more difficulty evacuating. The elderly are considered most vulnerable because they require extra time or outside assistance during evacuations and are more likely to seek or need medical attention that may not be available due to isolation during a storm event. Section 2 presents the statistical information regarding these populations in the County.

Impact on General Building Stock and Critical Facilities

The entire County's building stock and critical facilities are exposed to the tornado and windstorm hazard. Manufactured housing (i.e. mobiles homes) is particularly vulnerable to high winds and tornadoes. The U.S. Census Bureau defines manufactured homes as "movable dwellings, 8 feet or more wide and 40 feet or more long, design to be towed on its own chassis, with transportation gear integral to the unit when it leaves the factory, and without need of a permanent foundation (Census, 2010)." They can include multi-wides and expandable manufactured homes but exclude travel trailers, motor homes, and modular housing. Due to their light-weight and often unanchored design, manufactured housing is extremely vulnerable to high winds and will generally sustain the most damage.

Table 4.3.16-8 displays the number of manufactured housing units per municipality in Pike County. As noted, Dingman and Greene Townships have the greatest number of manufactured homes.

Table 4.3.16-8. Manufactured Housing Units per Municipality in Pike County

Municipality	Number of Manufactured Homes
Blooming Grove Township	123
Delaware Township	94
Dingman Township	397
Greene Township	442
Lackawaxen Township	205
Lehman Township	17
Matamoras Borough	0
Milford Borough	0
Milford Township	11
Palmyra Township	266
Porter Township	16
Shohola Township	241
Westfall Township	123
Pike County (Total)	**1,935**

Source: HAZUS-MH v3.1

Impact on Economy

Tornados and windstorms also impact the economy, including loss of business function (e.g., tourism, recreation), damage to inventory, relocation costs, and wage loss and rental loss due to repair/replacement of buildings. Impacts on transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. Utility infrastructure (power lines, gas lines, electrical systems) could sustain damage, and impacts could result in loss of power, which can affect business operations and provision of heating or cooling to the population.

Impact on the Environment

Tornado events are typically localized; therefore, environmental impacts are rarely widespread. Impacts of windstorms on the environment usually occur over a larger area. Severe damage to plant species is likely from both tornado and windstorm events. This includes uprooting or total destruction of trees, and increased threat to wildfire in areas of tree debris.

Future Growth and Development

As discussed and illustrated in Section 2.4, areas targeted for future growth and development have been identified across Pike County. Any areas of growth could be affected by the tornado and windstorm hazard because the entire County is exposed and potentially vulnerable to the wind hazard, particularly when associated with severe storms.

Effect of Climate Change on Vulnerability

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

4.3.17 Transportation Accident

Transportation hazards include hazardous materials (HazMat) in transit, vehicular accidents, aviation accidents, at-grade railroad crossings, and roadways vulnerable to floods. In 2013, the National Transportation Safety Board (NTSB) reported 34,678 transportation-related fatalities across the United States. Of those 34,678 fatalities, 32,719 were highway incidents, 891 were rail incidents, 443 were aviation incidents, 10 were pipeline incidents, and 615 were marine incidents (NTSB 2013). For the purpose of this plan update, transportation accidents are defined as incidents involving highway, air, and rail travel, resulting in death, serious injury, extensive property loss or damage or situations that cause delay or closure. Accidents related to hazardous materials are discussed in the environmental hazards profile in Section 4.3.4.

A transportation hazard may be defined as a condition created by movement of anything by common carrier. Transportation hazards can be divided into two categories: hazards created by the material being transported, and hazards created by the transportation medium. Transportation systems available in Pike County include roadways, rail lines, and airports. Major road accidents in the County are probable, and major rail and aviation accidents are possible. All County systems and supporting transportation resources provide services locally, regionally, and nationally. Vehicular, aviation, and railway, accidents are defined below:

- Vehicular Accidents: A vehicular accident is a road traffic incident that usually involves one vehicle colliding with another vehicle or other road user, such as an animal or a stationary roadside object. A vehicular accident may result in injury, property damage, or possible fatalities. Many factors contribute to vehicular accidents, including equipment failure, poor road conditions, weather, traffic volume, and driver behavior.
- Aviation Accidents: According to the International Civil Aviation Organization, an aviation accident occurs during operation of an aircraft between the time a person boards the aircraft with intent to fly to a destination, to the time the person has disembarked the aircraft. Three different situations qualify as an aviation accident: (1) a person is fatally or seriously injured; (2) the aircraft sustains damage or structural failure; or (3) the aircraft is missing or inaccessible. An aviation incident is an occurrence, other than an accident, associated with operation of an aircraft that affects or could affect the safety of operation (International Civil Aviation Organization 1994). Airport accidents and incidents have the potential to occur while the plane is over County airspace; not only directly on airport property.
- Railway Accidents: Railway accidents involve one or more trains. They can involve a train derailment or one train impacting another train, vehicle, or pedestrian.

This section provides a profile and vulnerability assessment of the transportation accident hazard for Pike County.

Location and Extent

Vehicular Accidents

Within Pike County, there are a total of 645 miles of developed state and municipal roads. State highways account for 392 miles of this total while 252 miles are local municipal roads. The County is home to significant transportation routes such as Interstate 84, US 209, US 6, PA 739, PA 434, PA 590, PA 507, PA 447, PA 402, and PA 390. Accidents can occur at any point along the roadways in the County. Figure 4.3.12-1 illustrates major transportation routes in the County. Figure 4.3.12-2 shows the traffic volume on key roadways.

There is no warning time for vehicular accidents. Factors contributing to these accidents are typically associated with the driver, vehicle, and environment. Factors associated with the driver include error, speeding, experience, and blood-alcohol level. Factors associated with the vehicle include type, condition, and center of gravity. Environmental factors include quality of the infrastructure, weather, and obstacles. The majority of vehicular accidents are attributed to the driver. Vehicular accidents can severely affect those directly involved, as well as others not directly involved. Other effects of vehicular accidents may include severe traffic delays, lost sales to businesses, delayed commodity shipments, and increased insurance costs (Cova and Conger 2003).

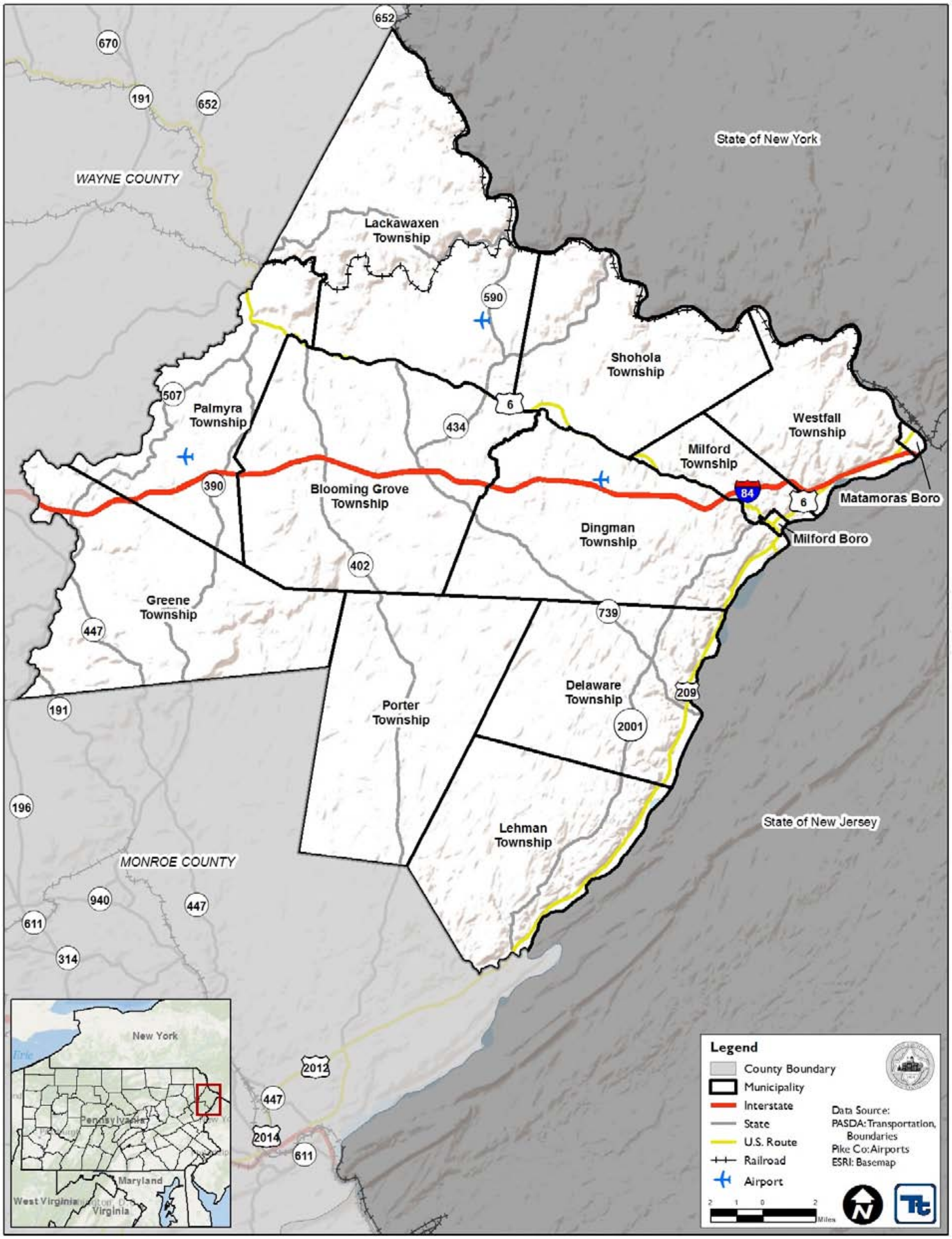
Railway Accidents

There are two railroad lines operating in the County which transport passengers and freight of all types, including hazardous materials. One rail line is owned by Norfolk Southern Railway and is leased by the Central New York Railroad and its parent company, the New York, Susquehanna, and Western Railroad (NYSW). All dispatching is now done by the NYSW. The second line in operation is the Stourbridge Railroad, a local shortline operation that is owned by the Lackawaxen-Honesdale Shippers Association. It directly interchanges at Lackawaxen, PA with the Norfolk Southern Railway that owns the mainline route between Binghamton and Port Jervis. The same line of railroad is, through trackage rights, also run regularly by the New York Susquehanna and Western Railway, a subsidiary of CSX. Therefore rail users have their choice of shipping via Norfolk Southern or CSX. The Stourbridge Railroad is also used by the Wayne County Chamber of Commerce for passenger excursions, an important component of the local tourist economy. These services are carefully coordinated with freight deliveries to ensure that freight services always enjoy preference.

Aviation Accidents

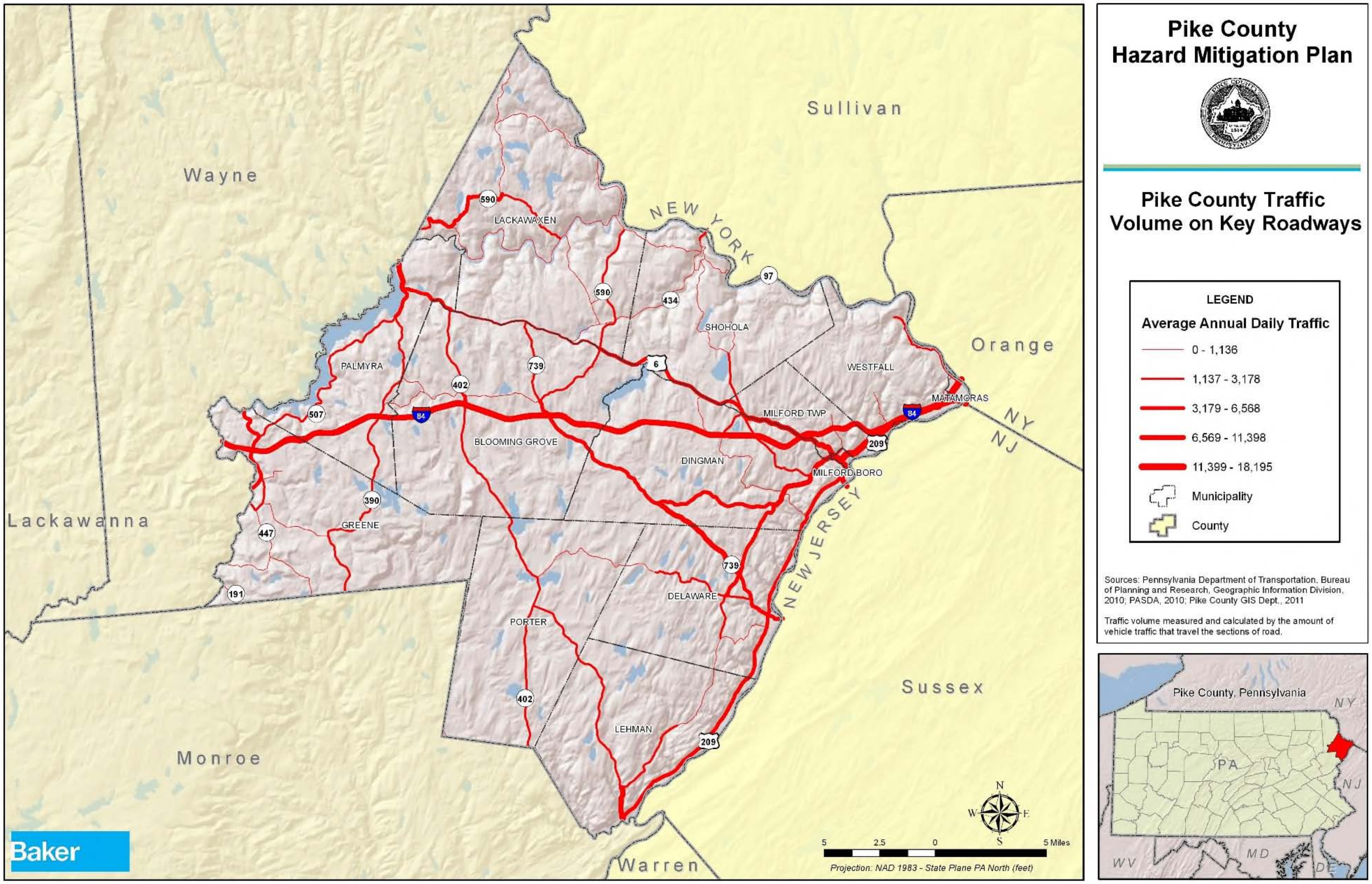
There are three private airports in Pike County for private aircraft: Myer Airfield (Dingman Twp); Mountain Bay Air Park (Palmyra Twp); and Boehm Airfield (Lackawaxen Twp). In addition, there is an abundance of air traffic from airports in neighboring municipalities and states. With Stewart International Airport in Newburgh, NY and the Wilkes-Barre Scranton Airport in Avoca, PA, much of the County finds itself under one of their approach patterns. Stewart is home to a New York Air National Guard unit which has several large C-5As at their disposal.

Figure 4.3.17-1. Pike County Transportation Systems



Sources: PennDOT, 2010; Pike County

Figure 4.3.17-2. Pike County Traffic Volume on Key Roadways



Source: *PennDOT 2010*

Range of Magnitude

Significant passenger vehicle, air, and rail transportation accidents can result in a wide range of outcomes from damage solely to property to serious injury or death. Most air incidents are nonfatal and cause minor injuries or property damage. The majority of motor vehicle crashes are non-fatal in Pennsylvania, but PennDOT estimates that every hour ten people are injured in a car crash, and every seven hours someone dies as a result of a car crash. Most fatal crashes occur in the summer months of July, and August, and September (PA HMP 2013).

Roadway accidents in Pike County range from minor crashes to more serious incidents that involve injuries or fatalities, or result in a release of hazardous materials (see Section 4.3.4). Information for this plan regarding fatalities associated with automobile crashes (Table 4.3.12-1), fatalities of pedestrians involved in transportation incidents (Table 4.3.13-2), and fatalities by person/crash type in Pike County (Table 4.3.13-3) was drawn from the National Highway Traffic Safety Administration (NHTSA) Fatality Analysis Reporting System (FARS) 2015 data.

Table 4.3.17-1. Fatalities from Automobile Crashes

Year	Pennsylvania	Pike County
2010	1,324	7
2011	1,286	6
2012	1,310	8
2013	1,210	8
2014	1,195	9
Total	**6,325**	**38**

Source: NHTSA 2016

Table 4.3.17-2. Fatalities of Pedestrians

Year	Pennsylvania	Pike County
2010	145	0
2011	147	0
2012	163	1
2013	147	1
2014	161	0
Total	**763**	**2**

Source: NHTSA 2016

Table 4.3.17-3. Fatalities by Person/Crash Type in Pike County

Fatality Type	2011	2012	2013	2014	2015
Total Fatalities (All Crashes)*:	8	6	8	9	7
(1) Alcohol-Impaired Driving (BAC=.08+) Fatalities	1	0	0	8	4
(2) Single Vehicle Crash Fatalities	5	6	5	6	4
(3) Large Truck Involved Crash Fatalities	1	0	2	1	3
(4) Speeding Involved Crash Fatalities	5	4	2	4	7
(5) Rollover Involved Crash Fatalities	4	3	3	3	2
(6) Roadway Departure Involved Crash Fatalities	6	6	7	9	7

Fatality Type	2011	2012	2013	2014	2015
(7) Intersection (or Intersection Related) Crash Fatalities	0	0	0	0	0
Passenger Car Occupant Fatalities	4	1	6	3	1
Light Truck Occupant Fatalities	3	2	1	3	5
Motorcyclist Fatalities	1	2	0	2	0
Pedestrian Fatalities	0	1	1	0	0
Bicyclist (or Other Cyclist) Fatalities	0	0	0	0	0

Source: NHTSA 2016
(1) Crash Involved at Least One Driver or Motorcycle Rider With a BAC of .08 or Above
(2) Crash Involved Only One Vehicle In Transport
(3) Crash Involved at Least One Large Truck
(4) Crash Involved at Least One Vehicle Speeding
(5) Crash Involved at Least One Vehicle That Rolled Over
(6) Crash Involved at Least One Vehicle That Departed the Roadway (FHWA Definition)
(7) Crash Occurred Within an Intersection or Within the Approach to an Intersection
**A Fatality Can Be in More Than One Category. Therefore Sum of the Individual Cells Will Not Equal the Total Due to Double Counting*

Rail accidents can vary widely in terms of injuries, fatalities, property damage, and interruption of service, depending on the nature and severity of the accident. Local residents may also be involved in rail accidents while traveling outside the County.

Aircraft accidents can vary from a single-engine aircraft having a "hard landing" and causing damage to the aircraft, to a crash of a small turboprop or jet aircraft, to a crash of a large jet aircraft (such as a Boeing 727). Other aircraft accidents could include helicopter or experimental aircraft crashes. Aviation accidents also can involve radio-controlled or drone aircraft devices, many of which are experimental and not subject to defined regulatory oversight, potentially complicating issues with and for the public that could arise if one of these devices crashes.

A worst case scenario within Pike County would involve an accident where a tanker truck hauling hazardous materials has an accident on Interstate 84, resulting in a release of its cargo on the major roadway. This incident would block traffic on Pike County's major transportation routes, and could threaten the health and safety of individuals on the roadways and in surrounding neighborhoods. In addition, a release could necessitate closure of critical facilities in the County. The worst-case scenario for a railroad accident would be similar to that described for a roadway accident (i.e., a train carrying a hazardous substance crashing along the rail line). The worst-case scenario for an aviation accident would be a major plane crash into a residential or industrial area, causing mass fatalities and property destruction. The most likely transportation accident in the County would involve a single vehicle hitting an object and sustaining minimal damage.

Past Occurrence

Vehicular transportation accidents are a daily occurrence across the Commonwealth of Pennsylvania and in Pike County. According to PennDOT, in 2015, Pike County had 604 vehicular crashes and seven traffic deaths. The most common transportation accidents in the County are highway accidents involving motor vehicles. The County's most serious transportation concerns involve Interstate 84 and US 209. These routes have the highest annual average traffic counts, the most truck traffic, and have illustrated the most potential for disaster in the past. Additionally, there is a temporal aspect to highway transportation accidents; in the spring and early summer, when construction and narrowed lanes are commonplace, the incidence of large-scale transportation accidents increases. Table 4.3.12-4 summarizes the overall vehicular crash data, as reported by

PennDOT, for Pike County from 2005 through 2015. Additionally, Pike County identified 10,168 vehicle accidents from 2010 to 2016 (as of October 5, 2016) (Pike County 2016).

Most motor vehicle accidents in Pike County have been limited to one to three vehicles. Recent exceptions to this include:

- A 1994 Westfall accident that occurred at the PA/NY border on I-84 westbound involving 14 vehicles,
- A 1997 accident along I-84 westbound during a snow storm involving 24 vehicles,
- A 2003 accident along I-84 eastbound in Dingman Township involving one straight truck and six tractor-trailer trucks (damage resulting from this accident took over 12 hours to clean up), and
- An early 2005 accident during a snow squall on I-84 eastbound in Westfall that involved approximately 14 vehicles.

Table 4.3.17-4. Total Number of Crashes, Traffic Deaths, and Pedestrian Deaths for Pike County, 2005 to 2015

Year	Total Crashes	Total Traffic Deaths	Total Pedestrian Deaths
2005	675	12	0
2006	641	9	0
2007	684	9	0
2008	735	13	1
2009	595	5	1
2010	667	7	0
2011	633	8	0
2012	593	6	1
2013	579	8	1
2014	591	9	0
2015	604	7	0
TOTAL	**6,997**	**93**	**4**

Sources: Pike County HMP 2012; PennDOT 2015; PennDOT 2010

Aviation accidents are the least frequent type of transportation accident. The National Transportation Safety Board (NTSB), the federal agency responsible for aviation accident information, indicates that from January 2010 to October 2016, there were 193 air transportation accidents in Pennsylvania. Of those 193 accidents, one occurred in Pike County. Prior to 2010, there have been 20 accidents identified in the NTSB database. Details regarding some of the aviation accident events that occurred in Pike County are described below.

- 1992 - a small single seat plane crashed into the Delaware River in Westfall Township, killing the pilot
- 1994 - a small plane crashed in Blooming Grove Township resulting in minor injuries
- 1995 - a small plane crashed near Mountain Bay Airpark in Palmyra Township
- 1996 - a small plane crashed off of Shiny Mountain Road in Palmyra Township, and in the same year, a small plane crashed in Lehman Township, killing two and injuring two
- 2006 - three people died from a small aircraft crash in Palmyra Township
- May 2009 - a small plane crashed into a group of trees in Dingman Township; no fatalities or injuries were reported

- August 7, 2009 – Milford/Shohola – as a plane was taking off, it became airborne early due to a dip in the runway and the plane drifted with its left wing hitting a tree. There were four people onboard and minor injuries were reported.
- March 27, 2016 – A helicopter crashed in Greene Township, killing one person. The crash occurred in a heavily wooded area north of Skytop Lodge, off Route 390 and south of Promised Land State Park.

Due to a decrease in rail traffic since 1976 with the formation of Conrail, there have been few railway accidents. Rail incidents include: the 1978 derailment north of Mill Rift, the 1995 derailment north of Pond Eddy, and a 2001 car-train collision in Lackawaxen that resulted in one death. Additionally, PEIRS data was also used identify railroad incidents that occurred between 2002 and 2009. Two railroad incidents were reported, one each in 2003 and 2005. In 2003, a New York Susquehanna & Western train derailed four cars on the Norfolk Southern line. The 2005 rail incident involved train cars derailing on the New York Susquehanna and Western rail line in Shohola Township. Neither injury nor material spill was reported for either incident (Pike County HMP 2012). The Federal Railroad Administration Office of Safety Analysis (FRA) and the NTSB were both queried for events that occurred in Pike County between 2010 and 2016. Neither resource identified rail accidents in Pike County. (FRA 2016; NTSB 2016).

Future Occurrence

Considering the current transportation network within the County and the steady increase in traffic volume, it is safe to assume that the number of vehicle accidents will continue to increase. Incidents involving air or rail should remain low. The County's population has increased over the last decade, meaning it is likely that traffic volumes have also risen. New residents have limited knowledge of detour routes and alternate routes around accidents which contributes to the accident-related congestion experienced recently in the County. The trucking industry is expected to continue, maintaining and possibly increasing the number of tractor-trailers on the County's road system. Transportation accidents may increase slightly over the next five years without proper mitigation strategies in place.

For the 2017 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of transportation accident events for Pike County. Information from PennDOT, NTSB, FRA and Pike County were used to identify the number of transportation accident events that occurred between 1950 and 2015. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimate percent chance of an incident occurring in a given year. Based on these statistics, there is an estimated 100-percent chance of a transportation accident (any type) event occurring in any given year in Pike County.

Table 4.3.17-5. Probability of Future Transportation Accident Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Vehicular	10,172	156.49	0.01	1.0	100%
Railway	2	0.03	33.00	0.03	3.0%
Aviation	21	0.32	3.14	0.32	31.8%

Sources: NTSB 2016; FRA 2016; PennDOT 2016; Pike County 2016

Therefore, based on this and past occurrences, the probability of transportation accidents is characterized as *highly likely* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1). However, the low number of rail and air traffic accidents in the County indicates that the bulk of future transportation accidents will be roadway accidents.

Vulnerability Assessment

The entire County has been identified as the hazard area for transportation accidents. The following subsections evaluate and provide estimates for the potential impacts of transportation hazards on Pike County, including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impacts, including those on life, safety, and health; and on general building stock, critical facilities, the economy, and future growth and development
- Further data collections that will assist in understanding this hazard over time

Overview of Vulnerability

The transportation systems in the County heavily rely upon use of its roadways. Vehicular accidents can occur on any of the roadways and can result in loss of life, destruction of property, or damage to the infrastructure, which can inhibit the use of the roadways. However, natural hazards can also cause problems for residents and commuters traveling throughout the County. Interstate 84, US-209, and PA-739 experience high volumes of vehicles, from personal vehicles to buses and larger, tractor trailers. High traffic volumes combined with severe storms (rain, snow, etc.) can lead to an increase chance of transportation accidents. Rail lines running through the northern region of the County, as well as airports in the surrounding areas can also result in transportation accidents that can impact the County.

Data and Methodology

Regarding this hazard, data were obtained from the County, local officials, and federal data sources. In addition, the Steering and Planning Committees have identified roadways within the County that are vulnerable to other natural hazards (flood).

Impact on Life, Health, and Safety

Transportation hazards could lead to potential losses in categories of human health and life, property, and natural resources. Vehicular accidents, flooded roadways, and other roadway impairments may result in injury or death to drivers and passengers on the road, the public in the immediate vicinity, and emergency services personnel. The number of people exposed depends on population density, time of exposure (day or night), and proportions of the population located indoors and outdoors.

Vehicular accidents are not the only transportation incidents that can impact human health and life, property, and natural resources; rail accidents can also impact those living near surrounding rail lines. Residents in Lackawaxen, Shohola, and Westfall Townships are vulnerable to such incidents. Two nearby airports also increase the risk of airplane accidents for most of the County.

The County and its municipalities are prepared to manage and respond to transportation hazards. Refer to Section 5 (Capability Assessment) for further information regarding Pike County emergency response capabilities.

Impact on General Building Stock, Critical Facilities, Economy, and Future Development

Because of insufficient data, a full loss estimate was not completed for the transportation hazard. Loss of roadway use and public transportation services would affect thousands of commuters, employment, day-to-day operations within the County, and delivery of critical municipal and emergency services. Disruption of one or more of the modes of transportation in use in Pike County can lead to congestion of another, and affect both the County and the region as a whole. As discussed in Section 2.4, areas targeted for future growth and development have been identified across the County. Increased development in the County and region will lead to increased road traffic.

Table 4.3.17-5 shows the vulnerability of addressable structures and critical facilities for each kind of transportation accident. For this analysis, the hazard area for highway accidents was defined as locations within a ¼ mile of Interstate, US highways, and State roads; jurisdictions within a 5 mile radius of an airport are vulnerable to airplane accidents. Similar to highway accidents, the hazard area for rail accidents is a ¼ mile buffer around the rail lines. Using these definitions, all jurisdictions are vulnerable to at least one type of transportation accident.

Table 4.3.17-6. Addressable structures and critical facilities vulnerable to railroad, highway, and airport accidents.

Municipality	Total Addressable Structures	Addressable Structures within ¼ mi. of railroad	Critical Facilities within ¼ mi. of railroad	Addressable Structures within ¼ mi. of Major Highway*	Critical Facilities within ¼ mi. of Major Highway*	Addressable Structures within 5 mi. Radius of Airport	Critical Facilities within 5 mi. Radius of Airport
Blooming Grove Township	3,998	0	0	452	8	0	0
Delaware Township	4,253	0	0	611	4	0	0
Dingman Township	5,480	0	0	603	9	0	0
Greene Township	3,275	0	0	836	3	413	0
Lackawaxen Township	4,562	394	1	409	7	0	0
Lehman Township	5,995	0	0	303	3	0	0
Matamoras Borough	972	85	0	751	5	0	0
Milford Borough	718	0	0	707	13	0	0
Milford Township	784	0	0	431	5	0	0
Palmyra Township	3,981	27	0	2,143	5	0	0
Porter Township	912	0	0	258	2	0	0
Shohola Township	2,311	181	2	470	3	0	0
Westfall Township	1,175	107	1	551	11	0	0
TOTAL	**38,416**	**794**	**4**	**8,525**	**78**	**413**	**0**

**Major Highways include Interstates, US Highways and State Highways.*
Source: HAZUS-MH 3.1; Pike County; PADOT

Each municipality has addressable structures located within ¼ mile of major highways; Palmyra Township has the greatest number of structures (2,143) located within ¼ mile of major highways. Each municipality also has critical facilities within ¼ mile of major highways; of these, Milford Borough has the greatest number (13).

Lackawaxen Township has the greatest number of addressable structures (394), while Shohola Township has the most critical facilities (2) vulnerable to rail accidents. Greene Township is the only municipality with structures located within a 5-mile radius of an airport (the Spring Hill airport); however, structures throughout the County are vulnerable to airplane accidents as planes fly over.

Additional Data and Next Steps

Based on limited data regarding the probability and potential impact of this hazard, a quantitative loss estimate was not completed for this HMP. Over time, the County can work with appropriate agencies to collect additional data to support mitigation planning, consider potential risks, and prioritize mitigation measures for this hazard.

It is recognized that the County must compile and maintain data regarding specific concerns and past losses from this hazard. These data should include specific information regarding damage or loss of life, property, or infrastructure; and any data pertaining to potential or actual cost and logistics of responding to an event caused by this hazard (locations of road closures, map detours, traffic counts, durations of closures and detours; and costs to respond). These data will be included in future revisions of the HMP, and can be used to support future mitigation grant efforts (benefit cost analysis).

Studying traffic and potential transportation accident patterns could provide information on vulnerability of specific road segments and nearby populations. Increased understanding of the types of HazMat transported through the County will also support mitigation efforts. Maintaining a record of these frequently transported materials can facilitate development of preparatory measures to respond to a release. Predicting costs to respond to a release, remediate the environment, or repair damaged infrastructure would be useful for developing mitigation options.

4.3.18 Urban Fire and Explosions

Urban fire and explosion hazards incorporate vehicle and building/structure fires as well as overpressure rupture, overheat, or other explosions that do not ignite. This hazard occurs in denser, more urbanized areas statewide and most often occurs in residential structures. Urban fires can more easily spread from building to building in these denser areas. Furthermore, urban fires are a more significant threat in areas with a significant proportion of buildings over 50 years of age. Urban fires and explosions often begin as a result of other hazards, particularly storms, lightning strikes, drought, transportation accidents, hazardous materials releases, criminal activity (arson), and terrorism (PA HMP 2013).

This section provides a hazard profile and vulnerability assessment of the urban fire and explosions hazard for Pike County.

Location and Extent

Structural and urban fires within Pike County have had a detrimental impact on life, property, and the local economy over the past decade. The age of many residential structures within the region combined with changes in building construction and materials has increased the threat of fire loss that is occurring on a regular basis.

As defined by the National Fire Protection Agency (NFPA) in the *NFPA 901: Standard Classifications for Incident Reporting and Fire Protection Data*, a structure fire is defined as "Any fire inside, on, under, or touching a structure." This definition includes any mobile residential structure such as a mobile or modular home, but does not include roadworthy vehicles such as recreation vehicles (NFPA 2011). Significant urban fires are limited to densely populated areas of the County that contain large and/or multiple buildings. Urban fires may start in single structure, but spread to nearby buildings or throughout a large building if adequate fire control measures are not in place.

Significant explosions are most common in densely populated areas and at industrial facilities that utilize combustible hazardous materials. Explosions can also occur in conjunction with automobile, boat, and rail accidents. All such explosions can turn into fires, spreading to nearby structures.

Range of Magnitude

The severity of urban fires is measured according to the losses associated with the incident. The impact to the local economy is minimal with the loss of a residential structure, but effects of the loss of a large manufacturing facility that employs a large number of people can be extensive. Likewise, the impact to the local environment from a single residential fire is minimal, while the impact from an industrial or commercial fire can take years to measure. Finally, the loss of life caused by urban fires appears to be opposite of the previous two impacts. The loss of life is more likely to be associated with a residential fire than an industrial or commercial building fire. Building compositions combined with the time of day of the incident are risk factors that can increase the chance for the loss of life during a residential-type fire.

Although most instances of fire do not reach disaster proportions, the sum of the impact of all small fires is often much greater than the impact of the few major fire and explosion hazards that occur. There are additional economic consequences related to this hazard. Urban fires and explosions may result in lost wages due to temporarily or permanently closed businesses, destruction and damage involving business and personal assets, loss of tax base, recovery costs, and lost investments on destroyed property. The secondary effects of urban fire and explosion events relate to the ability of public, private, and non-profit entities to provide post-incident relief. Human services agencies (community support programs, health and medical services, public assistance programs and social services) can be affected by urban fire and explosion events as well. Effects may consist of physical damage to facilities and equipment, disruption of emergency communications, loss of health and medical facilities and supplies, and an overwhelming load of victims who are suffering from the effects of the urban fire, including loss of their home or place of business.

A worst-case urban fire event in Pike County occurred in 1998 when the largest fire ever recorded in Pike County occurred at the Altec-Lansing warehouse in Milford Township. The fire burned through the 80,000 square foot space and resulted in $6 million in damages.

Past Occurrence

Pike County experiences a number of urban fire and explosion events each year, most of which are small and affect a limited number of structures. PEIRS data indicates that from 2002-2009, there have been 19 urban fire events reported to PEMA (see Table 4.3.18-1). Of the municipalities in Pike County, both Dingman and Westfall Townships had the highest number of urban fires reported to PEIRS with four events reported by each. Please note that since PEIRS is a voluntary reporting system, this is not an inclusive list of fires in the County. Since 2009, Pike County has experienced mainly residential structure fires and explosions. Pike County indicated that a total of 1,472 fire incidents occurred in the County from 2010 to October 2016 (Pike County 2016). The table below includes events identified in PEIRS and other sources.

Table 4.3.18-1. Urban Fire Events in Pike County, 2003 to 2016

Community	Type of Event	Date	Description of Event
Blooming Grove Township	Tire Fire	03/26/2003	Tire fire at the Lord's Valley Towing junkyard; no injuries reported
Westfall Township	Vehicle Fire	06/25/2003	A tractor-trailer fire occurred on I-84, closing one lane; cleanup and recovery done by My Place Towing
Delaware Township	Structure Fire	01/24/2005	Residential structure fire; one fatality reported
Dingman Township	Structure Fire	04/26/2005	Residential structure fire completely destroyed a home; three fatalities reported
Milford Township	Structure Fire	09/11/2005	Riding stable fire; no injuries reported
Westfall Township	Structure Fire	02/14/2006	Residential structure fire; one fatality and two injuries reported
Blooming Grove Township	Vehicle Fire	05/09/2006	Truck fire on I-84, no traffic backup; small amount of diesel fuel spilled onto road; cleanup coordinated by local emergency units; no injuries reported
Milford Township	Structure Fire	10/02/2006	Residential structure fire; State Route 6/209 temporarily closed; no injuries reported
Blooming Grove Township	Vehicle Fire	05/25/2007	A tractor-trailer fire occurred on I-84, closing the westbound exit ramp; trailer was hauling water and orange juice; no injuries reported
Dingman Township	School Fires	09/26/2007	Fire at Dingman-Delaware Primary School in the Delaware Valley School District; no injuries reported
Westfall Township	Structure Fire	12/08/2007	Commercial structure fire; one fatality reported
Westfall Township	Structure Fire	12/09/2007	Residential structure fire; no injuries reported
Lehman Township	Structure Fire	08/09/2008	Residential structure fire; one fatality reported
Dingman Township	Structure Fire	09/18/2008	Residential structure fire; no injuries reported
Delaware Township	Vehicle Fire	10/14/2008	Vehicle fire at intersection of State Route 739 and Nichercronk; thirty gallons of diesel fuel spilled; cleanup coordinated by emergency personnel
Milford Township	Vehicle Fire	12/29/2008	Tractor-trailer carrying chickens caught fire on I-84; accident impeded eastbound traffic
Dingman Township	Structure Fire	01/23/2009	Fire at Hilltop Xtra Mart Gas Station; no injuries reported

Community	Type of Event	Date	Description of Event
Shohola Township	Structure Fire	03/27/2009	Residential structure fire and barn fire; no injuries reported
Lehman Township	Structure Fire	03/30/2009	Residential structure fire; one fatality reported
Shohola Township	Structure Fire	10/03/2014	8 100-lb. propone tanks self-vented
Westfall Township	Structure Fire	09/24/2016	Commercial structure
Dingman Township	Vehicle Fire	09/25/2016	Description of event not available
Porter Township	Structure Fire	09/27/2016	Residential home
Delaware Township	Vehicle Fire	09/30/2016	Description of event not available

Sources: Pike County HMP 2011; Pike County 2016

Pike County also has record of several additional large fires or explosions that taxed the county's fire organization beyond normal daily operations:

- February 1981 – a large fire gutted the Arlington Hotel outside Milford in Dingman Township,
- September 1981 – a large fire in Milford Borough destroyed an auto body shop and several apartments,
- March 1982 – a large fire in Milford Borough destroyed a vacant hotel,
- 1991 – Several businesses destroyed along Route 739 in Blooming Grove Township,
- September 1992 – Several businesses destroyed at a strip mall along Route 739 in Blooming Grove Township,
- June 1994 – Milford Borough – a large portion of the Tom Quick Inn was gutted,
- March 1996 – Lehman Township – Pocmont Resort was destroyed,
- February 1997 – Several businesses destroyed along Route 739 in Blooming Grove Township,
- June 1998 – Milford Township – Altec-Lansing – lightning ignited the largest fire to ever hit Pike County, destroying an 80,000 square feet of warehouse space, resulting in more than $6 million in damage. The warehouse was full of complete product awaiting shipment. More than 30 fire departments from Pennsylvania, New Jersey and New York fought unsuccessfully (This fire occurred at the same time the county was dealing with tornadoes at the western end of the county and was caused by the same storm front. Other fires also occurred during the same period).
- February 2005 – Westfall Township – a fire at the lumberyard at Luhr's Ace Hardware caused a reported $1 million in damage,
- March 2005 – Lackawacken Township – a fire destroyed the main building Masthope Ski facility.
- November 2008 – A Columbia Gas Transportation and Storage Company pipeline exploded near the intersection of Route 6 and I-84. The company raised the pressure in the line during a test which caused the pipe to explode and a large piece of pipe to be flung one hundred yards through the air. No injuries were reported (Kane, Tom, The River Reporter, 2008)
- January 19, 2011 – Westfall Township – a log cabin in the Township was destroyed by a fire. One person died as a result of the fire (Brelje 2011).

- June 13, 2012 – an explosion destroyed a home in the community of Gold Key Estates located in Dingman Township. The explosion occurred while men were working on the water system of the home. Three people, including the homeowner, were in the house at the time of the explosion. All three escaped with minor injuries (Brelje 2012).

Future Occurrence

Many factors contribute to the cause of urban fires and explosions. Due to the various factors, urban areas in Pennsylvania are considered at risk to one degree or another. Minor urban fires can be expected every day in Pennsylvania. Major fires will continue to occur several times a year, particularly in dense, urban areas with aging building stock. However, the probability of future occurrences may decrease with the construction of new buildings to building codes that address fire prevention, detection, and extinguishments. Also, continued efforts to increase public awareness of the dangers of urban fires will help to mitigate injury, death, and property loss. The probability of future occurrence may increase in communities whose populations are growing and where new areas are developed (PA HMP 2013).

For the 2017 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of urban fire and explosion events for Pike County. Information from the 2012 Pike County HMP, PEIRS, input from Pike County, and local newspapers were used to identify the number of urban fire and explosion events that occurred between 1950 and 2015. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimate percent chance of an incident occurring in a given year. Based on these statistics, there is an estimated 100-percent chance of an urban fire or explosion event occurring in any given year in Pike County.

Table 4.3.18-2. Probability of Future Urban Fire and Explosion Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Urban Fires and Explosions	1,332	20.49	0.05	1.0	100%

Sources: Pike County HMP 2012; Pike County 2016

Based on available historical data, the future occurrence of urban fire and explosion events can be considered *possible* as defined by the Risk Factor Methodology probability criteria (refer to Section 4.4) with minor events happening more frequently than major fires or explosions in the future.

Vulnerability Assessment

The potential for urban fire and explosions is not limited to any one area of the County; however structures most at risk include the aging building stock constructed prior to established building codes. Human error can play an important role in creating the potential for a major urban or forest fire. The vulnerability of the citizens and property of Pike County to fire and related incidents depends on many factors. A positive factor helping to mitigate the risk is the advanced fire services provided within the County. On the negative side, many homes and business have not been updated to current fire safety codes. The risk of loss caused by fire increases each year that these structures go without safety updates. In Pennsylvania, the most vulnerable population groups are the elderly, age 65 and over, and the low-income earners. The elderly had the highest number of deaths resulting from fire and all population groups. The elderly represent a large portion of the population spectrum.

Although newer buildings are constructed with higher safety standards and with more fire-resistant material, large numbers of older, highly vulnerable buildings remain throughout Pike County. Until these buildings are upgraded or replaced, the risk will continue.

As the population of the County increases, the number of housing units increases. Although the majority of this housing growth has been single family type buildings, there has been an increase in townhouse buildings being built, including senior housing apartments being built in Matamoras and Westfall. In addition, there are additional units of this type being proposed in other areas of the County. The majority of this growth is in areas with little or no central water supply system. In addition, there has been and continues to be commercial growth, including several retail stores in excess of 100,000 square feet.

Areas where large buildings are located or development is closely spaced should be considered more vulnerable to urban fire and explosion events; in Pike County, these denser jurisdictions include Matamoras and Milford Boroughs. However, Pike County as a whole is low density in comparison with other counties in Pennsylvania (U.S. Census, 2000).

The quick response of fire departments in the County helps reduce loss of life and property damage from urban fires and explosions. Pike County is protected by 19 volunteer fire departments – 16 are located within the County. The Lumberland, NY fire department provides initial response to a small portion of Westfall and Shohola Townships at Pond Eddy, PA; the Welcome Lake, PA (Wayne Co.) provides protection for the upper portion of Lackawaxen Township and Greene-Dreher (Wayne Co.) provides protection for a portion of Greene Township. Dispatch for all county-based departments except for Bushkill is through the County's 9-1-1 center. Bushkill is dispatched from Monroe County.

Although many departments have seen a significant reduction in available help, most have added to their apparatus arsenals. Currently there are approximately 30 engines, 20 tankers, 5 ladder trucks, and an assortment of rescue and support-type vehicles. The most common pump sizes are 1,000 and 1,250 gallons per minute (GPM). However, there are some with capacities of 1,500 GPM to over 2,000 GPM. Most engines are now carrying 750 or 1,000 gallons of water and the average tanker size is over 2,000 gallons. In addition, there is over 5 miles of large diameter (4" or 5") hose throughout the county.

4.3.19 Utility Interruptions

A utility interruption, or power failure, is defined as any interruption or loss of fuel service from disruption of power transmission caused by accident, sabotage, natural hazards, or equipment failure (also referred to as a loss of power or power outage). A significant power failure is defined as any incident of a long duration that would require the involvement of the local or State emergency management organizations to coordinate provision of food, water, heating, cooling, and shelter.

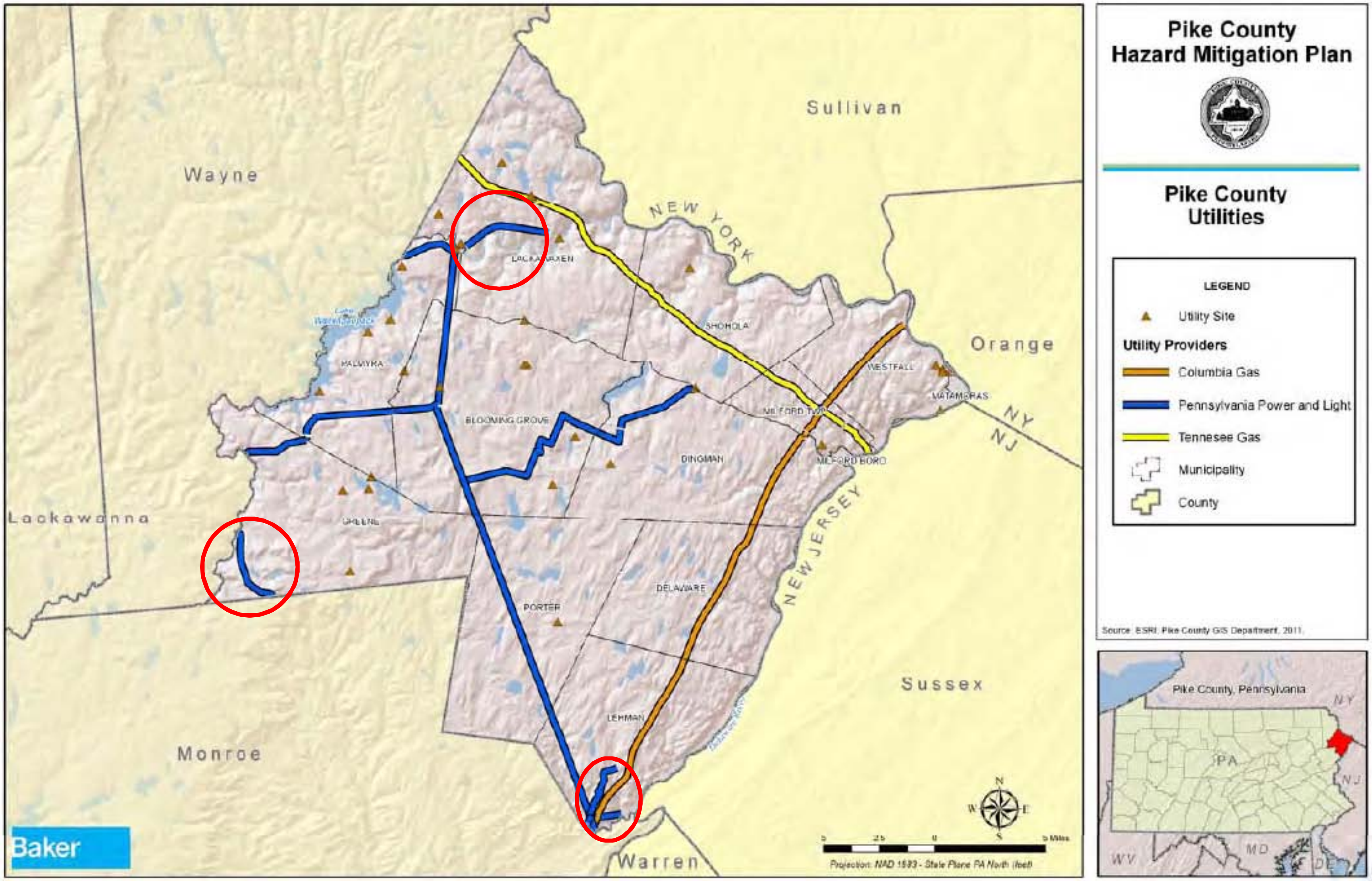
This section provides a profile and vulnerability assessment of the utility interruption hazard for Pike County.

Location and Extent

Utility interruptions in Pike County include disruptions in water, fuel, electric and telecommunications capabilities. In Pike County the focus is primarily on power failures which are often a secondary impact of another hazard event. For example, severe thunderstorms or winter storms could bring down power lines and cause widespread disruptions in electricity service. Strong heat waves may result in rolling blackouts where power may not be available for an extended period of time. Local outages may be caused by traffic accidents or wind damage. Utility interruptions and power failures can take place throughout the County.

Utility interruptions can also be caused by disruptions in service to pipeline transmission lines. Columbia Gas and Tennessee Gas have pipelines that bisect the County (Figure 4.3.19-1). In addition, there are countless miles of residential connections to larger water, gas, and liquid pipelines. Lines can become damaged by cold temperatures thus causing cracks and disruptions in service. Public water service can also be impacted by dam failures which would cause a break in water service.

Figure 4.3.19-1. Location of Utilities in Pike County



Source: Pike County HMP 2012

Note: Red circled areas of Pennsylvania Power and Light are not presented on shapefile provided by Pike County

Range of Magnitude

Generally speaking, the most severe utility interruptions are regional power outages. Regional loss of power affects lighting; heating, ventilation, and air conditioning (HVAC) and other support equipment; communications; fire and security systems; and refrigerators, which can in turn cause loss of water and sewer service, and food spoilage. These effects are especially severe for individuals with functional needs and the elderly.

At a minimum, power outages can cause short-term disruption in the orderly functioning of businesses, government operations, and private citizen functions and activities. Examples of everyday functions that would be affected by power outages include traffic signals, elevators, and retail sales. A worst case scenario for utility interruption in Pike County occurred in January 2005 when an ice storm caused major power outages effecting thousands of customers in Monroe, Carbon, Lackawanna, Wayne and Pike Counties. Because of the amount of equipment damage caused by the ice, some areas did not have power restored for over a week. Fortunately, Pike County did not have damage to the extent of its neighbors to the southwest.

Sabotage also plays a role in some utility outages. Sabotage may be the direct result of a malicious attack against utilities, or may be the secondary effect of the theft of copper wiring. In report published in October 2010 titled "An Updated Assessment of Copper Wire Theft from Electric Utilities," the U.S. Department of Energy's (DOE) Office of Electricity Delivery and Energy Reliability reported that United States-based utilities suffer several million dollars' worth of copper thefts annually (DOE 2010). The estimated minutes of outages experienced by utilities nationwide as a result of copper theft were 456,000 or about 7,600 hours (American Public Power Association [APPA] 2012).

Past Occurrence

In Pike County, minor power outages occur annually, approximately two to five times each year. They are most often associated with winter storms and wind storms. Table 4.3.19-1 displays utility interruption events reported to PEIRS between 2002 and 2009.

Table 4.3.19-1. Utility Interruption at Pike County from 2002 to 2009

Date	Location	Type
01/17/2002	TOWNSHIP OF PALMYRA	Phone outage
03/02/2002	BUSHKILL	Phone outage
07/24/2002	TOWNSHIP OF DINGMAN	Power outage
01/18/2003	TOWNSHIP OF DELAWARE	Power outage
01/22/2003	TOWNSHIP OF DINGMAN	Power outage
11/14/2003	COUNTYWIDE	Phone outage
12/11/2003	TOWNSHIP OF DELAWARE	Power outage
06/16/2004	TOWNSHIP OF LEHMAN	Phone outage
08/26/2004	TOWNSHIP OF BLOOMING GROVE	Phone outage
09/26/2004	TOWNSHIP OF MILFORD	Power outage
10/10/2004	TOWNSHIP OF BLOOMING GROVE	Phone outage
01/06/2005	COUNTYWIDE	Power outage
01/24/2005	TOWNSHIP OF WESTFALL	Phone outage
03/24/2005	TOWNSHIP OF WESTFALL	Power outage
06/09/2005	MATAMORAS	Phone outage
06/10/2005	TOWNSHIP OF WESTFALL	Power outage

Date	Location	Type
06/17/2005	COUNTYWIDE	Power outage
02/19/2006	COUNTYWIDE	Power outage
07/20/2006	MATAMORAS	Water Main Break
10/25/2006	MATAMORAS	Water Main Break
08/09/2007	TOWNSHIP OF BLOOMING GROVE	Phone outage
06/10/2008	TOWNSHIP OF WESTFALL	Phone outage
10/28/2008	COUNTYWIDE	Power outage
01/17/2009	COUNTYWIDE	Phone outage

Pike County has record of several other utility interruptions in addition to those above mentioned:

- Pike County was affected by the November 1965 power outage that blacked out the entire northeastern United States.
- Pike County was affected by the nationwide gasoline shortages during the 1970s and had its share of long lines, high prices and facilities without product. Provisions were made in each situation to insure adequate supplies for emergency vehicles.
- The majority of the electrical outages have been weather related, being caused by snow and ice storms to windstorms. Recent long term outages include spring 1997 snowstorm that brought down trees and wires, blacking out large portions of the county for days; an August 1997 series of thunderstorms that left widespread outages and the tornado outbreak of May 1998.
- In August 2003, a large portion of northeast and north central United States as well as a large portion of Canada was hit by an electrical outage. The eastern portion of Pike County that is served by Orange and Rockland Utilities was affected and was without power for several hours.
- Met Ed has experienced numerous outages in its portion of coverage in Pike County. In many cases, it appears that the cause is the utility companies' inability to meet the demands of an increasing population. Unfortunately, many of these outages have occurred in the winter months.
- August 28 – September 3, 2011 – Hurricane Irene had a large impact on Pennsylvania and its electric distribution companies. The storm brought high winds and heavy rain to the eastern third of Pennsylvania. The wind and rain caused over 750,000 customer outages at the peak of the storm. Total number of Pike County Light & Power customers impacted by the outage was 4,366 customers (Bureau of Technical Utility Services 2012).
- October 2012 – Hurricane Sandy had a large impact on Pennsylvania and its electric distribution companies. The storm brought tropical storm winds and heavy rain to the eastern third of Pennsylvania as well as high winds throughout the center of the state. Approximately 1.79 million customers experienced an outage at some point as a result of the storm. During Hurricane Sandy, Pike County was without power from October 29th through November 9th. Total number of Pike County Light & Power customers impacted by the outage was 4,487 (Bureau of Technical Utility Services 2013).
- March 22, 2014 – A power outage from Pike County to Middletown, New York affected approximately 16,000 residences and businesses. In Pike County, 4,400 customers were without power. The outage was widespread in the county between Dingmans Ferry, Matamoras, Milford Borough, and Milford and Westfall Townships. The outage was due to equipment failure at a substation. Power was restored by the early afternoon (Pocono Record 2014).
- December 5, 2015 – A substation in Middletown, New York failed and knocked out power in Orange and Sullivan Counties in New York State as well as Pike County, Pennsylvania. Approximately 52,000 customers were without power in these counties. Power was restored by the early evening (abc7NY 2015).

- August 15, 2016 – Thousands of customers were without power for a few hours in Pike County as a result of equipment problems at a substation. At the peak of the outage, approximately 9,000 customers were impacted. Power was restored by the early evening (Over 2016).

Future Occurrence

Minor power failure events (i.e. short outage) events may occur several times a year for any given area in the County, while major (i.e. widespread, long outage) events take place once every few years. Power failures are often occurrences during severe weather and therefore, should be expected during those events. For the 2017 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of utility interruption events for Pike County. Information from the 2012 Pike County HMP, the Pennsylvania Bureau of Technical Utility Services, input from Pike County, and local newspapers were used to identify the number of utility interruption events that occurred between 1950 and 2015. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimate percent chance of an incident occurring in a given year. Based on these statistics, there is an estimated 100-percent chance of a utility interruption event occurring in any given year in Pike County.

Table 4.3.19-2. Probability of Future Utility Interruption Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Utility Interruption	1,402	21.57	0.05	1.0	100%

Sources: Pike County HMP 2012; Pike County 2016; Pennsylvania Bureau of Technical Utility Services 2012 and 2013

Based on available historical data, the future occurrence of utility interruption events can be considered *highly likely* as defined by the Risk Factor Methodology probability criteria (refer to Section 4.4) with minor events happening more frequently than major or long term interruptions in the future.

Vulnerability Assessment

Utility interruptions most severely affect individuals with access and functional needs (e.g., children, the elderly, and individuals with special medical needs). Special medical equipment will not function without power. Likewise, a loss of air conditioning during periods of extreme heat or the loss of heating during extreme cold can be especially detrimental to those with medical needs, children, and the elderly. A lack of clean, potable water has health implications for all residents.

All facility infrastructure considered critical are vulnerable to utility interruptions, especially the loss of power. The establishment of reliable backup power at these facilities is extremely important to continue to provide for the health, safety, and well-being of Pike County's population. As stated above, areas of the County were without power for more than 10 days as a result of Hurricane Sandy. Any critical facilities within these areas without emergency back-up power would have been unable to provide assistance to the community for an extended period of time. The impact Hurricane Sandy had on the County illustrates the importance of critical facilities installing emergency generators to ensure adequate emergency response in all situations.

No data regarding economic impacts from utility interruptions in Pike County is available. However, utility interruptions can cause economic impacts stemming from lost income, spoiled food and other goods, costs to the owners or operators of the utility facilities, and costs to government and community service groups.

4.3.20 Wildfire

This section provides a profile of and vulnerability assessment for the wildfire hazard. A wildfire is an uncontrolled fire spreading through vegetative fuels, exposing and possibly consuming structures. Wildfires often begin unnoticed and can spread quickly, creating dense smoke that can be seen for miles. A wildland fire is a wildfire in an area where development is essentially nonexistent, except for roads, railroads, power lines, and similar facilities. A wildland-urban interface (WUI) fire is a wildfire in a geographical area where structures and other human development meet or intermingle with wildland or vegetative fuels.

Location and Extent

Wildfires take place in less developed or completely undeveloped areas, spreading rapidly through vegetative fuels. They can occur any time of the year, but mostly occur during long, dry, hot spells. Any small fire, if not quickly detected and suppressed, can get out of control. Most wildfires are caused by human carelessness, negligence, and ignorance. However, some are precipitated by lightning strikes and in rare instances, spontaneous combustion. Wildfires in Pennsylvania can occur in open fields, grass, dense brush, and forests.

Wildfires can occur at any time of the year, but are most likely in Pike County during a drought, and can occur in fields, grass, and brush as well as in the forest itself. Under dry conditions or droughts, wildfires have the potential to burn forests as well as croplands.

Because a majority (an estimated 88-percent or 294,464 acres) of Pike County's land cover is forestland, the potential geographic extent of wildfires is quite large (USDA Forest Service, 2004). Under dry conditions or droughts, wildfires have the potential to burn forests as well as croplands. The greatest potential for wildfires is in the spring months of March, April, and May, and the autumn months of October and November; 83% of all Pennsylvania wildfires occur in these two time periods. In the spring, bare trees allow sunlight to reach the forest floor, drying fallen leaves and other ground debris. In the fall, dried leaves are also fuel for fires.

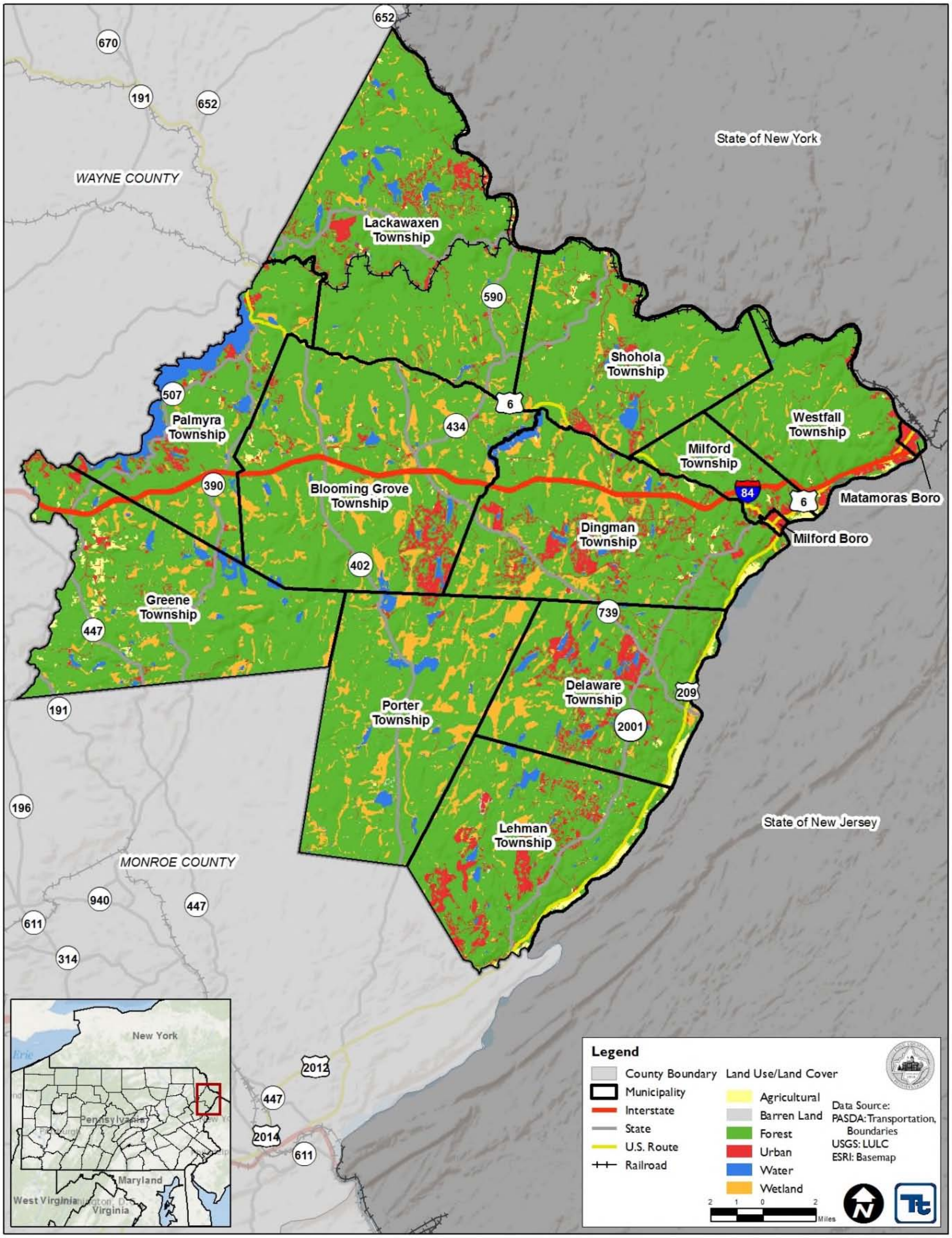
Table 4.3.20-1. Land Use Summary for Pike County

Land Use Category	Total Area (square miles)	Percent of Total
Agricultural	0.2	<1%
Barren Land	2.9	<1%
Forest	447.3	78.9%
Rangeland	2.5	<1%
Urban Built Up	46.2	8.1%
Water	20.7	3.6%
Wetland	47.3	8.3%
Total	**567.2**	**100%**

Source: USGS 2011

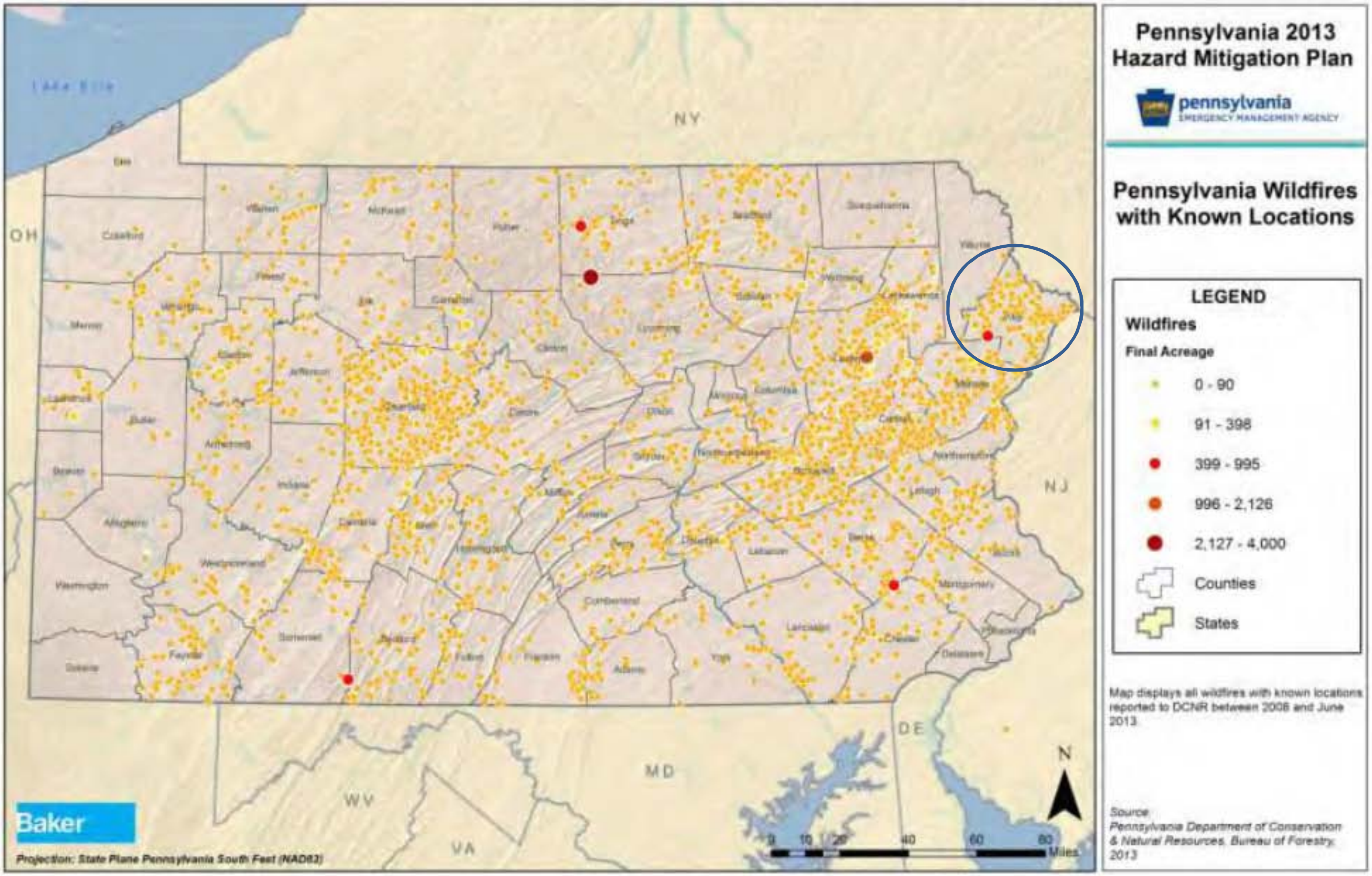
Figure 4.3.20-1 illustrates the land cover across Pike County. As the figure shows, a majority of Pike County is forested. Figure 4.3.20-2 shows the locations of wildfires throughout Pennsylvania that the Pennsylvania Department of Conversation and Natural Resources (PA DCNR), Bureau of Forestry (BOF) responded to from 2002 to June 2013. Wildfires are known to be an underreported event. Many wildfires occur every year and are suppressed by volunteer fire departments without any response or assistance from BOF. Therefore, these locally controlled blazes may not be represented in BOF records.

Figure 4.3.20-1. Land Cover in Pike County



Source: USGS – National Land Cover Database (NLCD) 2011

Figure 4.3.20-2. Location of Wildfire Events responded to by BOF from 2002-2013



Source: PEMA 2013
Note: Blue circle was added to highlight Pike County's location within Pennsylvania.

According to the Pennsylvania 2013 Standard State All-Hazard Mitigation Plan, areas of the Commonwealth that have large home developments built in volatile fuel types are at risk for catastrophic wildfires. Many areas of the state are at risk for large wildfires, but northeastern Pennsylvania is the most at risk for loss of life and/or property due to the number of homes at risk for wildfires. This area has large home developments built in volatile fuel types including scrub oak, mountain laurel, blueberry, and huckleberry. If spring weather conditions were perfect for a fire (i.e. clear sky, high winds, low relative humidity, and a prolonged period of dry weather), it is possible that 10,000 acres could burn in areas of Monroe or Pike Counties (PA HMP 2013).

Several tools are available to estimate fire potential location and extent, including (but not limited to) the Wildland/Urban Interface, Wildland Fire Assessment System and PA DCNR Priority Landscape Analysis. These tools are discussed in further detail below.

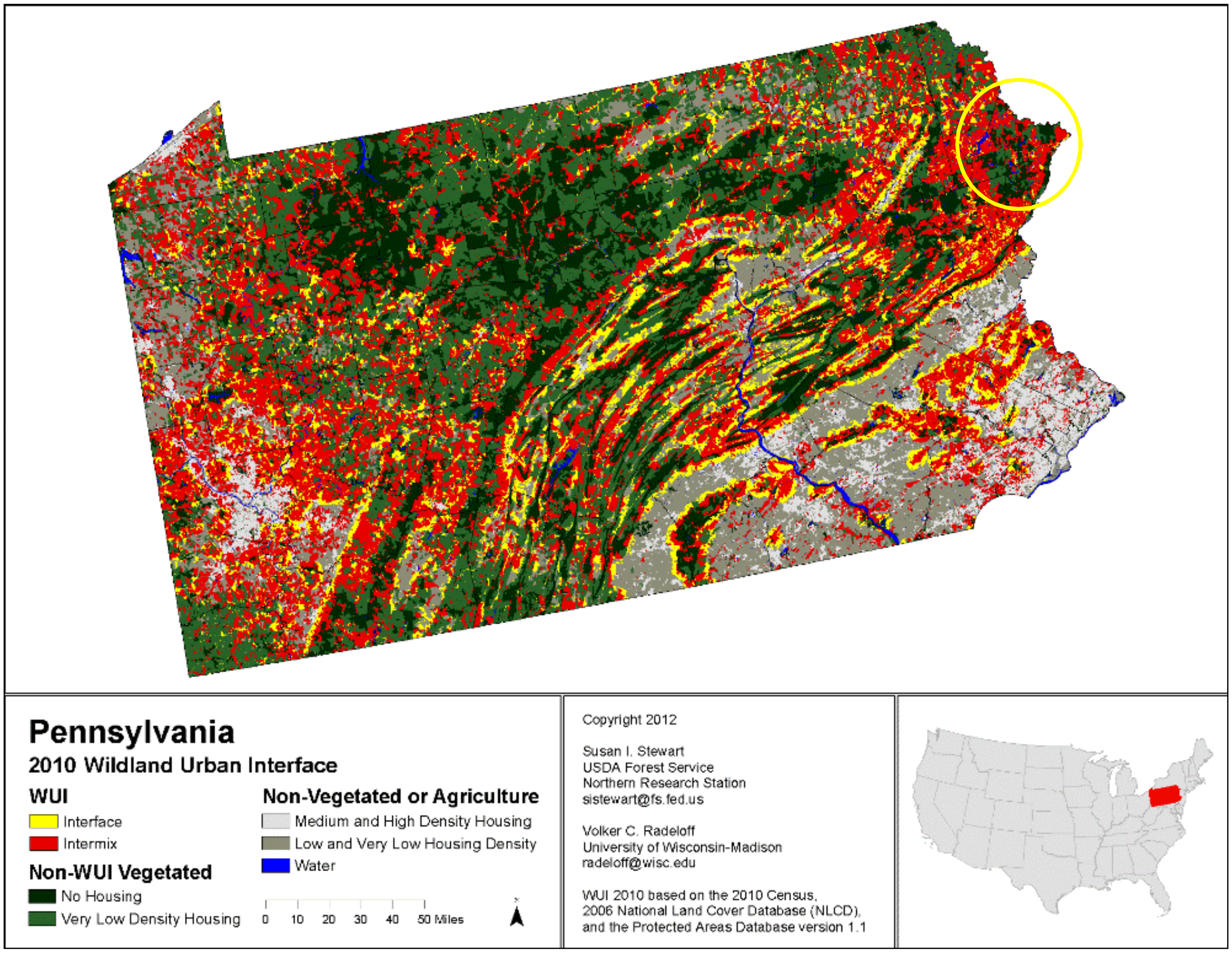
Wildland/Urban Interface (WUI)

The WUI is the area where houses and wildland vegetation coincide. The WUI is divided into two categories: intermix and interface. Intermix WUI are areas where housing and vegetation “intermingle.” Intermix areas have more than one house per 40 acres and have more than 50 percent vegetation. Interface WUI are areas with housing in the vicinity of contiguous wildland vegetation. Interface areas have more than one house per 40 acres, have less than 50 percent vegetation, and are within 1.5 miles of an area larger than 1,235 acres that is more than 75 percent vegetated (Stewart et al. 2005).

The California Fire Alliance determined that areas within 1.5 miles of wildland vegetation are the approximate distance that firebrands can be carried from a wildland fire to the roof of a house. Therefore, even structures not located within the forest are at risk from wildfire. This buffer distance, along with housing density and vegetation type, were used to define the WUI (Stewart et al. 2005).

Concentrations of WUI can be seen along the east coast of the United States including the area around Pittsburgh, Pennsylvania, and the eastern half of Pennsylvania. Pike County is identified as having many areas of very low-density housing or no housing due to the large amount of forested area. Areas where recreation and tourism dominate are also places where WUI is common (Stewart et al. 2005). Figure 4.3.20-3 depicts the WUI for Pennsylvania in 2010, and Figure 4.3.20-4 illustrates the WUI for Pike County. Concentrations of WUI areas greater than 50 percent are classified as WUI (intermix or interface) in the County.

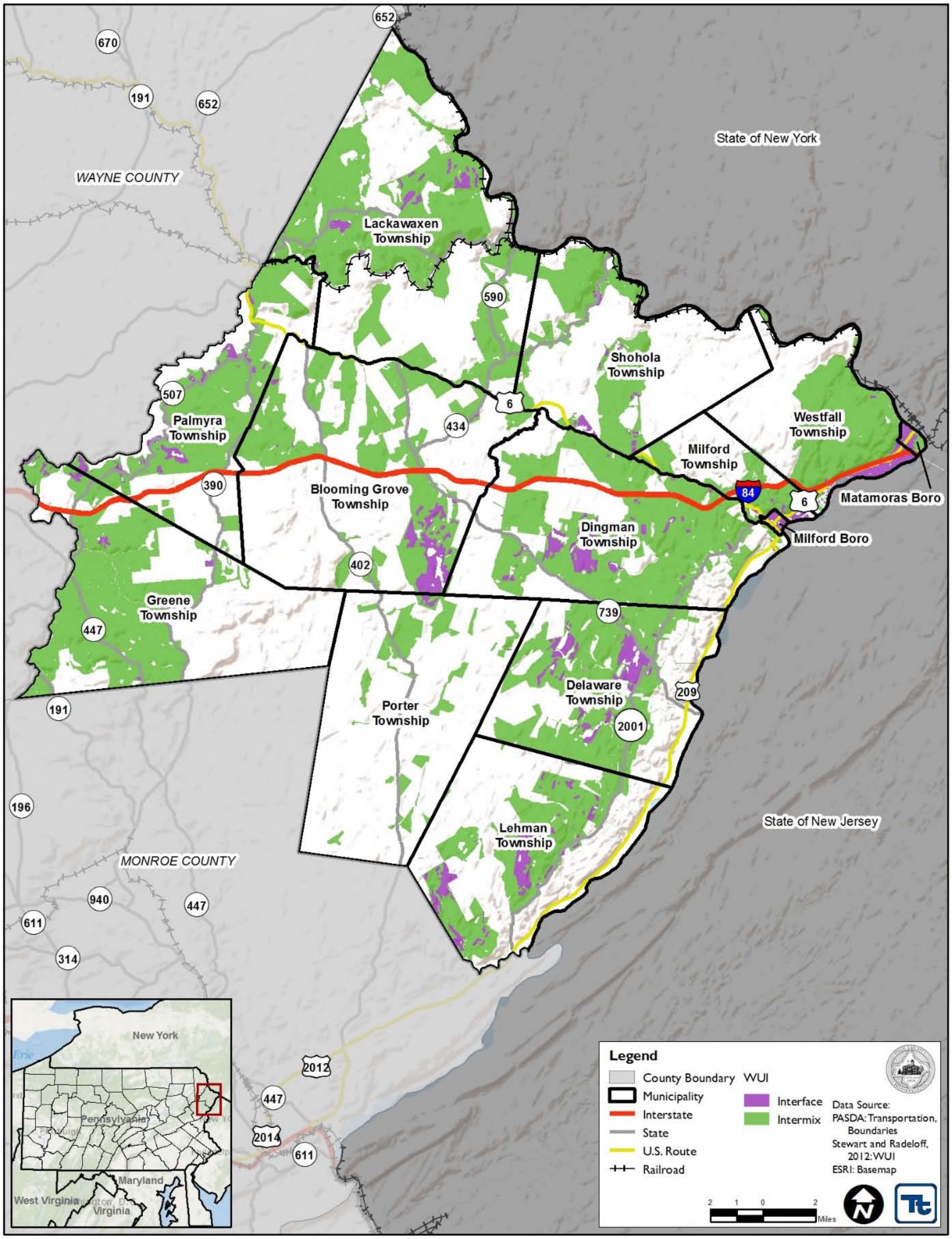
Figure 4.3.20-3. 2010 WUI for Pennsylvania



Source: Stewart 2012

Note: Yellow circle highlights Pike County's location within Pennsylvania.

Figure 4.3.20-4. WUI for Pike County



Source: Stewart and Radeloff 2012

Wildland Fire Assessment System (WFAS)

The Wildland Fire Assessment System (WFAS) is an Internet-based information system maintained at the National Interagency Fire Center (NIFC) in Boise, Idaho, that provides a national view of weather and fire potential, including national fires danger, weather maps and satellite-derived "Greenness" maps (U.S. Forestry Service [USFS] 2016). Each day during the fire season, national maps of selected fire weather and fire danger components of the National Fire Danger Rating System (NFDRS) are produced by the WFAS (WFAS 2012). The Fire Danger Rating level, described in Table 4.3.20-2 below, takes into account current and antecedent weather, fuel types, and both live and dead fuel moisture. The adjective class rating is a method of normalizing rating classes across different fuel models, indexes, and station locations. It is based primarily on a fuel model cataloged for the station, the fire danger index selected to reflect staffing levels, and climatological class breakpoints. Local station managers provide this information to USFS (USFS 2012).

Table 4.3.20-2. Fire Danger Rating and Color Code

Fire Danger Rating and Color Code	Description
Low (L) (Dark Green)	Fuels do not ignite readily from small firebrands, although a more intense heat source, such as lightning, may start fires in duff or punky wood. Fires in open cured grasslands may burn freely a few hours after rain, but woods fires spread slowly by creeping or smoldering and burning in irregular fingers. There is little danger of spotting.
Moderate (M) (Light Green or Blue)	Fires can start from most accidental causes, but with the exception of lightning fires in some areas, the number of starts is generally low. Fires in open cured grasslands will burn briskly and spread rapidly on windy days. Timber fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel, especially draped fuel, may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
High (H) (Yellow)	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly, and short-distance spotting is common. High-intensity burning may develop on slopes or in concentrations of fine fuels. Fires may become serious and their control difficult unless they are attacked successfully while they are small.
Very High (VH) (Orange)	Fires start easily from all causes and, immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics such as long-distance spotting and fire whirlwinds when they burn into heavier fuels.
Extreme (E) (Red)	Fires start quickly, spread furiously, and burn intensely. All fires are potentially serious. Development into high intensity burning will usually be faster and occur from smaller fires than in the very high fire danger class. Direct attack is rarely possible and may be dangerous except immediately after ignition. Fires that develop headway in heavy slash (trunks, branches, and tree tops) or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions the only effective and safe control action is on the flanks until the weather changes or the fuel supply lessens.

Source: USFS 2012

Pennsylvania Department of Conservation and Natural Resources (PA DCNR) Priority Landscape Analysis

The PA DCNR conducted a wildfire priority landscape analysis identifying areas where wildland fires are predicted to occur and become problematic. The areas are classified into high, medium, and low categories. The high classification is defined as an area prone to extreme fire behavior, with the potential to cause extensive property damage, or that could threaten the safety of the Commonwealth's citizens. The following five datasets were used for this analysis:

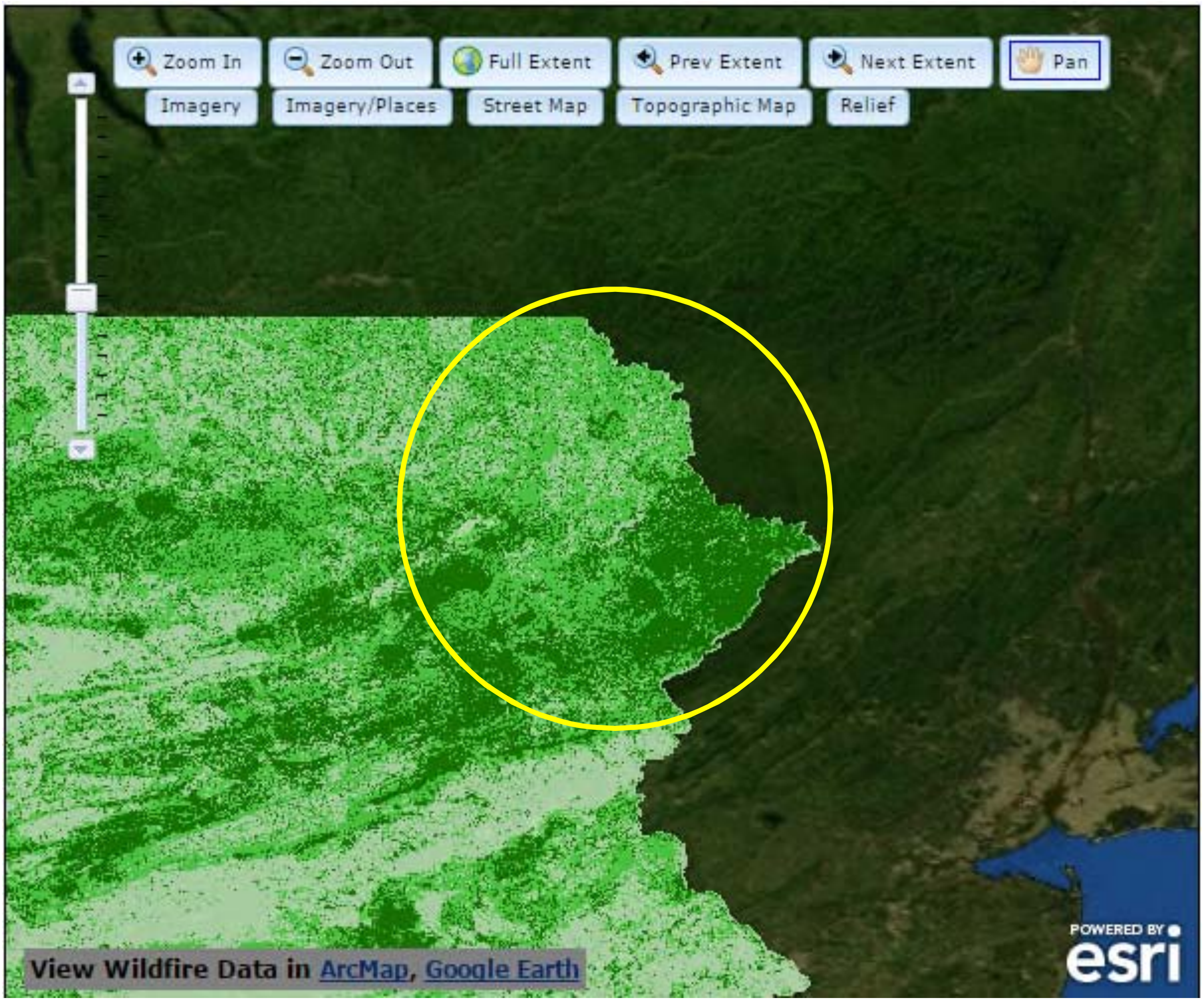
- 2002 WUI

- 2006 LANDFIRE
- 2002 – 2008 Pennsylvania Wildfire Point Origin Occurrences
- Percent Slope
- 2009 Local Assessment of Values, Risks, Hazards.

The WUI classifies areas where homes and other human development meet or intermingle with undeveloped land. LANDFIRE characterizes the land's vegetation into fuel models that predict various fire behavior intensities. The Pennsylvania wildfire Point Origin Occurrences are records of wildland fire origins that have been reported. Percent slope aids in predicting fire behavior from the terrain. The local assessment of values, risks, and hazards is a municipality-based rating system; this assessment has been made by local wildland fire managers (PA DCNR Date Unknown). Table 4.3.20-6 illustrates the output for the wildfire priority landscapes model for Pike County.

The greatest potential for wildfires is in the spring months of March, April, and May, and the autumn months of October and November. These months generally bring clear skies, high winds, low relative humidity, and prolonged periods of dry weather. In the spring, bare trees allow sunlight to reach the forest floor, drying fallen leaves and other ground debris. The same theory applies for the fall; however, the drier conditions are a more crucial factor. People cause most wildfires in Pennsylvania, often by burning debris. Several fires have started in a person's backyard and traveled through dead grasses and weeds into bordering woodlands. According to the Pennsylvania Emergency Management Agency (PEMA) Standard All-Hazard Mitigation Plan, 92 percent of Pennsylvania wildfires burn less than 10 acres and are suppressed within the first burning period (PEMA 2013).

Figure 4.3.20-5. Wildfire Priority Landscapes in Pike County



Source: PA DCNR Date Unknown (http://www.apps.dcnr.state.pa.us/forestry/farmbill/prioritylandscapes.html)
Notes: Low Priority = 0–0.21 (light green); Medium Priority = 0.21–0.35 (medium green); High Priority = 0.35–1 (dark green)
Pike County location within yellow circle

Range of Magnitude

Wildfire events in Pike County can range from small fires that can be managed by local firefighters to large fires burning many acres of land. Large events may require evacuation from one or more communities and necessitate regional or national firefighting support. The impact of a severe wildfire can be devastating. A wildfire has the potential to kill people, livestock, fish, and wildlife. They often destroy property, valuable timber, forage, and recreational and scenic resources.

In addition to the risk wildfires pose to the general public and property owners, the safety of firefighters is also a concern. Although loss of life among firefighters does not occur often in Pennsylvania, it is always a risk. More common firefighting injuries include falls, sprains, abrasions or heat-related injuries such as dehydration. Response to wildfires also exposes emergency responders to the risk of motor vehicle accidents and can place them in remote areas away from the communities that they are chartered to protect.

While some fires are not human-caused and are part of natural succession processes, a wildfire can kill people, livestock, fish and wildlife. They often destroy property, valuable timber, forage and recreational and scenic values. The most significant environmental impact is the potential for severe erosion, silting of stream beds and reservoirs, and flooding due to ground-cover loss following a fire event. Wildfire can also have a positive environmental impact in that they burn dead trees, leaves, and grasses to allow more open spaces for new vegetation to grow and receive sunlight. Another positive effect is that it stimulates the growth of new shoots on trees and shrubs and its heat can open pine cones and other seed pods.

The worst-case scenario for Pike County occurred in April 2016 known as the "16-Mile Fire". More than 100 firefighters from local and out-of-state fire companies were deployed to battle a large wildfire near the border of Pike and Monroe Counties. Two cabins, three seasonal homes and six outbuildings were destroyed by the fire. More than 8,000 acres burned in state-owned forest and private property.

Past Occurrence

Wildfires are a constant threat in Pike County. There have been 225 wildfire events reported to the Pennsylvania Department of Conservation and Natural Resources Bureau of Forestry between 2002 and 2008. This number does not include wildfires that were not reported to DCNR or that were controlled solely by the volunteer fire departments in the County, this is the most comprehensive list of wildfire occurrences available for Pike County. Table 4.3.20-3 shows the list of wildfire events reported to the DCNR from 2002-2008.

Of all of Pike County's jurisdictions, Dingman Township had the most wildfires between 2002 and 2008 according to DCNR. However, as a result of one large fire event in 2008, Greene Township had the largest total number of acres burned by wildfires between 2002 and 2008 with 1,001 acres burned.

Table 4.3.20-3. List of wildfire events reported in Pike County from 2002-2008 (DCNR 2010)

Year	Municipality	Area (acres)	Year	Municipality	Area (acres)
2002	BLOOMING GROVE TWP	0.25	2008	DINGMAN TWP	0.10
2003	BLOOMING GROVE TWP	0.20	2008	DINGMAN TWP	0.10
2003	BLOOMING GROVE TWP	0.50	2008	DINGMAN TWP	0.10
2003	BLOOMING GROVE TWP	0.10	2008	DINGMAN TWP	1.00
2004	BLOOMING GROVE TWP	0.50	2008	DINGMAN TWP	0.50
2005	BLOOMING GROVE TWP	0.70	2008	DINGMAN TWP	0.00
2005	BLOOMING GROVE TWP	0.10	2008	DINGMAN TWP	0.10
2005	BLOOMING GROVE TWP	0.20	2004	GREENE TWP	1.50
2005	BLOOMING GROVE TWP	0.10	2005	GREENE TWP	1.20
2005	BLOOMING GROVE TWP	0.20	2006	GREENE TWP	0.40
2005	BLOOMING GROVE TWP	31.00	2006	GREENE TWP	0.30
2006	BLOOMING GROVE TWP	0.10	2008	GREENE TWP	0.10
2006	BLOOMING GROVE TWP	0.10	2008	GREENE TWP	0.40
2006	BLOOMING GROVE TWP	0.10	2008	GREENE TWP	2.00
2006	BLOOMING GROVE TWP	0.50	2008	GREENE TWP	0.10
2006	BLOOMING GROVE TWP	0.10	2008	GREENE TWP	995.00
2006	BLOOMING GROVE TWP	0.10	2002	LACKAWAXEN TWP	0.10

Year	Municipality	Area (acres)	Year	Municipality	Area (acres)
2006	BLOOMING GROVE TWP	0.10	2002	LACKAWAXEN TWP	0.75
2006	BLOOMING GROVE TWP	0.20	2002	LACKAWAXEN TWP	8.00
2007	BLOOMING GROVE TWP	9.20	2002	LACKAWAXEN TWP	0.25
2007	BLOOMING GROVE TWP	0.10	2003	LACKAWAXEN TWP	4.50
2007	BLOOMING GROVE TWP	0.30	2003	LACKAWAXEN TWP	0.25
2008	BLOOMING GROVE TWP	0.10	2004	LACKAWAXEN TWP	1.50
2008	BLOOMING GROVE TWP	0.40	2005	LACKAWAXEN TWP	3.00
2008	BLOOMING GROVE TWP	0.25	2006	LACKAWAXEN TWP	0.20
2001	DELAWARE TWP	0.70	2006	LACKAWAXEN TWP	0.20
2001	DELAWARE TWP	4.50	2006	LACKAWAXEN TWP	0.10
2002	DELAWARE TWP	2.00	2006	LACKAWAXEN TWP	0.20
2002	DELAWARE TWP	0.70	2006	LACKAWAXEN TWP	0.10
2002	DELAWARE TWP	0.10	2007	LACKAWAXEN TWP	0.20
2002	DELAWARE TWP	0.10	2007	LACKAWAXEN TWP	0.10
2002	DELAWARE TWP	0.10	2007	LACKAWAXEN TWP	2.20
2002	DELAWARE TWP	0.10	2008	LACKAWAXEN TWP	0.20
2002	DELAWARE TWP	0.40	2008	LACKAWAXEN TWP	0.50
2002	DELAWARE TWP	0.10	2008	LACKAWAXEN TWP	0.50
2002	DELAWARE TWP	0.10	2008	LACKAWAXEN TWP	0.50
2002	DELAWARE TWP	0.20	2008	LACKAWAXEN TWP	2.00
2002	DELAWARE TWP	0.10	2008	LACKAWAXEN TWP	0.20
2002	DELAWARE TWP	0.10	2002	LEHMAN TWP	4.50
2002	DELAWARE TWP	0.10	2002	LEHMAN TWP	0.50
2002	DELAWARE TWP	0.10	2002	LEHMAN TWP	0.50
2002	DELAWARE TWP	0.20	2003	LEHMAN TWP	0.50
2002	DELAWARE TWP	0.40	2003	LEHMAN TWP	0.50
2004	DELAWARE TWP	0.10	2004	LEHMAN TWP	0.25
2004	DELAWARE TWP	0.01	2004	LEHMAN TWP	0.10
2004	DELAWARE TWP	0.10	2005	LEHMAN TWP	0.20
2004	DELAWARE TWP	0.05	2005	LEHMAN TWP	0.10
2004	DELAWARE TWP	0.10	2005	LEHMAN TWP	2.10
2004	DELAWARE TWP	0.10	2006	LEHMAN TWP	0.60
2005	DELAWARE TWP	0.20	2006	LEHMAN TWP	0.50
2005	DELAWARE TWP	0.10	2007	LEHMAN TWP	0.10
2005	DELAWARE TWP	0.10	2007	LEHMAN TWP	0.10
2006	DELAWARE TWP	0.30	2008	LEHMAN TWP	0.50
2006	DELAWARE TWP	0.10	2008	LEHMAN TWP	2.20
2006	DELAWARE TWP	0.10	2008	LEHMAN TWP	0.10
2006	DELAWARE TWP	0.10	2008	LEHMAN TWP	0.10

Year	Municipality	Area (acres)	Year	Municipality	Area (acres)
2006	DELAWARE TWP	0.10	2008	LEHMAN TWP	0.50
2007	DELAWARE TWP	0.10	2008	LEHMAN TWP	0.10
2007	DELAWARE TWP	0.20	2008	LEHMAN TWP	0.10
2007	DELAWARE TWP	0.20	2006	MATAMORAS BORO	0.10
2007	DELAWARE TWP	0.10	2002	MILFORD TWP	0.75
2007	DELAWARE TWP	0.10	2005	MILFORD TWP	4.00
2007	DELAWARE TWP	0.10	2006	MILFORD TWP	3.30
2007	DELAWARE TWP	0.10	2007	MILFORD TWP	0.10
2008	DELAWARE TWP	0.50	2007	MILFORD TWP	0.50
2008	DELAWARE TWP	0.20	2007	MILFORD TWP	0.20
2008	DELAWARE TWP	0.10	2008	MILFORD TWP	0.20
2008	DELAWARE TWP	0.10	2008	MILFORD TWP	0.00
2008	DELAWARE TWP	2.50	2008	MILFORD TWP	0.30
2008	DELAWARE TWP	0.20	2008	MILFORD TWP	1.00
2002	DINGMAN TWP	0.60	2008	MILFORD TWP	0.20
2002	DINGMAN TWP	0.10	2003	PALMYRA TWP	1.20
2002	DINGMAN TWP	0.50	2005	PALMYRA TWP	0.75
2002	DINGMAN TWP	0.10	2005	PALMYRA TWP	0.20
2003	DINGMAN TWP	0.50	2005	PALMYRA TWP	0.10
2003	DINGMAN TWP	0.30	2006	PALMYRA TWP	0.10
2003	DINGMAN TWP	0.20	2007	PALMYRA TWP	0.10
2004	DINGMAN TWP	2.00	2007	PALMYRA TWP	5.00
2005	DINGMAN TWP	0.30	2008	PALMYRA TWP	0.20
2005	DINGMAN TWP	0.25	2008	PALMYRA TWP	0.40
2005	DINGMAN TWP	0.75	2008	PALMYRA TWP	0.40
2005	DINGMAN TWP	0.10	2002	PORTER TWP	1.50
2005	DINGMAN TWP	0.20	2003	PORTER TWP	1.00
2005	DINGMAN TWP	0.10	2003	PORTER TWP	0.20
2005	DINGMAN TWP	0.20	2005	PORTER TWP	0.10
2005	DINGMAN TWP	0.10	2005	PORTER TWP	0.10
2005	DINGMAN TWP	0.10	2007	PORTER TWP	0.20
2006	DINGMAN TWP	2.50	2008	PORTER TWP	0.20
2006	DINGMAN TWP	0.20	2002	SHOHOLA TWP	0.25
2006	DINGMAN TWP	0.33	2002	SHOHOLA TWP	1.70
2006	DINGMAN TWP	0.25	2003	SHOHOLA TWP	4.70
2006	DINGMAN TWP	0.20	2003	SHOHOLA TWP	4.50
2006	DINGMAN TWP	0.10	2005	SHOHOLA TWP	0.20
2006	DINGMAN TWP	3.00	2005	SHOHOLA TWP	0.10
2006	DINGMAN TWP	0.10	2006	SHOHOLA TWP	5.00

Year	Municipality	Area (acres)	Year	Municipality	Area (acres)
2006	DINGMAN TWP	0.10	2006	SHOHOLA TWP	2.00
2006	DINGMAN TWP	8.00	2006	SHOHOLA TWP	0.75
2006	DINGMAN TWP	0.10	2006	SHOHOLA TWP	0.60
2006	DINGMAN TWP	0.50	2007	SHOHOLA TWP	0.25
2006	DINGMAN TWP	0.10	2007	SHOHOLA TWP	1.50
2007	DINGMAN TWP	0.10	2007	SHOHOLA TWP	0.10
2007	DINGMAN TWP	1.50	2008	SHOHOLA TWP	0.60
2007	DINGMAN TWP	0.00	2008	SHOHOLA TWP	0.10
2007	DINGMAN TWP	0.10	2008	SHOHOLA TWP	0.10
2007	DINGMAN TWP	0.40	2002	WESTFALL TWP	0.25
2007	DINGMAN TWP	0.00	2003	WESTFALL TWP	0.20
2007	DINGMAN TWP	0.10	2004	WESTFALL TWP	3.30
2007	DINGMAN TWP	0.10	2005	WESTFALL TWP	18.00
2007	DINGMAN TWP	0.10	2008	WESTFALL TWP	0.20
2008	DINGMAN TWP	0.10	2008	WESTFALL TWP	0.10
2008	DINGMAN TWP	0.20	2008	WESTFALL TWP	0.60
2008	DINGMAN TWP	0.20	2008	WESTFALL TWP	0.10
2008	DINGMAN TWP	1.50			
				TOTAL	**1,199**

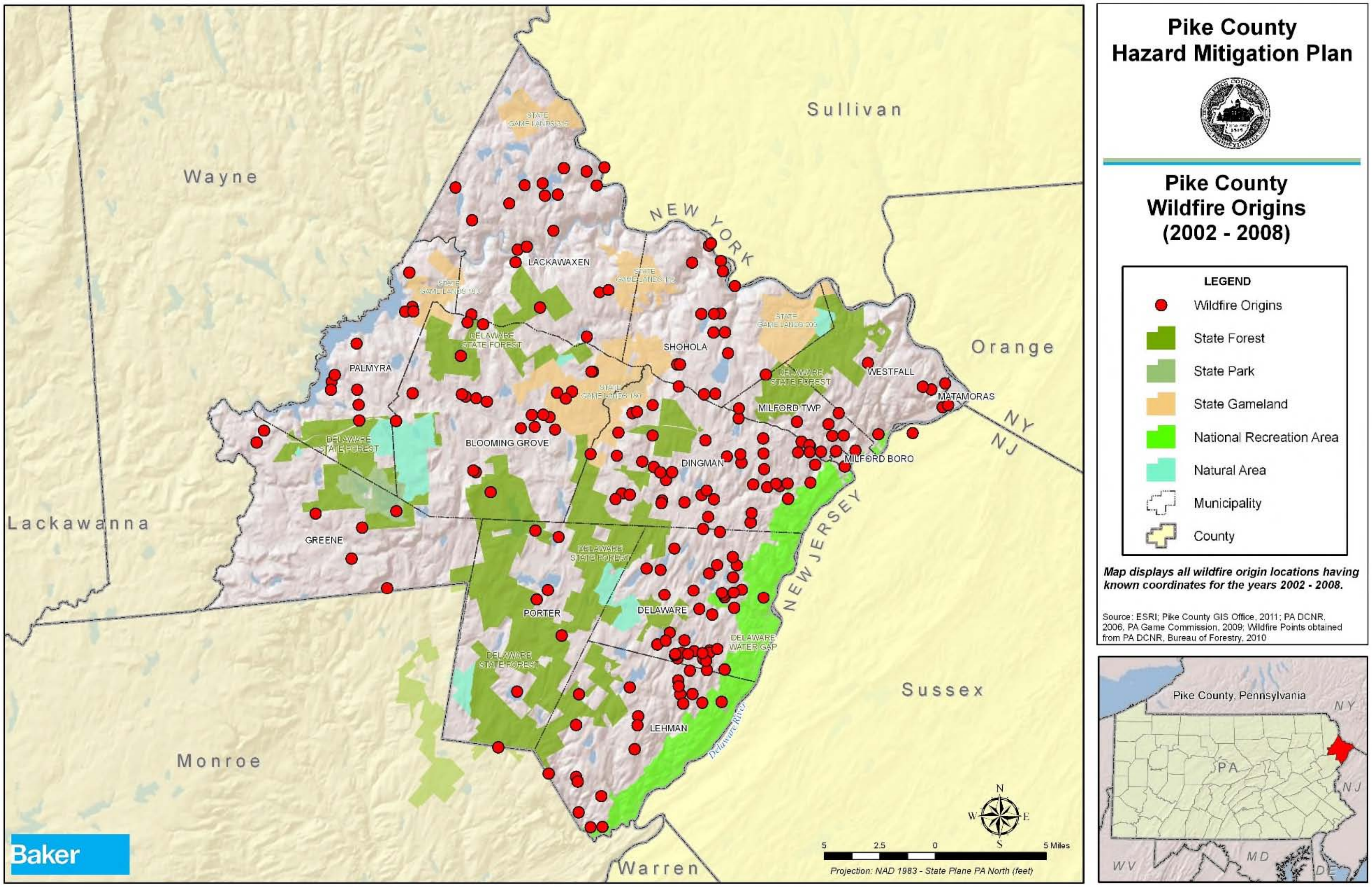
Source:

In addition to the events identified above, the following provides details regarding several severe events that impacted Pike County:

- April 1990 – a large wildfire burned approximately 200 acres of woodlands located at the end of Firetower Road in Westfall and Shohola Townships.
- March 1999 - a controlled burn performed by the National Park Service accidentally spread due to rapid changes in weather conditions. The wildfire burned close to 500 acres and required several days and resources and manpower from several states to extinguish.
- April 2016 – 16-Mile Fire – More than 100 firefighters from local and out-of-state fire companies were deployed to battle a large wildfire near the border of Pike and Monroe Counties. Two cabins, three seasonal homes and six outbuildings were destroyed by the fire. More than 8,000 acres burned in state-owned forest and private property.

Figure 4.3.20-6 maps the origins of the wildfire events which were reported to the DCNR listed in Table 4.3.20-3 above. It is important to note that this is not an inclusive map of all wildfires, just those with known locations. The map shows that previous occurrences of wildfires have occurred throughout the entire County instead of concentrated in a single jurisdiction or area of Pike County.

Figure 4.3.20-6. Wildfire Origins in Pike County Between 2002 and 2008



Future Occurrence

In Pennsylvania, wildfire events will continue to occur each year. However, the likelihood of one of those fires attaining significant size and intensity is unpredictable and highly dependent on environmental conditions and firefighting response. Weather conditions, particularly drought events, increase the likelihood of wildfires occurring. Additionally, invasive forest insects can increase the likelihood of wildfires occurring; insects that attack and kill trees increase the total wildfire fuel available in wooded areas. Climate change is also likely to increase the probability of future wildfires. Prolonged periods of drought caused by climate change can potentially increase the length of the wildfire season and provide a more favorable climate for ignition (Pennsylvania HMP 2013).

For the 2017 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of wildfire events for Pike County. Information from the 2012 Pike County HMP, input from Pike County, and local newspapers were used to identify the number of wildfire events that occurred between 1950 and 2015. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimate percent chance of an incident occurring in a given year. Based on these statistics, there is an estimated 100-percent chance of a wildfire event occurring in any given year in Pike County.

Table 4.3.20-4. Probability of Future Wildfire Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Wildfires	1,202	18.49	0.05	1.0	100%

Sources: Pike County HMP 2012; Pike County 2016

Based on available historical data, the future occurrence of wildfires in Pike County can be considered *highly likely* as defined by the Risk Factor Methodology probability criteria (refer to Section 4.4). However, the likelihood of one of those fires attaining significant size and intensity is unpredictable and highly dependent on environmental conditions and firefighting response. Weather conditions like drought and wind can increase the likelihood of wildfires occurring. Any fire, without the quick response or attention of fire-fighters, forestry personnel, or visitors to the forest, has the potential to become a wildfire.

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed and vulnerable in the identified hazard area. The following text evaluates and estimates the potential impact of the wildfire hazard on the County, including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on (1) life, health and safety; (2) general building stock; (3) critical facilities; (4) economy; and (5) future growth and development
- Effects of climate change on vulnerability
- Further data collections that will assist understanding this hazard over time.

Overview of Vulnerability

Wildfire hazards can impact significant areas of land, as evidenced by wildfires throughout the United States in recent years. Fire in urban areas has the potential for great damage to infrastructure, loss of life, and strain on lifelines and emergency responders because of the high density of population and structures that can be affected in these areas. Wildfire, however, can spread quickly, become a huge fire consisting of thousands of acres, and present greater challenges for allocating resources, defending isolated structures, and coordinating multi-jurisdictional response.

Data and Methodology

Information regarding the wildfire hazard included input and data from PA DCNR, the University of Wisconsin-Madison, and the Steering Committee. The WUI (interface and intermix) obtained through the SILVIS Lab, Department of Forest Ecology and Management, University of Wisconsin-Madison, defines the wildfire hazard area. The asset data (population, building stock, and critical facilities) presented in the County Profile (Section 2) was used to support an evaluation of assets exposed and the potential impacts and losses associated with this hazard. Available and appropriate geographic information system (GIS) data were overlaid on the hazard area to identify what assets are exposed to wildfire. The limitations of this analysis are recognized, and as such the analysis is used only to provide a general estimate.

Impact on Life, Health, and Safety

As demonstrated by historical wildfire events, potential losses include human health and life of residents and responders. The most vulnerable populations include emergency responders and those within a short distance of the interface between the built environment and the wildland environment.

The County land within the WUI data was overlaid on the 2010 U.S. Census population data to estimate the Pike County population vulnerable to the wildfire hazard (U.S. Census 2010). The census blocks with their center within the hazard area were used to calculate the estimated population exposed to the wildfire hazard. Table 4.3.20-5 summarizes the estimated population exposed by municipality.

Table 4.3.20-5. Estimated Population Located within the WUI in Pike County

Municipality	U.S. Census 2010 Population	Estimated Population Exposed	Percent of Total
Blooming Grove Township	4,819	3,610	74.9%
Delaware Township	7,396	6,622	89.5%
Dingman Township	11,926	10,904	91.4%
Greene Township	3,956	3,354	84.8%
Lackawaxen Township	4,994	4,203	84.2%
Lehman Township	10,663	9,855	92.4%
Matamoras Borough	2,469	2,469	100.0%
Milford Borough	1,021	1,018	99.7%
Milford Township	1,530	1,312	85.8%
Palmyra Township	3,312	2,738	82.7%
Porter Township	485	351	72.4%
Shohola Township	2,475	1,905	77.0%
Westfall Township	2,323	2,113	91.0%
Pike County (Total)	**57,369**	**50,454**	**87.9%**

Source: *U.S. Census 2010, Stewart and Radeloff 2012*
Notes:
WUI *Wildland-Urban Interface*

Impact on General Building Stock

The most vulnerable structures to wildfire events are those within the WUI. Buildings constructed of wood or vinyl siding are generally more likely to be damaged by the fire hazard than buildings constructed of brick or concrete. The WUI was overlaid on the default building inventory in Hazards U.S. – Multi-Hazard (HAZUS-MH) to estimate the replacement cost of buildings and on the County provided spatial layer of buildings to estimate number of structures exposed to the wildfire hazard in Pike County. The replacement cost value (RCV) of the census blocks with their center in the WUI was totaled. Table 4.3.20-6 summarizes the estimated building stock inventory exposed by municipality.

Table 4.3.20-6. Building Stock Replacement Value and Structures Located within the WUI in Pike County

Municipality	Total GBS RCV	Estimated GBS RCV Exposed	Percent of Total	Total Number of Structures	Number of Structures in Hazard Area	Percent of Total
Blooming Grove Township	$1,160,095,000	$952,006,000	82.1%	3,998	3,343	83.6%
Delaware Township	$1,496,677,000	$1,370,343,000	91.6%	4,253	3,895	91.6%
Dingman Township	$1,984,820,000	$1,837,445,000	92.6%	5,480	4,997	91.2%
Greene Township	$956,640,000	$795,710,000	83.2%	3,275	2,929	89.4%
Lackawaxen Township	$1,231,170,000	$1,117,412,000	90.8%	4,562	4,069	89.2%
Lehman Township	$1,992,003,000	$1,887,895,000	94.8%	5,995	5,775	96.3%
Matamoras Borough	$377,318,000	$377,318,000	100.0%	972	972	100.0%
Milford Borough	$413,430,000	$357,170,000	86.4%	718	670	93.3%

Municipality	Total GBS RCV	Estimated GBS RCV Exposed	Percent of Total	Total Number of Structures	Number of Structures in Hazard Area	Percent of Total
Milford Township	$670,787,000	$336,893,000	50.2%	784	609	77.7%
Palmyra Township	$1,244,483,000	$1,155,235,000	92.8%	3,981	3,700	92.9%
Porter Township	$388,599,000	$252,871,000	65.1%	912	583	63.9%
Shohola Township	$759,299,000	$680,794,000	89.7%	2,311	2,101	90.9%
Westfall Township	$383,781,000	$295,530,000	77.0%	1,175	977	83.1%
Pike County (Total)	**$13,059,102,000**	**$11,416,622,000**	**87.4%**	**38,416**	**34,620**	**90.1%**

Source: HAZUS-MH v3.1; Stewart and Radeloff 2012
Notes:
GBS General Building Stock
RCV Replacement cost value
WUI Wildland-Urban Interface

Impact on Critical Facilities

A number of critical facilities are located in the wildfire hazard area. Many of these facilities are the locations for vulnerable populations (schools) and responding agencies to wildfire events (fire and police). Table 4.3.20-7 summarizes the number of critical facilities identified by the County plan participants that are located within the wildfire hazard area.

Table 4.3.20-7. Number of Critical Facilities in the WUI in Pike County

Facility Type	Number of Facilities in Hazard Area	
	Interface	Intermix
Blooming Grove Township	1	9
Delaware Township	2	6
Dingman Township	2	8
Greene Township	0	4
Lackawaxen Township	2	10
Lehman Township	2	7
Matamoras Borough	6	3
Milford Borough	6	0
Milford Township	2	3
Palmyra Township	2	11
Porter Township	0	0
Shohola Township	0	4
Westfall Township	2	1
Pike County (Total)	**36**	**63**

Source: Stewart and Radeloff 2012; Pike County 2016
Notes:
WUI Wildland-Urban Interface

Impact on the Economy

Wildfire events can have major economic impacts on a community from the initial loss of structures and the subsequent loss of revenue from destroyed businesses and decreases in tourism. Wildfire can also severely damage roads and infrastructure. Portions of Interstates I-84 and I-70, US Routes US-6 and US-3209, and multiple State Routes including, PA-434, PA-2001, PA-402, and PA-390 run through WUI areas. This factor should be considered for determine evacuation routes for Pike County residents.

Future Growth and Development

Areas targeted for potential future growth and development in the next 5 years have been identified across the County at the municipal level. It is anticipated that any new development and new residents in the WUI will be exposed to the wildfire hazard.

Effect of Climate Change on Vulnerability

According to USFS, climate change will likely alter the atmospheric patterns that affect fire weather. Changes in fire patterns will, in turn, affect carbon cycling, forest structure, and species composition. Climate change associated with elevated greenhouse gas concentrations may create an atmospheric and fuel environment that is more conducive to large, severe fires (USFS 2011).

Fire interacts with climate and vegetation (fuel) in predictable ways. Understanding the interactions of climate, fire, and vegetation interactions is essential for addressing issues associated with climate change that include:

- Effects on regional circulation and other atmospheric patterns that affect fire weather
- Effects of changing fire regimes on the carbon cycle, forest structure, and species composition, and
- Complications from land-use change, invasive species, and an increasing WUI (USFS 2011)

It is projected that higher summer temperatures will likely increase the high fire risk by 10 to 30-percent. Fire occurrence and area burned could increase across the United States as a result of the increase of lightning activity, the frequency of surface pressure and associated circulation patterns conducive to surface drying, and fire-weather conditions, in general, which are conducive to severe wildfires. Warmer temperatures will also increase the effects of drought and increase the number of days each year with flammable fuels and extending fire seasons and areas burned (USFS 2011).

Pennsylvania's Department of Environmental Protection (PADEP) was directed by the Climate Change Act (Act 70 of 2008) to initiate a study of the potential impacts of global climate change on the Commonwealth. The June 2009 Pennsylvania Climate Impact Assessment's main findings indicate Pennsylvania may be at increased risk for wildfires, but it is unclear how large the increase in risk will be (Shortle and others 2009).

Future changes in fire frequency and severity are difficult to predict. Global and regional climate changes associated with elevated greenhouse gas concentrations could alter large weather patterns, thereby affecting fire-weather conditions that are conducive to extreme fire behavior (USFS 2011).

Additional Data and Next Steps

As the data and resources become available, a custom building inventory can be generated to capture the construction of structures (such as roofing material, fire detection equipment, and structure age) to further refine the vulnerability analysis. As stated earlier, buildings constructed of wood or vinyl siding are generally more likely to be damaged by the fire hazard than buildings constructed of brick or concrete. The proximity of these building types to the WUI should be identified for further evaluation. Development and availability of these data would permit a more detailed estimate of potential vulnerabilities, including loss of life and potential structural damages.

In locations where homes are at risk for wildfires, the BOF's WUI Guidance Document is available to assist homeowners, community associations, local government, and developers to assess and mitigate the potential dangers of a wildfire. The guidance also provides information for developing an action plan in coordination with local emergency managers. Communities at risk for wildfires can adopt by local ordinance the "International Wildland-Urban Interface Code" of the Uniform Construction Code.

4.3.21 Winter Storm

This section provides a profile and vulnerability assessment of the winter storm hazard in Pike County. Winter storms occur, on average, approximately five times each year in Pennsylvania. From November through March, the State is exposed to winter storms that move up the Atlantic coast or sweep in from the west. Every county in the Commonwealth is subject to severe winter storms; however, the northern tier, western counties, and mountainous regions tend to undergo winter weather more frequently and with greater severity.

Winter storms can produce more damage than any other severe weather event, including tornados. Complications caused by winter storms can lead to road closures, especially of secondary and farm roads; business losses to commercial centers built in outlying areas because of supply interruption and loss of customers; property losses and roof damages from snow and ice loading and fallen trees; utility interruptions; and loss of water supplies. Flooding can result from winter storm events as well.

Most severe winter storm hazards include heavy snow (snowstorms), blizzards, sleet or freezing rain, ice storms, and Nor'easters. Because most extra-tropical cyclones (mid-Atlantic cyclones locally known as Northeasters or Nor'Easters) generally occur during winter weather months, these hazards have also been grouped as a type of severe winter weather storm. Types of severe winter weather events or conditions are further defined as follows:

- Heavy Snow: According to the National Weather Service (NWS), heavy snow is generally considered snowfall accumulating to depths of 4 inches or more within 12 hours or less; or snowfall accumulating to depths of 6 inches or more within 24 hours or less. A snow squall is an intense but limited-duration period of moderate to heavy snowfall, also known as a snowstorm, accompanied by strong, gusty surface winds and possibly lightning (generally moderate to heavy snow showers) (NWS 2009). Snowstorms are complex phenomena involving heavy snow and winds, whose impact can be affected by a great many factors, including a region's climatological susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, and occurrence during the course of the day, weekday versus weekend, and time of season (Kocin and Uccellini 2013).

- Blizzard: Blizzards are characterized by low temperatures, wind gusts of 35 miles per hour (mph) or more, and falling and/or blowing snow that reduces visibility to 0.25 mile or less for an extended period of time (3 or more hours) (NWS 2009). A severe blizzard is defined as an event with wind velocity of 45 mph, temperatures of 10 degrees Fahrenheit (°F) or lower, and a high density of blowing snow with visibility frequently measured in feet over an extended period of time.

- Sleet or Freezing Rain: Sleet is defined as pellets of ice composed of frozen or mostly frozen raindrops or refrozen, partially-melted snowflakes. These pellets of ice usually bounce after hitting the ground or other hard surfaces. Freezing rain is rain that falls as a liquid but freezes into glaze upon contact with the ground. Both types of precipitation, even in small accumulations, can cause significant hazards to a community (NWS 2009).

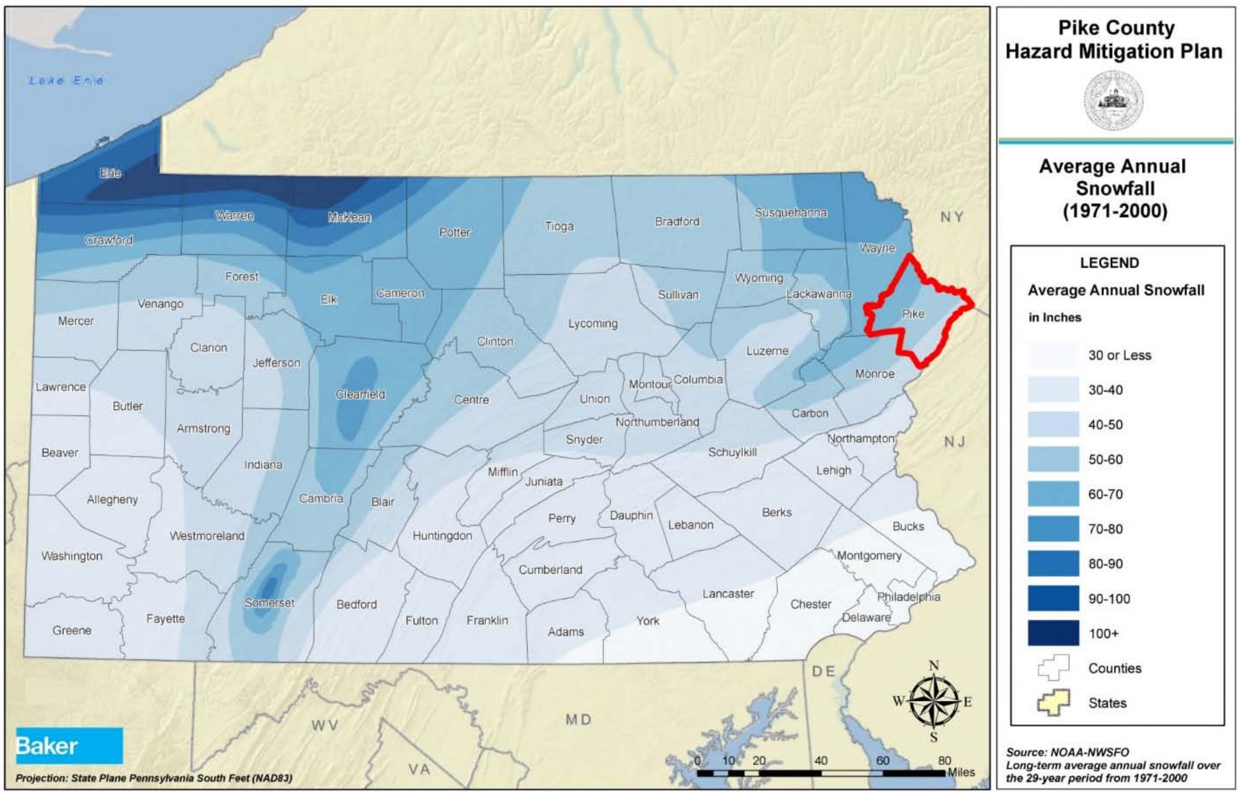
- Ice storm: An ice storm is described as an occasion when damaging volumes of ice are expected to accumulate during freezing rain situations. Significant accumulations of ice pull down trees and utility lines, resulting in loss of power and means of communication. These accumulations of ice make walking and driving extremely dangerous, and can create extreme hazards to motorists and pedestrians (NWS 2009).

Location and Extent

Winter storms can consist of cold temperatures and heavy snow or ice. Major winter storms occur in Pennsylvania several times annually and are regional events. Every county in the Commonwealth, including Pike, is subject to severe winter storms.

Within Pike County there are variations in the average amount of snowfall that is received throughout different parts of the County because of terrain differences; higher elevations experience greater snowfalls than lower-lying areas. Generally, the average annual snowfall in the County increases from the southeast to northwest as shown in Figure 4.3.21-1.

Figure 4.3.21-1. Average Annual Snowfall (1971-2000) for Pennsylvania



The magnitude or severity of a severe winter storm depends on several factors including a region's climatological susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, time of occurrence during the day (e.g., weekday versus weekend), and time of season.

The extent of a severe winter storm can be classified by meteorological measurements and by evaluating its societal impacts. National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) currently produces the Regional Snowfall Index (RSI) for significant snowstorms that affect the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from 1 to 5. The index is based on spatial extent of the storm, amount of snowfall, and interaction of extent and snowfall totals with population (based on the 2000 U.S. Census). NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA-NCDC 2011). Table 4.3.21-1 describes the five RSI ranking categories.

Table 4.3.21-1. RSI Ranking Categories

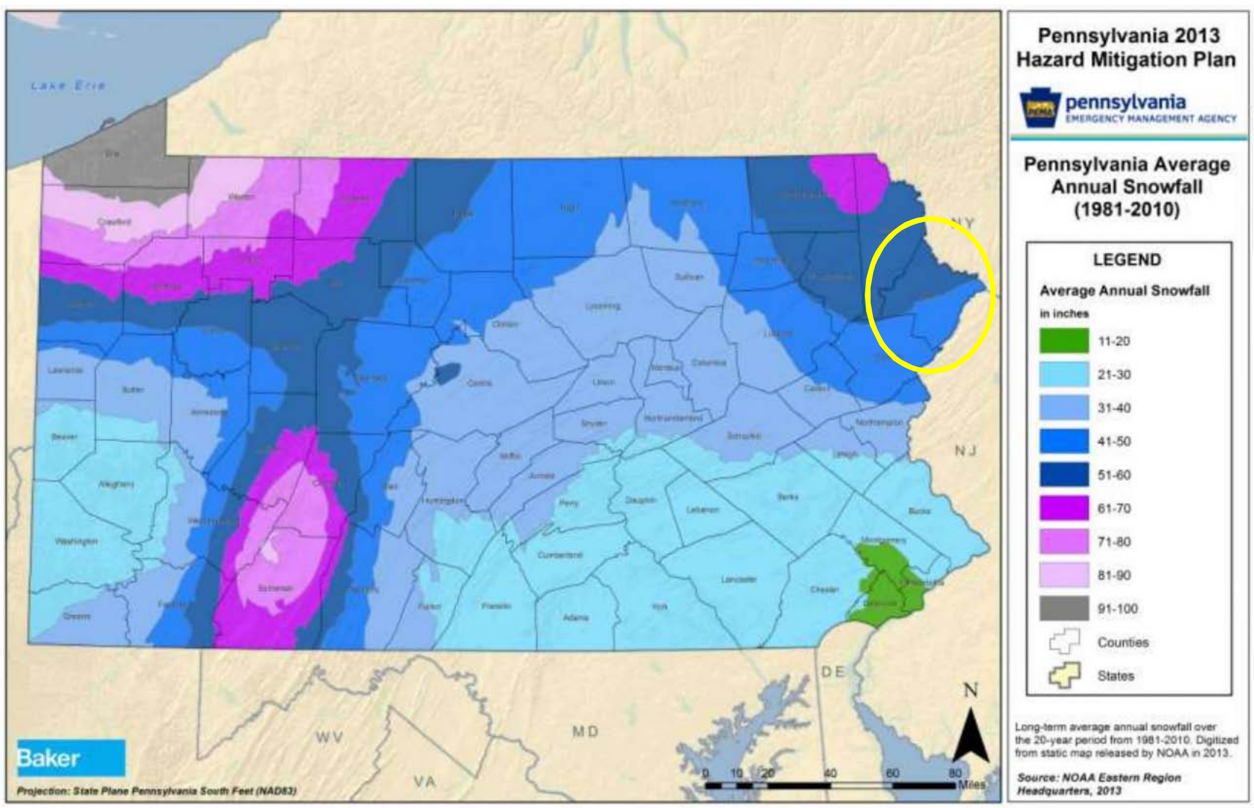
Category	Description	RSI Value
1	Notable	1-3
2	Significant	3-6
3	Major	6-10
4	Crippling	10-18
5	Extreme	18.0+

Source: NOAA-NCDC 2011

Notes: RSI Regional Snowfall Index

All of Pike County is susceptible to winter storms. Based on annual snowfall averages according to the 2013 State Hazard Mitigation Plan (HMP) (Figure 4.3.21-2), Pike County expectedly would receive an average of 41-60 inches of snowfall accumulation during the winter season.

Figure 4.3.21-2. Pennsylvania Average Annual Snowfall, 1981-2010



Source: Pennsylvania State HMP 2013

Note: The yellow circle indicates the approximate location of Pike County.

Range of Magnitude

Winter storms consist of cold temperatures, heavy snow or ice and sometimes strong winds. They begin as low-pressure systems that move through Pennsylvania following the jet stream. Being located in the northeast portion of Pennsylvania, Pike County often experiences the effects of Nor'Easter storms – low pressure fronts that move northward along the Atlantic coastline, pulling large amounts of moisture off of the Atlantic Ocean.

Due to their regular occurrence, these storms are considered hazards only when they result in damage to communications networks, impacts vegetation, cause structural collapse, cause very serious transportation problems and utility interruptions. Winter storms have also been known to contribute to severe flooding. A winter storm can adversely affect roadways, utilities, business activities, and can cause frostbite or loss of life. These storms may include one or more of the following weather events:

- **Heavy Snowstorm:** Accumulations of four inches or more in a six-hour period, or six inches or more in a twelve-hour period.
- **Sleet Storm:** Significant accumulations of solid pellets which form from the freezing of raindrops or partially melted snowflakes causing slippery surfaces posing hazards to pedestrians and motorists.
- **Ice Storm:** Significant accumulations of rain or drizzle freezing on objects (trees, power lines, roadways, etc.) as it strikes them, causing slippery surfaces and damage from the sheer weight of ice accumulation.
- **Blizzard:** Wind velocity of 35 miles per hour or more, temperatures below freezing, considerable blowing snow with visibility frequently below one-quarter mile prevailing over an extended period of time.
- **Severe Blizzard:** Wind velocity of 45 miles per hour, temperatures of 10 degrees Fahrenheit or lower, a high density of blowing snow with visibility frequently measured in feet prevailing over an extended period time.

Any of the above events can result in the closing of major or secondary roads, particularly in rural locations, stranded motorists, transportation accidents, loss of utility services, and depletion of oil heating supplies. Environmental impacts often include damage to shrubbery and trees due to heavy snow loading, ice build-up and/or high winds which can break limbs or even bring down large trees. Gradual melting of snow and ice provides excellent groundwater recharge. However, high temperatures following a heavy snowfall can cause rapid surface water runoff and severe flooding.

Figure 4.3.21-1 shows mean annual snowfall in Pike County to be 40 to 50 inches in the southern part of the County, 50 to 60 inches in the central section, and 60 to 70 inches in the northwest. Two of the twelve Presidential Disaster and Emergency Declarations affecting Pike County have been in response to hazard events related to winter storms (see Table 4.2-1). Other reported winter storm events since 1994, including those associated with Disaster Declarations, are listed in Table 4.3.21-1.

A worst case scenario for winter storms occurred in March 1997. An isolated snow storm which affected only the northeast portion of Pennsylvania dumped up to 30 inches of very wet snow in Pike County. This storm caught everyone by surprise, stranding thousands of travelers along Interstate 84. This storm also brought down hundreds of trees throughout the county, dropping power and telephone lines, leaving large portions of the county without electricity and/or telephone service for up to five days. Highway departments and emergency responders struggled to cope with the multiple problems this storm caused. Eventually, with the help of the National Guard, over 1,200 people were brought off the highways and placed in shelters.

Past Occurrence

The Commonwealth of Pennsylvania has a long history of severe winter weather. In the winter of 1993-4, the state was hit by a series of protracted winter storms. The severity and nature of these storms combined with accompanying record-breaking frigid temperatures posed a major threat to the lives, safety and well-being of Commonwealth residents and caused major disruptions to the activities of schools, businesses, hospitals, and nursing homes.

As mentioned above, the first of these devastating winter storms occurred in early January with record snowfall depths (in excess of 33 inches in the southwest and south-central portions of the Commonwealth), strong winds and sleet/freezing rains. Numerous storm-related power outages were reported, and as many as 600,000 residents were without electricity, in some cases for several days at a time. A ravaging ice storm followed, affecting the southeastern portion of the Commonwealth, which closed major arterial roads and downed trees and power lines. Utility crews from a five-state area were called to assist in power restoration repairs. Officials from PP&L stated that this was the worst winter storm in the history of the company, and related damage-repair costs exceeded $5,000,000.

Serious power supply shortages continued through mid-January because of record cold temperatures at many places, causing sporadic power generation outages across the Commonwealth. The entire Pennsylvania-New Jersey-Maryland grid and its partners in the District of Columbia, New York and Virginia experienced 15-30 minute rolling blackouts, threatening the lives of people and the safety of the facilities in which they resided. Power and fuel shortages affecting Pennsylvania and the East Coast power grid system required the Governor to recommend power conservation measures be taken by all commercial, residential, and industrial power consumers.

The record cold conditions resulted in numerous water-main breaks and interruptions of service to thousands of municipal and city water customers throughout the Commonwealth. Additionally, the extreme cold in conjunction with accumulations of frozen precipitation resulted in acute shortages of road salt. As a result, trucks were dispatched to haul salt from New York to expedite deliveries to PA Department of Transportation (DOT) storage sites.

During January and February 1994, Pennsylvania experienced at least 17 regional or statewide winter storms. The consequences of these disasters resulted in the need for intervention by the President in an effort to alleviate the severity of the hardship and to aid the recovery of the hardest-hit counties.

In January 1996, another series of severe winter storms with 27- and 24-inch accumulated snow depths was followed by 50 to 60 degree temperatures resulting in rapid melting and flooding.

In addition to the events described above, other winter storm events that impacted Pike County are listed in Table 4.3.21-2. Details regarding some of these events are provided below.

Table 4.3.21-2. Previous Winter Storm Events Impacting Pike County Since 1994

Location	Date	Type
Lehigh, Monroe, Northampton, Pike	11/27/1994	Winter Storm
Multiple Counties	12/09/1994	Freezing Rain
Multiple Counties	12/14/1994	Freezing Drizzle
Multiple Counties	12/31/1994	Freezing Rain
Multiple Counties	01/06/1995	Winter Storm
Multiple Counties	01/31/1995	Freezing Rain
Multiple Counties	02/03/1995	Heavy Snow
Multiple Counties	02/15/1995	Freezing Rain

Location	Date	Type
Berks, Carbon, Lehigh, Monroe, Northampton, Northern Wayne, Pike	02/15/1995	Freezing Rain
Carbon, Monroe, Northern Wayne, Pike	02/27/1995	Freezing Rain
Multiple Counties	03/08/1995	Snow
Multiple Counties	06/01/1995	Snow Drought
Multiple Counties	11/14/1995	Heavy Snow
Multiple Counties	01/02/1996	Heavy Snow
Multiple Counties	01/07/1996	Heavy Snow
Multiple Counties	01/12/1996	Heavy Snow
Multiple Counties	03/06/1996	Heavy Snow
Lackawanna, Luzerne, Northern Wayne, Pike, Susquehanna, Wyoming	03/31/1997	Heavy Snow
Lackawanna, Luzerne, Northern Wayne, Pike, Susquehanna, Wyoming	04/01/1997	Heavy Snow
Multiple Counties	12/29/1997	Heavy Snow
Lackawanna, Northern Wayne, Pike	01/15/1998	Ice Storm
Multiple Counties	02/23/1998	Heavy Snow
Lackawanna, Northern Wayne, Pike, Susquehanna	03/20/1998	Heavy Snow
Bradford, Lackawanna, Luzerne, Northern Wayne, Pike, Susquehanna, Wyoming	01/02/1999	Ice Storm
Multiple Counties	01/13/1999	Winter Storm
Lackawanna, Luzerne, Northern Wayne, Pike	03/14/1999	Heavy Snow
Multiple Counties	01/20/2000	Heavy Snow
Multiple Counties	01/25/2000	Heavy Snow
Multiple Counties	01/30/2000	Heavy Snow
Multiple Counties	02/13/2000	Ice Storm
Multiple Counties	02/18/2000	Heavy Snow
Lackawanna, Luzerne, Northern Wayne, Pike, Susquehanna, Wyoming	04/08/2000	Heavy Snow
Lackawanna, Luzerne, Northern Wayne, Pike, Wyoming	12/13/2000	Winter Storm
Lackawanna, Northern Wayne, Pike, Susquehanna	12/30/2000	Heavy Snow
Lackawanna, Luzerne, Northern Wayne, Pike	01/20/2001	Heavy Snow
Lackawanna, Luzerne, Northern Wayne, Pike, Susquehanna, Wyoming	02/05/2001	Heavy Snow
Pike	02/16/2001	Ice Storm
Pike	02/22/2001	Heavy Snow
Multiple Counties	02/24/2001	Ice Storm
Bradford, Lackawanna, Luzerne, Northern Wayne, Pike, Susquehanna, Wyoming	03/04/2001	Heavy Snow
Northern Wayne, Pike, Susquehanna	03/12/2001	Ice Storm
Bradford, Lackawanna, Luzerne, Northern Wayne, Pike, Susquehanna, Wyoming	01/06/2002	Heavy Snow
Bradford, Lackawanna, Luzerne, Northern Wayne, Pike, Susquehanna, Wyoming	01/31/2002	Winter Storm
Bradford, Lackawanna, Luzerne, Northern Wayne, Pike, Susquehanna, Wyoming	02/01/2002	Winter Storm
Lackawanna, Luzerne, Northern Wayne, Pike, Wyoming	12/05/2002	Heavy Snow
Bradford, Lackawanna, Luzerne, Northern Wayne, Pike, Susquehanna, Wyoming	12/11/2002	Winter Weather/mix
Bradford, Lackawanna, Luzerne, Northern Wayne, Pike, Susquehanna, Wyoming	12/24/2002	Heavy Snow
Bradford, Lackawanna, Luzerne, Northern Wayne, Pike, Susquehanna, Wyoming	01/03/2003	Heavy Snow
Bradford, Lackawanna, Luzerne, Northern Wayne, Pike,	02/17/2003	Heavy Snow

Location	Date	Type
Susquehanna, Wyoming		
Pike	03/06/2003	Heavy Snow
Multiple Counties	12/06/2003	Heavy Snow
Lackawanna, Northern Wayne, Pike, Susquehanna	01/28/2004	Heavy Snow
Multiple Counties	01/06/2005	Winter Weather/mix
Multiple Counties	01/23/2005	Heavy Snow
Multiple Counties	03/01/2005	Heavy Snow
Multiple Counties	03/24/2005	Heavy Snow
Multiple Counties	10/25/2005	Winter Weather/mix
Lackawanna, Luzerne, Northern Wayne, Pike, Southern Wayne, Susquehanna, Wyoming	12/09/2005	Heavy Snow
Lackawanna, Luzerne, Northern Wayne, Pike, Southern Wayne, Wyoming	12/16/2005	Winter Storm
Multiple Counties	02/13/2007	Winter Storm
Pike, Southern Wayne, Wyoming	03/16/2007	Heavy Snow
Pike, Southern Wayne	02/22/2008	Winter Storm
Multiple Counties	12/19/2008	Heavy Snow
Multiple Counties	10/15/2009	Winter Weather
Multiple Counties	02/10/2010	Winter Storm
Pike, Southern Wayne	02/23/2010	Winter Storm
Multiple Counties	02/25/2010	Winter Storm
Bradford, Luzerne, Pike, Southern Wayne, Wyoming	02/20/2011	Winter Storm
Multiple Counties	02/23/2011	Winter Storm
Multiple Counties	10/29/2011	Winter Storm
Multiple Counties	12/14/2013	Winter Storm
Multiple Counties	01/02/2014	Winter Storm
Multiple Counties	02/05/2014	Winter Storm
Multiple Counties	02/13/2014	Winter Storm
Multiple Counties	11/26/2014	Winter Storm
Multiple Counties	02/01/2015	Heavy Snow
Multiple Counties	01/23/2016	Heavy Snow

Source: Pike County HMP 2012; NOAA NCEI 2016
Note: Events with the location "Multiple Counties" include Pike County

Between 1954 and 2016, FEMA issued a major disaster (DR) or emergency (EM) declaration for the Commonwealth of Pennsylvania for eight winter storm-related events, classified as one or a combination of the following disaster types: severe winter storm, snowstorm, blizzard, winter storm, severe storm, and snowfall. Generally, these disasters covered a wide region of the State; therefore, they may have impacted many counties. However, not all counties were included in the disaster declarations. Of those events, Pike County has been included in two winter storm-related declarations during this time period (FEMA 2016).

Table 4.3.21-3. FEMA DR and EM Declarations for Winter Storm Events in Pike County

FEMA Declaration Number	Date(s) of Event	Event Type	Location
EM-3105	March 13-17, 1993	Severe Snowfall and Winter Storm	67 counties including Pike County
DR-1085	January 6-12, 1996	Blizzard of 96	51 counties including Pike County

Source: FEMA 2016

In addition to the events identified above, Pike County and other sources have record of winter storms. These include:

- January 1966 - very heavy snow causes problems across the entire state.
- November 1971 - heavy snow fell on Pike County on Thanksgiving, stranding hundreds of travelers along Rt. 84.
- January 1978 - very heavy snow brought the county to a standstill for two days.
- February 1978 - another storm similar to the one only about a week earlier with the same effects.
- March 1993 - a major Nor'easter hit the county, dumping in excess of 24 inches of snow over the majority of the county. This storm affected the entire east coast from Florida to Maine. Pike County was eligible for Public Assistance under the Presidential Declaration (EM-3105).
- February 20-21, 2011 - Snow fell across northeast Pennsylvania on the 20th and brought between six and eight inches of snow to Pike County.
- March 23, 2011 - Cold air combined with significant moisture brought widespread snow to northeast Pennsylvania. Snowfall totals ranged from five to 10 inches, with a foot of snow falling in higher terrain of western Bradford County. In Pike County, snowfall totals ranged from five to nine inches.
- October 28, 2011 (Nor'Easter/Winter Storm) - An early season winter storm brought wet snow across northeast Pennsylvania. Snow amounts varied depending on elevation. More than a foot of snow fell in the Poconos. In Pike County, snowfall totals across the county averaged around 12 inches.
- December 14-15, 2013 - Moderate to heavy snowfall fell across portions of the Poconos and the northern tier of Pennsylvania. The highest snowfall of 10 inches was reported in Bradford County. In Pike County, snowfall totals ranged from eight to 10 inches.
- February 5, 2014 - An intense snow band developed and produced as much as one to three inches of snow per hour during the morning of February 5th. Widespread snow amounts ranged from seven to 16 inches, with the highest totals occurring across the northern tier of Pennsylvania. In Pike County, snowfall totals ranged from 11 to 14 inches across the county. The highest amount of 14 inches fell in Panther (Greene Township).
- November 26, 2014 - A low pressure system brought snow into northeast Pennsylvania during the morning and afternoon of November 26th. The highest snowfall total of 10.2 inches was reported in Wyoming County. In Pike County, snowfall totals ranged from six to 10 inches, with the highest amount of 10 inches falling in the Borough of Milford.
- January 23, 2016 - This blizzard brought record-breaking snow across southern Pennsylvania but just clipped Luzerne, Pike and Lackawanna Counties. Snowfall totals ranged from six to eight inches in southern Pike and Lackawanna Counties. Up to 15.5 inches of snow fell in the Hazelton area with much less snow falling in the north. In Pike County, snowfall totals ranged from a few inches in the far northern section of the county to between six and seven inches in the Borough of Milford and Greentown (Greene Township).

Future Occurrence

Winter storms are a regular, annual occurrence in Pike County. Table 4.3.21-4 shows the probability of receiving measureable snowfall by month in Pike County at the listed snow station locations. These probabilities are based on data collected over a minimum of 20 years. There is slight variation in the probabilities of snowfall in different locations in Pike County.

Table 4.3.21-4. Probability of Measurable Snowfall in Pike County by Snow Station Location

Month	Probability (%)			
	Hawley 1 E	Lake Minisink	Matamoras	Paupack 1 WSW
January	100.00%	100.00%	96.70%	98.40%
February	100.00%	100.00%	100.00%	95.40%
March	97.50%	90.00%	93.20%	96.90%
April	66.70%	47.80%	53.10%	73.40%
May	3.90%	0.00%	0.00%	0.00%
June	0.00%	0.00%	0.00%	0.00%
July	0.00%	0.00%	0.00%	0.00%
August	0.00%	0.00%	0.00%	0.00%
September	0.00%	0.00%	0.00%	0.00%
October	8.80%	7.10%	1.90%	4.50%
November	68.80%	40.00%	55.00%	72.10%
December	96.30%	96.00%	95.30%	90.50%

Source: Pike County HMP 2012

For the 2017 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of winter storm (heavy snow, blizzard, sleet/freezing rain, winter weather, and winter storm) events for Pike County. Information from the 2012 Pike County HMP, NOAA-NCEI storm events database, and the Pennsylvania State Climatologist were used to identify the number of winter storm events that occurred between 1950 and 2015. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimate percent chance of an incident occurring in a given year. Based on these statistics, there is an estimated 100-percent chance of a winter storm event occurring in any given year in Pike County.

Table 4.3.21-5. Probability of Future Winter Storm Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Winter Weather	70	1.08	0.94	1.0	100%

Sources: Pike County HMP 2012; NOAA-NCEI 2016; Pennsylvania State Climatologist 2016

Based on available historical data, the future occurrence of winter storm events can be considered *highly likely* as defined by the Risk Factor Methodology probability criteria (refer to Section 4.4).

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For winter storm events, all of Pike County has been identified as the hazard area. Therefore, all assets (population, structures, critical facilities and lifelines), as described in the County Profile (Section 2), are vulnerable. This section includes an evaluation and estimation of potential impacts of winter storm events on the County, including:

- Overview of vulnerability

- Data and methodology used for the evaluation
- Impacts on (1) life, health, and safety; (2) general building stock; (3) critical facilities; (4) economy; (5) environment; and (6) future growth and development
- Effect of climate change on vulnerability
- Further data collections that will assist understanding this hazard over time.

Overview of Vulnerability

Winter storms are a concern based on the frequency of winter storm effects on Pike County. Additionally, winter storms are of significant concern because of direct and indirect costs associated with these events, delays caused by the storms, and impacts on people and facilities of the region.

Data and Methodology

National weather databases, the 2013 Pennsylvania HMP, and local resources were referenced to collect and analyze information about severe winter storm impacts on Pike County. The 2010 U.S. Census data and the Hazards U.S. – Multi-Hazard (HAZUS-MH) building inventory for Pike County were referenced to support an evaluation of assets exposed to this hazard and potential impacts associated with this hazard.

Impact on Life, Health, and Safety

According to the NOAA National Severe Storms Laboratory (NSSL), winter weather indirectly kills hundreds of people in the United States every year, primarily from automobile accidents, overexertion, and exposure. Winter storms are often accompanied by strong winds creating blizzard conditions with blinding wind-driven snow, drifting snow, extreme cold temperatures, and dangerous wind chill. Winter storms are considered deceptive killers because most deaths and other impacts or losses are indirectly related to the storms. People can die in traffic accidents on icy roads, of heart attacks while shoveling snow, or of hypothermia from prolonged exposure to cold.

Heavy snow can immobilize a region and paralyze a city, shutting down air and rail transportation, stopping flow of supplies, and disrupting medical and emergency services. Accumulations of snow can collapse buildings and knock down trees and power lines. In rural areas, homes and farms may be isolated for days, and unprotected livestock may be lost. In the mountains, heavy snow can lead to avalanches (NSSL 2006).

Heavy accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Communications and power can be disrupted for days while utility companies work to repair the extensive damage. Even small accumulations of ice may cause extreme hazards to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces (NSSL 2006).

For the purposes of this Plan, the entire population of Pike County is considered exposed to winter storm events (U.S. Census 2010). The elderly are considered most susceptible to this hazard because of their increased risk of injuries and death from falls and overexertion and/or hypothermia from exposure while attempting to clear snow and ice. In addition, winter storm events can reduce ability of these populations to access emergency services. Residents with low incomes may not have access to housing, or their housing may be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply). The County Profile (Section 2) of this Plan provides population statistics for each participating municipality and a summary of the more vulnerable populations (over the age of 65 and individuals living below the U.S. Census poverty threshold).

Impact on General Building Stock

The entire general building stock inventory in Pike County is exposed and vulnerable to the winter storm hazard. Snow accumulation in excess of building design conditions may be vulnerable to structure failure and possible collapse. In general, structural impacts include damage to roofs and building frames, rather than to building content. Structural failure due to roof snow loads can be linked to several different causes, including but not limited to:

- Actual snow load significantly exceeds design snow load
- Drifting and sliding snow conditions
- Deficient workmanship
- Insufficient operation and maintenance
- Improper design
- Inadequate drainage design
- Insufficient design; in older buildings, insufficient design is often related to inadequate snow load design criteria in the building code in effect when the building was designed (FEMA 2013)

Current modeling tools are not available to estimate specific losses from this hazard. As an alternate approach, this Plan considers percentage damages that could result from winter storm conditions. Table 4.3.21-6. General Building Stock Exposure (Structure Only) and Estimated Losses from Winter Storm Events in Pike County below summarizes percent damages to Pike County's total general building stock (structure only) that could result from winter storm conditions. Considering professional knowledge and currently available information, potential losses from this hazard are considered overestimated; hence, values in Table 4.3.21-6. General Building Stock Exposure (Structure Only) and Estimated Losses from Winter Storm Events in Pike County are conservative estimates of losses associated with severe winter storm events.

Table 4.3.21-6. General Building Stock Exposure (Structure Only) and Estimated Losses from Winter Storm Events in Pike County

Municipality	Total GBS (Structure Only)	1% of Total	5% of Total	10% of Total
Blooming Grove Township	$768,042,000	$7,680,420	$38,402,100	$76,804,200
Delaware Township	$973,607,000	$9,736,070	$48,680,350	$97,360,700
Dingman Township	$1,287,496,000	$12,874,960	$64,374,800	$128,749,600
Greene Township	$624,259,000	$6,242,590	$31,212,950	$62,425,900
Lackawaxen Township	$816,292,000	$8,162,920	$40,814,600	$81,629,200
Lehman Township	$1,303,700,000	$13,037,000	$65,185,000	$130,370,000
Matamoras Borough	$237,231,000	$2,372,310	$11,861,550	$23,723,100
Milford Borough	$224,907,000	$2,249,070	$11,245,350	$22,490,700
Milford Township	$414,595,000	$4,145,950	$20,729,750	$41,459,500
Palmyra Township	$824,628,000	$8,246,280	$41,231,400	$82,462,800
Porter Township	$255,805,000	$2,558,050	$12,790,250	$25,580,500
Shohola Township	$488,962,000	$4,889,620	$24,448,100	$48,896,200
Westfall Township	$238,350,000	$2,383,500	$11,917,500	$23,835,000
Pike County (Total)	**$8,457,874,000**	**$84,578,740**	**$422,893,700**	**$845,787,400**

Source: HAZUS-MH 3.1 Note: GBS General building stock

An area especially vulnerable to the winter storm hazard is the floodplain. At-risk building stock and infrastructure in floodplains are addressed in the flood hazard profile (Section 4.3.5). Generally, losses from flooding associated with winter storms should be less than those associated with a 1-percent or 0.2-percent flood. In summary, snow and ice melt can cause both riverine and urban flooding. Estimated losses from riverine flooding in the County are discussed in Section 4.3.5.

Impact on Critical Facilities

Full functionality of critical facilities such as police, fire, and medical services is essential for response during and after a winter storm event. These critical facility structures are largely constructed of concrete and masonry; therefore, they should undergo only minimal structural damage from severe winter storm events. Because power interruption can occur, backup power is recommended for critical facilities and infrastructure.

Impact on the Economy

Infrastructure at risk from the winter storm hazard includes roadways that could be damaged by application of salt, and intermittent freezing and warming conditions that can damage roads over time. Costs of snow and ice removal and repair of roads damaged by the freeze/thaw cycle can drain local financial resources. Potential secondary impacts from winter storms also affect the local economy, including loss of utilities, interruption of transportation corridors, and loss of business function.

Impact on the Environment

Environmental impacts often include damage to trees and shrubs caused by heavy snow loading, ice buildup, and/or high winds, which can break limbs and down large trees. An indirect effect of winter storms is impairment of surface and groundwater adjacent to roadway surfaces treated with salt, chemicals, and other de-icing materials (PEMA 2013).

Winter storms have a positive environmental impact: gradual melting of snow and ice provides groundwater recharge. However, abrupt high temperatures following a heavy snowfall can cause accelerated snowmelt, rapid surface water runoff, and severe flooding (PEMA 2013).

Future Growth and Development

Areas targeted for potential future growth and development within the next 5 years have been identified across the County at the municipal level, and are further discussed in Section 2.4 of this Plan. For the winter storm hazard, Pike County in its entirety has been identified as the hazard area. Therefore, any new development will be exposed to such risks.

Effect of Climate Change on Vulnerability

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

The climate of Pennsylvania has changed in several ways. Over the past 100 years, annual average temperatures have been rising across the State. Warmer winters have led to decrease in snow cover and earlier arrival of spring. Recent analyses based on the Intergovernmental Panel on Climate Change models suggest a decrease in frequency and an increase in intensity of extra-tropical winter cyclones. However, based on the methodology applied, some models show no significant change in the storm track whereas others indicate a northward displacement of the storm track in the North Atlantic. For the mid-Atlantic region, there is little indication of a change in storm activity or track over Pennsylvania. An overall increase in winter precipitation is anticipated, with a decrease in snow and increase in rain during winter months. Projections of future occurrences of extra-tropical cyclones in Pennsylvania are uncertain. Based on available information and projections, winter storms are anticipated to continue to affect Pennsylvania in the future. Future improvements in modeling smaller-scale climatic processes can be expected, and will lead to improved understanding of the ways the changing climate will alter temperature, precipitation, and storm events in Pennsylvania (Shortle and others 2009).

Additional Data and Next Steps

The assessment above identifies vulnerable populations and economic losses associated with the winter storm hazard. Historical data on structural losses to general building stock are not adequate to predict specific losses to this inventory; therefore, the percent of damage assumption methodology was applied. This methodology is based on FEMA How-to Series (FEMA 386-2), Understanding Your Risks, Identifying and Estimating Losses (FEMA 2001), and FEMA's Using HAZUS-MH for Risk Assessment (FEMA 433) (FEMA 2004). Acquisition of additional/actual data regarding (1) valuations of general building stock and (2) critical infrastructure losses would further support future estimates of potential exposure of and damage to the general building stock inventory.

4.4 HAZARD VULNERABILITY SUMMARY

This section describes the methodology and tools used to support the risk assessment process.

4.4.1 Methodology

The risk assessment process used for this HMP update is consistent with the process and steps presented in the Federal Emergency Management Agency (FEMA) 386-2, State and Local Mitigation Planning How-to-Guide, Understanding Your Risks – Identifying Hazards and Estimating Losses (FEMA 2001). This process identifies and profiles the hazards of concern and assesses the vulnerability of assets (population, structures, critical facilities, and the economy) at risk in the community. A risk assessment provides the foundation for the community's decision makers to evaluate mitigation measures that can help reduce the impacts of a hazard when one occurs (mitigation measures are described in Section 6). The risk assessment process consists of the following steps:

Step 1: The first step of the risk assessment process is to identify the hazards of concern. FEMA's current regulations only require an evaluation of natural hazards. Natural hazards are natural events that threaten lives, property, and other assets. Natural hazards often can be predicted to reoccur the same geographical locations because they are related to weather patterns or physical characteristics of an area.

Step 2: The next step of the risk assessment is to prepare a profile for each hazard of concern. These profiles assist communities in evaluating and comparing the hazards that can impact their area. Each type of hazard has unique characteristics that vary from event to event. That is, the impacts associated with a specific hazard can vary depending on the magnitude and location of each event (a hazard event is a specific, uninterrupted occurrence of a particular type of hazard). Further, the probability of occurrence of a hazard in a given location impacts the priority assigned to that hazard. Finally, each hazard will impact different communities in different ways based on geography, local development, population distribution, age of buildings, and mitigation measures already implemented.

Steps 3 and 4: To understand risk, a community must evaluate its assets (Step 3) and determine which assets are exposed or vulnerable to the identified hazards of concern (Step 4). Hazard profile information—combined with data regarding population, demographics, general building stock, and critical facilities at risk—prepares the community to develop risk scenarios and estimate potential damages and losses for each hazard. Critical facilities in Pike County are presented in Section 2.6 of this HMP.

Tools

To address the DMA 2000 requirements and better understand potential vulnerability and losses associated with hazards of concern, Pike County used standardized tools combined with local, state, and federal data and expertise to conduct the risk assessment. Tools used by Pike County to support the risk assessment are described in the sections below.

Hazards U.S. – Multi-Hazard (HAZUS-MH)

In 1997, FEMA developed a standardized model for estimating losses caused by earthquakes known as Hazards U.S. (HAZUS). HAZUS was developed in response to the need for more effective national-, state-, and community-level planning and the need to identify areas that face the highest risk and potential for loss. HAZUS was expanded into a multi-hazard methodology (HAZUS-MH) with new models for estimating potential losses from wind (hurricanes) and flood (riverine and coastal) hazards. HAZUS-MH is a geographic information system (GIS)-based software tool that applies engineering and scientific risk calculations that have been developed by hazard and information technology experts to provide defensible damage and loss estimates. These methodologies are accepted by FEMA and provide a consistent framework for assessing risk across a variety of hazards. The GIS framework also supports the evaluation of hazards and assessment of inventory and loss estimates for these hazards.

HAZUS-MH uses GIS technology to produce detailed maps and analytical reports that estimate a community's direct physical damage to building stock, critical facilities, transportation systems, and utilities. To generate this information, HAZUS-MH has default data for inventory, vulnerability, and hazards. These default data can be supplemented with local data to provide a more refined analysis. Damage reports can include induced damage (such as inundation, fire, and threats posed by hazardous materials and debris) and direct economic and social losses (such as casualties, shelter requirements, and economic impact) depending on the hazard and available local data. HAZUS-MH's open data architecture can be used to manage community GIS data in a central location. The use of this software also promotes consistency of current and future data output, and standardization of data collection and storage. The guidance "Using HAZUS-MH for Risk Assessment: How-to Guide" (FEMA 433) was relied upon to support the application of HAZUS-MH for this risk assessment and plan (FEMA 2015). More information on HAZUS-MH is available at https://www.fema.gov/hazus .

In general, probabilistic analyses were performed to develop estimates of long-term average losses (annualized losses) for the earthquake and hurricane/tropical storm/Nor'Easter hazards, as well as an expected or estimated distribution of losses (mean return period losses) for the earthquake; flood, flash flood, and ice jam; and hurricane/tropical storm/Nor'Easter hazards. The probabilistic hazard analyses generate estimates of damage and loss for specified return periods. For annualized losses, HAZUS-MH 3.1 calculates the maximum potential annual dollar loss resulting from various return periods averaged on a per-year basis. The analysis consists of the summation of all HAZUS-supplied return periods (e.g., 10, 50, 100, 200, 500) multiplied by the return period probability (as a weighted calculation). In summary, the estimated cost of a hazard (earthquake, flood, and wind hazards) each year is calculated.

The following custom methodologies in HAZUS-MH 3.1 (HAZUS-MH) were used to assess potential exposure and losses associated with hazards of concern for Pike County:

- Inventory: The default demographic data in HAZUS-MH 3.1, based on the 2010 U.S. Census, were used for the potential loss analysis (such as for sheltering and injuries) for each hazard model.

  The default building inventory in HAZUS-MH 3.1 was used for Pike County. The occupancy classes available in HAZUS-MH 3.1 were condensed into categories (residential, commercial, industrial, agricultural, religious, government, and educational) to facilitate the analysis and the presentation of results. Residential loss estimates address both multi-family and single-family dwellings. Building replacement cost values are based upon 2015 RS Means Company, Inc. (RS Means) valuations. Both layers were merged and used to calculate the exposure for each hazard.

  An updated critical facility inventory was also developed and incorporated into HAZUS-MH, replacing the default essential facility (police, fire, schools, etc.), transportation facility, and utility inventories for the earthquake, flood, and wind hazard models. This comprehensive inventory was developed by gathering input from Pike County Office of Community Planning, participating municipalities, and the Steering Committee.

  The "user-defined facilities" category includes all assets that Pike County deemed critical to include in the inventory and that do not fit within a pre-defined HAZUS-MH facility category. These facilities include County buildings, senior care facilities, and municipality-owned buildings.

  HAZUS-MH 3.1 incorporates two types of census block-based data, homogenous and dasymetric. Homogenous census blocks display the full extent of each block, while the dasymetric census blocks have had homogenous undeveloped areas (bodies of area, forests, etc.) removed. The dasymetric blocks were developed to provide more accurate loss estimates by excluding uninhabited and undeveloped areas of a census block.

- Earthquake: A probabilistic assessment was conducted for Pike County for the 100-, 500- and 2,500-year mean return periods (MRP) in HAZUS-MH 3.1 to analyze the earthquake hazard and provide a range of loss estimates for Pike County. Default demographic and building stock data from HAZUS-MH 3.1 and updated critical facility inventories were used for the analysis. The probabilistic method uses information from historic earthquakes and inferred faults, locations, and magnitudes and computes the probable ground-shaking levels that may be experienced during a recurrence period by Census tract.

  As noted in the HAZUS-MH Earthquake User Manual, "*Uncertainties are inherent in any loss estimation methodology. They arise in part from incomplete scientific knowledge concerning earthquakes and their effects upon buildings and facilities. They also result from the approximations and simplifications that are necessary for comprehensive analyses. Incomplete or inaccurate inventories of the built environment, demographics and economic parameters add to the uncertainty. These factors can result in a range of uncertainly in loss estimates produced by the HAZUS Earthquake Model, possibly at best a factor of two or more*" (FEMA 2015f). However, HAZUS' potential loss estimates are acceptable for the purposes of this HMP.

  Ground shaking is the primary cause of earthquake damage to manmade structures and soft soils amplify ground shaking. One contributor to the site amplification is the velocity at which the rock or soil transmits shear waves (S-waves). The National Earthquake Hazard Reduction Program (NEHRP) developed five soil classifications that impact the severity of an earthquake, ranging from A to E. Soil classified as A represents hard rock that reduces ground motions from an earthquake, and E represents soft soils that amplify and magnify ground shaking and increase building damage and losses. NEHRP soil classifications were not available for Pike County at the time of this analysis. Soils were estimated as NEHRP soil Type D across Pike County as a conservative approach to this risk assessment. Groundwater was set at a depth of 5 feet (default setting). Damages and losses due to liquefaction, landslide, or surface fault rupture were not included in this analysis.

- Flood, Flash Flood, and Ice Jam: The FEMA Digital Flood Insurance Rate Map (DFIRM) dated October 2000 was used to evaluate exposure for the 1- and 0.2-percent annual chance flood events, and determine potential future losses for the 1-percent annual chance event in Pike County. These flood events are generally considered by planners and evaluated under federal programs such as the National Flood Insurance Program (NFIP). HAZUS-MH 3.1 was used to develop the depth grid for the 1-percent annual chance flood depth grid using the FEMA DFIRM data and the 1/3 Arc Second elevation model from U.S. Geological Survey (USGS). The depth grid was integrated into HAZUS-MH 3.1 and the model was run to estimate potential losses using the dasymetric census blocks.

- Hurricane/Tropical Storm/Nor'Easter: After reviewing historic data, a HAZUS-MH 3.1 probabilistic analysis was performed for the 100- and 500-year MRP events to analyze the wind hazard losses for Pike County. The probabilistic hurricane hazard contains data on historic hurricane events and wind speeds; the model activates a database of thousands of potential storms with tracks and intensities reflecting the full spectrum of Atlantic hurricanes observed since 1886, and then identifies those storms with tracks associated with the County. It also includes surface roughness and vegetation (tree coverage) maps for the County. Surface roughness and vegetation data support the modeling of wind force across various types of land surfaces. Default demographic and building stock data (homogenous census block) from HAZUS-MH 3.1 and updated critical facility inventories were used for the analysis.

ESRI ArcGIS

For the following hazards, ArcGIS was used to assess potential exposure for hazards of concern with delineated hazard areas in Pike County. The defined hazard areas were overlaid upon the asset data (population, building stock, critical facilities) to estimate the exposure to each hazard. The limitations of these analyses are recognized, and as such the analyses are only used to provide a general estimate:

- Environmental Hazards: Federal SARA, the Emergency Planning and Community Right to Know Act, and the Commonwealth of Pennsylvania set up requirements for producing, storing, and transporting hazardous materials. These hazardous materials are susceptible to spilling at the facilities or during transit. The Pennsylvania Department of Transportation State Roads layer (2011) was used to define the hazard area around major roadways. The hazard area was defined as a ¼ mile buffer around the Interstate, State, and US roadways. Additionally, SARA II facilities were provided by the County, along with specified vulnerability radii for each facility. These in conjunction with the ¼ roadway buffer were used to estimate the exposure to the asset data.

- Landslide: The Geology — Landslide Incidence and Susceptibility geographic information system (GIS) layer from the National Atlas was used to coarsely define the general landslide susceptible area. Available information and a preliminary assessment are provided below.

  According to Radbruch-Hall and others, the Landslide Incidence and Susceptibility GIS layer from National Atlas:

  > "….was prepared by evaluating formations or groups of formations shown on the geologic map of the United States (King and Beikman 1974) and classifying them as having high, medium, or low landslide incidence (number of landslides) and being of high, medium, or low susceptibility to landsliding. Thus, those map units or parts of units with more than 15 percent of their area involved in landsliding were classified as having high incidence; those with 1.5 to 15 percent of their area involved in landsliding, as having medium incidence; and those with less than 1.5 percent of their area involved, as having low incidence. This classification scheme was modified where particular lithofacies are known to have variable landslide incidence or susceptibility. In continental glaciated areas, additional data were used to identify surficial deposits that are susceptible to slope movement. Susceptibility to landsliding was defined as the probable degree of response of the areal rocks and soils to natural or artificial cutting or loading of slopes or to anomalously high precipitation. High, medium, and low susceptibility are delimited by the same percentages used in classifying the incidence of landsliding. For example, it was estimated that a rock or soil unit characterized by high landslide susceptibility would respond to widespread artificial cutting by some movement in 15 percent or more of the affected area. We did not evaluate the effect of earthquakes on slope stability, although many catastrophic landslides have been generated by ground shaking during earthquakes. Areas susceptible to ground failure under static conditions would probably also be susceptible to failure during earthquakes" (Radbruch-Hall 1982).

- Nuclear Incident: Populations, building stock, and critical facilities within the Plume Exposure Pathway Emergency Planning Zone (EPZ), which is a 10 mile radius around the facility, or the Ingestion Exposure Pathway EPZ, which is a 50 mile radius around the facility, of a nuclear power plant are susceptible to a nuclear incident. Pike County is located within the Ingestion Exposure Pathway EPZs of the Susquehanna Steam Electric Station located in Luzerne County, PA and the Indian Point Power Plant in Buchanan, NY. The 50 mile EPZs were used to define the hazard area for a nuclear incident.

- Wildfire: The wildfire urban interface, known as WUI, obtained through the SILVIS Lab, Department of Forest Ecology and Management, University of Wisconsin-Madison was used to define the wildfire hazard areas. The University of Wisconsin-Madison wildland fire hazard areas are based on the 2010 Census and 2006 National Land Cover Dataset and the Protected Areas Database. For the purposes of this risk assessment, the high-, medium- and low-density interface areas were combined and used as the 'interface' hazard area and the high-, medium- and low-density intermix areas were combined and used as the 'intermix' hazard areas. The defined hazard area was overlaid upon the asset data (population, building stock, critical facilities) to estimate the exposure to each hazard.

4.4.2 Ranking Results

As discussed in Section 4.2, Hazard Identification, a comprehensive range of natural and non-natural hazards that pose significant risk to Pike County were selected and considered in this plan. However, the communities in Pike County have differing levels of exposure and vulnerability to each of these hazards. It is important for each community participating in this plan to recognize those hazards that pose the greatest risk to their community and direct their attention and resources accordingly to most effectively and efficiently manage risk.

To this end, a relative hazard risk ranking process was conducted for the County using the Risk Factor (RF) methodology identified in Section 5 and Appendix 9 of Pennsylvania Emergency Management Agency's (PEMA) All-Hazard Planning Standard Operating Guide (PEMA October 2013). The guidance states:

> "The RF approach produces numerical values that allow identified hazards to be ranked against one another (the higher the RF value, the greater the hazard risk). RF values are obtained by assigning varying degrees of risk to five categories for each hazard: *probability, impact, spatial extent, warning time,* and *duration*.
>
> To calculate the RF value for a given hazard, the assigned risk value for each category is multiplied by the weighting factor. The sum of all five categories equals the final RF value, as demonstrated in the example equation below:

Example Equation

RF Value = [(Probability x .30) + (Impact x .30) + (Spatial Extent x .20) + (Warning Time x .10) + (Duration x .10)]

> Hazards identified as high risk have RFs greater than or equal to 2.5. RFs ranging from 2.0 to 2.4 are considered moderate risk hazards. Hazards with RFs less than 2.0 are considered low risk."

Table 4.4-1 identifies the five risk assessment categories, the criteria and associated risk level indices used to quantify their risk, and the suggested weighting factor (weight value) applied to each risk assessment category. Table 4.4-2 shows the five risk assessment categories' values for each of Pike County's hazards, and each hazard's RF.

Table 4.4-1. Summary of Risk Factor (RF) Approach

Summary of Risk Factor (RF) Approach				
Risk Assessment Category	Degree of Risk			Weight Value
	Level	Criteria	Index	
PROBABILITY *What is the likelihood of a hazard event occurring in a given year?*	UNLIKELY	LESS THAN 1% ANNUAL PROBABILITY	1	30%
	POSSIBLE	BETWEEN 1% & 49.9% ANNUAL PROBABILITY	2	
	LIKELY	BETWEEN 50% & 90% ANNUAL PROBABILITY	3	
	HIGHLY LIKELY	GREATER THAN 90% ANNUAL PROBABILTY	4	
IMPACT *In terms of injuries, damage, or death, would you anticipate impacts to be minor, limited, critical, or catastrophic when a significant hazard event occurs?*	MINOR	VERY FEW INJURIES, IF ANY. ONLY MINOR PROPERTY DAMAGE & MINIMAL DISRUPTION ON QUALITY OF LIFE. TEMPORARY SHUTDOWN OF CRITICAL FACILITIES.	1	30%
	LIMITED	MINOR INJURIES ONLY. MORE THAN 10% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES FOR MORE THAN ONE DAY.	2	
	CRITICAL	MULTIPLE DEATHS/INJURIES POSSIBLE. MORE THAN 25% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES FOR MORE THAN ONE WEEK.	3	
	CATASTROPHIC	HIGH NUMBER OF DEATHS/INJURIES POSSIBLE. MORE THAN 50% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES FOR 30 DAYS OR MORE.	4	
SPATIAL EXTENT *How large of an area could be impacted by a hazard event? Are impacts localized or regional?*	NEGLIGIBLE	LESS THAN 1% OF AREA AFFECTED	1	20%
	SMALL	BETWEEN 1 & 10.9% OF AREA AFFECTED	2	
	MODERATE	BETWEEN 11 & 25% OF AREA AFFECTED	3	
	LARGE	GREATER THAN 25% OF AREA AFFECTED	4	
WARNING TIME *Is there usually some lead time associated with the hazard event? Have warning measures been implemented?*	MORE THAN 24 HRS	SELF-DEFINED *(NOTE: Levels of warning time and criteria that define them may be adjusted based on hazard addressed.)*	1	10%
	12 TO 24 HRS	SELF-DEFINED	2	
	6 TO 12 HRS	SELF-DEFINED	3	
	LESS THAN 6 HRS	SELF-DEFINED	4	
DURATION *How long does the hazard event usually last?*	LESS THAN 6 HRS	SELF-DEFINED *(NOTE: Levels of warning time and criteria that define them may be adjusted based on hazard addressed.)*	1	10%
	LESS THAN 24 HRS	SELF-DEFINED	2	
	LESS THAN 1 WEEK	SELF-DEFINED	3	
	MORE THAN 1 WEEK	SELF-DEFINED	4	

Source: PEMA All-Hazard Mitigation Planning Standard Operating Guide, October 2013

Table 4.4-2. Risk Ranking for Pike County

HAZARD RISK	HAZARDS	RISK ASSESSMENT CATEGORY					RISK FACTOR (RF)
		PROBABILITY	IMPACT	SPATIAL EXTENT	WARNING TIME	DURATION	
HIGH	Flood	4	3	3	2	3	3.2
	Drought	4	2	4	1	4	3.1
	Pandemic	4	2	4	1	4	3.1
	Wildfire	4	2	3	4	3	3.1
	Winter Hazard	4	2	4	2	3	3.1
	Environmental Hazards	4	2	3	4	2	3.0
	Utility Interruption	4	2	2	4	4	3.0
	Extreme Temperatures	3	2	4	2	3	2.8
	Invasive Species	4	1	4	1	4	2.8
	Radon Exposure	4	1	4	1	4	2.8
	Transportation Accident	4	2	1	4	1	2.5
MODERATE	Tornado/Windstorm	3	2	2	4	1	2.4
	Nuclear	1	2	3	4	4	2.3
	Drowning	4	1	1	4	1	2.2
	Hurricane/Nor'Easter	2	2	3	1	3	2.2
	Landslide	2	3	1	4	1	2.2
	Dam Failure	1	3	2	4	1	2.1
	Terrorism	2	2	2	4	1	2.1
	Urban Fire	2	2	1	4	2	2.0
LOW	Earthquake	1	1	4	4	1	1.9
	Lightning	2	1	1	4	1	1.6

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 considered *potential* in that they generally represent losses that could occur in a countywide hazard scenario. In events that are localized, losses may be lower, while regional events could yield higher losses.

The data utilized to conduct the vulnerability assessment came from a variety of sources as noted throughout each hazard profile and Appendix A. As summarized in the Methodology subsection the 2010 U.S. Census demographic data and default building inventory (2015) and associated replacement cost value of the structures and contents in HAZUS-MH 3.1 were used for Pike County. Replacement cost value is the current cost of returning an asset to its pre-damaged condition, using present-day cost of labor and materials. A comprehensive critical facility inventory update was developed by gathering input from the Pike County Office of Community Planning, participating municipalities, and the Steering Committee.

Potential loss estimates provided in Section 4.3 (Hazard Profiles) were either based on historic losses, current-condition losses and/or predictive losses by performing spatial analyses in GIS and hazard probabilistic modeling. In summary, HAZUS-MH was used to estimate potential losses for the earthquake, flood and hurricane/tropical storm/Nor'Easter hazards. For many of the hazards evaluated, historic data are not adequate to model future losses at this time. For these hazards of concern, areas and inventory susceptible to specific hazards were mapped and exposure was evaluated to help guide mitigation efforts (mitigation efforts are discussed further in Section 6). Spatial analyses were conducted to assess potential exposure for hazards of concern with delineated hazard areas: environmental hazards, landslide, nuclear incident and wildfire. Where GIS data are not available for some hazards, a qualitative analysis was conducted using the best available data and professional judgment.

For this risk assessment, the loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

1) Approximations and simplifications necessary to conduct such a study
2) Incomplete or dated inventory, demographic, or economic parameter data
3) The unique nature, geographic extent, and severity of each hazard
4) Mitigation measures already employed by the participating municipalities and the amount of advance notice residents have to prepare for a specific hazard event

These factors can result in a range of uncertainty in loss estimates, possibly by a factor of 2 or more. Therefore, potential exposure and loss estimates are approximate. These results do not predict precise results and should be used to understand relative risk. Over the long term, Pike County will collect additional data to assist in developing refined estimates of vulnerabilities to natural and non-natural hazards.

For more details on the potential loss estimates for each hazard, refer to Section 4.3 (Hazard Profiles).

4.4.4 Future Development and Vulnerability

Risk and vulnerability to natural and human-made hazard events are not static. Risk will increase or decrease as counties and municipalities see changes in land use and development as well as changes in population. Population change (in terms of total and demographics) and the age of the housing stock continue to be main indicators of vulnerability change in Pike County.

Although Pike County experienced a 23-percent increase in population from 2000 to 2012, as summarized in Section 2, according to the Pennsylvania Population Projections from the Center for Rural Pennsylvania, the population in Pike County is projected to decrease over the coming decades. Unfortunately, the population projections are not available at the municipal-level.

Continued analysis of the age structure in Pike County will provide deeper understanding on future vulnerability to at-risk populations. Approximately 16.2 percent of Pike County's population is age 65 or older. As these residents continue to age in the County, they may have increased special needs. For example, many residents in this age bracket may be unable to drive; therefore, development of special evacuation plans for them may be necessary. They may also have hearing or vision impairments that could hinder their reception of emergency instructions. Both older and younger populations are at higher risks for contracting certain diseases. Pike County's combined under-5-years-of-age and over-65 populations constitute approximately 21.1 percent of its population.

Less than 1 percent of Pike County's population lives in "group quarters" - communal settings that can include inmates in a prison, students in a dorm, or elderly or mentally disabled in group-care homes. Many residents living in group quarters have special needs. It is important to ensure that each group-quarter facility has its own emergency plan to account for the unique needs of its residents during a hazard event.

Approximately 3 percent of Pike County's population is not proficient in English. Future hazard mitigation strategies should consider addressing language barriers to ensure that all residents can receive emergency instructions.

In addition, remote and sparsely populated municipalities also face higher vulnerability to hazards because they do not have as easy access to care facilities or response personnel. For instance, the sparsely populated municipalities such as Porter Township face increased vulnerability to winter storms and urban fire and explosion due to isolation, access issues, and longer emergency response times.

The aging housing stock in Pike County is another source of current and future vulnerability in many hazard events. According to the American Community Survey Estimate (2010-2014), there are over 3,000 structures in Pike County built earlier than 1940 (8 percent of the building stock). As discussed throughout the risk assessment (Section 4), Pike County can experience strong gusts of wind during windstorms, tornadoes, hurricane, tropical storms, or Nor'Easters. The structure of these older houses may be more at risk of destruction under these strong wind conditions. These structures may also be at risk during flooding and winter storm events if the materials are either not strong enough to withstand the pressure or weight of the precipitation or are liable to leak, causing further risk of destruction to the house. In addition, there is a very large number of second homes in Pike County with residential properties vacant for months at a time. This also presents challenges in terms of communication to owners during times of emergency.

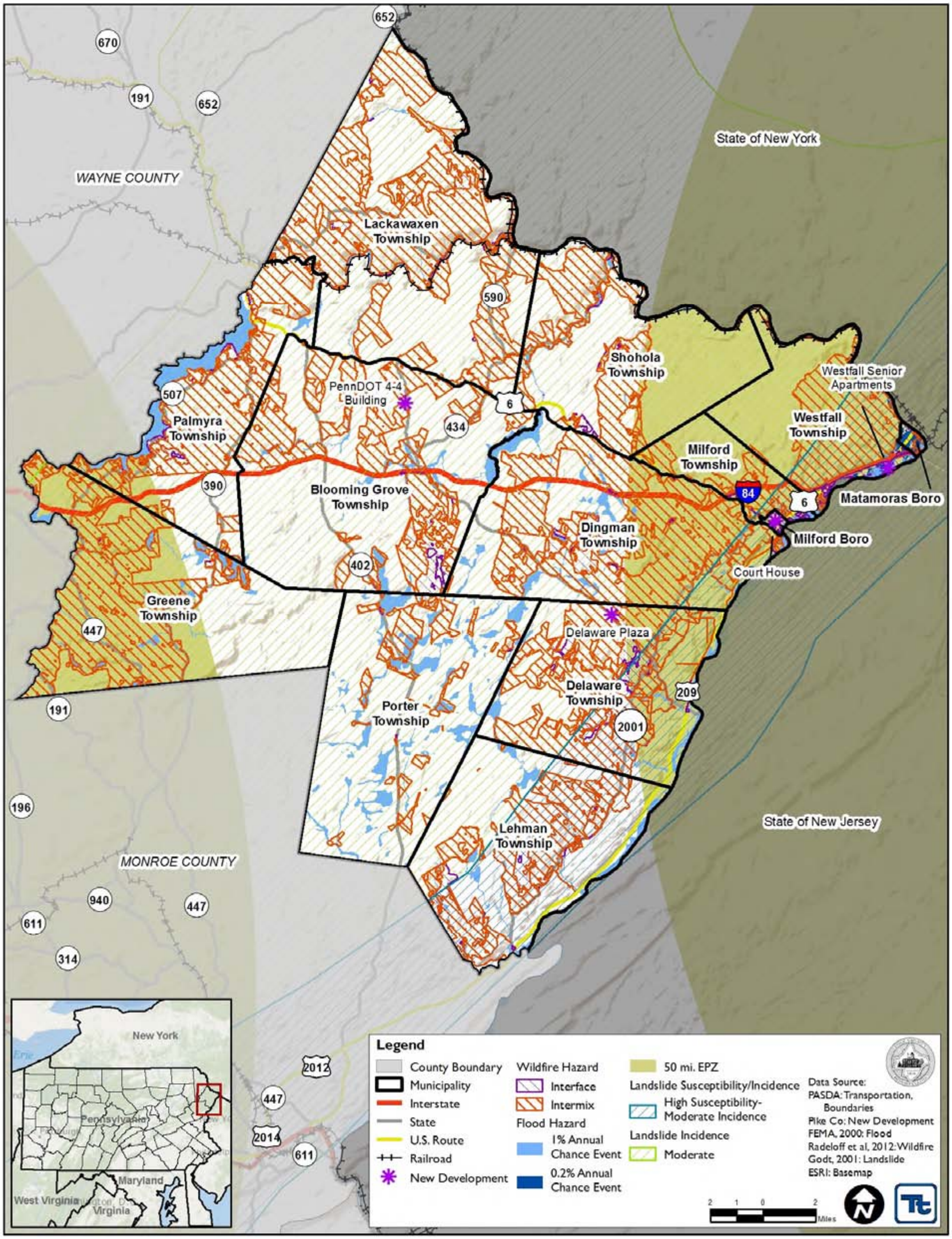
While any development increases the risk of damage and loss to natural hazards, a number of factors indicate that this increase in risk is low and mitigated by existing federal, state, county and local regulations, policies and programs. All 13 municipalities in Pike County have an adopted Subdivision & Land Development Ordinance (SALDO) and 12 of the 13 municipalities have adopted local zoning ordinances. The Pike County Office of Community Planning reviews subdivisions and land developments based upon the municipality's SALDO, zoning regulations, and other land use regulations. Land developments and subdivisions are also reviewed for their consistency with the goals and objectives identified in the County's Comprehensive Plan and also for appropriate 'best management practices'.

Pike County has identified areas of potential new development and will work with municipal, nonprofit, and private-sector partners to plan and pursue these projects. Table 4.4-3 summarizes the potential new development identified. A spatial analysis was conducted utilizing the potential development location and the delineated hazard areas to determine if any are potentially at risk (refer to Figure 4.4-1). As noted in Section 6 (Mitigation Strategy), Pike County Office of Community Planning identified a new mitigation strategy to, alongside the municipal offices, review comprehensive plans to ensure that designated-growth areas area not within high hazard areas identified in the HMP. In addition, Westfall Township identified a new mitigation strategy to promote or adopt higher regulatory and zoning standards to manage hazard risk; specifically, through updates to the building codes, flood ordinances, and subdivision and land development ordinances. The goals of increased standards are to ensure new buildings and infrastructure are discouraged or prohibited in high-hazard areas in their jurisdiction.

Table 4.4-3. Potential New Development and Hazard Areas

Property or Development Name	Municipality	Location	Known Hazard Zone(s)
Pike County Courthouse	Milford Borough	410 Broad Street	Landslide: High Susceptibility-Moderate Incidence; Nuclear: 50 Mile EPZ
Delaware Plaza	Delaware Township	Tax Map #136.00-02-46.002	Landslide: Moderate Incidence
PennDOT 4-4 Building	Blooming Grove Township	Tax Map # 059.00-01-11	Wildfire: Intermix; Landslide: Moderate Incidence
Westfall Senior Apartments (94 units)	Westfall Township	Tax Map #98.00-01-16.003	Flood: 1% Annual Chance Event; Wildfire: Interface; Landslide: High Susceptibility-Moderate Incidence; Nuclear: 50 Mile EPZ

Figure 4.4-1. Potential New Development and Hazard Areas



SECTION 5 CAPABILITY ASSESSMENT

The capability assessment evaluates Pike County's capabilities and resources already in place at the municipal, county, state, and federal levels to reduce hazard risks. The assessment also identifies where improvements can be made to increase disaster resistance in the community.

The first step in organizing hazard mitigation capabilities or resources for the Pike County Hazard Mitigation Plan (HMP) update is to describe the basic approaches available to reduce hazard risks. According to the 2013 Pennsylvania Emergency Management Agency (PEMA) All-Hazard Mitigation Planning Standard Operating Guide (SOG), the following four general approaches may reduce hazard risks:

- **Local Plans and Regulations** – These actions include government authorities, policies, or codes that influence the ways land is developed and buildings are constructed.
- **Structure and Infrastructure** – These actions involve modifying existing structures and infrastructure or constructing new structures to reduce hazard vulnerability.
- **Natural Systems Protection** – These are actions that minimize damage and losses and also preserve or restore the functions of natural systems.
- **Education and Awareness** – These are actions taken to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. Education and awareness actions may also include participation in national programs (PEMA SOG 2013).

Capability assessments document the existing resources available to local communities to reduce hazard risks. Resources can be divided into the following five categories (according to the PEMA All-Hazard Mitigation Planning SOG). For each basic capability or approach, one or more of the five resources described below may be available:

- **Human resources** include local police, fire, ambulance, and emergency management and response personnel; local government services; and electric, gas, and other utility providers that are critical during disasters.
- **Physical resources** include the equipment and vehicles (such as emergency response and recovery equipment and vehicles), public lands, facilities, and buildings available to the community.
- **Technical/technological resources** include early warning systems, weather alert radios, stream-level monitoring gauges, and 9-1-1 communications systems. They also include technical requirements established by law, regulation, or ordinance.
- **Informational resources** include materials about disasters, and actions related to hazard mitigation and planning. Informational resources are available from a wide variety of sources such as applicable websites, libraries, and state and federal agencies.
- **Financial resources** identify the sources of funding available for hazard mitigation. Most state and federal grant programs require local communities to provide at least part of the necessary project funding in real dollars or through in-kind services. Local communities need to assess their financial capability and resources to implement hazard mitigation action plans.

5.1 UPDATE PROCESS SUMMARY

During the plan update process, Pike County and all participating municipalities were surveyed to provide an updated assessment of their mitigation planning capabilities. Each municipality was provided with a Capability Assessment Survey, based on Appendix 3 of the October 2013 edition of the PEMA All-Hazard Mitigation Planning SOG (PEMA SOG 2013). The survey was provided to each of the municipal planning points of contact at the municipal kick-off meeting. Completed capability assessment surveys, whether completed by hand, electronically, or filled in working alongside the planning consultant, may be found in Appendix D.

Pike County has a number of resources it can access to implement hazard mitigation initiatives including emergency response measures, local planning and regulatory tools, administrative assistance and technical expertise, fiscal capabilities, and participation in local, regional, state, and federal programs. The presence of these resources enables community resiliency through actions taken before, during, and after a hazard event. The most important resources which provide the basis for addressing hazard potential and mitigation are the emergency services manpower, equipment, fiscal and other resources available within Pike County communities.

This section describes and summarizes the federal, state, county, and local capabilities to address hazard risk in Pike County.

5.2 CAPABILITY ASSESSMENT FINDINGS

A jurisdiction's ability to effectively manage natural hazard risk is directly related to their level of hazard mitigation capabilities. As such, mitigation strategies developed in coordination with Pike County's municipalities have a direct effect on establishing new capability functions in the community or strengthening existing capabilities.

Pike County and all municipalities updated and completed the Capability Assessment Survey (Appendix C). Based on the capability assessment results and information from the Pike County Office of Community Planning, all of Pike County's jurisdictions have local land use controls. In the past, to address previous growth pressures, the municipalities took a more pro-active role in updating their comprehensive plans and land use ordinances. However, some of these have not been updated recently. When updating their ordinances, local governments can go farther to use land use regulations to direct development away from hazard-prone areas, including utilizing the HMP update as part of that process. The updated mitigation strategy reflects new county and municipal-level actions to integrate the HMP into future plan updates and to strengthen local ordinances.

All municipalities participate in the National Flood Insurance Program (NFIP) however, no communities in Pike County participate in the Community Rating System (CRS). All municipalities in the County have been designated as floodprone. Community participation in CRS can provide premium reductions for properties located outside of Special Flood Hazard Areas of up to 10 percent and reductions for properties located in Special Flood Hazard Areas of up to 45 percent. These discounts can be obtained by undertaking public information, mapping and regulations, flood damage reduction and flood preparedness activities (FEMA, 2009). Select municipalities have identified a new mitigation action to join the CRS.

Many municipalities were not aware that they have an NFIP Floodplain Administrator, and who maintains this role. Pike County has added a new mitigation action to provide NFIP Floodplain Administrator education/training over the next plan update cycle.

Numerous roads and intersections exist in the County where flooding issues repeatedly occur. Some of these roads and intersections are state routes. The County and local municipalities face challenges in mitigating flood events on state routes because these roads are owned and maintained by the Commonwealth of Pennsylvania. Local municipalities do not have the authority to independently carry out a mitigation project to directly address. In these situations, the Pennsylvania Department of Transportation must decide to undertake the project. Since the Pennsylvania Department of Transportation is often most concerned with larger, critical transportation routes, smaller state roads and intersections which significantly affect a local community may not get the attention they need for the Commonwealth to take on a mitigation project. Several municipalities modified previous mitigation actions to coordinate with the Pennsylvania Department of Transportation to address roadway flooding.

Finally, limited funding is a critical barrier to the implementation of hazard mitigation activities in Pike County. The County will need to rely on regional, state and federal partnerships for financial assistance. Pike County will continue to alert municipalities when FEMA grant funding is available to apply and implement eligible projects in this HMP update.

The following sections further detail the capability assessment findings.

5.2.1 Planning and Regulatory Capability

County and Municipal Planning Capabilities

While municipalities in Pennsylvania must comply with the minimum regulatory requirements established under the Pennsylvania Municipal Planning Code, they otherwise have considerable latitude in adopting ordinances, policies, and programs that can support their ability to manage natural and non-natural hazard risk. Specifically, municipalities can manage these risks through comprehensive land use planning, hazard-specific ordinances (for example, flood damage prevention, sinkholes, and steep slopes), zoning, site-plan approval, and building codes. Specific plans under the planning and regulatory capability guiding hazard mitigation in Pike County are described in the sections below.

Pike County Planning Division

Created by resolution of the Pike County Board of Commissioners in August 1965, the Pike County Planning Commission has served as an Advisory Board to the Pike County Board of Commissioners on matters of future growth and development over its 45 year history. Many of the Planning Commission's efforts are focused on providing assistance to the County's 13 municipalities.

The following duties summarize the functions and activities of the Planning Commission in Pike County:

- To provide for the active participation of all local governments and public and private agencies in a review of the needs, requirements, and goals of the County
- To establish a continuing program of public education aimed at creating an awareness and understanding among the people of the County of their common interest in the sound development of the county as a whole.
- To undertake research and surveys of existing conditions and future prospects of the physical, economic, social and governmental resources of the County.
- To prepare and keep updated a long range comprehensive plan of development that will provide for the best future growth of the County in terms of its specific needs, requirements and goals; present the Comprehensive Plan for the consideration of the governing body; and promote public interest in, and the understanding of, the comprehensive plan and planning.
- To assist local planning agencies by providing information on matters of county and regional significance.
- To provide technical planning assistance to local municipalities.
- To encourage cooperation among local governments and regional authorities and to encourage and assist with the development of multi-municipal planning efforts.

Pike County Office of Community Planning

Pike County Office of Community Planning is the County department that comprehensively addresses county-wide planning issues and initiatives. The Community Planning Office responsibilities include development, management and implementation of County planning initiatives and coordination and implementation of the Pike County Comprehensive Plan. Other core responsibilities of the Office of Community Planning are to provide professional technical planning assistance to municipal governments in such areas as municipal comprehensive planning, zoning, subdivision and land development, and to support and help facilitate local municipal and multi-municipal planning initiatives.

The Pike County Office of Community Planning was designated as the official county planning department by Ordinance of the Pike County Board of Commissioners. Authorization for this official designation falls under Section 201 of the PA Municipalities Planning Code (MPC).

All 13 municipalities in Pike County have an adopted Subdivision & Land Development Ordinance (SALDO) and 12 of the 13 municipalities have adopted local zoning ordinances. The Pike County Office of Community Planning reviews subdivisions and land developments based upon the municipality's SALDO, zoning regulations, and other land use regulations. Land developments and subdivisions are also reviewed for their consistency with the goals and objectives identified in the County's Comprehensive Plan and also for appropriate 'best management practices'.

Pike County Comprehensive Plan

The purpose of the Pike County Comprehensive Plan, last updated in 2006, is to set countywide planning goals and priorities, develop partnerships, and enance the quality of life for residents in the County. The Comprehensive Plan is a non-regulatory document that provides statistical information and existing conditions to support future goals of a county or municipality. It establishes a vision for future growth and development and provides an implementation strategy to reach that identified vision.

The plan is prepared with a broad range of subjects including housing, land use, economic development, transportation, infrastructure, community facilities, scenic and natural resources, historical resources, open space, greenways and trail planning. This plan provides an invaluable tool for municipal and county officials to guide the overall development of the County.

The Pike County Open Space, Greenways and Recreation Plan was adopted by the Pike County Board of Commissioners in August 2008 as an official component of the Pike County Comprehensive Plan.

The Pike County 'Planning for the Future' full-color map/brochure describes and depicts the benefits of best planning practices. The project entails educational materials and guides that assist in implementation of the Pike County Comprehensive Plan. The informational project supports the improved ability of municipal governmental in local land use planning; strives to protect the County's natural resources; identifies threats to the Upper Delaware Corridor and the County as a whole in regard to gas drilling operations, and assists in enhancing social and economic vitality of the County and the region.

The Pike County Comprehensive Plan was reviewed to ensure the plan goals were considered and aligned with the update of the HMP goals.

Sawkill Creek and Vandermark Creek Watershed – A Rivers Conservation Plan

Pike County was awarded a grant from the Pennsylvania Department of Conservation and Natural Resources (DCNR) to develop a comprehensive management plan for the Sawkill-Vandermark Creeks Watershed. The Sawkill-Vandermark Creeks Watershed is recognized locally and regionally for its important natural, recreational and economic resources. The purpose of the grant was to work with local residents to develop a "Rivers Conservation / Watershed Management Plan" by identifying significant natural, recreational and cultural resources; determining the issues, concerns and threats to river/watershed resources and values; and recommending methods to conserve, enhance and restore the watershed's streams and waterways.

Stormwater Management Planning

The Pennsylvania legislature enacted the Stormwater Management Act (Act 167 of 1978), commonly called Act 167. The Act enables the regulation of development and activities that cause accelerated runoff and encourages watershed-based planning and management of stormwater. The Department of Environmental Protection is the public agency charged with overseeing implementation of the Act 167 plans. Act 167 Stormwater Management Plans are intended to improve stormwater management practices, mitigate potential negative impacts from future land uses, and to improve the condition of impaired waterways. Pike County completed Phase I of its Act 167 planning and in 2010 completed Phase II through to a Final Draft of a County-wide Act 167 Plan and a Model Ordinance for Municipalities. Per the Act, once the Act 167 Plan is adopted by the County and approved by the PA DEP, each municipality must adopt and implement ordinances needed to regulate development in a manner consistent with the Act 167 Plan. The new ordinance then replaces any previously adopted stormwater management ordinances.

Although Pike's Countywide Stormwater Management Plan and Model Ordinance were drafted in 2010, final adoption by the County did not take place. While state legislation requires completion and adoption of these Act 167 plans, state support such as personnel to assist municipalities with planning and ordinance implementation and funding for rural communities to implement such ordinances has been very limited or non-existent through the years. In this current climate, Pike County has chosen to put this Act 167 process on hold. Despite this, Pike County and Pike County Conservation District (PCCD) have been using the elements of the drafted Act 167 plan and are working with local communities to provide critical education and outreach on the benefits of stormwater management to flood mitigation, surface and groundwater quality protection and protection of the natural drainage regime of our waterways. PCCD is moving forward on priority watershed planning to focus outreach efforts in problem areas and to work with communities interested in trying to retrofit or address stormwater issues to reduce flooding issues. Please note that Pike County has few "impaired" waterways and the majority of waterways are designated as high quality and exceptional value -- special protection waters. Protection and mitigation strategies are a critical component of the education and outreach efforts of the County.

Additionally, with the changes in PA Code 25, Chapter 102 Erosion and Sediment Control state regulations in 2010, PCCD works with PADEP to address stormwater management requirements included in most land development projects throughout all municipalities in the County. Although Pike County currently has no MS4s (Municipal Separate Storm Sewer Systems) as classified by EPA and PADEP, PCCD has been in discussion with local entities which may be designated as MS4s in the future to work towards the requirements for public education, participation and mapping of systems.

As noted in the Plan Integration section below, the problem areas and potential solutions to flooding and drainage issues identified in Pike County's Stormwater Management Plan were considered, and where still appropriate, were included in this updated mitigation strategy.

Comprehensive Plans, Zoning, and Subdivision Regulations

As noted earlier, Comprehensive Plans promote sound land use and regional cooperation among local governments to address planning issues. These plans serve as the official policy guide for influencing the location, type and extent of future development by establishing the basis for decision-making and review processes on zoning matters, subdivision and land development, land uses, public facilities and housing needs over time. County governments are required by law to adopt a comprehensive plan, while local municipalities may do so at their option. Future comprehensive plan updates and improvements will consider 2017 HMP findings. Several municipalities have joined to develop multi-municipal comprehensive planning efforts in the County (e.g., Westfall Township and Matamoras Borough; and Lackawaxen and Shohola Townships and Milford Borough and Milford Township). All municipal comprehensive plans pre-date the 2013 HMP.

Building codes regulate construction standards for new construction and substantially renovated buildings. Standards can be adopted that require resistant or resilient building design practices to address hazard impacts common to a given community. In 2003, the Commonwealth of Pennsylvania implemented Act 45 of 1999, the Uniform Construction Code (UCC), a comprehensive building code that establishes minimum regulations for most new construction, including additions and renovations to existing structures. All 13 municipalities in Pike County are required to adhere to the Pennsylvania UCC. On December 10, 2009 the Commonwealth adopted regulations of the 2009 International Code Council's codes (residential and commercial). The effective date of the regulations is December 31, 2009. However, several residential provisions from the 2015 IECC as of been adopted as of January 1, 2016.

Through administration of floodplain ordinances, municipalities can ensure that all new construction or substantial improvements to existing structures located in the floodplain are flood-proofed, dry-proofed, or built above anticipated flood elevations. Floodplain ordinances may also prohibit development in certain areas altogether. The NFIP establishes minimum ordinance requirements which must be met in order for that community to participate in the program. However, a community is permitted and in fact, encouraged, to adopt standards which exceed NFIP requirements. Through participation in the NFIP, all municipalities within the County have floodplain regulations in place. As discussed in Section 5.2, when municipalities in Pike County's update floodplain ordinances again, the PA model ordinance will be recommended.

As noted earlier, SALDOs are intended to regulate the development of housing, commercial, industrial or other uses, including associated public infrastructure, as land is subdivided into buildable lots for sale or future development. Within these ordinances, guidelines on how land will be divided, the placement and size of roads and the location of infrastructure can reduce exposure of development to hazard events. All jurisdictions within Pike County have adopted and enforce a subdivision and land development ordinance.

Zoning ordinances allow for local communities to regulate the use of land in order to protect the interested and safety of the general public. Zoning ordinances can be designed to address unique conditions or concerns within a given community. They may be used to create buffers between structures and high-risk areas, limit the type or density of development and/or require land development to consider specific hazard vulnerabilities. Twelve of the 13 municipalities in Pike County have zoning regulations; Greene Township does not have zoning.

The local Comprehensive Plans were also reviewed to ensure their plan goals were considered and aligned with the update of the HMP goals.

Pike County Emergency Management

The Pike County Emergency Management Agency and its municipalities have been active in growing their capabilities since the 2013 HMP with a 2014 Continuity of Operations Plan, a 2015 Emergency Operations Plan and becoming a StormReady county in 2016. The Pike County Emergency Management Agency has also assisted Hemlock Farms and Masthope (private developments in Blooming Grove and Lackawaxen Townships, respectively) to become Firewise communities. The agency continues to support these private communities with yearly training and all the necessary paperwork to maintain their status.

Emergency Operations Plan (EOP)

The Pike County EOP, dated 2015, is an all-hazards plan that complies with the National Incident Management System and basis for coordinated and effective response to any disaster in Pike County. The EOP is reviewed on an annual basis. The EOP was utilized when updating the HMP; for example, the list of designated shelters was used to assist with updating the critical facility inventory for the HMP risk assessment. The EOP and the HMP are compatible plans in that they both identify known areas of concern and use their resource annexes to mitigate the hazard and associated risk.

The Emergency Management Services Code (PA Title 35) requires that all municipalities in the Commonwealth have a local EOP which is updated every two years. All 13 jurisdictions in the County have a local EOP. The intent of the Pike County EOP update is for all of the municipalities to sign onto the plan. Then they will be responsible for maintaining their individual resource listings and contact information moving forward.

Continuity of Operations Plan

Continuity of Operations Planning is the process of developing advance arrangements and procedures that enable an organization to continue its essential functions despite events that disrupt them. The current plan was developed in 2014 and is reviewed on a yearly basis. The update process involves using all the County plans such as the County EOP and HMP to ensure best practices are being used and that County entities are still be able operate in a time of emergency.

Local Emergency Management Capabilities

Each municipality has a designated local emergency management coordinator who possesses a unique knowledge of the impact hazard events have on their community. A significant amount of information used to develop the HMP update was obtained from the emergency management coordinators, many of whom participated as part of the HMP update as primary points of contact for their municipality.

According to Pennsylvania Title 35 (Emergency Management Services Code), Chapter 7500, the following stipulations apply:

- Each political subdivision of Pennsylvania is directed and authorized to establish a local emergency management organization in accordance with the plan and program of PEMA. Each local organization shall have responsibility for emergency response and recovery within the territorial limits of the political subdivision within which it is organized, and shall conduct such services outside of its jurisdictional limits as may be required under this part.
- The governing body of a political subdivision may declare a local disaster emergency upon finding a disaster has occurred or is imminent. The effect of a declaration of a local disaster emergency is to activate the response and recovery aspects of any and all applicable local emergency management plans and to authorize the furnishing of aid and assistance.
- Each local organization of emergency management shall have a coordinator who shall be responsible for the planning, administration, and operation of the local organization.
- Each political subdivision shall adopt an Intergovernmental Cooperation agreement with other political subdivisions to accomplish the following:
    - Prepare, maintain, and keep current a disaster emergency management plan for (1) the prevention and minimization of injury and damage caused by disaster, (2) prompt and effective response to disaster, and (3) disaster emergency relief and recovery consistent with the Pennsylvania Emergency Management Plan.
    - Establish, equip, and staff an EOC (integrated with warning and communication systems) to support government operations in emergencies, and provide other essential facilities and equipment for agencies and activities assigned emergency functions.
    - Provide individual and organizational training programs to ensure prompt, efficient, and effective disaster emergency services.
    - Organize, prepare, and coordinate all locally available manpower, materials, supplies, equipment, facilities, and services necessary for disaster emergency readiness, response, and recovery.
    - Adopt and implement precautionary measures to mitigate the anticipated effects of a disaster. Execute and enforce such rules and orders as the agency shall adopt and promulgate under the authority of this part.
    - Cooperate and coordinate with any public and private agency or entity in achieving any purpose of this part.
    - Have available for inspection at its EOC all emergency management plans, rules, and orders of the Governor and the agency.
    - Provide prompt and accurate information regarding local disaster emergencies to appropriate Commonwealth and local officials and agencies and the general public.

  - Participate in all tests, drills, and exercises—including remedial drills and exercises—scheduled by the agency or by the federal government.
  - Participate in the program of integrated flood warning systems under Section 7313 (6) (relating to powers and duties).
- Direction of disaster emergency management services is the responsibility of the lowest level of government affected. When two or more political subdivisions within a county are affected, the county organization shall exercise responsibility for coordination and support to the area of operations. When two or more counties are involved, coordination shall be provided by PEMA or by area organizations established by PEMA.
- When all appropriate locally available forces and resources are fully committed by the affected political subdivision, assistance from a higher level of government shall be provided.
- Local coordinators of emergency management shall develop mutual aid agreements with adjacent political subdivisions for reciprocal emergency assistance. The agreements shall be consistent with the plans and programs of PEMA.

A summary of existing federal, State, regional, and County programs (regulatory and otherwise) to manage specific hazard risks may be found in the hazard profiles in Section 4 of this plan update. While the risk of certain hazards can be addressed at least partially through mitigation, the risks of other hazards (particularly certain non-natural hazards) are primarily managed through the preparedness and response elements of emergency management, or through other regulatory programs at the federal and State levels.

Participation in the National Flood Insurance Program

According to FEMA's 2002 National Flood Insurance Program (NFIP) program description, the U.S. Congress established the NFIP with the passage of the National Flood Insurance Act of 1968 (FEMA 2002). The NFIP is a federal program enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for state and community floodplain management regulations that reduce future flood damages.

Participation in the NFIP is based on an agreement between communities and the federal government. If a community adopts and enforces a floodplain management ordinance to reduce future flood risk to new construction and substantial improvements in floodplains, the federal government will make flood insurance available within the community as a financial protection against flood losses. This insurance is designed to provide an alternative to disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods (FEMA 2002).

All jurisdictions in Pike County participate in the NFIP (see Table 5-1). Local municipalities participate in the program through ordinance adoption and floodplain regulation and enforcement while the Pike County Office of Community Planning provides an oversight and coordination role. Similarly, permitting processes needed for building construction and development in the floodplain are implemented at the municipal level through various ordinances (e.g. zoning, subdivision/land development and floodplain ordinances), but the Office of Community Planning provides technical assistance and guidance upon request.

The Pennsylvania Floodplain Management Act (Act 166) mandates municipal participation in and compliance with the NFIP. It also establishes higher regulatory standards for new or substantially improved structures which are used for the production or storage of dangerous materials (as defined by Act 166) by prohibiting them in the floodway. Additionally, Act 166 establishes the requirement that a Special Permit be obtained prior to any construction or expansion of any manufactured home park, hospital, nursing home, jail and prison if said structure is located within a special flood hazard area.

As new Digital Flood Insurance Rate Maps (DFIRMs) are published, the Pennsylvania State NFIP Coordinator housed at the Pennsylvania Department of Community and Economic Development (DCED), works with communities to ensure the timely and successful adoption of an updated floodplain management ordinance by reviewing and providing feedback on existing and draft ordinances. In addition, DCED provides guidance and technical support through Community Assistance Contacts (CAC) and Community Assistance Visits (CAV). There are no communities in Pike County currently participating in the NFIP Community Rating System (FEMA CIS, 2011).

FEMA Region III makes an ordinance review checklist available to communities which lists required provisions for floodplain management ordinances. This checklist helps communities develop an effective floodplain management ordinance that meets federal requirements for participation in the NFIP.

The DCED provides communities, based on their CFR, Title 44, Section 60.3 level of regulations, with a suggested ordinance document to assist municipalities in meeting the minimum requirements of the NFIP along with the Pennsylvania Flood Plain Management Act (Act 166). These suggested or model ordinances contain provisions that are more restrictive than state and federal requirements. Suggested provisions include, but are not limited to:

- Prohibiting manufactured homes in the floodway.
- Prohibiting manufactured homes within the area measured 50 feet landward from the top-of bank of any watercourse within a special flood hazard area.
- Special requirements for recreational vehicles within the special flood hazard area.
- Special requirement for accessory structures.
- Prohibiting new construction and development within the area measured 50 feet landward from the top-of bank of any watercourse within a special flood hazard area.
- Providing the County Conservation District an opportunity to review and comment on all applications and plans for any proposed construction or development in any identified floodplain area.

Pike County received new digital flood insurance rate maps (DFIRMS) on October 6, 2000. The digital maps greatly enhanced mitigation capabilities as they relate to identifying flood hazards and were a significant improvement to the pervious paper Flood Insurance Rate Maps (FIRMS). Flood maps and flood data are accessible to residents at municipal offices, the Pike County Office of Community Planning and the Pike County Conservation District, and online at msc.fema.gov.

FEMA, along with the DCED, and the Pennsylvania Emergency Management Agency (PEMA), recently led a Flood Risk Discovery process in the Lackawaxen Watershed. A portion of the Lackawaxen Watershed is located in Pike County. Discovery is the first phase of a Risk Mapping, Assessment, and Planning (Risk MAP) flood risk project, designed to collect data and information from the community to provide a more holistic picture of where flood-related vulnerabilities exist, determine the current flood hazards, and identify opportunities to facilitate mitigation planning to help your community further actions to reduce flood damage across the watershed. Pike County continues to monitor the Lackawaxen Watershed RiskMAP initiative.

With the release of the maps in 2000, the Pike County Conservation District worked with all of the County's municipalities, FEMA and the DCED to assist with the update of municipal floodplain ordinances. All Pike County municipalities have adopted floodplain ordinances and/or provisions within their zoning ordinance to implement standards consistent with the updated FIRM mapping. However, few of the ordinances go beyond these minimum requirements, and those that do only do so in prohibiting new construction or development in the 1-percent annual chance floodplain (refer to Table 5-1).

Table 5-1. Results of Analysis of Standards in Municipal Floodplain Ordinances

Jurisdiction	Meets NFIP Standards*	Exceeds NFIP Standards*	Provisions that Exceed NFIP Standards *
Blooming Grove Township	X		
Delaware Township	X		
Dingman Township		X	Prohibit new construction/development in 1-percent annual chance floodplain
Greene Township	X		
Lackawaxen Township	X		
Lehman Township	X		
Matamoras Borough	X		
Milford Borough	X		
Milford Township		X	Prohibit new construction/development in 1-percent annual chance floodplain
Palmyra Township		X	Prohibit new construction/development in 1-percent annual chance floodplain
Porter Township	X		
Shohola Township	X		
Westfall Township	X		

Source: 2012 Pike County Hazard Mitigation Plan

Additional information on the NFIP program and its implementation within Pike County may be found in the flood hazard profile in Section 4.3.7.

Community Rating System (CRS)

In the 1990s, the Flood Insurance Administration (FIA) established the Community Rating System (CRS) to encourage local governments to increase their standards for floodplain development. The goal of the program is to encourage communities—through flood insurance rate adjustments—to implement standards above and beyond the minimum required in order to:

- Reduce losses from floods
- Facilitate accurate insurance ratings
- Promote public awareness of the availability of flood insurance

The CRS is a voluntary program designed to reward participating jurisdictions for their efforts to create more disaster-resistant communities using the principles of sustainable development and management. By enrolling in the CRS, municipalities can leverage greater flood protection while receiving flood insurance discounts. Currently, no municipalities in Pike County participate in the CRS.

Pike County, along with many of the municipalities, have identified specific mitigation initiatives in this plan update to help build and enhance mitigation-related planning and regulatory capabilities in Pike County including joining the CRS. Table 5-2 summarizes the planning and regulatory capabilities as provided by plan participants. Copies of the individual responses are provided in Appendix D.

Table 5.2-2. Planning and Regulatory Capability

Jurisdiction	Hazard Mitigation Plan	EOP	Disaster Recovery Plan	Evacuation Plan	COOP Plan	NFIP	NFIP – CRS	Floodplain Regulations	Floodplain Mgmt. Plan	Zoning Regulations	Subdivision Regulations	Comprehensive Land Use Plan (or General, Master, or Growth Mgmt. Plan)	Open Space Mgmt. Plan	Stormwater Mgmt. Plan/Ordinance	Natural Resource Protection Plan	Capital Improvements Plan	Economic Dev. Plan	Historic Preservation Plan	Farmland Preservation	Building Code	Fire Code	Other
Blooming Grove Township	X	X	-	X	X	X	-	X	-	X	X	X	X	X	-	-	-	-	-	X	X	-
Delaware Township	X	X		X	X	X		X		X	X	X	X	X						X		
Dingman Township	X	X	-	-	-	X	-	X	-	X	X	X	-	X	-	-	-	-	-	X	X	-
Greene Township	X	X	-	X	X	X	-	X	-	-	X	X	-	X	-	-	-	-	-	X	-	-
Lackawaxen Township	X	X	-	-	-	X	-	X	-	X	X	X	X	-	-	-	-	-	-	X	-	-
Lehman Township	X	X	X	X	X	X	-	X	-	X	X	X	X	X	-	X	-	-	-	X	X	-
Matamoras Borough	X	X	UD	UD	UD	X	-	X	-	X	X	X								X		
Milford Borough	X	X	X	X	X	X	-	X	-	X	X	X	-	-	-	-	-	-	-	X		*
Milford Township	X	X				X	-	X		X	X	X								X		
Palmyra Township	X	X	-	-	-	X	-	X	-	X	X	X	X	X	-	-	-	-	-	X	-	-
Porter Township	X	X		X	X	X	-	X		X	X	X								X		
Shohola Township	X	X	-	-	-	X	-	X	-	X	X	X	X	X	-	-	-	X	-	X	-	
Westfall Township	X	X	-	X	-	X	-	X	-	X	X	X	X	X	-	X	-	-	-	X	X	
Pike County	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-	X	X	X	X	-	-	

Source: HMP Capability Assessment Surveys, 2016;
"X" indicates that the jurisdiction currently has this capability in place.
"UD" indicates this capability is under development.
"-" indicates no capability is currently in place.
A blank space indicates no response was received from the jurisdiction.
"" Milford Borough has a historic preservation ordinance.*
COOP = Continuity of Operations Plan
EOP = Emergency Operations Plan
CRS = Community Rating System
NFIP = National Flood Insurance Program

5.2.2 Administrative and Technical Capability

Administrative capability is described by an adequacy of departmental and personnel resources for the implementation of mitigation-related activities. Technical capability relates to an adequacy of knowledge and technical expertise of local government employees or the ability to contract outside resources for this expertise in order to effectively execute mitigation activities. Common examples of skill sets and technical personnel needed for hazard mitigation include: planners with knowledge of land development/management practices, engineers or professionals trained in construction practices related to buildings and/or infrastructure (e.g. building inspectors), planners or engineers with an understanding of natural and/or human caused hazards, emergency managers, floodplain managers, land surveyors, scientists familiar with hazards in the community, staff with the education or expertise to assess community vulnerability to hazards, personnel skilled in geographic information systems, resource development staff or grant writers, fiscal staff to handle complex grant application processes.

Municipalities are further supported by county, regional, State, and federal administrative and technical capabilities. For this HMP, the majority of support agencies and resources have been identified and referenced throughout this plan update.

Pike County and its municipalities have identified specific mitigation initiatives described in Section 6 which will help build and enhance mitigation-related administrative and technical capabilities.

Federal and State Capabilities

Federal agencies which can provide technical assistance for mitigation activities include, but are not limited to:

- U.S. Army Corp of Engineers
- Department of Housing and Urban Development
- Department of Agriculture
- Economic Development Administration
- Emergency Management Institute
- Environmental Protection Agency
- FEMA
- Small Business Administration

State agencies which can provide technical assistance for mitigation activities include, but are not limited:

- Pennsylvania Department of Community and Economic Development
- Pennsylvania Department of Conservation and Natural Resources
- Pennsylvania Department of Environmental Protection
- Pennsylvania Silver Jackets

The PA DCNR Bureau of Forestry attended the HMP kick-off meeting and completed a capability assessment survey. Their survey noted the following staff/personnel resources in the Bureau: planners with land use/land development knowledge; planners or engineers with natural and/or human-caused hazards knowledge; engineers or professionals trained in building and/or infrastructure construction projects; land surveyors; GIS skills; grant writers; and staff with expertise in benefit-cost analysis.

The Pennsylvania Silver Jackets Team is an interagency (federal, regional, profession and Commonwealth agencies) team dedicated to working collaboratively with the Commonwealth and appropriate stakeholders in developing and implementing solutions to flood hazards by combining available agency resources, which include funding, programs, and technical expertise. The goal of the Silver Jackets program is to promote interagency collaboration and to leverage available national, regional and local resources. The team provides a variety of flood risk management resources available to the public and can found here: http://www.nab.usace.army.mil/Home/Silver-Jackets/

County Capabilities

Pike County Conservation District

Pike County Conservation District was established in 1956 by the Pike County Board of Commissioners and has worked actively since then to carry out programs focused on conservation of soil, water and natural resources. The District is governed by a Board of Directors who meet monthly to help plan programs, guide staff and coordinate efforts which provide conservation assistance and education in Pike County. District staff provide technical assistance for residents on natural resource and watershed conservation, groundwater protections, grant writing, and program administration. In addition, technical staff are trained to review construction plans; conduct inspections for erosion and stormwater on construction sites; and handle permitting related to waterway obstructions.

The Conservation District coordinated the formation of the Pocono Source Water Protection Collaborative in 2013. The Collaborative was formed to safeguard drinking water by protecting it at its source, as well as provide education and outreach on groundwater (potable water) protection.

The Conservation District Watershed Specialist position works with all citizen-based watershed groups; currently there are two watershed groups, one watershed management district and the Pocono Source Water Protection Collaborative. The District provides advice, guidance, and assist with their activities (everything from water monitoring, education/outreach, programs, etc.). The Collaborative has been working with water suppliers throughout the County on development of source water protection plans and education/outreach on water resource conservation.

The Conservation District works with municipalities to provide technical assistance and funding for improvements via the PA Dirt, Gravel and Low Volume Road Maintenance Program. In addition, the Conservation District created an Education Reimbursement Grant program for applicants who are eligible for the PA Dirt, Gravel and Low Volume Road program to attend trainings conducted by the Penn State Center for Dirt and Gravel Road Studies (Center).

Pike County Office of Community Planning

As noted earlier in this section, the Pike County Office of Community Planning comprehensively addresses county-wide planning issues and initiatives. Pike County Office of Community Planning initiatives include:

- Tick Borne Disease Task Force - Pike County Tick Borne Disease Task Force and the Pike County Commissioners have joined forces to help prevent the spread of tick borne diseases. The Task Force will work to educate the public about the prevalence and dangers of tick borne diseases, how to protect yourself from becoming infected, and how to enjoy your time outside. The Pike County Tick Borne Disease Task Force is focused on decreasing the number of tick borne illnesses by building community awareness through education, support, and advocacy.

- Agricultural Land Preservation Program - The purpose of the Pike County Agricultural Land Preservation Program is to protect and promote the continued agricultural use of valuable agricultural lands by acquiring agricultural conservation easements on actively farmed lands within Ag Security Areas (ASA's). The purchase of these easements from willing and interested landowners will provide these landowners with a more viable option for retaining the small farm operations and our local communities' rural character.

- Planning Commission - Created by Resolution of the Pike County Board of Commissioners in August 1965, the Pike County Planning Commission has served as an Advisory Board to the Pike County Board of Commissioners on matters of future growth and development over its forty-five year history.

Many of the Planning Commission's efforts are focused on providing assistance to the County's thirteen municipalities.

- Scenic Rural Character Preservation – The program's mission is to protect the County's natural resources, preserve sensitive natural areas and critical open space, and provide parks and recreation areas and improving planning efforts at both the County and municipal levels.

- Marcellus Shale Task Force – The task force is a Commissioner-appointed standing committee established in October 2010 to build capacity for addressing current and future issues and opportunities related to Marcellus Shale activity in Pike County.

Pike County Emergency Management Agency

The Pike County Emergency Management Agency provides the leadership and resources to address hazard incidents and coordinates countywide emergency management efforts. Currently, 9-1-1 calls and emergency communications are handled by the Pike County Communications Center for all the municipalities except Lehman Township. Monroe County handles Lehman Township calls and provides dispatch services for Bushkill Fire and EMS. Pennsylvania State Police handles their own. The Pike County 911 Center dispatches for 15 volunteer fire departments, 10 volunteer ambulance corps, two volunteer quick response services and three municipal police departments in addition to receiving the 911 calls for the geographic areas served by the Pennsylvania State Police. Under a mutual aid program for fire companies, available fire fighters and equipment are coordinated from all fire companies.

As of 2016, there are 19 volunteer fire departments based within Pike County that provide service. In addition, the Greene-Dreher Fire Department from Wayne County provides service to part of Greene Township, Welcome Lake Fire Department from Wayne County provides service to the upper portion of Lackawaxen Township and the Lumberland Fire Department from Sullivan County, NY provides service to the Pond Eddy portion of Shohola and Westfall Townships.

EMS Service is provided by nine Ambulance Services units. Of the nine ambulance services, six are part of the fire service. Bushkill Emergency Corps which services Lehman Township is based in and dispatched by Monroe County. Newfoundland Ambulance is based in and dispatched by Wayne County. Tusten Ambulance and Lumberland Fire Department Ambulance are based in and dispatched by Sullivan County, NY. Port Jervis Ambulance is based in Orange County, NY.

The average fire department in Pike County has approximately 22 active members. The County and our local communities are similar to the rest of the state in that our communities have seen a regular and marked decline of volunteers over the past 20 years. It is estimated that there are no more than 500 active volunteers in the County between both fire and emergency medical services. Currently there are approximately 27 engines, 20 tankers, five ladder trucks and an assortment of rescue and support type vehicles. The most common pump sizes are 1,250 and 1,500 gallons per minute. However, there are some with capacities of 1,500 gallons per minute to over 2,000 gallons per minute. Most engines are now carrying 750 or 1,000 gallons of water and the average tanker size is over 2,000 gallons. In addition, there is over five miles of large diameter (4" or 5") hose throughout the County.

In addition to the firefighting abilities of the departments located in the County's municipalities, the Pennsylvania Bureau of Forestry, Delaware State Forest District #19 and the National Park Service, Delaware Water Gap National Recreation Area have employees working within the County who have as their responsibility firefighting and other emergency services capabilities.

Formed in May 2003, the Pike County Advanced Life Support (ALS) is comprised of paid paramedics and volunteer Emergency Medical Technician drivers. ALS goes beyond basic life support in that paramedics can start intravenous solutions and administer drugs. Pike County ALS recently relocated from the Dingman Township Volunteer Fire Department firehouse on Log Tavern Road to the Milford Professional Park on Buist

Road in Dingman Township. ALS is looking for a permanent central location in the County due to the importance of distance to and from hospitals. Hospitals are located in Port Jervis, NY; East Stroudsburg, PA; Honesdale, PA; Newton, NJ; and Scranton, PA.

Particular concerns of Pike County ALS include bringing together all EMS to discuss improving service in the County; improving funding to pay medics more and pay expenses; and increasing the number of medics and the number of stations in the County in order to expand the service area. Additional ALS services in the County are provided from Honesdale, Bushkill, and Hamlin.

The Pike County Visioning Final Report issued in October 1999 and the Pike County Comprehensive Plan adopted in November 2006 both highlighted the challenge that Pike County communities are experiencing in regard to provision of services, including fire and emergency medical service, as a result of the tremendous population growth pressures which the County experienced and may experience over the next 10 years.

The County relies almost entirely on volunteers to provide vital EMS and fire services for residents. A dozen all-volunteer fire companies serve the 13 municipalities in the county. Approximately 23 volunteer fire and ambulance companies provide protection throughout the County. These companies collectively have approximately 500 volunteers who provide emergency services throughout the county. Approximately 85 to 100-percent of the total funds used to run these companies come from private donations. Most of these companies are confronted with ongoing problems of retaining volunteers, raising sufficient funds to purchase and maintain adequate and updated equipment, and obtaining sufficient training. As the number of residents and residences increase and the number of volunteers decrease, fire services currently stretched to their limits, will be further stressed to provide adequate emergency protection for the County.

The problems for EMS services are very similar. The over-riding problem is lack of manpower to handle the volume of calls. EMS services in the County rely on volunteers, and the number of volunteers has been dropping largely due to liability issues, the risk of AIDS, higher training requirements, the increasingly mundane nature of the work (i.e., increasing number of “transportation calls” from an aging population and fewer emergency calls), and other related problems.

Both services are suffering from problems associated with the rapid and somewhat haphazard growth in the county, particularly in the private residential communities. Lack of standards for roads and signs has made it difficult and occasionally impossible to respond to life and property-threatening emergencies. EMS and fire program managers throughout the county feel that volunteerism needs to improve to adequately respond to the increasing call volumes.

The Pike County Emergency Management Agency continues to assist local municipalities and their volunteer local Emergency Management Coordinators in all areas of emergency management. This includes assisting with local EOP reviews and updates, liaising with stakeholders that need to be contacted during regular business hours, and providing GIS mapping support on local projects.

Pike County utilizes Code Red to alert citizens and partners with timely information to assist them with making informed decisions. Code Red delivers emergency and weather alerts, health notifications, building alerts, and road closures to name a few. The agency is actively conducting outreach to all municipalities and residents to register for Code Red. All Pike County Emergency Management technology is tested quarterly to ensure critical information is disseminated properly.

The Pike County Emergency Management Agency continues to host regular weather courses with the National Weather Service Binghamton office as part of their technical support services to municipalities and residents. In addition, the agency continues to serve as a bridge between the PA DCNR and the two Firewise communities.

Municipal Capabilities

Participating municipalities in this planning effort were provided with a capabilities survey. Table 5-3 summarizes the responses of the municipalities and County based on administrative and technical capability. Copies of the individual responses are found in Appendix D.

Based on assessment results, municipalities in Pike County have low-to-moderate administrative and technical staff needed to conduct hazard mitigation activities. There seems to be sufficient emergency management staff (although volunteer positions) across the County and a majority of municipalities have engineering capabilities. However, there seems to be a common lack of personnel for land surveying and scientific work related to community hazards. This result is not necessarily surprising since these tasks are typically contracted to outside providers. Many communities were unaware they have an NFIP Floodplain Administrator. A majority of communities do not have their own personnel skilled in geographic information systems (GIS) but the County is able to support the municipalities with some GIS services. All municipalities have an identified emergency management coordinator, though one individual may share duties between two municipalities.

Other local organizations that could act as partners include the Pike County Conservation District, Pike County Office of Community Planning, the County Council of Governments, County economic development staff, and school districts.

In addition watershed associations and other environmental advocacy groups can provide support such as the National Park Service, Lackawaxen River Conservancy, the Twin and Walker Creek Watershed Conservancy, the Twin Lakes Conservancy, the Delaware Highlands Conservancy, and the Lake Wallenpaupack Watershed Management District. Most organizations of these types provide grass roots citizen support which can assist with education and outreach on important issues. Watershed volunteers can also provide important input on the science of water resources through monitoring programs. Watersheds can be planning and management areas for stream conservation and protection, stormwater management, water supply budgeting, watershed based zoning, and integrated resource planning. Getting citizen based groups such as watershed organizations involved with municipal planning in hazard mitigation efforts can provide a comprehensive approach to addressing hazard mitigation opportunities and can provide important education and outreach to the local residents.

Table 5-3. Administrative and Technical Capability

Jurisdiction	Planners (with land use/land development knowledge)	Planners or engineers (with natural and/or human caused hazards knowledge)	Engineers or professionals trained in building and/or infrastructure construction practices	Emergency Manager	NFIP Floodplain Administrator	Land surveyors	Scientists or staff familiar with the hazards of the community	Personnel skilled in GIS and/or FEMA's HAZUS program	Grant writers or fiscal staff to handle large/complex grants	Staff with expertise or training in benefit-cost analysis	Other
Blooming Grove Township	X	-	X	X	X	X	X	X	X	X	
Delaware Township	X	X	X	X	X						
Dingman Township	X	X	X	X	X	-	-	-	X		
Greene Township	X	X	X	X	X	-	-	-	-	-	
Lackawaxen Township	X	X	X	X	X	X	X	X	X	X	
Lehman Township	X	X	X	X	X	-	X	-	-	X	
Matamoras Borough			X	X	X						
Milford Borough	X	X	X	X	X						
Milford Township	X	X	X	X	X	-	-	-	-	-	-
Palmyra Township	X	X	X	X	X	-	-	-	-	-	-
Porter Township	-	-	X	X	X	-	-	-	-	-	
Shohola Township	X	-	X	X	X	-	-	-	X	-	
Westfall Township	X	X	X	X	X	X	X	X	X	X	
Pike County	X	X	X	X	-	-	X	X	X	-	

Notes:
"X" indicates that the jurisdiction currently has this capability in place (even if contracted as needed).
"-" indicates no capability is currently in place.
DK indicates "don't know."
Blank space indicates no response was received from the municipality.
FEMA = Federal Emergency Management Agency
GIS = Geographic Information System
HAZUS = Hazards U.S.
NFIP = National Flood Insurance Program

Political Capability

For a hazard mitigation project, political capability speaks to a jurisdiction's ability, will, and commitment to supporting risk management activities and programs within all aspects of their community's governance. This commitment may be evidenced through the adoption and appropriate enforcement of mitigation-related ordinances and plans (zoning, comprehensive planning, site-plan review, building code, higher regulatory standards), appropriate and critical mitigation-related outreach to vulnerable property owners and the public in general, an appropriate dedication of resources (administrative, technical, fiscal) to implement identified priority mitigation projects/actions, and the integration and coordination of the findings and recommendations of this plan update within other complementary and supportive plans and programs.

Strong political capabilities are built over time; they are not necessarily transferred from one elected official to the next. Communities that have had to repeatedly face hazard events and their impacts tend to be those that build and maintain greater mitigation capabilities, and this is certainly the case with political (including public) will. Through this mitigation planning, update, and implementation process, FEMA and the State are promoting efforts to build political and popular support to improve the management of hazard risk at the local level.

One of the most difficult capabilities to evaluate involves the political will of a jurisdiction to enact meaningful policies and projects designed to mitigate hazard events. The adoption of hazard mitigation measures may be seen as an impediment to growth and economic development. In many cases, mitigation may not generate interest among local officials when compared with competing priorities. Therefore, the local political climate must be considered when designing mitigation strategies, as it could be the most difficult hurdle to overcome in accomplishing the adoption or implementation of specific actions.

The capability assessment surveys provided to each jurisdiction included an assessment of local political capability, where the respondent was asked to rate their community's political capability to effect and support hazard mitigation on a scale ranging from "5 – Very Willing" to "0 – Unwilling to Adopt Policies/Programs." Completed capability assessment worksheets returned from communities are provided in Appendix D. By its very nature, an assessment of political capabilities tends to be highly subjective, and any such local assessment provided by a community should not necessarily be considered statistically valid or reflective of the opinions of others in the community.

Table 5-4. Political Capability

Jurisdiction	Very Willing	Moderate to Very Willing	Moderately Willing	Unwilling to Moderately Willing	Unwilling
Blooming Grove Township	X				
Delaware Township			X		
Dingman Township	X				
Greene Township			X		
Lackawaxen Township			X		
Lehman Township	X				
Matamoras Borough		X			
Milford Borough			X		
Milford Township	X				

Jurisdiction	Very Willing	Moderate to Very Willing	Moderately Willing	Unwilling to Moderately Willing	Unwilling
Palmyra Township		X			
Porter Township			X		
Shohola Township			X		
Westfall Township	X				
Pike County			X		

Notes:
"X" indicates the identified jurisdiction political effort currently in place.
Blank space indicates no response was received from the jurisdiction.

5.2.3 Fiscal Capability

Mitigation projects and initiatives are largely or entirely dependent on available funding. As such, it is critical to identify all available sources of funding at the local, county, regional, state, and federal level to support implementation of the mitigation strategies identified in this plan update.

Jurisdictions fund mitigation projects though existing local budgets, local appropriations (including referendums and bonding), and through myriad federal and state loan and grant programs.

Federal mitigation grant funding (Stafford Act 404 and 406) is available to all communities with a current HMP (this plan); however, most of these grants require a "local share" in the range of 10 to 25 percent of the total grant amount. This section describes the funding sources and programs available to Pike County in support of their mitigation efforts.

Federal Hazard Mitigation Funding Opportunities

Hazard Mitigation Grant Program (HMGP)

HMGP (Stafford Act 404 and 406) is a post-disaster mitigation program made available to states by FEMA after each federal disaster declaration. The HMGP can provide up to 75 percent funding for hazard mitigation measures and can be used to fund cost-effective projects that will protect public or private property in an area covered by a federal disaster declaration or that will reduce the likely damage from future disasters. Examples of projects include acquisition and demolition of structures in hazard-prone areas, flood proofing or elevation to reduce future damage, minor structural improvements, and development of state or local standards.

Projects must fit into an overall mitigation strategy for the area identified as part of a local planning effort. All applicants must have a FEMA-approved HMP. Applicants who are eligible for the HMGP include state and local governments, certain nonprofit organizations or institutions that perform essential government services, and Indian tribes and authorized tribal organizations. Individuals or homeowners cannot apply directly for the HMGP; a local government must apply on their behalf. Applications are submitted to PEMA and placed in rank order for available funding and submitted to FEMA for final approval. Eligible projects not selected for funding are placed in an inactive status and may be considered as additional HMGP funding becomes available.

FEMA Stafford Act Sections 404 and 406 are two distinct criteria associated with mitigation funding. Participation in FEMA 404 HMGP may cover mitigation activities including raising, removing, relocating, or replacing structures within flood hazard areas. FEMA 406 HMGP is applied to parts of a facility that were actually damaged by a disaster, and the mitigation measures that provide protection from subsequent events.

Flood Mitigation Assistance (FMA) Program

FMA provides funding to assist states and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the NFIP. FMA is funded annually; no federal disaster declaration is required. Only NFIP-insured homes and businesses are eligible for mitigation in this program. Funding for FMA is very limited and, as with the HMGP, individuals cannot apply directly for the program. Applications must come from local governments or other eligible organizations.

The federal government cost share for an FMA project is 75 percent. At least 25 percent of the total eligible costs must be provided by a non-federal source, and of this 25 percent, no more than half can be provided as in-kind contributions from third parties. At a minimum, a FEMA-approved local HMP is required before a project can be approved. FMA funds are distributed from FEMA to the State. PEMA serves as the grantee and program administrator for FMA.

As of fiscal year 2013, the Severe Repetitive Loss and Repetitive Flood Claims Programs were dismantled and incorporated into the FMA Program. As a result, residential and non-residential properties currently insured with NFIP are eligible to receive FMA funds as long as they meet either the Repetitive Loss (RL) properties or Severe Repetitive Loss (SRL) property definitions as described in Section 4.3.7 of this plan.

Pre-Disaster Mitigation (PDM) Program

The PDM program is an annually funded, nationwide, competitive grant program. No disaster declaration is required. Federal funds will cover 75 percent of a project's cost up to $3 million. As with the HMGP and FMA, a FEMA-approved local HMP is required to be approved for funding under the PDM program.

In addition to these FEMA grants, the federal government, through the Emergency Management Institute, offers training in all aspects of emergency management, including hazard mitigation. The courses available at the Institute are free to local government staff.

Federal Disaster Assistance Programs

Following a disaster, various types of assistance may be made available by local, state, and federal governments. The types and levels of disaster assistance depend on the severity of the damage and the declarations that result from the disaster event. Should the President of the United States declare the event a major disaster, the following general types of assistance are offered:

- Individual Assistance – provides help for homeowners, renters, businesses, and some nonprofit entities after disasters occur. This program is largely funded by the U.S. Small Business Administration largely funds this program. For homeowners and renters, those who suffered uninsured or underinsured losses may be eligible for a Home Disaster Loan to repair or replace damaged real estate or personal property. Renters are eligible for loans to cover personal property losses. Individuals may borrow up to $200,000 to repair or replace real estate, $40,000 to cover losses to personal property and an additional 20 percent for mitigation. For businesses, loans may be made to repair or replace disaster damages to property owned by the business, including real estate, machinery and equipment, inventory and supplies. Businesses of any size are eligible. Non-profit organizations such as charities, churches, private universities, etc. are also eligible. An Economic Injury Disaster Loan provides necessary working capital until normal operations resume after a physical disaster. These loans are restricted (by law) to small businesses only.

- Public Assistance – provides cost reimbursement aid to local governments (state, county, local, municipal authorities, and school districts) and certain nonprofit agencies that were involved in disaster response and recovery programs or that suffered loss or damage to facilities, or property used to deliver government-like services. This program is largely funded by FEMA with both local and state matching contributions required.

U.S. HUD Community Development Block Grants (CDBG)

The U.S. HUD CDBGs are federal funds intended to provide low- and moderate-income households with decent housing, a suitable living environment, and expanded economic opportunities. Eligible activities include community facilities and improvements, roads and infrastructure, housing rehabilitation and preservation, development activities, public services, economic development, planning, and administration. Public improvements may include flood and drainage improvements. In limited instances and during times of "urgent need" (for example, post-disaster) as defined by the CDBG National Objectives, CDBG funding may be used to acquire a property located in a floodplain that was severely damaged by a recent flood, demolish a structure severely damaged by an earthquake, or repair a public facility severely damaged by a hazard event. Pike County and several of its municipalities have utilized CDBG funding for infrastructure and other necessary improvements to increase County resiliency.

Additional Federal Resources

Weatherization Assistance Program: Minimizes the adverse effects of high-energy costs on low-income, elderly, and handicapped citizens through client education activities and weatherization services like heating system modifications and insulation (US DOE, 2011).

Section 108 Loan Guarantee Programs: Provides loan guarantees as security for federal loans for acquisition, rehabilitation, relocation, clearance, site preparation, special economic development activities, and construction of certain public facilities and housing (HUD, 2011).

U.S. Department of Agriculture: Provides disaster assistance through the following:

- The Emergency Conservation Program provides emergency funding for farmers to rehabilitate farmland damaged by natural disasters and for carrying out emergency water conservation measures during periods of severe drought.
- The Non-insured Crop Disaster Assistance Program provides financial assistance for non-insurable crop losses and planting prevented by disasters.

Emergency Watershed Protection Program: Undertake emergency measures, including the purchase of floodplain easements, for runoff retardation and soil erosion prevention to safeguard lives and property from floods, drought, and the products of erosion on any watershed whenever fire, flood, or any other natural occurrence is causing or has caused a sudden impairment of the watershed (NRCS, 2011). It is not necessary for a national emergency to be declared for an area to be eligible for assistance. The program objective is to assist sponsors and individuals in implementing emergency measures to relieve imminent hazards to life and property created by a natural disaster. Activities include providing financial and technical assistance to remove debris from streams, protect destabilized stream banks, establish cover on critically eroding lands, repairing conservation practices, and the purchase of floodplain easements. The program is designed for installation of recovery measures.

State Hazard Mitigation Funding Opportunities

State programs which may provide financial support for mitigation activities include, but are not limited to:

- Community Conservation Partnerships Program
- Community Revitalization Program
- Floodplain Land Use Assistance Program
- Growing Greener Program
- Keystone Grant Program
- Local Government Capital Projects Loan Program
- Land Use Planning and Technical Assistance Program
- Pennsylvania Heritage Areas Program
- Pennsylvania Recreational Trails Program

- Shared Municipal Services
- Technical Assistance Program

Marcellus Shale Legacy Fund - Act 13 of 2012

Watershed Restoration and Protection Program (WRPP) **-** Act 13 of 2012 establishes the Marcellus Legacy Fund and allocates funds to the Commonwealth Financing Authority for watershed restoration and protection projects. The overall goal of this program is to restore and maintain restored stream reaches impaired by the uncontrolled discharge of nonpoint source polluted runoff, and ultimately to remove these streams from the PA DEP's Impaired Waters list.

Greenways, Trails and Recreation Program (GTRP) **-** In addition, Act 13 of 2012 allocates funds to the Commonwealth Financing Authority for planning, acquisition, development, rehabilitation and repair of greenways, recreational trails, open space, parks and beautification projects. Projects can involve development, rehabilitation and improvements to public parks, recreation areas, greenways, trails, and river conservation.

Flood Mitigation Projects – Finally, Act 13 of 2012 allocates funds to the Commonwealth Financing Authority for funding Statewide initiatives to assist with flood mitigation projects.

While most of the identified fiscal capabilities are available to all of the municipalities in Pike County, the extent to which communities have leveraged these funding sources varies widely. It is expected that communities familiar with accessing grant programs will continue to pursue those grant sources, as appropriate.

Municipal Capabilities

The implementation of mitigation actions requires time and fiscal resources. While some mitigation actions are less costly than others, it is important that money is available locally to implement policies and projects. Financial resources are particularly important if jurisdictions are trying to take advantage of state or federal mitigation grant funding opportunities that require local-match contributions. Based on survey results and municipal feedback, most municipalities within the County perceive fiscal capability to be limited.

Capital Improvement Planning

Capital improvement plans are often recommended by counties to their municipalities, as these plans help identify specific capital projects to be funded and completed according to a defined schedule. Some of these projects involve improvements to facilities and infrastructure that provide hazard mitigation benefits. As such, during this update process, the County and its municipalities have been encouraged to consider the mitigation benefits associated with their known or anticipated capital projects as a way to help prioritize their execution and to develop awareness that mitigation grants may be available to help fund such projects.

Municipalities participating in this planning effort were provided with a capabilities survey. Table 5-5 summarizes the responses of the County and municipalities based on fiscal capabilities. Copies of the individual municipal responses are found in Appendix D.

Table 5-5. Fiscal Capability

Jurisdiction	Capital Improvements Program	Community Development Block Grants (CDBG)	Special Purpose Taxes	Gas/Electric Utility Fees	Water/Sewer Fees	Stormwater Utility Fees	Development Impact Fees	General Obligation, Revenue, and/or Special Tax Bonds	Partnering Arrangements or Intergovernmental Agreements	Other
Blooming Grove Township	-	X	X	-	-	-	-	-	-	
Delaware Township	X	X	X					X	X	
Dingman Township		X	X	-	-	-	-	X		
Greene Township	X	X	X	-	-	-	-	X	X	
Lackawaxen Township	X	X	-	-	-	-	-	-	-	
Lehman Township	X	X	X	-	-	-	-	X	X	
Matamoras Borough	-	X	X	-	-	-	-	X	X	
Milford Borough		X	X							
Milford Township	-	X	-	-	-	-	-	X	X	
Palmyra Township	-	X	-	-	-	-	-	-	X	-
Porter Township	-	X	-	-	-	-	-	-	-	
Shohola Township	-	X	-	-	-	-	X	-	X	
Westfall Township	NA	X	NA	NA	-	-	-	-	X	
Pike County	X	X	X	-	-	-	-	X	X	

Notes:
"X" indicates that the jurisdiction currently has this capability in place.
"-" indicates no capability is currently in place.
DK indicates "don't know."
NA indicates the jurisdiction noted not applicable.
Blank space indicates no response was received from the jurisdiction.

5.2.4 EDUCATION AND OUTREACH

Education and outreach programs and methods are used to implement mitigation activities and communicate hazard-related information. Examples include obtaining certification in programs such as Firewise and StormReady; and developing and communicating hazard awareness and safety information to residents such as the recent implementation of CodeRed countywide.

Pike County has many informational resources available to the public. Planning documents, guides, and education and outreach publications discussed previously are available for review by the public on the Pike County Office of Community Planning website: https://www.pikepa.org/planning.html. For example, the Pike County Tick Borne Diseases Task Force has brochures, hand books and fact sheets posted on their website: https://www.pikepa.org/tick.html

The Pike County Conservation District places great emphasis on education and outreach efforts through the following:

- Classroom and community education programs
- Municipal workshops and outreach
- Environmental Education Project grants
- Pike/Wayne Envirothon
- Workshops, technical assistance and outreach to residents and businesses on environmental permitting
- Regular communication with local, state, and federal legislators regarding conservation issues.

The Pike County Conservation District provides outreach on groundwater and surface water quality, quantity, and protection to schools in the county. They have also been requested in the past to provide informational sessions on stormwater management.

In 2016, the Conservation District added an education/outreach coordinator to their staff who provides monthly newsletters, media releases, website updates, and information on social media on water/soil resource protection, stormwater mitigation, flooding, invasive species, etc. The District plans to hold at least three outreach efforts specifically for municipalities in 2017; one of which was held in February. In addition, the Conservation District has developed a user-friendly small projects guide to ensure anyone planning a construction project or any earth disturbance in the County is meeting all regulations.

The Pike County Conservation District works with PA DEP and USDA Natural Resources Conservation Service as well as private landowners on emergency permitting after disasters. The Conservation partnership covers Wayne and Pike County and includes government, non-profit organizations and others. They meet regularly to coordinate all outreach efforts and have actively pursued topics such as flooding, stormwater control, best management practices, and similar.

The Pike County Emergency Management Agency maintains Pike County's StormReady certification. Pike County made the strong commitment to implement measures to save lives and protect property when severe weather strikes. The program helps local leaders and residents better prepare for hazardous weather conditions. The Pike County Emergency Management Agency reaches out to residents to obtain assistance in monitoring the weather. Further, NOAA classes have been hosted by the county agency to teach residents how to properly monitor the weather and become more prepared in the future.

The Pike County Emergency Management Agency assisted Masthope and Hemlock Farms (private developments) to become Firewise communities. They continue to serve as the bridge between the PA Department of Conservation and Natural Resources and both Firewise communities and provide yearly training and assistance with necessary paperwork to Masthope and Hemlock Farms. In addition, the Pike County Emergency Management Agency works with the three school districts to review their emergency action plans and disaster response plans. Further, audits are conducted to ensure adequate backup power and water contingencies are in place so schools may serve as shelters. The agency is also involved in the three schools assisting with the emergency responder clubs and material development for classes.

The Pike County Road Task Force continues to coordinate winter operations with State, municipal and school district officials. They meet monthly and include County, municipalities, PennDOT, Conservation District as regular attendees. The task force also has a committee which meets yearly and brings in the school district representatives from throughout the county to prepare and address potential issues related to winter storms.

At the municipal level, education and outreach capabilities vary. Some municipalities have the capability to handle outreach initiatives while others rely on County resources. For example, Delaware Township hosted an emergency management open house on October 28, 2016 to discuss the Township's Emergency Operations Plan, personal preparedness and more. The Shohola Township Fire Department visits the local school in the fall for fire prevention month to discuss fire safety and hold a smoke trailer demonstration; in the spring, for 'Environmental Day' where forestry equipment and fire trucks are available for students to learn about.

All municipalities have a municipal website, with the exception of Greene Township. Several municipal websites post local plans and ordinances. Many post hazard information regarding hazard-related topics including, but not limited to, the following: preparedness, early warning siren systems (Matamoras), fire protection, invasive species, tick-bite prevention, hazardous materials disposal and how to register for the County's Code Red notification system. The local fire departments and local Emergency Managers are active in the schools participating in programs such as Fire Safety in the fall and attending other community activities to conduct outreach. Appendix D details the outreach and education conducted at the municipal level.

As noted earlier, watershed associations and other environmental advocacy groups can provide support such as the National Park Service, Lackawaxen River Conservancy, the Twin and Walker Creek Watershed Conservancy, the Twin Lakes Conservancy, the Delaware Highlands Conservancy, the Lake Wallenpaupack Watershed Management District, Pocono Source Water Protection Collaborative and Common Waters. These organizations can assist with education and outreach on important issues. Common Waters is an informal consortium that covers New York, New Jersey and Pennsylvania in the Upper Delaware Region. They have conducted education and outreach on forest habitats and the connection to water sources.

Table 5-6 summarizes the responses of the municipalities based on their education and outreach capabilities. Copies of the individual responses are found in Appendix D.

Table 5-6. Education and Outreach Capabilities

Jurisdiction	Firewise Certification	StormReady Certification	Natural disaster or safety-related school programs	Ongoing public education or information program (e.g., responsible water use, fire safety, household preparedness, environmental education)	Public-private partnership initiatives addressing disaster-related issues	Local citizen groups or non-profit organizations (focused on environmental protection, emergency preparedness, access and functional needs populations, etc.)	Other (website with mitigation information posted)
Blooming Grove Township	X	-	-	X	-*	X	X
Delaware Township	-	-	X	X	X	X	X
Dingman Township	-	-	X	X	-*		X
Greene Township	-	-	X	-	X	-	-
Lackawaxen Township	X	-		X			X
Lehman Township	-	-		X			X
Matamoras Borough	-	-	X	X	-*	X	X
Milford Borough	-	-	X	X	-*	-	X
Milford Township	-	-		X			X
Palmyra Township	-	-	X	X	X	X	X
Porter Township	-	-	-	X	X	-	X
Shohola Township	-	-	X	X	-		X
Westfall Township	-	-	-	X	-	-	X
Pike County	-	X	X	X	X	X	X

Notes:
"X" indicates that the jurisdiction currently has this capability in place.
"-" indicates not is currently in place.
DK indicates "don't know."
NA indicates the jurisdiction noted not applicable.
Blank space indicates no response was received from the jurisdiction.
Pike County is recognized by the National Weather Service as a StormReady county inclusive of all municipalities
** No formal partnership but the Borough works well with local businesses; for example, in Matamoras Borough Price Chopper has distributed water in the past.*

5.2.5 Plan Integration

According to FEMA, plan integration is a process where communities look critically at their existing planning framework and align efforts. Integration of hazard mitigation principles into other local planning mechanisms (comprehensive plans, transportation plans, floodplain ordinances, etc.) and vice versa is vital to build a safer, more resilient community. This two-way exchange of information supports community-wide risk reduction, both before and after disasters occur. Not only will the community's planning efforts be better integrated, but by going through this process there is a higher level of interagency coordination, which is just as important as the planning mechanisms themselves.

Within Pike County there are many existing plans and programs that support hazard risk management, and thus it is critical that this hazard mitigation plan integrate and coordinate with, and complement, those mechanisms.

During the Act 167 planning process in Pike County, Pike County Conservation District staff worked with municipal officials to identify problem areas and types. Eight (8) of the thirteen (13) municipalities in Pike County reported problem areas through a questionnaire distributed during Phase I planning and reviewed during Phase II of the Act 167 planning process. Field reconnaissance of the problem areas completed by the Conservation District staff occurred during Phase II to document existing conditions, assess problem locations, identify the general contributory drainage patterns and determine watershed divides. As part of the HMP update, municipalities utilized the results of the Act 167 planning process to identify unresolved problem areas and potential mitigation solutions; many of which included roadway flooding and insufficient drainage. Refer to Section 6 (Mitigation Strategy) which outlines the updated mitigation strategy for all plan participants.

The Pike County Emergency Management Agency utilized county and local emergency plans to compile information and update the HMP. For example, the evacuation plan was used to identify shelters for the critical facility inventory. According to the Pike County Emergency Management Director, all County plans are reviewed and updated on an annual basis. The HMP update will be utilized to update County emergency plans in the future.

It is the intention of Pike County and all municipalities to continue to incorporate mitigation planning into its planning tools through the HMP update goals, mitigation actions identified in this update, and utilization of the risk assessment results to support hazard awareness and risk management approaches. During the planning process of this HMP update, the Steering and Planning Committee members discussed how they will work with local government officials to integrate the newly adopted hazard mitigation goals and actions into the general operations of government and partner organizations. Further, the sample adoption resolution (Section 8) includes a resolution item stating the intent of the County and local governing body to adopt the Pike County Hazard Mitigation Plan as part of the Pike County Comprehensive Plan.

Incorporation of Existing Plans, Studies, Reports and Technical Information

The Pike County HMP update strived to use the best available technical information, plans, studies and reports throughout the plan process to support hazard profiling; risk and vulnerability assessment; review and evaluation of mitigation capabilities; and the identification, development and prioritization of county and local mitigation strategies.

The asset and inventory data used for the risk and vulnerability assessments is presented in the County Profile (Section 2). Pike County Geographic Information System (GIS) data was used as the foundation to the inventory development; however it was enhanced and corrected as part of the HMP process by the Steering Committee and municipal participants to provide the County a more robust inventory to utilize moving forward.

Best available data and technical information from local, state, and federal sources was utilized to develop the risk and vulnerability assessment, as presented in the Hazard Profiling and Risk Assessment Section (Section

4). Further, the source of technical data and information used may be found within Appendix A (Authorities and References).

Plans, reports and other technical information were identified and provided directly by the County, participating jurisdictions and numerous stakeholders involved in the planning effort, as well as through independent research by the planning consultant. The County and municipalities were tasked with updating the inventory of their Planning and Regulatory capabilities as presented above, and providing relevant planning and regulatory documents as applicable. Relevant documents, including plans, reports, and ordinances were reviewed to identify:

- Existing municipal capabilities;
- Needs and opportunities to develop or enhance capabilities, which may be identified within the County or local mitigation strategies;
- Mitigation-related goals or objectives, considered during the development of the overall Goals (see Section 6);
- Proposed, in-progress, or potential mitigation projects, actions and initiatives to be incorporated into the updated County and local mitigation strategies.

The following local regulations, codes, ordinances and plans were requested and, when available, reviewed during this plan process in an effort to develop mitigation planning goals, objectives and mitigation strategies that are consistent across local and regional planning and regulatory mechanisms; and thus develop complementary and mutually supportive plans, including:

- Comprehensive Plans
- Building Codes, Zoning and Subdivision Ordinances
- NFIP Flood Damage Prevention Ordinances
- Stormwater Management Plans
- Emergency Management and Response Plans
- Land Use and Open Space Plans
- Capital Plans
- Commonwealth of Pennsylvania Hazard Mitigation Plan

A partial listing of the plans, reports, and technical documents reviewed in the preparation of this plan is included in Table 5-7. Refer to Section 6 (Mitigation Strategy) and Section 7 (Plan Maintenance) which discusses in further detail the integration of mitigation into ongoing and future planning mechanisms in Pike County.

Table 5-7. Record of Review of Existing Programs, Policies and Technical Documents from Participating Jurisdictions

Existing plan, program or technical documents	Date	Jurisdictional Applicability
Blooming Grove Township Comprehensive Plan	2008	Blooming Grove Township
Blooming Grove Township Subdivision & Land Development Ordinance (No. 63)	June 20, 2011	Blooming Grove Township
Blooming Grove Township Zoning Ordinance (No. 62)	June 20, 2011	Blooming Grove Township
Blooming Gove Township Building Code	December 2, 1996	Blooming Grove Township
Blooming Grove Township Water Well Ordinance (No. 55)	Not Available	Blooming Grove Township
Blooming Grove Township Comprehensive Plan - maps	2008	Blooming Grove Township
Pike County Comprehensive Plan	November 2006	Countywide
Pike County's Open Space, Greenways, and Recreation Plan	2012	Countywide

Existing plan, program or technical documents	Date	Jurisdictional Applicability
Pike Outdoors: A Public Lands Guide for Sportsmen and Outdoor Enthusiasts	January 2012	Countywide
Growing…Naturally: The Pike County Open Space, Greenways, and Recreation Plan	August 2008	Countywide
Easement Purchase Program Manual	December 2009	Countywide
Pike County Scenic Rural Character Preservation Program - Grant Manual	December 21, 2011	Countywide
Northeastern Pennsylvania Metropolitan Planning Organization Long-Range Transportation Plan	March 2016	Countywide
Pike County Residential Developments	January 2010	Countywide
Sawkill Creek Watershed Act 167 Stormwater Management Plan	Date Unknown	Countywide
Lackawaxen River Watershed Act 167 Stormwater Management Plan	June 1994	Countywide
Regional Catastrophic Planning Team Housing Data and Report	2010	Countywide
Regional Catastrophic Planning Team Report	2011	Countywide
Cannonsville Dam Inundation Maps	2015	Countywide
Pike County COOP-COG	Not Available	Countywide
Delaware Township Floodplain Ordinance (102)	February 14, 2001	Delaware Township
Delaware Township Roads and Drainage Facilities (106)	September 10, 2014	Delaware Township
Delaware Township Zoning Ordinance (110)	May 29, 2013	Delaware Township
Delaware Township Subdivision and Land Development Ordinance (107)	September 10, 2014	Delaware Township
Planning Our Future - Delaware Township Comprehensive Plan	October 30, 2006	Delaware Township
Dingman Township Comprehensive Plan Update	1999	Dingman Township
Dingman Township Subdivision and Land Development Ordinance	September 16, 2014	Dingman Township
Dingman Township Zoning Ordinance	July 2, 2002	Dingman Township
Greene Township Subdivision and Land Development Ordinance	October 7, 2015	Greene Township
Greene Township Comprehensive Plan	April 2010	Greene Township
Lackawaxen Township and Shohola Township Multi-Municipal Comprehensive Plan	2009	Lackawaxen Township; Shohola Township
Lackawaxen Township Subdivision and Land Development Ordinance	July 15, 1992	Lackawaxen Township
Lackawaxen Township Zoning Ordinance	March 2001	Lackawaxen Township
Comprehensive Plan for Lehman Township	Date Unknown	Lehman Township
Lehman Township Open Space and Recreation Plan	January 2009	Lehman Township
Lehman Township Zoning Ordinance (No. 99)	June 17, 2004	Lehman Township
Lehman Township Flood Plain Ordinance (No. 93)	February 7, 2001	Lehman Township
Lehman Township Stormwater Management Ordinance (No. 104)	October 6, 2005	Lehman Township
Lehman Township Subdivision & Land Development Ordinance (No. 103)	October 6, 2005; Amended 2008	Lehman Township
Matamoras Borough and Westfall Township Comprehensive Plan and Open Space, Greenways and Recreation Plan	February 2011	Matamoras Borough; Westfall Township
Matamoras Zoning Ordinance	September 2008	Matamoras Borough
Milford Borough/Milford Township Comprehensive Plan	November 6, 2006	Milford Borough; Milford Township
Milford Borough Subdivision and Land Development Ordinance	June 5, 2000	Milford Borough

Existing plan, program or technical documents	Date	Jurisdictional Applicability
Milford Borough Zoning Ordinance	February 4, 2008	Milford Borough
Milford Township Subdivision and Land Development Ordinance	2004	Milford Township
Milford Township Zoning Ordinance	March 3, 2014	Milford Township
Palmyra Township Recreation and Open Space Plan	March 2006	Palmyra Township
Palmyra Township Comprehensive Plan	October 2009	Palmyra Township
Palmyra Township Subdivision and Land Development Ordinance	August 20, 2013	Palmyra Township
Palmyra Township Zoning Ordinance	August 20, 2013	Palmyra Township
Porter Township Comprehensive Plan	2010	Porter Township
Porter Township Zoning Ordinance	July 5, 2011	Porter Township
Shohola Township Building Ordinance	2004	Shohola Township
Shohola Township Zoning Ordinance	January 30, 2009	Shohola Township
Shohola Township Zoning Ordinance (Revised)	January 2016	Shohola Township
Shohola Township Subdivision and Land Development Ordinance	January 2012	Shohola Township
Westfall Ordinance Zoning Ordinance	September 2005	Westfall Township
Westfall Township Subdivision and Land Development Ordinance	November 2007	Westfall Township

Self-Assessment

Through the capability assessment surveys, all participating jurisdictions were further asked to provide a self-assessment of their jurisdiction's capability in the areas of planning and regulatory, administrative and technical, fiscal, community/political, and community resilience. Respondents evaluated their degree of capability in these areas as "Limited", "Moderate," or "High." Table 5-8 summarizes the results from municipalities within Pike County that completed capability self-assessment worksheets.

Table 5-8. Capability Self-Assessment Matrix

Municipality	Capability Category					
	Planning and Regulatory Capability	Administrative and Technical Capability	Fiscal Capability	Education And Outreach	Community Political Capability	Community Resiliency Capability
Blooming Grove Township	Limited	Limited	Limited	Limited	Moderate	Limited
Delaware Township	Moderate	Limited	Moderate	Moderate*	Moderate	Limited
Dingman Township	High	Moderate	High	Moderate	Moderate	High
Greene Township	Moderate	Limited	Moderate	Limited	Moderate	Limited
Lackawaxen Township	Moderate	High	Moderate		Moderate	High
Lehman Township	High	High	High		Limited	Limited
Matamoras Borough	Moderate	High	High	Limited	Moderate	Moderate

Municipality	Capability Category					
	Planning and Regulatory Capability	Administrative and Technical Capability	Fiscal Capability	Education And Outreach	Community Political Capability	Community Resiliency Capability
Milford Borough	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Milford Township	Moderate	Moderate	Moderate		Moderate	Moderate
Palmyra Township	Limited	Limited	Limited	Limited	Limited	Limited
Porter Township	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Shohola Township	Limited	Limited	Limited	Moderate	Moderate	Moderate
Westfall Township	Limited	Limited	Limited	Limited	Limited	Limited
Pike County	Moderate	High	Limited	Moderate	Moderate	Limited

Notes:
"-" indicates no capability is currently in place.
Blank space indicates no response was received from the jurisdiction.
**Limited specifically for mitigation, but moderate for response and recovery emergency management phases.*

Detailed information regarding the municipalities' capabilities self-assessments can be found in the survey responses provided in Appendix D.

SECTION 6 MITIGATION STRATEGY

This section describes the process by which the Pike County Planning Team will reduce or eliminate potential losses from the natural and non-natural hazards identified in Section 4.2 of this HMP. The mitigation strategy focuses on existing and potential future mitigation actions to alleviate the effects of hazards on Pike County's population, economy, and general building stock.

This section provides a summary of the 2017 HMP update process, outlines the mitigation goals and objectives set forth in the 2017 HMP update, describes the process for identifying and analyzing mitigation techniques, and provides the mitigation action plan.

6.1 UPDATE PROCESS SUMMARY

The goals and objectives listed in the Pike County HMP were first examined through the dispersal of the Mitigation Strategy 5-Year Plan Review Worksheet (Mitigation Review Worksheet). During the 5-year review, the Planning Team members were afforded the opportunity to comment on the goals, objectives, and actions that were listed in the existing HMP.

The general mitigation planning approach used to develop this plan is based on (1) the Federal Emergency Management Agency (FEMA) publication, "Local Mitigation Planning Handbook," as well as (2) the Pennsylvania All-Hazard Mitigation Planning Standard Operating Guide (SOG):

1. **Review of Existing Mitigation Plan Goals, Objectives and Mitigation Action Plan:** Existing mitigation goals and objectives, and the 2012 HMP mitigation actions were first examined at the Kick-Off Meeting and revisited during the Mitigation Strategy Meeting; both meetings were open to members of the Planning Team and stakeholders. The Steering Committee thoroughly reviewed and updated the mitigation goals and objectives utilizing the latest information gathered through the hazard profiles, vulnerability assessments, and the risk assessment; they were also compared to the State HMP goals and objectives. The updated goals and objectives were then presented at the Mitigation Strategy Meeting for final review and approval. Plan participants continued to review and provide progress on the 2012 mitigation actions throughout the planning process.
2. **Develop and Update Mitigation Strategies:** Mitigation actions were identified based on the risk assessment, mitigation goals and objectives, existing policies, and input from the Planning Team and planning partners.
3. **Mitigation Strategy Prioritization and Implementation:** The potential mitigation actions were qualitatively evaluated and described in more detail in Section 6.4 of this HMP. Mitigation actions were prioritized into three categories: high, medium, and low. High-priority and medium-priority mitigation actions are recommended for implementation before low-priority actions; however, based on County and municipal-specific needs, cost estimation, and available funding, some low-priority mitigation actions may be addressed first.
4. **Document the Mitigation Planning Process:** The entire mitigation planning process is documented throughout this HMP, particularly in Section 3.

This section summarizes past mitigation goals, past mitigation action status and provides an update of mitigation strategies, and additional past mitigation accomplishments.

6.1.1 Review of the Past Mitigation Goals

The mitigation goals identified in the 2012 version of the HMP are listed below:

- **Goal 1:** Provide for properly managed and environmentally sound growth and disaster-resistant development.
- **Goal 2:** Reduce the potential impact of natural and human made hazards on property.

- **Goal 3:** Enhance and improve emergency services provided to the growing population of Pike County.
- **Goal 4:** Reduce vulnerability including loss of life and damage to assets from natural and human-made hazards.
- **Goal 5:** Conserve, protect, and enhance existing natural and water resources.
- **Goal 6:** Increase awareness, understanding, and preparedness across all sectors by encouraging hazard risk, preparedness, and mitigation related education and outreach activities.

6.1.2 Past Mitigation Action Status and Update of Mitigation Strategies

In the 2012 HMP, Pike County identified 87 actions and initiatives to support an improved understanding of hazard risk and vulnerability and to enhance mitigation capabilities. Progress on the 2012 mitigation actions was evaluated during the 2017 update process.

Pike County, via various representatives on the Steering Committee and Planning Team, was provided with a Mitigation Review Worksheet identifying all of the County and municipal actions and initiatives from the 2012 HMP. The respondents were asked to indicate the status of each action ("No Progress/Unknown," "In Progress/Not Yet Complete," "Continuous," "Completed," or "Discontinued"), and provide review comments on each.

The completed Mitigation Action Plan Review Worksheet is provided in Table 6-1. Projects and initiatives identified as "Complete" and "Discontinued" have been removed from this plan update. The actions that the County has identified as "No Progress/Unknown," "In Progress/Not Yet Complete," or "Continuous" have been carried forward in the updated mitigation strategies identified in Table 6-4 (unless otherwise determined by the County to be a discontinued project). The language in some actions being carried over has been adjusted to reflect changes to County needs and capabilities. Some actions were also merged to reduce redundant efforts on behalf of the County and its municipalities.

Table 6-1. Past Mitigation Action Status

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Pike County							
Pike County Office of Community Planning	Action 1: Complete and implement Phase II of the Countywide Stormwater Management Plan (Act 167 Plan)					Discontinued in 2010 – Final Draft Plan presented at public meeting and met with public opposition. Redraft after public meeting – no further action.	Continue education/outreach among local officials as to the benefits of implementing this plan. New lead is Pike County Conservation District (Office of Community Planning will support)
Pike County Office of Community Planning; Pike County EMA; Pike County GIS Office	Action 2: Assess 2000 Countywide FIRMs and make recommendations to FEMA for critical areas for next FIRM update.				X – Updated FIRMs effective October 6, 2000		

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Pike County Office of Community Planning; Pike County EMA	Action 3: Implement groundwater level wells monitoring to assess potable groundwater levels in drought periods.			In progress; Started in 2007 and grant funding awarded and extended through 2018			Continue on-going groundwater level monitoring through 2018 to assess potable groundwater level giving 10-years of data for drought trigger analysis. New lead agency is Pike County Conservation District.
Pike County EMA, DCNR	Action 26: Work with municipalities to become "Storm Ready" and "Firewise" communities			X On-going action for Firewise; Pike County EMA actively works with the Pocono Environmental Education Center to get more communities involved in Firewise	X Pike County is now a StormReady County.		Include in the 2017 HMP update and modify action as follows; Pike County EMA to continue working with Pocono Environmental Education Center and municipalities to participate in Firewise.
Pike County and All Municipalities	Action 29: Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials			X This is a very active task force that meets monthly; stakeholders attend (e.g, PennDOT).			Include in HMP update as is.

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Pike County Office of Community Planning	Action 30: Utilize the County's Marcellus Shale task force to prepare for and educate municipalities about updating ordinances and proper permitting for Marcellus Shale gas wells			On-going; Conservation District participates regarding permitting and education. The Delaware River Basin Commission implementation of Marcellus Regulations within basin is on hold.			Include in 2017 HMP as is.
Pike County Office of Community Planning; Pike County EMA	Action 32: Develop a Pandemic Plan to assess the threat of pandemics in the County and prepare for them.			X Incorporating the State's Pandemic Plan into the County's Plan		Currently a capability of Pike County EMA and will continue to update as needed. No separate action needed in 2017 HMP update.	

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Pike County Office of Community Planning	Action 33: Work with communities to adopt DCED model floodplain ordinance which exceeds NFIP standards by: • Prohibiting manufactured homes in the floodway. • Prohibiting manufactured homes within the area measured 50 feet landward from the top-of bank of any watercourse within a special flood hazard area. • Including special requirements for recreational vehicles within the special flood hazard area. • Including special requirement for accessory structures. Prohibiting new construction and development within the area measured 50 feet landward from the top-of bank of any watercourse within a special flood hazard area.				X The Pike County Conservation District worked with municipalities and DCED in 2001-2002 to update all municipal floodplain ordinances to meet NFIP standards and included updated FEMA maps.		
Pike County Office of Community Planning	Action 34: Increase awareness of and participation in FEMA's Community Rating System (CRS) Program.	X					Carry forward as is; Conservation District can assist

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Pike County Office of Community Planning	Action 35: Work with municipalities to provide performance standards in local land use ordinances for development projects particularly in hazard areas			X Pike County Office of Community Planning comments on any incoming stormwater or flooding plans if there is a concern or a deficiency.			New action revised: Promote or adopt higher regulatory and zoning standards to manage hazard risk; specifically, through updates to the building codes, flood ordinances, and subdivision and land development ordinances. Goals of increased standards are to ensure new buildings and infrastructure are discouraged or prohibited in high-hazard areas in their jurisdiction.
Pike County EMA	Action 36: Develop a County Task Force to identify ways to incentivize volunteer fire fighting, address equipment and facility upgrades, provide training opportunities for emergency service providers, and upgrade EMS service in eastern and central areas of Pike County			X			Include in 2017 HMP as is.

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Pike County EMA	Action 37: Work with watershed associations and municipal officials to coordinate water conservation and sewage management programs in local communities.			X Pike County Conservation District works regularly with watershed organizations; and coordinated the formation of the Pocono Source Water Protection Collaborative in 2013 to assist with groundwater (potable water) protection from potential contamination sources and provide education/outreach on same.			Include in the 2017 HMP update. This is an on-going action. Conservation District can co-lead this action.

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Pike County Office of Community Planning; Pike County EMA	Action 38: Work with partner organizations to develop informational releases about hazard mitigation for newspapers, websites, circulars, and property owners association newsletters			X – Pike County Office of Community Planning is working on tick-borne diseases, drug take-back boxes in pharmacies, and the drug use issues. The Conservation District added an education/outreach coordinator to staff in 2016 who provides monthly newsletters, medial releases, website updates, and information on social medial on water/soil resource protection, stormwater mitigation, flooding, invasive species, etc.			This is an on-going action to be included in the 2017 HMP update. Conservation District can assist with this. Identify and coordinate with appropriate partners and agencies to arrange for data collection of flood and structure data necessary to perform a level 2 HAZUS analysis for the next hazard mitigation plan update. Building data may be collected as part of reassessment of Pike County properties. (i.e. Building Value, Lowest Floor Elevation, Building Type, Occupancy Type, Foundation Type, Number of Stories and Square Footage).

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Pike County Office of Community Planning; Pike County EMA	Action 39: Work with the municipalities to develop educational materials regarding the risk of drowning to distribute to resorts, hotels, and other vacation areas	X – due to funding/staffing limitations		X National Park Service has an active Campaign in this regard			Include in the 2017 HMP update.
Pike County school districts; Pike County EMA	Action 40: Seek school district participation in the U.S. Department of Education's "shake-out drills"					The Pike County EMA no longer conducts shake-out drills with the school districts; discontinue action.	
Pike County Commissioners	Action 45: Continue annual inspections and necessary maintenance and repairs at Kintz Creek Dam, Skyview Lake Dam, and the Taylor Pond Dam.			This is an ongoing action; annual inspections are conducted by the County.			Include in the 2017 HMP update. Modify action as follows: Pike County to continue working with USDA Natural Resources Conservation Service to design and rehabilitate Kintz Creek Dam.

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Pike County Office of Community Planning; Pike County EMA	Action 46: Identify and coordinate with appropriate partners and agencies to arrange for data collection of flood and structure data necessary to perform a level 2 HAZUS analysis for the next hazard mitigation plan update (i.e. Building Value, Lowest Floor Elevation, Building Type, Occupancy Type, Foundation Type, Number of Stories and Square Footage).		X As part of this HMP update, a critical facility update was completed and integrated into HAZUS-MH.				Carry forward to update and may be included in next plan update; add that building attributes may be collected as part of Pike County reassessment of properties.
Delaware Valley School District, East Stroudsburg Area School District, Wallenpaupack Area School District, Office of Community Planning; Pike County EMA	Action 47: Work with three school districts in Pike County to develop a list of mitigation actions for school facilities to include in the next HMP update.			X Evaluation emergency action plans on annual basis; work hand-in-hand with the three school districts. If anything missing, advise districts.			Include in HMP update but combine with Actions 48 and 49 as follows: Pike County EMA to continue to work with the three school districts on the following: 1. Annual review of emergency action plans and disaster response plans 2. Conduct audits and ensure adequate back-power and water contingencies are in place so they may serve as shelters

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Delaware Valley School District, East Stroudsburg Area School District, Wallenpaupack Area School District, Office of Community Planning; Pike County EMA	Action 48: Work with three school districts in Pike County to ensure that their disaster response plans are made available to the County Communications Center on an annual basis and that they are up to date.			X			Include in HMP update; Combine with Actions 47 and 49 as noted above.
East Stroudsburg Area School District; Pike County EMA	Action 49: Inspect and audit school facilities to determine that adequate emergency power and emergency water systems are in place so that school facilities can function as emergency shelters during hazard events.			X			Include in HMP update; Combine with Actions 47 and 48 as noted above.
Wallenpaupack Area School District, Pike County EMA	Action 50: Install a dry hydrant on the access road between the school campus and Lake Wallenpaupack.					X A drill was conducted there three years ago and results determined that this is no longer needed.	
Delaware Valley School District, Pike County EMA	Action 51: Install a new radio communication system on campus to communicate early warning information about hazards and emergency information between all campuses and offices.				X – The Delaware Valley School District has a system in place and funded themselves.		

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Pike County Office of Community Planning; Pike County EMA	Action 52: County to work with municipalities to develop databases to track development in the Special Flood Hazard Area (SFHA).			X			Include in 2017 update.
Pike County Office of Community Planning; Pike County EMA	Action 53: Hold a workshop to educate and train municipalities about annual FEMA funding sources and the grant application process.			X Pike County EMA provides information on funding sources regularly to municipalities.			Include in 2017 HMP update.
Blooming Grove Township							
Municipality	Action 5: Install new box culvert at TR342 - Tarkill Creek	X				X This is DCNR Property	

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Municipality	Action 6: Clean up debris in Blooming Grove Creek and Shohola Creek	BGC is the responsibility of the State - Unknown progress; Shohola Creek, or part of it, was cleaned up in 2015 when the State replaced the bridge on Route 739, just north of Route 84, with a new and longer bridge. During that construction, the creek flowing near and under the bridge was cleaned and widened.				X - BGC is the responsibility of the State - Unknown progress;	
Municipality	Action 22: Continue to target and prioritize at-risk structures for acquisition, relocation, and elevation					X	Blooming Grove does not have any RL or SRL properties. Include in 2017 HMP update as revised action BG-04.

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Pike County and All Municipalities	Action 29: Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials			X This active task force meets on a monthly basis.			Include in the 2017 HMP update (BG-01).
Delaware Township							
Municipality	Action 12: Conduct an Engineering Study of bridges and culverts on Park Road				X Culvert was replaced; Bridge due for inspection		
Emergency Services	Action 13: Purchase portable generators for support of reception centers in private communities during evacuations, isolation, and utility interruptions				X – This was completed via Northeast Terrorism Task Force (State funding).		Include in the 2017 (DE-06).
Emergency Services	Action 14: Complete an Emergency Access Roads Engineering Study to ensure viability of response to communities during hazard events	X					There are ownership and right-of-way issues. Access is on private or state property (DCNR). Refer to updated action DE-03.

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Municipality	Action 22: Continue to target and prioritize at-risk structures for acquisition, relocation, and elevation			X			No properties identified to mitigate at this time. The Township continues to provide this option to its residents. Include in 2017 HMP (DE-07).
Pike County and All Municipalities	Action 29: Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials			X This active task force meets on a monthly basis.			Include in the 2017 HMP update (DE-05).
Dingman Township							
Municipality	Action 10: Mitigate repetitive loss properties within the municipality.			X			The Township will continue to support the mitigation of vulnerable properties. Include as revised action in 2017 HMP update (refer to DI-03).
PennDOT and Municipality	Action 15: Conduct improvements on State-Owned roads that are repeatedly flooded					X Township does not have jurisdiction over state-owned roads.	

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Municipality	Action 22: Continue to target and prioritize at-risk structures for acquisition, relocation, and elevation			X			No properties identified to mitigate at this time. The Township continues to provide this option to its residents. Include in 2017 HMP (refer to DI-03).
Municipality	Action 23: Install a box culvert on TR 430 Tunnel Road	X					Include in 2017 HMP as revised action (DI-01).
Municipality	Action 27: Complete stormwater and flooding projects submitted for inclusion in Phase II of the Countywide Act 167 Plan.	X				X	No plan has been adopted to date.
Pike County and All Municipalities	Action 29: Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials			X This active task force meets on a monthly basis.			Include in the 2017 HMP update (refer to DI-04).
Greene Township							

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Municipality	Action 7: Investigate ways to mitigate flooding on Mountain View Road			X - Greene Township and Pike County Conservation District funded several projects through Dirt Gravel and Low Volume (DGLV) Road Program and Conservation District provided technical assistance to the Township. Several reports on Mountain View Road have been completed since 2010. There are other sections on Newfoundland end of road that experience flooding.			Include in 2017 and modify as follows: Investigate ways to mitigate roadway flooding including Mountain View Road (refer to G-03).
Municipality	Action 16: Elevate Old Greentown Road and enlarge sluice pipe				X		

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Municipality	Action 17: Repair, replace, or enlarge pipes in Beaver Dam, Bartelson, Old Greentown, Saw Mill, Mozzette, Mt. View, Misery, Lake Russell, and Creamery Roads.			Pike County Conservation District is working with the Township on a number of these roads; Dirt Gravel and Low Volume (DGLV) Road funding may be appropriate. Pike County Conservation District is providing technical assistance.			Completed Beaver Dam, Bartleson, Old Greentown, and Mozzette Road, working on others. Refer to G-05
Municipality	Action 22: Continue to target and prioritize at-risk structures for acquisition, relocation, and elevation			X			Include in 2017 HMP update as G-04.
Municipality	Action 27: Complete stormwater and flooding projects submitted for inclusion in Phase II of the Countywide Act 167 Plan.			X			
Pike County and All Municipalities	Action 29: Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials			X This active task force meets on a monthly basis.			Include in the 2017 HMP update as G-02.
Lackawaxen Township							

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Municipality	Action 10: Mitigate repetitive loss properties within the municipality.			X			Include in 2017 HMP update to support the mitigation of vulnerable structures (LA-02).
Municipality	Action 22: Continue to target and prioritize at-risk structures for acquisition, relocation, and elevation			X			Include in 2017 HMP update to support the mitigation of vulnerable structures (LA-02).
Municipality	Action 28: Install two additional warning sirens on the Lackawaxen River				X		Sirens are present on the river – Gelderman Flats, Hemlocks Route 590
Pike County and All Municipalities	Action 29: Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials			X Township crew checks water conditions and utilizes the weather channel			Include in the 2017 HMP update (LA-01).
Municipality	Action 31: Install water level detectors (stream gauges) on two bridges on the Lackawaxen River				X		
Lehman Township							

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Municipality	Action 22: Continue to target and prioritize at-risk structures for acquisition, relocation, and elevation			X			Include in 2017 HMP update to support the mitigation of vulnerable structures (LE-02).
Municipality	Action 27: Complete stormwater and flooding projects submitted for inclusion in Phase II of the Countywide Act 167 Plan.			X			Refer to LE-03
Pike County and All Municipalities	Action 29: Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials			X This active task force meets on a monthly basis.			Include in the 2017 HMP update (LE-01).
Township EMC; Home Owners Associations	Action 42: Increase public awareness of residents about flooding hazards through articles in Township and private community newsletters			X Township continues to conduct outreach; no action needed			
Township Board of Supervisors	Action 43: Implement Stormwater BMPs along Mink Pond Road				X Township paid for this work; installed drainage ditches and new culverts		

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Township Board of Supervisors	Action 44: Conduct stormwater management engineering study for Winona Falls Road / Lehman Community Park and implement recommendations				X Township completed study and all stormwater work; they had a grant from State for the community Park		
Matamoras Borough							
Municipality	Action 8: Install a 6' Dike and Bulkhead at Avenue R and 10th Street - Airport Park.					X This project is no longer a priority for the Borough. Discontinue.	
Municipality	Action 9: Raise the Delaware River Bank from Route 84 to the Mid Delaware Bridge, including Flood Gates					X This project is no longer a priority for the Borough. Discontinue.	

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Municipality	Action 19: Secure evacuation shelters to provide locations for the safety of Township residents during hazard events			X			We currently have two shelters that are certified by the Red Cross as evacuation centers. The new elementary school opened this fall in the Borough. It features a full cafeteria with kitchen and a large gymnasium. The Borough is working with the school district to gain permission to use this facility as an evacuation shelter. Once we receive the district's ok, we will ask the Red Cross to certify the location.
Municipality	Action 22: Continue to target and prioritize at-risk structures for acquisition, relocation, and elevation					X	Include new action in the 2017 HMP to support the mitigation of vulnerable structures (MA-01).

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Municipalities (Matamoras and Westfall), DRBC, USACOE	Action 24: Clean up islands of debris in the Delaware River near Benny Kill, on Mashipacong Island, and south of the I-84 bridge that resulted from high water and flooding in order to prevent future water blockages that create flooding and ice jams					Our DPW does not have the proper equipment or training to clean up debris in the river. Further, permits are required for this work. Discontinue.	
Municipality	Action 25: Purchase and install a camera system to monitor the Delaware River at different locations					X	
Pike County and All Municipalities	Action 29: Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials			X This active task force meets on a monthly basis.			Include in the 2017 HMP update (MA-03).
Milford Borough							
Municipality	Action 21: Replace and upgrade storm water system catch basins and covered piping in the Borough						Include in 2017 HMP as new action: Work County to integrate the location and attributes of the stormwater system into GIS; identify areas in need of replacement and upgrades (MB-02).

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Municipality	Action 22: Continue to target and prioritize at-risk structures for acquisition, relocation, and elevation					The Borough will discontinue this project as it does not apply; however the Borough will include a new mitigation action to support the mitigation of properties (refer to new action MB-03).	
Pike County and All Municipalities	Action 29: Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials			X The Borough Streets Department (two individuals) work with the county on winter preparedness; and maintain vehicles and equipment for snow removal. This is an ongoing action.			Include in the 2017 HMP update (MB-01).
Milford Township							

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Municipality	Action 22: Continue to target and prioritize at-risk structures for acquisition, relocation, and elevation			X			The Milford Township Building Inspector (Code Enforcement Officer) examines first floor elevations when inspecting new buildings. Include in 2017 HMP update as support the mitigation of vulnerable structures (MT-02).
Pike County and All Municipalities	Action 29: Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials			X On the third Thursday of each month there is a Road Task Force Meeting and Milford Township has their road master go and participate.			Include in the 2017 HMP update (MT-01).
Municipality	Action 41: Purchase an emergency backup generator				X Milford Township purchased an emergency backup generator for the Township building (shelter)		

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Palmyra Township							
Municipality	Action 4: Clean debris from Wallenpaupack Creek.					X Wallenpaupack Creek exists only as part of Lake Wallenpaupack when the dam is opened; otherwise an empty channel. Remove action.	
Municipality	Action 22: Continue to target and prioritize at-risk structures for acquisition, relocation, and elevation	X				X	
Municipality	Action 27: Complete stormwater and flooding projects submitted for inclusion in Phase II of the Countywide Act 167 Plan.	X				167 Funding discontinued/not available. No projects identified at this time.	
Pike County and All Municipalities	Action 29: Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials			X This active task force meets on a monthly basis.			Include in the 2017 HMP update (PA-01).
Porter Township							
Municipality	Action 10: Mitigate repetitive loss properties within the municipality.			X			Include in the 2017 HMP update as a revised action to support the mitigation of vulnerable structures (new action PO-02).

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Municipality	Action 18: Replace culvert on Whittaker Road		Pike County Conservation District working with the Township through Dirt Gravel and Low Volume (DGLV) Road Program to assess if eligible for funding. The Conservation District visited the site in November 2016 to assess stream and culverts for eligibility under funding source.				Include in 2017 HMP. Refer to updated action PO-01.
Municipality	Action 22: Continue to target and prioritize at-risk structures for acquisition, relocation, and elevation			X			Include in the 2017 HMP update as a revised action to support the mitigation of vulnerable structures (new action PO-02).

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Pike County and All Municipalities	Action 29: Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials			X This active task force meets on a monthly basis.			Include in the 2017 HMP update (new action PO-06).
Shohola Township							
Municipality	Action 11: Replace Aumueller Bridge with a new bridge that will not get washed out.	X				This is a County-owned bridge that was stabilized a few years ago. The Township does not have jurisdiction.	
Municipality	Action 22: Continue to target and prioritize at-risk structures for acquisition, relocation, and elevation	X – The Township does not maintain a list of properties to mitigate.					Include in the 2017 HMP update to support the mitigation of properties (revised action S-04).
Municipality	Action 27: Complete stormwater and flooding projects submitted for inclusion in Phase II of the Countywide Act 167 Plan.	X – No projects completed to date that the Township is aware of. No projects identified at this time.					
Pike County and All Municipalities	Action 29: Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials			X This active task force meets on a monthly basis.			Include in the 2017 HMP update (new action S-01).

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Westfall Township							
Municipality	Action 9: Raise the Delaware River Bank from Route 84 to the Mid Delaware Bridge, including Flood Gates	X				X Nothing progressed to date. Other projects identified in 2017 HMP update to mitigate flooding	
Municipality	Action 10: Mitigate repetitive loss properties within the municipality.		X				X New lead is Westfall Township Road Master; Updated action will be to support the mitigation of properties. Future projects will be accomplished as funds become available (new action W-09).

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Municipality	Action 22: Continue to target and prioritize at-risk structures for acquisition, relocation, and elevation		X				Road Master and Emergency Management Coordinator. Updated action will be to support the mitigation of properties. Future project will be accomplished as funds become available (new action W-09).
Municipalities (Matamoras and Westfall), DRBC, USACOE	Action 24: Clean up islands of debris in the Delaware River near Benny Kill, on Mashipacong Island, and south of the I-84 bridge that resulted from high water and flooding in order to prevent future water blockages that create flooding and ice jams			X Maintenance is continuus	This project was completed by USACE. Matamoras, Port Jervis and Westfall Township are now responsible to maintain the channel which is inspected by the DRBC every two years.		

Jurisdiction/ Responsible Party	2012 Mitigation Action	Status 1. Please describe what was accomplished and indicate % complete. 2. If there was no progress, indicate what obstacles/delays encountered? 3. If there was progress, how is/was the action being funded (e.g., FEMA HMGP grant, local budget)?					Describe Next Step 1. Including in 2017 HMP? Revise/reword (e.g., to be more specific or change lead agency. 2. If discontinue, explain why.
		No Progress/ Unknown	In Progress/ Not Yet Complete	Continuous	Completed	Discontinued	
Municipality	Action 27: Complete stormwater and flooding projects submitted for inclusion in Phase II of the Countywide Act 167 Plan.			X			Include in 2017 HMP update. The new lead is Road Master and Emergency Management Coordinator; Future project will be accomplished as funds become available
Pike County and All Municipalities	Action 29: Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials			X			Include in 2017 HMP update. The new lead is Westfall Township Road Master (new action W-11).

X = Indicates the status response received from the jurisdiction. If additional details were provided, they are included in the table cell as well.

6.1.3 Additional Past Mitigation Accomplishments

Pike County and its municipalities are dedicated to mitigation activities and comprehensive all-hazards planning. To that end, the County has engaged in mitigation activities beyond those identified in its 2012 HMP. The County and its municipalities have demonstrated a proactive approach, commitment to resiliency, and desire to protect both physical assets and citizens against hazard losses through the following additional accomplishments:

- Pike County upgraded to using CodeRED, a system to alert residents in the event of a weather emergency or road closure.
- CDBG funding was utilized to complete the following mitigation projects:
    - Fire communications tower in Greene Township
    - Emergency generator for Matamoras Borough
    - Improvements to the Shohola Township and Milford Borough Fire Houses
- Several projects funded through the Pennsylvania Dirt Gravel and Low Volume Roads Program
- Establishment of the Pike County Tick-Borne Diseases Task Force
- Pike County, under the leadership of Pike County Board of Commissioners, initiated the drug-take box in local private pharmacies; previously residents needed to go to hospitals or police stations to drop-off unused medications
- Dingman Township is conducting outreach on the Township website and on social media to encourage residents to register for CodeRED.
- Lackawaxen Township is developing an ordinance for the safe installation of generators at private residences.
- Westfall Township is conducting outreach on social media to purchase NFIP flood insurance and posted on the website to encourage residents to register for CodeRED.
- Westfall Township completed the following flood mitigation projects identified in their Act 167 Study:
    - Increased the pipe capacity of the Decker Road and Heaters Hill Road pipe crossings (FEMA grants).
    - The Township Engineer and Road Master are reviewing a study to determine the best action to address the eroding slope of the Bush Kill Creek near Bluestone Boulevard (Pike County Conservation District grant).
    - Cleaning of box culverts on Mountain Avenue.

6.2 MITIGATION GOALS AND OBJECTIVES

This section describes the mitigation goals and objectives set forth in the 2017 HMP update.

6.2.1 2017 Mitigation Goals

The Steering Committee reviewed the 2012 HMP goals during a February 2017 Steering Committee meeting to determine their continuing applicability to County mitigation needs. After careful and deliberate discussion, the Steering Committee determined that the goals would be carried over to the 2017 update with changes or enhancements made to the wording. The updated goals and objectives were distributed to the Planning Team at the March 8, 2017 Mitigation Strategy Workshop. The Planning Team reviewed and approved the updated goals for the 2017 HMP. The 2017 County HMP goals are in line with State mitigation goals, embody the overarching needs and concerns of the County and participating municipalities, and address both natural and non-natural hazard risk reduction. The 2017 County HMP goals are listed below:

1. **Goal 1:** Provide for properly managed and environmentally sound growth and disaster-resistant development.
2. **Goal 2:** Reduce the potential impact of natural and human made hazards on property.
3. **Goal 3:** Enhance and improve emergency services provided to the growing population of Pike County.
4. **Goal 4:** Reduce vulnerability including loss of life and damage to assets and the environment from natural and human-made hazards.
5. **Goal 5:** Conserve, protect, restore and enhance existing natural systems and water resources that serve a natural hazard mitigation function.
6. **Goal 6:** Increase awareness, understanding, and preparedness across all sectors by encouraging hazard risk, preparedness, and mitigation related education, training and outreach activities.

6.2.2 2017 Mitigation Objectives

The goals listed above were used to develop relevant objectives. The objectives address the results of the vulnerability assessment in more specific terms and reflect the possible effects that can be mitigated for the identified hazards, as well as existing limitations in available data and information. The objectives were originally identified during the 2012 HMP update process were reviewed by the Steering Committee and updated during the February 2017 meeting to reflect changes in County priorities and capabilities since the last plan update. The revised and updated objectives were presented to the Planning Team and finalized at the March 2017 Mitigation Strategy Workshop. Objectives related to each of the goals are listed below and Table 6-2 summarizes the evaluation of all goals and objectives.

1. **Goal 1:** Provide for properly managed and environmentally sound growth and disaster-resistant development.
    a. **Objective 1.1:** Provide for better stormwater and floodplain management planning and implementation.
    b. **Objective 1.2:** Encourage and facilitate the development or revision of comprehensive plans and zoning/land-use ordinances to consider limiting development in high-hazard areas and reducing its impact.
2. **Goal 2:** Reduce the potential impact of natural and human made hazards on property.
    a. **Objective 2.1:** Identify and implement cost-effective structural and property protection projects to reduce the impacts from flooding including acquisition, elevation and relocation projects.
    b. **Objective 2.2:** Ensure that existing drainage systems such as pipes, culverts and channels are adequate and functioning properly.
    c. **Objective 2.3:** Maintain and enhance local regulatory standards with new hazard and risk information including full and effective building code enforcement, floodplain management, land use planning mechanisms and other natural hazard vulnerability-reducing regulations.
3. **Goal 3:** Enhance and improve emergency services provided to the growing population of Pike County.
    a. **Objective 3.1:** Enhance early notification systems and communication infrastructure to provide residents with adequate warning and information regarding all hazards.

   b. **Objective 3.2:** Ensure continuity of operations and adequate supplies for emergency response services, critical facilities and infrastructure.

4. **Goal 4:** Reduce vulnerability including loss of life and damage to assets and the environment from natural and human-made hazards.
   a. **Objective 4.1:** Identify and implement cost-effective mitigation projects to reduce flooding, reduce/eliminate sewage leakage and inflow/infiltration problems.
   b. **Objective 4.2:** Identify and evaluate the need for warning systems and storm shelters.
   c. **Objective 4.3:** Identify and implement initiatives to address existing and/or emerging public health and wellness concerns.
   d. **Objective 4.4:** Increase local government official awareness regarding mitigation funding opportunities to reduce vulnerability.
5. **Goal 5:** Conserve, protect, restore and enhance existing natural systems and water resources that serve a natural hazard mitigation function.
   a. **Objective 5.1:** Provide appropriate safeguards for the preservation of the quality of water resources, stream corridors, watershed areas, and floodplains.
   b. **Objective 5.2:** Ensure and maintain the natural drainage patterns and stream and waterway corridors to the greatest extent practicable to provide for properly functioning systems that assist with the reduction of flooding.
   c. **Objective 5.3:** Increase coordination with owners of upstream water control structures to ensure life and property protection in Pike County.
6. **Goal 6:** Increase awareness, understanding, and preparedness across all sectors by encouraging hazard risk, preparedness, and mitigation related education, training and outreach activities.
   a. **Objective 6.1:** Develop partnerships both at the local, state and federal government level as well as with local business, private communities, civic and volunteer organizations and other appropriate non-traditional partners to continue to develop a County-wide approach to identifying and implementing mitigation actions.
   b. **Objective 6.2:** Develop and distribute public awareness materials about natural hazard risks, preparedness, and mitigation.

Table 6-2. Steering and Planning Team Evaluation of 2012 Goals and Objectives

2012 Pike County Hazard Mitigation Plan Goals and Objectives		Evaluation
Goal 1	Provide for properly managed and environmentally sound growth and disaster-resistant development.	Keep as is; still applies.
Objective 1.1	Provide for better stormwater and floodplain management planning and implementation.	Keep as is; still applies.
Objective 1.2	Encourage and facilitate the development or revision of comprehensive plans and zoning/land-use ordinances to consider limiting development in high-hazard areas and reducing its impact.	Keep as is; still applies.
Goal 2	Reduce the potential impact of natural and human made hazards on property.	Keep as is; still applies.
Objective 2.1	Identify and implement structural and property protection projects to reduce the impacts from flooding including acquisition, elevation and relocation projects.	Objective was enhanced to include the words 'cost-effective'. *Identify and implement cost-effective structural and property protection projects to reduce the impacts from flooding including acquisition, elevation and relocation projects*
Objective 2.2	Ensure that existing drainage systems such as pipes, culverts and channels are adequate and functioning properly.	Keep as is; still applies.
Objective 2.3 (NEW)	New objective	New objective to align with Pike County priorities: *Maintain and enhance local regulatory standards with new hazard and risk information including full and effective building code enforcement, floodplain management, land use planning mechanisms and other natural hazard vulnerability-reducing regulations.*
Goal 3	Enhance and improve emergency services provided to the growing population of Pike County.	Keep as is; still applies.
Objective 3.1	Provide residents with adequate warning of potential floods and other weather related events.	Objective has been enhanced and modified as follows: *Enhance early notification systems and communication infrastructure to provide residents with adequate warning and information regarding all hazards.*
Objective 3.2	Ensure that emergency response services and critical facilities are adequate and are not interrupted by hazards.	Objective has been enhanced and modified as follows: *Ensure continuity of operations and adequate supplies for emergency response services, critical facilities and infrastructure.*

2012 Pike County Hazard Mitigation Plan Goals and Objectives		Evaluation
Goal 4	Reduce vulnerability including loss of life and damage to assets from natural and human-made hazards.	Goal was enhanced and modified as follows to include the environment: *Reduce vulnerability including loss of life and damage to assets and the environment from natural and human-made hazards.*
Objective 4.1	Identify and implement mitigation projects to reduce flooding, reduce/eliminate sewage leakage and inflow/infiltration problems.	Objective was enhanced to include the words 'cost-effective'. *Identify and implement cost-effective mitigation projects to reduce flooding, reduce/eliminate sewage leakage and inflow/infiltration problems.*
Objective 4.2	Identify and evaluate the need for warning systems and storm shelters.	Keep as is; still applies.
Objective 4.3 (NEW)	New objective	New objective to address new hazards of concern in 2017 HMP update: *Identify and implement initiatives to address existing and/or emerging public health and wellness concerns.*
Objective 4.4 (NEW)	New objective	New objective added based on capability assessment and municipal feedback: *Increase local government official awareness regarding mitigation funding opportunities to reduce vulnerability.*
Goal 5	Conserve, protect, and enhance existing natural and water resources	Goal has been enhanced and modified as follows: *Conserve, protect, restore and enhance existing natural systems and water resources that serve a natural hazard mitigation function.*
Objective 5.1	Provide appropriate safeguards for the preservation of the quality of stream corridors, watershed areas, and floodplains.	Objective has been enhanced as follows: *Provide appropriate safeguards for the preservation of the quality of water resources, stream corridors, watershed areas, and floodplains.*
Objective 5.2	Ensure that streams and rivers are functioning properly to reduce flooding.	Objective has been enhanced and modified as follows: *Ensure and maintain the natural drainage patterns and stream and waterway corridors to the greatest extent practicable to provide for properly functioning systems that assist with the reduction of flooding.*

2012 Pike County Hazard Mitigation Plan Goals and Objectives		Evaluation
Objective 5.3 (NEW)	New objective	New objective has been added to include coordinated water management outside of the county as follows: *Increase coordination with owners of upstream water control structures to ensure life and property protection in Pike County*.
Goal 6	Increase awareness, understanding, and preparedness across all sectors by encouraging hazard risk, preparedness, and mitigation related education and outreach activities.	Goal has been enhanced to include training: *Increase awareness, understanding, and preparedness across all sectors by encouraging hazard risk, preparedness, and mitigation related education, training and outreach activities.*
Objective 6.1	Develop partnerships both at the local, state and federal government level as well as with local business, private communities, civic and volunteer organizations and other appropriate non-traditional partners to continue to develop a County-wide approach to identifying and implementing mitigation actions.	Keep as is; still applies.
Objective 6.2	Develop and distribute public awareness materials about natural hazard risks, preparedness, and mitigation.	Objective has been enhanced to include non-natural hazards: *Develop and distribute public awareness materials about natural and human-made hazard risks, preparedness, and mitigation.*

6.3 IDENTIFICATION AND ANALYSIS OF MITIGATION TECHNIQUES

Concerted efforts were made to ensure that the County and its municipalities developed updated mitigation strategies. Updated strategies included activities and initiatives covering the range of mitigation action types described in recent FEMA planning guidance, "Local Mitigation Planning Handbook." Mitigation action types listed in the FEMA guidance include the following:

1. **Local Plans and Regulations:** These actions include government authorities, policies, or codes that influence the way land and buildings are being developed and built.
2. **Structure and Infrastructure Projects:** These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. These project types could apply to public or private structures as well as critical facilities and infrastructure. This type of action also involves projects to construct man-made structures to reduce the impact of hazards.
3. **Natural Systems Protection:** These are actions that minimize damage and losses, and also preserve or restore the functions of natural systems.
4. **Education and Awareness Programs:** These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. These actions may also include participation in national programs, such as NFIP and CRS, StormReady (NOAA) and Firewise (National Fire Protection Association [NFPA]) Communities (FEMA 2013).

The participants of the Mitigation Strategy Workshop and the Planning Team identified actions that relate to the techniques listed above. Table 6-3 identifies which mitigation techniques are applicable for the hazards included in the 2017 HMP.

Table 6-3. Mitigation Technique Matrix

Hazard	Local Plans and Regulations	Structure and Infrastructure Projects	Natural Systems Protection	Education and Awareness Programs
Dam Failure	✓	✓		✓
Drought	✓	✓	✓	✓
Drowning	✓			✓
Earthquake	✓	✓		✓
Environmental Hazards	✓	✓		✓
Extreme Temperature			✓	✓
Flood, Flash Flood, and Ice Jam	✓	✓	✓	✓
Hurricane, Tropical Storm, Nor'Easter	✓	✓	✓	✓
Invasive Species	✓		✓	✓
Landslide	✓	✓	✓	✓
Lightning		✓		✓
Nuclear Incident	✓			✓
Pandemic				✓
Radon Exposure	✓	✓		✓
Terrorism		✓		✓
Tornadoes and Windstorms	✓	✓		✓
Transportation Accidents	✓			✓
Urban Fire and Explosions	✓	✓		✓
Utility Interruption		✓		✓
Wildfire	✓	✓	✓	✓
Winter Storm		✓		✓

6.4 MITIGATION ACTION PLAN

Representatives from the County and all participating municipalities selected mitigation strategies and initiatives to pursue until the next plan update. These actions also include some actions identified during the 2012 update that are still relevant or in progress. This section describes 2017 mitigation initiatives, mitigation strategy prioritization and implementation, and prioritization of mitigation actions.

6.4.1 2017 Mitigation Initiatives

Table 6-4 summarizes the updated mitigation strategies identified by the County and all municipalities, including the following information:

- Mitigation actions for individual and multiple hazards
- Mitigation action type
- Department or agency primarily responsible for project initiation and/or implementation
- Estimated cost for the mitigation action, and identification of known or potential sources of funding
- Implementation schedule

- Implementation priority

The updated mitigation actions were documented by each jurisdiction using the Mitigation Action Worksheet distributed at the March 8, 2017 Mitigation Strategy Workshop. Refer to Appendix G for a blank version of the Mitigation Action Worksheet and completed worksheets. Specific mitigation actions were identified to prevent future losses; however, current funding is not identified for all of these actions at present. The County and municipalities have limited resources to take on new responsibilities or projects. The implementation of these mitigation actions is dependent on the approval of the local elected governing body and the ability of the jurisdiction to obtain funding from local or outside sources.

Each jurisdiction prioritized their proposed mitigation actions during the Mitigation Action Worksheet documentation process. In general, mitigation actions ranked as highest priorities would like to be addressed first within that jurisdiction; depending upon funding. However, medium- or low-priority mitigation actions will be considered for concurrent implementation as funding becomes available. Therefore, the ranking levels should be considered as a preliminary ranking, which will evolve based on prevailing priorities and discretion of local governments, the public, the Pennsylvania Emergency Management Agency (PEMA), and FEMA as the plan update is implemented.

Table 6-4. Hazard Mitigation Strategy

Note: Some of the identified mitigation initiatives in Table 6-4 are dependent upon available funding (grants and local match availability) and may be modified or omitted at any time based on the occurrence of new hazard events and changes in County or municipal priorities. Actions that have been carried over from the 2012 version of the HMP may have been reworded and given a new initiative designation to conform to current needs and procedures.

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
Pike County												
PC-01 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties should be a priority, when applicable.											
	See above.	Existing	Flood	1, 2, 4	County/Municipal Engineering with PEMA and FEMA support	High	High	FEMA HMA and local budget (or property owner) for cost share	Ongoing support; Long-term DOF (specific project application and implementation)	High	SIP	PP
PC-02 (Previous Action #38)	Work with partner organizations to develop informational releases about hazard mitigation for newspapers, websites, circulars, and property owners' association newsletters and attend Association of Community Associations meetings to discuss hazard mitigation, targeting all residents (full-time, seasonal, renters).											
	See above.	N/A	All Hazards	All	Pike County Office of Community Planning, Pike County Emergency Services	Medium	Low	Local budget; HMA programs with local or County match	Short (DOF)	Low	EAP	PI
PC-03	Maintain compliance with and good standing in the NFIP, including adoption and enforcement of floodplain management requirements (e.g., regulating all new and substantially improved construction in special-hazard flood areas), floodplain identification and mapping, and flood insurance outreach to the community. Further meet and/or exceed the minimum NFIP standards and criteria through the following NFIP-related continued compliance actions identified in subsequent initiatives.											
	See above.	New and Existing	Flood	All	NFIP Floodplain Administrators (FPA); with support from PEMA, ISO, FEMA	Medium - High	Low-Medium	Local budget	Ongoing	High	LPR	PR, PI
PC-04 (Previous	Promote or adopt higher regulatory and zoning standards to manage hazard risk; specifically, through updates to the building codes, flood ordinances, and subdivision and land development ordinances. Goals of increased standards are to ensure new buildings and infrastructure are discouraged or prohibited in high-hazard areas in their jurisdiction.											

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
Action 35; enhanced)	See above.	New and Existing	Flood	1, 2, 4, 6	Municipal NFIP FPA, with support of PEMA, Pike County Conservation District	Medium	Low	Local budget	Short (DOF)	Medium	LPR	PR
PC-05 (Previous Action #34)	Increase awareness of and participation in FEMA's Community Rating System (CRS) Program.	New and existing	Flood	1, 2, 4, 6	Pike County Office of Community Planning; Pike County Conservation District, Pike County EMA	Medium	Medium	Local budget	Short (DOF)	Medium	LPR	PR
PC-06	Pike County EMA will work with electric distribution companies to implement an annual tree-trimming program to minimize storm damage.	New and Existing	Utility Interruption; Hurricane/Tropical Storm, Winter Storm, Tornado/Windstorm	2, 3, 4, 5	Pike County EMA, County/Municipal Elected Officials, Electric Companies	High	Low	Local budget	Short (DOF)	High	LPR	PR, PI, ES
PC-07	Explore the creation of a Pike County Health Department	N/A	Pandemic	3, 4, 6	Pike County Office of Community Planning, Pike County EMA	High	Low-Medium	Local budget	Short (DOF)	Medium	LPR	PR
PC-08	Assess and update emergency operations center equipment to improve communication. Targeted needs include: • Generators, • Training Apparatus • Communications	Existing	All	2, 3, 4	Pike County EMA, PEMA	Medium	Medium	Local budget, FEMA HMGP and PDM	Ongoing	High	EAP, SIP	ES

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
PC-09 (Revised Previous Action #13)	Ensure continuity of operations at critical facilities and infrastructure. Options may include purchase and install generators.	Existing	All	2, 3, 4	Municipality, Pike County EMA	High (reduced interruption of critical facilities and services; life safety)	Medium - High	Local budget; Emergency Management grants as available	Ongoing	High	SIP	ES
PC-10	Work with County and power companies to identify roads within the municipality considered “critical;” these would be the first priority for clearing after an event involving downed power lines.	Existing	Hurricane/Tropical Storm/Nor’Easter, Tornado and Windstorm, Winter Storm, Flood, Utility Interruption	1, 2, 3, 4	Pike County EMA, Pike County Planning, Pike County Road Task Force, Municipal Public Works Departments; Local Power Companies	Medium	Medium	Local budget	Short (DOF)	High	SIP	ES
PC-11	Work with PEMA and PA DEP to obtain an updated list of dams and ownership; work with Silver Jackets to assist private dam owners and the financial hardship of maintenance.	Existing	Hurricane/Tropical Storm/Nor’Easter, Tornado and Windstorm, Winter Storm, Flood	1, 2	Pike County EMA; Pike County Office of Community Planning	High	Medium-Low	Local budget	Short (DOF)	High	LPR, SIP	PR, PP, SP, ES
PC-12	Install dry hydrants	Both	All	1, 2, 3, 4	Pike County EMA and Municipality	High	Medium-Low	Local budget	Short (DOF)	High	SIP	PP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
PC-13	Identify and monitor transportation routes of hazardous materials. Establish a communication chain between rail and Fire Departments regarding transport of spent fuel rods. • Interstate 84 and rail lines	Existing	Environmental Hazards	2, 3, 4	Pike County EMA, Municipality, PennDOT	High	High	Local budget; Emergency Management grants as available	Ongoing	High	SIP	PP
PC-14	Work with PennDOT to implement transportation upgrades to roads with high flooding vulnerability. Projects could include culvert enhancement, culvert replacement, and road elevation.	Existing	Flood	1, 2, 3, 4	Pike County Community Planning, Municipality, PennDOT	High	High	Local budget; State; FEMA HMA	Ongoing	High	SIP	PP
PC-15	Work with PennDOT and the National Park Service to utilize beet juice to supplement brine/salt to treat roads during winter conditions	Existing	Environmental Hazards, Winter Storm	4, 5	Pike County, Pike County Road Task Force, Municipalities; PennDOT; National Park Service	High	Medium	Local budget	Long (DOF)	Medium	NSP	NR
PC-16	Purchase Radiac Meters (e.g., UltraRadiac – Personal Radiation Monitor) and thermal detectors for when FD responds to rail incidents	Existing	Environmental Hazards	2, 3, 4	Pike County EMA, Municipalities	High	High	Local budget; Emergency Management grants as available	Long (DOF)	Low	SIP	ES

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
PC-17	Implement debris-flow projects, including slope stabilization, energy dissipation, or vegetative plantings.	Existing	Landslide, Earthquake	2, 4, 5	Pike County Conservation District, Municipality, PennDOT	High-Medium	High-Medium	Local budget; FEMA HMA	Ongoing	High	SIP, NSP	PP, NR
PC-18	Implement stormwater management projects to facilitate stormwater flow during severe storms.	Existing	Flood	1, 2, 4	Pike County Conservation District, Municipality, PennDOT	High	High	Local budget; FEMA HMA	Ongoing	Medium	SIP, NSP	PP, NR
PC-19	Pike County to work with the National Park Service to discuss areas that are in need of stream clearing	Existing	Flood	5, 6	Pike County Conservation District, Municipality, National Park Service	High	Medium	Local budget	Ongoing	High	EAP	NR, PR
PC-20	Continue to use and improve GIS capability to identify and prioritize hazards and critical infrastructure for mitigation, as well as areas targeted for potential new development.	New and Existing	All	3, 6	Pike County Community Planning, County Emergency Services	High	Medium	Local budget; Emergency Management grants as available	Ongoing	Medium	EAP	PR
PC-21	Explore development of an outreach effort which includes a model ordinance to require boat washing to prevent the spread of aquatic invasive species	Existing	Invasive Species	1, 2, 6	Pike County Conservation District, Municipality	Low	Medium	Local budget;	Long (DOF)	Low	LPR	PR

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
PC-22	Purchase and install boat washing stations to help prevent the spread of aquatic invasive species	N/A	Invasive Species	4, 5	Wallenpaupack Watershed Management District, National Park Service, Pike County Conservation District	Low	Medium	Local budget	Long (DOF)	Low	NSP	NR
PC-23	Provide training to local NFIP Floodplain Administrators to potentially include Certified Floodplain Manager (CFM) course.	N/A	Flood	6	Pike County Community Planning and Conservation District	High	Low	Local budget	Short (DOF)	High	LPR, EAP	PR
PC-24 (Previous Action # 26; enhanced)	Pike County EMA to continue working with Pocono Environmental Education Center and municipalities to participate in Firewise.	Both	Wildfire	All	Pike County EMA	High	Low	Local budget	Short (DOF)	High	EAP, LPR, NSP	PR, PP, NR
PC-25 (Previous Action 3; enhanced)	Continue groundwater level monitoring through at least 2018 to assess potable groundwater levels providing 10 years of data for drought trigger analysis.	Both	Drought	4, 5, 6	Pike County Conservation District	High	High	Existing Grant	Ongoing	High	LPR, EAP	PI, NR

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
PC-26 (Previous Action #29)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	Both	All	2, 3, 4	Municipal Elected Officials	High	Low	Local budget	Ongoing	High	LPR, EAP	PR, ES
PC-27 (Previous Action 30)	Utilize the County's Marcellus Shale task force to prepare for and educate municipalities about updating ordinances and proper permitting for Marcellus Shale gas wells	N/A	All	1, 5, 6	Pike County Office of Community Planning, Pike County Conservation District	High	Medium-Low	Local budget	Long (DOF)	Low	LPR, EAP	PR, PI
PC-28 New	Coordinate with the National Weather Service to hold an educational seminar regarding lightning safety	Existing	Lightning	3, 6	Pike County EMA, National Weather Service	High	Low	Local budget	Short (DOF)	Medium	EAP	PI

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
PC-29 (Previous Action 36)	Develop a County Task Force to identify ways to incentivize volunteer fire fighting, address equipment and facility upgrades, provide training opportunities for emergency service providers, and upgrade EMS service in eastern and central areas of Pike County	N/A	All	3	Pike County EMA	High	Low	Local budget	Short (DOF)	High	EAP	PI
PC-30 (Previous Action 37)	Work with watershed associations and municipal officials to coordinate water conservation and sewage management programs in local communities.	N/A	Drought	5, 6	Pike County EMA and Pike County Conservation District	High	Low	Local budget	Ongoing	Medium	EAP	PI
PC-31 (Previous Action 39)	Work recreation amenities to develop educational materials regarding the risk of drowning to distribute to resorts, hotels, and other vacation areas	Existing	Drowning	3, 5, 6	Pike County Office of Community Planning; Pike County EMA; PA Fish & Boat Commission, National Park Service	High	Low	Local budget	Short (DOF)	High	EAP	PI
PC-32 (Previous Action 45)	Pike County to continue working with USDA Natural Resources Conservation Service to design and rehabilitate Kintz Creek Dam.	Existing	Dam Failure	2, 3, 4, 6	Pike County EMA	High	High	Federal	Ongoing	Medium	SIP	PP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
PC-33 (Previous Actions 47, 48, 49)	Pike County EMA to continue to work with the three school districts on the following: 1. Annual review of emergency action plans and disaster response plans 2. Conduct audits and ensure adequate back-power and water contingencies are in place so they may serve as shelters	Existing	All	3, 6	Pike County EMA	High	Low	Local budget	Ongoing	High	LPR	ES
PC-34 (Previous Action 52)	County to work with municipalities to develop databases to track development in the Special Flood Hazard Area (SFHA).	Both	Flood, Severe Storm, Hurricane/Tropical Storm, Nor'Easter	All	Pike County Office of Community Planning	High	Low	Local budget	Long (DOF)	Medium	LPR	PR
PC-35 (Previous Action 53)	Hold a workshop to educate and train municipalities about annual FEMA funding sources and the grant application process.	N/A	All natural	2, 4, 6	Pike County Office of Community Planning; Pike County EMA	High	Low	Local budget	Short (DOF)	Medium	EAP	PR, PI
PC-36 New	Work with Westfall Township, Matamoras Borough and Milford Borough to map stormwater facilities, infrastructure, and conveyance systems including pipe sizes, inlets, outlets, and integrate into GIS system.	Both	Flood, Severe Storm, Hurricane/Tropical Storm, Nor'Easter	2, 4, 6	Pike County Office of Community Planning, Pike County Conservation District; Westfall Township, Matamoras and Milford Borough	High	Low	FEMA HMA, PEMA, Local budget	Short (DOF)	High	LPR	PR

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
PC-37 (Previous Action #1)	Conduct education/outreach among local officials as to the benefits of stormwater management, hazard mitigation and implementation of the Phase II Countywide Stormwater Management Plan. (Act 167 Plan)	Both	Flood, Severe Storm, Hurricane/Tropical Storm, Nor'Easter	5, 6	Pike County Conservation District; supported by Pike County Office of Community Planning	High	Low	Local budget	Ongoing	Medium	LPR	PR
PC-38 (Previous Action #46)	Identify and coordinate with appropriate partners and agencies to arrange for data collection of flood and structure data necessary to perform a level 2 HAZUS analysis for the next hazard mitigation plan update. Building data may be collected as part of reassessment of Pike County properties. (i.e. Building Value, Lowest Floor Elevation, Building Type, Occupancy Type, Foundation Type, Number of Stories and Square Footage).	Existing	All	3, 4, 6	Pike County Office of Community Planning	High	High	FEMA PDM	Long (DOF)	Medium	LPR	PR

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
PC-39 New	Conduct education and outreach on municipal stormwater systems and potential impact to flooding/water quality.	Existing	Flood, Severe Storm, Hurricane/Tropical Storm, Nor'Easter	5, 6	Pike County Conservation District; Municipalities	High	Low	Local budget	Short (DOF)	Medium	EAP	PI
PC-40 New	Participate in emergency planning for applicable hazard and emergency response events. Specific types of planning relevant to the County and its municipalities include EAPs for dams, radiological emergency plans for nuclear incidents, winter preparedness plans, evacuation signage plans, Phase II Act 167 Stormwater Management Plan, and commodity flow studies. Additionally, other plans should be reviewed to ensure coordination with hazard mitigation planning techniques.	N/A	All	3, 6	Pike County EMA, Municipalities	Medium	Low	Local budget	Ongoing	Medium	LPR	ES

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
PC-41 New	Pike County Office of Community Planning and applicable municipal offices will review their comprehensive plans to ensure that designated growth areas are not within high-hazard areas identified in the HMP.	Existing	All	1, 6	Pike County Planning, Municipal Supervisors	Medium	Low	Local budget	Ongoing	Low	LPR	PR
PC-42 New	Encourage all critical government facilities to have COOP and COG plans and to begin implementing appropriate backup systems.	Existing	All	2, 3, 4	County Planning and OES, Municipal Emergency Managements	High	Low	Staff time, local budget	Ongoing	High	LPR	PR, ES
PC-43 New	Hold annual meetings to ensure that mitigation, planning, preparedness, and response personnel are (1) cross-trained in each other's area of expertise, (2) aware of ongoing activities, and (3) fostering increased communication.	N/A	All	3, 6	Pike County EMA, Municipality	Medium	Low	Staff time, local budget	Ongoing	Medium	LPR	PR, ES
PC-44 New	Hold an education seminar and develop educational materials regarding radon exposure	Both	Radon Exposure	4, 6	Pike County EMA	High	Low	Local budget	Short (DOF)	Medium	LPR	PI

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
PC-45 New	Purchase and install weather station to capture meteorological data and communicate to smart phones to utilize information during response/recovery	N/A	All	3	Pike County Conservation District, Pike County EMA	High	Low	National Weather Service, State, Local	Short (DOF)	Medium	LPR	ES
PC-46 New	Pike County EMA to work with PennDOT to purchase and install cameras on I-84 at the Greentown and Milford exits	N/A	All	3, 4	PennDOT, Pike County EMA	High	Medium	State budget	Short (DOF)	Medium	LPR	ES
Blooming Grove Township												
BG-01 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	Both	All	2,3,4	Township Supervisor; Roadmaster	High	Low	Local budget	Short	High	LPR	ES
BG-02	Repair and increase the level of protection of Hemlock Dam on Hemlock Lake in Hemlock (increase to protect to the 500-year flood event as per communication from the State).	Existing	Flood, Severe Storm, Nor'Easter, Severe Winter	2, 4, 5	Township Supervisor	High	High	Federal and State	Short (depends on funding)	High	SIP	PP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
BG-03	Madden Road Bridge that crosses York Creek requires work to ensure safety: • Provide approach guide-rails and transitions • Remove debris and sediment from stream bed • Relocate beaver • Repair two areas of spalling under the bridge at each abutment	Existing	All Natural Hazards	2, 4, 5	Township Road Master	High	Medium	Federal and State	Short (depends on funding)	High	SIP	PP
BG-04 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	1, 2, 4	Township Supervisor	High	High	FEMA HMA;	Short (DOF)	High	SIP	PP
BG-05	Enhance the capacity of the current stormwater system in the Hemlock Farms Community Association to reduce flooding.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	1, 2, 4	Township Supervisor	High	High	FEMA HMA;	Short (DOF)	High	SIP	PP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
BG-06	Township building (a designated Red-Cross shelter) needs to be upgraded to include handicap bathrooms, showers, kitchen, technology upgrades to digitize records, and build a separate barn for storage of mechanical equipment and supplies (e.g., cots, blankets, MREs). Purchase additional property to accommodate parking for Township personnel, first-responders reporting to the Volunteer Fire Department next to the Township building (also a designated shelter) and sheltering residents.	Existing	All	1, 2, 4	Township Supervisor	High	High	Federal, State, Local; LSA Grant	Short (DOF)	High	SIP	PP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
BG-07	Identify mechanisms to educate and inform Township residents regarding CodeRED for example newsletters, link of Township website to the County Emergency page, social media and other methods of public communication.	N/A	All	3, 4, 6	Township Supervisor	High	High	Local	Short (DOF)	High	EAP	ES
BG-08	Utilize the Hazard Mitigation Plan (HMP) when updating the Comprehensive Master Plan; consider including hazard identification, hazard zones risk assessment information, and hazard mitigation goals as identified in the HMP.	Both	All	All	Township Supervisor, Contracted Planning Firm	High	Low	Local	Short (DOF)	High	LPR	PR
Delaware Township												
DE-01	Conduct a feasibility study to size and correctly design a backup-power system for the two buildings at Camp Akenac Recreation Hall and Maintenance building (Township-owned).	Existing	All	All	Township Administrator, Road Master and EMA Coordinator	High	Low	FEMA HMGP	Short (DOF)	High	SIP	PP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
DE-02	Identify locations in the Township where emergency sirens should be staged for all hazard emergency notification to residents and responders.	Both	All	All	Township Administrator, EMA Coordinator	High	Medium	FEMA HMGP	Short (DOF)	Medium	EAP	ES, PI
DE-03 (Previous Action #14)	Roads used to be interconnected but are no longer due to maintenance and right of ways. Conduct a geospatial study to identify roads that used to be connected that are needed to facilitate emergency service access to communities; and prioritize rehabilitation of these roads.	Both	All	1, 2, 3, 4	Township Administrator, Road Master and EMA Coordinator	High	Medium	Federal, State	Short DOF	High	SIP	PP
DE-04	Assess the bridge on Log and Twig Road's current status; determine if bridge can be mitigated to clear dam failure; and determine alternate route for emergency access, rehabilitate the dam headwalls.	Both	All	1, 2, 3, 4	Township Administrator, Road Master and EMA Coordinator	High	Medium	Federal, State	Short DOF	High	SIP	PP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
DE-05	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	Both	All	2,3,4	Township Administrator; Roadmaster	High	Low	Local budget	Short	High	LPR	ES
DE-06 (Previous Action #13, revised)	Ensure the continuity of operations at critical facilities. This may include backup power or staging equipment in the Township to respond/recover more quickly.	Existing	All	2, 3, 4	Township Administrator, EMA Coordinator	High	Medium	Federal, State, Local	Short (DOF)	High	SIP	PP
DE-07 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	1, 2, 4	Township Administrator	High	High	FEMA HMA;	Short (DOF)	High	SIP	PP
Dingman Township												

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
DI-01	Tunnel Road height and width restrictions prevent emergency vehicles and plows to utilize the road. This road is also subject to flooding. The elevation of Interstate-84 would alleviate the access issues. Work with PennDOT to address.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	1, 2, 3, 4	PennDOT, Township Supervisor	High	High	PennDOT	Short (DOF)	High	SIP	PP
DI-02	Rattlesnake Bridge on Spring Brook Road, a single-lane bridge (County-owned), with weight limit; 50 houses may have limited access to emergency services due to the weight restrictions causing an isolated population. Stormwater runoff on both sides have caused the abutments to the bridge to move on the sandy soils. Work with County Engineering to replace the bridge as a two-lane and realign as needed.	Both	All	1, 2, 3, 4	Pike County Engineering, Township Engineer (contract)	High	High	State, Local	Short (DOF)	High	SIP	PP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
DI-03 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	1, 2, 4	Township Supervisor	High	High	FEMA HMA;	Short (DOF)	High	SIP	PP
DI-04 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	Both	All	2,3,4	Township Supervisor	High	Low	Local budget	Short	High	LPR	ES
DI-05	Expand the Dingman Township Volunteer Fire Department which is the Township's designated shelter and EMC office to include showers that are ADA-compliant to take in more people during emergencies.	Existing	All	1, 2, 3, 4	EMA Coordinator	High	High	Federal, State, Local	Short (DOF)	High	SIP	PP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
DI-06	Ensure continuity of operations at Township critical facilities: • Township Garage by installing a permanent generator, • Municipal Office generator is old and requires an update; • Fire House may need an upgrade	Existing	All	2, 3, 4	EMA Coordinator	High	Medium	Federal, State, Local	Short (DOF)	High	SIP	PP
Greene Township												
G-01	Ensure the continuity of operations at critical facilities in the Township. Purchase and install a generator at the Hemlock Road Church which serves as the Township shelter.	Existing	All	2, 3, 4	EMA Coordinator	High	Medium	Federal, State, Local	Short (DOF)	High	SIP	PP
G-02 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	Both	All	2,3,4	Township Supervisor; Roadmaster	High	Low	Local budget	Short	High	LPR	ES
G-03	Investigate ways to mitigate flooding on Township roadways including Mountain View Road	Existing	Flood, Hurricane/Tropical Storm, Nor'Easter, Winter	2, 4	Township Supervisors	High	High	Federal, State, Local	Short (DOF)	High	SIP	PP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
G-04 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	1, 2, 4	Township Supervisors	High	High	FEMA HMA;	Short (DOF)	High	SIP	PP
G-05	Increase the capacity of pipes in the Township to reduce flooding	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	2, 3, 4	Township Supervisors	High	High	FEMA HMA;	Short (DOF)	High	SIP	PP
Lackawaxen												
LA-01 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	Both	All	2,3,4	EMA Coordinator	High	Low	Local budget	Short	High	LPR	ES

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
LA-02 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	1, 2, 4	EMA Coordinator	High	High	FEMA HMA;	Short (DOF)	High	SIP	PP
LA-03	Stabler Road entrance needs to be widened and engineering design is required to ensure the safety of vehicles. Currently the road is too narrow and requires a 180-degree turn and with growing traffic this is a safety concern. If the road is closed due to downed trees or vehicular accidents, there is no alternate route for emergency services and this creates an isolated and vulnerable population.	Both	All	2, 3, 4	Township Road Master	High	High	Federal, State, Local (Township paying for an engineer to initially examine)	Short (DOF)	High	SIP	PP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
LA-04	Improvements to Case Bridge to ensure it can handle flood waters: paving, rails, wing-walls, new bridge span and decking, beams,	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	2, 3, 4	Township Road Master, Township Engineer	High	High	Federal, State (PennDOT), Local (Township already invested $90,000 to investigate)	Short (DOF)	High	SIP	PP
LA-05	Ensure the continuity of operations at critical facilities in the Township.	Existing	All	2, 3, 4	Township Building Inspector	High	Medium	Federal, State, Local	Short (DOF)	High	SIP	PP
LA-06	Identify mechanisms to educate and inform Township residents regarding CodeRED for example newsletters, link of Township website to the County Emergency page, social media and other methods of public communication.	N/A	All	3, 4, 6	EMA Coordinator	High	Low	Local budget	Short	High	EAP	PI, ES
Lehman Township												
LE-01 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	Both	All	2,3,4	Public Works Department; Roadmaster	High	Low	Local budget	Short	High	LPR	ES

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
LE-02 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	1, 2, 4	Public Works Department	High	High	FEMA HMA;	Short (DOF)	High	SIP	PP
LE-03	Increase the capacity of the existing culverts along Broadhead Road in Lehman Township which regularly floods due to rain events and further harden the road embankments there are vulnerable to landslides.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	2, 3, 4	Public Works Department	High	High-Medium	FEMA HMA, Local match	Short (DOF)	High	SIP	PP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
LE-04	Raspberry Run Road is an emergency route for responders and a secondary route to evacuate camps and three private communities. If Minks Pond Road is not accessible (main road), this road needs to be used and more direct route. The Township would like to have Raspberry Run Road drivable during times of disaster as an emergency access route and requires subsurface stone and tar and chip to keep the road in useable shape.	Both	All	2, 3, 4	Public Works Department	High	High-Medium	State and Local	Short (DOF)	High	SIP	PP
Matamoras												
MA-01 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	1, 2, 4	EMA Coordinator and Borough Secretary	High	High	FEMA HMA; Local match	Short (DOF)	High	SIP	PP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
MA-02	Develop a public phone, web, media dialer, email notification system for all hazard communications Borough-wide.	N/A	All	2, 3, 4, 6	EMA Coordinator	High	High-Medium	Federal, State, Local	Short (DOF)	High	EAP	PI, ES
MA-03 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	Both	All	2,3,4	EMA Coordinator	High	Low	Local budget	Short	High	LPR	ES
Milford Borough												
MB-01 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	Both	All	2,3,4	Borough Council; Roadmaster	High	Low	Local budget	Short (DOF)	High	LPR	ES
MB-02	Work with the Pike County Office of Community Planning to map and/or update maps/plans for stormwater conveyance systems including pipe sizes, inlets, outlets, and integrate into GIS system	Both	Flood, Hurricane/Tropical Storm, Nor'Easter, Winter Storm	2, 3, 4	Borough Council, Pike County Office of Community Planning, Borough Street Department	Medium	Medium	Local	Short (DOF)	Medium	LPR	PR

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
MB-03 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	1, 2, 4	Borough Council	High	High	FEMA HMA; Local match	Short (DOF)	High	SIP	PP
MB-04	The Borough will continue to monitor and track rain events to determine if the stormwater system capacities are sufficient or if upgrades are needed to handle storm events.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	2, 3, 4	Borough Council	Medium	Medium	Local	Short (DOF)	Medium	LPR	PR
MB-05	Work to identify emergency shelters that could be utilized in times of weather event and natural disasters; obtain emergency backup power and supplies if so needed.	Both	All	2, 3, 4	Borough Council	Medium	Medium	Local	Short (DOF)	Medium	LPR	ES

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
MB-06	Identify mechanisms to educate and inform Borough residents regarding hazards events which could potentially impact the health and safety for example newsletters, social media and other methods of public communication.	N/A	All	2, 3, 4, 6	Borough Council	High	Medium-Low	Local, County, State	Short (DOF)	High	LPR	PI
Milford Township												
MT-01 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	Both	All	2,3,4	Township Road Master	High	Low	Local budget	Short (DOF)	High	LPR	ES
MT-02 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	1, 2, 4	Township Council	High	High	FEMA HMA; Local match	Short (DOF)	High	SIP	PP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
MT-03	Work with the gas company (formerly Columbia Gas) to develop an evacuation plan to address emergencies related to the compressor station or the pipeline itself.	Both	Utility interruption; Terrorism, Transportation Accident	2, 3, 4	EMA Coordinator	High	Medium	Gas Company, Local	Short (DOF)	High	LPR	PR
MT-04	Purchase a storage unit and shelter supplies including cots, blankets, MREs for the Township municipal hall that serves as a shelter	N/A	All	2, 3	EMA Coordinator	High	Medium	Federal, State, Local	Short (DOF)	High	LPR	ES
Palmyra Township												
PA-01 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	Both	All	2,3,4	Township Supervisors; Roadmaster	High	Low	Local budget	Short (DOF)	High	LPR	ES

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
PA-02	Township to facilitate outreach to private communities to obtain access rights to connecting roads for emergency services. This would provide increased access to both communities during hazard events such as storms that cause downed trees to provide multiple access points to populations and avoid isolated population. Construct gate with lock for Township and emergency services use only.	Both	All	2, 3, 4	Township Supervisors, Fire Company, EMS, EMA Coordinator	High	High	Federal (CDBG)	Short (DOF)	High	LPR	PI, ES
PA-03	Enhance education and awareness to seasonal population (lakeside communities) which increases population by greater than 50% on all hazards including the following: 1- Emergency communication systems (e.g., CodeRED) 2. Invasive species 3. Radon exposure	N/A	All	2, 3, 4, 6	Township Supervisors, EMA Coordinator	High	Medium	CDBG, State, Local	Short (DOF)	High	EAP	PI, ES
Porter Township												

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
PO-01 (Previous Action #18, enhanced)	Increase capacity of the existing stormwater system to include the following areas: • Old Route 402 – subject to flooding and erosion • Snow Hill Road • Whittaker Road	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	2, 3, 4	Township Road Master	High	High	Federal (FEMA HMA); CDBG	Short (DOF)	High	SIP	PP
PO-02 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	1, 2, 4	Township Road Master	High	High	FEMA HMA; Local match	Short (DOF)	High	SIP	PP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
PO-03	Develop a customized communication plan for Porter Township to convey risk in multiple formats due unique conditions in Porter Township (e.g., poor cell phone coverage, several small private communities and properties without electricity), increase usage of social media, leverage County communication system (CodeRED and reverse 911) and regularly update points of in the Township's Emergency Plan (primary and secondary points of contact) to distribute information.	N/A	All	2, 3, 4, 6	Township Supervisors	High	Medium-Low	FEMA HMA; CDBG	Short (DOF)	High	EAP	PI

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
PO-04	Bushkill Bridge (steel bridge) is Township owned and gets inspected by the County. This bridge gets washed out at both ends and water goes over the bridge deck; major scouring has occurred and damage of guiderails. Ice has also damaged the bridge. Elevate the bridge or investigate other methods to ensure flood waters can pass.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter, Winter Weather	2, 3, 4	Township Board of Supervisors, Township Road Master	High	High	FEMA HMA; CDRB	Short (DOF)	High	SIP	PP
PO-05	Ensure continuity of operations at Township critical facilities such as: 1) Township building does not have back-up power 2) Township-designated shelter (General Store - Pickerall Inn) needs to be replaced	Existing	All	2, 3, 4,	Township Board of Supervisors	High	Medium	FEMA HMA; CDBG	Short (DOF)	High	SIP	ES
PO-06 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	Both	All	2,3,4	Township Board of Supervisors	High	Low	Local budget	Short (DOF)	High	LPR	ES

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
Shohola Township												
S-01 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	Both	All	2,3,4	Township Supervisor; Roadmaster	High	Low	Local budget	Short (DOF)	High	LPR	ES
S-02	Ensure continuity of operations at Township buildings. The Town Barn that houses all equipment and vehicles (dump trucks, snow removal equipment, tractors) is in need of a backup generator to ensure continuity of operations during hazard events.	Existing	All	2, 3, 4	Township Supervisor	High	Medium-Low	FEMA HMA; Local	Short (DOF)	High	SIP	PP, ES

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
S-03	Sheltering: During Hurricane Irene, Twin Cedars (senior home) was evacuated to the Fire Department but it is not a suitable shelter; inadequate space; no handicap bathrooms and no shelter supplies. Construct an extension on the Fire Department to become a suitable shelter. Update the Township EOP to have the Township Building be primary shelter. It has larger rooms and handicap-accessible bathrooms. Purchase a storage unit and shelter supplies including cots, blankets, MREs for the Township to access when shelters open.	Existing	All	2, 3, 4	Township Supervisor	High	Medium-High	Federal, State (LSA Grant), Local	Short (DOF)	High	SIP	PP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
S-04 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	1, 2, 4	Township Supervisor, NFIP Floodplain Administrator	High	High	FEMA HMA; Local match	Short (DOF)	High	SIP	PP
Westfall Township												
W-01	Reduce flood impacts to critical facilities and emergency access roads. 1. Relocate the Township Highway Department 2. Relocate the Eastern Pike Regional Police Department 3. Emergency access road LaBar Lane and Decker Drive. 4. Westfall Township Fire Department	Existing	Flood, Hurricane/Tropical Storm, Nor'Easter	2, 3, 4	Township Supervisors	High	High	Federal, State, FEMA HMA; Local match	Short (DOF)	High	SIP	PP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
W-02	Conduct a feasibility study to evaluate mitigation alternatives to reduce flood impacts in Westfall Township and Matamoras Borough along the Route 6 corridor.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	2, 3, 4	Westfall Township Supervisors, Matamoras Township Supervisors	High	High	FEMA HMA; USACE; Local	Long (DOF)	High	LPR	PR
W-03	Conduct education and outreach to Township residents regarding the option of purchasing NFIP flood insurance.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	2, 3, 4, 6	Westfall Township Supervisors	High	Low	Local	Ongoing	High	LPR	PI
W-04	The access road (Riverview Terrace) to the Milford Senior Care & Rehabilitation Center, located between Route 6/209 and the Delaware River, floods causing ingress/egress challenges for the vulnerable population. Increase the capacity of the existing concrete pipes and culverts and explore connecting the driveway to the Delaware Valley School next door.	Existing	Flood, Hurricane/Tropical Storm, Nor'Easter	2, 3, 4	Westfall Township Supervisors	High	High	FEMA HMA; USACE	Long (DOF)	High	SIP	PP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
W-05	Purchase portable/deployable flood walls to mitigate flooding at the Township Municipal Building and the Westfall Fire Department located in the floodplain.	Existing	Flood, Hurricane/Tropical Storm, Nor'Easter	2, 3, 4	Westfall Township Supervisors	High	High	FEMA HMA;	Long (DOF)	High	SIP	SP, PP
W-06	Westfall Sewage Treatment Plant is located in the floodplain; electrical equipment is high enough but need to explore options to flood-proof the doors.	Existing	Flood, Hurricane/Tropical Storm, Nor'Easter	2, 3, 4	Westfall Township Supervisors	High	Medium	FEMA HMA;	Short (DOF)	Medium	SIP	PP
W-07	Install backflow prevention or water-tight door or flap at the southerly side of the pedestrian crossing. The water pressure from the flood water would seal the opening and alleviate flooding in the Township of Matamoras.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	2, 3, 4	Westfall Township Supervisors	High	High	FEMA HMA;	Short (DOF)	High	SIP	PP
W-08	Install backflow prevention valves on remaining pipes to reduce flooding along the Route 209 Commercial Area.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	2, 3, 4	Westfall Township Supervisors	High	High	FEMA HMA;	Short (DOF)	High	SIP	PP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
W-09 (Previous Actions #10 and #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	1, 2, 4	Westfall Township Supervisors	High	High	FEMA HMA;	Short (DOF)	High	SIP	PP
W-10	Construct an emergency access road at the end of the cul-de-sac at the end of Mountain Avenue to access I-84 (westbound) to provide increased access/egress in emergencies.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	2, 3, 4	Westfall Township EMA Coordinator; PennDOT	High	High	FEMA HMA; PennDOT	Long (DOF)	High	SIP	PP
W-11 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	Both	All	2,3,4	Township Supervisor	High	Low	Local budget	Short (DOF)	High	LPR	ES

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead and Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority***	Mitigation Category	CRS Category
W-12	Promote or adopt higher regulatory and zoning standards to manage hazard risk; specifically, through updates to the building codes, flood ordinances, and subdivision and land development ordinances. Goals of increased standards are to ensure new buildings and infrastructure are discouraged or prohibited in high-hazard areas in their jurisdiction.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	1, 2, 4	Township Supervisor	High	Low	Local	Short	High	LPR	PR
W-13	The Bush Kill Creek traverses under Bluestone Boulevard. The channel runs very close to the edge of the road and is eroding the slope. There is debris in the channel backing up. Review the study currently being conducted to determine best mitigation action to implement.	Both	Flood, Hurricane/Tropical Storm, Nor'Easter	2, 3, 5	Westfall Township Road Master	High	High	FEMA HMA; Pike County Conservation District, Local	Short (DOF)	High	NSP, SIP	PP, NR

Notes:
** The letters associated with the initiative number indicate the lead agency (i.e., County or municipality*
*** Does this mitigation initiative reduce the effects of hazards on new and/or existing buildings and/or infrastructure? Not applicable (N/A) is inserted if this does not apply.*
**** Priority indicates the prioritization identified by the lead agency. This priority may differ from the County prioritization on municipal actions because the municipal priority may be of higher ranking than the PA-STEEL/County priority. Further explanations are provided at the end of this section.*

CDBG = Community Development Block Grant
CRS = Community Rating System
EMA = Emergency Management Agency
EOC = Emergency Operations Center
FEMA = Federal Emergency Management Agency
FIRM = Flood Insurance Rate Map
FPA = Floodplain Administrator
GIS = Geographic information system
HMA = Hazard Mitigation Assistance
NFIP = National Flood Insurance Program
PADEP = Pennsylvania Department of Environmental Protection
PDM = Pre-Disaster Mitigation Program
PEMA = Pennsylvania Emergency Management Agency
SFHA = Special Flood Hazard Area
TBD = To Be Determined

Costs:
These rough estimates should be used where actual project costs cannot reasonably be established at this time:
Low = < $10,000
Medium = $10,000 to $100,000
High = > $100,000

Potential FEMA HMA Funding Sources:
DOF = Depending on funding
HMA = Hazard Mitigation Assistance Grant Program
HMGP = Hazard Mitigation Grant Program

Timeline:
Short Term = 1 to 5 years. Long Term = 5 years or greater. OG = Ongoing program.

Priority:
H = High
M = Medium
L = Low

Mitigation Category:
- *Education and Awareness Programs (EAP) - Actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. These actions may also include participation in national programs, such as StormReady and Firewise Communities.*
- *Local Plans and Regulations (LPR) - Actions include government authorities, policies or codes that influence the way land and buildings are being developed and built.*
- *Natural Systems Protection (NSP) - Actions that minimize damage and losses, and also preserve or restore the functions of natural systems.*
- *Structure and Infrastructure Project (SIP) - Actions that involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to public or private structures as well as critical facilities and infrastructure. This type of action also involves projects to construct manmade structures to reduce the impact of hazards.*

CRS Category:
- *Preventative Measures (PR) - Government, administrative or regulatory actions, or processes that influence the way land and buildings are developed and built. Examples include planning and zoning, floodplain local laws, capital improvement programs, open space preservation, and storm water management regulations.*
- *Property Protection (PP) - These actions include public activities to reduce hazard losses or actions that involve (1) modification of existing buildings or structures to protect them from a hazard or (2) removal of the structures from the hazard area. Examples include acquisition, elevation, relocation, structural retrofits, storm shutters, and shatter-resistant glass.*
- *Public Information (PI) - Actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. Such actions include outreach projects, real estate disclosure, hazard information centers, and educational programs for school-age children and adults.*
- *Natural Resource Protection (NR) - Actions that minimize hazard loss and also preserve or restore the functions of natural systems. These actions include sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.*
- *Structural Flood Control Projects (SP) - Actions that involve the construction of structures to reduce the impact of a hazard. Such structures include dams, setback levees, floodwalls, retaining walls, and safe rooms.*
- *Emergency Services (ES) - Actions that protect people and property during and immediately following a disaster or hazard event. Services include warning systems, emergency response services, and the protection of essential facilities*

6.4.2 Mitigation Strategy Prioritization and Implementation

Section 201.6(c) (3) (iii) of Title 44 Code of Federal Regulations (44 CFR) requires the prioritization of the action plan to emphasize the extent to which benefits are maximized according to a cost-benefit review of the proposed projects and their associated costs. This allows the jurisdictions to select the most cost-effective actions for implementation first, not only to use resources efficiently, but also to make a realistic start toward mitigating risks.

Mitigation benefits are defined as future damages and losses that would be eliminated and/or reduced by implementing the proposed mitigation project, and include physical damage to structures and infrastructure, loss of service or function, and emergency management costs. Particularly for physical ("shovel-in-the-ground") mitigation projects, jurisdictions were encouraged to estimate project costs as well as to identify the anticipated benefits. Where exact project costs and potential benefits were not available, ranges were identified (high, medium, low) for each, allowing a qualitative evaluation of project cost-effectiveness.

The PA-STEEL prioritization methodology is an evaluation process developed by PEMA to help identify the benefits and constraints of a particular mitigation action [Political, Administrative, Social, Technical, Economic, Environmental, and Legal (PA-STEEL)]. The PA-STEEL method provides a uniform approach for counties and jurisdictions to use to consider, in a systematic way, the best mitigation strategies for their communities. The following provides a brief discussion of each of the PA-STEEL evaluation criteria:

- **Political:** Understanding current opinions of community and state political leadership regarding issues related to the environment, economic development, safety, and emergency management will provide valuable insight into the level of political support offered for mitigation activities and programs. Proposed mitigation objectives sometimes fail because of a lack of political acceptability.
- **Administrative:** Under this part of the evaluation criteria, the Hazard Mitigation Working Group examines the anticipated staffing, funding, and maintenance requirements for the mitigation action to determine whether the jurisdiction has the personnel and administrative capabilities necessary to implement the action or whether outside help will be necessary.
- **Social:** The public must support the overall implementation strategy and specific mitigation actions. Therefore, the projects have to be evaluated in terms of community acceptance.
- **Technical:** It is important to determine whether the proposed action is technically feasible, will help to reduce losses in the long term, and has minimal secondary impacts. Here, the Hazard Mitigation Working Group determines whether the alternative action is a whole or partial solution, or not a solution at all.
- **Economic:** Every local, state, and tribal government experiences budget constraints at one time or another. Cost-effective mitigation actions that can be funded in current or upcoming budget cycles are much more likely to be implemented than mitigation actions requiring general obligation bonds or other instruments that would incur long-term debt to a community. States and local communities with tight budgets or budget shortfalls may be more willing to undertake a mitigation initiative if it can be funded, at least in part, by outside sources. "Big ticket" mitigation actions, such as large-scale acquisition and relocation, are often considered for implementation in a post-disaster scenario when additional federal and state funding for mitigation is available. Economic considerations must include the present economic base and projected growth.
- **Environmental:** Impact on the environment is an important consideration because of public desire for sustainable and environmentally healthy communities. In addition, many statutory considerations, such as the National Environmental Policy Act (NEPA), should be counted when using federal funds. Jurisdictions need to evaluate whether, when implementing mitigation actions, the potential negative consequences to environmental assets such as threatened and endangered species, wetlands, and other protected natural resources.

- **Legal:** Without the appropriate legal authority, the action cannot lawfully be undertaken. When considering this criterion, the Hazard Mitigation Working Group determines whether a jurisdiction has the legal authority at the state, tribal, or local level to implement the action, or whether the jurisdiction must pass new laws or regulations. Each level of government operates under a specific source of delegated authority. As a general rule, most local governments operate under enabling legislation that gives them the power to engage in different activities. Jurisdictions should identify the unit of government undertaking the mitigation action, and include an analysis of the inter-relationships between local, regional, state, and federal governments. Legal authority is likely to have a significant role later in the process when the state, tribe, or community determines the ways in which mitigation activities can best be carried out, and the extent to which mitigation policies and programs can be enforced (PEMA).

Municipal and County-level mitigation actions were evaluated and prioritized primarily using the PA-STEEL methodology. Table 6-5 contains the completed PA-STEEL action evaluation table for the updated mitigation strategies (listed in Table 6-4).

In accordance with the PEMA Standard Operating Guidance (SOG), the mitigation strategy evaluation through the PA-STEEL methodology also summarizes the feasibility factors for each action and summarizes the factors with benefits and costs weighed more heavily and, therefore given greater priority. Using cost-benefit weighted prioritization, mitigation actions were ranked as high, medium, or low-priority actions.

Other factors beyond the PA-STEEL numeric rankings may have to be considered during project prioritization. For example, a project might be designated medium priority because of the uncertainty of a funding source. This priority could be changed to “high” once a funding source has been identified such as a grant.

Table 6-5. Analysis of Mitigation Actions

Mitigation Action		PA-STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							Results	
		P Political			A Admin-istrative			S Social		T Technical			E Economic				E Environmental					L Legal				
No.	Name	Political Support	Local Champion	Public Support	Staffing	Funding Allocation	Maintenance / Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	**Benefit of Action (x3)**	**Cost of Action (x3)**	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HazMat / Waste Site	Consistent with Community Environmental Goals	Consistent with Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	Summary (Equal Weighting)	Summary (Priority Ranking)
PC-01 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties should be a priority, when applicable.	+	+	+	-	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	17 (+) 3 (-) 3 (N)	21 (+) 3 (-) 3 (N)
PC-02 (Previous Action #38)	Work with partner organizations to develop informational releases about hazard mitigation for newspapers, websites, circulars, and property owners' association newsletters.	+	+	+	-	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	17 (+) 3 (-) 3 (N)	21 (+) 3 (-) 3 (N)
PC-03	Maintain compliance with and good standing in the NFIP, including adoption and enforcement of floodplain management requirements (e.g., regulating all new and substantially improved construction in special-hazard flood areas), floodplain identification and mapping, and flood insurance outreach to the community. Further meet and/or exceed the minimum NFIP standards and criteria through the following NFIP-related continued compliance actions identified in subsequent initiatives.	+	+	+	+	N	+	+	+	+	+	+	+	+	+	N	+	N	N	+	+	+	+	+	18 (+) 2 (-) 2 (N)	23 (+) 0 (-) 4 (N)

Mitigation Action		PA-STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							Results	
		P Political			A Admin-istrative			S Social		T Technical			E Economic				E Environmental					L Legal				
No.	**Name**	Political Support	Local Champion	Public Support	Staffing	Funding Allocation	Maintenance / Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	**Benefit of Action (x3)**	**Cost of Action (x3)**	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HazMat / Waste Site	Consistent with Community Environmental Goals	Consistent with Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Summary (Equal Weighting)**	**Summary (Priority Ranking)**
PC-04 (Previous Action 35; enhanced)	Promote or adopt higher regulatory and zoning standards to manage hazard risk; specifically, through updates to the building codes, flood ordinances, and subdivision and land development ordinances. Goals of increased standards are to ensure new buildings and infrastructure are discouraged or prohibited in high-hazard areas in their jurisdiction.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	18 (+) 2 (-) 3 (N)	22 (+) 2 (-) 3 (N)
PC-05 (Previous Action #34)	Increase awareness of and participation in FEMA's Community Rating System (CRS) Program.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	18 (+) 2 (-) 3 (N)	22 (+) 2 (-) 3 (N)
PC-06	Pike County EMA will work with electric distribution companies to implement an annual tree-trimming program to minimize storm damage.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	18 (+) 2 (-) 3 (N)	22 (+) 2 (-) 3 (N)
PC-07	Explore the creation of a Pike County Health Department	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	N	N	N	+	+	N	+	+	17 (+) 2 (-) 4 (N)	21 (+) 2 (-) 34 (N)
PC-08	Assess and update emergency operations center equipment to improve communication. Targeted needs include: • Generators, • Training Apparatus • Communications	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	N	N	N	N	+	N	+	+	16 (+) 2 (-) 5 (N)	20 (+) 2 (-) 5 (N)

Mitigation Action		PA-STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							Results	
		P Political			A Admin-istrative			S Social		T Technical			E Economic				E Environmental					L Legal				
No.	Name	Political Support	Local Champion	Public Support	Staffing	Funding Allocation	Maintenance / Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	**Benefit of Action (x3)**	**Cost of Action (x3)**	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HazMat / Waste Site	Consistent with Community Environmental Goals	Consistent with Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	Summary (Equal Weighting)	Summary (Priority Ranking)
PC-09 (Revised Previous Action #13)	Ensure continuity of operations at critical facilities and infrastructure. Options may include purchase and install generators.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	N	N	N	N	+	N	+	+	16 (+) 2 (-) 5 (N)	20 (+) 2 (-) 5 (N)
PC-10	Work with County and power companies to identify roads within the municipality considered "critical;" these would be the first priority for clearing after an event involving downed power lines.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	N	N	N	+	+	N	+	+	17 (+) 2 (-) 4 (N)	21 (+) 2 (-) 4 (N)
PC-11	Work with PEMA and PA DEP to obtain an updated list of dams and ownership; work with Silver Jackets to assist private dam owners and the financial hardship of maintenance.	+	+	+	-	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	+	+	+	18 (+) 3 (-) 2 (N)	22 (+) 3 (-) 2 (N)
PC-12	Install dry hydrants	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	17 (+) 3 (-) 3 (N)	21 (+) 3 (-) 3 (N)
PC-13	Identify and monitor transportation routes of hazardous materials. Establish a communication chain between rail and Fire Departments regarding transport of spent fuel rods. • Interstate 84 and rail lines	+	+	+	-	-	+	+	+	+	+	+	+	+	+	-	+	N	N	N	+	N	+	+	16 (+) 3 (-) 4 (N)	20 (+) 3 (-) 4 (N)
PC-14	Work with PennDOT to implement transportation upgrades to roads with high flooding vulnerability. Projects	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	+	N	+	+	N	+	+	19 (+) 2 (-) 2 (N)	23 (+) 2 (-) 2 (N)

Mitigation Action		PA-STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							Results	
		P Political			A Admin-istrative			S Social		T Technical			E Economic				E Environmental					L Legal				
No.	Name	Political Support	Local Champion	Public Support	Staffing	Funding Allocation	Maintenance / Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	**Benefit of Action (x3)**	**Cost of Action (x3)**	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HazMat / Waste Site	Consistent with Community Environmental Goals	Consistent with Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	Summary (Equal Weighing)	Summary (Priority Ranking)
	could include culvert enhancement, culvert replacement, and road elevation.																									
PC-15	Work with PennDOT and the National Park Service to continue to utilize beet juice to supplement brine/salt to treat roads during winter conditions	+	+	+	+	-	+	+	+	+	+	+	+	+	N	-	+	+	N	+	+	+	+	+	19 (+) 2 (-) 2 (N)	23 (+) 2 (-) 2 (N)
PC-16	Purchase Radiac Meters (e.g., UltraRadiac – Personal Radiation Monitor) and thermal detectors for when FD responds to rail incidents	+	+	+	+	-	+	+	+	+	+	+	+	+	N	-	N	N	N	N	+	N	+	+	15 (+) 2 (-) 6 (N)	19 (+) 2 (-) 56 (N)
PC-17	Implement debris-flow projects, including slope stabilization, energy dissipation, or vegetative plantings.	+	+	+	+	-	+	+	+	+	+	+	+	+	N	-	+	N	N	+	+	N	+	+	17 (+) 2 (-) 4 (N)	21 (+) 2 (-) 4 (N)
PC-18	Implement stormwater management projects to facilitate stormwater flow during severe storms.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	18 (+) 2 (-) 3 (N)	22 (+) 2 (-) 3 (N)
PC-19	Pike County to work with the National Park Service to discuss areas that are in need of stream clearing	+	+	+	+	N	+	+	+	+	+	+	+	+	+	+	+	+	N	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)
PC-20	Continue to use and improve GIS capability to identify and prioritize hazards and critical infrastructure for mitigation, as well as areas targeted for potential new development.	+	+	+	+	N	+	+	+	+	+	+	+	+	+	+	+	N	+	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)
PC-21	Explore developing a model ordinance to require boat washing to prevent the spread of aquatic invasive species	+	+	-	+	N	-	-	+	+	+	+	+	+	+	N	+	+	N	+	+	N	+	+	16 (+) 3 (-) 4 (N)	20 (+) 3 (-) 4 (N)

Mitigation Action		PA-STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							Results	
		P Political			A Admin-istrative			S Social		T Technical			E Economic				E Environmental					L Legal				
No.	Name	Political Support	Local Champion	Public Support	Staffing	Funding Allocation	Maintenance / Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	**Benefit of Action (x3)**	**Cost of Action (x3)**	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HazMat / Waste Site	Consistent with Community Environmental Goals	Consistent with Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	Summary (Equal Weighting)	Summary (Priority Ranking)
PC-22	Purchase and install boat washing stations to help prevent the spread of aquatic invasive species	+	+	+	-	-	-	+	+	+	+	+	+	+	+	-	+	+	N	+	+	+	+	+	18 (+) 4 (-) 1 (N)	22 (+) 4 (-) 1 (N)
PC-23	Provide training to local NFIP Floodplain Administrators to potentially include Certified Floodplain Manager (CFM) course.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	18 (+) 2 (-) 3 (N)	22 (+) 2 (-) 3 (N)
PC-24 (Previous Action # 26; enhanced)	Pike County EMA to continue working with Pocono Environmental Education Center and municipalities to participate in Firewise.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	18 (+) 2 (-) 3 (N)	22 (+) 2 (-) 3 (N)
PC-25 (Previous Action 3; enhanced)	Continue groundwater level monitoring through at least 2018 to assess potable groundwater levels providing 10 years of data for drought trigger analysis.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)
PC-26 (Previous Action #29)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)
PC-27 (Previous Action 30)	Utilize the County's Marcellus Shale task force to prepare for and educate municipalities about updating ordinances and proper permitting for Marcellus Shale gas wells	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	+	+	+	19 (+) 2 (-) 2 (N)	23 (+) 2 (-) 2 (N)

Mitigation Action		PA-STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							Results	
		P Political			A Admin- istrative			S Social		T Technical			E Economic				E Environmental					L Legal				
No.	**Name**	Political Support	Local Champion	Public Support	Staffing	Funding Allocation	Maintenance / Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	**Benefit of Action (x3)**	**Cost of Action (x3)**	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HazMat / Waste Site	Consistent with Community Environmental Goals	Consistent with Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Summary (Equal Weighting)**	**Summary (Priority Ranking)**
PC-28 New	Coordinate with the National Weather Service to hold an educational seminar regarding lightning safety	+	+	+	+	-	+	+	+	+	+	+	+	+	N	-	+	N	N	+	+	N	+	+	17 (+) 2 (-) 4 (N)	21 (+) 2 (-) 4 (N)
PC-29 (Previous Action 36)	Develop a County Task Force to identify ways to incentivize volunteer fire fighting, address equipment and facility upgrades, provide training opportunities for emergency service providers, and upgrade EMS service in eastern and central areas of Pike County	+	+	+	-	-	+	+	+	+	+	+	+	+	+	+	N	N	N	+	+	N	+	+	17 (+) 2 (-) 4 (N)	21 (+) 2 (-) 4 (N)
PC-30 (Previous Action 37)	Work with watershed associations and municipal officials to coordinate water conservation and sewage management programs in local communities.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	+	+	+	19 (+) 1 (-) 3 (N)	23 (+) 1 (-) 3 (N)
PC-31 (Previous Action 39)	Work recreation amenities to develop educational materials regarding the risk of drowning to distribute to resorts, hotels, and other vacation areas	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	19 (+) 2 (-) 3 (N)	22 (+) 2 (-) 3 (N)
PC-32 (Previous Action 45)	Pike County to continue working with USDA Natural Resources Conservation Service to design and rehabilitate Kintz Creek Dam.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	+	+	+	20 (+) 1 (-) 2 (N)	24 (+) 1 (-) 2 (N)
PC-33 (Previous Actions 47, 48, 49)	Pike County EMA to continue to work with the three school districts on the following: 1. Annual review of emergency action plans and disaster response plans	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	+	+	+	20 (+) 1 (-) 2 (N)	24 (+) 1 (-) 2 (N)

Mitigation Action		PA-STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							Results	
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	2. Conduct audits and ensure adequate back-power and water contingencies are in place so they may serve as shelters																									
PC-34 (Previous Action 52)	County to work with municipalities to develop databases to track development in the Special Flood Hazard Area (SFHA).	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	+	19 (+) 1 (-) 3 (N)	23 (+) 1 (-) 3 (N)
PC-35 (Previous Action 53)	Hold a workshop to educate and train municipalities about annual FEMA funding sources and the grant application process.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	+	+	+	20 (+) 1 (-) 2 (N)	24 (+) 1 (-) 2 (N)
PC-36 New	Work with Westfall Township, Matamoras Borough and Milford Borough to map stormwater facilities, infrastructure, and conveyance systems including pipe sizes, inlets, outlets, and integrate into GIS system.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)
PC-37 (Previous Action #1)	Complete education/outreach among local officials as to the benefits of implementing the Phase II Countywide Stormwater Management Plan (Act 167 Plan)	+	+	+	+	-	+	-	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	N	16 (+) 3 (-) 4 (N)	20 (+) 2 (-) 4 (N)
PC-38 (Previous Action #46)	Identify and coordinate with appropriate partners and agencies to arrange for data collection of flood and structure data necessary to perform a level 2 HAZUS analysis for the next hazard mitigation plan update. Building data may be	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	N	N	N	N	+	N	+	+	16 (+) 2 (-) 5 (N)	20 (+) 2 (-) 5 (N)

Mitigation Action		PA-STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable: P Political			A Admin-istrative			S Social		T Technical			E Economic				E Environmental					L Legal			Results	
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	collected as part of reassessment of Pike County properties. (i.e. Building Value, Lowest Floor Elevation, Building Type, Occupancy Type, Foundation Type, Number of Stories and Square Footage).																									
PC-39 New	Conduct education and outreach on municipal stormwater systems and potential impact to flooding/water quality.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	+	+	+	N	+	+	19 (+) 2 (-) 2 (N)	23 (+) 2 (-) 2 (N)
PC-40 New	Participate in emergency planning for applicable hazard and emergency response events. Specific types of planning relevant to the County and its municipalities include EAPs for dams, radiological emergency plans for nuclear incidents, winter preparedness plans, evacuation signage plans, Phase II Act 167 Stormwater Management Plan, and commodity flow studies. Additionally, other plans should be reviewed to ensure coordination with hazard mitigation planning techniques.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	21 (+) 2 (-) 0 (N)	25 (+) 2 (-) 0 (N)
PC-41 New	Pike County Office of Community Planning and applicable municipal offices will review their comprehensive plans to ensure that designated growth areas are not within high-hazard areas identified in the HMP.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	N	+	+	20 (+) 2 (-) 1 (N)	24 (+) 2 (-) 1 (N)

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PC-42 New	Encourage all critical government facilities to have COOP and COG plans and to begin implementing appropriate backup systems.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	N	N	N	+	+	N	+	+	17 (+) 2 (-) 4 (N)	21 (+) 2 (-) 4 (N)
PC-43 New	Hold annual meetings to ensure that mitigation, planning, preparedness, and response personnel are (1) cross-trained in each other's area of expertise, (2) aware of ongoing activities, and (3) fostering increased communication.	+	+	+	+	-	+	+	+	+	+	+	+	+	N	-	N	N	N	+	+	N	+	+	16 (+) 2 (-) 5 (N)	20 (+) 2 (-) 5 (N)
PC-44 New	Hold an education seminar and develop educational materials regarding radon exposure	+	+	+	+	-	+	+	+	+	+	+	+	+	N	-	N	N	N	+	+	N	+	+	16 (+) 2 (-) 5 (N)	20 (+) 2 (-) 5 (N)
PC-45 New	Purchase and install weather station to capture meteorological data and communicate to smart phones to utilize information during response/recovery	+	+	+	+	-	+	+	+	+	+	+	+	+	N	-	+	N	N	+	+	N	+	+	17 (+) 2 (-) 4 (N)	21 (+) 2 (-) 4 (N)
PC-46	Pike County EMA to work with PennDOT to purchase and install cameras on I-84 at the Greentown and Milford exits	+	+	+	+	-	-	N	+	+	+	+	+	+	N	-	N	N	+	+	+	+	-	N	14 (+) 4 (-) 5 (N)	18 (+) 4 (-) 5 (N)
Blooming Grove																										
BG-01 (Previous Action #29	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)

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wording enhanced)	school district officials																									
BG-02	Repair and increase the level of protection of Hemlock Dam on Hemlock Lake in Hemlock (increase to protect to the 500-year flood event as per communication from the State).	+	+	+	-	-	-	+	+	+	+	+	+	+	N	-	+	N	N	+	+	N	+	+	16 (+) 3 (-) 4 (N)	20 (+) 3 (-) 4 (N)
BG-03	Madden Road Bridge that crosses York Creek requires work to ensure safety: • Provide approach guide-rails and transitions • Remove debris and sediment from stream bed • Relocate beaver • Repair two areas of spalling under the bridge at each abutment	+	+	+	-	-	+	+	+	+	+	+	+	+	+	-	+	N	N	N	+	N	+	+	16 (+) 3 (-) 4 (N)	20 (+) 3 (-) 4 (N)
BG-04 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	+	+	+	-	-	N	+	+	+	+	+	+	+	+	-	+	N	N	N	+	+	+	+	16 (+) 3 (-) 4 (N)	20 (+) 3 (-) 4 (N)
BG-05	Enhance the capacity of the current stormwater system in the Hemlock Farms Community Association to reduce flooding.	+	+	+	-	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	17 (+) 3 (-) 3 (N)	21 (+) 3 (-) 3 (N)

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BG-06	Township building (a designated Red-Cross shelter) needs to be upgraded to include handicap bathrooms, showers, kitchen, technology upgrades to digitize records, and build a separate barn for storage of mechanical equipment and supplies (e.g., cots, blankets, MREs). Purchase additional property to accommodate parking for Township personnel, first-responders reporting to the Volunteer Fire Department next to the Township building (also a designated shelter) and sheltering residents.	+	+	+	+	-	+	+	+	+	+	+	+	+	N	-	N	N	N	N	+	N	+	+	15 (+) 2 (-) 6 (N)	19 (+) 2 (-) 6 (N)
BG-07	Identify mechanisms to educate and inform Township residents regarding CodeRED for example newsletters, link of Township website to the County Emergency page, social media and other methods of public communication.	+	+	+	+	-	+	+	+	+	+	+	+	+	N	+	N	N	N	N	+	N	+	+	15 (+) 2 (-) 6 (N)	19 (+) 2 (-) 6 (N)
BG-08	Utilize the Hazard Mitigation Plan (HMP) when updating the Comprehensive Master Plan; consider including hazard identification, hazard zones risk assessment information, and hazard mitigation goals as identified in the HMP.	+	+	+	+	-	-	+	+	+	+	+	+	+	+	-	+	+	N	+	+	N	+	+	18 (+) 3 (-) 2 (N)	22 (+) 3 (-) 2 (N)
Delaware Township																										

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DE-01	Conduct a feasibility study to size and correctly design a backup-power system for the two buildings at Camp Akenac Recreation Hall and Maintenance building (Township-owned).	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	N	N	N	N	+	N	+	+	16 (+) 2 (-) 5 (N)	20 (+) 2 (-) 5 (N)
DE-02	Identify locations in the Township where emergency sirens should be staged for all hazard emergency notification to residents and responders.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	N	N	N	+	+	N	+	+	17 (+) 2 (-) 4 (N)	21 (+) 2 (-) 4 (N)
DE-03 (Previous Action #14)	Roads used to be interconnected but are no longer due to maintenance and right of ways. Conduct a geospatial study to identify roads that used to be connected that are needed to facilitate emergency service access to communities; and prioritize rehabilitation of these roads.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	18 (+) 2 (-) 3 (N)	22 (+) 2 (-) 3 (N)
DE-04	Assess the bridge on Log and Twig Road's current status; determine if bridge can be mitigated to clear dam failure; and determine alternate route for emergency access, rehabilitate the dam headwalls.	+	+	+	-	-	-	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	16 (+) 4 (-) 3 (N)	20 (+) 4 (-) 3 (N)
DE-05	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)
DE-06	Ensure the continuity of operations at	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	N	N	N	N	+	N	+	+	16 (+) 2 (-)	20 (+) 2 (-)

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(Previous Action #13, revised)	critical facilities. This may include backup power or staging equipment in the Township to respond/recover more quickly.																								5 (N)	5 (N)
DE-07 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	+	+	+	-	-	N	+	+	+	+	+	+	+	+	-	+	N	N	N	+	+	+	+	16 (+) 3 (-) 4 (N)	20 (+) 3 (-) 4 (N)
Dingman Township																										
DI-01	Tunnel Road height and width restrictions prevent emergency vehicles and plows to utilize the road. This road is also subject to flooding. The elevation of Interstate-84 would alleviate the access issues. Work with PennDOT to address.	+	+	+	-	-	-	+	+	+	+	+	+	+	+	-	N	N	N	N	+	+	-	+	14 (+) 5 (-) 4 (N)	18 (+) 5 (-) 4 (N)
DI-02	Rattlesnake Bridge on Spring Brook Road, a single-lane bridge (County-owned), with weight limit; 50 houses may have limited access to emergency services due to the weight restrictions causing an isolated population. Stormwater runoff on both sides have caused the abutments to the bridge to move on the sandy soils. Work with	+	+	+	-	-	-	+	+	+	+	+	+	+	+	-	N	N	N	N	+	N	+	+	14 (+) 4 (-) 5 (N)	18 (+) 4 (-) 5 (N)

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	County Engineering to replace the bridge as a two-lane and realign as needed.																									
DI-03 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	+	+	+	-	-	N	+	+	+	+	+	+	+	+	-	+	N	N	N	+	+	+	+	16 (+) 3 (-) 4 (N)	20 (+) 3 (-) 4 (N)
DI-04 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)
DI-05	Expand the Dingman Township Volunteer Fire Department which is the Township's designated shelter and EMC office to include showers that are ADA-compliant to take in more people during emergencies.	+	+	+	+	-	+	+	+	+	+	+	+	+	N	-	N	N	N	N	+	N	+	+	15 (+) 2 (-) 6 (N)	19 (+) 2 (-) 6 (N)
DI-06	Ensure continuity of operations at Township critical facilities: • Township Garage by installing a permanent generator, • Municipal Office generator is old and requires an update;	+	+	+	-	-	+	+	+	+	+	+	+	+	+	-	N	N	N	N	+	N	+	+	15 (+) 3 (-) 5 (N)	19 (+) 3 (-) 5 (N)

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	• Fire House may need an upgrade																									
Greene Township																										
G-01	Ensure the continuity of operations at critical facilities in the Township. Purchase and install a generator at the Hemlock Road Church which serves as the Township shelter.	+	+	+	-	-	+	+	+	+	+	+	+	+	+	-	N	N	N	N	+	N	+	+	15 (+) 3 (-) 5 (N)	19 (+) 3 (-) 55 (N)
G-02 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)
G-03	Investigate ways to mitigate flooding on Township roadways including Mountain View Road	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	N	+	N	+	+	17 (+) 2 (-) 4 (N)	21 (+) 2 (-) 4 (N)
G-04 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	+	+	+	-	-	N	+	+	+	+	+	+	+	+	-	+	N	N	N	+	+	+	+	16 (+) 3 (-) 4 (N)	21 (+) 3 (-) 4 (N)
G-05	Increase the capacity of pipes in the Township to reduce flooding	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	18 (+) 2 (-) 3 (N)	22 (+) 2 (-) 3 (N)

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Lackawaxen Township																										
LA-01 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)
LA-02 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	+	+	+	-	-	N	+	+	+	+	+	+	+	+	-	+	N	N	N	+	+	+	+	17 (+) 3 (-) 4 (N)	21 (+) 3 (-) 4 (N)
LA-03	Stabler Road entrance needs to be widened and engineering design is required to ensure the safety of vehicles. Currently the road is too narrow and requires a 180-degree turn and with growing traffic this is a safety concern. If the road is closed due to downed trees or vehicular accidents, there is no alternate route for emergency services and this creates an isolated and vulnerable population.	+	+	+	-	-	+	+	+	+	+	+	+	+	+	-	N	N	N	N	+	N	+	N	14 (+) 3 (-) 6 (N)	18 (+) 3 (-) 6 (N)
LA-04	Improvements to Case Bridge to ensure it can handle flood waters: paving, rails,	+	+	+	-	-	+	+	+	+	+	+	+	+	+	-	N	N	N	N	+	N	+	N	14 (+) 3 (-)	18 (+) 3 (-)

Mitigation Action		PA-STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							Results	
		P Political			A Admin-istrative			S Social		T Technical			E Economic				E Environmental					L Legal				
No.	Name	Political Support	Local Champion	Public Support	Staffing	Funding Allocation	Maintenance / Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	**Benefit of Action (x3)**	**Cost of Action (x3)**	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HazMat / Waste Site	Consistent with Community Environmental Goals	Consistent with Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	Summary (Equal Weighing)	Summary (Priority Ranking)
	wing-walls, new bridge span and decking, beams,																								6 (N)	6 (N)
LA-05	Ensure the continuity of operations at critical facilities in the Township.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	N	N	N	N	+	N	+	+	16 (+) 2 (-) 5 (N)	20 (+) 2 (-) 5 (N)
LA-06	Identify mechanisms to educate and inform Township residents regarding CodeRED for example newsletters, link of Township website to the County Emergency page, social media and other methods of public communication.	+	+	+	+	+	+	+	+	+	+	+	+	+	N	+	N	N	N	N	+	N	+	+	17 (+) 0 (-) 6 (N)	21 (+) 0 (-) 6 (N)
Lehman Township																										
LE-01 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)
LE-02 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	+	+	+	-	-	N	+	+	+	+	+	+	+	+	-	+	N	N	N	+	+	+	+	17 (+) 3 (-) 4 (N)	21 (+) 3 (-) 4 (N)

Mitigation Action		PA-STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							Results	
		P Political			A Admin-istrative			S Social		T Technical			E Economic				E Environmental					L Legal				
No.	Name	Political Support	Local Champion	Public Support	Staffing	Funding Allocation	Maintenance / Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	**Benefit of Action (x3)**	**Cost of Action (x3)**	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HazMat / Waste Site	Consistent with Community Environmental Goals	Consistent with Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	Summary (Equal Weighting)	Summary (Priority Ranking)
LE-03	Increase the capacity of the existing culverts along Broadhead Road in Lehman Township which regularly floods due to rain events and further harden the road embankments there are vulnerable to landslides.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	N	+	N	+	+	17 (+) 2 (-) 4 (N)	21 (+) 2 (-) 4 (N)
LE-04	Raspberry Run Road is an emergency route for responders and a secondary route to evacuate camps and three private communities. If Minks Pond Road is not accessible (main road), this road needs to be used and more direct route. The Township would like to have Raspberry Run Road drivable during times of disaster as an emergency access route and requires subsurface stone and tar and chip to keep the road in useable shape.	+	+	+	-	-	+	+	+	+	+	+	+	+	N	-	N	N	N	N	+	N	+	+	17 (+) 3 (-) 6 (N)	21 (+) 3 (-) 6 (N)
Matamoras Borough																										
MA-01 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	+	+	+	-	-	N	+	+	+	+	+	+	+	+	-	+	N	N	N	+	+	+	+	16 (+) 3 (-) 4 (N)	20 (+) 3 (-) 4 (N)

Mitigation Action		PA-STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							Results	
		P Political			A Admin-istrative			S Social		T Technical			E Economic				E Environmental					L Legal				
No.	Name	Political Support	Local Champion	Public Support	Staffing	Funding Allocation	Maintenance / Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	**Benefit of Action (x3)**	**Cost of Action (x3)**	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HazMat / Waste Site	Consistent with Community Environmental Goals	Consistent with Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	Summary (Equal Weighting)	Summary (Priority Ranking)
MA-02	Develop a public phone, web, media dialer, email notification system for all hazard communications Borough-wide.	+	+	+	-	-	+	+	+	+	+	+	+	+	N	+	N	N	N	N	+	N	+	+	16 (+) 2 (-) 5 (N)	20 (+) 2 (-) 5 (N)
MA-03 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)
Milford Borough																										
MB-01 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)
MB-02	Work with the Pike County Office of Community Planning to map and/or update maps/plans for stormwater conveyance systems including pipe sizes, inlets, outlets, and integrate into GIS system	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)

Mitigation Action		PA-STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							Results	
		P Political			A Admin-istrative			S Social		T Technical			E Economic				E Environmental					L Legal				
No.	Name	Political Support	Local Champion	Public Support	Staffing	Funding Allocation	Maintenance / Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	**Benefit of Action (x3)**	**Cost of Action (x3)**	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HazMat / Waste Site	Consistent with Community Environmental Goals	Consistent with Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	Summary (Equal Weighing)	Summary (Priority Ranking)
MB-03 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	+	+	+	-	-	N	+	+	+	+	+	+	+	+	-	+	N	N	N	+	+	+	+	16 (+) 3 (-) 4 (N)	20 (+) 3 (-) 4 (N)
MB-04	The Borough will continue to monitor and track rain events to determine if the stormwater system capacities are sufficient or if upgrades are needed to handle storm events.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	N	N	N	+	+	+	+	19 (+) 1 (-) 3 (N)	23 (+) 1 (-) 3 (N)
MB-05	Work to identify emergency shelters that could be utilized in times of weather events and natural disasters; obtain emergency backup power and supplies if so needed.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	N	+	+	+	+	18 (+) 2 (-) 3 (N)	22 (+) 2 (-) 3 (N)
MB-06	Identify mechanisms to educate and inform Borough residents regarding hazards events which could potentially impact the health and safety for example newsletters, social media and other methods of public communication.	+	+	+	+	+	+	+	+	+	+	+	+	+	N	+	N	N	N	N	+	N	+	+	17 (+) 0 (-) 6 (N)	21 (+) 0 (-) 6 (N)
Milford Township																										

Mitigation Action		PA-STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable: P Political			A Admin-istrative			S Social		T Technical			E Economic				E Environmental					L Legal			Results	
No.	Name	Political Support	Local Champion	Public Support	Staffing	Funding Allocation	Maintenance / Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	**Benefit of Action (x3)**	**Cost of Action (x3)**	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HazMat / Waste Site	Consistent with Community Environmental Goals	Consistent with Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Summary (Equal Weighing)**	**Summary (Priority Ranking)**
MT-01 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)
MT-02 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	+	+	+	-	-	N	+	+	+	+	+	+	+	+	-	+	N	N	N	+	N	+	+	16 (+) 3 (-) 5 (N)	20 (+) 3 (-) 5 (N)
MT-03	Work with the gas company (formerly Columbia Gas) to develop an evacuation plan to address emergencies related to the compressor station or the pipeline itself.	+	+	+	-	-	N	+	+	+	+	+	+	+	+	-	+	N	+	N	+	N	+	+	16 (+) 3 (-) 4 (N)	20 (+) 3 (-) 4 (N)
MT-04	Purchase a storage unit and shelter supplies including cots, blankets, MREs for the Township municipal hall that serves as a shelter	+	+	+	-	-	N	+	+	+	+	+	+	+	+	-	N	N	N	N	+	N	+	+	14 (+) 3 (-) 6 (N)	18 (+) 3 (-) 6 (N)
Palmyra Township																										

Mitigation Action		PA-STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							Results	
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No.	Name	Political Support	Local Champion	Public Support	Staffing	Funding Allocation	Maintenance / Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	**Benefit of Action (x3)**	**Cost of Action (x3)**	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HazMat / Waste Site	Consistent with Community Environmental Goals	Consistent with Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Summary (Equal Weighing)**	**Summary (Priority Ranking)**
PA-01 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)
PA-02	Township to facilitate outreach to private communities to obtain access rights to connecting roads for emergency services. This would provide increased access to both communities during hazard events such as storms that cause downed trees to provide multiple access points to populations and avoid isolated population. Construct gate with lock for Township and emergency services use only.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	18 (+) 2 (-) 3 (N)	22 (+) 2 (-) 3 (N)
PA-03	Enhance education and awareness to seasonal population (lakeside communities) which increases population by greater than 50% on all hazards including the following: 1- Emergency communication systems (e.g., CodeRED) 2. Invasive species 3. Radon exposure	+	+	+	+	+	+	+	+	+	+	+	+	+	N	+	N	N	N	N	+	N	+	+	17 (+) 0 (-) 6 (N)	21 (+) 0 (-) 6 (N)
Porter Township																										

Mitigation Action		PA-STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							Results	
		P Political			A Admin-istrative			S Social		T Technical			E Economic				E Environmental					L Legal				
No.	Name	Political Support	Local Champion	Public Support	Staffing	Funding Allocation	Maintenance / Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	**Benefit of Action (x3)**	**Cost of Action (x3)**	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HazMat / Waste Site	Consistent with Community Environmental Goals	Consistent with Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Summary (Equal Weighing)**	**Summary (Priority Ranking)**
PO-01 (Previous Action #18, enhanced)	Increase capacity of the existing stormwater system to include the following areas: • Old Route 402 – subject to flooding and erosion • Snow Hill Road • Whittaker Road	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	18 (+) 2 (-) 3 (N)	22 (+) 2 (-) 3 (N)
PO-02 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	+	+	+	-	-	N	+	+	+	+	+	+	+	+	-	+	N	N	N	+	+	+	+	16 (+) 3 (-) 4 (N)	20 (+) 3 (-) 4 (N)
PO-03	Develop a customized communication plan for Porter Township to convey risk in multiple formats due unique conditions in Porter Township (e.g., poor cell phone coverage, several small private communities and properties without electricity), increase usage of social media, leverage County communication system (CodeRED and reverse 911) and regularly update points of in the Township's Emergency Plan (primary and secondary points of contact) to distribute information.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	N	N	N	N	+	N	+	+	16 (+) 2 (-) 5 (N)	20 (+) 2 (-) 5 (N)

Mitigation Action		PA-STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							Results	
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No.	Name	Political Support	Local Champion	Public Support	Staffing	Funding Allocation	Maintenance / Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	**Benefit of Action (x3)**	**Cost of Action (x3)**	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HazMat / Waste Site	Consistent with Community Environmental Goals	Consistent with Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Summary (Equal Weighing)**	**Summary (Priority Ranking)**
PO-04	Bushkill Bridge (steel bridge) is Township owned and gets inspected by the County. This bridge gets washed out at both ends and water goes over the bridge deck; major scouring has occurred and damage of guiderails. Ice has also damaged the bridge. Elevate the bridge or investigate other methods to ensure flood waters can pass.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	N	N	N	N	+	N	+	+	16 (+) 2 (-) 5 (N)	20 (+) 2 (-) 5 (N)
PO-05	Ensure continuity of operations at Township critical facilities such as: 1) Township building does not have back-up power 2) Township-designated shelter (General Store - Pickerall Inn) needs to be replaced	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	N	N	N	N	+	N	+	+	16 (+) 2 (-) 5 (N)	20 (+) 2 (-) 5 (N)
PO-06 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)
Shohola Township																										
S-01 (Previous Action #29 wording	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)

Mitigation Action		PA-STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							Results	
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No.	Name	Political Support	Local Champion	Public Support	Staffing	Funding Allocation	Maintenance / Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	**Benefit of Action (x3)**	**Cost of Action (x3)**	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HazMat / Waste Site	Consistent with Community Environmental Goals	Consistent with Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	Summary (Equal Weighing)	Summary (Priority Ranking)
enhanced)																										
S-02	Ensure continuity of operations at Township buildings. The Town Barn that houses all equipment and vehicles (dump trucks, snow removal equipment, tractors) is in need of a backup generator to ensure continuity of operations during hazard events.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	N	N	N	N	+	N	+	+	16 (+) 2 (-) 5 (N)	20 (+) 2 (-) 5 (N)
S-03	Sheltering: During Hurricane Irene, Twin Cedars (senior home) was evacuated to the Fire Department but it is not a suitable shelter; inadequate space; no handicap bathrooms and no shelter supplies. Construct an extension on the Fire Department to become a suitable shelter. Update the Township EOP to have the Township Building be primary shelter. It has larger rooms and handicap-accessible bathrooms. Purchase a storage unit and shelter supplies including cots, blankets, MREs for the Township to access when shelters open.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	N	N	N	N	+	N	+	+	16 (+) 2 (-) 5 (N)	20 (+) 2 (-) 5 (N)

Mitigation Action		PA-STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							Results	
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No.	**Name**	Political Support	Local Champion	Public Support	Staffing	Funding Allocation	Maintenance / Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	**Benefit of Action (x3)**	**Cost of Action (x3)**	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HazMat / Waste Site	Consistent with Community Environmental Goals	Consistent with Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Summary (Equal Weighting)**	**Summary (Priority Ranking)**
S-04 (Previous Action #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	+	+	+	-	-	N	+	+	+	+	+	+	+	+	-	+	N	N	N	+	+	+	+	16 (+) 3 (-) 4 (N)	20 (+) 3 (-) 4 (N)
Westfall Township																										
W-01	Relocate critical facilities to reduce flood impacts.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	18 (+) 2 (-) 3 (N)	22 (+) 2 (-) 3 (N)
W-02	Conduct a feasibility study to evaluate mitigation alternatives to reduce flood impacts in Westfall Township and Matamoras Borough along the Route 6 corridor.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	18 (+) 2 (-) 3 (N)	22 (+) 2 (-) 3 (N)
W-03	Conduct education and outreach to Township residents regarding the option of purchasing NFIP flood insurance.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	N	N	N	+	+	N	+	+	18 (+) 1 (-) 4 (N)	22 (+) 1 (-) 4 (N)
W-04	The access road (Riverview Terrace) to the Milford Senior Care & Rehabilitation Center, located between Route 6/209 and the Delaware River, floods causing ingress/egress challenges for the vulnerable population. Increase the capacity of the existing concrete pipes and culverts and explore connecting the	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	18 (+) 2 (-) 3 (N)	22 (+) 2 (-) 3 (N)

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No.	Name	Political Support	Local Champion	Public Support	Staffing	Funding Allocation	Maintenance / Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	**Benefit of Action (x3)**	**Cost of Action (x3)**	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HazMat / Waste Site	Consistent with Community Environmental Goals	Consistent with Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	Summary (Equal Weighing)	Summary (Priority Ranking)
	driveway to the Delaware Valley School next door.																									
W-05	Purchase portable/deployable flood walls to mitigate flooding at the Township Municipal Building and the Westfall Fire Department located in the floodplain.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	18 (+) 2 (-) 3 (N)	22 (+) 2 (-) 3 (N)
W-06	Westfall Sewage Treatment Plant is located in the floodplain; electrical equipment is high enough but need to explore options to flood-proof the doors.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	18 (+) 2 (-) 3 (N)	22 (+) 2 (-) 3 (N)
W-07	Install backflow prevention or water-tight door or flap at the southerly side of the pedestrian crossing. The water pressure from the flood water would seal the opening and alleviate flooding in the Township of Matamoras.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	18 (+) 2 (-) 3 (N)	22 (+) 2 (-) 3 (N)
W-08	Install backflow prevention valves on remaining pipes to reduce flooding along the Route 209 Commercial Area.	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	18 (+) 2 (-) 3 (N)	22 (+) 2 (-) 3 (N)
W-09 (Previous Actions #10 and #22 wording enhanced)	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	+	+	+	+	-	-	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	+	17 (+) 3 (-) 3 (N)	21 (+) 3 (-) 3 (N)

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No.	Name	Political Support	Local Champion	Public Support	Staffing	Funding Allocation	Maintenance / Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	**Benefit of Action (x3)**	**Cost of Action (x3)**	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HazMat / Waste Site	Consistent with Community Environmental Goals	Consistent with Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	Summary (Equal Weighing)	Summary (Priority Ranking)
W-10	Construct an emergency access road at the end of the cul-de-sac at the end of Mountain Avenue to access I-84 (westbound) to provide increased access/egress in emergencies.	+	+	+	-	-	-	+	+	+	+	+	+	+	+	-	N	N	N	N	N	+	-	-	12 (+) 6 (-) 5 (+)	16 (+) 6 (-) 5 (+)
W-11 (Previous Action #29 wording enhanced)	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)
W-12	Promote or adopt higher regulatory and zoning standards to manage hazard risk; specifically, through updates to the building codes, flood ordinances, and subdivision and land development ordinances. Goals of increased standards are to ensure new buildings and infrastructure are discouraged or prohibited in high-hazard areas in their jurisdiction.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	+	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)
W-13	The Bush Kill Creek traverses under Bluestone Boulevard. The channel runs very close to the edge of the road and is eroding the slope. There is debris in the channel backing up. Review the study currently being conducted to determine	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	N	N	+	+	N	+	N	17 (+) 2 (-) 4 (N)	21 (+) 2 (-) 4 (N)

Mitigation Action		PA-STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							Results	
		P Political			A Admin-istrative			S Social		T Technical			E Economic				E Environmental					L Legal				
No.	Name	Political Support	Local Champion	Public Support	Staffing	Funding Allocation	Maintenance / Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	**Benefit of Action (x3)**	**Cost of Action (x3)**	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HazMat / Waste Site	Consistent with Community Environmental Goals	Consistent with Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Summary (Equal Weighing)**	**Summary (Priority Ranking)**
	best mitigation action to implement.																									

Notes:
CDBG = Community Development Block Grant
CRS = Community Rating System
EOC = Emergency Operations Center
FEMA = Federal Emergency Management Agency
FIRM = Flood Insurance Rate Map
FPA = Floodplain Administrator
GIS = Geographic information system
HMA = Hazard Mitigation Assistance
NFIP = National Flood Insurance Program
PADEP = Pennsylvania Department of Environmental Protection
PEMA = Pennsylvania Emergency Management Agency
SFHA = Special Flood Hazard Area
TBD = To Be Determined

6.4.3 Prioritization of Mitigation Actions

Once the mitigation actions were evaluated, the Planning Team set about prioritizing them to create an implementation strategy. FEMA mitigation planning requirements indicate that any prioritization system used shall include a special emphasis on the extent to which benefits are maximized according to a cost-benefit review of the proposed projects. Though the PA-STEEL values for each action are somewhat qualitative, all of the actions listed as having an economic impact indicated that that impact would be beneficial to the community. Whether the actions had associated costs or not, those mitigation actions could not be ruled out based on the benefit or cost values in the PA-STEEL evaluation. Implementation of any project will be based on a benefit-cost analysis as described in FEMA 386-5: Using Benefit Cost Review in Mitigation Planning (FEMA 2007). The specific economic benefits and costs will be determined prior to application for funding of the mitigation project.

Participants in the 2017 HMP update process provided comments via the Mitigation Action Worksheet process that allowed for the prioritization of the mitigation actions listed in Table 6-5 using the PA-STEEL criteria. To evaluate and prioritize the mitigation actions, the County identified *favorable* and *less favorable* factors for each action. Table 6-5 summarizes the evaluation methodology and provides the results of this evaluation for all 121 mitigation actions (46 County actions and 75 municipal actions) in two columns. The first results column includes a summary of the feasibility factors, placing equal weight on all factors. The second results column reflects feasibility scores with benefits and costs weighted more heavily; and therefore, given greater priority. A weighting factor of 3 was used for each benefit and cost element. Therefore, a "+" benefit factor rating equals three pluses, and a "-" benefit factor rating equals three minuses in the total prioritization score.

The results of the weighted PA-STEEL matrix were examined to prioritize the mitigation actions. The number of unfavorable ratings was subtracted from the number of favorable ratings to determine each action's score. The average score was 19, with a standard deviation of 2.8. Actions that received more than 21 points (one standard deviation above the average) were assigned high priority. Actions that received scores of 19 to 21, inclusive, were assigned medium priority. Other actions were assigned low priority.

The actions in Table 6-6 are listed in order of priority, with the high-priority actions first. This list of actions is the result of the planning effort led by the Planning Team and represents what the County and municipalities consider most important. Any actions, including projects, to be implemented will have benefits outweighing their associated costs (i.e., the benefit-cost ratio would be greater than 1).

As noted earlier, Mitigation Action Worksheets were developed for each project included in the HMP. The prioritization provided in the PA-STEEL table may differ slightly from the County and municipal ranking assigned of high, medium or low in Table 6-4 and on these worksheets. For instance, a municipality may have submitted a Mitigation Action Worksheet where the project was designated as high priority; however, the PA-STEEL prioritization considers it a medium priority. Based on conversations with the County and municipalities, the high, medium and low priority assigned during the action identification and documentation process on the worksheets was driven by risk (greatest hazard risk and avoided losses), available funding, and in-house resources to implement the proposed action. The County and each municipality determined the priority when comparing these factors across their jurisdiction only. The PA-STEEL prioritization considers additional factors and through the averaging process, compares actions and priority ranking County-wide. In many cases, actions ranked high using PA-STEEL because outside funding may not be needed to implement the action.

A blank Mitigation Action Worksheet template is included in Appendix H. The set of completed action worksheets and a table summarizing the worksheets by jurisdiction are presented in Appendix I.

Table 6-6. Prioritized Mitigation Actions

Mitigation Action		Score
High Priority		
PC-19	Pike County to work with the National Park Service to discuss areas that are in need of stream clearing.	24
PC-20	Continue to use and improve GIS capability to identify and prioritize hazards and critical infrastructure for mitigation, as well as areas targeted for potential new development.	24
PC-25	Continue groundwater level monitoring through at least 2018 to assess potable groundwater levels providing 10 years of data for drought trigger analysis.	24
PC-36	Work with Westfall Township, Matamoras Borough and Milford Borough to map stormwater facilities, infrastructure, and conveyance systems including pipe sizes, inlets, outlets, and integrate into GIS system.	24
BG-01, DE-05, DI-04, G-02, LA-01, LE-01, MA-03, MB-01, MT-01, PA-01, PC-26, PO-06, S-01, W-11	Continue activities of the Pike County Road Task Force to address emergency preparedness, winter preparedness, and coordination of winter operations with school district officials	24
MB-02	Work with the Pike County Office of Community Planning to map and/or update maps/plans for stormwater conveyance systems including pipe sizes, inlets, outlets, and integrate into GIS system	24
W-12	Promote or adopt higher regulatory and zoning standards to manage hazard risk; specifically, through updates to the building codes, flood ordinances, and subdivision and land development ordinances. Goals of increased standards are to ensure new buildings and infrastructure are discouraged or prohibited in high-hazard areas in their jurisdiction.	24
PC-32	Pike County to continue working with USDA Natural Resources Conservation Service to design and rehabilitate Kintz Creek Dam.	23
PC-33	Pike County EMA to continue to work with the three school districts on the following: 1) Annual review of emergency action plans and disaster response plans; 2) Conduct audits and ensure adequate backup power and water contingencies are in place so they may serve as shelters	23
PC-35	Hold a workshop to educate and train municipalities about annual FEMA funding sources and the grant application process.	23
PC-40	Participate in emergency planning for applicable hazard and emergency response events. Specific types of planning relevant to the County and its municipalities include EAPs for dams, radiological emergency plans for nuclear incidents, winter preparedness plans, evacuation signage plans, Phase II Act 167 Stormwater Management Plan, and commodity flow studies. Additionally, other plans should be reviewed to ensure coordination with hazard mitigation planning techniques.	23
PC-30	Work with watershed associations and municipal officials to coordinate water conservation and sewage management programs in local communities.	22
PC-34	County to work with municipalities to develop databases to track development in the Special Flood Hazard Area (SFHA).	22
PC-41	Pike County Office of Community Planning and applicable municipal offices will review their comprehensive plans to ensure that designated growth areas are not within high-hazard areas identified in the HMP.	22
MB-04	The Borough will continue to monitor and track rain events to determine if the stormwater system capacities are sufficient or if upgrades are needed to handle storm events.	22
Medium Priority		
PC-03	Maintain compliance with and good standing in the NFIP, including adoption and enforcement of floodplain management requirements (e.g., regulating all new and substantially improved construction in special-hazard flood areas), floodplain identification and mapping, and flood insurance outreach to the community. Further meet and/or exceed the minimum NFIP standards and criteria through the following NFIP-related continued compliance actions identified in subsequent initiatives.	21
PC-14	Work with PennDOT to implement transportation upgrades to roads with high flooding vulnerability. Projects could include culvert enhancement, culvert replacement, and road elevation.	21
PC-15	Work with PennDOT and the National Park Service to utilize beet juice to supplement brine/salt to treat roads during winter conditions	21
PC-27	Utilize the County's Marcellus Shale task force to prepare for and educate municipalities about updating ordinances and proper permitting for Marcellus Shale gas wells	21
PC-39	Conduct education and outreach on municipal stormwater systems and potential impact to flooding/water quality.	21

	Mitigation Action	Score
LA-06	Identify mechanisms to educate and inform Township residents regarding CodeRED for example newsletters, link of Township website to the County Emergency page, social media and other methods of public communication.	21
MB-06	Identify mechanisms to educate and inform Borough residents regarding hazards events which could potentially impact the health and safety for example newsletters, social media and other methods of public communication.	21
PA-03	Enhance education and awareness to seasonal population (lakeside communities) which increases population by greater than 50% on all hazards including the following: Emergency notification systems, invasive species, radon exposure	21
W-03	Conduct education and outreach to Township residents regarding the option of purchasing NFIP flood insurance.	21
DE-02	Identify locations in the Township where emergency sirens should be staged for all hazard emergency notification to residents and responders.	21
PC-04	Promote or adopt higher regulatory and zoning standards to manage hazard risk; specifically, through updates to the building codes, flood ordinances, and subdivision and land development ordinances. Goals of increased standards are to ensure new buildings and infrastructure are discouraged or prohibited in high-hazard areas in their jurisdiction.	20
PC-05	Increase awareness of and participation in FEMA's Community Rating System (CRS) Program.	20
PC-06	Pike County EMA will work with electric distribution companies to implement an annual tree-trimming program to minimize storm damage.	20
PC-18	Implement stormwater management projects to facilitate stormwater flow during severe storms.	20
PC-23	Provide training to local NFIP Floodplain Administrators to potentially include Certified Floodplain Manager (CFM) course.	20
PC-24	Pike County EMA to continue working with Pocono Environmental Education Center and municipalities to participate in Firewise.	20
PC-31	Work recreation amenities to develop educational materials regarding the risk of drowning to distribute to resorts, hotels, and other vacation areas	20
G-05	Increase the capacity of pipes in the Township to reduce flooding	20
MB-05	Work to identify emergency shelters that could be utilized in times of weather event and natural disasters; obtain emergency backup power and supplies if so needed.	20
PA-02	Township to facilitate outreach to private communities to obtain access rights to connecting roads for emergency services. This would provide increased access to both communities during hazard events such as storms that cause downed trees to provide multiple access points to populations and avoid isolated population. Construct gate with lock for Township and emergency services use only.	20
PO-01	Increase capacity of the existing stormwater system to include the following areas:	20
W-01	Reduce flood impacts to critical facilities and emergency access roads.	20
W-02	Conduct a feasibility study to evaluate mitigation alternatives to reduce flood impacts in Westfall Township and Matamoras Borough along the Route 6 corridor.	20
W-04	The access road (Riverview Terrace) to the Milford Senior Care & Rehabilitation Center, located between Route 6/209 and the Delaware River, floods causing ingress/egress challenges for the vulnerable population. Increase the capacity of the existing concrete pipes and culverts and explore connecting the driveway to the Delaware Valley School next door.	20
W-05	Purchase portable/deployable flood walls to mitigate flooding at the Township Municipal Building and the Westfall Fire Department located in the floodplain.	20
W-06	Westfall Sewage Treatment Plant is located in the floodplain; electrical equipment is high enough but need to explore options to flood-proof the doors.	20
W-07	Install backflow prevention or water-tight door or flap at the southerly side of the pedestrian crossing. The water pressure from the flood water would seal the opening and alleviate flooding in the Township of Matamoras.	20
W-08	Install backflow prevention valves on remaining pipes to reduce flooding along the Route 209 Commercial Area.	20
DE-03	Roads used to be interconnected but are no longer due to maintenance and right of ways. Conduct a geospatial study to identify roads that used to be connected that are needed to facilitate emergency service access to communities; and prioritize rehabilitation of these roads.	20
PC-07	Explore the creation of a Pike County Health Department	19
PC-10	Work with County and power companies to identify roads within the municipality considered "critical;" these would be the first priority for clearing after an event involving downed power lines.	19

	Mitigation Action	Score
PC-11	Work with PEMA and PA DEP to obtain an updated list of dams and ownership; work with Silver Jackets to assist private dam owners and the financial hardship of maintenance.	19
PC-17	Implement debris-flow projects, including slope stabilization, energy dissipation, or vegetative plantings.	19
PC-28	Coordinate with the National Weather Service to hold an educational seminar regarding lightning safety	19
PC-29	Develop a County Task Force to identify ways to incentivize volunteer fire fighting, address equipment and facility upgrades, provide training opportunities for emergency service providers, and upgrade EMS service in eastern and central areas of Pike County	19
PC-42	Encourage all critical government facilities to have COOP and COG plans and to begin implementing appropriate backup systems.	19
PC-45	Purchase and install weather station to capture meteorological data and communicate to smart phones to utilize information during response/recovery	19
BG-08	Utilize the Hazard Mitigation Plan (HMP) when updating the Comprehensive Master Plan; consider including hazard identification, hazard zones risk assessment information, and hazard mitigation goals as identified in the HMP.	19
G-03	Investigate ways to mitigate flooding on Township roadways including Mountain View Road	19
LE-03	Increase the capacity of the existing culverts along Broadhead Road in Lehman Township which regularly floods due to rain events and further harden the road embankments there are vulnerable to landslides.	19
W-13	The Bush Kill Creek traverses under Bluestone Boulevard. The channel runs very close to the edge of the road and is eroding the slope. There is debris in the channel backing up. Review the study currently being conducted to determine best mitigation action to implement.	19
Low Priority		
PC-01	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties should be a priority, when applicable.	18
PC-02	Work with partner organizations to develop informational releases about hazard mitigation for newspapers, websites, circulars, and property owners' association newsletters.	18
PC-08	Assess and update emergency operations center equipment to improve communication. Targeted needs include:	18
PC-09	Ensure continuity of operations at critical facilities and infrastructure. Options may include purchase and install generators.	18
PC-12	Install dry hydrants	18
PC-22	Purchase and install boat washing stations to help prevent the spread of aquatic invasive species	18
PC-37	Complete education/outreach among local officials as to the benefits of implementing the Phase II Countywide Stormwater Management Plan (Act 167 Plan)	18
PC-38	Identify and coordinate with appropriate partners and agencies to arrange for data collection of flood and structure data necessary to perform a level 2 HAZUS analysis for the next hazard mitigation plan update. Building data may be collected as part of reassessment of Pike County properties. (i.e. Building Value, Lowest Floor Elevation, Building Type, Occupancy Type, Foundation Type, Number of Stories and Square Footage).	18
PC-43	Hold annual meetings to ensure that mitigation, planning, preparedness, and response personnel are (1) cross-trained in each other's area of expertise, (2) aware of ongoing activities, and (3) fostering increased communication.	18
PC-44	Hold an education seminar and develop educational materials regarding radon exposure	18
BG-05	Enhance the capacity of the current stormwater system in the Hemlock Farms Community Association to reduce flooding.	18
DE-06	Ensure the continuity of operations at critical facilities. This may include backup power or staging equipment in the Township to respond/recover more quickly.	18
G-04	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	18
LA-02	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	18
LA-05	Ensure the continuity of operations at critical facilities in the Township.	18
LE-02	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	18

	Mitigation Action	Score
LE-04	Raspberry Run Road is an emergency route for responders and a secondary route to evacuate camps and three private communities. If Minks Pond Road is not accessible (main road), this road needs to be used and more direct route. The Township would like to have Raspberry Run Road drivable during times of disaster as an emergency access route and requires subsurface stone and tar and chip to keep the road in useable shape.	18
MA-02	Develop a public phone, web, media dialer, email notification system for all hazard communications Borough-wide.	18
PO-03	Develop a customized communication plan for Porter Township to convey risk in multiple formats due unique conditions in Porter Township (e.g., poor cell phone coverage, several small private communities and properties without electricity), increase usage of social media, leverage County communication system (CodeRED and reverse 911) and regularly update points of in the Township's Emergency Plan (primary and secondary points of contact) to distribute information.	18
PO-04	Bushkill Bridge (steel bridge) is Township owned and gets inspected by the County. This bridge gets washed out at both ends and water goes over the bridge deck; major scouring has occurred and damage of guiderails. Ice has also damaged the bridge. Elevate the bridge or investigate other methods to ensure flood waters can pass.	18
PO-05	Ensure continuity of operations at Township critical facilities such as: Township building, Township-designated shelter	18
S-02	Ensure continuity of operations at Township buildings. The Town Barn that houses all equipment and vehicles (dump trucks, snow removal equipment, tractors) is in need of a backup generator to ensure continuity of operations during hazard events.	18
S-03	Sheltering: During Hurricane Irene, Twin Cedars (senior home) was evacuated to the Fire Department but it is not a suitable shelter; inadequate space; no handicap bathrooms and no shelter supplies. Construct an extension on the Fire Department to become a suitable shelter. Update the Township EOP to have the Township Building be primary shelter. It has larger rooms and handicap-accessible bathrooms. Purchase a storage unit and shelter supplies including cots, blankets, MREs for the Township to access when shelters open.	18
W-09	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	18
DE-01	Conduct a feasibility study to size and correctly design a backup-power system for the two buildings at Camp Akenac Recreation Hall and Maintenance building (Township-owned).	18
PC-21	Explore development of an outreach effort which includes a model ordinance to require boat washing to prevent the spread of aquatic invasive species	17
PC-13	Identify and monitor transportation routes of hazardous materials. Establish a communication chain between rail and Fire Departments regarding transport of spent fuel rods.	17
PC-16	Purchase Radiac Meters (e.g., UltraRadiac – Personal Radiation Monitor) and thermal detectors for when FD responds to rail incidents	17
BG-02	Repair and increase the level of protection of Hemlock Dam on Hemlock Lake in Hemlock (increase to protect to the 500-year flood event as per communication from the State).	17
BG-03	Madden Road Bridge that crosses York Creek requires work to ensure safety.	17
BG-04	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	17
BG-06	Township building (a designated Red-Cross shelter) needs to be upgraded to include handicap bathrooms, showers, kitchen, technology upgrades to digitize records, and build a separate barn for storage of mechanical equipment and supplies (e.g., cots, blankets, MREs). Purchase additional property to accommodate parking for Township personnel, first-responders reporting to the Volunteer Fire Department next to the Township building (also a designated shelter) and sheltering residents.	17
BG-07	Identify mechanisms to educate and inform Township residents regarding CodeRED for example newsletters, link of Township website to the County Emergency page, social media and other methods of public communication.	17
DE-07, DI-03, MA-01, MB-03, MT-02, PO-02, S-04	Support the mitigation of vulnerable structures via retrofit (e.g. elevation, flood-proofing) or acquisition/relocation to protect them from future damage; repetitive loss and severe repetitive loss properties will be a priority, when applicable.	17
DI-05	Expand the Dingman Township Volunteer Fire Department which is the Township's designated shelter and EMC office to include showers that are ADA-compliant to take in more people during emergencies.	17
MT-03	Work with the gas company (formerly Columbia Gas) to develop an evacuation plan to address emergencies related to the compressor station or the pipeline itself.	17
DI-06	Ensure continuity of operations at Township critical facilities:	16

Mitigation Action		Score
G-01	Ensure the continuity of operations at critical facilities in the Township. Purchase and install a generator at the Hemlock Road Church which serves as the Township shelter.	16
DE-04	Assess the bridge on Log and Twig Road's current status; determine if bridge can be mitigated to clear dam failure; and determine alternate route for emergency access, rehabilitate the dam headwalls.	16
LA-03	Stabler Road entrance needs to be widened and engineering design is required to ensure the safety of vehicles. Currently the road is too narrow and requires a 180-degree turn and with growing traffic this is a safety concern. If the road is closed due to downed trees or vehicular accidents, there is no alternate route for emergency services and this creates an isolated and vulnerable population.	15
LA-04	Improvements to Case Bridge to ensure it can handle flood waters: paving, rails, wing-walls, new bridge span and decking, beams,	15
MT-04	Purchase a storage unit and shelter supplies including cots, blankets, MREs for the Township municipal hall that serves as a shelter	15
PC-46	Pike County EMA to work with PennDOT to purchase and install cameras on I-84 at the Greentown and Milford exits	14
DI-02	Rattlesnake Bridge on Spring Brook Road, a single-lane bridge (County-owned), with weight limit; 50 houses may have limited access to emergency services due to the weight restrictions causing an isolated population. Stormwater runoff on both sides have caused the abutments to the bridge to move on the sandy soils. Work with County Engineering to replace the bridge as a two-lane and realign as needed.	14
DI-01	Tunnel Road height and width restrictions prevent emergency vehicles and plows to utilize the road. This road is also subject to flooding. The elevation of Interstate-84 would alleviate the access issues. Work with PennDOT to address.	13
W-10	Construct an emergency access road at the end of the cul-de-sac at the end of Mountain Avenue to access I-84 (westbound) to provide increased access/egress in emergencies.	10

Notes:
CRS = Community Rating System
EAP = Emergency Action Plan
EOC = Emergency Operations Center
FEMA = Federal Emergency Management Agency
FIRM = Flood Insurance Rate Map
FPA = Floodplain Administrator
GIS = Geographic information system
HMA = Hazard Mitigation Assistance
NFIP = National Flood Insurance Program
PADEP = Pennsylvania Department of Environmental Protection
PDM = Pre-Disaster Mitigation Program
PEMA = Pennsylvania Emergency Management Agency
SFHA = Special Flood Hazard Area

SECTION 7 PLAN MAINTENANCE PROCEDURES

This section describes the system that Pike County and all participating jurisdictions have established to monitor, evaluate, and update the hazard mitigation plan (HMP) (Section 7.1); implement the mitigation plan through existing programs (Section 7.2); and solicit continued public involvement for plan maintenance (Section 7.3).

7.1 UPDATE PROCESS SUMMARY

Monitoring, evaluating and updating the HMP is critical to maintaining its value and success in Pike County's hazard mitigation efforts. Ensuring effective implementation of mitigation activities paves the way for continued momentum in the planning process and gives direction for the future. This section explains who will be responsible for maintenance activities and what those responsibilities entail. It also provides a methodology and schedule of maintenance activities including a description of how the public will be involved on a continued basis.

To the best of the knowledge of the Pike County Steering Committee, no HMP progress reports were submitted from municipalities for the period of 2013 to 2016 although some mitigation actions were accomplished during this period and reported during the 2017 HMP planning process.

The Steering Committee reviewed the 2012 plan maintenance procedures and updated it making it more specific and detailed in several aspects. For example, the annual planning meeting may occur as part of a regularly-scheduled meeting such as the Emergency Management Coordinator quarterly meetings and/or the Pike County Planning Commission meetings. In addition, the plan will continue to be available on the Pike County Planning website. The 2017 plan maintenance procedures also elaborate on how this plan may be integrated into other planning mechanisms in the County.

7.2 MONITORING, EVALUATING, AND UPDATING THE PLAN

The Pike County Office of Community Planning intends to remain intact as the organization responsible for monitoring, evaluating, and updating this plan. Mr. Michael Mrozinski shall continue to serve as the HMP Coordinator for the Planning Team. Each participating jurisdiction is expected to retain a municipal hazard mitigation representative to support the jurisdiction's input to the monitoring, evaluating, and updating responsibilities identified in this section.

Table 7-1 identifies the county and municipal members of the Hazard Mitigation Planning Team as of the date of this HMP. Pike County also made an effort to include stakeholders on the Planning Team to ensure broad input and participation.

Table 7-1. Planning Team

Entity	Name	Title
Blooming Grove Township	Nicholas Mazza	Chairman, Board of Supervisors
	Robert Palumbo	Emergency Management Coordinator
Delaware Township	Jeffrey Sheetz	Chairman, Board of Supervisors
	George Beodeker	Emergency Management Coordinator
Dingman Township	Tom Mincer	Chairman, Board of Supervisors
	William Mikulak	Emergency Management Coordinator
Greene Township	Edward Simon	Supervisor
	Allen Shiffler	Emergency Management Coordinator
Lackawaxen Township	Michael Mancino	Chairman, Board of Supervisors

Entity	Name	Title
	William Fallon	Emergency Management Coordinator
Lehman Township	Robert H. Rohner, Jr	Chairman, Board of Supervisors
	Edward Bland	Emergency Management Coordinator
Matamoras Borough	Joseph Sain	President, Matamoras Borough Council
	Thomas Oliver	Emergency Management Coordinator
Milford Borough	Patrick Beck	President, Milford Borough Council
	David E. Ruby	Emergency Management Coordinator
Milford Township	Gary M. Clark	Chairman, Board of Supervisors
	Robert DiLorenzo	Emergency Management Coordinator
Palmyra Township	Tom Simons	Chairman, Board of Supervisors
	Nick Spinelli	Emergency Management Coordinator
Porter Township	William Powell	Chairman, Board of Supervisors
	Robert Hellyer	Emergency Management Coordinator
Shohola Township	George P. Hoeper	Chairman, Board of Supervisors
	Clint Malzahn	Emergency Management Coordinator; Fire Chief
Westfall Township	Bob Melvin*	Chairman, Board of Supervisors
	Bob Ewbank	Emergency Management Coordinator
Pike County Board of Commissioners	Matthew Osterberg	Chairman
	Rich Caridi	Vice Chairman
	Steve Guccini	Commissioner
Pike County Commissioners Office	Gary Orben	Chief Clerk
Pike County Office of Community Planning	Michael Mrozinski*	Director
	Jessica Grohmann	Assistant Planning Director
	Brian Snyder*	Community Planner
Pike County Emergency Management Agency	Timothy Knapp*	Coordinator
Pike County Conservation District	Sally Corrigan*	Executive Director
Pike County Sheriff's Office	Philip Bueki	Sheriff
Pike County Public Safety	Bernie Swartwood	Director of Communications
Delaware Valley School District	John Bell	Superintendent
East Stroudsburg Area School District	Sharon Laverdue	Superintendent
Wallenpaupack Area School District	Michael Silsby	Superintendent
Pennsylvania Department of Conservation and Natural Resources	Lorne Possinger	Eastern Regional Recreation and Parks Advisor
	Tim Dugan	District Forester, Bureau of Forestry
	Mike Roche	Assistant Manager, Bureau of Forestry
Pennsylvania Department of Environmental Protection	Bob Pitcavage	Northeast Liaison
Pennsylvania Emergency Management Agency	Thomas Hughes	State Hazard Mitigation Officer
	Ernie Szabo	Mitigation Planner
	Anthony J. Camillocci	Eastern Area Office Representative
Pennsylvania Game Commission	Daniel Figured	Northeast Director
PennDOT District 4-4	Kenneth Thiele	Maintenance Manager for Pike County
Penn State Extension	Nancy Grotevant	Pocono District Extension Director
Pennsylvania Power & Light	Alana Roberts	Regional Affairs Director
Orange & Rockland Utilities	Thomas Brizzolara	Director Public Affairs

Entity	Name	Title
Pike Co Light & Power/Corning Gas	Matt Cook	Operations
Upper Delaware Council	Laurie Ramie	Executive Director
Upper Delaware Scenic & Recreational River	Kris Heister	Superintendent
PA Senate 20th District	Andrew Seder	Eastern District Field Representative
PA House of Representatives 139th District	Jill Gamboni	Outreach Specialist
PA House of Representatives 189th District	Kathleen Moran	Representative Aide
Brookfield Energy Partners	Katie Lester	Compliance Specialist
Delaware Water Gap National Recreation Area	John Donahue	Superintendent
Lake Wallenpaupack Watershed Management District	Nick Spinelli	Director
Twin and Walker Creeks Conservancy	Chet Dawson	President
Wayne County, Pennsylvania	Brian Smith	Chairman, Board of Commissioners
	Craig Rickard	Planning Director
Monroe County, Pennsylvania	John Moyer	Chairman, Board of Commissioners
	Christine Meinhart-Fritz	Planning Director
Warren County, New Jersey	Richard Gardner	Director, Board of Chosen Freeholders
	David Dech	Planning Director
Sussex County, New Jersey	Carl Lazzaro	Director, Board of Chosen Freeholders
	Autumn Sylvester	Planning Director
Sullivan County, New York	Luis Alvarez	Chairman, Legislature
	Freda Eisenberg	Planning Commissioner
Orange County, New York	L. Stephen Brescia	Chairman, Legislature
	David Church	Planning Commissioner

**Steering Committee Member*

Understanding that individual commitments change over time, each jurisdiction and its representatives are responsible for informing the Pike County HMP Coordinator of any changes in representation by formal letter. The HMP Coordinator will strive to keep the Planning Team makeup as a uniform representation of planning partners and stakeholders within the planning area. The HMP Coordinator shall maintain the current membership of the Planning Team on the Pike County Office of Community Planning website (http://www.pikepa.org/planning.html) or in publicly accessible County records.

The following sections describe the monitoring, evaluating, and updating process and protocols for the Pike County HMP.

7.2.1 Monitoring

The Planning Team shall be responsible for (1) monitoring progress on, and evaluating the effectiveness of, the HMP, and (2) documenting this progress in a progress report. Prior to Planning Team progress meetings (detailed below), Planning Team representatives may collect information from departments, agencies, and organizations involved with the mitigation activities identified in Section 6 of this plan. The representatives will make phone calls and conduct meetings with persons responsible for initiating and/or overseeing the mitigation projects to obtain progress information. Copies of any grant applications filed on behalf of any of the participating jurisdictions shall be provided to the Planning Team. Further, the representatives shall obtain any public comments made on the HMP from their municipal supervisor, mayor, or councilperson, and provide public comments to the Planning Team for inclusion in the progress report.

The Planning Team representatives shall be expected to document the following, as needed and as appropriate:

- Hazard events and losses occurring in their jurisdiction including their nature and extent, and the effects that hazard mitigation actions have had on impacts and losses
- Progress on the implementation of mitigation actions, including efforts to obtain outside funding for mitigation actions
- Any obstacles or impediments to the implementation of actions
- Additional mitigation actions believed to be appropriate and feasible
- Public and stakeholder input and comment on the Plan

The planning partnership may refer to the evaluation forms, Worksheets #6.1, 6.2, 7.1, and 7.2 in the FEMA Local Mitigation Planning Handbook (March 2013) guidance document, to assist in the evaluation process (Appendix H).

7.2.2 Evaluating

The evaluation of the HMP is an assessment of whether the planning process and actions have been effective, whether the HMP's goals are being reached, and whether changes are needed. The plan will be evaluated on an annual basis to determine the effectiveness of the programs, and to reflect changes that may affect mitigation priorities or available funding.

The status of the HMP will be discussed and documented at an annual plan review meeting with the Hazard Mitigation Planning Team. This meeting may occur as part of a regularly-scheduled public meetings; either the Emergency Management Coordinator quarterly meetings or the Pike County Planning Commission meetings. The annual plan review meeting will be advertised using the Pike County Emergency Management Agency social media and posted on the calendar on the Pike County website. At least one month before the progress plan review meeting, the Pike County HMP Coordinator will advise Planning Team members of the meeting date, agenda, and expectations of the members. The Pike County HMP Coordinator may also distribute additional materials including mitigation project opportunity forms for jurisdictions that may have new information.

The Pike County HMP Coordinator will be responsible for calling and coordinating the progress plan review meeting, and assessing progress toward achieving plan goals and objectives. These evaluations will assess whether:

- Goals and objectives address current and expected conditions
- The nature or magnitude of the risks has changed
- The HMP has been implemented into land use processes on the County and municipal levels
- Current resources are appropriate for implementing the HMP and if different or additional resources are now available
- Actions are cost effective
- Schedules and budgets are feasible
- Implementation problems exist—such as technical, political, legal, or coordination issues with other agencies
- Outcomes have occurred as expected
- Changes in County or municipal resources have impacted plan implementation (for example, funding, personnel and equipment)
- New agencies, departments or staff should be incorporated, including other local governments as defined under Title 44 of the Code of Federal Regulations (CFR), Section 201.6
- Documentation has been completed for any hazards that occurred during the last year

Specifically, the Planning Team will review the mitigation goals, objectives, activities, and projects using performance-based indicators, including:

- New agencies/departments created that have authority to implement mitigation actions or are required to meet goals, objectives, and actions
- Project evaluation based on current needs of the mitigation plan
- Project completion regarding progress of proposed or ongoing actions
- Under/over spending regarding proposed mitigation action budgets
- Achievement of the goals and objectives
- Resource allocation to note if resources are required to implement mitigation activities
- Timeframe comments on whether proposed schedules are sufficient to address actions
- Budget notes (in other words, if budget basis should be changed or is sufficient)
- Lead/support agency commitment notes (if there is a lack of commitment on the part of lead or support agencies)
- Resource comments regarding whether resources are available to implement actions
- Feasibility comments regarding whether certain goals, objectives, or actions prove to be unfeasible

Finally, the Planning Team will evaluate the ways other programs and policies have conflicted or augmented planned or implemented measures, and shall identify policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions (described further under the "Implementation of Mitigation Plan through Existing Programs" subsection presented below in Section 7.2). Other programs and policies can include those that address:

- Economic development
- Environmental preservation and permitting
- Historic preservation
- Redevelopment
- Health and/or safety
- Recreation
- Land use/zoning
- Public education and outreach
- Transportation

The Pike County HMP Coordinator shall be responsible for preparing an HMP Annual Progress Report and if needed, a report after a major declaration, which will be based on the provided local progress reports from each jurisdiction, information presented at the Planning Team meeting, and other information as appropriate and relevant. These reports will provide data for the 5-year update of this HMP and will assist in pinpointing implementation challenges. By monitoring the implementation of the HMP, the Planning Team will be able to assess which projects are completed, which projects are no longer feasible, and which projects may require additional funding. The progress reports will be submitted to PEMA and FEMA Region 3.

This progress report shall apply to all planning partners who have provided input, and as such, shall be developed according to an agreed-upon format and with adequate allowance for input and comment of each planning partner prior to completion and submission to the State Hazard Mitigation Officer. Each planning partner will be responsible for providing this report to its governing body for their review.

During the Planning Team meeting, the planning partners shall establish a schedule for the draft development, review, comment, amendment, and submission of the HMP progress report to the State Hazard Mitigation Officer.

The HMP will also be evaluated and revised following any major disasters to determine whether the recommended actions remain relevant and appropriate. The risk assessment will also be revisited to see if any changes are necessary based on the pattern of disaster damages or if data listed in the Section 4.3 (Hazard Profiles) of this HMP have been collected to facilitate the risk assessment. These revisions are opportunities to increase the community's disaster resistance and build a better and stronger community.

7.2.3 Updating

Section 44 CFR 201.6.d.3 requires that local hazard mitigation plans be reviewed, revised as appropriate, and resubmitted for approval in order to remain eligible for benefits awarded under the Disaster Mitigation Act of 2000 (DMA 2000). The Pike County Hazard Mitigation Planning Team has updated this HMP on a 5-year cycle from the date of initial plan adoption. This update to the HMP shows changes since the 2012 version. The next update to the HMP will occur in 2022.

To facilitate the update process, the Pike County HMP Coordinator—with support from the Planning Team—shall hold a meeting 3 years from the date of plan approval in 2017 to develop and commence with the implementation of a detailed plan update program. The Pike County HMP Coordinator shall invite representatives from the Pennsylvania Emergency Management Agency (PEMA) to this meeting to provide guidance on plan update procedures. This program shall, at a minimum, establish the parties responsible for managing and completing the HMP update effort, features needed to be included in the updated plan, and a detailed timeline with milestones to ensure that the update is completed according to regulatory requirements.

At this meeting, the Planning Team shall determine the resources needed to complete the update. The Pike County HMP Coordinator shall be responsible for ensuring that needed resources are secured (e.g., grant funding).

Following each 5-year update of the mitigation plan, the updated plan will be distributed for public comment. After all comments are addressed, the HMP will be revised and distributed to all Planning Team members and the Pennsylvania State Hazard Mitigation Officer. During this update process, the Planning Team will invite jurisdictions that were nonparticipating (if applicable) during the last update or not as involved in the planning process, as well as additional relevant stakeholders and outside agencies, to join the Planning Team to ensure as comprehensive inclusion as possible.

7.2.4 Implementation of Mitigation Plan Through Existing Programs

The intention of the Planning Team and participating jurisdictions is to incorporate mitigation planning as an integral component of daily government operations. Planning Team members will work with local government officials to integrate the newly adopted hazard mitigation goals and actions into the general operations of government and partner organizations. Further, the sample adoption resolution (located in Section 8) includes a resolution item stating the intent of the local governing body to incorporate mitigation planning as an integral component of government and partner operations. By doing so, the Planning Team anticipates the following:

1) Hazard mitigation planning will be formally recognized as an integral part of overall emergency management efforts.
2) Hazard mitigation planning will be formally recognized as an integral part of land use policies and mechanisms.
3) The HMP, the Comprehensive Plans for Pike County and its municipalities, and County and municipal Emergency Operations Plans (EOP) will become mutually supportive documents that work in concert to meet the goals and needs of County residents.
4) Duplication of effort can be minimized.

Integration of Mitigation into Ongoing and Future Planning Mechanisms

As noted in Section 6, Pike County has made a concerted effort to reduce their vulnerability to natural and non-natural hazards in its planning and in its daily operations since the Pike County HMP was last updated in 2012. The County and its jurisdictions have implemented various programs and projects to reduce the impacts of hazards, including stormwater improvement projects, ensuring continuity of operations through the installation of generators at critical facilities, and education and outreach on numerous natural and non-natural hazards. These projects, programs, and regulations have reduced risk caused by natural and non-natural hazards and support the goals and objectives of this HMP. It is the intent of the County and its participating municipalities to strengthen this focus on mitigation by continuing existing policies, and by further implementing the mitigation policies contained in this HMP. Implementation actions will include incorporating the goals of the HMP into ongoing planning, zoning, building, and engineering activities. Specifically, the County will urge municipalities to take the following actions:

- Fund hazard mitigation projects or actions in operating budgets to the extent possible
- Notify other municipalities about grant and other funding opportunities as they arise
- Evaluate whether all construction projects meet hazard mitigation goals and objectives
- Use data and maps from this HMP as supporting documentation in grant applications
- Ensure local planning or economic development groups identify hazard areas when assisting new businesses in finding a location
- Look at mitigation actions when allocating funding for the municipal budgets
- Incorporate hazard mitigation actions in daily operations and on all projects
- Include hazard mitigation when updating municipal ordinances
- Identify hazard areas in updates of comprehensive plans to identify land use issues
- Review the hazard mitigation plan prior to land use or zoning changes, and permitting or development decisions

The information on hazard, risk, vulnerability, and mitigation contained in this HMP is based on the best science and technology available at the time of the HMP's preparation. Additionally, certain plans, including progress on the Act 167 Plan, were incorporated directly into this HMP. All participating jurisdictions recognize that this information can be invaluable in making decisions under other planning programs, such as comprehensive, capital improvement, and emergency management plans. Existing processes and programs through which the mitigation plan should be implemented are described below.

The plan participants will make every effort to implement the relevant sections and or data contained in the HMP utilizing administrative, budgetary, and regulatory processes as well as partnerships to the maximum extent, as described below.

Administrative

Administrative processes include departmental or organizational work plans, policies, or procedural changes, which could be addressed by the following departments:

- Planning
- Emergency Services
- Conservation District
- Road Departments

Additional administrative measures may integrating the HMP into county-level plans and any municipal updates to comprehensive plans as noted in Section 6.

Budgetary

In terms of budgetary processes, the County will review budgets and, if funding is available, include a line item for mitigation actions. In addition, the County will maximize mitigation aspects of proposed projects, and will encourage municipalities to do likewise.

Regulatory

Regulatory measures—such as the creation of ordinances and other directives—will be considered to support hazard mitigation in the following areas:

- Comprehensive Planning - Institutionalize hazard mitigation for new construction and land use.
- Zoning and Ordinances
- Building Codes - Enforcement of codes or higher standards in hazard areas
- Capital Improvements Plan – Consider projects identified in the HMP and include hazard mitigation in the design of new construction.
- National Flood Insurance Program (NFIP) – Continue participation in this program and explore participation in Community Rating System (CRS) Program.
- Prior to formal changes (amendments) to master plans, zoning, ordinances, capital improvement plans, or other mechanisms that control development, all above-mentioned plans will be reviewed to ensure they are consistent with the hazard mitigation plan.

Funding

The County and its jurisdictions will consider multiple grant sources to fund eligible projects. These opportunities may include, but are not limited to:

- Federal
    - Federal Emergency Management Agency (FEMA) Pre-Disaster Mitigation Program (PDM)
    - FEMA Flood Mitigation Assistance Program (FMA)
    - FEMA Hazard Mitigation Grant Program (HMGP-Stafford Act, Section 404)
    - U.S. Department of Housing and Urban Development (HUD) Community Development Block Grant (CDBG)
    - U.S. Economic Development Administration (EDA) Public Works Program
- State
    - Pennsylvania Department of Transportation (PennDOT) Pennsylvania Infrastructure Bank
    - Pennsylvania Dirt, Gravel and Low Volume Roads program
    - Act 13 Marcellus Shale Legacy Funds - Flood Mitigation Program
- Nonprofit organizations, foundations, and private sources

Other potential federal funding sources include:

- Stafford Act, Section 406 – Public Assistance Program Mitigation Grants
- Federal Highway Administration
- Catalog of Federal Domestic Assistance
- U.S. Fire Administration – Assistance to Firefighter Grants
- U.S. Small Business Administration Pre and Post-Disaster Mitigation Loans
- U.S. Department of Economic Development Administration Grants
- U.S. Army Corps of Engineers
- U.S. Department of Interior, Bureau of Land Management
- Other sources as yet to be defined

Partnerships

The following opportunities for partnerships will be encouraged to provide a broader support and understanding of hazard mitigation:

- Existing neighborhood communities
- Creative Partnership Opportunities for Funding and Incentives
  - Public-Private Partnerships including utilities and businesses
  - State cooperation
  - In-kind resources

- Partnership Opportunities with other Federal, State, and Local Agencies
  - American Red Cross (ARC)
  - U.S. Army Corps of Engineers (USACE)
  - Department of Homeland Security (DHS)
  - Federal Emergency Management Agency (FEMA)
  - National Oceanic and Atmosphere Administration (NOAA)
  - National Weather Service (NWS)
  - Pennsylvania Department of Transportation (PennDOT)
  - Pennsylvania Department of Environmental Protection (PA DEP)
  - Pennsylvania State Police (PSP)
  - United States Department of Agriculture (USDA)
  - United States Department of Transportation (USDOT)
  - United States Geological Service (USGS)
  - Watershed Associations

During the HMP evaluation process, the Planning Team will identify additional policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions, and will include these findings and recommendations in the HMP Progress Report.

7.3 CONTINUED PUBLIC INVOLVEMENT

Pike County and participating jurisdictions are committed to the continued involvement of the public in the hazard mitigation process. Therefore, the HMP will be posted on the Pike County Office of Community Planning website (http://www.pikepa.org/planning.html) during the five year cycle, and copies of the HMP will be made available for review during normal business hours at the Pike County Office of Community Planning.

The Pike County HMP Coordinator will be responsible for receiving, tracking, and filing public comments regarding this HMP. The public will have an opportunity to comment on the HMP at the 3-year review meeting for the HMP and during the 5-year plan update. Pike County will maintain an active link on the Pike County Office of Community Planning website to collect public comments.

The Pike County HMP Coordinator is responsible for coordinating the HMP evaluation portion of the meeting, soliciting feedback, collecting and reviewing the comments, and ensuring their incorporation in the 5-year plan update, as appropriate. Additional meetings may also be held as deemed necessary by the Planning Team. The purpose of these meetings would be to provide an opportunity for the public to express concerns, opinions, and ideas about the mitigation plan.

The Planning Team representatives shall be responsible to ensure that:

- Public comment and input on the HMP, and hazard mitigation in general, are recorded and addressed, as appropriate. An opportunity to comment on the HMP will be provided directly on the project website, and provisions for public comment, in writing, will also be made. All public comments shall be addressed to:

Michael Mrozinski, Director
Pike County Community Planning
837 Route 6, Unit 3
Shohola, PA 18458
T: 570.296.3500 F: 570.296.3501
mmrozinski@pikepa.org
www.pikepa.org/planning.html

- Copies of the latest approved HMP are available for review at the municipal buildings along with instructions to facilitate public input and comment on the HMP.
- Pike County HMP website (www.pikecountypahmp.com) is being maintained throughout the 2017 update. A draft copy of the HMP will be posted for public comment. Upon conclusion of the HMP 2017 update, appropriate notifications and links to the HMP will be maintained on the Pike County Office of Community Planning website (http://www.pikepa.org/planning.html).
- Public notices will be made, as appropriate, to inform the public of the availability of the HMP, particularly during plan update cycles.

The Pike County HMP Coordinator shall ensure that:

- Public comment and input on the HMP (and hazard mitigation in general) are recorded and addressed, as appropriate
- The Pike County Office of Community Planning website is maintained and updated, as appropriate
- All public and stakeholder comments received are documented and maintained
- Copies of the latest approved HMP are available for review at the Pike County Office of Community Planning, along with instructions to facilitate public input and comment on the HMP
- Public notices (including media releases) are made, as appropriate, to inform the public of the availability of the HMP, particularly during plan update cycles

SECTION 8 PLAN ADOPTION

By adopting the Pike County Hazard Mitigation Plan (HMP), local governing bodies demonstrate their commitment to fulfill the mitigation goals and objectives outlined in the plan. Adoption of the HMP by Pike County and each participating jurisdiction legitimizes the HMP and authorizes responsible agencies to execute their responsibilities.

Each participating jurisdiction will continue with formal adoption proceedings upon conditional approval of this HMP from the Federal Emergency Management Agency (FEMA), known as Approval Pending Adoption (APA). Each participating jurisdiction understands that conditional approval of the HMP will be provided for those municipalities that meet the planning requirements with the exception of the adoption requirement, as stated above.

Following adoption or formal action on the HMP, each participating jurisdiction must submit a copy of the resolution or other legal instrument showing formal adoption (acceptance) of the HMP to the Pike County Hazard Mitigation Coordinator. Pike County will forward the executed resolutions to the Pennsylvania Emergency Management Agency (PEMA), who will subsequently forward the resolutions to FEMA. Each participating jurisdiction understands that FEMA will transmit acknowledgement of verification of formal HMP adoption and the official approval of the HMP to the Hazard Mitigation Coordinator. Resolutions reflecting the formal adoption of this HMP by the County and participating jurisdictions are included in Appendix F of this HMP. A sample resolution to be used by the County and its jurisdictions is provided on the following pages in Section 8.

Pike County Hazard Mitigation Plan

County Adoption Resolution

Resolution No. ___________________

Pike County, Pennsylvania

WHEREAS, the municipalities of Pike County, Pennsylvania, are most vulnerable to natural and human-made hazards, which may result in loss of life and property, economic hardship, and threats to public health and safety, and

WHEREAS, Section 322 of the Disaster Mitigation Act of 2000 (DMA 2000) requires state and local governments to develop and submit for approval to the President a mitigation plan that outlines processes for identifying their respective natural hazards, risks, and vulnerabilities, and

WHEREAS, Pike County acknowledges the requirement of Section 322 of DMA 2000 to have an approved Hazard Mitigation Plan as a prerequisite to receiving post-disaster Hazard Mitigation Grant Program funds, and

WHEREAS, the Pike County Hazard Mitigation Plan has been developed by Pike County Office of Community Planning in cooperation with other County departments, local municipal officials, and the citizens of Pike County, and

WHEREAS, a public involvement process consistent with the requirements of DMA 2000 was conducted to develop the Pike County Hazard Mitigation Plan, and

WHEREAS, the Pike County Hazard Mitigation Plan recommends mitigation activities that will reduce losses to life and property affected by both natural and human-made hazards that face the County and its municipal governments,

NOW THEREFORE BE IT RESOLVED by the governing body for the County of Pike that:

- The 2017 Pike County Hazard Mitigation Plan is hereby adopted as the official Hazard Mitigation Plan of the County and
- The 2017 Pike County Hazard Mitigation Plan is hereby adopted as a part of the Pike County Comprehensive Plan, and
- The respective officials and agencies identified in the implementation strategy of the 2017 Pike County Hazard Mitigation Plan are hereby directed to implement the recommended activities assigned to them

ADOPTED, this _________ day of ________________, 2017

ATTEST:

____

PIKE COUNTY COMMISSIONERS

By _______________________________

By _______________________________

By _______________________________

Pike County Hazard Mitigation Plan

Municipal Adoption Resolution

Resolution No. ___________________

< *Municipality Name*>, Pike County, Pennsylvania

WHEREAS, the <*Municipality Name*>, Pike County, Pennsylvania, is most vulnerable to natural and human-made hazards, which may result in loss of life and property, economic hardship, and threats to public health and safety, and

WHEREAS, Section 322 of the Disaster Mitigation Act of 2000 (DMA 2000) requires state and local governments to develop and submit for approval to the President a mitigation plan that outlines processes for identifying their respective natural hazards, risks, and vulnerabilities, and

WHEREAS, the <*Municipality Name*> acknowledges the requirement of Section 322 of DMA 2000 to have an approved Hazard Mitigation Plan as a prerequisite to receiving post-disaster Hazard Mitigation Grant Program funds, and

WHEREAS, the Pike County Hazard Mitigation Plan has been developed by Pike County Office of Community Planning in cooperation with other County departments, and officials and citizens of <*Municipality Name*>, and

WHEREAS, a public involvement process consistent with the requirements of DMA 2000 was conducted to develop the Pike County Hazard Mitigation Plan, and

WHEREAS, the Pike County Hazard Mitigation Plan recommends mitigation activities that will reduce losses to life and property affected by both natural and human-made hazards that face the County and its municipal governments,

NOW THEREFORE BE IT RESOLVED by the governing body for the <*Municipality Name*>:

- The 2017 Pike County Hazard Mitigation Plan is hereby adopted as the official Hazard Mitigation Plan of the <*Municipality Name*>, and
- The 2017 Pike County Hazard Mitigation Plan is hereby adopted as a part of the Pike County Comprehensive Plan, and
- The respective officials and agencies identified in the implementation strategy of the 2017 Pike County Hazard Mitigation Plan are hereby directed to implement the recommended activities assigned to them.

ADOPTED, this _________ day of ________________, 2017

ATTEST:	**< *MUNICIPALITY NAME*> REPRESENTATIVES**
____________________________	By _______________________________
	By _______________________________
	By _______________________________