Delaware County 2011 Hazard Mitigation Plan

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Table of Acronyms			
ACRONYM	**FULL NAME**	**ACRONYM**	**FULL NAME**
BMP	Best Management Practice	NDIS	National Drought Information System
CAC	Community Assistance Contacts	NDMC	National Drought Mitigation center
CAV	Community Assistance Visits	NFIP	National Flood Insurance Program
CFR	Code of Federal Regulations	NFPA	National Fire Protection Association
CRS	Community Ratings System	NHC	National Hurricane Center
DMA 2000	Disaster Mitigation Act of 2000	NOAA	National Oceanic and Atmospheric Association
DCPD	Delaware County Planning Department	NPL	Superfund National Priorities List
DCED	Department of Community and Economic Development	NWS	National Weather Service
DCEMA	Delaware County Emergency Management Agency	PEIRS	Pennsylvania Emergency Incident Reporting System
DCNR	Department of Conservation and Natural Resources	PA DEP	Pennsylvania Department of Environmental Protection
DCNR-BOF	Department of Conservation and Natural Resources-Bureau of Forestry	PASDA	Pennsylvania Spatial Data Access
DELCORA	Delaware County Regional Water Quality Control Authority	PDSI	Palmer Drought Severity Index
DFIRM	Digital Flood Insurance Rate Map	PEMA	Pennsylvania Emergency Management Agency
DVRPC	Delaware Valley Regional Planning Commission	PennDOT	Pennsylvania Department of Transportation
EOP	Emergency Operations Plan	PHGA	Peak Horizontal Ground Acceleration
EPA	Environmental Protection Agency	PHL	Philadelphia International Airport
EPCRA	Emergency Planning and Community Right-to-Know Act	RF	Risk Factor

Table of Acronyms			
ACRONYM	**FULL NAME**	**ACRONYM**	**FULL NAME**
FBRM	Flood Boundary and Floodway Maps	SALDO	Subdivision and Land Development Ordinance
FEMA	Federal Emergency Management Agency	SARA	Superfund Amendments and Reauthorization Act
FMA	Flood Mitigation Assistance	SFHA	Special Flood Hazard Area
FIRM	Flood Insurance Rate Map	SFIP	State Flood Insurance Program
GIS	Geographic Information Systems	TDS	Total Dissolved Solids
HMP	Hazard Mitigation Plan	TRI	Toxic Release Inventory
HMPT	Hazard Mitigation Planning Team	UCC	Uniform Construction Code
HMPU	Hazard Mitigation Plan Update	US DOT	United States Department of Transportation
HMSC	Hazard Mitigation Steering Committee	USACE	United States Army Corps of Engineers
HVA	Hazard Vulnerability Assessment	USDA	United States Department of Agriculture
LEPC	Local Emergency Planning Committee	USGS	United States Geological Survey
MRLC	Multi-Resolution Land Characteristics Consortium	WYO	Write Your Own
NCDC	National Climatic Data Center		

1. Introduction

1.1. Background

Across the United States, natural and human-caused disasters have led to increasing levels of deaths, injuries, property damage, and interruption of business and government services. The time, money, and efforts to recover from these disasters exhaust resources, diverting attention from important public programs and private agendas. Since 1955 there have been forty-three Presidential Disaster and Emergency Declarations in Pennsylvania, sixteen of which affected Delaware County. In addition to these Presidential Declarations, there have been eighteen Gubernatorial Proclamations of Disaster Emergency affecting Delaware County since 1954. The emergency management community, citizens, elected officials and other stakeholders in Delaware County, Pennsylvania recognize the impact of disasters on their community and support proactive efforts needed to reduce the impact of natural and human-caused hazards.

Hazard mitigation is a phrase that describes actions taken to prevent or reduce the long term risks to life and property from hazards. 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.

Accordingly, the Delaware County Hazard Mitigation Planning Team (HMPT), composed of government leaders from Delaware County and the Commonwealth, in cooperation with elected officials of the County and its municipalities, have prepared this Hazard Mitigation Plan (HMP). The Plan is the result of work by citizens of the County to develop a pre-disaster multi-hazard mitigation plan that will not only guide the County towards greater disaster resistance, but will also respect the character and needs of the community.

1.2. Purpose

The purpose and intent of the Delaware County Hazard Mitigation Plan is to reduce losses to life, property, and the environment caused by natural disasters. In addition, the Hazard Mitigation Plan aims to achieve the following subset of goals.

- Identify natural hazards that impact Delaware County;
- Identify, introduce, and implement cost-effective hazard mitigation measures in order to accomplish County goals and objectives and to raise awareness of and acceptance of hazard mitigation;
- Strengthen ability and effectiveness of response in order to reduce loss of life, property, and the environment caused by natural and human-made disasters;
- Increase disaster resistance and resilience of County and municipal facilities and infrastructure;
- Comply with state and federal legislative requirements for County mitigation in order for the County to be eligible for federal and technical assistance from state and federal hazard mitigation programs.

The Disaster Mitigation Act of 2000 (DMA 2000), Section 322 requires that local governments (communities/counties), as a condition of receiving federal disaster mitigation funds, have a mitigation plan that describes the process for identifying hazards, creating a risk assessment and vulnerability analysis, identifying and prioritizing mitigation strategies, and developing an implementation schedule for the County and each of the municipalities. The planning process and the plan itself allow Delaware County and its participating municipalities to establish a foundation for future mitigation activities, capitalize upon implementation of resources and opportunities, and implement life and property-saving mitigation measures.

Congress authorized the establishment of a Federal grant program to provide financial assistance to States and communities for flood mitigation planning and activities. The Federal Emergency Management Agency (FEMA) has designated this Flood Mitigation Assistance (FMA).

1.3. Scope

The Delaware County 2011 HMP has been prepared to meet requirements set forth by the FEMA and (PEMA) in order for the County to be eligible for funding and technical assistance from state and federal hazard mitigation programs. It will be updated and maintained to continually address both natural and human-made hazards determined to be of significant risk to the County and/or its local municipalities. Updates will take place following significant disasters or at a minimum, once a year.

1.4. Authority and References

Authority for this plan originates from the following federal sources:

- Robert T. Stafford Disaster Relief and Emergency Assistance Act, 42 U.S.C., Section 322, as amended;
- Code of Federal Regulations (CFR), Title 44, Parts 201 and 206; and
- Disaster Mitigation Act of 2000, Public Law 106-390, as amended.
- National Flood Insurance Act of 1968, as amended, 42 U.S.C. 4001 *et seq.*

Authority for this plan originates from the following Commonwealth of Pennsylvania sources:

- Pennsylvania Emergency Management Services Code. Title 35, Pa C.S. Section 101.
- Pennsylvania Municipalities Planning Code of 1968, Act 247 as reenacted and amended by Act 170 of 1988.
- Pennsylvania Stormwater Management Act of October 4, 1978. P.L. 864, No. 167.

The following Federal Emergency Management Agency (FEMA) guides and reference documents were used to prepare this document:

- FEMA 386-1: *Getting Started*. September 2002.
- FEMA 386-2: *Understanding Your Risks: Identifying Hazards and Estimating Losses*. August 2001.
- FEMA 386-3: *Developing the Mitigation Plan*. April 2003.
- FEMA 386-4: *Bringing the Plan to Life*. August 2003.
- FEMA 386-5: *Using Benefit-Cost Review in Mitigation Planning*. May 2007.

- FEMA 386-6: *Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning*. May 2005.
- FEMA 386-7: *Integrating Manmade Hazards into Mitigation Planning*. September 2003.
- FEMA 386-8: *Multijurisdictional Mitigation Planning*. August 2006.
- FEMA 386-9: *Using the Hazard Mitigation Plan to Prepare Successful Mitigation Projects*. August 2008.
- FEMA *Local Multi-Hazard Mitigation Planning Guidance*. July 1, 2008.
- FEMA *National Fire Incident Reporting System 5.0: Complete Reference Guide*. January, 2008.

The following Pennsylvania Emergency Management Agency (PEMA) guides and reference documents were used prepare this document:

- PEMA: *Hazard Mitigation Planning Made Easy!*
- PEMA Mitigation Ideas: *Potential Mitigation Measures by Hazard Type; A Mitigation Planning Tool for Communities*. March 6, 2009.
- PEMA: *Draft Standard Operating Guide*. October 9, 2009.

The following additional guidance document produced by the National Fire Protection Association (NFPA) was used to update this plan:

- NFPA 1600: *Standard on Disaster/Emergency Management and Business Continuity Programs*. 2007

2. Community Profile

2.1. Geography and Environment

Delaware County is a county located in the southeast corner of Pennsylvania (see Figure 2.1-1). It borders the states of Delaware to the southwest and New Jersey to the southeast. In Pennsylvania it borders Philadelphia County on the east, Montgomery County on the northeast and Chester County on the northwest. Delaware County has a land area of 184 square miles, a majority of which is developed land.

Delaware County is a primarily urban county, with rings of development radiating from the border of Philadelphia. Fifty-one percent of the county consists of developed land, and 44 percent of the remaining land is devoted to forest land and agricultural uses. In 2000, eight percent of Delaware County's land was protected open space, either as parks or as land trusts (DCED, 2005). There is one state park in Delaware County, Ridley Creek State Park, which consists of 2,606 acres. The park includes facilities for picnicking and fishing as well as trails for hiking, biking, horseback riding and cross-country skiing (DCNR, 2008).

The County is comprised of two distinct physiographic regions. Its southern area, closest to the Delaware River, lies within the Atlantic Coastal Plain. This area constitutes generally low, flat, poorly drained land extending from Marcus Hook Borough northeastward on a line paralleling Route 13 into Yeadon Borough. The rest of the County is in the Piedmont Plateau and is characterized by rolling uplands, low hills, and well-drained soils.

Delaware County has a relatively moderate climate. Even though it is close to the Atlantic Ocean, the weather is more continental than maritime. While the average high temperature in July is only 86 degrees, summers can be humid with temperatures often exceeding 90 degrees. Winters are comparatively mild. January, the coldest month, has an average low temperature of approximately 23 degrees.

On average, the County receives a little more than 41 inches of rainfall per year. Rainfall distribution throughout the year is relatively consistent. Typically, the highest annual rainfall occurs in July. However, thunderstorms or the occasional summer tropical storm or hurricane can dramatically increase rainfall totals for any given month.

The County has numerous streams and creeks constituting ten watersheds, all of which drain to the Delaware Bay Basin through three major rivers: the Delaware River, Schuylkill River, and Christiana River. The watersheds of Delaware County are displayed in Figure 2.1-2

Figure 2.1-1: Base map of Delaware County (Delaware County GIS Department, 2011).

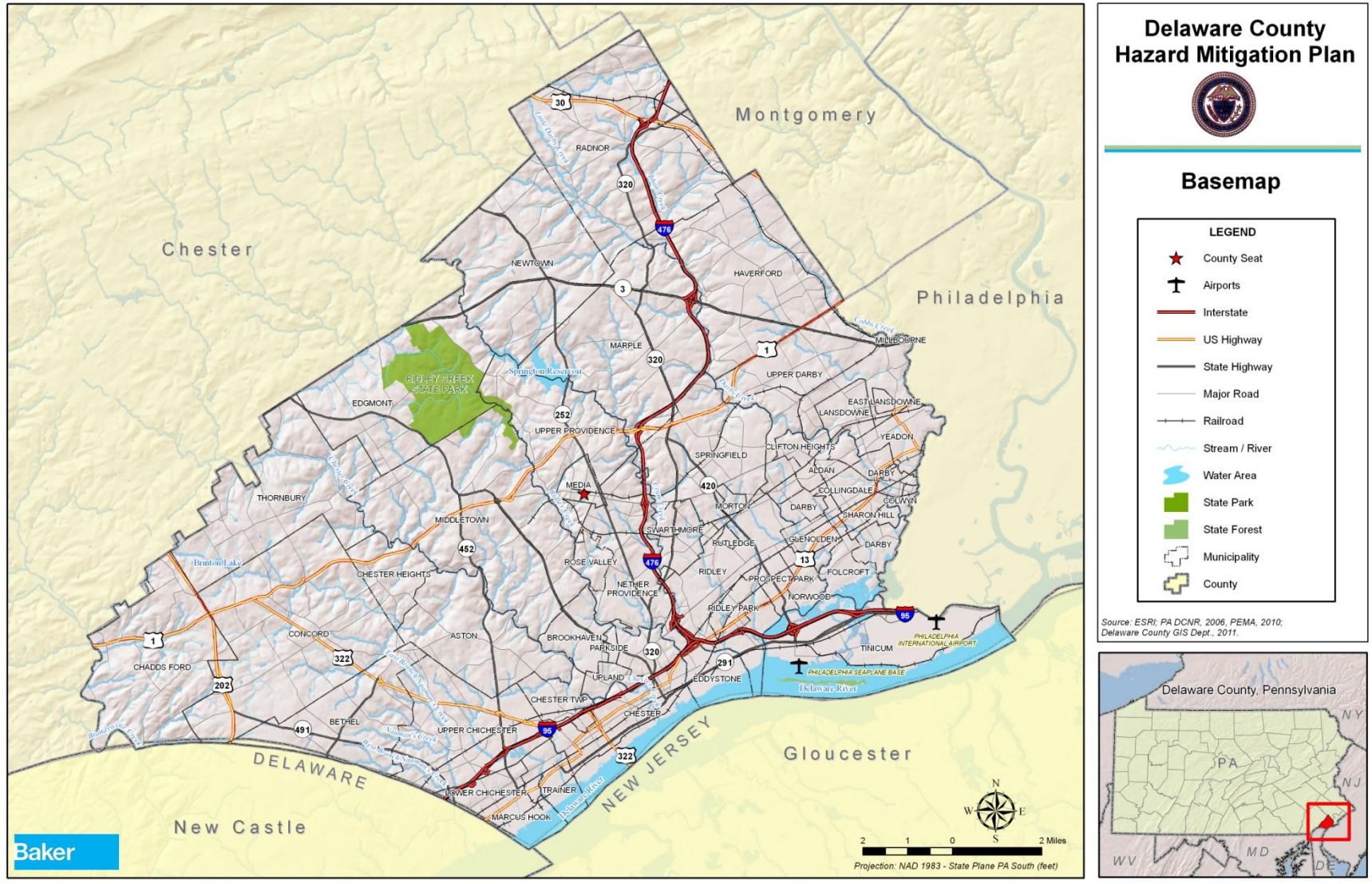
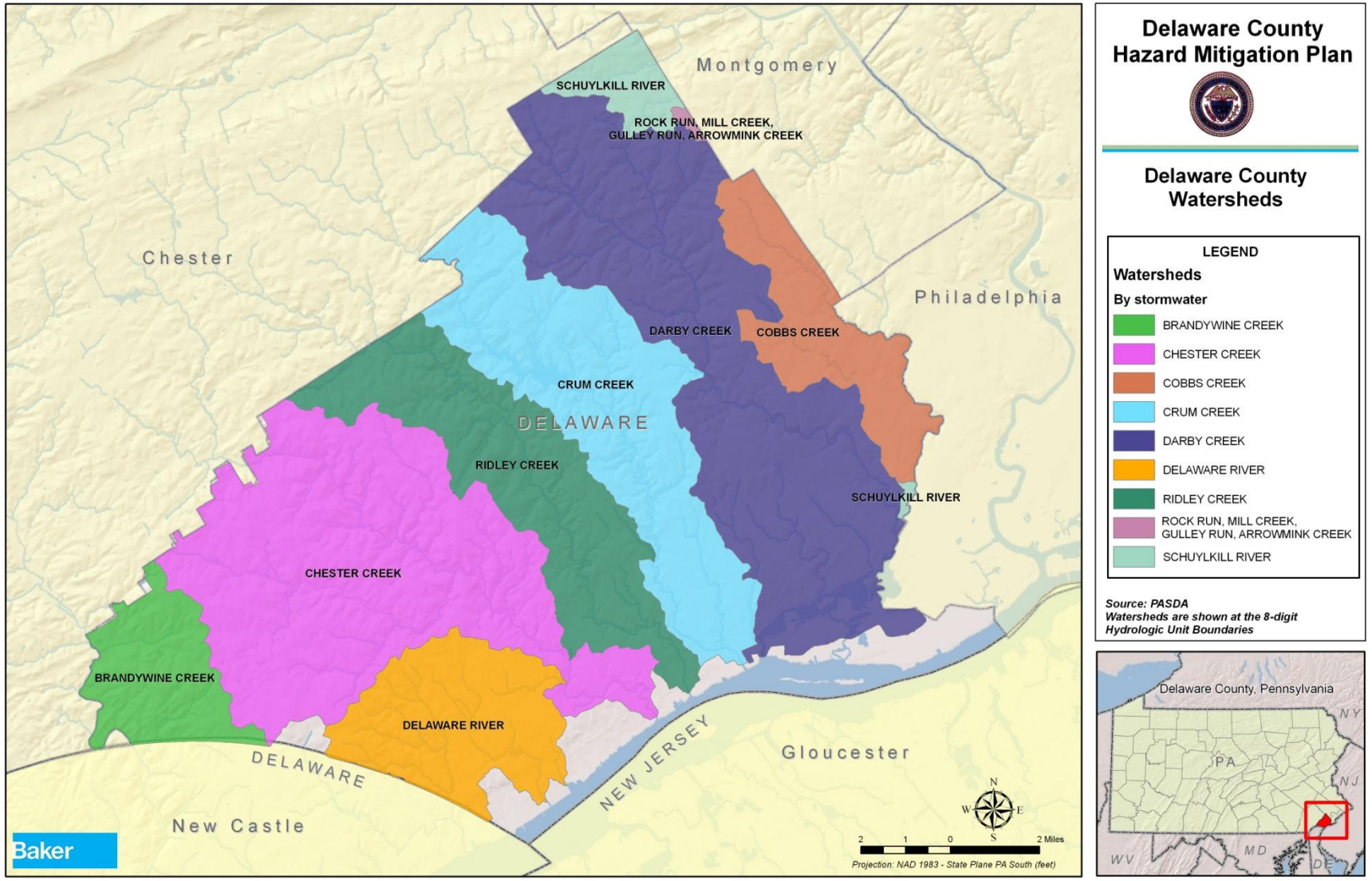


Figure 2.1-2: Major watersheds of Delaware County (PASDA, 2010).



2.2. Community Facts

Delaware County was created in 1789 from parts of Chester County. The county was named after the Delaware River which makes up the southern border of Delaware County (DelawareCountyPA, 2010). The county operates under a home rule charter that was adopted in May 1975. Delaware County consists of 27 boroughs: Aldan, Brookhaven, Chester Heights, Clifton Heights, Collingdale, Colwyn, Darby, East Lansdowne, Eddystone, Folcroft, Glenolden, Lansdowne, Marcus Hook, Media, Millbourne, Morton, Norwood, Parkside, Prospect Park, Ridley Park, Rose Valley, Rutledge, Sharon Hill, Swarthmore, Trainer, and Upland. There are 21 townships in Delaware County: Aston, Bethel, Chadds Ford, Chester, Concord, Darby, Edgmont, Haverford, Lower Chichester, Marple, Middletown, Nether Providence, Newtown, Radnor, Ridley, Springfield, Thornbury, Tinicum, Upper Chichester, Upper Darby, and Upper Providence. Additionally, the city of Chester is located in Delaware County, making a total of 49 municipalities located in the county. The county seat of Delaware County has been Media since 1851, and was in the city of Chester before that.

The major land uses and economic forces in Delaware County have historically been determined by its proximity to both Philadelphia and the Delaware River. Since it was first settled in the 1700s, people have been settling in consecutive rings around Philadelphia to be in closer proximity to the trade and culture in the neighboring county. Because of the relatively flat terrain and the proximity to jobs and opportunities, new residential developments sprung up farther west of Philadelphia throughout the middle and late 1900s (DCED, 2005).

In the 20th Century, large businesses and industrial operations began to move into Delaware County because of its proximity to trade routes along the Delaware River. These companies, including Boeing, Sun Shipbuilding, Ford Motor Company, Westinghouse Electric Company, Sun and Conoco Phillips Refineries, a portion of the Philadelphia International Airport, and numerous hospitals and universities leant to opportunities for residents moving to the area. Delaware County reached its highest population in 1970, with 603,456 residents, but there has since been decline as the population has moved out of the area or to suburbs further outside the city.

2.3. Population and Demographics

According to the 2010 Census, the population of Delaware County is 558,979. The County's population grew 1.47% since the 2000 Census. Table 2.3-1 shows the distribution of population of County population by municipality in the each of these decennial censuses. The western municipalities saw the largest increases in population. Concord Township had the largest percent change in population since 2000, with a 73.47% increase in population. Chester Township saw the largest percent decrease in population since 2000 with a 14.42% loss of population.

Table 2.3-1: List of municipalities in Delaware County with associated populations (U.S. Census, 2011).

MUNICIPALITY	2000 POPULATION	2010 POPULATION	PERCENT CHANGE (%)
Aldan Borough	4,313	4,152	-3.73%
Aston Township	16,203	16,592	2.40%
Bethel Township	6,421	8,791	36.91%
Brookhaven Borough	7,985	8,006	0.26%
Chadds Ford Township	3,170	3,640	14.83%
Chester City	36,854	33,972	-7.82%
Chester Township	4,604	3,940	-14.42%
Chester Heights Borough	2,481	2,531	2.02%
Clifton Heights Borough	6,779	6,652	-1.87%
Collingdale Borough	8,664	8,786	1.41%
Colwyn Borough	2,453	2,546	3.79%
Concord Township	9,933	17,231	73.47%
Darby Borough	10,299	10,687	3.77%
Darby Township	9,622	9,264	-3.72%
East Lansdowne Borough	2,586	2,668	3.17%
Eddystone Borough	2,442	2,410	-1.31%
Edgmont Township	3,918	3,987	1.76%
Folcroft Borough	6,978	6,606	-5.33%
Glenolden Borough	7,476	7,153	-4.32%
Haverford Township	48,498	48,491	-0.01%
Lansdowne Borough	11,044	10,620	-3.84%
Lower Chichester Township	3,591	3,469	-3.40%
Marcus Hook Borough	2,314	2,397	3.59%
Marple Township	23,737	23,428	-1.30%
Media Borough	5,533	5,327	-3.72%
Middletown Township	16,064	15,807	-1.60%
Millbourne Borough	943	1,159	22.91%
Morton Borough	2,715	2,669	-1.69%
Nether Providence Township	13,456	13,706	1.86%
Newtown Township	11,700	12,216	4.41%
Norwood Borough	5,985	5,890	-1.59%

Table 2.3-1: List of municipalities in Delaware County with associated populations (U.S. Census, 2011).

MUNICIPALITY	2000 POPULATION	2010 POPULATION	PERCENT CHANGE (%)
Parkside Borough	2,267	2,328	2.69%
Prospect Park Borough	6,594	6,454	-2.12%
Radnor Township	30,878	31,531	2.11%
Ridley Township	30,791	30,768	-0.07%
Ridley Park Borough	7,196	7,002	-2.70%
Rose Valley Borough	944	913	-3.28%
Rutledge Borough	860	784	-8.84%
Sharon Hill Borough	5,468	5,697	4.19%
Springfield Township	23,677	24,211	2.26%
Swarthmore Borough	6,170	6,194	0.39%
Thornbury Township	7,093	8,028	13.18%
Tinicum Township	4,353	4,091	-6.02%
Trainer Borough	1,901	1,828	-3.84%
Upland Borough	2,977	3,239	8.80%
Upper Chichester Township	16,842	16,738	-0.62%
Upper Darby Township	81,821	82,795	1.19%
Upper Providence Township	10,509	10,142	-3.49%
Yeadon Borough	11,762	11,443	-2.71%
TOTAL	**550,864**	**558,979**	**1.47%**

The median income of households in Delaware County is $61,605 (in 2009 inflation-adjusted numbers). This is a little over $10,000 more than the national median household income (U.S. Census ACS, 2005-2009). Over nine percent of the County population lives in poverty.

The median age of the County population is 38.3 years with seventy-six percent of the population over 18 years of age and over fourteen percent 65 years or older. There are an estimated 220,716 housing units, ninety-three percent of which are occupied with seven percent being vacant (U.S. Census ACS, 2005-2009). The median value of an owner occupied home in the County is $224,400. Almost seventy-six percent of the County population is White and almost eighteen percent of the County population is Black.

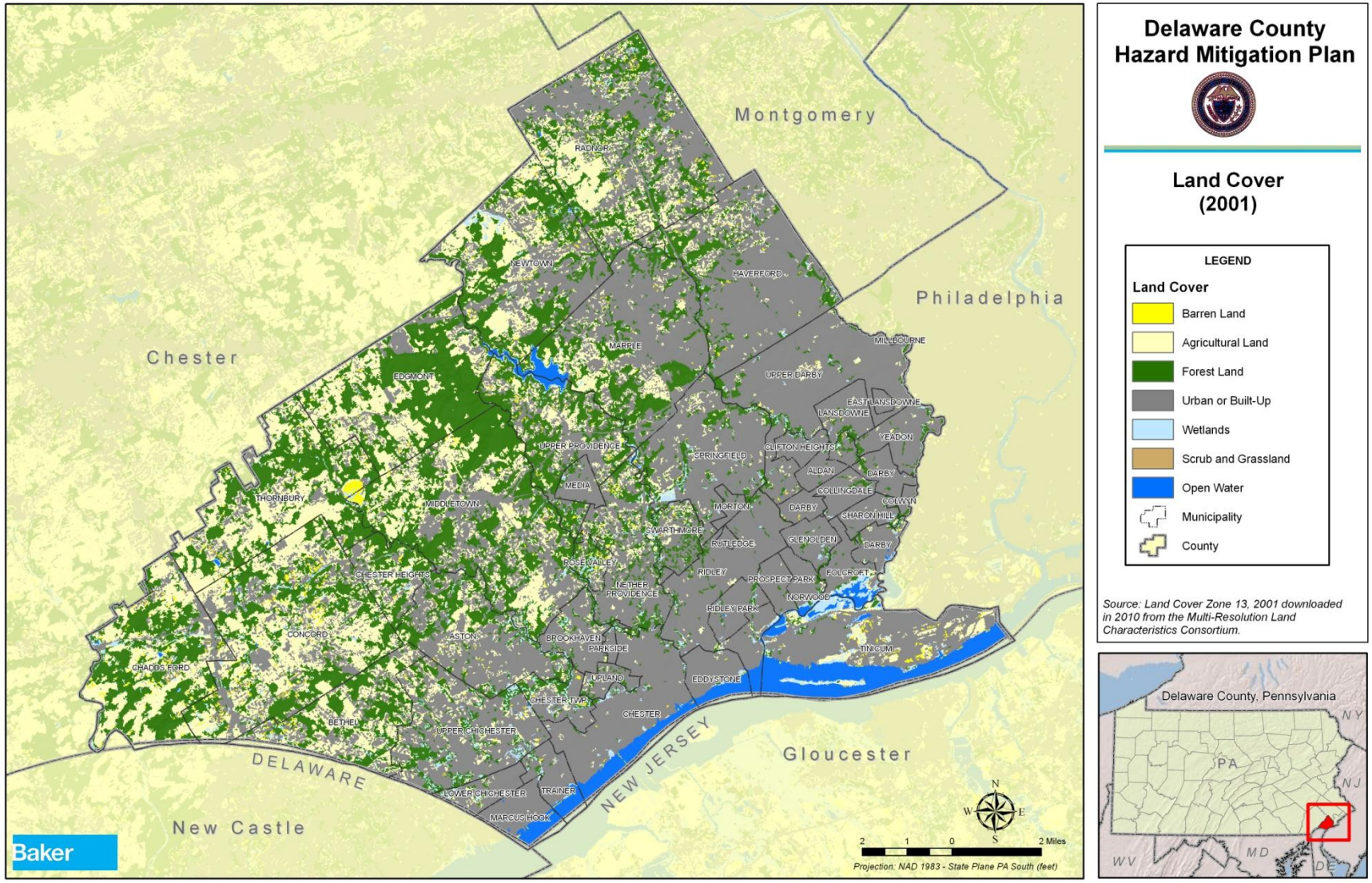
2.4. Land Use and Development

Over fifty-one percent of Delaware County is developed residential, commercial and industrial areas. Much of this developed land consists of single-family detached housing units and parking lots. As of 2007, there are 79 farms in Delaware County, which is a four percent increase as compared to 2002. Almost 4,400 acres of Delaware County, or about four percent, of Delaware County is farmland (USDA, 2007).

Delaware County has a population density of 3,038 people per square mile. Delaware County has recently put more emphasis on revitalizing downtowns and first generation suburbs than developing previously undeveloped land. Additional efforts by the Delaware Valley Regional Planning Commission to increase the amount of protected open space to twenty-five percent by 2025 will serve to limit development in un-developed areas (DCED, 2005). The current land cover map can be found in Figure 2.4-1.

Transportation facilities within Delaware County include highway, rail, and air facilities. Delaware County has an extensive network of major highways, including U.S. Interstates 476/Blue Route and 95, U.S. Routes 202, 322, 1 and 13; and PA Routes 252, 352, 452, 291, 3, 320 and 420. In addition to roadways, the County has a number of railroads including the SEPTA regional rails, AMTRAK passenger lines, and the CSX freight line. In addition, the County includes 13 miles of waterfront along the Delaware River. The Philadelphia International Airport is in the southeast part of Delaware County.

Figure 2.4-1: Delaware County land cover (MRLC Consortium, 2001).



2.5. Data Sources and Limitations

The Delaware County tax assessment database was used as an inventory of parcels throughout the County. The list of critical facilities provided in **Appendix E** was developed based on information from the Delaware County Planning Department's division of GIS and Information Services. The Division of GIS and Information Services also provided spatial data on land use, transportation routes and stations, streams, sewer lines, pump stations, emergency facilities, schools, churches, utility pipelines, and water bodies.

The countywide Effective Digital Flood Insurance Rate Map (DFIRM), published on November 18, 2009, was provided by the Delaware County Planning Department. This data provides flood frequency and elevation information used in the flood hazard risk assessment. Additional data for the base map was provided by the Pennsylvania Game Commission and the Pennsylvania Department of Conservation and Natural Resources.

Additional information used to complete the risk assessment for this plan was taken from various government agency and non-government agency sources. Those sources are cited where appropriate throughout the plan and on each map with full references listed in **Appendix A – Bibliography**. It should be noted that numerous GIS datasets were obtained from the Pennsylvania Spatial Data Access (PASDA) website (http://www.pasda.psu.edu/). PASDA is the official public access geospatial information clearinghouse for the Commonwealth of Pennsylvania. PASDA was developed by the Pennsylvania State University as a service to the citizens, governments, and businesses of the Commonwealth. PASDA is a cooperative project of the Governor's Office of Administration, Office for Information Technology, Geospatial Technologies Office and the Penn State Institutes of Energy and the Environment of the Pennsylvania State University.

In order to assess the vulnerability of different jurisdictions to the hazards, data on past occurrences of damaging hazard events was gathered. For a number of historic natural-hazard events, the National Climatic Data Center (NCDC) database was utilized. NCDC is a division of the US Department of Commerce's National Oceanic and Atmospheric Administration (NOAA). Information on hazard events is compiled by NCDC from data gathered by the National Weather Service (NWS), another division of NOAA. NCDC then presents it on their website in various formats. The data used for this plan came from the US Storm Events database, which "documents the occurrence of storms and other significant weather phenomena having sufficient intensity to cause loss of life, injuries, significant property damage, and/or disruption to commerce" (NOAA, 2006).

HAZUS-MH is a powerful risk assessment methodology for analyzing potential losses from floods, hurricane winds and earthquakes. In HAZUS-MH, current scientific and engineering knowledge is coupled with the latest GIS technology to produce estimates of hazard-related damage before, or after, a disaster occurs. Version MR-4 of this software was used to estimate losses for floods in Delaware County.

This HMP evaluates the vulnerability of the County's critical facilities. For the purposes of this plan, critical facilities are those entities that are essential to the health and welfare of the

community. The list of critical facilities was developed in conjunction with the Delaware County Planning Derpartment and Delaware County Department of Emergency Services. This includes airports, fire stations, hospitals, paramedic units, police stations, rail stations, Red Cross shelters, schools, and treatment plants. Table 2.5-1 summarizes the critical facilities in Delaware County by type and by municipality. For a complete listing of critical facilities, please see **Appendix E**.

Table 2.5-1: Summary of Critical Facilities by Type and Municipality.										
MUNICIPALITY	CRITICAL FACILITY TYPE									
	AIRPORT	FIRE STATION	HOSPITAL	PARA-MEDICS	POLICE STATION	RAIL STATION	RED CROSS SHELTER	SCHOOL	TREATMENT PLANT	GRAND TOTAL
Aldan Borough	0	0	0	0	1	4	1	1	0	7
Aston Township	0	2	0	0	1	0	4	11	1	19
Bethel Township	0	1	0	0	1	0	1	1	0	4
Brookhaven Borough	0	1	0	0	1	0	1	4	1	8
Chadds Ford Township	0	0	0	0	0	0	0	1	3	4
Chester City	0	2	1	0	1	2	0	14	1	21
Chester Heights Borough	0	1	0	0	0	1	0	2	3	7
Chester Township	0	1	0	0	1	0	0	3	0	5
Clifton Heights Borough	0	1	0	0	1	4	0	2	0	8
Collingdale Borough	0	2	0	0	1	4	2	3	0	12
Colwyn Borough	0	1	0	0	1	1	1	0	0	4
Concord Township	0	1	0	0	0	0	4	7	20	32
Darby Borough	0	2	1	1	1	1	3	5	0	14
Darby Township	0	3	0	0	2	0	2	3	0	10
East Lansdowne Borough	0	1	0	0	1	0	1	2	0	5
Eddystone Borough	0	2	0	0	1	1	1	1	0	6
Edgmont Township	0	1	0	0	0	0	0	1	8	10
Folcroft Borough	0	1	0	0	1	1	1	2	0	6
Glenolden Borough	0	1	0	0	1	1	1	3	0	7
Haverford Township	0	5	0	1	1	7	8	20	0	42
Lansdowne Borough	0	1	0	0	1	2	2	5	0	11

Table 2.5-1: Summary of Critical Facilities by Type and Municipality.										
MUNICIPALITY	CRITICAL FACILITY TYPE									
	AIRPORT	FIRE STATION	HOSPITAL	PARA-MEDICS	POLICE STATION	RAIL STATION	RED CROSS SHELTER	SCHOOL	TREATMENT PLANT	GRAND TOTAL
Lower Chichester Township	0	1	0	0	1	0	0	3	0	5
Marcus Hook Borough	0	3	0	0	1	1	0	1	0	6
Marple Township	0	1	0	1	1	0	4	10	0	17
Media Borough	0	1	0	0	2	0	1	3	0	7
Middletown Township	0	3	1	1	1	1	3	10	0	20
Millbourne Borough	0	1	0	0	1	0	0	0	0	2
Morton Borough	0	1	0	0	1	0	0	0	0	2
Nether Providence Township	0	2	0	0	1	12	5	6	0	26
Newtown Township	0	2	0	0	1	0	3	9	1	16
Norwood Borough	0	1	0	0	1	1	1	4	0	8
Parkside Borough	0	1	0	0	1	0	1	1	0	4
Prospect Park Borough	0	1	0	0	1	1	3	3	0	9
Radnor Township	0	1	0	0	1	11	5	23	0	41
Ridley Park Borough	0	1	1	1	1	2	2	4	0	12
Ridley Township	0	8	0	0	1	0	6	14	0	29
Rose Valley Borough	0	0	0	0	0	0	0	1	1	2
Rutledge Borough	0	1	0	0	0	0	0	0	0	1
Sharon Hill Borough	0	1	0	0	1	3	2	4	0	11
Springfield Township	0	1	1	2	1	9	4	10	0	28

Table 2.5-1: Summary of Critical Facilities by Type and Municipality.

MUNICIPALITY	CRITICAL FACILITY TYPE									
	AIRPORT	FIRE STATION	HOSPITAL	PARA-MEDICS	POLICE STATION	RAIL STATION	RED CROSS SHELTER	SCHOOL	TREATMENT PLANT	GRAND TOTAL
Swarthmore Borough	0	1	0	0	1	1	2	4	0	9
Thornbury Township	0	0	0	0	0	0	0	4	10	14
Tinicum Township	2	2	0	0	1	0	1	2	1	9
Trainer Borough	0	5	0	0	1	0	0	0	0	6
Upland Borough	0	1	1	1	1	0	0	2	0	6
Upper Chichester Township	0	3	0	0	1	0	0	9	0	13
Upper Darby Township	0	5	1	1	1	26	12	26	0	72
Upper Providence Township	0	1	0	0	1	1	2	6	13	24
Yeadon Borough	0	1	0	0	1	1	3	4	0	10
Grand Total	***2***	***80***	***7***	***9***	***44***	***99***	***93***	***254***	***63***	***651***

When applicable, Pennsylvania Emergency Incident Reporting System (PEIRS) incident data spanning approximately the last eight years (1/1/2002 -6/1/2009) was used in the 2011 plan update. Although PEIRS data proved valuable, primarily in the human-made hazards section where few records of past occurrences exist, data limitations exist in that the reporting system is not mandatory. As a result, while PEIRS reports provide important information on the frequency of past events, because it is a voluntary reporting system, the number and frequency of events may be under-reported. PEIRS information was used in the following hazard profile sections: Environmental Hazards (Hazardous Material Releases); Transportation Accident; Urban Fire and Explosion, and Utility Interruption.

Every attempt was made to provide consistency in reported data and in data sources. However, at the time of this plan update, the US Census Bureau is in the middle of tabulating the results of the 2010 Decennial Census; at this time, population counts are available at only the municipal, county, and state level. No population counts exist for Census Tracts or Blocks in Pennsylvania at this point. As a result, while population change data is reported in this HMP by municipality from 2000-2010, the calculated population at risk to flooding in Section 4.3.4.5 is derived from the 2000 Census Block geography. It was important to use the 2000 Block data to interpolate the population living in the SFHAs because larger geographies would grossly overestimate risk. In addition, the age of housing units reported in Section 4.3.12.5 comes from the 2005-2009 American Community Survey because the Decennial Census no longer collects this information. As new data from the 2010 Census becomes available between 2011 and 2013, it will be incorporated into the HMP.

Perhaps the most significant limitation in this plan is the absence of building point data for Delaware County. Building points typically allow for the identification of structures located within the danger zone of any given hazard. Without this information, estimating potential losses depended on examining the number of parcels within determined hazard areas without regard to the location of structures on the parcels. A parcel might partially intersect with a hazard area like the Special Flood Hazard Area, but it is unknown whether or not the structure(s) located on that parcel is in the section intersecting the hazard area.

Using parcels also does not allow for a specific analysis of the exact number and type of structures vulnerable to hazard events. The approximate number of mobile homes in the County was extrapolated from FEMA's Comprehensive Data Management System. The parcel layer provided by the Delaware County's GIS and Information Services Division did not include the number of structures on any given parcel, and it is important to note that **the number of parcels is not equal to the number of structures in the County**. As a result, for flood, flash flood, and ice jam, environmental hazards (hazardous material releases), levee failure, transportation accidents, and wildfire - the hazards whose vulnerability analysis focuses on the intersection of parcels and a hazard area - the exact number of structures that fall within a hazard area cannot be determined. Only the number of vulnerable parcels may be concretely discussed. This leads to a potential underestimation of vulnerability. Action 22 of the mitigation strategy of this plan addresses data limitations and stresses the importance of developing a linkage between the County tax assessment records and parcels in the County's GIS system to allow future revision of the plan to more easily incorporate information about properties and their

construction for the next plan update. It is important to note that while the exact number of vulnerable structures is unknown, feedback from the HMPT suggests that the total loss estimates values associated with the vulnerable parcels were accurate.

Estimating potential losses that may occur as a result of hazard events requires a full range of information and accurate data. There are a number of site-specific characteristics that reduce a given structure's vulnerability and consequential losses. Examples include first-floor elevation, the number of stories, construction type, foundation type and the age and condition of the structure. The parcel assessment database includes the total assessed value for each parcel but does not include information on key variables that impact vulnerability, such as the age and value of individual structures, specific information on building height, construction type and first floor elevations.

Throughout the risk and vulnerability assessment included in Section 4, descriptions of limited data indicate some areas in which the County and municipalities can improve their ability to identify vulnerable structures and improve loss estimates. As the County and municipal governments work to increase their overall technical capacity and implement comprehensive planning goals, they will also attempt to improve the ability to identify areas of increased vulnerability.

3. Planning Process

3.1. Process and Participation Summary

The Delaware County Hazard Mitigation Plan Steering Committee, now referred to as the Hazard Mitigation Planning Team (HMPT), was established in 2004 to develop a hazard mitigation plan (HMP) for Delaware County and to provide advice to County Council, assist with identification of natural hazards and data collection, review and comment on interim work products, identify mitigation needs, and generate municipal input and involvement. The 2006 HMP Steering Committee was comprised of members from the Delaware County Board of Assessment, Conservation District, and Intercommunity Health Coordination, Park and Recreation, Emergency Services, and Planning Department, and Aqua PA, DELCORA, and several municipal representatives.

The Committee's specific activities included:

- Assist Delaware County Planning Department (DCPD) staff with natural hazard identification (type, location, extent, etc.);
- Assist DCPD with data collection activities
- Provide all existing information available to assist with the project,
- Help obtain information from municipalities, as needed,
- Obtain, research, or otherwise prepare additional materials relative to each member's area of expertise, as requested by DCPD;
- Review and comment on interim work products;
- Assist in the identification of mitigation needs (i.e., new floodplain maps because existing ones are inadequate, flood studies) and mitigation opportunities (i.e., buyout of a particular block of homes, repair a bridge);
- Promote the plan to municipalities and other interested parties;
- Provide other technical support on the project, as requested by DCPD.

Efforts were made to solicit input from municipalities and the public throughout the planning process to create the 2006 HMP. Delaware County took a multi-jurisdictional approach to preparing this hazard mitigation plan. The County had resources (e.g., funding, data, GIS, etc.) which local jurisdictions lacked. However, the County could not develop the plan on its own. To undertake such a regional planning effort, the County needed to involve its member municipalities since only they have the legal authority to enforce compliance with land use planning and development issues. The County undertook an intensive effort to involve all 49 municipalities in the planning process for the 2006 Delaware County HMP.

To begin the 2011 HMP update process, the Delaware County Planning Department and Delaware County Department of Emergency Services held a kickoff meeting to reconvene the Hazard Mitigation Planning Team. Representatives from municipalities, county agencies, adjacent counties, non-profit groups, and other stakeholders were mailed an invitation to attend the meeting. Contact information was obtained from all meeting attendees and used to create a HMPT mailing list. Section 3.2 provides a discussion of the HMPT as well as a table of members with their corresponding organization.

Municipal officials and the other stakeholders continued to receive notification regarding all HMP meetings via telephone, email, or some combination. A brief description of each meeting that was held is available in Section 3.3. In addition, meeting minutes, describing in detail, events of each meeting are available in **Appendix C – Meeting and Other Participation documentation.**

In order to obtain information from municipalities and other stakeholders, forms and surveys were distributed and collected throughout the planning process. Some of the forms were completed during planning meetings while others were sent via email or were posted to the HMP website, www.DelawareHMP.com. These forms were completed and returned in between scheduled meetings. All municipalities were required to have a representative attend at least one meeting and provide pertinent information for the HMP update. Table 3.1-1 lists each municipality along with their specific participation and contributions to the planning process. Sign-in sheets for each meeting with individual names are available in **Appendix C – Meeting and Other Participation Documentation** along with all completed forms and surveys.

Table 3.1-1: Summary of participation from local municipalities during the 2011 HMPU.

MUNICIPALITY	MEETING						WORKSHEETS/SURVEYS/FORMS					
	KICK-OFF MEETING February 3, 2011	**RISK ASSESSMENT / MITIGATION SOULTIONS WORKSHOP** March 31, 2011	**PLANNING TEAM TELE-CONFERENCE #1** April 20, 2011	**PUBLIC MEETING** April 28, 2011	**PLANNING TEAM TELE-CONFERENCE #2** May 5, 2011	**PLANNING TEAM TELE-CONFER-ENCE #3** June 1, 2011	**CAPABILITY ASSESS-MENT SURVEY**	**EVAL. OF HAZARDS AND RISK FORM**	**COUNTY-WIDE OR JURIS-DICTIONAL RISK FACTOR EVALUATION**	**GOALS AND OBJEC-TIVES EVAL. FORM**	**HMP COMMENT FORM**	**MITIGATION ACTION**
Aldan Borough	✓	✓		✓				✓	✓			✓
Aston Township	✓	✓		✓			✓	✓	✓	✓		✓
Bethel Township		✓		✓					✓	✓		✓
Brookhaven Borough	✓	✓					✓	✓	✓	✓		✓
Chadds Ford Township		✓					✓	✓	✓	✓		✓
Chester City		✓							✓	✓		✓
Chester Township		✓		✓			✓	✓	✓	✓		✓
Chester Heights Borough			✓									✓
Clifton Heights Borough	✓	✓		✓			✓	✓	✓			✓
Collingdale Borough				✓			✓					✓
Colwyn Borough			✓				✓					✓
Concord Township	✓	✓		✓			✓	✓	✓	✓		✓
Darby Borough			✓				✓					✓
Darby Township	✓							✓				✓
East Lansdowne Borough	✓	✓		✓			✓	✓	✓	✓		✓
Eddystone Borough					✓							✓
Edgmont Township	✓	✓		✓			✓	✓	✓	✓		✓
Folcroft Borough	✓						✓	✓				✓
Glenolden Borough			✓				✓	✓	✓			✓
Haverford Township	✓	✓						✓	✓	✓		✓

Table 3.1-1: Summary of participation from local municipalities during the 2011 HMPU.

MUNICIPALITY	MEETING						WORKSHEETS/SURVEYS/FORMS					
	KICK-OFF MEETING February 3, 2011	**RISK ASSESSMENT / MITIGATION SOULTIONS WORKSHOP** March 31, 2011	**PLANNING TEAM TELE-CONFERENCE #1** April 20, 2011	**PUBLIC MEETING** April 28, 2011	**PLANNING TEAM TELE-CONFERENCE #2** May 5, 2011	**PLANNING TEAM TELE-CONFER-ENCE #3** June 1, 2011	**CAPABILITY ASSESS-MENT SURVEY**	**EVAL. OF HAZARDS AND RISK FORM**	**COUNTY-WIDE OR JURIS-DICTIONAL RISK FACTOR EVALUATION**	**GOALS AND OBJEC-TIVES EVAL. FORM**	**HMP COMMENT FORM**	**MITIGATION ACTION**
Lansdowne Borough			✓	✓			✓	✓				✓
Lower Chichester Township						✓						✓
Marcus Hook Borough		✓							✓			✓
Marple Township	✓	✓					✓	✓	✓	✓		✓
Media Borough	✓	✓		✓			✓	✓	✓			✓
Middletown Township	✓	✓		✓			✓	✓	✓	✓		✓
Millbourne Borough	✓		✓				✓					✓
Morton Borough			✓				✓					✓
Nether Providence Township			✓					✓				✓
Newtown Township		✓							✓	✓		✓
Norwood Borough	✓	✓		✓			✓	✓	✓	✓		✓
Parkside Borough		✓		✓			✓	✓	✓	✓		✓
Prospect Park Borough			✓				✓	✓				✓
Radnor Township					✓		✓	✓				✓
Ridley Township			✓				✓	✓				✓
Ridley Park Borough					✓		✓	✓				✓
Rose Valley Borough			✓				✓	✓				✓
Rutledge Borough				✓							✓	✓
Sharon Hill Borough				✓			✓					✓
Springfield Township	✓	✓		✓			✓	✓	✓	✓		✓

Table 3.1-1: Summary of participation from local municipalities during the 2011 HMPU.

MUNICIPALITY	MEETING						WORKSHEETS/SURVEYS/FORMS					
	KICK-OFF MEETING February 3, 2011	**RISK ASSESSMENT / MITIGATION SOULTIONS WORKSHOP** March 31, 2011	**PLANNING TEAM TELE-CONFERENCE #1** April 20, 2011	**PUBLIC MEETING** April 28, 2011	**PLANNING TEAM TELE-CONFERENCE #2** May 5, 2011	**PLANNING TEAM TELE-CONFER-ENCE #3** June 1, 2011	**CAPABILITY ASSESS-MENT SURVEY**	**EVAL. OF HAZARDS AND RISK FORM**	**COUNTY-WIDE OR JURIS-DICTIONAL RISK FACTOR EVALUATION**	**GOALS AND OBJEC-TIVES EVAL. FORM**	**HMP COMMENT FORM**	**MITIGATION ACTION**
Swarthmore Borough		✓					✓	✓	✓	✓		✓
Thornbury Township	✓	✓							✓	✓		✓
Tinicum Township	✓	✓					✓	✓	✓			✓
Trainer Borough		✓					✓	✓	✓	✓		✓
Upland Borough		✓		✓			✓	✓	✓	✓		✓
Upper Chichester Township			✓				✓	✓				✓
Upper Darby Township			✓				✓					✓
Upper Providence Township		✓					✓	✓	✓	✓		✓
Yeadon Borough	✓		✓									✓

With funding support from PEMA, Michael Baker Jr., Inc., a full-service engineering firm that provides hazard mitigation planning guidance and technical support, assisted the County through the update process. The 2011 Delaware County HMP Update was completed in May 2011.

The 2011 HMP follows an outline developed by PEMA in 2009 which provides a standardized format for all local HMPs in the Commonwealth of Pennsylvania. As a result, the format of the 2011 Delaware County HMPU contrasts with the 2006 Delaware County HMP, but all information that was still current was carried over into the new plan. These changes are summarized in Table 3.1-2. Additional update summaries are provided for each section of the plan in Sections 4.1, 5.1, 6.1, and 7.1.

Table 3.1-2: Summary of changes to the format of the 2006 and 2011 versions of the Delaware County HMP.

2006 HMP SECTION	2011 HMPU SECTION
Chapter 1. Introduction	Section 1
Purpose of the Plan	Section 1.2
About Delaware County	Section 2
Natural Environment	Section 2
Description of the Planning Process	Section 3.1
Chapter 2. Hazard Vulnerability Assessment	Section 4
Earthquakes	Sections 4.3.2
Extreme Heat	Section 4.3.3
Floods	Section 4.3.4
Land Failure	Sections 4.3.6, 4.3.9
Severe Weather	Sections 4.3.1, 4.3.5, 4.3.10, 4.3.12
Wildfires	Section 4.3.11
Chapter 3. Mitigation Capabilities and Resources	Section 5
Delaware County's Capabilities and Resources	Section 5.2
State Capability and Resources	Section 5.2
Federal Capability and Resources	Section 5.2
Chapter 4. Mitigation Goals and Objectives	Section 6
Terminology	Section 6.2
Goals	Section 6.2
Mitigation Objectives	Section 6.2
Chapter 5. Alternative Mitigation Actions	Section 6.4
Chapter 6. Mitigation Plan and Implementation Strategy	Sections 6.4; 7

3.2. The Planning Team

The Hazard Mitigation Steering Committee for the 2011 HMP Update included:

1) John Pickett, Director, Delaware County Planning Department

2) Larry Bak, Deputy Emergency Management Coordinator, Delaware County Department of Emergency Services
3) Karen Holm, Environmental Planning Manager, Delaware County Planning Department
4) Shaun Bollig, Senior Planner, Delaware County Planning Department
5) Zach Barner, Associate Planner, Delaware County Planning Department
6) Alexis Melusky, Planner, Michael Baker Jr., Inc.

The HMSC developed a list of potential HMPT members which included municipal officials, state and Delaware County government representatives, adjacent county representative and other stakeholders and non-profit organizations. These individuals were invited to participate in the HMP update process. **Appendix C** contains copies of meeting invitations and a list of invitees. The HMSC worked throughout the process to plan and hold meetings, collect information and conduct public outreach.

The stakeholders listed in Table 3.2-1 served on the 2011 countywide HMPT and actively participated in the planning process through attendance at meetings, completion of assessment surveys, or submission of comments. Participants representing multiple jurisdictions are listed more than once.

Table 3.2-1: Stakeholders who participated in the planning process.

MUNICIPALITY/ORGANIZATION	PARTICIPANT(S)
Sue Kelley	Aldan Borough
Tony Fernandes	Aqua PA
Thomas Morgan	Aston Township
Brett Small	Bethel Township
Mary Ellen McKinley, John Wilwert Jr.	Brookhaven Borough
Joe Barakat	Chadds Ford Township
Neil Lovekin	Chester County EMA
Larry Ward	Chester Heights Borough
Steve Polaha	Chester Township
James Johnson	City of Chester
Bernard Pipe	Clifton Heights Borough
George Kaiser	Collingdale Borough
Mary Beth Straguzzi	Colwyn Borough
Fred Field	Concord Township
Jason Polle	Darby Borough
Paul J. Strus	Darby Township
Jaclyn Rhoads	DCVA / PA Sea Grant
Robert Holm	Delaware County Intercommunity Helath
Maureen Hennessey Herman	Delaware County Intercommunity Helath
John Dowd	Delaware County Treasurer's Office
George Bobnak	East Lansdowne Borough

Table 3.2-1: Stakeholders who participated in the planning process.	
MUNICIPALITY/ORGANIZATION	**PARTICIPANT(S)**
Thom Iannacci	Eddystone Borough
Franci Howat	Eddystone Borough
Susan Sharp	Edgmont Township
William Matthews	Folcroft Borough
Brian Hoover	Glenolden Borough
James A. Marino	Haverford Township
Mike Joswiak, Craig Totaro	Lansdowne Borough
Joe Possenti	Lower Chichester Township
Robert Kinsey	Marcus Hook Borough
Jim Castaldi, Jan Ceton	Marple Township
Jim Jeffrey	Media Borough
John McKeown	Middletown Township
David Biloon, Rufus Stokes	Millbourne Borough
Martha Preston	Morton Borough
Pat O'Rouke	Nether Providence Township
Jim Sheldrake	Newtown Township
Greg Grillone	Norwood Borough
David Favinger	Parkside Borough
Joyce Morrison	Penn State Cooperative Extension
Michael McCartney	Philadelphia International Airport
Pat O'Connell	Prospect Park Borough
William Martin, George Smith	Radnor Township
Carole Nasella	Ridley Park Borough
Bob Griffith	Ridley Township
Paula Healy	Rose Valley Borough
Diane McGaughey	Rutledge Borough
Thomas Hendrick	Sharon Hill Borough
John M. Pietrafitta	Springfield Township
Jane Billings	Swarthmore Borough
Willard M. McMullin	Thornbury Township
Ralph L. Slatten Jr., David Schreiber	Tinicum Township
Eileen Nelson	Trainer Borough
H. Ray Peden, David Favinger	Upland Borough
Judy Lizza, Glenn Holt	Upper Chichester Township
Tom Judge, Allison Lee	Upper Darby Township
Alan Mancil	Upper Providence Township
Rufus Stokes, Bill Neal	Yeadon Borough

3.3. Meetings and Documentation

The following meetings were held during the plan update process. Invitations, agendas, sign-in sheets, and minutes for these meetings are included in **Appendix C**.

February 3, 2011 – Kickoff Meeting held at the Delaware County Government Center – County Council Room to discuss project scope, schedule, goals and available resources. Hazards from the 2006 plan were evaluated and new hazards to include in the 2011 update were selected using the Evaluation of Hazards and Risk Form. Capability Assessment Surveys were also completed by municipal attendees.

March 10, 2011 – Internal Mitigation Strategy Review Meeting held via conference call with the HMSC to conduct a preliminary review of plan goals and objectives and evaluate the status of 2006 plan actions/projects in advance of the entire community reviewing the Mitigation Strategy.

March 31, 2011 – Risk Assessment / Mitigation Solutions Workshop held at the Delaware County Government Center – County Council Room to review the HMPU's risk assessment and discuss hazards. Both countywide and jurisdictional risk factors and mitigation goals and objectives were reviewed by the HMPT. Projects from the 2006 HMP were reviewed by municipalities who had included projects in the 2006 HMP and new projects and actions were developed to be included in the HMPU.

April 20, 2011 – Planning Team Teleconference #1 held via conference call for any jurisdiction that had been unable to attend a regularly scheduled meeting. An overview of the HMP update process was presented. Identified hazards and their risk factors were reviewed and a description of the mitigation strategy was given. Prior to the call, meeting participants were emailed a Capability Assessment Survey, a 2006 HMP Action/Project Review Worksheet (if applicable), and a Mitigation Action Form for completion and submission.

April 28, 2011 – Final Public Meeting held at the Delaware County Government Center – County Council Room to update the public about the HMP process and findings. The meeting was advertised in the local newspaper, the Delaware County Daily Times on April 21, 2011. Municipalities were emailed a meeting reminder and encouraged to inform their residents about the meeting. Several verbal comments were noted in the meeting minutes and attendees were asked to review the entire plan on the County's website www.DelawareHMP.com and provide written comments within a 30-day comment period.

May 5, 2011 – Planning Team Teleconference #2 held via conference call for any jurisdiction that had been unable to attend a regularly scheduled meeting. An overview of the HMP update process was presented. Identified hazards and their risk factors were reviewed and a description of the mitigation strategy was given. Prior to the call, meeting participants were emailed a Capability Assessment Survey, a 2006 HMP Action/Project Review Worksheet (if applicable), and a Mitigation Action Form for completion and submission.

June 1, 2011 – Planning Team Teleconference #3 held via conference call to obtain the participation of Lower Chichester Township who had been unable to attend a regularly scheduled meeting. An overview of the HMP update process was presented. Identified hazards and their risk factors were reviewed and a description of the mitigation strategy was given. Prior to the call, the municipality was emailed a blank mitigation action form to submit a action for the plan.

3.4. Public & Stakeholder Participation

Each municipality was given multiple opportunities to participate in the HMP update process through invitation to meetings, review of risk assessment results and mitigation actions, and an opportunity to comment on a final draft of the HMP. The seven tools listed below were distributed with meeting invitations, at meetings, and on the HMP update website to solicit information, data, and comments from both local municipalities and other key stakeholders in Delaware County. Responses to these worksheets and surveys are included in **Appendix C: Meeting and Other Participation Documentation**.

1. **Capability Assessment Survey:** Collects information on local planning, regulatory, administrative, technical, fiscal, political and resiliency capabilities that can be included in the plan's Capability Assessment section.

2. **Evaluation of Hazards and Risk Form:** Collects information from the HMPT regarding whether there have been changes to the frequency of occurrence, magnitude of impact, or geographic extent of hazards identified in the 2006 HMP. In addition, the form asks members of the HMPT to select any additional hazards that they believe should be considered for inclusion in the 2011 HMPU.

3. **Mitigation Strategy Goal and Objective Comment Worksheet:** Collected comments and suggestions from municipalities on the HMPU goals and objectives that had been vetted by the HMSC.

4. **Countywide and Jurisdictional Risk Evaluation Worksheet:** These forms asked the HMPT to review the Countywide Risk Factors for the hazards and provide feedback. In addition, municipal representatives were asked to review their jurisdiction's risk for each hazard in comparison to the Countywide risk factors to comment on whether they had the same risk, or a greater or less than risk than the County as a whole.

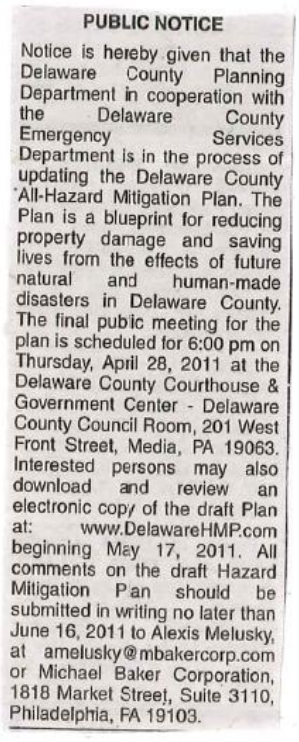
5. **2006 Project Evaluation Form:** Because Delaware County had an extensive list of actions/projects in the 2006 HMP, municipalities were asked to evaluate the status of projects submitted in the previous planning process, indicating if there had been progress, if a project had been discontinued or completed, and whether each project should be carried over into the 2011 Plan.

6. **Mitigation Action Form:** Allows communities to propose mitigation actions for the HMP and include information about each action such as a lead agency/department, implementation schedule, priority, estimated costs, and potential funding source(s).

7. **HMP Comment Form:** Provided to representatives and the public at the public meeting and used to provide comments on the hazards, risk assessment, mitigation strategy, and any other topics of the users choice.

Community participation and comment was encouraged throughout the planning process, particularly through the project website, www.DelawareHMP.com. This site acted as a repository for the entire planning process, including presentations, agendas, minutes, and worksheets from each meeting as well as promulgating meeting dates, times, and important announcements. The public was also encouraged to provide images and stories on the effects of the identified hazards in their community on the website. A newspaper notice was published in the Delaware County Daily Times newspaper to notify the citizens of Delaware County of the date and time of the public meeting. A copy of this newspaper notice is shown in Figure 3.4-1.

Figure 3.4-1: Public notice published in the Delaware County Daily Times on April 21, 2011.



PUBLIC NOTICE

Notice is hereby given that the Delaware County Planning Department in cooperation with the Delaware County Emergency Services Department is in the process of updating the Delaware County All-Hazard Mitigation Plan. The Plan is a blueprint for reducing property damage and saving lives from the effects of future natural and human-made disasters in Delaware County. The final public meeting for the plan is scheduled for 6:00 pm on Thursday, April 28, 2011 at the Delaware County Courthouse & Government Center - Delaware County Council Room, 201 West Front Street, Media, PA 19063. Interested persons may also download and review an electronic copy of the draft Plan at: www.DelawareHMP.com beginning May 17, 2011. All comments on the draft Hazard Mitigation Plan should be submitted in writing no later than June 16, 2011 to Alexis Melusky, at amelusky@mbakercorp.com or Michael Baker Corporation, 1818 Market Street, Suite 3110, Philadelphia, PA 19103.

Additionally, notification of the HMP update sent to representatives from neighboring counties is included in **Appendix C**.

Delaware County posted the 2011 Draft HMP update on the HMP update website (www.DelawareHMP.com) beginning on May 17, 2011 and accepted comments through June 16, 2011. The availability of the draft HMPU was made public by placing a public notice in the Delaware County Daily Times on April 21, 2011 and disseminating the information to the HMPT via email. Comments were to be submitted in writing to Shaun Bollig of the Delaware County Planning Department, to Alexis Melusky of Michael Baker Jr., Inc., by mail or email; or online on the HMP Update website.

Several public comments were received at the public meeting and incorporated in the plan. In addition, the Delaware County Planning Department reviewed the draft HMP and provided several comments during the 30 day comment period. Furthermore, a comment was received from Concord Township regarding changes to the municipality's flood vulnerability map. Copies of all comments received are available in **Appendix C – Meeting and Other Participation Documentation**. All comments were addressed in this plan update.

3.5. Multi-Jurisdictional Planning

This HMP was developed using a multi-jurisdictional approach. With funding support from PEMA, the County departments had resources such as technical expertise and data which local

jurisdictions lacked. However, involvement from local municipalities was critical to the collection of local knowledge related to hazard events and mitigation activities. Local municipalities also have the legal authority to enforce compliance with land use planning and development issues. The County undertook an intensive effort to involve all 49 municipalities in the planning process. Tables 3.1-1 and 3.2-1 list jurisdictional participation 2011 HMPU.

Table 3.1-1 documents jurisdictional presence at the meetings described in Section 3.3 and other involvement from each jurisdiction throughout the planning process. Each municipality was mailed or emailed invitations to all meetings and received telephone call or email reminders (if email addresses were available) prior to each meeting. A planning team teleconference was held to give jurisdictions that had previously been unable to physically attend any other meeting an opportunity to participate. Surveys and forms were emailed to jurisdictions requesting that local information be provided and jurisdictions were also directed to the HMP update website where all forms were posted. In the end, all 49 municipalities in the County participated in the plan, thus achieving 100% participation.

3.6. Existing Planning Mechanisms

There are numerous existing regulatory and planning mechanisms in place at the state, County, and municipal level of government which support hazard mitigation planning efforts. These tools include the Commonwealth of Pennsylvania Standard All-Hazard Mitigation Plan, the Delaware County Emergency Operations Plan, the Delaware County Hazard Vulnerability Assessment, the Delaware County Pandemic Influenza Preparedness and Response Plan and Strategic National Stockpile Implementation Plan, the Delaware County Hazardous Commodity Flow Study, local Emergency Operation Plans, local floodplain management ordinances, local zoning ordinances, local subdivision and land development ordinances, local comprehensive plans, Act 167 Stormwater Management plans, and other watershed, greenway, or environmental plans. These mechanisms were discussed at community meetings and are described in Section 5.2. Information from several of these documents has been incorporated into this plan and mitigation actions have been developed to further integrate these planning mechanisms into the hazard mitigation planning process.

The County Hazard Vulnerability Analysis provided direction for hazard identification as well as information on past occurrences and vulnerability. Floodplain management ordinance information was used to aid in the establishment of local capabilities in addition to participation in the NFIP.

4. Risk Assessment

4.1. Process Summary

This risk assessment provides a factual basis for activities proposed by the County in their mitigation strategy. Hazards that may affect Delaware County are identified and defined in terms of location and geographic extent, magnitude of impact, previous events and likelihood of future occurrence. This hazard profile structure differs from what was used in the 2006 Delaware County HMP; however all information from the previous plan has been included or updated in the 2011 HMPU, unless otherwise indicated.

The Delaware County Hazard Mitigation Planning Team reviewed the natural hazards profiled in the 2006 Delaware HMP at a February 3, 2011 kickoff meeting. It was determined that all of the existing hazards should be continued into the plan update. Additionally, the HMPT reviewed hazards on PEMA's standard list of hazards using an *Evaluation of Hazards and Risk Form* and decided that seven additional hazards should be profiled in the plan update: Pandemic, Dam Failure, Environmental Hazards (Hazardous Material Release), Levee Failure, Transportation Accident, Urban Fire and Explosion, and Utility Interruption. Hazard profiles were then developed in order to define the characteristics of the hazard as it applies to Delaware County.

Following hazard identification and profiling, a vulnerability assessment was performed to identify the impact of natural or human-caused hazard events on people, buildings, infrastructure and the community. Each natural and human-made hazard is discussed in terms of its potential impact on individual communities in Delaware County, including the types of parcels and critical facilities that may be at risk. The assessment allows the County and its municipalities to focus mitigation efforts on areas most likely to be damaged or most likely to require early response to a hazard event. A vulnerability analysis was performed which identifies parcels, critical facilities or people that may be impacted by hazard events and describes what those events can do to physical, social and economic assets. Depending upon data availability, assessment results consist of an inventory of vulnerable structures or populations.

4.2. Hazard Identification

4.2.1. Table of Presidential Disaster Declarations

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. There have been forty-three presidential disaster declarations in Pennsylvania. Table 4.2-1 identifies Presidential Disaster and Emergency Declarations issued between 1955 through 2010 that have affected Delaware County. Additional declarations beyond 2010 can be found on the FEMA website at: http://www.fema.gov/news/disasters_state.fema?id=42.

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

DECLARATION NUMBER	DATE	EVENT
1898	April, 2010	Severe Winter Storms and Snowstorms
1649	June, 2006	Proclamation of Emergency - Flooding
3235	September, 2005	Proclamation of Emergency - Hurricane Katrina
1557	September, 2004	Tropical Depression Ivan
1538	August, 2004	Multiple Storm Systems
1497	September, 2003	Hurricane Isabel/Henri
3180	February, 2003	Severe Winter Storms
1294	September, 1999	Hurricane Floyd
1085	January, 1996	Severe Winter Storms
1093	January, 1996	Flooding
1015	January, 1994	Severe Winter Storms

Table 4.2-1: Presidential Disaster and Emergency Declarations affecting Delaware County.		
DECLARATION NUMBER	**DATE**	**EVENT**
3105	March, 1993	Blizzard
400	July, 1973	Flood
340	June, 1972	Flood (Agnes)
312	September, 1971	Flood
206	September, 1965	Drought

In addition to these Presidentially-declared events, eighteen events warranted Gubernatorial Disaster Declarations or Proclamations. Table 4.2-2 lists Gubernatorial Disaster Declarations or Proclamations that have been issued for Delaware County between 1954 and 2009.

Table 4.2-2: Gubernatorial Disaster Declarations or Proclamations affecting Delaware County.	
DATE	**EVENT**
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
April, 2006	Proclamation of Emergency - Regulations
February, 2002	Drought and Water Shortage
July, 1999	Drought
June, 1998	Severe Storms / Tornadoes
May, 1998	I-95 Highway Disaster
September, 1995	Drought
November, 1980	Drought Emergency
February, 1978	Blizzard
January, 1978	Heavy Snow
February, 1974	Truckers Strike
February, 1972	Heavy Snow
January, 1966	Heavy Snow
August, 1965	Drought
February, 1958	Heavy Snow

Delaware 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 Delaware County between 1954 and 2010.

Table 4.2-3: Small Business Administration Disaster Declarations affecting Delaware County.	
DATE	**EVENT**
August, 2009	Storms and Flooding
January, 2009	Fire
September, 2008	Fire
August, 2008	Fire
November, 2007	Fire
April, 2007	Severe Storms and Flooding
May, 2001	Fire
March, 2001	Fire
August, 1991	Flash Flood
July, 1989	Flood

4.2.2. Summary of Hazards

Table 4.2-3 summarizes hazards identified in the 2006 Delaware County HMP which included the County's Hazard Vulnerability Assessment (HVA). The 2006 HMP did not identify or profile human-made hazards.

Table 4.2-4: Natural hazards identified in Delaware County 2006 HMP.
HAZARD
Earthquakes
Extreme Heat
Floods
Land Failure
Droughts
Hurricanes and Tropical Storms
Tornadoes and Windstorms
Winter Storms
Wildfires

The hazards shown in Table 4.2-3 were not ranked according to risk in the 2006 HMP. All hazards identified in 2006 HMP were included in the 2011 HMPU.

At the Stakeholder kickoff meeting, the members of the HMPT were each provided with a *Evaluation of Hazards and Risk Form* and the PEMA Standard List of Hazards which is a comprehensive list of all hazards to be considered for evaluation in the 2011 HMPU. This list was obtained primarily from the 2007 Edition of the National Fire Protection Association's *NFPA 1600: Standard on Disaster/Emergency Management and Business Continuity Programs* (NFPA, 2007). Following review of this hazards list and completion of the *Evaluation of Hazards and Risk Form*, several additional hazards were considered in need of risk assessment. Several HMPT members raised concerns over risk of pandemic and it was identified as a new

natural hazard for the 2011 HMPU. In addition, since the 2006 HMP did not profile human-made hazards, the HMPT decided to add dam failure, environmental hazards – hazardous material release, levee failure, transportation accident, urban fire and explosion, and utility interruption. Table 4.2-4 contains a complete list of all potential hazards in Delaware County identified through the risk assessments and planning meetings. Hazard profiles are included in Section 4.3 for each of these hazards.

Table 4.2-5: List and description of natural and human-made hazards profiled in the 2010 HMP.

HAZARD TYPE	HAZARD	HAZARD DESCRIPTION
Natural Hazards	**Drought**	Drought is a natural climatic condition which occurs in virtually all climates, the consequence of a natural reduction in the amount of precipitation experienced over a long period of time, usually a season or more in length. High temperatures, prolonged winds, and low relative humidity can exacerbate the severity of drought. This hazard is of particular concern in Pennsylvania due to the presence of farms as well as water-dependent industries and recreation areas across the Commonwealth. A prolonged drought could severely impact these sectors of the local economy, as well as residents who depend on wells for drinking water and other personal uses (National Drought Mitigation Center, 2006).
	Earthquake	An earthquake is the motion or trembling of the ground produced by sudden displacement of rock usually within the upper 10-20 miles of the Earth's crust. Earthquakes result from crustal strain, volcanism, landslides, or the collapse of underground caverns. Earthquakes can affect hundreds of thousands of square miles, cause damage to property measured in the tens of billions of dollars, result in loss of life and injury to hundreds of thousands of persons, and disrupt the social and economic functioning of the affected area. Most property damage and earthquake-related deaths are caused by the failure and collapse of structures due to ground shaking which is dependent upon amplitude and duration of the earthquake (FEMA, 1997).
	Extreme Temperature	Extreme cold temperatures drop well below what is considered normal for an area during the winter months and often accompany winter storm events. Combined with increases in wind speed, such temperatures in Pennsylvania can be life threatening to those exposed for extended periods of time. Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined (Lawrence County, PA HMP, 2004).
	Flood, Flash Flood, & Ice Jam	Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding is typically experienced when precipitation occurs over a given river basin for an extended period of time. Flash flooding is usually a result of heavy localized precipitation falling in a short time period over a given location, often along mountain streams and in urban areas where much of the ground is covered by impervious surfaces. The severity of a flood event is dependent upon a combination of stream and river basin topography and physiography, hydrology, precipitation and weather patterns, present soil moisture conditions, the degree of vegetative clearing as well as the presence of impervious surfaces in and around flood-prone areas. Winter flooding can include ice jams which occur when warm temperatures and heavy rain cause snow to melt rapidly. Snow melt combined with heavy rains can cause frozen rivers to swell, which breaks the ice layer on top of a river. The ice layer often breaks into large chunks, which float downstream, piling up in narrow passages and near other obstructions such as bridges and dams. All

Table 4.2-5: List and description of natural and human-made hazards profiled in the 2010 HMP.		
HAZARD TYPE	**HAZARD**	**HAZARD DESCRIPTION**
		forms of flooding can damage infrastructure (USACE, 2007).
	Hurricane, Tropical Storm, & Nor'easter	Hurricanes and tropical storms are classified as cyclones and are any closed circulation developing around a low-pressure center in which the winds rotate counter-clockwise (in the Northern Hemisphere) and whose diameter averages 10-30 miles across. While most of Pennsylvania is not directly affected by the devastating impacts cyclonic systems can have on coastal regions, many areas in the state are subject to the primary damaging forces associated with these storms including high-level sustained winds, heavy precipitation and tornadoes. Areas in southeastern Pennsylvania could be susceptible to storm surge and tidal flooding. The majority of hurricanes and tropical storms form in the Atlantic Ocean, Caribbean Sea and Gulf of Mexico during the official Atlantic hurricane season which extends from June through November (FEMA, 1997).
	Landslide	A landslide is the downward and outward movement of slope-forming soil, rock and vegetation reacting to the force of gravity. Landslides may be triggered by both natural and human-caused changes in the environment, including heavy rain, rapid snow melt, steepening of slopes due to construction or erosion, earthquakes and changes in groundwater levels. Mudflows, mudslides, rockfalls, rockslides and rock topples are all forms of a landslide. Areas that are generally prone to landslide hazards include previous landslide areas, the bases of steep slopes, the bases of drainage channels, developed hillsides and areas recently burned by forest and brush fires.
	Pandemic	A pandemic occurs when infection from of a new strain of a certain disease, to which most humans have no immunity, substantially exceeds the number of expected cases over a given period of time. Such a disease may or may not be transferable between humans and animals. (Martin & Martin-Granel, 2006).
	Subsidence and Sinkhole	Subsidence is a natural geologic process that commonly occurs in areas with underlying limestone bedrock and other rock types that are soluble in water. Water passing through naturally occurring fractures dissolves these materials leaving underground voids. Eventually, overburden on top of the voids causes a collapse which can damage structures with low strain tolerances. This collapse can take place slowly over time or quickly in a single event, but in either case. Karst topography describes a landscape that contains characteristic structures such as sinkholes, linear depressions, and caves. In addition to natural processes, human activity such as water, natural gas, and oil extraction can cause subsidence and sinkhole formations. (FEMA, 1997).
	Tornado & Windstorm	A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground. Tornadoes are most often generated by thunderstorm activity (but sometimes result from hurricanes or tropical storms) when cool, dry air intersects and overrides a layer of warm, moist air forcing the warm air to rise rapidly. The damage caused by a tornado is a result of high wind velocities and wind-blown debris. According to the National Weather Service, tornado wind speeds can range between 30 to more than 300 miles per hour. They are more likely to occur during the spring and early summer months of March through June

Table 4.2-5: List and description of natural and human-made hazards profiled in the 2010 HMP.		
HAZARD TYPE	**HAZARD**	**HAZARD DESCRIPTION**
		and are most likely to form in the late afternoon and early evening. Most tornadoes are a few dozen yards wide and touch-down briefly, but even small, short-lived tornadoes can inflict tremendous damage. Destruction ranges from light to moderate depending on the intensity, size and duration of the storm. Structures made of light materials such as mobile homes are most susceptible to damage. Waterspouts are weak tornadoes that form over warm water and are relatively uncommon in Pennsylvania. An average of over 800 tornadoes are reported annually nationwide, resulting in an average of 80 deaths and 1,500 injuries (NOAA, 1995). Based on NOAA Storm Prediction Center Statistics, the number of recorded F3, F4, & F5 tornadoes between 1950-1998 ranges from <1 to 15 per 3,700 square miles across Pennsylvania (FEMA, 2009).
	Wildfire	A wildfire is a raging, uncontrolled fire that spreads rapidly through vegetative fuels, exposing and possibly consuming structures. Wildfires often begin unnoticed and can spread quickly, creating dense smoke that can be seen for miles. Wildfires can occur at any time of the year, but mostly occur during long, dry hot spells. Any small fire in a wooded area, if not quickly detected and suppressed, can get out of control. 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 fields, grass, brush and forests. 98% of wildfires in Pennsylvania are a direct result of people, often caused by debris burns (Department of Conservation and Natural Resources, 2009).
	Winter Storm	Winter storms may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation. A winter storm can range from a moderate snowfall or ice event over a period of a few hours to blizzard conditions with wind-driven snow that lasts for several days. Many winter storms are accompanied by low temperatures and heavy and/or blowing snow, which can severely impair visibility and disrupt transportation. The Commonwealth of Pennsylvania has a long history of severe winter weather.
Technological and Human-made Hazards	**Dam Failure**	A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but immense damage and loss of life is possible in downstream communities when such events occur. Aging infrastructure, hydrologic, hydraulic and geologic characteristics, population growth and design and maintenance practices should be considered when assessing dam failure hazards. The failure of the South Fork Dam, located in Johnstown, PA, was the deadliest dam failure ever experienced in the United States. It took place in 1889 and resulted in the Johnstown Flood which claimed 2,209 lives (FEMA, 1997). Today there are approximately 3,200 dams and reservoirs throughout Pennsylvania (PADEP, 2008).
	Environmental Hazards	Environmental hazards are hazards that pose threats to the natural environment the built environment, and public safety through the diffusion of harmful substances, materials, or products. Environmental hazards include the following: • **Hazardous material releases** – at fixed facilities or as such materials are in transit and including toxic chemicals, infectious substances, biohazardous waste, and any materials that are explosive, corrosive, flammable, or radioactive (PL 1990-165, § 207(e)). • **Air or Water Pollution** – the release of harmful chemical and waste materials into water bodies or the atmosphere, for example (National Institute of Health Sciences, July 2009; EPA, *Natural Disaster PSAs*, 2009).

Table 4.2-5: List and description of natural and human-made hazards profiled in the 2010 HMP.		
HAZARD TYPE	**HAZARD**	**HAZARD DESCRIPTION**
	Levee Failure	A levee is a human-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding (Interagency Levee Policy Review Committee, 2006). Levee failures or breaches occur when a levee fails to contain the floodwaters for which it is designed to control or floodwaters exceed the height of the constructed levee. Fifty-one of Pennsylvania's 67 counties have been identified as having at least one levee (FEMA Region III, 2009).
	Transportation Accidents	Transportation accidents can result from any form of air, rail, water, or road travel. It is unlikely that small accidents would significantly impact the larger community. However, certain accidents could have secondary regional impacts such as a hazardous materials release or disruption in critical supply/access routes, especially if vital transportation corridors or junctions are present.
	Urban Fire and Explosion	An urban fire involves a structure or property within an urban or developed area. For hazard mitigation purposes, major urban fires involving large buildings and/or multiple properties are of primary concern. The effects of a major urban fire include minor to significant property damage, loss of life, and residential or business displacement. Explosions are extremely rapid releases of energy that usually generate high temperatures and often lead to fires. The risk of severe explosions can be reduced through careful management of flammable and explosive hazardous materials. (FEMA, 1997).
	Utility Interruption	Utility interruption hazards are hazards that impair the functioning of important utilities in the energy, telecommunications, public works and information network sectors. Utility interruption hazards include the following: • Geomagnetic Storms – including temporary disturbances of the Earth's magnetic field resulting in disruptions of communication, navigation, and satellite systems (National Research Council et al., 1986). • Fuel or Resource Shortage – resulting from supply chain breaks or secondary to other hazard events, for example (Mercer County, PA, 2005). • Electromagnetic Pulse – originating from an explosion or fluctuating magnetic field and causing damaging current surges in electrical and electronic systems (Institute for Telecommunications Sciences, 1996). • Information Technology Failure – due to software bugs, viruses, or improper use (Rainer Jr., et al, 1991). • Ancillary Support Equipment – electrical generating, transmission, system-control, and distribution-system equipment for the energy industry (Hirst & Kirby, 1996). • Public Works Failure – damage to or failure of highways, flood control systems, deepwater ports and harbors, public buildings, bridges, dams, for example (U.S. Senate Committee on Environment and Public Works, 2009). • Telecommunications System Failure – damage to data transfer, communications, and processing equipment, for example (FEMA, 1997). • Transmission Facility or Linear Utility Accident – liquefied natural gas leakages, explosions, facility problems, for example (United States Department of Energy, 2005). • Major Energy, Power, Utility Failure – interruptions of generation and distribution, power outages, for example (United States DOE, 2000).

4.3. Hazard Profiles and Vulnerability Analysis

NATURAL HAZARDS

4.3.1. Drought

4.3.1.1. Location and Extent

A drought is an extended period where rainfall and water availability fall below a region's requirements contributing to depletion of groundwater and surface water. Droughts can occur at any time of the year but have the greatest impact to society during the warm summer months. Droughts are regional climatic events, so when these events occur in Delaware County, impacts are felt across the entire County as well as areas outside County boundaries. The spatial extent for areas of impact can range from areas of Pennsylvania to the entire mid-Atlantic region. The impact of a drought is generally felt first by the agricultural sector, which is dependent on precipitation and groundwater. Figure 2.4-1 in the Community Profile section of this plan shows that the majority of agricultural land in Delaware County is located in the western portion of the country and would be hardest hit by a drought.

4.3.1.2. Range of Magnitude

Drought is a normal part of virtually all climates, the consequence of a natural reduction in the amount of precipitation experienced over a long period of time, usually a season or more in length. High temperatures, prolonged winds, and low relative humidity can exacerbate the severity of drought.

Droughts can be categorized into four types: meteorological, agricultural, hydrological, and socioeconomic. A meteorological drought is defined based on the degree of dryness in comparison to the average precipitation and the duration of the dry period. Agricultural droughts are linked by how the characteristics of a meteorological and hydrological drought impact agriculture. The focus lies on evapotranspiration, soil water deficits, and reduced groundwater and reservoir levels. Hydrological droughts are associated with the effect precipitation shortfalls have on the surface and subsurface water supply. Socioeconomic drought is defined by its association to the supply and demand of economic goods and the ability to maintain this economic essential based on elements of meteorological, hydrological, and agricultural droughts. These types of droughts occur when the socioeconomic demand for a particular good cannot be met due to drought conditions (NDMC, 2009).

The Commonwealth uses five parameters to assess drought conditions:

1) Stream flows (compared to benchmark records).
2) Precipitation (measured as the departure from normal, 30 year average precipitation).
3) Reservoir storage levels in a variety of locations (especially three New York City reservoirs in upper Delaware River Basin).
4) Groundwater elevations in a number of counties (comparing to past month, past year and historic record).
5) The Palmer Drought Severity Index (PSDI) – a soil moisture algorithm calibrated for relatively homogeneous regions which measures dryness based on recent precipitation and temperature (see Table 4.3.1-1).

Table 4.3.1-1: Palmer Drought Severity Index (NDMC, 2009).	
SEVERITY CATEGORY	**PSDI VALUE**
Extremely wet	4.0 or more
Very wet	3.0 to 3.99
Moderately wet	2.0 to 2.99
Slightly wet	1.0 to 1.99
Incipient wet spell	0.5 to 0.99
Near normal	0.49 to -0.49
Incipient dry spell	-0.5 to -0.99
Mild drought	-1.0 to -1.99
Moderate drought	-2.0 to -2.99
Severe drought	-3.0 to -3.99
Extreme drought	-4.0 or less

Phases of drought preparedness in Pennsylvania in order of increasing severity are:

- Drought Watch: A period to alert government agencies, public water suppliers, water users and the public regarding the potential for future drought-related problems. The focus is on increased monitoring, awareness and preparation for response if conditions worsen. A request for voluntary water conservation is made. The objective of voluntary water conservation measures during a drought watch is to reduce water uses by five percent in the affected areas. Due to varying conditions, individual water suppliers or municipalities may be asking for more stringent conservation actions.
- Drought Warning: This phase involves a coordinated response to imminent drought conditions and potential water supply shortages through concerted voluntary conservation measures to avoid or reduce shortages, relieve stressed sources, develop new sources, and if possible forestall the need to impose mandatory water use restrictions. The objective of voluntary water conservation measures during a drought warning is to reduce overall water uses by ten to fifteen percent in the affected areas. Due to varying conditions, individual water suppliers or municipalities may be asking for more stringent conservation actions.
- Drought Emergency: This stage is a phase of concerted management operations to marshal all available resources to respond to actual emergency conditions, to avoid depletion of water sources, to assure at least minimum water supplies to protect public health and safety, to support essential and high priority water uses and to avoid unnecessary economic dislocations. It is possible during this phase to impose mandatory restrictions on non-essential water uses that are provided in the Pennsylvania Code (Chapter 119), if deemed necessary and if ordered by the Governor of Pennsylvania. The objective of water use restrictions (mandatory or voluntary) and other conservation measures during this phase is to reduce consumptive water use in the affected area by fifteen percent, and to reduce total use to the extent necessary to preserve public water

system supplies, to avoid or mitigate local or area shortages, and to assure equitable sharing of limited supplies.

- Local Water Rationing: Although not a drought phase, local municipalities may, with the approval of the PA Emergency Management Council, implement local water rationing to share a rapidly dwindling or severely depleted water supply in designated water supply service areas. These individual water rationing plans, authorized through provisions of the Pennsylvania Code (Chapter 120), will require specific limits on individual water consumption to achieve significant reductions in use. Under both mandatory restrictions imposed by the Commonwealth and local water rationing, procedures are provided for granting of variances to consider individual hardships and economic dislocations.

Areas with extensive agricultural land use are most vulnerable to drought. Droughts result in reductions of stream flows, lake/reservoir storage, and of groundwater levels. These events have adverse impacts on public water supplies for human consumption, rural water supplies for livestock consumption and agricultural operations, water quality, soil moisture, water for navigation and recreation. When a dry period continues for an extended timeframe and affects the public water supplies, it often leads to restrictions on water use. Dry periods can also affect navigation if water levels in rivers drop too low. Additionally, a long-term drought can adversely affect woodlands and the ability to fight wildfires.

Additional 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.

There has been one presidential disaster declaration and five gubernatorial declarations for drought since 1955 in Delaware County (Tables 4.2-1 and 4.2-2). A worst case scenario for droughts occurred in February 2002. The Governor declared a disaster proclamation for drought, placing a ban on non-essential use of water. The Springton Reservoir in Delaware County was at 43 percent of capacity. Normal is 70 percent. The February precipitation total of 0.55 at the Philadelphia International Airport was the driest February on record. The declaration gave the Delaware River Basin Commission the authority to take water from municipal reservoirs to maintain river levels. The releases helped protect the riverbank and aquatic life and also prevented salt water from flowing up the Delaware River.

4.3.1.3. Past Occurrence

Declared drought status for Delaware County from 1980 to 2010 is shown in Table 4.3.1-2. Descriptions for drought status categories (i.e. *watch*, *warning*, and *emergency*) are included in Section 4.3.1.2. The Pennsylvania Department of Environmental Protection (DEP) is the agency responsible for collecting drought information. Data for all counties in the Commonwealth is available for the years 1980 through 2010.

Table 4.3.1-2: Delaware County Declared Drought Status from 1980 to 2010 (PADEP, 2011).

DATE	DROUGHT STATUS	DATE	DROUGHT STATUS
Nov 18, 1980 - Apr 20, 1982	Emergency (Eastern portion only)	Sept 1, 1995 - Dec 18, 1995	Watch
Apr 26, 1985 - Oct 22, 1985	Watch (Eastern portion only)	Dec 3, 1998 - Dec 8, 1998	Watch
Oct 22, 1985 - Dec 19, 1985	Watch	Dec 9, 1998 - Dec 16, 1998	Warning
Jul 7, 1988 - Aug 24, 1988	Watch	Dec 16, 1998 - Mar 15, 1999	Emergency
Nov 18, 1980 – Apr 20, 1982	Emergency	Dec 3, 1998 – Dec 14, 1998	Watch
Apr 26, 1985 – Dec 19, 1985	Watch	Dec 14, 1998 – Mar 15, 1999	Warning
July 7, 1988 – Aug 24, 1988	Watch	Mar 15, 1999 – June 10, 1999	Watch
Aug 24, 1988 – Dec 12, 1988	Warning	June 10, 1999 – July 20, 1999	Warning
Mar 3, 1989 – May 15, 1989	Watch	July 20, 1999 – September 30, 1999	Emergency
June 28, 1991 – July 24, 1991	Warning	Sept 30, 1999 –May 5, 2000	Watch
July 24, 1991 – Apr 20, 1992	Emergency	Aug 24, 2001 –May 13, 2002	Watch
Apr 20, 1992 – June 23, 1992	Warning	Sept 5, 2002 – Nov 7, 2002	Watch
June 23, 1992 – Sept 11, 1992	Watch	Apr 11, 2006 – June 30, 2006	Watch
Sept 1, 1995 – Sept 20, 1995	Warning	Aug 8, 2007 – Sept 5, 2007	Watch
Sept 20, 1995 – Nov 8, 1995	Emergency	Oct 5, 2007 – Jan 11, 2008	Watch
Nov 8, 1995 – Dec 18, 1995	Warning	Nov 7, 2008 – Jan 26, 2009	Watch
Jul 17, 1997 – Nov 13, 1997	Watch	Sept 16, 2010 – Nov 10, 2010	Watch

Delaware County also has record a drought events prior to 1980.

Table 4.3.1-3: Delaware County Declared Drought Status from prior to 1980.

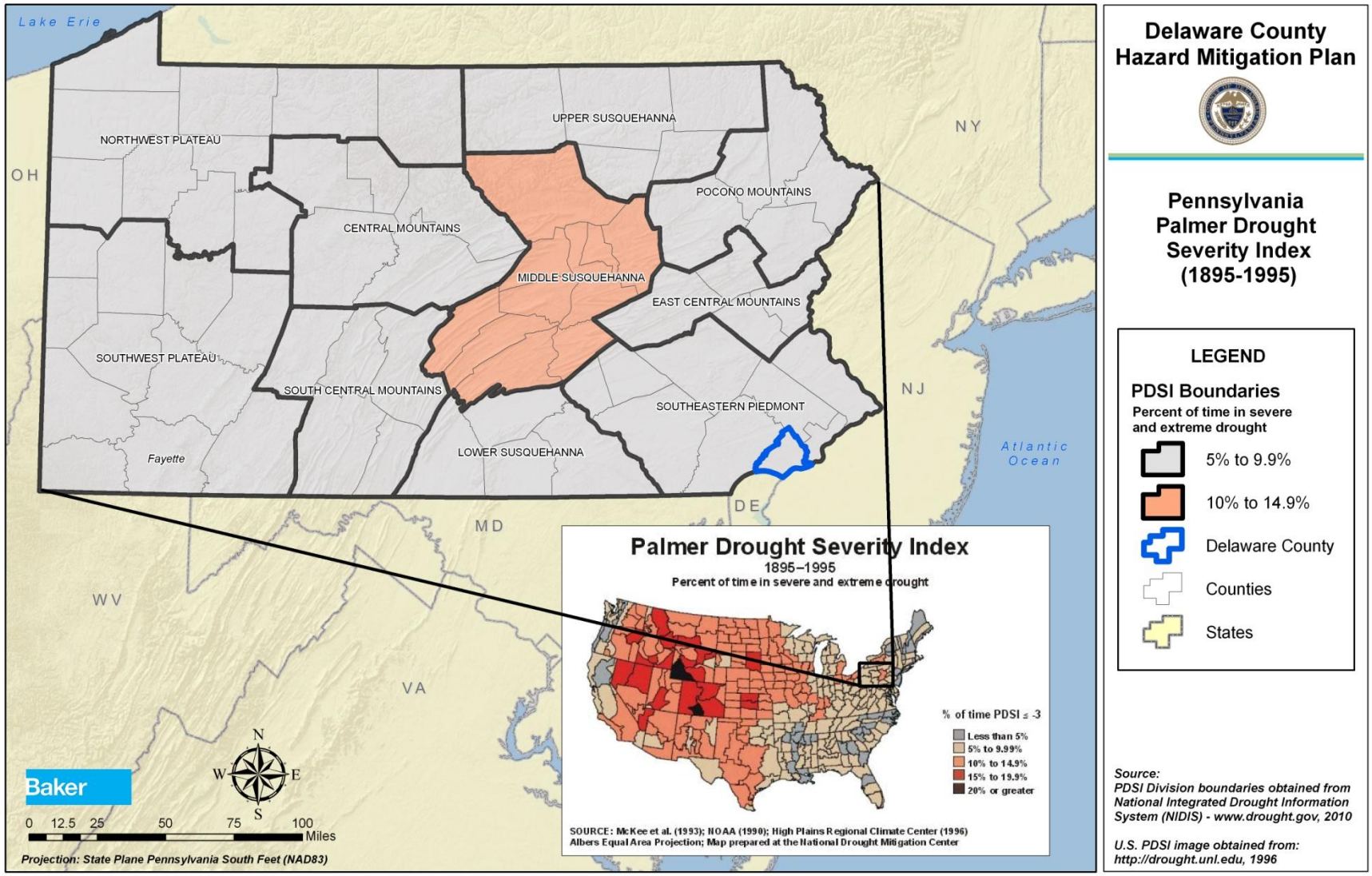
DROUGHT PERIOD	DURATION	LOWEST PSDI
Nov 1895 – Jan 1896	3 months	-3.62 in 1/1896
Dec 1900 – Feb 1901	3 months	-4.00 in 2/1901
Nov 1909 – Dec 1909	2 months	-3.81 in 12/1909
Oct 1910 – Mar 1911	6 months	-3.62 in 12/1910
Nov 1918 – Dec 1918	2 months	-3.19 in 12/1918
Aug 1923 – Dec 1923	5 months	-3.53 in 8/1923
Aug 1930 – June 1931	11 months	-5.15 in 1/1931

Table 4.3.1-3: Delaware County Declared Drought Status from prior to 1980.		
DROUGHT PERIOD	**DURATION**	**LOWEST PSDI**
Nov 1931 – Dec 1931	2 months	-3.51 in 12/1931
Nov 1941 – Jan 1942	3 months	-3.17 in 11/1941
Dec 1949 – Jan 1950	2 months	-3.40 in 1/1950
Aug 1957 – Nov 1957	4 months	-3.84 in 11/1957
Jul 1963 – Aug 1963	2 months	-3.45 in 8/1963
Aug 1964 - Feb 1965	7 months	-4.08 in 11/1964
Apr 1965 – Jan 1966	10 months	-4.47 in 12/1965
June 1966 – Aug 1966	3 months	-4.64 in 8/1966

4.3.1.4. Future Occurrence

It is difficult to forecast the severity and frequency of future drought events in Delaware County. Based on national data from 1895 to 1995, Delaware County is in severe or extreme drought approximately 5 to 9.9 percent of the time (see Figure 4.3.1-1). This is equivalent to a PDSI value less than or equal to *-3*. Therefore, the future occurrence of drought can be considered *possible* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1).

Figure 4.3.1-1: Percent of time areas of the United States have PSDI values <= -3 (NIDIS, 2010).



4.3.1.5. Vulnerability Assessment

While Delaware County does not possess a large agricultural sector, drought remains a concern within the County. In addition to the water needs of residents, the County also has waterfront industries along the Delaware River dependent on ships being able to navigate the river. A prolonged drought could also allow for the migration of the salt line northward into Delaware County, increasing corrosion control costs for industry and can raise the treatment costs for public water suppliers.

There are two large public water companies in the County, Aqua Pennsylvania and Chester Water Authority. These companies are interconnected, allowing water to be redirected as needed throughout the County. The majority of their water is obtained through surface water with a small amount coming from wells. Additionally, a portion of the water used by these companies comes from sources outside of the County.

Those residents not serviced by public water companies utilize private wells and are most susceptible to the effects of a drought because their drinking water can dry up. Table 4.3.1-4 shows the number of domestic wells per municipality. It is important to note that the well data was obtained from the Pennsylvania DEP via fractracker.org and is not a complete database of all domestic wells in the County. The below table represents the only comprehensive data set of domestic wells available.

Table 4.3.1-4: Number of domestic wells per municipality in Delaware County (PA DEP, 2011).

MUNICIPALITY	DOMESTIC WELLS
Aldan Borough	22
Aston Township	NA
Bethel Township	18
Brookhaven Borough	NA
Chadds Ford Township	37
Chester City	2
Chester Township	NA
Chester Heights Borough	3
Clifton Heights Borough	1
Collingdale Borough	NA
Colwyn Borough	NA
Concord Township	48
Darby Borough	NA
Darby Township	1
East Lansdowne Borough	NA
Eddystone Borough	NA
Edgmont Township	14
Folcroft Borough	NA
Glenolden Borough	NA
Haverford Township	11

Table 4.3.1-4: Number of domestic wells per municipality in Delaware County (PA DEP, 2011).	
MUNICIPALITY	**DOMESTIC WELLS**
Lansdowne Borough	NA
Lower Chichester Township	NA
Marcus Hook Borough	NA
Marple Township	14
Media Borough	NA
Middletown Township	13
Millbourne Borough	NA
Morton Borough	NA
Nether Providence Township	NA
Newtown Township	17
Norwood Borough	NA
Parkside Borough	NA
Prospect Park Borough	NA
Radnor Township	12
Ridley Township	NA
Ridley Park Borough	NA
Rose Valley Borough	NA
Rutledge Borough	NA
Sharon Hill Borough	NA
Springfield Township	NA
Swarthmore Borough	NA
Thornbury Township	60
Tinicum Township	NA
Trainer Borough	NA
Upland Borough	NA
Upper Chichester Township	12
Upper Darby Township	1
Upper Providence Township	9
Yeadon Borough	1
TOTAL	**296**

If a drought lasts for an extended period of time, water restrictions will be enforced. It is important that the communities in the County have methods in place to inform their residents and industry of drought emergencies and restrictions that might be in place.

4.3.2. Earthquake

4.3.2.1. Location and Extent

An earthquake is a sudden violent shaking of the earth's surface caused by the movement of tectonic plates along fault lines. The movement of these plates releases energy that radiates seismic waves resulting in damage to buildings, roads, bridges, and infrastructure. The degree

of damage depends on the magnitude of the event, the soil conditions, construction standards, and building characteristics.

Earthquakes are sometimes preceded by foreshocks and followed by aftershocks. These are small earthquakes that occur in the same location as the larger earthquake. Certain areas of the world are more prone to severe earthquakes than others. In the United States, California and the West Coast are commonly known to suffer from damaging earthquakes. While Pennsylvania does not have an extensive history of earthquakes, they have occurred in the state with negative impacts on residents.

Earthquake epicenters in Pennsylvania are not evenly distributed. There is a large concentration in the southeastern region of the state, specifically in southeastern Pennsylvania and particularly the Lancaster area. Three earthquake epicenters have been measured in Delaware County. Earthquake events in the Pennsylvania region including Delaware County are mild. When events occur, they impact very small areas less than 100 kilometers in diameter.

4.3.2.2. Range of Magnitude

An earthquake's severity can be measured in terms of intensity and magnitude. Intensity is based on ground effects or damage caused by the shaking ground on buildings, people, and natural features. The measure varies throughout the affected area based on location with respect to the epicenter. Magnitude is associated with the amount of seismic energy released at the epicenter of the earthquake. This value is based on the amplitude of the earthquake waves recorded on calibrated instruments. The value has no correlation to damage, and the scale in which it is recorded is referred to as the Richter Scale. Table 4.3.2-1 summarizes Richter Scale magnitudes as they relate to the spatial extent of impacted areas. Based on historical events, earthquakes in the Pennsylvania region do not exceed magnitudes greater than 6.0.

Table 4.3.2-1: 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; 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 damaged	<6.9
IX	Ruinous	Some houses collapse, ground cracks, pipes break open	
X	Disastrous	Ground cracks profusely, many buildings destroyed, liquefaction and landslides widespread	<7.3
XI	Very	Most buildings and bridges collapse, roads,	<8.1

Table 4.3.2-1: Modified Mercalli Intensity Scale with associated impacts.			
SCALE	**INTENSITY**	**DESCRIPTION OF EFFECTS**	**CORRESPONDING RICHTER SCALE MAGNITUDE**
	Disastrous	railways, pipes and cables destroyed, general triggering of other hazards	
XII	**Catastrophic**	Total destruction, trees fall, ground rises and falls in waves	>8.1

An additional way to express an earthquake's severity is to compare its acceleration to the normal acceleration due to gravity. Peak ground acceleration (PGA) measures the strength of ground movements in this manner. PGA represents the rate of change of motion of the earth's surface during an earthquake as a percent of the established rate of acceleration due to gravity.

The impact an earthquake event has on an area is typically measured in terms of earthquake intensity. Intensity is most commonly measured using the Modified Mercalli Intensity (MMI) Scale based on direct and indirect measurements of seismic effects. A detailed description of the Modified Mercalli Intensity Scale is shown in Table 4.3.2-2. The earthquakes that occur in Pennsylvania originate deep with the Earth's crust; not on an active fault. Therefore, little or no damage is expected. No injury or severe damage from earthquake events has been reported in Delaware County.

Though the impacts of earthquakes can be numerous, widespread, and devastating, Delaware County is unlikely to experience an earthquake that causes more than moderate to no damage. However, a worst case scenario could occur if an earthquake happened with an epicenter in the County and a magnitude of 5.0 or more. The largest earthquake ever recorded in Pennsylvania was the Pymatuning Earthquake which occurred in 1998 and had a magnitude of 5.2. A similar earthquake in Delaware County could cause damage to buildings, infrastructure, and historic properties.

Table 4.3.2-2: Richter scale magnitudes and associated earthquake size effects.	
RICHTER MAGNITUDES	**EARTHQUAKE EFFECTS**
Less than 3.5	Generally not felt, but recorded.
3.5-5.4	Often felt, but rarely causes damage.
Under 6.0	At most, slight damage to well-designed buildings; can cause major damage to poorly constructed buildings over small regions.
6.1-6.9	Can be destructive in areas where people live up to about 100 kilometers across.
7.0-7.9	Major earthquake; can cause serious damage over large areas.
8.0 or greater	Great earthquake; can cause serious damage in areas several hundred kilometers across.

4.3.2.3. Past Occurrence

Earthquakes are relatively infrequent and uncommon in Delaware County, but there is existing data to indicate that earthquake activity has occurred rarely in the past causing minimal if any

damage. The three earthquakes with epicenters in Delaware County are shown on Figure 4.3.2-1 which displays recorded earthquake events in Pennsylvania between 1724 and 2003. Earthquake events are shown in other areas of Pennsylvania and there are also epicenter events shown in neighboring counties and in New Jersey and Delaware.

Delaware County has record of several earthquakes whose effects were felt in the County. On December 8, 1737, a strong earthquake was felt in New York, Boston, Philadelphia, and New Castle. On November 11 and 14, 1840, earthquakes at Philadelphia were accompanied by an unusual swell on the Delaware River.

A strong shock (V intensity) on May 31, 1884, in Allentown had reports of dishes being thrown from tables. An earthquake centered in New York City in August of 1884, was felt in 30 towns from Hartford, Connecticut to West Chester, Pennsylvania. A strong earthquake (VI intensity) was centered in Allentown in May of 1908, shaking down a few chimneys. The disturbance was felt for 93 miles.

The area around Sinking Spring near Reading experienced minor damage (VI intensity) with plaster falling from walls, dishes and bottles tumbling from shelves, and furniture being upset during an event on January 7, 1954. Tremors were felt in the area for a month afterwards.

A moderate earthquake on September 14, 1961, centered in the Lehigh Valley shook buildings over a broad area and alarmed many residents. Minimal damage was reported (V intensity), but citizens were upset.

A small earthquake on December 10, 1968, with an epicenter in New Jersey, had effects in the Darby Borough area as well as the City of Philadelphia (V intensity). The shock only measured 2.5 on the Richter Scale, but it was strong enough to shake tollbooths on the Benjamin Franklin and Walt Whitman Bridges and broke windows in some locations in New Jersey.

Figure 4.3.2-1: Map showing the location of significant earthquake epicenters in Pennsylvania.

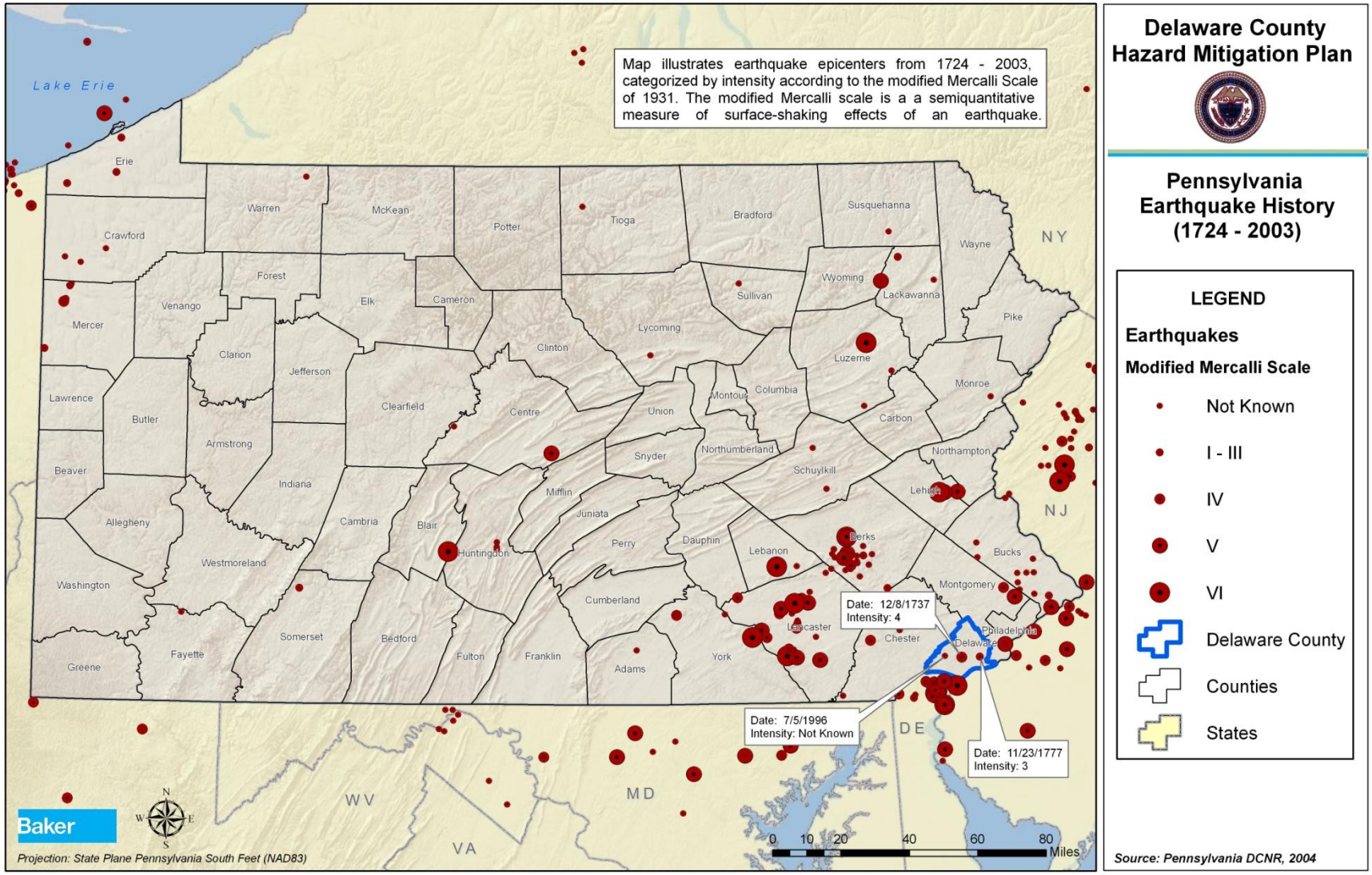
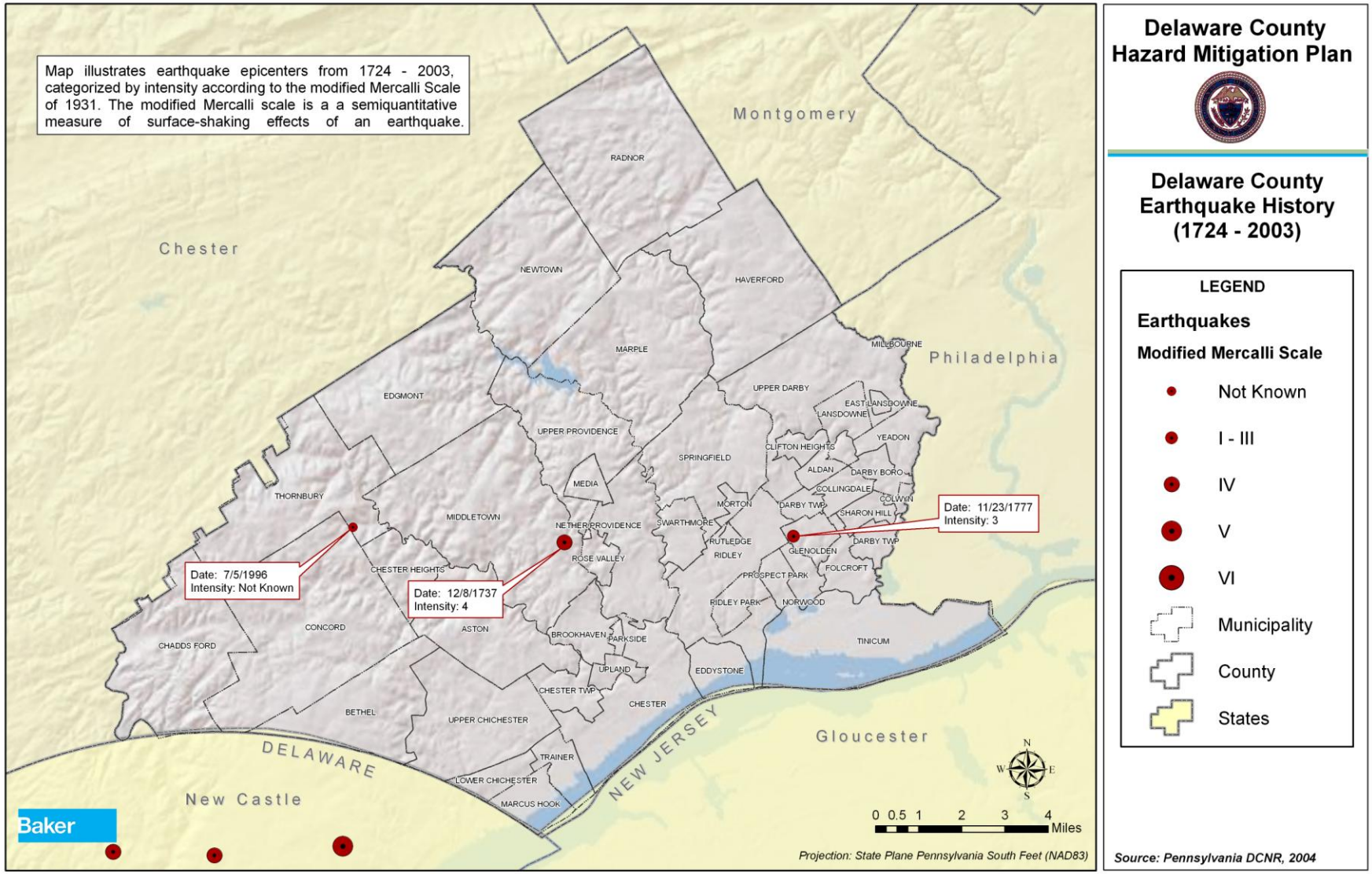


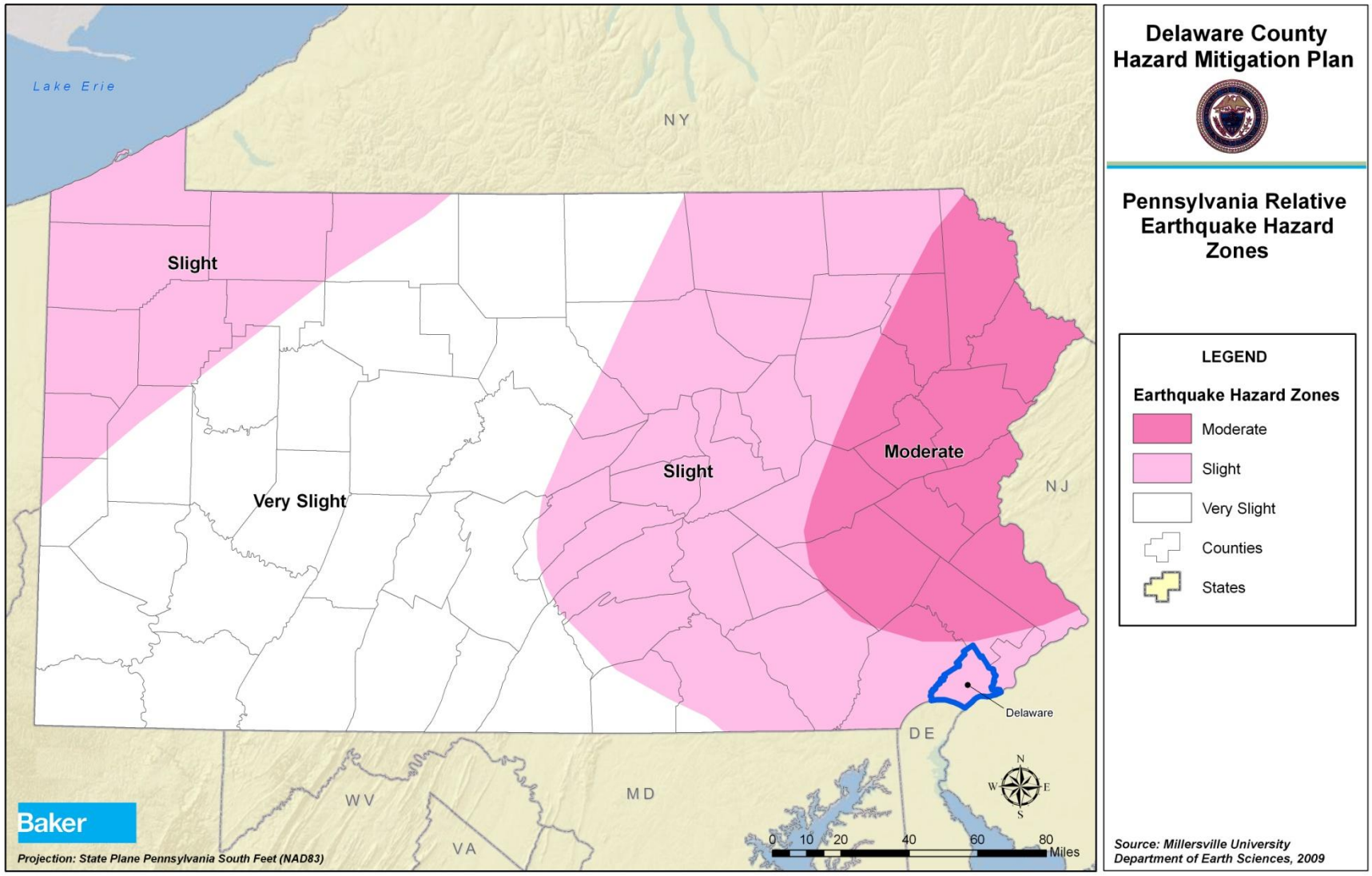
Figure 4.3.2-2: Delaware County earthquake history, focus on Delaware County.



4.3.2.4. Future Occurrence

Figure 4.3.2-2 shows the relative earthquake hazard zones in Pennsylvania identified by the Department of Earth Sciences at Millersville University. According to this map, earthquake hazards are "slight" for Delaware County, meaning the PGA ten percent probability of exceedance over a 50-year period equals 5-10 PGA. In general, ground acceleration must exceed 15 PGA for significant damage to occur, although soil conditions at local sites are extremely important in controlling how much damage will occur as a consequence of a given amount of ground acceleration. Therefore the future occurrence of earthquakes in Delaware County can be considered *unlikely* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1).

Figure 4.3.2-2: Map of Pennsylvania earthquake hazard zones (Millersville University Department of Earth Sciences, 2009).



4.3.2.5. Vulnerability Assessment

Delaware County is located in a zone where earthquake vulnerability is expected to be only slight. No major damage or casualties have been reported from earthquake events. While historic data indicates that the County is susceptible to the forces of earthquakes, damage has been isolated and minimal. The effects of earthquake (if the hazard exists) could potentially be anything from detected only on seismographs to ground water wells collapsing to total destruction, trees falling, ground rises and falls in waves.

Buildings most at risk to the effects of earthquakes are those with thick walls as they do not resist shock well, brick buildings, chimneys, and heavy roof tiles. Additionally, construction on soft or filled soil is more susceptible to the shockwaves of earthquakes. The type of construction and age of homes is important when considering the amount of damage that might be sustained in an earthquake. Therefore, it is important to determine the types and ages of buildings that are present within the County as the first step in determining the impact of earthquakes.

It is important for developers to consider the possibility of earthquake damage when designing and constructing buildings. Unlike areas such as southern California where earthquakes are prevalent, building codes in Pennsylvania generally do not contain provisions that account for the forces of earthquakes. However, the Universal Building Code is a hazard-based code that has specific requirements for new construction and retrofit of existing buildings. All municipalities in Delaware County have adopted these codes, or more stringent variations.

4.3.3. Extreme Temperature

4.3.3.1. Location and Extent

Delaware County is subject to extreme temperatures in the summer and winter seasons. Extreme heat occurs when temperatures hover ten degrees or more above the average high temperature for a region for several weeks. Urban environments tend to retain the heat well into the night, leaving little opportunity for dwellings to cool. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when a “dome” of high atmospheric pressure traps hazy, damp air near the ground. Excessively dry and hot conditions can provoke dust storms and low visibility. A heat wave combined with a drought is a very dangerous situation.

Extreme heat is a concern in Delaware County during the summer months. The National Weather Service will issue warnings and watches prior to an event to allow people time to prepare. An excessive heat warning will be issued if heat stress conditions are forecast to occur within the next 24 hours. A heat advisory is issued if heat stress is forecast to occur within the next 24 hours (if air mass is MT+, less than 5 deaths are forecast). An excessive heat watch is issued if heat stress conditions are forecast to occur in the next 24 to 48 hours, and an excessive heat outlook is issued if heat stress conditions are forecast to occur in the next 48 to 120 hours.

Extreme cold temperatures drop well below what is considered normal for an area during the winter months and often accompany winter storm events. Combined with increases in wind speed, such temperatures in Pennsylvania can be life threatening to those exposed for extended periods of time.

Figure 4.3.3-1 and Figure 4.3.3-2 show mean maximum and minimum temperatures for Delaware County compared to the rest of Pennsylvania. The average maximum temperature for Delaware County lies in the mid to upper 80s. The average minimum temperature for Delaware County lies in the mid 20s.

Figure 4.3.3-1: Map showing average minimum temperature based on temperature data collected between 1971 and 2000 (USDA/NRCS, 2006).

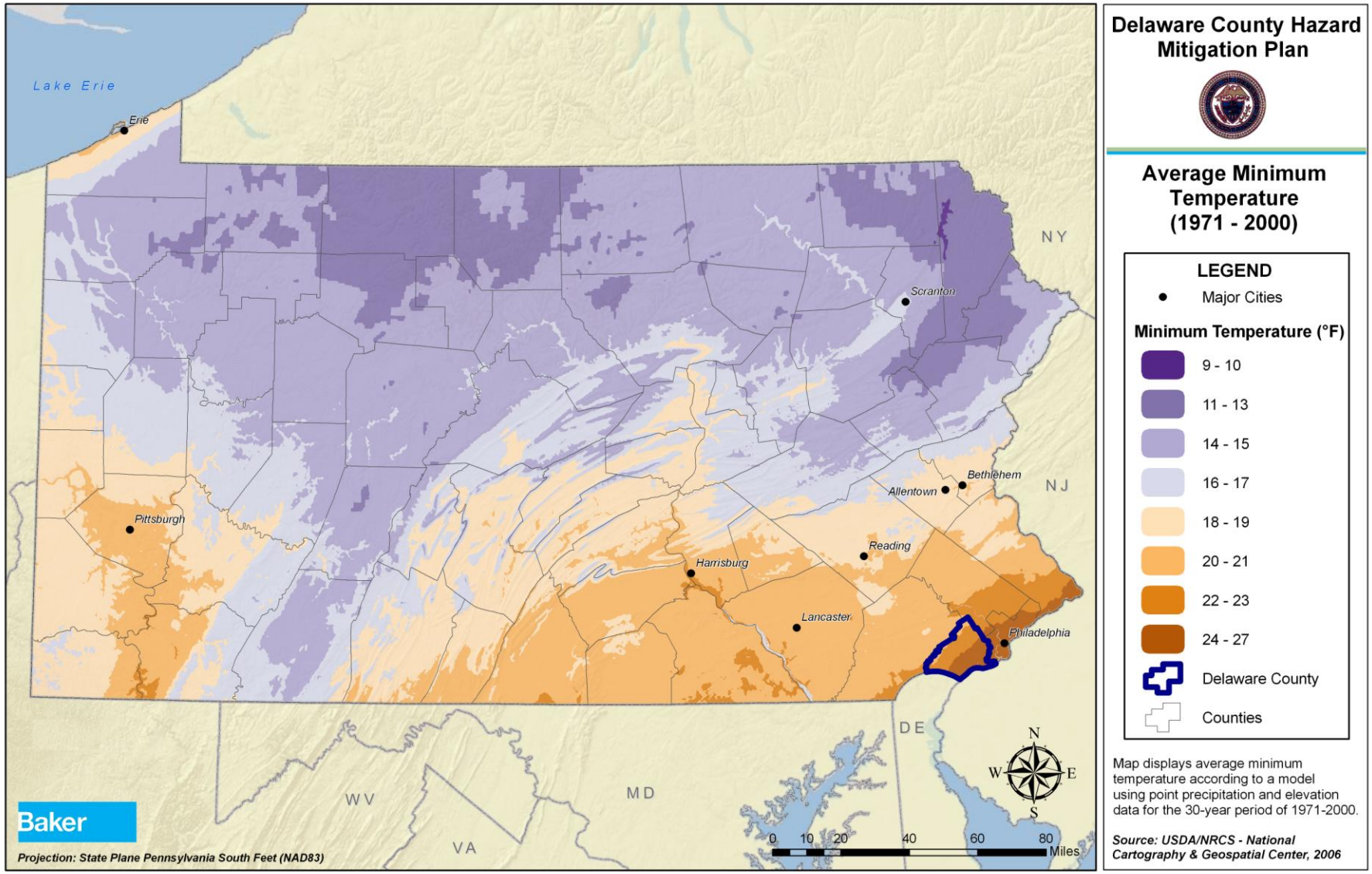
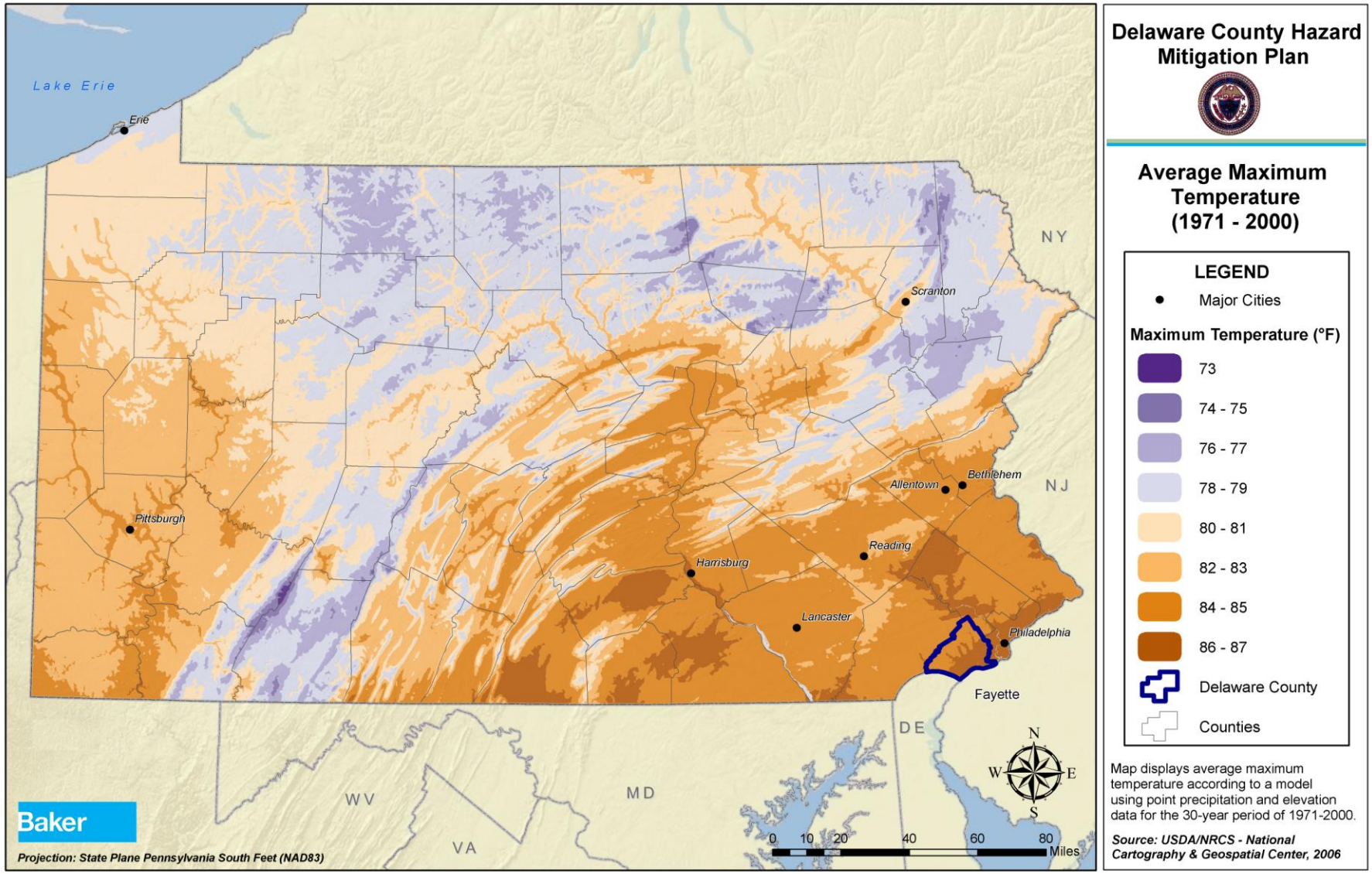


Figure 4.3.3-2: Map showing average maximum temperature based on temperature data collected between 1971 and 2000 (USDA/NRCS, 2006).



4.3.3.2. Range of Magnitude

The severity of extreme heat is based on the ambient air temperature coupled with the relative humidity. A prolonged heat wave that occurs during drought conditions can be very dangerous as the necessary water resources needed are limited. If extreme temperatures remain for a prolonged period, power supplies may be affected as electricity demands from air conditioners overdraw the supply leading to rolling brownouts. Exposure to heat can cause health problems indirectly, such as through the increased work load on the heart. This can be especially dangerous to individuals with preexisting medical conditions, typically the elderly.

Cold weather has a number of effects, most dramatically on the general population mortality rate. The average mortality on a winter's day is about 15% higher than on a summer's day. Cold weather is directly responsible for deaths through such things as hypothermia, influenza, and pneumonia. It is also an indirect factor in a number of ways such as death and injury from falls, accidents, carbon monoxide poisoning, and house fires all of which are partially attributable to cold.

The following impacts can be observed following extreme temperature events:

- **Health Impacts** - The health impacts of extreme cold are greater in terms of mortality in humans, but often after more prolonged exposure vs. a cold snap. Extreme heat waves, however, can prove more deadly over a shorter duration. At greatest risk of death in heat waves are the urban-dwelling elderly without access to an air-conditioned environment for at least part of the day.
- **Transportation** – Cold weather can impact automotive engines, possibly stranding motorists, and stress metal bridge structures. Highway and railroad tracks can become distorted in high heat. Disruptions to the transportation network and accidents due to extreme temperatures represent an additional risk.
- **Agriculture** – Absolute temperature and duration of extreme cold can have devastating effects on trees and winter crops. Livestock is especially vulnerable to heat and crop yields can be impacted by heat waves that occur during key development stages.
- **Energy** - Energy consumption rise significantly during extreme cold weather, and any fuel shortages or utility failures that prevent the heating of a dwelling place residents in extreme danger. Extreme heat also can result in utility interruptions, and sagging transmission lines due to the heat can lead to shorting out.

Extremely high temperatures cause heat stress which can be divided into four categories (see Table 4.3.3-1). 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. Note that while the temperatures in Table 4.3.3-1 serve as a guide for various danger categories, the impacts of high temperatures will vary from person to person based on individual age, health, and other factors.

Table 4.3.3-1: Four categories of heat stress (FEMA, 1997).

DANGER CATEGORY	HEAT DISORDERS	APPARENT TEMPERATURE (°F)
I (Caution)	Fatigue possible with prolonged exposure and physical activity.	80 to 90
II (Extreme Caution)	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and physical activity.	90 to 105
III (Danger)	Sunstroke, heat cramps, or heat exhaustion likely; heat stroke possible with prolonged exposure and physical activity.	105 to 130
IV (Extreme Danger)	Heatstroke or sunstroke imminent.	>130

The severity of extreme heat is also based on the ambient air temperature coupled with the relative humidity. Figure 4.3.3-3 explains the health effects suffered by people due to extreme heat and humidity.

Figure 4.3.3-3: The heat index (NSIS, 1997-2005).

Air Temp (°F)	Relative Humidity (percentage)																				
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
135°	120	126																			
130°	117	122	131																		
125°	111	116	123	131	141																
120°	107	111	116	123	130	139	148														
115°	105	107	111	115	120	127	135	143	151												
110°	99	102	105	108	112	117	123	130	137	143	150										
105°	95	97	100	102	105	109	113	118	123	129	135	142	149								
100°	91	93	95	97	99	101	104	107	110	115	120	126	132	138	144	150					
95°	87	88	90	91	93	94	96	98	101	104	107	110	114	119	124	130	136	140	150		
90°	83	84	85	86	87	88	90	91	93	95	96	98	100	102	106	109	113	117	122	126	131
85°	78	79	80	81	82	83	84	85	86	87	88	89	90	91	93	95	97	99	102	105	108
80°	73	74	75	76	77	77	78	79	79	80	81	81	82	83	84	85	86	87	88	89	90
75°	69	69	70	71	72	72	73	73	74	74	75	75	76	76	77	77	78	78	79	79	80
70°	64	64	65	65	66	66	67	67	68	68	69	69	70	70	70	70	71	71	71	71	72

= Heatstroke risk extremely high

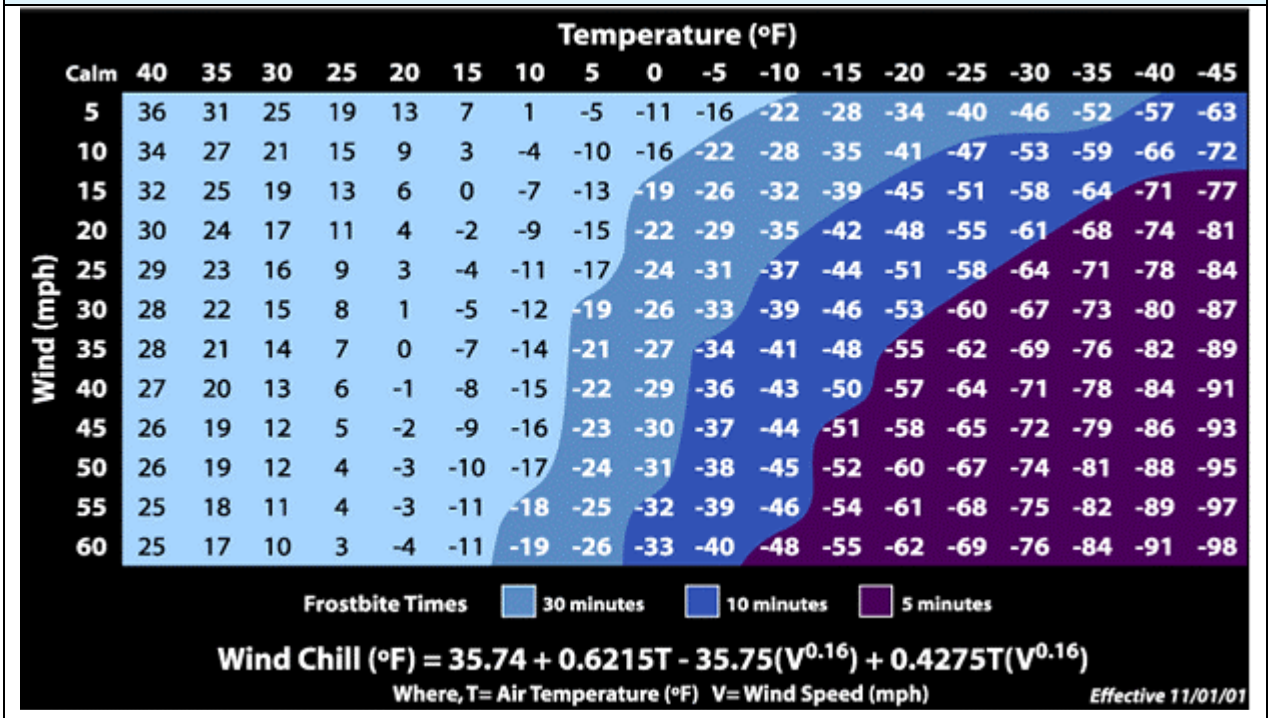
= Heat exhaustion likely, heatstroke possible

= Heat exhaustion possible

= Fatigue possible

In addition, Delaware County is susceptible to periods of weather where temperatures do not go beyond the freezing mark for days or even weeks at a time. Exposure to extreme cold can lead to frostbite and if exposed for too long, even death. Pipes in homes may burst, and residential fires increase as people use space heaters and other unsafe means to heat their homes. Figure 4.3.3-4 displays windchills and frostbite times.

Figure 4.3.3-4: National Weather Service windchill chart (NWS, 2009).



A potential worst-case extreme temperature scenario for extreme temperatures in Delaware County occurred on July 4, 1999. Eastern Pennsylvania experienced a heat wave that lasted the entire Independence Day weekend. The combination of temperature and humidity produced heat indices of around 100 degrees during the afternoon of each day of the weekend. There were 74 heat related deaths and over 100 reported heat related injuries in a 10 county region. Seven of these deaths were reported in Delaware County. Four of the Delaware County heat related deaths were persons who were taking medication which automatically raises body temperatures and makes them more susceptible to the heat.

4.3.3.3. Past Occurrence

Periods of extreme heat occur frequently in the summer months in Delaware County. Table 4.3.3-2 includes extreme heat and cold events that have occurred in the County between 1950 and 2011. The table also illustrates the danger associated with these events when examining the death toll and injuries.

Table 4.3.3-2: Previous temperature extremes impacting Delaware County from 1994-2011 (NCDC, 2011).

DATE	EVENT	DURATION (IN DAYS)	MAX OR MIN TEMPERATURE (degrees Fahrenheit)	DEATHS	INJURIES
6/13/1994	Heat Wave	9	100	5 (0)	N/A
7/6/1994	Heat Wave	5	99	10 (0)	N/A
2/6/1995	Extreme Cold	1	-9	1 (0)	0
7/1/1995	Excessive Heat	30	100	67 (0)	N/A
8/1/1995	Unseasonably Warm & Dry	30	N/A	29 (0)	N/A
12/9/1995	Unseasonably Cold	3	-30	2 (0)	0
2/4/1996	Extreme Cold	3	-12	0	0
5/19/1996	Excessive Heat	3	98	1 (0)	4
1/17/1997	Extreme Cold	4	-7	3 (0)	0
4/9/1997	Unseasonably Cold	3	29	0	0
6/21/1997	Excessive Heat	6	96	4 (0)	0
7/12/1997	Excessive Heat	7	98	24 (1)	0
8/16/1997	Excessive Heat	2	100	2 (0)	0
6/25/1998	Excessive Heat	2	97	3 (0)	0
7/20/1998	Excessive Heat	4	94	11 (0)	75
8/22/1998	Heat Wave	5	95	0	0
9/27/1998	Unseasonably Hot	1	93	0	0
6/7/1999	Excessive Heat	3	98	2 (0)	1
7/4/1999	Excessive Heat	3	102	74 (7)	135
7/16/1999	Excessive Heat	4	99	0	0
7/23/1999	Excessive Heat	10	100	9 (1)	0
6/26/2001	Excessive Heat	5	94	3 (0)	0
7/24/2001	Excessive Heat	2	94	2 (0)	0
8/6/2001	Excessive Heat	5	101	22 (0)	N/A
6/24/2002	Excessive Heat	4	99	3 (0)	0
7/1/2002	Excessive Heat	5	102	15 (0)	0
7/15/2002	Excessive Heat	5	97	2 (0)	0
7/28/2002	Excessive Heat	3	100	3 (0)	0
8/1/2002	Excessive Heat	5	101	9 (0)	0
8/11/2002	Excessive Heat	9	99	8 (0)	0
1/14/2003	Extreme Cold/Wind	16	8	4 (0)	0

Table 4.3.3-2: Previous temperature extremes impacting Delaware County from 1994-2011 (NCDC, 2011).

DATE	EVENT	DURATION (IN DAYS)	MAX OR MIN TEMPERATURE (degrees Fahrenheit)	DEATHS	INJURIES
	Chill				
6/23/2003	Excessive Heat	5	97	3 (0)	0
7/4/2003	Excessive Heat	6	95	4 (0)	0
1/9/2004	Extreme Cold/Wind Chill	3	4	2 (0)	0
1/15/2004	Extreme Cold/Wind Chill	2	7	1 (0)	0
12/20/2004	Extreme Cold/Wind Chill	1	10	0	0
1/18/2005	Extreme Cold/Wind Chill	1	10	2 (0)	1
1/23/2005	Extreme Cold/Wind Chill	2	-5	1 (0)	0
1/28/2005	Extreme Cold/Wind Chill	1	6	0	0
6/13/2005	Excessive Heat	2	94	3 (0)	0
7/18/2005	Excessive Heat	2	92	6 (0)	0
7/25/2005	Excessive Heat	3	98	7 (0)	0
8/2/2005	Excessive Heat	4	96	5 (0)	N/A
8/11/2005	Excessive Heat	4	97	2 (0)	0
7/16/2006	Excessive Heat	3	98	3 (0)	0
8/1/2006	Excessive Heat	3	98	24 (0)	40
7/8/2007	Excessive Heat	3	96	1 (0)	0
8/7/2007	Excessive Heat	2	97	0	0
4/25/2009	Heat	3	93	0	24
8/10/2009	Excessive Heat	1	103	0	0
8/16/2009	Heat	6	95	1 (0)	0
6/23/2010	Excessive Heat	2	97	0	36
6/27/2010	Excessive Heat	1	96	2 (0)	0
7/16/2010	Excessive Heat	3	100	4 (2)	0

4.3.3.4. Future Occurrence

Due to its location and geography, the County is more likely to encounter excessive heat than extreme cold weather. Topography and vegetation can impact temperature differentials across the County. Also, the urban nature of many parts of the County increase the effect of heat as the buildings and pavement retain more heat than vegetated areas. Therefore the future

occurrence of extreme temperature hazards in Delaware County can be considered *possible* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1).

4.3.3.5. Vulnerability Assessment

The potential for extreme heat and cold always exists in and around the summer and winter months. Meteorologists and weather forecasters can normally predict the temperature with excellent accuracy. Adhering to extreme temperature warnings can significantly reduce the risk of temperature related deaths. Those hardest hit by both heat and cold waves are adults 75 years of age or older, many who are already physically vulnerable. Excessive heat exposure also affects people with certain pre-existing medical conditions, including cardiovascular disease, respiratory illnesses, and obesity. A heat wave that lasts for an extended period of time can affect the power supply for a region as the demand for energy to run air conditioning is too high for the supply. This can lead to rolling brownouts and even blackouts, further endangering people's health.

Urban areas can also exacerbate a heat wave when stagnant atmospheric conditions trap pollutants, thus adding contaminated air to excessively hot temperatures. This could be an issue in the heavily developed areas of the County.

The range of these impacts, especially health effects, can be mitigated through improved forecasts, warnings, community preparedness and appropriate community based response. While air conditioning is the most immediate method to cool homes and buildings, new green building techniques can also be utilized to reduce the effects of high temperatures. Planting shade trees along streets and near homes and buildings has been proven to reduce the ambient air temperature, especially in urban areas with a large amount of asphalt. Additionally, the use of green roofs on large flat roofed buildings should be encouraged. Vegetation on these roofs is aesthetically pleasing and, like shade trees, helps to counteract the effects of the urban heat sink.

It is important that communities have plans in place to help vulnerable populations during an extreme heat or extreme cold events. Communities should make their local government buildings available to the public during the heat of the day or during the cold. They should also communicate with their residents regarding steps they can take to keep cool and warning signs of health related problems due to the high or low temperatures.

In urban areas where the asphalt and roofs can become heat sinks, residents should be urged to plant trees that will shade homes and help absorb heat. Additionally, where applicable, green roofs should be used. These techniques have been shown to greatly reduce ambient air temperatures in highly developed urban and suburban areas.

4.3.4. Flood, Flash Flood, Ice Jam

4.3.4.1. Location and Extent

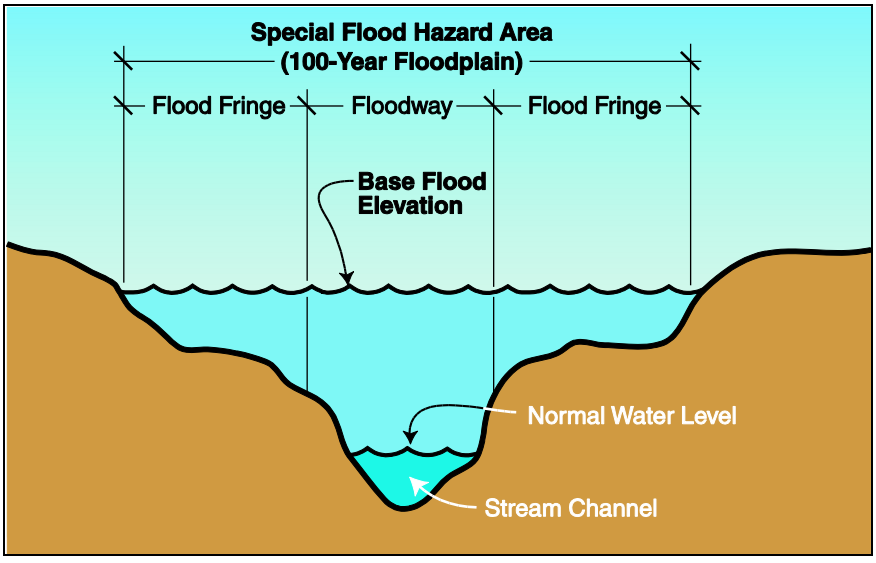
A flood is a natural event for rivers and streams. Flooding occurs when excess water from snowmelt or rainfall fills a stream, causing it to overflow onto the stream banks and adjacent floodplains. Floodplains are lowlands adjacent to rivers, streams, and creeks that are subject to recurring floods. Flash flood conditions can result from a large amount of rainfall over a short

time span. Similarly, a small amount of rain can also result in floods in locations where the soil is frozen or saturated from a previous wet period or if the rain is concentrated in an area of impervious surfaces such as large parking lots, paved roadways, or other densely developed areas. In addition, ice jams can occur when broken river ice caught in a narrow channel of a river or stream results in flooding.

Delaware County is located in the lower Delaware River Basin. The major creeks within the County include the Brandywine, Chester, Ridley, Crum, Darby, Cobbs, Naamans, and Marcus Hook Creeks. Delaware County is flood prone because of the generally flat terrain and because most of the communities are located along streams and river valleys. 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.

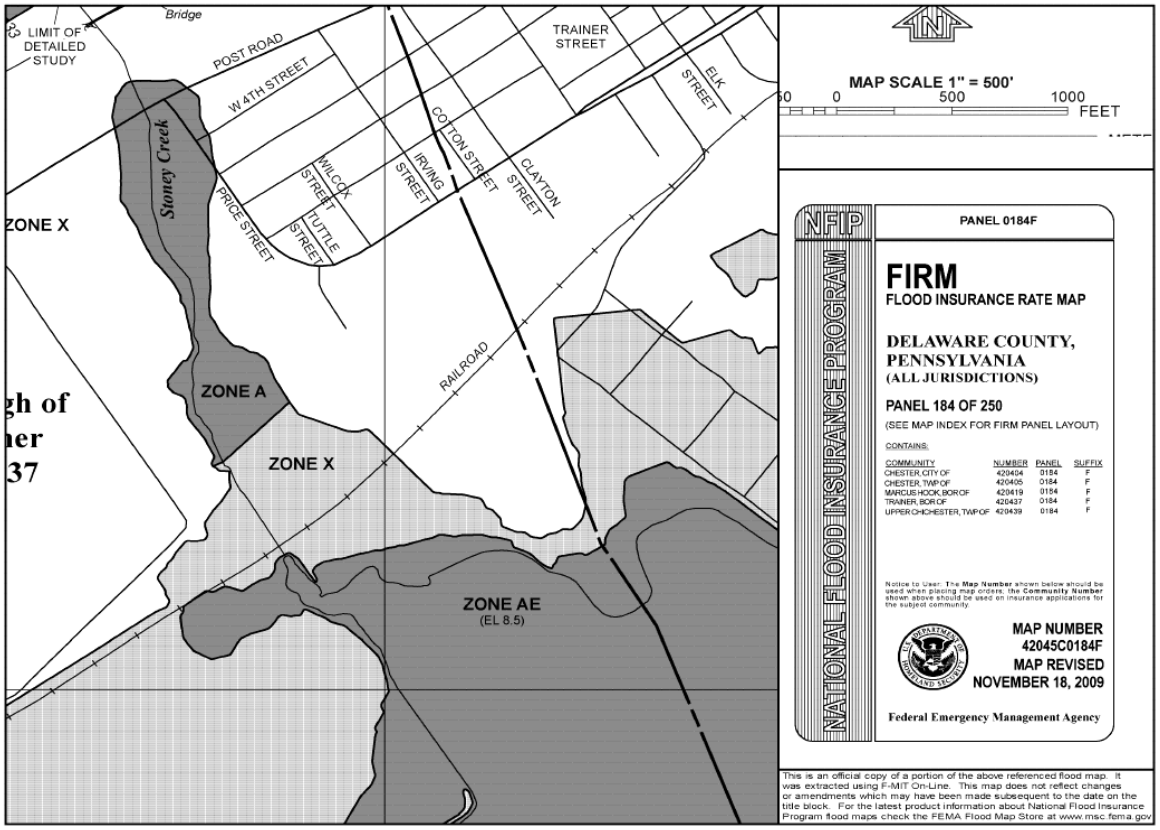
The size of the floodplain is described by the recurrence interval of a given flood. Flood recurrence intervals are explained in more detail in Section 4.3.4.4. However, in assessing the potential spatial extent of flooding it is important to know that a floodplain associated with a flood that has a ten percent chance of occurring in a given year is smaller than the floodplain associated with a flood that has a 0.2% annual chance of occurring. The National Flood Insurance Program (NFIP), for which Flood Insurance Rate Maps (FIRM) are published, identifies the 1% annual chance flood. This 1% annual chance flood event is used to delineate the *Special Flood Hazard Area* (SFHA) and identify *Base Flood Elevations*. Figure 4.3.4-1 illustrates these terms. The SFHA serves as the primary regulatory boundary used by FEMA, the Commonwealth of Pennsylvania and Delaware County local governments.

Figure 4.3.4-1: Diagram identifying Special Flood Hazard Area, 1% annual chance (100-Year) floodplain, floodway and flood fringe.



Countywide DFIRMs were published for Delaware County on November 18, 2009. All communities within the County are now shown on a single set of countywide FIRMs. Previous FIRMs and Flood Boundary and Floodway Maps (FBFM) were digitized to produce a DFIRM that is compatible with GIS. An example of the mapping products published is shown in Figure 4.3.4-2. FIRMs for the entire county can be obtained from the FEMA Map Service Center (http://www.msc.fema.gov). These maps can be used to identify the expected spatial extent and elevation of flooding from a 1% and 0.2% annual chance event. Forty-eight of the forty-nine municipalities in the County were determined to have special flood hazard areas (SFHA). East Lansdowne Borough does not have any SFHA.

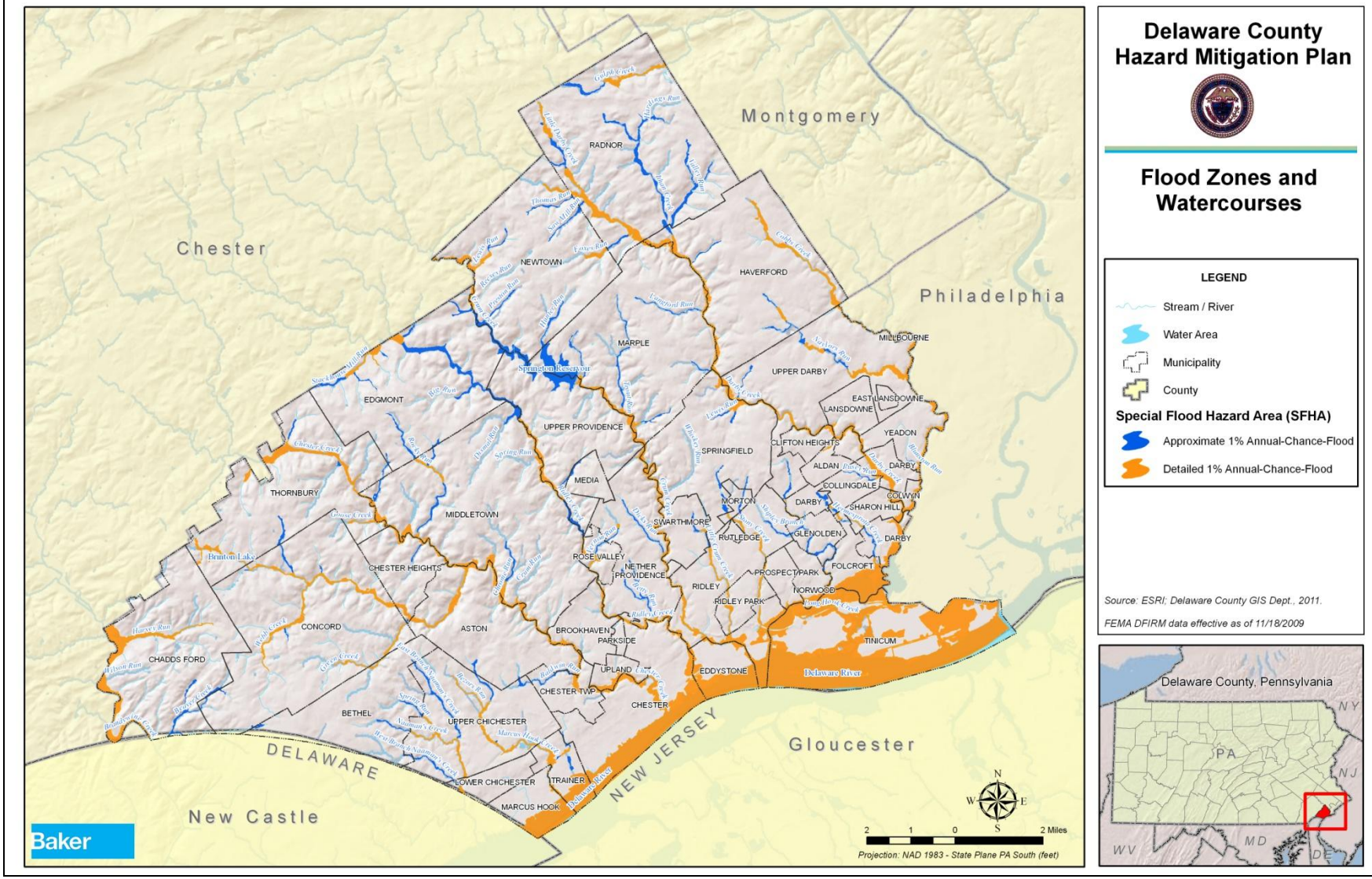
Figure 4.3.4-2: FIRM Panel 42045C0184F, effective November 18, 2009, showing flood hazard areas along the Delaware River.



Flood sources identified in the most recent mapping project include: East Branch Chester Creek, East Branch Chester Creek, East Branch Marcus Hook Creek, Foxes Run, Green Creek, Gulph Creek Panels, Harvey Run Panels, Harvey Run Branch, Hermesprota Creek (Lower Reach), Hermesprota Creek (Upper Reach), Hermesprota Creek (MacDade Boulevard Reach), Lewis Run, Little Crum Creek, Little Darby Creek, Lobbs Run, Marcus Hook Creek, Muckinipattis Creek, Naaman Creek, Naylors Run, Old Barn Drive Tributary, Pony Tail Run,

Ridley Creek, Rocky Run, South Fork West Branch Chester Creek, Spring Run, Stackhouse Mill Run, Stoney Creek, Stony Creek, Sweet Water Road Tributary, Vernon Run, and West Branch Chester Creek. Figure 4.3.4-3 shows the location of watercourses and flood zones in Delaware County. The location of approximate and detailed (including Base Flood Elevations) Special Flood Hazard Areas (1% annual chance zones) are shown.

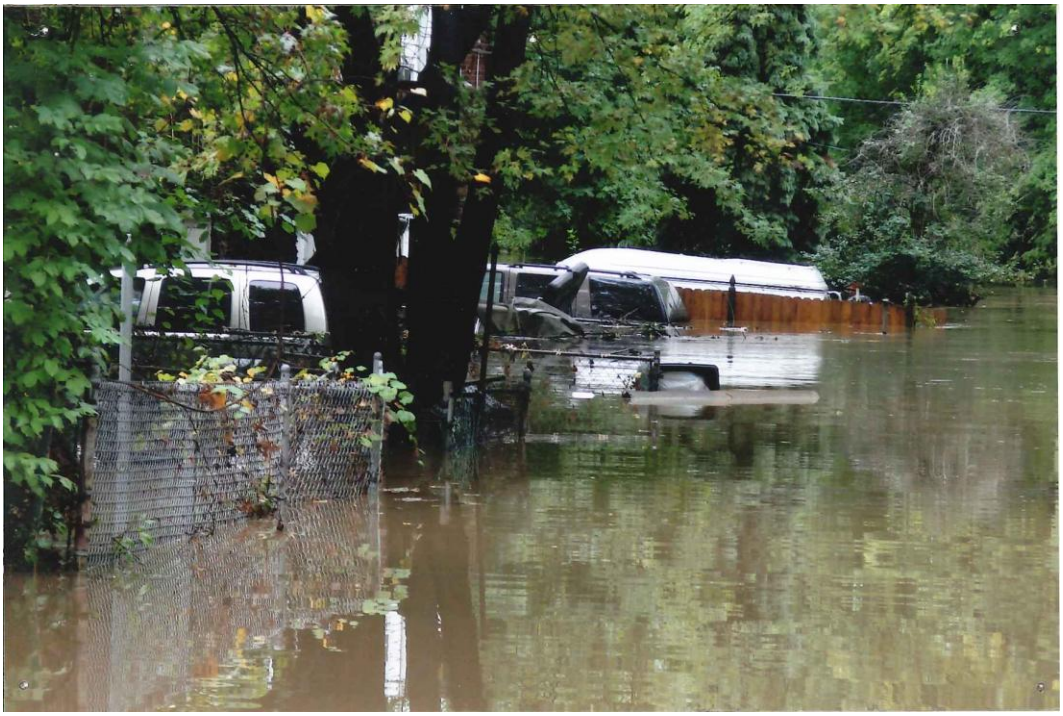
Figure 4.3.4-3: Map showing the location of watercourses and flood zones throughout Delaware County.



4.3.4.2. Range of Magnitude

Floods are considered hazards when they affect people and property. Nationwide, hundreds of floods occur each year, making flooding one of the most common hazards in all 50 states and U.S. territories. Flooding is common in Pennsylvania and can occur during any season of the year from a variety of sources. Every two to three years, serious flooding occurs along one or more of Pennsylvania's major rivers or streams, and it is not unusual for this to occur several years in succession. Most injuries and deaths from flooding happen when people are swept away by flood currents, and most property damage results from inundation by sediment-filled water as seen in Figure 4.3.4-4.

Figure 4.3.4-4: Flood waters covering vehicles in driveways behind Powell Road in Chester Township (photo courtesy of Chester Township).



Several factors determine the severity of floods, including rainfall intensity and duration, topography, and ground cover. Additional conditions found within the County that can exacerbate the effects of floods include steep slopes, obstructions, hazardous materials facilities, and quantities of impervious surface. Steep slopes increase the velocity at which water travels over the land, increasing the speed of runoff entering the receiving body of water. Obstructions such as bridge abutments can block flood flow and trap debris, damming floodwaters, and potentially causing increased flooding upstream. Hazardous materials facilities that store hazardous materials in the 1% annual chance floodplain present potential sources of contamination during flood events. Paved surfaces that replace once-vegetated ground cover with buildings, concrete, and asphalt increase the surface runoff of stormwater.

In addition to floods associated with precipitation events, this plan recognizes the long-range potential for flooding along the Delaware River and its tidal tributaries resulting from *sea level rise* associated with effects of global warming. The Delaware Valley Regional Planning Commission, with funding provided by DEP and the National Oceanic and Atmospheric Administration, has studied the potential impacts of sea level rise on the region as a whole, and, in cooperation with county planning agencies, identified critical areas and infrastructure that could be impacted should this condition occur in the future. As this is a very broad topic with long-range and far-reaching consequences, flooding from sea level rise will not be directly addressed in the Hazard Mitigation Plan at this time. However, for background information, please see the plan entitled "Sea Level Rise Impacts in the Delaware Estuary of Pennsylvania," (DVRPC, June 2004).

In Delaware County there are seasonal differences in how floods are caused. In the winter and early spring (February to April), major flooding has occurred as a result of heavy rainfall on dense snow pack throughout contributing watersheds, although the snow pack is generally moderate during most winters. Winter floods also have resulted from runoff of intense rainfall on frozen ground, and local flooding has been exacerbated by ice jams in streams and creeks. Ice jam floods occur on rivers that are totally or partially frozen. A rise in stream stage will break up a totally frozen river and create ice flows that can pile up on channel obstructions such as shallow riffles, log jams, or bridge piers. The jammed ice creates a dam across the channel over which the water and ice mixture continues to flow, allowing for more jamming to occur. Flood events caused by ice jams are limited primarily to the Delaware River. According to the Delaware County Department of Emergency Services, the Delaware River near Delaware County and Philadelphia does experience ice jams however, the Coast Guard and Army Corps of Engineers work to break the ice in the river in order to keep the Philadelphia port open. The Delaware County Department of Emergency Services reports that in the past, some smaller marinas in Delaware County municipalities and mouths of some creeks experience ice jams but without much consequence. However, on several occasions conditions have been right to cause flooding. Specific data on ice jam incidents in the County is not available from the Delaware County Department of Emergency Services or the National Climatic Data Center (NCDC).

Summer floods have occurred from intense rainfall on dry hard-packed or previously saturated soils. Summer thunderstorms deposit large quantities of rainfall over a short period of time have also produced flash flooding. In addition, the County occasionally experiences intense rainfall from tropical storms and hurricanes in late summer and early fall (see Section 4.3.5). An end of summer flood caused a worst case scenario flash flood on September 16, 1999 when hurricane Floyd battered Eastern Pennsylvania, causing Delaware County to be declared a disaster area. During this flood, a 67-year-old man drowned in Darby Borough while delivering pizzas. About 1,000 people were evacuated and 3,500 homes were flooded. Storm event totals for the County averaged eight to twelve inches of rainfall. Property damage resulting from this flood was fifteen million dollars.

Although floods can cause damage to property and loss of life, floods are naturally occurring events that benefit riparian systems which have not been disrupted by human actions. Such

benefits include groundwater recharge and the introduction of nutrient rich sediment improving soil fertility. However, the destruction of riparian buffers, changes to land use and land cover throughout a watershed, and the introduction of chemical or biological contaminants which often accompany human presence cause environmental harm when floods occur. Hazardous material facilities are potential sources of contamination during flood events. Other negative environmental impacts of flooding include: water-borne diseases, heavy siltation, damage or loss of crops, and drowning of both humans and animals.

4.3.4.3. Past Occurrence

Delaware 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. Of the types of flooding that occur in the County, flash flooding is the most common. Delaware County has approximately three flash flooding events every year (Delaware County Civil Defense, 1984).

As mentioned above, major creeks within the County include the Brandywine, Chester, Ridley, Crum, Darby, Cobbs, Naamans, and Marcus Hook Creeks; each of which experiences varying degrees of flood events. The lower portions of the Darby and Cobbs Creeks experience significant flooding problems during heavy rainstorms. In 1999, during Hurricane Floyd, Darby Borough experienced devastating flooding to homes and businesses along Darby Creek. Flood damage resulted in 43 homes being declared uninhabitable. These structures were later purchased by FEMA and razed, creating open space in the floodplain. More recently, Darby Creek and its tributaries, in particular Naylor's Run, overflowed their banks during a series of strong storms in August of 2004. The resulting flash floods in Haverford Township, Upper Darby Township, and Darby Borough damaged 500 homes and 80 businesses.

Chester Creek also experiences recurrent flooding along lower portions of the watershed in Upland Borough where the creek has several bridges spanning its width. The bridges work as a funnel, narrowing the creek and obstructing large volumes of water that result from heavy rains. During a storm in 1971, flooding was so severe that 130 businesses and 770 homes were damaged. Due to this continuing problem, Upland Borough has initiated studies that explore ways to minimize flooding along the creek. The Township of Chester, which is up stream from Upland Borough, also suffers from recurrent flooding of Chester Creek in an area known as Toby Farms. The obstruction of the Creek by the bridges spanning Chester Creek in Upland Borough contributes to the extensive flooding in the Toby Farms area.

Table 4.3.4-1 lists flood event information from 1993 to 2010 obtained from the NCDC, including flood events that have resulted in disaster declarations. In fact, five of the sixteen Presidential Disaster and Emergency Declarations affecting Delaware County have been in response to hazard events related to flooding (see Table 4.2-1).

Table 4.3.4-1: Flood and flash flood events impacting Delaware County from 1993-2010 (NCDC, 2011). "Countywide" indicated several locations in the County were affected.

DATE	LOCATION & DESCRIPTION
4/10/93	Delaware and Chester Counties. Flood – Two inches of rainfall flooded Brandywine Creek drainage basin.
11/28/93	Multiple Counties. Flood/Flash Flood – A slow-moving storm caused widespread heavy rains and flooding across many counties in Pennsylvania.
12/5/93	Multiple Counties. Flood/Flash Flood – A storm in eastern Pennsylvania caused an average of 2 to 4 inches of rainfall in the area.
12/14/93	Delaware, Bucks and Philadelphia Counties. Tidal Flood – Pressure systems in Canada and North Carolina caused minor to moderate flooding along the Delaware River and its estuaries.
6/6/94	Delaware County. Flood/Flash Flood – Torrential downpours produced as much as 1 inch of rain in 10 minutes causing widespread urban flooding.
3/8/95	Delaware County. Flood/Flash Flood.
6/26/95	Western Portion of Delaware County. Flood/Flash Flood – Heavy rain caused widespread road flooding.
7/17/95	Delaware County. Flood/Flash Flood – Slow moving thunderstorms produced 3.75 inches of rainfall within an hour. Flooding closed West Chester Pike.
1/19/96	Multiple Counties. Flood/flash flood – The combination of snowmelt and a storm producing up to 2 inches of rain caused flash flooding of almost every stream and roadway in eastern Pennsylvania.
1/27/96	Multiple Counties. Flood – Heavy rain produced 1 to 1.5 inches of rainfall on over saturated soil causing flooding of larger streams and rivers in eastern Pennsylvania.
4/16/96	Western Portion of Delaware County. Flash Flood – Rainfall between 1.5 and 2 inches fell causing Brandywine Creek and smaller streams in western Delaware County to flood.
8/13/96	Delaware County. Flash Flood – Heavy rain produced up to 2.5 inches of rain flooding creeks in two counties.
10/19/96	Multiple Counties. Flood/Flash Flood – Heavy rain flooded smaller creeks in southeastern Pennsylvania. A state of emergency was declared in Darby because of severe flooding.
12/2/96	Delaware County. Flash Flood – Steady and sometimes heavy rain flooded stream and creek flooding.
12/14/96	Delaware, Bucks, Chester, Montgomery and Philadelphia Counties. Flood – Heavy rains flooded larger streams and rivers in southeast Pennsylvania.
1/25/97	Multiple Counties. Flood – Heavy rain produced 1 to 1.5 inches of rain causing flooding in streams and creeks in southeastern Pennsylvania.
4/2/98	Delaware and Chester Counties. Flood – A series of storms produced between 0.5 and 3 inches of rainfall causing flooding in the Brandywine Creek.
5/12/98	Delaware, Bucks and Philadelphia Counties. Tidal Flooding – Heavy rains combined with tidal effects of a full moon produced high tide flooding along the Delaware River.
8/17/98	Delaware, Bucks and Chester Counties. Flood – Heavy rain caused urban and poor drainage flooding.
1/3/99	Delaware, Bucks and Philadelphia Counties. Tidal Flood – Increased runoff from heavy rains and higher than normal tides caused tidal flooding along the Delaware River.
3/21/99	Multiple Counties. Flood – Heavy rain combined with over saturated soil from snowfall caused flooding in major creeks and streams in southeast Pennsylvania.
5/24/99	Multiple Counties. Flood – Two sets of storms caused heavy downpours in southeastern Pennsylvania resulting in urban, poor drainage and stream flooding.
8/26/99	Delaware, Chester and Montgomery Counties. Flash Flood – A series of storms produced torrential downpours resulting in urban, poor drainage and smaller stream flooding.
9/16/99	Multiple Counties. Flood/Tidal Flood – Hurricane Floyd produced torrential rainfall in eastern Pennsylvania. Delaware and Bucks County suffered the most damage and evacuated over

Table 4.3.4-1: Flood and flash flood events impacting Delaware County from 1993-2010 (NCDC, 2011). "Countywide" indicated several locations in the County were affected.

DATE	LOCATION & DESCRIPTION
	7,000 residents. Over 12 inches of rainfall was recorded in Delaware County and flooded roadways caused one casualty in Darby Borough.
3/21/00	Multiple Counties. Flood – Heavy rain caused river and stream flooding in eastern Pennsylvania.
7/27/00	Northern Portion of Delaware County. Flood – Rainfall of 3 inches caused flooding along streams in northern Delaware County.
12/17/00	Multiple Counties. Flood – Heavy rain caused urban, poor drainage, stream and river flooding in southeast Pennsylvania.
6/16/00	Delaware County. Flood/Flash Flood – Torrential downpours producing over 4 inches of rain in 90 minutes caused flash flooding of streams and poor drainage areas.
11/17/02	Multiple Counties. Flood – A northeaster produced steady and sometimes heavy rain in southeast Pennsylvania causing flooding of rivers and streams.
2/22/03	Delaware County. Flash Flood – The combination of snowmelt and heavy rains produced poor drainage, urban and creek flooding.
3/20/03	Delaware and Chester Counties. Flood – Heavy rain combined with over saturated soil to produce minor river flooding.
6/21/03	Delaware County. Flood – Heavy rain produced rainfall between 2 to 4 inches causing flooding in poor drainage areas as well as in most streams and rivers in the county. Flooding caused mudslides and falling trees across county.
8/10/03	Newtown Square. Flash Flood – Runoff from a series of storms in Chester County caused Crum Creek to flood in Newtown Square.
9/15/03	Delaware County. Flash Flood – Remnants of Tropical Storm Henri produced heavy rain and runoff into the creeks. There was minor flooding along Chester and Crum Creeks and major flooding along Brandywine Creek.
9/23/03	Delaware County. Flood – Heavy rain caused flooding in Brandywine Creek and in poor drainage areas.
10/27/03	Delaware County. Flood – A series of storms produced 1 to 3 inches of rainfall resulting in poor drainage flooding as well as flooding in Brandywine Creek.
12/11/03	Delaware County. Flood – Heavy rain combined with snowmelt to produce widespread poor drainage and some stream and river flooding.
2/6/04	Delaware County. Flood – Heavy rain combined with snowmelt to produce widespread poor drainage as well as stream and river flooding.
7/12/04	Delaware County. Flash Flood – A series of storms produced heavy rain causing widespread poor drainage and creek flooding across the county.
7/27/04	Northern Portion of Delaware County. Flash Flood – A series of storms produced up to 5 inches of rainfall causing poor drainage and stream flooding in the northern part of the county.
8/1/04	Eastern Portion of Delaware County. Flash Flood – Torrential rainfall caused flash flooding for streams and poor drainage areas in the eastern part of the county. About 660 residents were evacuated; 142 homes, 77 apartments and 69 businesses suffered major damage.
9/18/04	Delaware County. Flood – The remnants of Hurricane Ivan produced heavy rain, between 1 and 4 inches, and runoff causing flooding in creeks across the county.
9/28/04	Delaware County. Flash Flood – The remnants of Hurricane Jeanne produced torrential downpour resulting in between 3 to 8 inches of rainfall across the county. Widespread poor drainage, roadway, stream and creek flooding occurred.
11/28/04	Delaware County. Flood – Heavy rain produced 2 inches of rainfall causing poor drainage, stream and creek flooding.
1/14/05	Delaware County. Flood – Heavy rain produced up to 2 inches of rain across county causing urban, poor drainage, stream and creek flooding.

Table 4.3.4-1: Flood and flash flood events impacting Delaware County from 1993-2010 (NCDC, 2011). "Countywide" indicated several locations in the County were affected.

DATE	LOCATION & DESCRIPTION
3/28/05	Delaware County. Flood – A series of storms produced 1.5 to 2.5 inches of rainfall causing urban, poor drainage, stream and creek flooding.
4/2/05	Delaware County. Flood – Heavy rain produced about 3 inches of rainfall and caused poor drainage, roadway, river and stream flooding.
10/8/05	Delaware County. Flash Flood – The remnants of Tropical Storm Tammy produced heavy rains resulting in 3 to 5 inches of rainfall. Flooding resulted in creeks and poor drainage areas.
12/16/05	Delaware County. Flood – The combination of snowmelt and almost 2 inches of rainfall caused minor flooding in creeks across the county.
1/4/06	Delaware and Philadelphia Counties. Tidal Flood – Pressure systems and heavy rain produced minor tidal flooding along the Delaware River and its tributaries.
1/31/06	Delaware and Philadelphia Counties. Tidal Flood – Spring tides and a low pressure system produced minor tidal flooding during high tide along the Delaware River and its tributaries.
6/2/06	Southern Portion of Delaware County. Flash Flood – Slow moving storms with torrential rains produced 2 to 4 inches of rainfall resulting in roadway, creek and stream flooding.
6/26/06	Chadds Ford Township. Flood – Runoff from heavy rain in Brandywine Creek caused minor flooding from the creek in Chadds Ford.
6/28/06	Delaware, Bucks and Philadelphia Counties. Flood/Flash Flood/Tidal Flood – Heavy rains and high tides resulted in tidal flooding along the Delaware River and its tributaries. The storms caused 4 to 5 inches of rainfall resulting in additional roadway and stream flooding.
8/29/06	Newtown Square. Flood – Runoff from heavy rain caused minor flooding along Crum Creek in Newtown Square.
10/7/06	Delaware and Philadelphia Counties. Tidal Flood – Runoff from rain contributed to tidal flooding during high tide along the Delaware River and its tributaries.
10/28/06	Delaware County. Flood/Tidal Flood – Heavy rain produced runoff contributing to tidal flooding during high tide along the Delaware River and its tributaries. Additional flooding in poor drainage and streams was caused by about 2 inches of rain.
11/8/06	Delaware County. Tidal Flood – Runoff from rain contributed to tidal flooding during high tide along the Delaware River and its tributaries.
11/16/06	Delaware and Philadelphia Counties. Tidal Flood – Runoff from heavy rain and strong south flow in the Delaware River resulted in minor tidal flooding along the river and its tributaries.
1/1/07	Delaware County. Tidal Flood – Runoff from heavy rain and upriver wind flow caused minor tidal flooding along the Delaware River and its tributaries.
3/2/07	Multiple Counties. Flood/Tidal Flood – Heavy rain produced 1 to 3 inches of rain in eastern Pennsylvania which combined with snowmelt to cause roadway, stream and creek flooding. Additional tidal flooding occurred along the Delaware River and its tributaries.
4/15/07	Multiple Counties. Flood/Tidal Flood – Heavy rain from a northeaster caused roadway, stream and creek flooding in eastern Pennsylvania. Additional minor tidal flooding occurred because of combination of heavy runoff and onshore flow.
4/18/07	Delaware County. Tidal Flood – The combination of remnant onshore flow from the northeaster, fresh storm runoff and spring tides caused tidal flooding along the Delaware River and its tributaries.
4/27/07	Aldan Borough. Flood – Runoff from heavy rain in Chester County caused flooding along Brandywine Creek.
6/13/07	Delaware County. Tidal Flood – Weak onshore flow, a high pressure system and spring tides combined to cause tidal flooding along the Delaware River and its tributaries.
10/27/07	Delaware County. Flood/Tidal Flood – Over 3 inches of rainfall caused flooding in poor drainage areas and streams. Runoff from the rain combined with a high pressure system to cause tidal flooding along the Delaware River and its tributaries.

Table 4.3.4-1: Flood and flash flood events impacting Delaware County from 1993-2010 (NCDC, 2011). "Countywide" indicated several locations in the County were affected.	
DATE	**LOCATION & DESCRIPTION**
2/13/08	Delaware County. Flood – Between 2 to 3.5 inches of rainfall and melting ice caused urban, poor drainage, creek and river flooding.
9/28/08	Radnor Township. Flood – A series of storms produced heavy rain causing roadway and stream flooding.
12/12/08	Delaware County. Flood/Tidal Flood – Heavy rain caused flooding of streams and creeks across the county and also contributed to tidal flooding during high tide along the Delaware River and its tributaries.
8/2/09	Multiple Counties. Flash Flood – Heavy rains produced 4 to 5 inches of rain in southeastern Pennsylvania. Flooding in creeks in Delaware county resulted in evacuations and destroyed roadways in eastern parts of the county.
8/29/09	Upper Darby Township. Flash Flood – Remnants of Tropical Storm Canny produced torrential downpours resulting in flash flooding of streets across the township.
10/24/09	Delaware, Bucks, Chester and Montgomery Counties. Flood/Flash Flood – Heavy rains caused flooding of streams and creeks in Delaware County.
12/9/09	Delaware County. Flood – Runoff from heavy rain caused poor drainage and creek flooding.
12/26/09	Multiple Counties. Flood – The combination of melting snow and between 1 to 2.5 inches of rain across southeastern Pennsylvania caused poor drainage and creek flooding in Delaware County.
1/25/10	Delaware County. Flood – Over an inch of rainfall caused creek and poor drainage flooding.
3/13/10	Multiple Counties. Flood – Four days of rain in southeastern Pennsylvania resulted in almost 4 inches of rain in Delaware County causing creek and poor drainage flooding across the area.
3/28/10	Delaware County. Tidal Flood – Runoff from storms and spring tides contributed to flooding along the Delaware River and its tidal tributaries during high tide.
3/29/10	Delaware County. Flood – A series of storms produced 2 to 4 inches of rainfall causing flooding in Chester and Crum Creeks.
7/14/10	Delaware County. Flood/Flash Flood – Storms produced flash flooding of smaller creeks as well as considerable highway and poor drainage flooding.
10/1/10	Multiple Counties. Flood – A series of storms in eastern Pennsylvania caused 5 to 10 inches of rain over 2 days. Flooding was worse in Delaware County than in rest of the area, especially in Darby Borough, Chester Township, Bethel Township and Newtown Square.

In addition, Delaware County has record of several historical flood events prior to 1993. These are presented in Table 4.3.4-2.

Table 4.3.4-2: Historical flood and flash flood events impacting Delaware County.	
DATE	**LOCATION & DESCRIPTION**
08/20/1955	Flood.
03/15/1996	Flood.
01/23/1959	Flood.
09/18/1971	Flood.
06/23/1973	Flood. (Agnes)
07/17/1973	Flood.
07/1989	Flood.
08/1991	Flash Flood.

In addition to the aforementioned past flood events, the NFIP identifies properties that frequently experience flooding. *Repetitive loss properties* are structures insured under the NFIP which have had at least two paid flood losses of more than $1,000 over any ten year period since 1978. Table 4.3.4-3 displays repetitive loss properties by jurisdiction and type in Delaware County. The County has 178 repetitive loss properties, 127 of which are single family homes. Darby Borough has the most repetitive loss properties (37), followed by Upland Borough (23) and Upper Darby Township (21).

Table 4.3.4-3: Summary of the number and type of Repetitive Loss properties by municipality (PEMA, 2010).

MUNICIPALITY	TYPE					SUM OF REPETITIVE LOSS PROPERTIES
	NON-RESIDENTIAL	2-4 FAMILY	SINGLE FAMILY	CONDO	OTHER RESIDENT	
Aldan Borough	0	0	0	0	0	**0**
Aston Township	**1**	**0**	**0**	**0**	**0**	**1**
Bethel Township	0	0	0	0	0	**0**
Brookhaven Borough	**0**	**0**	**6**	**0**	**0**	**6**
Chadds Ford Township	**1**	**0**	**1**	**0**	**0**	**2**
Chester Township	**0**	**0**	**16**	**0**	**0**	**16**
Chester City	**2**	**0**	**11**	**1**	**0**	**14**
Chester Heights Borough	0	0	0	0	0	**0**
Clifton Heights Borough	0	0	0	0	0	**0**
Collingdale Borough	**2**	**0**	**1**	**0**	**0**	**3**
Colwyn Borough	**4**	**0**	**2**	**0**	**0**	**6**
Concord Township	**1**	**0**	**2**	**0**	**0**	**3**
Darby Township	**1**	**0**	**0**	**0**	**0**	**1**
Darby Borough	**9**	**1**	**27**	**0**	**0**	**37**
East Lansdowne Borough	0	0	0	0	0	**0**
Eddystone Borough	**1**	**0**	**0**	**0**	**0**	**1**
Edgmont Township	**0**	**0**	**0**	**0**	**1**	**1**
Folcroft Borough	0	0	0	0	0	**0**
Glenolden Borough	**0**	**0**	**1**	**0**	**0**	**1**
Haverford Township	**2**	**0**	**5**	**0**	**0**	**7**
Lansdowne Borough	**0**	**0**	**1**	**0**	**0**	**1**
Lower Chichester Township	0	0	0	0	0	**0**
Marcus Hook Borough	0	0	0	0	0	**0**
Marple Township	**0**	**0**	**0**	**1**	**0**	**1**
Media Borough	0	0	0	0	0	**0**
Middletown Township	**0**	**0**	**1**	**0**	**0**	**1**
Millbourne Borough	0	0	0	0	0	**0**
Morton Borough	**0**	**0**	**1**	**0**	**2**	**3**
Nether Providence	**0**	**0**	**1**	**0**	**0**	**1**

Table 4.3.4-3: Summary of the number and type of Repetitive Loss properties by municipality (PEMA, 2010).

MUNICIPALITY	TYPE					SUM OF REPETITIVE LOSS PROPERTIES
	NON-RESIDENTIAL	2-4 FAMILY	SINGLE FAMILY	CONDO	OTHER RESIDENT	
Township						
Newtown Township	0	0	0	0	0	**0**
Norwood Borough	0	0	0	0	0	**0**
Parkside Borough	0	0	0	0	0	**0**
Prospect Park Borough	0	0	0	0	0	**0**
Radnor Township	**0**	**0**	**6**	**0**	**0**	**6**
Ridley Township	**2**	**1**	**4**	**0**	**0**	**7**
Ridley Park Borough	0	0	0	0	0	**0**
Rose Valley Borough	0	0	0	0	0	**0**
Rutledge Borough	0	0	0	0	0	**0**
Sharon Hill Borough	0	0	0	0	0	**0**
Springfield Township	**0**	**0**	**11**	**0**	**0**	**11**
Swarthmore Borough	0	0	0	0	0	**0**
Thornbury Township	**0**	**0**	**1**	**0**	**0**	**1**
Tinicum Township	**0**	**0**	**1**	**0**	**0**	**1**
Trainer Borough	0	0	0	0	0	**0**
Upland Borough	**11**	**0**	**11**	**1**	**0**	**23**
Upper Chichester Township	**1**	**0**	**1**	**0**	**0**	**2**
Upper Darby Township	**5**	**0**	**16**	**0**	**0**	**21**
Upper Providence Township	0	0	0	0	0	**0**
Yeadon Borough	0	0	0	0	0	**0**
TOTAL	**43**	**2**	**127**	**3**	**3**	**178**

A property is considered a *severe repetitive loss property* either when there are at least four losses each exceeding $5,000 or when there are two or more losses where the building payments exceed the property value. As of March 4, 2010, there was one severe repetitive loss property in Delaware County. It is a single family residential property located in Springfield Township (Table 4.3.4-4).

Table 4.3.4-4: Summary of the number and type of Severe Repetitive Loss properties by municipality (PEMA, 2010).

MUNICIPALITY	TYPE					SUM OF REPETITIVE LOSS PROPERTIES
	NON-RESIDENTIAL	2-4 FAMILY	SINGLE FAMILY	CONDO	OTHER RESIDENT	
Aldan Borough	0	0	0	0	0	**0**
Aston Township	0	0	0	0	0	**0**
Bethel Township	0	0	0	0	0	**0**

Table 4.3.4-4: Summary of the number and type of Severe Repetitive Loss properties by municipality (PEMA, 2010).

MUNICIPALITY	TYPE					SUM OF REPETITIVE LOSS PROPERTIES
	NON-RESIDENTIAL	2-4 FAMILY	SINGLE FAMILY	CONDO	OTHER RESIDENT	
Brookhaven Borough	0	0	0	0	0	**0**
Chadds Ford Township	0	0	0	0	0	**0**
Chester Township	0	0	0	0	0	**0**
Chester City	0	0	0	0	0	**0**
Chester Heights Borough	0	0	0	0	0	**0**
Clifton Heights Borough	0	0	0	0	0	**0**
Collingdale Borough	0	0	0	0	0	**0**
Colwyn Borough	0	0	0	0	0	**0**
Concord Township	0	0	0	0	0	**0**
Darby Township	0	0	0	0	0	**0**
Darby Borough	0	0	0	0	0	**0**
East Lansdowne Borough	0	0	0	0	0	**0**
Eddystone Borough	0	0	0	0	0	**0**
Edgmont Township	0	0	0	0	0	**0**
Folcroft Borough	0	0	0	0	0	**0**
Glenolden Borough	0	0	0	0	0	**0**
Haverford Township	0	0	0	0	0	**0**
Lansdowne Borough	0	0	0	0	0	**0**
Lower Chichester Township	0	0	0	0	0	**0**
Marcus Hook Borough	0	0	0	0	0	**0**
Marple Township	0	0	0	0	0	**0**
Media Borough	0	0	0	0	0	**0**
Middletown Township	0	0	0	0	0	**0**
Millbourne Borough	0	0	0	0	0	**0**
Morton Borough	0	0	0	0	0	**0**
Nether Providence Township	0	0	0	0	0	**0**
Newtown Township	0	0	0	0	0	**0**
Norwood Borough	0	0	0	0	0	**0**
Parkside Borough	0	0	0	0	0	**0**
Prospect Park Borough	0	0	0	0	0	**0**
Radnor Township	0	0	0	0	0	**0**
Ridley Township	0	0	0	0	0	**0**
Ridley Park Borough	0	0	0	0	0	**0**
Rose Valley Borough	0	0	0	0	0	**0**
Rutledge Borough	0	0	0	0	0	**0**
Sharon Hill Borough	0	0	0	0	0	**0**
Springfield Township	**0**	**0**	**1**	**0**	**0**	**1**
Swarthmore Borough	0	0	0	0	0	**0**
Thornbury Township	0	0	0	0	0	**0**

Table 4.3.4-4: Summary of the number and type of Severe Repetitive Loss properties by municipality (PEMA, 2010).						
MUNICIPALITY	TYPE					SUM OF REPETITIVE LOSS PROPERTIES
	NON-RESIDENTIAL	2-4 FAMILY	SINGLE FAMILY	CONDO	OTHER RESIDENT	
Tinicum Township	0	0	0	0	0	**0**
Trainer Borough	0	0	0	0	0	**0**
Upland Borough	0	0	0	0	0	**0**
Upper Chichester Township	0	0	0	0	0	**0**
Upper Darby Township	0	0	0	0	0	**0**
Upper Providence Township	0	0	0	0	0	**0**
Yeadon Borough	0	0	0	0	0	**0**
TOTAL	**0**	**0**	**1**	**0**	**0**	**1**

Floods are the most common and costly natural catastrophe in the United States. In terms of economic disruption, property damage, and loss of life, floods are “nature’s number-one disaster.” For that reason, flood insurance is almost never available under industry-standard homeowner’s and renter’s policies. The best way for citizens to protect their property against flood losses is to purchase flood insurance through the NFIP.

Congress established the NFIP in 1968 to help control the growing cost of federal disaster relief. The NFIP is administered by the FEMA, part of the U.S. Department of Homeland Security. The NFIP offers federally-backed flood insurance in communities that adopt and enforce effective floodplain management ordinances to reduce future flood losses.

Since 1983, the chief means of providing flood insurance coverage has been a cooperative venture of FEMA and the private insurance industry known as the Write Your Own (WYO) Program. This partnership allows qualified property and casualty insurance companies to “write” (that is, issue) and service the NFIP’s Standard Flood Insurance Policy (SFIP) under their own names.

Today, nearly 90 WYO insurance companies issue and service the SFIP under their own names. More than 4.4 million federal flood insurance policies are in force. These policies represent $650 billion in flood insurance coverage for homeowners, renters, and business owners throughout the United States and its territories.

The NFIP provides flood insurance to individuals in communities that are members of the program. Membership in the program is contingent on the community adopting and enforcing floodplain management and development regulations.

The NFIP is based on the voluntary participation of communities of all sizes. In the context of this program, a “community” is a political entity – whether an incorporated city, town, township, borough, or village, or an unincorporated area of a county or parish – that has legal authority to adopt and enforce floodplain management ordinances for the area under its jurisdiction.

National Flood Insurance is available only in communities that apply for participation in the NFIP and agree to implement prescribed flood mitigation measures. Newly participating communities are admitted to the NFIP's Emergency Program. Most of these communities quickly earn "promotion" to the Regular Program.

The Emergency Program is the initial phase of a community's participation in the NFIP. In return for the local government's agreeing to adopt basic floodplain management standards, the NFIP allows local property owners to buy modest amounts of flood insurance coverage.

In return for agreeing to adopt more comprehensive floodplain management measures, an Emergency Program community can be "promoted" to the Regular Program. Local policyholders immediately become eligible to buy greater amounts of flood insurance coverage. All participating municipalities in Delaware County are in the Regular Program. Table 4.3.4-5 lists the Delaware County municipalities participating in the NFIP. Note that most municipalities in the County participate in the program. The only exception is Rutledge Borough whose participation is suspended.

The minimum floodplain management requirements to be part of the Regular Program include:

- Review and permit all development in the SFHA;
- Elevate new and substantially improved residential structures above the Base Flood Elevation;
- Elevate or dry floodproof new and substantially improved non-residential structures;
- Limit development in floodways;
- Locate or construct all public utilities and facilities so as to minimize or eliminate flood damage; and
- Anchor foundation or structure to resist floatation, collapse, or lateral movement.

In addition, Regular Program communities are eligible to participate in the NFIP's Community Rating System (CRS). Under the CRS, policyholders can receive premium discounts of 5 to 45 percent as their cities and towns adopt more comprehensive flood mitigation measures. Currently, no municipalities in Delaware County participate in CRS.

Table 4.3.4-5: Delaware County Municipal Participation in the National Flood Insurance Program.

COMMUNITY	PARTICIPATION STATUS	CID	INITIAL FIRM IDENTIFIED	CURRENT EFFECTIVE MAP DATE
Aldan Borough	PARTICIPATING	420401	09/17/80	11/18/09
Aston Township	PARTICIPATING	421602	07/16/81	11/18/09
Bethel Township	PARTICIPATING	421606	08/10/79	11/18/09
Brookhaven Borough	PARTICIPATING	420403	02/14/76	11/18/09
Chadds Ford Township	PARTICIPATING	420402	09/05/79	11/18/09
Chester Heights Borough	PARTICIPATING	420406	01/16/80	11/18/09
Chester City	PARTICIPATING	420404	08/01/79	11/18/09
Chester Township	PARTICIPATING	420405	05/15/84	11/18/09

Table 4.3.4-5: Delaware County Municipal Participation in the National Flood Insurance Program.				
COMMUNITY	**PARTICIPATION STATUS**	**CID**	**INITIAL FIRM IDENTIFIED**	**CURRENT EFFECTIVE MAP DATE**
Clifton Heights Borough	PARTICIPATING	420407	05/16/77	11/18/09
Collingdale Borough	PARTICIPATING	420408	02/02/77	11/18/09
Colwyn Borough	PARTICIPATING	420409	05/02/77	11/18/09
Concord Township	PARTICIPATING	420410	01/05/78	11/18/09
Darby Borough	PARTICIPATING	420411	07/18/77	11/18/09
Darby Township	PARTICIPATING	421603	04/03/84	11/18/09
East Lansdowne Borough	PARTICIPATING	420412	11/06/81	(NSFHA)
Eddystone Borough	PARTICIPATING	420413	02/02/77	11/18/09
Edgmont Township	PARTICIPATING	420414	09/01/77	11/18/09
Folcroft Borough	PARTICIPATING	420415	08/01/77	11/18/09
Glenolden Borough	PARTICIPATING	420416	11/18/81	11/18/09
Haverford Township	PARTICIPATING	420417	07/05/77	11/18/09
Landsdowne Borough	PARTICIPATING	420418	02/03/82	11/18/09
Lower Chichester Township	PARTICIPATING	421604	09/22/78	11/18/09
Marcus Hook Borough	PARTICIPATING	420419	09/16/81	11/18/09
Marple Township	PARTICIPATING	420420	09/01/77	11/18/09
Media Borough	PARTICIPATING	420421	09/28/79	11/18/09
Middletown Township	PARTICIPATING	420422	02/15/79	11/18/09
Millbourne Borough	PARTICIPATING	422408	09/22/78	11/18/09
Morton Borough	PARTICIPATING	420423	01/16/80	11/18/09
Nether Providence Township	PARTICIPATING	420424	12/01/78	11/18/09
Newtown Township	PARTICIPATING	420991	09/17/80	11/18/09
Norwood Borough	PARTICIPATING	420425	05/03/82	11/18/09
Parkside Borough	PARTICIPATING	420426	07/05/77	11/18/09
Prospect Park Borough	PARTICIPATING	420427	03/18/80	11/18/09
Radnor Township	PARTICIPATING	420428	08/01/77	11/18/09
Ridley Park Borough	PARTICIPATING	420430	01/02/80	11/18/09
Ridley Township	PARTICIPATING	420429	01/06/83	11/18/09
Rose Valley Borough	PARTICIPATING	420431	02/02/77	11/18/09
Rutledge Borough	SUSPENDED	420432	03/18/80	11/18/09
Sharon Hill Borough	PARTICIPATING	420433	08/15/79	11/18/09
Springfield Township	PARTICIPATING	420434	01/19/78	11/18/09
Swarthmore Borough	PARTICIPATING	420435	05/16/77	11/18/09
Thornbury Township	PARTICIPATING	425390	04/27/73	11/18/09
Tinicum Township	PARTICIPATING	421605	05/01/80	11/18/09
Trainer Borough	PARTICIPATING	420437	09/30/77	11/18/09
Upland Borough	PARTICIPATING	420438	12/10/76	11/18/09

Table 4.3.4-5: Delaware County Municipal Participation in the National Flood Insurance Program.				
COMMUNITY	**PARTICIPATION STATUS**	**CID**	**INITIAL FIRM IDENTIFIED**	**CURRENT EFFECTIVE MAP DATE**
Upper Chichester Township	PARTICIPATING	420439	05/16/77	11/18/09
Upper Darby Township	PARTICIPATING	420440	03/01/78	11/18/09
Upper Providence Township	PARTICIPATING	420441	06/15/77	11/18/09
Yeadon Borough	PARTICIPATING	420442	11/01/79	11/18/09

4.3.4.4. Future Occurrence

In Delaware County, flooding occurs commonly and can occur during any season of the year. Therefore the future occurrence of floods in Delaware County can be characterized as *highly likely* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1). 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 1% annual chance flood is a flood which has a 1 percent chance of occurring over a given year. The DFIRMs, once effective, will be able to be used to identify areas subject to the 1- and 0.2 percent-annual-chance flooding. Areas subject to 2% and 10% 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 4.3.4-6 shows a range of flood recurrence intervals and associated probabilities of occurrence.

Table 4.3.4-6: Recurrence intervals and associated probabilities of occurrence (USACOE, 2011).		
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

4.3.4.5. Vulnerability Assessment

Delaware County is vulnerable to flooding that causes loss of lives, property damage, and road closures. For purposes of assessing vulnerability, the County focused on community assets that are located in the 1%-annual-chance floodplain. While greater and smaller floods are possible, information about the extent and depths for this floodplain is available for all municipalities countywide, thus providing a consistent basis for analysis. Flood vulnerability maps for each applicable local municipality, showing the 1%-annual-chance flood hazard area and addressable structures, critical facilities and transportation routes within it, are included in **Appendix D**. These maps were created using FEMA Countywide digital data from the current effective FIRMS.

Table 4.3.4-7 displays the total number of parcels and the number of critical facilities intersecting the SFHA along with the total number of parcels and critical facilities in each municipality. 8,959 (4.5%) of all parcels in the County are located in the SFHA. Chester City, Darby Borough, Darby Township, Haverford Township, Marple Township, Middletown Township, Nether Providence Township, Newtown Township, Radnor Township, Ridley Township, Springfield Township, Tinicum Township, Trainer Borough, Upper Chichester Township, and Upper Darby Township each have over 200 parcels located in the SFHA and are the most vulnerable to flood losses. On the other end of the spectrum, East Lansdowne Borough, Lower Chichester Township, Millbourne Borough, Parkside Borough, and Rutledge Borough have either no or few parcels in the SFHA therefore are least vulnerable to the 1 percent-annual-chance flood event. Reference Section 2.5 for detailed information regarding the use of parcel data verses building points.

Table 4.3.4-7 also displays the number of critical facilities that are located in the SFHA by jurisdiction. Approximately 3% of all critical facilities are located in the SFHA and are located in twelve of the 49 municipalities in Delaware County. Tinicum Township has the most vulnerable critical facilities with five. For more information on the flood vulnerability of each individual critical facility, please see **Appendix E**.

Table 4.3.4-7: Structure and critical facility vulnerability summary for flood hazards.

MUNICIPALITY	TOTAL PARCELS	TOTAL PARCELS IN SFHA	TOTAL ASSESSED PARCEL VALUE IN SFHA	TOTAL CRITICAL FACILITIES	TOTAL CRITICAL FACILITIES IN SFHA	ESTIMATED 2000 POPULATION IN SFHA
Aldan Borough	1,699	32	$3,967,367	7	0	268
Aston Township	6,405	161	$38,423,320	19	1	440
Bethel Township	3,377	75	$14,625,447	4	0	322
Brookhaven Borough	2,681	68	$12,665,678	8	0	0
Chadds Ford Township	1,714	118	$36,669,632	4	0	11
Chester City	13,964	469	$164,968,878	21	0	830
Chester Heights	1,046	38	$8,151,784	7	1	29
Chester Township	1,659	143	$24,533,413	5	0	0
Clifton Heights Borough	2,547	39	$10,311,940	8	0	99

Table 4.3.4-7: Structure and critical facility vulnerability summary for flood hazards.

MUNICIPALITY	TOTAL PARCELS	TOTAL PARCELS IN SFHA	TOTAL ASSESSED PARCEL VALUE IN SFHA	TOTAL CRITICAL FACILITIES	TOTAL CRITICAL FACILITIES IN SFHA	ESTIMATED 2000 POPULATION IN SFHA
Collingdale Borough	3,169	67	$9,670,901	12	0	0
Colwyn Borough	920	129	$7,401,506	3	0	516
Concord Township	5,018	165	$40,865,527	25	1	66
Darby Borough	3,832	292	$41,070,510	14	1	385
Darby Township	4,099	204	$69,117,072	10	0	128
East Lansdowne	928	0	$0	5	0	0
Eddystone Borough	965	139	$169,530,878	6	0	413
Edgmont Township	1,473	102	$81,287,277	10	2	0
Folcroft Borough	2,605	86	$26,821,818	6	0	706
Glenolden Borough	2,184	108	$63,063,592	7	0	425
Haverford Township	18,044	519	$180,128,342	42	2	1,534
Lansdowne Borough	3,994	59	$7,448,610	11	0	286
Lower Chichester	1,405	13	$6,721,560	6	0	0
Marcus Hook Borough	1,021	30	$10,936,500	5	0	0
Marple Township	8,395	295	$201,403,464	17	0	346
Media Borough	2,073	36	$5,610,570	15	0	0
Middletown Township	5,092	245	$88,696,186	20	0	255
Millbourne Borough	236	3	$1,117,830	2	0	0
Morton Borough	1,007	103	$15,824,708	3	0	141
Nether Providence	5,082	358	$115,195,328	18	0	151
Newtown Township	4,844	225	$132,533,643	16	0	7
Norwood Borough	1,995	33	$4,239,978	8	0	195
Parkside Borough	847	2	$292,200	4	0	0
Prospect Park Borough	2,048	55	$7,266,838	9	0	35
Radnor Township	8,264	710	$466,226,413	41	0	1,066
Ridley Park Borough	2,382	83	$26,048,606	12	0	12
Ridley Township	11,264	539	$178,021,180	29	1	821
Rose Valley Borough	462	78	$22,097,815	2	0	24
Rutledge Borough	281	11	$1,285,510	1	0	0
Sharon Hill Borough	2,137	65	$15,498,660	11	0	37
Springfield Township	9,402	286	$146,975,350	27	2	141
Swarthmore Borough	1,588	86	$830,783,792	9	0	116
Thornbury Township	2,378	120	$97,917,664	14	1	18
Tinicum Township	2,256	516	$206,776,911	9	5	661
Trainer Borough	4,172	519	$18,180,458	6	1	29
Upland Borough	1,032	174	$25,344,881	6	0	171
Upper Chichester	6,732	505	$197,030,773	13	0	12
Upper Darby Township	22,070	699	$268,116,442	72	1	3,165
Upper Providence	3,914	135	$43,389,564	24	0	105

Table 4.3.4-7: Structure and critical facility vulnerability summary for flood hazards.						
MUNICIPALITY	TOTAL PARCELS	TOTAL PARCELS IN SFHA	TOTAL ASSESSED PARCEL VALUE IN SFHA	TOTAL CRITICAL FACILITIES	TOTAL CRITICAL FACILITIES IN SFHA	ESTIMATED 2000 POPULATION IN SFHA
Yeadon Borough	3,563	22	$37,005,200	11	0	0
TOTAL	**198,265**	**8,959**	**$4,181,261,516**	**644**	**19**	**13,966**

Additional information on flood vulnerability and losses in Delaware County, including the 1 percent annual chance flood event results from HAZUS, is provided in Section 4.4.3, Potential Loss Estimates.

The County also tries to reduce the risk of flooding attributed to increases in impervious surfaces by creating Act 167 Stormwater Management Plans. Act 167 plans require municipalities to adopt stringent stormwater management ordinances that aim to minimize additional flows to local streams and creeks during storm events. Through the use of best management practices (BMPs) and limits on discharge rates, these new ordinances should help to prevent increases in flooding problems but will not solve already existing problems. The plans themselves contain a plethora of information concerning land use and hydrology in the watershed. Included in each plan are detailed obstruction evaluations (including size, shape, and ability to pass various storm events), municipal surveys regarding flooding problem areas, frequency, extent of damage, and speculation as to the cause of these problems. The data also includes information on existing and proposed stormwater management facilities. There are three Act 167 Plans in effect in Delaware County: Ridley Creek (1988), Chester Creek Watershed Act 167 Plan (June 2002), and Darby and Cobbs Creeks Watershed Act 167 Plan (May 2005). There are two other Act 167 Plans in progress: Phase II of the Crum Creek Act 167 Plan is currently underway and a Brandywine Creek Act 167 Plan is being prepared by Chester County and will affect only a small portion of land area in Delaware County. More information regarding which municipalities have adopted Act 167 plans can be found in Section 5.2.3.

The Army Corps of Engineers Philadelphia District and Pennsylvania DEP are also working to reduce flood vulnerability in Delaware County. The two agencies held a workshop on March 29, 2011 to gather information from stakeholders on flooding problem areas in Delaware County (among other things). The data will be used to prioritize areas where the two agencies can assist in the design and construction of priority regional watershed improvement projects. Although the agencies are only in early stages of the project, meeting minutes from the 03/29/2011 meeting indicate the stakeholders identified flooding problem areas in the Darby, Crum, Ridley, Chester, and Delaware River watersheds. Due to the sensitivity of the data collected, the list of problem areas identified by stakeholders at the meeting is included in **Appendix C**.

4.3.5. Hurricane, Tropical Storm, Nor'easter

4.3.5.1. Location and Extent

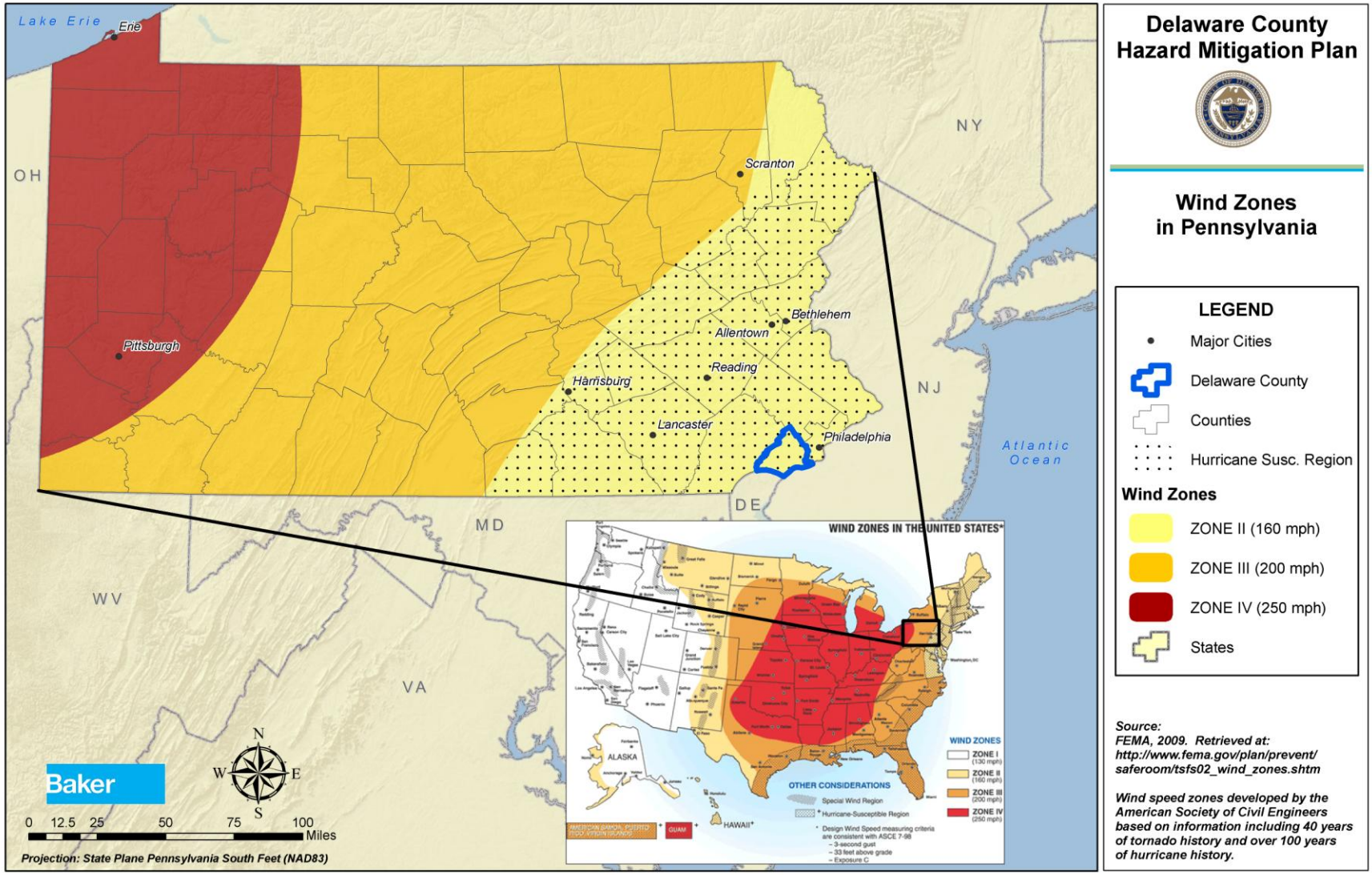
A hurricane is a type of tropical cyclone, which is a generic term for a cyclonic, low-pressure system that features strong winds and precipitation. Tropical storms impacting Delaware County develop in tropical or sub-tropical waters found in the Atlantic Ocean, Gulf of Mexico, or Caribbean Sea. Cyclones with maximum sustained winds of less than 39 miles per hour are called tropical depressions. A tropical storm is a cyclone with maximum sustained winds between 39-74 mph. These storms sometimes develop into hurricanes with wind speeds in excess of 74 mph.

Delaware County is located about 45 miles inland from the Delaware Bay and approximately 60 miles inland from the Atlantic Coast, meaning it is in an area of Pennsylvania where tropical storms could track inland causing heavy rainfall 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 Delaware County are equally subject to the impacts of hurricanes, tropical storms, and nor'easters that track through or near the County. Areas in Delaware County which are subject to flooding, wind, and winter storm damage are particularly vulnerable.

Figure 4.3.5-1 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.

Delaware County falls within Zone II, meaning design wind speeds for shelters and critical facilities should be able to withstand a three second gust of up to 160 mph, regardless of whether the gust is the result of a tornado, hurricane, tropical storm, or windstorm event. Delaware County also falls wholly within the identified Hurricane Susceptibility Region.

Figure 4.3.5-1: Wind zones in Pennsylvania and Delaware County (FEMA, 2009).



4.3.5.2. Range of Magnitude

Tropical cyclones with maximum sustained winds of less than 39 miles per hour (mph) are called *tropical depressions*. A *tropical storm* is a cyclone with maximum sustained winds between 39-74 mph. These storms sometimes develop into *hurricanes* with wind speeds in excess of 74 mph. *Extra-tropical* is a term used to describe a hurricane or tropical storm whose cyclone has lost its "tropical" characteristics and has cold air at its core, rather than warm air. While an extra-tropical storm denotes a change in weather pattern and how a coastal storm is gathering energy, it may still have winds that are tropical storm or hurricane force. The impacts associated with hurricanes and tropical storms are primarily wind damage and flooding. It is not uncommon for tornadoes to develop during these events. Historical tropical storm and hurricane events have brought intense rainfall, sometimes leading to damaging floods, northeast winds, which, combined with waterlogged soils, caused trees and utility poles to fall.

The impact tropical storm or hurricane events have on an area is typically measured in terms of wind speed. Expected damage from hurricane force winds is measured using the Saffir-Simpson Scale. The Saffir-Simpson Scale categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure, and storm surge potential (characteristic of tropical storms and hurricanes), which are combined to estimate potential damage. Table 4.3.5-1 lists Saffir-Simpson Scale categories with associated wind speeds and expected damages. Categories 3, 4, and 5 are classified as "major" hurricanes. While major hurricanes comprise only 20 of all tropical cyclones making landfall, they account for over 70 percent of the damage in the United States. The intensity of a storm is also impacted by its orientation, location of landfall, and speed. The likelihood of these damages occurring in Delaware County is assessed in Section 4.3.5.4, *Future Occurrence*.

Table 4.3.5-1: Saffir-Simpson Scale categories with associated wind speeds and damages (NHC, 2009).

STORM CATEGORY	WIND SPEED (mph)	DESCRIPTION OF DAMAGES
1	74-95	MINIMAL: Damage is limited primarily to shrubbery and trees, unanchored mobile homes, and signs. No significant structural damage.
2	96-110	MODERATE: Some trees are toppled, some roof coverings are damaged, and major damage occurs to mobile homes. Some roofing material, door, and window damage.
3	111-130	EXTENSIVE: Some structural damage to small residences and utility buildings, with a minor amount of curtain wall failures. Mobile homes are destroyed. Large trees are toppled. Terrain may be flooded well inland.
4	131-155	EXTREME: Extensive damage to roofs, windows, and doors; roof systems on small buildings completely fail. More extensive curtain wall failures. Terrain may be flooded well inland.
5	>155	CATASTROPHIC: Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Massive evacuation of residential areas may be required.

It is important to recognize the potential for flooding events during hurricanes and tropical storms; the risk assessment and associated impact for these events is included Section 4.3.4. Wind impacts in Delaware County generally include downed trees and utility poles, which can spark widespread utility interruptions. Wind impacts are particularly an issue for mobile homes and other manufactured housing; these structures are often not well-anchored and are highly susceptible to wind damage in a hurricane, tropical storm, or nor'easter.

The worst case scenario for hurricane, tropical storm, or nor'easter event in Delaware County was Hurricane Diane, which struck Pennsylvania in 1955 and resulted in a Presidential Disaster Declaration. Diane made landfall in North Carolina on August 17, taking a west-northwest track that cut through central Virginia, Maryland, southeast Pennsylvania, New Jersey, and New York. The storm tracked into south-central Pennsylvania, turning eastward and soaking eastern and southeastern Pennsylvania, including Delaware County. The state storm summary for Diane reported that "the Hurricane Flood of 1955, which affected 6,600 square miles, 'was the most disastrous flood ever to strike eastern Pennsylvania'" (Gelber, 2002). This storm is considered the ninth most costly hurricane event (adjusted costs to 1994 dollars), with cumulative damages of $7 million in the Northeastern US.

4.3.5.3. 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 4.3.5-2 lists all coastal storms having centers of circulation to pass through or within 25 nautical miles of Delaware County. Typically when these storms reach Delaware County, they have lost their hurricane speed winds, so structural damage is usually not as bad as coastal communities' experience.

Table 4.3.5-2: Previous coastal storms tracking through or near Delaware County.

YEAR	EVENT	STRENGTH IN/NEAR DELAWARE COUNTY
1988	Chris	Tropical Depression
1955	Diane	Tropical Storm
1945	Not Named	Extra-tropical Storm
1939	Not Named	Tropical Depression
1934	Not Named	Extra-tropical Storm
1929	Not Named	Extra-tropical Storm
1915	Not Named	Tropical Storm

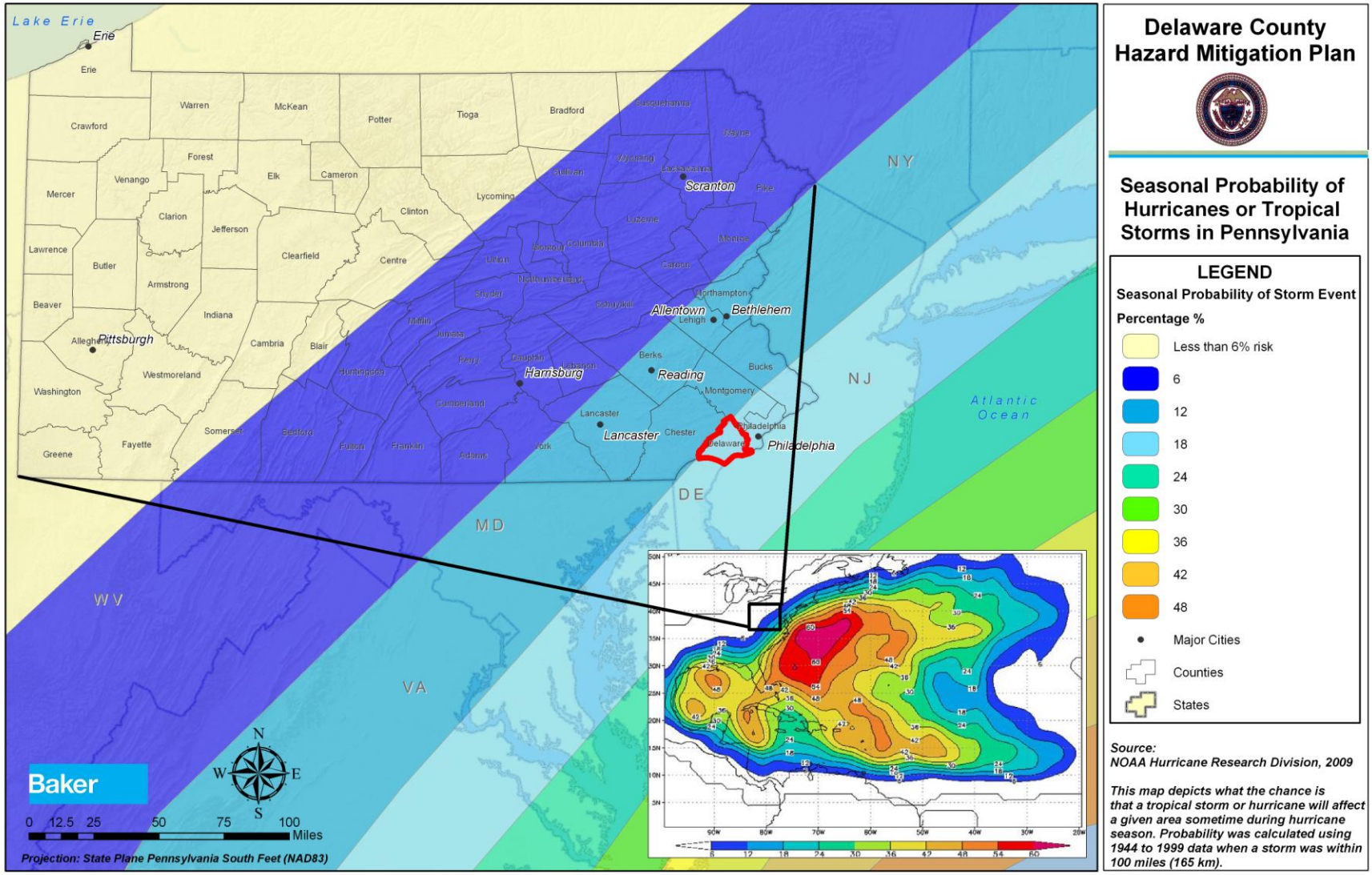
It is important to note that a number of hurricane, tropical storm, and nor'easter events have impacted the County without tracking through or near it; these storm events include Hurricanes Agnes (1972), Floyd (1999), and Henri/Isabel (2003) and Tropical Depression Ivan (2004). Each of these storm events resulted in a Presidential Disaster Declaration.

4.3.5.4. 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 4.3.5-2 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 an 18 percent chance of experiencing a tropical storm or hurricane event between June and November of any given year in the County. This translates to a future occurrence of *possible*, as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1).

Figure 4.3.5-2: Seasonal probability of a hurricane or tropical storm affecting Delaware County (NOAA HRD, 2009).



4.3.5.5. Vulnerability Assessment

A vulnerability assessment for hurricanes and tropical storms focuses on the impacts of flooding and severe wind. Therefore, the assessment for flood-related vulnerability is addressed in Section 4.3.4.5. In addition, mobile/manufactured homes are vulnerable to hurricanes, tropical storms, and nor'easters. Section 4.3.10.5 discusses vulnerability to wind damage and includes Table 4.3.10-4 which shows the number of mobile homes per community. The County is also vulnerable to severe winter weather impacts caused by nor'easters which are evaluated in 4.3.12.5.

4.3.6. Landslide

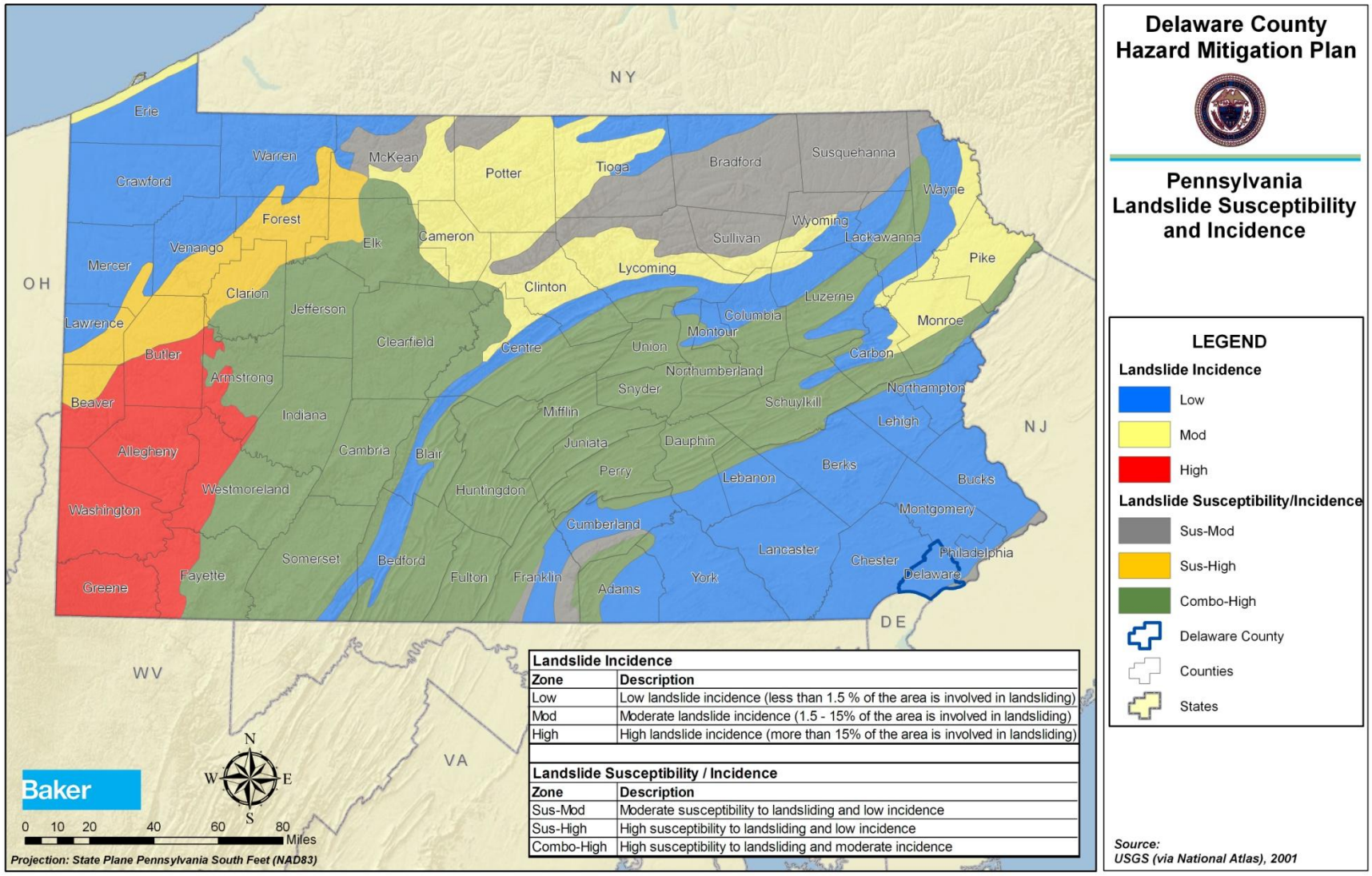
4.3.6.1. Location and Extent

Slope failures often occur in areas with moderate to steep slopes, conductive geology, and high precipitation. They can take the form of rockfalls, rockslides, block glide, debris slide, earth flow, mud flow, and other slope failures. With the appropriate geology and topography, most landslides are associated with precipitation events – either periods of sustained above-average precipitation, specific rainstorms, or snowmelt events. Other elements that determine slope stability are vegetative cover and slope aspect. Contributing causes of landslides include erosion, removal of vegetative cover, and ground shaking from earthquakes. Human activities that can contribute to slope failure include altering the slope gradient, increasing the soil's water content, and removing vegetative cover.

A slope greater than 7% (approximately around 15 degrees) needs special considerations for building roads according to common engineering practice, and a slope of 15% (approximately around 25 degrees) is generally unstable and highly sensitive to surface changes.

The USGS identifies Delaware County as falling into two distinct zones of landslide susceptibility and incidence (Figure 4.3.6-1). The majority of Delaware County has a low incidence of occurrence of landslides. However, a small portion of the County bordering the Delaware River has a *Sus-Mod* susceptibility to landslides, meaning these areas have a moderate susceptibility to landslides with a low incidence of occurrence.

Figure 4.3.6-1: Map of general landslide hazard areas and municipalities in Delaware County (USGS, 2001).



4.3.6.2. Range of Magnitude

Land failure can have potentially devastating consequences, but in very localized areas. Structures or infrastructure built on susceptible land will likely collapse as their footings slide downhill. Structures below the land failure can be crushed. Landslides cause damage to transportation routes, utilities, and buildings and create travel delays and other side effects. Fortunately, deaths and injuries due to landslides are rare in Pennsylvania. Almost all of the known deaths due to 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 injury. As residential and recreational development increases on and near steep mountain slopes, the hazard from these rapid events will also increase. Most Pennsylvania landslides are moderate to slow moving and damage property rather than people.

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. A 1991 estimate showed an average of $10 million per year is spent on landslide repair contracts across the Commonwealth and a similar amount is spent on mitigation costs for grading projects (DCNR, 2010).

There are no officially recorded landslides in Delaware County. However, steep slopes in the county could pose a threat and produce landslides that result in injury, death or substantial property. Minor landslides could cause property damage to vehicles, damage to roads resulting in temporary road closures, and minor personal injury. A possible worst-case scenario could occur in Delaware County if a landslide occurred along one of the major interstates (I-95 or I-476) during rush hour. The landslide could cause damage to vehicles and the roadway and injuries to people. In addition, the landslide would have secondary effects caused by shutting down the roadway in order to clean up.

4.3.6.3. Past Occurrence

No comprehensive list of landslide incidents is available at this time, as there is no formal reporting system in place in the county or the Commonwealth.

4.3.6.4. Future Occurrence

Based on historical events, The future occurrence of landslides can be considered *unlikely* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1). However, mismanaged intense development in steeply sloped areas could increase the frequency of occurrence. In addition, roadcuts throughout the county pose a threat and increase the probability of a slide at any one of the areas at any time.

4.3.6.5. Vulnerability Assessment

Communities in Delaware County are not particularly vulnerable to landslides. However, Marcus Hook Borough, Trainer Borough, Chester Township, Eddystone Borough, Ridley Township, and Tinicum Township are in an area of moderate susceptibility to landslides and therefore slightly vulnerable to landslides than other municipalities in the County. However, transportation routes throughout the County located at the base or crest of cliffs should be considered vulnerable to this hazard. An inventory of these areas is not available.

Several municipalities in Delaware County have adopted steep slope ordinances to reduce the amount of development taking place on steep slopes in the County and reduce vulnerability to landslides. Table 4.3.6-1 depicts municipalities in Delaware County that have adopted steep slope ordinances.

Table 4.3.6-1: Municipal Steep Slope Ordinance Status.

MUNICIPALITY	STEEP SLOPE ORDINANCE
Aldan Borough	Yes
Aston Township	Yes
Bethel Township	No
Brookhaven Borough	No
Chadds Ford Township	Yes
Chester City	Yes
Chester Township	No
Chester Heights Borough	Yes
Clifton Heights Borough	No
Collingdale Borough	No
Colwyn Borough	No
Concord Township	Yes
Darby Borough	No
Darby Township	No
East Lansdowne Borough	No
Eddystone Borough	No
Edgmont Township	Yes
Folcroft Borough	No
Glenolden Borough	No
Haverford Township	Yes
Lansdowne Borough	No
Lower Chichester Township	No
Marcus Hook Borough	Yes
Marple Township	Yes
Media Borough	Yes
Middletown Township	Yes
Millbourne Borough	No
Morton Borough	No
Nether Providence Township	Yes
Newtown Township	Yes
Norwood Borough	No
Parkside Borough	No
Prospect Park Borough	No
Radnor Township	Yes

Table 4.3.6-1: Municipal Steep Slope Ordinance Status.	
MUNICIPALITY	**STEEP SLOPE ORDINANCE**
Ridley Township	Yes
Ridley Park Borough	No
Rose Valley Borough	Yes
Rutledge Borough	No
Sharon Hill Borough	No
Springfield Township	Yes
Swarthmore Borough	No
Thornbury Township	Yes
Tinicum Township	No
Trainer Borough	No
Upland Borough	No
Upper Chichester Township	Yes
Upper Darby Township	No
Upper Providence Township	Yes
Yeadon Borough	No

4.3.7. Pandemic

4.3.7.1. Location and Extent

Pandemic is defined as a disease affecting or attaching the population of an extensive region which may include several countries and/or continents. It is further described as extensively epidemic. Generally, pandemic events cause sudden, pervasive illness in all age groups on a global scale, though some age groups may be more at risk. As such, pandemic events cover a wide geographic area and can affect large populations, including the entirety of Delaware County, depending on the disease. The exact size and extent of the infected population is dependent upon how easily the illness is spread, the mode of transmission, and the amount of contact between infected and non-infected persons.

Delaware County is primarily concerned with the possibility of a pandemic influenza outbreak or a West Nile Virus outbreak. West Nile Virus is a vector-borne disease that can cause headache, high fever, neck stiffness, disorientation, tremors, convulsions, muscle weakness, paralysis, and, in its most serious form, death. The virus spreads via mosquito bite and is aided by warm temperatures and wet climates conducive to mosquito breeding. West Nile Virus has been detected in Delaware County every year from 2000-2010. The virus is highly temporal with most cases occurring between April and October (PADEP-WNCP, 2009).

Influenza, also known as “the flu”, is a contagious disease that is caused by the influenza virus and typically presents with fever, headache, sore throat, cough, and muscle aches. Influenza is considered to have pandemic potential if it is novel, meaning that people have no immunity to it, virulent, meaning that it causes deaths in normally healthy individuals, and easily transmittable from person-to-person. Influenza spreads via the air in crowded populations in enclosed spaces, and it may persist on surfaces and in the air. Individuals are communicable for three to five

days after clinical onset. Pandemic influenza planning began in response to the H5N1 (avian) flu outbreak in Asia, Africa, Europe, the Pacific, and the Near East in the late 1990s and early 2000s. H5N1 did not reach pandemic proportions in the United States, but the County began actively planning for an occurrence of an influenza pandemic in 2007. As stated in the Pennsylvania Department of Health Influenza Pandemic Response Plan, "an influenza pandemic is inevitable and will probably give little warning," underscoring the importance of planning for this hazard (PA DOH, 2005).

4.3.7.2. Range of Magnitude

The impact of a pandemic ranges from, on the low end, large numbers of individuals being sick for short periods of time to, on the high end, a situation in which so many people are simultaneously ill that the County is unable to maintain its continuity of government, schools would be closed, and economic activity could grind to a halt. In the worst cases, the County could expect multiple deaths. However, the magnitude of a pandemic in Delaware County will range significantly depending on the aggressiveness of the disease in question and the ease of transmission.

In the case of West Nile Virus, slightly less than 80% of cases are clinically asymptomatic. Approximately 20% of cases result in mild infection, called West Nile Fever, lasting two to seven days. However, one in 150 cases result in severe neurological disease or death. Since the appearance of West Nile Virus in Delaware County in 2000, the worst years for West Nile Virus in Delaware County were 2004 and 2005, when human cases of the virus led to deaths. The virus is typically more serious in older adults.

Pandemic influenza is more easily transmitted person-to-person than West Nile Virus, but advances in medical technologies have greatly reduced the number of deaths caused by influenza over time. In terms of lives lost, the impact various pandemic influenza outbreaks have had globally over the last century has declined (see Table 4.3.7-2). The 1918 Spanish flu pandemic remains the worst-case scenario for pandemic event on record. While mortality figures were probably under-reported, in the first month of the pandemic alone, 8,000 Pennsylvanians died from the flu or its complications (USDHHS, 2010).

In contrast, the severity of illness from the 2009 H1N1 influenza flu virus has varied, with the gravest cases occurring mainly among those considered at high risk. High risk populations considered more vulnerable include children, the elderly, pregnant women, and chronic disease patients with reduced immune system capacity. Most people infected with H1N1 in 2009 and early 2010 have recovered without needing medical treatment. However, the virus has resulted in many deaths, one of which occurred in Delaware County. According to the CDC, about 70% of those who have been hospitalized with the 2009 H1N1 flu virus in the United States have belonged to a high risk group (CDC, 2009).

The magnitude of a pandemic may be exacerbated by the fact that an influenza pandemic will cause outbreaks across the United States, limiting the ability to transfer assistance from one jurisdiction to another. Additionally, effective preventative and therapeutic measures, including vaccines and other medications, will likely be in short supply or will not be available.

There are no true environmental impacts in pandemic disease outbreaks, but there may be significant economic and social costs. Widespread illness may increase the likelihood of shortages of personnel to perform essential community services. In addition, high rates of illness and worker absenteeism occur within the business community, and these contribute to social and economic disruption. Social and economic disruptions could be temporary but may be amplified in today's closely interrelated and interdependent systems of trade and commerce. Social disruption may be greatest when rates of absenteeism impair essential services, such as power, transportation, and communications.

4.3.7.3. Past Occurrence

West Nile Virus arrived in the United States in 1999 and was first detected in Delaware County 2000 when mosquito pools, dead birds and/ or horses in counties tested positive for the virus. Since then, the number of positive counties, human cases, and West Nile deaths has fluctuated with the temperature and precipitation each year. Table 4.3.7-1 illustrates the virus's overall cases, human cases, and mortality from 2001-2010.

Table 4.3.7-1: Previous West Nile Virus occurrences in Delaware County from 2001-2010 (PA West Nile Control Project, 2011).

YEAR	NUMBER OF POSITIVE CASES	POSITIVE HUMAN CASES	HUMAN DEATHS
2001	31	1	0
2002	110	5	0
2003	54	6	0
2004	9	2	1
2005	4	3	1
2006	17	0	0
2007	39	0	0
2008	107	2	0
2009	17	0	0
2010	118	1	0

While West Nile Virus occurrences are fairly recent, 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 4.3.7-2

Table 4.3.7-2 List of previous significant outbreaks of influenza over the past century (Global Security, 2009; World Health Organization, 2009).

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

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 of 1968 with deaths peaking between December, 1968 and January, 1969 (Global Security, 2009). More recently, 458 cases of 2009 H1N1 have been confirmed in Delaware County resulting in 1 death.

4.3.7.4. Future Occurrence

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 due to climate change, the range of the virus in the United States will grow (Epstein, 2001).

As with West Nile Virus, the precise timing of pandemic influenza is uncertain. Based on historical events, Delaware 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). As a result, future pandemic events are considered *possible* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1).

4.3.7.5. Vulnerability Assessment

In general, jurisdictions that are more densely populated are more vulnerable to pandemic disease when the disease is directly spread from human to human, but every jurisdiction in the County has some vulnerability to this kind of disease threat. There are not estimates available for the vulnerability of populations to West Nile Virus, but there are for pandemic influenza. According to the County's Pandemic Influenza Response Plan, should a pandemic reach the County, it is assumed that 35 percent of the population would become infected. This would result in an estimated 200,000 people becoming ill over the six-month epidemic period. Of these cases, 750-1000 people would need inpatient hospital services in the first month alone; doctors and other health professionals would expect to see an additional 75,000 outpatient visits. In all, the County could expect 600-800 deaths during the first six weeks of the pandemic (Delaware County Pandemic Influenza Preparedness and Response Plan, 2008).

4.3.8. Radon Exposure

4.3.8.1. Location and Extent

Radon is a gas that cannot be seen or smelled. It is a noble gas that originates by the natural radioactive decay of uranium and thorium. Like other noble gases (e.g., helium, neon, and argon), radon forms essentially no chemical compounds and tends to exist as a gas or as a dissolved atomic constituent in groundwater. Two isotopes of radon are significant in nature, 222Rn and 220Rn, formed in the radioactive decay series of 238U and 232Th, respectively.

The isotope thoron (i.e. 220Rn) has a half-life (time for decay of half of a given group of atoms) of 55 seconds, barely long enough for it to migrate from its source to the air inside a house and pose a health risk. However, radon (i.e. 222Rn), which has a half-life of 3.8 days, is a widespread hazard. The distribution of radon is correlated with the distribution of radium (i.e. 226Ra), its immediate radioactive parent, and with uranium, its original ancestor. Due to the short half-life of radon, the distance that radon atoms can travel from their parent before decay is generally limited to distances of feet or tens of feet. Each county in Pennsylvania is classified as having a *low*, *moderate*, or *high* radon hazard potential. Delaware County is classified as having a high hazard, meaning there is a predicted indoor radon level of 4 pCi/L or more (see Figure 4.3.8-1).

Radioactivity caused by airborne radon has been recognized for many years as an important component in the natural background radioactivity exposure of humans, but it was not until the 1980s that the wide geographic distribution of elevated values in houses and the possibility of extremely high radon values in houses were recognized. In 1984, routine monitoring of employees leaving the Limerick nuclear power plant in nearby Montgomery County while it was still under construction and not yet functional, showed that readings on a construction worker at the plant frequently exceeded expected radiation levels. However, only natural, nonfission-product radioactivity was detected on him.

Subsequent testing of the employee's home in the Reading Prong section of Pennsylvania (a physiographic province north of Delaware County – Delaware County is located in the Piedmont and Atlantic Coastal Plain Provinces – see Figure 4.3.8-2) showed extremely high radon levels around 2,500 pCi/L (pico Curies per Liter). To put this amount in perspective, the Environmental Protection Agency guidelines state that actions should be taken if radon levels exceed 4 pCi/L in a home, and uranium miners have a maximum exposure of 67 pCi/L. As a result of this event, the Reading Prong became the focus of the first large-scale radon scare in the world.

Figure 4.3.8-1: Delaware County Radon Hazard Zone (EPA, 1993).

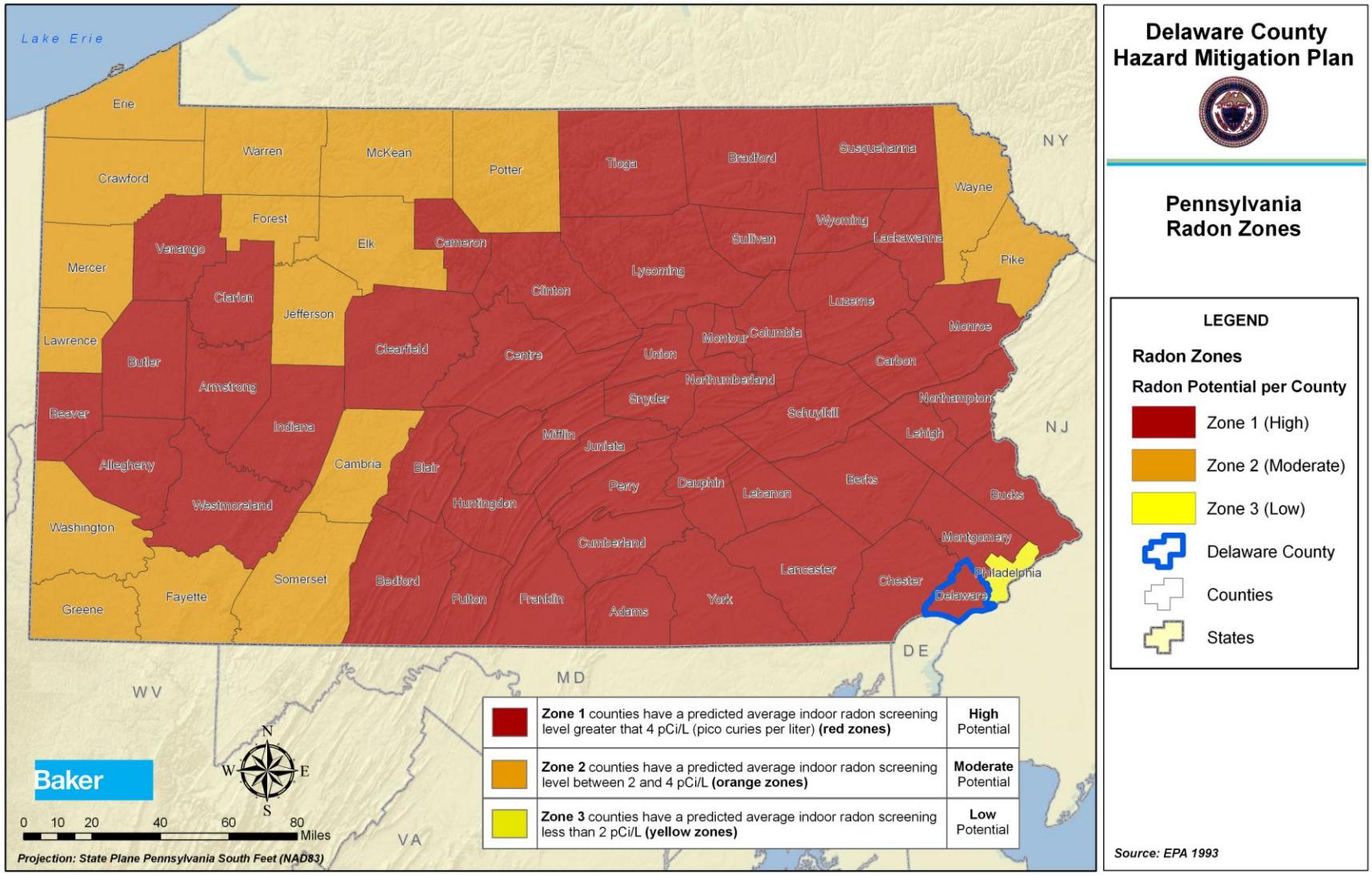
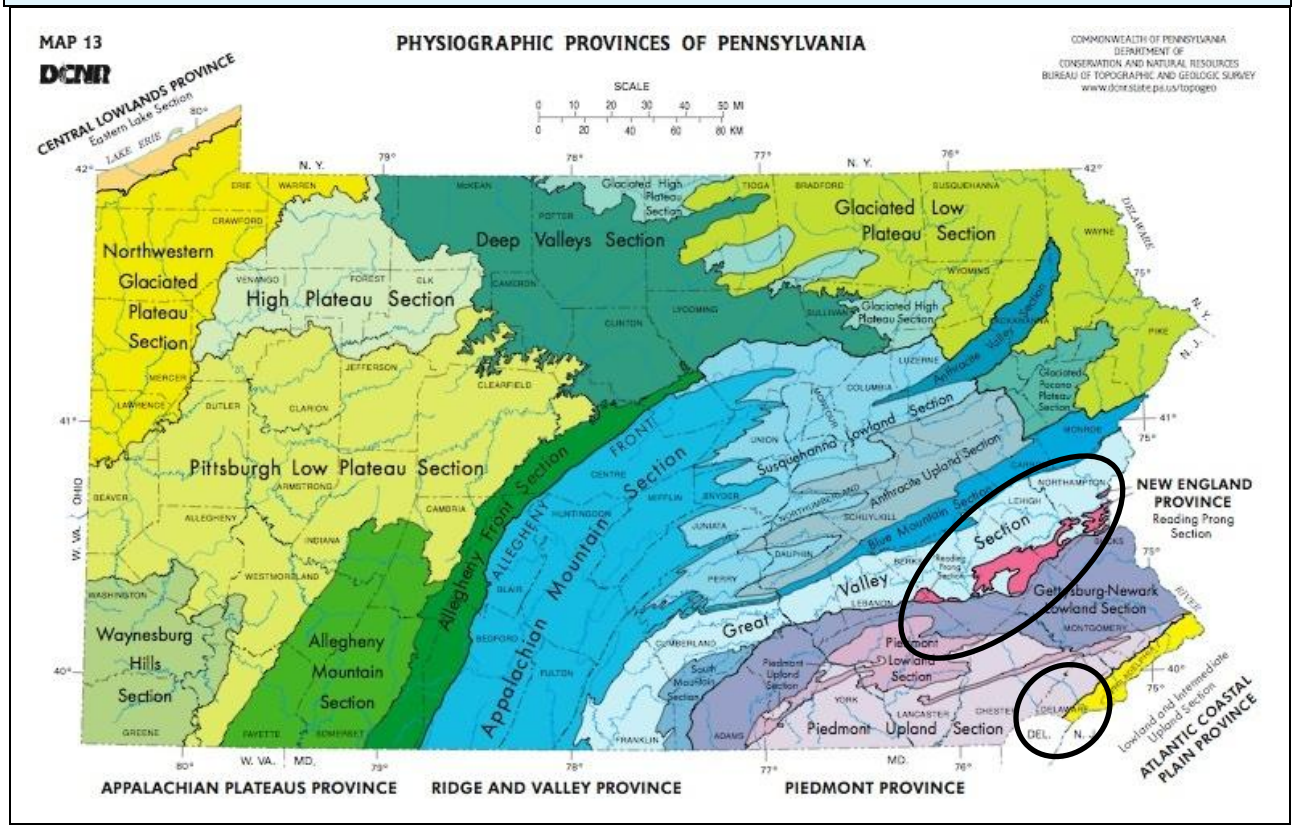


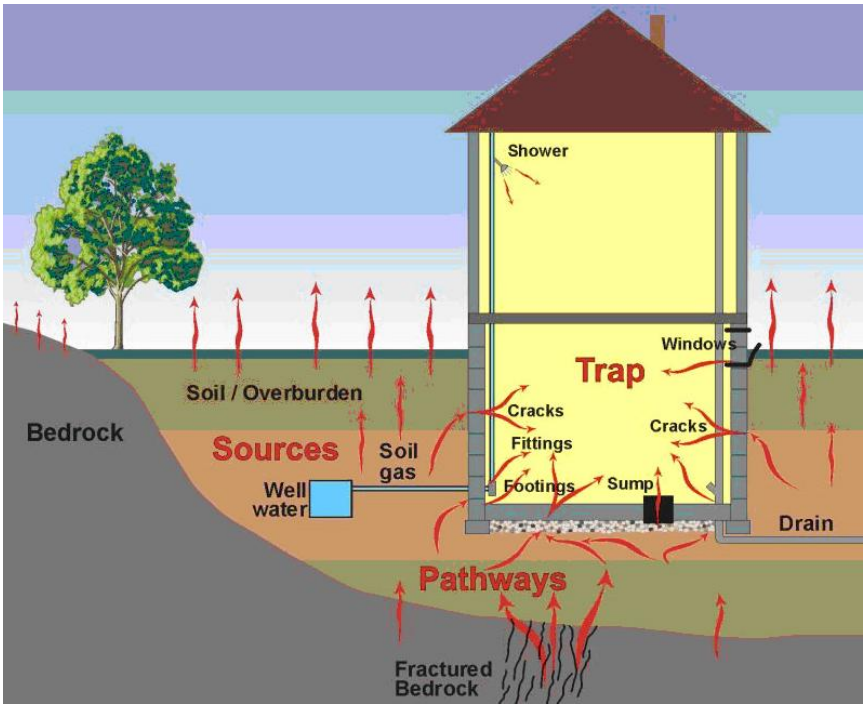
Figure 4.3.8-2: Pennsylvania physiographic provinces (PA DCNR, 2011).



Three sources of radon in houses are now recognized (shown in Figure 4.3.8-3):

- Radon in soil air that flows into the house;
- Radon dissolved in water from private wells and exsolved during water usage; this is rarely a problem in Pennsylvania; and
- Radon emanating from uranium-rich building materials (e.g. concrete blocks or gypsum wallboard)

Figure 4.3.8-3: Sketch of radon entry points into a house (Arizona Geological Survey, 2006).



High radon levels were initially thought to be exacerbated in houses that are tightly sealed, but 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 in radon concentrations. Outflows of air from a house, caused by a furnace, fan, thermal "chimney" effect, or wind effects, require that air be drawn into the house to compensate. If the upper part of the house is tight enough to impede influx of outdoor air (radon concentration generally <0.1 pCi/L), then 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 (see Figure 4.3.8-3). Soil gas typically contains from 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.

The radon concentration of soil gas depends upon a number of soil properties, the importance of which is still being evaluated. In general, ten to fifty 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. For houses

built on bedrock, fractured zones may supply air having radon concentrations similar to those in deep soil.

Several areas of Delaware County have had high radon level test results. The areas and test results are shown in more detail in Table 4.3.8-2.

4.3.8.2. Range of Magnitude

Exposure to radon is the second leading cause of lung cancer after smoking. It is the number one cause of lung cancer among non-smokers. Radon is responsible for about 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, there is no evidence that children are at greater risk of lung cancer than are adults (EPA, March 2010). The main hazard is actually from the radon daughter products (218Po, 214Pb, 214Bi), which may become attached to lung tissue and induce lung cancer by their radioactive decay.

Table 4.3.8-1: Radon risk for smokers and non-smokers (EPA, March 2010).

RADON LEVEL (cCi/L)	IF 1,000 PEOPLE WERE EXPOSED TO THIS LEVEL OVER A LIFETIME…*	RISK OF CANCER FROM RADON EXPOSURE COMPARES TO…**	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 2pCi/L is difficult
0.4	About 3 people could get lung cancer	(Average outdoor radon level)	
NON-SMOKERS			
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 2pCi/L is difficult

Table 4.3.8-1: Radon risk for smokers and non-smokers (EPA, March 2010).			
RADON LEVEL (cCi/L)	**IF 1,000 PEOPLE WERE EXPOSED TO THIS LEVEL OVER A LIFETIME…***	**RISK OF CANCER FROM RADON EXPOSURE COMPARES TO…****	**ACTION THRESHOLD**
0.4	-	(Average outdoor radon level)	
NOTE: Risk may be lower for former smokers. ** Lifetime risk of lung cancer deaths from 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.*			

According to the EPA, the average radon concentration in the indoor air of homes nationwide is about 1.3 pCi/L. The EPA recommends homes be fixed if the radon level is 4 pCi/L or more. However, because there is no known safe level of exposure to radon, the EPA also recommends that Americans consider fixing their home for radon levels between 2 pCi/L and 4 pCi/L (PADEP, 2011b). Table 4.3.4-1 shows the relationship between various radon levels, probability of lung cancer, comparable risks from other hazards, and action thresholds. As is shown in Table 4.3.4-1, a smoker exposed to radon has a much higher risk of lung cancer.

The worst-case scenario for radon exposure in Delaware County would be that a large area of tightly sealed homes provided residents high levels of exposure over a prolonged period of time without the resident being aware. This worst-case scenario exposure then could lead to a large number of people with cancer attributed to the radon exposure.

4.3.8.3. Past Occurrence

Current data on abundance and distribution of radon as it affects individual houses in Pennsylvania in general and Delaware County specifically is considered incomplete and potentially biased. The EPA estimates that the average indoor concentration in Pennsylvania basements is about 7.1 pCi/L and 3.6 pCi/L on the first floor.

The Pennsylvania Department of Environmental Protection Bureau of Radiation Protection provides information for homeowners on how to test for radon in their houses. If a test is reported to the Bureau over 4 pCi/L, then the Bureau works to help the homeowners make repairs to their houses to mitigate against high radon levels. The total number of tests reported to the Bureau since 1990 and their results are provided by zip code on the Bureau's website. However, this information is only provided if over 30 tests total were reported in order to best approximate the average for the area. In Delaware County thirty-nine zip codes had sufficient tests reported to the Bureau to report their findings, which are shown in Table 4.3.8-2.

Table 4.3.8-2: Radon level tests and results in Delaware County zip codes (PADEP, 2011).				
ZIP CODE	**AREA OF DELAWARE COUNTY**	**TEST LOCATION**	**NUMBER OF TESTS**	**AVERAGE RESULT (pCi/L)**
19003	Ardmore	Basement	1870	2.82
		First Floor	637	1.29
19014	Aston	Basement	1647	2.34

Table 4.3.8-2: Radon level tests and results in Delaware County zip codes (PADEP, 2011).				
ZIP CODE	**AREA OF DELAWARE COUNTY**	**TEST LOCATION**	**NUMBER OF TESTS**	**AVERAGE RESULT (pCi/L)**
		First Floor	354	1.21
19015	Brookhaven	Basement	850	1.74
		First Floor	232	1.09
19008	Broomall	Basement	2011	3.46
		First Floor	612	1.94
19010	Bryn Mawr	Basement	2986	3.47
		First Floor	947	1.64
19317	Chadds Ford	Basement	1796	2.52
		First Floor	401	1.37
19319	Cheney	Basement	41	3.39
		First Floor	N/A	N/A
19013	Chester	Basement	312	2.43
		First Floor	82	1.38
19018	Clifton Heights	Basement	1296	2.62
		First Floor	358	3.04
19022	Crum Lynne	Basement	68	1.97
		First Floor	N/A	N/A
19023	Darby	Basement	623	1.73
		First Floor	184	.99
19026	Drexel Hill	Basement	3340	3.09
		First Floor	920	1.56
19029	Essington	Basement	102	2.02
		First Floor	35	1.19
19032	Folcroft	Basement	261	1.49
		First Floor	51	.86
19033	Folsom	Basement	413	2.4
		First Floor	100	1.15
19342	Glen Mills	Basement	1710	2.86
		First Floor	397	1.62
19036	Glenolden	Basement	621	1.82
		First Floor	172	1.05
19041	Haverford	Basement	921	3.98
		First Floor	306	1.72
19083	Havertown	Basement	5028	3.25
		First Floor	1452	1.71
19043	Holmes	Basement	130	1.99
		First Floor	46	1.18
19050	Lansdowne	Basement	2383	3
		First Floor	778	1.49

Table 4.3.8-2: Radon level tests and results in Delaware County zip codes (PADEP, 2011).				
ZIP CODE	**AREA OF DELAWARE COUNTY**	**TEST LOCATION**	**NUMBER OF TESTS**	**AVERAGE RESULT (pCi/L)**
19061	Marcus Hook/Chichester	Basement	1754	2.74
		First Floor	327	1.52
19063	Media	Basement	4340	4.35
		First Floor	1094	2.31
19070	Morton	Basement	479	3.39
		First Floor	108	2.01
19073	Newtown Square	Basement	2650	3.3
		First Floor	735	1.68
19074	Norwood	Basement	210	2.15
		First Floor	67	1.24
19076	Prospect Park	Basement	291	2.5
		First Floor	85	1.11
19078	Ridley Park	Basement	585	2.31
		First Floor	157	1.1
19079	Sharon Hill	Basement	264	2.61
		First Floor	70	.91
19064	Springfield	Basement	2936	4.17
		First Floor	804	2.21
19081	Swarthmore	Basement	1030	3.07
		First Floor	285	1.51
19373	Thornton	Basement	91	1.68
		First Floor	355	3.8
19082	Upper Darby	Basement	2027	2.52
		First Floor	605	1.13
19085	Villanova	Basement	1354	2.75
		First Floor	426	1.42
19086	Wallingford	Basement	1744	3.18
		First Floor	451	1.65
19087	Wayne	Basement	6999	5.52
		First Floor	2249	2.9
19094	Woodlyn	Basement	214	2.32
		First Floor	49	1.18
19096	Wynnewood	Basement	2617	3.53
		First Floor	872	1.82

Radon exposure has also occurred in Delaware County as a result of non-naturally occurring radon. In 1991, the EPA investigated homes in Lansdowne Borough, East Lansdowne Township, Upper Darby Township, Aldan Borough, Yeadon Borough, and Darby Borough and found radon contamination resulting from the disposal of radioactive materials generated by W.

L. Cummings Radium Processing Company (New York Times, 1991; EPA, 2011). The company conducted radium refining operations from 1915 to 1925 and radioactive sand resulting from plant operations was mixed with materials used to construct buildings or used for fill material at the various properties in Delaware County. The EPA placed forty properties on the "National Priorities List" under the Superfund site name the Austin Avenue Radiation site. The site was remediated and deleted from the National Priorities List in 2002.

4.3.8.4. Future Occurrence

Radon exposure is inevitable given present soil, geologic, and geomorphic factors in Delaware County. Future occurrence of high radon level hazards can be considered *possible* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1).

Development in areas where previous radon levels have been 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 with proper testing for both past and future development and appropriate mitigation measures.

4.3.8.5. Vulnerability Assessment

As Table 4.3.8-2 shows, houses in a number of Delaware County municipalities or cities could be susceptible to high levels of radon. The average pCi/L testing result in the Wayne zip code (Radnor Township) and Media zip code (Media Borough, Middletown Township, Upper Providence Township, Broomall Township, Springfield Township, Chester Heights Borough, Aston Township, and Rose Valley Borough) was over 4 and a number of other zip codes had testing results over 3. In addition, at the HMPU risk assessment workshop several municipalities indicated that they had a radon risk including East Lansdowne Township, Ridley Township, Haverford Township, and Aston Township.

Smokers can be up to ten times more vulnerable to lung cancer from high levels of radon depending on the level of radon they are exposed to (see Table 4.3.8-1). Older houses that have crawl spaces or unfinished basements are more vulnerable as well because of the increased exposure to soils which could be releasing higher levels of radon gas. Additionally, houses that rely on wells for their water may face an additional risk, although this type of exposure is low and rare in Pennsylvania.

Proper testing for radon levels should be completed across Delaware County, especially in the areas of higher incidence levels and for those individuals and households that face the contributing risks described above. This testing will determine the level of vulnerability that residents face in their homes, as well as in their businesses and schools. The Pennsylvania Department of Environmental Protection Bureau of Radiation Protection provides short and long term tests to determine radon levels as well as information on how to mitigate high levels of radon in a building. According to the EPA repairs to houses to protect against radon can cost on average the same as regular house repairs (EPA, October 2010).

4.3.9. Subsidence and Sinkhole

4.3.9.1. Location and Extent

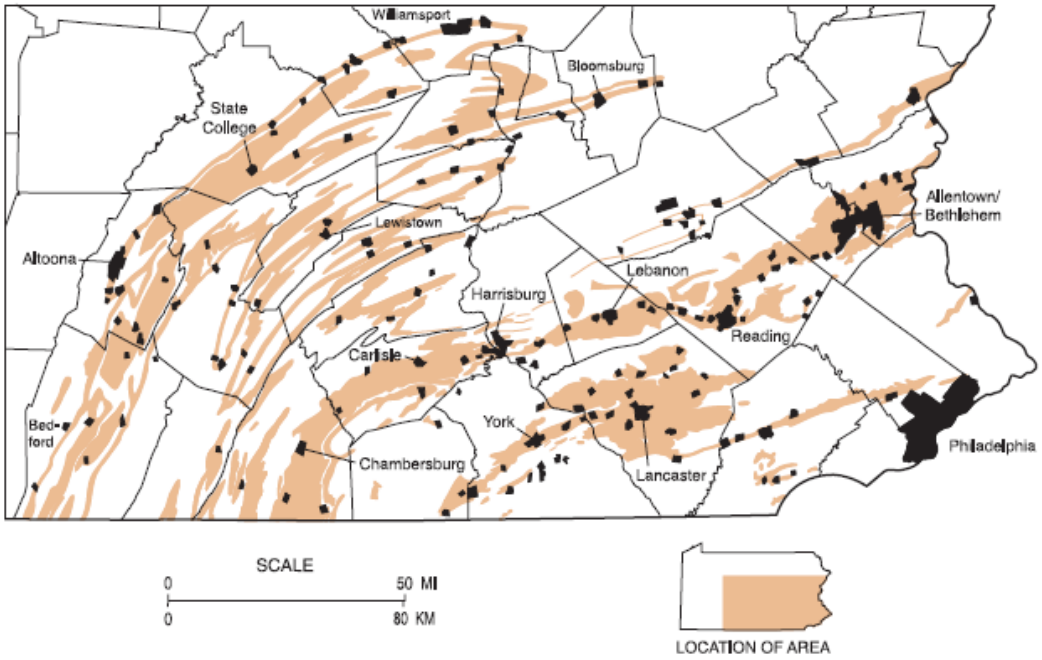
A sinkhole can be defined as a subsidence feature that can form rapidly and which is characterized by a distinct break in the land surface and the downward movement of surface materials into the resulting hole or cavity. Sinkholes are generally found in areas underlain by carbonate bedrock (such as limestone and dolomite), found in large areas of central and eastern Pennsylvania. They occur naturally due to the physical and chemical weathering of the bedrock. Water passing through naturally occurring fractures and bedding planes dissolve the bedrock leaving voids below the surface. Eventually, overburden on top of the voids collapse, leaving surface depressions resulting in karst topography. Characteristics structures associated with karst topography include sinkholes, linear depressions and caves. Often, sub-surface solution of limestone will not result in the immediate formation of karst features.

Subsidence can also occur as a result of underground mining, excessive pumping of groundwater, or subsurface erosion due to the failure of existing utility lines. Additionally, sinkholes can occur in areas where streams or wetlands have been filled.

Although the actual subsidence process occurs over a long period of time, the final collapse can occur very rapidly. Collapse sometimes occurs only after a large amount of activity, or when a heavy burden is placed on the overlying material. Abrupt or long-term changes in the ground surface may also occur following sub-surface fluid extraction (e.g. natural gas, water, oil, etc…).

According to DCNR, Delaware County does not have the carbonate geology that results in sinkholes. This is displayed in Figure 4.3.9-1. However, the County does have areas where streams and wetlands have been filled and constructed over. These areas are susceptible to subsidence and sinking.

Figure 4.3.9-1: Map of areas in eastern and central Pennsylvania susceptible to subsidence based on the presence of underlying carbonate rock formations with urban areas shown in black (Kochanov, 1999).



4.3.9.2. Range of Magnitude

Subsidence and sinkhole events may occur gradually or abruptly. Events could result in minor elevation changes or deep, gaping holes in the ground surface. Subsidence and sinkhole events can cause severe damage in urban environments, although gradual events can be addressed before significant damage occurs. If long-term subsidence or sinkhole formation is not recognized and mitigation measures are not implemented, fractures or complete collapse of building foundations and roadways may result.

A worst case scenario for subsidence and sinkholes would be if a sinkhole occurred under a critical facility such as a hospital. Not only could structural damage occur to the building, but there could be injuries to people as well. In addition, part of the facility would have to be closed in order to repair the structural damage and this would reduce the hospital's capacity and ability to treat people with other illnesses and injuries.

4.3.9.3. Past Occurrence

Delaware County does not have a record of a significant subsidence-based disaster. However, the Pennsylvania Department of Conservation and Natural Resources provides an online *Sinkhole Inventory Database* of sinkholes throughout the Commonwealth. The database does not contain any recorded sinkhole or subsidence events for Delaware County. However, there have been unofficial reports of sinkholes at several locations in Delaware County, which are believed to be caused by flooding, poor fill, and construction over streams.

4.3.9.4. Future Occurrence

Based on the lack of karst geology but presence of filled ground and utilities, the future occurrence of subsidence and sinkholes can be considered *possible* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1).

4.3.9.5. Vulnerability Assessment

The entire County is equally vulnerable to the effects of natural subsidence events. Local roads need annual repair and damage to water and gas lines and telephone and electrical entry road facilities could occur in highly populated areas. Areas of filled wetlands or streams should be identified, and the prohibition of development in these areas should be encouraged. Additionally, caution should be taken when building structures on filled ground.

4.3.10. Tornado and Windstorm

4.3.10.1. Location and Extent

A tornado, a violently rotating funnel-like vortex, is an extraordinary feature of severe thunderstorms. A condensation funnel does not need to reach to the ground for a tornado to be present; a debris cloud beneath a thunderstorm is all that is needed to confirm the presence of a tornado, even in the total absence of a funnel. While the extent of tornado damage is usually localized, the extreme winds of this vortex can be among the most destructive on earth when they move through populated, developed areas.

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. May to August is the most likely time for tornadoes to occur in Pennsylvania. Tornado movement is characterized in two ways: direction and speed of the spinning winds and forward movement of the tornado/storm track. Rotational wind speeds of the vortex can range from 100 mph to more than 250 mph. In addition, the speed of forward motion can be zero to 45 or 50 mph. Therefore, some estimates place the maximum velocity (combination of ground speed, wind speed, and upper winds) of tornadoes at about 300 mph.

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 often accompany tornadoes and are caused by the movement of air from areas of higher pressure to areas of lower pressure – the greater the difference in pressure, the stronger the winds. Wind storms are generally defined as sustained wind speeds of 40 mph or greater lasting for one hour or longer, or winds of 58 mph or greater for any duration. The Fujita Tornado Scale (or the “F-Scale”) classifies United States tornadoes into six intensity categories, named F0 to F5, based upon the estimated maximum winds occurring within the funnel. The F-Scale has subsequently become the definitive meter for estimating wind speeds within tornadoes based upon the damage done to buildings and structures.

Figure 4.3.10-1 shows that the county is located in the Zone II wind zone. Figure 4.3.10-2 depicts that tornado activity has occurred throughout the entire county.

4.3.10.2. Range of Magnitude

Each year, tornadoes account for $1.1 billion in damages and cause over 80 deaths nationally (NCAR, 2001). While the extent of tornado damage is usually localized, the vortex of extreme wind associated with a tornado can result in some of the most destructive forces on Earth. Rotational wind speeds can range from 100 mph to more than 250 mph. In addition, the speed of forward motion can range from 0 to 50 mph. Therefore, some estimates place the maximum velocity (combination of ground speed, wind speed, and upper winds) of tornadoes at about 300 mph. The damage caused by a tornado is a result of the high wind velocity and wind-blown debris, also accompanied by lightning or large hail. The most violent tornadoes have rotating winds of 250 miles per hour or more and are capable of causing extreme destruction and turning normally harmless objects into deadly missiles.

Damages and deaths can be especially significant when tornadoes move through populated, developed areas. The destruction caused by tornadoes ranges from minor to extreme depending on the intensity, size and duration of the storm as described below. Typically, tornadoes cause the greatest damages to structures of light construction such as mobile homes.

The Enhanced Fujita Scale, also known as the “EF-Scale,” measures tornado strength and associated damages. The EF-Scale is an update to the earlier Fujita Scale, also known as the “F-Scale,” that was published in 1971. It classifies United States tornadoes into six intensity categories, as shown in Table 4.3.10-1, based upon the estimated maximum winds occurring within the wind vortex. Since its implementation by the National Weather Service in 2007, the EF-Scale has become the definitive metric for estimating wind speeds within tornadoes based upon damage to buildings and structures. F-Scale categories with corresponding EF-Scale wind speeds are provided in Table 4.3.10-1 since the magnitude of previous tornado occurrences is based on the F-Scale.

Table 4.3.10-1: Enhanced Fujita Scale (EF-Scale) categories with associated wind speeds and description of damages.

EF-SCALE NUMBER	WIND SPEED (mph)	F-SCALE NUMBER	TYPE OF DAMAGE POSSIBLE
EF0	65–85	F0-F1	**Minor damage**: Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e., those that remain in open fields) are always rated EF0.
EF1	86-110	F1	**Moderate damage**: Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111–135	F1-F2	**Considerable damage**: Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136–165	F2-F3	**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	166–200	F3	**Devastating damage**: Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	F3-F6	**Extreme damage**: Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (300 ft); steel reinforced concrete structure badly damaged; high-rise buildings have significant structural deformation.

Figure 4.3.10-1 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.

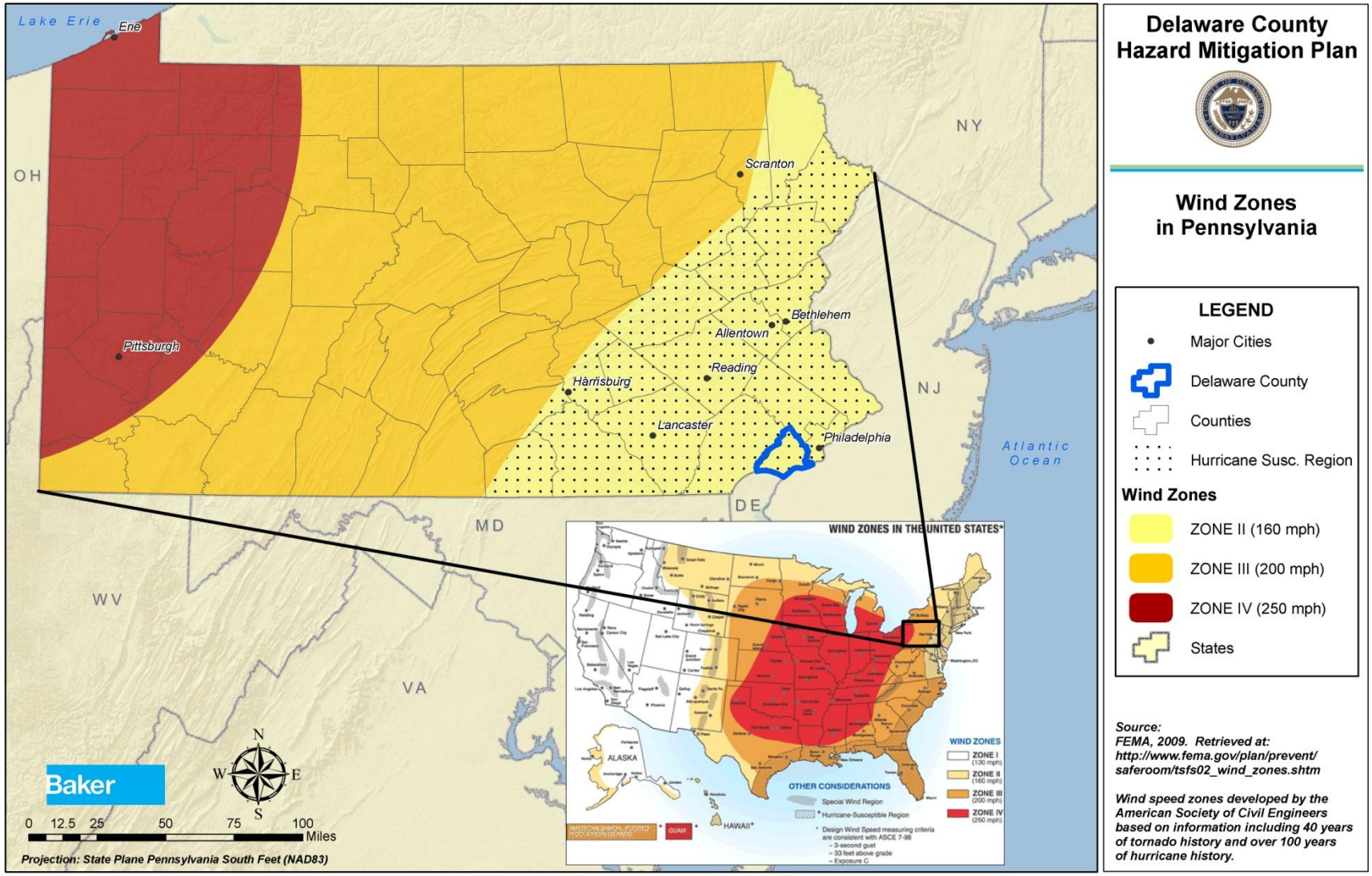
Delaware County falls within Zone II, meaning design wind speeds for shelters and critical facilities should be able to withstand a three second gust of up to 160 mph, regardless of whether the gust is the result of a tornado, hurricane, tropical storm, or windstorm event. Therefore, these structures should be able to withstand speeds experienced in an EF3 tornado. Figure 4.3.10-1 also indicates that Delaware County is susceptible to hurricanes.

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 4.3.10-1 in order to prevent release of hazardous materials into the environment.

A worst case scenario for tornados occurred in 1993 when an F1 tornado touched down in Media, moving northeast toward Drexel Hill and northern Springfield. It uprooted many trees,

tore the roof off of several buildings, and damaged vehicles. No deaths or injuries were reported however it caused $5 million in damages. Additionally 40,000 customers lost power countywide.

Figure 4.3.10-1: Design wind speeds for community shelters across the United States (FEMA, 2009).



4.3.10.3. 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 Delaware County between 1950 and 2011 is shown in Table 4.3.10-2 with an associated Fujita Tornado Scale magnitude. A map showing the approximate location of previous events is included in Figure 4.3.10-2.

Table 4.3.10-2: Previous tornado events between 1950 and 2011 in Delaware County (NCDC, 2011).

LOCATION	DATE	ESTIMATED LENGTH	ESTIMATED WIDTH	MAGNITUDE	ESTIMATED PROPERTY DAMAGE ($)
Countywide	06/29/73	1.90 miles	63 yards	F2	25,000
Countywide	07/15/92	0.70 miles	100 yards	F1	250,000
Springfield	09/27/93	3.00 miles	200 Yards	F1	5,000,000
Trainer	08/22/10	Approx. 0.60 miles	N/A	F0	25,000

Windstorm events may be the result of thunderstorms, hurricanes, tropical storms, winter storms, or nor'easters. There have been fifty high wind events recorded in Delaware County since 1950. The highest wind speed recorded in the County occurred as a result of thunderstorm winds that took place on March 18, 1989 producing 78 knot winds. A list of events greater than 50 knots that have occurred since 1950 is shown in Table 4.3.10-3.

Figure 4.3.10-2: Tornadoes that have touched down in Delaware County between 1950 and 2008 (NWS via National Atlas, 1950-2004).

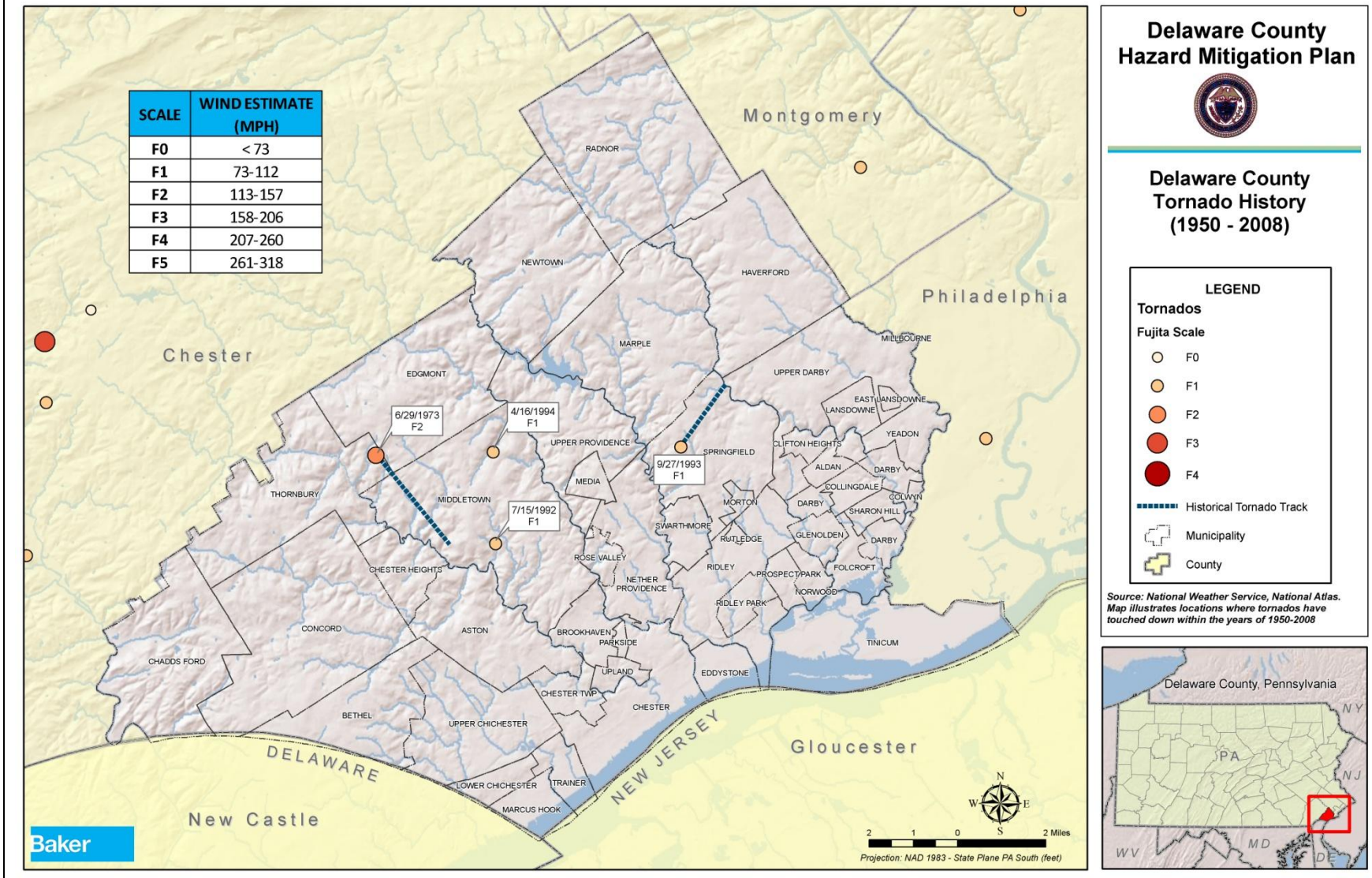


Table 4.3.10-3: Previous windstorm events greater than 50 knots in Delaware County between 1950 and 2011 (NCDC, 2011).

LOCATION	DATE	ESTIMATED WIND SPEED (knots)	ESTIMATED PROPERTY DAMAGE ($)
Countywide	6/11/1958	74	NP
Countywide	6/23/1969	59	NP
Countywide	4/09/1970	52	NP
Countywide	7/16/1980	54	NP
Countywide	7/22/1980	55	NP
Countywide	5/08/1984	58	NP
Countywide	3/18/1989	78	NP
Countywide	11/20/1989	69	NP
Countywide	11/20/1989	52	NP
Countywide	11/20/1989	53	NP
Countywide	8/13/1990	52	NP
Countywide	6/16/1991	52	NP
Countywide	6/30/1991	52	NP
Countywide	7/07/1991	52	NP
Countywide	7/23/1991	53	NP
Melrose Park	4/09/1995	52	NP
Countywide	1/19/1996	58	NP
Countywide	3/19/1996	52	NP
Darby	5/01/1997	52	NP
Chester	5/06/1997	60	200,000
Countywide	6/01/1998	60	NP
Upper Darby	6/26/1998	56	NP
Countywide	11/02/1999	58	NP
Countywide	12/12/2000	51	360,000
Countywide	4/09/2001	52	NP
Countywide	9/04/2001	52	NP
Boothwyn	5/27/2002	57	NP
Countywide	8/24/2002	52	NP
Broomall	7/05/2003	52	NP
Newton Square	8/30/2003	52	NP
Countywide	9/18/2003	52	32,200,000
Thornton	9/23/2003	61	1,000,000
Haverford	10/14/2003	56	NP
Countywide	11/13/2003	52	2,200,000
Countywide	8/04/2004	52	NP
Radnor	9/28/2004	52	NP
Springfield	11/25/2004	52	NP
Sharon Hill	5/28/2005	52	NP

Table 4.3.10-3: Previous windstorm events greater than 50 knots in Delaware County between 1950 and 2011 (NCDC, 2011).

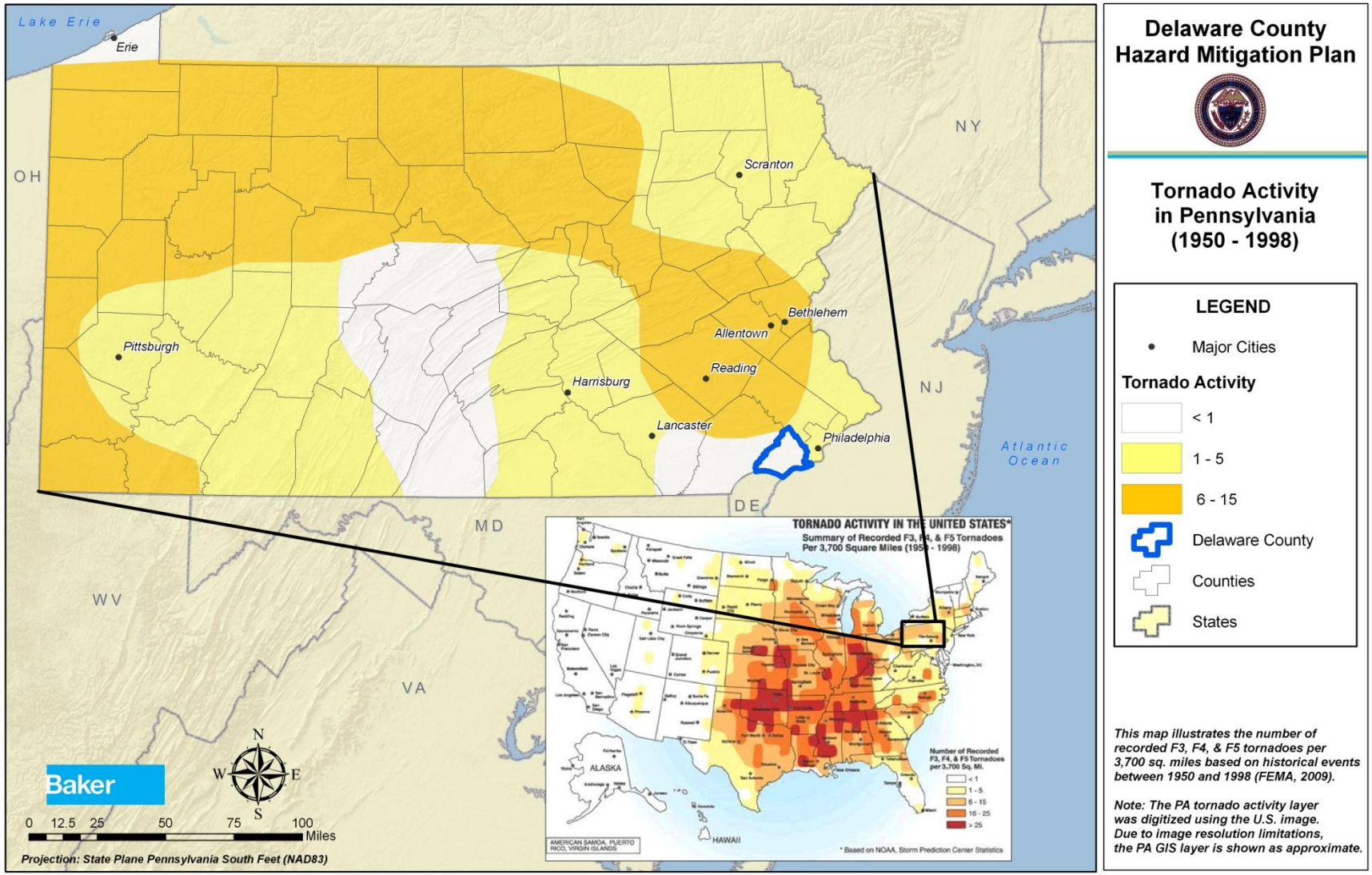
LOCATION	DATE	ESTIMATED WIND SPEED (knots)	ESTIMATED PROPERTY DAMAGE ($)
Darby	6/06/2005	52	NP
Edgmont	8/14/2005	52	NP
Countywide	1/14/2006	53	600,000
Bryn Mawr	7/02/2006	52	NP
Boothwyn	7/18/2006	52	NP
Villanova	8/25/2006	52	NP
Chester Heights	8/29/2006	52	NP
Newton Square	5/16/2007	52	NP
Chadds Ford	5/27/2007	56	NP
Florida Park	3/08/2008	56	100,000
Media	7/17/2009	52	NP
Florida Park	6/24/2010	66	1,000,000

4.3.10.4. Future Occurrence

According to the National Weather Service, the Commonwealth of Pennsylvania has an annual average of ten 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, with a 0.019 percent annual probability of occurring, 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.

Based on tornado activity information for Pennsylvania between 1950 and 1998, Delaware County lies within an area that has experienced less than one F3, F4, or F5 tornadoes per 3,700 square miles (see Figure 4.3.10-3). This equals a less than two percent chance that the planning area will be affected by a Category F3, F4, or F5 tornado each year. The probability of tornadoes in Delaware County can be considered *possible* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1).

Figure 4.3.10-3: Number of recorded F3, F4, & F5 Tornadoes per 3,700 sq. miles based on historical events between 1950 and 1998 (FEMA, 2009).



4.3.10.5. Vulnerability Assessment

High winds and tornadoes can affect an entire county equally. The age, conditions, and building quality of homes can make structures more susceptible to damage from high winds. While the frequency of windstorms and minor tornadoes is expected to remain relatively constant, vulnerability increases in more densely developed areas. It is important to identify specific critical facilities and assets that are most vulnerable to the hazard and take stock in the condition of structures and infrastructure that are susceptible.

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 4.3.10-4 displays the number of manufactured housing units per municipality in Delaware County. Aston Township, Marple Township, Trainer Borough and Upper Darby Township are all more vulnerable to tornadoes and windstorms as each municipality has over fifty mobile homes.

Table 4.3.10-4: Manufactured housing units per municipality in Delaware County (Census ACS, 2005-2009).

MUNICIPALITY	NUMBER OF MOBILE HOMES
Aldan Borough	11
Aston Township	323
Bethel Township	35
Brookhaven Borough	0
Chadds Ford Township	0
Chester City	27
Chester Township	40
Chester Heights Borough	0
Clifton Heights Borough	14
Collingdale Borough	13
Colwyn Borough	0
Concord Township	13
Darby Borough	0
Darby Township	7
East Lansdowne Borough	0
Eddystone Borough	9
Edgmont Township	0
Folcroft Borough	0
Glenolden Borough	0
Haverford Township	26

Table 4.3.10-4: Manufactured housing units per municipality in Delaware County (Census ACS, 2005-2009).	
MUNICIPALITY	**NUMBER OF MOBILE HOMES**
Lansdowne Borough	0
Lower Chichester Township	0
Marcus Hook Borough	0
Marple Township	69
Media Borough	0
Middletown Township	9
Millbourne Borough	0
Morton Borough	0
Nether Providence Township	0
Newtown Township	0
Norwood Borough	5
Parkside Borough	0
Prospect Park Borough	0
Radnor Township	0
Ridley Township	0
Ridley Park Borough	9
Rose Valley Borough	0
Rutledge Borough	0
Sharon Hill Borough	0
Springfield Township	8
Swarthmore Borough	0
Thornbury Township	13
Tinicum Township	0
Trainer Borough	80
Upland Borough	0
Upper Chichester Township	23
Upper Darby Township	59
Upper Providence Township	0
Yeadon Borough	22
TOTAL	**815**

4.3.11. Wildfire

4.3.11.1. Location and Extent

A wildfire is an uncontrolled fire spreading through vegetative fuels, exposing and possibly consuming structures. Wildfires often go unnoticed and can spread quickly, creating dense smoke that can be seen for miles. Wildfires take place in less developed or completely undeveloped areas, with the exception of roads, railroads, power lines, and similar facilities. 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.

Only about 20.5% of Delaware County's land cover is dedicated to agriculture or forestland, so the geographic extent of wildfires is fairly limited. However, they can occur anywhere in this forested and agricultural land. 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.

4.3.11.2. Range of Magnitude

The severity of a wildfire can be described as the amount of resources it takes to fight the fire as well as the amount of land the fire consumes. Wildfire events can range from small fires that can be managed by local firefighters to large fires impacting 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 worst case scenario for wildfires in Delaware County would be if a large fire were to break out in Ridley Creek State Park, the largest wooded area in the County, in May when fires are most likely to occur and the park is also likely to be full of tourists. Should a fire break out in the Park at that time, there would be potential not only for the loss of a significant open space resource but also for loss of life and property.

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.

4.3.11.3. Past Occurrence

There have been ten wildfire events in Delaware County reported to the Pennsylvania Department of Conservation and Natural Resources Bureau of Forestry from 2002-2008. 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, but it is the most comprehensive list of wildfire occurrences available for Delaware County. Table 4.3.11-1 shows the list of wildfire events reported to the DCNR. NCDC notes an additional past occurrence; on November 11, 2001, an early morning fire occurred near Ridley Creek Park in Edgmont Township.

Of all of Delaware County's jurisdictions, wildfires have been concentrated in ten of the jurisdictions: Aston Township, Brookhaven Borough, Chester Heights Borough, Concord Township, Edgmont Township, Lower Chichester Township, Middletown Township, Newtown Township, Upper Chichester Township, and Upper Providence Township. The wildfires have all been fairly small, with the largest burning 2.25 acres and the smallest consuming only 0.1 acres.

Table 4.3.11-1: List of wildfire events reported in Delaware County from 2001-2009 (NCDC, 2011; DCNR, 2010).

YEAR	MUNICIPALITY	AREA (acres)
2001	Edgmont Township	unknown
2002	Chester Heights Borough	1.0
2003	Upper Chichester Township	1.3
2004	Upper Providence Township	0.1
2004	Brookhaven Borough	1.0
2004	Lower Chichester Township	1.2
2005	Newtown Township	0.17
2005	Middletown Township	0.3
2006	Concord Township	1.25
2006	Upper Providence Township	0.25
2006	Aston Township	2.25

Figure 4.3.11-1 maps the origins of the wildfire events which were reported to the DCNR listed in Table 4.3.11-1 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 but in only a few jurisdictions.

Figure 4.3.11-1: Wildfire origins in Delaware County between 2002 and 2008. (DCNR-BOF, 2009)

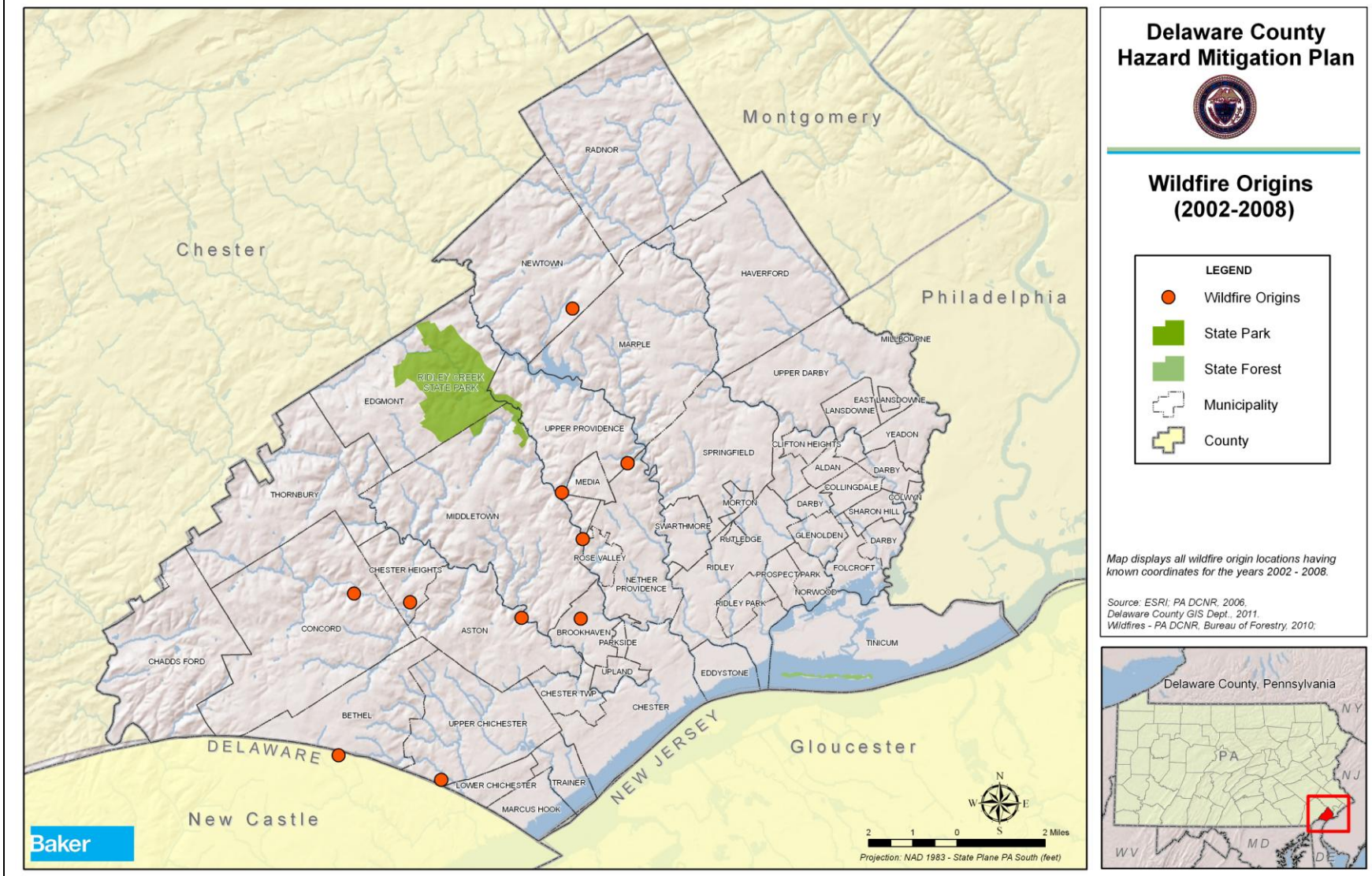
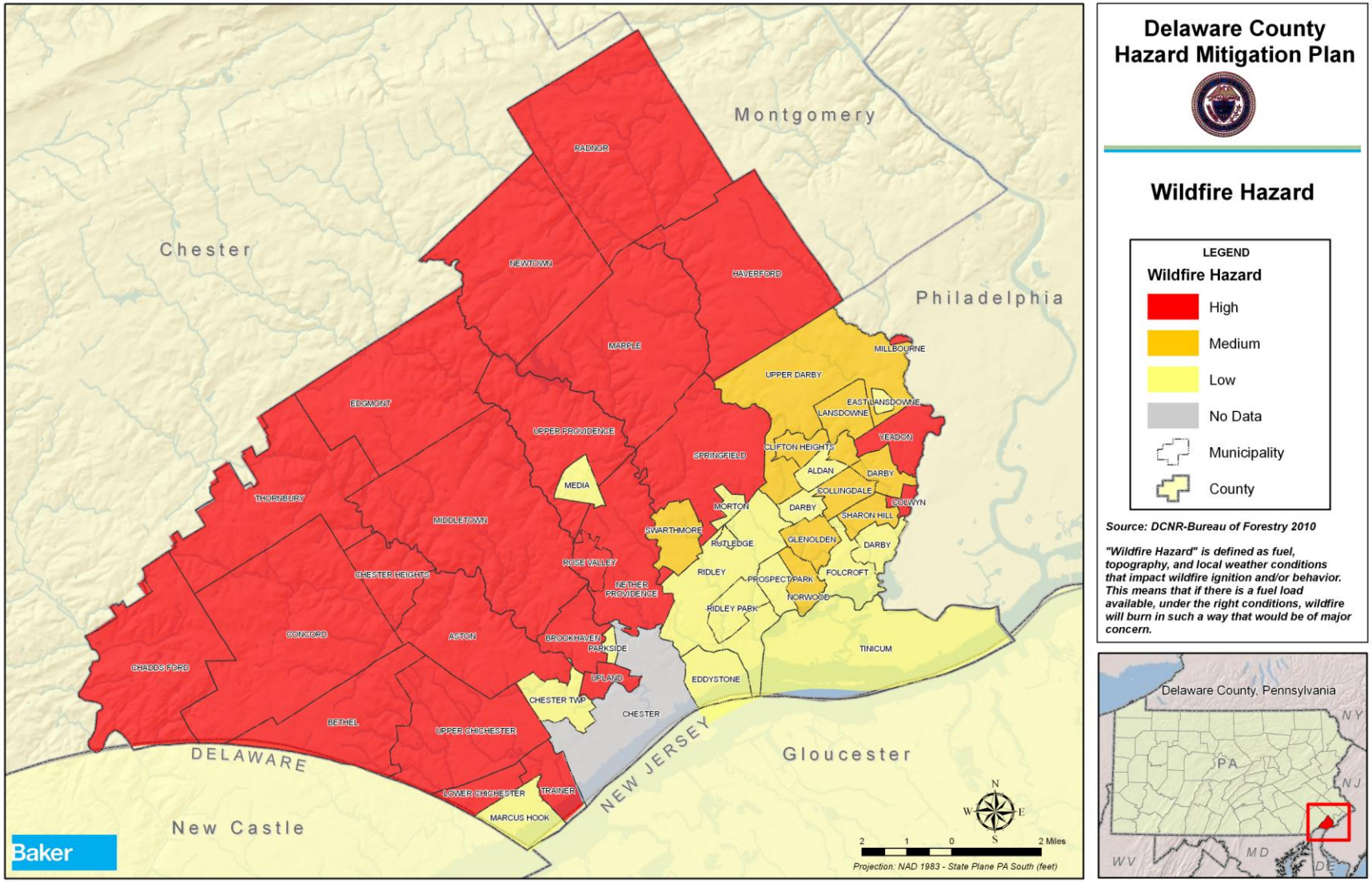


Figure 4.3.11-2: Wildfire hazard potential per municipality in Delaware County.



4.3.11.4. Future Occurrence

Over the five year period between 2003 and 2007, 18,132 acres of state forest have burned in Pennsylvania and 8.82 acres of land have burned in Delaware County in the wildfire events shown in Figure 4.3.11-1. Weather conditions like drought 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.

The probability of a wildfire occurring in Delaware County is *likely* in any given year as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1). However, the likelihood of one of those fires attaining significant size and intensity is unpredictable and highly dependent on environmental conditions and firefighting response.

4.3.11.5. Vulnerability Assessment

The Pennsylvania Bureau of Forestry has conducted an independent wildfire hazard risk assessment for the various municipalities across Delaware County. Results of that assessment are shown in Figure 4.3.11-2. *Wildfire hazard* is defined based on conditions that affect wildfire ignition and/or behavior such as fuel, topography and local weather. Based on this assessment, 24 jurisdictions, mostly located in western Delaware County where there are still large tracts of undeveloped land in close proximity to suburban housing developments, have a *high* wildfire rating. Ten municipalities within Delaware County have a *medium* wildfire hazard potential, almost all of which are in the eastern portion of the County. Fifteen jurisdictions, generally spatially concentrated in the southeastern part of the County, are considered to have *low* wildfire hazard potential. There is no wildfire hazard rating for the City of Chester. Table 4.3.10-2 lists the jurisdictions having each wildfire *hazard* rating.

Table 4.3.11-2: List of jurisdictions with each wildfire "hazard" rating.

HIGH HAZARD JURISDICTIONS	MEDIUM HAZARD JURISDICTIONS	LOW HAZARD JURISDICTIONS
Aston Township	Clifton Heights Borough	Aldan Borough
Bethel Township	Collingdale Borough	Chester Township
Brookhaven Borough	Darby Borough	Darby Township
Chadds Ford Township	Glenolden Borough	East Lansdowne Borough
Chester Heights Borough	Lansdowne Borough	Eddystone Borough
Colwyn Borough	Norwood Borough	Folcroft Borough
Concord Township	Sharon Hill Borough	Marcus Hook Borough
Edgmont Township	Swarthmore Borough	Media Borough
Haverford Township	Upper Darby Township	Morton Borough
Lower Chichester Township		Parkside Borough
Marple Township		Prospect Park Borough
Middletown Township		Ridley Township
Millbourne Borough		Ridley Park Borough
Nether Providence Township		Rutledge Borough
Newtown Township		Tinicum Township
Radnor Township		

Table 4.3.11-2: List of jurisdictions with each wildfire "hazard" rating.		
HIGH HAZARD JURISDICTIONS	**MEDIUM HAZARD JURISDICTIONS**	**LOW HAZARD JURISDICTIONS**
Rose Valley Borough		
Springfield Township		
Thornbury Township		
Trainer Borough		
Upland Borough		
Upper Chichester Township		
Upper Providence Township		
Yeadon Borough		

Using this DCNR assessment, the parcels and critical facilities most vulnerable to wildfire hazards are those located within the 25 high-rated jurisdictions. Table 4.3.11-3 shows the total parcels and critical facilities in the high wildfire hazard areas. Please note that the individual vulnerability of communities will differ based on the design of the urban/wildland interface, the number of ingress and egress points into a community, and the availability of water to fight fires. Of the high-rated jurisdictions, Haverford Township has the highest number of both parcels and critical facilities vulnerable to wildfire events with over 18,000 vulnerable parcels and 42 vulnerable critical facilities. On the other end of the spectrum, Millbourne Borough has the fewest at-risk parcels with 236 and 2 critical facilities.

Table 4.3.11-3: Parcels and critical facilities vulnerable to wildfires in Delaware County.		
MUNICIPALITY	**TOTAL PARCELS**	**TOTAL CRITICAL FACILITIES IN HIGH WILDFIRE HAZARD AREAS**
Aston Township	6,405	19
Bethel Township	3,377	4
Brookhaven Borough	2,681	8
Chadds Ford Township	1,714	4
Chester Heights Borough	1,046	7
Colwyn Borough	920	3
Concord Township	5,018	32
Edgmont Township	1,473	10
Haverford Township	18,044	42
Lower Chichester Township	1,405	6
Marple Township	8,395	17
Media Borough	2,073	15
Middletown Township	5,092	20
Millbourne Borough	236	2
Nether Providence Township	5,082	18
Newtown Township	4,844	17
Radnor Township	8,264	39

Table 4.3.11-3: Parcels and critical facilities vulnerable to wildfires in Delaware County.		
MUNICIPALITY	**TOTAL PARCELS**	**TOTAL CRITICAL FACILITIES IN HIGH WILDFIRE HAZARD AREAS**
Rose Valley Borough	462	2
Springfield Township	9,402	27
Thornbury Township	2,378	14
Trainer Borough	4,172	6
Upland Borough	1,032	6
Upper Chichester Township	6,732	13
Upper Providence Township	3,914	24
Yeadon Borough	3,563	11
TOTAL	**107,724**	**573**

4.3.12. Winter Storm

4.3.12.1. Location and Extent

Winter storms consist of cold temperatures, snow, and ice. They begin as low-pressure systems that move through Pennsylvania either following the jet stream or developing as extra-tropical cyclonic weather systems over the Atlantic Ocean called nor'easters. The effects of these storms can sometimes last for weeks, bringing several inches or even feet of snow and ice and cold temperatures. Winter storms occur on the average of 35 times a year in Pennsylvania.

Every county in the Commonwealth is affected by these storms with the northern and western counties and mountainous regions experiencing these storms more frequently and to a greater extent. Delaware County experiences all levels of winter storms from ice storms and freezing rain to heavy snow and blizzards. Generally, the average annual snowfall in the County is consistent throughout the County (see Figure 4.3.12-1).

4.3.12.2. Range of Magnitude

Winter storms consist of cold temperatures, heavy snow or ice and sometimes strong winds. Because winter storms are a regular occurrence in Delaware County, they are considered hazards only when they result in damage to specific structures and/or overwhelm local capabilities to handle disruptions to traffic, communications, and electric power. The cost of removing snow, repairing damages, especially from ice storms, and the loss to businesses can have a negative economic impact for communities. Winter storms can generate other hazards such as infrastructure disruption (blocked roads and power outages), human-caused hazards (traffic accidents and trapped vehicles), and technological problems (communication system outages and overload). Winter storms can adversely affect roadways, utilities, business activities, and can cause loss of life, frostbite, or freezing.

Winter 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:** Sleet is formed when snow falling to the earth partially melts as it passes through a layer of warm air. The precipitation then passes through a cold layer of air and refreezes into solid pellets. Sleet causes surfaces to become slippery, posing hazards to pedestrians and motorists.

- **Ice Storm:** An ice storm occurs when rain freezes upon impact with the ground or other objects such as trees and power lines. Heavy accumulations of ice can bring down trees and topple utility poles, disrupting power and communication for days while crews make the necessary repairs. The icy conditions are also dangerous for pedestrians and vehicular traffic.

- **Blizzard:** According to the National Weather Service, a blizzard is a severe snowstorm that occurs when winds reach 35mph or more. The blowing snow reduces visibility to less the ¼ of a mile for at least 3 hours. Storms that meet these criteria are not frequent in Delaware County; however, storms that produce blizzard-like conditions are a common occurrence.

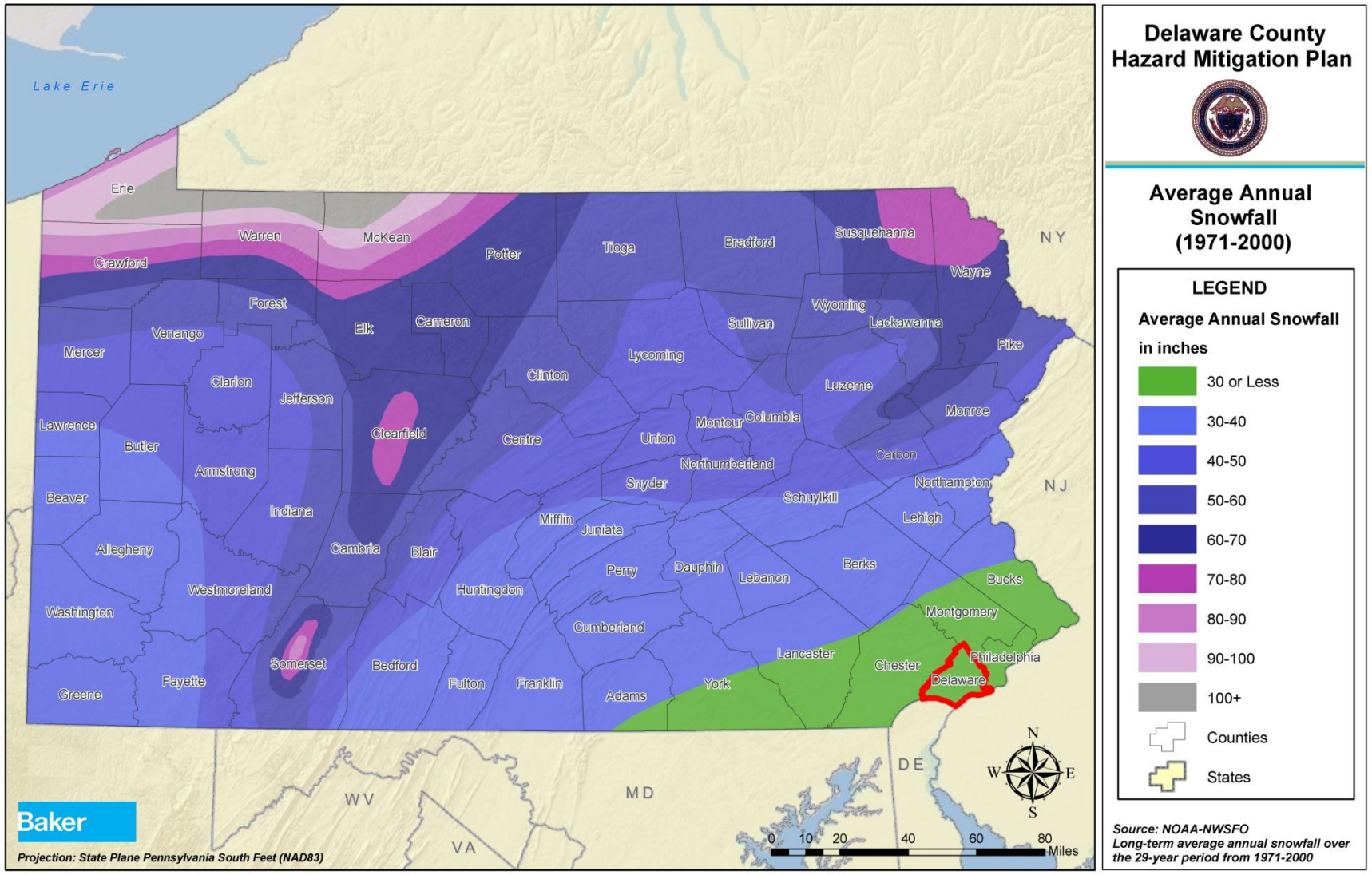
- **Severe Blizzard:** Wind velocity of 45 mph, temperatures of 10 degrees Fahrenheit or lower, a high density of blowing snow with visibility frequently measured in feet prevailing over an extended period time.

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 4.3.12-1 shows mean annual snowfall in Delaware County is 30 inches or less. Five of the sixteen Presidential Disaster and Emergency Declarations affecting Delaware have been in response to hazard events related to winter storms (see Table 4.2-1). In addition to the events described above, other winter storm events, including those associated with Disaster Declarations, are listed in Table 4.3.12-1 below**.**

The worst case scenario of a winter storm in Delaware County occurred on December 19, 2009. A major winter storm hit central and southeast Pennsylvania. Snowfall averaged 12 to 23 inches in and around the local Philadelphia area. The 23.2 inches of snow that fell at Philadelphia International Airport was the second heaviest single event snowfall on record and the heaviest ever for the month of December. A 51-year-old man died of a stroke while he was shoveling the snow in Havertown. Approximately seventy percent of flights were cancelled on the 19th at Philadelphia International Airport.

Figure 4.3.12-1: Mean Annual Snowfall for Pennsylvania and Delaware County (NOAA–NWSFO).



4.3.12.3. Past Occurrence

Delaware County as well as the Commonwealth of Pennsylvania has a long history of severe winter weather. Significant winter storm events that have affected Delaware County since 1995 are listed in Table 4.3.12-1**.** The NCDC data on past occurrences for winter storm events since 1995 is the only comprehensive list of data available for the county aside from information from past disaster declarations. Many of the winter storms have been localized storms that have only affected Delaware County and surrounding southeastern Pennsylvania Counties.

Table 4.3.12-1: Previous winter storm events impacting Delaware County since 1995 (NCDC, 2011). Events with the location "Multiple Counties" include Delaware County.

LOCATION	DATE	TYPE
Delaware, Bucks, Chester, Montgomery and Philadelphia Counties	2/3/95	Heavy Snow
Multiple Counties	2/15/95	Freezing Rain
Multiple Counties	2/26/95	Light Snow
Delaware, Bucks, Chester, Montgomery and Philadelphia Counties	2/27/95	Freezing Rain and Sleet
Delaware, Bucks, Chester, Montgomery and Philadelphia Counties	12/14/95	Wintry Mix
Multiple Counties	12/16/95	Snow
Multiple Counties	12/18/95	Winter Storm
Multiple Counties	2/2/96	Heavy Snow
Delaware, Bucks, Chester, Montgomery and Philadelphia Counties	2/16/96	Heavy Snow
Delaware, Bucks, Chester, Montgomery and Philadelphia Counties	1/9/97	Wintry Mix
Delaware, Bucks, Chester, Montgomery and Philadelphia Counties	1/11/97	Snow
Delaware, Bucks, Chester, Montgomery and Philadelphia Counties	1/22/97	Black Ice
Delaware, Berks, Chester and Philadelphia Counties	2/8/97	Snow
Delaware, Berks, Bucks, Chester, Montgomery and Philadelphia Counties	2/14/97	Wintry Mix
Multiple Counties	3/31/97	Heavy Snow
Multiple Counties	4/1/97	Heavy Snow
Delaware, Bucks, Chester, Montgomery and Philadelphia Counties	12/23/98	Snow
Multiple Counties	1/2/99	Wintry Mix
Multiple Counties	1/8/99	Wintry Mix
Multiple Counties	1/13/99	Winter Storm
Multiple Counties	3/14/99	Heavy Snow
Delaware County	1/20/00	Heavy Snow
Delaware, Bucks, Chester,	1/25/00	Winter Storm

Table 4.3.12-1: Previous winter storm events impacting Delaware County since 1995 (NCDC, 2011). Events with the location "Multiple Counties" include Delaware County.		
LOCATION	**DATE**	**TYPE**
Montgomery and Philadelphia Counties		
Multiple Counties	1/30/00	Winter Storm
Multiple Counties	2/3/00	Snow
Delaware, Bucks, Chester, Montgomery and Philadelphia Counties	2/18/00	Wintry Mix
Multiple Counties	4/9/00	Snow
Delaware and Philadelphia Counties	12/13/00	Freezing Rain
Multiple Counties	12/19/00	Snow
Multiple Counties	12/30/00	Heavy Snow
Multiple Counties	1/5/01	Snow
Multiple Counties	1/20/01	Winter Storm
Delaware, Bucks, Chester, Montgomery and Philadelphia Counties	2/5/01	Winter Storm
Delaware, Berks, Bucks, Chester, Montgomery and Philadelphia Counties	2/12/01	Wintry Mix
Multiple Counties	2/22/01	Heavy Snow
Delaware, Chester and Philadelphia Counties	3/4/01	Wintry Mix
Delaware County	1/19/02	Winter Storm
Multiple Counties	3/17/02	Wintry Mix
Multiple Counties	12/5/02	Heavy Snow
Delaware, Berks, Bucks, Chester, Montgomery and Philadelphia Counties	1/5/03	Winter Weather/Mix
Delaware, Berks, Bucks, Chester, Montgomery and Philadelphia Counties	1/29/03	Winter Weather/Mix
Multiple Counties	2/6/03	Heavy Snow
Multiple Counties	2/10/03	Winter Weather/Mix
Delaware and Philadelphia Counties	2/15/03	Winter Weather/Mix
Delaware and Philadelphia Counties	2/16/03	Winter Storm
Multiple Counties	2/23/03	Winter Weather/Mix
Delaware, Chester, Montgomery and Philadelphia Counties	2/27/03	Winter Weather/Mix
Multiple Counties	3/6/03	Winter Weather/Mix
Multiple Counties	4/7/03	Winter Weather/Mix
Multiple Counties	12/5/03	Winter Storm
Delaware, Bucks, Chester, Montgomery and Philadelphia Counties	12/14/03	Winter Weather/Mix
Delaware, Bucks, Chester, Montgomery and Philadelphia Counties	1/17/04	Winter Weather/Mix
Delaware, Berks, Chester,	1/23/04	Winter Weather/Mix

Table 4.3.12-1: Previous winter storm events impacting Delaware County since 1995 (NCDC, 2011). Events with the location "Multiple Counties" include Delaware County.		
LOCATION	**DATE**	**TYPE**
Montgomery and Philadelphia Counties		
Delaware, Berks, Bucks, Chester, Montgomery and Philadelphia Counties	1/25/04	Winter Weather/Mix
Delaware, Bucks, Chester, Montgomery and Philadelphia Counties	1/27/04	Winter Weather/Mix
Delaware, Bucks, Chester, Montgomery and Philadelphia Counties	2/5/04	Winter Weather/Mix
Delaware, Berks, Bucks, Chester, Montgomery and Philadelphia Counties	3/16/04	Winter Weather/Mix
Delaware, Bucks, Chester, Montgomery and Philadelphia Counties	3/18/04	Winter Weather/Mix
Multiple Counties	12/19/04	Winter Weather/Mix
Multiple Counties	12/26/04	Winter Weather/Mix
Multiple Counties	1/19/05	Winter Weather/Mix
Multiple Counties	1/22/05	Heavy Snow
Multiple Counties	1/24/05	Winter Weather/Mix
Delaware, Berks, Bucks, Chester, Montgomery and Philadelphia Counties	1/29/05	Winter Weather/Mix
Multiple Counties	2/20/05	Winter Weather/Mix
Delaware, Berks, Bucks, Chester, Montgomery and Philadelphia Counties	2/24/05	Heavy Snow
Multiple Counties	2/28/05	Heavy Snow
Multiple Counties	3/1/05	Heavy Snow
Multiple Counties	3/8/05	Winter Weather/Mix
Multiple Counties	12/4/05	Winter Weather/Mix
Delaware and Philadelphia Counties	12/6/05	Heavy Snow
Delaware, Bucks, Chester, Montgomery and Philadelphia Counties	12/9/05	Winter Storm
Delaware and Philadelphia Counties	12/15/05	Winter Weather/Mix
Multiple Counties	2/12/06	Winter Storm
Delaware, Bucks, Montgomery and Philadelphia Counties	3/2/06	Winter Weather
Delaware and Chester Counties	1/25/07	Winter Weather
Multiple Counties	2/13/07	Winter Storm
Delaware, Bucks, Montgomery and Philadelphia Counties	2/25/07	Winter Storm
Multiple Counties	3/7/07	Winter Weather
Multiple Counties	3/16/07	Winter Storm
Multiple Counties	12/2/07	Winter Weather
Delaware, Berks, Montgomery	1/17/08	Winter Weather

Table 4.3.12-1: Previous winter storm events impacting Delaware County since 1995 (NCDC, 2011). Events with the location "Multiple Counties" include Delaware County.		
LOCATION	**DATE**	**TYPE**
and Philadelphia Counties		
Multiple Counties	2/12/08	Winter Storm
Multiple Counties	2/22/08	Winter Storm
Delaware, Berks, Chester and Montgomery Counties	11/21/08	Winter Weather
Delaware, Bucks, Montgomery and Philadelphia Counties	12/21/08	Winter Weather
Multiple Counties	12/23/08	Winter Weather
Delaware and Philadelphia Counties	1/6/09	Winter Weather
Delaware and Philadelphia Counties	1/10/09	Winter Weather
Delaware, Berks and Chester Counties	1/19/09	Winter Weather
Multiple Counties	1/27/09	Winter Storm
Delaware, Chester, Montgomery and Philadelphia Counties	2/3/09	Heavy Snow
Multiple Counties	3/1/09	Winter Storm
Multiple Counties	12/19/09	Heavy Snow
Delaware and Chester Counties	12/31/09	Winter Weather
Multiple Counties	1/8/10	Winter Weather
Delaware and Philadelphia Counties	1/30/10	Winter Weather
Multiple Counties	2/2/10	Winter Weather
Multiple Counties	2/5/10	Winter Storm
Multiple Counties	2/9/10	Winter Storm
Delaware and Philadelphia Counties	2/15/10	Winter Weather
Delaware, Lehigh and Montgomery Counties	2/16/10	Winter Weather
Multiple Counties	2/25/10	Winter Storm

The winter of 1993-1994 brought severe winter storms and record cold to Delaware County. The storms impacted the County through much of January, causing major disruptions to schools, businesses, hospitals, and nursing homes. A storm dropping deep snow was followed by a severe ice storm that resulted in numerous power outages. The record cold resulted in numerous water main breaks. Coupled with the precipitation, the cold led to a shortage of road salt, requiring trucks to be dispatched to New York State to acquire additional supplies.

Over President's Day weekend in February of 2003, Delaware County experienced a near record snowfall. The storm began on Saturday, February 16th and continued until late morning on February 17th. The snowstorm resulted in the closing of government offices, schools, and businesses and also grounded air traffic across the Commonwealth.

In addition to snow, the County has experienced numerous storms with freezing rain, sleet, and black ice. Icy weather results in traffic accidents as well as hindered pedestrian movement throughout the County.

4.3.12.4. Future Occurrence

Winter storms are a regular, annual occurrence in Delaware County and the future occurrence of winter storms hazard can be considered *highly likely* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1). Approximately thirty-five winter storm events occur across Pennsylvania and about seven occur in Delaware County annually. Table 4.3.12-2 shows the probability of receiving measureable snowfall by month in Delaware County. These probabilities are based on data collected over a minimum of 33 years.

Table 4.3.12-2: Probability of measurable snowfall in Delaware County measured at the Marcus Hook Snow Station (NCDC, 2011).

MONTH	PROBABILITY (%)
	Marcus Hook Station
January	83.9
February	76.5
March	73.8
April	7.8
May	0
June	0
July	0
August	0
September	0
October	1.6
November	15.6
December	63.3

4.3.12.5. Vulnerability Assessment

Based on the information available, all communities in Delaware County are essentially equally vulnerable to the direct impacts of winter storms. Although Delaware County is a predominantly urban county, residents of the more rural areas of the County may be more susceptible to winter storms, especially when emergency medical assistance is required.

Vulnerability to the effects of winter storms on buildings is dependent on the age of the building (and what building codes may have been in effect at the time), type of construction, and condition of the structure (i.e., how well has the structure been maintained). Aged, dilapidated, or poorly constructed buildings are more susceptible to damage. The roofs of these structures are susceptible to collapse from heavy snow loads if old or not constructed properly. Individual structure data was not available regarding the type of construction material used and the condition of the structure. However, structure age was available. Table 4.3.12-3 below shows that most structures in Delaware County were built since 1940, yet 49,711 structures, approximately 23% percent of all structures in the County, are 60 or more years old. In three municipalities over half of their structures were built prior to 1940: Darby Borough, Marcus Hook Borough, and Rutledge Borough. Haverford Township has the most structures in Delaware

County built before 1940 (5,925 of 18,637). Additional information on construction type and building codes enforced at time of construction would allow a more thorough assessment of the vulnerability of structures to winter storm impacts such as severe wind and heavy snow loading.

Table 4.3.12-3: Age of housing units in Delaware County (ACS, 2005-2009).

MUNICIPALITY	TOTAL NUMBER OF HOUSING UNITS	NUMBER OF HOUSING UNITS BUILT BEFORE 1940	PERCENT OF HOUSING UNITS BUILT BEFORE 1940
Aldan Borough	1,872	333	17.8%
Aston Township	6,364	428	6.7%
Bethel Township	3,308	199	6.0%
Brookhaven Borough	3,565	98	2.7%
Chadds Ford Township	1,372	66	4.8%
Chester City	16,379	4,901	29.9%
Chester Township	1,796	73	4.1%
Chester Heights Borough	1,126	57	5.1%
Clifton Heights Borough	2,962	727	24.5%
Collingdale Borough	3,411	1,105	32.4%
Colwyn Borough	842	400	47.5%
Concord Township	5,270	234	4.4%
Darby Borough	3,819	2,188	57.3%
Darby Township	3,833	264	6.9%
East Lansdowne Borough	973	447	45.9%
Eddystone Borough	1,046	432	41.3%
Edgmont Township	1,699	155	9.1%
Folcroft Borough	2,671	290	10.9%
Glenolden Borough	3,158	956	30.3%
Haverford Township	18,637	5,925	31.8%
Lansdowne Borough	4,834	2,403	49.7%
Lower Chichester Township	1,618	333	20.6%
Marcus Hook Borough	1,004	580	57.8%
Marple Township	8,251	452	5.5%
Media Borough	3,272	1,117	34.1%
Middletown Township	5,683	619	10.9%
Millbourne Borough	410	163	39.8%
Morton Borough	1,210	160	13.2%
Nether Providence Township	4,736	745	15.7%
Newtown Township	4,953	278	5.6%

Table 4.3.12-3: Age of housing units in Delaware County (ACS, 2005-2009).			
MUNICIPALITY	**TOTAL NUMBER OF HOUSING UNITS**	**NUMBER OF HOUSING UNITS BUILT BEFORE 1940**	**PERCENT OF HOUSING UNITS BUILT BEFORE 1940**
Norwood Borough	2,236	781	34.9%
Parkside Borough	937	296	31.6%
Prospect Park Borough	2,534	1,193	47.1%
Radnor Township	10,867	2,472	22.7%
Ridley Township	12,236	1,332	10.9%
Ridley Park Borough	3,022	1,039	34.4%
Rose Valley Borough	350	87	24.9%
Rutledge Borough	315	185	58.7%
Sharon Hill Borough	2,220	816	36.8%
Springfield Township	8,255	1,092	13.2%
Swarthmore Borough	2,030	874	43.1%
Thornbury Township	2,271	257	11.3%
Tinicum Township	1,993	543	27.2%
Trainer Borough	816	170	20.8%
Upland Borough	1,236	409	33.1%
Upper Chichester Township	6,870	569	8.3%
Upper Darby Township	32,549	9,486	29.1%
Upper Providence	4,706	410	8.7%
Yeadon Borough	5,199	1,572	30.2%
TOTAL	**220,716**	**49,711**	**22.5%**

People residing in structures lacking adequate equipment to protect against cold temperatures or significant snow and ice are more vulnerable to winter storm events. Even for communities that are prepared to respond to winter storms, severe events involving snow accumulations that exceed six or more inches in a twelve hour period can cause a large number of traffic accidents, strand motorists due to snow drifts, interrupt power supply and communications, and cause the failure of inadequately designed and/or maintained roof systems.

Winter storms have the ability to cripple pedestrian and vehicular movement in the County. These storms can also impact power and communication capabilities. It is not possible to reduce the impact this weather has on County resources and infrastructure; however, it is important to be prepared when the adverse weather arrives. Communities should maintain adequate salt supplies as well as have preparations in place for snow removal. Additionally, utility companies should have plans for dealing with the impacts of winter weather on their infrastructure.

It is important to take precautionary actions prior to the arrival of a winter storm. Preparations should include warning the public of the storm's impending arrival, readying public works and road crews, and awareness of the post hazard needs that will be required.

HUMAN-MADE HAZARDS

4.3.13. Dam Failure

Due to sensitivity issues, the Dam Failure profile can be found in **Appendix G**.

4.3.14. Environmental Hazards – Hazardous Material Release

4.3.14.1. Location and Extent

Environmental hazards in Delaware County focus on hazardous material releases. Hazardous material releases can occur at fixed site facilities or along transportation routes. These releases can result in injury and death and may contaminate air, water and soils.

Delaware County is home to many manufacturing facilities and industries, including oil refineries located along the Delaware River. 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. There are 77 SARA Title III facilities in Delaware County.

Because SARA Title III facilities are covered under their own unique planning process and are continually evaluated through the LEPC, this Hazard Mitigation Plan will focus on the Environmental Protection Agency (EPA)-identified hazardous materials sites. This dataset, publicly available at http://www.epa.gov/enviro/geo_data.html, includes a number of materials facilities including:

- Superfund National Priorities List (NPL) sites,
- RCRAInfo (EPA and state treatment, storage, disposal) facilities,
- Toxic Release Inventory System (TRI) sites,
- Integrated Compliance Information System (ICIS) and Permit Compliance System (PCS) - National Pollutant Discharge Elimination System (NPDES) Majors,
- RCRAInfo - Large Quantity Generators (LQG),
- Air Facility System (AFS) - Major discharges of air pollutants,
- RCRAInfo - Corrective Actions,
- Risk Management Plan,
- Section Seven Tracking System Sites (Pesticides), and

- ACRES - Brownfields Properties.

Using this dataset wfill help to provide a more complete picture of the risk of hazardous materials releases in the County. Delaware County has 121 EPA-identified hazardous materials sites throughout the County, shown in Figure 4.3.14-1. Chester City has the most hazardous materials facilities with twenty. For a complete listing of EPA-identified hazardous materials sites, please see **Appendix H**.

Transportation of hazardous materials on highways involves tanker trucks or trailers. Unsurprisingly, large trucks are responsible for the greatest number of hazard material release incidents. Hazardous material releases from rail transport are also of concern due to collisions and derailments that result in large spills. Furthermore, Delaware County shares a border with the Delaware River, a major US shipping channel where many large ships and barges potentially carrying hazardous material pass each day. Pipelines can also transport hazardous liquids and flammable substances such as natural gas. Incidents can occur when pipes corrode, when they are damaged during excavation, incorrectly operated, or damaged by other forces.

The Delaware County Local Emergency Planning Committee developed a Hazardous Commodity Flow Study (2002) to address hazardous material risk assessment and emergency response preparedness for the transportation of hazardous materials. The study focused on roads, railroads, waterways, and pipelines. The study found that commercial vehicle traffic ranges from 30 to 1,724 commercial vehicles passing one roadside point in a two hour period. Of these, 1 to 91 commercial vehicles carrying hazardous materials pass a roadside point in a two hour period. Therefore approximately 6% of all commercial vehicles in the County carry hazardous materials. The study found that 160 different hazardous materials have been monitored on county roads and the top two hazardous materials were fuel oil and gasoline. The Delaware County LEPC's Hazardous Commodity Flow Study found that roads in the southern portion of the County (Interstates 95 and 476; US Routes 322, 13, and 202; and State Route 452) possess the highest frequency of hazardous material transport and the greatest amount of total commercial traffic.

Commercial rail lines (CSX and Norfolk Southern) provide commercial railroad service in the eastern half of the County, along the I-95 corridor and Delaware River. There are no commercial railroads through the interior of the county. The Delaware County Hazardous Commodity Flow Study found that railroads transport 140 types of hazardous materials through county. Fifteen of these are unique only to rail transport.

The Delaware County Hazardous Commodity Flow Study found that 2,800 ships and 4,000 barges arrive annually in the Delaware River. The study identified 29 hazardous materials that are transported on the Delaware River. Crude oil accounts for 80% of the total hazmat tonnage. A large tanker can carry 2 million barrels or 84 million gallons of crude oil. Major transportation routes of hazardous materials are shown with the EPA-identified hazardous materials sites in Delaware County in Figure 4.3.14-1.

The Delaware County Hazardous Commodity Flow Study found that there are eleven pipeline companies that have operations in 35 municipalities. The pipelines transport fifteen types of hazardous materials including hazardous liquids such as crude oil and refined products (gasoline, kerosene, and jet fuel) or are used for gas transmission (primarily natural gas). In addition, there are three oil refineries and four oil storage terminals in the County.

Figure 4.3.14-2 shows the municipalities in Delaware County that contain these utility pipelines that transport these materials. Due to the sensitive nature of the data the exact location of the pipelines are not shown. More information on the companies who have pipelines operating in each municipality can be found in Table 4.3.14-5.

Figure 4.3.14-1: Delaware County hazardous material facilities and major roadways.

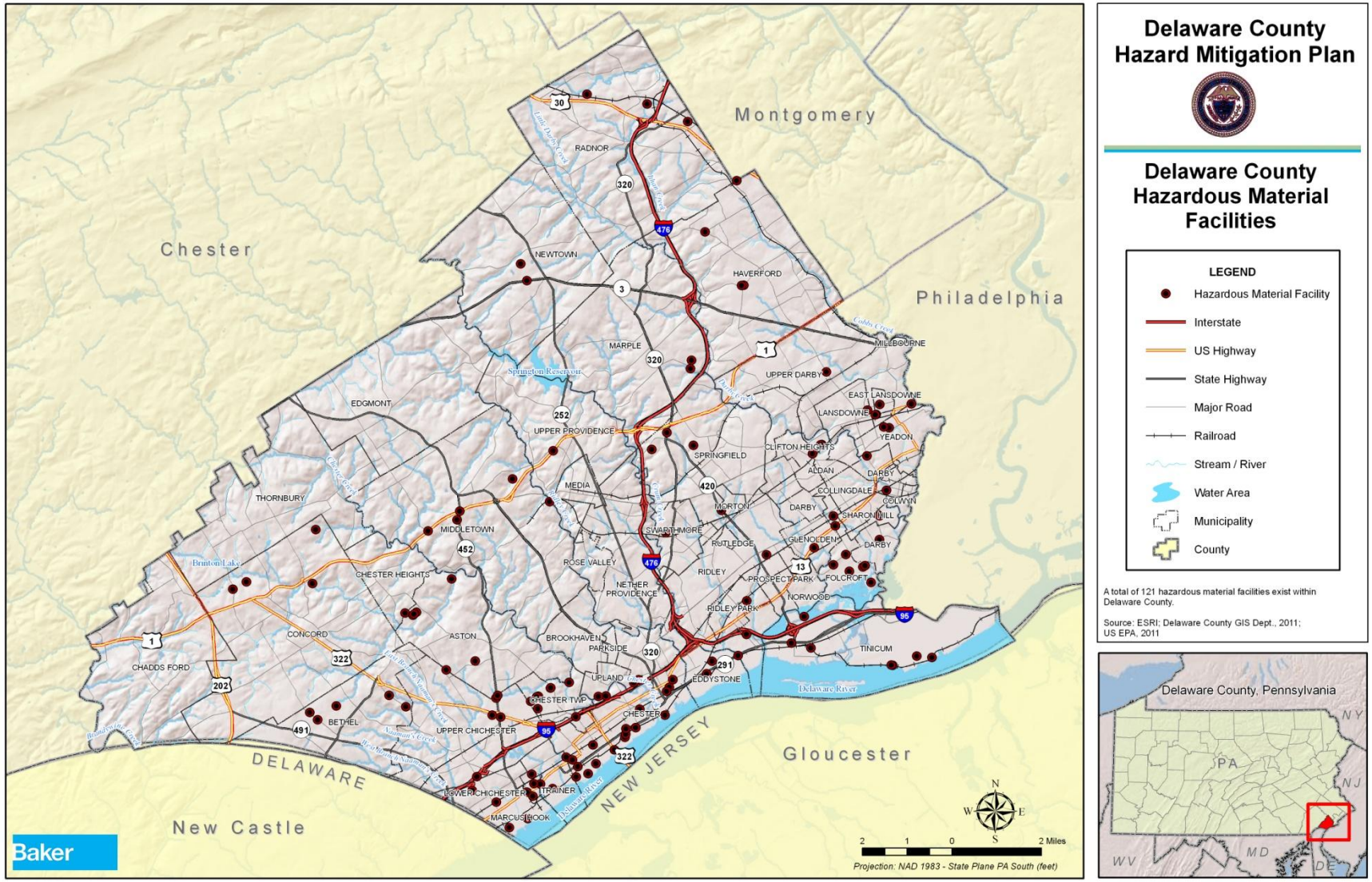
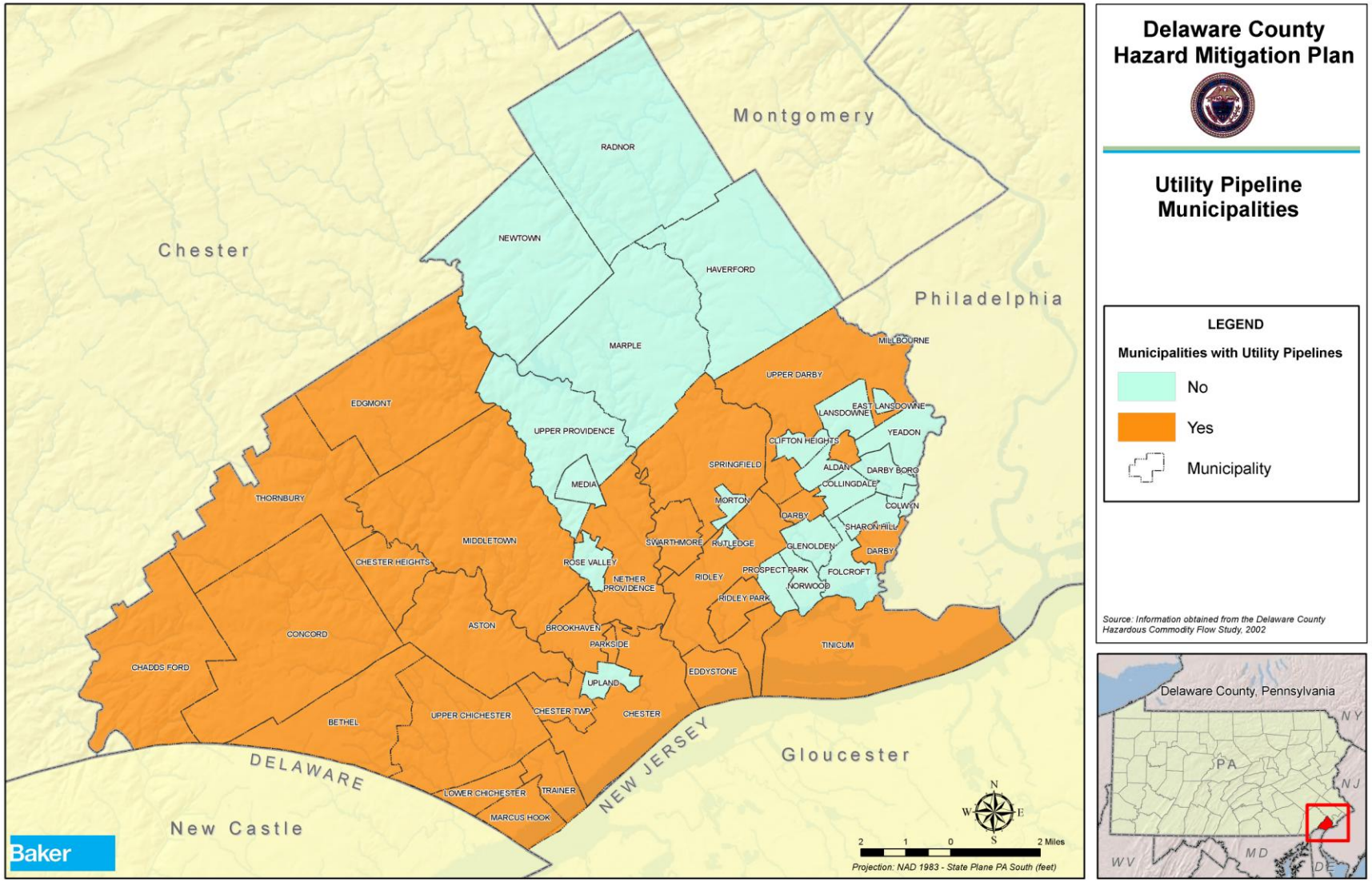


Figure 4.3.14-2: Delaware County municipalities with utility pipelines (Delaware County Hazardous Commodity Flow Study, 2002).



4.3.14.2. Range of Magnitude

Hazardous material releases can contaminate air, water and soils, possibly resulting in death and/or injuries. Dispersion can take place rapidly when transported by water and wind. While often accidental, releases can occur as a result of human carelessness, intentional acts, or natural hazards. When caused by natural hazards, these incidents are known as secondary events. Hazardous materials can include toxic chemicals, radioactive materials, infectious substances and hazardous wastes. Such releases can affect nearby populations and contaminate critical or sensitive environmental areas.

With a hazardous material release, whether accidental or intentional, there are several potentially exacerbating or mitigating circumstances that will affect its severity or impact. Mitigating conditions are precautionary measures taken in advance to reduce the impact of a release on the surrounding environment. Primary and secondary containment or shielding by sheltering-in-place protects people and property from the harmful effects of a hazardous material release. Exacerbating conditions, or characteristics that can enhance or magnify the effects of a hazardous material release, include:

- **Weather conditions:** affects how the hazard occurs and develops
- **Micro-meteorological effects of buildings and terrain:** alters dispersion of hazardous materials
- **Non-compliance with applicable codes (e.g. building or fire codes) and maintenance failures (e.g. fire protection and containment features):** can substantially increase the damage to the facility itself and to surrounding buildings.

Whether or not a hazardous materials site is contained in the SFHA is also a concern, as there could be larger-scale water contamination during a flood event should the flood compromise the production or storage of hazardous chemicals. Such a situation could swiftly move toxic chemicals throughout a water supply and across great distances.

The severity of a given incident is dependent not only on the circumstances described above, but also with the type of material released and the distance and related response time for emergency response teams. The areas within closest proximity to the releases are generally at greatest risk, yet depending on the agent, a release can travel great distances or remain present in the environment for a long period of time (e.g. centuries to millennia for radioactive materials), resulting in extensive impacts on people and the environment.

A worst case scenario for hazardous material release occurred in Delaware County on November 26, 2004 when the *Athos I* tanker struck a large, submerged anchor while preparing to dock at a New Jersey refinery on the opposite side of the Delaware River as Delaware County (NOAA, 2010). The tanker's bottom was punctured and nearly 265,000 gallons of crude oil were discharged into the Delaware River and its tributaries. Delaware County resources affected by the oil spill included shorelines, aquatic creatures, wildlife, and recreational areas used by the public.

4.3.14.3. Past Occurrence

Cumulatively, EPA TRI records indicate that there have been a total of 54,917,494 pounds of chemicals released from fixed sites in Delaware County between 1987 and 2008 (EPA, 2008). Beyond the TRI records, 686 hazardous material release incidents have been reported to PEMA. These are displayed in Table 4.3.14-1. These incidents include hazardous material release at both fixed site facilities and through transportation accidents.

Table 4.3.14-1: Previous hazardous materials incidents in Delaware County between 2002 and 2009 (PIERS, 2002-2009).

Incident Type	2002	2003	2004	2005	2006	2007	2008	2009	Total Incidents
Bio-Hazardous Waste	1	0	0	0	0	0	0	0	**1**
Chemical Release	26	26	14	28	23	15	14	2	**148**
Chemical Spill	2	2	6	4	7	8	6	4	**39**
CO2 Release	0	0	0	1	0	0	0	0	**1**
Crude Oil Spill	3	1	1	2	0	1	0	1	**9**
Diesal Fuel Spill	4	5	2	4	1	6	4	1	**27**
Fish Kill	1	0	1	0	0	0	1	0	**3**
Gasoline Spill	4	6	4	0	5	1	1	2	**23**
Heating Oil Spill	4	6	9	4	3	6	5	1	**38**
Hydraulic Oil Spill	1	0	0	0	1	1	0	1	**4**
Jet Fuel	0	0	0	0	0	1	0	0	**1**
Kerosene Spill	1	0	0	0	0	0	0	0	**1**
Natural Gas Release	2	1	0	0	0	0	1	0	**4**
Oil Sheen	2	8	10	6	8	10	5	2	**51**
Oil Spill	7	10	9	2	5	6	5	3	**47**
Pesticide Spill	0	0	0	0	0	0	1	0	**1**
Propane Release	0	0	0	0	1	0	0	0	**1**
Raw Sewage	1	0	0	0	0	0	0	0	**1**
Sewage Spill	1	2	3	1	2	1	0	1	**11**
Sludge Spill	0	0	0	1	0	0	0	0	**1**
Storage Tank Leak/Spill	1	0	0	0	0	0	0	0	**1**
Total	**81**	**82**	**85**	**73**	**199**	**132**	**90**	**27**	**686**

In addition, the Delaware County Hazardous Commodities Flow Study reports that there were 14 reported pipeline incidents in Delaware County between 1984 and 2001. These resulted in two injuries and $4.7 million in property damages. Between 2002 and 2009 there have been two known pipeline incidents that involved a pipeline leak or break (PEIRS, 2002-2009). One occurred due to operator error in Upper Chichester Township and the other involved rupture of a natural gas pipeline by a contractor digging in Radnor Township. Neither of the two events resulted in injuries.

4.3.14.4. Future Occurrence

While many incidents involving hazardous materials releases have occurred in Delaware County in the past, they are generally difficult to predict. Any occurrence is largely dependent upon the accidental or intentional actions of a person or group. The future occurrence of hazardous material releases in Delaware County can be considered *highly likely* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1).

4.3.14.5. Vulnerability Assessment

Jurisdictions that are home to one or more of the EPA-identified hazardous materials facilities should be considered vulnerable to hazardous materials releases from fixed facilities. Table 4.3.14-3 illustrates the number of sites by municipality in Delaware County. Chester City has the highest concentration of facilities with twenty. Tinicum Township and Folcroft Borough have the second highest amount of sites with 7 each. Municipalities in the table below with zero facilities have a much lower relative vulnerability to fixed hazardous materials incidents.

Populations in and around the communities that are home to hazardous material facilities sites are more vulnerable to facility releases, particularly those within 1.5 miles of the facility. Table 4.3.14-3 also shows the number of parcels and critical facilities within 1.5 miles of hazardous materials sites. Chester City (the municipality with the most hazardous material facilities) has the fourth highest number of parcels (13,964) within 1.5 miles of hazardous materials sites. Upper Darby Township has the most parcels within 1.5 miles of hazardous materials sites, with 21,876 parcels. Haverford Township and Ridley Township also have more than 10,000 parcels within 1.5 miles of hazardous materials sites.

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.

Table 4.3.14-2: EPA-Identified hazardous materials facilities per municipality in Delaware County (EPA, 2008).

MUNICIPALITY	NUMBER OF EPA-IDENTIFIED HAZARDOUS MATERIALS FACILITIES	TOTAL PARCELS WITHIN 1.5 MILE BUFFER OF HAZARDOUS MATERIAL SITES	TOTAL CRITICAL FACILITIES WITHIN 1.5 MILE BUFFER OF HAZARDOUS MATERIAL SITES
Aldan Borough	0	1,699	7
Aston Township	5	6,405	19
Bethel Township	5	3,147	4
Brookhaven Borough	0	2,175	8
Chadds Ford Township	0	499	2
Chester City	20	13,964	21
Chester Heights Borough	1	1,046	7
Chester Township	8	1,659	5
Clifton Heights Borough	3	2,547	8

Table 4.3.14-2: EPA-Identified hazardous materials facilities per municipality in Delaware County (EPA, 2008).

MUNICIPALITY	NUMBER OF EPA-IDENTIFIED HAZARDOUS MATERIALS FACILITIES	TOTAL PARCELS WITHIN 1.5 MILE BUFFER OF HAZARDOUS MATERIAL SITES	TOTAL CRITICAL FACILITIES WITHIN 1.5 MILE BUFFER OF HAZARDOUS MATERIAL SITES
Collingdale Borough	1	3,169	12
Colwyn Borough	0	920	3
Concord Township	4	3,748	24
Darby Borough	2	3,832	14
Darby Township	1	4,099	10
East Lansdowne Borough	1	928	5
Eddystone Borough	3	965	6
Edgmont Township	0	2	0
Folcroft Borough	7	2,605	6
Glenolden Borough	1	2,184	7
Haverford Township	4	16,541	40
Lansdowne Borough	1	3,994	11
Lower Chichester Township	1	1,405	6
Marcus Hook Borough	6	1,021	5
Marple Township	2	4,116	11
Media Borough	0	2,073	15
Middletown Township	4	4,286	20
Millbourne Borough	0	231	2
Morton Borough	1	1,007	3
Nether Providence Township	0	3,154	13
Newtown Township	2	3,923	14
Norwood Borough	0	1,995	8
Parkside Borough	0	847	4
Prospect Park Borough	0	2,048	9
Radnor Township	3	6,948	32
Ridley Park Borough	1	2,382	12
Ridley Township	2	11,256	29
Rose Valley Borough	0	248	1
Rutledge Borough	0	281	1
Sharon Hill Borough	1	2,137	11
Springfield Township	3	9,368	27
Swarthmore Borough	1	1,588	9
Thornbury Township	0	1,281	6
Tinicum Township	7	2,255	9

Table 4.3.14-2: EPA-Identified hazardous materials facilities per municipality in Delaware County (EPA, 2008).

MUNICIPALITY	NUMBER OF EPA-IDENTIFIED HAZARDOUS MATERIALS FACILITIES	TOTAL PARCELS WITHIN 1.5 MILE BUFFER OF HAZARDOUS MATERIAL SITES	TOTAL CRITICAL FACILITIES WITHIN 1.5 MILE BUFFER OF HAZARDOUS MATERIAL SITES
Trainer Borough	3	3,730	6
Upland Borough	3	1,032	6
Upper Chichester Township	6	6,668	13
Upper Darby Township	3	21,876	71
Upper Providence Township	2	3,577	22
Yeadon Borough	3	3,563	11
TOTAL	**121**	**180,424**	**595**

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.

As mentioned in Section 4.3.14.3, the Delaware County LEPC's Hazardous Commodity Flow Study found that roads in the southern portion of the County (Interstates 95 and 476; US Routes 322, 13, and 202; and State Route 452) possess the highest frequency of commercial traffic carrying hazardous materials. Therefore, they pose the greatest risk to municipalities located in that area. However, the Hazardous Commodity Flow Study found that these municipalities have emergency response officials who are trained in hazardous material response. It is the adjacent municipalities who are more at risk because hazardous materials pass through them but they are not trained to respond to incidents. Table 4.3.14-4 shows municipalities that the Hazardous Commodity Flow Study found are most vulnerable to hazardous materials releases from roadway transportation. These municipalities should review their training and equipment needs for hazardous material incident response.

Table 4.3.14-3: Municipalities in Delaware County most vulnerable to roadway hazardous materials releases (LEPC, 2002).

ROADWAY	MUNICIPALITIES
I-476	Radnor, Haverford, Marple, Upper Providence, Springfield, Swarthmore, Nether Providence
US Route 202	Concord, Chadds Ford
US Route 322	Concord, Chadds Ford, Thornbury
SR 452	Middletown

Regarding vulnerability to rail accidents that involve the release of hazardous materials, the following municipalities are bisected by commercial rail lines: Marcus Hook, Lower Chichester, Trainer, Upper Chichester, Chester Township, Chester Borough, Upland, Eddystone, Ridley, Ridley Park, Prospect Park, Norwood, Sharon Hill, Glenolden, Collingdale, Darby Borough, Yeadon, Colwyn, and Tinicum. Populations living within ¼ mile railways should be considered more vulnerable in the event of a transportation incident involving hazardous materials. For more information on the numbers of parcels located within ¼ mile of major railways, please see Section 4.3.16.5.

Regarding transportation of hazardous materials by water, the municipalities immediately adjacent to the Delaware River are most vulnerable if a hazardous material release were to occur on the Delaware River. In addition, chemicals and materials can travel up the tributaries of the Delaware River also making municipalities along the river's tributaries vulnerable.

There are eleven pipeline companies that have operations in 35 municipalities in the County. The municipalities through which pipelines directly pass are most vulnerable to pipeline incidents that would involve the release of hazardous materials. Table 4.3.14-5 displays municipalities and pipeline transmission companies in their boundaries. In addition, there are oil refineries or terminals in Bethel Township, Upper Chichester Township, Marcus Hook Borough, Trainer Borough, and Darby Township which also increase the risk to those jurisdictions of hazardous materials releases as well as urban fire and explosions.

Table 4.3.14-4: Municipalities and pipeline transmission companies in their boundaries (LEPC, 2002).

MUNICIPALITY	PIPELINE COMPANY
Aldan Borough	None
Aston Township	Buckeye Pipeline Company Columbia Gas Transmission-Oxford Sunoco Pipeline Company, LP Texas Easter Products Pipeline Company Texas Eastern Transmission, LP
Bethel Township	Buckeye Pipeline Company Colonial Pipeline Company Columbia Gas Transmission-Oxford PPL Interstate Energy Company Sunoco Pipeline Company, LP Texas Easter Products Pipeline Company Transcontinental Gas Pipeline
Brookhaven Borough	Buckeye Pipeline Company Columbia Gas Transmission-Oxford Exxon/Mobil Pipe Line Company Sunoco Pipeline Company, LP Texas Eastern Transmission, LP
Chadds Ford Township	Colonial Pipeline Company Columbia Gas Transmission-Oxford

Table 4.3.14-4: Municipalities and pipeline transmission companies in their boundaries (LEPC, 2002).

MUNICIPALITY	PIPELINE COMPANY
Chester City	Sunoco Pipe Line Company, LP Texas Eastern Transmission, LP Transcontinental Gas Pipeline
Chester Heights Borough	PPL Interstate Energy Company Sunoco Pipe Line Company, LP
Chester Township	Exxon/Mobil Pipeline Company Sunoco Pipe Line Company, LP Texas Eastern Transmission, LP
Clifton Heights Borough	None
Collingdale Borough	None
Colwyn Borough	None
Concord Township	Buckeye Pipeline Company Colonial Pipeline Company Columbia Gas Transmission-Oxford PPL Interstate Energy Company Sunoco Pipeline Company, LP Texas Eastern Products Pipeline Company Transcontinental Gas Pipeline
Darby Borough	None
Darby Township	Sunoco Pipe Line Company, LP
East Lansdowne Borough	None
Eddystone Borough	Columbia Gas Transmission-Oxford Texas Eastern Transmission, LP
Edgmont Township	Mobile Pipe Line Company Sunoco Pipe Line Company, LP Texas Eastern Transmission, LP
Folcroft Borough	None
Glenolden Borough	None
Haverford Township	None
Lansdowne Borough	None
Lower Chichester Township	Colonial Pipeline Company Columbia Gas Transmission-Oxford Shell Pipeline Company Sunoco Pipe Line Company, LP Texas Eastern Transmission, LP Transcontinental Gas Pipeline

Table 4.3.14-4: Municipalities and pipeline transmission companies in their boundaries (LEPC, 2002).

MUNICIPALITY	PIPELINE COMPANY
Marcus Hook Borough	Buckeye Pipeline Company Columbia Gas Transmission-Oxford Shell Pipeline Company Sunoco Pipe Line Company, LP Texas Eastern Products Pipeline Company Tosco Refining Company Transcontinental Gas Pipeline
Marple Township	None
Media Borough	None
Middletown Township	Buckeye Pipeline Company Columbia Gas Transmission –Oxford Exxon/Mobile Pipe Line Company Sunoco Pipe Line Company, LP Texas Eastern Transmission, LP
Millbourne Borough	None
Morton Borough	None
Nether Providence Township	Buckeye Pipeline Company Columbia Gas Transmission –Oxford Exxon/Mobile Pipe Line Company Sunoco Pipe Line Company, LP Texas Eastern Transmission, LP
Newtown Township	None
Norwood Borough	None
Parkside Borough	Texas Eastern Transmission, LP
Prospect Park Borough	None
Radnor Township	None
Ridley Park Borough	Buckeye Pipeline Company Exxon/Mobil Pipe Line Company Sunoco Pipe Line Company Texas Eastern Transmission, LP
Ridley Township	Buckeye Pipeline Company Columbia Gas Transmission-Oxford Exxon/Mobil Pipe Line Company Sunoco Pipe Line Company Texas Eastern Transmission, LP
Rose Valley Borough	None
Rutledge Borough	None
Sharon Hill Borough	None
Springfield Township	Buckeye Pipeline Company Sunoco Pipe Line Company, LP

Table 4.3.14-4: Municipalities and pipeline transmission companies in their boundaries (LEPC, 2002).

MUNICIPALITY	PIPELINE COMPANY
Swarthmore Borough	Buckeye Pipeline Company Sunoco Pipe Line Company, LP
Thornbury Township	Buckeye Pipeline Company PPL Interstate Energy Company Sunoco Pipe Line Company, LP Texas Eastern Products Pipeline Company Transcontinental Gas Pipeline
Tinicum Township	Buckeye Pipeline Company Colonial Pipe Line Company Columbia Gas Transmission-Oxford Exxon/Mobil Pipe Line Company Sunoco Pipe Line Company Texas Eastern Transmission, LP
Trainer Borough	Buckeye Pipeline Company Conoco/Phillips Texas Eastern Products Pipeline Company Transcontinental Gas Pipeline
Upland Borough	None
Upper Chichester Township	Buckeye Pipeline Company Colonial Pipeline Company Columbia Gas Transmission-Oxford Shell Pipeline Company PPL Interstate Energy Company Sunoco Pipeline Company, LP Texas Easter Products Pipeline Company Texas Eastern Transmission, LP Transcontinental Gas Pipeline
Upper Darby Township	Buckeye Pipe Line Company
Upper Providence Township	None
Yeadon Borough	None

4.3.15. Levee Failure

4.3.15.1. Location and Extent

Levee failures, like dam failures, have the potential to place large numbers of people and great amounts of property at risk. Unlike dams, levees are built parallel to a river or another body of water to protect the population and structures behind it from risks of casualty or damage during flooding events (FEMA, 2008). Levees do not serve a purpose beyond flood protection, unlike dams which can serve to store water or generate energy in addition to protect areas from flooding.

Levees are designed to provide a specific level of protection, so flooding events could overtop the levees if these events exceeded the levee specifications. Additionally, levees can also fail if they are allowed to decay or deteriorate, so regular maintenance of levees is critical. Damage to the area beyond a levee if it fails could be more significant than if the levee was not present (FEMA, 2008).

In 2010 FEMA identified fourteen levees within Delaware County by compiling data taken from preliminary and final FIRMs and from the United States Army Corps of Engineers (FEMA R3, 2010). There are twelve levees in Tinicum Township, one in the City of Chester, and one levee in Trainer Borough. In addition, there is one levee in Colwyn Borough that was not identified in the FEMA 2010 study. More details about the location of all fifteen levees in Delaware County are listed in Table 4.3.15-1. The levees can be seen in Figure 4.3.15-1.

The City of Chester owns and maintains its levee. It was constructed in 1954 and is accredicted. The levee in Trainer Borough is owned by British Petroleum. It is unknown what year the levee was built and it is not accredited. Tinicum Township owns one of the levees located in its township boundaries ("Tinicum - Delaware River Levee 2") and John Heinz National Wildlife Refuge owns one of the levees in the township ("Tinicum - Long Hook Creek Levee 2"). The Tinicum - Long Hook Creek Levee 2 is accredited however the Tinicum - Delaware River Levee 2 is not accredited. In addition, the ownership of the remaining ten levees in Tinicum Township is unknown. The R3 Levees.org website does not contain any information about ownership of these levees and Tinicum Townshi's engineer indicated that they do not know who are the owners. In addition, a planner at the Philadelphia International Airport indicated that the airport does not own any of the nearby levees in Tinicum Township.

The levee in Colwyn Borough is owned by a private property owner. It is unknown who contructed the levee and the Army Corps of Engineers has recently been asked to investigate if they constructed it or modified a previously existing levee. There are six badly deteriorated structures on the parcel that are protected by the levee, eleven industrial zoned structures on an adjacent parcel, and approximately 80 single family residential units that are vulnerable to damage when the Darby Creek overtops the levee. Colwyn Borough has determined that no maintenance has been performed on the levee and there are no records on file to indicate that a maintenance or inspection plan has been prepared.

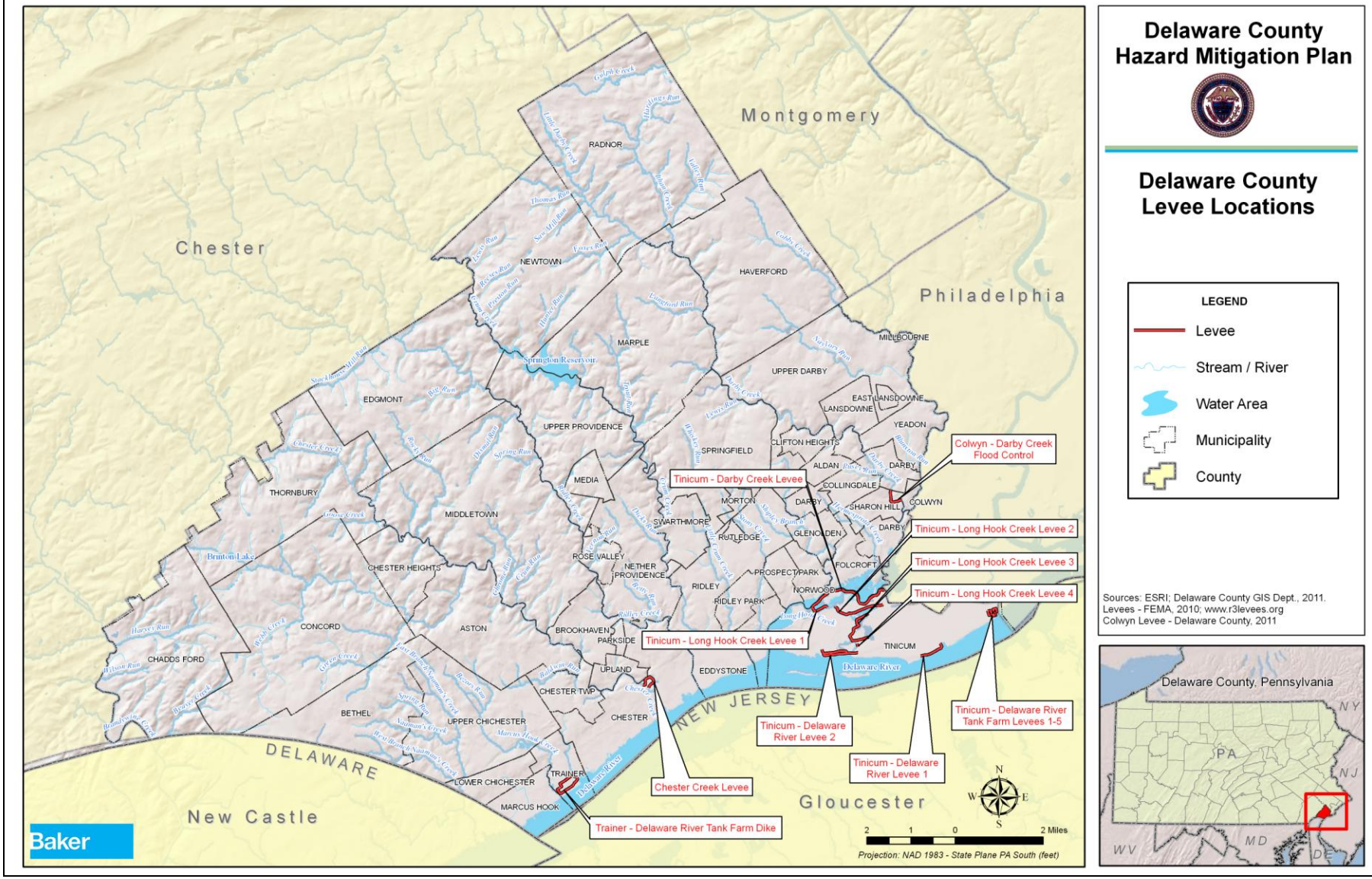
The County is aware of the current lack of data available about the levees in the County and plans to address it through a mitigation action to acquire levee information for the remaining levees before the next HMP update (see action 77 in Table 6.4-1).

Table 4.3.15-1: Levees in Delaware County (FEMA R3, 2010; Delaware County, 2011).

MUNICIPALITY	LEVEE	FLOOD SOURCE	RIVER BASIN
Chester City	Chester Creek Levee	Chester Creek	Lower Delaware
Colwyn Borough	Colwyn - Darby Creek Flood Control	Darby Creek	Lower Delaware
Tinicum Township	Tinicum - Delaware River Tank Farm Levee 1	Delaware River	Lower Delaware
Tinicum	Tinicum - Delaware River Tank	Delaware River	Lower Delaware

Table 4.3.15-1: Levees in Delaware County (FEMA R3, 2010; Delaware County, 2011).			
MUNICIPALITY	**LEVEE**	**FLOOD SOURCE**	**RIVER BASIN**
Township	Farm Levee 2		
Tinicum Township	Tinicum - Delaware River Tank Farm Levee 3	Delaware River	Lower Delaware
Tinicum Township	Tinicum - Delaware River Tank Farm Levee 4	Delaware River	Lower Delaware
Tinicum Township	Tinicum - Delaware River Tank Farm Levee 5	Delaware River	Lower Delaware
Tinicum Township	Tinicum - Delaware River Levee 1	Delaware River	Lower Delaware
Tinicum Township	Tinicum - Darby Creek Levee	Darby Creek	Lower Delaware
Trainer Borough	Trainer - Delaware River Tank Farm Dike	Delaware River	Lower Delaware
Tinicum Township	Tinicum - Long Hook Creek Levee 1	Long Hook Creek	Lower Delaware
Tinicum Township	Tinicum - Long Hook Creek Levee 2	Long Hook Creek	Lower Delaware
Tinicum Township	Tinicum - Long Hook Creek Levee 3	Long Hook Creek	Lower Delaware
Tinicum Township	Tinicum - Long Hook Creek Levee 4	Long Hook Creek	Lower Delaware
Tinicum Township	Tinicum - Delaware River Levee 2	Delaware River	Lower Delaware

Figure 4.3.15-1: Location of Levees in Delaware County (FEMA, 2010).



4.3.15.2. Range of Magnitude

A levee failure or breach causes flooding in landward areas adjacent to the structure. The failure of a levee or other flood protection structure could be devastating depending on the level of flooding for which the structure is designed and the amount of landward development present. Large volumes of water may be moving at high velocities, potentially causing severe damage to buildings, infrastructure, trees and other large objects.

The environmental impacts of a levee failure result in significant water quality and debris disposal issues. Flood waters will back up sanitary sewer systems and inundate waste water treatment plants, causing raw sewage to contaminate residential and commercial buildings and the flooding waterway. The contents of unsecured containers of oil, fertilizers, pesticides and other chemicals get added to flood waters. Hazardous materials may be released and distributed widely across the floodplain. Water supplies and waste water treatment could be off-line for weeks. After the flood waters subside, contaminated and flood damaged building materials and contents must be properly disposed. Contaminated sediment must be removed from buildings, yards and properties. In addition, severe erosion is likely which can impact local ecosystems.

The worst case scenario for levee failure in Delaware County would be if the levees failed in Tinicum Township. There are twelve levees protecting the population of Tinicum Township from the water that surrounds the population living in this municipality. If these levees were to fail the over 4,000 residents and property in the Township would be in danger from high flood waters.

4.3.15.3. Past Occurrence

There is anecdotal information of several areas where levees have overtopped in Delaware County. Colwyn Borough has indicated that the Darby Creek has risen above the elevation of the existing levee in the Borough, causing flooding to the interiors of adjacent structures up to eight feet. As a result of several storm events, including Hurricane Floyd, residents and tenants were evacuated. Several residential units were demolished after the Colwyn levee overtopped during Hurricane Floyd.

There is also anecdotal information from the Delaware County Department of Emergency Services of complaints of water overtopping the levee in the Toby Farms development located between Brookhaven Borough and Upland Borough. In addition, the Delaware County Department of Emergency Services reports that there have been Small Business Assistance loans given to neighborhoods to help with the clean up for flooding events caused by these levee failures.

4.3.15.4. Future Occurrence

Similarly to dam failures, given certain circumstances, levee failures can occur at any time. However, the probability of future occurrence can be reduced through proper design, construction and maintenance measures. Most levees are designed to meet a specified level of flooding. While FEMA focuses on mapping levees that will reduce the risk of a 1%-annual-chance flood, other levees may be designed to protect against smaller or larger floods. Design specifications provide information on the percent-annual-chance flood a structure is expected to withstand, provided that it has been adequately constructed and maintained. If the levees in

Delaware County are properly maintained the future occurrence of levee failure can be considered *unlikely* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1).

4.3.15.5. Vulnerability Assessment

A levee typically protects the buildings and population within a 2,000 foot buffer. Table 4.3.15-2 displays the number of critical facilities and parcels within a 2,000 foot buffer of each levee. These facilities would be in danger from the effects of severe flooding if the levees in the area failed. As population grows in the areas protected by levees the risk to the residents and structures in this area will also increase.

Table 4.3.15-2: Number of parcels and critical facilities falling within a 2,000-foot buffer of levees

LEVEE	FLOOD SOURCE	NUMBER OF CRITICAL FACILITIES WITHIN 2,000 FOOT LEVEE BUFFER	NUMBER OF PARCELS WITHIN 2,000 FOOT LEVEE BUFFER
Chester Creek Levee	Chester Creek	8	1695
Colwyn - Darby Creek Flood Control	Darby Creek	10	2673
Tinicum - Delaware River Tank Farm Levee 1	Delaware River	0	20
Tinicum - Delaware River Tank Farm Levee 2	Delaware River	0	19
Tinicum - Delaware River Tank Farm Levee 3	Delaware River	0	19
Tinicum - Delaware River Tank Farm Levee 4	Delaware River	0	19
Tinicum - Delaware River Tank Farm Levee 5	Delaware River	0	19
Tinicum - Delaware River Levee 1	Delaware River	0	6
Tinicum - Darby Creek Levee	Darby Creek	1	1279
Trainer - Delaware River Tank Farm Dike	Delaware River	2	153
Tinicum - Long Hook Creek Levee 1	Long Hook Creek	3	699
Tinicum - Long Hook Creek Levee 2	Long Hook Creek	2	696
Tinicum - Long Hook Creek Levee 3	Long Hook Creek	3	347
Tinicum - Long Hook Creek Levee 4	Long Hook Creek	0	82
Tinicum - Delaware River Levee 2	Delaware River	0	365

4.3.16. Transportation Accidents

4.3.16.1. Location and Extent

For the purposes of this plan, transportation accidents are defined as incidents involving highway, air and rail travel. The major transportation systems in Delaware County, including the US and State highways, railroads and airports, are shown in Figure 4.3.16-1. Within Delaware County, there are about 25 miles of interstates, 450 miles of state roads, 1,350 miles of secondary and municipal roads, and 356 bridges in the County (PennDOT, 2009; FHA, 2009). The County's busiest transportation routes include Interstates 476 and 95; U.S. Routes 1, 13, 202 and 322; and Pennsylvania Routes 3, 252, 291, 320, 420, 452 and 491. Figure 4.3.16-3 illustrates the average annual daily traffic for Delaware County roads.

Delaware County has passenger rail service for the Eastern and central part of the County (Figure 4.3.16-2). It consists of Amtrak service and SEPTA regional rail, trolley lines and subway. There are four regional rail lines servicing the County. These include the Airport line, Media/Elwyn line, Wilmington/Newark line and the Paoli/Thorndale Line. Two trolley lines have their final destination in Delaware County: the Media and Sharon Hill line and the Norristown High Speed Line. In addition to passenger rail service, there are two commercial rail lines (CSX and Norfolk Southern) which provide pass through the eastern half of the County, along the I-95 corridor and Delaware River.

There are two airport facilities in Delaware County. One of these is the Philadelphia International Airport (PHL), the largest and busiest airport in Pennsylvania. PHL is the 26th-busiest airport in the World. More than 700 planes depart from PHL daily and fly to over 120 different destinations (PHL Information, 2011). A five-mile radius around the airport can be considered a high-risk area, since most aviation incidents occur near landing or take-off sites.

4.3.16.2. Range of Magnitude

Significant transportation accidents can result in death or serious injury or extensive property loss or damage. Road and railway accidents in particular have the potential to result in hazardous materials release as well if the accident involves a vehicle carrying hazardous materials. Section 4.3.14 covers hazardous material releases in more detail.

A worst case scenario for transportation accidents occurred in the County at the beginning of Memorial Day weekend in 1998. On Interstate 95 near the Pennsylvania-Delaware border, a tanker truck loaded with 8,700 gallons of gasoline swerved to avoid a passing car, crashed across a concrete barrier and exploded after striking a pickup truck. It caused a disruption in traffic along I-95 for five weeks. Two people were killed and the reconstruction project cost was $3.5 million.

Figure 4.3.16-1: Delaware County transportation system (ESRI, 2010; PEMA, 2010; Delaware County GIS Department, 2011).

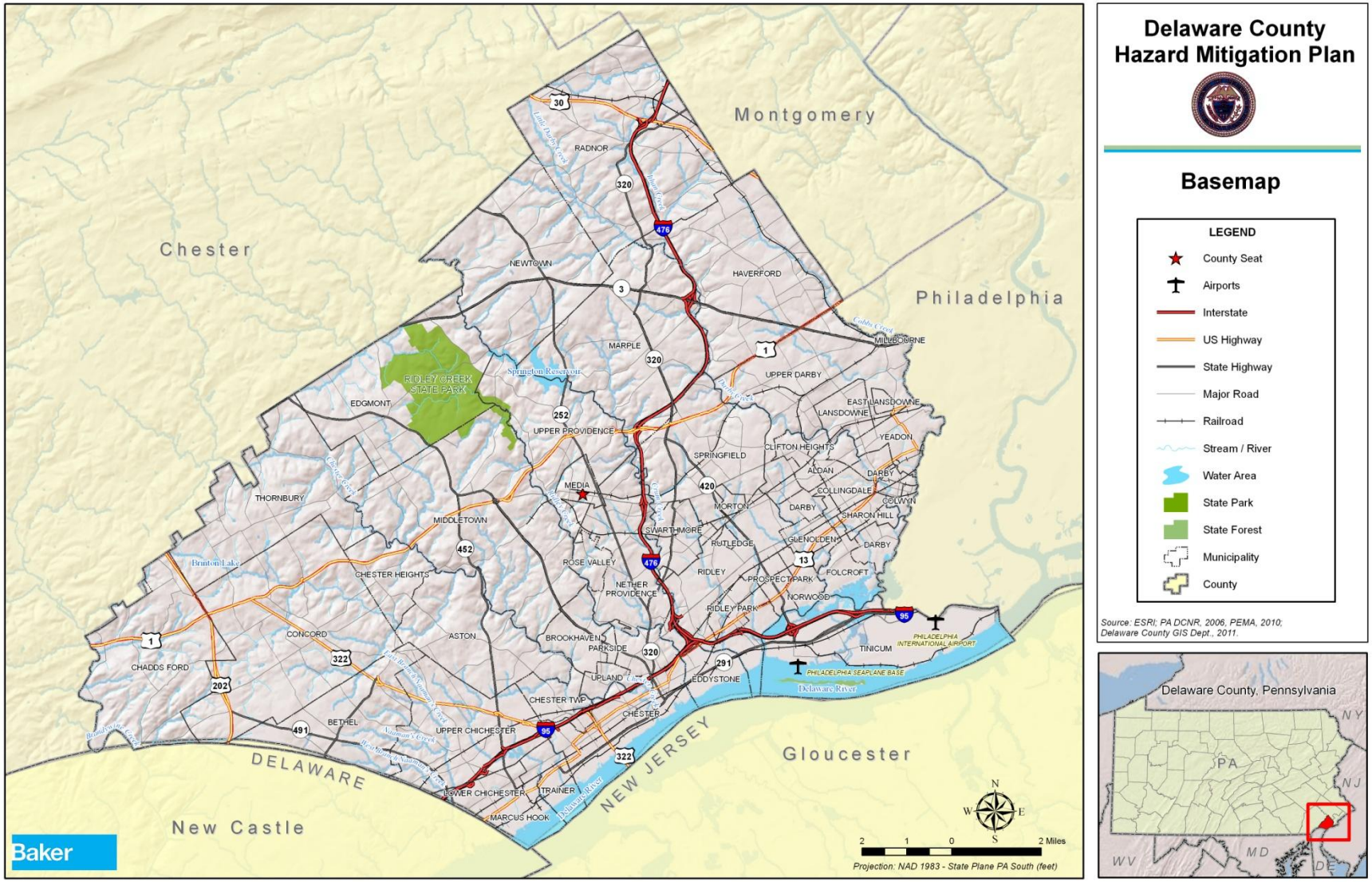


Figure 4.3.16-2: Delaware County rail systems (ESRI, 2010; Delaware County GIS Department, 2011).

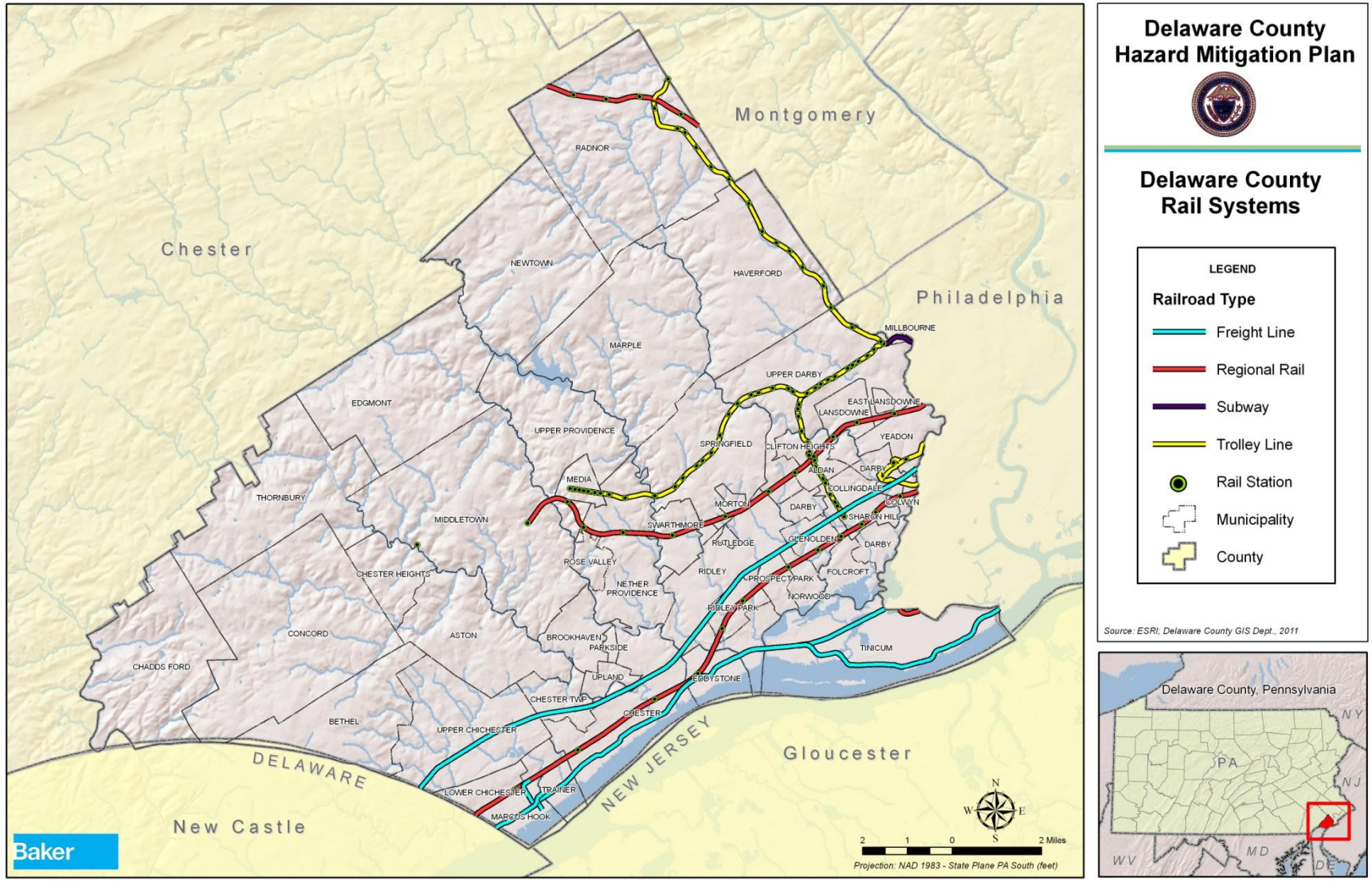
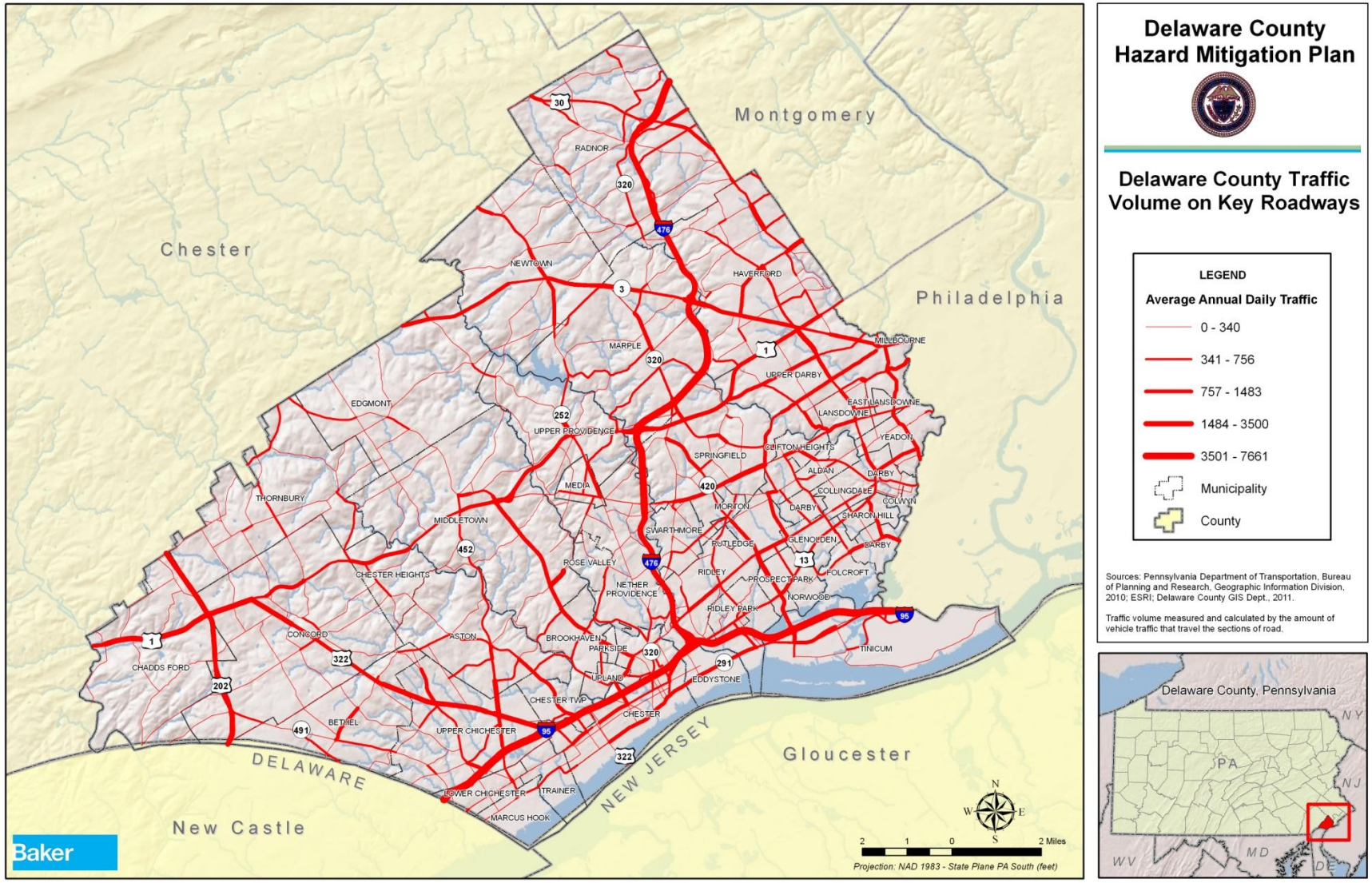


Figure 4.3.16-3: Average annual daily traffic on key roadways in Delaware County (PennDOT, 2010; Delaware County GIS Department, 2011).



4.3.16.3. Past Occurrence

The most common transportation accidents in the County involve highway incidents involving motor vehicles. The County's most serious transportation concerns involve the highways which have the heaviest traffic flows, including Interstates 95 and 476; U.S. Routes 1, 202 and 322; and Pennsylvania Routes 3, 291, 320 and 452. Table 4.3.16-1 below summarizes the five-year vehicular crash data from 2005-2009 for Delaware County.

Table 4.3.16-1: Total number of crashes, traffic deaths, and pedestrian deaths for Delaware County from 2005 – 2009 (PennDOT, 2010).

YEAR	TOTAL CRASHES	TOTAL TRAFFIC DEATHS	TOTAL PEDESTRIAN DEATHS
2005	4,870	31	7
2006	4,920	29	7
2007	4,613	22	2
2008	4,532	21	3
2009	4,360	20	6

There have been two recent railroad accidents in Delaware County, in 2006 and 2010. In the 2006 incident one fatality was reported as an individual was struck by an unoccupied Amtrak train (PEIRS, 2002-2008). In the 2010 accident, two girls were struck and killed by an Amtrak train (WPVI, 2010).

There have been two aviation accidents in the County, both in 2004. Both incidents were at the Philadelphia International Airport. In both cases the planes developed smoke in the cockpit, however no injuries were reported (PEIRS, 2002-2008).

4.3.16.4. Future Occurrence

The County's population has increased slightly over the last decade so it can be assumed that local traffic has increased slightly as well. However the trucking industry is expected to continue to grow across the state, which will increase the number of long haul trucks operating in the County on a daily basis since several major highways and interstates traverse the County. Transportation incidents may increase slightly over the next five years without proper mitigation strategies in place. Based on the roadway traffic and past occurrences, the future occurrence of transportation accidents in Delaware County can be considered *highly likely* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1).

In addition, Delaware County has several commercial rail lines and many passenger lines with routine service so the risk of rail accidents is expected to remain constant as there is not a significant increase in traffic predicted for the rail lines.

The average rate of aviation accidents nation-wide is 8.47 accidents per 100,000 flight hours. The likelihood of an aviation incident is generally low; however with part of the Philadelphia International Airport located directly in the County, the future occurrence may be slightly elevated.

4.3.16.5. Vulnerability Assessment

A transportation related accident can occur on any stretch of road or railway in Delaware County. However, severe accidents are more likely along interstates or highways such as Interstates 476 and 95, U.S. Routes 1, 13, 202 and 322, and Pennsylvania Routes 3, 252, 291, 320, 420, 452 and 491, which experience heavier traffic volumes including heavy freight vehicles. The combination of high traffic volume, severe winter weather in the County and large numbers of hazardous materials haulers increase the chances of traffic accidents occurring.

In June 2010 the Delaware Valley Regional Planning Commission's transportation operations and safety units conducted a Road Safety and Operations Audit to address concerns on a ten-mile stretch of I-95 in Delaware County (DVRPC, 2011). The audit team identified specific areas of concern and projects to address these. As of February 2011 the following projects were completed in relation to the findings of this audit, including replacing milepost markers and exit signs, making clearer pavement markings near I-476 to address merging issues, removing vegetation blocking signs, and re-striping select ramps in this area. These projects are aimed at reducing vehicular accidents along this particular stretch of the interstate which was identified as especially prone to traffic accidents.

The population and buildings closest to major highways are most at risk in the event of a transportation accident involving hazardous materials. Table 4.3.16-2 shows number of parcels and critical facilities located within a ¼ mile of railroads, airports or major highways. For the assessment in the table, major roads included interstates, US Highways, and State Highways. There are 78,539 parcels and 252 critical facilities located within a quarter mile of major roads (Table 4.3.16-2). Municipalities with a high number of parcels (over 4,000) along major roads include: Chester City, Haverford Township, Marple Township, and Upper Darby Township. Similarly, these municipalities have a large number of critical facilities located within a quarter mile of major roads and thus more vulnerable to road-related transportation accidents.

In addition, the potential for a major railroad accident in Delaware County exists but accidents are not expected to go beyond the rail right-of-way, unless hazardous materials are involved. Like highway incidents, rail incidents can impact populations living near rail lines. Like roadway accidents, the population and buildings closest to rail lines are most vulnerable in the event of an accident, especially one that involved hazardous materials. There are 66,993 parcels and 292 critical facilities within a quarter mile of rail lines in Delaware County. Chester City and Upper Darby Township have the most parcels located within a ¼ mile of railroads. Radnor Township, Springfield Township, and Upper Darby Township have the most critical facilities located along railroads although Upper Darby has nearly over twice as many critical facilities in this hazard area than do Springfield Township and Radnor Township.

Delaware County is also susceptible to airplane accidents due to the air traffic through the two airport facilities in the County. The population within a five mile radius of these facilities is the most vulnerable in the instance of a crash, since most crashes occur near takeoff or landing sites. There are 77,709 parcels and 224 critical facilities located within a five mile radius of the eleven airports in Delaware County. Chester City and Ridley Township are most vulnerable to aviation accidents as they each have more than 11,000 parcels within a five miles radius of an

airport. Ridley Township has the most critical facilities (29) located within the five mile airport radius.

Table 4.3.16-2: Parcels and critical facilities within vulnerable radii of major highways, rail lines, and airports in Delaware County (ESRI, 2010; PEMA 2010; Delaware County GIS Department, 2011).

MUNICIPALITY	TOTAL PARCELS	PARCELS WITHIN 1/4 MILE OF RAILROAD	CRITICAL FACILITIES WITHIN 1/4 MILE OF RAILROAD	PARCELS WITHIN 1/4 MILE OF MAJOR HIGHWAYS	CRITICAL FACILITIES WITHIN 1/4 MILES OF MAJOR HIGHWAYS	PARCELS WITHIN 5 MILES RADIUS OF AIRPORT	CRITICAL FACILITIES WITHIN 5 MILE RADIUS OF AIRPORT
Aldan Borough	1,699	1,175	7	0	0	1,699	7
Aston Township	6,405	0	0	974	4	0	0
Bethel Township	3,377	0	0	1,872	3	0	0
Brookhaven Borough	2,681	0	0	772	5	1,619	2
Chadds Ford Township	1,714	0	0	620	2	0	0
Chester City	13,964	9,681	17	13,052	19	11,162	0
Chester Heights Borough	1,046	0	0	290	2	0	0
Chester Township	1,659	375	3	622	3	621	2
Clifton Heights Borough	2,547	1,550	7	0	0	2,038	8
Collingdale Borough	3,169	2,448	9	851	1	3,169	12
Colwyn Borough	920	767	3	0	0	920	3
Concord Township	5,018	0	0	1,638	8	0	0
Darby Borough	3,832	3,226	10	1,600	5	3,832	14
Darby Township	4,099	380	0	0	0	4,099	10
East Lansdowne Borough	928	347	0	213	0	376	0
Eddystone Borough	965	755	5	802	5	965	6
Edgmont Township	1,473	0	0	605	3	0	0
Folcroft Borough	2,605	701	2	339	0	2,605	6
Glenolden Borough	2,184	1,975	7	1,148	5	2,184	7
Haverford Township	18,044	3,443	12	4,787	10	0	0
Lansdowne Borough	3,994	1,274	6	0	0	1,179	6
Lower Chichester Township	1,405	425	4	919	6	0	0

Table 4.3.16-2: Parcels and critical facilities within vulnerable radii of major highways, rail lines, and airports in Delaware County (ESRI, 2010; PEMA 2010; Delaware County GIS Department, 2011).

MUNICIPALITY	TOTAL PARCELS	PARCELS WITHIN 1/4 MILE OF RAILROAD	CRITICAL FACILITIES WITHIN 1/4 MILE OF RAILROAD	PARCELS WITHIN 1/4 MILE OF MAJOR HIGHWAYS	CRITICAL FACILITIES WITHIN 1/4 MILES OF MAJOR HIGHWAYS	PARCELS WITHIN 5 MILES RADIUS OF AIRPORT	CRITICAL FACILITIES WITHIN 5 MILE RADIUS OF AIRPORT
Marcus Hook Borough	1,021	1,021	5	798	5	0	0
Marple Township	8,395	0	0	4,115	8	0	0
Media Borough	2,073	1,343	15	880	2	0	0
Middletown Township	5,092	173	1	2,074	12	0	0
Millbourne Borough	236	236	2	236	2	0	0
Morton Borough	1,007	735	3	528	1	1,007	3
Nether Providence Township	5,082	1,046	7	1,816	10	3,589	13
Newtown Township	4,844	0	0	1,882	6	0	0
Norwood Borough	1,995	738	6	777	6	1,995	8
Parkside Borough	847	0	0	668	4	847	4
Prospect Park Borough	2,048	1,252	9	1,672	7	2,048	9
Radnor Township	8,264	2,890	19	3,328	19	0	0
Ridley Park Borough	2,382	2,107	12	1,077	3	2,382	12
Ridley Township	11,264	3,552	8	3,388	9	11,263	29
Rose Valley Borough	462	56	0	2	0	129	0
Rutledge Borough	281	13	0	70	0	281	1
Sharon Hill Borough	2,137	2,115	11	1,488	7	2,137	11
Springfield Township	9,402	3,016	19	3,321	12	3,801	7
Swarthmore Borough	1,588	520	7	711	6	1,588	9
Thornbury Township	2,378	0	0	443	0	0	0
Tinicum Township	2,256	1,774	6	1,779	7	2,256	9
Trainer Borough	4,172	1,620	5	1,920	3	980	0
Upland Borough	1,032	153	3	123	3	1,032	6

Table 4.3.16-2: Parcels and critical facilities within vulnerable radii of major highways, rail lines, and airports in Delaware County (ESRI, 2010; PEMA 2010; Delaware County GIS Department, 2011).

MUNICIPALITY	TOTAL PARCELS	PARCELS WITHIN 1/4 MILE OF RAILROAD	CRITICAL FACILITIES WITHIN 1/4 MILE OF RAILROAD	PARCELS WITHIN 1/4 MILE OF MAJOR HIGHWAYS	CRITICAL FACILITIES WITHIN 1/4 MILES OF MAJOR HIGHWAYS	PARCELS WITHIN 5 MILES RADIUS OF AIRPORT	CRITICAL FACILITIES WITHIN 5 MILE RADIUS OF AIRPORT
Upper Chichester Township	6,732	1,690	5	3,549	5	0	0
Upper Darby Township	22,070	9,814	45	6,618	15	2,342	9
Upper Providence Township	3,914	472	4	1,617	8	1	0
Yeadon Borough	3,563	2,135	8	2,555	10	3,563	11
TOTAL	**198,265**	**66,993**	**292**	**78,539**	**251**	**77,709**	**224**

4.3.17. Urban Fire and Explosion

4.3.17.1. Location and Extent

Urban fire and explosion hazards incorporate vehicle and building/structure fires as well as overpressure rupture, overheat, or other explosions that do not ignite. Statewide, this hazard occurs in the denser, more urbanized areas and occurs most often in residential structures (US Fire Administration, 2009). Urban fires can more easily spread from building to building in these denser areas.

Urban fires and explosions often begin as a result of other hazards, particularly severe storms, drought, transportation accidents, hazardous materials releases, criminal activity such as arson, and terrorism.

4.3.17.2. Range of Magnitude

Severe urban fires result in extensive damage to residential, commercial, and/or public property. Damages range from minor smoke and/or water damage to the destruction of buildings. People are often displaced for several months to years depending on the magnitude of the fire or explosion event. Urban fires and explosions can also cause injuries and death; one of the worst fire incidents in Delaware County was the Corinthus Disaster in 1975 where 27 people lost their lives after a ship hit a docked Liberian tanker near a BP oil refinery (Marple Newtown County Press, September 2010, DCEMA, 1984). 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.

The most recent worst-case urban fire event occurred in Collingdale Borough on September 1, 2010, when an incident caused several propane tanks to explode at the Scully Welding Supply facility. Over thirty County fire companies turned out to fight the daunting fires that followed the explosions and all residents within a 3,000-foot radius were temporarily evacuated from the area.

4.3.17.3. Past Occurrence

Delaware 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 16 urban fire events reported to PEMA (see Table 4.3.17-1). Please note that since PEIRS is a voluntary reporting system, this is not an inclusive list of fires in the

County. Of the municipalities in Delaware County, the City of Chester had the highest number of urban fires reported to PEIRS with 4 events reported.

Table 4.3.17-1: Urban fire events reported to PEIRS, 2002-2009 (PEMA, 2010)

COMMUNITY	TYPE OF EVENT	DATE	DESCRIPTION OF EVENT
Prospect Park	Structure Fire	01/25/2002	N/A
Upland Borough	Structure Fire	02/02/2002	N/A
City of Chester	Structure Fire	04/02/2002	N/A
City of Chester	Structure Fire	01/27/2003	Five single family homes were impacted due to structure fire on East 7th Street.
City of Chester	Structure Fire	02/20/2004	Residential structure fire; no reported injuries
Nether Providence Township	Structure Fire	07/09/2004	Residential structure fire; no reported injuries
Upper Chichester Township	Vehicle Fire	04/18/2005	A trash truck had a small explosion and fire on it; cause of explosion is unknown and incident is under investigation. One injury was reported
City of Chester	Structure Fire	8/23/2005	Fire at the Atlantic Steel Company; no injuries reported
Thornbury Township	Structure Fire	11/17/2005	Fire at Glenn Mills State School; no injuries reported but approximately 890 residents displaced from homes. American Red Cross provided temporary shelter for displaced persons.
Marple Township	Structure Fire	07/10/2006	Commercial structure fire; no injuries reported
Trainer Borough	Explosion	08/18/2006	An explosion occurred due to equipment malfunction at the Congoleum plant, a tile and flooring manufacturing company.
Haverford Township	Structure Fire	03/01/2007	Fire at the old Havertown PCP facility; building unoccupied
Newtown Township	Structure Fire	03/12/2007	Residential structure fire; one fatality reported
Ridley Park Borough	Structure Fire	03/12/2007	Residential structure fire; one fatality reported
Chester Township	Structure Fire	03/19/2007	Commercial structure fire; two injuries reported
Sharon Hill	Structure Fire	09/27/2007	Fire occurred in a detached garage; five firefighters were injured. One firefighter was critically injured and two were treated then released

Since 2009, the end of the PEIRS data reporting time period, Delaware County has experienced mainly residential structure fires but also a few commercial structure fires and explosions. The largest most recent fire disaster was the explosion and resulting fire in Collingdale, Pennsylvania. Fortunately, only one person was injured during this event and firefighters were eventually able to settle the flames. Property damage was limited to the adjacent storage facility, but the damage was extensive (Collingdale Fire Company, 2011). Figure 4.3.17-1 shows the propane tanks burning following the explosion at the Scully Welding Supply Facility.

Figure 4.3.17-1: Explosion at Scully Welding Supply in Collingdale Borough on September 1, 2010 results in burning propane tanks as shown and nearby resident evacuation. (Collingdale Fire Company, 2011).

4.3.17.4. Future Occurrence

The future occurrence of urban fire and explosion events can be considered *likely* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1). Minor events are likely to happen more frequently than major fires or explosions in the future. The greatest urban fire and explosion threats in Delaware County are industrial fires. While residential fires are more common, industrial fires have a potentially higher risk because of the possibility of there being flammable chemicals and a sustained fuel source at industrial sites.

There is also a growing threat of natural gas, particularly methane, migration into homes and sparking fires and explosions. These events could occur more frequently moving forward if natural gas extraction grows in the County.

4.3.17.5. Vulnerability Assessment

Areas where large buildings are located or development is closely spaced should be considered more vulnerable to urban fire and explosion events; in Delaware County, these denser jurisdictions include Chester City, Haverford Township, Radnor Township, Upper Darby Township, and Riley Township. However, Delaware County as a whole has the second greatest density in Pennsylvania, so the entire County is more vulnerable as a result (US Census, 2000).

In order to adequately assess vulnerability to urban fires and explosions, detailed information on the design specifications, specifically fire codes, used for the construction of individual buildings is required. As of December 31, 2006, all communities in Pennsylvania are required to comply with the Uniform Construction Codes. This includes requirements to comply with both the International Fire Code and the International Wildland Urban Interface Code. The adoption and enforcement of these codes will hopefully decrease the overall vulnerability of structures in Delaware County. However, these regulations will only affect new construction, as well as

additions and renovations to existing structures. Older buildings that do not meet the criteria established in these modern fire codes will continue to remain vulnerable to urban fire and explosion events.

4.3.18. Utility Interruption

4.3.18.1. Location and Extent

Utility interruptions in Delaware County include disruptions in fuel, water, electric and telecommunications capabilities. A fuel shortage occurs when the supply of energy resources does not meet the demand. The inability to produce or transfer sufficient quantities of the energy resource at an acceptable cost to businesses, industry, and the public can create a national or regional fuel shortage. Fuel shortages can also be caused more locally by imbalances of supply due to weather or misdistribution.

Utility interruptions are often a secondary impact of another hazard. Severe thunderstorms, windstorms, tornados, and winter storms can also lead to more regional utility interruptions, while localized outages can be caused by traffic accidents or wind damage. Heat waves may also result in rolling blackouts where power may not be available for an extended period of time. Utility interruptions have the potential to take place throughout Delaware County.

4.3.18.2. Range of Magnitude

Most severe utility interruptions and power failures are regional events. A loss of utilities can have numerous impacts including, but not limited to, food spoilage, loss of water supply (either because of a damaged pipeline or well pump failure), loss of heating or air conditioning, basement flooding (sump pump failure), lack of indoor lighting, and lack of telephone and internet service. At a minimum, utility interruptions can cause short term disruption in the orderly functioning of business, government, and private citizen functioning and activities like traffic signals, elevators, and retail sales.

Likewise, most fuel shortages are regional or national events. A fuel shortage can have numerous impacts including increases in the cost of fuel putting an economic burden on families and businesses, long lines at gas stations due to fuel rationing, disruptions in freight traffic, incidents of violence, truck driver strikes, and a shortage of heating fuels.

These issues range from a minor nuisance to a full hazard event, but the degree of damage or harm depends on the population affected and the severity of the outage. At a minimum, power outages can cause short term disruption in the orderly functioning of business, government and private citizen functioning and activities. Examples of functions include traffic signals, elevators, and retail sales.

However, loss of heating and cooling capability is more dangerous in the winter and summer months, when heat sensitive populations like the elderly count on utilities and fuel to maintain a safe temperature. A worst case scenario for utility interruption in Delaware County would be a fuel shortage or power outage in the winter months, especially during a severe winter weather event, which may leave many homes without a source of heat.

4.3.18.3. Past Occurrence

Delaware County, like most of Pennsylvania, experienced long lines at gasoline pumps and shortages of fuel in 1973 as a result of the OPEC oil embargo. Government actions were taken to assure that fuels and power were available for emergency and priority users across the Commonwealth.

Windstorms and winter storms have caused localized power outages throughout Delaware County on numerous occasions. Extreme cold has hampered distribution of natural gas, while transportation accidents have also caused minor power outages. Minor utility interruptions occur annually in Delaware County, caused by these and other circumstances. There is no complete list of utility interruption events available for the County.

4.3.18.4. Future Occurrence

Minor, short-term utility interruptions may occur several times a year for any given area in Delaware County, while major, long-term events may take place once every few years. Utility interruptions are difficult to predict, but they are likely to have a relatively short duration of 24 hours or less. Since utility interruptions are sometimes by-products of severe weather events, citizens should prepare for them during severe storms.

A major fuel crisis could develop in the future depending on international relationship and tensions. However, significant changes seem to have reduced both the likelihood of another major oil embargo and/or drastic price increases. Alternative sources of energy, conservation and significant increases in efficiency through technological advances have reduced the growth in demand for oil thus reducing the probability of another 1973 type of crisis will occur.

The future occurrence of utility interruptions and fuel shortages can be considered *possible* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1).

4.3.18.5. Vulnerability Assessment

Although the risk for future occurrence of utility interruptions is low across Delaware County, there is higher frequency of incidents of contributing factors, namely traffic accidents and severe weather. Therefore, the County is vulnerable to these interruptions, though they are usually short lived.

Hospitals and emergency medical facilities, including retirement homes and senior centers, are particularly vulnerable to fuel shortages and utility interruptions as elderly populations are particularly vulnerable to temperature extremes. Back-up power generators are often used at these facilities, but the population will become particularly vulnerable if the fuel shortage or power outage lasts longer than the back-up power supply. Elderly residents who live outside of these facilities are vulnerable to these interruptions or fuel shortages as well, and they often do not have access to back-up power supplies. Sick or disabled residents are also vulnerable to these interruptions or shortages.

4.4. Hazard Vulnerability Summary

4.4.1. Methodology

Ranking hazards helps communities set goals and priorities for mitigation based on their vulnerabilities. A Risk Factor (RF) is a tool used to measure the degree of risk for identified hazards in a particular planning area. The RF can also be used to assist local community officials in ranking and prioritizing those hazards that pose the most significant threat to their area based on a variety of factors deemed important by the planning team and other stakeholders involved in the hazard mitigation planning process. The RF system relies mainly on historical data, local knowledge, general consensus opinions from the planning team and information collected through development of the hazard profiles included in Section 4.3. 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 were obtained by assigning varying degrees of risk to five categories for each of the eleven hazards profiled in the 2011 HMP. Those categories include: *probability*, *impact*, *spatial extent*, *warning time* and *duration*. Each degree of risk was assigned a value ranging from 1 to 4. The weighting factor is shown in Table 4.4-1. To calculate the RF value for a given hazard, the assigned risk value for each category was multiplied by the weighting factor. The sum of all five categories equals the final RF value, as demonstrated in the example equation:

Risk Factor Value = [(Probability x .30) + (Impact x .30) +
(Spatial Extent x .20) + (Warning Time x .10) + (Duration x .10)]

Table 4.4-1 summarizes each of the five categories used for calculating a RF for each hazard. According to the weighting scheme applied, the highest possible RF value is 4.0.

Table 4.4-1: Summary of risk factor approach used to rank hazard risk.

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	**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	**1**	**10%**
	LESS THAN 24 HRS	SELF-DEFINED	**2**	
	LESS THAN 1 WEEK	SELF-DEFINED	**3**	
	MORE THAN 1 WEEK	SELF-DEFINED	**4**	

(NOTE: Levels of warning time and criteria that define them may be adjusted based on hazard addressed.)

(NOTE: Levels of warning time and criteria that define them may be adjusted based on hazard addressed.)

4.4.2. Ranking Results

Using the methodology described in Section 4.4.1, Table 4.4-2 lists the Risk Factor calculated for each of the thirteen potential hazards identified in the 2011 Hazard Mitigation Plan Update. Hazards identified as *high* risk have risk factors greater than 2.5. Risk Factors ranging from 2.0 to 2.4 were deemed *moderate* risk hazards. Hazards with Risk Factors 1.9 and less are considered *low* risk.

Table 4.4-2: Ranking of hazard types based on Risk Factor methodology.

HAZARD RISK	HAZARD NATURAL (N) or MAN-MADE (M)	RISK ASSESSMENT CATEGORY					RISK FACTOR
		PROBABILITY	IMPACT	SPATIAL EXTENT	WARNING TIME	DURATION	
HIGH	Flood, Flash flood, Ice jam	4	3	4	3	3	3.5
	Winter Storm (N)	4	2	4	1	3	3.0

Table 4.4-2: Ranking of hazard types based on Risk Factor methodology.

HAZARD RISK	HAZARD NATURAL (N) or MAN-MADE (M)	RISK ASSESSMENT CATEGORY					RISK FACTOR
		PROBABILITY	IMPACT	SPATIAL EXTENT	WARNING TIME	DURATION	
	Environmental Hazards - (Hazardous Material	4	2	2	4	2	2.8
MODERATE	Extreme Temperature (N)	2	2	4	1	3	2.4
	Pandemic (N)	2	2	3	1	4	2.3
	Transportation accidents	4	1	1	4	1	2.2
	Drought (N)	2	1	4	1	4	2.2
	Hurricane, Tropical Storm, Nor'easter (N)	2	2	3	1	3	2.2
	Urban Fire and Explosion	3	2	1	4	1	2.2
	Wildfires (N)	3	1	2	2	3	2.1
	Tornados and Windstorms	2	2	2	4	1	2.1
	Utility Interruption (M)	2	1	2	4	3	2.0
LOW	Radon Exposure	2	1	2	1	4	1.8
	Levee Failure (M)	1	2	1	4	2	1.7
	Dam Failure (M)	1	2	1	4	2	1.7
	Subsidence and Sinkhole	2	1	1	4	1	1.6
	Earthquake (N)	1	1	2	4	1	1.5
	Landslide (N)	1	1	1	4	1	1.3

Based on these results, there are three *high* risk hazards, nine *moderate* risk hazards and six *low* risk hazards in Delaware County. Mitigation actions were developed for all high, moderate, and low risk hazards (see Section 6.4). The threat posed to life and property for moderate and high risk hazards is considered significant enough to warrant the need for establishing hazard-specific mitigation actions. Mitigation actions related to future public outreach and emergency service activities are identified to address low risk hazard events.

A risk assessment result for the entire county does not mean that each municipality is at the same amount of risk to each hazard. Table 4.4-3 shows the different municipalities in Delaware County and whether their risk is greater than (>), less than (<), or equal to (=) the risk factor assigned to the County as a whole.

Table 4.4-3: Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk

JURISDICTION	IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR															
	Flood, Flash Flood, Ice Jam	Winter Storm	Env. Hazards (Hazardous Material Release)	Extreme Temperature	Pandemic	Transportation Accident	Drought	Hurricane, Tropical Storm, Nor'easter	Urban Fire and Explosion	Wild fire	Tornado and Wind storm	Utility Interruption	Radon Exposure	Levee Failure	Subsidence and Sink hole	Earthquake	Land slide
	3.3	*3.0*	*2.8*	*2.4*	*2.3*	*2.2*	*2.2*	*2.2*	*2.2*	*2.1*	2.1	2.0	1.8	1.7	1.6	1.5	1.3
Aldan Borough	=	=	=	=	=	=	=	=	>	<	=	=	>	=	=	=	=
Aston Township	=	=	>	=	=	>	=	=	>	>	=	=	=	=	=	=	=
Bethel Township	=	=	>	=	=	=	>	=	=	>	=	>	=	=	=	=	=
Brookhaven Borough	=	=	=	=	=	=	=	=	>	>	=	=	=	=	=	=	=
Chadds Ford Township	>	>	<	=	=	>	=	=	=	>	=	=	=	=	=	=	=
Chester City	>	=	>	=	=	>	=	=	>	<	=	>	=	>	=	=	=
Chester Township	>	=	>	=	=	=	=	=	=	<	=	=	=	=	=	=	=
Chester Heights Borough	=	=	=	=	=	=	=	=	>	>	=	=	=	=	=	=	=
Clifton Heights Borough	=	=	=	=	=	=	=	=	>	=	=	=	=	=	=	=	=
Collingdale Borough	=	=	=	=	=	=	=	=	>	=	=	=	=	=	=	=	=
Colwyn Borough	=	=	=	=	=	=	=	=	>	>	=	=	=	>	=	=	=
Concord Township	=	=	=	=	=	=	>	=	=	>	=	>	=	<	=	=	=
Darby Borough	=	=	=	=	=	=	=	=	>	<	=	=	=	=	=	=	=
Darby Township	=	=	=	=	=	=	=	=	=	<	=	=	=	=	=	=	=
East Lansdowne Borough	<	>	=	=	=	>	=	>	>	<	>	>	>	<	=	=	<
Eddystone Borough	=	=	>	=	=	=	=	=	>	<	=	=	=	=	=	=	=
Edgmont Township	=	=	<	=	=	=	>	=	=	>	=	>	=	=	=	=	=
Folcroft Borough	=	=	=	=	=	=	=	=	>	<	=	=	=	>	=	=	=
Glenolden Borough	=	=	=	=	=	=	=	=	>	=	=	=	=	=	=	=	=
Haverford Township	=	=	=	=	=	=	=	=	=	>	=	=	>	=	=	=	=
Lansdowne Borough	=	=	=	=	=	=	=	=	>	=	=	=	>	=	=	=	=
Lower Chichester Township	=	=	>	=	=	=	=	=	=	>	=	=	=	=	=	=	=
Marcus Hook Borough	=	=	>	=	=	=	=	=	>	<	=	=	=	<	=	=	=
Marple Township	=	=	=	=	=	=	=	=	=	>	=	=	=	=	=	=	=
Media Borough	<	=	>	=	>	>	=	=	>	<	>	>	=	<	<	=	<
Middletown Township	=	=	=	=	=	=	>	=	=	>	=	=	=	=	=	=	=

Table 4.4-3: Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk

JURISDICTION	IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR																
	Flood, Flash Flood, Ice Jam	Winter Storm	Env. Hazards (Hazardous Material Release)	Extreme Temperature	Pandemic	Transportation Accident	Drought	Hurricane, Tropical Storm, Nor'easter	Urban Fire and Explosion	Wild fire	Tornado and Wind storm	Utility Interruption	Radon Exposure	Levee Failure	Subsidence and Sink hole	Earthquake	Land slide
	3.3	*3.0*	*2.8*	*2.4*	*2.3*	*2.2*	*2.2*	*2.2*	*2.2*	*2.1*	2.1	2.0	1.8	1.7	1.6	1.5	1.3
Millbourne Borough	=	=	=	=	=	=	=	=	>	>	=	=	=	=	=	=	=
Morton Borough	=	=	=	=	=	=	=	=	>	<	=	=	=	=	=	=	=
Nether Providence Township	=	=	=	=	=	=	=	=	=	>	=	=	=	=	=	=	=
Newtown Township	>	=	=	=	=	=	>	>	=	>	=	>	=	=	=	=	=
Norwood Borough	=	=	=	=	=	=	=	=	>	=	=	=	=	>	=	=	=
Parkside Borough	=	=	=	=	=	=	=	=	=	<	=	=	=	=	=	=	=
Prospect Park Borough	=	=	=	=	=	=	=	=	>	<	=	=	=	=	=	=	=
Radnor Township	=	=	=	=	=	=	>	=	=	>	=	=	=	=	=	=	=
Ridley Township	=	=	=	=	=	=	=	=	=	<	=	=	>	=	=	=	=
Ridley Park Borough	=	=	=	=	=	=	=	=	>	<	=	=	=	=	=	=	=
Rose Valley Borough	=	=	<	=	=	=	=	=	>	>	=	=	=	=	=	=	=
Rutledge Borough	=	=	=	=	=	=	=	=	>	<	=	=	=	=	=	=	=
Sharon Hill Borough	=	=	=	=	=	=	=	=	>	=	=	=	=	=	=	=	=
Springfield Township	=	=	=	=	=	=	=	=	=	>	=	=	=	=	=	=	=
Swarthmore Borough	=	=	=	=	=	>	=	=	>	>	=	=	=	=	=	=	=
Thornbury Township	=	=	<	=	=	=	>	=	=	>	=	=	=	=	=	=	=
Tinicum Township	>	=	>	=	=	>	=	>	>	<	=	=	=	>	=	=	=
Trainer Borough	=	=	>	=	=	=	=	=	>	>	=	=	=	>	=	=	=
Upland Borough	>	=	=	=	=	=	=	=	>	>	=	=	=	>	=	=	=
Upper Chichester Township	=	=	=	=	=	=	=	=	=	>	=	=	=	=	=	=	=
Upper Darby Township	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=
Upper Providence Township	>	=	=	=	=	>	>	=	=	>	=	>	=	>	=	=	=
Yeadon Borough	=	=	=	=	=	=	=	=	>	>	=	=	=	=	=	=	=

4.4.3. Potential Loss Estimates

Based on various kinds of available data, potential loss estimates were established for flood, flash flood, and ice jam, tornado and windstorms, wildfires and winter storms. Estimates

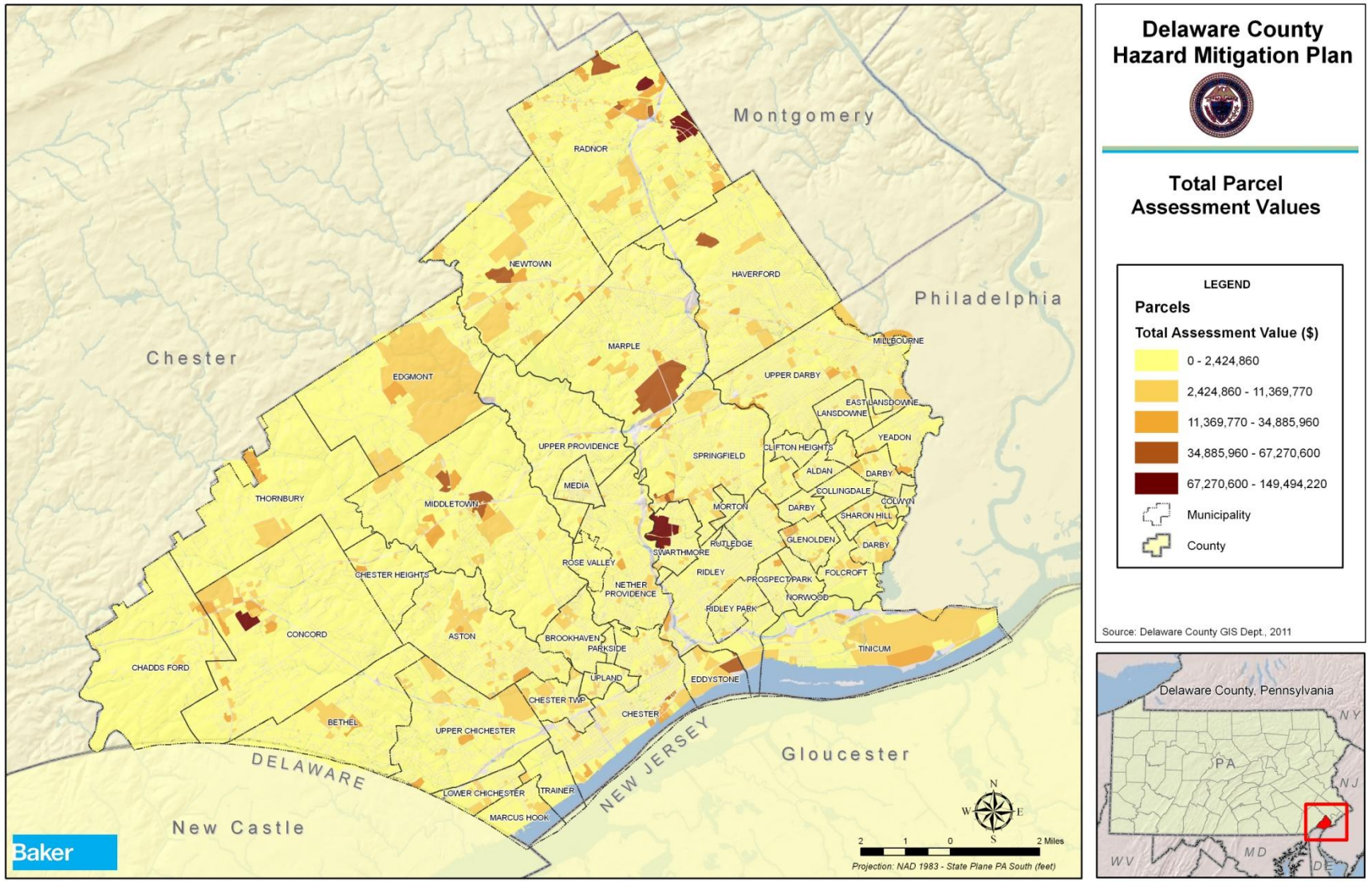
provided in this section are based on HAZUS-MH, version MR4, geospatial analysis, and previous events. Estimates are considered *potential* in that they generally represent losses that could occur in a countywide hazard scenario. In events that are localized, losses may be lower, while regional events could yield higher losses.

Potential loss estimates have four basic components, including:

- Replacement Value: Current cost of returning an asset to its pre-damaged condition, using present-day cost of labor and materials.
- Content Loss: Value of building's contents, typically measured as a percentage of the building replacement value.
- Functional Loss: The value of a building's use or function that would be lost if it were damaged or closed.
- Displacement Cost: The dollar amount required for relocation of the function (business or service) to another structure following a hazard event.

The parcel data used in this plan includes building values provided in the county tax assessment database. These values are representative of replacement value alone; content loss, functional loss, and displacement cost are not included. Figure 4.4-1 illustrates the range of parcel values in Delaware County. The 198,265 parcels in Delaware County have a cumulative assessed value of over $41 billion for the parcels and the land. The average assessed value of these parcels and land is $845 million. Radnor Township holds the largest amount of assets in the County with $5.6 billion. At the other end of the spectrum, Millbourne Borough has the potential to experience the least loss of all municipalities with just over $23.5 million in building and land assessed value.

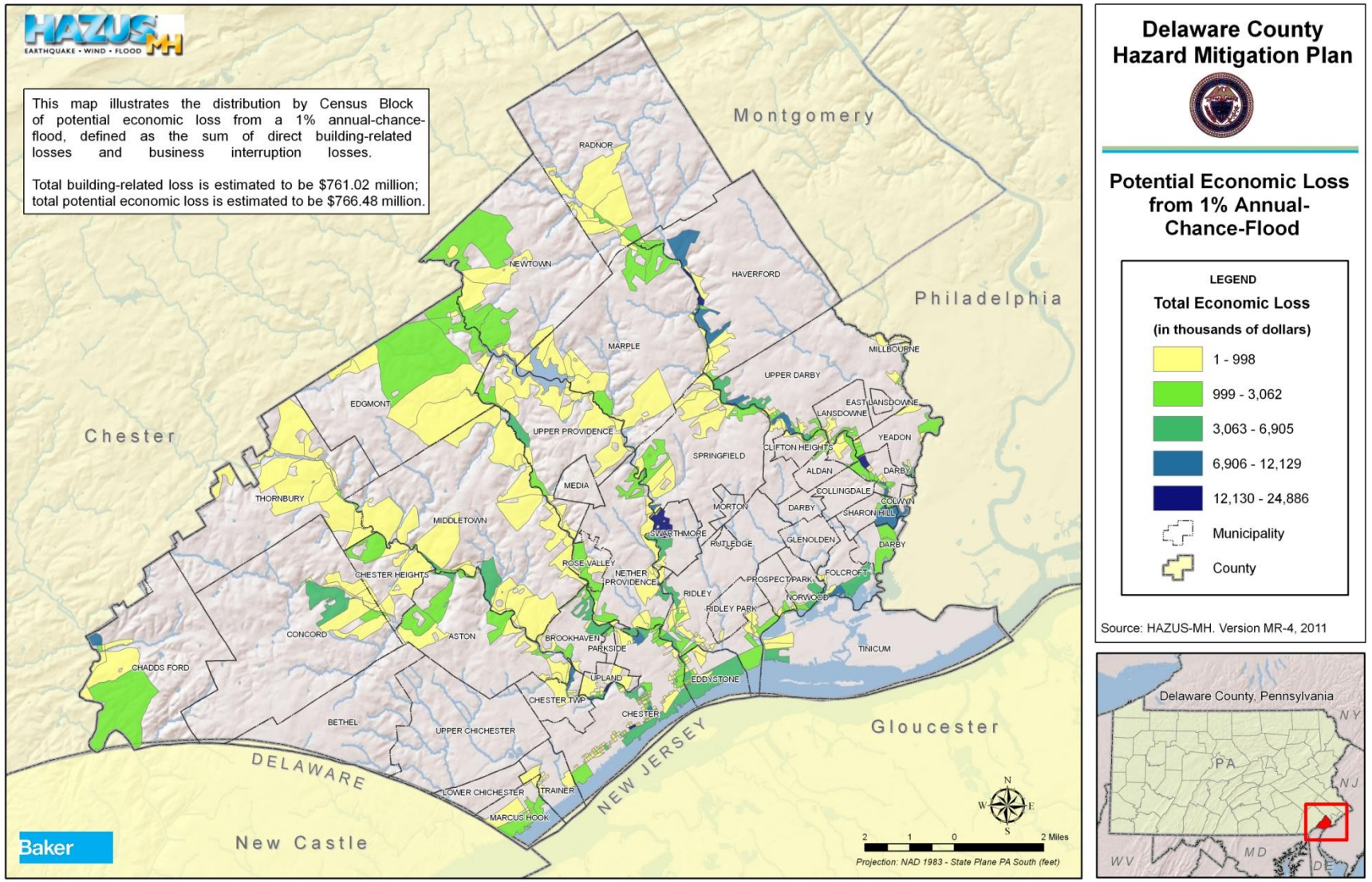
Figure 4.4-1: Delaware County parcel assessed values (Delaware County GIS Department, 2011).



The full suite of potential losses was able to be calculated for flood events using HAZUS-MH MR4, a standardized loss estimation software package available from FEMA. These studies provided estimates of total economic loss, building damage, content damage, and other economic impacts that can be used in local flood response and mitigation planning activity.

Using HAZUS-MH, total building-related losses for the 1% annual-chance flood event were estimated to be $761 million. Approximately 50% of these building-related losses were incurred by residential occupancies; a further 25% of building-related losses were incurred by commercial properties. Approximately 17% of the building-related losses were incurred by industrial occupancies. Figure 4.4-2 shows the spatial distribution of total economic losses at the Census block level. These total economic losses incorporate both building-related losses and business interruption losses. Some of the highest economic losses are expected in Swarthmore, Sharon Hill, and Upland Boroughs and in municipalities along the Delaware River. Tinicum Township is a river-bordering community; however, HAZUS results depict few losses. This is because the municipality is protected from floods by several levees. If these levees were not in place, flood events would impact more areas of the township and result in more losses. Total economic loss, including replacement value, content loss, functional loss, and displacement cost was estimated at $766.5 million for the entire County. The full HAZUS results report can be found in **Appendix F**.

Figure 4.4-2: Delaware County potential economic loss calculated with HAZUS-MH MR4.

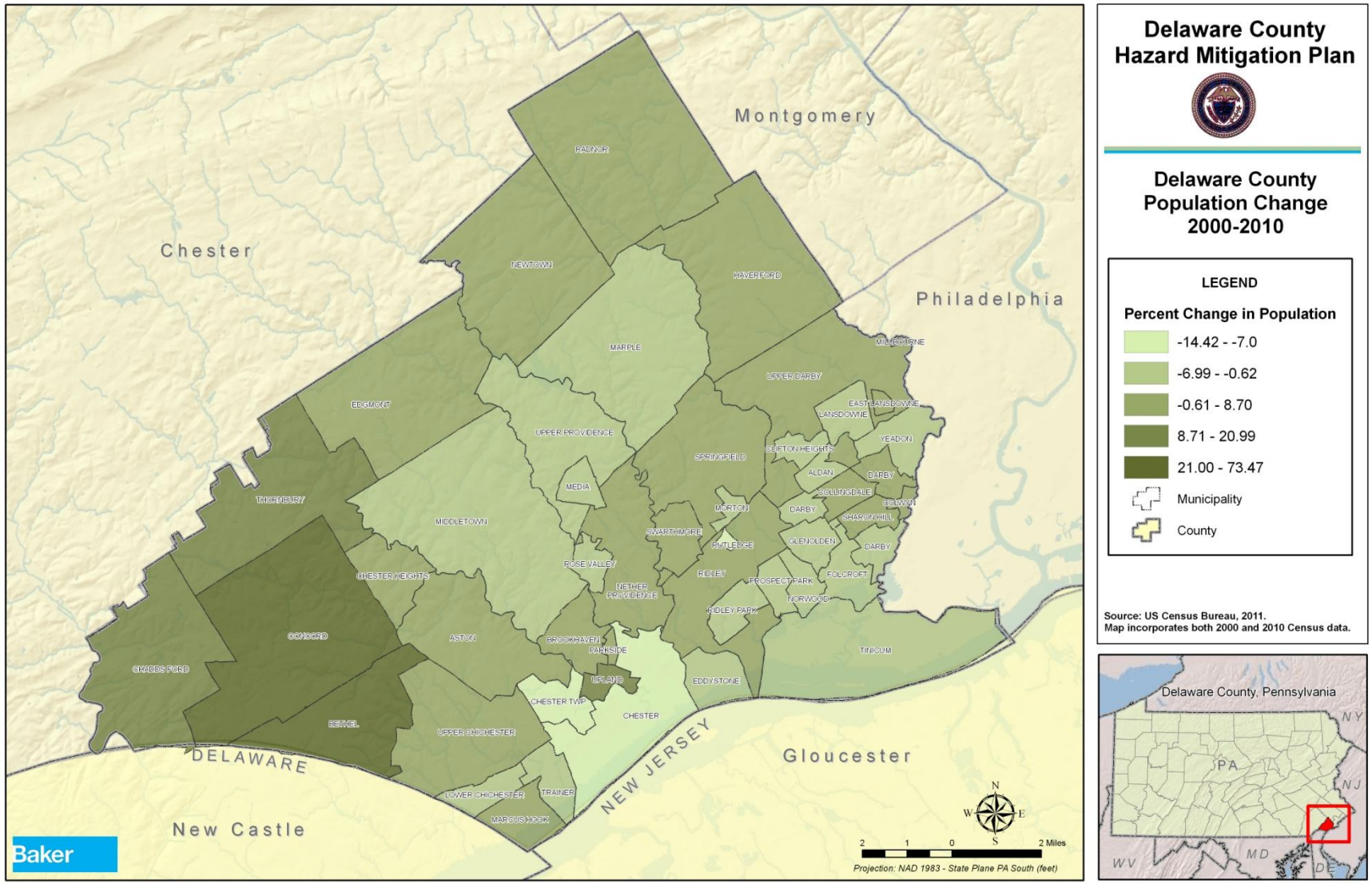


4.4.4. Future Development and Vulnerability

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. Delaware County is expected to experience a variety of factors that will, in some areas, increase vulnerability to hazards while in other areas, vulnerability may stay static or even be reduced.

Population change and the age of the housing stock are main indicators of vulnerability change in Delaware County. As discussed in Section 2.3, the total population of Delaware County has increased by 1.5 percent from 2000 to 2010. The population change in the County can be seen in Figure 4.4-3. This overall change reflects areas of growth in twenty-three municipalities along with loss in population in the remaining twenty-six (US Census, 2011). Of the twenty-three municipalities that grew in this time period, five experienced growth of over 10 percent: Thornbury Township grew by 13.18%, Chadds Ford Township grew by 14.83%, Millbourne Borough grew by 22.91%, Bethel Township grew by 36.91% and Concord Township grew by 73.47%. Concord Township is now the eighth largest municipality in Delaware County. Most of the municipalities that lost population between 2000 and 2010 did not lose large percentages, five municipalities lost over 5 percent of their population in this time period: Folcroft Borough lost 5.33%, Tinicum Township lost 6.02%, Chester City lost 7.82%. Rutledge Borough lost 8.84%, and Chester Township lost 14.42%. Chester City is the third most populous municipality in the County, which has not changed since 2000. Areas of higher density, in the larger municipalities and growing municipalities, face an increased vulnerability and loss estimates from most hazard events. However, the more remote and sparsely population municipalities face higher vulnerability because they do not have as easy access to care facilities or response personnel. In addition, municipalities that experienced a large increase in population experience a higher risk to hazards such as drought, wildfire, environmental hazards, utility interruption, and winter storms. The townships with the largest population increase percentages between 2000 and 2010 include Bethel, Concord, Chadds Ford, Millbourne, and Thornbury Townships. However, although these townships experienced large population increase percentages since the 2000 census, they do not have the largest overall populations. The three municipalities with the largest populations and thus higher vulnerability to hazards include Upper Darby Township, Haverford Township, and Chester City.

Figure 4.4-3: Municipal population change in Delaware County (US Census 2000 and 2011).



The aging housing stock in Delaware County is another source of current and future vulnerability in many hazard events. As discussed in Section 4.3.12.5, a moderate percentage of the housing stock, over 22 percent, was built before 1940. Delaware County can experience gusts of wind up to 160 miles per hour during windstorms or tornadoes. 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. Table 4.3.12-3 shows that the municipalities most vulnerable to these hazards, those with over 40 percent of structures built before 1940, are: Eddystone Borough, Swarthmore Borough, East Lansdowne Borough, Prospect Park Borough, Clowyn Borough, Lansdowne Borough, Darby Borough, Marcus Hook Borough, and Rutledge Borough.

Delaware County does not currently have a Comprehensive Plan to guide future development. However, all of the individual municipalities have comprehensive plans which provide guidance for where and how development should take place. The Delaware County Planning Department is working on drafting a Comprehensive Plan, which can address areas of vulnerability across the County when completed.

5. Capability Assessment

5.1. Update Process Summary

Delaware County has a number of resources that it can access to implement hazard mitigation initiatives. These resources include both private and public assets at the local, state, and federal levels. In this section Delaware County has identified the resources and capabilities that are currently in place to reduce the risk from their identified hazards. A capability assessment, put simply, means looking at what you are doing, what you are not doing, what you can do, and even what you are doing wrong to reduce your communities risks from hazards. This capability assessment looks at government programs and policies, regulations and ordinances, existing emergency plans, personnel and equipment, and the like. Additionally, the capability assessment looks at the resources available to local communities to reduce disaster risks.

The 2006 HMP identified the presence of local plans, ordinances, and codes in the County's municipalities. It also specified local, state, and federal resources available for mitigation efforts. Through responses to the *Capability Assessment Survey* distributed to all 49 municipalities and input from the HMSC and the HMPT, the 2011 HMPU provides an updated inventory of the most critical local planning tools available within each municipality and a summary of the fiscal and technical capabilities available through programs and organizations outside of the County. In addition, it identifies emergency management capabilities and the processes used for implementation of the National Flood Insurance Program.

While the capability assessment serves as a good instrument for identifying local capabilities, it also provides a means for recognizing gaps and weaknesses that can be resolved through future mitigation actions. The results of this assessment lend critical information for developing an effective mitigation strategy.

5.2. Capability Assessment Findings

5.2.1. Emergency Management

The Delaware County Department of Emergency Services coordinates countywide emergency management efforts. 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 this plan was obtained from the emergency management coordinators. The Emergency Management Services Code (PA Title 35) requires that all municipalities in the Commonwealth have a Local Emergency Operations Plan (EOP) which is updated every two years. All 49 municipalities in Delaware County have or are in the process of updating their local EOP. A countywide EOP also exists from 2006. Municipalities are not required to sign on to the County EOP although it is encouraged.

5.2.2. Participation in the NFIP

All of the municipalities in Delaware County have participated in the NFIP program in the past. Delaware County's DFIRMs went effective on November 18, 2009. The digital maps greatly enhanced mitigation capabilities as they relate to identifying flood hazards and are a significant improvement to the previously effective paper Flood Insurance Rate Maps. As of February 2011, there is one municipality (Rutledge Borough) that was suspended from the program (see

Table 5.2-1). The suspended municipality can rejoin the program if it submits a compliant ordinance, a letter from the Borough requesting reinstatement in the program, and a letter stating that there has not been any development in the special flood hazard area that was not in compliance with the minimum standards of the NFIP.

The NFIP is managed by local municipalities participating in the program through ordinance adoption and floodplain regulation while the Delaware County Planning Department and Delaware County Department of Emergency Services provide 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).

FEMA Region III makes available to communities, an ordinance review checklist 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 Pennsylvania Department of Community and Economic Development (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.

The Delaware County Planning Department recommended the DCED PA Model Floodplain Ordinance to the municipalities for their use in updating their floodplain ordinances with the release of the 2009 DFIRMS. In addition, the DCPD recommended additional stricter language to be included in the updated floodplain ordinances. The DCPD found in their review of the ordinances that most were consistent with the DCED model although many did not use the entire DCED model.

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 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 Delaware County currently participating in the NFIP Community Rating System (CRS) (FEMA CIS, 2011).

5.2.3. Planning and Regulatory Capability

The most important capabilities that the municipalities utilize are zoning, land use and floodplain management ordinances, and building codes. These tools provide mechanisms for the implementation of adopted mitigation strategies. Table 5.2-1 summarizes their presence within each municipality.

Table 5.2-1: Summary of planning tools adopted by each municipality in Delaware County (HMP Capability Assessment Surveys, 2011; Delaware County Planning Department 2011)

COMMUNITY	COMPRE-HENSIVE PLAN	BUILDING CODE	FLOODPLAIN ORDINANCE - NFIP PARTICIPANT	SUBDIVISION & LAND DEVELOPMENT ORDINANCE	ZONING ORDINANCE	Act 167 Stormwater Management	Building Permits Required
Aldan Borough	Y (multi-municipal)	Y	Y	Y	Y	Y (Darby-Cobbs)	Y
Aston Township	Y (multi-municipal)	Y	Y	Y	Y	Y (Chester)	Y
Bethel Township	Y	Y	Y	Y	Y	Y (Chester)	Y
Brookhaven Borough	Y (multi-municipal)	Y	Y	Y, County's	Y	Y (Ridley; Chester)	Y
Chadds Ford Township	Y	Y	Y	Y	Y	Y (Chester)	Y
Chester City	Y (currently being updated)	Y	Y	Y	Y	Y (Ridley; Chester)	Y
Chester Township	Y	Y	Y	Y	Y	Y (Chester)	Y
Chester Heights Borough	Y (will adopt update in fall 2011)	Y	Y	Y	Y	Y (Chester)	Y
Clifton Heights Borough	Y (multi-municipal)	Y	Y	Y, County's	Y	Y (Darby Cobbs)	Y
Collingdale Borough	Y (multi-municipal)	Y	Y	Y, County's	Y	Y (Darby Cobbs)	Y
Colwyn Borough	Y (multi-municipal)	Y	Y	Y, County's	Y	Y (Darby Cobbs)	Y
Concord Township	Y	Y	Y	Y	Y	Y (Chester)	Y
Darby Borough	Y	Y	Y	Y, County's	Y	Y (Darby Cobbs)	Y
Darby Township	Y	Y	Y	Y, County's	Y	Y (Darby Cobbs)	Y
East Lansdowne Borough	Y (multi-municipal)	Y	Y	Y, County's	Y	Y (Darby Cobbs)	Y
Eddystone Borough	Y (multi-municipal update to be adopted summer 2011)	Y	Y	Y, County's	Y	Y (Crum; Ridley)	Y

Table 5.2-1: Summary of planning tools adopted by each municipality in Delaware County (HMP Capability Assessment Surveys, 2011; Delaware County Planning Department 2011)

COMMUNITY	COMPRE-HENSIVE PLAN	BUILDING CODE	FLOODPLAIN ORDINANCE - NFIP PARTICIPANT	SUBDIVISION & LAND DEVELOPMENT ORDINANCE	ZONING ORDINANCE	Act 167 Stormwater Management	Building Permits Required
Edgmont Township	Y (currently being updated)	Y	Y	Y	Y	Y (Crum; Ridley; Chester)	Y
Folcroft Borough	Y	Y	Y	Y, County's	Y	Y (Darby Cobbs)	Y
Glenolden Borough	Y (multi-municipal update to be adopted summer 2011)	Y	Y	Y, County's	Y	Y (Darby Cobbs)	Y
Haverford Township	Y	Y	Y	Y	Y	Y (Darby Cobbs)	Y
Lansdowne Borough	Y (multi-municipal)	Y	Y	Y, County's	Y	Y (Darby Cobbs)	Y
Lower Chichester Township	Y (multi-municipal)	Y	Y	Y, County's	Y	N	Y
Marcus Hook Borough	Y	Y	Y	Y, County's	Y	N	Y
Marple Township	Y	Y	Y	Y	Y	Y (Darby Cobbs; Crum)	Y
Media Borough	Y (currently being updated)	Y	Y	Y	Y	Y (Crum; Ridley)	Y
Middletown Township	Y	Y	Y	Y	Y	Y (Ridley; Chester)	Y
Millbourne Borough	Y	Y	Y	Y, County's	Y	Y (Darby Cobbs)	Y
Morton Borough	Y	Y	Y	Y, County's	Y	Y (Darby Cobbs; Crum)	Y
Nether Providence Township	Y (multi-municipal)	Y	Y	Y	Y	Y (Crum; Ridley)	Y
Newtown Township	Y	Y	Y	Y	Y	Y (Darby Cobbs; Crum)	Y
Norwood Borough	Y	Y	Y	Y, County's	Y	Y (Darby Cobbs)	Y

Table 5.2-1: Summary of planning tools adopted by each municipality in Delaware County (HMP Capability Assessment Surveys, 2011; Delaware County Planning Department 2011)

COMMUNITY	COMPRE-HENSIVE PLAN	BUILDING CODE	FLOODPLAIN ORDINANCE - NFIP PARTICIPANT	SUBDIVISION & LAND DEVELOPMENT ORDINANCE	ZONING ORDINANCE	Act 167 Stormwater Management	Building Permits Required
Parkside Borough	Y (multi-municipal)	Y	Y	Y, County's	Y	Y (Ridley; Chester)	Y
Prospect Park Borough	Y (multi-municipal update to be adopted	Y	Y	Y, County's	Y	Y (Darby Cobbs)	Y
Radnor Township	Y	Y	Y	Y	Y	Y (Darby Cobbs)	Y
Ridley Township	Y (multi-municipal update to be adopted summer 2011)	Y	Y	Y	Y	Y (Darby Cobbs; Crum; Ridley)	Y
Ridley Park Borough	Y	Y	Y	Y	Y	Y (Darby Cobbs; Crum)	Y
Rose Valley Borough	Y (multi-municipal)	Y	Y	Y	Y	Y (Ridley)	Y
Rutledge Borough	Y (multi-municipal)	Y	Y - ordinance however No NFIP participant	Y	Y	Y (Darby Cobbs; Crum)	Y
Sharon Hill Borough	Y (multi-municipal)	Y	Y	Y	Y	Y (Darby Cobbs)	Y
Springfield Township	Y (multi-municipal)	Y	Y	Y	Y	Y (Darby Cobbs; Crum)	Y
Swarthmore Borough	Y (multi-municipal)	Y	Y	Y	Y	Y (Crum)	Y
Thornbury Township	Y	Y	Y	Y	Y	Y (Ridley; Chester)	Y
Tinicum Township	Y	Y	Y	Y	Y	Y (Darby Cobbs)	Y
Trainer Borough	Y	Y	Y	Y, County's	Y	N	Y
Upland Borough	Y (multi-municipal)	Y	Y	Y	Y	Y (Ridley; Chester)	Y
Upper Chichester Township	Y (multi-municipal)	Y	Y	Y (under development)	Y (under developme nt)	Y (Ridley; Chester)	Y
Upper Darby Township	Y	Y	Y	Y, County's	Y	Y (Darby Cobbs)	Y

Table 5.2-1: Summary of planning tools adopted by each municipality in Delaware County (HMP Capability Assessment Surveys, 2011; Delaware County Planning Department 2011)

COMMUNITY	COMPRE-HENSIVE PLAN	BUILDING CODE	FLOODPLAIN ORDINANCE - NFIP PARTICIPANT	SUBDIVISION & LAND DEVELOPMENT ORDINANCE	ZONING ORDINANCE	Act 167 Stormwater Management	Building Permits Required
Upper Providence Township	Y	Y	Y	Y	Y	Y (Crum; Ridley	Y
Yeadon Borough	Y	Y	Y	Y, County's	Y	Y (Darby Cobbs)	Y

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. Delaware County does not have an approved countywide Comprehensive Plan however they are currently in the process of drafting one. All municipalities in Delaware County have developed their own Comprehensive Plan, and several have adopted multi-municipal comprehensive plans (see Table 5.2-1). Future comprehensive plan updates and improvements will consider 2011 HMPU findings.

Building codes are important in mitigation, because codes are developed for regions of the country in consideration of the hazards present within that region. Consequently, structures that are built to applicable codes are inherently resistant to many hazards like strong winds, floods, and earthquakes and can help mitigate regional hazards like wildfires. In 2003, the Commonwealth of Pennsylvania implemented the Uniform Construction Code (Act 45 of 1999), a comprehensive building code that establishes minimum regulations for most new construction, including additions and renovations to existing structures. All 49 municipalities in Delaware County are required to adhere to the UCC. On December 10, 2009 the Commonwealth adopted regulations of the 2009 International Code Council's codes. The effective date of the regulations is December 31, 2009. Since all municipalities in Delaware County are required to abide by the UCC they are required to enforce the 2009 building code regulations for all building permits submitted after December 31, 2009. If a design or construction contract for proposed work was signed between December 31, 2006 and December 30, 2009 then the 2006 International Codes must be abided. In addition, all of the County's municipalities require building permits for new construction.

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, 49 municipalities within the County have floodplain regulations in place.

Subdivision and land development ordinances 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. The Delaware County Planning Department has developed a model Subdivision and Land Development Ordinance. Based on available information, all municipalities have subdivision and land development ordinances in place and many of these municipalities have adopted the County's model 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. Based on available information, a total of 20 municipalities have zoning regulations in place.

The Pennsylvania legislature enacted the Stormwater Management Act (Act 167 if 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.

There are three Act 167 Plans in effect in Delaware County: Ridley Creek (1988), Chester Creek Watershed Act 167 Plan (June 2002), and Darby and Cobbs Creeks Watershed Act 167 Plan (May 2005). In addition, a Brandywine Creek Act 167 Plan is being prepared by Chester County and will affect only a small portion of land area in Delaware County. Phase II of the Crum Creek Act 167 Plan is currently underway. The Delaware County Planning Department anticipates that the Crum Creek Act 167 Plan will be ready for adoption by the end of 2011. Municipalities in the Crum Creek watershed will be required to adopt the stormwater management ordinances included in the updated plan. The Crum Creek Act 167 Plan will serve the County-wide model ordinance for updates to future 167 plans and will place additional emphasis on water quality standards.

5.2.4. 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.

Based on assessment results, municipalities in Delaware County have somewhat moderate administrative and technical staff needed to conduct hazard mitigation-activities. There seems to be sufficient emergency management staff across the County and several municipalities have engineers. A common lack of personnel for land surveying and planners related to community hazards was reported. This result is not necessarily surprising since these tasks are typically contracted to outside providers. Few communities have personnel skilled in geographic information systems. All of the municipalities in the County have an identified emergency management coordinator. Some of these coordinators are responsible for more than one jurisdiction.

State agencies agency 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

Federal agencies which can provide technical assistance for mitigation activities include, but are not limited to:

- 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

Some examples of state training programs available for Delaware County and municipal staff which can better equip them to handle hazard mitigation activities include the “Building Code Enforcement: An Intergovernmental Approach,” “Statewide Building Code: Understand Your Options, Make a Choice,” “Basic Course for Zoning Officials,” and “Stormwater Management.” PEMA also offers training in conjunction with FEMA for emergency management and hazard mitigation activities with courses such as the “Hazardous Weather and Flooding Preparedness Course.”

As part of Pennsylvania’s anti-terrorism initiative, the Task Force on Security has launched proposals geared to strengthening emergency preparedness, quickening response and

enhancing communication and coordination at all levels. The proposals ranged from bolstering security at nuclear power plants and airports to expediting equipment acquisition for first responders.

5.2.5. Fiscal Capability

The decision and capacity to implement mitigation-related activities is often strongly dependent on the presence of local financial 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 communities are trying to take advantage of state or federal mitigation grant funding opportunities that require local-match contributions. Based on survey results, most municipalities within the County perceive fiscal capability to be moderate.

Delaware County and its municipalities may also be able to access several of the resources offered by the Commonwealth of Pennsylvania. One resource that may have particular application to hazard mitigation initiatives is the "Growing Greener" campaign. Growing Greener was first signed into law in 1999, investing nearly $650 million in preserving farmland and protecting open space, eliminating the maintenance backlog in state parks, cleaning up abandoned mines and restoring watersheds, providing funds for recreational trails, helping communities address land use, and providing new and upgraded water and sewer systems. The state recently renewed the grant program in 2005 to provide $650 million dollars to accomplish on the ground environmental projects. Many counties have received grants to address land use and open space issues. Delaware County could direct some of these funds (e.g., for recreational trails) towards hazard mitigation objectives like acquisition and demolition of flood-prone structures.

DCNR provides a single point of contact for communities seeking state assistance in support of local conservation initiatives. This assistance can take the form of grants, technical assistance, information exchange, and training.

Some additional sources of help from the Commonwealth include:

- **Local Government Capital Projects Loan Program (LGCPLP)**: Provides low interest loans for up to 50% of the total cost of purchasing equipment up to a maximum of $25,000 or 50% of the total cost of municipal facility needs up to $50,000 for small local governments with populations of 12,000 or less;
- **Shared Municipal Services Program (SMSP):** Provides grant funds to promote cooperation among municipalities, encouraging more efficient and effective delivery of municipal services like shared personnel activities or equipment or shared data processing operations;
- **Land Use Planning and Technical Assistance Program (LUPTAP):** Provides grant funds for the preparation of community comprehensive plans and ordinances to implement them;

- **Floodplain Land Use Assistance Program:** Provides grants and technical assistance to encourage the proper use of land and the management of floodplain lands including the costs for clerical, technical, and legal staff as well as advertising, public hearing, and consultant costs;
- **Community Revitalization Program:** Provides grant funds to support local initiatives that promote social and economic diversity to ensure a productive tax base and good quality of life with projects like construction or rehabilitation of infrastructure, building rehabilitation, public safety, recreation, and acquisition;
- **Community Development Block Grants (CDBG):** Provides grants of up to $500,000 and technical assistance for federally designated municipalities to undertake community development including housing rehabilitation, public services, community facilities, infrastructure improvements, and development and planning. Seventy (70)% of the grant money must go towards activities that benefit low and moderate income families;
- **Emergency Resources and Training Program (ERTP):** May be used for emergency responder improvement projects. Projects must demonstrate a benefit to community activities associated with police, fire, ambulance or related public safety services; and
- **Local Municipal Resources and Development Program (LMRDP):** Provides grants to municipalities to improve the quality of life in a community. Uses of the money include construction or rehabilitation of infrastructure, building rehabilitation, acquisition and demolition of structures, revitalization or construction of community facilities, the purchase or upgrade of machinery and equipment, public safety, and crime prevention.

Other state programs which may provide financial support for mitigation activities include, but are not limited to:

- Community Conservation Partnerships Program
- Keystone Grant Program
- Pennsylvania Heritage Areas Program
- Pennsylvania Recreational Trails Program
- Shared Municipal Services
- Technical Assistance Program

The federal government offers a number of mitigation-related funding and training resources. FEMA has several programs detailed below that support hazard mitigation. It should be noted that these programs require local governments to have a hazard mitigation plan in order to be eligible to receive such grants.

Pre-Disaster Mitigation Grants

The Pre-Disaster Mitigation (PDM) program provides funds to states, territories, Indian tribal governments, and communities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations. PDM grants are to be awarded on a competitive basis and without reference to state allocations, quotas, or other formula-based allocation of funds (FEMA, 2011c).

Hazard Mitigation Grant Program
Provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster (FEMA, 2011b).

Hazard Mitigation Grant Program funding is only available to applicants that reside within a presidentially-declared disaster area. Eligible applicants:

- State and local governments
- Indian tribes or other tribal organizations
- Certain nonprofit organizations

Individual homeowners and businesses may not apply directly to the program; however, a community may apply on their behalf.

HMGP funds may be used to fund projects that will reduce or eliminate the losses from future disasters. Projects must provide a long-term solution to a problem, for example, elevation of a home to reduce the risk of flood damages as opposed to buying sandbags and pumps to fight the flood. In addition, a project's potential savings must be more than the cost of implementing the project. Funds may be used to protect either public or private property or to purchase property that has been subjected to, or is in danger of, repetitive damage. Examples of projects include, but are not limited to:

- Acquisition of real property for willing sellers and demolition or relocation of buildings to convert the property to open space use
- Retrofitting structures and facilities to minimize damages from high winds, earthquake, flood, wildfire, or other natural hazards
- Elevation of flood-prone structures
- Development and initial implementation of vegetative management programs
- Minor flood control projects that do not duplicate the flood prevention activities of other federal agencies
- Localized flood control projects, such as certain ring levees and floodwall systems, that are designed specifically to protect critical facilities
- Post-disaster building code related activities that support building code officials during the reconstruction process

Flood Mitigation Assistance Program
The FMA program was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994 (42 U.S.C. 4101) with the goal of reducing or eliminating claims under the National Flood Insurance Program. FEMA provides FMA funds to assist states and communities in implementing measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the NFIP (FEMA, 2011a).

There are three types of FMA grants available to states and communities: planning, project, and technical assistance. Planning grants are given to prepare Flood Mitigation Plans. Only NFIP-participating communities with approved Flood Mitigation Plans can apply for FMA project grants. Project grants are available to implement measures to reduce flood losses, such as elevation, acquisition, or relocation of NFIP-insured structures. States are encouraged to prioritize FMA funds for applications that include repetitive-loss properties; these include structures with two or more losses each with a claim of at least $1,000 within any ten-year period since 1978. Technical assistance grants are available to state governments to help them administer the FMA program and activities. Project grants may be awarded for up to 10% of the project cost.

Public Assistance
The objective of this program is to provide assistance to states, local governments, and certain non-profit organizations to alleviate suffering and hardship resulting from major disasters or emergencies declared by the President (FEMA, 2011d). Through the Public Assistance Program, FEMA provides supplemental federal disaster grant assistance for the repair, replacement, or restoration of disaster-damaged publicly owned facilities and the facilities of certain private non-profit organizations. The federal share of assistance is not less than 75% of the eligible cost for emergency measures and permanent restoration. The grantee (usually the state) determines how the non-federal share (up to 25%) is split with the subgrantees (eligible applicants).

Repetitive Flood Claims (RFC) Program
Provides funding to reduce or eliminate the long-term risk of flood damage to structures insured under the NFIP that have one or more claim payments for flood damage. RFC funds may only be used for mitigation of structures in a state or community that cannot meet the requirements of the FMA program for either cost share or capacity to manage the activities.

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.

Other federal resources include:

- 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.

5.2.6. Political Capability

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 Survey* was used to capture information on each jurisdiction's political capability. Survey respondents were asked to identify examples of political capability, such as guiding development away from hazard areas, restricting public investments or capital improvements within hazard areas, or enforcing local development standards that go beyond minimum state or federal requirements (i.e. building codes, floodplain management ordinances, etc…). These examples were used to guide respondents in scoring their community on a scale of "unwilling" (0) to "very willing" (5) to adopt policies and programs that reduce hazard vulnerabilities. Of the 32 municipalities that responded, scores ranged from 0-5 with an average score of 4.1.

5.2.7. Self-Assessment

In addition to the inventory and analysis of specific local capabilities, the *Capability Assessment Survey* required each local jurisdiction to conduct its own self-assessment of its capability to effectively implement hazard mitigation activities. As part of this process, county and municipal officials were encouraged to consider the barriers to implementing proposed mitigation strategies in addition to the mechanisms that could enhance or further such strategies. In response to the survey questionnaire, local officials classified each of the capabilities as either "limited," "moderate" or "high." Table 5.2-2 summarizes the results of the self-assessment survey as a percentage of responses received. For example, 45% of communities who responded indicated their community had limited fiscal capabilities related to hazard mitigation activities that reduce hazard vulnerabilities.

Table 5.2-2: Summary of self-assessment capability responses expressed as a percentage of responses received.			
CAPABILITY CATEGORY	**LIMITED**	**MODERATE**	**HIGH**
Planning & Regulatory	27%	48%	24%
Administrative & Technical	30%	52%	18%
Fiscal	45%	52%	3%
Political	30%	52%	18%
Community Resiliency	27%	61%	12%

5.2.8. Existing Limitations

As mentioned, there are no communities in Delaware County participating in the NFIP Community Rating System. However, all municipalities in the County except for East Lansdowne Borough are prone to flooding from the rivers, streams, creeks and lakes that run throughout the county. Community participation in this program can provide premium reductions for properties located outside of Special Flood Hazard Areas of up to ten 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).

All 49 municipalities have zoning ordinances in place and thus local land use controls. However, not all of these have been amended since the new provisions were added to the Pennsylvania Municipalities Planning Code, amended in 2000.

There are no communities in Delaware County that participate in the *Firewise* program. However, all communities within the County have been identified as vulnerable to wildfire hazards and 24 of which are considered to be at high risk of wildfires. The Pennsylvania Firewise Community Program assists planned and existing communities in implementing management practices which reduce the risk of wildfire events. Firewise communities are those that avoid potential fire emergencies by addressing and correcting fire hazards and preparing for the threat of a wildfire event (DCNR – BOF, 2009). Improved participation in this program will reduce the loss of lives, property and resources to wildfires by building and maintaining communities using practices that are compatible with their natural surroundings.

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 since 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. In these situations, the Pennsylvania Department of Transportation must decide to undertake the project. Since the 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.

Finally, limited funding is a critical barrier to the implementation of hazard mitigation activities. The County will need to rely on regional, state and federal partnerships for financial assistance.

6. Mitigation Strategy

6.1. Update Process Summary

Mitigation *goals* are general guidelines that explain what the County wants to achieve. Goals are usually expressed as broad policy statements representing desired long-term results. Mitigation *objectives* describe strategies or implementation steps to attain the identified goals. Objectives are more specific statements than goals; the described steps are usually measurable and can have a defined completion date. There were six goals and twenty-four objectives identified in the 2006 HMP. A list of these goals and objectives as well as a review summary based on comments received from municipal representatives and other stakeholders who participated in the HMP update process is included in Table 6.1-1. These reviews are based on responses received from communities to the *Proposed Goals and Objectives Worksheet* and comments received from County officials. The *Proposed Goals and Objectives Worksheet* was provided to all municipal officials at the Risk Assessment / Mitigation Solutions Workshop and made available on the www.DelawareHMP.com website. **Appendix C** contains completed copies of the *Proposed Goals and Objectives Worksheets* received from municipal representatives and other stakeholders.

Table 6.1-1: List and review summary of 2006 mitigation strategy goals and objectives.	
Goal 1: Reduce the potential injury/death and damage to existing community assets due to flooding.	
Objective 1.1: Identify and evaluate protection of existing critical facilities with the highest relative vulnerability in the 100-year floodplain (now referred to as the 1% annual chance floodplain).	**Review:** The Hazard Mitigation Steering Committee agreed that this goal should be continued. Objective 1.6 was removed because Delaware County is satisfied with the DFIRMs that they received in 2009. Objectives 1.1 through 1.5 have been continued into the 2011 plan.
Objective 1.2: Identify and evaluate strategies for repetitive-loss properties.	
Objective 1.3: Provide public outreach/education regarding strategies (e.g., floodproofing) for property owners in the 100-year floodplain (now referred to as the 1% annual chance floodplain).	
Objective 1.4: Address identified data limitations regarding lack of detailed information about individual structures located in the 100-year floodplain (now referred to as the 1% annual chance floodplain).	
Objective 1.5: Identify and evaluate protection for hazardous material storage in the floodplain.	
Objective 1.6: Obtain updated detailed flood studies and FIRMs (including 500-year flood) for areas with the greatest potential damage and threat to residents.	
Goal 2: Reduce potential injury/death and damage to existing community assets due to severe weather and other identified hazards.	
Objective 2.1: Identify vulnerable buildings/populace and critical facilities; develop a comprehensive approach to reducing the possibility of damage and loss of function to those structures (and potential threat to residents) due to the effects of severe weather.	**Review:** The HMSC and municipal officials agreed this goal should continue into the HMPU. The wording of Objective 2.1 was modified to remove the word “populance” as the HMSC believed that the focus of the objective was on building and structures. The wording of Objective 2.3 was modified to change “storm shelters” to “temporary shelters” so that this would include other hazards.
Objective 2.2: Assess availability of backup power resources (generators) for critical facilities.	
Objective 2.3: Evaluate communities that require warning systems and storm shelters.	
Objective 2.4: Evaluate means of managing stranded travelers during winter storms.	
Objective 2.5: Provide public outreach/education for mobile-home owners on proper anchoring.	

Table 6.1-1: List and review summary of 2006 mitigation strategy goals and objectives.	
Objective 2.6: Address identified data limitations regarding lack of detailed information about characteristics of individual structures such as construction type, age, condition, presence of basement, compliance with current building codes, etc.	The HMSC agreed that Objective 2.4 should be removed from the plan as it is not applicable as Delaware County is an urban county. Objectives 2.2, 2.5, and 2.6 were continued into the 2011 HMPU.
Goal 3: Increase disaster resistance of County and municipal facilities and infrastructure.	
Objective 3.1: Identify and evaluate strategies for County and municipality owned repetitive-loss properties.	**Review:** The HMSC and municipal officials agreed that the wording of this goal should be modified to include all facilities and infrastructure, not just County and municipally-owned infrastructure. The wording of Objective 3.1 was modified to include protection of all repetitive loss properties, not just County and municipally-owned repetitive loss properties. In addition, language was added to the objective to include "other disaster-prone facilities, infrastructure, and properties" and protection "through the implementation of cost-effective and technically feasible mitigation projects." Objective 3.3 was removed from the plan as it is a duplicate objective listed under goal 2 as Objective 2.6. Objective 3.4 was continued into the 2011 HMPU and were renumbered. Objective 3.5 was reworded to also include evaluating and publicizing evacuation routes through signage.
Objective 3.2: Increase the capabilities of Delaware County's GIS system to produce estimates of hazard-related damage.	
Objective 3.3: Address identified data limitations regarding lack of detailed information about characteristics of individual structures such as construction type, age, condition, presence of basement, compliance with current building codes.	
Objective 3.4: Work with neighboring counties, states, and the federal government to address widespread hazards that can affect multiple communities.	
Objective 3.5: Examine current evacuation routes.	
Goal 4: Promote disaster-resistant future development.	
Objective 4.1: Direct new development away from high hazard areas.	**Review:** The HMSC and municipal officials agreed this goal and its two objectives should continue into the 2011

Table 6.1-1: List and review summary of 2006 mitigation strategy goals and objectives.	
Objective 4.2: Provide education and training for municipal officials on the need to promote disaster resistant development.	HMPU.
Goal 5: Promote hazard mitigation as a public value in recognition of its importance to the health, safety, and welfare of the population.	
Objective 5.1: Provide public education to increase awareness of hazards and opportunities for mitigation.	**Review:** The HMSC and municipal officials agreed this goal and its three objectives should continue into the 2011 HMPU.
Objective 5.2: Promote partnerships between municipalities and the County to continue to develop a Countywide approach to identifying and implementing mitigation actions.	
Objective 5.3: Continue the promotion of disaster resistance in the business community via the hazard mitigation planning initiative.	
Goal 6: Improve response and recovery capabilities.	
Objective 6.1: Increase awareness by residents (i.e., through public outreach/education) of actions to take during an emergency.	**Review:** The HMSC and municipal officials agreed that this goal should continue. Objective 6.1 was continued into the 2011 HMPU.
Objective 6.2: Enhance response capability of County and municipal fire, police, and emergency services personnel to special populations.	Objective 6.2 was modified to include language on educating municipalities about hazards and risk in order to improve response capability of County and municipal fire, police, and emergency services personnel.

Actions provide more detailed descriptions of specific work tasks to help the County and its municipalities achieve the goals and objectives. There were forty-one actions identified in the 2006 Delaware County HMP. The majority of existing mitigation actions have been carried over into the 2011 HMP as they are continuous actions, actions in progress, or actions that were not completed in the last five years but the County would like to continue them into the 2011 HMPU so that they can work to complete them over the next five years. A list of these actions as well as a review and summary of their progress based on comments received from stakeholders involved in the HMPU process is included in Table 6.1-2. Actions were evaluated by the HMSC and municipal officials with the intent of producing a usable mitigation action plan in 2011 with actions and projects that could be completed over the next five years.

Table 6.1-2: List and review summary of 2006 mitigation actions.	
ACTION	**REVIEW**
1.1.1. Identify existing critical facilities with the highest relative vulnerability.	This action is continuous and is included in the 2011 HMPU update. The wording of the action has been modified to specify protection from flood, flash flood, and ice jams. See Action 1.
1.1.2. Conduct cost-benefit analysis of protection of those assets.	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. The wording of the action has been clarified to specify that the "assets" are critical facilities. See Action 2.
1.2.1. Identify existing repetitive-loss and substantial-damage properties (floodplain managers).	This action is continuous and is included in the 2011 HMPU update. Wording of the action has been slightly modified to including working with municipal floodplain managers. See Action 3.
1.2.2. Conduct a cost-benefit analysis of protection of repetitive-loss assets.	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. See Action 4.
1.3.1. Work with municipal officials to increase awareness among property owners including informational mailings to property owners in the 100-year floodplain (now referred to as the 1% annual chance floodplain), and sponsor a series of workshops about costs and benefits of: • Acquiring and minimizing the cost of flood insurance coverage, and • Property elevation, dry flood proofing, and wet flood-proofing.	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. See Action 5.
1.3.2. Evaluate at the municipal level the suitability of the Community Rating System (CRS)1 for insurance premium reduction (and flood damage reduction).	This action is in progress and is being continued into the 2011 HMPU update. See Action 6.
1.4.1. Obtain information for structures in the areas with the highest relative vulnerability to determine the best property protection methods. The information to be obtained includes: • Lowest-floor elevation, • Number of stories, • Presence of a basement, and • Market and/or replacement value.	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. See Action 8.
1.4.2. Obtain information for all remaining structures in the 100-year floodplain (now referred to as the 1% annual chance floodplain) to determine the best property protection methods to promote with individual property owners. Techniques for gathering information over time should include developing and implementing a program for integrated information	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. See Action 9.

Table 6.1-2: List and review summary of 2006 mitigation actions.	
ACTION	**REVIEW**
"capture" at key points in normal municipal administrative procedures, including applications for building permits at municipal offices.	
1.5.1. Identify all storage of hazardous materials in floodplains (including non-addressable structures, such as propane tanks).	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. See Action 10.
1.5.2. Evaluate alternative methods to minimize risk from existing storage areas.	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. See Action 11.
1.5.3. Assess means to prevent future storage in floodplains.	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. See Action 12.
1.6.1. Apply to FEMA for funding to undertake detailed flood studies for the County's high-hazard areas to determine BFE and a full range of flood-recurrence intervals (2-, 5-, 10-, 25-, 50-, 100-year events) for use in future refinements of the mitigation plan. (2-, 5-, 10-, 25-, 50-, 100-year events are now referred to as the 50%, 20%, 10%, 4%, 2% and 1% annual chance flood events.)	This action has been removed from the plan since Delaware County is satisfied with the DFIRMs they received in 2009.
1.6.2. Apply to FEMA for updates of the most outdated FIRMs for high-hazard areas.	This action has been removed from the plan since Delaware County is satisfied with the DFIRMs they received in 2009.
2.1.1. Conduct a qualitative evaluation process for critical facilities and infrastructure to determine relative vulnerability and gather information for subsequent refinements of this mitigation plan.	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. See Action 13.
2.1.2. Develop an action plan for reducing the potential losses at identified critical facilities and infrastructure	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. See Action 14.
2.2.1. Identify critical facilities with the highest relative vulnerability to the effects of power outage (i.e., hospitals, nursing homes, fire, police, rescue, and emergency management.	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. The language of the action has been expanded to include critical infrastructure (i.e., water pumping stations, sewage treatment plants, phone lines). See Action 15.

Table 6.1-2: List and review summary of 2006 mitigation actions.	
ACTION	**REVIEW**
2.2.2. Assess availability of backup power resources (generators) for those facilities.	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. The wording has been modified to clarify that the "facilities" are critical facilities. See Action 16.
2.2.3. Upgrade backup power resources as necessary.	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. The wording of the action has been modified to include critical facilities. See Action 17.
2.3.1. Identify residents with the highest relative vulnerability to the effects of severe weather and prepare an implementation plan.	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. The wording of the action has been modified to change the word "residents" to "communities." See Action 18.
2.3.2. If warranted, implement additional storm shelters and warning systems, including: • Community sirens •Real time weather data for emergency management personnel • NOAA weather radios for vulnerable populance, and "Reverse 911" systems	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. The wording of the action has been modified to change "community sirens" to "text-based community warning systems." The words "if warranted" have been removed and the beginning part of the action had been modified to say "Promote the use of existing warning systems and implement additional warning systems, including:" See Action 19.
2.4.1. Conduct qualitative evaluation process for managing stranded travelers (e.g. temporary shelters).	This action had been modified to say "Conduct qualitative evaluation process to evaluate the ready state of existing shelters and needs for new shelters." See Action 20.
2.5.1. Work with municipal officials to increase awareness among mobile-home owners (i.e., informational mailings, workshops) about costs and benefits of proper anchoring.	This wording of this action has been modified to "Work with municipal officials to increase awareness among mobile-home owners and evaluate how many mobile homes have been anchored." See Action 21.
2.6.1. Develop a linkage between the County tax assessment records and parcels in the County GIS to allow future revision of this plan to more easily incorporate information about property values, construction types, etc.	This action is continuous and is included in the 2011 HMPU. See Action 22.

Table 6.1-2: List and review summary of 2006 mitigation actions.	
ACTION	**REVIEW**
3.1.1. Identify existing critical facilities with the highest relative vulnerability.	This action has been modified to include infrastructure as well as critical facilities. See Action 23.
3.1.2. Conduct cost-benefit analysis of protection of those assets.	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. See Action 24.
3.2.1. Identify emerging software systems for loss estimation.	This wording of this action has been expanded to include training County staff to use HAZUS software and Delaware County Department of Emergency Services damage reporting software. See Action 25.
3.2.2. Identify funding sources for equipment, software, and data purchasing and software training.	This action is continuous and is included in the 2011 HMPU. See Action 26.
3.4.1. Work closely with assessment office to determine how best to apply current data to the needs of emergency management.	This action is continuous and is included in the 2011 HMPU. See Action 27.
3.5.1. Develop mutual agreements with neighboring counties to utilize cooperative efforts to mitigate hazards that impact communities beyond political boundaries.	This action is in progress as the County Department of Emergency Services is working on preparation, response, and recovery and has developed mutual aid agreements between five counties. The action is continued into the 2011 HMPU. See Action 28.
3.6.1. Explore using existing and or planned multi-use trails as evacuation routes.	This action is in progress as both the Chester River Walk and East Coast Greenway are in the design stage. This action is continued into the 2011 HMPU. See Action 29.
4.1.1. Review existing regulations to ensure adequacy in reducing the amount of future development in identified hazard areas, especially steep slopes and floodplains.	This action is continuous and is included in the 2011 HMPU. See Action 30.
4.1.2. Review all comprehensive plans to ensure that designated growth areas are not in hazard areas.	This action is continuous and is included in the 2011 HMPU. See Action 31.
4.1.3. Review all capital improvements to ensure that infrastructure improvements are not directed towards hazardous areas.	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. See Action 32.
4.2.1. Hold workshops for governing bodies on the importance of prohibiting development in hazard-prone areas	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. See Action 33.
4.2.2. Provide model ordinances to municipalities that can be used to prohibit development in hazard-prone areas.	This action is continuous as ordinances such as steep slope, floodplain, and stormwater management ordinances are regularly provided to the municipalities. The action is continued into the 2011

Table 6.1-2: List and review summary of 2006 mitigation actions.	
ACTION	**REVIEW**
	HMPU. See Action 34.
5.1.1. Identify and publicize success stories as part of an overall consistent public relations program.	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. See Action 35.
5.2.1. Convene regular meetings of the HMPSC to discuss issues and progress related to the implementation of the plan.	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. See Action 36.
5.3.1. Renew and expand commitments to hazard mitigation planning among partner organizations.	This action has not been completed yet but is being continued into the 2011 because it is still a priority for the County. See Action 37.
6.1.1. Increase awareness by residents of actions to take during an emergency, including sheltering and evacuation procedures. Methods to be used can include public outreach (i.e., website, mailings, workshops, media coverage) and education.	This action is continuous as the County Emergency Management Department created a "residents awareness guide" and conducts outreach sessions on emergency awareness/preparedness. The action is continued into the 2011 HMPU. See Action 38.
6.2.1. Identify special populations requiring additional emergency response.	This wording of this action has been modified to say "Educate municipalities on special needs populations requiring additional emergency response." The action is continued into the 2011 HMPU. See Action 39.
6.2.2. Evaluate means to enhance response capability for those residents.	This action is continuous and is included in the 2011 HMPU. The word "those" was removed so that all residents would be included. See Action 40.

6.2. Mitigation Goals and Objectives

Based on results of the review of the mitigation goals and objectives established in 2006, a new set of goals and objectives was adopted in 2011. Tables 6.1-1 explains how several of the existing goals and objectives were revised. Table 6.2-1 shows the mitigation goals and objectives established for the 2011 HMPU. There are six goals and twenty-one objectives identified.

Table 6.2-1: List of 2011 mitigation strategy goals and objectives.	
GOAL 1	***Reduce the possible injury/death and damage to existing community assets due to flooding.***
Objective 1.1	*Identify and evaluate protection of existing critical facilities with the highest relative vulnerability in the 1% annual chance floodplain.*
Objective 1.2	*Identify and evaluate strategies for repetitive-loss properties.*
Objective 1.3	*Provide public outreach/education regarding strategies (e.g., floodproofing) for property owners in the 1% annual chance floodplain.*
Objective 1.4	*Address identified data limitations regarding lack of detailed information about individual structures located in the 1% annual chance floodplain.*
Objective 1.5	*Identify and evaluate protection for hazardous material storage in the floodplain.*
GOAL 2	***Reduce potential injury/death and damage to existing community assets due to severe weather and other identified hazards.***
Objective 2.1	*Identify vulnerable buildings and critical facilities; develop a comprehensive approach to reducing the possibility of damage and loss of function to those structures (and potential threat to residents) due to the effects of severe weather.*
Objective 2.2	*Assess availability of backup power resources (generators) for critical facilities.*
Objective 2.3	*Evaluate communities that require warning systems and temporary shelters.*
Objective 2.4	*Provide public outreach/education for mobile-home owners on proper anchoring.*
Objective 2.5	*Address identified data limitations regarding lack of detailed information about characteristics of individual structures such as construction type, age, condition, presence of basement, compliance with current building codes, etc.*
GOAL 3	***Increase disaster resistance of facilities and infrastructure in the County.***
Objective 3.1	*Identify and evaluate strategies for protection of repetitive-loss properties and other disaster-prone facilities, infrastructure, and properties through the implementation of cost-effective and technically feasible mitigation projects.*
Objective 3.2	*Increase the capabilities of Delaware County's GIS system to produce estimates of hazard-related damage.*
Objective 3.3	*Work with neighboring counties, states, and the federal government to address widespread hazards that can affect multiple communities.*
Objective 3.4	*Examine, evaluate, and publicize current evacuation routes (such as through installation of signage).*
GOAL 4	***Promote disaster resistant future development.***
Objective 4.1	*Direct new development away from high hazard areas.*
Objective 4.2	*Provide education and training for municipal officials on the need to promote disaster resistant development.*
GOAL 5	***Promote hazard mitigation as a public value in recognition of its importance to the health, safety, and welfare of the population.***
Objective 5.1	*Provide public education to increase awareness of hazards and opportunities for mitigation.*
Objective 5.2	*Promote partnerships between municipalities and the County to continue to develop a Countywide approach to identifying and implementing mitigation actions.*

Table 6.2-1: List of 2011 mitigation strategy goals and objectives.	
Objective 5.3	*Continue the promotion of disaster resistance in the business community via the hazard mitigation planning initiative.*
GOAL 6	***Improve Response and Recovery Capabilities.***
Objective 6.1	*Increase awareness by residents (i.e., through public outreach/education) of actions to take during an emergency.*
Objective 6.2	*Work with municipalities to educate them about hazards and risk in order to improve response capability of County and municipal fire, police, and emergency services personnel.*

6.3. Identification and Analysis of Mitigation Techniques

Appendix 7 of the 2009 Standard Operating Guide developed by PEMA provides a comprehensive list of hazard mitigation ideas. Delaware County used this guide to identify mitigation techniques and develop mitigation actions. There are six categories of mitigation actions which Delaware County considered in developing its Mitigation Action Plan. Those categories include:

- **Prevention:** Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built. These actions also include public activities to reduce hazard losses. Examples include planning, zoning, building codes, subdivision regulations, hazard specific regulations (such as floodplain regulations), capital improvement programs, and open-space preservation and stormwater regulations.
- **Property Protection:** Actions that involve modifying or removing existing buildings or infrastructure to protect them from a hazard. Examples include the acquisition, elevation and relocation of structures, structural retrofits, flood-proofing, storm shutters, and shatter-resistant glass. Most of these property protection techniques are considered to involve "sticks and bricks;" however, this category also includes insurance.
- **Public Education and Awareness:** Actions to inform and educate citizens, elected officials, and property owners about potential risks from hazards and potential ways to mitigate them. Such actions include hazard mapping, outreach projects, library materials dissemination, real estate disclosures, the creation of hazard information centers, and school age / adult education programs.
- **Natural Resource Protection:** Actions that, in addition to minimizing hazard losses also preserve or restore the functions of natural systems. These actions include sediment and erosion control, stream corridor restoration, forest and vegetation management, wetlands restoration or preservation, slope stabilization, and historic property and archeological site preservation.
- **Structural Project Implementation:** Mitigation projects intended to lessen the impact of a hazard by using structures to modify the environment. Structures include stormwater controls (culverts); dams, dikes, and levees; and safe rooms.
- **Emergency Services:** Actions that typically are not considered mitigation techniques but reduce the impacts of a hazard event on people and property. These actions are often taken prior to, during, or in response to an emergency or disaster. Examples include

warning systems, evacuation planning and management, emergency response training and exercises, and emergency flood protection procedures.

Table 6.3-1 provides a matrix identifying the mitigation techniques used for the moderate and high risk hazards in the County. The specific actions associated with these techniques are included in Table 6.4-1.

Table 6.3-1: Mitigation techniques used for the moderate and high risk hazards in Delaware County.

HAZARD	MITIGATION TECHNIQUE					
	PREVENTION	PROPERTY PROTECTION	PUBLIC EDUCATION AND AWARENESS	NATURAL RESOURCE PROTECTION	STRUCTURAL PROJECT IMPLEMENTATION	EMERGENCY SERVICES
Flood, Flash Flood, Ice Jam	✓	✓	✓	✓	✓	✓
Winter Storm	✓	✓	✓			✓
Environmental Hazards (Hazardous Material Releases)	✓	✓	✓			✓
Extreme Temperature			✓			✓
Pandemic			✓			✓
Transportation Accident	✓				✓	✓
Drought	✓		✓			✓
Hurricane, Tropical Storm, Nor'easter	✓	✓	✓		✓	✓
Urban Fire and Explosion	✓		✓		✓	✓
Wildfire	✓		✓			✓
Tornado and Windstorm	✓	✓	✓			✓
Utility Interruption			✓			✓

6.4. Mitigation Action Plan

A Risk Assessment / Mitigation Solutions Workshop was held on March 31, 2011 to develop a framework for the County Mitigation Action Plan (see meeting minutes in **Appendix C**). Following goals and objectives review and evaluation during the workshop, the group went over Mitigation Techniques using PEMA's *Mitigation Ideas* document. Prior to the workshop, the HMSC reviewed the mitigation actions from the existing HMP. During the workshop

municipalities who had project opportunity forms in the 2006 HMP, were given a list of their projects and asked to review whether each project was completed, discontinued, is continuous, in progress/not yet complete, or if there has been no progress on the project. "Completed" or "discontinued," actions/projects were not carried over to the 2011 Action Plan, nor were projects that were not related to hazard mitigation or the hazards profiled in this plan. It is important to note that many of the actions were consolidated if they were similar and generalized to remove location-specific information (i.e. Eliminate flooding at 123 Main Street) per FEMA guidance. The results of the evaluation can be found in **Appendix C**. In addition, all participants were given Mitigation Action Forms and asked to list new actions or projects to be included in the plan update. Participants were given the option of taking part in the existing list of potential actions developed by the HMSC or providing new actions of their choosing specific to their community. The HMSC reviewed the 2006 actions submitted by municipalities that did not turn in one of the above action/project forms and determined that the projects were still viable and should be continued into the 2011 HMPU. Additionally, several new actions were developed by the HMSC based on the 2011 risk assessment to address new hazards included in the plan and assigned to municipalities based on relevance.

Actions were selected for municipalities in one of the following ways: from a completed Mitigation Action Form or Project Opportunity Form, from a completed 2006 Project Evaluation Form; or from the HMSC's review of the 2006 Mitigation Action Plan and determination that certain actions were still viable and should be carried over into the 2011 HMPU.

The final list of 78 mitigation actions is contained in Table 6.4-1. At least one mitigation action was established for each moderate and high risk hazard in Delaware County. More than one action is identified for several hazards. Every participating jurisdiction has at least one mitigation action. Each mitigation action is intended to address one or more of the goals and objectives identified in Section 6.2. Actions 5, 6, and 7 address continued compliance and improved participation in the NFIP.

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.

COMMUNITY: Delaware County **ACTION NO: 1**	**ACTION:** Identify existing critical facilities with the highest relative vulnerability.
Category:	Property Protection
Hazard(s) Addressed:	Flood, Flash Flood, and Ice Jam
Lead Agency/Department:	DCPD, Delaware County DES
Implementation Schedule:	Within 5 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 2**	**ACTION:** Conduct cost-benefit analysis of protection of critical facilities.

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
Category:	Property Protection
Hazard(s) Addressed:	Flood, Flash Flood, and Ice Jam
Lead Agency/Department:	DCPD, Delaware County DES
Implementation Schedule:	Within 5 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 3**	**ACTION:** Work with municipal floodplain managers to identify existing repetitive-loss and substantial-damage properties.
Category:	Property Protection
Hazard(s) Addressed:	Flood, Flash Flood, and Ice Jam
Lead Agency/Department:	DCPD, Delaware County DES
Implementation Schedule:	ongoing
Funding Source:	FEMA/PEMA, County
COMMUNITY: Delaware County **ACTION NO: 4**	**ACTION:** Conduct a cost-benefit analysis of protection of repetitive-loss assets.
Category:	Property Protection
Hazard(s) Addressed:	Flood, Flash Flood, Ice Jam
Lead Agency/Department:	DCPD, Delaware County DES
Implementation Schedule:	Within 5 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 5**	**ACTION:** Work with municipal officials to increase awareness among property owners including informational mailings to property owners in the 1% annual chance floodplain, and sponsor a series of workshops about costs and benefits of: • Acquiring and minimizing the cost of flood insurance coverage, and • Property elevation, dry flood proofing, and wet flood-proofing.
Category:	Public Education and Awareness, NFIP
Hazard(s) Addressed:	Flood, Flash Flood, & Ice Jam
Lead Agency/Department:	DCPD
Implementation Schedule:	Ongoing
Funding Source:	FEMA/PEMA; County

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
COMMUNITY: Delaware County **ACTION NO: 6**	**ACTION:** Evaluate at the municipal level the suitability of the Community Rating System (CRS)1 for insurance premium reduction (and flood damage reduction).
Category:	Prevention; NFIP
Hazard(s) Addressed:	Flood, Flash Flood, & Ice Jam
Lead Agency/Department:	DCPD
Implementation Schedule:	1-3 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 7**	**ACTION:** Work with PEMA and FEMA to hold a municipal CRS workshop.
Category:	Prevention; NFIP
Hazard(s) Addressed:	Flood, Flash Flood, & Ice Jam
Lead Agency/Department:	DCPD, Delaware County DES
Implementation Schedule:	2-4 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 8**	**ACTION:** Obtain information for structures in the areas with the highest relative vulnerability to determine the best property protection methods. The information to be obtained includes: • Lowest-floor elevation, • Number of stories, • Presence of a basement, and • Market and/or replacement value.
Category:	Property Protection
Hazard(s) Addressed:	Flood, Flash Flood, Ice Jam
Lead Agency/Department:	DCPD, Delaware County DES
Implementation Schedule:	2-3 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 9**	**ACTION:** Obtain information for all remaining structures in the 1% annual chance floodplain to determine the best property protection methods to promote with individual property owners. Techniques for gathering information over time should include developing and implementing a program for integrated information “capture” at key points in normal municipal administrative procedures, including applications

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
	for building permits at municipal offices.
Category:	Property Protection
Hazard(s) Addressed:	Flood, Flash Flood, & Ice Jam
Lead Agency/Department:	DCPD, Delaware County DES
Implementation Schedule:	2-3 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 10**	**ACTION:** Identify all storage of hazardous materials in floodplains (including non-addressable structures, such as propane tanks).
Category:	Property Protection
Hazard(s) Addressed:	Environmental Hazards (Hazardous Material Release); Flood, flash flood, ice jam
Lead Agency/Department:	DCPD
Implementation Schedule:	2-3 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 11**	**ACTION:** Evaluate alternative methods to minimize risk from hazardous material existing storage areas.
Category:	Property Protection
Hazard(s) Addressed:	Environmental Hazards (Hazardous Material Release); Flood, flash flood, ice jam
Lead Agency/Department:	DCPD
Implementation Schedule:	2-3 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 12**	**ACTION:** Assess means to prevent future storage of hazardous materials in floodplains.
Category:	Property Protection
Hazard(s) Addressed:	Environmental Hazards (Hazardous Material Release); Flood, flash flood, ice jam
Lead Agency/Department:	DCPD
Implementation Schedule:	2-3 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County	**ACTION:** Conduct a qualitative evaluation process for critical

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
ACTION NO: 13	facilities and infrastructure to determine relative vulnerability and gather information for subsequent refinements of this mitigation plan.
Category:	Property Protection
Hazard(s) Addressed:	All
Lead Agency/Department:	DCPD; Delaware County DES
Implementation Schedule:	Within 5 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 14**	**ACTION:** Develop an action plan for reducing the potential losses at identified critical facilities and infrastructure.
Category:	Property Protection
Hazard(s) Addressed:	All
Lead Agency/Department:	DCPD; Delaware County DES
Implementation Schedule:	Within 5 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 15**	**ACTION:** Identify critical facilities and infrastructure with the highest relative vulnerability to the effects of power outage (i.e., hospitals, nursing homes, fire, police, rescue, emergency management, water pumping stations, sewage treatment plants, phone lines).
Category:	Emergency Services
Hazard(s) Addressed:	Utility Interruption
Lead Agency/Department:	Delaware County DES
Implementation Schedule:	1-3 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 16**	**ACTION:** Assess availability of backup power resources (generators) for critical facilities with a high vulnerability to the effects of power outage.
Category:	Emergency Services
Hazard(s) Addressed:	Utility Interruption
Lead Agency/Department:	Delaware County DES
Implementation Schedule:	1-3 years
Funding Source:	FEMA/PEMA; County

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
COMMUNITY: Delaware County **ACTION NO: 17**	**ACTION:** Upgrade backup power resources as necessary at critical facilities.
Category:	Emergency Services
Hazard(s) Addressed:	Utility Interruption
Lead Agency/Department:	Delaware County DES
Implementation Schedule:	1-3 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 18**	**ACTION:** Identify communities with the highest relative vulnerability to the effects of severe weather and prepare an implementation plan.
Category:	Prevention
Hazard(s) Addressed:	Drought; Flood, Flash flood, Ice Jam; Hurricane, Tropical Storm, Nor'easter; Tornado and Windstorm; Winter Storm
Lead Agency/Department:	Delaware County DES
Implementation Schedule:	3-5 years.
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 19**	**ACTION:** Promote the use of existing warning systems and implement additional warning systems, including: • Text-based community warning systems •Real time weather data for emergency management personnel • NOAA weather radios • "Reverse 911" systems
Category:	Emergency Services
Hazard(s) Addressed:	All
Lead Agency/Department:	Delaware County DES
Implementation Schedule:	Within 5 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 20**	**ACTION:** Conduct qualitative evaluation process to evaluate the ready state of existing shelters and needs for new shelters.
Category:	Structural; Emergency Services
Hazard(s) Addressed:	All
Lead Agency/Department:	Delaware County DES

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
Implementation Schedule:	Within 5 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 21**	**ACTION:** Work with municipal officials to increase awareness among mobile-home owners and evaluate how many mobile homes have been anchored.
Category:	Property Protection; Public Education and Awareness
Hazard(s) Addressed:	Flood, Flash Flood, Ice Jam; Hurricane, Tropical Storm, Nor'easter; Tornado and Windstorm
Lead Agency/Department:	DCPD; Delaware County DES
Implementation Schedule:	Within 5 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 22**	**ACTION:** Develop a linkage between the County tax assessment records and parcels in the County GIS to allow future revision of this plan to more easily incorporate information about property values, construction types, etc.
Category:	Prevention
Hazard(s) Addressed:	All
Lead Agency/Department:	DCPD; Delaware County Tax Assessors Office
Implementation Schedule:	2-3 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 23**	**ACTION:** Identify existing critical facilities and infrastructure with the highest relative vulnerability to hazards.
Category:	Property Protection
Hazard(s) Addressed:	All
Lead Agency/Department:	DCPD; Delaware County DES
Implementation Schedule:	Within 5 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 24**	**ACTION:** Conduct cost-benefit analysis of protection of vulnerable critical facilities and infrastructure.
Category:	Property Protection
Hazard(s) Addressed:	All
Lead Agency/Department:	DCPD; Delaware County DES

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
Implementation Schedule:	Within 5 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 25**	**ACTION:** Identify emerging software systems for loss estimation and train County staff to use existing HAZUS software and DES damage reporting software.
Category:	Property Protection
Hazard(s) Addressed:	Flood, Flash flood, and Ice jam; Earthquake; Hurricane, Tropical Storm, and Nor'easter
Lead Agency/Department:	Delaware County DES
Implementation Schedule:	Within 5 years.
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 26**	**ACTION:** Identify funding sources for hazard mitigation equipment, software, and data purchasing and software training.
Category:	Emergency Services
Hazard(s) Addressed:	All
Lead Agency/Department:	Delaware County DES
Implementation Schedule:	1-3 years.
Funding Source:	County
COMMUNITY: Delaware County **ACTION NO: 27**	**ACTION:** Work closely with assessment office to determine how best to apply current data to the needs of emergency management.
Category:	Emergency Services
Hazard(s) Addressed:	All
Lead Agency/Department:	Delaware County DES; Delaware County Tax Assessor's Office
Implementation Schedule:	1-3 years
Funding Source:	County
COMMUNITY: Delaware County **ACTION NO: 28**	**ACTION:** Develop mutual agreements with neighboring counties to utilize cooperative efforts to mitigate hazards that impact communities beyond political boundaries.
Category:	Prevention
Hazard(s) Addressed:	All
Lead Agency/Department:	DCPD; Delaware County DES
Implementation Schedule:	3-5 years

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
Funding Source:	County
COMMUNITY: Delaware County **ACTION NO: 29**	**ACTION:** Explore using existing and or planned multi-use trails as evacuation routes.
Category:	Prevention
Hazard(s) Addressed:	All
Lead Agency/Department:	DCPD; Delaware County DES
Implementation Schedule:	3-5 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 30**	**ACTION:** Review existing regulations to ensure adequacy in reducing the amount of future development in identified hazard areas, especially steep slopes and floodplains.
Category:	Prevention
Hazard(s) Addressed:	All
Lead Agency/Department:	DCPD
Implementation Schedule:	1-3 years
Funding Source:	County
COMMUNITY: Delaware County **ACTION NO: 31**	**ACTION:** Review all comprehensive plans to ensure that designated growth areas are not in hazard areas.
Category:	Prevention
Hazard(s) Addressed:	All
Lead Agency/Department:	DCPD
Implementation Schedule:	1-3 years
Funding Source:	County
COMMUNITY: Delaware County **ACTION NO: 32**	**ACTION:** Review all capital improvements to ensure that infrastructure improvements are not directed towards hazardous areas.
Category:	Prevention
Hazard(s) Addressed:	All
Lead Agency/Department:	DCPD
Implementation Schedule:	1-3 years
Funding Source:	County

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
COMMUNITY: Delaware County **ACTION NO: 33**	**ACTION:** Hold workshops for governing bodies on the importance of prohibiting development in hazard-prone areas.
Category:	Public Education and Awareness
Hazard(s) Addressed:	All
Lead Agency/Department:	DCPD; Delaware County DES
Implementation Schedule:	2-4 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 34**	**ACTION:** Provide model ordinances to municipalities that can be used to prohibit development in hazard-prone areas.
Category:	Prevention
Hazard(s) Addressed:	All
Lead Agency/Department:	DCPD
Implementation Schedule:	ongoing
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County **ACTION NO: 35**	**ACTION:** Identify and publicize success stories as part of an overall consistent public relations program.
Category:	Public Education and Awareness
Hazard(s) Addressed:	All
Lead Agency/Department:	DCPD; Delaware County DES
Implementation Schedule:	ongoing
Funding Source:	County
COMMUNITY: Delaware County **ACTION NO: 36**	**ACTION:** Convene regular meetings of the HMSC to discuss issues and progress related to the implementation of the plan.
Category:	Emergency Services; Prevention
Hazard(s) Addressed:	All
Lead Agency/Department:	DCPD; Delaware County DES
Implementation Schedule:	ongoing
Funding Source:	County
COMMUNITY: Delaware County	**ACTION:** Renew and expand commitments to hazard

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
ACTION NO: 37	mitigation planning among partner organizations.
Category:	Public Education and Awareness
Hazard(s) Addressed:	All
Lead Agency/Department:	DCPD; Delaware County DES
Implementation Schedule:	ongoing
Funding Source:	County
COMMUNITY: Delaware County	**ACTION:** Increase awareness by residents of actions to take during an emergency, including sheltering and evacuation procedures. Methods to be used can include public outreach (i.e., website, mailings, workshops, media coverage) and education.
ACTION NO: 38	
Category:	Public Education and Awareness
Hazard(s) Addressed:	All
Lead Agency/Department:	Delaware County DES
Implementation Schedule:	ongoing
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County	**ACTION**: Identify special populations requiring additional emergency response.
ACTION NO: 39	
Category:	Prevention; Emergency Services
Hazard(s) Addressed:	All
Lead Agency/Department:	DCPD; Delaware County DES
Implementation Schedule:	1-3 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County	**ACTION:** Evaluate means to enhance response capability for residents.
ACTION NO: 40	
Category:	Prevention; Emergency Services
Hazard(s) Addressed:	All
Lead Agency/Department:	Delaware County DES
Implementation Schedule:	1-3 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Delaware County	**ACTION:** Engage in public education activities about

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
ACTION NO: 41	Delaware County's Pandemic Influenza Preparedness and Response Plan.
Category:	Public Education and Awareness
Hazard(s) Addressed:	Pandemic
Lead Agency/Department:	DCPD; Delaware County Intercommunity Health Coordination
Implementation Schedule:	1-3 years
Funding Source:	FEMA/PEMA; County
COMMUNITY: Brookhaven Borough; Lower Chichester, Upper Chichester Township	**ACTION:** Update municipal zoning code to strengthen it to promote disaster-resistant development.
ACTION NO: 42	
Category:	Prevention
Hazard(s) Addressed:	All
Lead Agency/Department:	Municipalities; DCPD
Implementation Schedule:	2 years
Funding Source:	Staff time; CDBG; County
COMMUNITY: Aldan Borough, Aston Township, Bethel Township, Brookhaven Borough, Chadds Ford Township, Chester City, Chester Township, Chester Heights Borough, Clifton Heights Borough, Collingdale Borough, Colwyn Borough, Concord Township, Darby Borough, Darby Township, East Lansdowne Borough, Eddystone Borough, Edgmont Township, Folcroft Borough, Glenolden Borough, Haverford Township, Lansdowne Borough, Lower Chichester Township, Marcus Hook Borough, Marple Township, Media Borough, Middletown Township, Millbourne Borough, Morton Borough, Nether Providence Township, Newtown Township, Norwood Borough, Parkside Borough, Prospect Park Borough, Radnor Township, Ridley Township, Ridley Park Borough, Rose Valley Borough, Rutledge Borough, Sharon Hill Borough, Springfield Township, Swarthmore	**ACTION:** Acquire, elevate, flood-proof or relocate structures and properties in flood hazard areas.

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
Borough, Thornbury Township, Tinicum Township, Trainer Borough, Upland Borough, Upper Chichester Township, Upper Darby Township, Upper Providence Township, Yeadon Borough	
ACTION NO: 43	
Category:	Property Protection
Hazard(s) Addressed:	Flood, Flash Flood, and Ice Jam
Lead Agency/Department:	Municipalities
Implementation Schedule:	As needed
Funding Source:	FEMA/PEMA
COMMUNITY: Colwyn Borough	**ACTION:** Reduce urban fire hazard in borough by adding accessible routes for the handicapped in row home areas without existing handicap ramps or sidewalks.
ACTION NO: 44	
Category:	Structural Project Implementation
Hazard(s) Addressed:	Urban fire and explosion
Lead Agency/Department:	Colwyn Borough / Code Department
Implementation Schedule:	45 days following receipt of funding; construction could begin with completion in 120 days
Funding Source:	Staff time; PEMA; FEMA
COMMUNITY: Chester City; Collingdale Borough; Eddystone Borough, Edgmont Township; Marcus Hook Borough; Norwood Borough; Prospect Park Borough; Trainer Borough; Upland Borough; Upper Darby Township; Yeadon Borough	**ACTION:** Install, repair or replace culverts or storm sewers in areas of the municipality that experience flooding.
ACTION NO: 45	
Category:	Structural Project Implementation
Hazard(s) Addressed:	Flood, Flash Flood, and Ice Jam
Lead Agency/Department:	Municipalities
Implementation Schedule:	2-3 years
Funding Source:	Staff time; FEMA/PEMA
COMMUNITY: Chadds Ford Township; Edgmont Township; Aston Township	**ACTION:** Elevate roadways where necessary to allow water to flow underneath of them and reduce roadway flooding.

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
ACTION NO: 46	
Category:	Structural Project Implementation
Hazard(s) Addressed:	Flood, Flash Flood, and Ice Jam
Lead Agency/Department:	Municipalities
Implementation Schedule:	3-4 years
Funding Source:	Staff time; FEMA/PEMA; PennDOT
COMMUNITY: Haverford Township; Lansdowne Borough; Trainer Borough	**ACTION:** Explore opportunities and create stormwater infiltration areas in the municipality such as stormwater detention basins, rain gardens etc.
ACTION NO: 47	
Category:	Structural Project Implementation
Hazard(s) Addressed:	Flood, Flash Flood, and Ice Jam
Lead Agency/Department:	Municipalities
Implementation Schedule:	Within 5 years
Funding Source:	FEMA/PEMA; EPA; DEP
COMMUNITY: Collingdale Borough; Folcroft Borough; Lansdowne Borough; Marple Township; Morton Borough; Parkside Borough; Radnor Township; Springfield Township	**ACTION:** Explore opportunities to mitigate flooding and drainage problems in the municipality.
ACTION NO: 48	
Category:	Structural Project Implementation
Hazard(s) Addressed:	Flood, Flash Flood, and Ice Jam
Lead Agency/Department:	Municipalities
Implementation Schedule:	2-4 years
Funding Source:	Staff Time; FEMA/PEMA
COMMUNITY: Morton Borough	**ACTION:** Explore opportunities to improve pedestrian safety at the intersection of Route 420 and Yale/Morton Avenues (near railroad area).
ACTION NO: 49	
Category:	Structural Project Implementation
Hazard(s) Addressed:	Transportation Accident
Lead Agency/Department:	Municipality
Implementation Schedule:	1-3 years

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
Funding Source:	PennDOT
COMMUNITY: Swarthmore Borough **ACTION NO: 50**	**ACTION:** Create and distribute an educational pamphlet about the borough's floodplain regulations and the importance of floodplain regulations.
Category:	Public Education and Awareness
Hazard(s) Addressed:	Flood, Flash Flood, and Ice Jam
Lead Agency/Department:	Municipality
Implementation Schedule:	1 year
Funding Source:	Staff Time; FEMA/PEMA; WREN grant
COMMUNITY: Upper Providence Township **ACTION NO: 51**	**ACTION:** Explore projects to mitigate washout of Farnum Road from flooding.
Category:	Structural Project Implementation
Hazard(s) Addressed:	Flood, Flash Flood, and Ice Jam
Lead Agency/Department:	Municipality
Implementation Schedule:	1-2 years
Funding Source:	Staff Time; FEMA/PEMA
COMMUNITY: Brookhaven Borough; Chester Heights Borough; Darby Borough; Norwood Borough; Ridley Park Borough **ACTION NO: 52**	**ACTION:** Clean up debris in streams and along stream banks and bridges in municipality.
Category:	Natural Resource Protection
Hazard(s) Addressed:	Flood, Flash Flood, and Ice Jam
Lead Agency/Department:	Municipality
Implementation Schedule:	ongoing
Funding Source:	Staff Time
COMMUNITY: Collingdale Borough **ACTION NO: 53**	**ACTION:** Evaluate Borough's capabilities to respond to urban fires and explosions and make recommendations to increase capabilities.
Category:	Prevention
Hazard(s) Addressed:	Urban Fire and Explosion
Lead Agency/Department:	Municipality

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
Implementation Schedule:	1-3 years
Funding Source:	Staff Time
COMMUNITY: Darby Borough **ACTION NO: 54**	**ACTION:** Stabilize flood damaged residences in the municipality through use of tie-backs and relocation of living residences and utilities to first floors.
Category:	Property Protection
Hazard(s) Addressed:	Flood, Flash Flood, and Ice Jam
Lead Agency/Department:	Municipality
Implementation Schedule:	2-4 years
Funding Source:	Staff Time; FEMA/PEMA
COMMUNITY: Glenolden Borough; Middletown Township; Upland Borough **ACTION NO: 55**	**ACTION:** Stabilize, revegetate or reinforce stream banks in areas of the municipality where necessary.
Category:	Natural Resource Protection; Landslide
Hazard(s) Addressed:	Flood, Flash Flood, and Ice Jam
Lead Agency/Department:	Municipalities
Implementation Schedule:	2-4 years
Funding Source:	Staff Time; FEMA/PEMA; DEP; EPA
COMMUNITY: Rose Valley Borough **ACTION NO: 56**	**ACTION:** Conduct survey to assess the likely consequences of dam failure of dams on Ridley Creek and to assess the physical structure to determine the likelihood of failure. If defects exist, the survey should propose remedies. If the survey identifies severe adverse consequences of dam failure, mitigation possibilities should be identified.
Category:	Prevention
Hazard(s) Addressed:	Dam Failure
Lead Agency/Department:	Municipality; Aqua PA; ACOE
Implementation Schedule:	3-5 years
Funding Source:	Staff Time; FEMA/PEMA; ACOE
COMMUNITY: Upper Darby Township **ACTION NO: 57**	**ACTION:** Increase size of upstream impoundment areas for Cobbs Creek and Naylors Run.
Category:	Structural Project Implementation

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
Hazard(s) Addressed:	Flood, Flash Flood, and Ice Jam
Lead Agency/Department:	Municipality
Implementation Schedule:	2-4 years
Funding Source:	FEMA/PEMA
COMMUNITY: Ridley Township **ACTION NO: 58**	**ACTION:** Modernize traffic lights at intersections that are hazardous for pedestrian crossing.
Category:	Prevention
Hazard(s) Addressed:	Transportation Accident
Lead Agency/Department:	Municipality; PennDOT
Implementation Schedule:	1-2 years
Funding Source:	PennDOT
COMMUNITY: Glenolden Borough **ACTION NO: 59**	**ACTION:** Purchase a backup generator for the police station.
Category:	Emergency Services
Hazard(s) Addressed:	All
Lead Agency/Department:	Municipality
Implementation Schedule:	2-4 years
Funding Source:	FEMA/PEMA
COMMUNITY: Upper Darby Township **ACTION NO: 60**	**ACTION:** Conduct flood level monitoring along Naylor's Run Creek.
Category:	Prevention; Property Protection
Hazard(s) Addressed:	Flood, Flash Flood, and Ice Jam; Dam Failure
Lead Agency/Department:	Upper Darby Township Public Works Department
Implementation Schedule:	Within 5 years
Funding Source:	Municipality
COMMUNITY: Upper Darby Township **ACTION NO: 61**	**ACTION:** Upgrade Springton Road pumps.
Category:	Property Protection, Prevention, Emergency Services

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
Hazard(s) Addressed:	Flood, Flash Flood, and Ice Jam
Lead Agency/Department:	Upper Darby Township Public Works Department
Implementation Schedule:	Within 5 years
Funding Source:	Municipality; FEMA/PEMA
COMMUNITY: Upper Darby Township **ACTION NO: 62**	**ACTION:** Continue planning of dispersement locations as part of Disaster Relief Drug Distribution Program.
Category:	Emergency Services
Hazard(s) Addressed:	Pandemic
Lead Agency/Department:	Upper Darby Administrative Office and EMC
Implementation Schedule:	Within 5 years
Funding Source:	Staff time
COMMUNITY: Media Borough **ACTION NO: 63**	**ACTION:** Provide for operable, storm shutters on portions of municipal government center used for emergency operations command center and civilian shelter.
Category:	Property Protection
Hazard(s) Addressed:	Hurricane, Tropical Storm, and Nor'easter; Winter Storm; and Tornado and Windstorm
Lead Agency/Department:	Municipality
Implementation Schedule:	Within 5 years
Funding Source:	FEMA/PEMA; municipality
COMMUNITY: Media Borough **ACTION NO: 64**	**ACTION:** Remove shade trees in Borough that are susceptible to damage from high winds and icing.
Category:	Property Protection
Hazard(s) Addressed:	Hurricane, Tropical Storm, and Nor'easter; Winter Storm; and Tornado and Windstorm
Lead Agency/Department:	Municipality
Implementation Schedule:	Within 5 years
Funding Source:	FEMA/PEMA; municipality
COMMUNITY: Aston Township **ACTION NO: 65**	**ACTION:** Mitigate identified residences, businesses, Weir Park, Aston Middletown Little League Park, and Lewis H. Fisher Park from the effects of floods, flash floods, and ice jams.
Category:	Property Protection; Structural Projects

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
Hazard(s) Addressed:	Flood, flash flood, and ice jam
Lead Agency/Department:	Municipality
Implementation Schedule:	Within 5 years
Funding Source:	FEMA/PEMA
COMMUNITY: Concord Township **ACTION NO: 66**	**ACTION:** Purchase signs and temporary barricades to use to advise motorists not to drive through flood waters.
Category:	Prevention; Emergency Services
Hazard(s) Addressed:	Flood, flash flood, and ice jam
Lead Agency/Department:	Municipality
Implementation Schedule:	1-2 years
Funding Source:	FEMA/PEMA; municipality
COMMUNITY: Concord Township **ACTION NO: 67**	**ACTION:** Mark fire hydrants that get covered by snow plowing along Routes 1 and 202 with flags.
Category:	Prevention; Emergency Services
Hazard(s) Addressed:	Winter Storm
Lead Agency/Department:	Municipality
Implementation Schedule:	1-2 years
Funding Source:	Municipality
COMMUNITY: Delaware County, **ACTION NO: 68**	**ACTION:** Conduct emergency planning exercises for high hazard dams in the County to simulate hazard response.
Category:	Emergency Services
Hazard(s) Addressed:	Dam failure
Lead Agency/Department:	Delaware County DES and dam owners
Implementation Schedule:	2 years
Funding Source:	Army Corps of Engineers; DEP
COMMUNITY: Delaware County **ACTION NO: 69**	**ACTION:** Develop/update interface between dam owners' inundation mapping and the DCPD's GIS tools.
Category:	Emergency Services
Hazard(s) Addressed:	Dam failure

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
Lead Agency/Department:	DCPD and dam owners
Implementation Schedule:	2 years
Funding Source:	Army Corps of Engineers; DEP
COMMUNITY: Millbourne Borough **ACTION NO: 70**	**ACTION:** Prepare a comprehensive land use plan to address transit oriented development, floodplain development, and open space management in the Borough.
Category:	Prevention
Hazard(s) Addressed:	Flood, flash flood, ice jam; Transportation accidents
Lead Agency/Department:	Municipality
Implementation Schedule:	1 – 1.5 years
Funding Source:	DVRPC; PennDOT
COMMUNITY: Brookhaven Borough, Colwyn Borough, Nether Providence Township, Sharon Hill Borough; Upland Borough **ACTION NO: 71**	**ACTION:** Explore opportunities for construction of, repair, or reinforcement of floodwalls or levees to protect homes, businesses, or other structures in or near floodplains.
Category:	Structural Projects
Hazard(s) Addressed:	Flood, Flash Flood, Ice Jam; Levee Failure
Lead Agency/Department:	Municipalities
Implementation Schedule:	Within 5 years.
Funding Source:	FEMA/PEMA
COMMUNITY: Rutledge Borough **ACTION NO: 72**	**ACTION:** Install an emergency generator at the Borough Hall to supply electric for an emergency evacuation center.
Category:	Emergency Services
Hazard(s) Addressed:	All
Lead Agency/Department:	Municipality
Implementation Schedule:	2- 5 years.
Funding Source:	FEMA/PEMA
COMMUNITY: Delaware County; Aldan Borough, Aston Township, Bethel Township, Brookhaven Borough, Chadds Ford Township, Chester City, Chester Township, Chester Heights Borough, Clifton	**ACTION:** Conduct outreach to vulnerable populations during periods of extreme temperature, including establishing and promoting accessible heating or cooling centers in the community.

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
Heights Borough, Collingdale Borough, Colwyn Borough, Concord Township, Darby Borough, Darby Township, East Lansdowne Borough, Eddystone Borough, Edgmont Township, Folcroft Borough, Glenolden Borough, Haverford Township, Lansdowne Borough, Lower Chichester Township, Marcus Hook Borough, Marple Township, Media Borough, Middletown Township, Millbourne Borough, Morton Borough, Nether Providence Township, Newtown Township, Norwood Borough, Parkside Borough, Prospect Park Borough, Radnor Township, Ridley Township, Ridley Park Borough, Rose Valley Borough, Rutledge Borough, Sharon Hill Borough, Springfield Township, Swarthmore Borough, Thornbury Township, Tinicum Township, Trainer Borough, Upland Borough, Upper Chichester Township, Upper Darby Township, Upper Providence Township, Yeadon Borough	
ACTION NO: 73	
Category:	Public Education and Awareness
Hazard(s) Addressed:	Extreme Temperature
Lead Agency/Department:	DCPD; Delaware County Intercommunity Health Coordination; Municipalities
Implementation Schedule:	Ongoing
Funding Source:	County; Municipalities
COMMUNITY: Delaware County	**ACTION:** Educate residents about the importance of installing and maintaining smoke detectors and fire extinguishers on each floor of their home or other buildings.
ACTION NO: 74	
Category:	Public Education and Awareness
Hazard(s) Addressed:	Wildfire; Urban Fire and Explosion
Lead Agency/Department:	Delaware County DES
Implementation Schedule:	ongoing
Funding Source:	FEMA/PEMA; County

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
COMMUNITY: Eddystone Borough, Edgmont Township, Marple Township, Media Borough, Morton Borough, Nether Providence Township, Newtown Township, Ridley Township, Ridley Park Borough, Rutledge Borough, Springfield Township, Swarthmore Borough, Upper Providence Township **ACTION NO: 75**	**ACTION:** Adopt Crum Creek Act 167 plan and stormwater management ordinance once completed.
Category:	Prevention
Hazard(s) Addressed:	Flood, Flash Flood, Ice Jam
Lead Agency/Department:	DCPD; Municipalities
Implementation Schedule:	1-2 years
Funding Source:	County; Staff time
COMMUNITY: Ridley Park Borough **ACTION NO: 76**	**ACTION:** Dredge silt from Ridley Park Lake.
Category:	Structural Project
Hazard(s) Addressed:	Flood, Flash Flood, Ice Jam
Lead Agency/Department:	Municipality
Implementation Schedule:	1-2 years
Funding Source:	Municipality; DEP
COMMUNITY: Delaware County, Colwyn Borough, Tinicum Township **ACTION NO: 77**	**ACTION:** Obtain additional ownership, operation, and maintenance information for levees in Delaware County for the next HMPU.
Category:	Prevention
Hazard(s) Addressed:	Levee Failure
Lead Agency/Department:	DCPD
Implementation Schedule:	Within 5 years
Funding Source:	County
COMMUNITY: Aston Township, East Lansdowne Township, Haverford Township, Ridley Township	**ACTION:** Develop and implement a radon exposure prevention program.

Table 6.4-1: List of 2011 mitigation actions with information including community or communities affected, action category, hazard addressed, action description, lead agency/department and general implementation schedule.	
ACTION NO: 78	
Category:	Public Education and Awareness
Hazard(s) Addressed:	Radon Exposure
Lead Agency/Department:	Municipality
Implementation Schedule:	2-3 years
Funding Source:	Municipality; DEP

Table 6.4-1 lists seventy-eight mitigation actions, many of which will require substantial time commitments from staff at the County and local municipalities. Those that participated in the development of the 2011 HMP believe that each of these actions is attainable and can pragmatically be implemented over the next five-year cycle. While all of these activities will be pursued over the next five years, the reality of limited time and resources requires the identification of high priority mitigation actions. Prioritization allows the individuals and organizations involved to focus their energies and ensure progress on mitigation activities.

Mitigation actions were evaluated using the seven criteria which frame the *PASTEEL* method. These feasibility criteria include:

- **Political:** Does the action have public and political support?
- **Administrative:** Is there adequate staffing and funding available to implement the action in a timely manner?
- **Social:** Will the action be acceptable by the community or will it cause any one segment of the population to be treated unfairly?
- **Technical:** How effective will the action be in avoiding or reducing future losses?
- **Economic:** What are the costs and benefits of the action and does it contribute to community economic goals?
- **Environmental:** Will the action provide environmental benefits and will it comply with local, state and federal environmental regulations?
- **Legal:** Does the community have the authority to implement the proposed measure?

The *PASTEEL* method use political, administrative, social, technical, economic, environmental and legal considerations as a basis means of evaluating which of the identified actions should be considered most critical. Economic considerations are particularly important in weighing the costs versus benefits of implementing one action prior to another.

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. To do this in an efficient manner that is consistent with FEMA's guidance on using cost-benefit review in mitigation planning, the *PASTEEL* method was

adapted to include a higher weighting for two elements of the *economic* feasibility factor – Benefits of Action and Costs of Action. This method incorporates concepts similar to those described in Method C of FEMA 386-5: Using Benefit Cost Review in Mitigation Planning (FEMA, 2007).

Those participating in the 2011 HMPU provided comments which allowed for the prioritization of the mitigation actions listed in Table 6.4-1 using the seven *PASTEEL* criteria. In order to evaluate and prioritize the mitigation actions, participants identified *favorable* and *less favorable* factors for each action. Table 6.4-2 summarizes the evaluation methodology and provides the results of this evaluation for all seventy-eight mitigation actions. 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 three 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. Almost all of the actions received scores where their positive factors outweighed their negative factors. Only one action (Action 76) received scores where its negative factors outweighed its positive. Action 76 has to do with a dredging project. It received a negative ranking because dredging projects often have a high cost and are often difficult to obtain political and public support because of perceived negative environmental effects.

Table 6.4-2: Summary of mitigation action prioritization using PA STEEL methodology.

MITIGATION ACTIONS		PA STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							
		P Political			**A** Administrative			**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 w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**SUMMARY (EQUAL WEIGHTING)**	**SUMMARY (BENEFITS & COSTS PRIORITIZED)**
1	Identify existing critical facilities with the highest relative vulnerability.	+	+	+	N	N	N	+	+	+	N	+	+	+	+	N	N	N	N	N	+	+	+	N	13 (+) 0 (-) 10 (N)	17 (+) 0 (-) 10 (N)
2	Conduct cost-benefit analysis of protection of critical facilities.	+	+	+	-	N	N	+	+	+	N	+	+	+	+	N	N	N	N	N	+	+	+	N	13 (+) 1 (-) 9 (N)	17 (+) 1 (-) 9 (N)
3	Work with municipal floodplain managers to identify existing repetitive-loss and substantial-damage properties.	+	+	+	N	N	N	+	+	+	N	+	+	+	+	N	+	N	N	N	+	+	+	N	14 (+) 0 (-) 9 (N)	18 (+) 0 (-) 9 (N)
4	Conduct a cost-benefit analysis of protection of repetitive-loss assets.	+	+	+	-	N	N	+	+	+	N	+	+	+	+	N	N	N	N	N	+	+	+	N	13 (+) 1 (-) 9 (N)	17 (+) 1 (-) 9 (N)
5	Work with municipal officials to increase awareness among property owners including informational mailings to property owners in the 1% annual chance floodplain, and sponsor a series of workshops about costs and benefits of: • Acquiring and minimizing	+	+	+	N	-	N	+	+	+	N	+	+	+	+	-	N	N	N	N	+	+	+	N	13 (+) 2 (-) 8 (N)	17 (+) 2 (-) 8 (N)

Table 6.4-2: Summary of mitigation action prioritization using PA STEEL methodology.

MITIGATION ACTIONS		PA STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																						
		P Political			**A** Administrative			**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 w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**SUMMARY (EQUAL WEIGHTING)**	**SUMMARY (BENEFITS & COSTS PRIORITIZED)**
	the cost of flood insurance coverage, and • Property elevation, dry flood proofing, and wet flood-proofing.																								
6	Evaluate at the municipal level the suitability of the Community Rating System (CRS)1 for insurance premium reduction (and flood damage reduction).	+	+	+	N	N	N	+	+	+	N	+	+	+	+	N	N	N	N	N	+	+	+	N	13 (+) 0 (-) 10 (N)	17 (+) 0 (-) 10 (N)
7	Work with PEMA and FEMA to hold a municipal CRS workshop.	+	+	+	N	N	N	+	+	+	N	+	+	+	+	N	N	N	N	N	+	+	+	N	13 (+) 0 (-) 10 (N)	17 (+) 0 (-) 10 (N)
8	Obtain information for structures in the areas with the highest relative vulnerability to determine the best property protection methods. The information to be obtained includes: • Lowest-floor elevation, • Number of stories, • Presence of a basement, and	+	+	+	N	N	N	+	+	+	N	+	+	+	+	N	N	N	N	N	+	+	+	N	13 (+) 0 (-) 10 (N)	17 (+) 0 (-) 10 (N)

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	• Market and/or replacement value.																								
9	Obtain information for all remaining structures in the 1% annual chance floodplain to determine the best property protection methods to promote with individual property owners. Techniques for gathering information over time should include developing and implementing a program for integrated information “capture” at key points in normal municipal administrative procedures, including applications for building permits at municipal offices.	+	+	+	N	N	N	+	+	+	N	+	+	+	+	N	N	N	N	N	+	+	+	N	13 (+) 0 (-) 10 (N)	17 (+) 0 (-) 10 (N)
10	Identify all storage of hazardous materials in floodplains (including non-addressable structures, such	+	+	+	N	N	N	+	+	+	N	+	+	+	+	N	+	+	+	+	+	+	+	+	N	17 (+) 0 (-) 6 (N)	21 (+) 0 (-) 6 (N)

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	as propane tanks).																									
11	Evaluate alternative methods to minimize risk from hazardous material existing storage areas.	+	+	+	N	N	N	+	+	+	N	+	+	+	+	N	+	+	+	+	+	+	+	N	17 (+) 0 (-) 6 (N)	21 (+) 0 (-) 6 (N)
12	Assess means to prevent future storage of hazardous materials in floodplains.	+	+	+	N	N	N	+	+	+	+	+	+	+	+	N	+	+	+	+	+	+	+	N	18 (+) 0 (-) 5 (N)	22 (+) 0 (-) 5 (N)
13	Conduct a qualitative evaluation process for critical facilities and infrastructure to determine relative vulnerability and gather information for subsequent refinements of this mitigation plan.	+	+	+	N	N	N	+	+	+	N	+	+	+	+	N	N	N	N	N	+	+	+	N	13 (+) 0 (-) 10 (N)	17 (+) 0 (-) 10 (N)
14	Develop an action plan for reducing the potential losses at identified critical facilities and infrastructure.	+	+	+	N	N	N	+	+	+	N	+	+	+	+	N	+	N	N	N	+	+	+	N	14 (+) 0 (-) 9 (N)	18 (+) 0 (-) 9 (N)

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15	Identify critical facilities and infrastructure with the highest relative vulnerability to the effects of power outage (i.e., hospitals, nursing homes, fire, police, rescue, emergency management, water pumping stations, sewage treatment plants, phone lines).	+	+	+	N	+	+	+	+	+	N	+	+	+	+	N	+	+	+	+	+	+	+	N	19 (+) 0 (-) 4 (N)	23 (+) 0 (-) 4 (N)
16	Assess availability of backup power resources (generators) for critical facilities with a high vulnerability to the effects of power outage.	+	+	+	N	N	+	+	+	+	N	+	+	+	+	N	N	N	N	N	N	+	+	+	N	14 (+) 0 (-) 9 (N)	18 (+) 0 (-) 9 (N)
17	Upgrade backup power resources as necessary at critical facilities.	+	+	+	-	-	+	+	+	+	N	+	+	+	+	-	N	N	N	N	N	+	+	+	N	14 (+) 3 (-) 6 (N)	18 (+) 3 (-) 6 (N)
18	Identify communities with the highest relative vulnerability to the effects of severe weather and prepare an implementation plan.	+	+	+	-	-	+	+	+	+	N	N	+	+	+	-	N	N	N	N	N	+	+	+	N	13 (+) 3 (-) 7 (N)	17 (+) 3 (-) 7 (N)

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19	Promote the use of existing warning systems and implement additional warning systems, including: • Text-based community warning systems •Real time weather data for emergency management personnel • NOAA weather radios • “Reverse 911” systems	+	+	+	N	-	+	+	+	+	N	+	+	+	+	-	N	N	N	N	+	+	+	N	14 (+) 2 (-) 7 (N)	18 (+) 2 (-) 7 (N)
20	Conduct qualitative evaluation process to evaluate the ready state of existing shelters and needs for new shelters.	+	+	+	-	+	N	+	+	+	N	+	+	+	+	N	N	N	N	N	+	+	+	N	14 (+) 1 (-) 8 (N)	18 (+) 1 (-) 8 (N)
21	Work with municipal officials to increase awareness among mobile-home owners and evaluate how many mobile homes have been anchored.	+	+	+	-	-	-	+	+	+	N	+	+	+	+	-	+	N	N	N	+	+	+	N	14 (+) 4 (-) 5 (N)	18 (+) 4 (-) 5 (N)
22	Develop a linkage between	+	+	N	-	N	-	+	+	+	N	+	+	+	+	N	+	N	N	N	+	+	+	N	13 (+) 2 (-)	17 (+) 2 (-)

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	the County tax assessment records and parcels in the County GIS to allow future revision of this plan to more easily incorporate information about property values, construction types, etc.																							8 (N)	8 (N)
23	Identify existing critical facilities and infrastructure with the highest relative vulnerability to hazards.	+	+	+	N	N	N	+	+	+	N	+	+	+	+	N	N	N	N	N	+	+	+	N	13 (+) 0 (-) 10 (N)	17 (+) 0 (-) 10 (N)
24	Conduct cost-benefit analysis of protection of vulnerable critical facilities and infrastructure.	+	+	+	-	-	N	+	+	+	N	+	+	+	+	-	N	N	N	N	+	+	+	N	13 (+) 3 (-) 7 (N)	18 (+) 3 (-) 7 (N)
25	Identify emerging software systems for loss estimation and train County staff to use existing HAZUS software and DES damage reporting software.	+	N	N	+	-	+	+	+	+	N	+	+	+	+	-	N	N	N	N	+	+	+	N	13 (+) 2 (-) 8 (N)	17 (+) 2 (-) 8 (N)

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26	Identify funding sources for hazard mitigation equipment, software, and data purchasing and software training.	+	N	N	N	N	N	+	+	+	N	+	+	+	+	N	N	N	N	N	N	+	+	N	10 (+) 0 (-) 13 (N)	14 (+) 0 (-) 13 (N)
27	Work closely with assessment office to determine how best to apply current data to the needs of emergency management.	+	+	N	+	N	+	N	+	+	N	+	+	+	+	N	N	N	N	N	N	+	+	N	12 (+) 0 (-) 11 (N)	16 (+) 0 (-) 11 (N)
28	Develop mutual agreements with neighboring counties to utilize cooperative efforts to mitigate hazards that impact communities beyond political boundaries.	+	+	+	+	N	+	+	+	+	+	+	+	+	+	N	+	+	+	+	+	+	+	N	20 (+) 0 (-) 3 (N)	24 (+) 0 (-) 3 (N)
29	Explore using existing and or planned multi-use trails as evacuation routes.	+	+	+	N	N	N	+	+	+	N	+	+	+	+	N	+	+	+	+	+	+	+	N	17 (+) 0 (-) 6 (N)	21 (+) 0 (-) 6 (N)
30	Review existing regulations to ensure adequacy in reducing the amount of future development in identified	+	+	+	-	+	N	+	+	+	N	+	+	+	+	N	+	+	+	+	+	+	+	N	18 (+) 1 (-) 4 (N)	22 (+) 1 (-) 4 (N)

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	hazard areas, especially steep slopes and floodplains.																								
31	Review all comprehensive plans to ensure that designated growth areas are not in hazard areas.	+	+	+	-	+	N	+	+	+	+	+	+	+	+	N	+	+	+	+	+	+	+	N	19 (+) 1 (-) 3 (N)	23 (+) 1 (-) 3 (N)
32	Review all capital improvements to ensure that infrastructure improvements are not directed towards hazardous areas.	+	+	+	-	N	+	+	+	+	+	+	+	+	+	N	+	+	+	+	+	+	+	N	19 (+) 1 (-) 3 (N)	23 (+) 1 (-) 3 (N)
33	Hold workshops for governing bodies on the importance of prohibiting development in hazard-prone areas.	+	+	+	-	-	N	+	+	+	N	+	+	+	+	-	+	+	+	+	+	+	+	N	17 (+) 3 (-) 3 (N)	21 (+) 0 (-) 4 (N)
34	Provide model ordinances to municipalities that can be used to prohibit development in hazard-prone areas.	+	+	+	N	N	N	+	+	+	+	+	+	+	+	N	+	+	+	+	+	+	+	N	18 (+) 0 (-) 5 (N)	22 (+) 0 (-) 5 (N)
35	Identify and publicize success stories as part of an overall consistent public relations	+	+	+	+	N	N	+	+	+	N	+	+	+	+	N	N	N	N	N	+	+	+	N	14 (+) 0 (-) 9 (N)	18 (+) 0 (-) 9 (N)

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	program.																									
36	Convene regular meetings of the HMSC to discuss issues and progress related to the implementation of the plan.	+	+	N	N	N	N	+	+	+	N	+	+	+	+	N	N	N	N	N	+	+	+	N	12 (+) 0 (-) 11 (N)	16 (+) 0 (-) 11 (N)
37	Renew and expand commitments to hazard mitigation planning among partner organizations.	+	+	+	N	N	N	+	+	+	N	+	+	+	+	N	N	N	N	N	+	+	+	N	13 (+) 0 (-) 10 (N)	17 (+) 0 (-) 10 (N)
38	Increase awareness by residents of actions to take during an emergency, including sheltering and evacuation procedures. Methods to be used can include public outreach (i.e., website, mailings, workshops, media coverage) and education.	+	+	+	-	-	N	+	+	+	N	+	+	+	+	-	N	N	N	N	N	+	+	+	N	13 (+) 3 (-) 7 (N)	17 (+) 3 (-) 7 (N)
39	Identify special populations requiring additional	+	+	+	N	N	N	+	+	+	N	+	+	+	+	N	N	N	N	N	N	+	+	+	N	13 (+) 0 (-) 10 (N)	17 (+) 0 (-) 10 (N)

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	emergency response.																									
40	Evaluate means to enhance response capability for residents.	+	+	+	+	N	+	+	+	+	N	+	+	+	+	N	N	N	N	N	+	+	+	N	15 (+) 0 (-) 8 (N)	19 (+) 0 (-) 8 (N)
41	Engage in public education activities about Delaware County's *Pandemic Influenza Preparedness and Response Plan.*	+	+	+	N	N	N	+	+	+	N	+	+	+	+	N	N	N	N	N	+	+	+	N	13 (+) 0 (-) 1 (N)	17 (+) 0 (-) 1 (N)
42	Update municipal zoning code to strengthen it to promote disaster-resistant development.	+	+	+	+	N	+	+	+	+	N	+	+	+	+	N	N	N	N	N	+	+	+	N	15 (+) 0 (-) 8 (N)	19 (+) 0 (-) 8 (N)
43	Acquire, elevate, flood-proof or relocate structures and properties in flood hazard areas.	+	+	-	-	-	+	-	+	+	N	+	+	+	+	-	+	+	+	+	+	+	+	-	16 (+) 6 (-) 1 (N)	20 (+) 6 (-) 1 (N)
44	Reduce urban fire hazard in borough by adding accessible routes for the handicapped in	+	+	+	-	-	-	+	+	+	N	+	+	+	+	-	N	N	N	N	+	+	+	N	13 (+) 4 (-) 6 (N)	17 (+) 4 (-) 6 (N)

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	row home areas without existing handicap ramps or sidewalks.																								
45	Install, repair or replace culverts or storm sewers in areas of the municipality that experience flooding.	+	+	+	-	-	-	+	+	+	N	+	+	+	+	-	+	+	+	+	+	+	+	N	17 (+) 4 (-) 2 (N)	21 (+) 4 (-) 2 (N)
46	Elevate roadways where necessary to allow water to flow underneath of them and reduce roadway flooding.	+	+	-	-	-	+	-	+	+	N	+	+	+	+	-	+	+	+	+	+	+	+	N	16 (+) 5 (-) 2 (N)	20 (+) 5 (-) 2 (N)
47	Explore opportunities and create stormwater infiltration areas in the municipality such as stormwater detention basins, rain gardens etc.	+	+	+	-	-	-	+	+	+	N	+	+	+	+	-	+	+	+	+	+	+	+	N	17 (+) 4 (-) 2 (N)	21 (+) 4 (-) 2 (N)
48	Explore opportunities to mitigate flooding and drainage problems in the municipality.	+	+	+	N	-	N	+	+	+	N	+	+	+	+	-	+	+	+	+	+	+	+	N	17 (+) 2 (-) 4 (N)	21 (+) 2 (-) 4 (N)

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49	Explore opportunities to improve pedestrian safety at the intersection of Route 420 and Yale/Morton Avenues (near railroad area).	+	+	+	N	-	-	+	+	+	N	+	+	+	+	-	N	N	N	N	+	+	+	N	13 (+) 3 (-) 7 (N)	21 (+) 3 (-) 7 (N)
50	Create and distribute an educational pamphlet about the borough's floodplain regulations and the importance of floodplain regulations.	+	+	+	N	-	N	+	+	+	N	+	+	+	+	-	+	N	N	+	+	+	+	N	15 (+) 2 (-) 6 (N)	19 (+) 2 (-) 6 (N)
51	Explore projects to mitigate washout of Farnum Road from flooding.	+	+	+	-	-	-	+	+	+	N	+	+	+	+	-	+	+	+	+	+	+	+	N	17 (+) 4 (-) 2 (N)	21 (+) 4 (-) 2 (N)
52	Clean up debris in streams and along stream banks and bridges in municipality.	+	+	+	-	N	-	+	+	+	N	+	+	+	+	N	+	+	+	+	+	+	+	N	17 (+) 2 (-) 4 (N)	21 (+) 2 (-) 4 (N)
53	Evaluate Borough's capabilities to respond to urban fires and explosions and make recommendations to increase capabilities.	+	+	+	N	N	N	+	+	+	N	+	+	+	+	N	N	N	N	N	+	+	+	N	13 (+) 0 (-) 10 (N)	17 (+) 0 (-) 10 (N)

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54	Stabilize flood damaged residences in the municipality through use of tie-backs and relocation of living residences and utilities to first floors.	+	+	+	-	-	-	+	+	+	N	+	+	+	+	-	+	N	N	+	+	+	+	N	15 (+) 4 (-) 4 (N)	19 (+) 4 (-) 4 (N)
55	Stabilize, revegetate or reinforce stream banks in areas of the municipality where necessary.	+	+	+	-	-	-	+	+	+	N	+	+	+	+	-	+	+	+	+	+	+	+	N	17 (+) 4 (-) 2 (N)	21 (+) 4 (-) 2 (N)
56	Conduct survey to assess the likely consequences of dam failure of dams on Ridley Creek and to assess the physical structure to determine the likelihood of failure. If defects exist, the survey should propose remedies. If the survey identifies severe adverse consequences of dam failure, mitigation possibilities should be identified.	+	+	+	-	-	N	+	+	+	N	+	+	+	+	-	N	N	N	N	+	+	+	N	13 (+) 3 (-) 7 (N)	17 (+) 3 (-) 7 (N))

Table 6.4-2: Summary of mitigation action prioritization using PA STEEL methodology.

MITIGATION ACTIONS		PA STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							
		P Political			**A** Administrative			**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 w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**SUMMARY (EQUAL WEIGHTING)**	**SUMMARY (BENEFITS & COSTS PRIORITIZED)**
57	Increase size of upstream impoundment areas for Cobbs Creek and Naylors Run.	+	+	-	-	-	-	+	+	-	-	+	+	+	+	-	+	+	+	+	+	+	+	+	N	15 (+) 7 (-) 1 (N)	19 (+) 7 (-) 1 (N)
58	Modernize traffic lights at intersections that are hazardous for pedestrian crossing.	+	+	+	-	-	N	+	+	+	N	+	+	+	+	-	N	N	N	N	+	+	+	+	N	13 (+) 3 (-) 7 (N)	17 (+) 3 (-) 7 (N)
59	Purchase a backup generator for the police station.	+	+	N	N	-	+	N	+	+	N	+	+	+	+	-	N	N	N	N	+	+	+	+	N	12 (+) 2 (-) 9 (N)	16 (+) 2 (-) 9 (N)
60	Conduct flood level monitoring along Naylor's Run Creek.	+	+	N	-	-	-	+	+	+	N	+	+	+	+	-	+	+	+	+	+	+	+	+	N	16 (+) 4 (-) 3 (N)	20 (+) 4 (-) 3 (N)
61	Upgrade Springton Road pumps.	+	+	+	N	-	-	+	+	+	N	+	+	+	+	-	+	+	+	+	+	+	+	+	N	17 (+) 3 (-) 3 (N)	21 (+) 3 (-) 3 (N)

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62	Continue planning of dispersement locations as part of Disaster Relief Drug Distribution Program.	+	+	+	N	N	N	+	+	+	N	+	+	+	+	N	N	N	N	N	+	+	+	N	13 (+) 0 (-) 10 (N)	17 (+) 0 (-) 10 (N)
63	Provide for operable, storm shutters on portions of municipal government center used for emergency operations command center and civilian shelter.	+	+	N	N	-	N	N	+	+	N	+	+	+	+	-	N	N	N	N	+	+	+	N	11 (+) 2 (-) 10 (N)	15 (+) 2 (-) 10 (N)
64	Remove shade trees in Borough that are susceptible to damage from high winds and icing.	+	-	-	-	-	-	-	+	+	N	+	+	+	+	-	-	-	N	-	+	+	+	N	10 (+) 10 (-) 3 (N)	14 (+) 10 (-) 3 (N)
65	Mitigate identified residences, businesses, Weir Park, Aston Middletown Little League Park, and Lewis H. Fisher Park from the effects of floods, flash floods, and ice jams.	+	+	+	-	-	-	+	+	+	N	+	+	+	+	-	+	+	+	+	+	+	+	N	17 (+) 4 (-) 2 (N)	21 (+) 4 (-) 2 (N)

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66	Purchase signs and temporary barricades to use to advise motorists not to drive through flood waters.	+	N	N	N	-	+	+	+	+	N	N	+	+	+	-	N	N	N	N	+	+	+	N	11 (+) 2 (-) 10 (N)	15 (+) 2 (-) 10 (N)
67	Mark fire hydrants that get covered by snow plowing along Routes 1 and 202 with flags.	+	+	N	N	-	+	+	+	+	N	+	+	+	+	-	N	N	N	N	+	+	+	N	13 (+) 2 (-) 8 (N)	17 (+) 2 (-) 8 (N)
68	Conduct emergency planning exercises for high hazard dams in the County to simulate hazard response.	+	+	N	-	N	-	+	+	+	N	N	+	+	+	N	N	N	N	N	+	+	+	N	11 (+) 2 (-) 10 (N)	15 (+) 2 (-) 10 (N)
69	Develop/update interface between dam owners' inundation mapping and the DCPD's GIS tools.	+	+	N	-	N	-	+	+	+	N	+	+	+	+	N	N	N	N	N	+	+	+	N	12 (+) 2 (-) 9 (N)	16 (+) 2 (-) 9 (N)
70	Prepare a comprehensive land use plan to address transit oriented development, floodplain development, and	+	+	+	-	-	N	+	+	+	N	+	+	+	+	-	+	+	+	+	+	+	+	N	17 (+) 3 (-) 3 (N)	21 (+) 3 (-) 3 (N)

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	open space management in the Borough.																								
71	Explore opportunities for construction of, repair, or reinforcement of floodwalls or levees to protect homes, businesses, or other structures in or near floodplains.	+	+	+	-	-	-	+	+	+	-	N	+	+	+	-	+	+	N	+	+	+	+	N	15 (+) 5 (-) 3 (N)	19 (+) 5 (-) 3 (N)
72	Install an emergency generator at the Borough Hall to supply electric for an emergency evacuation center.	+	+	N	N	-	-	+	+	+	+	N	+	+	+	-	N	N	N	N	+	+	+	N	12 (+) 3 (-) 8 (N)	16 (+) 3 (-) 8 (N)
73	Conduct outreach to vulnerable populations during periods of extreme temperature, including establishing and promoting accessible heating or cooling	+	+	+	-	N	N	+	+	+	N	N	+	+	+	N	N	N	N	N	+	+	+	N	12 (+) 1 (-) 10 (N)	16 (+) 1 (-) 10 (N)

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MITIGATION ACTIONS		PA STEEL CRITERIA CONSIDERATIONS (+) Favorable (-) Less favorable (N) Not Applicable																							
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	centers in the community.																									
74	Educate residents about the importance of installing and maintaining smoke detectors and fire extinguishers on each floor of their home or other buildings.	+	+	+	-	N	N	+	+	+	N	+	+	+	+	N	+	N	+	+	+	+	+	N	16 (+) 1 (-) 6 (N)	20 (+) 1 (-) 6 (N)
75	Adopt Crum Creek Act 167 plan and stormwater management ordinance once completed.	+	+	+	N	N	N	+	+	+	N	+	+	+	+	N	+	+	N	+	+	+	+	N	16 (+) 0 (-) 7 (N)	20 (+) 0 (-) 7 (N)
76	Dredge silt from Ridley Park Lake.	+	-	-	N	-	-	-	+	-	-	-	+	-	+	-	-	-	N	-	+	+	+	-	7 (+) 14 (-) 2 (N)	9 (+) 16 (-) 2 (N)

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77	Obtain additional ownership, operation, and maintenance information for levees in Delaware County for the next HMPU.	N	N	+	-	N	+	+	N	+	-	N	+	+	+	N	+	+	+	+	+	+	+	N	14(+) 2(-) 7(N)	18(+) 2(-) 7(N)
78	Develop and implement a radon exposure prevention program.	+	+	+	-	-	-	+	+	+	-	+	+	+	+	-	N	N	N	+	+	+	+	N	14(+) 5(-) 4(N)	18(+) 5(-) 4(N)

7. Plan Maintenance

7.1. Process Summary

Monitoring, evaluating and updating this plan are critical to maintaining its value and success in Delaware 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 monitoring, evaluation, and updating, and what those responsibilities entail. The section also lays out the method and schedule of these activities and describes how the public will be involved on a continued basis.

The Delaware County HMSC reviewed the Plan Maintenance section of their 2006 HMP. Only a few minor changes were made to the 2006 methodology and schedule to make it somewhat more detailed than what is outlined in the 2006 HMPU. The 2006 maintenance process involved a review and update of the plan after a disaster and every five years. The primary change made to the 2011 HMPU involves having the HMSC meet within 30 days of a significant disaster to review the plan and update the plan within twelve months of the disaster. In addition, the HMSC decided to include language about determining whether grant applications should be submitted as the plan is being reviewed.

7.2. Monitoring, Evaluating and Updating the Plan

The plan needs a permanent entity to be in charge of and responsible for the plan maintenance processes of monitoring, evaluation, and updating. This plan recommends keeping the Delaware County Hazard Mitigation Plan Steering Committee as a permanent planning group designated to administer the plan maintenance processes of monitoring, evaluation and updating with support and representation from all participating municipalities.

John Pickett, Director of the Delaware County Planning Department, in coordination with and cooperation of Larry Bak, the Delaware County Department of Emergency Services Deputy Director, will lead the HMSC in all associated plan maintenance requirements including annual reviews. All interim meetings will be documented and meeting minutes will be incorporated in the next plan update.

The Committee will oversee the progress made on the implementation of the identified action items and update the plan, as needed, to reflect changing conditions. The Committee will, therefore, serve as the focal point for coordinating Countywide mitigation efforts. The HMSC will meet quarterly to address all of its responsibilities. It will serve in an advisory capacity to Delaware County Council and report to them as needed.

The Committee will monitor the mitigation activities by reviewing reports from the agencies identified for implementation of the different mitigation actions. The Committee will request that the responsible agency or organization submit a semi-annual report that provides adequate information to assess the status of mitigation activities. The Committee will then provide its feedback to the individual agencies.

Evaluation of the plan will not only include checking whether mitigation actions are implemented or not but also assessing their degree of effectiveness. This will be done by reviewing the

qualitative and quantitative benefits (or avoided losses) of the mitigation activities. These will then be compared to the goals and objectives the plan set out to achieve. The Committee will also evaluate mitigation actions if they need to be discontinued or modified in any way in light of new developments in the community. The progress will be documented by the Committee and submitted to County Council as needed.

Upon each HMP evaluation, the HMSC will consider whether applications should be submitted for existing mitigation grant programs. A decision to apply for funding will be based on appropriate eligibility and financial need requirements. The HMSC will also support local and County officials in applying for post-disaster mitigation funds when they are available. All state and federal mitigation funding provided to the County or local municipalities will be reported in subsequent plan updates. In addition, new plans and programs being developed within the County will be evaluated as to the ability and necessity to incorporate the 2011 HMP into them.

Throughout the hazard analysis and vulnerability assessment, descriptions of missing or inadequate data indicate some areas in which the County and municipalities can improve their ability to identify vulnerable structures. As the County and municipal governments work to increase their overall technical capacity and implement their comprehensive planning goals, they will attempt also to improve their ability to respond to identified hazard vulnerability identification and other needs. In short, the County and municipalities in subsequent versions of this plan will improve upon the hazard identification and vulnerability assessment by:

- Revamping County and municipal building permit and data collection systems to require and keep on file elevation certificates for all new construction, elevated structures, and other substantial improvements within the 1% annual chance floodplain areas.
- Updating the tax and GIS databases with information like addresses, foundation type, construction type, and first-floor elevations for each structure. The updated plan will be better able to identify structures in need of mitigation based on first floor elevations.
- Obtaining refined topographic contour information for the entire County, which will allow better identification of steep slopes within the County.
- Incorporating existing and in-progress stormwater management plans and projects into the vulnerability assessment and mitigation strategy to be better able to connect localized flooding issues with riverine flooding issues.

These recommendations are also noted in the action plan. These improvements will produce an even more effective vulnerability assessment and mitigation plan upon revision.

The plan will be updated every five years, as required by the Disaster Mitigation Act of 2000, or within twelve months of a disaster. Should a significant disaster occur within the County, the HMSC will reconvene within 30 days of the disaster to review the plan. The updated plan will account for any new developments in the community or special circumstances (e.g., post-disaster). Issues that come up during monitoring and evaluation that require changes in mitigation strategies and actions will be incorporated in the plan at this stage.

7.3. Incorporation into Other Planning Mechanisms

Since 2006, the County developed a Darby Creek Greenway Plan. Information from the 2006 Delaware County HMP was incorporated into this document where applicable, particularly in the flooding section of Chapter 2. This section of the greenway plan addresses the importance of adopting floodplain and riparian zone protection ordinances as well as recommends keeping floodplains vegetated. Moving forward, the HMSC believes that this document will be highly useful when updating and developing other planning mechanisms in the County. Specific documents that the HMSC will actively incorporate information from the 2011 HMPU into include:

- Delaware County Comprehensive Plan: Section 4.4.4, Future Development and Vulnerability, will provide information for the development of the County Comprehensive Plan by making available specific risk and vulnerability information for the entire county but more specifically the potential areas of growth. A County Comprehensive Plan is currently being drafted and data and information from the HMPU will be incorporated into it.
- Delaware County Emergency Operations Plan: The 2011 HMPU will provide information on risk and vulnerability that will be extremely important to consider and incorporate into the updated County EOP. Probability and vulnerability can direct emergency management efforts and response.
- Delaware County Hazard Vulnerability Analysis: The County's HVA and the County HMPU are mutually beneficial plans that are used together to better understand risk and vulnerability. Just as the existing County HVA was used to supplement the development of this plan, the 2011 HMP will be used to aid in goal and objective development, hazard identification, and risk assessment in the next County HVA.
- Local Land Use Regulations: The HMPU provides an opportunity to contribute to local land use regulations to steer development away from hazard-prone areas.
- Act 167 Stormwater Management Plans: These plans are currently under development or in place for several watersheds. The results of the 2011 HMPU vulnerability analysis, particularly for flooding, will be taken into consideration when finalizing these stormwater management plans and any new stormwater management plans.

7.4. Continued Public Involvement

The public will be involved during the evaluation and update of the plan through annual public education projects, public workshops, and hearings. The public will also have access to information via newsletters, mailings, and the different agencies implementing the plan. The County's website (www.co.delaware.pa.us/planning) can serve as a means of two-way communication by not only providing information about mitigation initiatives within the County, but also having feedback forms and other means for the public to express their views and comments. The HMSC will incorporate the public comments in the next update of the plan.

8. Plan Adoption

The Plan was submitted to the Pennsylvania State Hazard Mitigation Officer on xxxxx, 2011. It was forwarded to FEMA for final review and approval-pending-adoption on xxxxxx, 2011. FEMA granted approval-pending-adoption on *<Month Day, Year>*. Full approval from FEMA was received on *<Month Day, Year>*.

This section of the plan includes copies of the local adoption resolutions passed by Delaware County and its municipal governments as well as a completed Local Mitigation Plan Review Crosswalk. Adoption resolution templates are provided to assist the County and municipal governments with recommended language for future adoption of the HMP.

Delaware County 2011 Hazard Mitigation Plan

County Adoption Resolution

Resolution No. _____

Delaware County, Pennsylvania

WHEREAS, the municipalities of Delaware 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, Delaware County acknowledges the requirements 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 Delaware County 2011 Hazard Mitigation Plan has been developed by the Delaware County Planning Department and the Delaware County Department of Emergency Services in cooperation with other county departments, local municipal officials, and the citizens of Delaware County, and

WHEREAS, a public involvement process consistent with the requirements of DMA 2000 was conducted to develop the Delaware County 2011 Hazard Mitigation Plan, and

WHEREAS, the Delaware County 2011 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 Delaware that:

- The Delaware County 2011 Hazard Mitigation Plan is hereby adopted as the official Hazard Mitigation Plan of the County, and
- The respective officials and agencies identified in the implementation strategy of the Delaware County 2011 Hazard Mitigation Plan are hereby directed to implement the recommended activities assigned to them.

ADOPTED, this _____ day of _____, 2011

ATTEST:

_____

DELAWARE COUNTY COUNCIL

By _____

By _____

By _____

By _____

By _____

Delaware County 2011 Hazard Mitigation Plan

Municipal Adoption Resolution

Resolution No. _____
<*Borough/Township of Municipality Name*>, Delaware County, Pennsylvania

WHEREAS, the <*Borough/Township of Municipality Name*>, Delaware 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 <*Borough/Township of Municipality Name*> acknowledges the requirements 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 Delaware County 2011 Hazard Mitigation Plan has been developed by the Delaware County Planning Department and the Delaware County Department of Emergency Services in cooperation with other county departments, and officials and citizens of <*Borough/Township of Municipality Name*>, and

WHEREAS, a public involvement process consistent with the requirements of DMA 2000 was conducted to develop the Delaware County 2011 Hazard Mitigation Plan, and

WHEREAS, the Delaware County 2011 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 <*Borough/Township of Municipality Name*>:

- The Delaware County 2011 Hazard Mitigation Plan is hereby adopted as the official Hazard Mitigation Plan of the <*Borough/Township*>, and
- The respective officials and agencies identified in the implementation strategy of the Delaware County 2011 Hazard Mitigation Plan are hereby directed to implement the recommended activities assigned to them.

ADOPTED, this _____ day of _____, 2011

ATTEST: ***<BOROUGH/TOWNSHIP OF MUNICIPALITY NAME>***

_____ By _____

By _____

By _____

9. Appendices

Appendix A – Bibliography
Appendix B – Local Mitigation Plan Review Crosswalk
Appendix C – Meeting and Other Participation Documentation
Appendix D – Local Municipality Flood Vulnerability Maps
Appendix E – Critical Facilities
Appendix F – HAZUS Reports
Appendix G – Dam Failure Hazard Profile (Section 4.3.13)
Appendix H – EPA-Identified Hazardous Material Facilities