Monroe County Multi-Hazard Mitigation Plan

January 2025

Prepared for:

Monroe County Emergency Management Agency
5850 W Foster Curry Dr
Bloomington, IN 47403



Prepared by:

Christopher B. Burke Engineering, LLC
115 W. Washington St., Ste. 1368 S.
Indianapolis, IN 46204

Burke Project No. 19R.22-0232

CBB
BURKE

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF EXHIBITS

LIST OF APPENDICES

EXECUTIVE SUMMARY

The Federal Emergency Management Agency (FEMA) defines the disaster life cycle as the process through which emergency managers respond to disasters when they occur; help people and institutions recover from them; reduce the risk of future losses; and prepare for emergencies and disasters. In **Figure i** each phase in the Emergency Management Lifecycle; Mitigate, Prepare, Respond, and Recover has a description of the phase as well as a time frame within the disaster cycle. Although each of the phases is visually tied to a specific time period within the life cycle of the disaster, mitigation can take place throughout much of the disaster life cycle. The Monroe County Multi-Hazard Mitigation Plan (MHMP) update focuses on the mitigation activities that may be implemented throughout the disaster life cycle.

Figure i Phases of the Emergency Management Lifecycle

According to FEMA, mitigation is most effective when it is based on an inclusive, comprehensive, long-term plan that is developed before a disaster occurs. The MHMP planning process identifies hazards, the extent that they affect the municipality, and formulates mitigation practices to ultimately reduce the social, physical, and economic impact of the hazards.

The overall goals of the Monroe County MHMP, which align closely with the State of Indiana MHMP, are:

1) Lessen the impacts of disasters and enhance community resilience.
2) Minimize the loss of life and injuries caused by disasters.
3) Promote mitigation activities both prior to and following a disaster.

To achieve the stated goals the community strategy includes the following:

1) Lessen the impacts of disasters and enhance community resilience by:
   a. Supporting resilience opportunities within the community
   b. Incorporating the MHMP into local ordinances, local planning efforts and the community comprehensive plans
   c. Evaluating and strengthening collaboration among organizations
   d. Making sure essential facilities can withstand disasters
   e. Supporting the NFIP
   f. Identifying opportunities to reduce repetitive loss incidents

2) Minimize the loss of life and injures caused by disasters by:
   a. Improving warning systems for the residents
   b. Developing public awareness and outreach programs
   c. Improving shelter availability
   d. Developing a program of affordable housing that is resilient to flooding
   e. Improving education and training for emergency personnel and officials
   f. Developing ways to provide education, awareness, and warning of disasters to the underserved populations.

3) Promote mitigation activities prior to and following a disaster by:
   a. Ensuring better communication between federal, state and local officials
   b. Seizing opportunities to buy out properties, floodproof buildings, or improve building codes

c. Conducting new studies and/or research opportunities to reduce impacts from disasters and prepare for future events anticipating the impacts of our changing climate.
d. Conducting outreach efforts to educate community members of the risks and hazards in their area as well as encouraging the implementation of a variety of mitigation actions.

For National Flood Insurance Program (NFIP) communities to be eligible for future mitigation funds, they must adopt either their own MHMP or participate in the development of a multi-jurisdictional MHMP. Further, it is required that local jurisdictions review, revise, and resubmit the MHMP every five years. Representatives from Monroe County, the City of Bloomington and the Towns of Ellettsville and Stinesville have provided information, attended meetings, and participated in the planning process. The planning process used to update the Monroe County MHMP satisfies the requirements of a multi-jurisdictional plan.

During Planning Committee meetings, those in attendance revisited existing the 2018 MHMP and identified new critical facilities and local hazards; reviewed the State's mitigation goals and updated the local mitigation goals; reviewed the most recent local hazard data, vulnerability assessment, and maps; evaluated the effectiveness of existing mitigation measures and identified new mitigation projects; and reviewed materials for public participation. Keeping in mind the ever-changing climate, the team also examined the needs of underserved populations that may be more vulnerable to the impacts of the listed hazards. Meetings were conducted with key groups such as city planners, health department specialists, representatives of organizations serving the underserved populations and various emergency responders. Their information has been incorporated into this MHMP update. This plan update will examine each of the hazards with data from the past 5 years, where possible.

The review of hazards and risks is based on the methodology described in the Local Mitigation Planning Policy Guide FP 206-21-0002, Effective April 19, 2023. The plan identifies the hazards assessed, the nature of each hazard including historic occurrences, vulnerabilities, and the relationship to other hazards. Using a ranking tool known as the Calculated Risk Priority Index (CPRI), the planning team scored each of the hazards. **Table i** lists the hazards in the plan and the ranking. The CPRI scores reflect the hazards of most concern by the planning team members, recent experiences, changes in community demographics, and challenges.

Table i: CPRI Scores for All Hazards

Hazard	2024 Rank	CPRI Score
Wildfire	1	3.40
Winter	2	3.11
Hail/Thunder/Wind	3	3.10
Hazmat	4	2.90
Flood	5	2.87
Extreme Temperature	6	2.85
Tornado	7	2.72
Earthquake	8	2.35
Drought	9	2.21
Dam	10	1.85
Land subsidence	11	1.62

Lastly, the plan concludes with a discussion about mitigation actions. The MHMP lists a variety of mitigation actions the planning team members would like to accomplish within the next 5 years to enhance the resilience of Monroe County. In addition, it celebrates the mitigation successes from the

previous MHMP Plans and community actions which contribute to mitigating the various risks and hazards identified.

This MHMP is a living document which has a 5-year life span. During the next 5 years, Monroe County and the incorporated communities that adopt this plan will work to complete the mitigation actions as well as regularly noting items for the 2030 MHMP update. The County EMA and planning team members will also use tools contained in the Appendices, or similar documents, to track progress, and note changes that may impact community resilience.

1.0 INTRODUCTION

1.1 DISASTER LIFE CYCLE

The Federal Emergency Management Agency (FEMA) defines the disaster life cycle as the process through which emergency managers respond to disasters when they occur; help people and institutions recover from them; reduce the risk of future losses; and prepare for emergencies and disasters. The disaster life cycle, shown in **Figure 1** includes four phases:

Figure 1 Disaster Life Cycle

Mitigation – to prevent or to reduce the effects of disasters (building codes and zoning, vulnerability analyses, public education)
Preparedness – planning, organizing, training, equipping, exercising, evaluation and improvement activities to ensure effective coordination and the enhancement of capabilities (preparedness plans, emergency exercises/training, warning systems)
Response – the mobilization of the necessary emergency services and first responders to the disaster area (search and rescue; emergency relief)
Recovery – to restore the affected area to its previous state (rebuilding destroyed property, re-employment, and the repair of other essential infrastructure)

The Monroe County Multi-Hazard Mitigation Plan (MHMP) focuses on the mitigation phase of the disaster life cycle. According to FEMA, mitigation is most effective when it is based on an inclusive, comprehensive, long-term plan that is developed before a disaster occurs. Recent reviews of grant programs have determined for every $1 spent on mitigation efforts, between $6 and $10 are saved within the community on efforts following disasters. The MHMP planning process identifies hazards, the extent that they affect the municipality, and formulates mitigation practices to ultimately reduce the social, physical, and economic impact of the hazards.

1.2 PROJECT SCOPE & PURPOSE

REQUIREMENT §201.6(d)(3):

A local jurisdiction must review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and resubmit it for approval within five (5) years in order to continue to be eligible for mitigation project grant funding.

The purpose of mitigation planning is for State, local, and Indian tribal governments to identify the natural hazards that impact them, to identify actions and activities to reduce any losses from those hazards, and to establish a coordinated process to implement the plan, taking advantage of a wide range of resources. (44 CFR §201.1(b))

A FEMA-approved MHMP is required to apply for and/or receive project grants under the Building Resilient Infrastructure and Communities (BRIC), Hazard Mitigation Grant Program (HMGP), and Flood Mitigation Assistance (FMA). Additional detailed studies may need to be completed prior to applying for these grants even though this plan meets the requirements of DMA 2000 and eligibility requirements of the above listed grant programs.

The National Flood Insurance Program (NFIP) requires participating communities adopt either their own MHMP or participate in the development of a multi-jurisdictional MHMP to be eligible for future mitigation funds. The Indiana Department of Homeland Security (IDHS) and the United States Department of Homeland Security (US DHS)/FEMA Region V offices administer the MHMP program in Indiana. Local jurisdictions are required to review, revise, and resubmit the MHMP every five years. The MHMP updates must demonstrate that progress has been made in the last five years to fulfill the commitments outlined in the previously approved MHMP. The update may validate the information in the previously approved MHMP or may be a major rewrite depending on community needs and planning guidance. The updated MHMP is not intended to be an annex to the previously approved Plan; it stands on its own as a complete and current MHMP.

The Monroe County MHMP Update is a multi-jurisdictional planning effort led by the County Emergency Management Agency(EMA). This Plan was prepared in partnership with Monroe County, the City of Bloomington, and the Towns of Ellettsville and Stinesville. Representatives from these communities attended the Committee meetings, provided valuable information about their community, reviewed, and commented on the draft MHMP, and assisted with local adoption of the approved Plan. As each of the jurisdictions had an equal opportunity for participation and representation in the planning process, the process used to update the Monroe County MHMP satisfies the requirements of DMA 2000 in which multi-jurisdictional plans may be accepted.

The Community Rating Service (CRS) program is a voluntary incentive program that recognizes and encourages community floodplain activities that exceed the minimum NFIP requirements. As a result, flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions that meet the three goals of the CRS: (1) reduce flood losses; (2) facilitate accurate insurance rating; and (3) promote education and awareness of flood insurance. Savings in flood insurance premiums are proportional to the points assigned to various activities. A minimum of 500 points is necessary to enter the CRS program and receive a 5% flood insurance premium discount. This MHMP could contribute as many as 374 points toward participation in the CRS. At the time of this planning effort, the City of Bloomington and the Towns of Ellettsville and Stinesville, as well as Monroe County are participating in the NFIP. None of the communities participate in the CRS program. Throughout this Plan, activities that could count toward CRS points are identified with the NFIP/CRS logo. (**Figure 2)** Acronyms referenced throughout this plan are contained in **Appendix 1.**

Figure 2 NFIP/CRS Logo

Funding to update the MHMP was made available through a FEMA/DHS grant awarded to the Monroe County EMA and is administered by IDHS. Monroe County provided the local 25% match required by the grant. Christopher B. Burke Engineering, LLC (Burke) was hired to facilitate the planning process and prepare the Updated County MHMP.

1.3 ANALYSIS PROCESS

REQUIREMENT §201.6(c)(1):

The plan shall document the planning process used to prepare the plan, including how it was prepared, who was involved in the process, and how the public was involved.

Preparation for the Monroe County MHMP Update began in 2023, after the grant request was approved by FEMA and grant funds were awarded. The plan update process began immediately upon the hiring of Burke. The planning process to update the 2018 MHMP took 18 months.

1.3.1 Planning Committee and Involvement of Other Interested Parties

In March of 2023, the EMA invited members of the community to join the Planning Committee to guide the MHMP update planning process. These individuals were specifically invited to serve on the Committee because they were knowledgeable of local hazards; have been involved in hazard mitigation activities; have the tools necessary to reduce the impact of future hazard events; and/or served as a representative on the prior Planning Committee in 2018. Brown, Greene, Jackson, Lawrence, Morgan and Owen Counties were invited to attend the team meetings and were given an opportunity to provide input and feedback to the plan throughout the planning process and during draft review. No comments or corrections were received from the neighboring EMA offices. **Table 1** lists the individuals that actively participated on the Committee and the entity they represented.

Table 1: Monroe County MHMP Planning Team

Name	Title	Organization	Representing
Shelby Wood	Mobile Integrated Health Supervisor	Bloomington Fire Dept.	Bloomington
Jamie Washel	Deputy Chief	Bloomington Fire Dept.	Bloomington
Matt Bright	Deputy Chief	Monroe Fire	Bloomington
Genna Lynn	Ex Res. Director	Stone Belt	Business and Industry
Kelsey Thetonia	MS4 Coordinator	County Highway Dept. Stormwater Dept.	County
Justin Baker	Deputy Director	Monroe County EMA	County
Jamie Neibel	Director	Monroe County EMA	County
Christina Kempf	Preparedness Coordinator	Monroe County Health Dept.	County
Lori Kelley	Health Administrator	Monroe County Health Dept.	County
Russell Brummett	Major	Monroe County Sheriff Dept.	County
Kenny Parrish	Asst. Fire Chief	Ellettsville Fire Dept.	Ellettsville
Stephen Carey	Manager	IU Health EM	Hospital - Bloomington
John Summerlot	Director	IU Emergency Management	Indiana University
Bonnie Brown	EMA	Lawrence County EMA	Lawrence County
Patricia Colon	Disaster Program Manager	American Red Cross	NGO
Vinal Lee	Pastor and Director	The Salvation Army	NGO
Scott McGlocklin	Town Council President	Stinesville Town Council	Stinesville
Tom Goodwin	Chief	Bean Blossom Twp. Stinesville FD	Stinesville
John Poehlman	Member	COAD	Community
Tania Daffron	Assistant Chief	Bloomington Fire Dept.	Bloomington

Members of the Committee participated in the MHMP Update through various team meetings as well as outside group meetings where mitigation opportunities are supported or addressed. During the MHMP team meetings, the Committee:

- Reviewed the State's mitigation goals and updated the local mitigation goals.
- Reviewed the most recent local hazard data, vulnerability assessment, and maps.
- Comparatively evaluated and ranked the hazards based on probability of occurrence, impact, warning time and duration of the hazard event.

- Revisited existing (in the 2018 MHMP) critical and essential infrastructure and identified new critical infrastructure and local hazards.
- Evaluated the effectiveness of existing mitigation measures and identified new mitigation projects.
- Reviewed materials for public participation.

Meeting agendas and summaries are included in **Appendix 2**. Members of the Committee also reviewed a draft MHMP, provided comments and suggestions, and assisted with adoption of the Monroe County MHMP Update.

1.3.2 Public Involvement

The Monroe County EMA Director has reported on the planning effort at public commissioner's meetings, LEPC meetings, and other events and gatherings of first responders and community officials. A draft of the Monroe County MHMP Update was posted to the County website (www._____) for public review and comment. A media release indicating the posting of the draft MHMP and the ability to comment was submitted for publishing to _____(Newspaper). Of the ----- views, no comments or corrections were received from the public or the Committee. The media release, web page posting, and any comments received are included in **Appendix 3**.

Neighboring Emergency Managers were invited to attend both planning meetings as well as being provided with an opportunity to review the draft plan. No comments or corrections were received from the neighboring Emergency Management Agencies in Brown, Greene, Jackson, Lawrence, Morgan and Owen Counties.

1.4 PLANS, STUDIES, REPORTS, AND TECHNICAL INFORMATION

REQUIREMENT §201.6(c)(1):

The plan shall include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

During the development of the Monroe County MHMP Update, several relevant sources of information were reviewed either as a document or through discussions with local personnel. This exercise was completed to gather updated information since the development of the previous Monroe County MHMP, and to assist the Committee in developing potential mitigation measures to reduce the social, physical, and economic losses associated with hazards affecting Monroe County.

Just as the 2018 Monroe County MHMP informed the plan writers of key concerns for the communities in 2017, including housing, land development and flood risks, this planning effort includes the review of community specific plans and studies for incorporation in this plan update. For the purposes of this planning effort, the following materials (among others) were discussed and utilized:

- Monroe County Zoning Ordinance, 2024
- Monroe County 20-year Comprehensive Plan, 2012
- Monroe County Community Development Ordinance, 2024
- Monroe County MHMP, 2018
- Monroe County GIS data
- City of Bloomington Comprehensive Plan , 2018 with 2024 update
- City of Bloomington Unified Development Ordinance, 2024

- City of Bloomington Transportation Plan, 2019
- Envision Ellettsville Plan, 2024
- Town of Ellettsville Unified Development Ordinance, 2024
- NFIP Flood products including maps and studies for all participating NFIP communities. (See **Appendix 9** for a full listing of the maps used)

The Comprehensive Plans in coordination with multiple other plans examine community development, ensuring community and rural character, environmental stewardship, and transportation. Safety of the residents is a key component of the plan. The 2018 MHMP was used to inform decision makers during recent ordinance updates. Although the MHMP was not incorporated by name, key materials such as hazard information and the discussion of mitigation opportunities were incorporated into the Bloomington Comprehensive Plan, ordinance updates as well as GIS maps and local planning and zoning procedures. The NFIP Administrator uses the data sources from the MHMP along with recent updates by DNR to educate community members and enforce the floodplain ordinances. Monroe County and its incorporated communities strive to enhance the overall quality of life and keep people informed and out of harm's way.

This MHMP planning effort sought to use existing plans to inform the planning team about mitigation actions that would support the community development, as outlined in the comprehensive plans, and to support and/or enhance existing ordinances.

The Monroe County Building Department as well as the Monroe County Planning Department have jurisdiction over the unincorporated rural areas as well as the Town of Stinesville. All of the county development is addressed in the County Development Ordinance which has been amended as recent as 2024. Both the City of Bloomington and the Town of Ellettsville have their own planning and zoning commissions. Both have Unified Development Ordinances which have been updated in 2024.

In addition to local agencies and offices such as those listed above, several regional and state agencies were contacted and subsequently provided data for this planning effort. Those contacts, and the information they provided, include:

- Indiana Department of Natural Resources, Division of Water – *Flood insurance policies, claims, and payment information; NFIP Participation; DNR listed Dams and associated records; Dam Breach Inundation App; and IN Floodplain Information Portal.*
- Indiana Department of Natural Resources, Other Divisions – *Mining Records*
- Indiana Geologic Survey and Water – *Earthquakes in Indiana; Liquefaction Potential Map: Karst Regions and Maps of Karst locations*
- Indiana Geographic Information Office - *IndianaMap*
- Indiana Department of Homeland Security – *Current Fire and Building Code Information*
- FEMA, Region V – Repetitive loss structure counts and insurance payments
- Midwest Regional Climate Center – Climate Trends; County specific climate reports
- National Weather Service – Indianapolis Weather Forecast Office – Confirmation of WSSI tool; local storm reports; weather event photos.

The CRS program credits NFIP communities with a maximum of 170 points. Up to 15 points for organizing a planning committee composed of staff from various departments; up to 120 points for involving the public in the planning process; and up to 35 points for coordinating among other agencies and departments to resolve common problems relating to flooding and other known natural hazards.

2.0 COMMUNITY INFORMATION

Figure 3 Monroe County Location

Monroe County, established in 1818. The county is named for James Monroe who served as the 5th President of the United States from 1817 to 1825. Settlers began establishing their family homes and businesses in 1817 with the first business being a grist mill on Clear Creek. Salt was manufactured from the briny water of Salt Creek and in 1827 the first limestone quarry was established. Indiana University was established as a State Seminary in 1823 in the county seat, Bloomington. The county population increased when the New Albany Railroad came through the county in the 1850s connecting Bloomington to New Albany.

As the county seat, Bloomington was established in 1818 by settlers from Kentucky, Tennessee, Virginia and the Carolinas. Its name stems from the haven of blooms in the area resulting in the name Bloomington. The city is home to Indiana University, one of the oldest and largest state universities in the United States.

Figure 3 identifies the location of Monroe County within the state of Indiana. The total area of Monroe County is 411.32 square miles of which 394.51 square miles is land and 16.81 square miles is water.

2.1 POPULATION AND DEMOGRAPHICS

The US Census Bureau shows the 2023 population for Monroe County was 10,019 which ranks 87th of 92 in the State. Since 2020, Monroe County population has decreased by 2.9%. The Town of Vevay is the county's largest incorporated area, accounting for 17.7% of the county's population (1,777 people). Monroe County is a predominantly white community, making up 96.8% of the county's racial demographics. The county is 98.4% non-Hispanic and 1.6% Hispanic.

In 2023, the median age of the population in the county was 31.7. That is 6.5 years younger than the statewide median age of 38.2. The largest demographic age group in the county is Young Adults (25 to 44) making up 24.8% of the county's population. The second largest is the College Age group (18 to 44) making up 24.7% of the county and the third largest age group is the Older Adult group (45 to 65) at 19.5%. The Senior group (65 or older) follows, making up 15.3% of the population; then the School Age group (5 to 17) at 11.7% and finally the Preschool age group (0 to 4) at 4.0%. **Figure 4** shows the age distribution totals compared to the state.

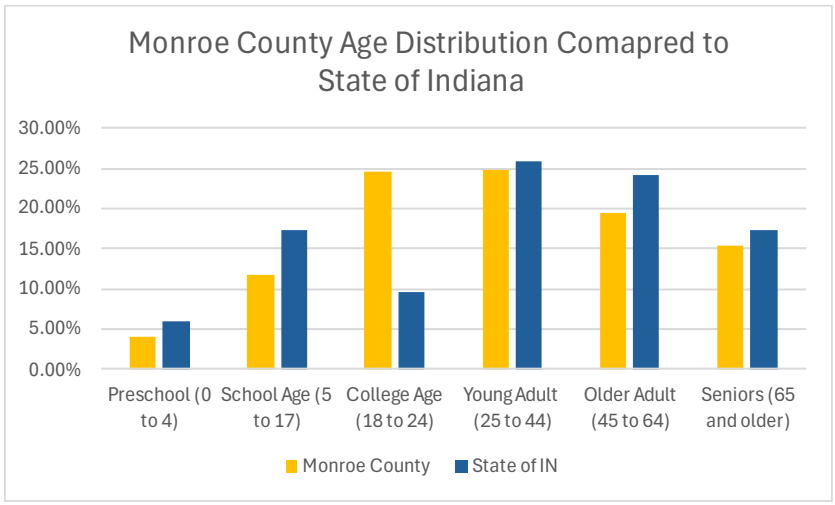


Figure 4: Age Distribution Compared to State Population

The approximate median household income in 2022 was reported to be $64,299 while the poverty rate in the same year was reported at 18.2% county-wide. In total, 7,675 (13.4%) of households are

married with children, and 14,474 (25.2%) of households are married without children. There are 3,567 (6.2%) single parents in Monroe County with the remaining 19,738 (34.3%) of the population living alone.

Within the county, 94.7% of adults older than 25, have reportedly completed a High School education. Further, 48.2% of those same adults have also completed a Bachelor of Arts or higher degree.

STATSIndiana shows the 2030 population projection for Monroe County to be 139,283, a decrease of 59 people bringing the county to 435 people less than the 2020 levels.

2.2 EMPLOYMENT

US Census data indicates that of the Monroe County workforce, the private sector is the largest employment sector within the county at 75.5%, followed by Government at 24.0% and then by Farming at 0.4%. "Government" is the largest employment category at 24.0%. "Other Private – not listed above" category represents the second largest group within the Private Sector Employment category at 19.7%. "Other Private" is a catchall category which addresses any employment category not normally reported on the census questionnaires. "Government" is followed by "Healthcare and Social Services" as the third largest at 11.2% of the workforce. The total resident labor force according to estimates in 2023 is 70,790 (with 310 unemployed) and as of October 2024, unemployment rate of 3.9%. The top 10 employers within Monroe County according to Hoosiers by the Numbers are:

1. Indiana Universite (Bloomington)
2. Cook Group Inc. (Bloomington)
3. IU Health Bloomington Hospital (Bloomington)
4. Indiana University Facility (Bloomington)
5. Simtra Biopharma Solutions (Bloomington)
6. Stone Belt (Bloomington)
7. Walmart Supercenter (Bloomington)
8. Crider & Crider, Inc. (Bloomington)
9. IVY Tech Community College (Bloomington)
10. Bloom Insurance (Bloomington)

The Bloomington Economic Development Corporation emphasizes the community's innovative high-tech talent base ready to support growth. With Indiana University and IVY Tech Community College both located in the city, the community's ability to support innovative industrial partners is ever present. The City's proximity to major national business hubs along with great recreational opportunities from the arts, drinking and dining establishments to natural escapes in the local forests and lakes.

2.3 TRANSPORTATION AND COMMUTING PATTERNS

Several major transportation routes pass through Monroe County. Interstate 69 along with State Roads 37, 45, 46, 48, and 446 serve as major corridors into and through the county. The recently completed I-69 Corridor serves as a major transportation artery serving shipments from Canada to Mexico. In addition, State Road 46 connects the City of Columbus Indiana with the City of Bloomington. Both communities rely on an innovative workforce to continue to advance the businesses and industries with each of the counties. CSX and the Indiana Rail Road Company operate rail lines which enter the county in the southwestern region and exit to the northeast. **Figure 5** shows the location of each of the transportation routes discussed.

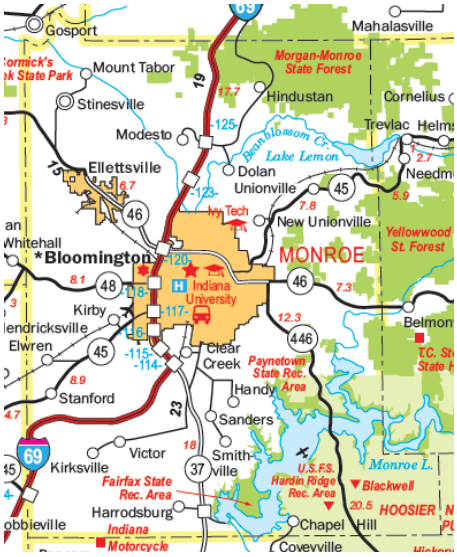


Figure 5 Monroe County Transportation Routes

Although Monroe County attracts about 11% of its work force to the community from neighboring counties. , Only 5% of the Monroe County workforce travels to neighboring counties for employment. According to STATSIndiana, 16,948 people commute into Monroe County daily. Furthermore, approximately 6,468 Monroe County residents commute to other counties, with Martin County receiving the greatest number of commuters (1,161).

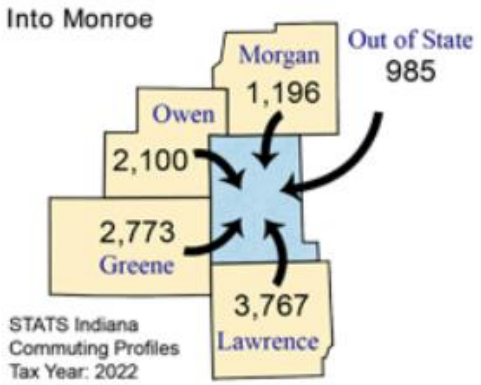


Figure 6 Commuting Pattern into Monroe County

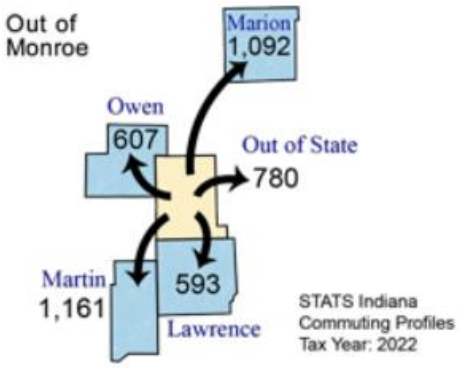


Figure 7 Commuting Pattern Out of Monroe County

Figure 6 indicates the number of Monroe County residents 16 and older do not live within Monroe County but commute into the County for employment purposes. **Figure 7** indicates the number of workers 16 and older who live in Monroe County and commute out of the county for employment.

2.4 CRITICAL AND ESSENTIAL INFRASTRUCTURE

REQUIREMENT §201.6(c)(2)(ii)(A):

The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas….

Figure 6 IU Health – Bloomington Hospital

Critical facilities, critical infrastructure, and essential facilities are the assets, systems, and networks, whether physical or virtual, so vital to local governments and the United States that their incapacitation or destruction would have a debilitating effect on security, economic security, public health or safety, or any combination thereof.

These structures are vital to the community's ability to provide essential services and protect life and property; are critical to the community's response and recovery activities; and/or are the facilities, the loss of which, would have a severe economic or catastrophic impact. The operation of these facilities becomes especially important following a hazard event.

The Monroe County EMA and GIS team provided the listing and locations of the following 433 critical and essential facilities for the MHMP update. **Figure 6** shows the Naval Support Activity Crane entry sign. This is not only a local, but also a national critical and essential facility. The following list identifies the number of each type of critical and essential facilities located in the county.

3	Airports/landing sites	21	Electrical Sub/Plant	44	Education& Library
100	Churches/Places of Worship	58	Government Buildings	22	Large Employers
60	Cell/Communications Towers	8	Law Enforcement	9	Large Gathering Places
26	Daycare Facilities	12	Medical	6	Tier II
18	EMS and/or Fire Stations	19	Gas and Oil Facilities		
24	Dams	3	Potable Water Towers		

Information provided by the EMA, the GIS provider, and the MHMP Planning Committee members was utilized to identify the types and locations of critical structures throughout the County. Draft maps were provided to the Planning Department and EMA, along with the Planning Committee for their review and all comments were incorporated into the maps and associated databases.

Exhibit 1, located after the narrative chapters of this document**,** illustrates the critical infrastructure identified throughout the unincorporated Monroe County and the individual municipalities. **Appendix 4** lists the critical and essential structures in Monroe County. Non-critical structures include residential, industrial, commercial, and other structures not meeting the definition of a critical or essential facility and are not required for a community to function. The development of this MHMP focused only on critical and essential structures; non-critical structures are neither mapped nor listed.

2.5 MAJOR WATERWAYS AND WATERSHEDS

According to the United States Geological Survey (USGS), there are 61 waterways in Monroe County, which are listed in **Appendix 5**. The county lies within three 8-digit Hydrologic Unit Code (HUC): Upper White, Lower White and Lower East Fork White Watersheds. The major waterways for each of these watersheds, and others, are identified on Exhibit 2. There are 2 USGS stream gauges located in Monroe County. Both are located near Monroe Lake. Salt Creek at Monroe Lake, USGS ID 03372400, monitors lake levels and Salt Creek near Harrodsburg, USGS ID 03372500, monitors Salt Creek on its way to Bedford, IN. No other gauges ae located in Monroe County. The White River watershed and the East Fork of the White River Watershed are divided, for the most part, by State Road 45 from the west southwest to the east northeastern boundaries of the county. Several reservoirs supply drinking water as well as serving as recreational centers within the county.

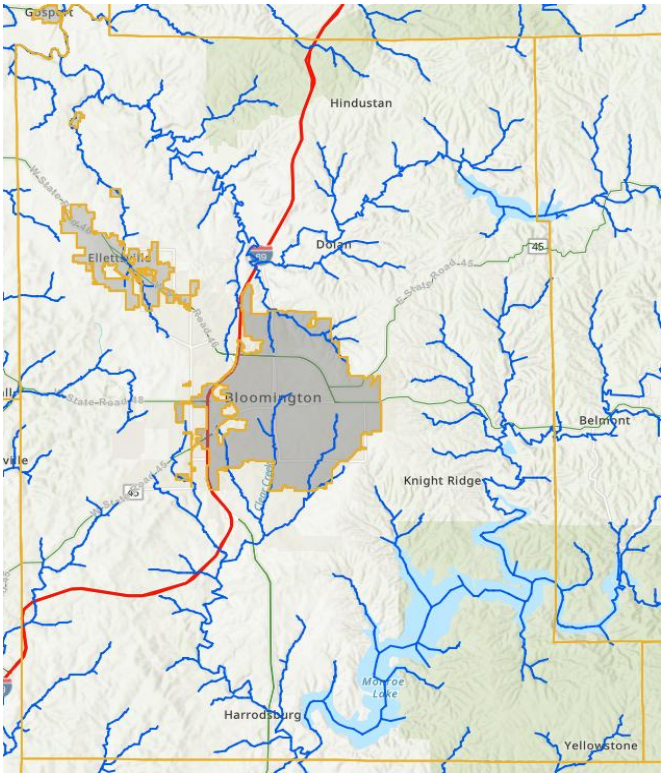


Figure 7 Major Waterways in Monroe County

2.6 NFIP PARTICIPATION

The National Flood Insurance Program (NFIP) is a FEMA program that enables property owners in participating communities to purchase insurance protection against losses from flooding. According to FEMA, participation in the National Flood Insurance Program (NFIP) is voluntary. Monroe County, and the City of Bloomington and the Towns of Ellettsville and Stinesville participate in the NFIP. At the time of this planning effort, according to the Indiana Department of Natural Resources, the County Assistant Director of Planning is responsible for the administration of the floodplain program in the unincorporated areas of the County as well as the Town of Stinesville. Substantial damage determinations are carried out by the floodplain administrators and their designated personnel to remain in compliance with the community flood ordinances. **Table 2** lists the NFIP number, effective map date, and the date each community joined the NFIP program.

Table 2: NFIP Participation

NFIP Community	NFIP Number	Effective Map Date	Join Date
Monroe County*	180444#	12/17/10	04/01/88
City of Bloomington	180169#	12/17/10	06/15/78
Town of Ellettsville	180170#	12/17/10	07/18/85
Town of Stinesville	180348#	12/17/10	06/20/11

2.7 TOPOGRAPHY

Monroe County is in the southcentral portion of Indiana. The county has significant changes in elevation ranging from the high point of 994ft at McGuire Benchmark located northwest of Bloomington to a low point of 499 ft near State Road 37 and the Lawrence County line. Monroe county is dominated by low rolling hills which are covered with vegetation including the Hoosier National Forest and Morgan Monroe State Forest. The flatter parts of the county are either dedicated to agriculture or urban development. The general drainage pattern is dependent on the location within the county. North and west of Bloomington drainage goes to the northwest with its ultimate destination being the White River. Areas south and east of Bloomington drain to the south eventually feeding into the East Fork of the White River. **Figure 8** shows the topographic map of Monroe County.

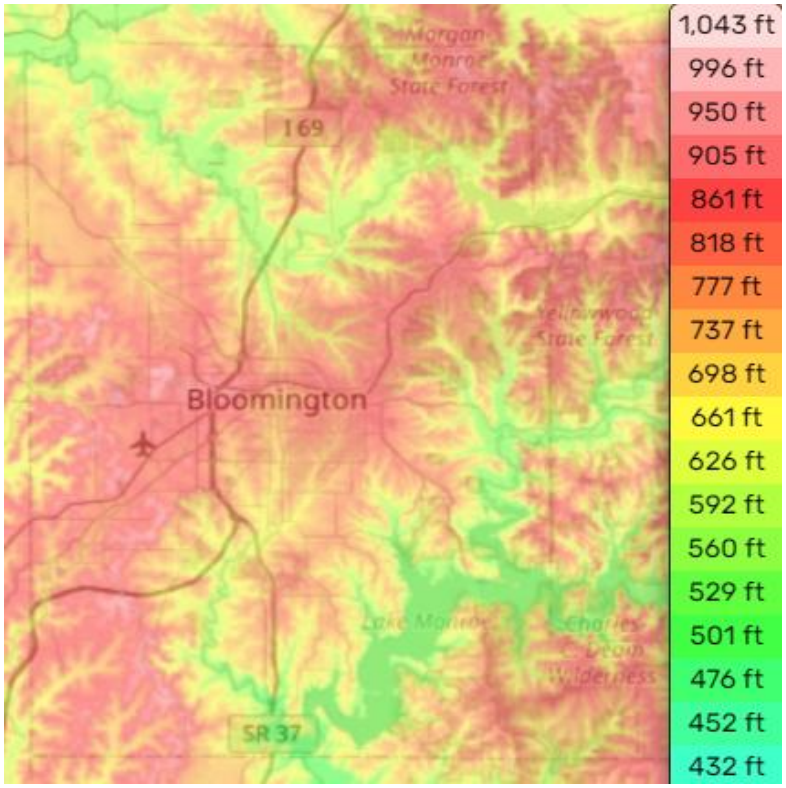


Figure 8 Topographic Map of Monroe County

The county has a total area of 411.32 square miles, of which 394.51 square miles (or 95.91%) is land and 16.81 square miles (or 4.09%) is water. Large areas within the county are part of the Hoosier National Forest and Morgan Monroe State Forest.

2.8 CLIMATE

The Midwestern Regional Climate Center (MRCC) provided climate data that includes information retrieved from the IU Bloomington Station, located in Monroe County, Indiana, identified as station USC00120784. In Monroe County, the annual average maximum temperature was 63.3 degrees Fahrenheit with an average annual low (minimum) temperature of 43.4 degrees Fahrenheit**.**

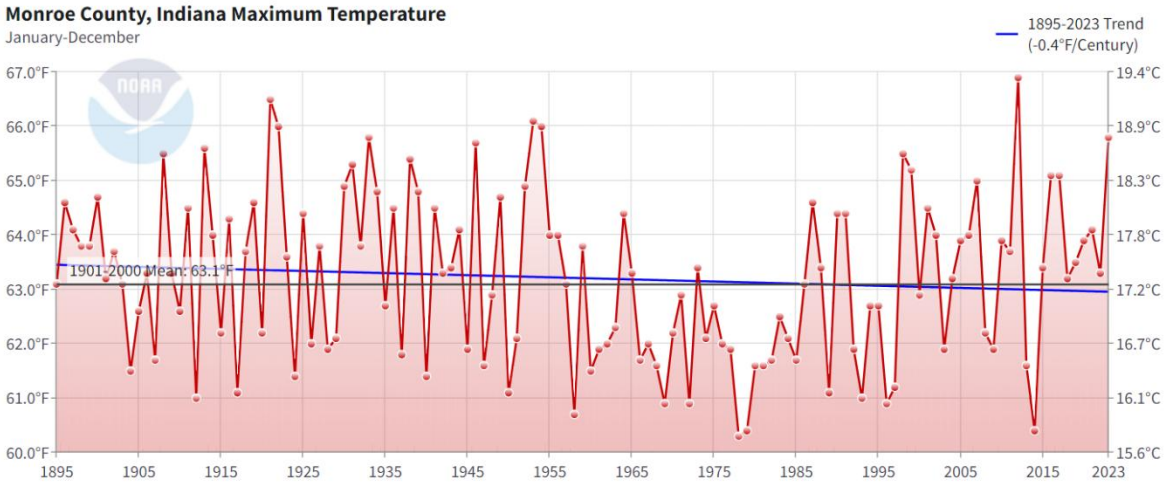


Figure 9 Monroe County Maximum Temperature Trends 1895-2023

According to the NCEI Normals based on 1991 – 2020 data, the warmest month normally is July with a maximum temperature of 85.1 and a mean of 75 degrees Fahrenheit. The highest single day maximum temperature was 110 degrees recorded on July 15, 1936.

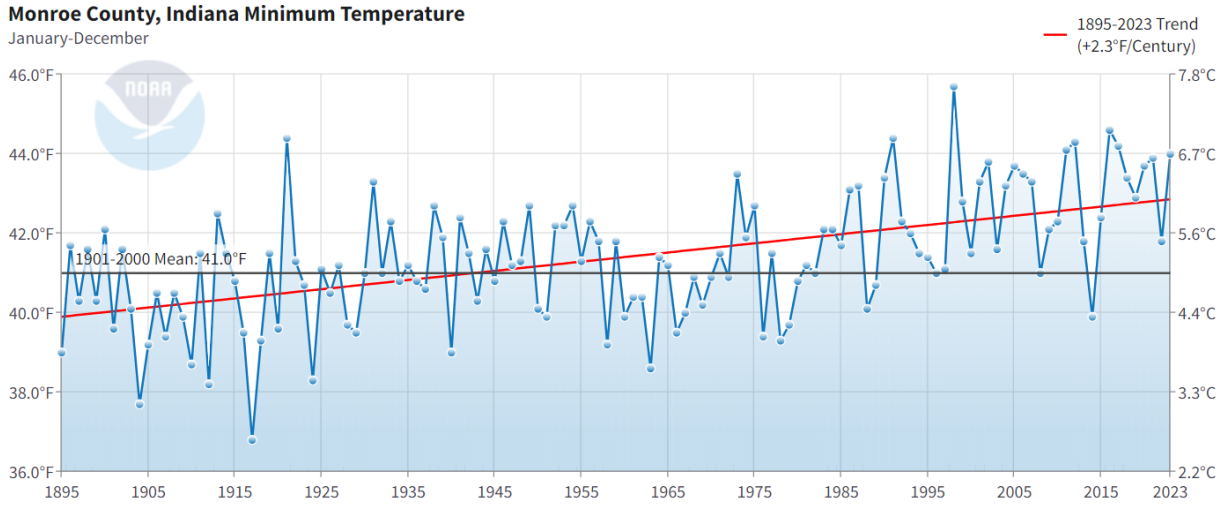


Figure 10 Monroe County Minimum Temperature Trends 1895 - 2023

Figure 9 and **Figure 10** chart the annual maximum and minimum temperatures and show trends utilizing data from the National Centers for Environmental Information (NCEI).

The coldest month based on this data is January at a mean temperature of 20.6 degrees. The coldest day recorded at the same site was on January 21, 1985, when the air temperature dipped to -21 degrees Fahrenheit.

According to the Midwest Regional Climate Center (MRCC) between January 2017 and December 2024 at IU Bloomington, IN (the nearest long-term weather data site), the maximum temperature was 96 degrees (7/6/22), and the lowest minimum temperature was -10 degrees (1/31/19). The average daily high was 64.1 degrees, which is 2.9 degrees cooler than the median within that time frame. Additionally, the average daily minimum temperature for the same five-year period was recorded at 44.3 degrees. That is 0.7 degrees warmer than the median temperature identified at 45-degrees Fahrenheit.

June is typically the wettest month of the year, with February being the driest. The average annual precipitation for Monroe County is 49.38 inches. In the past 6 years Monroe County had a low of 38.77 inches in 2022 and the highest annual precipitation of 53.56 inches occurring in 2021. The highest single day precipitation for the past 6 years was recorded June 19, 2021, with 4.95 inches of rain falling in a single 24-hour time period. The highest monthly precipitation rate between January 2018 and November 2024 occurred in June 2021 where 11.34 inches fell. That is 2.1 times the normal average monthly rainfall amount. On the opposite end of the spectrum the driest month

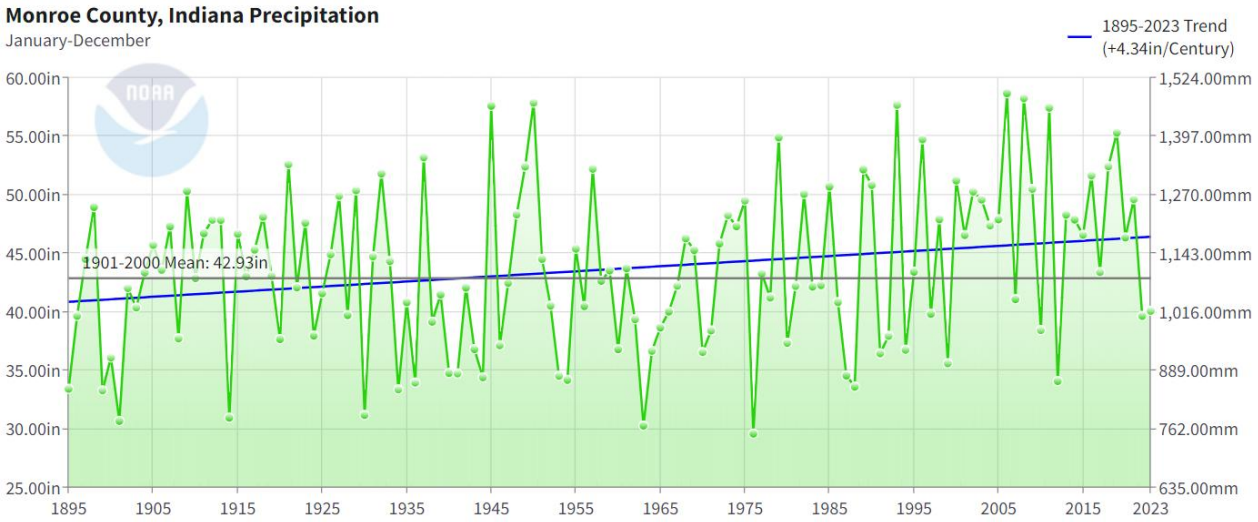


Figure 11 Monroe County Precipitation Trends 1895 - 2023

was October 2024 with 0.08 inches of precipitation. **Figure 11** illustrates the annual precipitation in Monroe County.

Purdue University Indiana Climate Change Impacts Assessment Report analyzed the increased frequency of short duration high volume rain events, also known as extreme precipitation events, in Indiana. According to the report, an extreme rain event occurs when more than 0.86 inches of rain falls in a day. Since 1900, the number of days per year with extreme rain has been increasing by 0.2 days per decade on average. However, most of that increase has occurred since 1990. The northwestern part of the state has seen the largest increase — a rate of about 0.4 days per decade. In **Figure 12** the trend line shows an increase in the

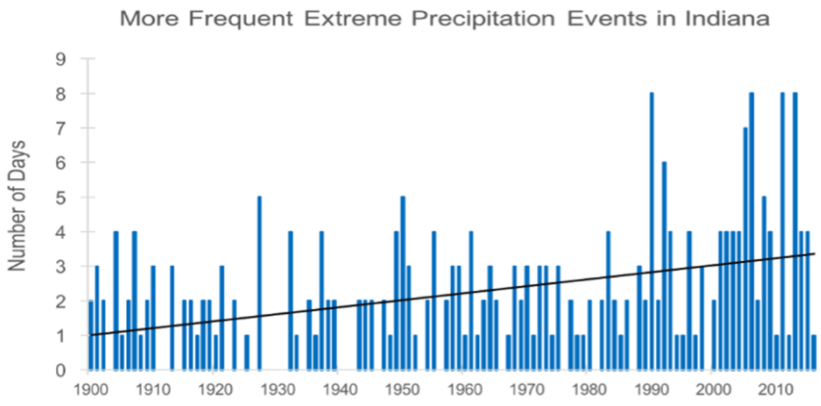


Figure 12 Extreme Precipitation Events in Indiana

number of days where the rainfall exceeds 99th percentile. This ever-increasing trend is resulting in more frequent flash flood and overland flood events.

According to NOAA National Centers for Environmental Information the State Climate Summary for Indiana the following observations have been observed based upon climate change:

- The temperatures have risen almost 1.5 degrees Fahrenheit since the beginning of the 20th Century. Temperatures in the 2000's have been higher than in any other historical period except during the early 1930's Dust Bowl era.
- Indiana has experienced an increase in the number of rain intensity is increasing and rain duration is decreasing.
- Extreme events are increasing, especially flooding.

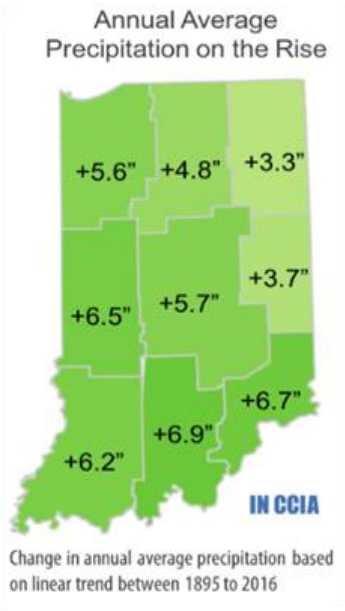


Figure 13 Annual Average Precipitation Change, Purdue

This is also verified in the Indiana Climate Change Assessment report from Purdue University (**Figure 13)**. In the report, the authors wrote, "This assessment documents that significant changes in Indiana's climate have been underway for over a century, with the largest changes occurring in the past few decades. These projections suggest that the trends that are already occurring will continue, and the rates of these changes will accelerate. They indicate that Indiana's climate will warm dramatically in the coming decades, particularly in summer. Both the number of hot days and the hottest temperatures of the year are projected to increase markedly. Indiana's winters and springs are projected to become considerably wetter, and the frequency and intensity of extreme precipitation events are expected to increase, although more research is needed in this area to better determine the details."

Changes in the climate have resulted in increased concerns about various hazards. The greatest concern is the increase in precipitation and the timing of that precipitation. Climate changes will be addressed in each of the hazards assessed.

2.9 UNDERSERVED, DISADVANTAGED AND SOCIALLY VULNERABLE POPULATIONS

For this planning effort, under the new FEMA guidance mitigation plan updates are required to include the perspective of socially vulnerable community members and the underserved communities in the county. The Agency for Toxic Substances and Disease Registry (ATSDR) and the Centers Disease Control (CDC) with higher education facilities to develop the Social Vulnerability Index (SVI). According to ATSDR/CDC, Social Vulnerability refers to the community's capacity to prepare for and respond to the stress of hazardous events ranging from natural disasters, such as tornadoes or disease outbreaks, to human caused threats, such as toxic chemical threats. Sixteen census-derived factors are

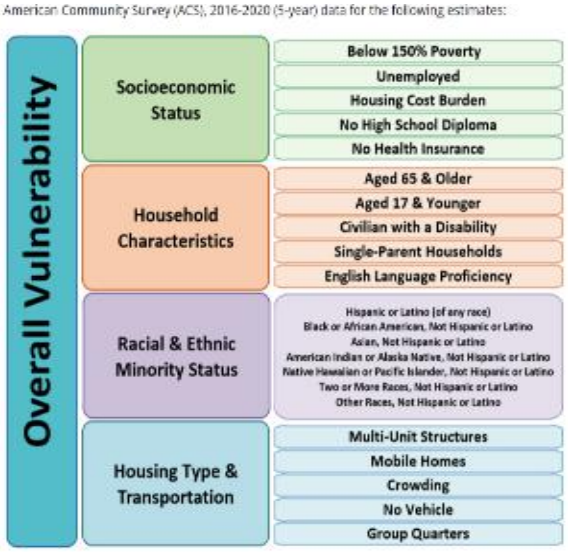


Figure 14 Social Vulnerability Factors

grouped into 4 general themes which summarize the extent of social vulnerability. **Figure 14** shows the 16 factors and how they are grouped into the four themes. The more factors impacting community members to more vulnerable those members are to the hazardous events.

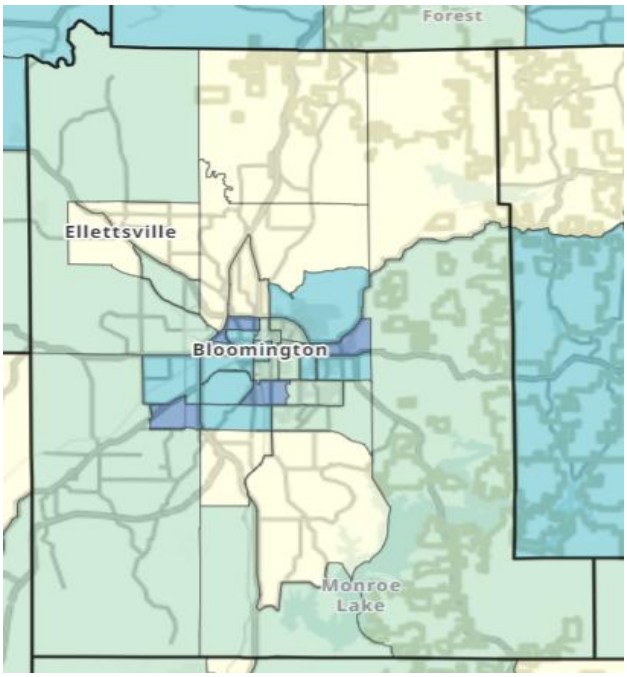


Figure 15 Overall Social Vulnerability

Figure 15 Is a map of the social vulnerabilty of each of the census tracts in Monroe County. Further details, including the 4 thematic maps may be found in **Appendix 11**. The Social Vulnerability Index is used in FEMA's National Risk Index, where the data is paired with expected annual losses, and community resilience to calculate a risk index for each of the hazards. This data is available both on the county level and the census tract level. Overall as a county the social vulnerability realaively high. The western 2/3 of the county rate raltively high with two areas in dark blue listed as very high. The eastern 1/3 of the county is relatively low to very low. When struck by the same intensity event, the areas in deep blue on **Figure 15** may require, more support in responding to and recovering from the hazardous event.

One last resource reviewed was the Climate and Economic Justice (CEJ) tool. Although the tool shows some similarities to the social vulnerabiltiy index, there are some differences.

The CEJ Tool highlights disadvantaged census tracts across all 50 states, the District of Columbia, and the U.S. territories. If the community is located in a census tracts that meet the thresholds for at least one of the tool's categories of burden, or if the community is on land within the boundaries of Federally Recognized Tribes then the people living within the census tract are considered disadvantaged.

Three census tracts within Monroe County are considered disadvantaged. (***Figure 16***) Each area is considered disavantaged beause the households from this area are above the 65th percentile for low income. Low income is defined as an income less than or equal to twice the federal poverty level, not including students enrolled in higher education. Additionally each area meets or exceeds one of the other criteria which includes climate change impacts, health, housing, transportation, and water and wastewater. A more detailed analysis of each area may be found in **Appendix 11**.

Figure 16 Monroe County Disadvantaged Populations

The team discussed the impacts of social vulnerability on the overall commuity and where possible has identified mitigation efforts to help address the hazards and make these areas of the community more resilient.

2.10 COMMUNITY CAPACITY

In Indiana the Fire Prevention and Building Safety Commission is tasked with the establishment and maintenance of fire and building safety codes. The commission also reviews variance requests, code modification proposals and orders enforcing the fire and building safety law. Only the commission is permitted to adopt codes for the state. Local communities may not adopt editions other than those adopted by the state. All jurisdictions of the state are required to follow the state adopted fire safety and building laws.

Local Building Officials serve as the local authority for building construction matters within their jurisdiction. In Monroe County, the County Planning Director and Building Commissioner serve all the unincorporated portions of the county as well as the Town of Stinesville. The City of Bloomington and the Town of Ellettsville have their own Planning and Building Departments. **Appendix 9** lists the local building official as well as several other key positions in each jurisdiction.

Digitally published ordinances are also referenced in Appendix 9 for easy access. County and community leaders take advantage of grant funding to help address non-budgeted activities. The Health Department along with IU Health and county EMS services work together to assure health and safety needs are met. The planning team identified a few community-wide needs such as how to encourage community members to take proactive steps to reduce their potential flood damage as well as addressing county overnight sheltering capabilities for unhoused individuals. Local groups have been working to find whole community solutions to address the challenges. As needs for capacity building are identified, the communities and their leadership work together to ensure the challenges are addressed.

The State of Indiana is presently working with subject matter experts to update the current fire and building safety codes to more recent International Code Council versions. Due to the hearing and adoptions processes this is a multi-year effort. It is hoped that within the next five years updated fire safety and building codes will be adopted to assist the community in becoming more resilient. In all cases, local floodplain ordinances are anticipated to be updated within the next five-year cycle using the state model ordinance to guide their process.

The current building codes for the state of Indiana are:

- Indiana Building Codes
  - 675 IAC 13-2.6 - 2014 Indiana Building Code using the International Building Code, 2012 Edition, First Printing
  - ANSI A117.1 - Accessible and Usable Buildings and Facilities, 2009 Edition, First Printing
- Indiana Residential Code
  - 675 IAC 14-4.4 - 2020 Indiana Residential Code using the 2018 International Residential Code for One- and Two-Family Dwellings, First Printing

3.0 RISK ASSESSMENTT

REQUIREMENT §201.6(c)(2):

[The risk assessment shall provide the] factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessment must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

A risk assessment measures the potential loss from a hazard incident by assessing the vulnerability of buildings, infrastructure, and people in a community. It identifies the characteristics and potential consequences of hazards, how much of the community may be affected by a hazard, and the impact on community assets. The risk assessment conducted for Monroe County and the communities within is based on the methodology described in the Local Mitigation Planning Handbook published by FEMA in 2023 and is incorporated into the following sections:

Section 3.1: Hazard Identification lists the natural, technological, and political hazards selected by the Planning Committee as having the greatest direct and indirect impact to the county as well as the system used to rank and prioritize the hazards.

Section 3.2: Hazard Profile for each hazard, discusses 1) historic data relevant to the county where applicable; 2) vulnerability in terms of number and types of structures, repetitive loss properties (flood only), estimation of potential losses, and impact based on an analysis of development trends; and 3) the relationship to other hazards identified by the Planning Committee.

Section 3.3: Hazard Summary provides an overview of the risk assessment process; a table summarizing the relationship of the hazards; and a composite map to illustrate areas impacted by the hazards.

3.1 HAZARD IDENTIFICATION

3.1.1 Hazard Selection

The MHMP Planning Committee reviewed the list of natural and technological hazards in the 2018 Monroe County MHMP, discussed recent events, and the potential for future hazard events. The Committee identified those hazards which affected Monroe County and each community selecting the hazards to study in detail as part of this planning effort. As shown in **Table 3,** these hazards include dam failure; earthquake; flood; hailstorms, thunderstorms, and windstorms; hazardous materials incident; snowstorms and ice storms; and tornado. All hazards studied within the 2018 Monroe County MHMP are included in the update. Since the COVID pandemic, the Health Department continues to develop plans and policies to better respond to and reduce the spread of both routine human disease-causing organisms as well as zoonotic diseases and changes in that field. Drought, Extreme Temperatures, Fires and Wildfires, and Land Subsidence, Landslide, and Fluvial Erosion were added to the update since they are key hazards in the most recent Indiana State Multi-Hazard Mitigation Plan. The team will continue to assess the hazard inclusion for future MHMP updates.

Table 3: Hazards Selected

Type of Hazard	List of Hazards	MHMP 2024
Natural	Drought	Yes
	Earthquake	Yes
	Extreme Temperature	Yes
	Fires and Wildfire	Yes
	Flood	Yes
	Hail/Thunder/Wind	Yes
	Land Subsidence/Landslide	Yes
	Snow / Ice Storm	Yes
	Tornado	Yes
Technological	Dam Failure	Yes
	Hazardous Material Incident	Yes

3.1.2 Hazard Ranking

The Planning Committee ranked the selected hazards in terms of importance and potential for disruption to the community using a modified version of the Calculated Priority Risk Index (CPRI). The CPRI is a tool by which individual hazards are evaluated and ranked according to an indexing system. The CPRI value (as modified by Burke) can be obtained by assigning varying degrees of risk probability, magnitude/severity, warning time, and the duration of the incident for each event, and then calculating as index value based on a weighted scheme. For ease of communications, simple graphical scales are used.

Probability:

Probability is defined as the likelihood of the hazard occurring over a given period. The probability can be specified in one of the following categories:

- Unlikely – incident is possible, but not probable, within the next 10 years.
- Possible – incident is probable within the next five years.
- Likely - incident is probable within the next three years.
- Highly Likely – incident is probable within the next calendar year.

Magnitude / Severity:

Magnitude/severity is defined by the extent of the injuries, shutdown of critical infrastructure, the extent of property damage sustained, and the duration of the incident response. The magnitude can be specified in one of the following categories:

- Negligible – few injuries OR critical infrastructure shutdown for 24 hours or less OR less than 10% property damaged OR average response duration of less than six hours.
- Limited – few injuries OR critical infrastructure shut down for more than one week OR more than 10% property damaged OR average response duration of less than one day.
- Significant – multiple injuries OR critical infrastructure shut down of at least two weeks OR more than 25% property damaged OR average response duration of less than one week.
- Critical – multiple deaths OR critical infrastructure shut down of one month or more OR more than 50% property damaged OR average response duration of less than one month.

Warning Time:

Warning time is defined as the length of time before the event occurs and can be specified in one of the following categories:

- More than 24 hours
- 12-24 hours
- 6-12 hours
- Less than six hours

Duration:

Duration is defined as the length of time that the actual event occurs. This does not include response or recovery efforts. The duration of the event can be specified in one of the following categories:

- Less than six hours
- Less than one day
- Less than one week
- Greater than one week

Calculating the CPRI:

The following calculation illustrates how the index values are weighted and how the CPRI value is calculated. CPRI = (Probability x 0.45) + (Magnitude/Severity x 0.30) + (Warning Time x 0.15) + (Duration x 0.10). For the purposes of this planning effort, the calculated risk is defined as:

- **Low** if the CPRI value is between 1 and 2.
- **Elevated** if the CPRI value is between 2 and 3.
- **Severe** if the CPRI value is between 3 and 4.

The CPRI value provides a means to assess the impact of one hazard relative to other hazards within the community. A value for each hazard was determined for each incorporated community, and then a weighted CPRI value was computed based on the community population.

Table 4 presents each community, population, and the weight applied to individual CPRI values. Weight was calculated based on the average percentage of each community's population in relation to the total population of the county. Thus, the results reflect the relative population influence of each community on the overall priority rank.

Table 4: Determination of Weighted Value for Communities

Community	Population (2023)	% of Total Population	Weighted Value
Monroe County	53,606	38.5%	0.385
City of Bloomington	78,840	56.6%	0.566
Town of Ellettsville	6,694	4.8%	0.048
Town of Stinesville	202	0.1%	0.001
Total	**139,342**	**100.0%**	**1**

3.2 HAZARD PROFILES

The hazards studied for this report are not equally threatening to all communities throughout Monroe County. While it would be difficult to predict the probability of an earthquake or tornado

affecting a specific community, it is much easier to predict where the most damage would occur in a known hazard area such as a floodplain or near a facility utilizing an Extremely Hazardous Substance (EHS). The magnitude and severity of the same hazard may cause varying levels of damage in different communities.

In the past eight years Indiana has had 3 FEMA disaster declarations and 1 FEMA Emergency Declaration. Monroe County was included in the 2 COVID disaster declarations as well as DR4704 listed below.

- DR 4363, declared May 5, 2018, for Severe Storms and Flooding
- DR 4704, declared April 15, 2023, for Severe Storms, Straight-line Winds and Tornadoes
- DR 4515, declared April 3, 2020, for COVID 19 Pandemic
- EM 3456, declared March 13, 2020,

In addition, the US SBA declared disasters for 10 Indiana events. Of all these events, Monroe County was included in the two COVID declarations (DR-4515 and EM-3456), 1 Presidential Disaster Declaration for severe storms , straight-line winds and tornadoes (DR4704) and was included as in 3 SBA declaration. The 3 declarations were:

- IN-00065 June 15-17, 2019, due to Tornadoes, High Winds, and Severe Storms – Primary County
- IN-00075 June 18-19, 2021, due to Severe Storms and Flooding – Primary County
- IN-20002 June 25, 2024, due to Severe Storms and Tornadoes – Primary County

In a US SBA disaster declaration, a Contiguous County is a county which may have sustained some damage in the major and/or destroyed categories, but not enough to meet thresholds. A primary County in a US SBA disaster declaration is the central county having sustained the greatest amount of damage categorized as major and/or destroyed.

This section describes each of the hazards that were identified by the Planning Committee for detailed study as a part of this MHMP Update. The discussion is divided into the following subsections:

- **Hazard Overview** provides a general overview of the causes, effects, and characteristics that the hazard represents.
- **Historic Data** presents the research gathered from local and national courses on the hazard extent and lists historic occurrences and probability of future incident occurrence.
- **Assessing Vulnerability** describes, in general terms, the current exposure, or risk, to the community regarding potential losses to critical infrastructure and the implications to future land use decisions and anticipated development trends. Impacts on specific populations of communities are also addressed within this section.
- **Relationship to Other Hazards** explores the influence one hazard may have upon another hazard.

3.2.1 Drought

Overview

Drought, in general, means a moisture deficit extensive enough to have social, environmental, or economic effects. Drought is not a rare and random climate incident; rather, it is a normal, naturally recurring feature of climate. Drought may occur in all climactic zones, but its characteristics vary significantly from one region to another. Drought is a temporary aberration and is different from aridity, which is restricted to low rainfall regions.

Figure 17 Urban Drought Conditions

There are four academic approaches to examining droughts; these are meteorological, hydrological, agricultural, and socio-economic. Meteorological drought is based on the degree, or measure, of dryness compared to a normal, or average amount of dryness, and the duration of the dry period. Hydrological drought is associated with the effects of periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply. Agricultural drought is related to agricultural impacts; and focuses on precipitation shortages, differences between actual and potential evapo-transpiration, soil water deficits, reduced ground water or reservoir levels, and crop yields. Socioeconomic drought relates the lack of moisture to community functions in the full range of societal functions, including power generation, the local economy, and food source **Figure 17** shows a yard affected by drought conditions.

Recent Occurrences

Data gathered from the U.S. Drought Monitor indicated that between January 1, 2018 – December 2024, there were 65 weeks where some portions of Monroe County were identified as being "Abnormally Dry" or at Drought Monitor Level D0. In addition, according to the Drought Monitor, there were 47 weeks where any portion of Monroe County was in a drought state higher than D0. **Figure 18** shows the distribution of weeks in drought over the 7-year time frame.

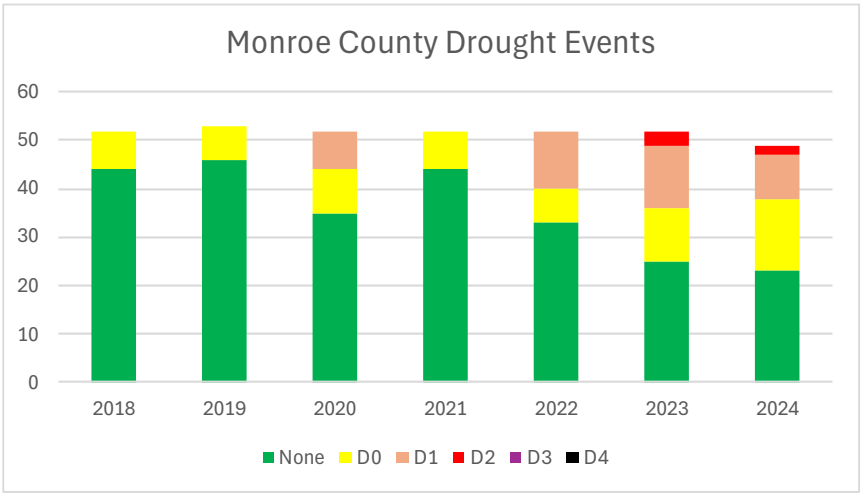


Figure 18 Drought Occurrences 2018 – December 2024

As rain patterns change there are periodic times when the county is deemed “Abnormally Dry” or D0. Most of these instances are resolved quickly as sufficient rain arrives and the soil rehydrates. On occasion, the rain is insufficient to address the dryness and weather conditions cause the soil to further dry out stressing crops and reducing lake levels. Examples of continued dryness can be found in 2019,20, 2022, 2023 and 2024. During each of these years, Monroe County was found to be in “Moderate Drought” or D1 or greater. On July 14, 2020, USDA/NASS records showed crop conditions as of July 12 rated poor or very poor have reached or surpassed 10% for corn in Indiana and Ohio, and soy in Illinois, Indiana, and Ohio. The highest level of drought experienced in Monroe County in the past six years is D2 or “Severe Drought”. Many people will recall the summer of 2012 throughout Indiana because drought conditions had intensified and reached D4 for 6 weeks in Monroe County. Burn bans were common and the fire threat was so great that all July 4 fireworks events were postponed or cancelled. Most recently, September 10, 2024 – November 5, 2024, Monroe County once again was at D2 for 5 weeks, D1 for an additional 6 weeks. Although not as severe as 2012, due to high winds and low humidity many communities contemplated potential burn bans**. Figure 19**, from the U.S. Drought Monitor, describes the rationale to classify the severity of droughts.

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

Figure 19 US Drought Monitor Drought Classification Descriptions

Table 5: Drought Trends in Monroe County since 2018

	Percent of Each Year in Drought					
	None	D0	D1	D2	D3	D4
2018	85%	15%	0%	0%	0%	0%
2019	87%	13%	0%	0%	0%	0%
2020	67%	17%	15%	0%	0%	0%
2021	85%	15%	0%	0%	0%	0%
2022	63%	13%	23%	0%	0%	0%
2023	48%	21%	25%	6%	0%	0%
2024	44%	29%	17%	4%	0%	0%

The National Climate Data Center (NCDC) does not report any events nor property or crop losses within Monroe County during this planning period in relation to drought. During discussions with the Planning Committee, effects from the drought were highlighted. Committee members recalled the dry conditions and discussed the large field/wildland fires which frequently occur during harvest season. Although NCDC does not show any reports of damage, fires during harvest result in damage to farming equipment even if crops are preserved. **Table 5** depicts the percentage of each year at each of the drought level indicated above. Monroe County has not exceeded D2-Severe Drought during the past 6 years.

The Planning Committee, utilizing the CPRI, determined the overall risk of drought throughout the county is “Elevated.”. The impact of drought was determined to be “Likely” for all of Monroe County. The magnitude of drought is anticipated to be “Negligible” to “Limited”. Further it is anticipated that with the enhanced weather forecasting abilities, the warning time for a drought is greater than 24 hours and the duration will be greater than one week. A summary is shown in **Table 6.**

Table 6: CPRI for Drought

Community	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
Monroe County	Likely	Negligible	> 24 hours	> 1 week	Elevated
City of Bloomington	Likely	Negligible	> 24 hours	> 1 week	Elevated
Town of Ellettsville	Likely	Limited	> 24 hours	> 1 week	Elevated
Town of Stinesville	Likely	Negligible	> 24 hours	> 1 week	Elevated

According to the National Drought Mitigation Center, scientists have difficulty predicting droughts more than one month in advance due to numerous variables such as the precipitation, temperature, soil moisture, topography, and air-sea interactions. Further anomalies may also enter the equation and create more dramatic droughts or lessen the severity of droughts. The damage anticipated throughout the county is predicted to be “Limited” to “Negligible” even though all the municipalities rely on groundwater and surface water supplies for fire response efforts and drinking water supplies. The communities would face a higher risk during the prolonged drought.(Most Indiana droughts tend to be less intense and much shorter than those experienced in the west and southwest of the country.) Businesses and industry that rely upon water for their processes and products would be impacted by water limitations within the cities and towns. Throughout the unincorporated areas of the county, increased crop and livestock damage would also be expected during a significant drought. In addition, the long-term stress on the forested land could result in additional tree deaths and debris during subsequent high wind events. During the last 6 years there has not been an increased incidence of wells going dry due to drought.

Assessing Vulnerability

This type of hazard will generally affect entire counties and even multi-county regions at one time. Within Monroe County, direct and indirect effects from a lengthy period of drought may include:

Direct Effects:

- Urban, developed areas, and local wildlife areas may experience revenue losses from decreased tourism; landscaping companies, golf courses revenue losses due to lack of growth and plant death; restrictions on industry cooling and processing demands; reduced incomes for businesses dependent on crop yields, and increased potential for fires.
- Rural areas within the county may experience revenue losses from reductions in decreased livestock and crop yields as well as increased incidence of field fires.
- Loss of tree canopy due to increased susceptibility to pests and diseases.
- Citizens served by drinking water wells or surface water supplies may be impacted during low water periods and may require drilling of deeper wells or loss of water service for a period.

Indirect Effects:

- Loss of income of employees from businesses and industry affected; loss of revenue to support services (food service, suppliers, etc.)

- Loss of revenue from recreational or tourism sectors associated with reservoirs, streams, and other open water venues.
- Lower yields from domestic gardens increasing the demand on purchasing produce and increased domestic water usage for landscaping.
- Increased demand for emergency responders and firefighting resources due to grass fires and increased medical calls for people having respiratory issues because of increased dust amounts.
- Drought conditions could make it more difficult for the underserved population as many of them do not have air conditioning which makes breathing more difficult and air quality conditions can become compromised.

According to Purdue's Indiana Climate Change Impacts Assessment climate change will as temperatures rise, and rainfall patterns shift, managing multiple water needs will become increasingly difficult. This could result in more drought conditions.

Estimating Potential Losses

It is difficult to estimate the potential losses associated with a drought for Monroe County because of the nature and complexity of this hazard and the limited data on past occurrences. However, for the purpose of this MHMP update, a scenario was used to estimate the potential crop loss and associated revenue lost due to a drought similar to that experienced during the drought of record from 1988. In 2023, Monroe County produced approximately 1.06M bushels of corn and 0.48M bushels of soybeans, as reported by the United States Department of Agriculture (USDA) National Agricultural Statistics Service. Using national averages of $4.70 per bushel of corn and $12.80 per bushel of soybeans, the estimated crop receipts for 2023 would be $11.13M. Using the range of crop yield decreases reported in 1988 and 1989, just after the 1988 drought period (50%-86%) and assuming a typical year, economic losses could range between $5.56M-$8.9M; depending on the crop produced and the market demand. Effects of drought on the crops can be seen in **Figure 20.**

Figure 20 Drought Effects on Crop

Purdue Agriculture News reports that as of March 2013, Indiana producers received more than $1.49B in crop insurance payments for 2012 corn, soybean, and wheat losses. This amount is nearly double that of the previous record, $522M following 2008 losses, also due to drought. These losses are still considered to be record-setting in terms of drought effects, damages, and costs for Indiana. In comparison, in 2022 Indiana received $51,104,285 in crop insurance from the drought and weather-related events.

According to a July 5, 2012, article in The Times (Noblesville, IN), "The effects of drought also could touch agricultural businesses, such as handlers and processors, equipment dealers, and see, fertilizer and pesticide providers." Additional losses associated with a prolonged drought are more difficult to quantify. Drought has lasting impacts on trees: death to all or portions of a tree, reduction in the tree's ability to withstand insects and diseases, and interruption of normal growth patterns. Such effects on trees, especially urban trees can lead to additional impacts, both environmentally

and monetarily in terms of the spread of Emerald Ash Borer insect and the weakening of tree limbs and trunks which may lead to increased damage during other hazard events such as wind and ice storms. Loss of trees also alters wildlife habitats causing wildlife to find new areas to live, often causing increased wildlife deaths as they navigate through more urbanized areas to reach new habitats.

Future Considerations

Advancements in plant hybrids and development have eased the impacts from short-lived droughts. Seeds and plants may be more tolerant of drier seasons and therefore fewer crop losses may be experienced.

As the municipal areas of the county continue to grow and expand, protocols may need to be updated to foster consistency throughout the communities and the unincorporated portions of the county for burn bans and water usage advisories.

According to the Indiana Climate Change Impacts Assessment, Indiana has experienced a rise in the average annual precipitation between 1895 and 2016; an increase of 6.7 inches for the area of Monroe County. This increase in precipitation may lessen the likelihood or overall impact of a long-term drought in Monroe County. However, the assessment also notes seasonal shifts in precipitation may lead to seasonal short-term droughts. In either scenario, changes in precipitation are not anticipated to relieve the area of a probability of a drought occurring.

Prior to municipalities expanding, provisions and considerations should be given regarding the potential additional demand for both water usage and fire response efforts. Following such expansion or development plans, alternative water sources should be explored. Since the previous MHMP was prepared, large scale and significant development has not occurred throughout the county. The majority of Monroe County remains largely unincorporated and rural in nature.

Relationship to Other Hazards

Discussions with the Planning Committee were held regarding the similar effects of prolonged periods of extreme heat and the similar impacts that may be experienced during these times. Planning and mitigation efforts for one hazard may benefit the other. It is anticipated that rural areas of the county may be more susceptible to brush and rangeland or woodland fires during a drought, while urban areas may experience these impacts in areas where several abandoned buildings or overgrown lots exist, and this may lead to increased losses associated with a fire.

3.2.2 Earthquake

Overview

An earthquake is a sudden, rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth's surface. For hundreds of millions of years, the forces of plate tectonics have shaped the earth as the huge plates that form the earth's surface move slowly over, under, and past each other. Sometimes the movement is gradual. At other times, the plates are locked together, unable to release the accumulating energy. When the accumulated energy grows strong enough, the plates break free, causing the ground to shake. Most earthquakes occur at the boundaries where the plates meet; however, some earthquakes occur in the middle of the plates.

Ground shaking from earthquakes can collapse buildings and bridges; disrupt gas, electric, and phone service; and sometimes trigger landslides, avalanches, flash floods, fires, and huge destructive ocean waves (tsunamis). Buildings with foundations resting on unconsolidated landfill and other unstable soil, and trailers and homes not tied to their foundations are at risk because they can move off their mountings during an earthquake. When an earthquake occurs in a populated area, it may cause deaths, injuries, and extensive property damage.

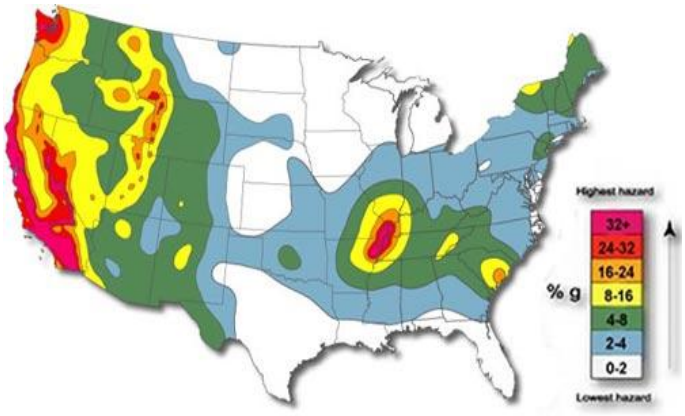


Figure 21 Earthquake Risk Areas in the US

Earthquakes strike suddenly, without warning. Earthquakes can occur at any time of the year and at any time of the day or night. On a yearly basis, 70-75 damaging earthquakes occur throughout the world. Estimates of losses from a future earthquake in the United States approach $200B.

One method of measuring the magnitude or energy of an earthquake is the Richter Scale. This scale uses whole numbers and decimal fractions whereby each increase of a whole number represents a release of 31 times more energy than the amount associated with the previous whole number on the scale. Scientists are currently studying the New Madrid fault area and have predicted that the chances of an earthquake in the M8.0 range occurring within the next 50 years are approximately 7%-10%. However, the chances of an earthquake at a M6.0 or greater, are at 90% within the next 50 years.

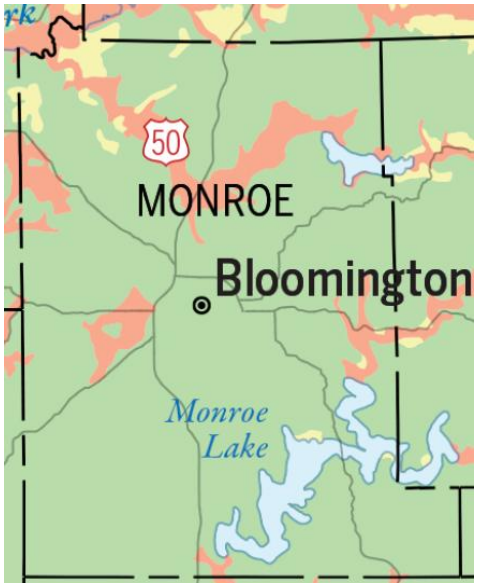


Figure 22 Earthquake Liquefaction Potential

There are 45 states and territories in the United States at moderate to very high risk from an earthquake, and they are located in every region of the county **(Figure 21)**. California experiences the most frequent damaging earthquakes; however, Alaska experiences the greatest number of large earthquakes – most located in uninhabited areas. The largest earthquakes felt in the United States were along the New Madrid Fault in Missouri, where a three-month long series of quakes from 1811 to 1812 occurred over the entire Eastern United States, with Missouri, Tennessee, Kentucky, Indiana, Illinois, Ohio, Alabama, Arkansas, and Mississippi experiencing the strongest ground shaking. Several smaller historic faults are located throughout the state of Indiana.

Additionally, some soil in Indiana is highly susceptible to liquefaction during earthquake conditions. The older riverbeds within Monroe County show signs of a potential for liquefaction, especially in the western ½ of the county where the potential is rated as high. (**Figure 22**)

Recent Occurrences

Indiana, as well as several other Midwestern states, lies in the most seismically active region east of the Rocky Mountains**. Figure 23** shows the 2014 Seismic Hazard for Indiana. The nearest known areas of concern for Monroe County are the Anna Fault, Wabash Seismic Zone, and the New Madrid Fault Zone.

On June 17, 2021, an earthquake centered near Bloomingdale, Indiana in Parke County was felt as far north as Chicago, Illinois and as far east as Cincinnati, Ohio. With a magnitude of 3.8 several localized reports included descriptions of shaking buildings and feelings of tremors. No injuries or severe damage was reported due to this incident. As reported by the NBC 5 Chicago, "Once the earthquake was confirmed, officials said the 9-1-1 phone line "started ringing immediately."" Before this event, the last earthquake to be felt in Indiana was a magnitude 5.1 centered in Sparta, North Carolina, and the last event to occur within the state (near this event) was a magnitude 2.3 earthquake centered in Haubstadt, IN on May 28, 2015. No injuries or damage were reported with either of these events.

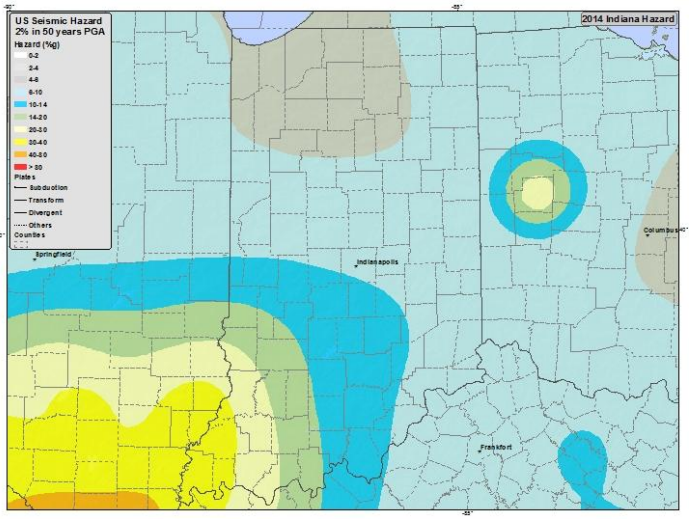


Figure 23 Indiana Seismic Zone Map

On December 30, 2010, central Indiana experienced an earthquake with a magnitude of 3.8; rare for this area in Indiana as it is only the 3rd earthquake of notable size to occur north of Indianapolis. Even rarer is the fact that scientists believe that the quake was centered in Greentown, Indiana approximately 13 miles southeast of Kokomo, Indiana. According to The Kokomo Tribune, "113 people called 911 in a 15-minute period after the quake, which was the first tremblor centered in Indiana since 2004". Further, a geophysicist from the USGS in Colorado stated, "It was considered a minor earthquake," and "Maybe some things would be knocked off shelves, but as far as some significant damage, you probably wouldn't expect it from a 3.8."

A M5.8 centered in Mineral, Virginia affected much of the East Coast on August 23, 2011. According to USA Today, 10 nuclear power plants were shut down for precautionary inspections following the quake, over 400 flights were delayed, and the Washington Monument was closed indefinitely pending detailed inspections by engineers.

Based on historical earthquake data, local knowledge of previous earthquakes, results of HAZUS-MH scenarios, and that Monroe County has not been directly impacted by an earthquake, the Committee determined that the probability of an earthquake occurring in all of Monroe County is "Likely" to "Unlikely". Should an earthquake occur, the impacts associated with this hazard are anticipated to be "Negligible" to "Limited". As with all earthquakes, it was determined that the residents of Monroe County would have little to no warning time (less than six hours) and that the duration of the event would be expected to be less than 6 hours. A summary is shown in **Table 7.**

Table 7: CPRI for Earthquake

	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
Monroe County	Likely	Negligible	< 6 hours	< 6 hours	Elevated
City of Bloomington	Likely	Negligible	< 6 hours	< 6 hours	Elevated
Town of Ellettsville	Likely	Negligible	< 6 hours	< 6 hours	Elevated
Town of Stinesville	Unlikely	Limited	< 6 hours	< 6 hours	Low

Per the Ohio Department of Natural Resources Division of Geological Survey, "…it is difficult to predict the maximum-size earthquake that could occur in the state and certainly impossible to predict when such an event would occur. In part, the size of an earthquake is a function of the area of a fault available for rupture. However, because all known earthquake-generating faults in Ohio are concealed beneath several thousand feet of Paleozoic sedimentary rock, it is difficult to directly determine the size of these faults." Further according to the Indiana Geological Survey, "…no one can say with any certainty when or if an earthquake strong enough to cause significant property damage, injury, or loss of life in Indiana will occur…we do indeed face the possibility of experiencing the potentially devastating effects of a major earthquake at some point in the future." The Committee felt that an earthquake occurring within or near Monroe County is "Likely" to occur within the next five years. At the present time, there is no link between earthquakes and changes in climate. There have been no earthquakes 3.0 or greater in or near Monroe County, Indiana in the past 6 years.

Figure 24 Minor Earthquake Damage

Assessing Vulnerability

Earthquakes generally affect broad areas and potentially many counties at one time. Within Monroe County, direct and indirect effects from an earthquake may include:

Direct Effects:

- Urban areas may experience more damage due to the number of structures, the multi-story nature of the structures, and critical infrastructure (fire houses, cell phone towers, health care facilities, etc.) located in these areas.

Figure 25 Structural Earthquake Damage

- Rural areas may experience losses associated with agricultural structures such as barns and silos.
- Bridges buried utilities (gas lines, waterlines, pipelines), and other infrastructure may be affected throughout the county and municipalities.
- The homeless or underserved population will need to be checked on, especially if they seek shelter under bridges or structures that are not stable.

Indirect Effects:

- Monroe County may be called upon to provide emergency response personnel to assist in the areas with more damage.
- Provide shelter for residents of areas with more damage.
- Delays in delivery of goods or services originating from areas more affected by the earthquake or originating at locations beyond the damaged areas, but that would have to be re-routed to avoid damaged areas.

The types of loss caused by an earthquake could be physical, economic, or social in nature. Due to the unpredictability and broad impact regions associated with an earthquake, all critical and non-critical infrastructure are at risk of experiencing earthquake related damage. Damage to structures, infrastructure, and even business interruptions can be expected following an earthquake. Examples of varying degrees of damage are shown in **Figure *24*** and **Figure *25*.**

Estimating Potential Losses

To determine the losses associated with an earthquake, the HAZUS-MH software was utilized in the Monroe County MHMP update. HAZUS-MH is a nationally standardized risk modeling methodology which identifies areas with high risk for natural hazards and estimates physical, economic, and social impacts of earthquakes, hurricanes, floods, and tsunamis. For this plan an arbitrary earthquake scenario placed a magnitude 5.0 within Monroe County.

Per the HAZUS-MH scenario noted above, there are over 5 thousand buildings in the region.

- Total economic losses are anticipated to be near $400.87M.
- 19% of the estimated losses are related to business interruption.
    - 12 buildings are anticipated to be damaged beyond repair.
    - 4 essential facilities with reduced functionality on day 1.
        - 2 Schools
        - 4 Fire Stations
- Transportation segments with reduced functionality after day 1
    - 9 Highway segments
    - 61 bridges,
    - 0 railway segments
    - 0 railway bridges
    - 1 airport runways.
- Utility Systems with reduced functionality on day 1
    - 1 communications system

No fires are estimated due to the earthquake were anticipated. The model estimates that a total of 18,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 63.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 720 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

The HAZUS-MH model computes anticipated economic losses for the hypothetical earthquake due to direct building losses and business interruption losses. Direct building losses are the costs to

repair or to replace the damage caused to the building and contents, while the interruption losses are associated with the inability to operate a business due to the damage sustained. Business interruption losses also include the temporary living expenses for those people displaced from their homes.

The HAZUS-MH Earthquake Model allows local building data to be imported into the analysis. However, these local data are imported as "general building stock," meaning that the points are assigned to a census tract rather than a specific XY coordinate. HAZUS performs the damage analysis as a county wide analysis and reports losses by census tract. While the results of the hypothetical scenario appear to be plausible, care should be taken when interpreting these results.

Future Considerations

While the occurrence of an earthquake in or near to Monroe County may not be the highest priority hazard studied for the development of the plan, it is possible that residents, business owners, and visitors may be affected should an earthquake occur anywhere within the state. For that reason, Monroe County should continue to provide education and outreach regarding earthquakes and earthquake insurance along with education and outreach for other hazards. As the county and the communities within the county grow and develop, the proper considerations for the potential of an earthquake to occur may help to mitigate social, physical, or economic losses in the future.

It can be anticipated that while all structures in Monroe County will remain at-risk of earthquake damage and effects, new construction or redevelopment may reduce the overall risks. As redevelopment or growth occurs, the new construction may be significantly sturdier. Further, as blighted or abandoned areas are addressed, those communities and the county are less susceptible to economic and physical damage associated with earthquakes. Since the last planning effort, no significant development has occurred within the county.

Relationship to Other Hazards

Hazardous materials incidents may occur because of damage to material storage containers or transportation vehicles involved in road crashes or train derailments. Further, dam failures, levee breaks, or landslides may occur following an earthquake or associated aftershocks due to the shifting of the soils in these hazard areas. These types of related hazards may have greater impacts on Monroe County communities than the earthquake itself. It is not expected that earthquakes will be caused by other hazards studied within this plan.

3.2.3 Extreme Temperature

Overview

Extreme Heat

Extreme heat is defined as a temporary elevation of average daily temperatures that hover 10 degrees or more above the average high temperature for the region for the duration of several weeks. Humid or muggy conditions, which add to the discomfort of elevated temperatures, occur when a dome of high atmospheric pressure traps water-laden air near the ground. In a normal year, approximately 175 Americans die from extreme heat.

According to the NWS, "The Heat Index or the "Apparent Temperature" is an accurate measure of how hot it really feels when the Relative Humidity is added to the actual air temperature." To find the Heat Index Temperature, refer to the Heat Index Chart in **Figure 26**. As an example, if the air temperature is 96°F and the relative humidity is 65%, the heat index – how hot it feels – is 121°F. The National Weather Service has 3 levels of Excessive Heat Notifications.

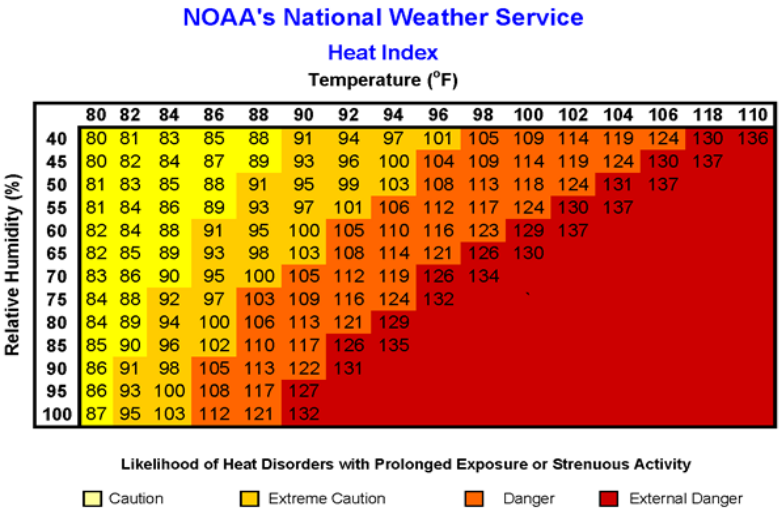


Figure 26 NWS heat Index Chart

1) A Heat Advisory - means that temperatures of at least 100°F* or Heat Index values of at least 105°F* are expected.

2) An Excessive Heat Watch means that Heat Index values are expected to reach or exceed 110°F* and not fall below 75°F* for at least a 48-hour period.

3) An Excessive Heat Warning means that Heat Index values are expected to reach or exceed 110°F* and not fall below 75°F* for at least a 48-hour period, beginning in the next 24 hours. A warning may also be issued for extended periods with afternoon heat index values of 105°F-110°F.

Classification	Heat Index	Effect on the body
Caution	80°F - 90°F	Fatigue possible with prolonged exposure and/or physical activity
Extreme Caution	90°F - 103°F	Heat stroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity
Danger	103°F - 124°F	Heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity
Extreme Danger	125°F or higher	Heat stroke highly likely

Figure 27 Extreme Heat Effects by Heat Index

It is important to also note that these heat index values were devised for shady, light wind conditions. Exposure to full sunshine may increase heat index values by up to 15°F. Further, high winds, particularly with very hot, dry air, can also be extremely hazardous.

As **Figure 27** indicates, there are four cautionary categories associated with varying heat index temperatures. Each category provides a heat index range along with effects on the human body.

People with underlying health issues, the very old or very young may be impacted at lower temperatures since their systems are less likely to be able to compensate for the heat and humidity.

Extreme Cold

Extreme cold is defined as a temporary, yet sustained, period of extremely low temperatures. Extremely low temperatures can occur in winter months when continental surface temperatures are at their lowest point and the North American Jet Stream pulls arctic air down into the continental United States. The jet stream is a current of fast-moving air found in the upper levels of the atmosphere. This rapid current is typically thousands of kilometers long, a few hundred kilometers wide, and only a few kilometers thick. Jet streams are usually found somewhere between 10-15 km (6-9 miles) above the Earth's surface. The position of this upper-level jet stream denotes the location of the strongest surface temperature contrast over the continent. The jet stream winds are strongest during the winter months when continental temperature extremes are greatest. When the jet stream pulls arctic cold air masses over portions of the United States, temperatures can drop below 0° F for one week or more. Sustained extreme cold poses a physical danger to all individuals in a community and can affect infrastructure function as well.(**Figure 28**)

Figure 28 Extreme Cold in December 2022

In addition to strictly cold temperatures, the wind chill temperature must also be considered when planning for extreme temperatures. The wind chill temperature, according to the NWS, is how cold people and animals feel when outside and it is based on the rate of heat loss from exposed skin. **Figure 29** identifies the Wind Chill Chart and how the same ambient temperature may feel vastly different in varying wind speeds.

Wind chill is a guide to winter danger

New wind chill chart

Frostbite occurs in 15 minutes or less

Wind (MPH) \ Temperature (°F)	30	25	20	15	10	5	0	-5	-10	-15	-10	-25
5	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40
10	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47
15	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51
20	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55
25	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58
30	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60
35	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62
40	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64
45	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65
50	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67
55	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68
60	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69

Figure 29 Wind Chill Guide

Recent Occurrences

The effects of extreme temperatures extend across large regions, typically affecting several counties, or states, during a single event. Between January 1, 2017, and November 30, 2024, according to the NCDC, there has been:

- 3 extreme heat events
  - Temperatures in the 90s and dewpoints in the upper 70s to near 80 degrees created heat index values in excess of 105 degrees on the afternoons of July 19 and 20, 2019.
  - On the afternoon of August 25, 2023, temperatures warmed into the 90s within an air mass containing high relative humidity. Apparent temperatures (heat index) soared above 105 degrees, with several stations topping 110 degrees.
  - 0 Deaths, 0 Injuries, no damages reported.
- 1 extreme cold event.
  - A cold front crossed the Ohio Valley Thursday, December 22, 2022, evening, with plummeting temperatures and strong winds. Sustained 20 to 30 mph winds had higher gusts of 35 to 45 mph resulting in wind chill temperatures at -25 degrees Fahrenheit.
  - 0 Deaths, 0 Injuries, no damages reported.

It is difficult to predict the probability that an extreme temperature event will affect Monroe County residents within any given year. However, based on historic knowledge and information provided by the community representatives, an extreme temperature event is "Highly Likely" (probably within the next year) to occur within the county and if an event did occur, it would result in "Negligible" to "Limited" impacts. **Table 8** identifies the CPRI for extreme temperatures-both heat and cold events for all communities in Monroe County. Recent climate changes have resulted in extreme cold temperatures shifting more-so into the months of January through March rather than the traditional winter period beginning in December. The number of days over 90 degrees has increased statewide. 90-degree days also are being recorded earlier in the summer months whereas in the past they were traditionally in the months of July through September. This is causing people to begin using air conditioners sooner and longer, increasing electric bills for homeowners and businesses.

Table 8: CPRI for Extreme Temperatures

	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
Monroe County	Highly Likely	Limited	> 24 hours	< 1 week	Elevated
City of Bloomington	Highly Likely	Limited	> 24 hours	< 1 week	Elevated
Town of Ellettsville	Highly Likely	Limited	> 24 hours	< 1 week	Elevated
Town of Stinesville	Highly Likely	Negligible	> 24 hours	> 1 week	Elevated

Assessing Vulnerability

As noted above, this type of hazard will generally affect entire counties and even multi-county regions at one time; however, certain portions of the population may be more vulnerable to extreme temperatures. For example, outdoor laborers, very young and very old populations, low-income populations, and those in poor physical condition are at an increased risk to be impacted during these conditions.

By assessing the demographics of Monroe County, a better understanding of the relative risk that extreme temperatures may pose to certain populations can be gained. In total, 19.8% of the county's

population is over 65 years of age, 5.9% of the population is below the age of 5, and approximately 21.9% of the children in the community lived in poverty in 2022. People within these demographic categories are more susceptible to social or health related impacts associated with extreme heat. Families below the poverty line are less likely to have functioning air conditioning in their homes. Because of high energy costs those who do have air conditioning may be less likely to use the units in a way to benefit their health and well-being. The same factors are key when looking at heating sources in cold temperatures. The elderly and those living below the poverty line are more likely to rely on alternative heating sources because of the cost of energy. These alternative heating sources are frequently the cause of carbon monoxide poisoning and/or house fires.

In January 2024, subzero windchills impacted the entire State of Indiana with Indianapolis reporting 84 hours of sub-zero windchills between January 13 and 17. Although not as cold as their neighbors to the north, Monroe County along with neighboring Counties sought to address the warming needs for unsheltered homeless people who reside in or travel through the community. Although there are some daytime facilities open to warm those who are cold, nighttime accommodations are limited at best.

Extreme heat can affect the proper function of organ and brain systems by elevating core body temperatures above normal levels. Elevated core body temperatures, usually more than 104°F are often exhibited as heat stroke. For weaker individuals, an overheated core body temperature places additional stress on the body, and without proper hydration, the normal mechanisms for dealing with heat, such as sweating to cool down, are ineffective. Examples of danger levels associated with prolonged heat exposure are identified in **Figure 30.** Extreme cold may result in similar situations as normal functions are impacted as the temperature of the body is reduced. Prolonged exposure to cold may result in hypothermia, frostbite, and even death if the body is not warmed.

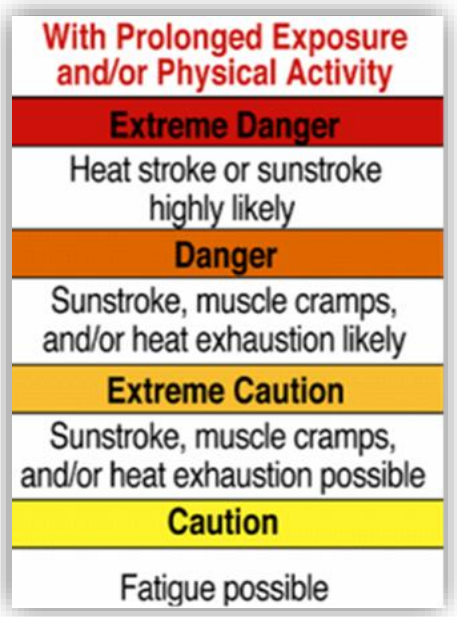


Figure 30 Heat Danger Classification

Within Monroe County, direct and indirect effects from a prolonged period of extreme temperature may include:

Direct Effects:

- Direct effects are primarily associated with health risks to the elderly, infants, people with chronic medical disorders, lower income families, outdoor workers, and athletes. Health risks can range from heat exhaustion or mild hypothermia to death due to heat stroke, amputations due to frost bite or death due to severe hypothermia.

Indirect Effects:

- Increased need for cooling or warming shelters.
- Increased medical emergency response efforts.
- Increased energy demands for heating or cooling.

Estimating Potential Losses

It is difficult to estimate the potential losses due to extreme temperatures as damage is not typically associated with buildings but instead with populations and people.

This hazard is not typically as damaging to structures or critical infrastructure as it is to populations so monetary damages associated with the direct effects of the extreme temperature are not possible to estimate accurately.

Indirect effects:

- Increased expenses for facilities such as healthcare or emergency services due to the increased number of calls and people seeking assistance.

- Manufacturing facilities where temperatures are normally elevated may need to alter work hours or experience loss of revenue if forced to limit production during the heat of the day.

- Energy suppliers may experience demand peaks during the hottest and/or coldest portions of the day.

- Extreme cold indirect effects include pipes freezing resulting in loss of access to water for industrial processes as well as personal hygiene, sanitation and hydration of livestock and people. These effects may disproportionately impact vulnerable populations (elderly and children) within the County.

Future Considerations

As more and more citizens are experiencing economic difficulties, local power suppliers along with charitable organizations have implemented programs to provide cooling and heating mechanisms to residents in need. Often, these programs are donation driven and the need for such assistance must be demonstrated. As susceptible populations increase, and/or as local economies are stressed, such programs may become more necessary to protect Monroe County's at-risk populations. Additionally, the increase in the number of unsheltered homeless in the area calls for innovative approaches to addressing heating and cooling needs after traditional business hours when this population is particularly susceptible.

The Climate Change Assessment identifies several temperature related considerations of which communities should be aware of and begin planning to avoid further impacts. For example, rising temperatures will increase the number of extreme heat days, thereby increasing the potential for heat related illnesses, potential hospitalizations, and medication costs to vulnerable populations. In addition, added days of extreme heat will impact agriculture, manufacturing, and potentially, water sources. Increasing greenspaces within the cities and towns not only provide benefits of stormwater control, carbon sequestration and air pollution filtration, but also are great for reducing the energy from the sun reaching the ground surface, thus cooling the area. Future community planning should include the incorporation of heat tolerant green infrastructure to lessen the impacts of extreme heat upon the community as a whole.

New construction associated with development of residential areas often brings upgraded and more efficient utilities such as central heating and air units further reducing vulnerabilities to the aging populations in those municipalities mentioned above. Conversely, new development associated with industrial or large commercial structures in the inner-urban centers often result in increased heat over time, which may cause additional stress to labor-related populations. Since the last planning effort, there has not been significant residential and commercial development within the county.

Extreme Temperatures: Relationship to Other Hazards

While extreme temperatures may be extremely burdensome on the power supplies in Monroe County, the Committee concluded that this type of hazard is not expected to cause any other

hazards studied. It is anticipated that due to prolonged extreme temperatures, primarily long periods of elevated temperatures, citizens may become increasingly agitated and irritable, and this may lead to disturbances requiring emergency responder intervention.

3.2.4 Fires and Wildfire

Overview

A wildfire, also known as a forest fire, vegetation fire, or a bushfire, is an uncontrolled fire in wildland areas and is often caused by lightning; other common causes are human carelessness and arson. Small wildfires may be contained to areas less than one acre, whereas larger wildfires can extend to areas that cover several hundred or even thousand acres. Generally, ambient weather conditions determine the nature and severity of a wildfire event. Very low moisture and windy conditions can help to exacerbate combustion in forested or brush areas (**Figure 31**) and turn a small brush fire into a major regional fire event in a very short period. Wildfires can be very devastating for residents and property owners.

Figure 31 Forest Fire

A structural fire is an incident where a fire starts within a structure and is largely contained to that structure. Causes of structure fires can be related to electrical shorts, carelessness with ignition sources and/or alternative heating sources, poor storage of flammable materials, as well as arson. These types of fires can be deadly if no warning or prevention measures are present. The most dangerous aspect of structural fires is the production of toxic gases and fumes that can quickly accumulate in enclosed areas of structures and asphyxiate those who might be in the structure.

Problems associated with structural fires are compounded when high-rise buildings catch fire. High-rise fires hinder the ability of rescue workers to fight the fire, reach impacted building occupants, and evacuate impacted occupants. Rescue efforts also become more complicated when handicapped or disabled persons are involved. Complications associated with high-rise fires typically increase as the height and occupancy levels of the buildings increase. Structural collapse is another concern associated with fires. Structural collapse often results in people becoming trapped and severely injured. However, it is important to note that the concern associated with structural collapse, is not limited to high-rise buildings; the collapse of smaller residential buildings can also lead to severe injury and death.

Combating a wildfire or a structure fire is extremely dangerous. If weather conditions change suddenly, the fire may change course and/or increase in strength potentially overtaking neighboring structures and firefighters, causing severe injury or death. Fires can travel at speeds greater than 45 mph. Members of the homeless community, hunters and/or campers may also be in the area of the fires with no means to escape.

Fire response capabilities are limited by the ever-dwindling number of volunteer firefighters. Just as the fire department rosters are shrinking, the ability of volunteer firefighters to respond from their place of employment, especially during “normal working hours” is shrinking. Many volunteers work outside of their fire department jurisdiction and employers are less likely to allow volunteers to leave the workplace for a fire call. This reduction in force further increases the risks for first responders and community members alike.

Recent Occurrences

Within the NCDC, there are no reports of wildfires occurring in Monroe County between January 1, 2017 to November 30, 2024. Larger field/grass and woods fires take place frequently , especially during the autumn harvest season. In 2006 in Pike County, Indiana two field fires burned over 350 acres (larger than most field fires in Indiana). On November 20, 2022, a 110-acre brush fire was brought under control by several volunteer fire departments and Indiana DNR staff at Brown County State Park. Grass fires in the median and along Interstate 65 recently closed the southbound lanes for a number of hours while fire departments attempted to extinguish the wind driven fires. **Figure 32** shows the devastation of a field fire in October 2024 believed to have been started by a malfunctioning combine.

Figure 32 Brush Fire Monroe Fire Protection District

The impacts of wildfires can be quite extensive and reach well beyond the borders of the jurisdiction fighting the fire. This is well demonstrated by the summerlong wildland fires in Canada in 2023. Over 16.5 million acres, an area the size of the entire state of Florida, burned between March and September. The fires resulted in smoke plumes which reached central Indiana at levels requiring people with asthma and other respiratory difficulties to remain indoors.

The NCDC does not report structure fires; therefore, local sources were utilized to provide information regarding residential and business fires.

Figure 33 House Fire September 21, 2020, Monroe Fire Protection District

Fires at residences are the most common fire hazard affecting Monroe County in the last several years. On March 29, 2020, six family members were killed in a house fire. The one adult and five children ranging in age from 10 to 15 years old were unable to be rescued due to the heat and dense smoke.(**Figure 33)**

Due to the expansive acreage of agricultural land within Monroe County, and the potential for urban areas to be at risk due to abandoned homes, blighted areas, or industrial activities, the

Planning Committee determined the probability to be “Highly Likely” throughout the County. **Table 9** identifies the CPRI rankings for fire in Monroe County.

Table 9: CPRI for Fire

	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
Monroe County	Highly Likely	Significant	< 6 hours	< 6 hours	Severe
City of Bloomington	Highly Likely	Significant	< 6 hours	< 6 hours	Severe
Town of Ellettsville	Highly Likely	Significant	< 6 hours	< 6 hours	Severe
Town of Stinesville	Highly Likely	Significant	< 6 hours	< 1 day	Severe

Information provided in **Table 10** highlights the number of fire calls the Monroe County fire departments responded to during the time period January 2018 through December 2022. Damage to structures, contents, crops, forests, and vehicles is significant for each municipality on an annual basis. Social losses, such as being unable to work following a residential structure fire or losses associated with a business fire should also be considered as an impact.

Table 10: Monroe County Fire Calls

Department	2018	2019	2020	2021	2022
City of Bloomington Fire Dept	243	248	268	295	345
Bloomington Township Fire Department	76	74	115	Joined with Monroe Fire Protection District	
Monroe Fire Protection District	102	129	146	216	253
Ellettsville Fire Department	53	64	74	72	67
VanBuren Township Fire Department	89	91	122	Joined with Monroe Fire Protection District	
Bean Blossom Township Stinesville Fire Department	Data not Available				
TOTAL	**563**	**606**	**725**	**583**	**665**

On the whole, the number of fire calls has been steadily increasing as homes, businesses and vehicles age. The figures in 2021 dropped, possibly because of impacts from the COVID isolation and work from home efforts as well as double counting of incidents when 2 smaller agencies were responding to the same incident versus the larger merged entity. The number of calls increased again in 2022 and is expected to continue its upward trend. Changes in climate have increased the probability of grass and field fires. In addition, the number of dates when winds exceed 15 mph has increased challenging firefighting efforts in the fields, wildlands, and structural fires.

Assessing Vulnerability

Physical, economic, and/or social losses impact not only the property owner whose property was damaged by the fire, but also the community. Typically, a structural fire is limited to one or two structures, as the fire response focuses on extinguishment as well as containment thus preventing the fire from spreading to neighboring structures. This type of action works to reduce the magnitude and severity. Nonetheless, the loss of or damage to historic structures, town squares, etc. takes a toll on the community spirit as well as the financial and physical loss.

Much of the unincorporated county is rural, which is also susceptible to brush and/or crop fires, especially in times of drought. Field fires, especially in the late summer and autumn, or barn fires have an immense impact on both agricultural operations and tourism.

Direct and indirect effects of fires and wildfires within Monroe County may include:

Direct Effects:

- Loss of structures (residential as well as agricultural)
- Loss of vital equipment (industrial and agricultural)
- Loss of forests
- Loss of natural resources and wildlife

Indirect Effects:

- Loss of revenue as businesses may be closed.
- Loss of revenue from reduced tourist activities in the county
- Increased emergency response times based on safety of roads.
- Loss of income if dependent on crop production or timber harvest

Estimating Potential Losses

Given the nature and complexity of a potentially large hazard such as a wildfire, it is difficult to quantify potential losses to property and infrastructure. As a result, all critical and non-critical structures and infrastructure may be at some degree of risk.

Monetary damages associated with the direct effects of the fires are difficult to estimate, other than utilizing historic information as provided. Indirect effects would cause increased efforts associated with emergency response services as wildfires are difficult to contain and may accelerate very quickly. Further, multi-level business or residential structures place increased risks to those who work or live within those structures or nearby structures.

Future Considerations

As populations increase and community growth increases, the need to respond to fire will remain an important municipal effort. As new construction or re-development occurs, especially new or existing critical infrastructure, it is important to ensure that these new structures are equipped to deal with the potential risks associated with this hazard. Those may include increased risk for wooden or flammable outer structures and potential lengthy power outages. With the adverse impacts of extreme temperatures and drought upon the heavily forested areas, consideration must be given to mitigating fire risks for structures that are built in the rural areas to limit losses should a wildland fire take place.

In addition, increased populations require increased housing. Many urban communities develop large multi-family residential structures, or apartment complexes, where structures are not only in close proximity to each other, but also house a large number of citizens. As communities age, some structures may become abandoned, significantly increasing the risk of fire due to potential vagrant populations and lack of maintenance. These areas should be considered at-risk and potentially demolished to avoid such risk and potential hazard.

In areas, such as Monroe County, which rely on volunteer firefighters and combination fire department, firefighting responses can be slowed due to the limited numbers of volunteers available at various times of the day. More people are working outside of the community in which they reside,

which limits volunteer presence to outside of normal working hours. Recruitment initiatives need to be continued and/or expanded as the firefighting needs and staffing levels continue to change.

Fires can also result in substantial indirect costs. Increased emergency response times, loss of work or the inability to get to work, as well as business interruption, are possible indirect effects of a fire and how it may affect those businesses related to cropland or natural resource areas.

Relationship to Other Hazards

Fires may certainly result in a hazardous materials incident if storage structures are within the path of the fire. Material storage containers farther away from the burn path may become damaged by high winds and embers resulting in a spill or release of materials. Fires may result from lightning either alone or associated with a thunderstorm. Typical wind speeds during a thunderstorm may also exacerbate the impacts from any ignitions from the lightning.

3.2.5 Flood

Overview

Floods are the most common and widespread of all the natural disasters. Most communities in the United States have experienced flooding because of spring rains, heavy rain and thunderstorms, or winter snow melts. A flood, as defined by the National Flood Insurance Program (NFIP), is a general and temporary condition of partial or complete inundation or two or more acres of normally dry land area or of two or more properties from overflow of inland or tidal waters, or unusual and rapid accumulation or runoff of surface waters from any sources, or a mudflow. Floods can be slow or fast rising but generally develop over a period of days. **(Figure 34)**

Flash flooding is a term often used to describe flood events which are a result of heavy or excessive rainfall in a short period of time, generally less than 6 hours. Unlike traditional flooding which can be slower developing, these raging torrents rip through river beds, streets and roads, and overland taking anything in its way with the force of the water. Flash floods typically occur within minutes up to a few hours after an excessive rain event.

Figure 34 Flooding in Bloomington (6/20/21), CBS4

In Monroe County, flooding and associated flood damage are most likely to occur during the spring because of heavy rains on frozen ground combined with melting snow and in the summer. However, provided the right saturated conditions, intense rainfall of short duration during rainstorms can produce damaging flash flood conditions, as well. There are no exceptions to when floods may occur. There are times when they are less likely but given the right atmospheric conditions a flood or flash flood can take place virtually any time. Climate change has directly impacted flooding with the increase in precipitation and the duration of the events being shorter.

The traditional benchmark for riverine or coastal flooding is a 1% Annual Exceedance Probability (AEP), formerly known as the 100-year flood. This is a benchmark used by FEMA to establish a standard of flood protection in communities throughout the country. The 1% AEP is referred to as the “regulatory” or “base” flood. Another term commonly used, the “100-year flood”, can be misleading. It does not mean that only one flood of that size will occur every 100 years, but rather there is a 1% chance of a flood of that intensity and elevation happening during any given event. In other words, the regulatory flood elevation has a 1% chance of being equaled, or exceeded, in any given event and it could occur more than once in a relatively short time period. The area impacted by the 1% AEP flood event is called the Special Flood Hazard Area (SFHA).

Recent Occurrences

The NCDC indicates that between January 1, 2018 to November 30, 2024, there were 5 flash floods, and 0 riverine floods reported in Monroe County. On June 19, 2021, A long lasting and multi-faceted storm system moved through central Indiana beginning during the late afternoon hours and continued through the evening hours with widespread damaging winds and very large hail. The

storm then transitioned into a flash flood event during the overnight hours with significant flash flooding occurring across portions of Owen and Monroe counties. A 31-year-old male was swept away in a vehicle in floodwaters from Clear Creek near the intersection of College Avenue and Dodds Street. Another person of unknown age and sex was also in the vehicle at the time but was able to escape with only minor injuries. Numerous videos and pictures showed standing water along portions of the downtown including Walnut Street. Many businesses in the area remained shut down for a week to clean up issues related to the flood waters. Water rushed into a nursing home which required the building to evacuate. Damage estimates during the initial reports were 25 million dollars.

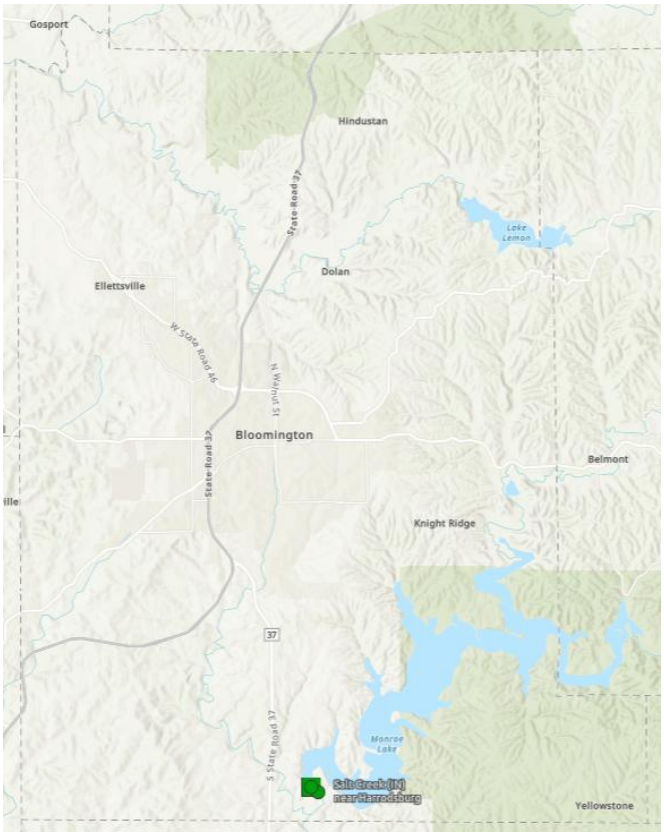


Figure 35 Monroe County Flood Gauges

Stream gauges are utilized to monitor surface water elevations and/or discharges at key locations and time periods. Some such gages are further equipped with NWS's National Water Prediction Service (NWPS) capabilities. These gauges have the potential to provide valuable information regarding historical high and low water stages, hydrographs representing current and forecasted stages, and a map of the surrounding areas likely to be flooded. Within Monroe County, there are 2 active gauges. Pictured in **Figure 35** are the two gauges located in the couth central portion of Monroe County.

- 03372400 Salt Creek (IN) at Monroe Lake
- 03372500 Salt Creek near Harrodsburg

The gauge at Monroe Lake monitors the lake levels.

The gauge near Harrodsburg has had 17 crests since January 1, 2018. Of those 20 crests the gauge reached the Moderate Flood Stage (26' or greater) twice. The remaining 15 times resulted in 13 Minor Flood Stage elevations (between 20 and 26'), 1 Action level (between 17' and 20') and 1 time below action stage (less than 17').

Flood insurance is a key for flood recovery. Any property having received two insurance claim payments for flood damages totaling at least $1,000, paid by the NFIP within any 10-year period since 1978 is defined as a repetitive loss property. These properties are important to the NFIP because they account for approximately 1/3 of the country's flood insurance payments. According to FEMA Region V, there are 6 repetitive loss structures in unincorporated Monroe County. There are none reported in any of the incorporated communities. **Table 11** identifies the number of repetitive losses and claims per community, as provided by FEMA. Note: FEMA does not have any Multiple Loss Properties listed as of September 30, 2024.

Table 11: Repetitive Properties, Claims, and Payments

Community	# Repetitive Loss Properties	Occupancy Type	Total # of Losses
Monroe County	5	5 Residences	Residences 13
City of Bloomington	4	3 Residences 1 Non-residential	Residences 7 Non-residential 7
Town of Ellettsville	3	2 Residences 1 Non-residential	Residences 4 Non-residential 3
Town of Stinesville	0	0	0
TOTAL	12	10 Residences 2 Non-residential	Residences 24 Non-residential 10

Table 12 further indicates the current premiums and coverage totals for individual communities.

Table 12: Insurance Premiums and Coverage

Community	Policies in Force	Flood Insurance Premiums	Flood Insurance Coverage, Millions
Monroe County	102	$93,963	$ 27.50
City of Bloomington	68	$65,622	$ 18.38
Town of Ellettsville	27	$53,389	$ 4.98
Town of Stinesville	1	$ 818	$ 0.04
TOTAL	53	$213,792	$ 49.90

As determined by the Committee, the probability of flooding occurring throughout Monroe County is "Possible" to "Highly Likely." This is largely based on recent experiences with the rivers and streams near the communities. The county and the unincorporated communities rated the magnitude "Limited" to "Significant". The Committee also determined that accurate warning time would be between less than 6 hours to 12 to 24 hours-based on forecasting methods, and local knowledge of stream activities. Finally, the duration of such an event is anticipated to last less than six hours to greater than a week. The recent flood events are examples of the changing climate and nature of flooding in Monroe County. The increased rain amount over a relatively short timeframe results in less absorption and increased run-off. Stream levels rise rapidly, surprising many and results in a number of water rescues. Monroe County has a flood prevention program which is working to assure properties in the community are as safe as possible from rising flood waters. The county is exploring ways to increase warning times and reduce flood impacts. A summary of flood CPRI is shown in **Table 13.**

Table 13: CPRI for Flood

	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
Monroe County	Possible	Significant	12-24 hours	> 1 week	Elevated
City of Bloomington	Highly Likely	Limited	< 6 hours	< 6 hours	Severe
Town of Ellettsville	Highly Likely	Limited	< 6 hours	< 6 hours	Severe
Town of Stinesville	Possible	Significant	6 - 12 hours	> 1 week	Elevated

Assessing Vulnerability

Flood events may affect large portions of Monroe County at one time as ditches and stream systems and areas with limited drainage cover many parts of the county and the incorporated communities. With the variable terrain and some steeper slopes, as well as increased high volume rain events, the roads within the county are vulnerable to frequent inundation isolating and/or restricting access to some parts of the communities. Wooded areas and farm fields have provided ample supply of debris causing clogs and damage to culverts, and bridges, in the past.

Whenever significant flooding impacts the communities in Monroe County, the concern about riverbank erosion also known as fluvial erosion is slightly elevated. Fluvial Erosion Hazard (FEH) represents the risk associated with natural stream movements and losses associated with buildings and infrastructure. In some cases, this may be represented by a gradual movement of a stream across a farm field. In other, more extreme instances, homes or other infrastructure may be lost as riverbanks or bluffs sluff into the water below. This will be discussed in greater detail within the landslide/land subsidence discussion. Log jam flooding can be a concern as bridges and culverts are the most frequently impacted since water flow is easily blocked at these locations forcing water outside of the banks.

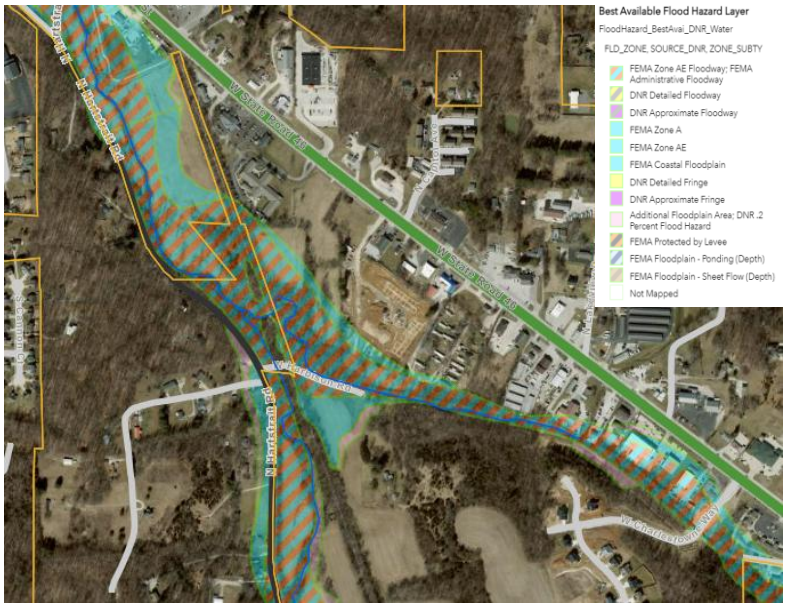


Figure 36 Floodway Mapping in Ellettsville, IN

The county seeks out mitigation measures whenever possible. Flood maps are a useful tool to identify and delineate the floodways and floodplains in a community. **Figure 36** shows a portion of the floodway in Ellettsville, IN.

All of the communities which are vulnerable to flooding either from short duration heavy rain events, or the more familiar riverine flooding have chosen to participate in the National Flood Insurance Program (NFIP).

Table 14: NFIP Participation in Monroe County

CID	Community	Init. FHBM Identified	Init FIRM Identified	Current Effective Map Date	Reg-Emerg Date	CRS
180444#	Monroe County*	3/6/1981	4/1/1988	12/17/2010	4/1/1988	No
180169#	City of Bloomington	6/21/1974	6/15/1978	12/17/2010	6/15/1978	No
180170#	Town of Ellettsville	6/14/1974	7/18/1985	12/17/2010	7/18/1985	No
180348#	Town of Stinesville	3/5/1976	12/17/2010	12/17/2010	6/20/2011	No

Both of the incorporated towns, the City of Bloomington, as well as the county participate in the NFIP and are in good standing according to the NFIP Status Book. According to the Indiana DNR Unity database, Monroe County has 52 map panels on file. The City of Bloomington has their own floodplain administrator. There are 15 map panels for the City of Bloomington to delineate the flood

hazards within the city boundaries. In the Town of Ellettsville, the Town's Floodplain Administrator administers 5 map panels. The Floodplain Administrator for the County also serves as the floodplain administrator for the Town of Stinesville which has only 1 map panel. **Table 14** provides general information about the floodplain programs in the county including the most recent effective map date from the NFIP. The floodplain administrators in Indiana are required to enforce the state approved community flood ordinance. This includes the identification of the floodplains for community members, conduct damage assessments after properties within the special flood hazard area have been damaged as well as the determination of substantial damage. Substantial damage is defined in the Indiana Model Flood Damage Prevention Ordinance as damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred. This is the standard which is used by each of the Floodplain Administrators in the county.

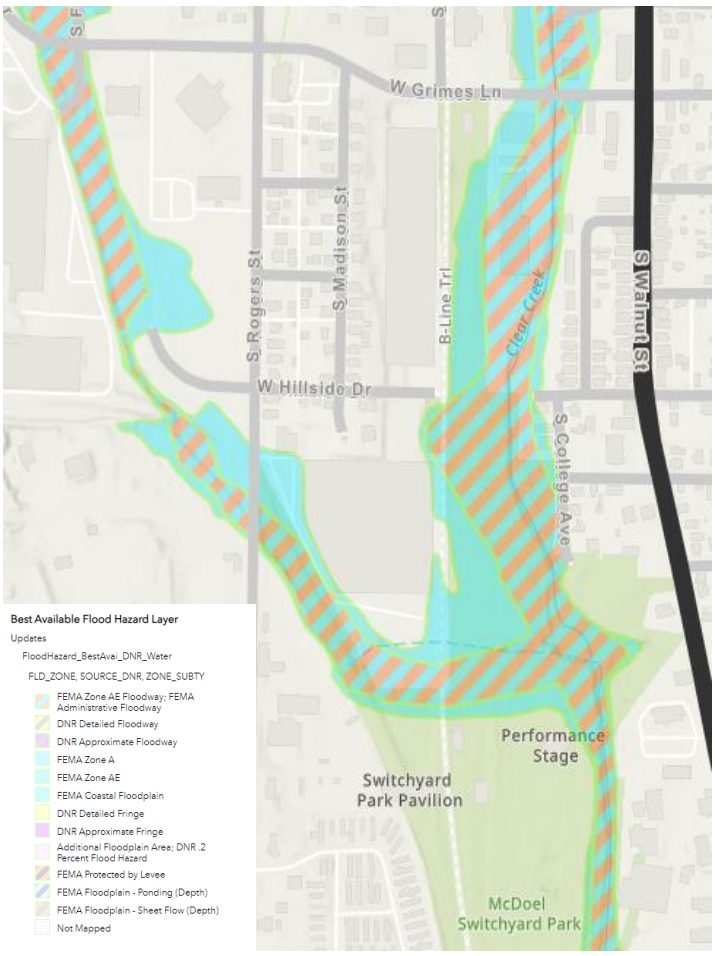


Figure 37 Special Flood Hazard Area in Bloomington, IN

Flood risk areas are frequently located within the boundaries of the disadvantaged and underserved population census blocks since these properties tend to be more affordable to rent or buy. However, with less financial capacity to mitigate their properties, flooding becomes an additional burden on the communities. Flash flooding, being less predictable, does not allow the advanced warning to be able to protect property and seek shelter out of harm's way, thus increasing vulnerability throughout the county, especially the underserved and disadvantaged community members. **Figure 37** shows the floodplain and floodway in and near McDowell Switchyard Park. Parks and storm sewer pipes are often used by unhoused community members as a place to rest and take shelter. With the sudden onset of flash flooding, it is difficult to notify people in these areas that flood waters may soon engulf their resting place and/or encampments. Homeless organizations as well as law enforcement are trying to find ways to notify these community members so there is no loss of life.

Within Monroe County, direct and indirect effects of a flood event may include:

Direct Effects:

- Structural and content damage and/or loss of revenue for properties affected by increased water.
- Increased costs associated with additional response personnel, evacuations, and sheltering needs.

- Increased potential impacts to infrastructure and buildings located within the SFHA.
- Increased cleanup costs for more frequent flash flood impacts.
- Loss of topsoil and deposition of sand due to flood inundation of farm fields.

Indirect Effects:

- Increased response times for emergency personnel when roads are impassable.
- Increased costs associated with personnel carrying out evacuations in needed areas.
- Increased risk of explosions and other hazards associated with floating propane tanks or other debris.
- Losses associated with missed work or school due to closures or recovery activities.
- Cancellations of special events in impacted areas or water related activities that become too dangerous due to high water.
- Debris removal costs to return local drainage to normal function.
- Getting notifications to the underserved populations that may not have access to radio, television, or social media of evacuations.

Estimating Potential Losses

Critical and non-critical structures located in regulated floodplains, poorly drained areas, or low-lying areas are most at risk for damages associated with flooding. For this planning effort, a GIS Desktop Analysis methodology was utilized to estimate flood damages.

For the GIS Desktop Analysis method, an analysis was completed utilizing the effective Digital FIRMs (DFIRMs) overlaid upon a Modified Building Inventory developed with information provided by Monroe County. Structures located within each flood zone were tallied using GIS analysis techniques.

In the assessment, any structure listed as less than 400 ft^2 in area or classified in the Assessor's database as a non-habitable structure was assumed to be an outbuilding. It was assumed that a building was located on a parcel if the value listed in the "Assessed Value (Improvements)" showed a value greater than zero dollars. Parcels that intersected any portion of the FEMA flood zones were considered to be flood prone, and subsequently, further analyzed separately from parcels without structures. Structure values were calculated using:

Residential = Assessed Value x 0.5
Commercial = Assessed Value x 1.0
Industrial = Assessed Value x 1.5
Agricultural = Assessed Value x 1.0
Education = Assessed Value x 1.0
Government = Assessed Value x 1.0
Religious = Assessed Value x 1.0

To estimate anticipated damages associated with each flood zone in Monroe County and communities, it was estimated that 25% of structures in the flood zones would be destroyed, 35% of structures would be 50% damaged, and 40% of structures would be 25% damaged. **Table 15** identifies the estimated losses associated with structures in the floodway, the 1% AEP (100-year floodplain), and the 0.2% AEP (500-year floodplain) areas by community within Monroe County.

Table 15: Monroe County Building Inventory Utilizing Best Available Data

Community	Floodway		1% AEP		0.2% AEP		Unnumbered	
	#	$, Million	#	$, Million	#	$. Million	#	$, Million
Monroe County	899	167.88	39	7.09	22	3.4	310	52.68
City of Bloomington	153	38.47	49	9.14	16	2.36	0	0
Town of Ellettsville	58	15.16	19	3.45	4	0.74	0	0
Town of Stinesville	5	0.74	3	0.6	1	0.15	0	0
TOTAL	1115	222.25	110	20.28	43	6.65	310	52.68

Utilizing the same GIS information and process, critical infrastructure within each of the flood hazard areas in Monroe County was assessed and are included in **Table 15**. These buildings are included in the overall number of structures and damage estimate information provided in **Table 16**.

Table 16: Critical and Essential Infrastructure in Flood Zones

Community	Floodway	1% AEP	0.2% AEP	DNR Zone A
Monroe County	Unknown124859 Tower Young Lake Dam Fieldstone Lake Dam Lake Monroe Sea Plane Base			Lake Monroe Sea Plane Base Griffy Reservoir Dam Lake Lemon Dam
City of Bloomington	Draghom Geden Tensung Ling Inc .			
Town of Ellettsville	Ellettsville Journal Ellettsville Town Hall Richland Township Ellettsville Street Department			

Utilizing the information in Table 15 regarding the number of structures within each of the flood hazard areas, it is also important to note the number of flood insurance policies within each area in Monroe County. For Monroe County this table can be misleading since it compares policies to structures in the 1% AEP. This table does not reflect the number of properties in the floodway. Insurance is key to recovery, yet many in the flood hazard areas do not have a policy.

Table 17 provides the comparison between the number of structures in the 1.0% AEP and the number of flood insurance policies. It is also important to note that flood insurance is voluntary

unless the property owner carries a federally subsidized mortgage; insurance coverage may be discontinued when the mortgage is completed. For Monroe County this table can be misleading since it compares policies to structures in the 1% AEP. This table does not reflect the number of properties in the floodway. Insurance is key to recovery, yet many in the flood hazard areas do not have a policy.

Table 17: Structures in the 1.0% AEP and Number of Flood Insurance Policies

Community	# Structures In 1.0% AEP	# Policies
Monroe County	39	102
City of Bloomington	49	68
Town of Ellettsville	19	27
Town of Stinesville	3	1
Total	110	198

Future Considerations

As the municipalities within Monroe County continue to grow in population and increase development, it can be anticipated that the number of critical and non-critical infrastructure will also increase accordingly. Monroe County and the Town of Ellettsville updated and adopted their Floodplain Ordinances in 2017. Bloomington and the Town of Stinesville adopted their ordinances in 2010. All the listed communities discourage critical facilities such as schools, medical facilities, community centers, municipal buildings, and other critical infrastructure from being located within the 1% AEP (100-year) floodplain. New structures must also be protected to that level along with flood-free access to reduce the risk of damage caused by flooding and to ensure that these critical infrastructures will be able to continue functioning during major flood events. Flooding due to poor drainage, low-lying land, or flash flooding is also an important consideration. It will be important for recognition of potential flood impacts to residents and businesses in these areas to be coupled with proper planning for future development and redevelopment of the flood zones. This would also include studying the inundation areas mapped through the development of the Indiana Floodplain Portal as well as studies of all the streams with 1 square mile or drainage area or greater. Since the previous planning effort, some development has occurred within the flood zones of Monroe County or the incorporated communities within the county. Due to terrain and heavily forested natural areas, community growth relies on the best utilization of the open land suitable for construction. This can place pressure on existing drainageways requiring further assessment and possible upgrades to accommodate the large volumes of rainwater reaching the streams and drains.

It is important to ensure that owners and occupants of residences and businesses within the known hazard areas, such as delineated or approximated flood zones and FEH, are well informed about the potential impacts from flooding incidents as well as proper methods to protect themselves and their property. Recent local efforts to educate property owners about how to increase their personal resilience are ongoing and encouraged.

Increased precipitation, as predicted in the Indiana Climate Change Assessment, is anticipated to come in the form of heavier, shorter events which lead to the increased potential for flooding and stress on infrastructure such as sanitary and storm sewers. Heavy precipitation events are anticipated to occur more frequently as temperatures rise, replacing rain when previously there was snow.

Despite these efforts, the overall vulnerability and monetary value of damages is expected to increase in the area unless additional measures, such as those discussed later in Chapter 4 of this report, are implemented.

Indirect effects of flooding may include increased emergency response times due to flooded or redirected streets (**Figure 38**), the danger of dislodged and floating propane tanks causing explosions, and the need for additional personnel to carry out the necessary evacuations. Additional effects may include sheltering needs for those evacuated, and the loss of income or revenue related to business interruptions. Several communities within Monroe County host numerous special events. These special events may have to be cancelled or postponed due to flooding or high-water levels.

Figure 38 Flooded Roads and Street Closures

Relationship to Other Hazards

While flooding creates social, physical, and economic losses, it may also cause other hazards to occur. For example, flooding may increase the potential for a hazardous materials incident to occur. Above ground storage facilities may be toppled or become loosened and migrate from the original location. In less severe situations, the materials commonly stored in homes and garages such as oils, cleaners, and de-greasers, may be mobilized by flood waters. Should access roads to hazardous materials handlers become flooded, or if bridges are damaged by flood waters, response times to more significant incidents may be increased, potentially increasing the damage associated with the release.

Increased volumes of water during a flood event may also lead to a dam failure. As the water levels rise in areas protected by dams, at some point, these structures will over-top or will breach leading to even more water being released. These two hazards, flood, and dam failure, when combined, may certainly result in catastrophic damage.

In a similar fashion, a snowstorm or ice storm can also lead to flooding on either a localized or regional scale. When a large amount of snow or ice accumulates, the potential for a flood is increased. As the snow or ice melts, and the ground becomes saturated or remains frozen, downstream flooding may occur. Ice jams near bridges and culverts may also result in flooding of localized areas and potentially damage the bridge or culvert itself.

Repeated flooding may also create impacts associated with landslides along riverbanks and bluff areas. As floodwaters travel through the systems, saturating shorelines and increasing volumes and velocities of water, the natural process of fluvial erosion may be exacerbated. As these processes are increased, structures and infrastructure located on bluffs or in proximity to the river may be at risk.

Flooding in known hazard areas may also be caused by dams that experience structural damage or failures not related to increased volumes or velocities of water. These “sunny day failures,” while not typical, may occur wherever these structures exist throughout the county.

The FEMA/NFIP Monroe County Flood Zones are shown on the map below.

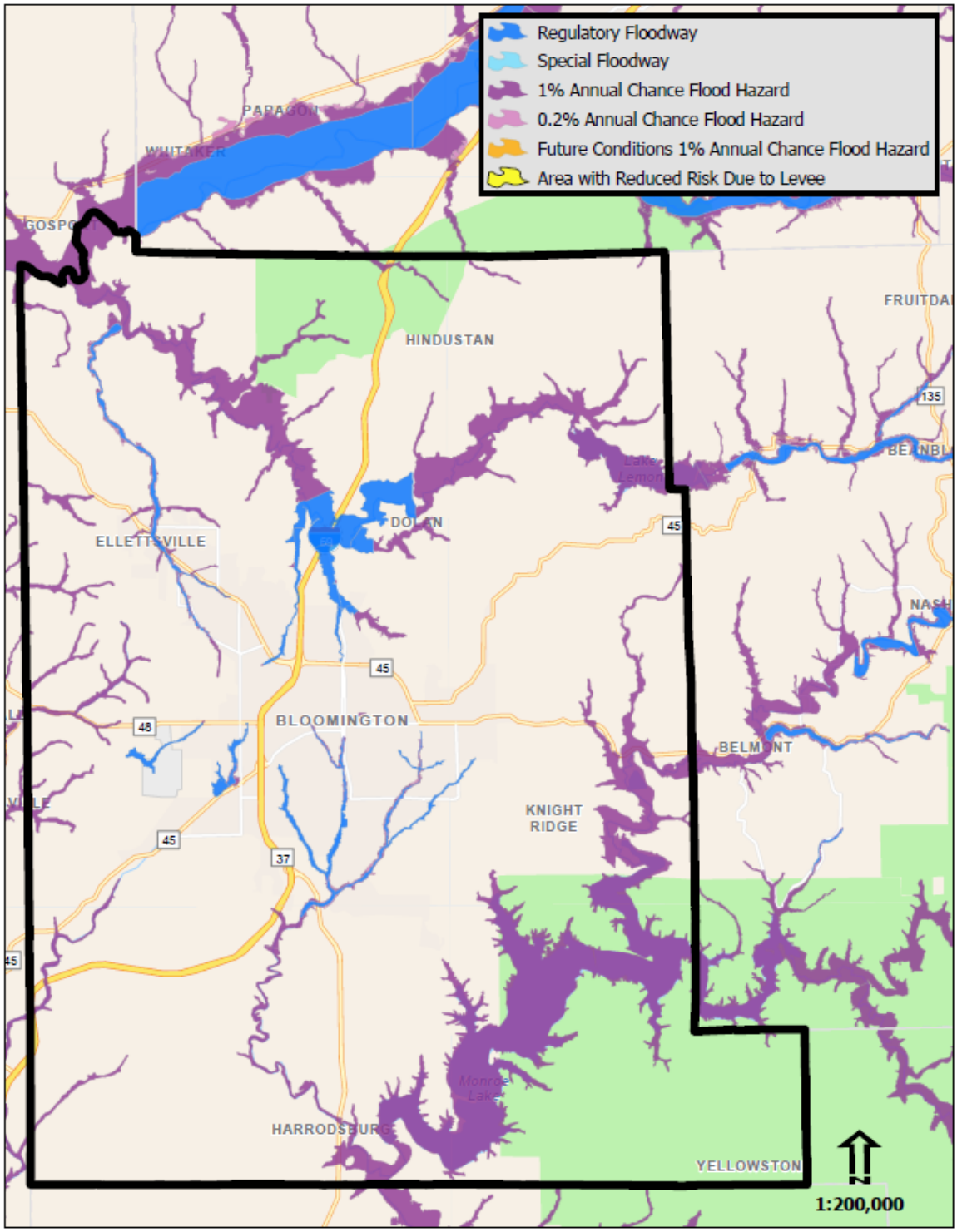


Figure 39 Floodplain Map of Monroe County

Readers wishing to access the most current floodplain map for their community or county are encouraged to go to the DNR Division of Water Floodplain Portal also known as INFIP (https://secure.in.gov/dnr/water/surface-water/indiana-floodplain-mapping/indiana-floodplain-information-portal/), or consult with your local floodplain administrator.

3.2.6 Hailstorms, Thunderstorms, and Windstorms

Overview

Hail occurs when frozen water droplets form inside a thunderstorm cloud, and then grow into ice formations held aloft by powerful thunderstorm updrafts, and when the weight of the ice formations becomes too heavy, they fall to the ground as hail. Hail size ranges from smaller than a pea to as large as a softball, and can be very destructive to buildings, vehicles (**Figure 40)** and crops. Even small hail can cause considerable damage to young and tender plants. Residents should take cover immediately in a hailstorm, and protect pets and livestock, which are particularly vulnerable to hail, and should be under shelter as well.

Thunderstorms are defined as strong storm systems produced by a cumulonimbus cloud, usually accompanied by thunder, lightning, gusty winds, and heavy rains. All thunderstorms are considered dangerous as lightning is one of the by-products of the initial storm. In the United States, on average, 300 people are injured, and 80 people are killed each year by lightning. Although most lightning victims survive, people struck by lightning often report a variety of long-term, debilitating symptoms. Other associated dangers of thunderstorms included tornados, high winds, hail, and flash flooding.

Windstorms or high winds can result from thunderstorm inflow and outflow, or downburst winds when the storm cloud collapses, and can result from strong frontal systems, or gradient winds (high- or low-pressure systems). High winds are speeds reaching 50 mph or greater, either sustained or gusting.

Recent Occurrences

In Monroe County, the NCDC has recorded 8 reports of hail on 5 separate dates from January 1, 2017 to November 30, 2024 . The largest hail was reported at 1.25 inches. No damage reports were recorded in the NCEI files for this event. The average diameter hail stone occurring throughout Monroe County ranges from ¾ to 1 inch with the largest one for this period of interest being 1.50 inches. According to the Midwest Regional Climate Center (MRCC) hail is considered severe if a thunderstorm produces hail stones larger than one inch in diameter, or larger than the size of a quarter.

Figure 40 Damage to Vehicle and Structure Caused by Hail

Significant windstorms are characterized by the top wind speeds achieved during the incident. Such high wind events characteristically occur in conjunction with thunderstorms and have historically occurred year-round with the greatest frequency and damage occurring in May, June, and August. However, the event that had the most property damage was on March 1, 2017, with $25,000. Within Monroe County, NCDC reports only 5 instances where top wind speeds were 60 mph or greater.

The NCDC recorded damages for hailstorms, thunderstorms, and windstorms throughout Monroe County. From January 1, 2017, to November 30,2024, there were 14 instances on 11 dates of

hailstorms. Of the 33 instances of thunderstorms and high wind events resulting in 39 reports damages added up to $6,050,500.00 in property damage and no additional crop damage. No injuries or deaths associated with these events. Many event reports included in the NCDC did not provide descriptive information on the social, physical, and economic losses resulting from individual storms specific to Monroe County. In local storm reports at the National Weather Service, where damages were reported, narrative descriptions of the event typically included reports of damage to broken tree limbs, downed power lines, or roof damage.

Appendix 6 provides the NCDC information regarding hailstorms, thunderstorms, and windstorms that have resulted in injuries, deaths, and monetary damage to property and/or crops.

According to the Institute for Business and Home Safety, central Indiana can expect to experience damaging hailstorms three to four times over 20 years; the average life of a residential roof. Further, thunderstorms and windstorms are considered a high frequency hazard and may occur numerous times per year. Climate change has impacted the frequency of hailstorms, thunderstorms, and windstorms.

The Committee determined the probability of a hailstorm, thunderstorm, or windstorm occurring anywhere throughout Monroe County is Highly Likely" and will typically affect broad portions of the county at one time resulting in potentially "Negligible" to "Limited" damages. As advancements in technologies such as weather radar systems and broadcast alerts are continually made, the warning time for such incidents may increase. Currently, the Committee feels that the warning time is expected to be less than 6 hours, for most, and the duration is expected to last less than six hours.

Indicative of a regional hazard, the probability, magnitude, warning time, and duration of a hailstorm, thunderstorm, or windstorm are expected to be similar throughout the county. These events are highly unpredictable, and the occurrences are distributed throughout the county, sometimes impacting one community more often or more severely than another. Therefore, the CPRI values reflect the distributed risk and associated priority for a hailstorm, thunderstorm, or windstorm. A summary is provided in **Table 18**.

Table 18: CPRI for Hailstorm, Thunderstorm, and Windstorm

	Probability	Magnitude / Severity	Warning Time	Duration	CPRI
Monroe County	Highly Likely	Limited	< 6 hours	< 6 hours	Severe
City of Bloomington	Highly Likely	Limited	< 6 hours	< 6 hours	Severe
Town of Ellettsville	Highly Likely	Limited	< 6 hours	< 6 hours	Severe
Town of Stinesville	Highly Likely	Negligible	< 6 hours	< 6 hours	Elevated

Specific locations and frequency of hailstorms, thunderstorms, and windstorms are difficult to predict as many of these individual events are without significant warning time and may have impacts to very limited areas or may affect broader areas. However, based on NCDC data and personal experiences of the Committee, it was determined that all areas within the County are anticipated to experience a hailstorm, thunderstorm, or windstorm within the calendar year. More likely, these communities will be impacted by several of these hazard events each year. The changing climate has resulted in storms as described above occurring virtually any time during the year. Significant temperature fluctuations encourage the development of thunder, wind and hailstorms outside of the traditional storm season. Although the storms are typically not as strong or long lived, they nonetheless cause emotional stress for those people who are weary of storms.

Assessing Vulnerability

The effects of a hailstorm, thunderstorm, or windstorm may be minimal to extensive in nature and may affect small or broad ranges of land area. Within Monroe County, direct and indirect effects from a hailstorm, thunderstorm, or windstorm may include:

Direct Effects:

- Damages to infrastructure (power lines)
- Damages to individual properties (homes, cars)
- Physical injuries may be experienced by those unable to find shelter during storm events, such as homeless people, hikers and outdoor workers.
- Loss of numerous trees in parks and forested areas.

Indirect Effects:

- Downed power lines due to falling tree limbs.
- Losses associated with power outages.
- Damages sustained from blowing debris.
- Cancellation or interruption of special events.

Estimating Potential Losses

Due to the unpredictability of this hazard all critical infrastructure and non-critical structures in Monroe County are at risk of damage including temporary or permanent loss of function. For hailstorms, thunderstorms, and windstorms, it is not possible to isolate specific critical infrastructure or non-critical structures that would be vulnerable to damages. However, areas where utility lines are above ground and areas where dead or dying trees have not been removed may be at a higher risk of property damage or power outages during hailstorms, thunderstorms, and windstorms. Additionally, mobile homes and accessory buildings such as pole barns and sheds may also be at a higher risk of damage from hailstorms, thunderstorms, and windstorms if not properly anchored to the ground. Damage from falling limbs or uprooted trees such as that shown in **Figure 41.** Homeless individuals and families who have alternative means of sheltering may experience greater losses since the stability of tents and alternative structures does not withstand the damaging forces of the storms. People working outdoors or travelling by bicycle may not be able to find shelter readily during pop up storm events.

Figure 41 Damage from a Windstorm

Future Considerations

As the population of the communities in Monroe County grows and the communities redevelop, it can be anticipated that the number of structures will also increase. To reduce the vulnerability for damage resulting from a hailstorm, thunderstorm, or windstorm, measures such as proper anchoring

are vital. This includes not only roof anchors but also mobile home anchors. Proper tree maintenance, and burial of power lines should be considered. Adoption and enforcement of the current International Building Codes is key to ensuring structures are able to withstand the power of wind and hailstorms. While measures can be taken to remove existing structures or prevent future structures from being built in known hazard areas such as floodplains and hazardous materials facility buffers, such measures are not applicable to hailstorms, thunderstorms, and windstorms due to the diffuse nature and regional impacts of this hazard. The intensity of these storm events is anticipated to increase with climate changes. If mitigation actions are not employed, the volume of damage to structures and potential injuries may increase.

Indirect effects resulting from a hailstorm, thunderstorm, or windstorm can include power outages caused by downed tree limbs or flying. debris, damage resulting from prolonged power outages, and damage to structures or property as a result of debris. Damage to homeless encampments resulting in loss of personal property and potential injuries are also a concern during storms.

Relationship to Other Hazards

Hailstorms, thunderstorms, and windstorms may be the precursor for other hazards. For example, hazardous materials incidents can be the result of a hailstorm, thunderstorm, or a windstorm. Material storage containers can become damaged by high winds, debris, or even lightning, and can result in a spill or release of materials. With wind speeds greater than 58 mph, tankers and other transportation vehicles carrying hazardous materials are also at risk while on the road. High winds may also cause gaseous substances to travel farther distances at a much faster rate, increasing the evacuation area necessary to protect residents and visitors of Monroe County.

Additionally, rainfall typically occurs with a thunderstorm and this additional precipitation may lead to localized flooding or riverine flooding depending on the amount of rain during the event. Debris from a windstorm may also lead to localized flooding if debris is deposited over drains or if obstructions are created by downed limbs, trees, or other storm related debris. A similar concern due to the potential precipitation would be dam failure. High winds may place debris near spillways, blocking the emergency drainage mechanism for the dams. High winds may also lead to structural damage to a dam or may cause damage to nearby trees or other structures, leading to indirect damage.

The risk of social losses also increases during a hailstorm, thunderstorm, or windstorm, as these hazards often result in downed power lines, utility poles, and trees. Debris such as this may impede traffic patterns and make it difficult for emergency vehicles (Fire, EMS, and Police) to pass through affected areas or people may be directly injured because of falling or flying debris.

3.2.7 Landslide/Subsidence

Overview

The term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over steepened slope is the primary reason for a landslide, there are other contributing factors. For example, erosion by rivers, glaciers, or ocean waves can cause rock to fall. Rock and soil slopes may be weakened through saturation by snowmelt or heavy rains, earthquakes can create stresses that make weak slopes fail, and excess weight from accumulation of rain or snow, stockpiling of rock or ore, from waste piles, or man-made structures that may stress weak slopes to the point of collapse.

Another important consideration is Fluvial Erosion Hazard (FEH). This represents the risk associated with natural stream movements and losses associated with buildings and infrastructure. In some cases, this may be represented by a gradual movement of a stream across a farm field. In other, more extreme instances, homes or other infrastructure may be lost as steep riverbanks or bluffs sluff into the water below.

Land subsidence, according to the USGS, is "a gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials." Further, there are three processes that contribute to subsidence: compaction of aquifer systems, drainage and subsequent oxidation of organic soils, and dissolution and collapse of susceptible rocks.

Recent Occurrences

The potential for landslides or land subsidence within Monroe County was discussed by the Planning Committee. IndianaMap shows that much of Monroe County west of I-69 and west of SR 37 has many Karst Sinkholes. In addition, the areas south of Bloomington have a number of sinkhole sites but less densely dispersed as the western portion of the County. To the knowledge of the Planning Committee, there are no surface or underground mining operations within the county. The DNR Coal Mine Information System Confirms the absence of mining operations in the county. **Figure 42** shows the where the sinkhole areas are located throughout the county. The Fluvial Erosion Hazard (FEH) zones in the area appear to be located within the 1% flood event boundaries. Stream banks should continue to be monitored, and studies may be needed to verify any changes over time. The greatest challenge in Monroe County is the landslide potential due to the steep terrain. This hazard has damaged numerous roadways after heavy rain events and flood events.

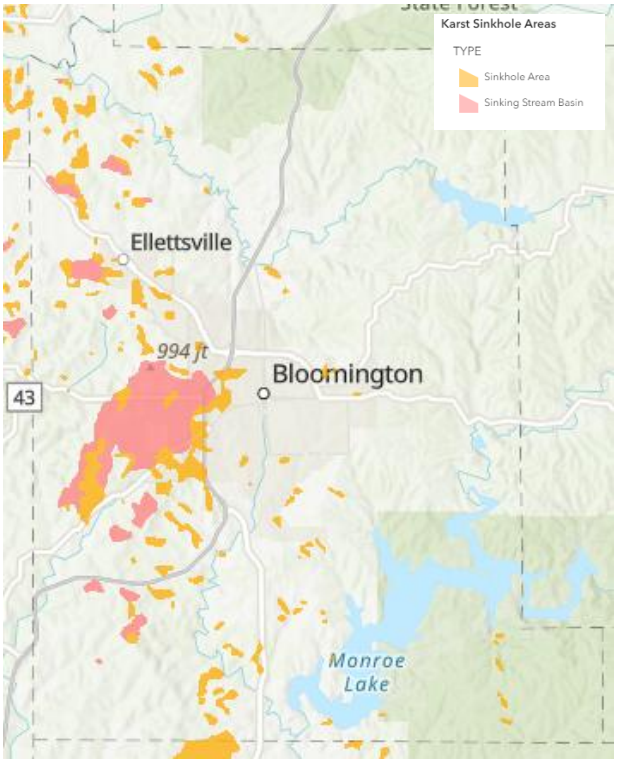


Figure 42 Karst Sinkhole Areas in Monroe County

The Committee determined the probability of a landslide or subsidence occurring in Monroe County is "Unlikely" to "Possible". Any event is expected to result in potentially "Negligible" to "Limited" damage. Currently, the Committee feels that the warning time is expected to be less than six hours, and similarly, the duration is expected

to last less than 6 hours up to possibly greater than a week. These events are highly unpredictable, and the risk is distributed throughout the county due to the variety of circumstances (mining vs karst, etc.). Therefore, the CPRI values reflect the distributed risk and associated priority for a landslide or subsidence event. A summary is provided in **Table 19**.

Table 19: CPRI for Land subsidence, Landslide and FEH

	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
Monroe County	Possible	Negligible	< 6 hours	< 6 hours	Low
City of Bloomington	Unlikely	Negligible	< 6 hours	< 6 hours	Low
Town of Ellettsville	Unlikely	Negligible	< 6 hours	< 6 hours	Low
Town of Stinesville	Unlikely	Limited	< 6 hours	> 1 week	Elevated

Assessing Vulnerability

Monroe County has a very low to relatively low expected annual loss from landslides. according to the FEMA National Risk Index. The Expected annual loss for Landslide in Monroe County is shown in **Figure 43**. The planning committee rated the Landslide, Land Subsidence and Fluvial Erosion Hazard as Low.

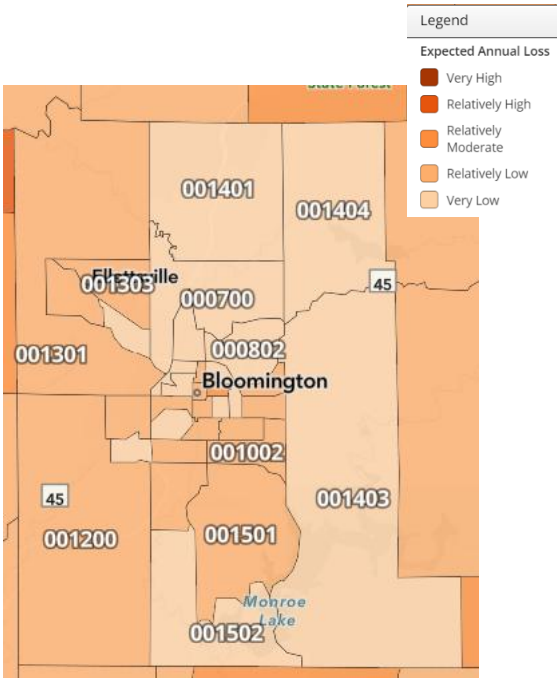


Figure 43 Risk Index for Landslide for Monroe County

Within Monroe County, direct and indirect effects may include:

Direct Effects:

- Damages to infrastructure (power lines, roads, bridges)
- Damages to individual properties (homes, cars)
- Loss of cropland immediately adjacent to the streams

Indirect Effects:

- Increased response time for emergency vehicles
- Losses associated with affected land (crop loss)
- Potential contamination of groundwater resources
- Loss of business due to roadway access and power loss.

Estimating Potential Losses

According to the National Risk Index, expected annual losses have been calculated for the areas in Monroe County which are at risk of damage including temporary or permanent loss of function. The greatest factor involving the higher annual losses is the potential for larger segments of the population to be exposed to the potential landslide hazard.

In addition, areas where FEH meander belt widths (FEH Zones) have been identified, may be at a higher risk of property damage caused by such events. To prepare a community based basic "what-if" scenario, the Indiana FEH GIS layers were overlaid onto parcel data provided by the County. **Table 20** identifies the number of structures within the FEH areas.

Table 20 Summary of Parcels in the FEH Zone

Community	#of Structures	# of Parcels	# of Critical / Essential Facilities
Monroe County	391	2,462	7
City of Bloomington	95	379	2
Town of Ellettsville	46	147	2
Town of Stinesville	28	69	0
Totals	**560**	**3,057**	**11**

Future Considerations

As the population of the communities in Monroe County increases, it can be anticipated that the number of critical and non-critical structures will also increase. To reduce the vulnerability for damages resulting from a landslide or land subsidence, FEH area GIS layers along with the floodplain information should be integrated into the building permit or approval process. In recent years, some limited development has occurred within these areas of Monroe County.

Although Monroe County rivers are considered relatively stable having little lateral movement annually, extreme precipitation events may cause erosion to take place in previously stable areas. Given this potential it is key the community continues to discourage construction of infrastructure and homes in the meander belt widths for each stream. Because of the changes in elevation in the county , landslide is a possibility, especially during extreme precipitation events. Caution must be exercised for existing structures. Monroe County and the incorporated communities should consider prevention efforts and opportunities to assure structures are not in potential slide areas. Future changes in climate may intensify this landslide risk and the community may wish to explore a variety of options to address local resilience enhancements.

As growth takes place, the indirect effects resulting from a landslide or land subsidence event can cause challenges for the community if transportation routes are damaged, and businesses must close due to access issues and loss of power. Cascading impacts can have long lasting effects on the local economy, community growth, health and welfare.

Relationship to Other Hazards

A landslide, subsidence event or FEH event may be the precursor for other hazards. Depending on the location of the event, material storage containers can become damaged resulting in a spill or release of materials and potentially contaminating groundwater reserves. Dam failures may occur in much the same fashion if located in the potential hazard areas, or resulting from heavy saturation following a rainstorm, heavy snow, or rapid snow melt. FEH may result in flooding in areas previously not impacted by flood due to debris clogging drainage ways and loss of earthen berms near the waterways.

Similarly, these types of events may be caused by hail, thunder, or windstorms and their effects on the soils; an earthquake may release the ground enough to set a slide in motion; or a flood may add increased soil saturation or weight to at-risk areas increasing the potential for an event and resulting damages.

3.2.8 Tornado

Overview

Tornadoes are defined as violently rotating columns of air extending from thunderstorms to the ground. Funnel clouds are rotating columns of air not in contact with the ground. However, the funnel cloud may reach the ground very quickly – becoming a tornado. If there is debris lifted and blown around by the "funnel cloud," then it has reached the ground and is a tornado.

Figure 44 Funnel Cloud During Lightning Storm at Night

A tornado is generated when conditions in a strong cell are produced that exhibit a wall of cool air that overrides a layer of warm air. The underlying layer of warm air rapidly rises, while the layer of cool air drops – sparking the swirling action. The damage from a tornado is a result of the high wind velocity and wind-blown debris. Tornado season is generally from April through June in Indiana, although tornadoes can occur at any time of year. Tornadoes tend to occur in the afternoons and evenings; over 80 percent of all tornados strike between 3:00 pm and 9:00 pm but can occur at any time of day or night as shown in **Figure 44.** Tornadoes occur most frequently in the United States east of the Rocky Mountains. In Indiana, tornadoes generally come from the southwest to the northeast and/or from west to east. While most tornadoes (69%) have winds of less than 100 mph, they can be much stronger. Although violent tornadoes (winds greater than 205 mph) account for only 2% of all tornadoes, they cause 70% of all tornado deaths. In 1931, a tornado in Minnesota lifted an 83-ton rail car with 117 passengers and carried it more than 80 feet. In another instance, a tornado in Oklahoma carried a motel sign 30 miles and dropped it in Arkansas. In 1975, a Mississippi tornado carried a home freezer more than a mile. Tornado debris can be clearly seen in **Figure 45.** According to an article in the New York Times, researchers say that in recent years tornadoes seem to be occurring in greater "clusters," and that the region known as tornado alley in the Great Plains, where most tornadoes occur, appears to be shifting eastward. This shift brings greater numbers and more intense tornadic storms to

Figure 45 Debris Flying as Tornado Destroys Apartments under Construction

Indiana. The actual number of tornadoes nationwide appears to remain constant near 1,200, but tornadoes are occurring more frequently in traditionally ”quiet” cooler months.

Recent Occurrences

Three Tornados have occurred in the past 6 years. The strongest was on March 31, 2023, when an EF-3 Tornado struck Stinesville. According to the National Weather Service, “The tornado reached peak intensity while crossing the Owen-Monroe County line, where the strongest winds in Monroe County were 152 mph along West Wolf Mountain Road. Here, 0.2 to 0.3 miles east of North County Line Road, the tornado destroyed both a mobile home and single-story homes with little anchoring on cinder blocks, among many damaged and debarked trees. Back closer to North County Line Road, and slightly farther north of the center of the tornado's path, winds had separated a trailer home from its attached structure and garage, allowing the home to roll and flatten. Farther east along West Wolf Mountain Road, EF2-intensity damage was observed 0.50 to 0.75 miles east of the county line, with areas where nearly all trees were uprooted or snapped, and several single-family homes lost large sections of roofing; a few debarked trees were observed, but with less frequency than seen closer to the county line.||The tornado continued for another 2.7 miles while gradually weakening through EF2 and EF1 intensities. At North Texas Ridge Road hardwood trees were snapped off while a few homes lost small portions of roofing. At the intersection of West Brighton Road and North Fulton Road a narrower corridor of smaller trees was snapped or uprooted, including one tree downed onto a house. The tornado track ended about 250 feet northeast of this intersection”. No one was injured during this event however 1.07 million dollars of damage was initially reported.

The classification of tornadoes utilizes the Enhanced Fujita Scale of tornado intensity and damage. Tornado intensity ranges from low intensity (EF0) tornadoes with effective wind speeds of 65-85 mph to high intensity (EF5+) tornadoes with effective wind speeds of 200+ mph. (**Table 21**) According to the NCDC, Monroe County experienced 3 tornado between January 1, 2018, and November 30, 2024. The tornados were rated as 1 EF1, 1 EF2 and 1 EF3. The EF3 had maximum winds up to 152 mph. It is anticipated that tornadoes will increase with the increased temperatures and number of storm systems moving across the county.

Table 21: Enhanced Fujita Scale for Tornados

EF-Scale	Windspeed, mph	Character of Damage	Relative Frequency	Typical Damages
EF0	65-85	Light damage	29%	Shallow rooted trees blown over; damage to roofs, gutters, siding
EF1	86-110	Moderate damage	40%	Mobile homes overturned, roofs stripped, windows broken
EF2	111-135	Considerable damage	24%	Large trees snapped, light-object missiles generated, cars lifted
EF3	136-165	Severe damage	6%	Severe damages to large buildings, trains overturned
EF4	166-200	Devastating damage	2%	Whole houses destroyed; cars thrown
EF5	200+	Incredible damage	<1%	High-rise buildings significantly damaged, strong framed homes blown away

The Committee estimated the probability of a tornado occurring in Monroe County would be “Possible” to “Highly Likely” and the magnitude and severity of such an event to be “Significant” to “Critical”. The overall risk index ranges from “Elevated” to “Severe” with the aggregate throughout the county being “Elevated”. As with many hazardous events, the Committee anticipated a short

warning time of typically less than six hours, and a relatively short duration, ranging from less than six hours to greater than 1 week. The summary is shown in **Table 22**

Table 22: CPRI for Tornado

	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
Monroe County	Likely	Significant	< 6 hours	< 6 hours	Elevated
City of Bloomington	Possible	Significant	< 6 hours	< 6 hours	Elevated
Town of Ellettsville	Highly Likely	Significant	< 6 hours	< 6 hours	Severe
Town of Stinesville	Highly Likely	Critical	< 6 hours	> 1 week	Severe

The Indiana State Climate Office estimates that throughout Indiana, there is an average of 20 tornado touchdowns per year. Based on the number of tornado touchdowns previously reported through the NCDC and local weather agencies, the Committee determined the aggregate general probability of a future tornado occurring in Monroe County is "Likely" (within the next couple years).

Assessing Vulnerability

As the path of a tornado is not pre-defined, it is difficult to isolate specific critical infrastructure and non-critical structures, or areas of the County that would be vulnerable to a tornado. Direct and indirect effects from a tornado may include:

Direct Effects:

- Increase damage to older construction including residential and business structures, mobile homes, and accessory structures (pole barns, silos, sheds, etc.)
- Damage to structures in the immediate pathway.(businesses, residences, warehouses, etc.)
- Loss of alternative housing stock nearby.
- Damages to above ground utility lines and structures

Indirect Effects:

- Loss of revenue for affected businesses.
- Expenses related to clean-up and debris removal from public rights of way and public facilities.
- Inability for property owners to work while dealing damages from the tornado and debris removal from high winds.
- Affected business owners may experience loss of revenue if they are unable to continue operations following the event. Similarly, if a business is affected and unable to operate, employees may experience a loss of wages during the period of recovery.

Estimating Potential Losses

Due to the unpredictability of this hazard, all critical and non-critical structures within the county are at risk of future damage or loss of function. Estimates of potential physical losses were determined through a hypothetical exercise where an EF2 intensity tornado traveled through portions of the county and the communities. This is intended to present a "what-if" scenario of a tornado incident and associated damages. Damage estimates were derived by assuming that 25% of all structures in the path of the tornado would be completely destroyed, 35% of the structures would be 50% damaged, and 40% of the structures would sustain 25% damage. These estimations were also determined utilizing three wind speed zones based on distance from the tornado path. Zone 1 is nearest the center of the tornado path, while Zone 3 is the farthest from the path and with a

theoretically lower wind speed. **Table 23** provides summary data for the hypothetical tornado traveling through the unincorporated portions of Monroe County as well as City of Linton, which is identified on **Exhibit 3**.

Table 23: Summary of Hypothetical Tornado Damages

	Zone 1		Zone 2		Zone 3		Total	
	#	$, Million	#	$, Million	#	$, Million	#	$, Million
Monroe County	148	31.90	60	11.73	61	12.97	269	7.83
City of Bloomington	129	27.14	89	19.26	114	23.74	332	28.16
Totals	277	59.04	149	30.99	175	36.71	601	126.74

Utilizing the same GIS information and process, critical infrastructure within each of the hypothetical tornado zones are included in **Table 24.** These buildings are included in the above table showing the number of structures and damage estimate information.

Table 24: Critical Infrastructure within Hypothetical Tornado

Community	Zone 1	Zone 2	Zone 3
Monroe County	Amerigas Bloomington Day Care Corp/Penny Lane West Monroe County Highway Garage	Grandview Elementary School SCCAP Head Start Grandview	Bureau Of Motor Vehicles/Bloomington
City of Bloomington	Bloomington Police Department/Central Dispatch Bloomington Fire Department Station 1 (Headquarters) Indiana Daily Student Indiana University Harmony School Indiana University Indiana University Health Bloomington Heliport Indiana Memorial Union City Of Bloomington Fire Department Station 1 Navy/Air Force/Marine Recruiting Station Youth Services Building	Bloomington Hospital Compass Early Learning Center - Downtown Campus View Child Care Center Pourhouse Cafe Inc First United Methodist Church Foundation of Bloomington Inc Bloomington First Church of The Nazarene Monroe County Convention Center Parking Garage	Cell Tower Cell Tower Indiana University White River Co-Op

Future Considerations

The communities of Monroe County host numerous events each year in addition to the regular tourist attractions and outdoor recreation opportunities which draw thousands of guests to the county annually. In addition to the numerous outdoor activities in the county, farming operations, as well as other outdoor professionals may not have readily accessible sheltering locations nearby. It is imperative that the EMA place continued importance on maintaining their outdoor warning siren coverage and/or support alternative notification methods for people who may not be tuned in to local media. Terrain, population density and outdoor recreation were considered in the placement of outdoor warning sirens to assure the greatest reasonable coverage possible in Monroe County. The existing siren locations are identified in **Figure *46*.**

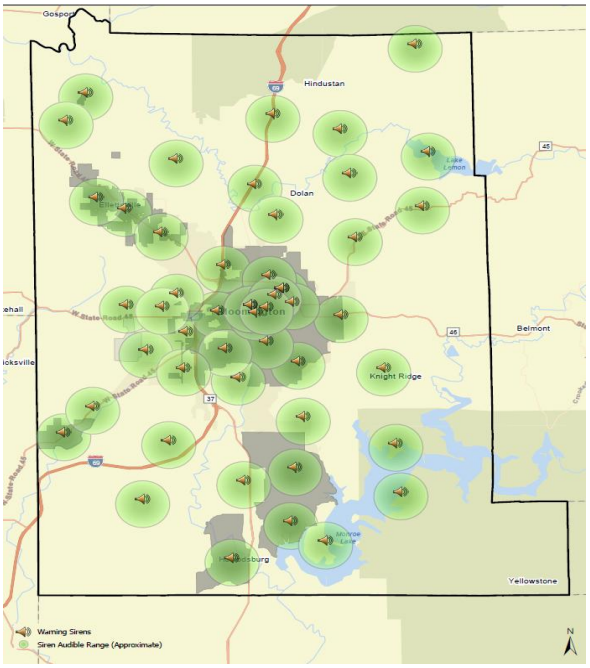


Figure 46 Siren locations in Monroe County

While it can be anticipated that new construction associated with development may be stronger than older or existing construction, existing older structures, barns, pole buildings, silos and mobile homes remain threatened by tornados. The unincorporated portions of the county will remain vulnerable, especially where the outdoor warning siren and/or other warning coverage is not present. It is impossible to predict the path of a tornado and therefore all current and future development will continue to be at risk for damage. Risks to the citizens of Monroe County may be lessened through participation in mass notification programs, use of weather radios, and turning on the emergency alert feature on cell phones. Having multiple means of warning citizens, businesses and visitors of incoming weather events is critical to continued economic growth and well-being of the communities and the county.

As the climate changes, the intensity of storms and tornados is going to increase. With these stronger winds, encouraging storm shelters for public buildings and mobile home communities is advised. Utilizing newer building technologies, roof ties would also be recommended for new buildings as well as multiple means to receive storm warnings and enable people to seek shelter.

Relationship to Other Hazards

Tornadoes may result in a hazardous materials incident. Material storage containers can become damaged by high winds and debris can result in a spill or release of materials. As wind speeds increase, the potential for damage to above ground storage containers also increases. Tankers and other transportation vehicles carrying hazardous materials are also at an increased risk while on the road or rail.

Tornadoes may also result in a dam failure as the increased wind speeds, and debris caused by the tornado, may directly impact the dam, or cause indirect damage by clogging outlet structures and/or emergency spillways. In addition, tornadoes may lead to structural fires as the destruction path is sometimes long and broad, leading to an increased number of potentially damaged homes, exposed power lines, gas leaks and substantial amounts of debris.

3.2.9 Winter Storm and Ice

Overview

A winter storm can range from moderate snow over a few hours to blizzard conditions with high winds, ice storms, freezing rain or sleet, heavy snowfall with blinding wind-driven snow, and extremely cold temperatures that can last for several days. Some winter storms may be large enough to affect several states while others may affect only a single community. Winter storms are typically accompanied by cold temperatures and blowing snow, which can severely reduce visibility. A winter storm is defined as one that drops four or more inches of snow during a 12-hour period, or six or more inches during a 24-hour span. An ice storm occurs when freezing rain falls from clouds and freezes immediately on contact with a variety of surfaces. All winter storms make driving and walking extremely hazardous. The aftermath of a winter storm can affect a community or region for days, weeks, and even months.

Figure 47 Ice Covered Power Lines

Storm effects such as extreme cold, flooding, and snow and ice accumulation can cause hazardous conditions and hidden problems for people in the affected area. **Figure 47** shows the added weight on trees and ice coated powerlines. People can become stranded on the road or trapped at home, without utilities or other services, including food, water, and fuel supplies. The conditions may overwhelm the capabilities of a local jurisdiction. Winter storms are considered deceptive killers as they may indirectly cause transportation accidents, and injury and death resulting from exhaustion/overexertion, hypothermia and frostbite from wind chill, and asphyxiation. House fires occur more frequently in the winter due to the use of alternative heat sources, such as space heaters, and lack of proper safety precautions.

Wind chill is a calculation of how cold it feels outside when the effects of temperature and wind speed are combined. On November 1, 2001, the NWS implemented a replacement Wind Chill Temperature (WCT) index for the 2001/2002 winter season. The reason for the change was to improve upon the current WCT Index, which was based on the 1945 Siple and Passel Index.

A winter storm watch indicates that severe winter weather may affect your area. A winter storm warning indicates that severe winter weather conditions are on the way. In the event of a blizzard, a winter storm warning will be issued and include the details of the blizzard - that large amount of falling or blowing snow and sustained winds of at least 35 mph are expected for several hours. In Monroe County, blowing snow may create visibility issues and ice creates significant challenges to those who use I-69 and other major roadways traversing the county. Such conditions can result

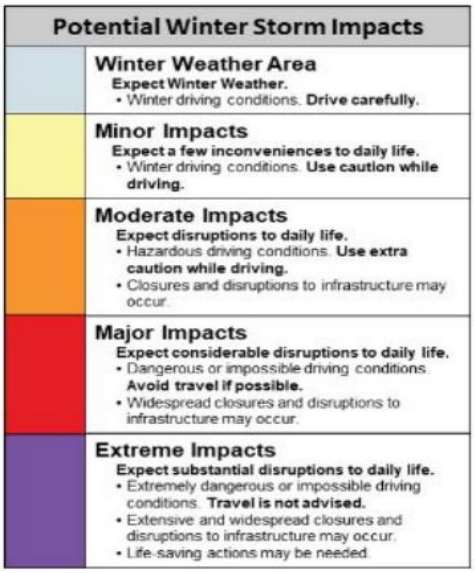


Figure 48 Winter Storm Impacts

in substantial personal and property damage, even death. The National Weather Service (October 15, 2018) consolidated their watch and warning products. In doing so, blizzards and lake effect snows are no longer separate watches and warnings, but instead are detailed as a part of winter storm watches and warnings. A large number of winter storm products are available on the internet from the National Weather Service. One is the Winter Storm Severity Index (WSSI). When a storm is forecast, the NWS can help communities better understand the potential impacts of storm using WSSI. **Figure 48** shows the description of the WSSI impacts. More detailed information with regards to the timing of the storms, etc., is provided as the event gets closer to the forecast area.

Recent Occurrences

From January 1, 2018 to November 30, 2024 the NCDC has recorded 1 ice storm, 2 heavy snow events, and 4 winter storms. NCDC reports indicated $1,500 property damage, no crop damage and no injuries, or deaths associated with the ice storm. No damage was reported for any of the other events. Many narrative descriptions indicated poor travel conditions, lots of power outages and debris associated with the winter weather events.

The probability, magnitude, warning times, and duration of a snowstorm or ice storm causing disruption to residents and businesses in Monroe County, as determined by the Planning Committee, is expected to be mostly consistent throughout the county and communities. It is "Highly Likely" that this type of hazard will occur in the area and will typically affect the entire county, and possibly several surrounding counties at one time, resulting in primarily "Significant" damage. The typical warning time for severe temperatures or several inches of snow associated with a winter storm is usually greater than 24 hours while the duration of the incident is anticipated to be less than 6 hours up to greater than 1 week. A summary is shown in **Table 25.**

Table 25: CPRI Summary for Winter Storms and Ice

	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
Monroe County	Highly Likely	Significant	> 24 hours	< 1 day	Severe
City of Bloomington	Highly Likely	Significant	> 24 hours	< 1 week	Severe
Town of Ellettsville	Highly Likely	Significant	> 24 hours	< 1 week	Severe
Town of Stinesville	Highly Likely	Significant	> 24 hours	> 1 week	Severe

The Planning Committee determined that the probability for a snowstorm or ice storm to occur in Monroe County and the communities within is "Highly Likely" or may occur within the calendar year. Based on historical data and the experience of the Planning Committee, snowstorms have become less frequent in Monroe County with the changing climate, however, ice storms bring more extensive challenges to the communities. Actions have been taken to mitigate many impacts from snow and ice storms. The Committee considered only the larger, more detrimental events for this effort.

Assessing Vulnerability

A snowstorm typically affects a large regional area with potential for physical, economic, and/or social losses. Direct and indirect effects of a snowstorm or ice storm within Monroe County may include:

Direct Effects:

- A number of businesses rely on the outside workforce and may experience loss of production as employees may not be able to get to work. The number of residents traveling to other areas for work results in loss of income due to the inability to reach their normal worksites.
- Rural (County) roads may impassable
- Expenses related to snow removal or brine/sand applications.
- Weight of ice and wet snow impacts older structures roofs as well as powerlines.
- Large ice and snow events interrupt economic activity within the community.

Indirect Effects:

- Loss of revenue as businesses are closed.
- Increased emergency response times based on safety of roads.
- Loss of income if workers are unable to get to their place of employment.
- Delayed impacts due to supply chain disruptions – products not received or shipped on time cause lost wages and revenues.
- Cancellation of special events and reduced tourist activities impact the local economy.

Estimating Potential Losses

Figure 49 Travel Impacted During Snowstorm

Given the nature and complexity of a regional hazard such as a snowstorm, it is difficult to quantify potential losses to property and infrastructure. As a result, all critical and non-critical structures and infrastructure are at risk from snowstorm and ice storm incidents.

For planning purposes, information collected in snowstorms impacting other communities around the nation is also useful in assessing the potential social, physical, and economic impact that a winter storm could have on communities. For example, a March 2003 snowstorm in Denver, Colorado dropped approximately 31 inches of snow and caused an estimated $34M in total damage. In addition, a February 2003 winter storm dropped an estimated 15-20 inches of snow in parts of Ohio. The Federal and Ohio Emergency Management Agencies and U.S. Small Business Administration surveyed damaged areas and issued a preliminary assessment of $17M in disaster related costs. These costs included snow and debris removal, emergency loss prevention measures, and public utilities repair. The agencies found over 300 homes and businesses either damaged or destroyed in six counties. Snowstorms and blizzards also make road travel difficult and dangerous, as seen in **Figure 49**

Looking a bit closer to home, In December 2008, Allen County had a wintry combination of freezing rains, snow and ice. This storm was the largest disaster for Indiana Michigan Power with 110,000 Allen County customers without power. One thousand six hundred (1,600) additional crew members

were brought in to restore electrical service to the county. According to the Journal Gazette $10 – $12 million was spent to clean up the debris, make repairs and labor costs for this event.

While the above examples indicate the wide-ranging and large-scale impact that winter storms can have on a community or region, winter storms generally tend to result in less direct economic impacts than many other natural hazards. According to the Workshop on the Social and Economic Impacts of Weather, which was sponsored by the U.S. Weather Research Program, the American Meteorological Society, the White House Subcommittee on Natural Disaster Relief, and others, winter storms resulted in an average of 47 deaths and more than $1B in economic losses per year between 1988 and 1995. However, these totals account for only 3% of the total weather-related economic loss and only 9% of fatalities associated with all weather-related hazards over the same period.

Future Considerations

As populations increase and communities continue to grow, the need to respond to snowstorms or ice storms will remain an important municipal effort. As new construction or re-development occurs, especially new or existing critical infrastructure, it is important to ensure that these new structures are equipped to deal with the potential risks associated with this hazard. Those may include lengthy power outages and potentially impassable transportation routes, making it difficult to obtain supplies or for passage of response vehicles. These hazard events will typically affect the entire county, perhaps multiple counties, and therefore all developments, current and future, will be at risk for damage associated with snow and ice storms. In addition, there will be a need for additional warming shelters for the underserved populations to take refuge and get warm and safe respite for stranded commuters on their way to or from work. This not only includes daytime available spaces but also overnight accommodation as the winter storms is often accompanied by very cold temperatures and wind chills.

Winter storms can also result in substantial indirect costs. Increased emergency response times, loss of work or the inability to get to work, as well as business interruption, are possible indirect effects of a winter storm. According to a report by the National Center for Environmental Predictions, the cold and snowy winter in late 1977 and early 1978, which impacted several heavily populated regions of the country, was partially responsible for reducing the nation's Gross Domestic Product (GDP) from an estimated growth rate of between 6% and 7% during the first three quarters of 1977 to approximately -1% in the last quarter of 1977 and 3% during the first quarter of 1978. Although the changing climate shows warming trends, it does not rule out a significant winter storm event. Such events may be more intense due to the changes and cause greater volumes of snow to be removed. In addition, the water content of the snow is anticipated to increase, thus making the snow heavier, adversely impacting older structures roofs.

Relationship to Other Hazards

Winter storms and ice storms can lead to flooding as the precipitation melts and enters local receiving waters. This increased volume of water on already saturated, or still frozen ground can quickly result in flood-related damage to structures and properties **(Figure 50**) as well as within the stream or river channel. Monroe County has an increased risk of flooding following heavy precipitation events. The increased flooding may then lead to a dam failure within the same area, further exacerbating the damage.

Hazardous materials incidents may be caused by poor road conditions during winter storms or ice storms. Many hazardous materials are transported by rail or by tanker over highways and

interstates. In the more rural areas of Monroe County, or where open areas are more susceptible to snow drifts on roads, the possibility of a traffic related hazardous materials incident may increase due to road obstruction and lack of visibility.

Figure 50 Flooding Caused by Snow Melt

Power outages and other infrastructure failures may also occur during a winter storm. Weight from snow and ice accumulations can directly or indirectly cause power lines to fail. During extreme cold temperatures, power outages may prove deadly for certain populations such as the homeless, the elderly or ill. Power outages in the winter are especially dangerous as families try to generate heat using alternative heat sources. Alternative heating sources may not be safely used or may be placed too close to combustible materials resulting in fires and burn injuries or death.

3.2.10 Dam and Levee Failure

Overview

A dam is defined as a barrier constructed across a watercourse for the purpose of storage, control, or diversion of water. Dams typically are constructed of earth, rock, concrete, or mine tailings. A dam failure is a collapse, breach, or other failure resulting in downstream flooding.

A dam impounds water in the upstream area, referred to as the reservoir. The amount of water impounded is measured in acre-feet. An acre-foot is the volume of water that covers an acre of land to a depth of one foot. As a function of upstream topography, even a small dam may impound or detain many acre-feet of water. Two factors influence the potential severity of a full or partial dam failure: the amount of water impounded, and the density, type, and value of development and infrastructure located downstream.

Of the approximately 80,000 dams identified nationwide in the National Inventory of Dams, the majority are privately owned. Each regulated dam is assigned a downstream hazard classification based on the potential loss of life and damage to property should the dam fail. The three classifications are high, significant, and low. With changing demographics and land development in downstream areas, hazard classifications of regulated are updated continually. The following definitions of hazard classification currently apply to dams in Indiana:

- High Hazard Dam: a structure, the failure of which may cause the loss of life and severe damage to homes, industrial and commercial buildings, public utilities, major highways, or railroads.
- Significant Hazard Dam: a structure, the failure of which, may damage isolated homes and highways or cause the temporary interruption of public utility services.
- Low Hazard Dam: a structure, the failure of which, may damage farm buildings, agricultural land, or local roads.

In Indiana, not all dams are regulated. To be regulated by the Indiana Department of Natural Resources (DNR), To be a jurisdictional structure, the dam must meet at least one of the following criteria:

- Have a drainage area above the dam of more than one square mile.
- The dam is 20 feet in height or greater.
- The dam impounds a volume of more than 100 acre-feet of water.

A dam's classification may be changed to a High-hazard classification through a successful petition by a downstream property owner. Federally owned and operated dams are not under Indiana DNR's jurisdiction. Examples of Federally regulated dams include Federal Energy Regulatory Commission (FERC) and US Army Corps of Engineers (USACE) structures. Although regulations are similar, there are additional requirements based on the regulating agency.

A levee is a flood control structure engineered and designed to hold water away from a building. Levees protect buildings from flooding as well as from the force of water, from scour at the foundation, and from impacts of floating debris. Flood protection levees principle causes of levee failure, like those associated with dam failure, include overtopping, surface erosion, internal erosion, and slides within the levee embankment or the foundation walls. Levees are designed to protect against a particular flood level and may be overtopped in a more severe event. When a levee system fails or is overtopped, the result can be catastrophic and often more damaging than if the levee were not there, due to increased elevation differences and water velocity. The water flowing through the breach continues to erode the levee and increases the size of the breach until it is repaired or water levels on the two sides of the levee have equalized. The FEMA and US Army Corps of Engineers (USACE) remind people living and working behind levees that there is always a residual risk when

living or working in a facility located behind a levee. Levees reduce the risk of a flood, but do not completely eliminate that risk.

Recent Occurrences

Within Monroe County, there are 17 structures listed in the National Inventory of Dams and 26 structures are listed in the DNR Unity Database. Of the 26 structures, 8 are classified as a high hazard dam, 7 are classified as a low hazard structure, 4 are considered significant hazard structures and the remaining 7 are unclassified. Of the 26 structures, 14 are either under minimum standards, decommissioned or breached and 1 of the high hazard dams is regulated by the federal government only. **Table 26** shows all the structures listed on the DNR inventory and National Inventory of Dams (NID). According to local information and state dam safety records, there have not been any recent dam failures or incidents within Monroe County.

Table 26: Dams in Monroe County

Dam Name	Owner Type	State Regulated Dam	Hazard Potential Classification	IEAP Prepared	Notes
Cherry Lake Dam	State	Yes	Significant	No	
University Lake Dam	State	Yes	Low	No	
Leonard Spring Dam	Not Listed	No	High	No	Not state listed
Bethal Lake Dam	Private	No	Low	No	Under Minimum
Schacht Lake Dam	Private	No	High	No	Breached
Bean Blossom Dam	State	No	Low	No	Breached
Bugher Lake Dam	Private	No	Low	No	Under Minimum
Young Lake Dam	Private	No	High	No	Decommissioned
Bryant Creek Lake Dam	State	Yes	High	Yes	
Arnold Lake Dam	Private	Yes	Significant	No	
Fieldstone Lake Dam	Private	Yes	Significant	No	
Camp Hunt Lake Dam	Private	Yes	Low	No	
Griffy Reservoir Dam	Public Utility	Yes	High	Yes	
Lake Lemon Dam	Local Government	Yes	High	Yes	
Egenolf Lake Dam	Private	Yes	High	Yes	
Weimer Lake Dam	Private	Yes	Significant	No	Decommissioned
Monroe Dam	Federal	No	High	Yes	Federal Regulated
Shawnee Lake Dam	Private	Yes	Low	No	
Wiley Lake Dam	Private	No		No	Under Minimum
Camp Whipper-Will Dam	Private	No		No	Under Minimum
Hardin Lake Pond	Private	No		No	Under Minimum

Dam Name	Owner Type	State Regulated Dam	Hazard Potential Classification	IEAP Prepared	Notes
Hale Lake Dam	Private	No	Low	No	Under Minimum
53-19	Private	No		No	Under Minimum
53-21	Private	No		No	Under Minimum
Hartman Dam	Private	No		No	Under Minimum
Ellis Gardens Dams	Private	No		No	Under Minimum

According to the National Levee Database (NLD) managed by the USACE, there are no regulated levee systems in Monroe County.

The Indiana Silver Jackets Team completed a survey of levee like features also known as non-levee embankments. The non-levee embankments are not certified or engineered structures. They are earthen structures which act like levees, however, are not capable of protecting the features behind the structures adequately. In fact, non-levee embankments impose lateral constraints on flood flows, reducing the floodplain storage capacity and increasing the flood velocity. These non-levee embankments can cause stream erosion and downstream flooding. Some farms along the rivers and streams rely on these embankments to keep flood waters out of their fields. Non-Levee Embankments can be found near the northwest corner of the county and along Clear Creek in the south. (**Figure 51**)

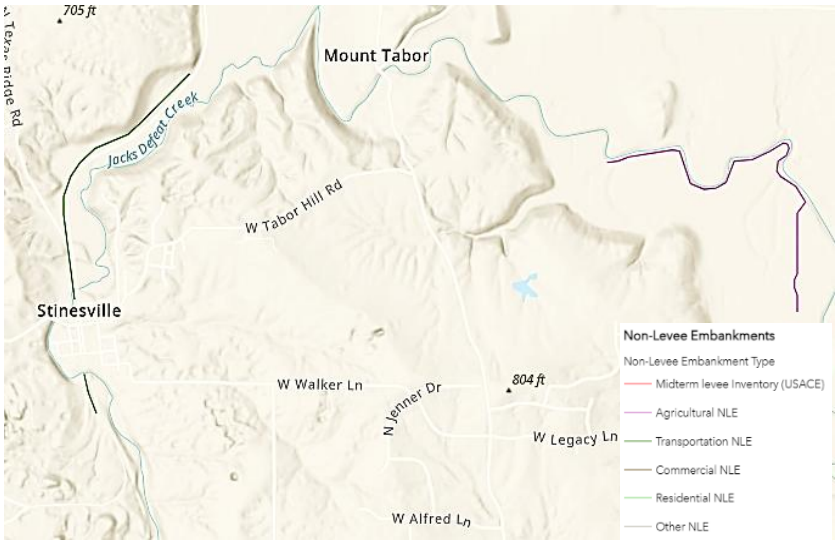


Figure 51 Non-Levee Embankments near Stinesville

Based on the information provided to them and their local knowledge, experience, and expertise, the Committee determined the probability of a dam failure is "Unlikely." The magnitude of a dam failure can cause "Negligible" to "Significant" damage to nearby downstream residences and infrastructure. The warning time ranges from 12-24 hours or greater. **Table 27** provides a summary of the Planning Committee's expectations during a dam failure.

Table 27: CPRI Summary for Dam and Levee Failure

	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
Monroe County	Unlikely	Significant	12 - 24 hours	< 1 day	Low
City of Bloomington	Unlikely	Significant	12 - 24 hours	< 1 day	Low
Town of Ellettsville	Unlikely	Significant	12 - 24 hours	< 1 day	Low
Town of Stinesville	Unlikely	Negligible	> 24 hours	< 6 hours	Low

Assessing Vulnerability

The actual magnitude and extent of damage due to a dam failure depends on the nature of the breach, the volume of water that is released, and the width of the floodplain valley to accommodate the flood wave. Due to the conditions beyond the control of the dam owner or engineers, there may be unforeseen structural problems, natural forces, mistakes in operation, negligence, or vandalism that may cause a structure to fail. All of the active high hazard dams in Monroe County currently have Incident or Emergency Action Plans developed.

Incident and Emergency Action Plans (IEAPs) are now required for all high hazard dams by state law; however, these plans are not mandated for the significant or low hazard structures. Dam owners are, however, encouraged to prepare an IEAP to help identify whom to notify and what actions may need to take place in the event of an incident or emergency event affecting the dam. For the state regulated high hazard dams, the Indiana DNR dam safety webpage shows areas which areas would be inundated during a dam failure.

Within Monroe County, direct and indirect effects from a dam failure may include:

Direct Effects:

- Potential loss of life and severe damage to downstream homes, industrial and commercial buildings, public utilities, major highways, or railroads
- Loss of use of reservoirs for flood control, recreation, and water supply

Indirect Effects:

- Loss of land in the immediate scour area
- Increased response times due to damaged or re-routed transportation routes and/or bridges
- Long lasting economic impacts on the community due to business closures, and relocation of impacted property owners.

Estimating Potential Losses

As of July 1, 2022, the State of Indiana is requiring High Hazard dams to have Incident and Emergency Action Plans (IEAPs) developed. These plans have detailed potential dam failure inundation areas identified along with at-risk structures identified. The actual magnitude and extent of damage depends on the type of dam break, the volume of water that is released, and the width of the floodplain valley to accommodate the dam break flood wave. All dam owners are encouraged to develop an IEAP.

Utilizing GIS maps and orthoimagery, the infrastructure and other features below this dam can be identified. This imagery will show properties that would be isolated due to the inundation of the roadways leading in and out of the area as well as those properties which would be inundated. Error! Reference source not found. shows the location of Reservoir 26 Dam as well as some of the i nfrastructure located nearby. This image shows where models predict the water, and debris would flow and the associated depths. The inundation map helps address questions and concerns of downstream property owners.

For Monroe Lake Dam, the US Army Corps of Engineers (USACE) has modeled a number of potential breach scenarios. **Table 28** shows the breach scenarios and the differences based on the amount of water being held behind the dam.

Table 28: Monroe Lake Dam Breach Scenarios

Scenario	Pool Elevation	Daytime People at Risk	Nighttime People at Risk	Buildings at Risk	Economic Cost
Maximum High Pool - BREACH	568.2	1,463	2,886	1,826	$257,522,743
Top of Active Storage Pool - BREACH	555.6	854	1,692	1,075	$150,072,718
Normal High Pool (10% EDP) - BREACH	544.3	447	890	581	$94,408,116
Normal Low Pool (90% EDP) - BREACH	536.2	288	579	379	$71,143,658

Future Considerations

As areas near existing dams continue to grow in population, it can be anticipated that the number of critical and non-critical structures could also increase accordingly. Location of these new facilities should be carefully considered, and precautions should be taken to ensure that schools, medical facilities, municipal buildings, and other critical infrastructure are located outside of the delineated or estimated dam failure inundation areas. Also, flood-free access should be provided for these facilities. Large areas of new development have not yet occurred downstream of the dams in Monroe County. Until such development or re-development downstream of a dam is prohibited, those areas remain vulnerable to losses and damage associated with a failure of that structure.

It is also particularly important to all downstream communities and property owners that dam IEAPs are developed, kept up-to-date, and routinely exercised to ensure the greatest safety to those within the hazard area. Although not mandated, this is a best management practice for Significant and Low Hazard dams as well.

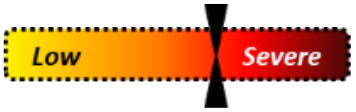
As the climate continues to change, strong storms, tornadoes and high-volume short duration rain events may threaten various parts of the dam structures such as clogging outlets with debris and bank erosion with rapidly changing water levels. Vigilance and regularly monitoring all dam structures is recommended.

Relationship to Other Hazards

With the potentially large volumes and velocities of water released during a breach, it can be expected that such a failure would lead to flooding and debris flow within the inundation areas downstream of the dam. Nearby bridges and roads are also in danger of being destroyed or damaged due to a dam failure. Bridges may become unstable, and portions of road surfaces may be washed away. Entire roads may be undermined by the forces of the water and debris. Other infrastructure such as utility poles and lines may be damaged as the water and debris flows along. Buried utility pipes may become exposed due to scouring; all of which may lead to utility failures within the area downstream of the dam failure.

Due to flood and debris flow damages, hazardous materials facilities and transportation routes may be damaged resulting in releases. If LP gas tanks are located nearby, they may be torn from their mountings and would become part of the flowing debris as well as leaking their contents from the ruptured service lines.

3.2.11 Hazardous Materials Incident



Overview

Hazardous materials are substances that pose a potential threat to life, health, property, and the environment if they are released. Examples of hazardous materials include corrosives, explosives, flammable materials, radioactive materials, poisons, oxidizers, and dangerous gases. Despite precautions taken to ensure careful handling during manufacture, transport, storage, use, and disposal, accidental releases are bound to occur. These releases create a serious hazard for workers, neighbors, and emergency response personnel. Emergency response to a release may require fire, safety/law enforcement, search and rescue, and hazardous materials response units.

Figure 52 Potentially Hazardous Waste

As materials are transported for treatment, disposal, or transport to another facility, all infrastructure, facilities, and residences near the transportation routes are at an elevated risk of being affected by a hazardous materials release. Often these releases can cause serious harm to Monroe County and its residents if proper and immediate actions are not taken. Most releases are the result of human error or improper storage (**Figure 52**), and corrective actions to stabilize these incidents may not always be feasible or practical in nature.

Railways often transport materials that are classified as hazardous and preparations need to be made and exercised for situations such as derailments, train/vehicle crashes, and/or general leaks and spills from transport cars.

Recent Occurrences

During conversations with Committee members and through information provided by local news outlets, it was noted that numerous small and moderately sized incidents involving manufacturing facilities and transportation routes have occurred since the development of the original MHMP. However, the number of SARA Title III Tier II facilities utilizing, storing, and/or manufacturing chemicals has decreased over the years as facilities reduce the amount hazardous materials on site. Both Tier II and other chemical facilities as well as businesses and industries rely on just in time delivery which results in an increase in the number of delivery vehicles transporting hazardous materials across the county. Vehicular traffic on I69 carries materials across the Southeast corner of the country from Canada to Mexico. State Roads 37, 45, 46, 48, and 446 serve both Monroe County as well as neighboring counties.

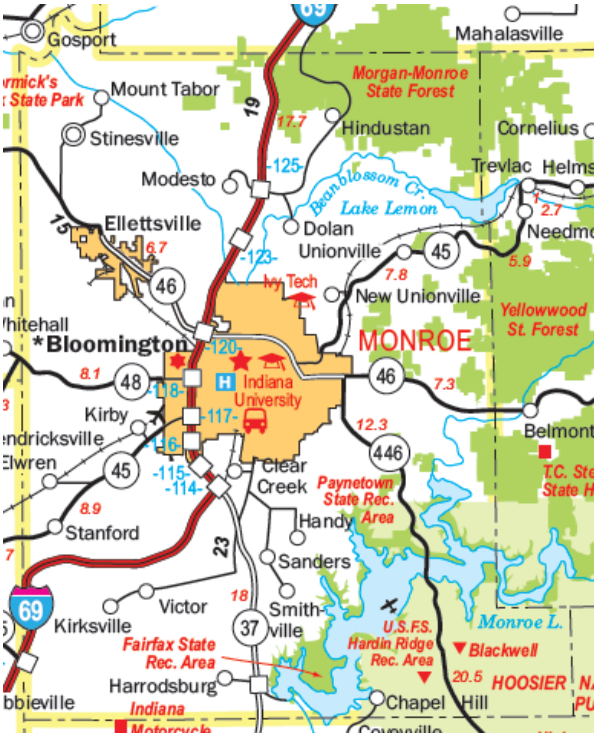


Figure 53 Transportation Map of Monroe County

When I 69 and/or the major transportation arteries through the county are closed or experiencing traffic slowdowns, the local roadways and state roads are often used as detours to avoid traffic accidents, and slowdowns. The volume of traffic increases the potential for incidents. (**Figure 53**) Monroe County does have a hazardous materials response capacity to address larger incidents as well as mutual aid agreements should an incident exceed their capacity.

In addition to vehicular traffic, the county has two railroads, The Indiana Railroad (INRD) and CSX. INRD comes from Illinois, through Green County to Bloomington and then heads on to Indianapolis. Both railroads regularly make available documentation on the commodities transported through the county.

According to the Committee, the probability of a hazardous materials release or incident is "Highly Likely" in all areas due to the number of transportation routes within and through county. "Negligible" to "Critical" damages are anticipated to result from an incident. The level of damage is dependent upon the location of the event. As with hazards of this nature, a short warning time of less than six hours and a relatively short duration, less than a day to greater than a week is anticipated. In the event of a larger hazardous materials incident the duration may be a bit longer than with smaller events which last less time. A summary is shown in **Table 29.**

Table 29: CPRI Summary for Hazardous Materials

	Probability	Magnitude / Severity	Warning Time	Duration	CPRI
Monroe County	Highly Likely	Negligible	< 6 hours	< 1 day	Elevated
City of Bloomington	Highly Likely	Negligible	< 6 hours	< 1 day	Elevated
Town of Ellettsville	Highly Likely	Negligible	< 6 hours	< 1 day	Elevated
Town of Stinesville	Highly Likely	Critical	< 6 hours	> 1 week	Severe

Relatively small hazardous materials incidents have occurred throughout the county in the past and will, according to the Committee, occur again. As the number of hazardous materials producers, users, and transporters increase within or surrounding Monroe County, it can be anticipated that the likelihood of a future incident will also increase. Additionally, as the I-69 traffic increases, shipments of hazardous materials will continue to increase, enhancing the potential for accidents.

Assessing Vulnerability

Within Monroe County, direct and indirect effects from a hazardous materials incident may include:

Direct Effects:

- Acute or chronic health issues due to chemical exposure.
- Closure of impacted railroad crossings.
- Possible crop or livestock damage from chemical exposure.
- Damage to infrastructure from leaks, accidents, or recovery operations.
- Expense of decontamination and reconstruction of affected structures.

Indirect Effects:

- Loss of revenue or production while testing, recovery and/or reconstruction occurs.
- Anxiety or stress related to the event.
- Potential evacuation of neighboring structures or facilities.
- Evacuation and/or relocation of homeless persons living in the impacted area.
- Added expenses detouring traffic around incident location.

- Expenses incurred due to response, testing, and cleaning of the affected areas.

Figure 54 Hazardous Material Incident

While the possibility of a large incident occurring may be possible, the vulnerability of Monroe County has been lowered due to the enactment of Superfund Amendments and Reauthorization Act (SARA) Title III national, state, and local requirements. SARA Title III, also known as the Emergency Planning and Community Right to Know Act (EPCRA), establishes requirements for planning and training at all levels of government and industry. EPCRA also establishes provisions for citizens to have access to information related to the type and quantity of hazardous materials being utilized, stored, transported, or released within their communities.

One local result of SARA Title III is the formation of the Local Emergency Planning Committee (LEPC). This committee has the responsibility for preparing and implementing emergency response plans, cataloging Safety Data Sheets (SDS) formerly known as Material Safety Data Sheets (MSDS), creating chemical inventories of local industries and businesses, and reporting materials necessary for compliance.

In Monroe County, facilities are subject to SARA Title III provisions due to the presence of listed hazardous materials in quantities at or above the minimum threshold established by the Act. These facilities are also required to create and distribute emergency plans, and facility maps to local emergency responders such as the LEPC, fire departments, and police departments. With this knowledge on hand, emergency responders and other local government officials can be better prepared to plan for an emergency and the response it would require, and to better prevent serious effects to the community involved.

Estimating Potential Losses

In addition, the very nature of these events makes predicting the extent of their damage very difficult. A small-scale spill or release might have a minor impact and would require only minimal response efforts. Another slightly larger incident might result in the disruption of business or traffic patterns, and in this situation, might require active control response measures to contain a spill or release. However, even small, or moderate events could potentially grow large enough that mass evacuations or shelter in place techniques are needed, multiple levels of response are utilized, and additional hazards such as structural fires and/or additional hazardous materials releases (or explosions) may occur. Given the unpredictable nature of hazardous materials incident, an estimate of potential losses was not generated.

Future Considerations

Additional facilities, both critical and non-critical in nature may be affected if a hazardous materials release were to occur along a transportation route. All of the state roads are traveled by carriers of hazardous materials. As businesses and industries increase in the area, the increased use of these routes will increase the number of transportation related incidents.

By restricting development within the known hazardous materials facility buffer zones, future losses associated with a hazardous materials release can be reduced. Critical infrastructure should be especially discouraged from being located within these areas. Further, by restricting construction in these zones, the number of potentially impacted residents may also be reduced, lowering the risk for social losses, injuries, and potential deaths. Future construction of hazardous materials facilities should be located away from critical infrastructure such as schools, medical facilities, municipal buildings, and daycares. Such construction would likely reduce the risk to highly populated buildings and populations with physical or social, emotional, or behavioral challenges or considerations such as children, elderly, and medically fragile individuals.

Many facilities constructed within close proximity to a hazardous materials facility are similar due to local zoning ordinances. This reduces the risk and vulnerability of some populations. However, there are several facilities and numerous transportation routes located throughout each of the communities making current and future development at risk for losses associated with a hazardous materials release.

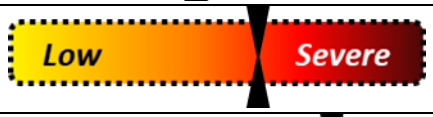
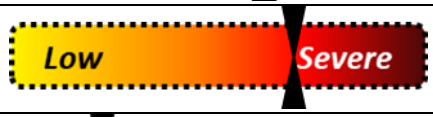
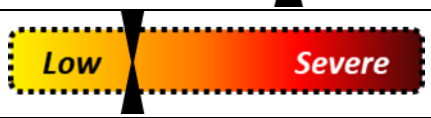
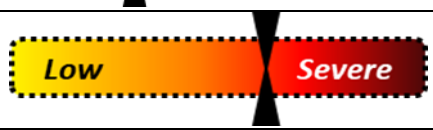
Relationship to Other Hazards

Dependent on the nature of the release, conditions may exist where a fire or spark ignites a flammable or explosive substance. As the fire spreads throughout the facility or the area, structural and/or property damage will increase. If the hazardous substances are in enclosed containers such as railroad tank cards, cylinders or other containers, near heat generating events such as a fire, explosion becomes a risk as well. Response times to a hazardous materials incident may be prolonged until all necessary information is collected detailing the type and amount of chemicals potentially involved in the incident. Depending on the nature of the incident, further delays may take place until qualified Hazardous Materials Responders with the appropriate response and monitoring equipment can be transported to the incident location. While this may increase structural losses, it may decrease social losses such as injuries or even deaths.

3.3 HAZARD SUMMARY

For the development of this MHMP, the Committee utilized the CPRI method to prioritize the hazards they felt affected Monroe County. Hazards were assigned values based on the probability or likelihood of occurrence, the magnitude or severity of the incident, as well as warning time and duration of the incident itself. A weighted CPRI was calculated based on the percent of the county's population present in the individual communities. **Table 30** summarizes the CPRI values for the various hazards studied within this MHMP.

Table 30: All CPRI Scores Combined

Hazard Type	List of Hazards	Weighted Average CPRI	CPRI Score
Natural	Drought		2.21
	Earthquake		2.35
	Extreme Temperatures		2.85
	Fire/Wildfire		3.40
	Flood		2.87
	Hail/Thunder/Windstorm		3.10
	Landslide/Subsidence		1.62
	Tornado		2.72
	Winter Storm/Ice		3.11
Technological	Dam & Levee Failure		1.85
	Hazardous Materials Incident		2.90

It is important to understand the cause-and-effect relationship between the hazards selected by the Committee. **Table 31** can be utilized to identify those relationships. For example, a winter storm (along the side of the table) can result in a flood (along the top of the table). In a similar fashion, a

hazardous materials incident (along the top of the table) can be caused by an earthquake; flood; tornado; or a winter storm or ice storm (along the side of the table).

Table 31: Hazard Reference Table

EFFECT → / CAUSE ↓	Drought	Earthquake	Extreme Temperature	Fires and Wildfire	Flood	Hail/ Thunder/ Windstorm	Landslide / Subsidence	Tornado	Winter Storm / Ice	Dam & Levee Failure	Hazardous Materials
Drought				X							
Earthquake				X			X			X	X
Extreme Temperature											X
Fires and Wildfire											X
Flood							X			X	X
Hail/ Thunder/ Windstorm				X	X		X			X	X
Landslide / Subsidence/ FEH					X						X
Tornado				X						X	X
Winter Storm/ Ice					X					X	X
Dam & Levee Failure					X		X				X
Hazardous Materials				X							

As a method of better identifying the potential relationships between hazards, the community exhibits can be referenced to indicate the proximity of one or more known hazard areas such as the delineated floodplains and the locations of EHS facilities. For this reason, many of the communities in Monroe County may be impacted by more than one hazard at a time, depending on certain conditions. It can be anticipated that if a flood were to occur within these areas, there would be a potentially increased risk of a facility experiencing a hazardous materials incident. These areas may also be at a greater risk of a dam or non-levee embankment failure.

Future development in areas where multiple known hazard areas (dam failure inundation areas, floodplains and surrounding hazardous materials facilities) overlap should undergo careful design, review, and construction protocol to reduce the risk of social, physical, and economic losses due to a hazard incident. While it may certainly be difficult, critical infrastructure should not be constructed within these regions.

4.0 MITIGATION GOALS AND PRACTICES

This section identifies the overall goal for the development and implementation of the Monroe County MHMP. A summary of existing and proposed mitigation practices discussed by the Committee is also provided.

4.1 MITIGATION GOALS

REQUIREMENT §201.6(c)(3)(i):
[The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

The Committee reviewed the mitigation goals as outlined within the 2018 Monroe County MHMP and determined that the goals remain valid and effective. In summary, the overall goal of the Monroe County MHMP is to reduce the social, physical, and economic losses associated with hazard incidents through emergency services, natural resource protection, prevention, property protection, public information, and structural control mitigation practices.

4.2 MITIGATION PRACTICES

REQUIREMENT §201.6(c)(3)(ii):

[The mitigation strategy shall include a] section that identifies and analyzed a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

REQUIREMENT §201.6(c)(3)(iii):

[The mitigation strategy section shall include] an action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

In 2005, the Multi-Hazard Mitigation Council conducted a study about the benefits of hazard mitigation. This study examined grants over a 10-year period (1993-2003) aimed at reducing future damages from earthquakes, wind, and flood. It found that mitigation efforts were cost-effective at reducing future losses; resulted in significant benefits to society; and represented significant potential savings to the federal treasury in terms of reduced hazard-related expenditures. This study found that every $1 spent on mitigation efforts resulted in an average of $4 savings for the community. The study also found that FEMA mitigation grants are cost-effective since they often lead to additional non-federally funded mitigation activities and have the greatest benefits in communities that have institutionalized hazard mitigation programs.

A more recent (2017) study by the National Institute of Building Sciences, reviewed over 20 years of federally funded mitigation grants, not only from FEMA but also from the US Economic Development Administration (EDA) and the US Department of Housing and Urban Development (HUD). From this broadened review, it has been determined that for every $1 spent on mitigation, $6 is saved on disaster costs. In addition, by designing and construction buildings which exceed select items in the 2015 International Code, $4 can be saved for every $1 invested in those changes.

Six primary mitigation practices defined by FEMA are:

- **Emergency Services** – measures that protect people during and after a hazard.
- **Natural Resource Protection** – opportunities to preserve and restore natural areas and their function to reduce the impact of hazards.
- **Prevention** – measures that are designed to keep the problem from occurring or getting worse.
- **Property Protection** – measures that are used to modify buildings subject to hazard damage rather than to keep the hazard away.
- **Public Information** – those activities that advise property owners, potential property owners, and visitors about the hazards, ways to protect themselves and their property from the hazards.
- **Structural Control** – physical measures used to prevent hazards from reaching a property.

4.2.1 Existing Mitigation Practices

As part of this planning effort, Committee members were forwarded a copy of the prior MHMP's mitigation actions. Team members reviewed those actions and were asked to consider any and all other mitigation actions based on the hazards discussed during the hazard identification and risk assessment activities. During the mitigation action planning team meeting, the Committee discussed the strengths and weaknesses of existing mitigation practices and made recommendations for improvements, as well as suggested new practices. The committee also examined practices employed by neighboring communities assessing the viability of those actions within Monroe County. The following is a summary of existing hazard mitigation practices which have been completed or are ongoing within Monroe County. A list of the former mitigation actions included in the 2018 MHMP and their status may be found in **Appendix 12.**

<u>Emergency Services</u>

- Training and table-top exercises are conducted by the LEPC and include response agencies such as police, fire, and local EMS agencies.
- The county has outdoor warning sirens located to cover most areas where there are concentrations of people (cities towns and census designated places) and maintains them in operational condition. The sirens are operated and are regularly tested using a centralized system.

<u>Natural Resource Protection</u>

- Current facility maps and response plans are on file for all Tier II HazMat facilities.
- The County supports outdoor recreation and preservation of natural features through a robust trail and parks network.
- Bloomington has a natural resource protection advisory group working with the parks board and is home to Sustainable Bloomington, a city lead climate resiliency team.

<u>Prevention</u>

- Information related to natural hazards has been incorporated into plans and guidance materials to better guide future growth and development.
- The COAD has developed a heavy rain event resiliency training program and flyer and has been assisting community members in identifying opportunities to make their homes resilient from flash floods and floods.

Property Protection

- Drainage system maintenance, including repair and replacement of culverts, occurs as scheduled throughout the county.
- A Debris Management Plan was created during the past five years.
- A Stormwater Utility was established to help the communities pursue good stormwater management practices and compliance with the MS4 program.

Public Information

- Outreach materials and hazard preparedness materials are routinely provided online, within offices and agencies in Monroe County, at large public events, speaking opportunities within schools, etc.
- The EMA and response agencies utilize websites and social media to convey messages to the public prior to, during and following hazardous events.
- Monroe County communities utilize applications and social media pages to keep the community members informed.

Structural Control

- County drainage ditches are cleared and are maintained to prevent localized flooding, increased erosion, and material deposition.
- Utilities throughout the county perform routine tree canopy maintenance along rights of way to reduce damages from trees to electrical lines as well as nearby structures.
- A long-range Drainage Plan was developed and completed.

4.2.2 Proposed Mitigation Practices

After reviewing existing mitigation practices, the Committee reviewed mitigation ideas for each of the hazards studied and identified which of these they felt best met their needs as a community according to selected social, technical, administrative, political, and legal criteria. The following identifies the key considerations for each evaluation criteria:

- **Social** – mitigation projects will have community acceptance, they are compatible with present and future community values, and do not adversely affect one segment of the population.
- **Technical** – mitigation projects will be technically feasible, reduce losses in the long-term, and will not create more problems than they solve.
- **Administrative** – mitigation projects may require additional staff time, alternative sources of funding, and have some maintenance requirements.
- **Political** – mitigation projects will have political and public support.
- **Legal** – mitigation projects will be implemented through the laws, ordinances, and resolutions that are in place.
- **Economic** – mitigation projects can be funded in current or upcoming budget cycles.
- **Environmental** – mitigation projects may have negative consequences on environmental assets such as wetlands, threatened or endangered species, or other protected natural resources.

Table 32 lists a summary of all proposed mitigation practices identified for all hazards, as well as information on the local status, local priority, benefit-cost ratio, project location, responsible entities, and potential funding sources, associated with each proposed practice. The proposed mitigation practices are listed in order of importance to Monroe County for implementation. Unless otherwise noted in the responsible entity column of Table 32, all actions are intended to

take place on a countywide basis. If a particular community is leading the activity, or if the activity is specific to a single community, that community will be listed as the responsible entity. Projects identified by the Committee to be of "high" local priority may be implemented within five years from final Plan adoption. Projects identified to be of "moderate" local priority may be implemented within 5-10 years from final Plan adoption, and projects identified by the Committee to be of "low" local priority may be implemented within 10+ years from final Plan adoptions. However, depending on availability of funding, some proposed mitigation projects may take longer to implement.

As part of the process to identify potential mitigation projects, the Planning Committee weighed the benefit derived from each mitigation practice against the estimated cost of that practice. This basic benefit-cost ratio was based on experience and professional judgement and was utilized to identify the mitigation practices as having a high, moderate, or low benefit-cost ratio. Preparing detailed benefit-cost ratios was beyond the scope of this planning effort and the intent of the MHMP.

In Table 32 where City and Towns are referenced as Cities and Towns, or City and Town, this term is inclusive of all the incorporated cities and towns – City of Bloomington, as well as the Towns of Ellettsville and Stinesville.

The update of this MHMP is a necessary step of a multi-step process to implement programs, policies, and projects to mitigate the effect of hazards in Monroe County. The intent of this planning effort was to identify the hazards and the extent to which they affect the county and to determine what type of mitigation strategies or practices may be undertaken to mitigate these hazards. A FEMA-approved MHMP is required to apply for and/or receive project grants under the BRIC, HMGP, and FMA. Although this MHMP meets the requirements of DMA 2000 and eligibility requirements of these grant programs additional detailed studies may need to be completed prior to applying for these grants. **Section 5.0** of this plan includes an implementation plan for all high priority mitigation practices identified by the Committee.

The CRS program credits NFIP communities a maximum of 97 points for setting goals to reduce the impact of flooding and other known natural hazards (2 points); identifying mitigation projects that include activities for prevention, property protection, natural resource protection, emergency services, structural control projects, and public information (up to 95 points).

.

Table 32: Proposed Mitigation Measures

Mitigation Practice	Mitigation Strategy	Hazard Addressed	Status	Priority	Benefit-Cost Ratio	Responsible Entity	Funding Source
Building Protection 1. Continue outreach to community members on ways they can enhance their heavy rain event flash flooding resilience. 2. Study public structures that are vulnerable and establish a plan for relocation. 3. Study public structures that are vulnerable and establish a plan for relocation. 4. Harden fire stations.	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☒ Structural Control	☐ Drought ☒ Earthquake ☐ Extreme Temperature ☐ Fire ☒ Flood ☒ Hail/Thunder/Wind ☐ Landslide/Subsidence ☒ Tornado ☒ Winter Storm/Ice ☐ Dam Failure ☐ HazMat Incident	**Proposed Enhancements –** 1. Continue outreach to community members on ways they can enhance their heavy rain event flash flooding resilience. 2. Identify and create an inventory of public structures at risk of flooding. 3. Investigate and assess potential solutions for each of the structures at risk of flooding. 4. Harden dispatch center, which is located over the bus station, for both security as well as weather hazards.	Medium - #1, #2, #3, #4	Moderate	EMA Floodplain Administrators for City, County and Towns COAD Resilience Team	General Budget FEMA BRIC Grants Stormwater Utility Funding
Emergency Preparedness and Warning 1. Develop a database of special needs populations. 2. Explore alternate means of emergency notification 3. Develop a program to distribute weather radios to all critical facilities and large businesses. 4. Install additional warning sirens. 5. Continue and enhance outreach to homeless at feeding sites prior to and during heavy rain events and other weather threats. Encourage using alternative shelter locations instead of stormwater sewer pipes under the city. 6. Develop a database of special needs populations. 7. Harden fire stations 8. Harden fire stations 9. Harden fire stations	☒ Emergency Services ☐ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☐ Structural Control	☒ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Fire ☒ Flood ☒ Hail/Thunder/Wind ☒ Landslide/Subsidence ☒ Tornado ☒ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Proposed Enhancements –** 1. Evaluate how Smart 911 works from both a responder perspective and member of the public perspective. Implement recommended improvements. 2. Continue to educate community members on how to receive emergency notifications. Consider all sources - Everbridge, IPAWS, Facebook, X (formerly known as Twitter), county websites, IU Notify, etc. 3. Encourage the purchase of weather alert radios for all critical facilities and large businesses. 4. Update current outdoor warning sirens. 5. Continue and enhance outreach to homeless at feeding sites prior to and during heavy rain events and other weather threats. Encourage using alternative shelter locations instead of stormwater sewer pipes under the city. 6. Encourage automatic displays of information in the special notes portion of Smart 911. 7. Identify and prepare secondary and tertiary locations along with "go boxes" to relocate dispatch during disaster events. Seriously consider separating location from police department . 8. Establish outreach to group home organization with in-service training. 9. Reduce the presence of human water in the stream due to use of the outfall as a restroom by unhoused individuals. Explore solutions and monitor outfall for coliform to help water recreators downstream.	High # 1, #2, #3, #4, #5 Medium – #6, #7, #8, #9	High to Moderate	County EMA Health Dept. Outreach Coordinators Feeding Site Managers 911 Communications Center MS4 Coordinators and Environmental Health Testing Teams	General Budget Community Foundation Grants Special Interest Groups/ Fraternal Organizations IPSIC District Health Coalition

Mitigation Practice	Mitigation Strategy	Hazard Addressed	Status	Priority	Benefit-Cost Ratio	Responsible Entity	Funding Source
Emergency Response and Recovery 1. Develop a debris management plan. 2. Develop a program to distribute fans to elderly population. 3. Continue to encourage interoperability and countywide fire department and first responder training. 4. Organize a countywide search and rescue team. 5. Assist county highway with better integration and partnerships during storms with tree limbs and other debris. 6. Assure priority routes for tree clearing is in accordance with the debris management plan. Encourage use of a consistent communication process	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☐ Structural Control	☒ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Fire ☒ Flood ☒ Hail/Thunder/Wind ☒ Landslide/Subsidence ☒ Tornado ☒ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Proposed Enhancements –** 1. Update the debris management plan. 2. Continue to work on the development of a program to distribute fans to the elderly population. 3. Continue to encourage interoperability and countywide fire department and first responder training. 4. Organize a countywide search and rescue team. 5. Assist county highway with better integration and partnerships during storms with tree limbs and other debris. 6. Assure priority routes for tree clearing is in accordance with the debris management plan. Encourage use of a consistent communication process	High - #1, Medium - #2, #3, #4, #5, #6	High	County EMA	Health Grants Assistance to Firefighter Grants Foundation Grants IDHS training Programs (free) Local budget
Generators and Power Back Up 1. Purchase back-up generators for schools. 2. Purchase back-up generators for schools.	☒ Emergency Services ☐ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☐ Public Information ☒ Structural Control	☐ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Fire ☒ Flood ☒ Hail/Thunder/Wind ☒ Landslide/Subsidence ☒ Tornado ☒ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Proposed Enhancements –** 1. Install hookup for generator(s) at the Stinesville Community Center (shelter) and acquire stationary generator or mobile units. 2. Explore and encourage schools to purchase back-up generators.	Medium - #1, #2	Moderate	County EMA Town of Stinesville School Superintendents	FEMA BRIC Grants State Revolving Loan Funds General Budget Donations
Geographic Information Systems (GIS) 1. Continue using GIS tools to allow community members to visualize hazards such as flooding, erosion, etc.	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☒ Structural Control	☒ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Fire ☒ Flood ☒ Hail/Thunder/Wind ☒ Landslide/Subsidence ☒ Tornado ☒ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Proposed Enhancements –** 1. Continue using GIS tools to allow community members to visualize hazards such as flooding, erosion, etc.	Medium - #1	High	County GIS Analyst	General budget Program specific funds such as Healthcare Coalition, etc.
Land Use Management, Ordinances and Zoning 1. Develop an ordinance to require new residential construction to include sprinkler systems. 2. Encourage development of an ordinance regarding heating and cooling repairs during extreme temperature events.	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☒ Structural Control	☒ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Fire ☒ Flood ☒ Hail/Thunder/Wind ☒ Landslide/Subsidence ☒ Tornado ☒ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Proposed Enhancements –** 1. Encourage the development of an ordinance to require new residential construction to include residential fire sprinkler systems. 2. Encourage development of an ordinance regarding heating and cooling repairs during extreme temperature events.	Medium - #1, #2	High	County Attorney County Fire Chiefs Association (Ellettsville, Bloomington, Stinesville/Bean Blossom Twp., and Monroe Fire Protection District) Council on Aging	General Budget FEMA BRIC Grants

Mitigation Practice	Mitigation Strategy	Hazard Addressed	Status	Priority	Benefit-Cost Ratio	Responsible Entity	Funding Source
Public Education and Outreach 1. Establish public outreach programs to educate residents on the hazards affecting the County. 2. Develop a database of special needs populations. 3. Develop public information for businesses on emergency preparedness. Include a checklist of things to have in place before a disaster event. 4. Prepare an Emergency Preparedness Seminar for Private and Not for Profit entities and hold the seminars quarterly. seminar	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☐ Structural Control	☒ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Fire ☒ Flood ☒ Hail/Thunder/Wind ☒ Landslide/Subsidence ☒ Tornado ☒ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Proposed Enhancements –** 1. Continue to educate residents on the hazards affecting the county. 2. Conduct a public education campaign on updating personal information in Smart 911. 3. Develop public information for businesses on emergency preparedness. Include a checklist of things to have in place before a disaster event. 4. Prepare an Emergency Preparedness Seminar for Private and Not for Profit entities and hold the seminars quarterly. seminar	High - #1 Medium - #2, #3, #4,	Moderate	County EMA 911 Communications Center County Public Information Officer	FEMA HMGP Grants Donations Foundation Grants Utility Company Grants.
Safer Rooms and Community Shelters 1. Advertise state homeowner storm shelter grant program whenever the program becomes available. 2. Construct safe houses at mobile home parks (see list of locations below); also construct shelters for county recreational parks. 3. Encourage subdivision developers to install a community shelter for new or enlarging subdivisions.	☒ Emergency Services ☐ Nat. Res. Protection ☐ Prevention ☐ Property Protection ☒ Public Information ☒ Structural Control	☒ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Fire ☒ Flood ☒ Hail/Thunder/Wind ☒ Landslide/Subsidence ☒ Tornado ☒ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Proposed Enhancements –** 1. Advertise state homeowner storm shelter grant program whenever the program becomes available. 2. Encourage the construction of community shelters at mobile home parks and county recreational facilities. 3. Encourage subdivision developers to install a community shelter for new or enlarging subdivisions.	Medium –#1, #2, #3	Moderate	County EMA County Planning Commission City and Town Planning Departments	General Budget Donations FEMA BRIC Grants
Trees 1. Maintain a system for clearing branches from power lines	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☒ Structural Control	☐ Drought ☐ Earthquake ☐ Extreme Temperature ☐ Fire ☒ Flood ☐ Hail/Thunder/Wind ☒ Landslide/Subsidence ☐ Tornado ☐ Winter Storm/Ice ☐ Dam Failure ☐ HazMat Incident	**Proposed Enhancements –** 1. Encourage continuation of a systematic clearing of branches from powerlines	Medium #1	Moderate to High	County EMA Bloomington Utilities Director Town (Ellettsville and Stinesville) Utilities Director and Board	General Fund Utility Company Grants

Hazard Specific Mitigation Actions

Mitigation Practice	Mitigation Strategy	Hazard Addressed	Status	Priority	Benefit-Cost Ratio	Responsible Entity	Funding Source
Management of Dams 1. Update or create new EAP's	☐ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☐ Public Information ☒ Structural Control	☐ Drought ☐ Earthquake ☐ Extreme Temperature ☐ Fire ☒ Flood ☐ Hail/Thunder/Wind ☐ Landslide/Subsidence ☐ Tornado ☐ Winter Storm/Ice ☒ Dam Failure ☐ HazMat Incident	**Proposed Enhancements –** 1. Update existing IEAPs and create new IEAP's for dams without emergency plans	Low - #1	Moderate to High	County EMA Dam Owners	General Budget OCRA Grants IDEM Grants

Mitigation Practice	Mitigation Strategy	Hazard Addressed	Status	Priority	Benefit-Cost Ratio	Responsible Entity	Funding Source
Earthquake 1. Conduct a study of the fault line under Lake Monroe Dam **2.** Install inertial valves at critical facilities	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☒ Structural Control	☐ Drought ☐ Earthquake ☐ Extreme Temperature ☐ Fire ☒ Flood ☐ Hail/Thunder/Wind ☒ Landslide/Subsidence ☐ Tornado ☐ Winter Storm/Ice ☐ Dam Failure ☐ HazMat Incident	**Proposed Enhancements –** 1. Conduct a study of the fault line under Lake Monroe Dam 2. Encourage the installation of inertial valves at critical facilities.	Low - #1, #2	Moderate to High	EMA Director	University Grants Utility Grants
Floodplain Management 1. Institute a buy-out plan for homes/critical infrastructure in the following areas: Bloomington - 25 2. Continue compliance of the NFIP, for all NFIP communities 3. Institute a buy-out plan for homes/critical infrastructure in the following areas: Unincorporated County 4. Completes a study of the problem in the floodplain (Jackson Creek) 5. Conduct a study of Clear Creek within and beyond the city limits. 6. Elevate Mount Tabor Road at Bean Blossom Bridge 7. Upgrade Ellettsville's culverts to be larger	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☒ Structural Control	☐ Drought ☐ Earthquake ☐ Extreme Temperature ☐ Fire ☒ Flood ☐ Hail/Thunder/Wind ☒ Landslide/Subsidence ☐ Tornado ☐ Winter Storm/Ice ☐ Dam Failure ☐ HazMat Incident	**Proposed Enhancements –** 1. Determine the number and location of flood prone properties eligible for acquisition especially in Bloomington, Ellettsville and the unincorporated county. 2. Encourage Continue compliance of the NFIP, for all NFIP communities, assist and educate new staff. 3. Explore the feasibility of flood easements. 4. Complete a study of the problem in the floodplain (Jackson Creek) 5. Conduct a study of Clear Creek within and beyond the city limits. 6. Continue the efforts to elevate Mt. Tabor Road and Bean Blossom Bridge 7. Encourage Ellettsville to upgrade culvert sizes	High - #1, #2 Medium - #3, #4, #5, #6 Low - #7	High to Moderate	Floodplain Administrators – City, County and Towns County Surveyor County Highway Ellettsville Stormwater Program and MS4 Coordinator	INAFSM USDA/NRCS DNR OCRA Surveyor Budget
Hazardous Materials 1. Conduct a commodity flow study. 2. Verify that local hospitals are equipped to treat multiple types of chemical exposure. 3. Train and educate MS4 and LEPC regarding notification of spill responses for hazardous materials and radiation. 4. Conduct training for confined space rescue. 5. Conduct training for confined space rescue. **6.** Conduct training for confined space rescue	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☐ Structural Control	☐ Drought ☐ Earthquake ☐ Extreme Temperature ☐ Fire ☐ Flood ☐ Hail/Thunder/Wind ☐ Landslide/Subsidence ☐ Tornado ☐ Winter Storm/Ice ☐ Dam Failure ☒ HazMat Incident	**Proposed Enhancements –** 1. Include the new i-69 corridor in an updated commodity flow study of the county. 2. Better understand the hospital surge capacity and encourage planning to address chemically contaminated patients. 3. Train and educate MS4 and LEPC regarding notification of spill responses for hazardous materials and radiation. 4. Educate emergency response personnel about confined space and confined space rescue. 5. Establish a confined space rescue team with trained team members and purchase necessary new equipment. 6. Encourage communication for confined space entries.	High - #1, #2, #3, #4, #5, #6	High	LEPC Chair County EMA All City, Town and Township Fire Departments (Ellettsville, Bloomington, Stinesville/Bean Blossom Twp., and Monroe Fire Protection District) MS4 Coordinators	HMEP Grants IDHS Training Grants MS4 Utility Funding Assistance to Firefighters Grants

Mitigation Practice	Mitigation Strategy	Hazard Addressed	Status	Priority	Benefit-Cost Ratio	Responsible Entity	Funding Source
Stormwater Management 1. Encourage the adoption of the model stormwater ordinance. 2. Conduct a countywide stormwater study	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☐ Structural Control	☐ Drought ☐ Earthquake ☐ Extreme Temperature ☐ Fire ☐ Flood ☐ Hail/Thunder/Wind ☐ Landslide/Subsidence ☐ Tornado ☐ Winter Storm/Ice ☐ Dam Failure ☒ HazMat Incident	**Proposed Enhancements –** 1. Encourage the adoption of the model stormwater ordinance. **2.** Conduct a countywide stormwater study combining all the MS4s together.	High - #1 Medium - #2		MS4 Coordinators for City of Bloomington and Town of Ellettsville	Stormwater Utility Fund

5.0 IMPLEMENTATION PLAN

The following is a proposed plan for implementing all high priority mitigation practices identified in this Plan. It should be noted that implementation of each of these proposed practices may involve several preparatory or intermediary steps. However, to maintain clarity, not all preparatory or intermediary steps are included. Medium and low priority categories are listed but will not show implementation steps. Implementation steps for the medium and low priority actions will be developed as the actions draw closer to execution.

5.1 BUILDING PROTECTION

The mitigation activities within this category are medium priority. Implementation steps will be identified when the community is ready to proceed with the mitigation action.

5.2 EMERGENCY PREPAREDNESS AND WARNING

Develop a database of special needs populations. Evaluate how Smart 911 works from both a responder perspective and member of the public perspective. Implement recommended improvements.

- Assemble an evaluation team that includes first responders as well as members of the community. Include representatives from the cognitive and functional needs community who identify challenges in the system.
- Walk through the Smart 911 system demonstrating the functionalities currently in use as well as any options that may be available.
- Identify challenges and opportunities to improve the Smart 911 system. Provide multiple solution recommendations to address the challenges. Before fully implementing changes (going live) reconvene the evaluation team to walk through the updated system to avoid any new stumbling blocks or implementation issues.

Continue to educate community members on how to receive emergency notifications. Consider all sources - Everbridge, IPAWS, FaceBook, X (fomerly known as Twitter), county websites, IU Notify, etc.

- Assemble a listing of ways to receive emergency notifications along with a list of pros and cons for each such as timeliness of notificaiton, accuracy of the information being shared, availability of the notification, etc.
- Remove any sources from the listing which may provide inaccurate information or information which would endanger members of the public.
- Create a flyer which identifies ways to get emergency notifications and the informaiton each method provides. Include a listing of pros and cons to help members make informed decisions on which sources to utilize.

Encourage the purchase of weather alert radios for all critical facilities and large busineses.

- Consult with weather alert radio vendors regarding the costs of the various models of weather alert radios. Determine if there are any volume discounts, etc.
- Determine if there are any state programs or grant funds available to assist with the costs to acquire the radios, rather than each entity purchasing their own.

- Determine any financial shortfalls to identfy any fund raising efforts or puchase plan alertations needed such as purchasing a portion in a phased approach.

Update current outdoor warning sirens.

- Inventory all the outdoor warning sirens identifying location, make model, purchase date (if available) and any maintenance or functionality issues.
- Consult with manufacturers to determine what updates and/or upgrades are available for the existing sirens. Identify the costs of each of the updates/upgrades. Assess which are must have updates versus those which are nice ot have. Determine if there are any volume discounts, etc.
- Determine if there are any state programs or grant funds available to assist with the costs to ugrade the sirens. Are there any alternative funding means to complete upgrades such as sponsorships, adopt a siren, chamber of commerce funding, etc.
- Prioritize the upgrades and create an implementation plan which may be used to guide the upgrades and track progress.

Continue and enhance outreach to homeless at feeding sites prior to and during heavy rain events and other weather threats. Encourage using alternative shelter locations instead of stormwater sewer pipes under the city.

- Identify the number of homeless people using the storm sewer pipes as shelter.
- Work with the homeless feeding sites to make available flyers about weather issues which make the sewers an undesireable location for shelter, including rapid and sudden increases in water flow resulting in loss of property, possible loss of life if cant get out of the way, etc. Have conversations with influencers within the homeless community about the risks and alternative safe sheltering options.
- Create a notificaiton means (such as air horns) that may be used to alert those in the pipes before a storm event. Identify ways to secure the pipes so that homeless cannot access them in the future

5.3 EMERGENCY RESPONSE AND RECOVERY

Update the debris management plan.

- Review the existing debris management plan as well as current guidance regarding debris management.
- Identify the portions of the plan requiring update. Determine if the updating is extensive or limited and what is needed to make the update process successful such as planning team meetings, data or agreements with participants, etc.
- Partition the update into reasonable milestones and address each area completing the updates and then moving on to the next with the team.

5.4 GENERATORS AND POWER BACK UP

The activities within this category are medium and low priorities. Implementation steps will be identified when the community is ready to proceed with the mitigation actions.

5.5 GEOGRAPHIC INFORMATION SERVICES (GIS)

The activity within this category is a medium priority. Implementation steps will be identified when the community is ready to proceed with the mitigation action.

5.6 LAND USE MANAGEMENT, ORDINANCES AND ZONING

The activities within this category are medium priority. Implementation steps will be identified when the community is ready to proceed with the mitigation actions.

5.7 PUBLIC EDUCATION AND OUTREACH

Continue to educate residents on the hazards affecting the county.

- Form a public outreach team to help identify outreach opportunities and materials already available for distribution. Team participants could include educators, the health department, fire department, law enforcement, soil and water conservation, various NGOs, etc.
- Using available outreach materials, tailored for the Monroe County communities, prepare outreach flyers, fact sheets, social media clips to make community members aware of each of the hazards and ways people can be more resilient. Be creative in partnering with businesses to create small incentives to reward resilient actions by community members.
- Establish a speaker's bureau to present informational material to various community organizations and groups.

5.8 SAFE ROOMS AND SHELTERS

The activities within this category are medium priority. Implementation steps will be identified when the community is ready to proceed with the mitigation actions.

5.9 EARTHQUAKE

The mitigation activities in this category are low priority. Implementation steps will be identified when the community is ready to proceed with the mitigation action.

5.10 FLOODPLAIN MANAGEMENT

Determine the number and location of flood prone properties eligible for acquisition especially in Bloomington, Ellettsville and the unincorporated county.

- Use existing data sources to identify repetitive frequently flooding properties such as floodplain administrator records, NFIP repetitive loss lists and GIS maps showing properties located in the floodway. Identify areas where flooding is known to take place which may not be dientified using other sources of data.
- Create a listing of addresses, assessed value, occupancy, and determine if properties are eligible under acquisition grant funding programs. Determine if there is interest in being acquired and if the city, county or town would be willing to take possession of the property in perpetuity for flood storage.

- Run cost benefit analysis (BCA) calculations prioritize the lisitng based on the BCA and general interest to be acquired.

Encourage continued NFIP compliance for all NFIP communities. Assist and educate new staff.

- Host NFiP compliance training sessions for community leaders and staff to assure everyone understands what is expected of a participating community.
- Encourage job shadowing with experienced NFIP program staff and peer mentoring to act as a resource for new staff.
- Prepare checklists and other job aides to help new staff be successful in their role working in NFIP compliance.

5.11 MANAGEMENT OF HIGH HAZARD DAMS

The mitigation activity in this category is a low priority. Implementation steps will be identified when the community is ready to proceed with the mitigation action.

5.12 HAZARDOUS MATERIALS

Conduct a commodity flow study. Include the new I-69 corridor in an updated commodity flow study of the county.

- Review previous commodity flow study to determine the location of monitoring points previously used. Identify additional locations with heavy traffic flow of hazardous materials shipments.
- Determine if local staff will conduct traffic counts, or if a contractor will be employed to conduct the study. If local staff are used, train staff on personal safety and devise a recordation method that is consistent among observers. Coordinate with Indiana State Police to determine the best manner and location to observe traffic on I-69.
- Review data to determine if there are any gaps based on time of day, day of week or location. Also consider the seasonality of shipments. Work with Crane to determine if there are any shipments of concern arriving through Monroe County which would not be identified with placards.

Verify that local hospitals are equipped to treat multiple types of chemical exposure. Better understand the hospital surge capacity and encourage planning to address chemically contaminated patients.

- Schedule informational training sessions between the hospital(s) and fire departments and hazardous materials teams.
- Review processes each organization has in place and how a hazardous materials incident can impact overall hospital and field operations, patient capacity, and staffing and needs for staffing, support or other functions.
- Establish a cross-agency plan to address a multi casualty, hazardous materials exposure incident with all agencies, including hospital, plans and procedures to address the situation. Upon completion of the plan conduct an exercise to test the planning assumptions and processes.

Train and educate MS4 and LEPC regarding notification of spill responses for hazardous materials and radiation.

- Establish a leadership team consisting of MS4 coordinators and key LEPC members. Become familiar with each organization's reporting requirements and follow up actions.
- Create a training session to explain reporting requirements and the need for communications between first responders and MS4 staff.
- Establish an operating guideline which helps staff to ensure the appropriate notifications have been made in a manner which is acceptable and useful to all the team members.

Educate emergency response personnel about confined space and confined space rescue.

- Identify training resources from OSHA and peers to help educate personnel about confined space and confined space rescue.
- Use a variety of methods to deliver training to emergency responders to include but not limited to newsletters, flyers, videos, guest speakers and hands on training.
- When interest has been developed through basic information sharing listed above conduct the technical rescue training programs beginning at awareness level and working up to technician level.

Establish a confined space rescue team with trained team members and purchase necessary new equipment.

- Identify the individuals who have completed or are interested in completing the technical rescue training program. Determine their willingness to participate in a confined space rescue team.
- Identify needs to establish the team considering both health monitoring requirements, fit testing as well as equipment needs. Identify an agency which is willing to sponsor the team and manage team operations and equipment.
- Assemble team, conduct team training sessions, acquire needed equipment including monitoring equipment, PPE, etc.

Encourage communication for confined space entries.

- Work with training officers to determine best communication strategies and needs.
- Discuss the communication needs and methods with current confined space team members. Examine anecdotal evidence as needed to help identify where communication needs exist.
- Work with chief officers to train with confined space teams to emphasize the need for communications and the differences between traditional firefighting incidents and confined space incidents..

5.13 STORMWATER

Encourage the adoption of the model stormwater ordinance.

- Review the model stormwater ordinance. Identify ordinance requirements already in place.

- Present the model ordinance to the County attorney and key council members, commissioners, and town board members explaining the benefits of adopting the model ordinance.
- Have the model ordinance drafted in a format acceptable to the council and/or board and present for consideration.

5.14 TREES

The mitigation activity in this category is a medium priority. Implementation steps will be identified when the community is ready to proceed with the mitigation action.

6.0 PLAN MAINTENANCE PROCESS

6.1 MONITORING, EVALUATING, AND UPDATING THE PLAN

REQUIREMENT §201.6(c)(4)(i):

[The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year

To effectively reduce social, physical, and economic losses in Monroe County, it is important that implementation of this MHMP be monitored, evaluated, and updated. The EMA Director is ultimately responsible for the MHMP. As illustrated in Section 4.2 Mitigation Practices, this Plan contains mitigation program, projects, and policies from multiple departments within each incorporated community. Depending on grant opportunities and fiscal resources, mitigation practices may be implemented independently, by individual communities, or through local partnerships. Therefore, the successful implementation of this MHMP will require the participation and cooperation of the entire Committee to successfully monitor, evaluate, and update the Monroe County MHMP.

The EMA Director will reconvene the MHMP Committee on an annual basis and following a significant hazard incident. The team will examine each mitigation action within the plan to evaluate its effectiveness answering the following questions:

- Has the nature, magnitude, and/or type of risk changed? If so, what new mitigation actions are needed to address this change?
- Are the current resources appropriate for implementation? If not, what additional resources are needed to address the shortfall?
- Are there implementation problems, such as technical, political, legal, or coordination issues with other agencies? How can these issues be addressed?
- Have the outcomes occurred as expected? If not, is something else needed to achieve the desired outcome?
- Have the agencies and other partners participated as originally proposed? If not, determine why and how the action outcomes can be met?

During the annual meetings, the Implementation Checklist provided in **Appendix 10** will be helpful to track any progress, successes, and problems experienced. This will also be a tool to follow up on the progress made and effectiveness of the planned actions.

The data used to prepare this MHMP was based on “best available data” or data that was readily available during the development of this Plan. Because of this, there are limitations to the data. As more accurate data becomes available, updates should be made to the list of essential facilities and infrastructure, the risk assessment, and vulnerability analysis.

DMA 2000 requires local jurisdictions to update and resubmit their MHMP within five years (from the date of FEMA approval) to continue to be eligible for mitigation project grant funding. In Monroe County, the EMA Director will once again reconvene the MHMP Committee for a series of meetings designed to replicate the original planning process. Information gathered following individual hazard incidents and annual meetings will be utilized along with updated vulnerability assessments to assess the risks associated with each hazard common in Monroe

County. These hazards, and associated mitigation goals and practices will be prioritized and detailed as in Section 3.0 this MHMP. Sections 4.0 and 5.0 will be updated to reflect any practices implemented within the interim as well as any additional practices discussed by the Committee during the update process. The plan update process will incorporate new planning guidance and best practices as planning requirements are updated.

Prior to submission of the updated MHMP, at a public meeting, such as the county commissioners meeting, a representative of the planning team will present information about the plan to residents of Monroe County and will provide them an opportunity for review and comment of the draft MHMP. A media release will be issued providing information related to the update, the planning process, and details of the public invitation to review and comment on the plan update.

6.2 INCORPORATION INTO EXISTING PLANNING MECHANISMS

REQUIREMENT §201.6(c)(4)(ii):

[The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as the comprehensive or capital improvements, when appropriate.

Many of the mitigation practices identified as part of this planning process are ongoing with some enhancement needed. Where needed, modifications will be proposed for each NFIP communities' planning documents and ordinances during the regularly scheduled update including comprehensive plans, floodplain management plans, zoning ordinances, site development regulations, and permits. Modifications include discussions related to hazardous material facility buffers, floodplain areas, and discouraging development of new essential facilities and infrastructure in known hazard areas. The previous plan was not directly integrated into other plans, as the newer plans were not updated during the tenure of the 2018 edition. Although not directly integrated, the materials from this plan were used to help guide the community through various incidents and events.

The MHMP will be used to update floodplain and zoning ordinances based upon recommendations from the plan. For example, information in this plan new ordinances and studies be initiated by the recommendations, such as flood studies, flood response studies, and watershed management studies to protect against floods. The information included in this plan can be very helpful in preparing comprehensive plans, transportation plans, and emergency plans to mitigate hazard material impacts and response to hazards such as tornados. These plans also illustrate the importance of planning for the unserved populations and how to develop mitigation efforts that include them in future plans.

In Monroe County this is a similarly timed process. As the county or one of the incorporated communities embarks upon their ordinance updates, information is shared with the neighboring incorporated communities. Each community then evaluates the materials provided and will seek adoption or incorporation on a similar schedule. This process has worked well in the past and is the anticipated method of future incorporation of materials into plan and ordinance updates. In a similar fashion the updating of comprehensive community plan, parks plan, etc. will be able to incorporate at risk population information as well as

mitigation action opportunities**.** **Table 33** is an example of the process the communities use to incorporate planning elements into other community plans and ordinances.

Table 33 MHMP Incorporation Process

Step	Description of Process Action
1	Adopt MHMP at Commissioner Meeting, City Council Meeting, or Town Board Meeting
2	Identify document update cycles for each of the following:
	a) Comprehensive Plan b) Capital Improvement Plan c) Zoning Ordinances d) Floodplain Ordinance e) Stormwater Plans f) Other plans not listed above
3	Present applicable data to the planning team and team leads for inclusion
4	Highlight applicable mitigation actions to be included in the plan
5	Assist with incorporation and adoption of the plans, as needed.

6.3 CONTINUED PUBLIC INVOLVEMENT

REQUIREMENT §201.6(c)(4)(iii):

[The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.

Continued public involvement is critical to the successful implementation of the Monroe County MHMP. Comments gathered from the public on the MHMP will be received by the EMA Director and forwarded to the MHMP Committee for discussion. Education efforts for hazard mitigation will be the focus of the annual Severe Weather Awareness Week as well as incorporated into existing stormwater planning, land use planning, and special projects/studies efforts. Once adopted, a copy of this Plan will be available for the public to review in the EMA Office and the Monroe County website. Periodic reminder notices will be placed on social media to continue to solicit feedback and input on changes for the future plans.

Updates or modifications to the Monroe County MHMP require a public notice, reconvening the planning committee in accordance with FEMA local mitigation planning guidance and meeting with the incorporated community leaders prior to submitting revisions to the individual jurisdictions for approval and re-adoption.

The CRS program credits NFIP communities a maximum of 28 points for adopting the Plan (2 points); establishing a procedure for implementation, review, and updating the Plan; and submitting an annual evaluation report (up to 26 points).

REFERENCES

ASFPM Certified Floodplain Manager Program Information. (n.d.). Retrieved 2019, from Association of State Floodplain Managers: http://www.floods.org

American Legal Publishing (2024). Ellettsville Indiana Code of Ordinances (2024) Retrieved from: https://codelibrary.amlegal.com/codes/ellettsville/latest/ellettsville_in/

American Legal Publishing (2024). Monroe County Indiana Code of Ordinances (2023) Retrieved from: https://codelibrary.amlegal.com/codes/Monroecounty/latest/overview

Britt, R. R. (2005, June 22). *New Data Confirms Strong Earthquake Risk to Central U.S*. Retrieved December 2015, from livescience: http://www.livescience.com/3871-data-confirms-strong-earthquake-risk-central.html

Cincinnati Business Courier. (2003, March 11). Ohio Winter Storm Losses Hit $17.5 Million. Cincinnati, Ohio, United States. Retrieved from https://www.bizjournals.com/cincinnati/stories/2003/03/10/daily24.html

Department of Homeland Security. (2022). *National Risk Index for Natural Hazards*. Retrieved from Federal Emergency Management Agency: https://www.fema.gov/flood-maps/products-tools/national-risk-index

Department of Homeland Security. (n.d.). *Hazard Mitigation Assistance*. Retrieved 2023, from Federal Emergency Management Agency: www.fema.gov/hazard-mitigation-assistance

Department of Homeland Security. (n.d.). *Hazard Mitigation Planning*. Retrieved 2023, from Federal Emergency Management Agency: www.fema.gov/hazard-mitigation-planning

Department of Homeland Security. (n.d.). HAZUS-MH (v1.3). Federal Emergency Management Agency.

Department of Homeland Security. (n.d.). *National Flood Insurance Program Community Rating System*. Retrieved 2024, from Federal Emergency Management Agency: www.fema.gov/national-flood-insurance-program-community-rating-system

Federal Emergency Management Agency (FEMA), Local Mitigation Planning Policy Guide, FP 206-21-0002, Released April 19, 2022, Effective April 19, 2023, OMB Collection #1660-0062, Retrieved from https://www.fema.gov/sites/default/files/documents/fema_local-mitigation-planning-policy-guide_042022.pdf

Federal Emergency Management Agency (FEMA), Natural Mitigation Saves Interim Report Fact Sheet, June 2018

Federal Emergency Management Agency (FEMA), NFIP Community Status Book, https://www.fema.gov/cis/IN.csv, accessed 12/12/23

Fires Roar Across Central Indiana. (2010, September 23). *www.upi.com*.

Hansen, M. C. (2005). Educational Leaflet No. 9. *Earthquakes in Ohio* . Ohio Department of Natural Resources, Division of Geological Survey.

Hoosiers By the Numbers, Major Employers for Monroe County, https://www.hoosierdata.in.gov/nav.asp?id=197 , accessed 10/12/24

Indiana Department of Environmental Management. (2022). Integrated Water Monitoring and Assessment Report. *303(d) List of Impaired Waters*. Retrieved from Nonpoint Source Water Pollution. https://www.in.gov/idem/nps/watershed-assessment/water-quality-assessments-and-reporting/section-303d-list-of-impaired-waters/

Indiana Department of Homeland Security. (n.d.). *Mitigation & Recovery*. Retrieved 2023, from Indiana Department of Homeland Security: https://www.in.gov/dhs/emergency-management-and-preparedness/mitigation-and-recovery/

Indiana Department of Natural Resources. (2023). Dam Inspections and records. *Monroe County, Indiana*, Retrieved from https://dowunity.dnr.in.gov/#/Community

Indiana Department of Natural Resources. (2024). Flood Insurance Information. *Monroe County*, Retrieved from https://dowunity.dnr.in.gov/#/Community

Indiana Department of Natural Resources (2024), Indiana Floodplain Information Portal, Retrieved from https://secure.in.gov/dnr/water/surface-water/indiana-floodplain-mapping/indiana-floodplain-information-portal/

DNR, Fluvial Erosion Hazards Map, https://indnr.maps.arcgis.com/apps/webappviewer/index.html?id=43e7b307a0184c7c851b5068941e2e23 , accessed 12/21/23

Indiana Department of Transporatation (2022) Road and Railroad Maps – INDOT , retrieved 2023, from https://www.in.gov/indot/files/RailSystemMap_Med_StWide_11x17_RH_Final.pdfIndiana

Geological Survey. (n.d.). *Earthquakes in Indiana*. Retrieved 2014, from Indiana Geological Survey: https://igws.indiana.edu/earthquakes/

Indiana Geological and Water Survey, Map of Indiana showing Known Faults and Historic Earthquake Epicenters having Magnitude 3.0 and Larger,Retrieved 2022, from https://igws.indiana.edu/bookstore/details.cfm?Pub_Num=MM84

Indiana University. (2022). *IndianaMap*. Retrieved from Indiana Geological & Water Survey: https://www.indianamap.org/

Indiana University. (n.d.). *Indiana Earthquakes*. Retrieved from Indiana Geological & Water Survey: https://igws.indiana.edu/earthquakes/recent

Insurance Institute for Business & Home Safety. (n.d.). Retrieved from Insurance Institute for Business & Home Safety: www.disastersafety.org

Monroe County, Indiana. (2023). Geographic Information Systems data

Mack, J. (2015, May 5). *Michigan Earthquake: "Big Deal" for a Couple of Reasons, US Geological Survey Scientist says.* Retrieved 2016, from www.mlive.com: http://www.mlive.com/news/kalamazoo/index.ssf/2015/05/feds_on_michigan_earthquake_un.html#incart_river_index_topics

Midwest Regional Climate Center. (2024). *Midwest Climate: Climate Summaries*. Retrieved 2024, from Midwest Regional Climate Center: https://mrcc.purdue.edu/mw_climate/climateSummaries/climSumm.jsp

National Drought Mitigation Center. (n.d.). *US Drought Monitor*. Retrieved 2024, from https://droughtmonitor.unl.edu/

NFIP Flood Insurance Data and Analytics. Retrieved August 2024 from:*https://nfipservices.floodsmart.gov/reports-flood-insurance-data*

National Land Cover Database (2019). Retrieved 2024, from Multi-Resolution Land Characteristics Consortium: https://www.mrlc.gov/viewer/

National Oceanic and Atmospheric Administration. (n.d.). *Safety*. Retrieved from National Weather Service: https://www.weather.gov/safety/

National Oceanic and Atmospheric Administration. (n.d.). *Storm Events Database*. Retrieved 11/1/24, from National Centers for Environmental Information: https://www.ncdc.noaa.gov/stormevents/

National Weather Service Indianapolis , Heat Information Page, https://www.weather.gov/ind/heatinfo, accessed 12/14/23

National Weather Service, Flood gages and crests, https://water.noaa.gov/, accessed 11/1/24

No Adverse Impact. (n.d.). Retrieved 2022, from Assocation of State Floodplain Managers: https://www.floods.org/resource-center/nai-no-adverse-impact-floodplain-management/

Peng, Jin; 2017, Morphological Filters In Floodplain For Demextracted Data – Using Minimum Bounding Circle & Youden Index – Non-levee embankment description

Phases of disaster management - Community Emergency Response Guide | Emergency Management (fairfaxcounty.gov) https://www.fairfaxcounty.gov/emergencymanagement/cerg accessed 2/9/24

Public Law 106-390. (2000, October 30). *Disaster Mitigation Act of 2000*.

Purdue Climate Change Research Center, Purdue University. (2021). Retrieved from Indiana Climate Change Impacts Assessment: https://ag.purdue.edu/indianaclimate/

Purdue University. (2013, March 12). Indiana Crop Insurance Payouts Top $1 Billion . *Purdue Agricultural News*.

STATS Indiana. (2024). Indiana IN Depth. *Monroe County*. Retrieved from http://www.stats.indiana.edu/profiles/

The Guardian, Canadian Wildfires 2023, https://www.theguardian.com/world/2023/nov/09/canada-wildfire-record-climate-crisis, last accessed 12/14/23

Topographic -map.com, Topographic map of Monroe County, https://en-us.topographic-map.com/map-mz4pz4/Monroe-County/ accessed 10/13/24

United States Department of Agriculture. (n.d.). *Indiana Field Office County Estimates*. Retrieved 2024, from National Agriculture Statistical Service: https://www.nass.usda.gov/Statistics_by_State/Indiana/Publications/County_Estimates/index.php

United States Department of Agriculture, Soil Conservation Service. (n.d.). *Soil Survey of Monroe County, Indiana.*

United States Department of Agriculture, Crop Loss Data, https://www.rma.usda.gov/-/media/RMA/State-Profiles/2022/Indiana-2022-State-Profile-Form_updated-1-10-23_PDF.ashx?la=en, accessed 12/14/23

US Drought Monitor – Retrieved 2024, from https://www.drought.gov/states/indiana/county/Monroe

US Army Corps of Engineers. (2024). *Dams of Monroe County, Indiana*. Retrieved from National Inventory of Dams: https://nid.sec.usace.army.mil/#/

US Geological Survey, Seismic hazards map, https://www.usgs.gov/media/images/2014-seismic-hazard-map-indiana, accessed 12/14/23.

US Geological Survey Water Watch (nd) Retrieved from https://waterwatch.usgs.gov/m=real&r=in.