

Greene County 2025 Hazard Mitigation Plan



Prepared for:

Greene County Emergency
Management Agency

55 W Greene St,
Waynesburg, PA 15370

Prepared by:

MCM Consulting
Group, Inc.

328 Innovation
Boulevard Suite 222

State College, PA



*Greene County, Pennsylvania
2025 Hazard Mitigation Plan*

Certification of Annual Review Meetings

YEAR	DATE OF MEETING	PUBLIC OUTREACH ADDRESSED? *	SIGNATURE
2025			
2026			
2027			
2028			
2029			

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

*Greene County, Pennsylvania
2025 Hazard Mitigation Plan*

Record of Changes

DATE	DESCRIPTION OF CHANGE MADE, MITIGATION ACTION COMPLETED, OR PUBLIC OUTREACH PERFORMED	CHANGE MADE BY (PRINT NAME)	CHANGE MADE BY (SIGNATURE)

*Greene County, Pennsylvania
2025 Hazard Mitigation Plan*

Table of Contents

Record of Changes	3
Table of Contents	4
Figures.....	7
Tables	9
Acronyms.....	12
Executive Summary	16
1. Introduction	19
1.1. Background.....	19
1.2. Purpose.....	19
1.3. Scope.....	20
1.4. Authority and References.....	20
2. Community Profile	22
2.1. Geography and the Environment	22
2.2. Community Facts	23
2.3. Population and Demographics	25
2.4. Land Use and Development.....	29
2.5. Data Sources	30
3. Planning Process	37
3.1. Update Process and Participation Summary.....	37
3.2. The Planning Team	38
3.3. Meetings and Documentation.....	39
3.4. Public and Stakeholder Participation	41
3.5. Multi-Jurisdictional Planning.....	42
4. Risk Assessment.....	47
4.1. Update Process Summary.....	47
4.2. Hazard Identification.....	48
4.2.1. Presidential and Gubernatorial Disaster Declarations	48
4.2.2. Summary of Hazards.....	51
4.2.3. Climate Change.....	57
4.3. Hazard Profiles.....	59

*Greene County, Pennsylvania
2025 Hazard Mitigation Plan*

4.3.1.	Drought	59
4.3.2.	Earthquake	71
4.3.3.	Extreme Temperature	83
4.3.4.	Flooding, Flash Flooding, and Ice Jam Flooding	91
4.3.5.	Hurricane, Tropical Storm	108
4.3.6.	Invasive Species	117
4.3.7.	Landslide.....	130
4.3.8.	Pandemic, Epidemic, Endemic, and Infectious Disease	136
4.3.9.	Radon Exposure	148
4.3.10.	Subsidence, Sinkhole.....	160
4.3.11.	Tornado, Windstorm	168
4.3.12.	Wildfire	183
4.3.13.	Winter Storm.....	193
4.3.14.	Building/Structural Collapse/Blighted Properties	205
4.3.15.	Civil Disturbance.....	208
4.3.16.	Dam Failure	212
4.3.17.	Environmental Hazards.....	239
4.3.18.	Substance Use Disorder	253
4.3.19.	Terrorism/Cyberterrorism.....	262
4.3.20.	Transportation Accidents	272
4.3.21.	Urban Fire and Explosion	280
4.3.22.	Utility Interruption	284
4.4.	Hazard Vulnerability Summary.....	292
4.4.1.	Methodology	292
4.4.2.	Ranking Results	294
4.4.3.	Potential Loss Estimates.....	300
4.4.4.	Future Development and Vulnerability	300
5.	Capability Assessment.....	303
5.1.	Update Process Summary	303
5.2.	Capability Assessment Findings	304
5.2.1.	Planning and Regulatory Capability.....	304
5.2.2.	Administrative and Technical Capability.....	313

*Greene County, Pennsylvania
2025 Hazard Mitigation Plan*

5.2.3.	Financial Capability.....	317
5.2.4.	Education and Outreach	320
5.2.5.	Plan Integration	321
6.	Mitigation Strategy.....	323
6.1.	Update Process Summary.....	323
6.2.	Mitigation Goals and Objectives.....	329
6.3.	Identification and Analysis of Mitigation Techniques.....	331
6.4.	Mitigation Action Plan.....	334
7.	Plan Maintenance	357
7.1.	Update Process Summary	357
7.2.	Monitoring, Evaluating and Updating the Plan	357
7.3.	Continued Public Involvement.....	358
8.	Plan Adoption	360
8.1.	Resolutions	360
9.	Appendices	361
	APPENDIX A: References	361
	APPENDIX B: FEMA Local Mitigation Review Tool.....	361
	APPENDIX C: Meetings and Support Documents.....	361
	APPENDIX D: Municipal Flood Maps	361
	APPENDIX E: Critical and Community Lifeline Facilities.....	361
	APPENDIX F: 2025 HAZUS Reports	361
	APPENDIX G: 2025 Mitigation Project Opportunities	361
	APPENDIX H: 2025 Mitigation Action Evaluation & Prioritization	361
	APPENDIX I: Annual Review Documentation.....	361
	APPENDIX J: Greene County & Municipal Adoption Resolutions	361

*Greene County, Pennsylvania
2025 Hazard Mitigation Plan*

Figures

Figure 1 - Köppen-Geiger Climate Map.....	22
Figure 2 - Unemployment Rate Jan. 2014 to Oct. 2024	27
Figure 3 - Greene County Basemap.....	33
Figure 4 - Greene County Watersheds.....	34
Figure 5 - Greene County Population Density.....	35
Figure 6 - Greene County Land Use	36
Figure 7 - Pennsylvania Palmer Drought Index 1900 – 2024.....	63
Figure 8 - U.S. Drought Monitor, Pennsylvania.....	64
Figure 9 - Palmer Drought Severity Index.....	65
Figure 10 - Drought-Vulnerable Land Use and Public Water Supply	70
Figure 11 - Ramapo Fault System	71
Figure 12 - Pennsylvania Earthquake Hazard Zones	80
Figure 13 - Pennsylvania Oil and Gas Geology.....	81
Figure 14 - Pennsylvania Recorded Earthquake Events	82
Figure 15 - National Weather Service’s Heat Index Matrix	84
Figure 16 - National Weather Service’s Wind Chill Matrix.....	84
Figure 17 - Observed and Projected Temperature Change for Pennsylvania.....	86
Figure 18 - Average Minimum Temperature Trends for Pennsylvania.....	89
Figure 19 - Average Maximum Temperature Trends for Pennsylvania	90
Figure 20 - Flooding and Floodplain Diagram	92
Figure 21 - Loss by Occupancy Type	95
Figure 22 - Pennsylvania Wind Zones.....	114
Figure 23 - Historic Tropical Storms/Hurricanes in Pennsylvania.....	115
Figure 24 - Historic Tropical Storms/Hurricanes in Greene County	116
Figure 25 - Emerald Ash Borer Infestation in Pennsylvania	118
Figure 26 - Hemlock Woolly Adelgid Infestation in Pennsylvania.....	119
Figure 27 - Pennsylvania Spotted Lanternfly Infestation	129
Figure 28 - Landslide Hazard Areas	135
Figure 29 - Pennsylvania Department of Health Districts	147
Figure 30 - Sketch of Radon Entry Points into a House.....	150
Figure 31 - Pennsylvania Radon Levels	158
Figure 32 - Radon Levels by Zip Code.....	159
Figure 33 - Sinkhole Susceptibility in Pennsylvania	165
Figure 34 - Abandoned Mined Sites in Greene County.....	166
Figure 35 - Unsuitable Areas for Mining in Pennsylvania	167
Figure 36 - Pennsylvania Wind Zones.....	180
Figure 37 - Tornado Activity in Greene County.....	181
Figure 38 - Tornado Activity in Pennsylvania.....	182
Figure 39 - Seasonal Wildfire Percentages	187
Figure 40 - Wildland Urban Interface.....	191

***Greene County, Pennsylvania
2025 Hazard Mitigation Plan***

Figure 41 - Fire Station Locations	192
Figure 42 - Pennsylvania Annual Snowfall 1981 – 2010	203
Figure 43 - Winter Storm Events by County in Pennsylvania.....	204
Figure 44 - Greene County Dams	236
Figure 45 - Greene County Levee Locations	237
Figure 46 - Greene County Levee Location – Freeport.....	238
Figure 47 - Oil and Gas Well Locations	250
Figure 48 - Environmental Hazard Transportation Vulnerability.....	251
Figure 49 - Annual Truck Traffic Percentages	252
Figure 50 - Opioid Overdose Deaths in Pennsylvania 2022.....	260
Figure 51 - Opioid Overdose Deaths in Pennsylvania 2023.....	261
Figure 52 - Active Shooter Incidents - 20 Year Active Shooter Summary	266
Figure 53 - Education Environments	267
Figure 54 - Major Transportation Routes	276
Figure 55 - Airports and Vulnerability Zones.....	277
Figure 56 - Average Daily Traffic on Major Highway Vulnerability	278
Figure 57 - Utility Pipelines Vulnerability	279
Figure 58 - Greene County Working Fires	283
Figure 59 - Greene County Utilities.....	291

*Greene County, Pennsylvania
2025 Hazard Mitigation Plan*

Tables

Table 1 - Watersheds in Greene County	23
Table 2 - Greene County National Historic Places	24
Table 3 - Population Change in Greene County	25
Table 4 - Greene County Top Employers	28
Table 5 - Quarterly Census of Employment and Wages, 2023 Annual Averages in Greene County	28
Table 6 - Steering Committee	38
Table 7 - Local Planning Team	39
Table 8 - HMP Process Timeline	40
Table 9 - Municipality Worksheets, Surveys, and Forms Participation	43
Table 10 - Presidential & Gubernatorial Disaster Declarations	48
Table 11 - Drought Preparation Phases	60
Table 12 - Palmer Drought Severity Index	61
Table 13 - Economic and Environmental Impacts of Drought Events	62
Table 14 - Past Drought Events in Greene County	63
Table 15 - Population Change in Greene County	68
Table 16 - Richter Scale	72
Table 17 - Modified Mercalli Intensity Scale	73
Table 18 - Recent Earthquake Trends in Northeastern United States	75
Table 19 - Past Extreme Temperature Occurrences for Greene County	85
Table 20 - Flood Hazard High Risk Zones	92
Table 21 - HAZUS Building Loss Figures	94
Table 22 - HAZUS Business Interruption Economic Loss Figures	94
Table 23 - Past Flood and Flash Flood Events	96
Table 24 - Repetitive Loss Properties	98
Table 25 - Summary of Type of Repetitive Loss Properties by Municipality	100
Table 26 - Severe Repetitive Loss Properties	100
Table 27 - Municipal NFIP Policies & Vulnerability	100
Table 28 - Flood Probability Summary	102
Table 29 - Expected Damage to Essential Facilities (HAZUS)	103
Table 30 - County Structures Within Special Flood Hazard Area	103
Table 31 - Community Lifeline Facilities Additional Information	104
Table 32 - Saffir-Simpson Hurricane Scale	109
Table 33 - History of Coastal Storms Impacting Greene County	110
Table 34 - Annual Probability of Wind Speeds	111
Table 35 - Prevalent Invasive Species	120
Table 36 - Future Vulnerable Species	124
Table 37 - Structure Vulnerability Data	132
Table 38 - Pandemic Influenza Phases	138
Table 39 - Past Pandemic Events in the United States	140

***Greene County, Pennsylvania
2025 Hazard Mitigation Plan***

Table 40 - West Nile Virus Control Program in Greene County since 2018	141
Table 41 - Lyme Disease Data for Greene County	141
Table 42 - Radon Risk for Smokers and Nonsmokers.....	151
Table 43 - Radon Test Results in Greene County.....	153
Table 44 - Suggested Actions and Time Frame for Exposure to Radon Daughters	154
Table 45 - Enhanced Fujita Scale	170
Table 46 - Greene County Tornado History	172
Table 47 - Greene County High Wind History.....	172
Table 48 - Wildland Fire Assessment System	184
Table 49 - Annual Summary of Wildfire Events	185
Table 50 - NESIS Winter Storm Rankings	194
Table 51 - Recent Annual Snowfall Estimates	196
Table 52 - Greene County Winter Weather History	196
Table 53 - Population per Municipality under 5 Years or 65 Years or Older	199
Table 54 - Civil Disturbance Events Reported to PEMA 2018-2023.....	210
Table 55 - High-Hazard Dams Municipality Summary.....	213
Table 56 - Greene County Dam Inventory	213
Table 57 - Greene County Levee Inventory	217
Table 58 - Dam Classification	220
Table 59 - High-Hazard Potential Dams Risk Type	222
Table 60 - Greene County High-Hazard Dam Vulnerability Data	223
Table 61 - Greene County High-Hazard Dam Vulnerability Data - Infrastructure	225
Table 62 - Greene County High-Hazard Dam Vulnerability Data - Infrastructure Names	226
Table 63 - Number of Vulnerable Structure within Leveed Areas	235
Table 64 - Hazardous Material Incidents.....	241
Table 65 - TRI Facilities	247
Table 66 - Oil and Gas Wells & Drinking Water Wells	249
Table 67 - Drug Overdose Mortality in Greene County	255
Table 68 - Drugs Present in 2020 Pennsylvania Overdose Deaths.....	255
Table 69 - PennDOT Crash Report for Greene County.....	274
Table 70 - Urban Fire Occurrence	281
Table 71 - Greene County Utility Providers	284
Table 72 - Utility Interruptions in Greene County.....	286
Table 73 - 2018 Winter Storms Riley and Quinn Power Outages	287
Table 74 - Risk Factor Approach Summary	292
Table 75 - Risk Factor Approach Summary Continued.....	293
Table 76 - Risk Factor Assessment.....	294
Table 77 - Countywide Risk Factor	296
Table 78 - 2010 – 2020 Population Change.....	301
Table 79 - Greene County Municipal Floodplain Administrator Designees	313
Table 80 - 2018 Mitigation Goals and Objectives Review.....	323
Table 81 - 2018 Mitigation Actions Review.....	325

***Greene County, Pennsylvania
2025 Hazard Mitigation Plan***

Table 82 - 2025 Goals and Objectives	329
Table 83 - Mitigation Strategy Technique Matrix	333
Table 84 - 2025 Mitigation Action Plan	337
Table 85 - Municipal Hazard Mitigation Actions Checklist.....	351
Table 86 - Objective to Action Checklist	354
Table 87 - Actions Tied to Hazard.....	354

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Acronyms

AACT:	American Academy of Clinical Toxicology
ACHA:	American College Health Association
ACMT:	American College of Medical Toxicology
AHJ:	Authority Having Jurisdiction
AMD:	Acid Mine Drainage
ANSI:	American National Standards Institute
ASAM:	American Society of Addiction Medicine
ASHRAE:	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASIRT:	Association for Safe International Road Travel
BFE:	Base Flood Elevation
CBRNE:	Chemical, Biological, Radiological, Nuclear, or Explosive
CDC:	Centers for Disease Control and Prevention
CERT:	Community Emergency Response Team
CFR:	Code of Federal Regulations
CFS:	Commodity Flow Study
CHSN:	College Health Surveillance Network
CCIDRAP:	Center for Infectious Disease Research and Policy
CRS:	Community Rating System
DCNR:	Department of Conservation and Natural Resources
DDAP:	Department of Drug and Alcohol Programs
DEA:	Drug Enforcement Administration
DFIRM:	Digital Flood Insurance Rate Map
DMA:	Disaster Mitigation Act
DPS:	Department of Public Safety
EF:	Enhanced Fujita
EIA:	Energy Information Administration
EMA:	Emergency Management Agency
EMPG:	Emergency Management Performance Grant
EMS:	Emergency Medical Services
EOP:	Emergency Operations Plan

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

EPA:	Environmental Protection Agency
EPCRA:	Emergency Planning and Community Right-To-Know Act
EPZ:	Emergency Planning Zone
FBI:	Federal Bureau of Investigations
FEMA:	Federal Emergency Management Agency
FMA:	Flood Mitigation Assistance Grant Program
FRA:	Federal Railroad Association
GIS:	Geographic Information Systems/Sciences
HAZUS:	Hazards U.S. Software
HMA:	Hazard Mitigation Assistance
HMEP:	Hazardous Material Emergency Planning Grant
HMGP:	Hazard Mitigation Grant Planning
HMP:	Hazard Mitigation Plan
HMRF:	Hazardous Material Response Fund
HSCA:	Hazardous Sites Cleanup Act
HSGP:	Homeland Security Grant Program
HVE:	Homegrown Violent Extremist
ICC:	International Code Council
IES:	Illuminating Engineering Society
LEPC:	Local Emergency Planning Committee
LGTBQ:	Lesbian, Gay, Bisexual, Trans & Queer
LPT:	Local Planning Team
MAT:	Medication-Assisted Treatment
MPC:	Municipalities Planning Code
NARM:	Notification and Resource Manual
NAS:	Neonatal Abstinence Syndrome
NCDC:	National Climatic Data Center
NCEI:	National Centers for Environmental Information
NFIP:	National Flood Insurance Program
NFPA:	National Fire Protection Association
NIH:	National Institute of Health
NLD:	National Levee Database

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

NOAA:	National Oceanic and Atmospheric Administration
NTP:	Narcotic Treatment Program
NWS:	National Weather Service
OIH:	Opioid-Induced Hyperalgesia
ODU:	Opioid Use Disorder
PA DCED:	Pennsylvania Department of Community and Economic Development
PA DEP:	Pennsylvania Department of Environmental Protection
PA DOA:	Pennsylvania Department of Agriculture
PA GWIS:	Pennsylvania Groundwater Information System
PA HART:	Pennsylvania Helicopter Aquatic Rescue Team
PAWNVCP:	Pennsylvania West Nile Virus Control Program
PDMP:	Prescription Drug Monitoring Program
PDSI:	Palmer Drought Severity Index
PEMA:	Pennsylvania Emergency Management Agency
PennDOT:	Pennsylvania Department of Transportation
PHMSA:	Pipeline and Hazardous Materials Safety Administration
PISC:	Pennsylvania Invasive Species Council
POD:	Points of Dispensing
PWSA:	Public Water Service Area
RF:	Risk Factor
SARA:	Superfund Amendments and Reauthorization Act
SC:	Steering Committee
SFHA:	Special Flood Hazard Area
TRI:	Toxic Release Inventory
UCC:	Uniform Construction Code
US HHS:	United States Department of Health and Human Services
USACE:	United States Army Corp of Engineers
USDA:	United States Department of Agriculture
USDA FS:	United States Department of Agriculture Forest Service
USGS:	United States Geological Survey
WL:	Working Level

*Greene County, Pennsylvania
2025 Hazard Mitigation Plan*

WMD: Weapon of Mass Destruction

WUI: Wildland Urban Interface

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Executive Summary

Mitigation is the effort to reduce loss of life and property by lessening the impact of disasters. Hazard mitigation focuses attention and resources on county and municipal policies and actions that will produce successive benefits over time. State and local governments engage in hazard mitigation planning to identify risks and vulnerabilities associated with natural as well as human-caused hazards and develop long-term strategies for protecting people and property from future hazard events. Mitigation plans are key to breaking the cycle of disaster damage, reconstruction, and repeated damage. This plan represents the work of citizens, elected and appointed government officials, business leaders, and volunteer and nonprofit groups to protect community assets, preserve the economic viability of the community, and save lives.

In 2024, the Greene County Emergency Management Agency contracted the services of a consulting agency to revise and update the Greene County Hazard Mitigation Plan. The plan was successfully updated in accordance with the requirements set forth by PEMA and FEMA. The updated Greene County Hazard Mitigation Plan was adopted by the Greene County Commissioners in 2025. All twenty-six municipalities adopted the 2018 Greene County Hazard Mitigation Plan as the municipal hazard mitigation plan, and it is anticipated that all participating municipalities will adopt the 2025 Greene County Hazard Mitigation Plan Update.

The Greene County Commissioners secured a grant to complete the 2025 update to the Greene County Hazard Mitigation Plan. MCM Consulting Group, Inc. was hired to assist the county with the update of the plan. The planning kick-off meeting was conducted on September 30, 2024.

The planning process for the 2025 Greene County Hazard Mitigation Plan Update consisted of the following:

- Identification and prioritization of the hazards that may affect the county and its municipalities.
- Assessment of the county and municipalities' vulnerability to these hazards.
- Identification of the mitigation actions and projects that can reduce that vulnerability.
- Development of a strategy for implementing the actions and projects, including identifying the agency(ies) responsible for that implementation.

Throughout the planning process, the public was given the opportunity to comment on the existing HMP and provide suggestions for the updated version. Due to COVID-19, public meetings were conducted via an online survey to provide residents an opportunity to provide input on the HMP. Several meetings were held in person with a virtual option, and participants were invited to submit surveys and other documents via an online survey.

The following hazards were identified by the local planning team as presenting the highest risk to the county and its municipalities:

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Natural hazards:

- Drought
- Earthquake
- Extreme Temperature
- Flooding, Flash Flooding, Ice Jam Flooding
- Hurricane and Tropical Storm
- Invasive Species
- Landslide
- Pandemic and Infectious Disease
- Radon Exposure
- Subsidence, Sinkhole
- Tornado/Windstorm
- Wildfire
- Winter Storm

Human-caused hazards:

- Blighted Properties
- Civil Disturbance
- Dam Failure, Levee Failure
- Environmental Hazards – Fixed Facility, Transportation
- Substance Use Disorder
- Terrorism/Cyberterrorism
- Transportation Accidents
- Urban Fire and Explosion
- Utility Interruption

A total of twenty-two hazards have been identified in the 2025 Greene County Hazard Mitigation Plan. A total of fifteen identified hazard profiles were listed in the previous 2018 plan update. The new hazards include extreme temperature, blighted properties, civil disturbance, substance use disorder, terrorism/cyberterrorism, and urban fire and explosion.

To mitigate against the effects of these hazards, the local planning team identified the following goals for hazard mitigation over the next five years:

- Reduce potential injury/death and damage to existing community assets due to floods, flash floods, and ice jams.
- Reduce potential injury/death and damage to community assets due to all hazards.
- Promote disaster-resistant future development.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

- Promote hazard mitigation as a public value in recognition of its importance to the health, safety, and welfare of the population.
- Improve response and recovery capabilities.
- Protect critical infrastructure.

Mitigation actions are specific risk reduction projects and activities that help achieve goals. A total of forty-eight actions were developed for this plan update as they pertain to hazards identified by the local planning team. The 2018 Greene County Hazard Mitigation Plan consisted of twenty-seven total actions. The individual objectives and actions that will be implemented are shown in Section 6.4. Each municipality was provided with the opportunity to submit new project opportunity forms for this update. A total of forty project opportunity forms were submitted during the 2018 HMP update. A total of nine project opportunities were submitted for this plan update.

The 2025 Greene County Hazard Mitigation Plan is the cornerstone to reducing Greene County's vulnerability to disasters. It is the commitment to reducing risks from hazards and serves as a guide for decision makers as they commit resources to reducing the effects of hazards. Hazard mitigation is the only phase of emergency management specifically dedicated to breaking the cycle of damage, reconstruction, and repeated damage.

The 2025 Greene County Hazard Mitigation Plan is a living document that reflects ongoing hazard mitigation activities and requires monitoring, evaluating, and updating to ensure the mitigation actions are implemented. To facilitate the hazard mitigation planning process and adhere to regulatory requirements, the plan will be reviewed annually, and any major revisions will be incorporated into the five-year update.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

1. Introduction

1.1. Background

The Greene County Board of Commissioners, in response to the Disaster Mitigation Act of 2000 (DMA 2000), organized a countywide hazard mitigation planning effort to prepare, adopt, and implement a multi-jurisdictional Hazard Mitigation Plan (HMP) for Greene County and all its twenty-six municipalities. The Greene County Emergency Management Agency was charged by the County Board of Commissioners to prepare the 2025 plan. The 2018 HMP has been utilized and maintained during the five-year life cycle.

The Greene County Commissioners were successful in securing hazard mitigation grant funding to update the county hazard mitigation plan. The pre-disaster mitigation grant funding was administered by the Pennsylvania Emergency Management Agency and provided to Greene County as a sub-grantee. The Greene County Commissioners assigned the Greene County Emergency Management Agency with the primary responsibility to update the hazard mitigation plan. MCM Consulting Group, Inc. was selected to complete the update of the HMP. A local hazard mitigation planning team was developed comprised of government leaders and citizens from Greene County. This updated HMP will provide another solid foundation for the Greene County Hazard Mitigation Program.

Hazard mitigation describes sustained actions taken to prevent or minimize long-term risks to life and property from hazards and to create successive benefits over time. Pre-disaster mitigation actions are taken in advance of a hazard event and are essential to breaking the disaster cycles of damage, reconstruction, and repeated damage. With careful selection, successful mitigation actions are cost-effective means of reducing risk of loss over the long term.

Hazard mitigation planning has the potential to produce long-term and recurring benefits. A core assumption of mitigation is that current dollars invested in mitigation practices will significantly reduce the demand for future dollars by lessening the amount needed for recovery, repair, and reconstruction. These mitigation practices will also enable residents, businesses, and industries to reestablish themselves in the wake of a disaster, getting the economy back on track sooner with less interruption.

1.2. Purpose

The purpose of this all-hazard mitigation plan (HMP) is:

- Protect life, safety, and property by reducing the potential for future damages and economic losses that result from hazards.
- Qualify for additional grant funding, in both the pre-disaster and the post-disaster environment.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

- Speed recovery and redevelopment following future disaster events.
- Demonstrate a firm local commitment to hazard mitigation principles.
- Comply with both state and federal legislative requirements for local hazard mitigation plans.

1.3. Scope

This Greene County Multi-Jurisdictional Hazard Mitigation Plan serves as a framework for saving lives, protecting assets, and preserving the economic viability of the twenty-six municipalities in Greene County. The HMP outlines actions designed to address and reduce the impact of a full range of natural hazards facing Greene County, including drought, earthquakes, flooding, tornadoes, hurricanes/tropical storms, invasive species, and severe winter weather. Human-caused hazards such as transportation accidents, emergency services shortage, hazardous materials spills, and fires are also addressed.

A multi-jurisdictional planning approach was utilized for the Greene County HMP update, thereby eliminating the need for each municipality to develop its own approach to hazard mitigation projects, common mitigation goals and objectives, and an evaluation of a broad capabilities assessment examining policies and regulations throughout the county and its municipalities.

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
- 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

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

- 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
- FEMA Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards. January 2013
- FEMA Rehabilitation of High Hazard Potential Dams: Grant Program Guidance, June 2020

The following Pennsylvania Emergency Management Agency (PEMA) guides and reference documents were used to 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: All-Hazard Mitigation Planning Standard Operating Guide, 2020.

The following document produced by the National Fire Protection Association (NFPA) provided additional guidance for updating this plan:

- NFPA 1600: Standard on Disaster/Emergency Management and Business Continuity Programs. 2011

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

2. Community Profile

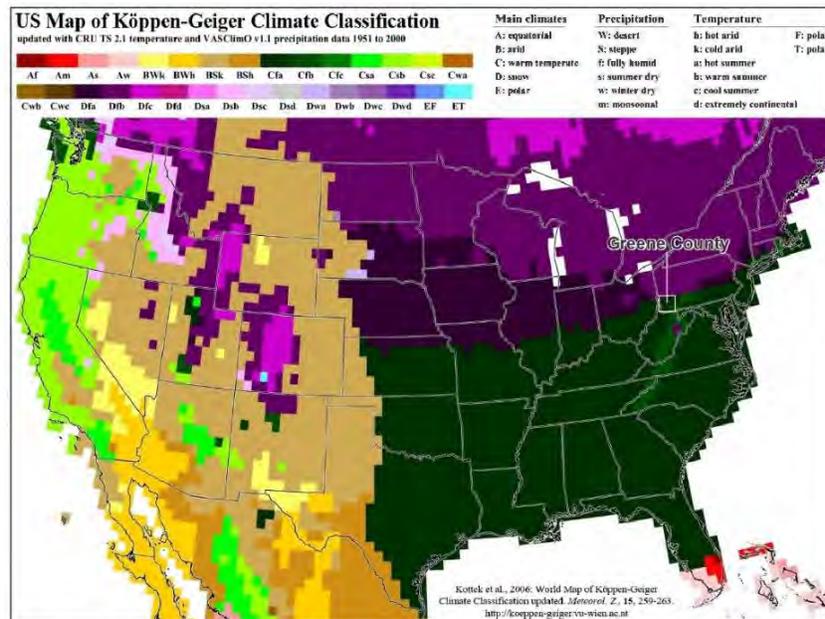
2.1. Geography and the Environment

Greene County covers approximately 578 square miles and is situated in southwest Pennsylvania. The county is bordered by Monongalia County, WV and Wetzel County, WV in the south, Marshall County, WV in the west, Washington County, PA to the north, and by Fayette County, PA to the east. Greene County lies within the Waynesburg Hills section of the Appalachian Plateaus physiographic province of Pennsylvania. The county is the 58th ranked county in terms of population within the Commonwealth of Pennsylvania. There is a total of 576 square miles of land and two square miles of water.

Greene County presents a wide range of topographic features. The surface is very hilly with narrow hilltops and steeply sloped narrow valleys. Elevations in the county range from a high of 1,657 feet near Garrison to a low of 761 feet in Cumberland Township near the Monongahela River.

The Köppen-Geiger Climate Areas map classifies Greene County, and the rest of Pennsylvania, as Humid Continental, which can be seen in *Figure 1 – Köppen-Geiger Climate Map*. While the counties of Pennsylvania share many weather similarities, there are also a few unique characteristics to the area.

Figure 1 - Köppen-Geiger Climate Map



According to current data, the climate in Greene County is temperate, being characterized by moderately hot summers and moderately severe winters. In winter, the average temperature is

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

34.46°F and the average daily minimum temperature is 25.58°F. In summer, the average temperature is 71.38°F and the average daily maximum temperature is 82.63°F. The average amount of snowfall each winter is about 30.1 inches.

River and stream valleys dominate the landscape of Greene County. The Monongahela River is the primary feature that runs along the entire eastern side of the county. Its major tributaries include Dunkard Creek, Muddy Creek, and South Fork Tenmile Creek.

Greene County is comprised of ten watersheds:

Table 1 - Watersheds in Greene County

Watersheds in Greene County
Tenmile Creek
Muddy Creek – Monongahela River
Robinson Fork – Enlow Fork
Fish Creek
Middle Grave Creek – Grave Creek
South Fork Tenmile Creek
Dunkard Creek
Paw Paw Creek-Monongahela River
Dunkard Fork
West Virginia Fork Fish Creek

2.2. Community Facts

Greene County was created on February 9, 1796, from a part of Washington County. The county was named after General Nathanael Greene, a military officer, who served in the Continental Army during the Revolutionary War. Waynesburg is the county seat named after Revolutionary War hero Anthony Wayne. Waynesburg was known for its large coal industry during the 19th and 20th centuries.

The following boroughs and townships are located in Greene County:

- Boroughs: Carmichaels, Clarksville, Greensboro, Jefferson, Rices Landing, and Waynesburg
- Townships: Aleppo, Center, Cumberland, Dunkard, Franklin, Freeport, Gilmore, Gray, Greene, Jackson, Jefferson, Monongahela, Morgan, Morris, Perry, Richhill, Springhill, Washington, Wayne, and Whiteley

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Table 2 - Greene County National Historic Places

Greene County National Historic Places		
Building/Location	Date added to NRHP	Municipality
Alexander V. Boughner House	03/09/1995	Greensboro Borough
Bridge in Franklin Township	06/22/1988	Franklin Township
Carmichaels Covered Bridge	06/22/1979	Carmichaels Borough
Colver-Rogers Farmstead	11/21/2003	Morgan Township
John Corbley Farm	05/03/1984	Greene Township
John Minor Crawford House	07/27/1995	Monongahela Township
William Crawford House	11/12/1992	Cumberland Township
William Cree House	07/15/2002	Jefferson Township
Fisher Site	11/15/1982	Richhill Township
Richard T. Foley Site	05/10/1984	Jackson Township
Glassworks-Core House	07/27/1995	Monongahela Township
George West Gordon Farm	08/24/2000	Whiteley Township
Greene Academy	12/12/1976	Carmichaels Borough
Greene Hills Farm	04/04/1973	Franklin Township
Greensboro Public School	03/09/1995	Greensboro Borough
Hamilton-Ely Farmstead	03/02/2006	Whiteley Township
Hanna Hall	04/18/1979	Waynesburg Borough
Charles Grant Heasley House	02/21/1991	Franklin Township
Hughes House	12/27/1972	Jefferson Township
James Jones House	03/09/1995	Greensboro Borough
Thomas Kent Jr. Farm	08/16/2000	Franklin Township
King Covered Bridge	06/22/1979	Wayne Township
Lippincott Covered Bridge	06/22/1979	Morgan Township
Mason and Dixon Survey Terminal Point	06/25/1973	Perry Township
McClelland-Grimes Farm	06/28/2010	Morgan and Washington Townships
Miller Hall	04/14/1978	Waynesburg Borough
James Parreco House	03/09/1995	Greensboro Borough
Peters-Graham House	03/09/1995	Greensboro Borough
Reppert-Gabler House	07/27/1995	Monongahela Township
John Rex Farm	05/08/1998	Jefferson Township
Scott Covered Bridge	06/22/1979	Center Township
Shriver Covered Bridge	06/22/1979	Center Township
Sugar Grove Petroglyphs	03/20/1986	Monongahela Township
White Covered Bridge	06/22/1979	Greene Township
Nettie Woods Covered Bridge	06/22/1979	Center Township
W. A. Young and Sons Foundry and Machine Shop	12/23/2016	Rices Landing Borough
Source: National Register of Historic Places (2024)		

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

2.3. Population and Demographics

The total population for Greene County is 36,484 based on the 2020 United States Census Bureau, American Community Survey estimates. The total change in population for Greene County from 2010 to 2020 was a decrease of 2,519 residents and a change of -6.46%. The most populous municipality is Franklin Township. The municipalities in the county that had the largest percentage of decrease from 2010 to 2020 were Gray Township (-45.71%) and Springhill Township (-41.86%). The municipalities that had the highest percentage of increase for the period from 2010 to 2020 were Greensboro Borough (47.71%) and Jackson Township (38.14%). *Table 3 – Population Change in Greene County* illustrates the trends and data from United States Census Bureau. These figures are based off data from the United States Census Bureau in 2020. *Figure 5 – Greene County Population Density* illustrates the average population density values per census track in the various municipalities of Greene County.

Table 3 - Population Change in Greene County

Population Change in Greene County from 2010-2020			
Municipality	2010 Census	2020 Census	Percent of Change 2010-2020
Aleppo Township	564	557	-1.24
Carmichaels Borough	461	481	4.34
Center Township	1,202	1,276	6.16
Clarksville Borough	271	199	-26.57
Cumberland Township	6,620	6,225	-5.97
Dunkard Township	2,315	2,122	-8.34
Franklin Township	7,259	6,874	-5.30
Freeport Township	249	216	-13.25
Gilmore Township	221	232	4.98
Gray Township	245	133	-45.71
Greene Township	492	538	9.35
Greensboro Borough	262	387	47.71
Jackson Township	451	623	38.14
Jefferson Borough	288	266	-7.64
Jefferson Township	2,575	2,194	-14.80
Monongahela Township	1,563	1,638	4.80
Morgan Township	2,675	2,068	-22.69
Morris Township	826	791	-4.24
Perry Township	1,391	1,352	-2.80
Rices Landing Borough	477	600	25.79

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Population Change in Greene County from 2010-2020			
Municipality	2010 Census	2020 Census	Percent of Change 2010-2020
Richhill Township	860	821	-4.53
Springhill Township	387	225	-41.86
Washington Township	1,160	936	-19.31
Wayne Township	1246	1,108	-11.08
Waynesburg Borough	4,177	3,975	-4.84
Whiteley Township	766	647	-15.54
Source: United States Census Bureau, American Community Survey (2010, 2020)			

During this hazard mitigation planning period, socially vulnerable populations were reviewed for Greene County. For the purposes of this hazard mitigation plan, socially vulnerable populations include the unhoused and unsheltered populations of Greene County, individuals who have mobility challenges, and those populations which may have not had an active role in hazard mitigation planning in the past. Social vulnerability can also include portions of the population that may not have access to specific resources or community lifelines. In Greene County, this includes, but is not limited to, populations with limited internet access, those individuals who do not have easy access to public transportation, and those populations that are not near grocery or food community lifelines. In Greene County, populations located far from grocery stores or food locations are at increased vulnerability to natural and human-caused hazards.

Vulnerable populations in Greene County are represented by a variety of different groups. The Greene County Planning and Community Development Department represents individuals located or utilizing low-income housing.

There are approximately 16,253 housing units in Greene County, Pennsylvania. Of these housing units, there are an estimated 13,957 households within the county, with an average size of 2.33 persons. Married couples make up a majority of households in the county with 80.9%, with an average household size of 2.88 persons. The estimated owner-occupied housing rate of Greene County is 78.5%, with an overall occupancy rate of 87.1% of all units. The median value of the owner-occupied housing units in Greene County from 2018 to 2022 is \$140,900.00. The median monthly owner's costs for a structure with a mortgage was \$1,208 and the median monthly owner's costs for a structure without a mortgage was \$479.00. The median gross rent for rental properties in Greene County was \$754.00 for the same date range.

The racial composition of the county is 94.1% White, 3.8% Black or African American, 1.6% Hispanic or Latino, 0.3% American Indian and Alaska Native, 0.4% Asian, 0-1% native Hawaiian and other Pacific Islander, and 1.4% two or more races. The median age of residents in Greene County is 43.1 years of age, which is higher than the median age of Pennsylvania at 41.1

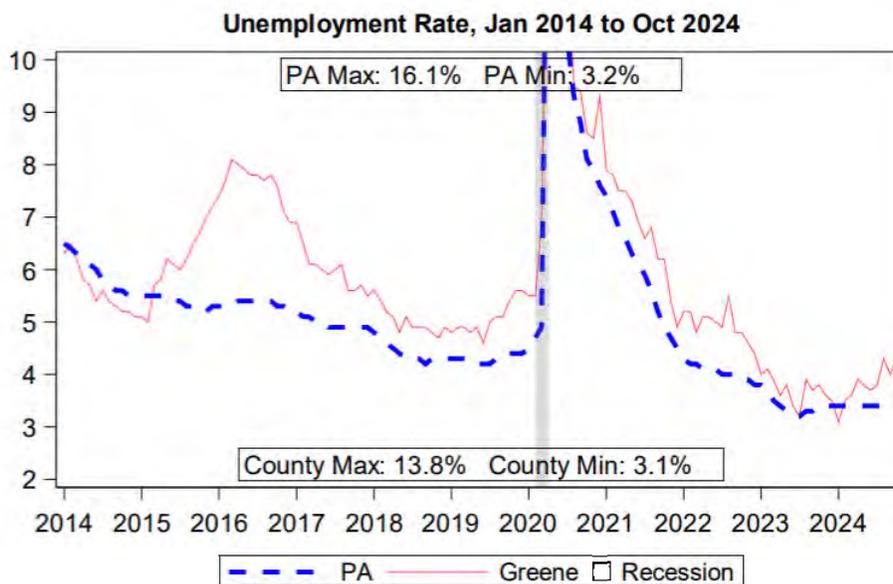
Greene County, Pennsylvania 2025 Hazard Mitigation Plan

and the national median of 39.2% years of age. The percentage of Greene County under the age of 5 years old is 4.1%, between the ages of 18 and 64 years old is 59.8%, and aged 65 years old and older is 21.5%.

The median household income for households in Greene County is \$66,283.00 and the poverty rate of Greene County is 13.0% of the total population. The poverty rate for the Commonwealth of Pennsylvania as a whole is 12.0%. There are approximately 2,519 veterans in Greene County. The median veteran income in Greene County as of 2019 was \$38,178.00, and the veteran unemployment rate in the county was approximately 3.5%.

The Covid-19 Pandemic created an increase in unemployment and interruptions in employment throughout the United States, to include Pennsylvania and Greene County. According to Pennsylvania Department of Labor and Industry data, there was a large spike in unemployment both across the Commonwealth and Greene County. At the height of the Covid-19 Pandemic in the spring of 2020, the unemployment rate for Greene County hit 13.8% of the working population of the county. That is lower than the peak unemployment percentage for Pennsylvania, which peaked at 16.5% of the working population of the entire state. *Figure 2 – Unemployment Rate Jan. 2014 to Oct. 2024* illustrates the trend and large spike in unemployment. The unemployment rate for Greene County is 4.3%, which roughly accounted for 700 working age adults (ages 16 to 65).

Figure 2 - Unemployment Rate Jan. 2014 to Oct. 2024



Source: Pennsylvania Department of Labor & Industry

Greene County’s leading industries are mining, public administration, retail trade, education, and healthcare. The primary employment providers within Greene County are displayed below in *Table 4 - Greene County Top Employers*.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Table 4 - Greene County Top Employers

Greene County Employers (Excluding State Employers)	
Ranking	Company
1	Consol Pennsylvania Coal Company
2	Iron Cumberland LLC
3	GMS Mine Repair & Maintenance Inc
4	County of Greene
5	Wal-Mart Associates Inc
6	The Waynesburg University
7	Central Greene School District
8	Carmichaels Area School District
9	Washington Health System Greene
Source: Pennsylvania Department of Labor & Industry, 2024	

The top employers' data was obtained through the Pennsylvania Department of Labor and Industry, Center for Workforce Information and Analysis. This data only provided a list of employers, their ranking, and North American Industry Classification System (NAICS) descriptions. *Table 5 – Quarterly Census of Employment and Wages, 2023 Annual Averages in Greene County* only calls out how many locations per NAICS description and total number of employees.

Table 5 - Quarterly Census of Employment and Wages, 2023 Annual Averages in Greene County

Quarterly Census of Employment and Wages, 2023 Annual Averages in Greene County (PA DLI)					
NAICS	Description	Number of Locations	Number of Employees	Employment Percentage	Average Wages
11	Agriculture, Forestry, Fishing, and Hunting	4	ND	ND	ND
21	Mining, Quarrying, and Oil & Gas	34	2,153	18.3%	\$119,999.00
22	Utilities	13	159	1.3%	\$90,993.00
23	Construction	71	1,063	9.0%	\$66,227.00
31-33	Manufacturing	27	435	3.7%	\$61,398.00
42	Wholesale Trade	26	337	2.9%	\$80,620.00
44-45	Retail Trade	106	1,255	10.6%	\$36,350.00
48-49	Transportation and Warehousing	61	554	4.7%	\$67,141.00

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Quarterly Census of Employment and Wages, 2023 Annual Averages in Greene County (PA DLI)					
NAICS	Description	Number of Locations	Number of Employees	Employment Percentage	Average Wages
51	Information	11	54	0.5%	\$50,635.00
52	Finance and Insurance	31	233	2.0%	\$67,338.00
53	Real Estate, Rental, and Leasing	18	104	0.9%	\$69,538.00
54	Professional and Technical Services	43	162	1.4%	\$55,701.00
55	Management of Companies and Enterprises	11	73	0.6%	\$108,002.00
56	Administrative and Waste Services	20	149	1.3%	\$39,963.00
61	Educational Services	17	ND	ND	ND
62	Healthcare and Social Assistance	149	1,454	12.3%	\$46,835.00
71	Arts, Entertainment, and Recreation	13	106	0.9%	\$17,438.00
72	Accommodation and Food Services	64	754	6.4%	\$21,170.00
81	Other Services (Except Public Administration)	63	295	2.5%	\$36,388.00
92	Public Administration	42	1,309	11.1%	\$63,333.00
-	Total, All Industries	822	11,785	100%	\$65,150.00

Source: NAICS (North American Industry Classification System)

2.4. Land Use and Development

Greene County is composed of twenty-six municipalities, which include:

- Twenty townships
- Six boroughs

The majority of acreage in Greene County is forested, while approximately 28.2% (or 104,424 acres) of the acreage is agriculture. Greene County has a total area of 578 square miles, with 576 square miles of land and two square miles of water.

Greene County has approximately 369,920 acres of total land area, and 1,280 acres of water area, with a population per square mile of 62.4 persons based on 2020 data estimates. Forested areas make up 62.0% of the county, while agriculture makes up approximately 28.2% of the total land

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

area in Greene County, and high density urban, low density urban, water, transitional, resource extraction, quarries, and wetlands each account for 9.8% of the land area.

Systems

The specific systems in Greene County must also be considered when discussing the community characteristics. Food, water, and shelter are of primary concern when looking at a community's lifelines. As Greene County is a rural county, food areas and grocery stores are spread over a wide geographic area. Specific grocery stores can be found in Greensboro, Carmichaels, Rices Landing, Clarksville, Jefferson, and Waynesburg. Water in Greene County is primarily provided by small, local water authorities and public water suppliers. Local domestic water wells are also prevalent throughout the entire community. Shelter features in Greene County during emergencies can include municipal borough and township buildings and any buildings that are currently part of emergency response and recovery planning for Greene County.

2.5. Data Sources

The following data sources were used during the update process:

- United States Census Bureau.
- National Climatic Data Center (NCDC).
- National Oceanic and Atmospheric Administration (NOAA).
- Pennsylvania Department of Conservation and Natural Resources (PA DCNR).
- Pennsylvania Department of Environmental Protection (PA DEP).
- Pennsylvania Department of Labor and Industry (PA DLI).
- Pennsylvania Groundwater Information System (PaGWIS).
- Pennsylvania Emergency Incident Reporting System. (PEIRS)
- Pennsylvania Emergency Management Agency (PEMA).
- Greene County Comprehensive Plan 2019.

The countywide Digital Flood Insurance Rate Maps (DFIRM) were used for all flood risk analysis and estimation of loss. Greene County DFIRMs were approved and effective in 2013. The DFIRM database provides flood frequency and elevation information used in the flood hazard risk assessment. Other Greene County GIS datasets including road centerlines, structures, and municipalities were utilized in conjunction with the DFIRM data.

In order to assess the vulnerability of different jurisdictions to the hazards, data on past occurrences of damaging weather events was compiled. A large number of natural-hazard events were gathered from the National Climatic Data Center (NCDC) database. The NCDC is a division of the United States Department of Commerce's National Oceanic and Atmospheric Administration (NOAA). Information on hazard events is compiled by the NCDC from data gathered by the National Weather Service (NWS), another division of NOAA. The data is then

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

presented by the NCDC as tabular data that can be queried in the United States Storm Events database, which “documents the occurrences 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). The classification of storm events in the database is based off of data collected from around the United States and the Commonwealth of Pennsylvania, so the data may not be filed under the correct storm category due to user input error. The reason for this data issue results from some storm events falling under multiple categories, including but not limited to winter storm, ice storm, tornado, hurricane / tropical storm, flooding, and flash flooding. Many of the events listed in the United States Storm Events database can fall under multiple of these categories. In an effort to include a comprehensive list of prior storm events for Greene County, search queries with multiple storm classifications were conducted for each hazard.

Throughout the risk and vulnerability assessment included in Section 4 of this Hazard Mitigation Plan, descriptions of limited data indicate some areas in which the county and the 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.

This hazard mitigation plan evaluates the vulnerability of the county’s community lifelines. For the purposes of this plan, critical infrastructure facilities are those entities that are essential to the health, welfare, and safety of the community. This includes but is not limited to airports, emergency medical service (EMS) stations, communication facilities and towers, day care centers and preschools, fire departments, hospitals and medical facilities, police departments, schools, and senior living facilities. The locations of these facilities were provided by the Greene County GIS Department.

Geographic Information Systems (GIS) Data

GIS data was utilized in risk assessment, estimation of loss and the development of map products for the hazard mitigation plan update. A foundation of data was available from the Greene County GIS Department. Some of the utilized data was downloaded from the Pennsylvania Spatial Data Access (PASDA). A large portion of the plan utilizes census data from the United States Census Bureau, but the 2020 census data collection and dissemination was disrupted due to the Covid-19 Pandemic in 2020 and 2021. The 2020 census was delayed, and the information received during the census was spread out due to social distancing and the limiting of census takers going door to door to gather information.

The Greene County GIS Department provided the following layers for use in the development of hazard profiles and hazard profile mapping for the 2025 Hazard Mitigation Plan Update:

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

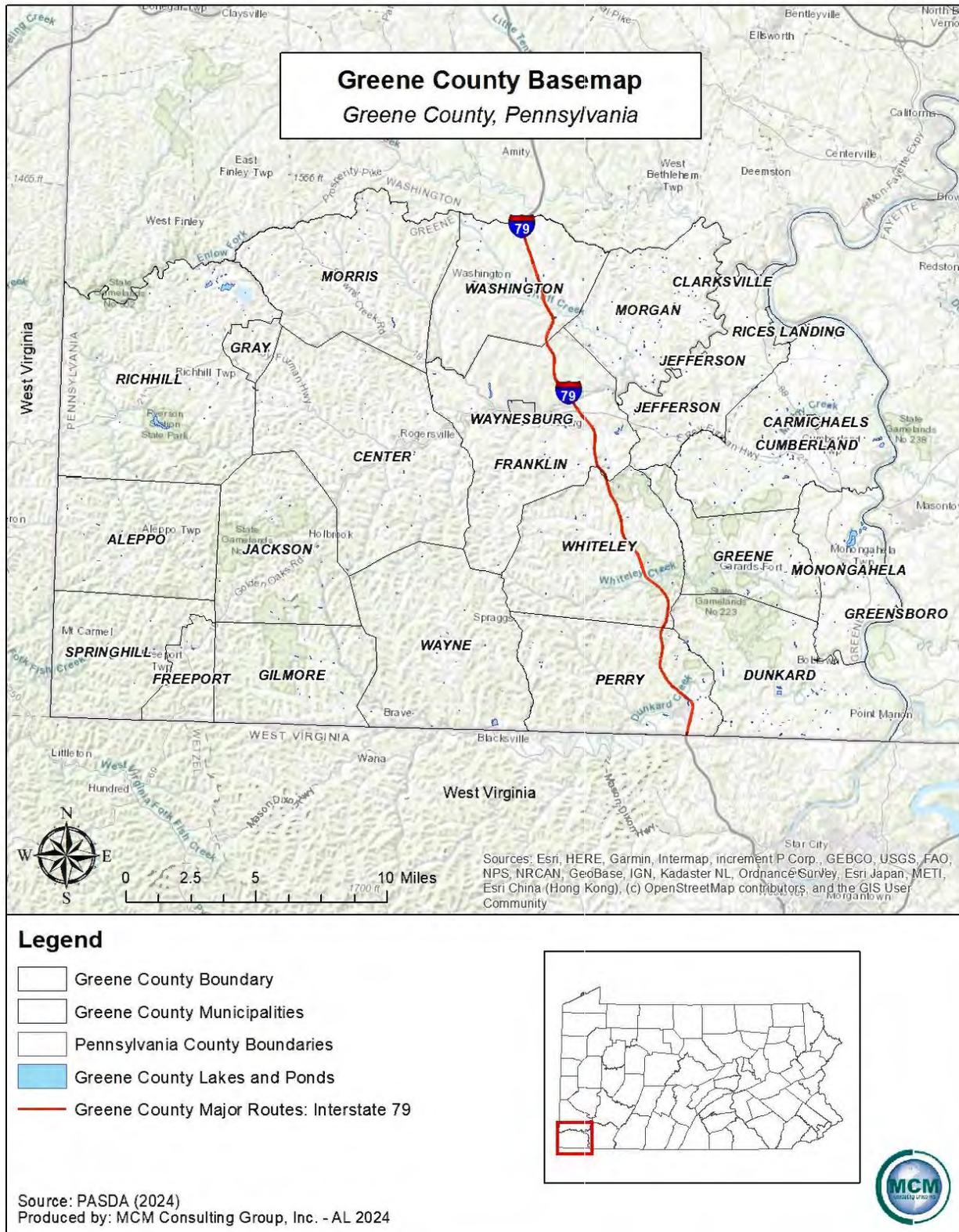
- Greene County Emergency Service Boundary – EMS
- Greene County Emergency Service Boundary – Fire
- Greene County Emergency Service Boundary – Law
- Greene County Emergency Service Boundary – Public Safety Answering Point
- Greene County Municipalities
- Greene County Road Centerlines
- Greene County Site Structure Address Points

The following GIS Data layers were developed for use in the 2025 Hazard Mitigation Plan Update:

- Greene County Abandoned Mine Inventory Locations
- Greene County Airports
- Greene County Community Lifeline Facilities
- Greene County Dam Inventory
- Greene County Electric Substations
- Greene County Electric Transmission Lines
- Greene County Ground Water Withdrawal Points
- Greene County Historic Streams
- Greene County Hospitals
- Greene County Lakes and Ponds
- Greene County Land Use Features
- Greene County Local Parks
- Greene County Major Transportation Routes
- Greene County Natural Areas
- Greene County Natural Gas Pipelines
- Greene County National Register of Historic Places
- Greene County Power Plants
- Greene County Public Water Supply Areas
- Greene County Slope Features
- Greene County Tornado Impacted Municipalities
- Greene County Traffic Information
- Greene County Watersheds
- Greene County Wildland Urban Interface

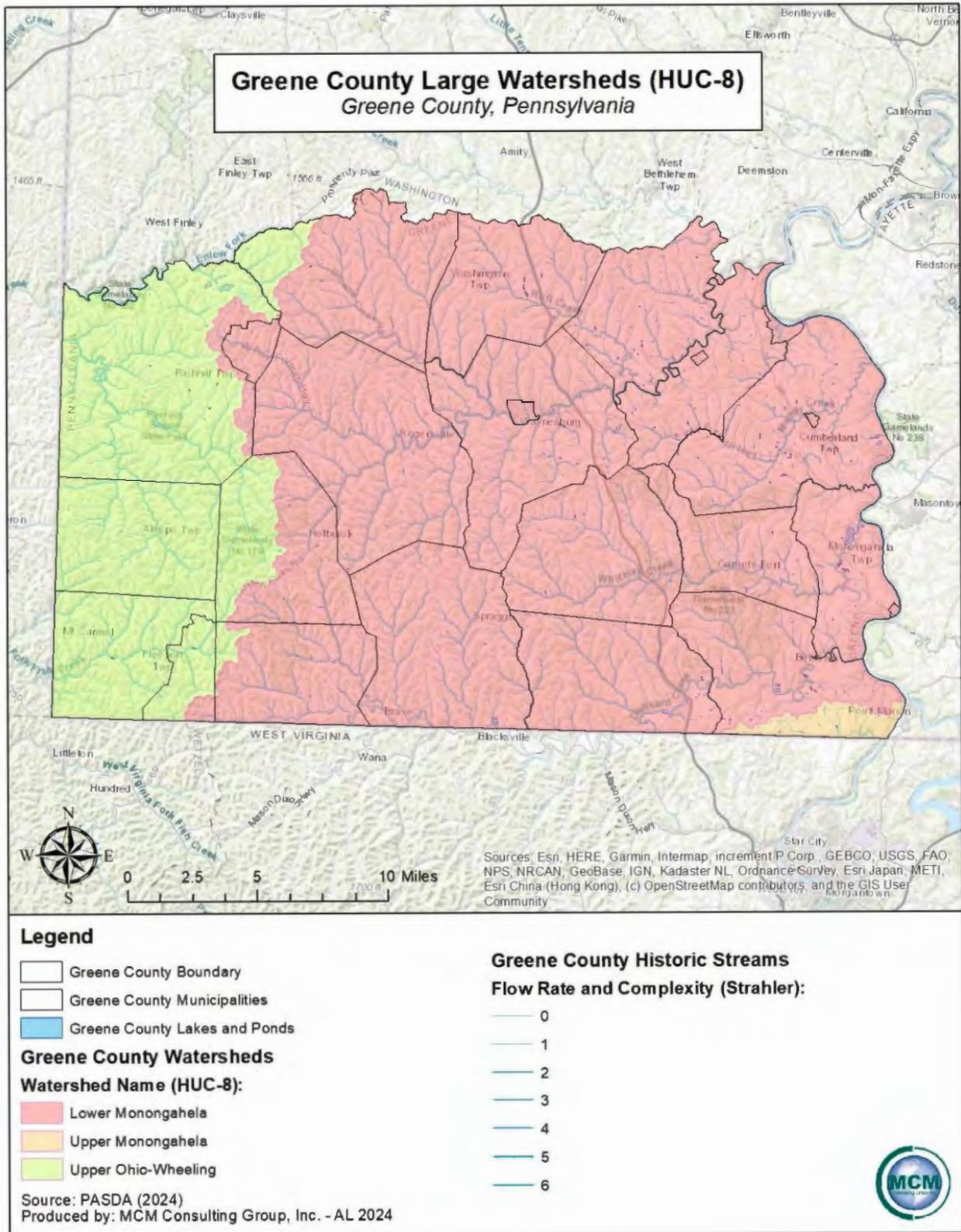
Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 3 - Greene County Basemap



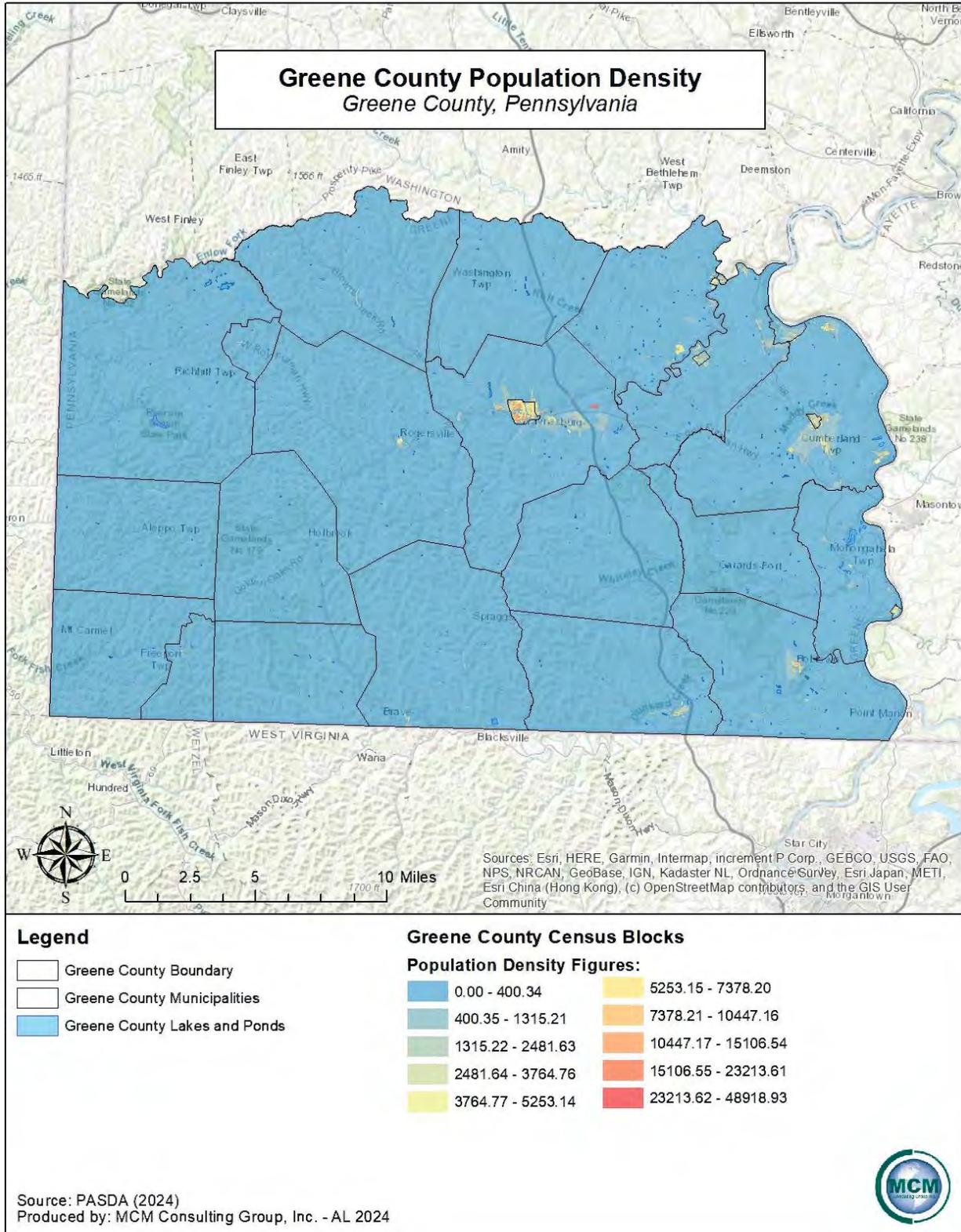
Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 4 - Greene County Watersheds



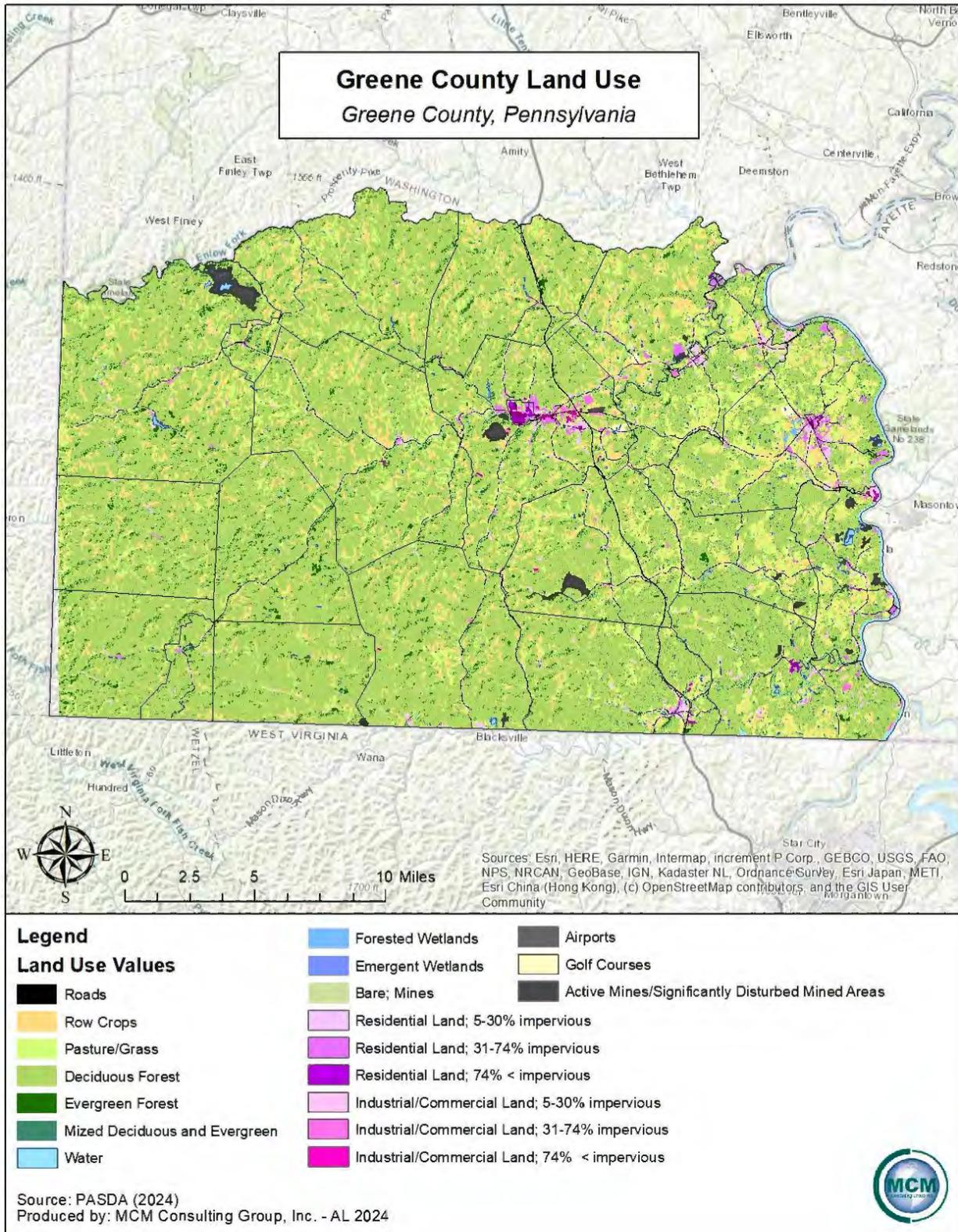
Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 5 - Greene County Population Density



Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 6 - Greene County Land Use



3. Planning Process

3.1. Update Process and Participation Summary

The Greene County Hazard Mitigation Plan update began September 30, 2024. The Greene County Commissioners were able to secure a hazard mitigation grant to start the process. The Greene County Emergency Management Agency was identified as the lead agency for the Greene County Hazard Mitigation Plan update. The planning process involved a variety of key decision makers and stakeholders within Greene County. Greene County immediately determined that the utilization of a contracted consulting agency would be necessary to assist with the plan update process. MCM Consulting Group, Inc. was selected as the contracted consulting agency to complete the update of the hazard mitigation plan. The core hazard mitigation team, which was referred to as the steering committee, included officials from the Greene County Emergency Management Agency and MCM Consulting Group, Inc. (MCM).

The process was developed around the requirements laid out in the Federal Emergency Management Agency (FEMA) Local Hazard Mitigation Crosswalk, referenced throughout this plan, as well as numerous other guidance documents including, but not limited to, Pennsylvania's All-Hazard Mitigation Standard Operating Guide, FEMA's State and Local Mitigation Planning How-to Guide series of documents (FEMA 386-series), and the National Fire Protection Association (NFPA) 1600 Standard on Disaster/Emergency Management and Business Continuity Programs.

MCM Consulting Group, Inc. assisted Greene County Emergency Management Agency in coordinating and leading public involvement meetings, local planning team meetings, analysis, and the writing of the updated HMP. The Greene County Local Planning Team (LPT) worked closely with MCM in the writing and review of the HMP. MCM conducted project meetings and local planning team meetings throughout the update process. Due to COVID-19, meetings were held with the option to attend virtually. Meeting agendas, meeting minutes and sign-in sheets were developed and maintained for each meeting conducted by MCM. These documents are detailed in Appendix C of this plan.

Public meetings with local elected officials were held, as well as work sessions and in-progress review meetings with the Greene County Local Planning Team and staff. At each of the public meetings, respecting the importance of local knowledge, municipal officials were strongly encouraged to submit hazard mitigation project opportunity forms, complete their respective portions of the capability's assessment and review, and eventually adopt the county hazard mitigation plan. Greene County will continue to work with all local municipalities to collect local hazard mitigation project opportunities.

The HMP planning process consisted of:

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

- Applying for and receiving a hazard mitigation planning grant (HMPG) to fund the planning project.
- Announcing the initiative via press releases and postings on the county website.
- Involving elected and appointed county and municipal officials in a series of meetings, training sessions, and workshops.
- Identifying capabilities and reviewed the information with the municipalities.
- Identifying hazards.
- Assessment of risk and analyzing vulnerabilities.
- Identifying mitigation strategies, goals, and objectives.
- Developing an implementation plan.
- Announcing completion via press releases and postings on the county website.
- Plan adoption at a public meeting of the Greene County Board of Commissioners.
- Plan submission to FEMA and PEMA.

The 2018 Greene County HMP was completed in April of 2018. The 2025 plan follows an outline developed by PEMA which provides a standardized format for all local HMPs in the Commonwealth of Pennsylvania. The 2025 HMP format is consistent with the PEMA recommended format. The 2025 Greene County HMP combined dam failure and levee failure profiles; and has added additional hazard profiles to the HMP, and these additional profiles increased the subsections in section 4.3 of the HMP.

3.2. The Planning Team

The 2025 Greene County Hazard Mitigation Plan update was led by the Greene County Steering Committee. The Greene County Steering Committee provided guidance and leadership for the overall project. The steering committee assisted MCM Consulting Group, Inc. with dissemination of information and administrative tasks. *Table 6 – Steering Committee* outlines the individuals that comprise this team.

Table 6 - Steering Committee

Greene County Hazard Mitigation Plan Update Steering Committee		
Name	Organization	Position
Richard Policz	Greene County Emergency Management Agency	Director
Mike Rearick	MCM Consulting Group, Inc.	Director of Operations
Jason Roblin	MCM Consulting Group, Inc.	Project Manager
Daniel Becker	MCM Consulting Group, Inc.	Consultant
Alyssa Rusnock	MCM Consulting Group, Inc.	Project Coordinator
Adam Leister	MCM Consulting Group, Inc.	Senior GIS Consultant
Ashley Day	MCM Consulting Group, Inc.	Project Coordinator

In order to represent the county, the Greene County Steering Committee developed a diversified list of potential local planning team (LPT) members. Members that participated in the 2018

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

hazard mitigation plan were highly encouraged to join the 2025 team. The steering committee then provided invitations to the prospective members and provided a description of duties to serve on the LPT. The invitations for members of the LPT were disseminated by the Greene County Emergency Management Agency utilizing letters, email, and telephone calls. These invitations included local and regional agencies involved in HMP activities, agencies with the authority to regulate development, neighboring communities, businesses and academia, and representatives for county offices and agencies involved in reaching out to socially vulnerable populations. The LPT worked throughout the process to plan and hold meetings, collect information, and conduct public outreach.

The stakeholders listed in *Table 7 – Local Planning Team* served on the 2025 Greene County Hazard Mitigation Local Planning Team, actively participated in the planning process by attending meetings, completing assessments, surveys, and worksheets and/or submitting comments. All potential local planning team members were presented with an email invitation prior to the local planning team kickoff meeting on 10/30/2024. Those invitation letters for the local planning team are included in Appendix C – Support Documentation of this hazard mitigation plan update.

Individuals representing local interests in dams were presented with the opportunity to participate in the local planning team. Emails were sent to officials involved in the ownership of dams. Increased participation for representatives for socially vulnerable and unserved populations in Greene County is a goal for the next planning period, and mitigation actions can be found in section 6.4.

Table 7 - Local Planning Team

Greene County Hazard Mitigation Plan Local Planning Team		
Name	Organization	Position
Richard Policz	Greene County Emergency Management Agency	Director
Tyler Zeh	Greene County Planning & Community Development	GIS Manager
Kyle Lamb	Greene County Planning & Community Development	Director
Connie Bloom	Industrial Development Authority/ Greene County Department of Planning and Community Development	Director
Lisa Snider	Greene County Conservation District	Director

3.3. Meetings and Documentation

Meetings with local elected officials and the local planning team were held as needed. At each of the meetings, municipal officials were strongly encouraged to submit hazard mitigation project opportunity forms, complete their respective portions of the capability assessment, review and eventually adopt the multi-jurisdictional HMP. *Table 8 – HMP Process Timeline* lists the meetings held during the HMP planning process, which organizations and municipalities

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

attended and the topic that was discussed at each meeting. All meeting agendas, sign-in sheets, presentation slides, and other documentation are in Appendix C.

The draft plan was made available for public review on 03/11/2025. The draft was advertised on Greene County’s social media page and was made available digitally on the Greene County website at: <https://greenecountypa.gov/Department-Emergency-Management-Agency>

The public comment period remained open until 04/11/2025. All public comments were submitted via an online survey or in writing to Richard Policz, the Greene County Emergency Management Agency Director. Public commenting was available during the public comment period via a Survey Monkey link that was advertised on the county website and social media pages. No public comments were received for this planning period, so no comments are included in Appendix C of this hazard mitigation plan update.

Table 8 - HMP Process Timeline

Greene County HMP Process Timeline		
Date	Meeting	Description
09/30/24	Greene County and MCM Steering Committee Kickoff Meeting (Virtual)	Meeting was used to determine individuals to invite to the local planning team and to review the draft project schedule.
10/17/24	Municipal Convention Presentation	Meeting was used for initial HMP update process review with the municipalities. Initial worksheets were introduced and reviewed (Haz ID, Capability assessments, project opportunity, and NFIP survey).
10/30/24	Local Planning Team Kickoff Meeting (Onsite): Risk Factor Assessment	Meeting was used to review the project schedule and discuss roles and responsibilities for the hazard mitigation plan. Initial worksheets were introduced and reviewed (Haz ID, Capability assessments, project opportunity, and NFIP survey). The risk factor assessment was reviewed and assigned as homework.
11/07/24	Local Planning Team Meeting (Onsite): Risk Factor Assessment and Mitigation Strategy	Selection of hazards for the 2025 hazard mitigation plan was conducted. Risk factor scores were also updated based on changing conditions in Greene County since the 2018 HMP. Meeting was also used to begin the local planning team work on the mitigation strategy section of the hazard mitigation plan.
11/19/24	Local Planning Team Meeting (Virtual): Mitigation strategy	Meeting was used to continue the local planning team work on the mitigation strategy section of the hazard mitigation plan. This included a review of the previous mitigation goals, objectives, and actions.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Greene County HMP Process Timeline		
Date	Meeting	Description
12/11/24	Municipality Meeting to Review Initial Forms and Surveys (Virtual Only)	Meeting was used to reintroduce the initial worksheets (Haz ID, Capability assessments, project opportunity, and NFIP survey) for municipal completion and to assist in completion if needed.
12/17/24	Local Planning Team (Onsite) Meeting: Mitigation Strategy Evaluation and Prioritization	Meeting was used to finalize the 2025 mitigation strategy goals, objectives, and actions and to review the mitigation action evaluation and prioritization process.
12/17/24	Municipality Mitigation Opportunity Form Development (Onsite)	Meeting was used to review the municipality mitigation opportunity forms and to work with individual municipalities on form development.
12/17/24	Public Meeting – Risk Assessment Section (Onsite)	Meeting was used as a public meeting to review the completed risk assessment section with constituents of Greene County.
02/03/25	Local Planning Team (Virtual) Meeting: Draft Plan Review	Meeting was used to review the draft plan with the Greene County local planning team.
02/12/25	Public Meeting: Draft plan presentation	Meeting was used as a public meeting to review the draft hazard mitigation plan with the constituents of Greene County.

3.4. Public and Stakeholder Participation

Greene County engaged numerous stakeholders and encouraged public participation during the HMP update process. Advertisements for public meetings were completed utilizing the local newspaper and the Greene County website. Copies of those advertisements are in Appendix C. Municipalities and other county entities were invited to participate in various meetings and encouraged to review and update various worksheets and surveys. Copies of all meeting agendas, meeting minutes and sign-in sheets are in Appendix C. Worksheets and surveys completed by the municipalities and other stakeholders are located in appendices of this plan update as well. Municipalities were also encouraged to review hazard mitigation related items with other constituents located in the municipality like businesses, academia, private and nonprofit interests.

The tools listed below were distributed with meeting invitations, provided directly to municipalities for completion and return to the Greene County Emergency Management Agency or at meetings to solicit information, data, and comments from both local municipalities and other key stakeholders. Responses to these worksheets and surveys are available for review at the Greene County Emergency Management Agency.

1. **Risk Assessment Hazard Identification and Risk Evaluation Worksheet:** Capitalizes on local knowledge to evaluate the change in the frequency of occurrence, magnitude, or impact and/or geographic extent of existing hazards and allows communities to evaluate hazards not previously profiled using the Pennsylvania Standard List of Hazards.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

2. **Capability Assessment Survey:** Collects information on local planning, regulatory, administrative, technical, fiscal, and political capabilities that can be included in the countywide mitigation strategy.
3. **Municipal Project Opportunity Forms and Mitigation Actions:** Copies of the 2018 mitigation opportunity forms that were included in the current HMP were provided to the municipalities for review and amendment. These opportunities are in Appendix G. The previous mitigation actions were provided and reviewed at update meetings. New 2025 municipal project opportunity forms are included as well, located in Appendix G.

In an effort to capture public input, Greene County LPT held in-person meetings and offered on-line surveys. Members of the public were also encouraged to contact Greene Emergency Management Agency or MCM Consulting Group, Inc. with any comments or questions regarding this update. Any public comment that was received during public meetings or during the draft review of the plan were documented and included in the plan. Copies of newspaper public meeting notices, website posted public notices, and other correspondence are included in Appendix C of this plan.

3.5. Multi-Jurisdictional Planning

Greene County used an open, public process to prepare this HMP. Meetings and letters to municipal officials were conducted to inform and educate them about hazard mitigation planning and its local requirements. Municipal officials provided information related to existing codes and ordinances, the risk and impacts of known hazards on local infrastructure and critical facilities and recommendations for related mitigation opportunities. The pinnacle to the municipal involvement process was the adoption of the final plan. *Table 9 – Municipality Worksheets, Surveys, and Forms Participation* reflects the municipalities participation by completing worksheets, surveys, and forms.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Table 9 - Municipality Worksheets, Surveys, and Forms Participation

Greene County HMP Worksheets, Surveys, and Forms Participation							
Municipality	Representative	Position	Capability Assessment Survey	Risk Assessment Hazard Identification and Risk Evaluation Worksheet	NFIP	Risk Factor	Hazard Mitigation Opportunity Form Review and Updates
Aleppo Township	Charles Martin Jr.	Chairman	X		X		
	David Logan	Supervisor					
	Phillip Hook	Solicitor					
Carmichaels Borough	Mark Hanley	Borough Council President	X	X			
	Linda Metz	Secretary/Treasurer					
Center Township	Harry Gillispie	Chairman	X	X			14 review
	Paul Cook	Supervisor					
	Dawn Horr	Secretary/Treasurer					
	Dan Stoneking	Vice Chairman					
Clarksville Borough	Sherry Furman	VP Council	X	X			
Cumberland Township	Samuel Hastings	Chairman	X	X	X		
	Melanie Leasure	Secretary/Treasurer					
	Sarah Berisen	Admin Assistant					
	James Sokol	Supervisor					
	William Nicholson	Vice Chairman					
Dunkard Township	Christine Dafonzo	Supervisor	X			X	
	Walt Nestic	Road Crew					
	Ricky Hall	Road Crew					
	Lenny Novak	Road Crew					
	Kevin Robinson	Road Crew					
	Rodger Franks	Chairman					
	Brian Gansor	Vice Chairman					
	Jacalyn Fletcher	Tax Collector					
Franklin Township	Corbly Orndorff	Chairman	X	X	X		
	Margie Mason	Tax Collector					
	Angela Riley	Secretary/Treasurer					
	Todd Hoy	Vice Chairman					
	William Walker	Supervisor					
Freeport Township	Timothy Brady	Supervisor	X	X	X - inc		5 new and 1 review
	Barbara Curry	Secretary/Treasurer					
	Joann Shipman	Auditor					

**Greene County, Pennsylvania
2025 Hazard Mitigation Plan**

Greene County HMP Worksheets, Surveys, and Forms Participation							
Municipality	Representative	Position	Capability Assessment Survey	Risk Assessment Hazard Identification and Risk Evaluation Worksheet	NFIP	Risk Factor	Hazard Mitigation Opportunity Form Review and Updates
Gilmore Township	Jared Rode	Vice Chairman	X - inc	X			
	Jeffery Rode	Chairman					
Gray Township	Andrew Wise	Chairman				X	
Greene Township	Kenneth Kiger	Chairman	X	X			2 review
	Robert Huggins						
	Dorothy Cline	Tax Collector					
	Judith Hamlin	Secretary/Treasurer					
Greensboro Borough	Ed Abbott	Mayor	X				
Jackson Township	Ellen Fern Weaver	Auditor	X	X			3 review
	Carol Peters	Auditor					
	Owen Kiger	Chairman					
	Alisha Kiger	Assistant Secretary					
	Jonathan Crawford	Supervisor					
	Kathy Kiger	Tax Collector					
Jefferson Borough	Jeffrey Coneybeer	President	X	X			
	Relda Litten	Secretary/Treasurer					
Jefferson Township	Ryan Wise	Supervisor	X	X	X		1 New
	Rick Tekavec	Chairman					
	Mike Devecka	Vice Chairman					
	Jamie Forman	Laborer					
	Duane Walters	Laborer					
Monongahela Township	Bill Monahan	Township Supervisor	X	X	X		
Morgan Township	Jeff Sholtis	Chairman	X - inc	X			
	Brandon Lindsley	Laborer					
	Erik Mullen	Supervisor					
	Jim Gayman	Auditor					
	Shirl Barnhart	Vice Chairman					
Morris Township	Roger Creech	Vice Chairman	X				
	Steve Mooney	Chairman					
	Charles Anderson	Supervisor					
	James Shank	Laborer					

*Greene County, Pennsylvania
2025 Hazard Mitigation Plan*

Greene County HMP Worksheets, Surveys, and Forms Participation							
Municipality	Representative	Position	Capability Assessment Survey	Risk Assessment Hazard Identification and Risk Evaluation Worksheet	NFIP	Risk Factor	Hazard Mitigation Opportunity Form Review and Updates
	Judy Moninger	Secretary/Treasurer					
Perry Township	Christine Jarrell	Secretary/Treasurer					
	Frank Basile	Vice Chairman	X	X	X	X	
	Tom Brookover	Supervisor					
Rices Landing Borough	Tom Toegarden	Councilman	X		X		
	Lori Durr	Secretary					
Richhill Township	Charles Kiger	Vice Chairman					
	Deborah Penska	Secretary/Treasurer					
	Jon Helphenstine	Auditor	X	X	X		
	Matt Robinson	Chairman					
	Tom Chess	Supervisor					
Springhill Township	Richard DeBolt	Vice Chairman					
	Amanda DeBolt	Tax Collector	X	X	X		
	Danny Yoss	Chairman					
	Chris Simms	Solicitor					
Washington Township	Mary Pratt	Secretary/Treasurer					
	Charles Hickman	Supervisor					
	Jason Rosa	Laborer					
	Walt Stout	Chairman					3 review
Wayne Township	Joan Lemley	Tax Collector	X	X	X		
	Mike Harmon	Supervisor					
Waynesburg Borough	Athena Bowman	Borough Manager	X	X	X	X	3 new and 7 review
	Bryan Cumberledge	Street Department Manager					
Whiteley Township	Roger Hayes	Vice Chairman					
	Janice Carroll	Secretary/Treasurer					
	Phillip Seybold	Laborer	X	X			
	Jeffery Raddish	Chairman					
	Linda VanDruff	Tax Collector					

The majority of the twenty-six municipalities within Greene County adopted the 2018 Greene County Hazard Mitigation Plan as the municipal hazard mitigation plan. The goal of the Greene

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

County Local Planning Team is to have 100% participation by municipalities in adopting the 2025 Greene County Hazard Mitigation.

The table above was completed with the most accurate information available at the time of the writing of this Hazard Mitigation Plan Update. Since the writing of this plan, some of the municipalities listed above may have provided information to Greene County which updates their participation status.

4. Risk Assessment

4.1. Update Process Summary

A key component to reducing future loss is to first have a clear understanding of what the current risks are and what steps may be taken to lessen their threat. The development of the risk assessment is a critical first step in the entire mitigation process, as it is an organized and coordinated way of assessing potential hazards and risks. The risk assessment identifies the effects of both natural and human-caused hazards and describes each hazard in terms of its frequency, severity, and county impact. Numerous hazards were identified as part of the process.

A risk assessment evaluates threats associated with a specific hazard and is defined by probability and frequency of occurrence, magnitude, severity, exposure, and consequences. The Greene County risk assessment provides in-depth knowledge of the hazards and vulnerabilities that affect Greene County and its municipalities. This document uses an all-hazards approach when evaluating the hazards that affect the county and the associated risks and impacts each hazard presents.

This risk assessment provides the basic information necessary to develop effective hazard mitigation/prevention strategies. Moreover, this document provides the foundation for the Greene County Emergency Operations Plan (EOP), local EOPs and other public and private emergency management plans.

The Greene County risk assessment is not a static document, but rather, is a biennial review requiring periodic updates. Potential future hazards include changing technology, new facilities and infrastructure, dynamic development patterns and demographic and socioeconomic changes into or out of hazard areas. By contrast, old hazards, such as brownfields and landfills, may pose new threats as county conditions evolve.

Using the best information available and geographic information systems (GIS) technologies, the county can objectively analyze its hazards and vulnerabilities. Assessing past events is limited by the number of occurrences, scope and changing circumstances. For example, ever-changing development patterns in Pennsylvania have a dynamic impact on traffic patterns, population density and distribution, storm water runoff and other related factors. Therefore, limiting the risk assessment to past events is myopic and inadequate.

The Greene County Local Planning Team (LPT) reviewed and assessed the change in risk for all natural and human-caused hazards identified in the 2018 hazard mitigation plan. The mitigation planning team then identified hazards that were outlined within the Pennsylvania Hazard Mitigation Plan but not included in the 2018 Greene County Hazard Mitigation Plan that could impact Greene County. The team utilized the hazard identification and risk evaluation worksheet that was provided by the Pennsylvania Emergency Management Agency.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

The Greene County Steering Committee met with municipalities and provided guidance on how to complete the municipal hazard identification and risk evaluation worksheet. Nineteen municipalities in Greene County returned a complete hazard identification and risk evaluation worksheet. This information was combined with the county information to develop an overall list of hazards that would need to be profiled.

Once the natural and human-caused hazards were identified and profiled, the local planning team then completed a vulnerability assessment for each hazard. An inventory of vulnerable assets was completed utilizing GIS data and local planning team knowledge. The team used the most recent Greene County assessment data to estimate loss to particular hazards. Risk factors were then assessed to each of the twenty-two hazards utilizing the hazard prioritization matrix. This assessment allows the county and its municipalities to focus on and prioritize local mitigation efforts on areas that are most likely to be damaged or require early response to a hazard event.

4.2. Hazard Identification

4.2.1. Presidential and Gubernatorial Disaster Declarations

Table 10 – Presidential & Gubernatorial Disaster Declaration contains a list of all Presidential and Gubernatorial disaster declarations that have affected Greene County and its municipalities from 1955 through 2024, according to the Pennsylvania Emergency Management Agency.

Table 10 - Presidential & Gubernatorial Disaster Declarations

Presidential Disaster Declarations and Gubernatorial Declarations and Proclamations		
Date	Hazard Event	Action
October 1954	Flood (Hazel)	Presidential Disaster Declaration
August 1956	Flood	Presidential Disaster Declaration
January 1966	Heavy Snow	Gubernatorial Disaster Declaration
February 1972	Heavy Snow	Gubernatorial Disaster Declaration
June 1972	Flood (Agnes)	Presidential Disaster Declaration
February 1974	Truckers Strike	Gubernatorial Disaster Declaration
December 1974	Heavy Snow/Power Outage	Gubernatorial Disaster Declaration
February 1978	Blizzard	Gubernatorial Disaster Declaration
January 1978	Heavy Snow	Gubernatorial Disaster Declaration
November 1985	Flood	Presidential Disaster Declaration
March 1993	Blizzard	Presidential Emergency Declaration
January 1994	Severe Winter Storm	Presidential Disaster Declaration
January 1996	Flooding	Presidential Disaster Declaration
January 1996	Severe Winter Storm	Presidential Disaster Declaration
July 1996	Flooding	Presidential Disaster Declaration
July 1999	Drought	Gubernatorial Disaster Declaration

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Presidential Disaster Declarations and Gubernatorial Declarations and Proclamations		
Date	Hazard Event	Action
September 1999	Hurricane Floyd	Presidential Disaster Declaration
February 2003	Severe Winter Storm	Presidential Emergency Declaration
September 2003	Hurricane Isabel/Henri	Presidential Disaster Declaration
December 2003	High Winds and Heavy Rains	Gubernatorial Disaster Declaration
September 2004	Tropical Depression Ivan	Presidential Disaster Declaration
March 2005	Heavy Rainfall/Snowstorm /Embankment Failures	Gubernatorial Proclamation of Emergency
September 2005	Hurricane Katrina	Gubernatorial Disaster Declaration
September 2005	Hurricane Katrina	Presidential Proclamation of Emergency
September 2006	Tropical Depression Ernesto	Gubernatorial Proclamation of Emergency
April 2006	Regulations	Gubernatorial Proclamation of Emergency
February 2007	Regulations	Gubernatorial Proclamation of Emergency
February 2007	Severe Winter Storm	Gubernatorial Proclamation of Emergency
April 2007	Severe Winter Storm	Gubernatorial Proclamation of Emergency
April 2007	Severe Storm	Gubernatorial Disaster Declaration
February 2010	Severe Winter Storm	Gubernatorial Proclamation of Emergency
April 2010	Severe Winter Storm	Presidential Emergency Declaration
January 2011	Severe Winter Storm	Gubernatorial Proclamation of Emergency
August 2011	Severe Storms and Flooding (Lee/Irene)	Gubernatorial Proclamation of Emergency
April 2012	Spring Winter Storms	Gubernatorial Proclamation of Emergency
October 2012	Hurricane Sandy	Gubernatorial Proclamation of Emergency
October 2012	Hurricane Sandy	Presidential Proclamation of Emergency
June 2013	High Winds, Thunderstorms, Heavy Rain, Tornado, Flooding	Gubernatorial Proclamation of Emergency

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Presidential Disaster Declarations and Gubernatorial Declarations and Proclamations		
Date	Hazard Event	Action
January 2014	Extreme Weather/Utility Interruption	Gubernatorial Proclamation of Disaster Emergency
February 2014	Severe Winter Storm	Gubernatorial Proclamation of Disaster Emergency
February 2014	Severe Winter Storm	Gubernatorial Proclamation of Disaster
February 2014	Severe Winter Storm	Gubernatorial Proclamation of Disaster
January 2015	Severe Winter Storms	Gubernatorial Proclamation of Emergency
August 2015	Severe Storms	Gubernatorial Proclamation of Emergency
January 2016	Severe Winter Storm	Gubernatorial Proclamation of Emergency
March 2017	Severe Winter Storm	Gubernatorial Proclamation of Emergency
March 2017	Severe Winter Storm	Gubernatorial Proclamation of Emergency
January 2018	Opioid Crisis	Gubernatorial Proclamation of Emergency
August 2018	Severe Weather	Gubernatorial Proclamation of Emergency
January 2019	Severe Winter Event	Gubernatorial Proclamation of Emergency
March 2020	COVID-19 Pandemic	Gubernatorial Proclamation of Emergency
March 2020	COVID-19 Pandemic	Presidential Disaster Declaration
March 2020	COVID-19 Pandemic	Presidential Proclamation of Emergency
December 2020	Severe Winter Event	Gubernatorial Proclamation of Emergency
February 2021	Severe Winter Event	Gubernatorial Proclamation of Emergency
April 2021	Civil Disturbance	Gubernatorial Proclamation of Emergency
August 2021	Hurricane Ida	Gubernatorial Proclamation of Emergency

Source: Pennsylvania Emergency Management Agency and Federal Emergency Management Agency

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.2.2. Summary of Hazards

The Greene County LPT was provided the Pennsylvania Standard List of Hazards to be considered for evaluation in the 2025 HMP Update. Following a review of the hazards considered in the 2018 HMP and the standard list of hazards, the local planning team decided that the 2025 plan should identify, profile, and analyze twenty-two hazards. These twenty-two hazards include all of the hazards profiled in the 2018 plan and six new hazards. The list below contains the hazards that have the potential to impact Greene County as identified through previous risk assessments, the Greene County Hazard Vulnerability Analysis, and input from those who participated in the 2025 HMP update. Hazard profiles are included in Section 4.3 for each of these hazards.

Identified Natural Hazards

Drought

Drought is defined as a deficiency of precipitation experienced over an extended period, usually a season or more. Droughts increase the risk of other hazards, like wildfires, flash floods, and landslides or debris flows. This hazard is of particular concern in Pennsylvania due to the prevalence of farming and other water-dependent industries, water dependent recreation uses, and residents who depend on wells for drinking water.

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.

Extreme Temperature

Extreme heat often results in the highest number of annual deaths of all weather-related hazards. In most of the United States, extreme heat is defined as a long period (2 to 3 days) of high heat and humidity with temperatures above 90 degrees. Extremely cold air comes every winter in at least part of the country and affects millions of people across the United States. The arctic air, together with brisk winds, can lead to dangerously cold wind chill values. People exposed to extreme cold are susceptible to frostbite and hypothermia in a matter of minutes.

Flooding, Flash Flooding, and Ice Jam Flooding

Flooding is the temporary condition of partial or complete inundation of normally dry land, and it is the most frequent and costly of all-natural hazards in Pennsylvania. Flash flooding is usually

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

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. Winter flooding can include ice jams which occur when warm temperatures and heavy rain cause snow to melt rapidly. Melting snow 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.

Hurricane/Tropical Storm

Hurricanes, tropical storms, and nor'easters are classified as cyclones and are any closed circulation developing around a low-pressure center in which the winds rotate counterclockwise (in the Northern Hemisphere) and whose diameter averages 10-30 miles across. Potential threats from hurricanes include powerful winds, heavy rainfall, storm surges, coastal and inland flooding, rip currents, tornadoes, and landslides. The Atlantic hurricane season runs from June 1 to November 30.

Invasive Species

An invasive species is a species that is not indigenous to the ecosystem under consideration and whose introduction causes or is likely to cause economic, environmental, or human harm. These species can be any type of organism: plant, fish, invertebrate, mammal, bird, disease, or pathogen.

Landslide

In a landslide, masses of rock, earth or debris move down a slope. Landslides can be caused by a variety of factors, including earthquakes, storms, fire, and human modification of land. Areas that are prone to landslide hazards include previous landslide areas, areas on or at the base of slopes, areas in or at the base of drainage hollows, developed hillsides with leach field septic systems, and areas recently burned by forest or brush fires.

Pandemic and Infectious Disease

A pandemic is a global outbreak of disease that occurs when a new virus emerges in the human population, spreading easily in a sustained manner, and causing serious illness. An epidemic describes a smaller scale infectious outbreak, within a region or population, that emerges at a disproportionate rate. Infectious disease outbreaks may be widely dispersed geographically, impact large numbers of the population, and could arrive in waves lasting several months at a time.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Radon Exposure

Radon is a radioactive gas produced by the breakdown of uranium in soil and rock that can lead to lung cancer in people exposed over a long period of time. Most exposure comes from breathing in radon gas that enters homes and buildings through foundation cracks and other openings. According to the DEP, approximately 40% of Pennsylvania homes have elevated radon levels.

Subsidence/Sinkhole

Land subsidence is a gradual settling or sudden sinking of the ground surface due to the movement of subsurface materials. A sinkhole is a subsidence feature resulting from the sinking of surficial material into a pre-existing subsurface void. Subsidence and sinkholes are geologic hazards that can impact roadways and buildings and disrupt utility services. Subsidence and sinkholes are most common in areas underlain by limestone and can be exacerbated by human activities such as water, natural gas, and oil extraction.

Tornadoes/Windstorm

A tornado is a narrow, violently rotating column of air that extends from the base of a thunderstorm to the ground. About 1,250 tornadoes hit the U.S. each year, with about sixteen hitting Pennsylvania. Damaging winds exceeding 50-60 miles per hour can occur during tornadoes, severe thunderstorms, winter storms, or coastal storms. These winds can have severe impacts on buildings, pulling off the roof covering, roof deck, or wall siding and pushing or pulling off the windows.

Wildfire

A wildfire is an unplanned fire that burns in a natural area. Wildfires can cause injuries or death and can ruin homes in their path. Wildfires can be caused by humans or lightning, and can happen anytime, though the risk increases in period of little rain. In Pennsylvania, 98% of wildfires are caused by people.

Winter Storm

A winter storm is a storm in which the main types of precipitation are snow, sleet, or freezing rain. 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. Most deaths from winter storms are not directly related to the storm itself, but result from traffic accidents on icy roads, medical emergencies while shoveling snow, or hypothermia from prolonged exposure to cold.

Greene County, Pennsylvania

2025 Hazard Mitigation Plan

Identified Human Caused Hazards

Building/Structural Collapse/Blighted Properties

Buildings and other engineered structures, including bridges, may collapse if their structural integrity is compromised, especially due to effects from other natural or human-made hazards. Older buildings or structures, structures that are not built to standard codes, or structures that have been weakened are more susceptible to be affected by these hazards.

Civil Disturbance

A civil disturbance is defined by FEMA as a civil unrest activity (such as a demonstration, riot, or strike) that disrupts a community and requires intervention to maintain public safety.

Dam Failure

Dam failure is the uncontrolled release of water (and any associated waste) from a dam. This hazard often results from a combination of natural and human causes, and can follow other hazards such as hurricanes, earthquakes, and landslides. The consequences of dam failures can include property and environmental damage and loss of life.

Environmental Hazards/Hazardous Materials

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; Environmental Protection Agency, Natural Disaster PSAs, 2009).
- Superfund Facilities: hazards originating from abandoned hazardous waste sites listed on the National Priorities List (Environmental Protection Agency, National Priorities List, 2009).
- Manure Spills: involving the release of stored or transported agricultural waste, for example (Environmental Protection Agency, Environmental Impacts of..., 1998).
- Product Defect or Contamination; highly flammable or otherwise unsafe consumer products and dangerous foods (Consumer Product Safety Commission, 2003).

Hazardous material releases can contaminate air, water, and soils and have the potential to cause injury or death. Dispersion can take place rapidly when transported by water and wind. While

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

often accidental, releases can occur because of human carelessness, intentional acts, or natural hazards. When caused by natural hazards, these incidents are known as secondary events.

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 to provide protection from temporary flooding (FEMA, 2016). A levee failure or breach occurs when a levee fails to prevent flooding on the landside of the levee. The consequences of a sudden levee failure can be catastrophic, with the resulting flooding causing loss of life, emergency evacuations, and significant property damage.

Substance Use Disorder

An opioid epidemic is the rapid increase in the use of prescription and non-prescription opioid drugs in the United States beginning in the late 1990s and continuing throughout the first two decades of the 2000s. Opioids are a diverse class of moderately strong painkillers, including oxycodone, hydrocodone, and a very strong painkiller, fentanyl, which is synthesized to resemble other opiates such as opium-derived morphine and heroin. The potency and availability of these substances, despite their high risk of addiction and overdose, have made them popular both as formal medical treatments and as recreational drugs. Due to their sedative effects on the part of the brain which regulates breathing, opioids in high doses present the potential for respiratory depression and may cause respiratory failure and death.

The Commonwealth of Pennsylvania, along with other states in the nation has enacted legislation to curb the prescription and distribution of these drugs to try to prevent addiction rising from abuse as a painkiller. This includes, but is not limited to, restrictions to prescribing to minors, quantity limits, a prescription database with entry requirements and other limits to its availability.

Terrorism/Cyberterrorism Incidents

Terrorism is the use of force or violence against persons or property with the intent to intimidate or coerce. Acts of terrorism include threats of terrorism; assassinations; kidnappings; hijackings; bomb scares and bombings; cyber-attacks (computer-based); and the use of chemical, biological, nuclear, and radiological weapons. Cyber-attacks have become an increasingly pressing concern. Cyberterrorism refers to acts of terrorism committed using computers, networks, and the internet. The most widely cited definition comes from Denning's Testimony before the Special Oversight Panel on Terrorism: "Cyberterrorism...is generally understood to mean unlawful attacks and threats of attack against computers, networks, and the information stored therein when done to intimidate or coerce a government or its people in furtherance of political or social objectives. Further, to qualify as cyberterrorism, an attack should result in violence against persons or property, or at least cause enough harm to generate fear."

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Transportation Accidents

Transportation accidents are technological hazards involving the nation's system of land, sea, and air transportation infrastructure. A flaw or breakdown in any component of this system can and often does result in a major disaster involving loss of life, injuries, property and environmental damage, and economic consequences.

Urban Fire and Explosions

Urban fires and explosions include those fires and explosions that occur within urban, or developed, regions, and often pose an increased threat due to their tendency to easily spread to neighboring structures. The effects may be minor or severe and include injury, loss of life, property damage, and residential or economic disruption/displacement.

Utility Interruption

Utility interruption hazards are hazards that impair the functioning of important utilities in the energy, telecommunications and 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.
- 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, deep-water ports and harbors, public buildings, bridges, dams, for example (Unit-ed States 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 Department of Energy, 2000).

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.2.3. Climate Change

Impacts of Climate Change on Identified Hazards

Humans have become the dominant species on Earth and our society and influence is globalized. Human activity such as the large-scale consumption of fossil fuels and de-forestation has caused atmospheric carbon dioxide concentrations to significantly increase and a notable diversity of species to go extinct. The result is rapid climate change unparalleled in Earth's history and an extinction event approaching the level of a mass extinction (Barnosky et al., 2011; Wake & Vredenburg, 2008). The corresponding rise of average atmospheric temperatures is intensifying many natural hazards and further threatening biodiversity. The effects of climate change on these hazards are expected to intensify over time as temperatures continue to rise, so it is prudent to be aware of how climate change is impacting natural hazards.

The most obvious change is in regard to extreme temperatures. As average atmospheric temperatures rise, extreme high temperatures become more threatening, with record high temperatures outnumbering record low temperatures 2:1 in recent years. As climate change intensifies, it is expected that the risk of extreme heat will be amplified whereas the risk of extreme cold will be attenuated. Some studies show increased insect activities during a similar rapid warming event in Earth's history. Other studies make projections that with the warming temperatures and lower annual precipitation that are expected with climate change, there will be an expansion of the suitable climate for mosquitos, potentially increasing the risk of infectious disease.

Climate change is likely to increase the risk of droughts (Section 4.3.1). Higher average temperatures mean that more precipitation will fall as rain rather than snow, snow will melt earlier in the spring, and evaporation and transpiration will increase. Along with the prospect of decreased annual precipitation, the risk of hydrological and agricultural drought is expected to increase (Sheffield & Wood, 2008). Correspondingly this will impact wildfires. Drought is accompanied by drier soils and forests, resulting in an elongated wildfire season and more intense and long-burning wildfires (Pechony & Shindell, 2010). However, the Southwest United States is at a greater risk of this increased drought and wildfire activity than Greene County in the Eastern United States.

While it may seem counterintuitive considering the increased risk of drought, there is also an increased risk of flooding associated with climate change (Section 4.3.3). Warmer temperatures mean more precipitation will fall as rain rather than snow. Combined with the fact that warmer air holds more moisture, the result is heavier and more intense rainfall and dam and levee failures. Similarly, winter storms are expected to become more intense, if possibly less frequent. Climate change is also expected to result in more intense hurricanes and tropical storms. With the rise of atmospheric temperatures, ocean surface temperatures are rising, resulting in warmer and more moist conditions where tropical storms develop (Stott et al., 2010). A warmer ocean

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

stores more energy and is capable of fueling stronger storms. It is projected that the Atlantic hurricane season is elongating, and there will be more category 4 and 5 hurricanes than before (Trenberth, 2010).

Climate change is contributing to the introduction of new invasive species (Section 4.3.6). As maximum and minimum seasonal temperatures change, non-native species are able to establish themselves in previously inhospitable climates where they have a competitive advantage. This may shift the dominance of ecosystems in the favor of non-native species, contributing to species loss and the risk of extinction.

This type of sudden global change is novel to humanity. Despite the myriad of well thought out research, there is still much uncertainty surrounding the future of the Earth. All signs point to the intensification of the hazards mentioned above, especially if human society and individuals do not make swift and significant changes combat species losses.

Where applicable, climate change will be discussed for each hazard profile in this hazard mitigation plan. All natural hazards will have a discussion on climate change vulnerability, while certain human-caused hazards may not experience significant vulnerabilities from climate change adaptation and will not have direct narrative addressing those impacts.

Climate change was also taken into account when capabilities were being reviewed, and mitigation actions were being developed and updated.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.3. Hazard Profiles

4.3.1. Drought

4.3.1.1 Location and Extent

While Pennsylvania is generally more water-rich than many U.S. states, the commonwealth may experience drought conditions intermittently throughout the calendar year. A drought is broadly defined as a time period of prolonged dryness that contributes to the depletion of ground and surface water. Droughts are regional climatic events, so when such an event occurs in Greene County, impacts are not restricted to the county and are often more widespread. The spatial extent of the impacted area can range from localized areas in Pennsylvania to the entire Mid-Atlantic region.

There are three types of droughts:

Meteorological Drought – A deficiency of moisture in the atmosphere compared to average conditions. Meteorological drought is defined by the duration of the deficit and degree of dryness and is often associated with below average rainfall. Depending on the severity of the drought, it may or may not have a significant impact on agriculture and the water supply.

Agricultural Drought – A drought inhibiting the growth of crops, due to a moisture deficiency in the soil. Agricultural drought is linked to meteorological and hydrologic drought.

Hydrologic Drought – A prolonged period without rainfall that has an adverse effect on streams, lakes, and groundwater levels, potentially impacting agriculture.

Droughts are often the leading contributing factor to wildfires, as they leave areas with little to no moisture.

4.3.1.2 Range of Magnitude

The average annual precipitation of 38 inches of rain occurs primarily during the spring and summer months. This value is derived from an average of ten years of mean annual precipitation data for Greene County. Rural farming areas of Greene County are most at risk when a drought occurs. A drought can create a significant financial burden for the community. While forested areas make up 62.0% of Greene County, agriculture makes up approximately 28.2% of the total land area, increasing the geographic extent of drought vulnerability in the county. Under dry conditions or droughts, wildfires have the potential to burn forests as well as croplands.

100.0% of Greene County farms are family-owned and operated. Additionally, around 33.0% of the county farmland use is devoted to crop cultivation, 29.0% of farmland is woodland, 28.0% is pastureland, and 10.0% is for other purposes. Wildfires are often the most severe secondary effect associated with drought. Wildfires can devastate wooded and agricultural areas, structures near high wildfire loads, and farm production facilities, thus threatening natural resources.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Prolonged drought conditions can have a lasting impact on the economy and can cause major ecological changes, such as increases in scrub growth, flash flooding, and soil erosion.

For recreational enjoyment, the county boasts several local parks, one state park, game lands, and natural areas that include a series of trail systems – all of which are at risk for the effects of drought.

Long-term water shortages during severe drought conditions can have a significant impact on agribusiness, public utilities, and other industries reliant on water for production services. Greene County also has a growing agritourism business that would be threatened by long-term drought.

Local municipalities may, with the approval of the Pennsylvania Emergency Management Council, implement local water rationing. These individual water rationing plans, authorized through provisions of 4 PA code Chapter 120, will require specific limits on individual water consumption to achieve significant reductions in use. Under mandatory water usage restrictions imposed by the commonwealth and/or local municipalities, procedures are provided for granting of variances to consider individual hardships and economic dislocations. *Table 11 – Drought Preparation Phases* shows the FEMA-defined levels of drought severity along with suggested actions, requests, and goals.

Table 11 - Drought Preparation Phases

Drought Preparation Phases				
Phase	General Activity	Actions	Request	Goal
Drought Watch	Early stages of planning and alert for drought possibility.	Increased water monitoring, awareness, and preparation for response among government agencies, public water suppliers, water users, the public.	Voluntary water conservation.	Reduce water use by 5%.
Drought Warning	Coordinate a response to imminent drought conditions and potential water shortages.	Reduce shortages – relieve stressed sources, develop new sources if needed.	Continue voluntary water conservation, impose mandatory water use restrictions if needed.	Reduce water use by 10 – 15%.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Drought Preparation Phases				
Phase	General Activity	Actions	Request	Goal
Drought Emergency	Management of operations to regulate all available resources and respond to emergency.	Support essential and high priority water uses and avoid unnecessary uses.	Possible restrictions on all nonessential water uses.	Reduced water uses by 15%.

Source: Pennsylvania Department of Environmental Protection, 2017

The commonwealth uses five parameters to assess drought conditions:

- Stream flows (compared to benchmark records)
- Precipitation (measured as the departure from normal, thirty-year average precipitation)
- Reservoir storage levels in a variety of locations such as three New York City reservoirs in the upper Delaware River Basin
- Groundwater elevations in several counties (comparing to past month, past year, and historic records)
- Soil moisture via the Palmer Drought Index as seen in *Table 12 – Palmer Drought Severity Index*, which is a soil moisture algorithm calibrated for relatively homogenous regions which measures dryness based on recent precipitation and temperature.

Table 12 - Palmer Drought Severity Index

Palmer Drought Severity Index (PDSI)	
Severity Category	PDSI 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

The effects of a drought can be far-reaching both economically and environmentally. Economic impacts include reduced productivity of aquatic resources, mandatory water use restrictions, well failures, cutbacks in industrial production, agricultural losses, and limited recreational opportunities. Environmental impacts of drought include those found in *Table 13 – Economic*

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

and *Environmental Impacts of Drought Events* and qualifies the potential economic and environmental impacts from a drought event.

Table 13 - Economic and Environmental Impacts of Drought Events

Economic and Environmental Impacts of Drought Events	
Economic	Environmental
<ul style="list-style-type: none"> - Reduced productivity of aquatic resources - Mandatory water use restrictions - Well failures. - Cutbacks in industrial production - Agricultural losses - Limited recreational opportunities 	<ul style="list-style-type: none"> - Hydrologic effects - Adverse effects on animal populations - Damage to plant communities - Increased number and severity of fires - Reduced soil quality - Air quality effects - Loss of quality in landscape

4.3.1.3 Past Occurrence

The Pennsylvania Department of Environmental Protection (PA DEP) maintains the most comprehensive data on drought occurrences across the commonwealth. Descriptions of drought status categories (i.e., watch, warning, and emergency) are included in the “Range of Magnitude” section above. The declared drought status from 1980 to 2024 is shown in *Table 14 – Past Drought Events in Greene County*.

The National Oceanic and Atmospheric Administration (NOAA) has archived records showing extreme droughts for the commonwealth in 1931 and a prolonged event in the 1960s as seen in *Figure 7 – Pennsylvania Palmer Drought Index 1900 – 1999*.

Based on the county’s disaster history and other drought occurrence data, the worst drought event in Greene County occurred in the time span of November 1980 to April of 1982. More recent history shows the summer of 1999 was also severe. Extended dry weather spurred Governor Thomas Ridge to declare a drought emergency in fifty-five counties, inclusive of Greene County. During this event, precipitation deficits for that summer averaged five to seven inches below normal; the Susquehanna River hit record low flows, streams were dry, and many wells were depleted. Crop damage losses totaled over \$500 million statewide, and those losses equated to 70% to 100% of crop production. There were additional losses from the decline of milk production. Also, the state asked municipal and private water suppliers to restrict local water use.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Table 14 - Past Drought Events in Greene County

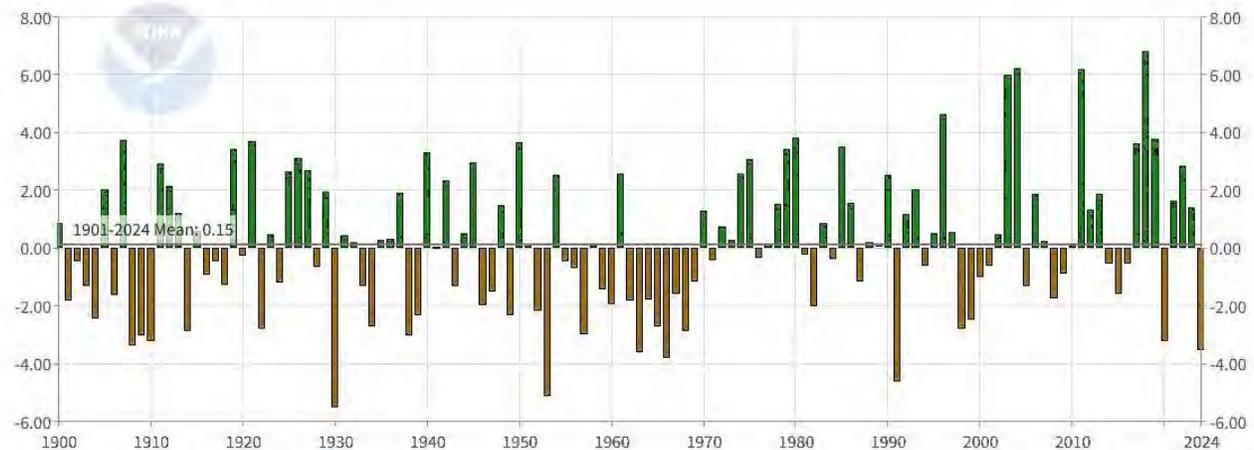
Past Drought Events in Greene County			
Start Date	End Date	Drought Status	Event Duration (Days)
07/07/1988	08/24/1988	Watch	48
08/24/1988	12/12/1988	Warning	110
03/03/1989	05/15/1989	Watch	73
06/28/1991	08/16/1991	Watch	49
08/16/1991	04/20/1992	Emergency	197
04/20/1992	06/23/1992	Warning	65
06/23/1992	01/15/1993	Watch	202
09/01/1995	12/18/1995	Watch	109
12/03/1998	12/14/1998	Watch	11
12/14/1998	03/15/1999	Warning	89
06/10/1999	06/18/1999	Watch	8
06/18/1999	07/20/1999	Warning	32
09/30/1999	05/02/2000	Watch	186
12/05/2001	05/13/2002	Watch	159
09/05/2002	06/18/2003	Watch	286
04/11/2006	06/30/2006	Watch	80
08/06/2007	01/11/2008	Watch	158
11/07/2008	01/26/2009	Watch	80
09/16/2010	11/10/2010	Warning	55
11/10/2010	12/17/2010	Watch	37
12/17/2010	07/19/2012	Watch	566
07/19/2012	08/31/2012	Watch	43
06/15/2023	TBD	Watch	TBD

Source: Pennsylvania Department of Environmental Protection, 2024

Figure 7 - Pennsylvania Palmer Drought Index 1900 – 2024

Greene County, Pennsylvania Palmer Drought Severity Index (PDSI)

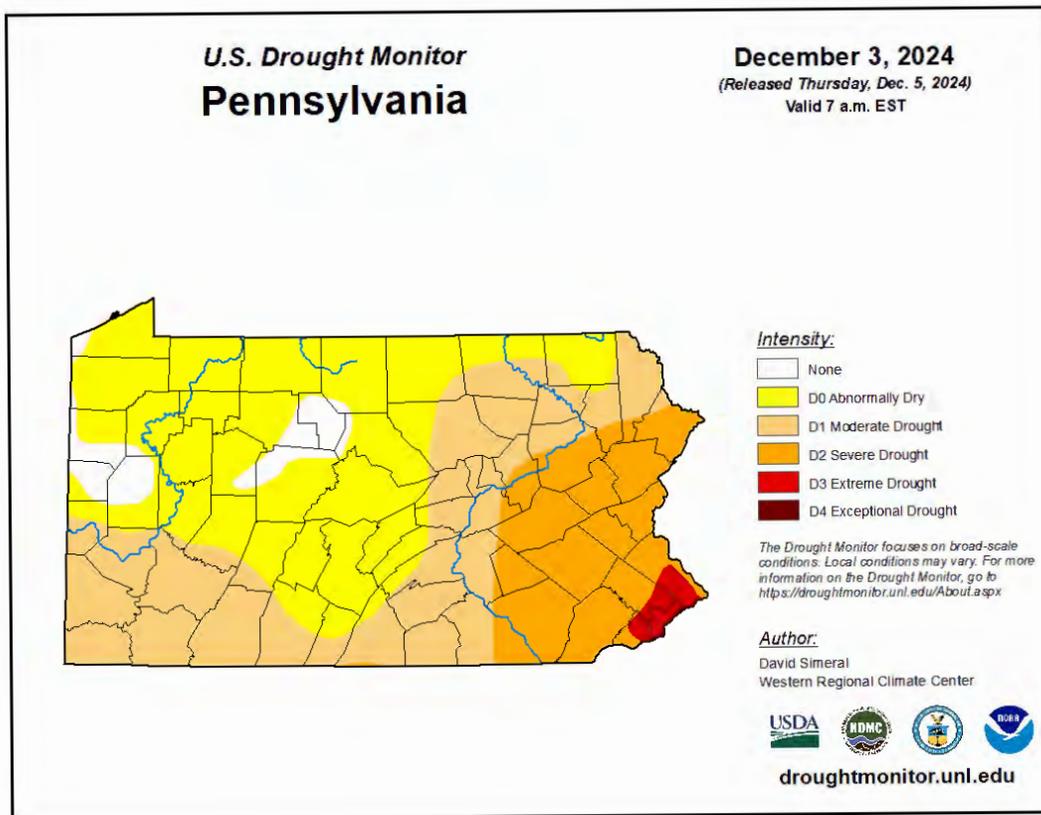
November



Greene County, Pennsylvania 2025 Hazard Mitigation Plan

The warmest July on record in Pennsylvania occurred in 2020, and sixteen counties entered Drought Watch status on August 21 of that year. In June 2021, dry conditions were again affecting the commonwealth. The year 2024 was abnormally dry, too. At the writing of this profile (December 2024), approximately 52.0% (24,097 square miles) of Pennsylvania was under drought conditions and 40.0% (18,436 square miles) was considered abnormally dry. *Figure 8 – U.S. Drought Monitor, Pennsylvania* illustrates the conditions of drought in Pennsylvania at the time of this report.

Figure 8 - U.S. Drought Monitor, Pennsylvania



4.3.1.4 Future Occurrence

It is difficult to forecast the exact severity and frequency of future drought events. Climate change may lead to increased uncertainty and extremity of climate events. Greene County experienced severe drought between 5% to 10% of the time between 1895 and 1995, as seen in *Figure 9 – Palmer Drought Severity Index*. This report can be used to make a rough estimate of the future probability of drought in Greene County, although it does not account for changes introduced by climate change. Drought conditions are expected to become more severe with climate change, as evaporation and transpiration will increase with higher temperatures.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 9 - Palmer Drought Severity Index

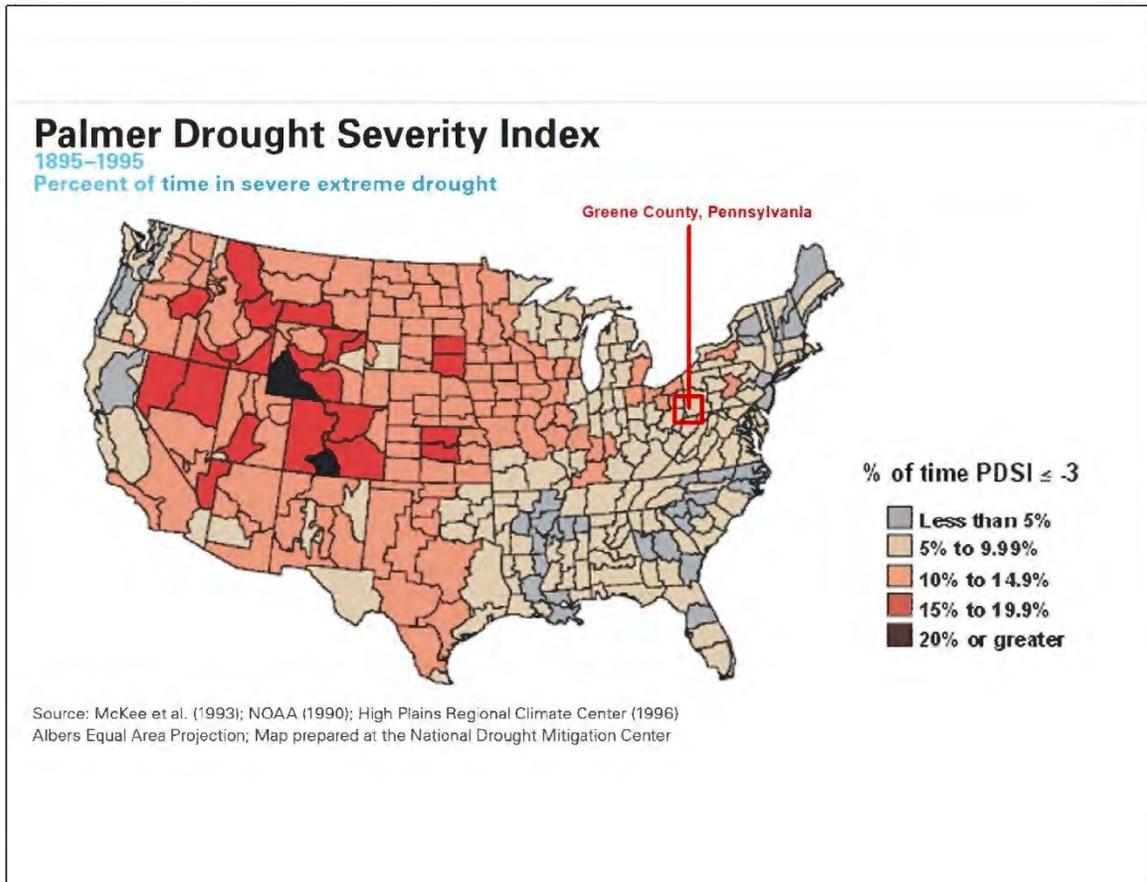


Figure 8 – U.S. Drought Monitor, Pennsylvania, above, show that Greene County was in a Drought Watch amidst moderately dry conditions.

The potential for a drought to occur in Greene County is high. Given the frequency of drought watches and warnings issued for Greene County and its municipalities, the county can reasonably expect to be under a drought watch every year or every few years. While some form of drought condition frequently exists in Greene County, the impact depends on the duration of the event, severity of conditions, and area affected. The map above shows that Greene County (and about three-quarters of Pennsylvania) is currently in some form of drought condition.

As stated above, trends indicate climate change will influence the frequency of droughts in the future. As global temperatures rise, weather patterns will change, increasing the number of dry days an area experiences. This could result in more drought periods for a local or regional area. Droughts could also become longer in duration, compared to previous patterns.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.3.1.5 Vulnerability Assessment

The magnitude of drought vulnerability depends on the duration and area of impact. However, other factors contribute to the severity of a drought. Unseasonably high temperatures, prolonged winds, and low humidity can heighten the impact of a drought.

Extended periods of drought can lead to lowered stream levels, altering the delicate balance of riverine ecosystems. Certain tree species are susceptible to fungal infections during prolonged periods of soil moisture deficit. Fall droughts pose a particular threat because groundwater levels are typically at their lowest following the height of the summer growing season.

Land use and major development is a factor that has the potential to impact the vulnerability to drought in Greene County. Land use, especially agricultural land use, can exacerbate dry conditions, and these agricultural areas can be damaged by drought. There are 114,089 acres of farmland in Greene County. If the number of agricultural acres increases, that increases the potential vulnerability for drought impacts. Conversely, if the agricultural acres decrease, the potential vulnerability of agriculture to drought decreases. Drought can also have an adverse effect on forested areas. A large percentage of Greene County is forest area, including deciduous, evergreen, mixed deciduous and evergreen, forested wetlands, and emergent wetlands. There is also one state park, five state game lands, and numerous natural areas that make up a large portion of the county. Long periods of drought can increase the potential for wildfires and invasive species that could damage these forested areas. Economic benefits through the provision of wood products would also be affected.

There are many hazards that can be considered cascading hazards related to drought events. Wildfire is the most severe cascading hazard effect associated with drought. Wildfires can devastate wooded and agricultural areas, threatening natural resources and farm production facilities. With drought events, water infiltration into the ground becomes more difficult. This lack of infiltration can result in flash flooding events in areas of steep slopes, canyons, and rolling hills. A loss of vegetation from a drought can also increase the occurrence of landslides in areas of steep slopes with loose packed soil profiles. A discussion on the county's vulnerability to wildfire, flash floods, and landslides can be found in Section 4.3.12.5, 4.3.4.5, and 4.3.7.5 respectively.

Droughts can have adverse effects on farms and other water-dependent industries resulting in local economic loss. Areas of extensive agriculture use are particularly vulnerable to drought; 114,089 acres of Greene County, or roughly 31.0% of the 369,920 total acres, make up farmland (United States Department of Agriculture [USDA], 2022 Census). The total number of farms in Greene County is 722, and the average acreage for farms in Greene County is 158 acres. Greene County ranks 54th of sixty-seven counties in the commonwealth for agricultural production, totaling over \$16 million annually. Agricultural production from crops, including nursery and

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

greenhouse crops, accounts for more than \$8.4 million in commerce annually. Production from livestock, poultry, and their products accounts for approximately \$8 million annually. The livestock that has the greatest potential to be impacted are the cattle and calves and the poultry layers. There are approximately 12,925 cattle and calves and roughly 1,165 poultry layers. Acreage for farming has increased since the 2017 USDA Census when there was a reported total of 112,089 farming and drought vulnerable acres.

Greene County also has approximately 1,257 domestic wells and one irrigation well that would be adversely impacted by drought events. This impact would lead to lower water levels for at least 1,257 households and potentially one large farm. This well information was obtained by using the PA GEOCODE application to find well information from 01/01/2020 to January 7, 2025.

Additionally, emergency services can be adversely impacted by drought as a cascading hazard. Local fire departments often utilize ponds, creeks, and streams for water onboard fire apparatus. With low water levels in waterbodies, responders may be unable to draft enough water to efficiently respond to and extinguish a fire. Also, with an increased number of potential wildfires due to drought conditions, agencies may not have the personnel to efficiently respond to all fires in a timely manner.

A map of properties with tillable agricultural land use, forestry, and other land in the county vulnerable to drought is shown below in *Figure 10 – Drought-Vulnerable Land Use*.

Populations in Greene County, including the socially vulnerable, underserved, and unserved populations, are at different levels of vulnerability. The socially vulnerable have an increased risk due to the unsheltered or homeless not having access to reliable sources of water. Also, those individuals who are considered socially vulnerable because of location in rural areas are also at an increased risk because of agricultural and well status.

As seen in *Table 15 – Population Change in Greene County*, eighteen municipalities in Greene County have experienced a population loss, and eight municipalities have seen a net population increase from the 2010 census to the 2020 census according to the U.S. Census Bureau, American Community Survey estimates. Based on this information, it can be speculated that these eight municipalities may have an increased vulnerability to drought conditions since 2010, due to the increase in population.

Municipalities with high vulnerability due to drought:

- Carmichaels Borough
- Center Township
- Gilmore Township
- Greene Township
- Greensboro Borough
- Jackson Township
- Monongahela Township
- Rices Landing Borough

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

All properties in Greene County that are part of the National Register of Historic Places have the same vulnerability to drought. No one property has a greater risk than the others, but each of the historic and cultural properties is vulnerable at some level. There are three dozen historic or cultural properties or buildings/neighborhoods, and drought could impact water supply delivery to those locations (see Community Profile).

Drought events in Greene County can impact certain systems and community lifelines that are tied into the historic or cultural properties. Water utilities can be directly impacted by drought events when prolonged dry weather lowers the available water in reservoirs and water systems used by a county or a community. Drought could impact electric utilities if moving water is used in electric generation. When water is used for electric generation, drought events could cause lower utilization and efficiency. This is more common in the western United States, but it could occur if any counties in Pennsylvania utilize water for power generation. Currently, Greene County does not use waterpower for electric generation. Other systems that could potentially be impacted by a drought event are wastewater utilities and any nuclear power generation that uses water in its process.

Table 15 - Population Change in Greene County

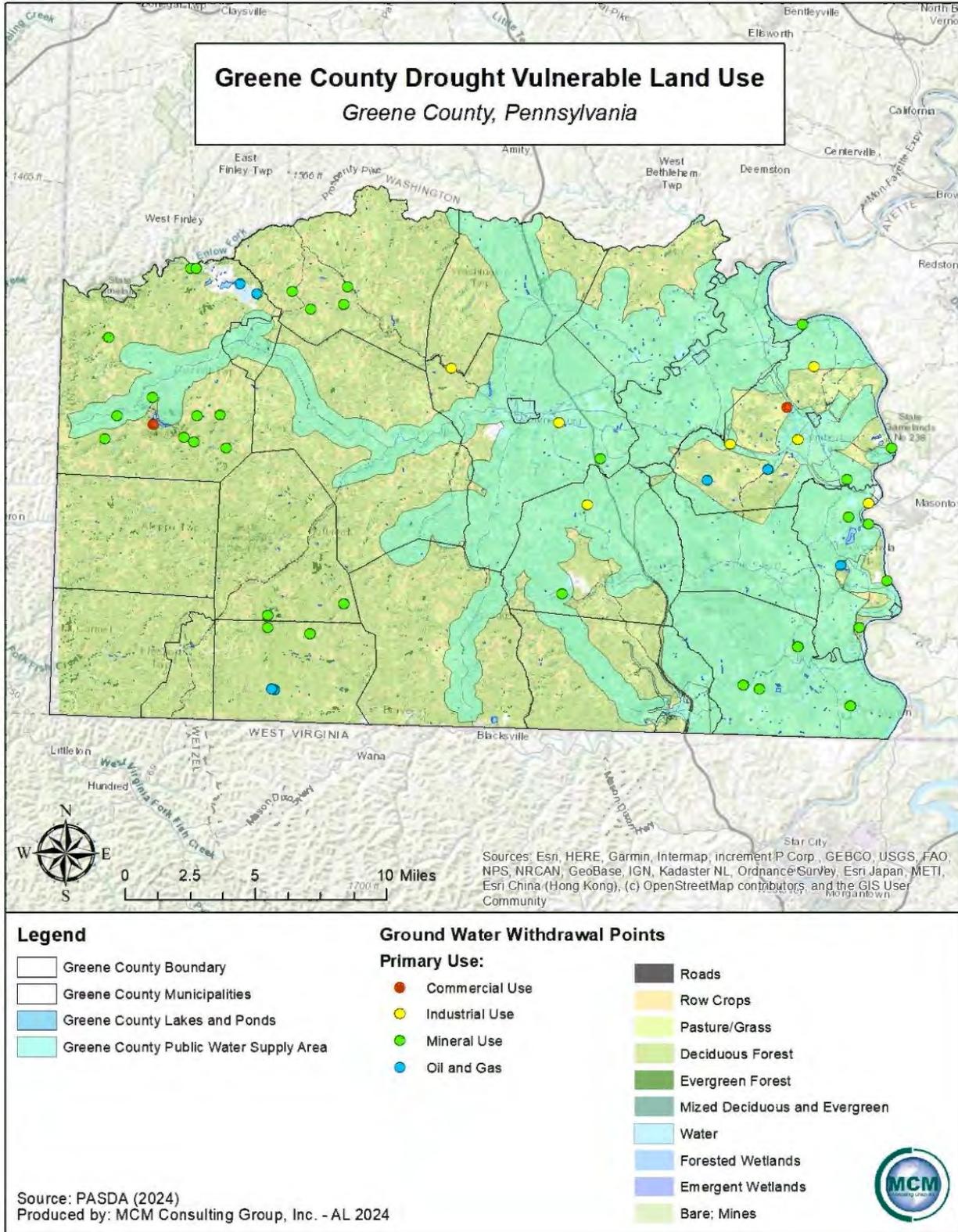
Population Change in Greene County from 2010-2020			
Municipality	2010 Census	2020 Census	Percent of Change 2010-2020
Aleppo Township	564	557	-1.24
Carmichaels Borough	461	481	4.34
Center Township	1,202	1,276	6.16
Clarksville Borough	271	199	-26.57
Cumberland Township	6,620	6,225	-5.97
Dunkard Township	2,315	2,122	-8.34
Franklin Township	7259	6874	-5.30
Freeport Township	249	216	-13.25
Gilmore Township	221	232	4.98
Gray Township	245	133	-45.71
Greene Township	492	538	9.35
Greensboro Borough	262	387	47.71
Jackson Township	451	623	38.14
Jefferson Borough	288	266	-7.64
Jefferson Township	2,575	2,194	-14.80
Monongahela Township	1,563	1,638	4.80
Morgan Township	2,675	2,068	-22.69
Morris Township	826	791	-4.24

***Greene County, Pennsylvania
2025 Hazard Mitigation Plan***

Population Change in Greene County from 2010-2020			
Municipality	2010 Census	2020 Census	Percent of Change 2010-2020
Perry Township	1391	1352	-2.80
Rices Landing Borough	477	600	25.79
Richhill Township	860	821	-4.53
Springhill Township	387	225	-41.86
Washington Township	1,160	936	-19.31
Wayne Township	1246	1108	-11.08
Waynesburg Borough	4,177	3,975	-4.84
Whiteley Township	766	647	-15.54
Source: United States Census Bureau, American Community Survey (2010, 2020)			

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 10 - Drought-Vulnerable Land Use and Public Water Supply



Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.3.2. Earthquake

4.3.2.1 Location and Extent

An earthquake is sudden movement of the earth's surface caused by the release of stress accumulated within or along the edge of the earth's tectonic plates, a volcanic eruption, or by a human induced explosion (DCNR, 2007). Earthquake events in Pennsylvania, including Greene County, are usually mild events, impacting areas no greater than 100 miles in diameter from the epicenter. A majority of earthquakes occur along boundaries between tectonic plates, and some earthquakes occur at faults on the interior of plates. Today, Eastern North America, including Greene County, Pennsylvania, is far from the nearest plate boundary. That plate boundary is the Mid-Atlantic Ridge and is approximately 2,000 miles to the east, under the Atlantic Ocean. The Ramapo Fault System runs through New York, New Jersey, and eastern Pennsylvania (See *Figure 11 – Ramapo Fault System*) This fault system is associated with some small earthquakes, and it is thought unlikely to produce significant disruption.

Figure 11 - Ramapo Fault System



When the supercontinent of Pangaea broke apart about 200 million years ago, the Atlantic Ocean began to form. Since then, many faults have developed. Locating all the faults would be an ideal approach to identifying the region's earthquake hazard; however, many of the fault lines in this region have no seismicity associated with them. The best way to determine earthquake history for Greene County is to conduct a probabilistic earthquake-hazard analysis with the earthquakes that have already happened in and around the county. (See *Figure 12 - Pennsylvania Earthquake Hazard Zones*). Nevertheless, the United States Geological Survey (USGS) indicates that Greene

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

County has a low earthquake risk, and no historical earthquake events have occurred.

Natural gas extraction of the Marcellus/Utica Shale formation (see *Figure 13 - Pennsylvania Oil and Gas Geology*) has occurred in many regions of the commonwealth, but eastern and southeastern Pennsylvania are not among them. Hydraulic fracturing, or fracking, is used to extract the gas, and the process is thought to lead to an increase in seismic activity (Meyer, 2016).

However, fracking does not appear to be linked to the increased rate of magnitude three and larger earthquakes (USGS 2014). In recent years, permits for extraction of the natural gas and oil in the commonwealth have been issued by the Pennsylvania Department of Environmental Protection, and 5,012 records of requested permits for gas extraction or injection wells were found for Greene County at the writing of this plan.

4.3.2.2 Range of Magnitude

Earthquakes result in the propagation of seismic waves, which are detected using seismographs. These seismograph results are measured using the Richter Scale, an open-ended logarithmic scale that describes the energy release of an earthquake. *Table 16 - Richter Scale* summarizes Richter Scale magnitudes as they relate to the spatial extent of impacted areas. The Modified Mercalli Intensity Scale (*Table 17 - Modified Mercalli Intensity Scale*) is an alternative measure of earthquake intensity that is scaled by the impacts of the earthquake event. Earthquakes have many secondary impacts, including disrupting critical facilities, transportation routes, public water supplies, and other utilities.

Table 16 - Richter Scale

Richter Scale	
Richter Magnitude	Earthquake Effects
Less than 3.5	Not generally 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.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Table 17 - Modified Mercalli Intensity Scale

Modified Mercalli Intensity Scale			
Scale	Intensity	Earthquake Effects	Richter Scale Magnitude
I	Instrumental	Detected only on seismographs.	
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 Disastrous	Most buildings and bridges collapse, roads, railways, pipes, and cables destroyed, general triggering of other hazards.	<8.1
XII	Catastrophic	Total destruction, trees fall, ground rises and falls in waves.	>8.1

4.3.2.3 Past Occurrence

According to USGS, no known earthquakes have had an epicenter within Greene County since 1724, before which local seismology cannot be known. However, several seismic events that occurred outside the county boundary may have been felt in the region.

On August 23, 2011, a 5.9 earthquake occurred in Virginia, and a 2.2 earthquake shook Reading, Pennsylvania (Berks County), on July 19, 2019. Further, a 3.4 earthquake struck Mifflintown (Juniata County) on June 13, 2019, and Bolivar (Westmoreland County) experienced a 2.9 event on October 6, 2020. Parts of the county may have experienced some of the shock waves from

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

these minor earthquakes and others that have occurred around the region, most notably New Jersey. The strongest recorded earthquake in Pennsylvania history (5.2) occurred on September 25, 1998, in northwestern Pennsylvania and is known as the Pymatuning Earthquake for its epicenter near Pymatuning Lake. The effects of the earthquake were felt across the commonwealth and were blamed for many wells in the region near the epicenter losing their water, while new springs appeared and old wells reemerged. A three-month date range revealed 120 dry household-supply wells on the ridge of Jamestown and Greenville, Pennsylvania. Declines of up to 100 feet were observed on a ridge where at least eighty of the wells resided. The degree of the damage varied. Some of the wells lost all power or could barely hold their yields and some of the water in wells turned black or began to smell of sulfur.

The most likely impetus of the wells drying was due to an increase in hydraulic conductivity of shale rock under this area caused by the earthquake. The quake affected the existing faults and created new faults in the shale. This created more permeability for the water to leak down from the hilltops on the ridge down to the valleys following the contours of the Meadville shale. Because the effects of large earthquakes can be felt hundreds of miles away, the historical earthquake epicenters near Greene County are shown below at *Figure 14 – Pennsylvania Recorded Earthquake Events*. A wider depiction of earthquake occurrences in the northeastern United States may be found here:

<https://earthquake.usgs.gov/earthquakes/map/?extent=14.26438,-141.32813&extent=56.51102,-48.60352>

4.3.2.4 Future Occurrence

Earthquake activity and intensities are difficult to predict, but a probabilistic analysis of prior earthquakes can assist in gauging the likelihood of future occurrences. *Figure 12 - Earthquake Hazard Zones* in 4.3.2.1 shows that Greene County is in a low hazard zone for earthquake activity according to the USGS (2014), suggesting a low probability of earthquake occurrence. However, according to the USGS, there has been a recent trend increasing the frequency of magnitude three and larger earthquakes in the central and eastern U.S. (*Table 18 - Recent Earthquake Trends in Northeastern U.S.*). This uptick in seismicity may be due to hydraulic fracturing activities, and specifically occurs due to wastewater from the fracking process being injected into the earth (Meyer, 2016). Recent studies have moved towards being able to predict such induced seismicity by looking at uplift after injections, but more work needs to be done to confirm uplift as a reliable indicator of induced seismicity (Shirzaei et al., 2016). It is important to note that seismicity can occur even after wells become inactive and injection rates decline (Shirzaei et al., 2016).

Isostatic Rebound is a hypothesis for earthquake occurrence that has been conceptualized for many years, according to Charles Scharnberger, a retired professor of geology at Millersville University, who monitors the seismic station there. Scharnberger said Pennsylvania

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

earthquakes are somewhat of a mystery, but they could have something to do with the westward shift of the North American tectonic plate. Though the plates meet in California, where most of the seismic activity occurs, that movement still causes stress, squeezing and pressure along the entire length of the plate, reverberating as far back as the East Coast. A 3.4 earthquake like the one in Mifflintown, Juniata County in 2019 is in the medium range for Pennsylvania and may occur every couple of years. According to the USGS, this was the strongest earthquake felt, or originating, in Pennsylvania that year. It was followed by a 1.3 aftershock.

The chances of a devastating earthquake are low, but do exist, according to Scharnberger, His calculations on the probability of a severe earthquake based on the historic record indicate it is about a one in 200 chance in any given year.

Climate change and its relationship with earthquakes is hard to identify. According to the U.S Geological Survey, climate change and earthquake correlation occurs when there is a large change in atmospheric pressure that can be caused by major storms which then could cause slow, small earthquakes. Over time, the release of energy from small earthquakes can lead to ground shaking earthquakes which can cause severe damage. This theory is not yet proven and is still subject to change but can provide some context to the impact of climate change.

Table 18 - Recent Earthquake Trends in Northeastern United States

Earthquake Trends in Northeastern U.S. (USGS, 2020)	
Year	Number of Magnitude 3+ Earthquakes
2015	0
2016	3
2017	4
2018	0
2019	5
2020	3

4.3.2.5 Vulnerability Assessment

According to the U.S. Geological Society Earthquake Hazards Program, an earthquake hazard is anything associated with an earthquake that may affect a resident’s normal activities. For Greene County, this could include surface faulting, ground shaking, landslides, liquefaction, dried or rejuvenated water wells, tectonic deformation, and seiches (sloshing of a closed body of water from earthquake shaking).

Earthquakes usually occur without warning and can impact areas a great distance from their point of origin (epicenter). Ground shaking is the greatest risk to building damage within Greene County. The risk to public safety and loss of life from an earthquake is dependent upon the

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

severity and proximity of the event. Injury or death to those inside buildings, or people walking below building ornamentation and chimneys is a higher risk to Greene County's general public during an earthquake. Infrastructure is more at risk on the east coast than the west coast because of aging buildings inventory.

There are 250 bridges in fair condition and sixty-three in poor condition publicly documented by the Pennsylvania Department of Transportation that could be damaged and made unusable by a major earthquake event. These locations are evenly distributed throughout the county and damage to any of them would be detrimental to transportation and emergency response in Greene County.

Impact of earthquakes on historic properties in Greene County

Greene County has a moderate number of historic and cultural properties that could be adversely impacted by earthquakes. The vulnerability of each is related to the construction practices of the property at the time that it was constructed. Many of the historic properties in Greene County were constructed before 1900 and are a type of construction vulnerable to increased seismic events (brick and stone). There are forty-four historic properties in Greene County that are registered with the National Register of Historic Places.

These locations are:

- Alexander V. Boughner House (Wood)
- Bridge in Franklin Township (Stone)
- Carmichaels Covered Bridge (Wood)
- Colver-Rogers Farmstead (Stone)
- John Corbley Farm (Brick/Stone)
- John Minor Crawford House (Brick/Stone)
- William Crawford House (Wood)
- William Cree House (Stone)
- Horn Davis Overholtzer Bridge (Wood/Collapsed)
- Fisher site (Archaeological)
- Richard T. Foley Site (Archaeological)
- Glassworks-Core House (Wood)
- Glassworks-Gabler House (Demolished)
- George West Gordon Farm (Brick/Stone)
- Greene Academy (Brick/Stone)
- Greene Hills Farm (Brick/Stone)
- Greensboro Historic District (Brick/Stone/Wood)
- Greensboro Public School (Stone)
- Grimes Covered Bridge (Wood/Destroyed)

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

- Hamilton-Ely Farmstead (Brick/Stone)
- Hanna Hall (Brick/Stone)
- Charles Grant Heasley House (Brick/Stone)
- Hughes House (Stone/Wood)
- James Jones House (Brick/Stone)
- Thomas Kent Jr. Farm (Brick/Stone)
- King Covered Bridge (Wood)
- Lippincott Covered Bridge (Wood)
- Albert Gallatin Memorial Bridge (Steel/Replaced)
- Mason and Dixon Survey Terminal Point (Stone)
- McClelland–Grimes Farm (Brick/Stone)
- Miller Hall (Brick/Stone)
- James Parreco House (Brick)
- Peters-Graham House (Wood)
- Reppert-Gabler House (Brick/Stone)
- John Rex Farm (Wood)
- Rice's Landing Historic District (Brick/Stone/Wood)
- Scott Covered Bridge (Wood)
- Shriver Covered Bridge (Wood)
- Sugar Grove Petroglyphs (archaeological)
- Ernest Thralls House (Brick)
- Waynesburg Historic District (Brick/Stone/Wood)
- White Covered Bridge (Wood)
- Nettie Woods Covered Bridge (Wood)
- W. A. Young and Sons Foundry and Machine Shop (Brick/Stone)

There are also three historic districts in Greene County. These areas are in Waynesburg, Rices Landing, and Greensboro. The historic districts are the Greensboro Historic District, Rice's Landing Historic District, and Waynesburg Historic District. These areas include approximately 282 buildings which are made of brick, stone, and wood.

Municipalities with elevated risk due to earthquakes:

- | | |
|-----------------------|----------------------|
| • Aleppo Township | • Franklin Township |
| • Carmichaels Borough | • Freeport Township |
| • Center Township | • Gilmore Township |
| • Clarksville Borough | • Gray Township |
| • Cumberland Township | • Greene Township |
| • Dunkard Township | • Greensboro Borough |

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

- Jackson Township
- Jefferson Borough
- Jefferson Township
- Monongahela Township
- Morgan Township
- Morris Township
- Perry Township
- Rices Landing Borough
- Richhill Township
- Springhill Township
- Washington Township
- Wayne Township
- Waynesburg Borough
- Whiteley Township

All of the socially vulnerable populations in Greene County are at an increased vulnerability to earthquakes. The homeless and the unsheltered populations are at risk if they are living in structurally unsound buildings and locations. Also, the economically vulnerable of Greene County may not have the capability to fix or rebuild if their homes are damaged from an earthquake event.

As seen in *Table 3 – Population Change in Greene County*, eighteen of the twenty-six total municipalities in Green County have experienced a population loss since the 2010 decennial census. Eight municipalities have seen a net population increase from the 2010 decennial census to the 2020 decennial census. Based on this information, it can be speculated that these eight municipalities may have an increased/equivalent vulnerability to earthquakes, since 2010, due to the increase in population and construction.

Land use is a factor that has the potential to impact earthquake severity. Land use, in the form of a built environment, such as residential expansion, can cause earthquake impact severity to increase. Impact severity increases because as the built environment expands and becomes more complex, the impact the event can have on that area may also increase due to an influx of people, infrastructure, and critical infrastructure in the hazard area. With eight municipalities seeing population increases between the 2010 decennial census and the 2020 decennial census, there has been a minimal increase in residential construction in Greene County.

The seismic forces associated with an earthquake pose an immediate threat to telecommunication infrastructure, or other critical infrastructure in a community. When an earthquake occurs, the resulting ground instability can lead to telephone pole collapse, disruption of fiber or copper cables systems, and in severe cases, cellular tower failure. The disruption to these networks, if the earthquake event is significant, can also result in a loss of communication capabilities, hindering response coordination, and leaving communities impacted by the earthquake vulnerable to other natural or human-caused hazards.

Earthquakes can also damage power distribution systems, leading to localized power outages or even widespread blackouts. Fallen power lines, damaged substations, and disrupted transformers may further contribute to the breakdown of the electrical grid surrounding the epicenter of the earthquake, and the consequences can include cascading pressure on essential services and other

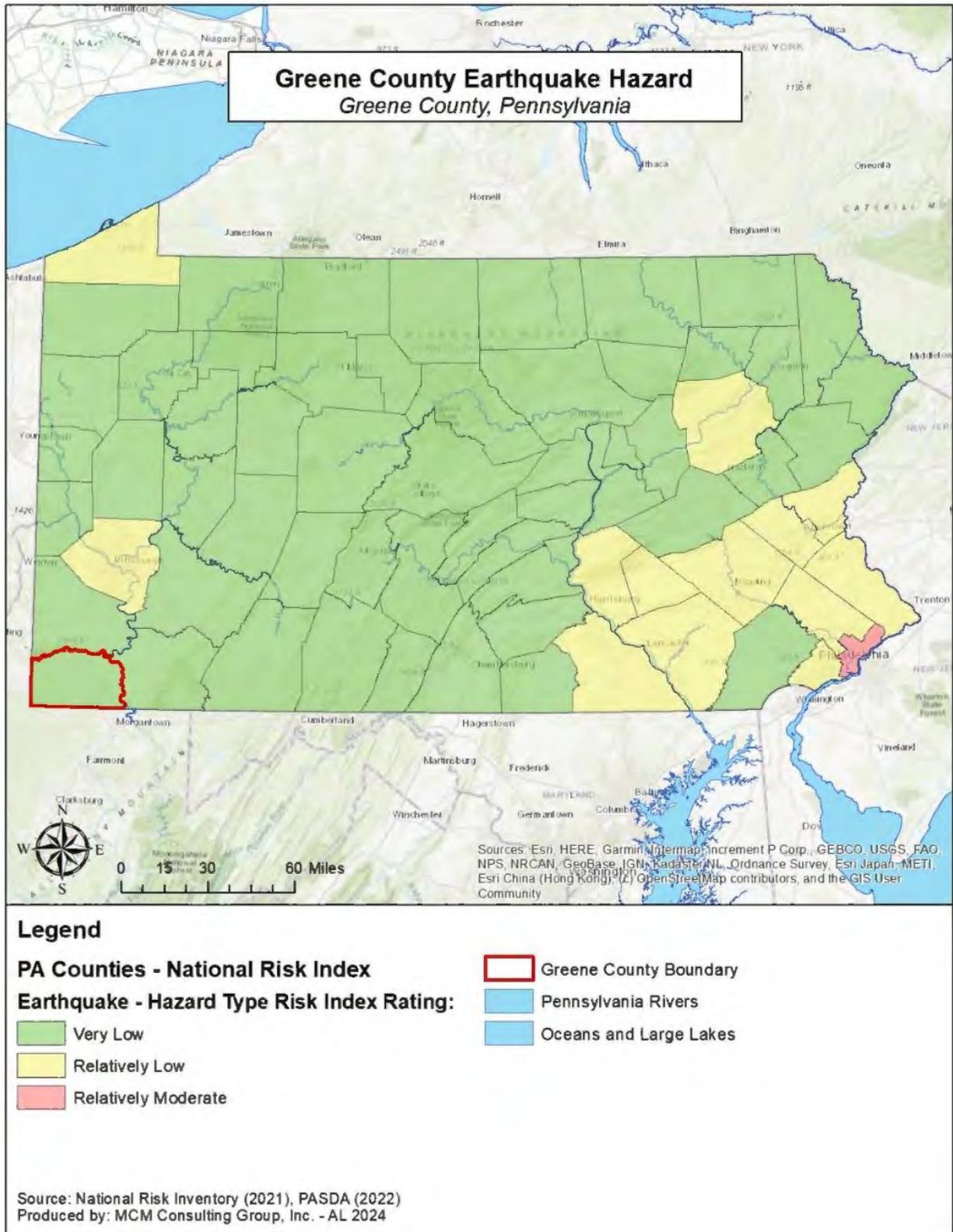
Greene County, Pennsylvania 2025 Hazard Mitigation Plan

community lifelines, further impeding emergency operations and the capabilities within the impacted jurisdictions.

Earthquake events can also pose a threat to natural gas, water, and the numerous other materials and chemicals transported through underground water systems in Greene County. During significant earthquakes, underground pipelines may crack, causing the transported material to leak into the ground and contaminate water sources in the county. In severe cases, water line bursts can cause cascading hazards to subsidence and sinkholes, when left unchecked. However, even in more contained scenarios, a small leak can have profound impact if the transported material is toxic or hazardous in nature, leading to degradation of the natural resources in the impacted communities.

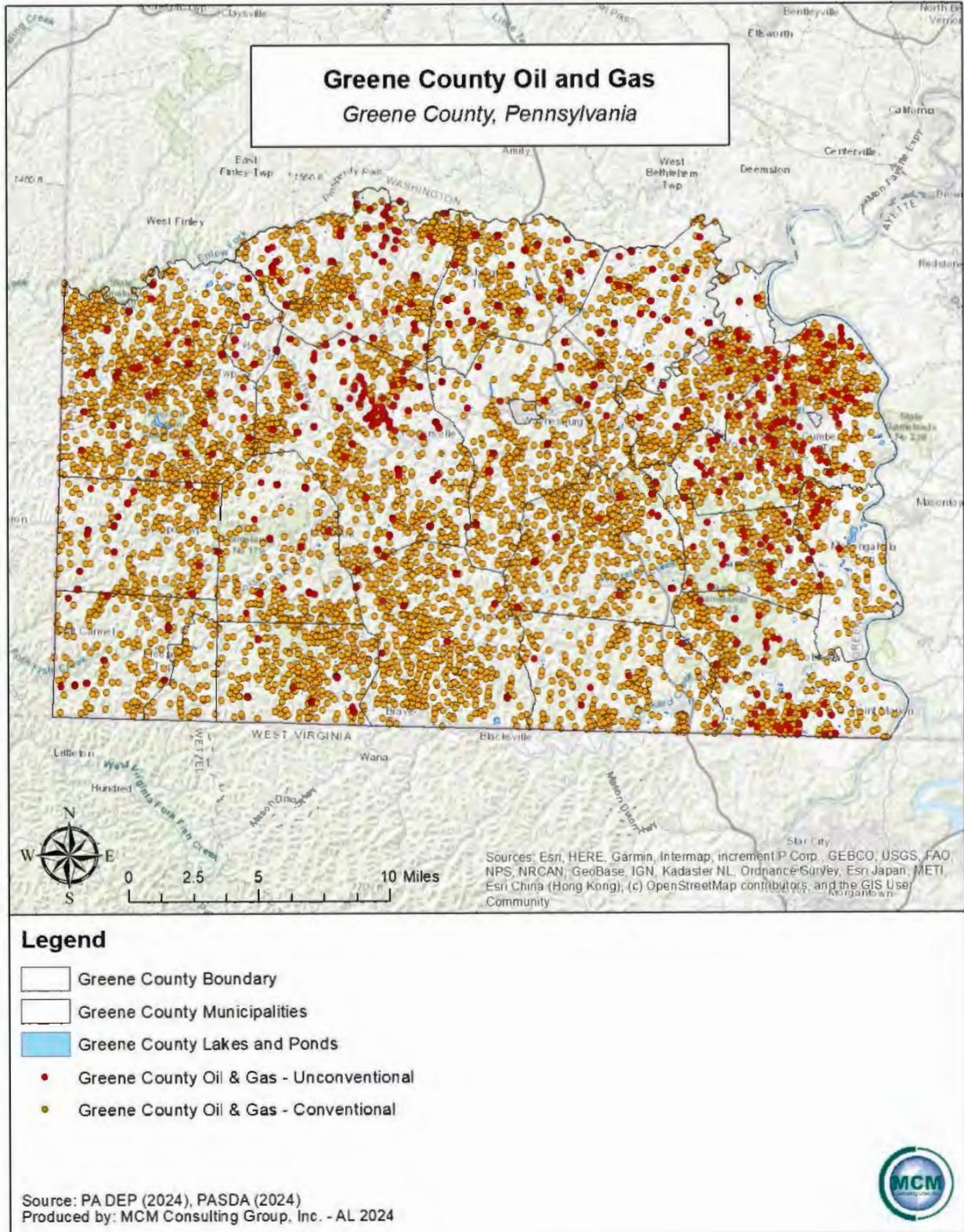
Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 12 - Pennsylvania Earthquake Hazard Zones



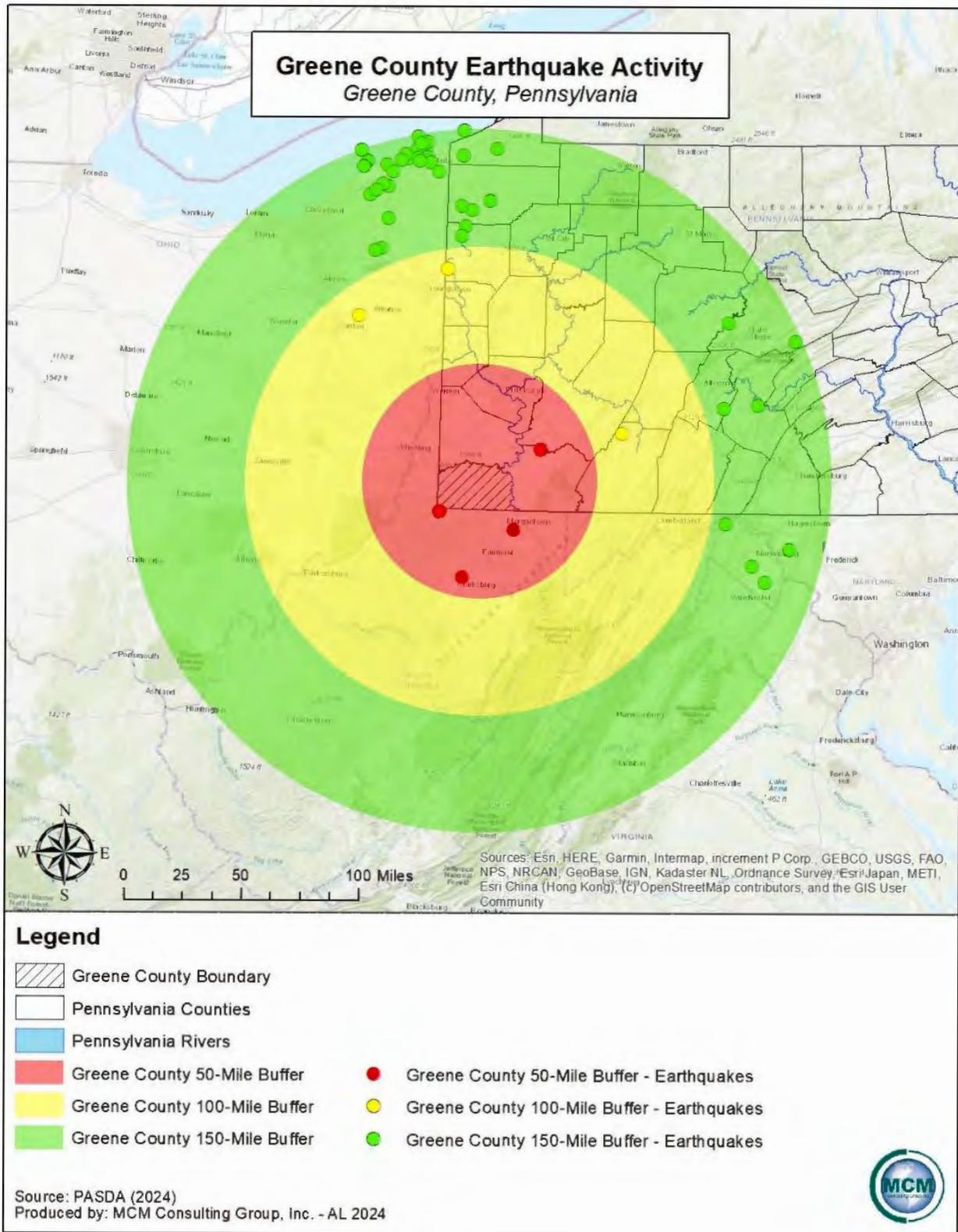
Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 13 - Pennsylvania Oil and Gas Geology



Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 14 - Pennsylvania Recorded Earthquake Events



Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.3.3. Extreme Temperature

4.3.3.1 Location and Extent

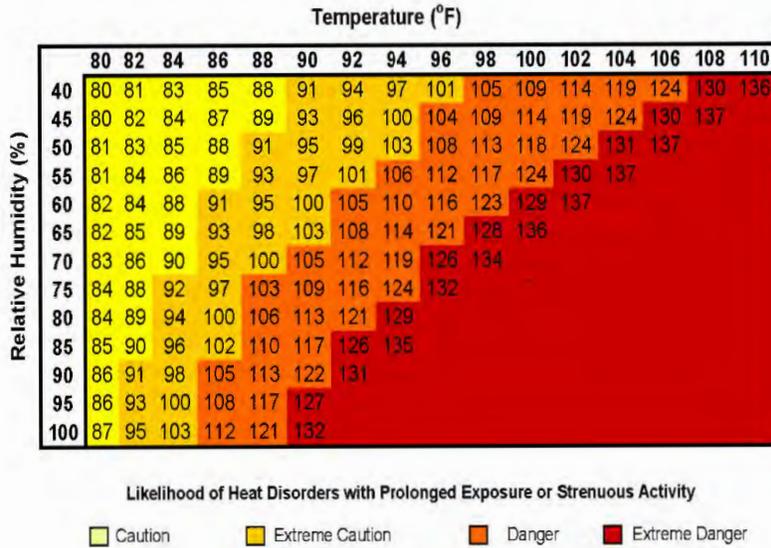
Pennsylvania, and more specifically, Greene County can experience many different temperature extremes. High temperatures occur about ten days per year at any location in Pennsylvania. However, southern parts of the state experience more than twice this number. Freezing temperatures occur on an average of 100 or more days per year with longest freeze-free period at near sea level locations such as northwest Pennsylvania (adjacent to Lake Erie). Extreme temperatures can be devastating – extreme heat can cause sunburn, heat cramps, heat exhaustion, heat stroke, and dehydration, while extreme cold can cause hypothermia and frostbite. Both can potentially cause long-lasting disabilities. January is typically the coldest month for Greene County, with average temperatures of 28.9°F. *Figure 18 - Average Minimum Temperature Trends for Pennsylvania* shows the average minimum temperatures in Pennsylvania with Greene County identified. July has typically been the warmest month for Greene County, with an average temperature of 72.0°F. *Figure 19 - Average Maximum Temperature Trends for Pennsylvania* shows the average maximum temperatures in Pennsylvania with Greene County identified. Temperatures can vary across Greene County due to elevation changes in topography.

4.3.3.2 Range of Magnitude

When extreme temperature events occur, they typically impact the entirety of Greene County, including the surrounding region. Extreme heat is described as temperatures that hover at least 10°F 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. Temperature advisories, watches, and warnings are issued by the National Weather Service relating impacts to the range of temperatures typically experienced in Pennsylvania. Heat advisories are issued when the heat index temperature is expected to be equal to 100°F, but less than 105°F. Excessive heat warnings are issued when heat indices are expected to reach or exceed 105°F and are issued within twelve hours of the onset. Excessive heat watches are issued when there is a possibility that excessive heat warning criteria may be experienced within twenty-four to seventy-two hours, but their occurrence and timing are still uncertain. A potential worst-case extreme temperature scenario would occur if widespread areas of the Commonwealth experienced 90°F or higher temperatures for an extended number of days. The heat could overwhelm the power grid and cause widespread blackouts, cutting off vital HVAC services for residents. It could create crisis management issues for senior citizens on fixed incomes, the homeless, and other vulnerable populations. The heat index is a measurement that takes into account both the temperature and relative humidity, and it is calculated as shown in *Figure 15 - National Weather Service's Heat Index Matrix*.

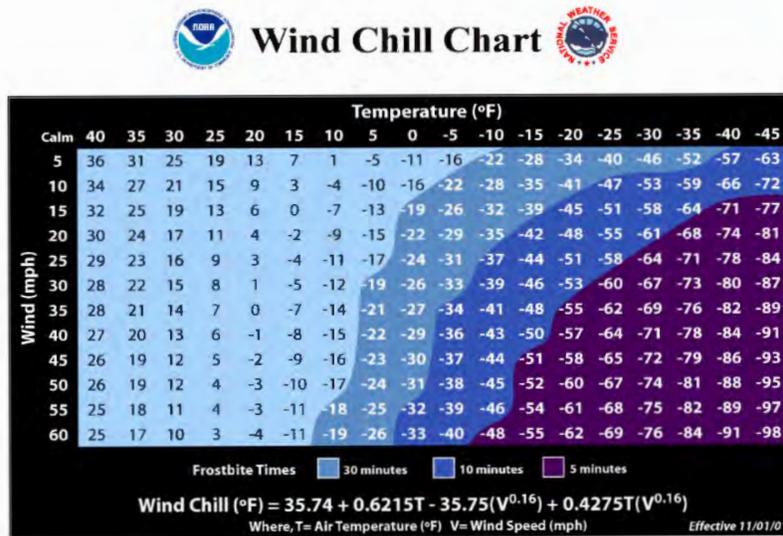
Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 15 - National Weather Service's Heat Index Matrix



Extreme cold temperatures drop well below typical temperatures and are often associated with winter storm events. Wind can make the apparent temperature drop further, and exposure to such extreme cold temperatures can cause hypothermia, frost bite, and death. Wind chill warnings are issued when wind chills drop to -25°F or lower. While this threshold applies to the entire state, the threshold for advisories varies based on regions. Wind chill advisories are issued in the south and western sections of Pennsylvania, when wind chill values drop to -10°F to -24°F. Wind chill advisories are issued in the southern-central to northern sections of the Commonwealth when wind chills drop to -15°F to -24°F. The National Weather Service created a wind chill chart which shows the time frostbite takes to set in depending on temperature and wind speed as shown in *Figure 16 - National Weather Service's Wind Chill Matrix*.

Figure 16 - National Weather Service's Wind Chill Matrix



Source: (NOAA NWS, 2001)

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.3.3.3 Past Occurrence

Greene County has had more past occurrences of extreme cold incidents than extreme heat due to the geographic location of the county. *Table 19 - Past Extreme Temperature Occurrences for Greene County* shows the past occurrence events associated with extreme temperature (hot and cold) that have occurred in Greene County. The data in the table was reported from early 2000s to the year 2024. Due to the source used, no further events have been documented since 2015, however, events most likely have occurred without being documented. With a total of three different extreme temperature events that have occurred, all the events were extreme cold related while there were no extreme heat related events recorded. There were no reports of death or injury related to the occurrences. However, numerous sources have provided information regarding past occurrences and losses associated with extreme temperatures in Greene County and the Commonwealth as a whole. Due to the number of sources available for information, the number of events and losses could vary slightly in number.

Data from the National Climatic Data Center reports that there have been 820 extreme temperature episodes in Pennsylvania from 2000 to present, resulting in a total of ninety-seven deaths and 103 injuries. Out of the 820 events, 525 of them were extreme cold related with four deaths. The other 295 events were extreme heat related with ninety-three deaths and 103 injuries across the state. The biggest event was on July 21, 2011, and ended on July 24, 2011, which did not have a significant effect on Greene County itself. In the 2011 event, there was a total of twenty-two deaths and forty-eight injuries during the course of the event across the commonwealth. Record-breaking heat temperatures were experienced in over thirty different counties.

Table 19 - Past Extreme Temperature Occurrences for Greene County

Past Extreme Temperature Occurrences for Greene County		
Location	Date	Type
Greene County	01/05/2014	Extreme Cold/Wind Chill
Greene County	02/19/2015	Extreme Cold/Wind Chill
Greene County	02/24/2015	Extreme Cold/Wind Chill
Source: NOAA, 2024		

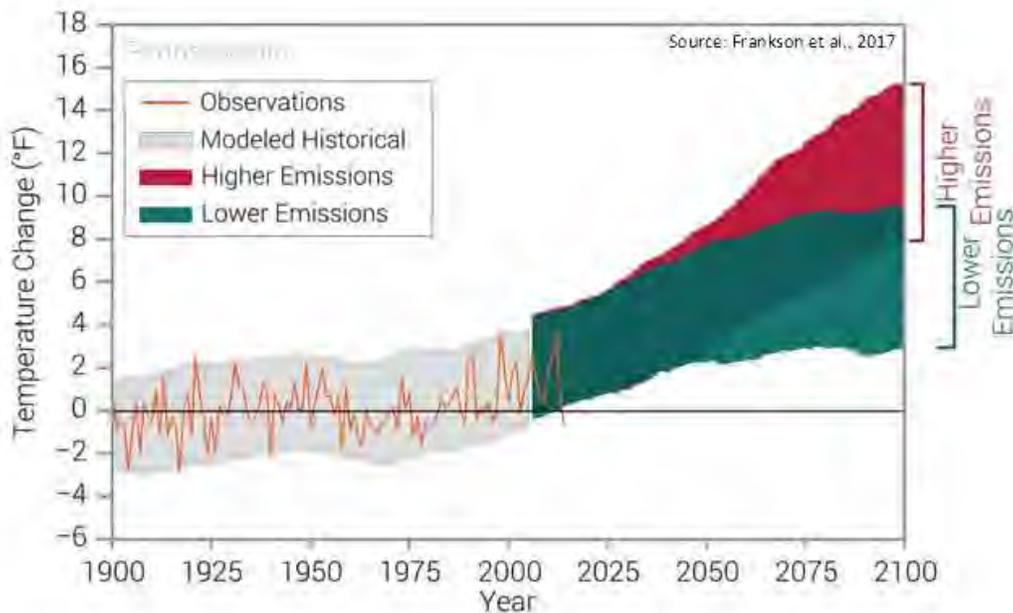
4.3.3.4 Future Occurrence

Extreme temperatures will continue to impact Greene County in the future. Anthropogenic climate change is causing extreme climatic events to occur more frequently, suggesting that extreme temperatures are becoming a more threatening hazard as the impacts of climate change intensify. The annual average temperature has increased by 1.2°F across the continental United States during the years 1986 to present compared to the time period 1901 to 1960, and temperatures are expected to continue rising. *Figure 17 - Observed and Projected Temperature Change for Pennsylvania* shows these projected changes in temperature for Pennsylvania based

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

on climate models considering the possibilities of increased and decreased levels of greenhouse gas emissions. In recent years, record high temperatures have outnumbered record low temperatures 2:1, so it is expected that the risk of extreme heat will be amplified whereas the risk of extreme cold will be attenuated. The Northeastern United States is expected to experience twenty to thirty more days with temperatures above 90°F, and twenty to thirty fewer days below freezing by approximately 2050. While there may be fewer extreme cold events, those that do occur are expected to reach record-setting low temperatures more often. Historically, Greene County has had more extreme cold events than extreme heat events due to the geographic location of the county; however, this balance is expected to shift somewhat in the coming years to include a greater proportion of extreme heat events.

Figure 17 - Observed and Projected Temperature Change for Pennsylvania



Source: (Frankson et al., 2017)

4.3.3.5 Vulnerability Assessment

Extreme temperatures are usually a regional hazard when they occur. The very old (sixty-five years or older, accounting for 19.7% of Greene County population) and the very young (five years or younger, accounting for 4.9% of Greene County population) are most vulnerable to extreme temperatures due to risk factors, mobility challenges, and disabilities. Extreme temperatures can increase the demand for utility services, often resulting in an increased cost which some consumers may be unable to afford. The increased demand for services may cause a decrease in availability of these services or failure of the system. A decrease or failure of the utility system during extreme temperature events would put a large population at great risk. Extreme temperature events can also drastically increase the volume of emergency calls, potentially overwhelming the public safety communications center. Extreme heat events can also

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

contribute to drought conditions, which in turn increase the risk of wildfire, as discussed in Section 4.

All properties in Greene County that are part of the National Register of Historic Places have the same risk to extreme temperature. No one property has a greater risk than the others, but each of the historic and cultural properties is vulnerable at some level.

Municipalities with high risk due to extreme temperature:

- Aleppo Township
- Carmichaels Borough
- Center Township
- Clarksville Borough
- Cumberland Township
- Dunkard Township
- Franklin Township
- Freeport Township
- Gilmore Township
- Gray Township
- Greene Township
- Greensboro Borough
- Jackson Township
- Jefferson Borough
- Jefferson Township
- Monongahela Township
- Morgan Township
- Morris Township
- Perry Township
- Rices Landing Borough
- Richhill Township
- Springhill Township
- Washington Township
- Wayne Township
- Waynesburg Borough
- Whiteley Township

Extreme temperatures can have a significant impact on land use within Greene County. Higher temperatures can affect the mountain snowpacks and vegetation land. It is important to note that higher land use and irrigation can cause more intense extreme temperatures. Based on this information it can be speculated that higher land use within the municipalities in Greene County will be impacted.

As seen in *Table 3 – Population Change in Greene County*, eighteen of the twenty-six municipalities in Greene County have experienced a population loss since the 2010 census and eight municipalities have seen a net population increase from the 2010 census to the 2020 census according to the U.S. Census Bureau, American Community Survey estimates. Based on this information, it can be speculated that Carmichaels Borough, Center Township, Gilmore Township, Greene Township, Greensboro Borough, Jackson Township, Monongahela Township, and Rices Landing Borough may have an increased vulnerability to extreme temperatures, since 2010, due to the increase in population. Populations in Greene County, including the socially vulnerable and unserved populations, are at different levels of vulnerability. The socially vulnerable have an increased risk due to the unsheltered or homeless not having proper, and adequate, access to shelter and heating, ventilation, and air conditioning (HVAC) to protect them from extreme temperature events.

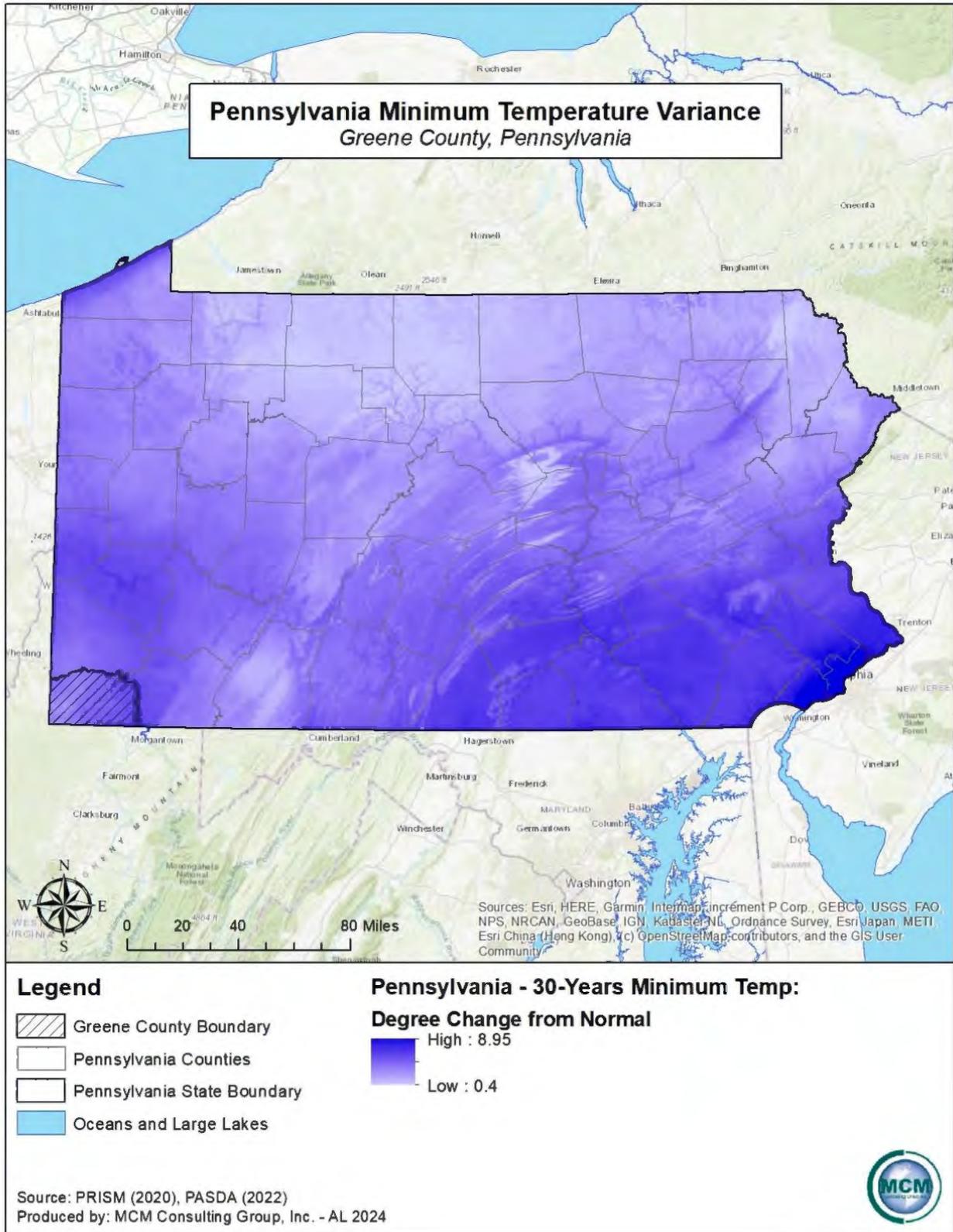
Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Extreme temperatures can have a significant impact on natural areas. Consecutive days of excessive heat or extreme cold can lead to the diminishment of natural habitats such as forests, rivers, and mountains as seen in Greene County. Excessive heat and extreme cold can cause these areas to lose the nourishment that is needed for these areas to survive and destroy the equilibrium within them. If trends continue there will be more days of excessive heat in the coming years that could impact the equilibrium in these natural areas and change their geographic features. Extreme temperatures and lack of rainfall can lead to drought and the diminishment of rivers and vegetation within the area.

Extreme temperatures can have significant impacts on systems and community lifelines that are essential for the operations of an area. The changing nature of extreme temperature events could account for different levels of impact for every system in an area. For example, excessive cold may disrupt water systems, potentially resulting in frozen or broken pipes due to water freezing in the system because of the lower temperatures. Extreme heat events may increase the demand for potable water for consumption and water for irrigation. This could result in lower reservoir levels and increased concern for water rationing. If extreme temperatures continue for an extended period, or if the extreme temperatures occur while a drought event is ongoing, the vulnerability of an area could be critical. Extreme temperatures could impact the power system by causing an increase for air conditioning in extreme heat events. When power demand is high for an already over-taxed power system, rolling power interruptions or brownouts can occur. This is more typical in the western United States but could occur in Pennsylvania if the conditions are met.

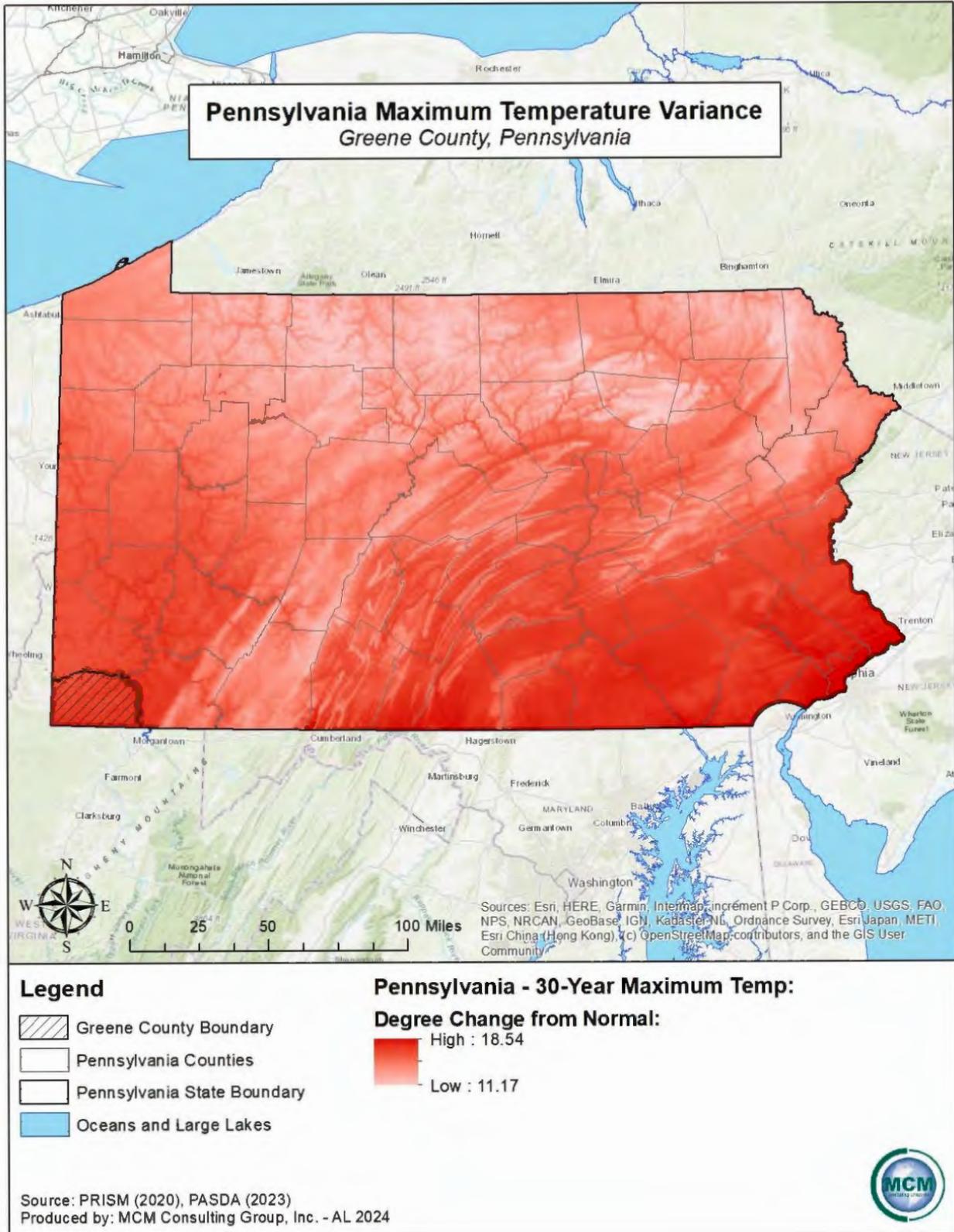
Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 18 - Average Minimum Temperature Trends for Pennsylvania



Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 19 - Average Maximum Temperature Trends for Pennsylvania



Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.3.4. Flooding, Flash Flooding, and Ice Jam Flooding

4.3.4.1 Location and Extent

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. Flash flooding is usually the result of heavy, localized precipitation falling in a short period of time over a given location, often in mountain streams and mountainous regions, and in urban areas where much of the ground is covered in impervious surfaces. Flash floods are relatively common in Greene County and the severity of those flood events is dependent upon a combination of creek, stream, and river basin topography and physiography, hydrology, precipitation, and weather patterns. Present soil conditions, the degree of vegetative clearing, and the presence of impervious cover must also be considered when determining the severity of a flood or flash flood event.

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 forms of flooding can damage infrastructure.

Floodplains are lowlands adjacent to rivers, streams, and creeks that are subject to recurring floods. The size of the floodplain is described by the recurrence interval of a given flood event. 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 10% chance of occurring in a given year is smaller than a floodplain associated with a flood that has a 0.2% chance of occurring.

The National Flood Insurance Program (NFIP) publishes digital flood insurance rate maps (DFIRMs). These maps identify the 1% annual chance flood area. The special flood hazard area (SFHA) and base flood elevations (BFE) are developed from the 1% annual chance flood event as seen in *Figure 20 – Flooding and Floodplain Diagram*. Structure located within the SFHA have a 26% chance of flooding in a thirty-year period. The SFHA serves as the primary regulatory boundary used by FEMA, the Commonwealth of Pennsylvania, and the Greene County local government. Federal floodplain management regulations and mandatory flood insurance purchase requirements apply to the following high-risk special flood hazard areas in *Table 20 – Flood Hazard High Risk Zones*. Appendix D of this hazard mitigation plan includes a flooding vulnerability map for each municipality in Greene County with vulnerable structures and community lifeline facilities identified using the most current DFIRM data for Greene County.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Past flooding events have been primarily caused by heavy rains, which cause small creeks and streams to overflow their banks, often leading to road closures. Flooding poses a threat to community lifeline facilities, agricultural areas, and those who reside or conduct business in the floodplain. The most significant hazard exists for facilities in the floodplain that process, use, or store hazardous materials. A flood could potentially release and transport hazardous materials throughout the area. Most flood damage to a property and structure located in the floodplain is caused by water exposure to the interior, high velocity water, and debris flow.

Figure 20 - Flooding and Floodplain Diagram

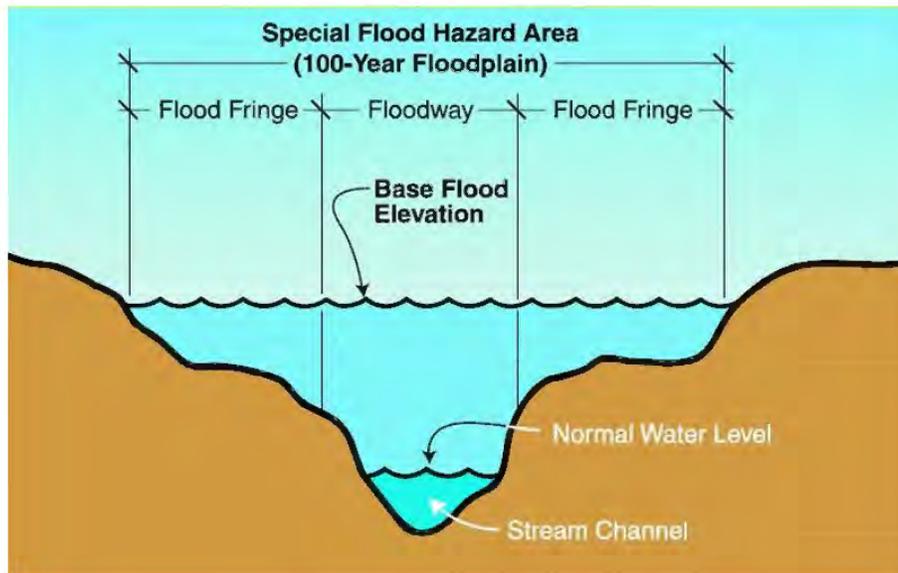


Table 20 - Flood Hazard High Risk Zones

Flood Hazard High Risk Zones	
Zone	Description
A	Areas subject to inundation by the 1% annual chance flood event. Because detailed hydraulic analysis has not been performed, no base flood elevations or flood depths are shown.
AE	Areas subject to inundation by the 1% annual chance flood event determined by detailed methods. BFEs are shown within these zones.
AH	Areas subject to inundation by the 1% annual chance shallow flooding (usually areas of ponding) where average depths are 1 – 3 feet. BFEs derived from detailed hydraulic analysis are shown in this zone.
AO	Areas subject to inundation by the 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are 1 – 3 feet. Average flood depths derived from detailed hydraulic analysis are shown within this zone.
AR	Areas that result from the decertification of a previously accredited flood protection system that is determined to be in the process of being restored to provide base flood protection.

Source: FEMA, 2017

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.3.4.2 Range of Magnitude

The Monongahela River Basin has caused significant flooding in Greene County, specifically on the following streams, creeks, and their tributaries:

- Monongahela River
 - South Fork Ten Mile Creek
 - Browns Creek
 - Dunkard Creek
 - Whiteley Creek

Several factors determine the severity of floods, including rainfall intensity and duration, topography, ground cover, and the rate of snowmelt. Water runoff is greater in areas with steep slopes and little to no vegetative ground cover. The mountainous terrain of Greene County can cause more severe floods as runoff reaches receiving water bodies more rapidly over steep terrain. This is of particular concern for areas along steep slopes and on the edges of valleys throughout Greene County.

Urbanization typically results in the replacement of vegetative ground cover with impermeable surfaces like asphalt and concrete, increasing the volume of surface runoff and stormwater, particularly in areas with poorly planned stormwater drainage systems. A large amount of rainfall over a short time span can cause flash flood events. Flash floods can occur very quickly and with little warning. A flash flood can also be deadly because of the rapid rise in water levels and devastating flow velocities. The more developed areas in the county can easily be susceptible to flash floods because of the significant presence of impervious surfaces, such as streets, sidewalks, parking lots, and driveways. Additionally, small amounts of rain can cause floods in locations where the soil is still frozen, saturated from a previous wet period or if the area is largely covered in impermeable surfaces such as parking lots, paved roadways, and other developed areas. The county occasionally experiences intense rainfall from tropical storms in late summer and early fall, which can potentially cause flooding as well.

Severe flooding can cause injuries and deaths and can have long-term impacts on the health and safety of citizens. Severe flooding can also result in significant property damage, potentially disrupting the regular function of community lifeline facilities and can have widespread negative effects on local economies. Industrial, commercial, and public infrastructure facilities can become inundated with flood waters, threatening the continuity of government and business. The vulnerable populations must be identified and located in flooding situations, as they are often home bound. Mobile homes and manufactured structures are especially vulnerable to high water levels. Flooding can have significant environmental impacts when the flood water releases and/or transports hazardous materials.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Severe flooding also comes with secondary effects that could have long lasting impacts on the population, economy, and infrastructure within Greene County. Power failures are the most common secondary effect associated with flooding. Coupled with a shortage of critical services and supplies, power failures could cause a public health emergency. Community lifelines, such as sewage and water treatment facilities, could fail, causing sewage overflows and the contamination of groundwater and drinking water. Flooding also has the potential to trigger cascading hazards, such as landslides, hazardous material spills, and dam failures.

The maximum threat of flooding for Greene County is estimated by looking at the potential loss data and repetitive loss data, both analyzed in the risk assessment section of the hazard mitigation plan. In these cases, the severity and frequency of damage can result in permanent population displacement, and businesses may close if they are unable to recover from the disaster.

Estimation of potential loss is completed through FEMA’s HAZUS software. A level two HAZUS scenario was performed for the entirety of Greene County. The FEMA Global Flood Risk Report and other reports generated by the software at the end of the scenario were utilized to estimate the amount of damage and loss from a flood. The total building loss for a 100-year flood based on a HAZUS level two scenario is displayed in *Table 21 – HAZUS Building Loss Figures*. The total business interruption values occurring from a proposed 100-year flood based on FEMA HAZUS data is illustrated in *Table 22 – HAZUS Business Interruption Economic Loss Figures*. *Figure 21 – Loss by Occupancy Type* illustrates the breakdown of economic losses by either residential, commercial, industrial, or other use type.

Table 21 - HAZUS Building Loss Figures

HAZUS Building Economic Loss Figures					
	Residential	Commercial	Industrial	Other	Total
Building:	\$31,080,000.00	\$6,240,000.00	\$1,720,000.00	\$1,580,000.00	\$40,620,000.00
Content:	\$13,790,000.00	\$17,500,000.00	\$3,620,000.00	\$7,420,000.00	\$42,330,000.00
Inventory:	\$0.00	\$320,000.00	\$510,000.00	\$30,000.00	\$860,000.00
Subtotal:	\$44,870,000.00	\$24,060,000.00	\$5,850,000.00	\$9,030,000.00	\$83,810,000.00
Source: HAZUS, 2024					

Table 22 - HAZUS Business Interruption Economic Loss Figures

HAZUS Business Interruption Economic Loss Figures					
	Residential	Commercial	Industrial	Other	Total
Income:	\$190,000.00	\$12,750,000.00	\$180,000.00	\$2,280,000.00	\$15,400,000.00
Relocation:	\$5,630,000.00	\$2,040,000.00	\$60,000.00	\$950,000.00	\$8,680,000.00

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

HAZUS Business Interruption Economic Loss Figures					
	Residential	Commercial	Industrial	Other	Total
Rental Income:	\$1,760,000.00	\$1,570,000.00	\$10,000.00	\$140,000.00	\$3,480,000.00
Wage:	\$480,000.00	\$14,410,000.00	\$140,000.00	\$28,330,000.00	\$43,360,000.00
Subtotal:	\$8,060,000.00	\$30,770,000.00	\$390,000.00	\$31,700,000.00	\$70,920,000.00
Source: HAZUS, 2024					

Figure 21 - Loss by Occupancy Type



Although floods can cause deaths, injuries, and damage to property, they 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 sediments which improves soil fertility. However, human development often disrupts natural riparian buffers by changing land use and land cover, and the introduction of chemical or biological contaminants that often accompany human presence and can contaminate habitats after flood events.

4.3.4.3 Past Occurrence

Greene County has experienced numerous flooding, flash flooding, and ice jam events in the past. The flooding and flash flooding were caused by a variety of heavy storms, inclement weather, tropical storms, and other issues. A summary of recent flood event history for Greene County from January 2000 to August 2024 is found in *Table 23 – Past Flood and Flash Flood Events*. Details of each event can be found in NOAA’s National Center for Environmental Information (NCEI) database.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Table 23 - Past Flood and Flash Flood Events

Past Flood and Flash Flood Events			
Event Location	Event Date	Event Type	Property Damage Estimate
Greene County (Entire County)	02/14/2000	Flash Flood	\$10,000.00
Greene County (Entire County)	02/18/2000	Flash Flood	\$20,000.00
Greene County (Entire County)	08/06/2000	Flash Flood	\$0.00
Greene County (Southeast)	05/18/2001	Flash Flood	\$0.00
Holbrook	07/05/2001	Flash Flood	\$0.00
Greene County (Entire County)	03/26/2002	Flood	\$5,000.00
Gray Township	06/06/2002	Flash Flood	\$10,000.00
Waynesburg Borough	06/13/2002	Flash Flood	\$0.00
Brave	07/23/2002	Flash Flood	\$0.00
Nineveh	02/23/2003	Flash Flood	\$0.00
Clarksville Borough	02/23/2003	Flash Flood	\$0.00
Aleppo Township	05/09/2003	Flash Flood	\$0.00
Waynesburg Borough	05/10/2003	Flash Flood	\$0.00
Kirby	05/10/2003	Flash Flood	\$5,000.00
Monongahela Township	07/08/2003	Flash Flood	\$15,000.00
Aleppo Township	08/27/2003	Flash Flood	\$0.00
Greensboro Borough	08/27/2003	Flash Flood	\$0.00
Greensboro Borough	08/29/2003	Flash Flood	\$0.00
Waynesburg Borough	11/19/2003	Flash Flood	\$250,000.00
Greene County (Entire County)	02/06/2004	Flood	\$0.00
Greene County (Entire County)	04/13/2004	Flood	\$0.00
Waynesburg Borough	05/11/2004	Flash Flood	\$0.00
Perry Township	05/21/2004	Flash Flood	\$0.00
Greene County (Entire County)	09/17/2004	Flood	\$6,140,000.00
Greene County (Entire County)	01/05/2005	Flood	\$15,000.00
Greene County (Entire County)	01/11/2005	Flood	\$0.00
Greene County (Entire County)	03/28/2005	Flood	\$0.00
Waynesburg Borough	12/13/2007	Flood	\$5,000.00
Jefferson Township	06/16/2008	Flash Flood	\$50,000.00
Greene County (Entire County)	05/13/2011	Flood	\$30,000.00
Cumberland Township	07/04/2011	Flood	\$10,000.00
Waynesburg Borough	07/22/2011	Flood	\$10,000.00
Gilmore Township	03/04/2015	Flood	\$0.00
Washington Township	07/06/2015	Flood	\$0.00
Rices Landing Borough	06/16/2016	Flood	\$2,000.00
Cumberland Township	06/16/2016	Flash Flood	\$8,000.00
Aleppo Township	12/18/2016	Flood	\$2,000.00

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Past Flood and Flash Flood Events			
Event Location	Event Date	Event Type	Property Damage Estimate
Jefferson Township	06/23/2017	Flash Flood	\$0.00
Franklin Township	06/23/2017	Flash Flood	\$0.00
Jefferson Township	07/28/2017	Flash Flood	\$1,500.00
Washington Township	07/29/2017	Flood	\$0.00
Jefferson Township	07/29/2017	Flood	\$0.00
Greene County (Entire County)	07/29/2017	Flash Flood	\$0.00
Center Township	01/12/2018	Flood	\$0.00
Greene County (Entire County)	04/03/2018	Flood	\$0.00
Cumberland Township	09/09/2018	Flood	\$1,000.00
Center Township	09/09/2018	Flood	\$1,000.00
Center Township	02/08/2019	Flood	\$0.00
Cumberland Township	02/08/2019	Flood	\$0.00
Waynesburg Borough	02/08/2019	Flood	\$0.00
Perry Township	07/29/2017	Flash Flood	\$5,000.00
Center Township	06/21/2021	Flood	\$0.00
Whiteley Township	01/03/2023	Flood	\$0.00
Center Township	04/01/2024	Flood	\$5,000.00
Jackson Township	04/03/2024	Flood	\$1,000.00
Waynesburg Borough	04/03/2024	Flood	\$0.00
Greene County (Entire County)	04/11/2024	Flash Flood	\$3,000.00
Center Township	04/12/2024	Flash Flood	\$1,000.00
Total:			\$6,605,500.00
Source: NCEI NOAA, 2024			
*Property Damage Values are estimated and are not exact figures. Data from NCEI.			

The National Flood Insurance Program (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. The hazard mitigation assistance (HMA) definition of a repetitive loss property is a structure covered by a contract for flood insurance made available under the NFIP that has incurred flood-related damage on two occasions, in which the cost of repair, on average, equaled or exceeded 25% of the market value of the structure at the time of each such flood event; at the time of the second incidence of flood-related damage, the contract for flood insurance contains increased cost of compliance coverage. *Table 24 – Repetitive Loss Properties* illustrates the communities that have repetitive loss properties, the total building payments, the contents payments, and the number of losses and properties. There are twenty-nine repetitive loss properties in Greene County. *Table 25 – Summary of Type of Repetitive Loss Properties by Municipality* illustrates the breakdown of type of repetitive loss properties in Greene County.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

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. *Table 26 – Severe Repetitive Loss Properties* illustrates the communities within Greene County that have severe repetitive loss properties, the total building payments, the contents payments, and the number of losses and properties. The data used in the table is based on data provided by PEMA.

Most municipalities in Greene County participate in the NFIP. Information on each participating municipality can be found in *Table 27 – Municipal NFIP Policies & Vulnerability*.

Table 24 - Repetitive Loss Properties

Repetitive Loss Properties						
Community Name	Community Number	Cumulative Building Payment	Cumulative Contents Payment	Sum of Total Paid	Losses	Properties
Aleppo Township	421667	\$82,241.30	\$13,522.64	\$95,763.94	3	1
Center Township	421668	\$7,481.52	\$2,026.38	\$9,507.90	2	1
Center Township	421668	\$11,961.27	\$0.00	\$11,961.27	2	1
Center Township	421668	\$20,041.34	\$0.00	\$20,041.34	2	1
Center Township	421668	\$12,814.70	\$3,091.61	\$15,906.31	2	1
Cumberland Township	421188	\$12,124.59	\$1,592.83	\$13,717.42	5	1
Franklin Township	422595	\$7,739.11	\$1,801.91	\$9,541.02	2	1
Franklin Township	422595	\$39,970.25	\$0.00	\$39,970.25	4	1
Franklin Township	422595	\$20,346.76	\$0.00	\$20,346.76	2	1
Franklin Township	422595	\$25,278.49	\$0.00	\$25,278.49	2	1
Franklin Township	422595	\$24,637.32	\$0.00	\$24,637.32	2	1
Franklin Township	422595	\$31,798.71	\$25,000.00	\$56,798.71	2	1
Gilmore Township	421672	\$17,209.07	\$210.00	\$17,419.07	4	1

**Greene County, Pennsylvania
2025 Hazard Mitigation Plan**

Repetitive Loss Properties						
Community Name	Community Number	Cumulative Building Payment	Cumulative Contents Payment	Sum of Total Paid	Losses	Properties
Washington Township	421678	\$33,838.59	\$25,364.37	\$59,202.96	2	1
Wayne Township	421679	\$3,821.13	\$205.00	\$4,026.13	2	1
Wayne Township	421679	\$11,309.68	\$5,834.37	\$17,144.05	2	1
Wayne Township	421679	\$5,303.22	\$0.00	\$5,303.22	2	1
Waynesburg Borough	420480	\$43,539.38	\$22,494.00	\$66,033.38	3	1
Waynesburg Borough	420480	\$64,602.39	\$21,000.00	\$85,602.39	3	1
Waynesburg Borough	420480	\$34,285.22	\$0.00	\$34,285.22	3	1
Waynesburg Borough	420480	\$6,949.11	\$0.00	\$6,949.11	3	1
Waynesburg Borough	420480	\$129,397.60	\$0.00	\$129,397.60	3	1
Waynesburg Borough	420480	\$26,661.40	\$0.00	\$26,661.40	3	1
Waynesburg Borough	420480	\$10,781.88	\$0.00	\$10,781.88	2	1
Waynesburg Borough	420480	\$19,876.26	\$0.00	\$19,876.26	2	1
Waynesburg Borough	420480	\$19,176.26	\$0.00	\$19,176.26	2	1
Waynesburg Borough	420480	\$5,818.15	\$0.00	\$5,818.15	2	1
Waynesburg Borough	420480	\$14,990.04	\$0.00	\$14,990.04	2	1
Waynesburg Borough	420480	\$20,000.00	\$0.00	\$20,000.00	2	1
Total:		\$763,994.74	\$122,143.11	\$886,137.85	72	29
Source: FEMA, 2024						

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Table 25 - Summary of Type of Repetitive Loss Properties by Municipality

Summary of Type of Repetitive Loss Properties by Municipality					
Municipality	Type				
	Non-Residential	2-4 Family	Single Family	Condo	Other Residential
Aleppo Township	1	0	0	0	0
Center Township	0	0	4	0	0
Cumberland Township	0	0	1	0	0
Franklin Township	3	0	4	0	0
Gilmore Township	0	0	1	0	0
Morris Township	1	0	0	0	0
Washington Township	1	0	1	0	0
Wayne Township	0	0	3	0	0
Waynesburg Borough	0	1	12	0	0
Source: FEMA, 2024					

Table 26 - Severe Repetitive Loss Properties

Severe Repetitive Loss Properties						
Community Name	Community Number	Cumulative Building Payments	Cumulative Contents Payments	Sum of Total Paid	Losses	Properties
Franklin Township	422595	\$57,936.18	\$26,739.08	\$84,675.26	5	1
Morris Township	421675	\$22,467.13	\$28,685.36	\$51,152.49	4	1
Washington Township	421678	\$56,211.12	\$0.00	\$56,211.12	5	1
Waynesburg Borough	420480	\$39,476.44	\$0.00	\$39,476.44	2	1
Total:		\$176,090.87	\$55,424.44	\$231,515.31	16	4
Source: FEMA, 2024						

Table 27 - Municipal NFIP Policies & Vulnerability

Municipal Participation in the National Flood Insurance Program			
Municipal Name	Community Number	Initial FHBM	Latest Mapping Dates
Aleppo Township	421667	12/27/1974	10/16/2015
Carmichaels Borough	420475	06/28/1974	10/16/2015
Center Township	421668	10/25/1974	10/16/2015
Clarksville Borough	420476	11/15/1974	10/16/2015

***Greene County, Pennsylvania
2025 Hazard Mitigation Plan***

Municipal Participation in the National Flood Insurance Program			
Municipal Name	Community Number	Initial FHBM	Latest Mapping Dates
Cumberland Township	421188	08/30/1974	10/16/2015
Dunkard Township	422431	01/10/1975	10/16/2015
Franklin Township	422595	01/03/1975	10/16/2015
Freeport Township	422432	01/03/1975	10/16/2015
Gilmore Township	422433	01/10/1975	10/16/2015
Gray Township	421669	12/20/1974	10/16/2015
Greene Township	421670	01/17/1975	10/16/2015
Greensboro Borough	420477	11/08/1974	10/16/2015
Jackson Township	421671	12/20/1974	10/16/2015
Jefferson Borough	N/A	N/A	N/A
Jefferson Township	421672	12/20/1974	10/16/2015
Monongahela Township	421673	07/11/1975	08/24/1984
Morgan Township	421674	11/01/1974	10/16/2015
Morris Township	421675	01/17/1975	10/16/2015
Perry Township	422434	01/10/1975	10/16/2015
Rices Landing Borough	420479	11/08/1974	10/16/2015
Richhill Township	421676	01/17/1975	10/16/2015
Springhill Township	421677	04/11/1975	10/16/2015
Washington Township	421678	11/01/1974	10/16/2015
Wayne Township	421679	12/27/1974	10/16/2015
Waynesburg Borough	420480	06/28/1974	10/16/2015
Whiteley Township	421680	12/27/1974	10/16/2015
Source: FEMA, 2024			
Note: FHBM: Flood Hazard Boundary Map			

4.3.4.4 Future Occurrence

Flooding is a frequent problem throughout the Commonwealth of Pennsylvania. Greene County will certainly be impacted by flooding events in the future, as Greene County experiences some degree of flooding annually. The threat of flooding is compounded in the late winter and early spring months, as melting snow can overflow streams, creeks, and tributaries, increasing the amount of groundwater, clogging stormwater culverts and bridge openings. The NFIP recognizes the 1% annual chance flood, also known as the base flood of a one-hundred-year 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% chance of occurring in a given year or is likely once every one-hundred years. The digital flood insurance maps (DFIRMs) are used to identify areas subject to the 1% annual chance of flooding.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

A property’s vulnerability to a flood is dependent upon its location in the floodplain. Properties along the banks of a waterway are the most vulnerable. The property within the floodplain is broken into sections depending on its distance from the waterway. The ten-year flood zone has a 10% chance of being flooded every year. However, this label does not mean that this area cannot flood more than once every ten years. This label simply designates the probability of a flood of this magnitude every year. Further away from this area is the fifty-year floodplain. This area includes all of the ten-year floodplain plus additional property. The probability of a flood of this magnitude occurring during a one-year period is 2%. A summary of flood probability is shown in *Table 28 – Flood Probability Summary*.

Table 28 - Flood Probability Summary

Flood Probability Summary	
Flood Recurrence Intervals	Annual Chance of Occurrence
10-year	10.00%
50-year	2.00%
100-year	1.00%
500-year	0.20%
Source: FEMA, 2009	

The future occurrences of flooding, flash flooding, and ice jam flooding in Greene County are expected to increase due to the rate of climate change in the Commonwealth of Pennsylvania, and the world. Climate change will include ocean temperature rise, which result in more intense hurricane and tropical storm seasons in the Atlantic Ocean. This intensity could result in an increase in the number of hurricanes and tropical storms that could impact Pennsylvania and Greene County. These hurricanes and tropical storms could result in a large volume of precipitation occurring over a short period of time, resulting in a flood or flash flood event. It is important to note that these impacts are the secondary result of other hazards, increased by climate change, that could result in flooding events.

4.3.4.5 Vulnerability Assessment

Riverine and Stream Flooding

Greene County is vulnerable to stream and river flooding on an annual basis. Flooding puts the entire population at some level of risk, whether through flooding of homes, businesses, places of employment, roadways, sewers, or water infrastructure. Flooding can cause significant power outages and poor road conditions that can lead to heightened transportation accident risk.

County community lifelines are the most vulnerable buildings and services when riverine and stream flooding is considered. Community lifeline facilities are facilities that, if damaged, would

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

present an immediate threat to life, public health, and safety. Facilities that use and store hazardous materials pose a potential threat to the environment during flooding events if flooding causes a leak, inundation, or equipment failure. Appendix D of this hazard mitigation plan includes a flooding vulnerability map for each municipality in Greene County, with vulnerable structures and community lifeline facilities that are located within the special flood hazard area.

Table 29 – Expected Damage to Essential Facilities (HAZUS) illustrates the estimated damage levels to certain essential facilities based on classifications in the HAZUS General Building Stock. There is one facility that is estimated to be at least moderately damaged by a 100-year flooding event in the HAZUS Level Two scenario that was completed for Greene County. That facility is a fire station. Plans for such an event, and the damage that would result to essential facilities, must be in place to successfully mitigate the potential disruption to community lifeline facilities.

Table 29 - Expected Damage to Essential Facilities (HAZUS)

Expected Damage to Essential Facilities				
Classification	Number of Facilities			
	Total:	At Least Moderate:	At Least Substantial:	Loss of Use:
Emergency Operations Center	1	0	0	0
Fire Stations	18	1	0	1
Hospitals	1	0	0	0
Police Stations	5	0	0	0
Schools	20	0	0	0

Table 30 - County Structures Within Special Flood Hazard Area shows the number of site structure address points within the Special Flood Hazard Area as well as the community lifeline facilities. This information was compiled using the Special Flood Hazard Area and GIS data provided by the Greene County GIS Department.

Table 30 - County Structures Within Special Flood Hazard Area

County Structures Within Special Flood Hazard Area		
Municipality	Site Structure Address Points Within Flood Area	Community Lifeline Facilities within Flood Area
Aleppo Township	29	0
Carmichaels Borough	6	0
Center Township	76	0
Clarksville Borough	0	0
Cumberland Township	55	0
Dunkard Township	42	0
Franklin Township	80	0
Freeport Township	31	0
Gilmore Township	21	0

**Greene County, Pennsylvania
2025 Hazard Mitigation Plan**

County Structures Within Special Flood Hazard Area		
Municipality	Site Structure Address Points Within Flood Area	Community Lifeline Facilities within Flood Area
Gray Township	8	0
Greene Township	9	0
Greensboro Borough	63	0
Jackson Township	15	0
Jefferson Borough	0	0
Jefferson Township	56	0
Monongahela Township	69	4
Morgan Township	53	0
Morris Township	22	1
Perry Township	96	0
Rices Landing Borough	22	0
Richhill Township	31	0
Springhill Township	39	0
Washington Township	29	0
Wayne Township	75	0
Waynesburg Borough	60	0
Whiteley Township	11	0
Totals:	998	5

Table 31 – *Community Lifeline Facilities Additional Information* illustrates the additional information including the community lifeline, the facility name, and the municipality that falls within the special flood hazard area for Greene County. This information was compiled using Greene County’s GIS information with the assistance of the Greene County GIS Department.

Table 31 - Community Lifeline Facilities Additional Information

Community Lifeline Facilities Additional Information		
Community Lifeline:	Facility Name:	Municipality:
Safety and Security	Greensboro Borough and Monongahela Township VFD	Monongahela Township
Energy	Hatfield’s Ferry Power Station	
Energy	Gray’s Landing L&D Hydroelectric Project	
Energy	Hatfield’s Ferry Power Station	Morris Township
Food, Hydration, Shelter	Hopkins Store	

In addition to the items listed above, there are six properties that are considered historic and cultural for Greene County that are registered with the National Register of Historic Place that are in the Special Flood Hazard Area. These properties are the John Minor Crawford House, the

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Glassworks – Core House, the Glassworks – Gabler House, the James Jones House, the Reppert-Gabler House, and the W.A. Young and Sons Foundry and Machine Shop. These locations are at an increased risk of flooding due to annual flood events unless mitigated.

Flash Flooding

Flash flooding is a common occurrence in Greene County and can occur anywhere in the county. A large portion of flash flooding occurs in populated areas that have increased impervious ground cover. During the risk assessment process, numerous resources were utilized to determine flash flooding locations in Greene County. Municipalities were asked to identify locations within the municipality that were prone to frequent flash flooding. The National Climatic Data Center was also queried to determine flash flood vulnerable areas. This data is reflected in *Table 23 – Past Flood and Flash Flood Events* above.

Locations that are identified as vulnerable to flash flooding in Greene County are as follows:

- Aleppo Township
- Greensboro Borough
- Center Township
- Waynesburg Borough

Although the above locations were identified as vulnerable areas in Greene County, they are not the only locations that are vulnerable to flash flooding. The Greene County Hazard Mitigation Team will continue to work with municipalities to identify vulnerable flash flooding locations and identify vulnerable populations and community lifeline facilities.

Municipalities with an increased risk to flooding, flash flooding, and ice jam flooding (due to the intersection with the Special Flood Hazard Area):

- Aleppo Township
- Carmichaels Borough
- Center Township
- Clarksville Borough
- Cumberland Township
- Dunkard Township
- Franklin Township
- Freeport Township
- Gilmore Township
- Gray Township
- Greene Township
- Greensboro Borough
- Jackson Township
- Jefferson Township
- Monongahela Township
- Morgan Township
- Morris Township
- Perry Township
- Rices Landing Borough
- Richhill Township
- Springhill Township
- Washington Township
- Wayne Township
- Waynesburg Borough
- Whiteley Township

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

All of the population of Greene County, including the unserved and the underserved populations, are at an increased vulnerability to flooding hazards. Most municipalities in Greene County directly interface with the regulatory flood boundaries in county. Unserved and underserved populations have the potential to be more vulnerable to flooding hazards in Greene County. Homeless, unsheltered, and displaced people would not have housing or homes to use as a shelter in the event of a flooding hazard. Those populations also may not have easy access to warning systems or alerts for flash flooding hazards. All of the county could be at increased vulnerability, specifically any populations located on the Monongahela River and South Fork Ten Mile Creek.

Systems in Greene County are at increased vulnerability to flooding hazards. All of the utilities in Greene County could be adversely impacted by very specific flooding and flash flooding events. Utilities may be damaged or destroyed from a flooding event, or from a cascading hazard from flooding events. Major flooding could cause an issue in the delivery of services, including electricity, to the citizens and residents of Greene County.

While flooding does not typically adversely affect natural areas, a comprehensive vulnerability assessment was completed for natural areas in Greene County, including public recreation areas, state parks, state game lands, and any other outdoor or natural area resources.

The following natural areas directly intersected with areas of the Special Flood Hazard Area (SFHA) for Greene County:

- State game land 179
- State game land 223
- State game land 302
- Ryerson Station State Park

Not all of these locations will be impacted by every flooding event in Greene County, but at least some of the areas listed above will be impacted due to their close proximity to the Special Flood Hazard Area (SFHA).

Impacts of flooding, flash flooding, and ice jam flooding can also be influenced by population change. As seen in *Table 3 – Population Change in Greene County*, eight municipalities have experienced population growth between the 2010 decennial census and the 2020 decennial census. Based on this information, it can be speculated that these eight municipalities have an increased vulnerability to flooding, flash flooding, and ice jam flooding hazards, since 2010. This increased vulnerability is due to more potential development and that development encroaching on high vulnerability areas for Greene County, including near the Special Flood Hazard Area.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Land use is a factor that has the potential to impact the vulnerability to flooding, flash flooding, and ice jam flooding in Greene County. Land use, in the form of a built environment, such as residential and commercial expansion, especially in the Special Flood Hazard Area or areas directly adjacent, could increase the severity impact of these hazards. The change of land use from areas of easy infiltration of groundwater to impervious surfaces can increase the severity and the frequency of flash floods, increasingly in areas where flash floods have occurred in the past. An influx of people, commercial enterprises, and infrastructure development also increases the vulnerability of areas to flooding, flash flooding, and ice jam flooding.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.3.5. Hurricane, Tropical Storm

4.3.5.1 Location and Extent

Greene County does not have any open-ocean coastline areas. However, the impacts from coastal storms such as tropical storms and hurricanes can expand inland. Tropical depressions are cyclones with maximum sustained winds of less than 39 miles per hour (mph). The system becomes a tropical storm when the maximum sustained winds reach between 39 and 74 miles per hour. When wind speeds exceed 74 mph, the system is considered a hurricane. Tropical storms impacting Greene County develop in tropical or sub-tropical waters found in the Atlantic Ocean, Caribbean Sea, or Gulf of Mexico. Another type of tropical storms is the nor'easter, which is a large cyclone that rotates clockwise and is typically associated with the Atlantic Ocean and the East Coast of the United States between North Carolina and Massachusetts. The name nor'easter comes from the direction that the strongest winds typically blow from the cyclone.

While Greene County is located about 265 miles inland of the East Coast of the United States, tropical storms can track inland and cause heavy rainfall and strong winds. Greene County is located inland of the East Coast region, designated by FEMA, as being Hurricane-Susceptible (see *Figure 22 – Pennsylvania Wind Zones*). Greene County falls within wind zones three and four as shown in *Figure 22 – Pennsylvania Wind Zones*. Zones three and four suggests that shelters and critical facilities should be able to withstand winds that range up to 160 MPH. Tropical storms and hurricanes are regional and seasonal events that can impact very large areas that are hundreds to thousands of miles across over the life of the storm. Hurricane and tropical storm seasons are typically from June to November. All communities within Greene County are equally subject to the impacts of hurricanes and tropical storms that track near the county. Areas in Greene County which are subject to flooding, wind, and winter storm damage are particularly vulnerable.

4.3.5.2 Range of Magnitude

The impact tropical storms or hurricane events have on an area is typically measured in terms of wind speed. Flood damage results from intense precipitation and wind, typically from coastal storms, which impact Greene County. Expected damage from hurricane force winds is measured using the Saffir-Simpson Scale (*Table 32 – Saffir-Simpson Scale*). The Saffir-Simpson Scale categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure, and storm surge potential. Categories three, four, and five are classified as “major” hurricanes, but category one and two storms can contain potential significant storm surge. Category one storms result in very dangerous winds with some damage, while category two storms result in extremely dangerous winds with extensive damage. Category three storms result in devastating damage and category four/five storms result in catastrophic damage. Although major hurricanes comprise only 20% of all tropical cyclones making landfall, they account for

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Table 32 - Saffir-Simpson Hurricane Scale

Saffir-Simpson Hurricane Scale		
Category	Wind Speed	
	mph	knots
5	157+	135+
4	131-155	114-134
3	111-130	96-113
2	96-110	84-95
1	74-95	65-83
Non-Hurricane Classifications		
Tropical Storm	39-73	34-64
Tropical Depression	0-38	0-33

over 70% of the damage in the United States. While hurricanes can cause high winds and associated impacts, it is also important to recognize the potential for flooding events during hurricanes, tropical storms, and nor'easters. In Greene County wind impacts from tropical events include downed trees and utility poles to cause utility interruptions. Mobile homes, because they may not be well-anchored, have a greater potential to be impacted by high winds. Additionally, these storms can produce high volumes of rainfall that cause flash flooding which can be followed by stream and riverine flooding. The risk assessment and associated impact for flooding events is included in Section 4.3.4.

4.3.5.3 Past Occurrence

Table 33 - History of Coastal Storms Impacting Greene

County lists all coastal storms that have impacted Greene County from 1888 to 2021 *Figure 23 – Historic Tropical Storms/Hurricanes in Pennsylvania* identifies some past hurricanes that had an inland path through Pennsylvania. Hurricane Agnes was a severe coastal storm event in June 1972 that impacted Greene County after making first landfall as a hurricane near Florida, Agnes weakened and exited back into the Atlantic off the North Carolina coast. The storm moved along the coast and made a second landfall near New York City as a tropical storm and merged with an extra-tropical low-pressure system over Pennsylvania. This brought extremely heavy rains to Pennsylvania that caused major flooding. Pennsylvania incurred \$2.8 billion in damages. There were fifty storm related deaths statewide. However, in Greene County, the most significant effects of Hurricane Agnes were due to extensive property and infrastructural damage. Agnes was only a category one hurricane but dropped more than fifteen inches of rain in the northeastern United States. Pennsylvania received the greatest amount of flood damage.

Hurricane Irene and Tropical Storm Lee impacted and caused damage to Greene County. Although, they were separate events, Hurricane Irene and Tropical Storm Lee together caused significant rainfall in Greene County due to how close the events took place. First, Tropical Storm Lee caused significant flooding in the central and eastern counties in Pennsylvania with wind damage that caused utility outages for 1-2 days. Then, Hurricane Irene caused additional flooding with utility interruptions for 5-8 days. Many flooding events took place in the county during this time.

Hurricane Sandy was another coastal storm event that caused significant damage to Greene County. Sandy caused significant wind damage and utility interruptions led to a fourteen-day disaster declaration. Hurricane Sandy ranks among the most damaging coastal storms to ever impact Greene County. Many areas of the county were without power for an extended period.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

The damage in Greene County had an assessed public assistance per capita cost of \$2.49. The total statewide public assistance cost was estimated at \$20,146,356.00.

Table 33 - History of Coastal Storms Impacting Greene County

History of Coastal Storms Impacting Greene County			
Year	Name	Speed (in knots) at time of county impact	Category at time of county impact
1957	Audrey	45	Extratropical Storm
1959	Gracie	25	Extratropical Storm
1963	Unnamed	25	Tropical Depression
1979	Bob	20	Tropical Depression
1979	Claudette	15	Tropical Depression
1979	Frederic	35	Tropical Storm
1979	David	35	Tropical Storm
1981	Bret	20	Tropical Depression
1985	Bob	25	Tropical Depression
1989	Hugo	40	Tropical Storm
1994	Beryl	15	Tropical Depression
1995	Erin	20	Tropical Depression
1995	Opal	40	Extratropical Depression
1996	Fran	30	Tropical Depression
1999	Dennis	20	Tropical Depression
2002	Isidore	20	Tropical Depression
2003	Isabel	50	Tropical Storm
2004	Frances	25	Extratropical Storm
2013	Sandy	35	Extratropical Storm
2015	Bill	15	Tropical Depression
2017	Cindy	25	Tropical Depression
2017	Nate	25	Extratropical Storm
2018	Florence	25	Extratropical Storm
2020	Bertha	20	Extratropical Storm
2021	Fred	20	Tropical Depression
2021	Ida	30	Extratropical Storm
Source: NOAA, 2024			

4.3.5.4 Future Occurrence

Although hurricanes and tropical storms can cause flood events consistent with 100 and 500-year flood levels, the probability of occurrence of hurricanes and tropical storms is measured relative to wind speed. *Table 34 – Annual Probability of Wind Speeds* shows the annual probability of winds that reach the strength of tropical storms and hurricanes in Greene County and the surrounding areas based on a sample period of forty-six years. According to FEMA, there is a very low probability each year that Greene County will experience winds from coastal storms

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

that could cause minimal to moderate damages (*Table 34 – Annual Probability of Wind Speeds*). The potential future impacts from a tropical storm or hurricane will be moderate. The probability of wind exceeding 118 mph is less than 0.0766% annually.

Table 34 - Annual Probability of Wind Speeds

Annual Probability of Wind Speeds (FEMA, 2000)		
Wind Speed (mph)	Saffir-Simpson Scale	Annual Probability of Occurrence (%)
45 - 77	Tropical Storms/Category 1 Hurricane	91.59
78 - 118	Category 1 to 2 Hurricanes	8.32
119 - 138	Category 3 to 4 Hurricanes	.0766
139 - 163	Category 4 to 5 Hurricanes	.0086
164 - 194	Category 5 Hurricanes	.00054
195 +	Category 5 Hurricanes	.00001
Source: FEMA, 2000		

There has been an increase in North Atlantic hurricane activity since the 1970s with locations of peak intensity tropical cyclones migrating poleward coinciding with tropics expansion. An index potential hurricane destructiveness suggests an increase over the past thirty years. Variability in tropical cyclone activity in the Atlantic is due to natural variability in ocean circulation, volcanic eruptions, and Saharan dust, as well as climate change resulting from greenhouse gases and sulfate aerosols.

Climate change is causing atmospheric temperatures to rise, which corresponds to a rise in ocean surface temperatures, resulting in warmer and moister conditions where tropical storms develop. However, the relationship between climate change and hurricanes can be complex due to the many other factors that are associated with hurricane development which include wind shear and air pollution. Warmer oceans store more energy and are capable of fueling stronger storms and it is projected that Atlantic hurricanes will become more intense and produce more precipitation as ocean surface temperatures rise. The storms associated with tropical storms/hurricanes can also linger around for a longer period of time in a given place due to the climate change which enhances destructive impacts in the future. Other possible connections of hurricanes in the near future related to climate change are the length of hurricane season and seeing more hurricanes earlier or later than usual hurricane season. There are expected to be more category four and five hurricanes in the Atlantic and the hurricane season may be elongated, all which impact the future of Greene County.

4.3.5.5 Vulnerability Assessment

The impacts of climate change are tangible and hazardous realities. Tropical storms tracking nearby Greene County can not only cause high winds, but also heavy rains to occur. A vulnerability assessment for hurricanes and tropical storms focusses on the impacts of flooding

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

and severe winds. Flooding associated from hurricanes/tropical storms can occur in areas throughout Greene County, which can cause damage to buildings and infrastructure. The assessment for flood-related vulnerability is addressed in Section 4.3.4.5 and a discussion of wind related vulnerability is addressed in Section 4.3.11.5. Due to the impact of hurricanes and tropical storms, the vulnerability for Greene County is high. Potential economic losses could include direct building losses and business interruption. Direct building loss is direct damage to any building or structure. Business interruption includes relocation, employee wage loss, expenses, income loss, etc. Greene County vulnerability level is high for direct building loss. The total direct building loss amount for Greene County equates to \$154,680,000.00. The total business interruption value for Greene County equates to \$70,870,000.00. Therefore, the vulnerability of direct building loss and business interruption is high.

As seen in *Table 3 – Population Change in Greene County*, eighteen of the twenty-six total municipalities in Greene County have experienced a population loss since the previous decennial census in 2010. However, eight municipalities saw minor total population growth over the same period. Based on this information, it can be speculated that these eight municipalities may have an increased vulnerability of hurricane and tropical storm conditions, since 2010, due to the increase in population.

Hurricanes and tropical storms may disproportionately affect underserved, unserved, and socially vulnerable populations, amplifying existing hardships. Fragile infrastructure in these areas is more prone to damage, which can hinder evacuation and rescue efforts. Limited access to resources exacerbates challenges during and after the storms, from securing safe shelter to obtaining essential supplies. Vulnerable communities often lack financial resilience, facing prolonged economic setbacks as local businesses may suffer.

Municipalities with increased risk to hurricane and tropical storm):

- Aleppo Township
- Carmichaels Borough
- Center Township
- Clarksville Borough
- Cumberland Township
- Dunkard Township
- Franklin Township
- Freeport Township
- Gilmore Township
- Gray Township
- Greene Township
- Greensboro Borough
- Jackson Township
- Jefferson Borough
- Jefferson Township
- Monongahela Township
- Morgan Township
- Morris Township
- Perry Township
- Rices Landing Borough
- Richhill Township
- Springhill Township
- Washington Township
- Wayne Township
- Waynesburg Borough
- Whiteley Township

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Land use is a factor that has the potential to impact hurricane and tropical storm severity. Land use, in the form of a built environment, such as residential expansion, can cause hurricane impact severity to increase. This impact severity increases because as the built environment expands and becomes more complex, the impact the event will have on that area also increases. This is due to an influx of people, infrastructure, and critical infrastructure and community lifelines in harm's way.

A hurricane or tropical storm has the potential to impact critical systems for the everyday operations of Greene County. This can include impacts to the transportation system, including major highways and transportation routes into and out of the county. There are primary areas of concern including Interstate 79 that runs through Greene County and close to the county seat of Waynesburg, PA. Also of specific concern is the small number of bridges that provided access to Fayette County across the Monongahela River. Specifically, there is a river crossing at Pennsylvania Route 21 near Carmichaels and Pennsylvania Route 88 near Point Marion could be impacted by a hurricane and tropical storm occurrence.

Utility systems are not immune to potential disruption from hurricane or tropical storm events, including the expected delay in restoring critical utility service to homes and businesses in Greene County. Wastewater and water treatment plant facilities are specifically designed near water areas, making them more susceptible to possible inundation during a hurricane or tropical storm event.

Hurricanes and tropical storms exert profound impacts on both natural and cultural areas. Ecologically, these intense weather events can result in habitat destruction, altering landscapes, and threatening biodiversity. Erosion and flooding may harm delicate ecosystems. Culturally, these storms endanger heritage sites, historic structures, and artifacts, eroding tangible, and intangible cultural elements. Sustainable recovery efforts must embrace an integrated approach, recognizing the interconnected vulnerability of natural, historical, and cultural landscapes to the formidable forces of hurricanes and tropical storms.

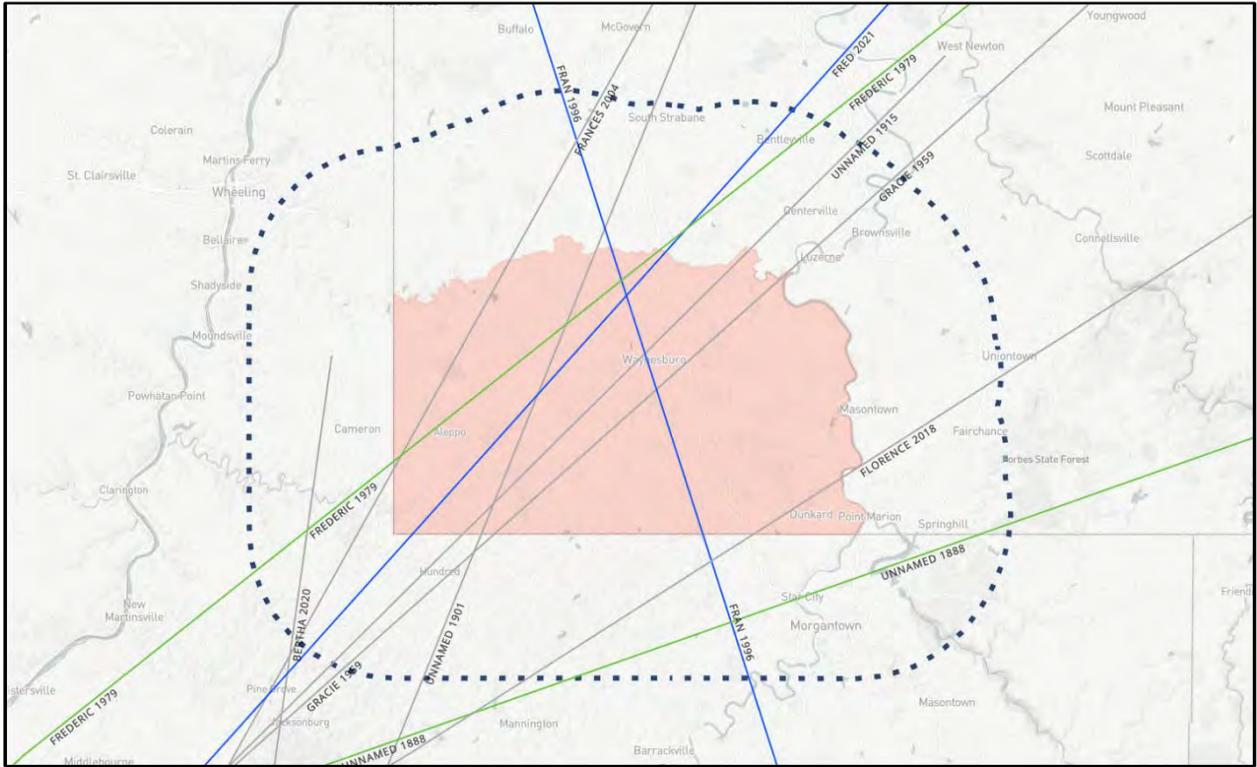
Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 22 - Pennsylvania Wind Zones



Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 24 - Historic Tropical Storms/Hurricanes in Greene County



Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.3.6. Invasive Species

4.3.6.1 Location and Extent

An invasive species is a species that is not indigenous to a given ecosystem and that, when introduced to a non-native environment, tends to thrive. The spread of an invasive species often alters ecosystems, which can cause environmental and economic harm and pose a threat to human health. Often, an invasive species spreads and reproduces quickly. Invasive species are not limited to organisms that come from a foreign country. Invasive species can come from a different region in the United States. The main instigator of invasive species is human activity. Either intentionally or unintentionally, other species may accompany people when they travel, introducing the stowaway species to a novel ecosystem. In a foreign ecosystem, a transported species may thrive, potentially restructuring the ecosystem and threatening its health. Common pathways for invasive species introduction to Pennsylvania include but are not limited to:

- Contamination of internationally traded products
- Hull fouling
- Ship ballast water release
- Discarded live fish bait
- Intentional release
- Escape from cultivation
- Movement of soil, compost, wood, vehicles or other materials and equipment
- Unregulated sale of organisms
- Smuggling activities
- Hobby trading or specimen trading

The Governor's Invasive Species Council of Pennsylvania (PISC), the lead organization for invasive species threats, recognizes two types of invasive species: Aquatic and Terrestrial.

Aquatic Invasive Species (AIS) are nonnative invertebrates, fishes, aquatic plants, and microbes that threaten the diversity or abundance of native species, the ecological stability of the infested waters, human health and safety, or commercial, agriculture, or recreational activities dependent on such waters.

Terrestrial Invasive Species (TIS) are nonnative plants, vertebrates, arthropods, or pathogens that complete their lifecycle on land instead of in an aquatic environment and whose introduction does or is likely to cause economic/environmental damage or harm to human health.

The location and extent of invasive threats is dependent on the preferred habitat of the species, as well as the species' ease of movement and establishment. For example, kudzu vine is an aggressive vascular plant. With wide ecological parameters and ease of spread, the vine is a more widespread invasive species threat. Other species' spread, such as the spotted lantern fly, has

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

been limited by state agency activity. First discovered in Berks County in 2014, the spotted lantern fly was placed under a quarantine by the Pennsylvania Department of Agriculture in thirteen counties. *Table 35 - Prevalent Invasive Species* lists invasive species that have been found in Greene County.

4.3.6.2 Range of Magnitude

The magnitude of invasive species threats ranges from nuisance to widespread killer. Some invasive species are not considered agricultural pests, and do not harm humans or cause significant ecological problems. For example, Brown Marmorated Stink Bugs are not considered to be an agricultural pest and do not harm humans. Other invasive species can have many negative impacts and cause significant changes in the composition of ecosystems. For example, the Emerald Ash Borer creates a 99% mortality rate in any ash tree it infects. The aggressive nature of many invasive species can cause significant reductions in biodiversity by crowding out native species. This can affect the health of individual host organisms as well as the overall well-being of the affected ecosystem. An example of a worst-case scenario for invasive species in Pennsylvania is the Emerald Ash Borer in Greene County and the surrounding region (see *Figure 25 - Emerald Ash Borer Infestation in Pennsylvania*).

Figure 25 - Emerald Ash Borer Infestation in Pennsylvania

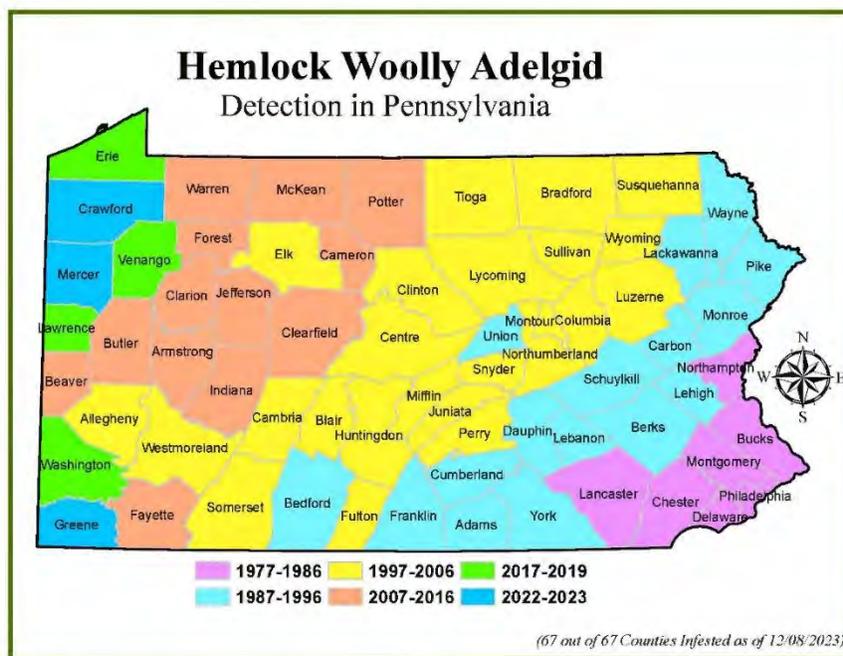


Another example of an invasive pest is the Hemlock Woolly Adelgid. Hemlock Woolly Adelgid is a fluid-feeding insect that feeds on hemlock trees throughout eastern North America, including Pennsylvania. The egg sacs of these insects look like the tips of cotton swabs clinging to the undersides of hemlock branches. Hemlock Woolly Adelgid was introduced from Asia into the Pacific Northwest in 1924. It is likely to have been introduced into the northeastern United States

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

in the 1950s, and it was first discovered in Pennsylvania in 1967. To date, all sixty-seven counties in Pennsylvania, including Greene County, have been infested with this insect. See *Figure 26 - Hemlock Woolly Adelgid Infestation in Pennsylvania*. Eastern hemlock (Pennsylvania's state tree) and Carolina hemlocks (found further south in the Smoky Mountain sections of the Appalachians) are more susceptible to Hemlock Woolly Adelgid damage than Asian and western hemlock trees due to feeding tolerance and predators that protect the latter species. Hemlock Woolly Adelgid sucks fluid from the base of hemlock needles. It may also inject toxins into the tree as it feeds, accelerating needle drop and branch dieback. Although some trees die within four years, trees often persist in a weakened state for many years. Hemlocks that have been affected by Hemlock Woolly Adelgid often have a grayish-green appearance (hemlocks naturally have a shiny, dark green color).

Figure 26 - Hemlock Woolly Adelgid Infestation in Pennsylvania



A final example of an invasive species is the Spotted Lanternfly. The Spotted Lanternfly is a harmful invasive species which feeds on plants, damaging or destroying them. This can negatively impact the areas of Pennsylvania known for outdoor scenery and activities. According to the Penn State Extension, the Spotted Lanternfly is a significant threat to Pennsylvania agriculture, landscapes, and natural ecosystems, including grape, tree-fruit, hardwood, and nursery industries, which collectively are worth nearly \$18 billion to the state's economy, outdoor recreation, and biodiversity. The Spotted Lanternfly was found in Greene County prior to 2024. The State Department of Agriculture gives the total number of infected counties as fifty-two, as of 2024. *Figure 27 – Pennsylvania Spotted Lanternfly Infestation* illustrates the counties in Pennsylvania that are considered to be in the quarantine zone for this pest.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

The magnitude of an invasive species threat is generally amplified when the ecosystem or host species is already stressed, such as in times of drought. The already weakened state of the native ecosystem causes it to succumb to an infestation more easily. A worst-case example could be the Hemlock Woolly Adelgid causing reduced biodiversity, increased wildfire potential, and thermal harm to small stream cold water fisheries and habitats.

4.3.6. Past Occurrence

Invasive species have been entering Pennsylvania since the arrival of European settlers, but not all occurrences required government action. Greene County is known for its great number of geographic features. There are various state game lands within the area which include state game lands 179, 223, and 302, as well as other areas in the county that have significant amounts of forest land and water features which species may invade. Due to the vast area of forests, there are many invasive terrestrial species that have been widespread in Greene County that are common problems throughout the Commonwealth. Some of the most popular problematic species in Greene County include:

- Emerald Ash Borer
- Hemlock Woolly Adelgid
- Spotted Lanternfly

Many of the extreme problematic species have been around for many years. However, the most recent problematic species are the Emerald Ash Borer, Hemlock Woolly Adelgid, and the Spotted Lanternfly. In 2007, both the Emerald Ash Borer and Hemlock Woolly Adelgid were both newly spotted species that caused extreme damage. Even more recently than 2007, the Spotted Lanternfly was detected in the commonwealth in 2014, and quarantine zone expanded to include Greene County.

Table 35 - Prevalent Invasive Species lists problematic non-native species that are established in Greene County.

Table 35 - Prevalent Invasive Species

Prevalent Invasive Species (iMapInvasives, 2024; PA DCNR, 2024)		
Common Name	Scientific	Type
Amur Honeysuckle	Lonicera maackii	Plant
Asiatic Clam	Corbicula fluminea	Animal
Asiatic Dayflower	Commelina communis	Plant
Autumn Olive	Elaeagnus umbellata	Plant
Bitter Dock	Rumex obtusifolius	Plant
Black Jetbead	Rhodotypos scandens	Plant
Black Medic	Medicago lupulina	Plant

**Greene County, Pennsylvania
2025 Hazard Mitigation Plan**

Prevalent Invasive Species (iMapInvasives, 2024; PA DCNR, 2024)		
Common Name	Scientific	Type
Black Mustard	Brassica nigra	Plant
Bohemian Knotweed	Reynoutria x bohemica	Plant
Bouncing-bet	Saponaria officinalis	Plant
Bull Thistle	Cirsium vulgare	Plant
Canada Bluegrass	Poa compressa	Plant
Canada Thistle	Cirsium arvense	Plant
Chicory	Cichorium intybus	Plant
Chinese Bushclover	Lespedeza cuneata	Plant
Colt's-foot	Tussilago farfara	Plant
Common Carp	Cyprinus carpio	Animal
Common Chickweed	Stellaria media	Plant
Common Crown-vetch	Securigera varia	Plant
Common Mullein	Verbascum thapsus	Plant
Common Speedwell	Veronica officinalis	Plant
Common Star-of-Bethlehem	Ornithogalum umbellatum	Plant
Common Velvetgrass	Holcus lanatus	Plant
Creeping Buttercup	Ranunculus repens	Plant
Creeping Himalayan Knotweed	Persicaria posumbu	Plant
Creeping Jenny	Lysimachia nummularia	Plant
Creeping Smartweed	Persicaria longiseta; Polygonum caespitosum var. longisetum	Plant
Curly Dock	Rumex crispus	Plant
Dame's Rocket	Hesperis matronalis	Plant
Emerald Ash Borer	Agilus planipennis	Animal
English Plantain	Plantago lanceolata	Plant
Field Garlic	Allium vineale	Plant
Freshwater Jellyfish	Craspedacusta sowerbyi	Animal
Garden Bird's-foot-trefoil	Lotus corniculatus	Plant
Garlic Mustard	Alliaria petiolata	Plant
Giant Bentgrass	Agrostis gigantea	Plant
Giant-chickweed	Myosoton aquaticum	Plant
Golden Algae	Prymnesium parvum	Plant
Goldfish	Carassius auratus	Animal
Grassleaf Ragwort	Packera glabella	Plant
Great Hedge Bedstraw	Galium mollugo	Plant
Greater Celandine	Chelidonium majus	Plant
Ground-ivy	Glechoma hederacea	Plant
Hairy Bittercress	Cardamine hirsuta	Plant

**Greene County, Pennsylvania
2025 Hazard Mitigation Plan**

Prevalent Invasive Species (iMapInvasives, 2024; PA DCNR, 2024)		
Common Name	Scientific	Type
Hemlock Woolly Adelgid	Adelges tsugae	Animal
Honeysuckle (species unknown)	Lonicera spp. (species unknown)	Plant
Japanese Barberry	Berberis thunbergii	Plant
Japanese Knotweed	Reynoutria japonica	Plant
Japanese Spiraea	Spiraea japonica	Plant
Japanese Stiltgrass	Microstegium vimineum	Plant
Jimsonweed	Datura stramonium	Plant
Joint-head Arthraxon	Arthraxon hispidus	Plant
Kentucky Bluegrass	Poa pratensis	Plant
Knapweed (species unknown)	Centaurea spp. (species unknown)	Plant
Lady's Thumb	Persicaria maculosa	Plant
Lesser Burdock	Arctium minus	Plant
Lesser Celandine	Ranunculus ficaria	Plant
Lesser Periwinkle	Vinca minor	Plant
Marshpepper Knotweed; Smartweed	Persicaria hydropiper	Plant
Meadow Timothy	Phleum pratense	Plant
Morrow's Honeysuckle	Lonicera morrowii	Plant
Moth Mullein	Verbascum blattaria	Plant
Multiflora Rose	Rosa multiflora	Plant
Narrowleaf Cattail	Typha angustifolia	Plant
Orange Daylily	Hemerocallis fulva	Plant
Orchard Grass	Dactylis glomerata	Plant
Poison-hemlock	Conium maculatum	Plant
Poverty Brome	Bromus sterilis	Plant
Privet (species unknown)	Ligustrum spp. (species unknown)	Plant
Purple Deadnettle	Lamium purpureum	Plant
Queen Anne's Lace	Daucus carota	Plant
Reed Canary Grass	Phalaris arundinacea	Plant
Roundleaf Bittersweet	Celastrus orbiculatus	Plant
Scribner's Bluegrass	Poa trivialis	Plant
Small-flower Hairy Willowherb	Epilobium parviflorum	Plant
Smooth Brome	Bromus inermis	Plant
Spotted Cat's-ear	Hypochaeris radicata	Plant
Spotted Laternfly	Lycorma delicatula	Animal

**Greene County, Pennsylvania
2025 Hazard Mitigation Plan**

Prevalent Invasive Species (iMapInvasives, 2024; PA DCNR, 2024)		
Common Name	Scientific	Type
Spotted Starthistle	Centaurea biebersteinii; Centaurea stoebe ssp. micranthos	Plant
Sweet Cherry	Prunus avium	Plant
Sweet Vernal Grass	Anthoxanthum odoratum	Plant
Sweetclover	Melilotus officinalis	Plant
Sweetflag, Calamus	Acorus calamus	Plant
Tree-of-Heaven	Ailanthus altissima	Plant
Watercress	Nasturtium officinale	Plant
White Clover	Trifolium repens	Plant
White Willow	Salix alba	Plant
Wild Parsnip	Pastinaca sativa	Plant
Wild Teasel	Dipsacus fullonum	Plant
Yellow Iris	Iris pseudacorus	Plant
Zebra Mussel	Dreissena polymorpha	Animal

4.3.6.4 Future Occurrence

According to the Pennsylvania Invasive Species Council (PISC), the probability of future occurrence for invasive species threats is growing due to the increasing volume of transported goods, increasing efficiency and speed of transportation, and expanding international trade agreements. Expanded global trade has created opportunities for many organisms to be transported to and establish themselves in new counties and regions. In 2017, Pennsylvania alone imported over \$83 billion in goods from abroad, including agricultural, forestry, and fishery goods that commonly carry unknown pests. Climate change is contributing to the introduction of new invasive species. As maximum and minimum seasonal temperatures change, pests can establish themselves in previously inhospitable climates. This also gives introduced species an earlier start and increases the magnitude of their growth, possibly shifting the dominance of ecosystems in the favor of non-native species. In order to combat the increase in future occurrences, the PISC released the Invasive Species Management Plan in April 2010 and updated the plan in 2017. The plan outlines the Commonwealth’s goals for managing the spread of nonnative invasive species and creates a framework for responding to threats through research, action, and public outreach and communication. More information can be found here: https://www.agriculture.pa.gov/Plants_Land_Water/PlantIndustry/GISC/Pages/default.aspx.

There are several invasive species that are found near Greene County but have not yet been detected inside the county (see *Table 36 – Future Vulnerable Species*). Especially in cases like this, control efforts, heightened awareness, and public outreach and education can help prevent an invasive species from becoming established in the future. Once a species is established, it is

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

more difficult to eradicate it from an ecosystem, so prevention is very important. Therefore, Japanese Knotweed, Marrow’s Honeysuckle, and Multiflora Rose are all widespread and highly problematic in nearby counties but have not been reported in Greene County (as shown in *Table 36 – Future Vulnerable Species*). The development of appropriate plans will assist the county in reducing the possibility of a future encounter with any of these species. Working toward keeping these species from entering the area would be beneficial to the forests of Greene County.

Climate change and its relationship with invasive species has a major correlation. According to the U.S Geological Survey, climate change has been creating a new pathway for invasive species to be introduced into the environment. As an example, the rise in temperature allows existing invasive species to expand their geographic area. Also, climate change hinders the tools for eliminating invasive species.

Table 36 - Future Vulnerable Species

Future Vulnerable Species (iMapInvasives, 2024; PA DCNR, 2024)		
Common Name	Scientific Name	Type
Alewife	<i>Alosa pseudoharengus</i>	Animal
Alsike Clover	<i>Trifolium hybridum</i>	Plant
Bishop's Goutweed	<i>Aegopodium podagraria</i>	Plant
Blue Cattail, Hybrid Cattail	<i>Typha x glauca</i>	Plant
Border Privet	<i>Ligustrum obtusifolium</i>	Plant
Brittle Naiad	<i>Najas minor</i>	Plant
Burning Bush	<i>Euonymus alatus</i>	Plant
Butter-and-eggs	<i>Linaria vulgaris</i>	Plant
Callery Pear	<i>Pyrus calleryana</i>	Plant
Chinese Wisteria	<i>Wisteria sinensis</i>	Plant
Chinese Yam	<i>Dioscorea polystachya</i> ; <i>Dioscorea batatas</i>	Plant
Climbing Nightshade	<i>Solanum dulcamara</i> var. <i>dulcamara</i>	Plant
Common Reed	<i>Phragmites australis</i> ssp. <i>australis</i>	Plant
Common St. John's-wort	<i>Hypericum perforatum</i>	Plant
Curly-leaf Pondweed	<i>Potamogeton crispus</i>	Plant
Cypress Spurge	<i>Euphorbia cyparissias</i>	Plant
Didymo	<i>Didymosphenia geminata</i>	Plant
English Ivy	<i>Hedera helix</i>	Plant
Eurasian Water-milfoil	<i>Myriophyllum spicatum</i>	Plant
European Privet	<i>Ligustrum vulgare</i>	Plant
Foxtail Mint	<i>Mentha x villosa</i>	Plant
Garden Stonecrop	<i>Hylotelephium telephium</i>	Plant

**Greene County, Pennsylvania
2025 Hazard Mitigation Plan**

Future Vulnerable Species (iMapInvasives, 2024; PA DCNR, 2024)		
Common Name	Scientific Name	Type
Glossy False Buckthorn	Frangula alnus	Plant
Hydrilla	Hydrilla verticillata	Plant
Japanese Hop	Humulus japonicus	Plant
Japanese-spurge	Pachysandra terminalis	Plant
Joint-head Arthraxon	Arthraxon hispidus	Plant
Jumping Worms (species unknown)	Amyntas-Metaphire spp. (species unknown)	Animal
Kentucky Bluegrass	Poa pratensis	Plant
Kentucky Bluegrass	Poa pratensis	Plant
Kentucky Bluegrass	Poa pratensis	Plant
Meadow Fescue	Schedonorus pratensis	Plant
Mile-a-minute vine	Persicaria perfoliata	Plant
Mint (species unknown)	Mentha spp. (species unknown)	Plant
Mouse-ear Hawkweed	Hieracium pilosella	Plant
Mugwort	Artemisia vulgaris	Plant
Mysterysnail spp. (species unknown)	Cipangopaludina spp. (species unknown)	Animal
Northern Catalpa	Catalpa speciosa	Plant
Norway Maple	Acer platanoides	Plant
Oxeye Daisy	Leucanthemum vulgare	Plant
Peppermint	Mentha x piperita	Plant
Perennial Pea	Lathyrus latifolius	Plant
Princess Tree	Paulownia tomentosa	Plant
Purple Loosestrife	Lythrum salicaria	Plant
Red-eared Slider	Trachemys scripta elegans	Animal
Rose-of-Sharon	Hibiscus syriacus	Plant
Sheep Sorrel	Rumex acetosella	Plant
Teasel (species unknown)	Dipsacus spp. (species unknown)	Plant
True Forget-me-not	Myosotis scorpioides	Plant
White Mulberry	Morus alba	Plant
Wild Basil	Clinopodium vulgare	Plant
Wineberry	Rubus phoenicolasius	Plant
Yellow-bellied Slider	Trachemys scripta scripta	Animal

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.3.6.5 Vulnerability Assessment

Greene County's vulnerability to invasion depends on the species in question. Human activity and mobility are ever increasing, and combined with the prospects of climate change, invasive species are becoming increasingly threatening. Invasive species can have adverse economic effects by impacting agriculture and logging activities. Natural forest ecosystems provide clean water, recreational opportunities, habitat for native wildlife, and places to enjoy the tranquility and transcendence of nature. The balance of forest ecosystems and forest health are vulnerable to invasive species threats. While there is significant acreage of wetlands, waterways, state parks, and game lands in Greene County where forest managers can impact invasive species, private lands can provide refuge for invasive species if landowners are unaware of or apathetic towards the threat.

Since there are large swatches of public land in Greene County, there is a risk of future damage from invasive species that are present in the area. With about 576 square miles of total land in Greene County, and two square miles of water, there is vulnerability to various land sites and waterways. If an invasive species were to invade the popular terrestrial areas or waterways in Greene County, a negative impact could occur. The invasion from an invasive species could cause damage to the scenic and natural resources needed in the county. Additionally, tourism for the county is vulnerable to the invasive species as well and would be affected if the parks were destroyed. Therefore, a great amount of land and native wildlife within Greene County are at risk with the presence of invasive species.

An interesting facet of the invasive species problem in Pennsylvania is that deer do not eat many invasive plants, giving invasive species a competitive advantage over the native species that deer prefer. As such, the management of deer populations in Greene County has a significant impact on the vulnerability of an ecosystem to invasive species, where overpopulation of deer favors invasive species.

The Governor's Invasive Species Council of Pennsylvania (PISC) has identified over 100 species threats that are or could potentially become significant in Pennsylvania. Of these threats, county and municipal leaders believe that the most significant are invasive forest pests like the Emerald Ash Borer, Hemlock Woolly Adelgid, the Spotted Lanternfly, and plants like the Tree-of-Heaven which have all been identified in red in *Table 35 - Prevalent Invasive Species*.

Due to the past experiences with invasive plants in the county, there are five primary components which help with managing invasive plants to lower vulnerability:

Prioritize: Public use areas such as state parks and other healthy forest ecosystems should be prioritized over developed and private areas. Locations with lower densities of invasive plants are often easier to control and should be given quick attention. Locations where humans are disturbing the landscape opens up niche space, and often times the aggressive invasive species

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

move in faster than native species. Such locations include areas around road work, ditch/culvert work, logging activities, stream improvement/stabilization and bridge work. Some species pose a higher risk than others - invasive species are easiest to control before they become widespread and established in an area, and for that reason, species that are less widespread should be prioritized for management.

Locate: Detailed locations should be recorded for invasive plants so sites can be easily relocated, treated, and monitored.

Delineate: The scale and extent of the infestation should be recorded and mapped so that the progress of the infestation can be monitored.

Control: Methods of control depend on the specific infestation, but the most common approaches are mechanical (cutting and hand-pulling) and chemical (herbicide treatments).

Monitor: Identified sites should be monitored and revisited as often as several times in a growing season (depending on the location/species). Monitoring can allow for early detection of spreading infestations. Most importantly, it prevents a relapse towards full-blown infestation.

It is best to act before a species can become established in the county, so forest management such as park rangers should be aware of invasive species found nearby Greene County, but not yet present in the county (priority species in *Table 36 – Future Vulnerable Species*). Public outreach and education are important to increase knowledge of these species to improve identification and prevention of invasion. Without action, due to the instances and extent of the current infestations, it is reasonable to project that the county’s vulnerability will increase.

All of the socially vulnerable populations in Greene County are at an increased vulnerability to invasive species. The homeless and the unsheltered populations are at risk due to not having a structure to reside in. Also, the economically vulnerable in Greene County may not have the capability to fix or hire pest control if their homes are damaged or overrun by invasive species.

As seen in *Table 3 – Population Change in Greene County*, eight municipalities have seen a net population increase from the 2010 decennial census to the 2020 decennial census. Based on this information, it can be speculated that these municipalities may have an increased risk to invasive species, since 2010, due to the increase in population and construction.

The historic properties in Greene County are at different levels of vulnerability to invasive species. Some of the historic properties in Greene County are made of brick and masonry construction and are at a lower risk of vulnerability from invasive species. Most of the culturally significant covered bridges in Greene County are made of wood and could be damaged by invasive species making them more vulnerable. There are also some historic properties that are made of stone and could be damaged by invasive species, although wood structures tend to be vulnerable.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Land use changes in Greene County could be a factor in the potential impact invasive species have on native species. Land use is a major factor with the severity of invasive species. Land use, in the form of a built environment, such as residential expansion, can cause invasive species impact severity to increase. Impact severity increases because as the built environment expands and becomes more complex, the impact the event will have on that area also increases because there is an influx of people, infrastructure, and critical infrastructure in the hazard area. According to Smithsonian Environmental Research Center, invasive species thrive on major land use disturbances, as an example the logging of a forest or flooding into a wetland can create conditions that invasive species thrive on to move into a specific area.

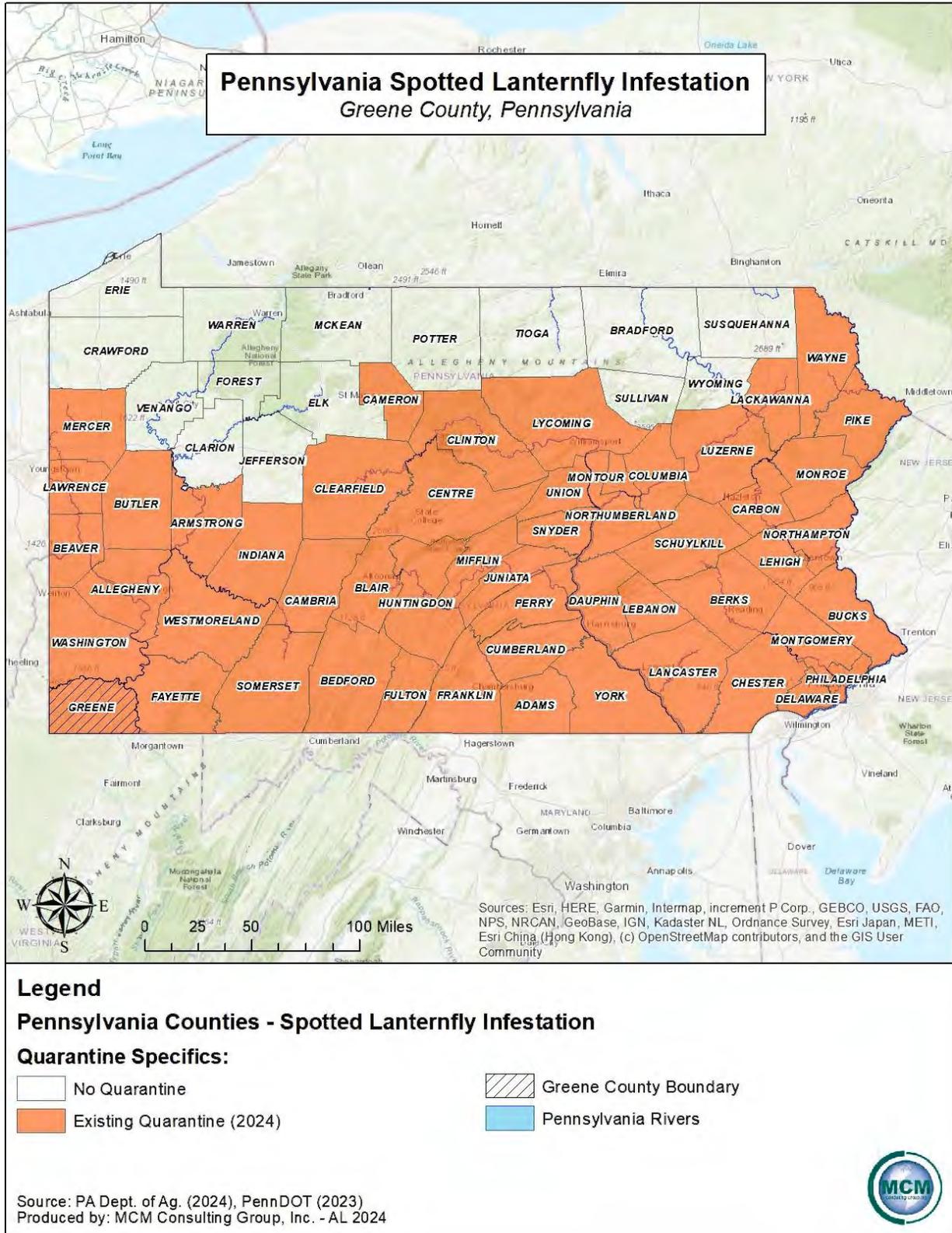
Invasive species in Greene County pose a significant threat to infrastructure systems through various mechanisms. Invasive plants like kudzu or Japanese knotweed can damage infrastructure such as roads, bridges, and buildings by infiltrating cracks and causing structural damage. Their aggressive growth can also obstruct drainage systems, leading to flooding and erosion, thus compromising the integrity of roads and bridges.

Invasive animals, such as feral hogs or zebra mussels, can disrupt infrastructure by burrowing into embankments, weakening them and increasing the risk of collapse. Additionally, animals like rodents or insects may gnaw on electrical wiring and utility cables, leading to malfunctions or even fires, posing risks to both infrastructure and public safety.

Furthermore, invasive species can interfere with transportation systems by clogging waterways. For example, invasive aquatic plants can impede navigation channels, necessitating costly scouring operations. Invasive insects like the emerald ash borer can devastate tree populations, including those lining roads or railways, posing hazards from falling trees and impacting transportation routes.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 27 - Pennsylvania Spotted Lanternfly Infestation



Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.3.7. Landslide

4.3.7.1 Location and Extent

Rock falls and other slope failures can occur in areas of Greene County with moderate to steep slopes. Many slope failures are associated with precipitation events – periods of sustained above-average precipitation, specific rainstorms, or snowmelt events. Rockfalls, rockslides, rock topples, block slides, debris flows, mud flows, and mud slides are all forms of landslides. Areas experiencing erosion, decline in vegetation cover and earthquakes are also susceptible to landslides. Human activities that contribute to slope failure include altering the natural slope gradient, increasing soil and water content, and removing vegetation cover. Areas where this type of human activity is common are areas that were excavated along highways and other roadways.

The Pennsylvania Department of Conservation and Natural Resources (PA DCNR) describes landslide susceptibility in Greene County as generally the highest susceptibility. *Figure 28 – Landslide Hazard Areas* shows areas of landslide susceptibility in Greene County. A majority of Greene County is located in the Waynesburg Hills section of the Appalachian Plateaus physiographic province which is known for high vulnerability based on the physiographic region to all forms of landslides. Steep slopes are evenly spread throughout the county and there are locations that can be prone to landslides in almost every municipality.

4.3.7.2 Range of Magnitude

Landslides cause damage to transportation routes, utilities, and buildings. They can also create travel delays and other side effects for transportation of people and material. Fortunately, death and injuries due to landslides are relatively rare in Pennsylvania. Almost all of the known deaths due to landslides have occurred when rocks fall or other slide along highways involve vehicles. Storm-induced debris flows are the only other type of landslide likely to cause injuries. As residential and recreational development increase 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 objects and buildings, rather than people.

The Pennsylvania Department of Transportation (PennDOT) and large municipalities incur substantial costs due to landslide damage and to additional 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 of Pennsylvania and a similar amount is spent on mitigation costs for grading projects (DCNR, 2009). A number of highway sites in Pennsylvania need temporary or permanent repair at an estimated cost of between \$300,000.00 and \$2 million each. Similar landslide events that affect traffic and roadways throughout the commonwealth occur intermittently throughout the year. A 7,500-pound rockslide closed down parts of Pennsylvania State Route 11 in Montour County, Pennsylvania in

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

November of 2020 for a number of weeks. Events of similar magnitude can and have occurred in and around Greene County.

The 2023 Pennsylvania Hazard Mitigation Plan lists Greene County as having a high incidence of landslides. Greene County landowners and real estate developers must know the magnitude of susceptibility within the county prior to the start of development.

4.3.7.3 Past Occurrence

No comprehensive list of landslide incidents in Greene County is available, and there is no formal reporting system in place. However, the 2023 Pennsylvania Hazard Mitigation Plan states that PennDOT and municipal departments are responsible for slides that inhibit the flow of traffic or damage roads and bridges, but they generally only repair the road and the adjacent right-of-way areas.

4.3.7.4 Future Occurrence

Mismanaged development in steeply sloped areas could increase the frequency of occurrence. Road cuts are the most common development that puts an area at an increased probability of a slide. The Pennsylvania Department of Environmental Protection (PA DEP) has an Erosion and Sediment (E & S) program that sets requirements intended to mitigate erosion associated with development projects of a certain scale. The guidelines offered in this program are similar to landslides prevention practices.

Climate change has the potential to increase the frequency of landslides in Greene County. Climate change could result in more intense rainfall from more frequent hurricanes and tropical storms. This increase in rainfall could cause an increase in soil runoff, therefore weakening slopes that are steep and considered to be a hazard. More frequent landslides could occur from this weakening of the slopes because soil movement will likely increase with a higher volume of precipitation.

4.3.7.5 Vulnerability Assessment

Landslides are often precipitated by other natural hazards such as earthquakes or floods. A significant landslide can cause millions of dollars in damage. Continued enforcement of floodplain management and proper road and building construction can mitigate the vulnerability to landslides. Floodplain management is important where mining has occurred within proximity to watercourses and associated flat-lying areas. Surface water may permeate into areas that still have open fractures and the build-up of surface water in those fractures could lead to unexpected flood events and landslide events.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Land use and development has the potential to increase the vulnerability of Greene County to landslides. Development of major infrastructure and commercial or residential areas near areas of steep slope, or areas where slopes are over 23° could create conditions in the future where landslides are more likely to occur. Also, the development of roadways, and the grading of roadway berms could also increase the potential for landslides. This is common in steeply sloped areas or areas where roads are built below a slope or embankment. The removal of forested areas or trees could cause landslides along slopes and embankments. Trees and tree root systems create hill stability, and the removal of those root systems could result in weakened slopes. This practice can be remediated and fixed with protection netting and gabion baskets or gabion walls.

A comprehensive database of land highly prone to erosion and landslides is difficult to produce. The potential for erosion and landslides should be considered when planning construction projects in Greene County. There are several general factors that can be indicators of landslide prone areas including:

- Locations on or close to steep hills.
- Areas of steep road cuts or excavations.
- Steep areas where surface run-off is channeled.
- Fan shaped areas of sediment and rock accumulations.
- Evidence of past sliding such as tilted utility line, tilted trees, cracks in the ground and irregularly, surfaced ground.

All the municipalities in Greene County are vulnerable to landslides. *Table 37 – Structure Vulnerability Data* illustrates the number of site structure address points per municipality and the number of structures in high slope areas. Landslide events are most likely to occur in steeply sloped areas and in places where landforms have been altered for purposes of highway construction or other development. This is especially true if development is located at the base or crest of cliffs or near large highway cut-outs. These areas should be considered vulnerable to landslides, particularly if mitigation measures have not been implemented.

Table 37 - Structure Vulnerability Data

Structure Vulnerability Data		
Municipality	Number of Addressable Structures Per Municipality	Number of Structures in Slope Area
Aleppo Township	376	3
Carmichaels Borough	222	0
Center Township	731	2
Clarksville Borough	57	0
Cumberland Township	2,973	3
Dunkard Township	1,243	3
Franklin Township	3,029	4

**Greene County, Pennsylvania
2025 Hazard Mitigation Plan**

Structure Vulnerability Data		
Municipality	Number of Addressable Structures Per Municipality	Number of Structures in Slope Area
Freeport Township	195	0
Gilmore Township	216	1
Gray Township	124	0
Greene Township	293	1
Greensboro Borough	159	0
Jackson Township	302	0
Jefferson Borough	179	0
Jefferson Township	1,391	0
Monongahela Township	851	2
Morgan Township	1,241	1
Morris Township	436	0
Perry Township	915	4
Rices Landing Borough	233	2
Richhill Township	659	6
Springhill Township	274	4
Washington Township	532	0
Wayne Township	737	2
Waynesburg Borough	1,359	0
Whiteley Township	430	0
Totals:	19,157	38

There are no historic or cultural properties in Greene County that are registered with the National Register of Historic Places and within a slope area of greater than 23°.

Municipalities with an increased risk to landslide (slope areas over 23°):

- Aleppo Township
- Carmichaels Borough
- Center Township
- Clarksville Borough
- Cumberland Township
- Dunkard Township
- Franklin Township
- Freeport Township
- Gilmore Township
- Gray Township
- Greene Township
- Greensboro Borough
- Jackson Township
- Jefferson Borough
- Jefferson Township
- Monongahela Township
- Morgan Township
- Morris Township
- Perry Township
- Rices Landing Borough
- Richhill Township
- Springhill Township
- Washington Township
- Wayne Township
- Waynesburg Borough
- Whiteley Township

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

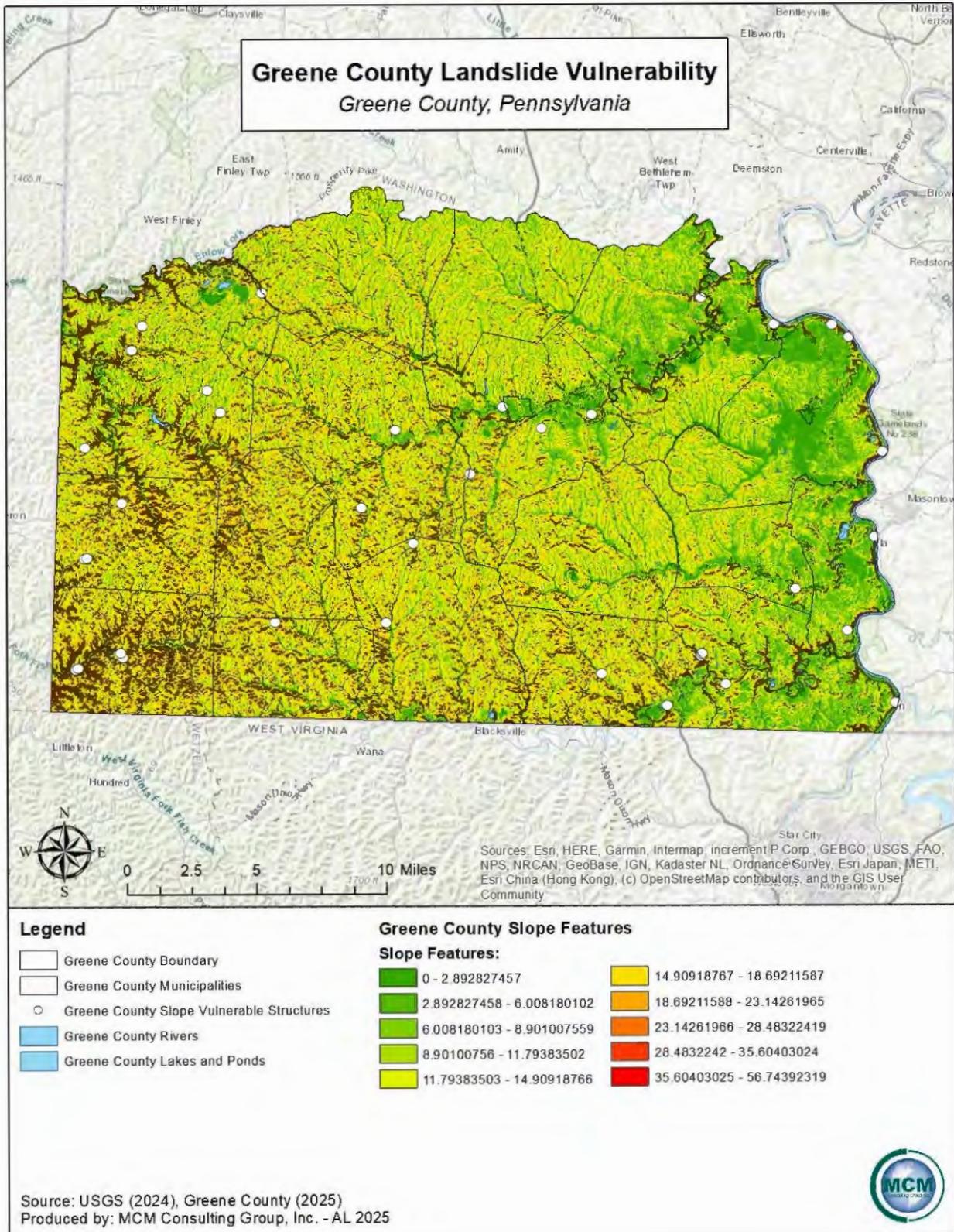
The socially vulnerable populations and communities in Greene County, including the homeless and unsheltered populations, are at an increased vulnerability to landslides. Those socially vulnerable populations can be found in the higher population density areas of the county. As seen in *Table 3 – Population Change in Greene County*, Carmichaels Borough, Center Township, Gilmore Township, Greene Township, Greensboro Borough, Jackson Township, Monongahela Township, and Rices Landing Borough have seen a net population increase from the 2010 census to the 2020 census, according to the U.S. Census Bureau, American Community Survey estimates. Based on this information, it can be speculated that these municipalities may have an increased/equivalent vulnerability to landslides, since 2010, due to the increase in population and construction.

When a landslide occurs, the resulting ground instability can lead to telephone pole collapse, disruption of fiber or copper cables systems, and in severe cases, cellular tower failure. The disruption to these networks, if the landslide event is significant, can also result in a loss of communication capabilities, hindering response coordination, and leaving communities impacted by the landslide vulnerable to other natural or human-caused hazards. Landslide events can also cause above ground localized transportation issues if an event were to occur along a transportation route through Greene County. This can cause a delay in daily transportation and may require alternate transportation routes to be established for an extended period of time.

Natural areas and resources in Greene County could be adversely impacted from landslides. Landslides typically occur in areas of steep slope, or areas of slope instability. Specific natural areas or parks that have the potential for landslides due to steep slopes include state game lands 179, 223, and 302, and Ryerson Station State Park. Landslides occur in natural areas on a regular basis and are often only reported substantially after occurrence. Natural resources that are utilized by the residents and businesses of Greene County could be damaged by landslides. This could include any farming, land cultivation, lumbering, or development of natural products.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 28 - Landslide Hazard Areas



Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.3.8. Pandemic, Epidemic, Endemic, and Infectious Disease

4.3.8.1 Location and Extent

Epidemic

An epidemic occurs when an infectious disease spreads more quickly than expected by medical and healthcare authorities. It is characterized by widespread growth or extent that spreads quickly and incurs a greater rate of novel or endemic cases than baseline estimates would initially project. When an epidemic occurs, it typically impacts a larger area than a localized outbreak. Epidemics often include multiple countries, although they do not always spread to different continents. In short, epidemics are regional.

Pandemic

A pandemic is a disease outbreak that spreads across countries or continents, which affects the population of a vast area. When a pandemic occurs, the event usually affects more people and takes more lives than an epidemic. Pandemics are described as an extensive epidemic. Generally, pandemic diseases cause sudden illness in all age groups on a global scale. Pandemics are continuous events in third-world countries but do not frequently affect the United States. A pandemic is measured and defined by the spreading of a disease rather than the fatalities with which it is associated. The characteristics of a pandemic outbreak include large and rapid scale spread, overload of healthcare systems, inadequate medical supplies, disruption of economy/society, and medical supply shortages. While a pandemic may be characterized as a type of epidemic, an epidemic is not a type of pandemic. Additionally, pandemics travel more efficiently than epidemics. In the event that a pandemic occurs in the eastern United States, the entirety of Greene County would likely be impacted.

Endemic

An endemic is described as a disease that is present in a community at all times but occurs in a relatively low frequency and is not spreading at a rapid rate. An endemic can be a previous pandemic such as influenza, or coronavirus (COVID-19), or a more regionalized virus such as Ebola virus in Africa. An endemic can become a pandemic if the disease mutates into a more virulent strain.

Infectious Disease

Infectious diseases are illnesses caused by pathogenic organisms such bacteria, viruses, fungi, or parasites. Organisms become harmful and cause disease under certain conditions. The sources of infectious disease may originate from contaminated food or waterways, infected animals/livestock, or infection from biological vectors such as mosquitoes, etc. Infectious diseases include influenza, rabies, Middle East Respiratory Syndrome (MERS), West Nile virus, Lyme Disease, Zika virus, and Ebola virus.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Pandemic and infectious disease events cover a wide geographical area and can affect large populations, potentially including the entire population of the Commonwealth of Pennsylvania. The exact size and extent of an infected population is dependent upon how easily the illness is spread, the mode of transmission, and the amount of contact between infected and uninfected individuals. The transmission rates of pandemic illnesses are often higher in more populated and urban areas where there are large concentrations of people. The transmission rate of infectious disease will depend on the mode of transmission of a given illness. Pandemic events can also occur after other natural disasters, particularly floods, when there is the potential for bacteria to grow in, and contaminate, standing water.

4.3.8.2 Range of Magnitude

Public health emergencies typically occur on a regional basis. The magnitude of pandemic or infectious disease threat in the Commonwealth will range significantly depending on the aggressiveness of the virus in question, factors within the community that are impacted (medical care access, population density, etc.), and the ease of transmission. For example, the West Nile virus produces clinically asymptomatic cases less than 80% of the time. Therefore, approximately 20% of the cases result in mild infection, also known as West Nile fever. However, there is a small percentage of cases that could result in severe neurological disease and even death.

Pandemic influenza has a higher transmission rate from person-to-person compared to the West Nile virus. Advances in medical technologies have greatly reduced the number of deaths caused by influenza over time. In the early 1900s, flu pandemics historically caused tens of millions of deaths, while the 2009 Novel H1N1, known as swine flu, caused fewer than 20,000 deaths world-wide. Many people infected with swine flu in 2009 recovered without needing medical treatment. Without recent medical inventions and technologies, modern influenza would be associated with higher morbidity rates. About 70% of those who were hospitalized during the 2009 H1N1 flu virus in the United States belonged to a high-risk group. However, with the COVID-19 pandemic, the transmission rates were much higher than any previous outbreaks related to other members of the coronavirus family such as SARS-CoV and MERS-CoV.

In the past 100 years, humanity did not face a microbial pandemic similar in scale to the COVID-19 pandemic. The worldwide transmission rate of COVID-19 from human to human rapidly advanced in 2020 and 2021. Of the six global outbreaks of viral infections, three were caused by coronaviruses (SARS, MERS, and COVID-19).

While there are limited secondary hazards related to public health emergencies, an outbreak can cause a variety of cascading hazards. Civil disorder due to supply shortages is the most common cascading hazard to result from pandemic, epidemic, or infectious disease. Additional potential effects could include: a shortage of medical supplies and personnel, hoarding of household paper

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

and cleaning supplies, school and business disruption, government closings, government restrictions on travel, low attendance at places of employment, slowed productivity, and widespread economic instability.

The World Health Organization (WHO) developed an alert system to help inform the world about the seriousness of a pandemic. The alert system has six phases, with Phase 1 being the lowest risk and Phase 6 being the greatest risk of pandemic. The phases were developed in 1999, but then revised in 2005 and 2009 to provide a global framework and aid countries in pandemic preparedness and response planning. These phases of alert systems were used during the COVID-19 pandemic. These phases are listed below in *Table 38 - Pandemic Influenza Phases*.

Table 38 - Pandemic Influenza Phases

Pandemic Influenza Phases	
Phase	Characteristics
Phase 1	No animal influenza virus circulating among animals has been reported to cause infection in humans.
Phase 2	An animal influenza virus circulating in domesticated or wild animals is known to have caused infection in humans and is therefore considered a specific potential pandemic threat.
Phase 3	An animal or human-animal influenza reassortant virus has caused sporadic cases or small clusters of disease in people but has not resulted in human-to-human transmission sufficient to sustain community-level outbreaks.
Phase 4	Human-to-human transmission (H2H) of an animal or human-animal influenza virus able to sustain community-level outbreaks has been verified.
Phase 5	The same identified virus has caused sustained community level outbreaks in two or more countries in one WHO region.
Phase 6	The pandemic phase is characterized by community level outbreaks in at least one other country in a different WHO region in addition to the criteria defined in Phase 5. Designation of this phase will indicate that a global pandemic is under way.
Post-Peak Period	Levels of pandemic influenza in most countries with adequate surveillance have dropped below peak levels.
Possible New Wave	Level of pandemic influenza activity in most countries with adequate surveillance rising again.
Post-Pandemic Period	Levels of influenza activity have returned to the levels seen for seasonal influenza in most countries with adequate surveillance.
Source: WHO, 2009	

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.3.8.3 Past Occurrence

Pandemic & Epidemic

Several pandemic influenza outbreaks have occurred over the past 100 years that not only affected Greene County but the United States as a whole. *Table 39 - Past Pandemic Events in the United States* illustrates the various past pandemic events that have occurred since the late 1800's. Prior to COVID-19, the worst recorded pandemic was the Spanish Flu, due to the amount of infection spread that was present in the world. The two most recent pandemics that have occurred in Greene County and the United States are the swine flu/Novel H1N1 and COVID-19 pandemics, with COVID-19 being the most current and having the highest transmission rates.

Spanish Flu

An estimated 1/3 of the world's population was infected and had clinically apparent illnesses during the 1918 - 1919 influenza pandemic. Pennsylvania experienced severe effects from the Spanish Flu. It claimed 500,000 lives in the United States, which included individuals in Greene County. There is a lack of data which provides exact numbers of deaths that occurred in Greene County from the Spanish Flu, however there were a total of 60,000 deaths in Pennsylvania. Deaths occurring in Greene County are included in this number. There were approximately 47,000 reported cases and 12,000 deaths in Philadelphia in just over four weeks. In the first six months, there were about half a million cases and 16,000 deaths of the Spanish Flu in Philadelphia. The factors of high population density including crowded and unhygienic conditions contributed to higher numbers of cases and death rates across Pennsylvania.

Swine Flu/Avian Flu/H1N1

Each year, different strains of influenza are labeled as potential pandemic threats. Strains of influenza, or the flu, are highly contagious as they commonly attack the respiratory tract in humans. Influenza pandemic 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. Avian flu did not reach pandemic proportions in the United States, but the country began planning for flu outbreaks.

Greene County was impacted by the H1N1 virus during 2009. The Pennsylvania Department of Health (PA DOH) set up clinics throughout the county to administer vaccines to at-risk populations. A total 10,940 cases and seventy-eight deaths occurred in Pennsylvania from this pandemic but there is insufficient data to determine the exact number of cases and deaths from swine flu in Greene County.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

COVID-19

Greene County was directly impacted by the COVID-19 pandemic. As of June 2023, Pennsylvania had an estimated 3,565,278 million total cases and 51,344 deaths related to the COVID-19 pandemic. The first cases in Pennsylvania were reported on March 6, 2020, in Delaware and Wayne counties. The first confirmed case of COVID-19 in Greene County was in March 2020. Beginning in December of 2020, there was a large-scale vaccination effort to combat COVID-19. Municipalities in Greene County indicated an increase in the pandemic and infectious disease section of the risk factor assessment municipal comparison.

Table 39 - Past Pandemic Events in the United States

Past Pandemic Events in the United States	
Year(s)	Common Name
1889	Russian Flu
1918	Spanish Flu/H1N1
1957	Asian Flu/H2N2
1968	Hong Kong Flu/H3N2
2009	Swine flu/Novel H1NI
2020	COVID-19

Sources: WHO & CDC, 2020

Infectious Disease

Not only has Greene County experienced pandemic events, but the county has also experienced infectious disease events. The two major infectious disease events experienced across Greene County and Pennsylvania as a whole are the West Nile Virus and Lyme Disease. Due to the climatic traits of Pennsylvania these infectious diseases thrive in Greene County. Both diseases are transmitted by the biological vector of an insect which is found throughout the county.

West Nile Virus

West Nile virus reached the United States in 1999 and a year later was detected in Pennsylvania when mosquito pools, dead birds, and/or horses in nineteen counties tested positive for the virus. By 2003, all counties in the Commonwealth had confirmed cases. A comprehensive network has been developed in Pennsylvania that includes trapping mosquitoes, collecting dead birds, and monitoring horses, people and, in past years, sentinel chickens. Although West Nile Virus positive cases are few in Greene County, 2018 had the most positive cases in Greene County since 2018. Over the past five years, no human has tested positive for West Nile Virus in Greene County. *Table 40 - West Nile Virus Control Program in Greene County since 2018* outlines the West Nile Virus within Greene County from 2018 to 2024.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Table 40 - West Nile Virus Control Program in Greene County since 2018

West Nile Virus Control Program in Greene County Since 2018				
Year	Total Positives	Human Positives	Mosquito Positives	Bird Positives
2018	31	0	31	0
2019	3	0	3	0
2020	0	0	0	0
2021	4	0	4	0
2022	7	0	7	0
2023	5	0	5	0
2024	6	0	6	0

Source: PA Department of Environmental Protection, 2024

Lyme Disease

Lyme Disease has been present in the United States and Greene County for many years. More wooded areas have higher cases due to ticks being the main biological vector. Lyme disease is found in all sixty-seven counties within Pennsylvania. Greene County has an overall approximately 161 confirmed cases of Lyme disease from 2000 until 2020, although actual totals may be significantly higher due to under reporting. Greene County as a whole has a moderately high positive total for Lyme Disease in the county, especially over the past several years. It is possible that numbers have risen dramatically due to lack of testing in previous years. Greene County experienced the highest number of positive cases in 2018 and 2019. Lyme disease case counts have been consistently rising over the past several years. It should be noted that information represented for each county may vary due to reporting practices. Hence these figures represent a rough estimate of the Lyme disease burden in Greene County. *Table 41 - Lyme Disease Data for Greene County* outlines the total positive cases of Lyme Disease within Greene County from 2000 to 2020. Data after 2020 was not available for this report.

Table 41 - Lyme Disease Data for Greene County

Lyme Disease Data for Greene County	
Year	Total Positives
2000	2
2001	2
2002	1
2003	0
2004	3
2005	0
2006	1
2007	0

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Lyme Disease Data for Greene County	
Year	Total Positives
2008	1
2009	0
2010	1
2011	0
2012	3
2013	3
2014	5
2015	6
2016	24
2017	29
2018	31
2019	36
2020	13
Source: PA Tick Check, 2024	

Zika Virus

The Zika virus is another infectious disease that is spread by mosquito bites, and it is related to West Nile virus. Zika virus can also be spread through sexual intercourse, blood transfusion, or passed from mother to child in the womb. The virus was first identified in 1947, but largely came to the attention of the United States in 2015 when there was an outbreak of Zika in Brazil. The direct illness caused by Zika can include fever, red eyes, joint pain, headache, and a rash, or sometimes no symptoms at all. Zika is problematic for pregnant mothers as the virus can result in microcephaly or cause other problems for brain development. For adults, the virus can be linked to increased incidence of Guillain-Barré syndrome.

4.3.8.4 Future Occurrence

Pandemic & Epidemic

The probability of a widespread public health emergency effecting Greene County is approximately once every ten years. Minor outbreaks of less serious communicable disease, such as influenza, will occur much more frequently. The occurrence of pandemic influenza outbreaks is unpredictable, and complete avoidance of the events is unlikely. Therefore, future occurrences of pandemics and infectious disease events are very likely. Pandemics may also emerge from other diseases, especially invasive pathogens for which Greene County and Pennsylvania as a whole lack natural immunity.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Influenza

It is estimated that 5% to 25% of Pennsylvanians get the flu each year, and 120 to 2,000 individuals die from complications of influenza. The CDC recommends that everyone six months and older get a flu vaccine every season to prevent future cases from rising. People who are at a high risk of serious flu illness should take flu antiviral drugs as soon as they get sick.

Infectious Disease

Infectious diseases such as West Nile Virus and Lyme Disease have been present in Greene County for many years and are expected to perpetuate. The best way to prevent infectious disease outbreaks, including West Nile Virus and Lyme Disease, is to actively address the causes of the diseases. West Nile Virus occurrence can be reduced by removing mosquito breeding locations in stagnant water sources and Lyme Disease occurrence can be reduced by utilizing insect repellants, removing ticks promptly, applying pesticides, and reducing tick habitats. Occurrence of Zika Virus can also be reduced by removing mosquito breeding areas and areas of stagnant water. Both West Nile Virus and Lyme Disease are expected to continue occurring in Greene County in the future.

Climate change can result in a wider range of pandemics, epidemics, and infectious diseases that can impact larger areas of the globe. As climate change continues, more populations have the potential to come into contact with vectors for diseases. The migration of animals could also increase vulnerability to this hazard for populations in Greene County. Climate change is discussed below in Section 4.3.8.5.

4.3.8.5 Vulnerability Assessment

Greene County is considered to be a moderate vulnerability county in regard to the pandemic events. It is extremely difficult to predict the occurrence and the magnitude of a pandemic or epidemic event. The COVID-19 pandemic disproportionately affected populations over the age of sixty-five, especially those in nursing homes. It has had disparate effect on socially vulnerable populations, including unsheltered and homeless individuals.

Elderly individuals, children and immune deficient individuals are the most vulnerable to disease. Nursing facilities, personal care facilities, daycares, schools, and hospitals are considered more vulnerable since there are often groups of these socially vulnerable individuals present at these community lifelines. Congregate living facilities, including correctional institutions and dormitories would also be at an increased risk due to the difficulties in adhering to the social distancing required to help stop the spread of a pandemic. During the COVID-19 pandemic, nursing homes and personal care homes in Pennsylvania reported high numbers of cases and deaths, and several county jails and state correctional institutions reported wide community spread.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Health-care workers and those working in direct-care (such as correctional institutions or those who cannot social distance due to their jobs) are more likely to be exposed to a pandemic disease. Those who work outdoors for extended periods of time in warm months may be more vulnerable to West Nile Virus, Lyme Disease, or the Zika virus.

The number of hospitals within the county, and availability of beds within the hospitals, determine the amount of care vulnerable and sick patients will receive. It is important for hospitals to review and exercise emergency response plans and continuity of operations plans (COOP) to ensure that there is an effective public health response.

All critical infrastructure facilities and community lifeline facilities are vulnerable to pandemic, epidemic, and infectious disease. The people working and operating these facilities are at an increased vulnerability based on location and dispersion of disease vectors. This includes all of the critical infrastructure in the county and the community lifeline facilities, a total of 125 locations. This includes but is not limited to one hospital, nine fire stations, five power plants, twenty historic buildings, and fifteen grocery stores. These locations are spaced evenly throughout the county but are clustered primarily in the boroughs of the county.

A pandemic can vastly impact historic resources by disrupting routine maintenance, leading to physical deterioration of structures and artifacts. The closure of cultural institutions, including museums and archives, hinders public access and educational activities. Economic downturns may reduce funding for preservation efforts, while a decline in tourism threatens the financial sustainability of historic sites. Community engagement may suffer if events and traditional practices are disrupted, affecting the transmission of cultural knowledge.

Municipalities with high risk due to pandemic, epidemic, and infectious diseases:

- Aleppo Township
- Carmichaels Borough
- Center Township
- Clarksville Borough
- Cumberland Township
- Dunkard Township
- Franklin Township
- Freeport Township
- Gilmore Township
- Gray Township
- Greene Township
- Greensboro Borough
- Jackson Township
- Jefferson Borough
- Jefferson Township
- Monongahela Township
- Morgan Township
- Morris Township
- Perry Township
- Rices Landing Borough
- Richhill Township
- Springhill Township
- Washington Township
- Wayne Township
- Waynesburg Borough
- Whiteley Township

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

During a public health emergency, the PA DOH may open emergency medicine centers called points of dispensing (PODs) to ensure that medicine, supplies, vaccines, and information reach Pennsylvania residents during a public health emergency. An open POD is where the general public goes to receive free emergency medicine and supplies from public health officials, while a closed POD provides free emergency medicine and supplies to a specific community, like a university, including faculty, staff, and students. Dispensing of medications/vaccines is a core function of the Strategic National Stockpile's Mass Dispensing of Medical Countermeasures Plan.

PODs are coordinated with county emergency managers by the PA DOH with the six regional healthcare districts (see *Figure 29 - Pennsylvania Department of Health Districts*). Greene County is in the southwest health district.

Land use and land development could directly impact the vulnerability of Greene County to pandemics, epidemics, and infectious diseases. Development of forested and rural areas could result in populations coming into direct contact with vectors for infectious disease including, most prominently, Lyme Disease and West Nile Virus. When areas that are rural and natural habitats for wildlife are developed, those vectors that live along and with wildlife have the potential to come into contact with the individuals developing the properties and the populations that will occupy or live in those areas. An increase in development could also lead to an increase in the number of individuals living in Greene County, increasing the county's vulnerability to pandemic events, like COVID-19.

Climate change can significantly impact the dynamics of pandemics, epidemics, and infectious diseases. Rising temperatures and altered precipitation patterns can expand the geographic range of disease vectors, such as mosquitoes carrying diseases like malaria and dengue fever. Changes in climate can also affect the behavior and distribution of animal hosts, potentially facilitating the transmission of zoonotic diseases to humans. Extreme weather events, intensified by climate change, can also disrupt healthcare systems and infrastructure, hindering the response to outbreaks. Additionally, shifts in temperature and humidity can influence the survival and spread of pathogens, potentially leading to the emergence of new infectious diseases. Overall, climate change exacerbates the complexity and challenges of managing and preventing pandemics and epidemics, making it crucial to address both environmental and public health concerns in a coordinated manner to mitigate the impact on global health.

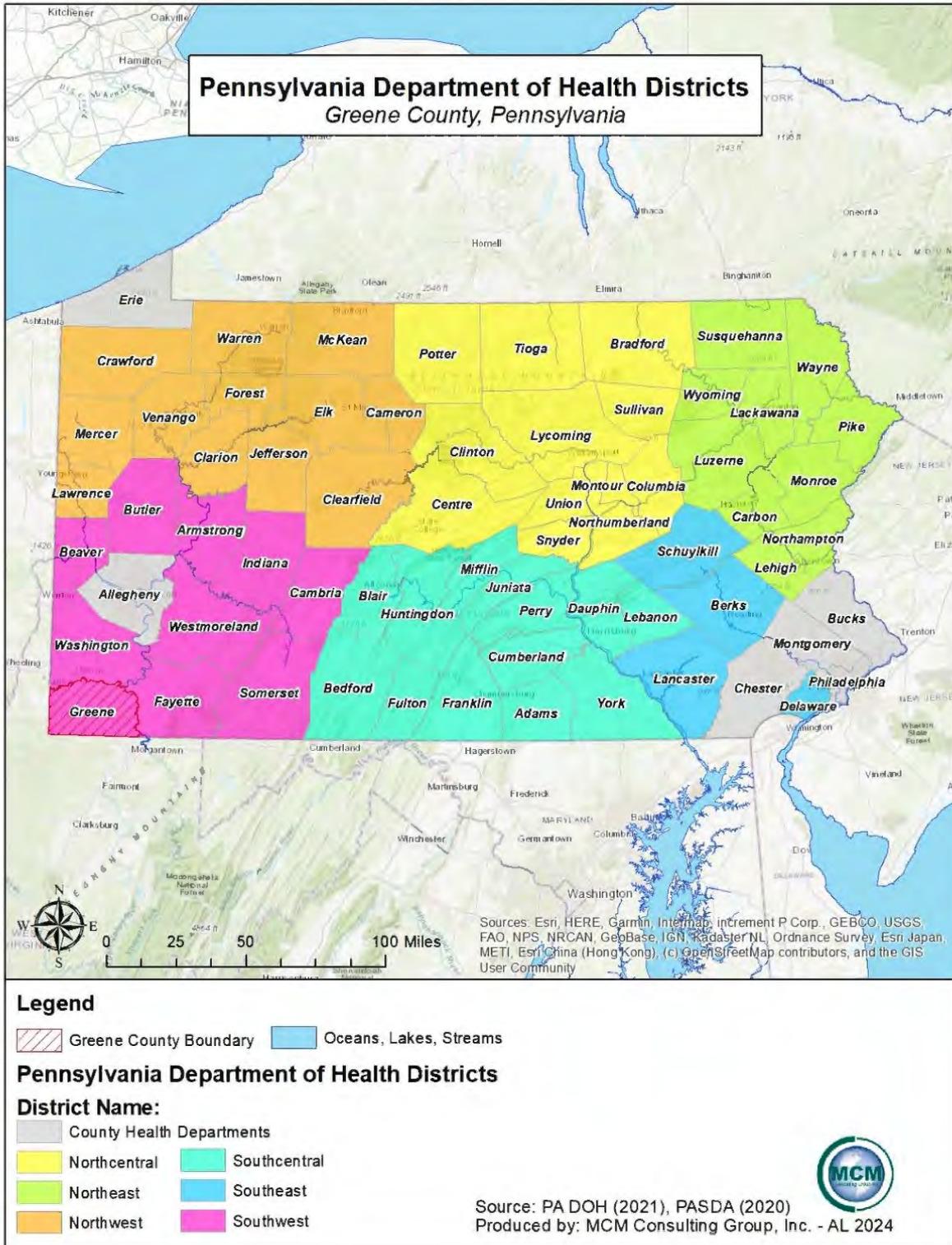
Population changes can directly impact the vulnerability of Greene County to pandemic events, like COVID-19. With increased populations there is a greater risk of the spread of communicable diseases, especially in areas where the population density is high. There are eight municipalities in Greene County that have seen an increase in population between 2010 and 2020. This

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

information is shown in *Table 3 – Population Change in Greene County*, Greene County should monitor population growth in the boroughs and cities of the county. The socially vulnerable populations in Greene County are at a higher vulnerability of pandemic, epidemic, and infectious diseases than lesser vulnerable populations. This is due to lack of health care services for homeless, unsheltered, and transient populations in Greene County and the difficulty in receiving treatment for health issues stemming from pandemics, epidemics, and infectious diseases. The national social vulnerability index for Greene County from CDC/ATSDR (Center for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry) is 0.3939 which represents a low level of vulnerability.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 29 - Pennsylvania Department of Health Districts



Source: PA DOH, 2019

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.3.9. Radon Exposure

4.3.9.1 Location and Extent

Airborne radon gas is radioactive and is a step in the radioactive decay of uranium to radium. Radon is a noble gas, cannot be seen, and has no odor. Like other noble gasses, radon gas is very stable, so it does not easily combine with other chemicals. Two isotopes of radon are commonly found: ^{222}Rn and ^{220}Rn . The ^{220}Rn isotope has a very short half-life, so it often only exists for fifty-five seconds, not long enough to pose a hazard to humans. The ^{222}Rn isotope has a half-life of 3.8 days which is long enough to pose a threat to humans. Still, due to the relatively short half-life of ^{222}Rn , it only exists in relative proximity to its radioactive parent, usually within tens of feet away. Radon is a carcinogen and when inhaled, it can lead to the development of lung cancer.

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. Radon was discovered as a significant source of natural radiation for humans in 1984 in the Reading Prong geologic province in Eastern Pennsylvania, when routine monitoring of employees leaving the not yet active Limerick nuclear power plant showed readings that a construction worker working on the plant frequently exceeded expected radiation levels despite the fact that the plant was not active. The Environmental Protection Agency (EPA) guidelines state that mitigation actions should be taken if levels exceed 4pCi/L in a home, and most uranium miners have a maximum exposure of 67 pCi/L. Subsequent testing of the Limerick power plant worker's home showed high radon levels of 2,500 pCi/L (pico Curies per Liter), triggering the Reading Prong to become the focus of the first large-scale radon scare.

Radon gas is considered ubiquitous and can be found in indoor and outdoor environments. There is no known safe level of exposure to radon. For most people in Pennsylvania, the greatest risk of radon exposure is from within their home in rooms that are below, directly in contact with, or immediately above the ground. Sources of radon include radon in the air from soil and rock beneath homes, radon dissolved in water from private wells and exsolved during water use (rare in Pennsylvania), and radon emanating from uranium-rich building materials such as concrete blocks or gypsum wallboard (also rare in Pennsylvania). Key factors in radon concentration in homes are the rates of air flow into and out of the house, the location of air inflow, and the radon content of air in the surrounding soil. Because of the flow dynamics of air inside of most houses, even a small rate of soil radon gas inflow can lead to elevated radon concentrations.

There are several factors that contribute to higher radon levels in soil gas:

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

- Proximity to elevated uranium rich deposits (>50ppm). Areas within a few hundred feet of such deposits are most at risk. Such deposits are rare in Pennsylvania.
- Some more common rocks have higher than average uranium content (5 to 50 ppm), and proximity to such rocks also increases the risk of radon exposure. These rock types include black shales as well as granitic and felsic alkali igneous rocks. This is the most common source of high radon levels in Pennsylvania. The Reading Prong elevated radon levels come from Precambrian granitic gneisses.
- Other soil and bedrock properties that facilitate radon mobility. The amount of pore space in the soil and its permeability – more porous soils will allow radon to travel more easily. Limestone-dolomite soils can also be predisposed to collect radon from radium resultant from weathering of iron oxide or clay surfaces. In some cases (like State College in Centre County, PA) even with underlying bedrock having normal uranium concentrations (.5 to 5 ppm), the vast majority of locations built on limestone-dolomite soils exceed radon concentrations of 4pCi/L, and many exceeded 20 pCi/L.

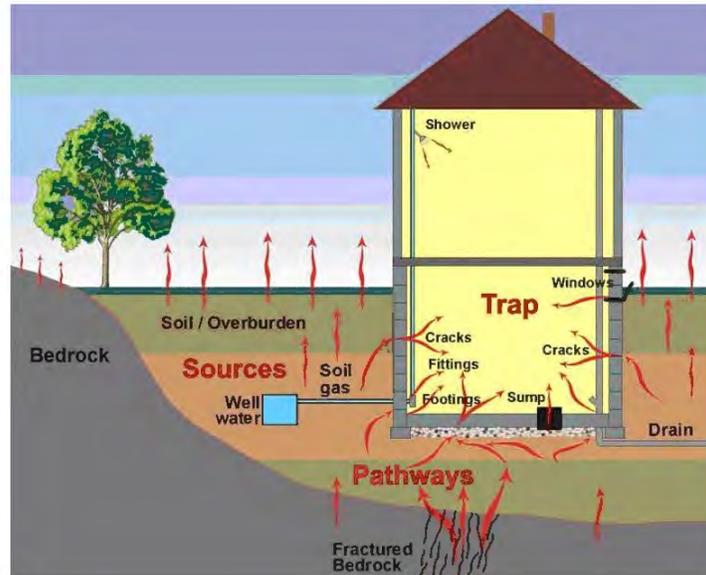
The following three sources of radon in houses are now recognized (see *Figure 30 - Sketch of Radon Entry Points into a House* below):

- 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.
- Radon emanating from uranium-rich building materials (e.g., concrete blocks or gypsum wallboard); this is not known to be a problem in Pennsylvania.

High radon levels were initially thought to be exacerbated in houses that are tightly sealed, but it is now recognized that rates of airflow 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 (where radon concentration is 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. 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.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 30 - Sketch of Radon Entry Points into 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, 10% to 50% 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 airflow, 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.

The second factor listed above is most likely the cause of high radon levels in Greene County. The data show that most reported zip codes in the county have high basement radon level test results. The areas and test results are shown in more detail in the past occurrence section.

4.3.9.2 Range of Magnitude

According to the EPA, about 21,000 lung cancer deaths each year in the U.S. are related to radon. It is the second leading cause of lung cancer after smoking and the number one cause of lung cancer among nonsmokers. Radon causes lung cancer by continuing to radioactively decay after being inhaled, and turning into a daughter product (^{218}Po , ^{214}Pb , ^{214}Bi) which may become attached to lung tissue and induce lung cancer due to the continued radioactive decay.

The EPA reports that the national average radon concentration of indoor air of homes is about 1.3 pCi/L, and they recommend that homes be fixed if the radon level is 4pCi/L or more. There

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

is, however, no safe level of radon exposure, so the EPA also recommends considering fixing a home if the radon level is between 2 pCi/L and 4 pCi/L.

Table 42 - Radon Risk for Smokers and Nonsmokers shows the relationship between various radon levels, probability of lung cancer, comparable risks from other hazards, and action thresholds. As seen in *Table 42 - Radon Risk for Smokers and Nonsmokers* below, a smoker exposed to radon has a much higher risk of lung cancer.

Table 42 - Radon Risk for Smokers and Nonsmokers

Radon Risk for Smokers and Nonsmokers			
Radon Level (pCi/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	

**Greene County, Pennsylvania
2025 Hazard Mitigation Plan**

Radon Risk for Smokers and Nonsmokers			
Radon Level (pCi/L)	If 1,000 People Were Exposed to this level over a lifetime...*	Risk of cancer from radon exposure compares to...***	Action Threshold
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
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.			

4.3.9.3 Past Occurrence

In 1984, the Pennsylvania Radon Bureau responded to the newly detected high radon levels with a massive radon monitoring, educational, and remediation effort. In the start of November 1986, over 18,000 homes had been screened for radon and approximately 59% were found to have radon daughter levels in excess of the 0.020 Working Level (WL) guideline. Radon daughter levels ranged up to 13 WL or 2600 pCi/L or radon gas.

The Pennsylvania Department of Environmental Protection (PA DEP) provides information for homeowners about how to test for radon in their homes, and when they receive a test result over 4 pCi/L, the PA DEP Bureau of Radiation Protection works to help homeowners repair the home and mitigate the hazard. The DEP has estimated that the national average indoor radon concentration is 1.3 pCi/L and the level for action is 4.0 pCi/L; however, they have estimated that the average indoor concentration in Pennsylvania basements is about 7.1 pCi/L and 3.6 pCi/L on the first floor. The PA DEP records all the tests they receive and categorize them in a searchable database by zip code. There are currently 2,174 zip codes in Pennsylvania, but the zip code radon test data only covers for 986 zip codes. The missing zip codes that report in the database as “N/A” for insufficient data either had fewer than thirty test results or no test results at all.

Figure 43 – Radon Test Results in Greene County shows a total of four zip codes in Greene County where tests were reported to the PA DEP to report their findings; those with no available data were not included in the table. The highest average radon level was reported from the 15370-zip code, which is in Waynesburg Borough, with an average reading of 7.2pCi/L within location of the basement. Most reporting zip codes in Greene County have average basement Radon levels slightly above the suggested EPA action level of 4 pCi/L. The average basement

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

reading for reporting zip codes in the county is 4.8 pCi/L, and there was insufficient data for the average first floor reading.

Table 43 - Radon Test Results in Greene County

Radon Level Test Results					
Zip Code	Postal Community	Location	Number of Tests	Max Result pCi/L	Average Result pCi/L
15320	Carmichaels	Basement	76	20.0	3.3
		First Floor	Insufficient Data		
15322	Clarksville	Basement	64	15.8	6.2
		First Floor	Insufficient Data		
15344	Jefferson	Basement	31	10.0	2.6
		First Floor	Insufficient Data		
15370	Waynesburg	Basement	249	265.1	7.2
		First Floor	Insufficient Data		
Source: PA DEP, 2024					

4.3.9.4 Future Occurrence

Radon exposure is likely given the geologic and geomorphic conditions in Greene County. The EPA and USGS have mapped radon potential in the US to help target resources and assist local governments in determining if radon-resistant features are applicable for new construction. The designations are broken down in three zones and are assigned by county, as shown in *Figure 31 – Pennsylvania Radon Levels*. Each zone reflects the average short-term measurement of radon that can be expected in a building without radon controls. Greene County is located within Zone 2 with counties of moderate potential for radon which indicate an intermediate likelihood of occurrence in the future.

1. Zone 1 has the highest potential and readings can be expected to exceed the 4 pCi/L recommended limit.
2. Zone 2 has a moderate potential for radon with levels expected to be between 2 and 4 pCi/L and
3. Zone 3 has a low potential with levels expected to be less than 2 pCi/L.

Due to the moderate likelihood of future occurrence, the level of radon daughters should be monitored. Radon daughters are the concentration of decay products of radon in the uranium chain. Fortunately, the presence of radon daughters can be monitored through the means as radon gas. *Table 44 - Suggested Actions and Time Frame for Exposure to Radon Daughters* provides suggested actions and time frames for varying levels of exposure to radon daughters.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Table 44 - Suggested Actions and Time Frame for Exposure to Radon Daughters

Suggested Actions and Timeframe for Exposure to Radon Daughters		
Exposure Level*	Suggested Action**	Timeframe For Plan
more than 5.0 WL***	Residents should either promptly relocate or undertake temporary remedial action to lower levels as far below 5.0 WL as possible. Smoking in high areas discouraged.	Within 2-3 days
1.0 to 5.0 WL	Residents should undertake temporary remedial action to lower levels as far below 1.0 WL as possible. Smoking in high areas discouraged.	Within 1 week
0.5 to 1.0 WL	Residents should undertake temporary remedial action to lower levels as far below 0.5 WL as possible.	Within 2 weeks
0.1 to 0.5 WL	Residents should undertake temporary remedial action to lower levels as far below 0.1 WL as possible. Higher exposure levels require action to be taken in a shorter	3 weeks to 3 months
0.02 to 0.1 WL	Residents should undertake temporary and/or permanent remedial action to lower levels below 0.02 WL. Higher exposure levels require action to be taken in a shorter	4 to 15 months

Climate change will have minor impacts on radon exposure in Greene County, if any. Climate change will have an increased impact on the vulnerability of individuals to radon if those individuals live in an area where permafrost is a feature of the climate. With rising global temperatures, permafrost can melt, resulting in increased soil and bedrock erosion. This can result in higher rates of radon exposure. This is of primary concern to those areas located in the northern latitudes and will not have a significant impact on the bedrock or soils of Greene County. It is possible that climate change could impact soil and bedrock erosion rates in Greene County, but these impacts would be minor or unknown, at this time.

4.3.9.5 Vulnerability Assessment

Proper testing for radon levels should be conducted across Greene County, especially in the areas of higher incidence levels, and for those individuals and households that are susceptible to the contributing risks. This testing will determine the level of vulnerability that residents face in their homes, as well as in their businesses and schools.

Greene County is in the EPA Radon Hazard Zone 2, meaning there is a moderate risk of radon exposure. Smokers can be up to ten times more vulnerable to lung cancer from high levels of radon depending on the level of radon to which they are exposed. Additionally, older homes that have crawl spaces or unfinished basements are more vulnerable to high radon levels. Average basement radon levels for homes that reported their results to the PA DEP are often found to be above the EPA action level of 4 pCi/L. *Figure 32 – Radon Levels by Zip Code* shows the best

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

available data from the EPA about the percentage of homes with radon levels at, or above, the EPA action level. The EPA estimates that an average radon mitigation system costs approximately \$1,200.00. The PA DEP 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 buildings. The 2023 PA HMP estimates that there are 3,010 vulnerable buildings in Greene County that are in areas with high radon test results, and the cost to mitigate the most impacted of those buildings (an estimated 20% of them or 602 buildings) would be \$722,400.00

The historic properties in Greene County are at varying levels of risk to radon levels. There are no historic properties that are at an increased risk of radon exposure. There are sixteen historic properties listed with the National Register of Historic Places that are located in areas that have had at least an average of between 2.6 pCi/L and 7.2 pCi/L of measured radon levels. Those properties are listed below.

- Carmichaels Covered Bridge
- Colver Rogers Farmstead
- Crawford, William, House
- Cree, William, House
- Greene Academy
- Greene Hills Farm
- Grimes Covered Bridge
- Hanna Hall
- Heasley, Charles Grant, House
- Hughes House
- Kent, Thomas, Jr. Farm
- Kent, Thomas, Jr., Farm
- Lippincott Covered Bridge
- Miller Hall
- Rex, John, Farm
- Waynesburg Historic District

The cultural resources in Greene County could be adversely impacted by radon exposure. If these locations have not been properly mitigated, the visitors to these locations could be at risk of radon exposure, even for a short time.

The direct hazard to radon exposure at these locations is not related to the buildings, but to the individuals who live, work, visit, and maintain these structures.

The vulnerability of natural areas to radon exposure is negligible. Since radon exposure typically is a natural hazard to humans when in enclosed spaces, and over a large portion of time, natural areas are at a lower risk. Most individuals are doing activities when outdoors and are usually not stationary for hours and days. The local parks, state game lands, state forests, and state parks are at low risk and low vulnerability.

Municipalities with an increased risk of radon exposure (with areas with a basement pCi/L over 12):

- None

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Municipalities without an increased risk of radon exposure (with areas with a basement pCi/L under 12):

- Aleppo Township
- Carmichaels Borough
- Center Township
- Clarksville Borough
- Cumberland Township
- Dunkard Township
- Franklin Township
- Freeport Township
- Gilmore Township
- Gray Township
- Greene Township
- Greensboro Borough
- Jackson Township
- Jefferson Borough
- Jefferson Township
- Monongahela Township
- Morgan Township
- Morris Township
- Perry Township
- Rices Landing Borough
- Richhill Township
- Springhill Township
- Washington Township
- Wayne Township
- Waynesburg Borough
- Whiteley Township

Socially vulnerable populations in Greene County are at an increased vulnerability to radon exposure than other groups in Greene County. Approximately 13% of the population of Greene County is in poverty, and those individuals may be located in areas of high radon risk. Those individuals may also be unable to purchase or install radon remediation kits and systems due to economic factors. Information from the Pennsylvania Department of Environmental Protection states that installing a radon reduction system can cost between \$500.00 to \$2,000.00 with the average costing \$1,000.00 (PA DEP, 2023). Radon exposure may also impact the health of those considered to be socially vulnerable. With unequal access or opportunity to health care, potential health effects related to radon exposure can go unreported and unaddressed in socially vulnerable populations.

Population changes, especially any increase in population, in Greene County pose an increased risk to vulnerability of radon exposure to individuals in each municipality. Between the 2010 and the 2020 US Census, eight municipalities in Greene County experienced population growth, those being Carmichaels Borough, Center Township, Gilmore Township, Greene Township, Greensboro Borough, Jackson Township, Monongahela Township, and Rices Landing Borough. These increases can be seen in *Table 3 – Population Change in Greene County*. Another risk to radon exposure due to population changes could occur from people moving into structures with basements that have been empty for extended periods of time or converting camps into homesteads. Education about the dangers of radon exposure should occur at the municipal level when existing homes are purchased. New construction can be built with radon prevention systems in place costing between \$500.00 to \$2,000.00 per building.

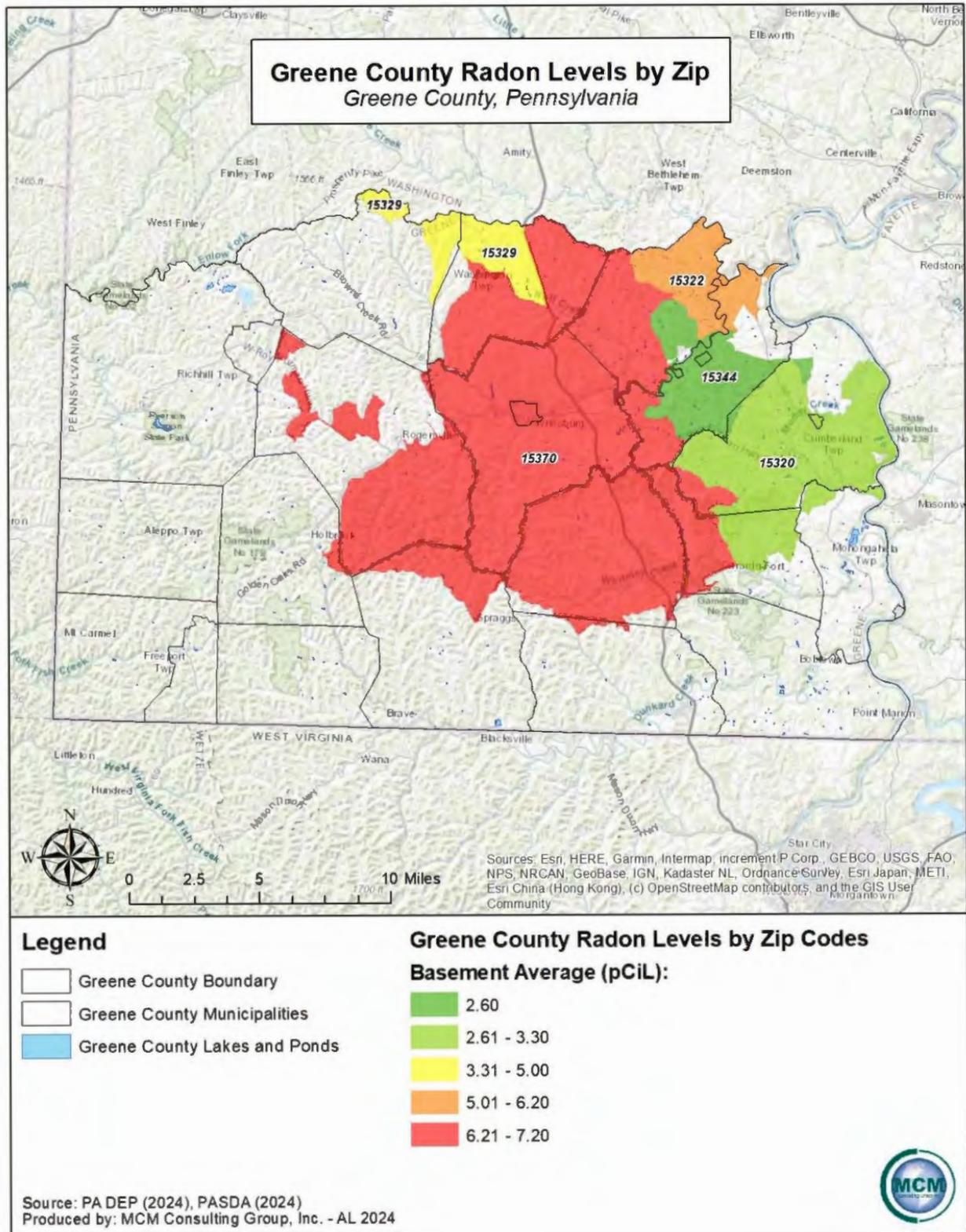
Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Land use could result in more rapid radon exposure if the areas being used for different land uses are over areas of high radon levels. If new land use results in exposure of the bedrock to weathering, increased radon exposure and leakage will occur. This could include the development of new or commercial properties in an area. New development may be built and constructed with radon reduction systems already in place, reducing the vulnerability for each new location with these systems. New development may have clean aggregate in construction, piping below the foundation slab, sealing of openings in foundations, or electric boxes in the attic for radon reduction system fans (PA DEP, 2023).

Radon can impact Greene County infrastructure systems by accelerating corrosion in metal components of buildings such as steel reinforcements in concrete, leading to weakening of structural elements over time. This corrosion can compromise the stability of bridges, tunnels, and other critical infrastructure. Additionally, radon-induced degradation of building materials like concrete can cause cracks, spalling, and overall degradation of structural integrity. Radon can infiltrate underground utility tunnels that can corrode pipes, conduits and electrical wiring which can lead to the potential of leaks and electric failures. Radon has the ability to compromise both structural and operational functions of infrastructure system.

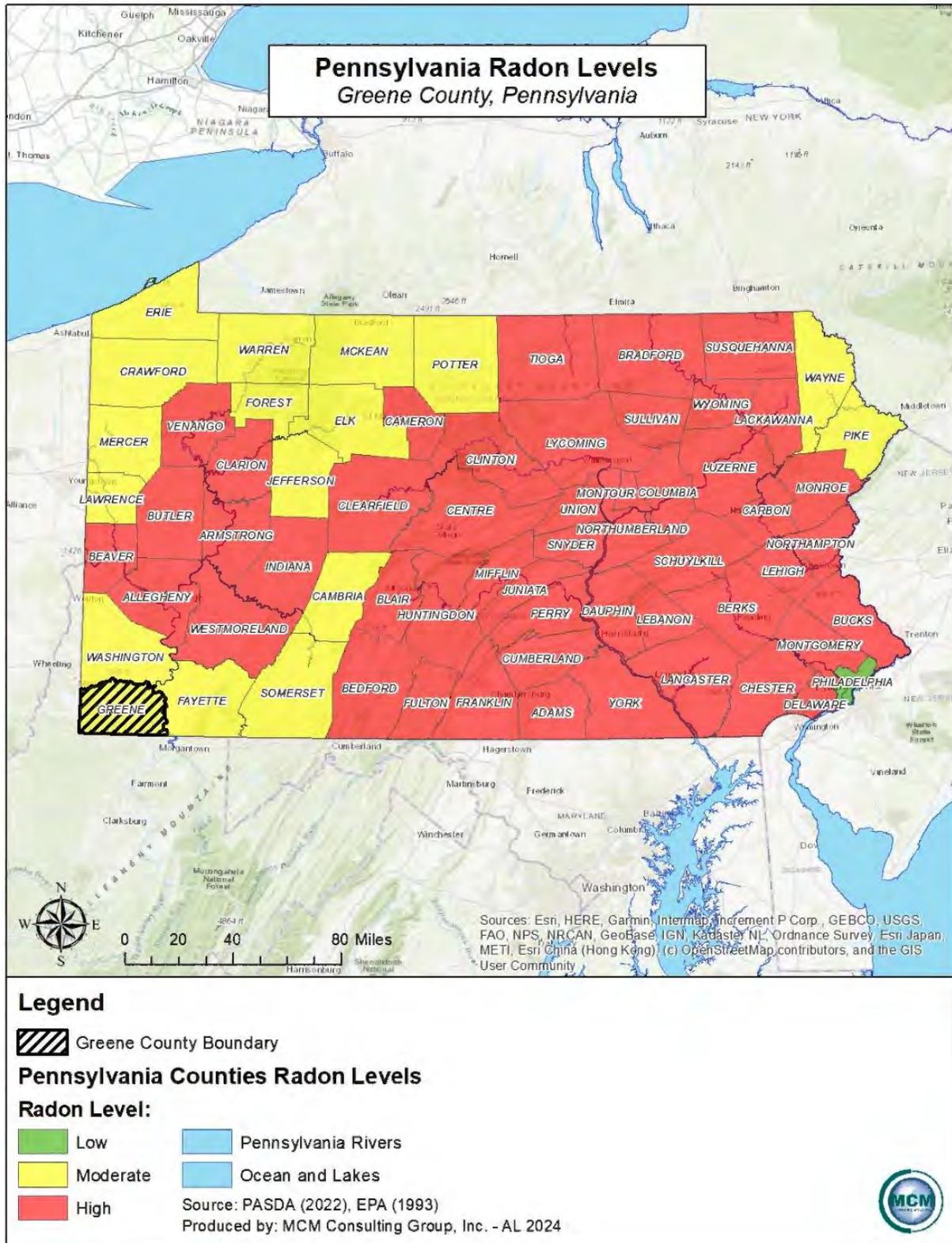
Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 31 - Pennsylvania Radon Levels



Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 32 - Radon Levels by Zip Code



Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.3.10. Subsidence, Sinkhole

4.3.10.1 Location and Extent

Subsidence is the sinking movement of the earth's surface; the result of this movement is commonly referred to as a sinkhole. There are two common causes of subsidence in Pennsylvania: 1) dissolution of carbonate rock such as limestone or dolomite and 2) mining activity. In the first case, water passing through naturally occurring fractures and bedding planes dissolves bedrock leaving voids below the surface. Eventually, overburden on top of those voids collapses, leaving surface depressions resulting in what is known as karst topography. Characteristic structures associated with karst topography include sinkholes, linear depressions, and caves. Often, sub-surface solutions of limestone will not result in the immediate formation of karst features. Collapse sometimes occurs only after a large amount of activity, or when a heavy burden is placed on overlying material. The bedrock geology is found mostly in the south-central and eastern portions of the Commonwealth of Pennsylvania, and Greene County is not located in a karst vulnerable area. Subsidence in Greene County is primarily to mining activity. This plan will focus on both carbonate rock / karst topography and mining activity. Greene County has a history of subsidence due to carbonate rock and mining activity.

Mining activity is concentrated in the southwestern region of the state. The majority of sub-surface (i.e., underground) extraction of materials such as oil, gas, coal, metal ores (i.e., copper, iron, and zinc), clay, shale, limestone, or water can result in slow-moving or abrupt shifts in the ground surface and these areas have a higher potential to be impacted by sinkholes and subsidence. Sinkholes often develop where the cover above a mine is thin. Sinkhole development normally occurs where the interval to the ground surface is less than three to five times the thickness of the extracted seam and the maximum interval is up to ten times the thickness of the extracted seam. In western Pennsylvania, most sinkholes develop where the soil and rock above a mine are less than fifty feet thick.

Human activity can also result in subsidence or sinkhole events. Leaking water pipes or structures that convey storm-water runoff may result in areas of subsidence as the water dissolves substantial amounts of rock over time. Poorly managed stormwater can be an exacerbating factor in subsidence events. In some cases, construction, land grading, or earthmoving activities that cause changes in stormwater flow can trigger sinkhole events.

4.3.10.2 Range and Magnitude

No two subsidence areas or sinkholes are exactly alike. Variations in size and shape, time period under which they occur (i.e., gradually, or abruptly), and the proximity to development ultimately determine the magnitude of damage incurred. Events could result in minor elevation

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

changes or deep, gaping holes in the surface. Subsidence and sinkhole events can be addressed before significant damage occurs.

Primarily, problems related to subsidence include the disruption of utility services and damages to private and public property including buildings, roads, and underground infrastructure. Isolated incidents of subsidence throughout the coal regions over the past years have affected houses, garages, and trees that have been swallowed up by subsidence holes. Lengths of local streets and highways, and countless building foundations have been damaged.

If long-term subsident or sinkhole formation is not recognized and mitigation measures are not implemented, fractures or complete collapse of building foundations and roadways may result. The worst-case scenario of a mine subsidence event for Greene County would be similar to an event in Allegheny County in 2013, when sixty-nine homes in Hyde Park sustained mine subsidence damage. The Pennsylvania Department of Environmental Protection responded to the subsidence by filling the mine voids at a cost of \$3.7 million. If mitigation measures are not taken, the cost to fill in and stabilize sinkholes can be significant although sinkholes are limited in range of magnitude.

Voids in the earth's subsurface are created where coal was previously mined and removed. The condition removes a significant portion of the support of the overlying rock strata that usually causes the rock strata to fall or subside into the voids that may damage dwellings or other surface structures above the affected areas. Mining locations across the county should be carefully noted and avoided as sites for new construction unless the proper measures are taken to ensure the mine's soundness.

The Greene County local planning team assigned a risk factor assessment score of 1.9 to subsidence and sinkhole formation. This places the hazard at a low risk factor. *Figure 33 – Sinkhole Susceptibility in Pennsylvania* illustrates the portions of the Commonwealth of Pennsylvania where sinkholes and subsidence are common. The hazard for subsidence and sinkholes in these regions is very high. Greene County has a large portion of mining areas and is therefore one of these regions.

4.3.10.3 Past Occurrence

There is no comprehensive list of mine subsidence in Greene County. The Pennsylvania Department of Conservation and Natural Resources (PA DCNR) provides an online sinkhole inventory database, which lists a total of 3,619 identified sinkholes in Pennsylvania as of 2024. Of these sinkholes none fall within Greene County. The fact that no sinkholes were identified does not necessarily mean there are no sinkholes in Greene County. Additionally, the Pennsylvania Department of Environmental Protection indicates that some small incidences of

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

sinkholes occur several times per week and cause limited damage and that many of these are related to failing infrastructure like water main breaks or collapsed pipes.

4.3.10.4 Future Occurrence

There is currently no reliable information regarding the probability of future occurrence of subsidence or sinkholes in Pennsylvania. One way of estimating the probability of future occurrences would be to project the historical trends into the future, but there is no comprehensive documentation of previous events in Greene County. The PA DEP has noted that mine subsidence events are constant though they vary in intensity and damage. Based on geological conditions and mining activities in Greene County, the annual occurrence of subsidence and sinkholes near past mining areas is considered likely. Although precise locations of future occurrences are difficult to predict due to site-specific conditions that contribute to sinkhole development, there are several signs that can signal potential development.

The signs include:

- Slumping or falling fence posts, trees, or foundations.
- Sudden formation of small ponds.
- Wilting vegetation.
- Discolored well water.
- Structural cracks in walls and/or floors.

Based on geological conditions and mining activity, subsidence events are likely to occur in Greene County. If land development and mining were to occur in an area that is unstable or unsafe, a subsidence event or sinkhole is likely to form. *Figure 35 – Unsuitable Areas for Mining in Pennsylvania* illustrates the areas of Pennsylvania where mining could potentially cause a subsidence event or a sinkhole. A significant number of these areas that are unsuitable for mining are located in and around Greene County.

Climate change may increase the frequency of subsidence in Greene County. Climate change could result in more intense rainfall from more frequent hurricanes and tropical storms, or it could result in hot, dry areas becoming increasingly dry. The increase in precipitation could result in ground swelling, due to soils that contain clay minerals absorbing the rainfall. This swelling is seen as an increase in vertical land motion, while shrinking is the decrease in vertical land motion. Shrinking occurs when there are high temperatures that cause the land to dry out, resulting in more movement in the soil, which can be seen as a gradual settling or sudden sinking of Earth's surface. The combination of shrinking and swelling could increase with climate change and ultimately increase the frequency of subsidence and sinkholes in Greene County.

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.3.10.5 Vulnerability Assessment

Areas of the county where commercial mining operations take place are the most vulnerable to subsidence and sinkhole hazards. Natural subsidence and sinkholes have never been reported in Greene County. A mined area may be differentially prone to subsidence based on its geology and depth of mineral seam, but reliable information about the different locations of varying depths of seams are not available. Geologists agree that all areas that are mined are prone to subsidence; therefore, coal mined areas are shown as vulnerable to mine subsidence.

Most of the mining that has occurred in Greene County was superficial mining of natural resources. The mine sites were abandoned after extraction can potentially become areas susceptible to subsidence events. These areas can be seen in *Figure 34 – Abandoned Mined Sites in Greene County*. Subsidence cannot be ruled out as a potential hazard for Greene County. There are no state or county critical infrastructure facilities at risk in the county due to sinkholes.

There are no critical infrastructure or community lifeline locations within 500 feet of abandoned mine areas in Greene County.

Municipalities with an increased risk of subsidence or sinkholes (abandoned mine areas):

- Cumberland Township
- Dunkard Township
- Greene Township
- Jefferson Township
- Monongahela Township
- Morgan Township
- Perry Township
- Richhill Township

Municipalities without an increased risk of subsidence or sinkholes (no abandoned mine areas):

- Aleppo Township
- Carmichaels Borough
- Center Township
- Clarksville Borough
- Franklin Township
- Freeport Township
- Gilmore Township
- Gray Township
- Greensboro Borough
- Jackson Township
- Jefferson Borough
- Morris Township
- Rices Landing Borough
- Springhill Township
- Washington Township
- Wayne Township
- Waynesburg Borough
- Whiteley Township

Underserved, unserved, and socially vulnerable populations face heightened impacts from subsidence and sinkholes. Limited resources often result in substandard infrastructure, exacerbating susceptibility to ground collapse. Housing in these areas is prone to structural damage, posing threats to lives and livelihoods. Displacement becomes a critical concern as

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

sinkholes disrupt communities, challenging access to safe shelter. Vulnerable populations may lack the financial means for adequate recovery, perpetuating economic hardships.

Population change can increase the impacts of subsidence or sinkholes in Greene County. Greene County has eight out of twenty-six total municipalities that had a population increase between the 2010 and the 2020 US Census. This population change can also be seen in *Table 3 – Population Change in Greene County*. Based on this information, it can be speculated that these municipalities may have an increased/equivalent vulnerability to subsidence and sinkholes since 2010, due to the increase in population and construction.

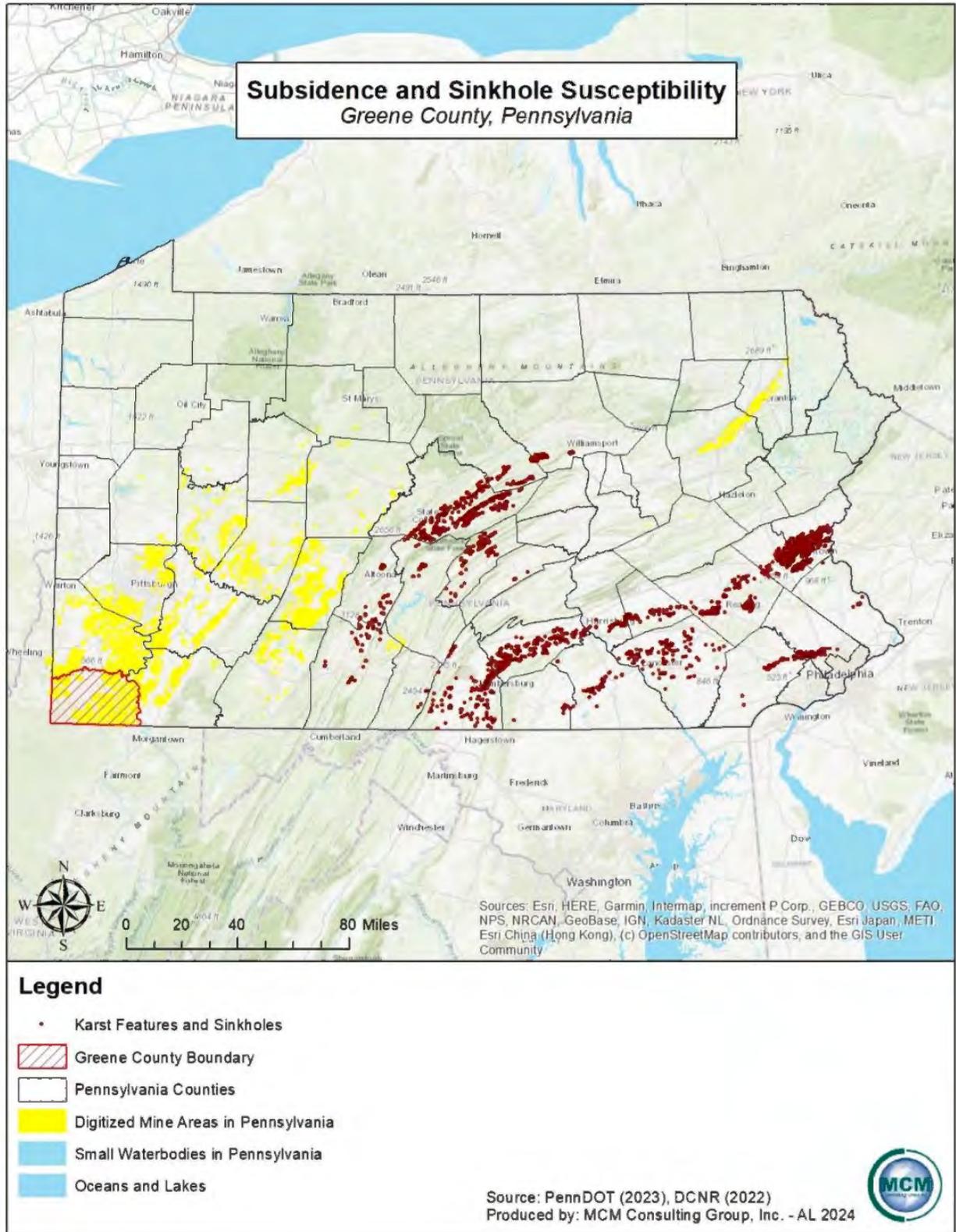
Current land use in Greene County can affect the vulnerability of the county to subsidence and sinkholes. Impervious surfaces allow pollutants from aerial and terrestrial sources to accumulate. During stormwater runoff, these pollutants will run into stormwater drains and directly to local waterbodies. When impervious surfaces increase, so does the quantity, speed, temperature, and pollutant load of the storm water runoff.

Subsidence and sinkholes present dual threats to both natural and cultural areas. Ecologically, these alter landscapes, compromising soil stability and disrupting ecosystems. Sinkholes can swallow habitats, impacting land use for the county. Culturally, the collapse of terrain endangers heritage sites, structures, and artifacts, erasing historical landscapes. Subsidence may threaten traditional agricultural practices linked to specific terrains.

Subsidence and sinkhole events can also pose a threat to systems within Greene County. Some systems that may be affected by subsidence and sinkhole events are natural gas, water, and the numerous other materials and chemicals transported through underground water systems in Greene County. During significant subsidence and sinkhole events, underground pipelines may crack, causing the transported material to leak into the ground and contaminating water sources in the county. Even in more contained scenarios, a small leak can have profound impact if the transported material is toxic or hazardous in nature, leading to degradation of the natural resources in the impacted communities. Subsidence and sinkhole events can also cause above ground localized transportation issues if an event were to occur along a transportation route through Greene County. This can cause a delay in daily transportation and may require alternate transportation routes to be established for an extended period of time.

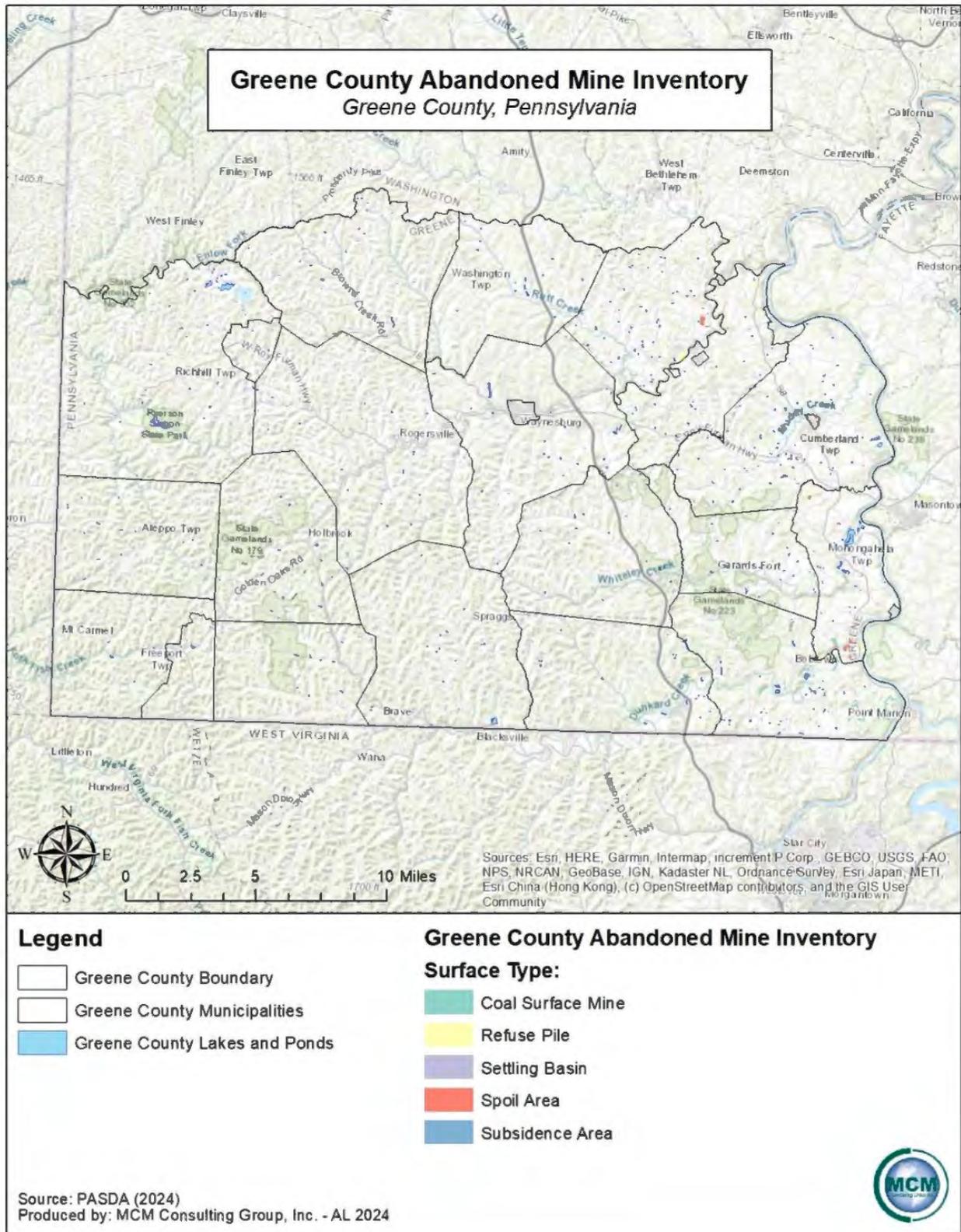
Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 33 - Sinkhole Susceptibility in Pennsylvania



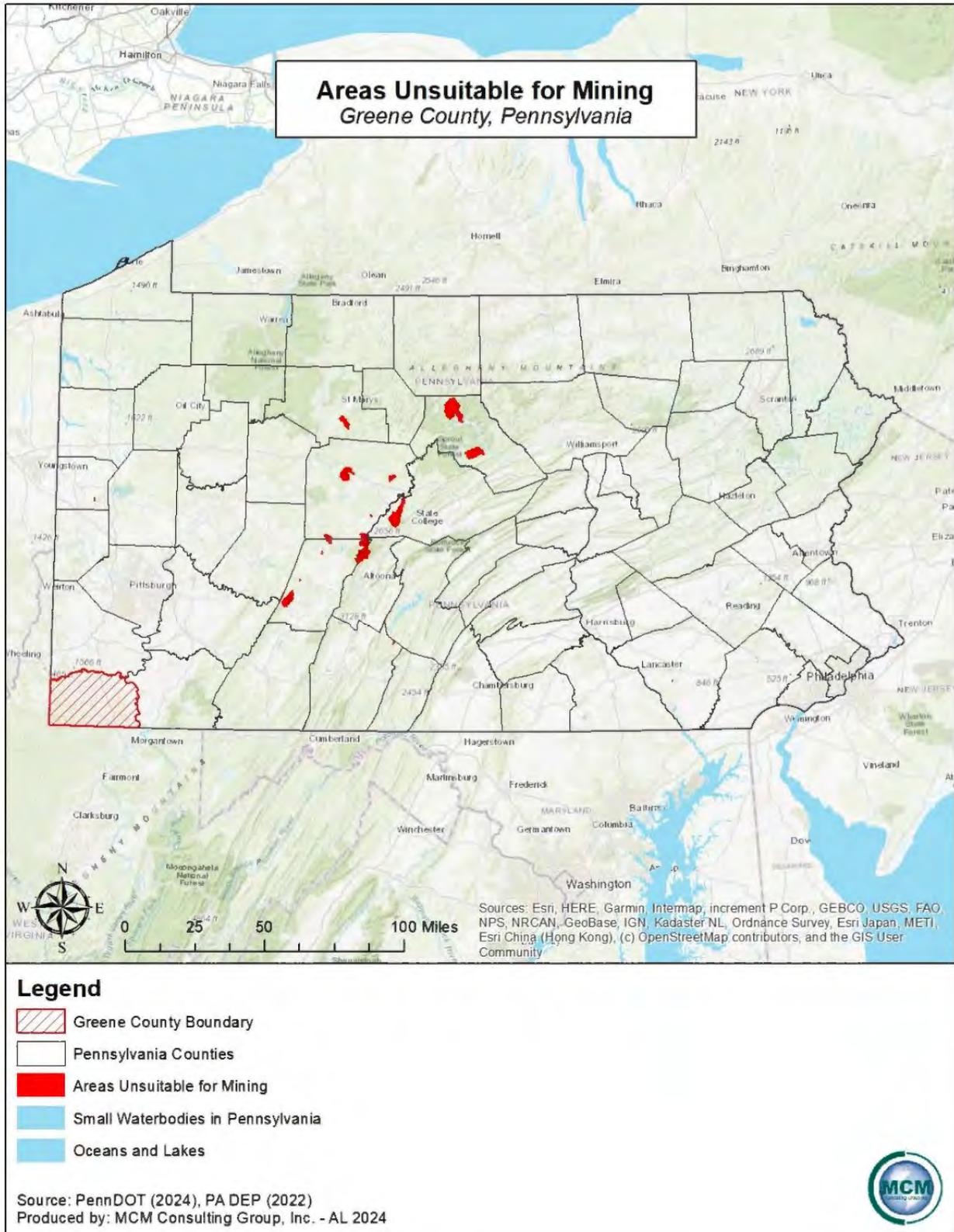
Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 34 - Abandoned Mined Sites in Greene County



Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 35 - Unsuitable Areas for Mining in Pennsylvania



Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.3.11. Tornado, Windstorm

4.3.11.1 Location and Extent

Tornadoes and windstorms can occur throughout Greene County and are usually localized in their location and extent. Severe thunderstorms may result in conditions favorable for the formation of windstorms, including tornadoes. Tornadoes are nature's most violent storms and can cause fatalities and devastation to neighborhoods and municipalities within the county and region. Tornadoes can occur at any time during the day or night but are most frequent during the late afternoon and early evening, which are typically the warmest hours of the day. Tornadoes are most likely to occur in the spring and summer.

Tornadoes

There are two main types of tornadoes: supercell and non-supercell. Supercell tornadoes are the most common and often the most dangerous type of tornado. A rotating updraft is key to the development of a supercell and, eventually, a tornado. Once the updraft is rotating and being fed by warm air, a tornado is formed. The other type of tornado is categorized as non-supercell, which is not as common as a supercell tornado. One type of non-supercell tornado is the "Quasi-Linear Convective Systems" (QLCS). The QLCS tornadoes typically arise during the late night or early morning hours and are typically weaker and more short-lived than supercell tornadoes. However, QLCS are more difficult to detect effectively. Another type of non-supercell tornado is a landspout. These tornadoes are narrow, rope-like funnels that form when a thundercloud grows without a rotating updraft, which causes the spinning motion common with tornadoes to appear near the ground.

Windstorms

Windstorms are experienced on a region-wide scale. The most frequent cause of windstorms in Pennsylvania are thunderstorms, although they may also be caused by hurricanes and winter storms. Windstorms are defined as sustained wind speeds of 40 mph or greater, lasting for at least one hour, or winds of 58 mph or greater lasting for any duration. There are a wide variety of windstorm events that can take place in Greene County.

4.3.11.2 Range of Magnitude

Tornadoes

Each year tornadoes account for \$1.1 billion in damages and cause over eighty deaths nationally. Thus far, 2011 was the second worst year on record for deadly tornadoes behind 1936. The number of tornado reports has increased since 1950. 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. The damage caused by a tornado is a result of the high-wind velocity and windblown debris, also accompanied by lightning or large hail. The most violent

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

tornadoes have rotating winds of 250 mph or more and are capable of causing extreme destruction and turning normally harmless objects into deadly projectiles.

Tornado movement is characterized in two ways: direction/speed of spinning winds and the forward movement of the tornado, also known as the storm track. The rotational wind speeds can range from 65 to more than 200 miles per hour (mph). The speed of forward motion can range from 0 mph to 50 mph. Forward motion of a tornado path can be a few to several hundred miles in length. Widths of tornadoes vary from less than 100 feet in diameter to more than a mile wide in regard to the largest tornadoes on record. The National Centers for Environmental Information (NCEI) reports that, “the maximum winds in tornadoes are often confined to extremely small areas and vary tremendously over short distance,” which explains why one house in a tornado’s path may be completely demolished while a neighboring house could remain untouched. Some tornadoes never touch the ground and remain short lived, while others may touch the ground or “jump” along its path.

The destruction from tornadoes can range from minor to severe depending on the intensity, size, and duration of the storm. Typically, tornadoes cause the greatest damage to structures of light-weight 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. These scales classify U.S. tornadoes into six intensity categories based upon the estimated maximum winds occurring within the wind vortex. This scale can be seen in *Table 45 – Enhanced Fujita Scale*. The EF-Scale became effective on February 1, 2007. 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. Previously recorded tornadoes are reported with the older F-Scale values, but *Table 45 – Enhanced Fujita Scale* shows F-Scale categories with corresponding EF-Scale wind speeds.

Figure 36 – Pennsylvania Wind Zones identifies wind speeds that could occur across the state, which may be used as the basis for design and evaluation of the structural integrity of shelters and critical facilities. The majority of Pennsylvania falls within Zone III, meaning that the design of shelters and critical facilities should be able to withstand a three-second gust of up to 200 mph, regardless of whether the gust is a result of a tornado, hurricane, tropical storm, or windstorm incident. The western portion of the state falls within Zone IV, which indicates shelters can withstand up to 250 mph winds, while the eastern side falls within Zone II where shelters should be designed to withstand up to 160 mph.

Since Greene County falls within Zone IV, shelters and critical facilities should be designed to withstand up to 250 mph winds, regardless of whether the gust is the result of a tornado, coastal storm, or windstorm event. While it is difficult to pinpoint the exact locations at the greatest risk

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

of a tornado, the southeast, southwest, and northwest sectors of the commonwealth are more prone to tornadoes.

Tornadoes/windstorms of all types have caused the following problems in Greene County:

- Power failures lasting four hours or longer.
- Loss of communications networks lasting four hours or more.
- Residents requiring evacuation or provision of supplies or temporary shelter.
- Severe crop loss or damage.
- Trees down or snapped off high above the ground/tree debris-fire fuel.
- Toppled high profile vehicles, including those containing hazardous materials.

Table 45 - Enhanced Fujita Scale

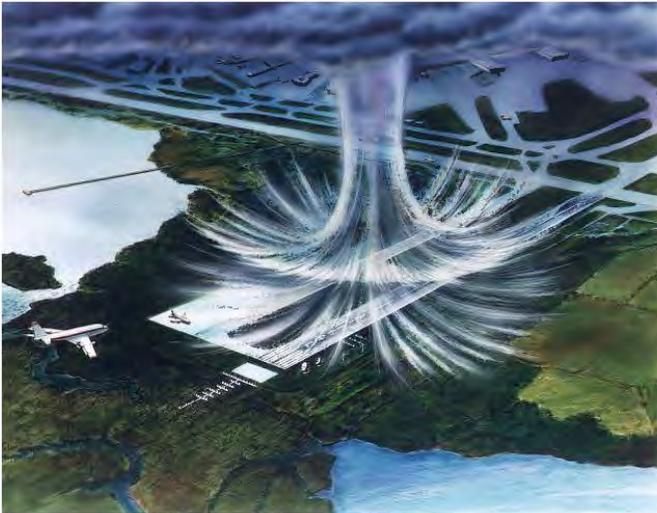
Enhanced Fujita Scale			
EF-Scale Number	Wind Speed (MPH)	F-Scale Number	Description of Potential Damage
EF0	65–85	F0-F1	Minor damage: Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (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 projectiles generated.
EF5	>200	F3-F6	Extreme damage: Strong frame houses leveled off foundations and swept away; automobile-sized projectiles fly through the air in excess of 100 m (300 ft.); steel reinforced concrete structure badly damaged; high-rise buildings have significant structural deformation.

Source: NWS, 2007

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Most of the tornadoes that have struck Greene County have occurred countywide. In 1985, a total of twenty-three confirmed tornadoes touched down across Eastern Ohio, Southwestern New York, and Central/Western Pennsylvania. This outbreak remains the worst in recorded history for this area. Of these twenty-three tornadoes, eight were of violent intensity (F4 or F5) with estimated wind speeds over 200 mph. Greene County was not impacted by the 1985 outbreak.

Windstorms



Windstorms can be broken down into multiple categories. Straight-line winds are the most common wind event and are different from tornadic winds. It is a ground level, non-rotational, wind that comes out of a thunderstorm. Downdrafts are columns of air that rapidly sink toward the ground and are classified as either a microburst or macroburst. A macroburst is the outward burst of strong winds that are near or at the surface with horizontal dimensions greater than 2 ½ miles. Macrobursts winds may begin over

a smaller area and then spread out to a wider area, sometimes producing damage similar to a tornado. On the other hand, microbursts are smaller outward bursts of strong winds near or at the surface. Microbursts are less than 2 ½ miles in horizontal dimension and are typically short-lived winds that last a maximum of ten minutes, with windspeeds reaching up to 100 mph. Microburst events can be wet or dry events. Wet microbursts are typically associated with heavy precipitation at the surface. Dry microbursts do not have precipitation associated with them and are commonly found in the western portion of the United States.

A gust front is characterized by wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Derecho is a long-lived windstorm that is associated with a band of rapidly moving showers or thunderstorms. A typical derecho contains various downbursts and microbursts. If the wind damage is more than 240 miles and includes wind gusts of at least 58 mph, the event would then be classified as a derecho.

4.3.11.3 Past Occurrence

Greene County has experienced nine tornado events since 1967, and 147 wind incidents between 1983 and summer of 2024 as seen in *Table 46 – Greene County Tornado History* and *Table 47 – Greene County High Wind History*. Numerous sources provide information in regard to past occurrences and losses associated with tornadoes/windstorms in Greene County and the commonwealth as a whole. Due to the number of sources available with information, specific

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

number of events and losses could vary slightly between sources. Tornado data was present until 2022, even though more recent events could have possibly occurred. Historically, the county has experienced both severe windstorms and tornadoes.

The most recent tornado impacted Hunters Cave on August 1, 2022.

Table 46 - Greene County Tornado History

Greene County Tornado History					
Location	Date	Magnitude (F/EF Scale)	Deaths	Injuries	Property Damage
Greene County	08/27/1967	F1	0	0	\$2,500.00
Greene County	06/25/1968	F2	0	1	\$250,000.00
Greene County	08/04/1968	F1	0	0	\$25,000.00
Greene County	03/27/1976	Unknown	0	0	\$25,000.00
Greene County	07/01/1990	F1	0	0	\$25,000.00
Kuhntown	08/22/2017	EF1	0	0	\$50,000.00
Graysville	10/02/2018	EF1	0	0	\$0.00
Crabapple	07/29/2021	EF1	0	0	\$100,000.00
Hunters Cave	08/21/2022	EF1	0	0	\$200,000.00
Source: NOAA NCEI, 2024 Estimated Values are marked*					

Table 47 - Greene County High Wind History

Greene County High Wind History				
Location	Date	Magnitude (knots)	Injuries	Property Damage
Greene County	7/21/1983	57 kts.	0	\$0.00
Waynesburg	5/18/1999	50 kts.	0	\$1,000.00
Rices Lndg	4/4/2003	55 kts.	0	\$1,000.00
Rices Lndg	7/7/2003	50 kts.	0	\$1,000.00
Morrisville	7/18/2003	50 kts.	0	\$1,000.00
Waynesburg	7/18/2003	50 kts.	0	\$2,000.00
Bobtown	8/3/2003	50 kts.	0	\$5,000.00
Countywide	8/26/2003	50 kts.	0	\$5,000.00
Greensboro	8/27/2003	50 kts.	0	\$0.00
Spraggs	8/27/2003	50 kts.	0	\$0.00
Countywide	5/21/2004	50 kts.	0	\$5,000.00
Spraggs	5/21/2004	50 kts.	0	\$2,000.00
New Freeport	8/4/2004	50 kts.	0	\$3,000.00
Waynesburg	8/10/2004	50 kts.	0	\$0.00
Crucible	6/6/2005	50 kts.	0	\$4,000.00
Waynesburg	6/14/2005	50 kts.	0	\$10,000.00
Garards Ft	6/30/2005	50 kts.	0	\$2,000.00
Aleppo	7/25/2005	50 kts.	0	\$20,000.00
Carmichaels	11/6/2005	50 kts.	0	\$12,000.00

***Greene County, Pennsylvania
2025 Hazard Mitigation Plan***

Greene County High Wind History				
Location	Date	Magnitude (knots)	Injuries	Property Damage
Nemacolin	4/14/2006	50 kts.	0	\$5,000.00
Morrisville	10/4/2006	50 kts.	0	\$0.00
Waynesburg	6/8/2007	50 kts.	0	\$0.00
Jefferson	6/8/2007	50 kts.	0	\$0.00
Waynesburg	6/13/2007	50 kts.	0	\$0.00
Carmichaels	6/19/2007	50 kts.	0	\$0.00
Waynesburg	7/15/2007	50 kts.	0	\$5,000.00
Crucible	8/8/2007	50 kts.	0	\$20,000.00
Jefferson	8/8/2007	50 kts.	0	\$20,000.00
Waynesburg	8/9/2007	50 kts.	0	\$25,000.00
Morrisville	8/9/2007	50 kts.	0	\$75,000.00
Fordyce	8/9/2007	50 kts.	0	\$50,000.00
Mather	8/25/2007	50 kts.	0	\$15,000.00
Carmichaels	8/25/2007	50 kts.	0	\$10,000.00
Jefferson	6/16/2008	50 kts.	0	\$75,000.00
Morrisville	7/8/2008	50 kts.	0	\$200,000.00
Hunters Cave	5/28/2009	50 kts.	0	\$25,000.00
Fordyce	5/28/2009	50 kts.	0	\$25,000.00
Morrisville	8/20/2009	50 kts.	0	\$50,000.00
Newtown	6/24/2010	50 kts.	0	\$30,000.00
Carmichaels	7/3/2011	50 kts.	0	\$10,000.00
Holbrook	7/11/2011	50 kts.	0	\$10,000.00
Waynesburg	8/1/2011	50 kts.	0	\$15,000.00
Rices Lndg	6/29/2012	60 kts.	0	\$2,500.00
Deep Vly	7/18/2012	50 kts.	0	\$25,000.00
Brave	7/18/2012	50 kts.	0	\$15,000.00
Carmichaels	7/26/2012	50 kts.	0	\$25,000.00
Morrisville	5/10/2013	50 kts.	0	\$5,000.00
Newtown	5/10/2013	50 kts.	0	\$10,000.00
Ryerson Station	6/13/2013	50 kts.	0	\$1,000.00
Graysville	6/25/2013	50 kts.	0	\$2,000.00
Carmichaels	7/10/2013	50 kts.	0	\$15,000.00
Morrisville	11/1/2013	50 kts.	0	\$75,000.00
Jefferson	6/11/2014	50 kts.	0	\$10,000.00
Morrisville	6/18/2014	50 kts.	0	\$5,000.00
Rutan	5/31/2015	50 kts.	0	\$5,000.00
Deer Lick	6/18/2015	50 kts.	0	\$5,000.00
Ruff Creek	6/18/2015	50 kts.	0	\$5,000.00
Carmichaels	7/9/2015	50 kts.	0	\$500.00
Crucible	6/16/2016	50 kts.	0	\$5,000.00
Morrisville	6/16/2016	50 kts.	0	\$8,000.00
Rices Lndg	7/14/2016	50 kts.	0	\$5,000.00
Deep Vly	7/24/2016	50 kts.	0	\$5,000.00
Carmichaels	10/20/2016	50 kts.	0	\$5,000.00

***Greene County, Pennsylvania
2025 Hazard Mitigation Plan***

Greene County High Wind History				
Location	Date	Magnitude (knots)	Injuries	Property Damage
Bluff	3/1/2017	50 kts.	0	\$5,000.00
Holbrook	3/1/2017	50 kts.	0	\$0.00
Rogersville	3/1/2017	50 kts.	0	\$5,000.00
Waynesburg	3/1/2017	50 kts.	0	\$5,000.00
Paisley	4/16/2017	52 kts.	0	\$3,000.00
Crucible	4/16/2017	50 kts.	0	\$2,500.00
Carmichaels	4/16/2017	50 kts.	0	\$2,500.00
Buzz	6/23/2017	50 kts.	0	\$2,500.00
Kuhntown	6/23/2017	50 kts.	0	\$2,500.00
Brock	6/23/2017	50 kts.	0	\$2,500.00
Nineveh	8/4/2017	50 kts.	0	\$2,500.00
Wind Ridge	8/4/2017	50 kts.	0	\$5,000.00
Poland Mines	8/4/2017	50 kts.	0	\$2,500.00
Kuhntown	8/22/2017	50 kts.	0	\$500.00
Fairchance	8/22/2017	50 kts.	0	\$500.00
Morrisville	5/12/2018	50 kts.	0	\$2,000.00
Morrisville	5/13/2018	50 kts.	0	\$500.00
Rices Lndg	5/13/2018	50 kts.	0	\$500.00
Kuhntown	7/15/2018	50 kts.	0	\$0.00
Ceylon	7/31/2018	50 kts.	0	\$10,000.00
Waynesburg Arpt	7/31/2018	50 kts.	0	\$0.00
Crucible	8/13/2018	50 kts.	0	\$500.00
Deer Lick	9/6/2018	50 kts.	0	\$0.00
Deer Lick	9/6/2018	50 kts.	0	\$0.00
Deer Lick	9/6/2018	50 kts.	0	\$0.00
Graysville	10/2/2018	50 kts.	0	\$1,000.00
Graysville	10/2/2018	50 kts.	0	\$1,000.00
Sycamore	10/2/2018	50 kts.	0	\$1,000.00
Khediye	10/2/2018	50 kts.	0	\$1,000.00
Carmichaels	5/25/2019	50 kts.	0	\$0.00
Graysville	6/24/2019	50 kts.	0	\$0.00
Rogersville	3/28/2020	50 kts.	0	\$2,000.00
Nemacolin	4/8/2020	50 kts.	0	\$5,000.00
Carmichaels	6/10/2020	50 kts.	0	\$3,000.00
Fordyce	6/10/2020	50 kts.	0	\$10,000.00
Garards Ft	6/10/2020	50 kts.	0	\$2,000.00
Rogersville	7/9/2020	50 kts.	0	\$0.00
Crucible	7/9/2020	50 kts.	0	\$0.00
Rices Lndg	7/9/2020	50 kts.	0	\$0.00
Wind Ridge	11/15/2020	50 kts.	0	\$50,000.00
Aleppo	6/14/2021	55 kts.	0	\$0.00
Spraggs	6/14/2021	55 kts.	0	\$0.00
Bristoria	6/21/2021	55 kts.	0	\$0.00
Simpson Store	6/21/2021	55 kts.	0	\$0.00

**Greene County, Pennsylvania
2025 Hazard Mitigation Plan**

Greene County High Wind History				
Location	Date	Magnitude (knots)	Injuries	Property Damage
Aleppo	6/21/2021	55 kts.	0	\$0.00
Jefferson	6/21/2021	55 kts.	0	\$0.00
Sandy Run	7/7/2021	50 kts.	0	\$10,000.00
Fordyce	7/7/2021	50 kts.	0	\$1,000.00
Garrison	7/7/2021	50 kts.	0	\$10,000.00
New Freeport	7/7/2021	50 kts.	0	\$1,000.00
Garrison	7/7/2021	50 kts.	0	\$5,000.00
Morrisville	7/29/2021	50 kts.	0	\$20,000.00
Bluff	8/13/2021	55 kts.	0	\$0.00
Deer Lick	8/13/2021	55 kts.	0	\$0.00
Nineveh	8/13/2021	55 kts.	0	\$0.00
New Freeport	6/8/2022	55 kts.	0	\$0.00
Oak Forest	6/8/2022	60 kts.	0	\$5,000.00
Carmichaels	6/8/2022	55 kts.	0	\$0.00
Pine Bank	6/8/2022	55 kts.	0	\$0.00
Brave	6/8/2022	60 kts.	0	\$0.00
Mapletown	6/8/2022	55 kts.	0	\$5,000.00
Nineveh	8/1/2022	55 kts.	0	\$0.00
Waynesburg	8/1/2022	55 kts.	0	\$0.00
Crabapple	11/27/2022	50 kts.	0	\$1,000.00
Morrisville	4/1/2023	55 kts.	0	\$0.00
Jefferson	6/3/2023	52 kts.	0	\$0.00
Lippincott	6/3/2023	52 kts.	0	\$0.00
Waynesburg Arpt	6/3/2023	60 kts.	0	\$0.00
Oak Forest	6/3/2023	52 kts.	0	\$0.00
Wind Ridge	8/12/2023	59 kts.	0	\$1,000.00
Rices Lndg	8/12/2023	60 kts.	0	\$1,000.00
Carmichaels	8/12/2023	60 kts.	0	\$1,000.00
Sandy Run	8/12/2023	59 kts.	0	\$1,000.00
Dilliner	8/12/2023	59 kts.	0	\$0.00
Waynesburg	2/28/2024	61 kts.	0	\$1,000.00
Spraggs	2/28/2024	61 kts.	0	\$5,000.00
Khedive	2/28/2024	61 kts.	0	\$2,000.00
Carmichaels	2/28/2024	61 kts.	0	\$20,000.00
Kirby	6/26/2024	50 kts.	0	\$1,000,000.00
Chartiers	8/31/2024	50 kts.	0	\$1,000.00
Ruff Creek	8/31/2024	50 kts.	0	\$1,000.00
Morrisville	8/31/2024	50 kts.	0	\$1,000.00
Castile	8/31/2024	50 kts.	0	\$3,000.00
Paisley	8/31/2024	50 kts.	0	\$0.00
Source: NOAA NCEI, 2024 Estimated Values are marked*				

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

4.3.11.4 Future Occurrence

In the United States, tornado activity has increased in variability, with a general decrease in the number of days a year on which activity occurs, but an increase in the number of tornadoes on those days. This indicates an increase in tornado outbreaks. The future probability of a disastrous tornado occurring in Greene County is ranked as possible, but not highly likely. While the chance of being hit by a tornado in Greene County is small, the damage that results when the tornado arrives can be devastating. An EF-5 tornado, with a 0.019% 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 in Pennsylvania. As jurisdictions within the county grow, and as residential and commercial construction continues, the number of people and properties will be greatly affected by tornadoes and windstorms as they increase accordingly.

Based on historic patterns, tornadoes are unlikely to remain on the ground for long distances, especially in areas of the country with hilly terrain, such as the majority of Pennsylvania. However, the high historical number of windstorms with winds at or over 50 knots indicates that the annual chance of a windstorm in the county is uniquely high. The annual tornado season has begun to lengthen, with the season starting earlier than it has historically and ending later. Pennsylvania had, for example, a record number of tornadoes in April and May of 2019 compared to any other April and May on record. Climate change is causing temperatures and air moisture to increase, increasing the frequency and intensity of tornadoes and windstorms. There remains some uncertainty regarding the recurrence of tornadoes. Therefore, the number of future tornadoes and windstorm events could potentially increase due to known and unknown factors.

Based on historical incidents, there are three zones in Pennsylvania that can either experience less than one, one to four, or five to ten of EF-2 or above tornadoes per 3,700 square miles. Communities in Greene County, as shown in Figure X – Tornado Activity in Greene County below, are expected to have one tornado approximately every ten years as a future occurrence. The approximation of one to four tornadoes annually assists with determining the rate of future tornado occurrences within Greene County. Future tornadoes will be similar to those that affected the county in past events.

Windstorm events occur on a more frequent basis compared to tornadoes. Greene County, specifically, experiences windstorm events more commonly than tornadoes, which causes power failure, loss of communication networks, and residents requiring temporary shelters and provision of supplies. Therefore, unlike tornadoes, this hazardous event has a highly likely probability for future events to occur within the county.

Climate change and its relationship with tornado outbreaks is hard to identify. Some recent studies suggest that as average temperatures begin to rise, so will the intense storms that often

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

lead to the creation of tornadoes. Warm, moist air is the most important aspect for developing strong tornadoes. Climate change can exacerbate this, and it could potentially lead to an increase in frequency and the severity of the events. Although not yet proven, this is one of the most prevalent theories on how climate change can impact tornado frequency and intensity.

4.3.11.5 Vulnerability Assessment

The frequency of windstorms and minor tornadoes is expected to remain relatively constant; vulnerability increases in more densely developed areas. Factors that impact the amount of damage caused by a tornado include the strength of the tornado, the time of day, and the area of impact. Usually, such distinct funnel clouds are localized phenomena impacting a small area. However, the high winds of tornadoes make them one of the most destructive natural hazards. There can be many cascading impacts of tornadoes and windstorms including, but not limited to, transportation accidents, hazardous material spills, flooding, and power outages. A proper warning system is vital for the public to be informed of what to do and where to go during such events.

Additional dangers that accompany tornado-associated thunderstorms, and which increase the vulnerability of Greene County, include:

- Flash floods – 146 deaths annually nationwide.
- Lightning – 75 to 100 deaths annually nationwide.
- Damaging straight-line winds – reaching 140 mph wind speed.
- Large hail – can reach the size of a grapefruit and can cause several million in damages annually to property and crops

The economy of Greene County is highly vulnerable to tornadoes. While there may be severe impact on financial and commercial systems of the economy, these storms, and the damage they cause, can disrupt business long-term. The local economy is vulnerable due to the possibility of being crippled by tornadoes and windstorms and their cascading effects when buildings and supporting infrastructure are destroyed in a storm. Power outages can create work stoppages, while transportation accidents and road closures can limit transportation of goods and services. Additionally, flooding cannot be discounted as it can destroy physical structures, merchandise, and equipment essential for business operation.

Greene County's environment is also vulnerable to tornado events. However, since tornado events are typically localized, environmental impacts are rarely widespread. The impact of windstorms on the environment typically takes place over a large area. In either case, where these events occur, severe damage to plant species is likely. This includes uprooting or total destruction of trees and an increased threat of wildfire in areas where dead trees are not removed. Most notably, hazardous material spills can pollute ground water systems and vegetation. In the case of hazardous material spills, the local environment can be negatively impact and can cause

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

extensive cleanup and mitigation efforts. Greene County is considered a rural county that has a great amount of tourism that occurs in the surrounding hills, mountains, and state parks. Not only is the environment at risk to tornadoes and windstorms, but hikers, tourists, and hunters are also at risk when out in the environment. Consequently, in the event of a tornado or severe storm, these tourists have limited emergency notification measures, which result in high vulnerability. A storm has the ability, potentially, to destroy structures, damage private and public property, and injure citizens and tourists to the area. People with disabilities, the elderly, functional needs, and non-English speaking residents are more vulnerable to tornadoes, windstorms, and their cascading effects. Without assistance to evacuate and/or seek shelter, and with potential difficulty understanding information, these at-risk populations may be unable to prepare themselves, or their homes and other possessions, to safely endure the storm.

Tornado, windstorm, and cascading events may affect a small portion, or the entirety, of the county. Therefore, it is important to identify specific critical facilities and assets that are most vulnerable to this hazard. Critical facilities are highly vulnerable to windstorms and tornado events. While many severe storms can cause exterior damage to structures, tornadoes can destroy structures, along with their surrounding infrastructure, immediately halting their function. Tornadoes are often accompanied by severe storms which can be threatening to critical facilities within the county. Many secondary effects from these disasters can jeopardize the operation of these critical facilities as well. Critical facilities are particularly vulnerable to power outages which can leave facilities functionless, potentially crippling infrastructure supporting the population of the county. Due to Pennsylvania Uniform Construction Code Act 45, trailers and mobile homes built before 2004, because of their lightweight construction and often unanchored design, are more vulnerable to high winds/tornadoes and will generally sustain more damage than will mobile homes built after 2004.

As seen in *Table 3 – Population Change in Greene County*, eight municipalities have seen a net population increase from the 2010 census to the 2020 census according to the U.S. Census Bureau, American Community Survey estimates. Based on this information, it can be speculated that these municipalities may have an increased/equivalent vulnerability to tornadoes and windstorms, since 2010, due to the increase in population and construction.

Tornadoes and windstorm events may disproportionately affect underserved, unserved, and socially vulnerable populations, amplifying existing hardships. Fragile infrastructure in these areas is more prone to damage, which can hinder evacuation and rescue efforts. Limited access to resources exacerbates challenges during and after the storms, from securing safe shelter to obtaining essential supplies. Vulnerable communities often lack financial resilience, facing prolonged economic setbacks as local businesses may suffer.

Land use, in the form of a built environment, such as residential expansion, can cause tornado impact severity to increase. Impact severity increases when built environment expansion

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

provides an influx of people, infrastructure, and critical infrastructure in harm's way. Since the population in Greene County had a minor overall increase between 2010 and 2020, it can be speculated that the built environment did not increase significantly.

There are no historic or cultural properties that are listed with the National Register of Historic Places that are at an increased risk of tornadoes in Greene County. This analysis was run off of the previous tornado paths in the county and 500 feet vulnerability zones. These locations are where tornadoes have previously developed and may develop again.

Tornadoes and windstorms exert profound impacts on both natural and cultural areas. Ecologically, these intense weather events can result in habitat destruction, altering landscapes, and threatening biodiversity. Culturally, these storms endanger heritage sites, historic structures, and artifacts, eroding tangible, and intangible cultural elements. Sustainable recovery efforts must embrace an integrated approach, recognizing the interconnected vulnerability of natural, historical, and cultural landscapes to the formidable forces of tornadoes and windstorms.

All of the critical infrastructure and community lifeline facilities are vulnerable to tornado events.

Municipalities with an increased risk of tornadoes (previously impacted):

- Center Township
- Franklin Township
- Gilmore Township
- Gray Township
- Morris Township
- Richhill Township
- Wayne Township

Municipalities without an increased risk of tornadoes (not previously impacted):

- Aleppo Township
- Carmichaels Borough
- Clarksville Borough
- Cumberland Township
- Dunkard Township
- Freeport Township
- Greene Township
- Greensboro Borough
- Jackson Township
- Jefferson Borough
- Jefferson Township
- Monongahela Township
- Morgan Township
- Perry Township
- Rices Landing Borough
- Springhill Township
- Washington Township
- Waynesburg Borough
- Whiteley Township

Greene County, Pennsylvania 2025 Hazard Mitigation Plan

Figure 36 - Pennsylvania Wind Zones

