2020 Bollinger County
Multi-Jurisdictional Hazard Mitigation Plan

5 Year Update

Southeast Missouri
Regional Planning Commission

Bollinger County Hazard Mitigation Planning Committee

Jurisdictional Representatives

Name	Title	Department	Jurisdiction/Agency/Organization
Leo Arnzen	Presiding Commissioner	Commission	Bollinger County
Roy Garner	Commissioner	Commission	Bollinger County
Kevin Cooper	Emergency Management Dir.	Public Safety	Bollinger County
Brittany Howard	County Clerk	Administration	Bollinger County
Michael Kiehne	Superintendent	Administration	Woodland R-IV School Dist.
Donna Bristow	Superintendent	Administration	Meadow Heights R-II School Dist.
Matt Britt	Superintendent	Administration	Leopold R-III School Dist.
Mike Henson	SRO/Deputy	Sheriff's Dept.	Zalma R-V School Dist./Bollinger County

Stakeholder Representatives

Name	Title	Department	Agency/Organization
Juanita Welker	Administrator	Administration	Bollinger County Health Dept.
Mike Henson	Sheriff's Deputy	Sheriff's Department	Sheriff's Department
Capt. Phillip E. Gregory	Commanding Officer	Administration	MSHP Region E
John Singleton	CEO	Administration	Black River Electric Cooperative
Hank Voelker	Regional Coordinator	Communications	Missouri State Emergency Management Agency
Art Goodin	Director	Southeast Regional Office	Missouri Department of Natural Resources
Leslie Sebaugh	Coordinator	Regional Homeland Security Oversight Committee	SEMO Regional Planning Commission

Rebecca Pecaut	Coordinator	Solid Waste Management District	SEMO Regional Planning Commission
Maria Stevenson	Executive Director	Administration	American Red Cross - Southeast Missouri Chapter
Brian Okenfuss	Area Engineer	Engineering & Design	Missouri Department of Transportation

Stakeholders are individuals or groups that are affected by a mitigation action or policy and include businesses, private organizations, and citizens. Unlike planning team members, stakeholders may not be involved in all stages of the planning process, but they inform the planning team on a specific topic or provide input from different points of view in the community. Many of the Stakeholders and Jurisdictional Representatives listed above provided feedback, input, and information through discussions over the phone, emails, or in-person, but were not in attendance at Hazard Mitigation Planning Team meetings.

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EXECUTIVE SUMMARY

The purpose of hazard mitigation is to reduce or eliminate long-term risk to people and property from hazards. Bollinger County and participating jurisdictions and school/special districts developed this multi-jurisdictional local hazard mitigation plan update to reduce future losses from hazard events to the County and its communities and school districts. The plan is an update of a plan that was approved on October 15, 2014. The plan and the update were prepared pursuant to the requirements of the Disaster Mitigation Act of 2000 to result in eligibility for the Federal Emergency Management Agency (FEMA) Hazard Mitigation Assistance Grant Programs.

The County Multi-Hazard Mitigation Plan is a multi-jurisdictional plan that covers the following jurisdictions that participated in the planning process:

- Unincorporated Bollinger County
- Meadow Heights R-II School District
- Woodland R-IV School District

Bollinger County and the entities listed above developed a Multi-Jurisdictional Hazard Mitigation Plan that was approved by FEMA on October 15, 2014 (hereafter referred to as the *2014 Hazard Mitigation Plan*). This current planning effort serves to update that previously approved plan.

The plan update process followed a methodology prescribed by FEMA, which began with the formation of a Hazard Mitigation Planning Committee (HMPC) comprised of representatives from Bollinger County and participating jurisdictions. The HMPC updated the risk assessment that identified and profiled hazards that pose a risk to the county and analyzed jurisdictional vulnerability to these hazards. The HMPC also examined the capabilities in place to mitigate the hazard damages, with emphasis on changes that have occurred since the previously approved plan was adopted. The HMPC determined that the planning area is vulnerable to several hazards that are identified, profiled, and analyzed in this plan. Riverine and flash flooding, winter storms, severe thunderstorms/hail/lightning/high winds, and tornadoes are among the hazards that historically have had a significant impact.

Based upon the risk assessment, the HMPC chose to keep the previous goals for reducing risk from hazards. The goals are:

1. Protect the health, safety, and welfare of residents and students.
2. Ensure the operation of critical facilities and services.
3. Protect public and private property.
4. Enhance informed decision making of mitigation actions.

To advance the identified goals, the HMPC developed recommended mitigation actions, which are detailed in Chapter 4 of this plan. The HMPC developed an implementation plan for each action, which identifies priority level, background information, ideas for implementation, responsible agency, timeline, cost estimate, potential funding sources, and more.

PREREQUISITES

This plan has been reviewed by and adopted with resolutions or other documentation of adoption by all participating jurisdictions and special districts. The documentation of each adoption is included in Appendix A, and a model resolution is included on the following page.

The following jurisdictions participated in the development of this plan and have adopted the multi-jurisdictional plan.

- Unincorporated Bollinger County
- Meadow Heights R-II School Dist.
- Woodland R-IV School Dist.

Model Resolution

Resolution # ____

Adopting the Bollinger County Multi-Jurisdictional Local Hazard Mitigation Plan

Whereas, the (Name of Government/District/Organization seeking FEMA approval of hazard mitigation plan) recognizes the threat that natural hazards pose to people and property within our community; and

Whereas, undertaking hazard mitigation actions will reduce the potential for harm to people and property from future hazard occurrences; and

Whereas, the U.S. Congress passed the Disaster Mitigation Act of 2000 ("Disaster Mitigation Act") emphasizing the need for pre-disaster mitigation of potential hazards;

Whereas, the Disaster Mitigation Act made available hazard mitigation grants to state and local governments; and

Whereas, an adopted Local Hazard Mitigation Plan is required as a condition of future funding for mitigation projects under multiple FEMA pre- and post-disaster mitigation grant programs; and

Whereas, the (Name of Government/District/Organization) fully participated in the hazard mitigation planning process to prepare this Multi-Jurisdictional Local Hazard Mitigation Plan; and

Whereas, the Missouri State Emergency Management Agency and the Federal Emergency Management Agency Region VII officials will review the "County A Multi-Jurisdictional Local Hazard Mitigation Plan," and approved it as to form and content; and

Whereas, the (Name of Government/District/Organization) desires to comply with the requirements of the Disaster Mitigation Act and to augment its emergency planning efforts by formally adopting the Ste. Genevieve County Multi-Jurisdictional Local Hazard Mitigation Plan; and

Whereas, adoption by the governing body for the (Name of Government/District/Organization) demonstrates the jurisdictions' commitment to fulfilling the mitigation goals outlined in this Multi-Jurisdictional Local Hazard Mitigation Plan; and

Whereas, adoption of this legitimizes the plan and authorizes responsible agencies to carry out responsibilities under the plan;

Now, therefore, be it resolved, that the (Name of Government/District/Organization) has adopted the "Bollinger County Multi-Jurisdictional Hazard Mitigation Plan" as an official plan.

Date: _____

Certifying Official: _____

1 INTRODUCTION AND PLANNING PROCESS

1.1 Purpose

The purpose of hazard mitigation is to reduce or eliminate long-term risk to people and property from hazards. Hazard mitigation is generally considered to be the actions taken well in advance of a disaster event. Actions taken immediately prior to or during an event or immediately following an event are typically considered response and recovery actions, respectively. This plan has been developed to assist participating jurisdictions in identifying potential hazard exposures and defining actions that can limit such.

For jurisdictions to be eligible for federal Hazard Mitigation Grants, they must participate in this planning process and adopt the plan by resolution. Any jurisdictions that do not participate will be ineligible for such grants until the next plan update is undertaken. This plan is viable for five (5) years from the date of FEMA approval.

For additional information about the Hazard Mitigation Planning Process, please refer to: the Disaster Mitigation Act of 2000 (Public Law 106-390) and the implementing regulations set forth by the Interim Final Rule published in the Federal Register on February 26, 2002, (44 CFR §201.6) and finalized on October 31, 2007 (hereafter referred to collectively as the Disaster Mitigation Act or DMA) and the Robert T. Stafford Disaster Relief and Emergency Act (Public Law 93-288).

1.2 Background and Scope

This hazard mitigation plan (HMP) is an update to the 2014 Bollinger County HMP which was approved by FEMA on October 15, 2014. This plan is valid for a period of five years and will undergo a full update cycle in 2025.

The following table provides a list of participants during this plan update. Note that Leopold R-III and Zalma R-V School Districts did participate in HMPC meetings and reviewed the 2014 plan and the draft 2020 plan. However, they have not yet developed their migitation actions nor adopted this plan through resolution. This plan will be amended to incorporate these jurisdictions as they complete the planning process.

Table 1.1. Plan Participants

Jurisdiction	NFIP Participant	Participating Jurisdiction (2014)	Participating Jurisdiction Criteria (2020)				Participating Jurisdiction (2020)
			Meetings Attended	Actions Developed	Draft Reviewed	Formal Adoption	
Bollinger County	Y	X	X	X	X	X	X
Leopold R-III School Dist.	N/A	X	X		X		
Meadow Heights R-II School Dist.	N/A	X	X	X	X	X	X
Woodland R-IV School Dist.	N/A	X	X	X	X	X	X
Zalma R-V School Dist.	N/A	X	X		X		X

Information in this plan will be used to help guide and coordinate mitigation activities and decisions for local land use and development policy in the future. Actions from this plan will also be incorporated into local jurisdiction's other planning efforts as appropriate.

1.3 Plan Organization

This HMP is organized into 5 main chapters, along with an executive summary and appendicies, as follows:

- Executive Summary
- Chapter 1: Introduction and Planning Process
- Chapter 2: Planning Area Profile and Capabilities
- Chapter 3: Risk Assessment
- Chapter 4: Mitigation Strategy
- Chapter 5: Plan Implementation and Maintenance
- Appendices

Table 1.2 shows a comparison between this plan's structure and that of the previous plan, along with a summary of changes in each section from the previous plan.

Table 1.2. Changes Made in Plan Update

Changes and Revisions	Current Plan Sections	Previous Plan Sections
Participants, stakeholders, resolution of adoption	Executive Summary & Prerequisites	Introduction
		Prerequisites
Information on the current planning process, including dates, locations, participants, and meetings	Introduction and Planning Process	The Planning Process
Information on the planning area including demographics, economics, and assets as well as the capabilities of each jurisdiction	Planning Area Profile and Capabilities	Risk Assessment
Information on jurisdictions' exposure to hazards	Risk Assessment	
Jurisdictions' previous, continuing, and new actions as well as the goals and objectives for the plan	Mitigation Strategy	Hazard Mitigation Program
Information on implementation with other plans and the maintenance schedule and responsibilities	Plan Implementation and Maintenance	Plan Maintenance Process
Additional relevant data	Appendices	Appendices

1.4 Planning Process

The Southeast Missouri Regional Planning Commission (SEMO RPC) was contracted by SEMA to facilitate the update of the HMP. RPC staff assisted local jurisdictions in the establishment of an HMPC as defined by the DMA and updated the committee on current requirements for the HMP process. Planning staff determined the plan had been maintained in accordance with the methodology set forth in the previous plan through communications with all participating jurisdictions on a yearly basis to assess the need for revisions to the plan, of which there were none. SEMO RPC staff also ensured the updated plan met the DMA requirements as established by federal regulations and that it followed the most current planning guidance of FEMA.

The RPC also facilitated the entire plan development process by identifying the data which HMPC participants should provide and conducting research and documentation necessary to augment such data and by soliciting public input in the planning process. Commission staff also produced the draft and final plan update in a FEMA-approvable document and coordinated plan

reviews with both SEMA and FEMA.

Table 1.3. Jurisdictional Representatives - Mitigation Planning Committee

Name	Title	Department	Jurisdiction/Agency/Organization
Leo Arnzen	Presiding Commissioner	Commission	Bollinger County
Roy Garner	Commissioner	Commission	Bollinger County
Kevin Cooper	Emergency Management Dir.	Public Safety	Bollinger County
Brittany Howard	County Clerk	Administration	Bollinger County
Michael Kiehne	Superintendent	Administration	Woodland R-IV School Dist.
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Mike Henson	SRO/Deputy	Sheriff's Dept.	Zalma R-V School Dist./Bollinger County

1.4.1 Multi-Jurisdictional Participation

Active participation in the hazard mitigation planning process is important to ensure each jurisdiction is adequately represented, that their needs and exposures are properly evaluated, and that their actions are appropriate and effective at addressing those needs and exposures. Representatives from the County, incorporated communities, public schools, and stakeholders were invited to participate in the planning process through certified mail and electronic communications. The DMA requires each jurisdiction to participate in the planning process and officially adopt the plan to be considered an eligible participant.

During its first meeting, the HMPC determined the criteria for being considered an eligible participant in this planning process, as follows:

- Representation (direct or through appointee) at a majority of the public HMPC meetings,
- Actively solicit public input and participation in planning process,
- Review prior plan,
- Complete HMP questionnaire,
- Update jurisdiction's hazard mitigation actions from previous plan,
- Review and comment on new draft, and
- Adoption of new plan.

For small, rural jurisdictions, participation in planning processes such as these can be difficult.

Many rural communities have no full-time staff, and in some cases have only a volunteer clerk. Making committee meetings, completing questionnaires, reviewing previous plans, validating actions, and commenting on drafts are entirely different undertakings for officials who have a full-time day job and a full-time elected position. Additionally, acquiring public input in rural areas can be challenging as well. Many residents lack adequate access to the internet, do not visit their local library or courthouse on a regular basis, and do not subscribe to other media. Limited resources, less population density, and longer commute times mean word of mouth spreads more slowly in these areas. These issues make it more difficult for small communities and the rural public to participate in planning processes.

Table 1.4 shows the manner of participation for jurisdictions involved in the planning process. Note that not all jurisdictions listed are full participants. Meeting sign-in sheets can be found in the appendix.

Table 1.4. Jurisdictional Participation in Planning Process

Jurisdiction	Kick-off Meeting	Meeting #2	Data Collection Questionnaire Response	Update/Develop Mitigation Actions
Bollinger County	X	X	X	X
Leopold R-III School Dist.	X	X		
Meadow Heights	X	X	X	X
Woodldand R-IV School Dist.	X	X	X	X
Zalma R-V School Dist.	X	X		

1.4.2 The Planning Steps

SEMO RPC and the county worked together to establish the framework and process for this planning effort using FEMA's *Local Mitigation Planning Handbook* (March 2013). The plan update was completed utilizing the 9-task approach within a more broad four-phase process:

1. Organize resources,
2. Assess risks,
3. Develop the mitigation plan, and
4. Implement the plan and monitor progress.

Into this process, SEMO RPC integrated a detailed 10-step planning process adapted from FEMA's Community Rating System (CRS) and Flood Mitigation Assistance programs. Thus, the process used for this plan meets the funding eligibility requirements of the Hazard Mitigation Grant Program, Pre-Disaster Mitigation Program, Community Rating System, and Flood Mitigation Assistance Program. Table 1.5 shows how this process fits into FEMA's original four-phase DMA process as well as the revised Nine Task Process outlined in the 2013 *Local Mitigation Planning Handbook* and the 10-step CRS process.

Table 1.5. County Mitigation Plan Update Process

Phase	Community Rating System (CRS) Planning Steps (Activity 510)	Local Mitigation Planning Handbook Tasks (44 CFR Part 201)
I	Step 1. Organize	Task 1: Determine the Planning Area and Resources
		Task 2: Build the Planning Team 44 CFR 201.6(c)(1)
	Step 2. Involve the public	Task 3: Create an Outreach Strategy 44 CFR 201.6(b)(1)
	Step 3. Coordinate	Task 4: Review Community Capabilities 44 CFR 201.6(b)(2) & (3)
II	Step 4. Assess the hazard	Task 5: Conduct a Risk Assessment 44 CFR 201.6(c)(2)(i) 44 CFR 201.6(c)(2)(ii) & (iii)
	Step 5. Assess the problem	
III	Step 6. Set goals	Task 6: Develop a Mitigation Strategy 44 CFR 201.6(c)(3)(i); 44 CFR 201.6(c)(3)(ii); and 44 CFR
	Step 7. Review possible activities	201.6(c)(3)(iii)
	Step 8. Draft an action plan	
IV	Step 9. Adopt the plan	Task 8: Review and Adopt the Plan
	Step 10. Implement, evaluate, revise	Task 7: Keep the Plan Current
		Task 9: Create a Safe and Resilient Community 44 CFR 201.6(c)(4)

Phase I

Step 1: Organize the Planning Team (Handbook Tasks 1 & 2)

The planning process resulting in the preparation of this plan document officially began with Meeting #1 in Mable Hill, MO on October 17, 2019. Participants of the meeting included representatives from all participating jurisdictions, additional school districts, and RPC staff. The purpose of this meeting was to set planning meeting dates, determine hazards to be included in the plan update, discuss options for the flood risk assessment methodology, develop an initial public participation strategy, and discuss the plan update format. Meeting materials are included in the appendix. An HMPC was created that includes representatives from each participating jurisdiction along with additional jurisdictions.

After the initial meeting, a second planning meetings was held on October 31, 2019. A complete list of all representatives of the agencies and organizations that participated on the HMPC is provided in the appendix.

The HMPC communicated during the planning process with a combination of face-to-face meetings, phone interviews, and email correspondence. The meeting schedule and topics are listed in Table 1.6.

Table 1.6. Schedule of HMPC Meetings

Meeting	Topic	Date
Planning Meeting #1	General overview of planning process, requirements, and schedule. Introduction to DMA, hazard identification, and public input strategy. Distribution of data collection guide to jurisdictions. Preliminary hazard rankings. Determine process to monitor, evaluate, and update plan.	October 17, 2019
Planning Meeting #2	Review of draft Risk Assessment, distribution of critical facility inventories for jurisdictions to validate/correct, development of plan goals. Mitigation action update, development, and prioritization.	October 31, 2019

During the meetings, SEMO RPC presented information on the scope and purpose of the plan, participation requirements of HMPC members, and the proposed project work plan and schedule. Plans for public involvement (Step 2) and coordination with other agencies and departments (Step 3) were discussed. SEMO RPC also introduced hazard identification requirements and data needs. The HMPC discussed potential hazards as well as past events and impacts and refined the identified hazards relevant to the County. The HMPC made preliminary determinations of probability and magnitude for each hazard identified.

Participants were given the Data Collection Guide to facilitate the collection of information needed to support the plan, such as data on historic hazard events, values at risk, and current capabilities. Each participating jurisdiction completed and returned the worksheets in the Data Collection Guide to the RPC. SEMO RPC integrated this information into the plan, supporting the development of Chapters 2 and 3.

Step 2: Plan for Public Involvement (Handbook Task 3)

At the kickoff meeting, the HMPC discussed options for soliciting public input on the mitigation plan. To provide an opportunity for the public to comment during the drafting stage, the committee determined the most effective method would be to invite the public to the HMPC meetings to gather direct input. The public was invited through postings (available in Appendix B) at city halls, libraries, and the county courthouse. Those jurisdictions with a social media presence also made the announcements available there.

The public was also given an opportunity to provide input on a draft of the complete plan prior to its submittal to the State and FEMA. The entire plan draft was made available on the RPC's website as a PDF document. In addition, two hard copies were made available; one at the Emergency Management Office and the other at the County Courthouse. The County and RPC announced the availability of the entire final draft plan and the two-week final public comment period on their websites. A copy of the announcement is provided in the appendix. The final public comment period was from January 17-January 31, 2020.

The HMPC invited other targeted stakeholders to comment on the draft plan via e-mail, and phone conversations, which are described in greater detail in Step 3: Coordinate with Other

Departments and Agencies. Minor comments were received and incorporated.

Much of the public's input was focused on specific actions they wanted jurisdictions to pursue. These suggestions were forwarded to the HMPC and were discussed with the pertinent jurisdiction and with the HMPC. The specific jurisdictions conducted internal assessments of the suggestions and incorporated the actions when feasible.

Step 3: Coordinate with Other Departments and Agencies and Incorporate Existing Information (Handbook Task 3)

There are numerous organizations whose goals and interests interface with hazard mitigation in Bollinger County. Coordination with these organizations and other community planning efforts is vital to the success of this plan. The County invited neighboring counties, other local, state, and federal departments and agencies to the planning meetings to learn about the hazard mitigation planning initiative. In addition, the HMPC developed a list of additional stakeholders involved in hazard mitigation activities, to invite to review and comment on the draft of the Multi-jurisdictional Hazard Mitigation Plan prior to submittal to the State and FEMA. Those agencies invited to meetings and/or comment on the plan draft included emergency management officials of adjacent counties, economic development agencies, and various state agencies such as the Department of Natural Resources and MoDOT. All positions were notified via written notice or email.

Title	Department	Agency/Organization
Administrator	Administration	Bollinger County Health Dept.
Commanding Officer	Administration	MSHP Region E
CEO	Administration	Black River Electric Cooperative
Mitigation Planner	Communication	Missouri State Emergency Management Agency
Director	Southeast Regional Office	Missouri Department of Natural Resources
Coordinator	Regional Homeland Security Oversight Committee	SEMO Regional Planning Commission
Coordinator	Solid Waste Management District	SEMO Regional Planning Commission
Executive Director	Administration	American Red Cross - Southeast Missouri Chapter
Area Engineer	SE District	Missouri Department of Transportation
Emergency Management Director	Emergency Management	Cape Girardeau County
Emergency Management Director	Emergency Management	Perry County
Emergency Management Director	Emergency Management	Madison County

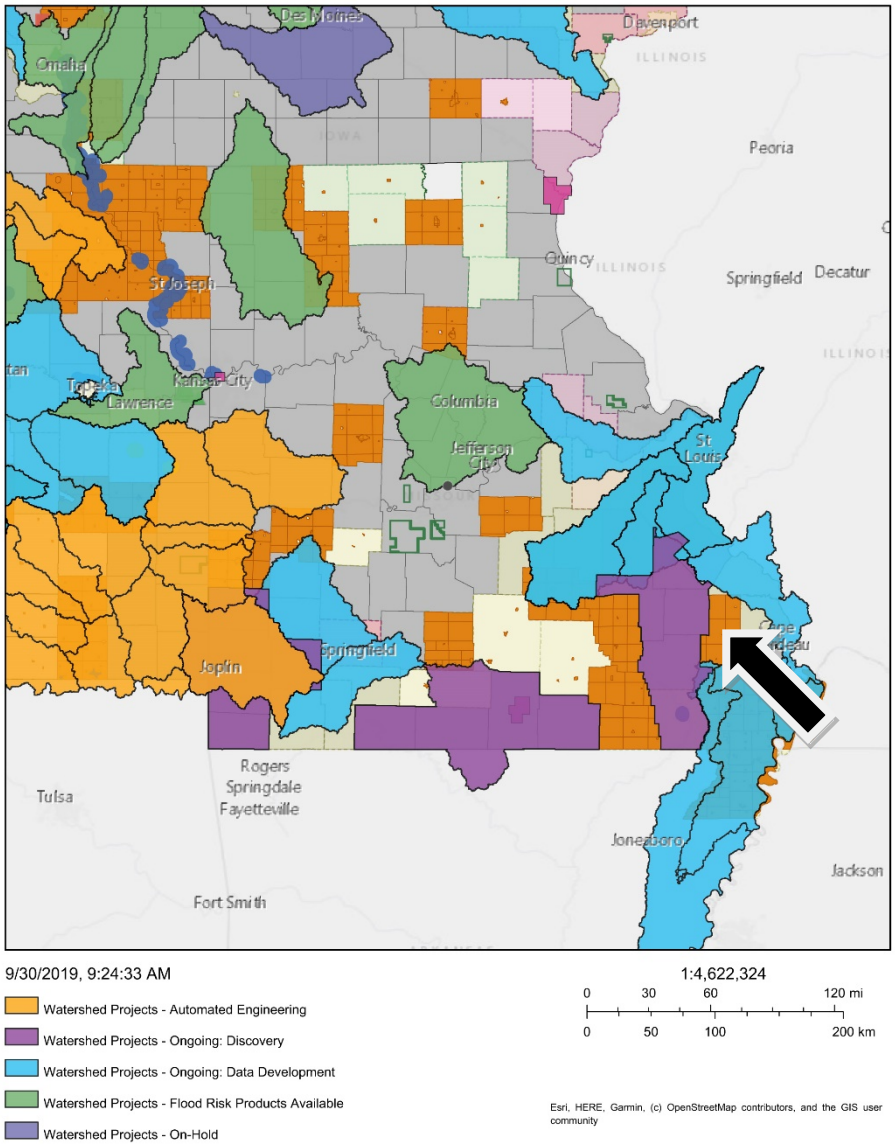
Emergency Management Director	Emergency Management	Wayne County
Emergency Management Director	Emergency Management	Stoddard County

Coordination with FEMA Risk MAP Project

Bollinger County is designated as “Effective FIS/FIRM” for the Risk MAP project. Risk Mapping, Assessment, and Planning (Risk MAP) is the Federal Emergency Management Agency (FEMA) Program that provides communities with flood information and tools they can use to enhance their mitigation plans and take action to better protect their citizens.

Through collaboration with State, Tribal, and local entities, Risk MAP delivers quality data that increases public awareness and leads to action that reduces risk to life and property. This data is not yet available for the County, though work is underway as the county falls into the Data Development Category. Figure 1.1 Risk MAP Status Map shows the status of regional counties.

Figure 1.1. RiskMAP Status Map (August 16, 2017)



Integration of Other Data, Reports, Studies, and Plans

In addition, input was solicited from many other agencies and organizations that provided information but were not able to attend planning meetings. As part of the coordination with other agencies, the HMPC collected and reviewed existing technical data, reports, and plans. These included:

- Missouri Hazard Mitigation Plan (2018),
- Bollinger County Hazard Mitigation Plan (2014),
- National Flood Insurance Program's Community Information System Reports,
- Digital Flood Insurance Rate Maps,
- DNR Dam and Reservoir Safety Program,
- DNR Sinkhole Location Data,
- MO Land Use Land Cover Data,
- National Fire Incident Reporting System Fire Incident Data,

- Various local plans such as Comprehensive Plans, Economic Development Plans, Emergency Operations Plans, Capital Improvement Plans, etc.

This information was used in the development of the hazard identification, vulnerability assessment, and capability assessment and in the formation of goals, objectives, and mitigation actions. These sources, as well as additional sources of information are documented throughout the plan and in the appendix.

Phase 2: Assess Risk (Handbook Task 5)

Step 4: Assess the Hazard: Identify and Profile Hazards

SEMO RPC assisted the HMPC in a process to identify the hazards that have impacted or could impact communities in the county. At the first meeting, the HMPC examined the history of disaster declarations in the county, the list of hazards considered in the 2018 Missouri State Hazard Mitigation Plan, and the hazards identified in the previous hazard mitigation plan. The committee then worked through this list of all potential hazards that could affect the planning area. They discussed past hazard events, types of damage, and where additional information might be found. The committee identified 11 natural hazards that have the potential to impact the planning area. Additional information on the hazard identification process and which hazards were identified for each jurisdiction is provided in Chapter 3.

During the kick-off meeting, the HMPC refined the list of hazards to make the analysis relevant to the County, discussed past events and impacts and came to consensus on the preliminary probability and magnitude on a county-wide basis. In addition, each jurisdiction completed a Data Collection Guide, including information on previous hazard events in their community. Utilizing the information from the Data Collection Guides as well as existing plans, studies, reports, and technical information as well as information available through internet research and GIS analysis, a profile was developed for each hazard identified. More information on the methodology and resources used to identify and profile the hazards can be found in Chapter 3.

Step 5: Assess the Problem: Identify Assets and Estimate Losses

Assets for each jurisdiction were identified through a combination of several resources. A listing of critical facilities in each jurisdiction from the previous HMP was presented at Meeting #2 for correction and validation. Methodologies and results of the analyses are provided in Chapter 3.

Additional assets such as historic, cultural, and economic assets as well as specific vulnerable populations and structures were obtained from a variety of sources as described in Chapter 3.

The HMPC also analyzed development trends from data available from the U.S. Census Bureau as well as information obtained from each jurisdiction such as Comprehensive Plans and Future Development Plans. For each hazard, there is a discussion regarding future development and how it may impact vulnerability to that specific hazard.

After profiling the hazards that could affect the county and identifying assets, the HMPC collected information to describe the likely impacts of future hazard events on the participating jurisdictions.

Existing mitigation capabilities were also considered in developing loss estimates. This

assessment consisted of identifying the existing mitigation capabilities of participating jurisdictions. This involved collecting information about existing government programs, policies, regulations, ordinances, and plans that mitigate or could be used to mitigate risk from hazards. Participating jurisdictions collected information on their regulatory, personnel, fiscal, and technical capabilities, as well as previous and ongoing mitigation initiatives. This information is included in Chapter 2 Planning Area Profile and Capabilities.

Specific capabilities such as participation in the National Flood Insurance Program as well as designation and placement of storm sirens are incorporated in the vulnerability analysis discussions, where applicable.

Taking into consideration the vulnerability and capability assessments, and where sufficient information was available, a variety of methods were used to estimate losses for each profiled hazard. For geographic hazards such as river flooding and wild fire, specific assets at risk and loss estimates were determined through GIS analysis. For other hazards such as weather-related hazards, loss estimates were developed based on statistical analysis of historic events and HMPC input. For dam and levee failure, GIS data was not available to identify specific geographic boundaries at risk. Therefore, the risk assessment is based on aerial photography analysis of development within an estimated hazard area. The methodologies for each loss estimate are described in detail in Chapter 3. Within each hazard section, the text provides details on how the hazard varies by jurisdiction, where applicable. In addition, at the conclusion of each hazard section, a summary table indicates the specific probability and magnitude of the hazard for each jurisdiction to show how the hazard varies. Where applicable, introductory text preceding the table highlights noted variables.

Results of the preliminary risk assessment were presented at Meeting #2 and the Draft Risk Assessment (Chapter 3) was provided to the HMPC for review and comment. Several comments, corrections, and suggestions were provided to SEMO RPC and incorporated into the risk assessment as appropriate.

Phase 3: Develop the Mitigation Plan (Handbook Task 6)
Step 6: Set Goals

SEMO RPC facilitated a discussion session with the HMPC during Meeting #2 to review and update goals. Common categories of mitigation goals were presented as well as the 2018 State Hazard Mitigation Plan goals.

This planning effort is an update to an existing hazard mitigation plan. As a result, the goals from the previous plan were reviewed. The planning committee decided the 2014 goals are still valid. The goals for the plan update are provided below.

1. Protect the health, safety, and welfare of residents and students.
2. Ensure the operation of critical facilities and services.
3. Protect public and private property.
4. Enhance informed decision making of mitigation actions.

Step 7: Review Possible Mitigation Actions and Activities

One of the focuses of Meeting #2 was to update the mitigation strategy by reviewing existing actions submitted in the previous mitigation plans as well as discuss relevant new actions

considered necessary as a result of the updated risk assessment. The development of mitigation actions was facilitated through group discussion of the capabilities and risks of each jurisdiction. Consideration was given to the analysis results provided in the risk assessment and the anticipated success for each project type. Committee members discussed issues such as: availability of funds, prioritization of actions, and feasibility of implementation utilizing the STAPLEE methodology as a guide. Projects relating to emergency response were discussed, but participants were encouraged to focus on long-term mitigation solutions since response-related mitigation actions occur on a routine basis as requirements of other plans. Complex projects that would necessitate use of large numbers of county resources were also discussed. This opportunity to discuss a broad range of mitigation alternatives allowed the jurisdictions to understand the overall priorities of the committee and to allow for discussion of the types of project most beneficial to each jurisdiction. As part of this discussion, consideration was given to the potential cost of each project in relation to the anticipated future cost savings.

Since this plan is an update to the *2014 Hazard Mitigation Plan*, the update of the mitigation strategy included review and update of the status of all actions included in the previous hazard mitigation plan. Jurisdictions were encouraged to maintain a focused approach and continue forward only those actions that are aimed at implementing long-term solutions to prevent losses from hazards. To facilitate the update of previous actions, a spreadsheet was provided to each jurisdiction prior to Meeting #2 with the actions they submitted in the previous mitigation plan. The jurisdictions were also provided instructions for completing the status of each of the previous actions as well as the details to provide for continuing and newly developed actions. A modified form of the STAPLEE prioritization tool was provided to assist jurisdictions in determining the prioritization that should be assigned to each action. Each participating jurisdiction prioritized the projects they submitted by indicating high, moderate, or low local priority. The completed spreadsheets with action details were returned to SEMO RPC. Chapter 4 provides additional details regarding the process undertaken to refine the mitigation strategy to make the County and its jurisdictions more disaster resistant.

Step 8: Draft an Action Plan

A complete draft of the plan was made available online and in hard copy for review and comment by the public, other agencies and interested stakeholders. This review period was from January 17-January 31, 2020. Methods for inviting interested parties and the public to review and comment on the plan were discussed in Steps 2 and 3, and materials are provided in the appendix. Comments were integrated into a final draft for submittal to SEMA and FEMA.

Step 9: Adopt the Plan (Handbook Task 8)

To secure buy-in and officially implement the plan, the governing bodies of each participating jurisdiction adopted the plan. Scanned copies of resolutions of adoption are included in the appendix of this plan.

Step 10: Implement, Evaluate, and Revise the Plan (Handbook Tasks 7 & 9)

The HMPC developed and agreed upon an overall strategy for plan implementation and for monitoring and maintaining the plan over time during Meeting #1. This strategy is described in Chapter 5, Plan Maintenance Process.

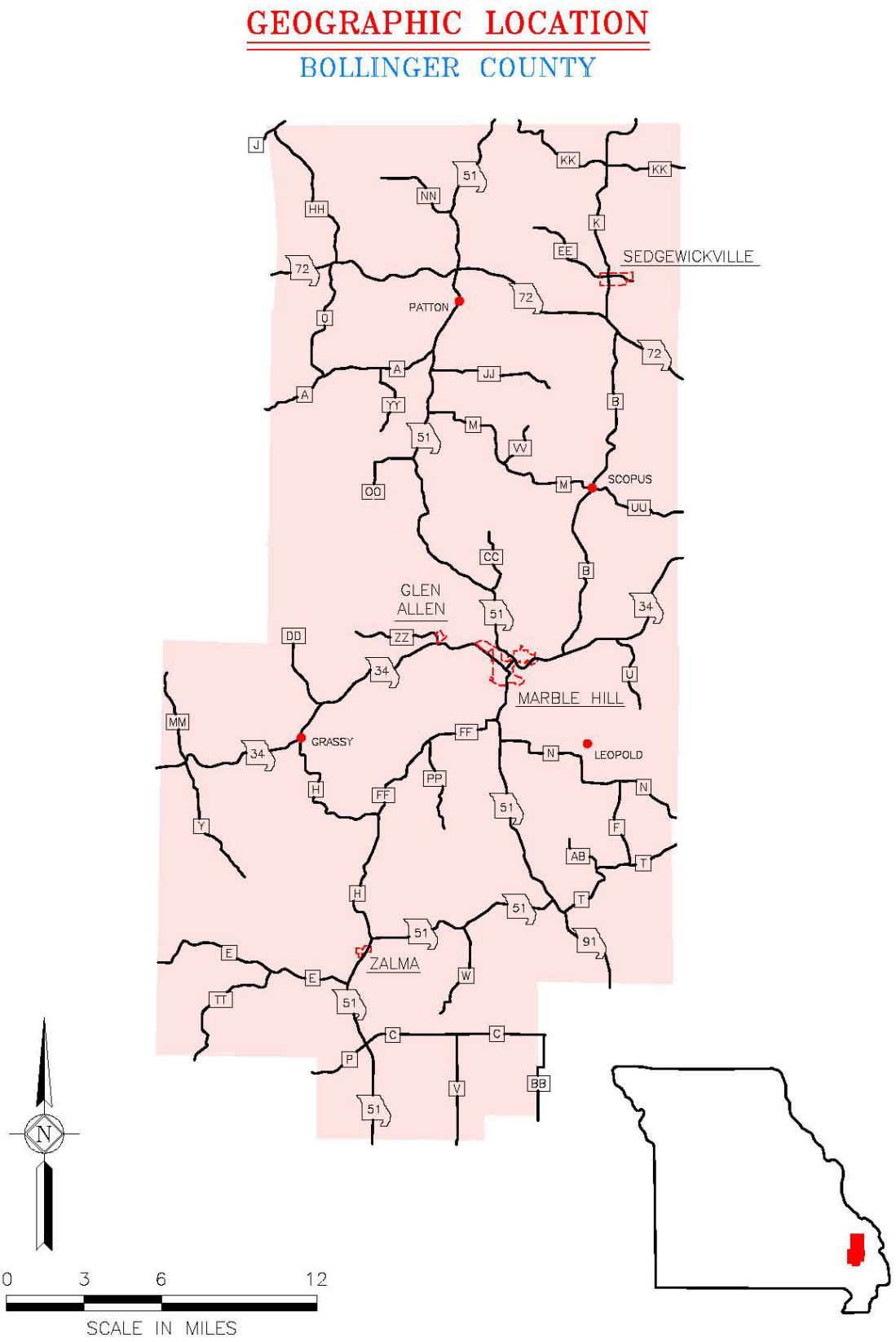
2 PLANNING AREA PROFILE AND CAPABILITIES

This chapter provides a general profile of Bollinger County followed by individual sections for each participating jurisdiction. The section for each jurisdiction provides an overview profile as well as details on existing capabilities, plans, and programs that enhance their ability to implement mitigation strategies.

2.1 Bollinger County Planning Area Profile

Figure 2.1 provides a map of the Ste. Genevieve County planning area. As of 2017, the total Bollinger County population was 12,347, a decline of -0.3% since 2012. The population growth rate of -0.3% was below both the nation's (4%) and the State's (2%). Bollinger County median household income was $40,791 in 2017, an increase of 10% over 2012, which is 1% greater than the national and state rates of 9%. The county's 2017 MHI is below that of both the nation and state, $57,652 and $51,542 respectively. Bollinger County median home value in 2017 was $109,800, down -5% from 2012 census estimates. County median home value is well below the state's median value and below the nation's median value ($155,100 and $214,500), while the rate of growth (negative for the county) was also well below both the state's rate of 4% and the nation's of 8%.

Figure 2.1. **Map of Bollinger County**



2.1.2 Geography, Geology and Topography

Bollinger County lies in the southeast part of the state. The Castor River Hills are the dominant topographic feature in the County. Terrain varies from moderate to steep slopes to relatively large areas of gentle to moderate slopes. The land is either timbered or used for agricultural or urban purposes.

The County can be broadly divided into two physiographic subregions. The Castor River Hills is the physiographic subregion covering the majority of Bollinger County. This subregion drains in a general southward direction through the Castor and Whitewater Rivers and their tributaries. Elevations of over 1,000' occur in the northern part of the area, sloping gently to elevations of 500' to 600' on the inter-stream divides along the southern margins of the area. The Advance Lowlands is the other subregion in the County. These lowlands occupy a portion of the Southeastern Missouri Lowlands between the uplands of Bollinger and Cape Girardeau Counties on the north and the Bloomfield Hills and Benton Hills on the south. This unit includes the southeastern portion of Bollinger County. The Advance Lowlands were formed by channels of the Mississippi River that flowed through this area before it was diverted through Thebes Gap at the east end of the Benton Hills. Relief in this area is low, generally 5' to 10' or less. Slopes are gentle to nearly level, and many swampy areas occur throughout the unit.

Bollinger County soils can be classified into seven broad general types. The Union-Goss-Gasconade-Crider Association is the first of these and covers the largest area of the County. It is found in the north, north-central and southern part of the County. The soils in this association have formed in cherty limestone residual material. Union soils have a silt-loam topsoil grading downward into a moderately permeable subsoil overlying a massive fragipan. Goss soils have a cherty, silt-loam topsoil overlying a moderately permeable, very cherty, silty-clay subsoil. These soils are found on steep upland slopes of from 2% to 45%. Gasconade soils are found on slopes ranging from 2% to 50%. They have a flaggy (blocky limestone fragments), clay-loam topsoil overlying a flaggy, clay subsoil. Crider soils occur on slopes ranging from nearly flat to 20%. Crider soils have a silt loam topsoil overlying a moderately permeable, silty-clay-loam subsoil.

The second soil association present in Bollinger County is the Hartville-Ashton-Cedargap-Nolin Association. This association occurs in the bottom lands along the Whitewater, Little Whitewater, and Castor River Diversion Channel. The bottoms include nearly level to moderately sloping terraces. These are primarily used for pasture, hay growing, and cultivated crops. These soils have formed in loamy alluvial deposits. The Hartville soils are deep, somewhat poorly drained, and found on nearly level to gently sloping terraces or second bottoms. The soils have a silt-loam topsoil overlying a moderately permeable, silt-loam subsoil. Ashton soils occur on slopes ranging up to 6% and have a high available water capacity. They have a silt-loam topsoil overlying a moderately permeable, silt-loam subsoil. The Cedargap soils are deep soils found on floodplains and are well drained to somewhat excessively drained. The soil has a cherty silt-loam topsoil overlying a cherty silt-loam subsoil. Nolin soils are deep, well drained soils occurring on low, nearly level (0% to 4% slopes) floodplains. They have a silt-loam topsoil overlying a moderately permeable, silt-loam subsoil.

A third association, Jonca-Lamotte-Lily-Ramsey, is found on broad, gently to moderately sloping pastures and broad, moderate to very seep divides in forested areas. Jonca soils have a silt-loam topsoil and a slowly permeable, silty-clay-loam subsoil. The subsoil overlies a compact, massive, brittle, loam fragipan. The Lamotte soils occur in uplands with slopes of 5% to 14%. These soils have a silt-loam topsoil overlying a silty-clay-loam subsoil. Lily soils are found on upland side slopes and ridges with 2% to 50% slopes. The soil has a loam topsoil overlying a clay-loam subsoil. Ramsey soils have a loam topsoil overlying a rapidly permeable loam subsoil. They are found on hills with slopes of 10% to 70%.

A fourth soil association present in Bollinger County is the Calhoun-Convent-Falaya Association. This

association is found in the bottom lands in the southeastern part of Bollinger County. These are broad, nearly level cultivated fields with a few pastures. It also includes some small areas of forest in low places that flood frequently. Calhoun soils are deep, poorly drained, and occur on slopes of less than 1%. These soils have a silt-loam topsoil overlying a slowly permeable, silty-clay-loam subsoil. The Convent soils are deep, somewhat poorly drained, occurring on slopes of up to 3%. They consist of a silt-loam topsoil overlying a moderately permeable subsoil of very fine sandy-loam and silt-loam layers. Soils of the Falaya association are deep and somewhat poorly drained. They occur on slopes of 2% or less and are subject to flooding if not protected by levees. Topsoil is silt-loam overlying a silt-loam subsoil.

The Menfro-Winfield Association is a fifth soil type in the County that occurs in two isolated areas. These soils are developed in loess and, therefore, are subject to severe erosion and gullying if not managed correctly. The soils are usually found in cultivated fields on gently to strongly sloping uplands and pastures on steeper side slopes. Menfro soils are deep and well drained, occurring on ridgetops and side slopes, where slopes range from 2% to 30%. These soils have a silt-loam topsoil overlying a moderately permeable, silty-clay-loam subsoil. Winfield soils are also found on ridgetops and side slopes, with slopes generally varying from 2% to 20%. They are deep but only moderately well drained. Winfield soils have a silt-loam topsoil overlying a moderately permeable, silty-clay-loam subsoil.

The sixth soil type found in Bollinger County is the Needleye-Captina-Clarksville-Doniphan Association. It occurs in a relatively small area in the southwestern part of the County. Terrain in this area includes small, irregularly shaped cultivated fields on moderately sloping ridgetops and broad forested areas on strongly sloping to very steep side slopes. The soils in this group have formed in weathered residual material developed from cherty limestone. Needleye soils are moderately well drained and have a fragipan layer. They have a silt-loam topsoil over a silty-clay-loam subsoil that has moderately slow permeability. It is underlaid by a massive, compact, brittle fragipan. Captina soils are also moderately well drained and have a fragipan, but they are found on stream terraces that have slopes of 1% to 12%. They are made up of a silt-loam topsoil and a slowly permeable, silty-clay-loam subsoil overlying a massive, compact, brittle fragipan. Clarksville soils are deep, somewhat excessively drained soils occurring on upper side slopes and ridges with slopes ranging from 2% to 60%. They are very cherty, silt-loam topsoil overlying a very cherty, silty-clay-loam subsoil that has moderately rapid permeability. Doniphan soils are deep, well drained soils found on side slopes and ridges. They are composed of a cherty, silt-loam topsoil overlying a moderately permeable clay subsoil.

The seventh soil association is the Calhoun-Amagon Association. It is found only in a small area in the bottoms of extreme southern Bollinger County. Calhoun soils are found on the higher elevations and are deep, poorly drained soils. They have a silt-loam topsoil overlying a slowly permeable, silty-clay-loam subsoil. Amagon soils are deep, poorly drained, and occur on slopes of up to 3%. They have a silt-loam topsoil overlying a slowly permeable, silty-clay-loam subsoil.

The predominate bedrock type in Bollinger County is dolomite, limestone, sandstone, and shale. An area of dolomite and sandstone forms an arc from the southwest corner of the County to the northwest corner. A third bedrock type occurring in the southeast to south-central part of the county is alluvium consisting of gravel, sand, silt and clay.

2.1.3 Climate

Because the County is located in the middle section of the United States, it is prone to several kinds of natural hazards. The county has a continental climate, meaning that the weather is changeable and has large variations in temperature and precipitation.

The county's climate parallels that of southeast Missouri. In general, the county has hot humid summers and mild to cold winters. Average temperatures fall in the 56° to 58° range. The warmest month is normally July, when average maximum temperatures are around 90° to 92°, and minimum temperatures range in the neighborhood of 62° to 68°. The coldest month is usually January, when maximum temperatures reach an average of only 45° to 46°, and minimum average temperatures run 25° to 28°. Below freezing temperatures usually occur on 80 to 100 days during the year.

Rainfall averages approximately 39 to 42 inches per year, while snowfall averages approximately 11 to 13 inches per year. Springtime and early summer are normally the seasons when much of the rainfall occurs during frequent thunderstorms. This is also the time when flooding normally occurs along the creeks and rivers in the county. On average, 60% of the annual rainfall occurs during the months from April through September.

2.1.4 Population/Demographics

Table 2.1 provides the populations for each city and the unincorporated county for 2012 and 2017 with the number and percent change. The unincorporated area's population was determined by subtracting the populations of the incorporated areas from the overall county population.

Table 2.1. County Population 2012-2017

Population				
	2012	2017	Change	% Change
Bollinger County	12,389	12,347	-42	-0.3%
Glen Allen	109	175	66	61%
Marble Hill	1,775	1,697	-78	-4%
Sedgewickville	217	183	-34	-16%
Unincorporated County	10,288	10,292	4	0%
Missouri	5,982,413	6,075,300	92,887	2%
United States	309,138,711	321,004,407	11,865,696	4%

Source: American FactFinder

According to the 2017 ACS, 7% of the county population is under the age of 5 and 17% is 65 and older. In 2017 there were 4,805 households with an average household size of 2.53 people.

The University of South Carolina developed an index to evaluate and rank the ability to respond to, cope with, recover from, and adapt to disasters. The index synthesizes 30 socioeconomic variables which research literature suggests contribute to reduction in a community's ability to prepare for, respond to, and recover from hazards. SoVI ® data sources include primarily those from the United States Census Bureau.

Figure 2.2 shows the county has a Medium Social Vulnerability Index when compared to counties nation-wide and a Medium-Low SoVI when compared to counties state-wide.

Figure 2.2. Ste. Genevieve County Social Vulnerability Index (SoVI)

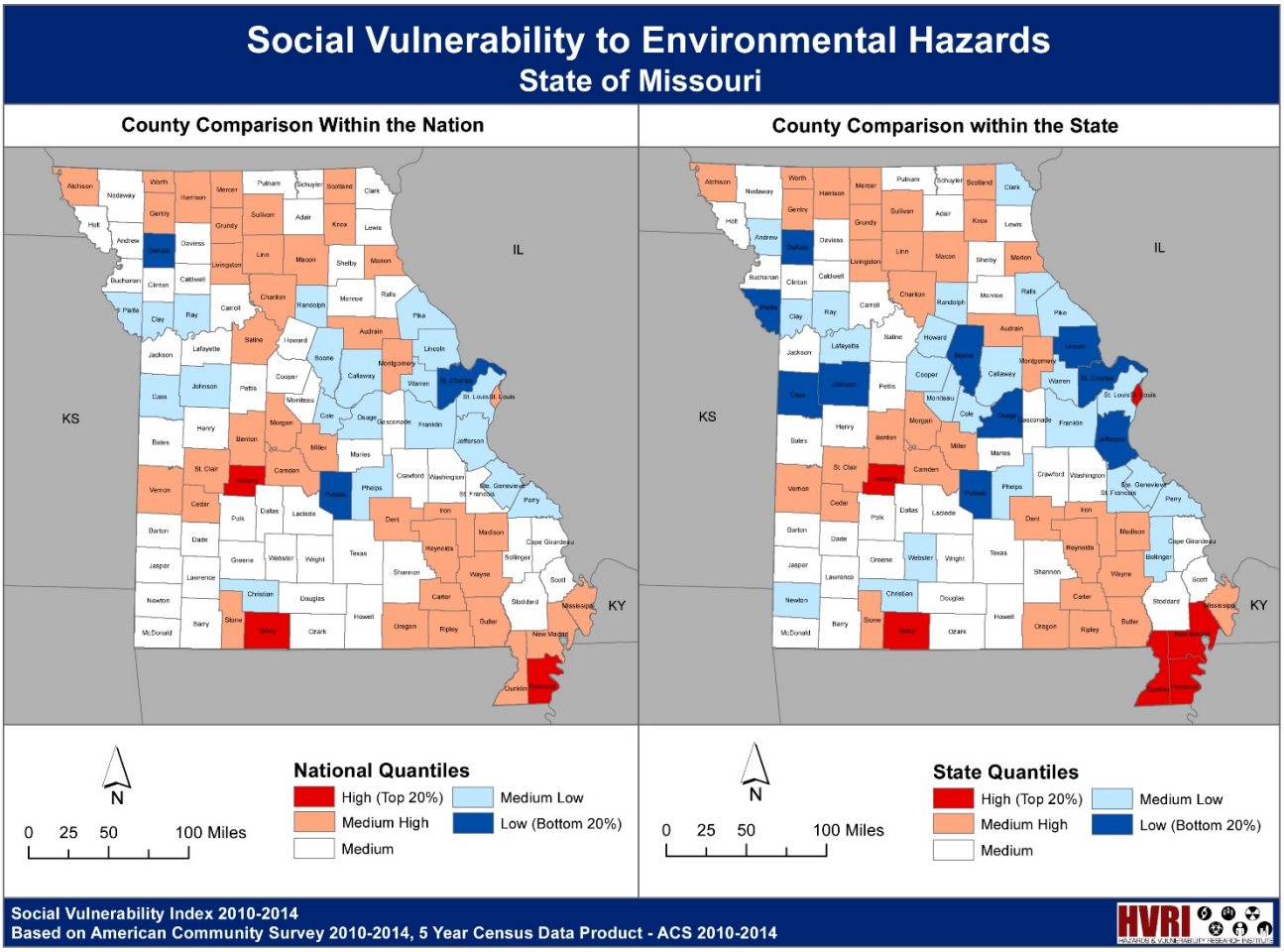


Table 2.2 provides additional demographic and economic indicators for participating jurisdictions. The county values are for all of the county, including the incorporated cities.

Table 2.2. 2017 Selected Demographics

Jurisdiction	% Labor Force Participation	% Population Unemployed	% Population Below Poverty Level	% Population High School graduate	% of Population with Bachelor's Degree or higher	% Households Limited English Proficiency
Bollinger County	52.7%	5.1%	20%	80%	9%	0%

Source: U.S. Census, 2017 American Community Survey, 5-year Estimates.

2.1.5 History

Bollinger County is situated in the southeastern part of Missouri. The County was formed from parts of Cape Girardeau, Madison, Stoddard and Wayne Counties in 1851. The County is named for George Frederick Bollinger who came to the area in 1797 from North Carolina. In 1800, he returned to North Carolina and brought back 20 families to settle in the area. He was a member of the first territorial assembly which met in St. Louis in 1812. Bollinger became a senator when Missouri became a state in 1821. He was one of the original senators to meet in the first state capitol in St. Charles.

Bollinger County's first courthouse was built in 1852 in Marble Hill. This structure burned in 1866 and was replaced by a new courthouse that burned in 1884. The present courthouse was completed in 1885 and has served the County since that time.

2.1.6 Occupations

Table 2.3 provides occupation statistics for the participating cities and the county as a whole.

Table 2.3. Occupation Statistics

Jurisdiction	Management, business, science, and arts	Service	Sales and office	Natural resources, construction, and maintenance	Production, transportation, and material moving
Ste. Genevieve County	24%	17%	19%	17%	22%

Source: U.S. Census, 2017 American Community Survey, 5-year Estimates.

2.1.7 Agriculture

According to the USDA's 2017 Census of Agriculture, the county had 756 farms comprised of 180,264 acres, with an average size of 238 acres. 489 of the farms in the county fall into the range of 50-499 acres. The average market value of land and buildings per farm was $597,725. Crops account for approximately $18.2 million of agriculture sales in the county, while livestock and poultry account for $13.8 million in sales.

2.1.8 FEMA Hazard Mitigation Assistance (HMA) Grants In Planning Area

Since 1993, there have been three HMA grants in the county totaling $2,213,373 in total project costs.

Table 2.4. FEMA HMA Grants In County, 1993-2019

Disaster Declaration	Project Type	Sub-Grantee	Date Approved	Project Total
4317	Safe Room	Bollinger County	2019-03-05	$1,407,000
1403	Acquisition of Private Real Property	Marble Hill	2005-01-20	$678,640
1736	Acquisition of Private Real Property	Marble Hill	2013-07-22	$127,733
Total				2,213,373$

Source: FEMA, 2020

2.1.9 FEMA Public Assistance (PA) Grants In Planning Area

Since 1993, there have been 133 PA grants in Ste. Genevieve County totaling $5,258,439.29 in total project costs.

Table 2.5. FEMA PA Grants In County, 1993-2019

Disaster No.	Applicant	Project Type	Project Size	Project Amount
1412	Woodland R-V	Public Buildings	Large	$32,681
1412	Woodland R-V	Public Buildings	Large	-$393,429
1412	Woodland R-V	Public Buildings	Large	$522,519
1412	Marble Hill	Public Buildings	Small	$3,989
1412	Marble Hill	Public Buildings	Small	$3,989
1412	Marble Hill	Public Utilities	Small	$8,798
1412	Marble Hill	Recreational or Other	Small	$4,024
1412	Marble Hill	Debris Removal	Small	$11,013
1412	Marble Hill	Protective Measures	Small	$1,750
1412	Marble Hill	Roads and Bridges	Small	$3,089
1412	Marble Hill	Protective Measures	Small	$4,254
1412	Marble Hill	Public Buildings	Small	-$3,989
1412	Bollinger County	Protective Measures	Small	$5,271
1412	Bollinger County	Debris Removal	Small	$10,074
1412	Bollinger County	Roads and Bridges	Large	$126,937
1412	Bollinger County	Roads and Bridges	Large	$444,071
1412	Bollinger County	Debris Removal	Small	$5,512
1412	Bollinger County Library	Public Buildings	Small	$9,426
1463	Bollinger County	Roads and Bridges	Large	$69,100
1463	Bollinger County	Roads and Bridges	Small	$46,462
1463	Bollinger County	Roads and Bridges	Large	$76,622
1463	Bollinger County	Debris Removal	Small	$1,705

1631	Bollinger County	Roads and Bridges	Small	$20,576
1631	Bollinger County	Roads and Bridges	Small	$1,761
1631	Bollinger County	Roads and Bridges	Large	$40,214
1631	Bollinger County	Roads and Bridges	Large	$182,270
1748	Bollinger County Public Health Center	Public Buildings	Small	$250
1748	Marble Hill	Protective Measures	Small	$9,094
1748	Marble Hill	Debris Removal	Small	$8,717
1748	Marble Hill	Debris Removal	Small	$33,490
1748	Bollinger County	Debris Removal	Small	$49,926
1748	Bollinger County	Debris Removal	Large	$92,715
1748	Bollinger County	Protective Measures	Small	$3,338
1748	Bollinger County Library	Public Buildings	Small	$1,000
1749	Bollinger County Public Health Center	Public Buildings	Small	$2,507
1749	Marble Hill	Roads and Bridges	Small	$1,199
1749	Marble Hill	Debris Removal	Small	$2,009
1749	Marble Hill	Roads and Bridges	Small	$1,667
1749	Marble Hill	Recreational or Other	Small	$1,560
1749	Marble Hill	Recreational or Other	Small	$1,500
1749	Marble Hill	Recreational or Other	Small	$22,385
1749	Marble Hill	Recreational or Other	Small	$2,850
1749	Marble Hill	Public Utilities	Small	$3,364
1749	Marble Hill	Roads and Bridges	Small	$5,350
1749	Marble Hill	Public Utilities	Small	$18,342
1749	Bollinger County	Debris Removal	Small	$3,124
1749	Bollinger County	Roads and Bridges	Small	$7,931
1749	Bollinger County	Roads and Bridges	Small	$7,762
1749	Bollinger County	Roads and Bridges	Small	$9,741
1749	Bollinger County	Roads and Bridges	Small	$7,426
1749	Bollinger County	Roads and Bridges	Small	$13,258
1749	Bollinger County	Roads and Bridges	Small	$3,739
1749	Bollinger County	Roads and Bridges	Small	$4,921
1749	Bollinger County	Roads and Bridges	Small	$29,946
1749	Bollinger County	Roads and Bridges	Small	$5,413
1749	Bollinger County	Roads and Bridges	Small	$11,261
1749	Bollinger County	Roads and Bridges	Small	$4,163
1749	Bollinger County	Roads and Bridges	Small	$9,908
1749	Bollinger County	Roads and Bridges	Small	$10,799
1749	Bollinger County	Roads and Bridges	Small	$7,621
1749	Bollinger County	Roads and Bridges	Small	$9,816
1749	Bollinger County	Roads and Bridges	Small	$10,563
1749	Bollinger County	Roads and Bridges	Small	$7,093
1749	Bollinger County	Roads and Bridges	Small	$5,196
1749	Bollinger County	Roads and Bridges	Small	$8,863

1749	Bollinger County	Roads and Bridges	Small	$51,707
1749	Bollinger County	Roads and Bridges	Small	$13,975
1749	Bollinger County	Roads and Bridges	Small	$19,637
1749	Bollinger County	Roads and Bridges	Small	$12,181
1749	Bollinger County	Roads and Bridges	Small	$9,581
1749	Bollinger County	Roads and Bridges	Small	$43,261
1749	Bollinger County	Roads and Bridges	Small	$11,464
1749	Bollinger County	Roads and Bridges	Small	$11,032
1749	Bollinger County	Roads and Bridges	Small	$14,875
1749	Bollinger County	Roads and Bridges	Small	$14,082
1749	Bollinger County	Roads and Bridges	Small	$16,733
1749	Bollinger County	Roads and Bridges	Small	$26,341
1749	Bollinger County	Roads and Bridges	Small	$24,625
1749	Bollinger County	Roads and Bridges	Small	$7,975
1749	Bollinger County	Roads and Bridges	Small	$11,735
1749	Bollinger County	Roads and Bridges	Small	$11,145
1749	Bollinger County	Debris Removal	Small	$8,595
1749	Bollinger County	Roads and Bridges	Small	$8,468
1749	Bollinger County	Roads and Bridges	Small	$58,404
1749	Bollinger County	Roads and Bridges	Small	$4,379
1749	Bollinger County	Roads and Bridges	Small	$9,444
1749	Bollinger County	Roads and Bridges	Small	$9,471
1749	Bollinger County	Roads and Bridges	Small	$12,585
1749	Bollinger County	Roads and Bridges	Small	$4,032
1749	Bollinger County Library	Public Buildings	Small	$1,494
1847	Bollinger County	Debris Removal	Small	$30,336
1847	Bollinger County	Debris Removal	Small	$48,937
1847	Bollinger County	Protective Measures	Small	$2,677
1847	Bollinger County	Protective Measures	Small	$24,456
1847	Bollinger County	Roads and Bridges	Small	$8,557
1847	Bollinger County	Debris Removal	Large	$146,773
1847	Bollinger County	Debris Removal	Large	$42,584
1847	Bollinger County	Roads and Bridges	Large	-$20,737
1847	Bollinger County	Roads and Bridges	Large	-$92,740
1847	Bollinger County	Roads and Bridges	Large	$172,642
1847	Bollinger County	Roads and Bridges	Large	$72,110
1847	Bollinger County	Roads and Bridges	Large	$81,275
1847	Bollinger County	Roads and Bridges	Large	-$34,943
1847	Bollinger County	Roads and Bridges	Large	$99,463
1847	Bollinger County	Roads and Bridges	Large	-$35,911
1980	Bollinger County	Roads and Bridges	Small	$29,054
1980	Bollinger County	Roads and Bridges	Small	$33,812
1980	Bollinger County	Roads and Bridges	Small	$24,239

1980	Bollinger County	Roads and Bridges	Small	$31,863
1980	Bollinger County	Roads and Bridges	Small	$29,776
1980	Bollinger County	Roads and Bridges	Small	$31,219
1980	Bollinger County	Roads and Bridges	Small	$12,530
1980	Bollinger County	Roads and Bridges	Small	$22,060
1980	Bollinger County	Roads and Bridges	Small	$20,630
1980	Bollinger County	Roads and Bridges	Small	$49,194
1980	Bollinger County	Roads and Bridges	Small	$29,892
1980	Bollinger County	Roads and Bridges	Small	$25,139
1980	Bollinger County	Roads and Bridges	Small	$33,801
1980	Bollinger County	Roads and Bridges	Small	$21,353
1980	Bollinger County	Roads and Bridges	Small	$28,002
1980	Bollinger County	Roads and Bridges	Small	$27,906
1980	Bollinger County	Roads and Bridges	Small	$27,405
4250	Bollinger County	Debris Removal	Small	$15,199
4250	Bollinger County	Roads and Bridges	Small	$9,919
4250	Bollinger County	Roads and Bridges	Small	-$2,350
4250	Bollinger County	Roads and Bridges	Small	$20,687
4250	Bollinger County	Roads and Bridges	Small	$18,536
4250	Bollinger County	Roads and Bridges	Small	$11,038
4250	Bollinger County	Roads and Bridges	Small	$53,073
4250	Bollinger County	Roads and Bridges	Small	$49,303
4317	Bollinger County	Roads and Bridges	Small	$116,122
4317	Bollinger County	Roads and Bridges	Small	$64,437
4317	Bollinger County	Roads and Bridges	Large	$142,239

2.2 Jurisdictional Profiles and Mitigation Capabilities

This section includes individual profiles for each participating jurisdiction as well as a discussion of previous mitigation initiatives and a summary table indicating specific capabilities of each jurisdiction that relate to their ability to implement mitigation opportunities. The unincorporated county is profiled first, followed by the school districts.

2.2.1 Unincorporated Bollinger County

The jurisdiction of Bollinger County includes all unincorporated areas within the county boundaries. The county government is a County Commission comprised of a Presiding Commissioner voted on by the entire county, and two Associate Commissioners voted on by their respective districts. The County government includes the following departments and offices:

- County Commissioners
- County Assessor
- County Attorney
- County Auditor
- County Recorder
- County Sheriff
- County Treasurer
- Emergency Management
- Health Department

Mitigation Initiatives/Capabilities

Table 2.6. County Mitigation Capabilities

Element	Yes, No, N/A	Comments and/or Weblink
Planning Capabilities		
Comprehensive Plan	Date: **No**	
Builder's Plan	Date: **N/A**	
Capital Improvement Plan	Date: **No**	
City Emergency Operations Plan	Date: **N/A**	
County Emergency Operations Plan	Date: **Yes, 2018**	
Local Recovery Plan	Date: **N/A**	
County Recovery Plan	Date**: No**	
City Mitigation Plan	Date: **N/A**	
County Mitigation Plan	Date: **Yes, 2014**	
Debris Management Plan	Date: **Yes, 2017**	

Element	Yes, No, N/A	Comments and/or Weblink
Economic Development Plan	Date: **No**	
Transportation Plan	Date**: No**	
Land-use Plan	Date: **No**	
Flood Mitigation Assistance (FMA) Plan	Date: **Yes, 2018**	
Watershed Plan	Date: **No**	
Firewise or other fire mitigation plan	Date**: No**	
Critical Facilities Plan (Mitigation/Response/Recovery)	Date: **No**	
Policies/Ordinance		
Zoning Ordinance	**No**	
Building Code	Version: **N/A**	
Floodplain Ordinance	Date: **Yes, 2018**	
Subdivision Ordinance	**N/A**	
Tree Trimming Ordinance	**No**	
Nuisance Ordinance	**No**	
Stormwater Ordinance	**No**	
Drainage Ordinance	**No**	
Site Plan Review Requirements	**No**	
Historic Preservation Ordinance	**No**	
Landscape Ordinance	**No**	
Seismic Construction Ordinance	**No**	
Program		
Zoning/Land Use Restrictions	**No**	**Flood portion only**
Codes Building Site/Design	**No**	**Flood portion only**
Hazard Awareness Program	**No**	
National Flood Insurance Program (NFIP)	**Yes**	
NFIP Community Rating System (CRS) program	**No**	**If so, what is your current level rating?**
National Weather Service (NWS) Storm Ready Certification	**No**	
Firewise Community Certification	**No**	
Building Code Effectiveness Grading (BCEGs)	**No**	

Element	Yes, No, N/A	Comments and/or Weblink
ISO Fire Rating	**Rating: Yes**	**Varies by Fire District**
Economic Development Program	**Yes**	
Land Use Program	**No**	
Public Education/Awareness	**No**	
Property Acquisition	**No**	**Except thru FEMA Hazzard Mitigations programs**
Planning/Zoning Boards	**No**	
Stream Maintenance Program	**N/A**	
Tree Trimming Program	**No**	
Engineering Studies for Streams (Local/County/Regional)	**No**	
Mutual Aid Agreements	**Yes**	**Regional Homeland Security (RHSOC)**
Studies/Reports/Maps		
Hazard Analysis/Risk Assessment (City)	**N/A**	
Hazard Analysis/Risk Assessment (County)	**Yes**	
Evacuation Route Map	**Yes**	
Critical Facilities Inventory	**No**	**Under development**
Vulnerable Population Inventory	**No**	**Under development**
Land Use Map	**Yes**	**Flood plain only**
Staff/Department		**Full Time or Part Time?**
Building Code Official	**No**	
Building Inspector	**No**	
Mapping Specialist (GIS)	**Yes**	**County Assessors office**
Engineer	**No**	
Development Planner	**No**	
Public Works Official	**No**	
Emergency Management Coordinator	**Yes**	**Part time**
NFIP Floodplain Administrator	**Yes**	**County Assessors office**
Emergency Response Team	**Yes**	**Fire Districts**
Hazardous Materials Expert	**Yes**	**Fire Districts**
Local Emergency Planning Committee	**No**	

Element	Yes, No, N/A	Comments and/or Weblink
County Emergency Management Commission	**No**	
Sanitation Department	**No**	
Transportation Department	**No**	
Economic Development Department	**No**	
Housing Department	**No**	
Historic Preservation	**No**	
Non-Governmental Organizations (NGOs)	**Is there a local chapter? Yes or No**	
American Red Cross	**No**	**Utilize Cape Girardeau office**
Salvation Army	**NO**	**Utilize Cape Girardeau**
Veterans Groups	**Yes**	
Local Environmental Organization	**No**	
Homeowner Associations	**No**	
Neighborhood Associations	**Yes**	**Neighborhood Watch**
Chamber of Commerce	**Yes**	
Community Organizations (Lions, Kiwanis, etc.	**Yes**	

Financial Resources	Is your jurisdiction able to? Yes or No
Apply for Community Development Block Grants	**Yes**
Fund projects thru Capital Improvements funding	**No**
Authority to levy taxes for specific purposes	**No**
Fees for water, sewer, gas, or electric services	**City Only**
Impact fees for new development	**No**
Incur debt through general obligation bonds	**Yes**
Incur debt through special tax bonds	**No**
Incur debt through private activities	**Yes**
Withhold spending in hazard prone areas	**No**

2.2.2 Summary of County/Municipality Capabilities

Table 2.7. Summary of Capabilties

Element	Yes, No, N/A	Comments and/or Weblink
Planning Capabilities		
Comprehensive Plan	Date: **No**	
Builder's Plan	Date: **N/A**	
Capital Improvement Plan	Date: **No**	
City Emergency Operations Plan	Date: **N/A**	
County Emergency Operations Plan	Date: **Yes, 2018**	
Local Recovery Plan	Date: **N/A**	
County Recovery Plan	Date**: No**	
City Mitigation Plan	Date: **N/A**	
County Mitigation Plan	Date: **Yes, 2014**	
Debris Management Plan	Date: **Yes, 2017**	
Economic Development Plan	Date: **No**	
Transportation Plan	Date**: No**	
Land-use Plan	Date: **No**	
Flood Mitigation Assistance (FMA) Plan	Date: **Yes, 2018**	
Watershed Plan	Date: **No**	
Firewise or other fire mitigation plan	Date**: No**	
Critical Facilities Plan (Mitigation/Response/Recovery)	Date: **No**	
Policies/Ordinance		
Zoning Ordinance	**No**	
Building Code	Version: **N/A**	
Floodplain Ordinance	Date: **Yes, 2018**	
Subdivision Ordinance	**N/A**	
Tree Trimming Ordinance	**No**	
Nuisance Ordinance	**No**	
Stormwater Ordinance	**No**	
Drainage Ordinance	**No**	

Element	Yes, No, N/A	Comments and/or Weblink
Site Plan Review Requirements	**No**	
Historic Preservation Ordinance	**No**	
Landscape Ordinance	**No**	
Seismic Construction Ordinance	**No**	
Program		
Zoning/Land Use Restrictions	**No**	**Flood portion only**
Codes Building Site/Design	**No**	**Flood portion only**
Hazard Awareness Program	**No**	
National Flood Insurance Program (NFIP)	**Yes**	
NFIP Community Rating System (CRS) program	**No**	**If so, what is your current level rating?**
National Weather Service (NWS) Storm Ready Certification	**No**	
Firewise Community Certification	**No**	
Building Code Effectiveness Grading (BCEGs)	**No**	
ISO Fire Rating	**Rating: Yes**	**Varies by Fire District**
Economic Development Program	**Yes**	
Land Use Program	**No**	
Public Education/Awareness	**No**	
Property Acquisition	**No**	**Except thru FEMA Hazzard Mitigations programs**
Planning/Zoning Boards	**No**	
Stream Maintenance Program	**N/A**	
Tree Trimming Program	**No**	
Engineering Studies for Streams (Local/County/Regional)	**No**	
Mutual Aid Agreements	**Yes**	**Regional Homeland Security (RHSOC)**
Studies/Reports/Maps		
Hazard Analysis/Risk Assessment (City)	**N/A**	
Hazard Analysis/Risk Assessment (County)	**Yes**	
Evacuation Route Map	**Yes**	
Critical Facilities Inventory	**No**	**Under development**
Vulnerable Population Inventory	**No**	**Under development**

Element	Yes, No, N/A	Comments and/or Weblink
Land Use Map	**Yes**	**Flood plain only**
Staff/Department		**Full Time or Part Time?**
Building Code Official	**No**	
Building Inspector	**No**	
Mapping Specialist (GIS)	**Yes**	**County Assessors office**
Engineer	**No**	
Development Planner	**No**	
Public Works Official	**No**	
Emergency Management Coordinator	**Yes**	**Part time**
NFIP Floodplain Administrator	**Yes**	**County Assessors office**
Emergency Response Team	**Yes**	**Fire Districts**
Hazardous Materials Expert	**Yes**	**Fire Districts**
Local Emergency Planning Committee	**No**	
County Emergency Management Commission	**No**	
Sanitation Department	**No**	
Transportation Department	**No**	
Economic Development Department	**No**	
Housing Department	**No**	
Historic Preservation	**No**	
Non-Governmental Organizations (NGOs)	**Is there a local chapter? Yes or No**	
American Red Cross	**No**	**Utilize Cape Girardeau office**
Salvation Army	**NO**	**Utilize Cape Girardeau**
Veterans Groups	**Yes**	
Local Environmental Organization	**No**	
Homeowner Associations	**No**	
Neighborhood Associations	**Yes**	**Neighborhood Watch**
Chamber of Commerce	**Yes**	
Community Organizations (Lions, Kiwanis, etc.	**Yes**	
Financial Resources		**Is your jurisdiction able to? Yes or No**

Element	Yes, No, N/A	Comments and/or Weblink
Apply for Community Development Block Grants		**Yes**
Fund projects thru Capital Improvements funding		**No**
Authority to levy taxes for specific purposes		**No**
Fees for water, sewer, gas, or electric services		**City Only**
Impact fees for new development		**No**
Incur debt through general obligation bonds		**Yes**
Incur debt through special tax bonds		**No**
Incur debt through private activities		**Yes**
Withhold spending in hazard prone areas		**No**

2.2.3 Public School District Profiles and Mitigation Capabilities

This section includes general profile information for the participating school districts in the county. Multiple other school districts cover small portions of the county; however, none of these districts have any structures or assets located in the county and are not included in this mitigation plan. For information on those school districts, see their respective county HMPs.

Figure 2.3. School Districts

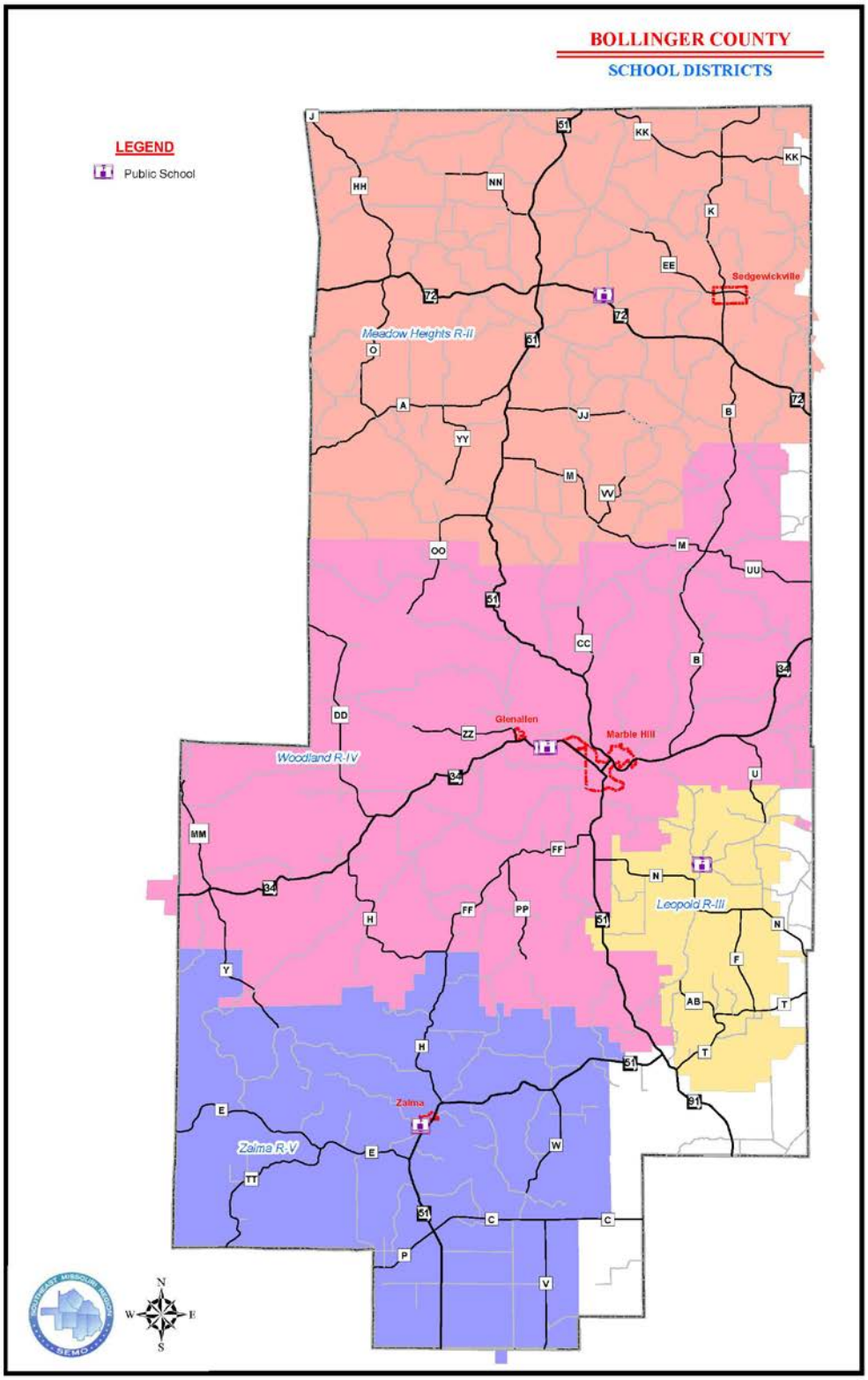


Table 2.8. School District Buildings and Enrollment Data, 2020

District Name	Building Name	Building Enrolment
Meadow Heights R-II	Meadow Heights Elem.	255
Meadow Heights R-II	Meadow Heights High	147
Meadow Heights R-II	Meadow Heights Middle	141
Meadow Heights R-II	**Total Enrollment**	**543**
Woodland R-IV	Woodland Elem.	349
Woodland R-IV	Woodland High	250
Woodland R-IV	Woodland Middle	258
Woodland R-IV	**Total Enrollment**	**857**

apps.dese.mo.gov/MCDS/Home.aspx

Table 2.9. Summary of Mitigation Capabilities-Meadow Heights R-II School District

Planning Elements	Yes/No	Date of Latest Version	Comments
Master Plan	Yes	2019	
Capital Improvement Plan	Yes	2019	
School Emergency Plan Shelter in place protocols Evacuation protocols	Yes	2015	
Weapons Policy	Yes	2019	

Administrative/Technical

Identify the technical and personnel resources responsible for activities related to hazard mitigation/loss prevention within your school district / institution.

Personnel Resources	Yes/No	Department/Position	Comments
Full-time building official (i.e. Principal)	Yes	Superintendent	
Emergency Manager	Yes	Superintendent	
Grant Writer	Yes	Superintendent	
Public Information Officer	Yes	Superintendent	

Financial Resources

Identify whether your school district /institution has access to or is eligible to use the following financial resources for hazard mitigation.

Financial Resources	Accessible/Eligible to Use (Y/N)	Comments
Capital improvements project funding	Yes	
Local funds	Yes	
General obligation bonds	Yes	
Special tax bonds	Yes	
Private activities/donations	Yes	
State and federal funds	Yes	

Table 2.1. Summary of Mitigation Capabilities-Woodland R-IV School District

Planning Elements	Yes/No	Date of Latest Version	Comments
Master Plan	Yes	2018	
Capital Improvement Plan	Yes	2016	
School Emergency Plan Shelter in place protocols Evacuation protocols	Yes	2019	
Weapons Policy	Yes	2010	

Administrative/Technical

Identify the technical and personnel resources responsible for activities related to hazard mitigation/loss prevention within your school district / institution.

Personnel Resources	Yes/No	Department/Position	Comments
Full-time building official (i.e. Principal)	Yes	Superintendent	
Emergency Manager	Yes	High School Principal	
Grant Writer	No		
Public Information Officer	No		

Financial Resources

Identify whether your school district /institution has access to or is eligible to use the following financial resources for hazard mitigation.

Financial Resources	Accessible/Eligible to Use (Y/N)	Comments
Capital improvements project funding	Yes	
Local funds	Yes	
General obligation bonds	Yes	
Special tax bonds	Yes	
Private activities/donations	Yes	
State and federal funds	Yes	

3 RISK ASSESSMENT

The goal of the risk assessment is to estimate the potential loss in the planning area, including loss of life, personal injury, property damage, and economic loss, from a hazard event. The risk assessment process allows communities and school/special districts in the planning area to better understand their potential risk to the identified hazards. It will provide a framework for developing and prioritizing mitigation actions to reduce risk from future hazard events.

There have been little changes in the county over the past 5 years. Between 2012 and 2017 (most recent data), the county population was stagnant, decreasing by 42 residents. The only community to experience any growth in population was Glen Allen, which added 66 residents between 2012 and 2019. As with the population, there has been only marginal commercial, office, and industrial development in the county and the communities. Combined, these changes mean that much of the exposure and risk in the planning area has remained relatively unchanged since the 2014 plan.

This chapter is divided into four main parts:

- **Section 3.1 Hazard Identification** identifies the hazards that threaten the planning area and provides a factual basis for elimination of hazards from further consideration;
- **Section 3.2 Assets at Risk** provides the planning area's total exposure to natural hazards, considering critical facilities and other community assets at risk;
- **Section 3.3 Future Land Use and Development** discusses areas of planned future development
- **Section 3.4 Hazard Profiles and Vulnerability Analysis** provides more detailed information about the hazards impacting the planning area. For each hazard, there are three sections: 1) Hazard Profile provides a general description and discusses the threat to the planning area, the geographic location at risk, potential severity/magnitude/extent, previous occurrences of hazard events, probability of future occurrence, risk summary by jurisdiction, impact of future development on the risk; 2) Vulnerability Assessment further defines and quantifies populations, buildings, critical facilities, and other community/school or special district assets at risk to natural hazards; and 3) Problem Statement briefly summarizes the problem and develops possible solutions.

3.1 Hazard Identification

The 11 hazards identified for this plan update are listed below:

- Dam Failure
- Drought
- Earthquake
- Extreme Heat
- Wildfires
- Flash & Riverine Flooding
- Sinkholes
- Levee Failure
- Severe Thunderstorms
- Tornadoes
- Severe Winter Weather

It should be noted that this mitigation plan, like most local HMP in the state, only includes natural hazards and does not address "man-made" hazards such as terrorism, structural fires, chemical spills, etc.

Sections 3.1.1 through 3.1.3 describe how these hazards were identified for this plan update.

3.1.1 Review of Existing Mitigation Plans

To determine which hazards to include in this plan update cycle, the HMPC considered all hazards from the previous HMP, hazards from surrounding counties' HMPs, and the State's current HMP. The HMPC decided to carry forward the hazards from the 2014 plan into this plan unchanged, as they felt there had been no significant changes in the county to warrant revision.

3.1.2 Review Disaster Declaration History

Federal disaster declarations may be granted when the severity and magnitude of an event surpasses the ability of the local government to respond and recover. Disaster assistance is supplemental and sequential. When the local government's capacity has been surpassed, a state disaster declaration may be issued, allowing for the provision of state assistance. If the disaster is so severe that both the local and state governments' capacities are exceeded; a federal emergency or disaster declaration may be issued allowing for the provision of federal assistance.

FEMA also issues emergency declarations, which are more limited in scope and do not include the long-term federal recovery programs of major disaster declarations. Determinations for declaration type are based on scale and type of damages and institutions or industrial sectors affected.

Table 3.1. FEMA Disaster Declarations In County, 2007-2019

Disaster Number	Description	Incident Period	Individual Assistance (IA) Public Assistance (PA)
DR-4451	Severe Storms, Tornadoes, and Flooding	4/29/2019 – 7/5/2019	PA
DR-4317	Severe Storms, Tornadoes, Straight-line Winds, and Flooding	4/28/2017 – 5/11/2017	IA, PA
DR-4250	Severe Storms, Tornadoes, Straight-line Winds, and Flooding	12/23/2015 – 1/9/2016	PA
DR-1980	Severe Storms, Tornadoes, and Flooding	4/10/2011 - 6/6/2011	IA, PA
DR-1847	Severe Storms, Tornadoes, and Flooding	5/8/2009 - 5/16/2009	PA
DR-1809	Severe Storms, Flooding, and a Tornado	9/11/2008 – 9/24/2008	PA
DR-1749	Severe Storms and Flooding	3/17/2008 - 5/9/2008	IA, PA
DR-1748	Severe Winter Storms and Flooding	2/10/2008 – 2/14/2008	PA
EM-3374	Severe Storms, Tornadoes, Straight-line Winds, and Flooding	12/22/2015 – 1/09/2016	
EM-3325	Flooding	6/1/2011 – 8/1/2011	
EM-3317	Severe Winter Storm	1/31/2011 – 2/05/2011	
EM-3303	Severe Winter Storm	1/26/2009 – 1/28/2009	
EM-3281	Severe Winter Storms	12/08/2007 – 12/15/2007	

Source: Federal Emergency Management Agencyhttp://www.fema.gov/disasters

3.1.3 Research Additional Sources

Additional data on locations and past impacts of hazards in the planning area was collected from the following sources:

- Missouri Hazard Mitigation Plans (2018)
- 2014 Bollinger County Hazard Mitigation Plan
- Federal Emergency Management Agency (FEMA)
- Missouri Department of Natural Resources (MDNR)
- National Drought Mitigation Center Drought Reporter
- US Department of Agriculture's (USDA) Risk Management Agency Crop Insurance Statistics
- National Agricultural Statistics Service (Agriculture production/losses)
- Data Collection Questionnaires completed by each jurisdiction
- State of Missouri GIS data
- Environmental Protection Agency (EPA)
- Flood Insurance Administration
- Missouri Department of Transportation (MoDOT)
- Missouri Division of Fire Marshal Safety
- National Fire Incident Reporting System (NFIRS)

- National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information (NCEI);
- County and local Comprehensive Plans when available
- County Emergency Management
- County Flood Insurance Rate Map, FEMA
- SILVIS Lab, Department of Forest Ecology and Management, University of Wisconsin
- U.S. Army Corps of Engineers
- U.S. Department of Transportation
- United States Geological Survey (USGS)

Note that the only centralized source of data for many of the weather-related hazards is the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information (NCEI). Although it is usually the best and most current source, there are limitations to the data which should be noted. The NCEI documents the occurrence of storms and other significant weather phenomena having sufficient intensity to cause loss of life, injuries, significant property damage, and/or disruption to commerce. In addition, it is a partial record of other significant meteorological events, such as record maximum or minimum temperatures or precipitation that occurs in connection with another event. Some information appearing in the NCEI may be provided by or gathered from sources outside the National Weather Service (NWS), such as the media, law enforcement and/or other government agencies, private companies, individuals, etc. An effort is made to use the best available information but because of time and resource constraints, information from these sources may be unverified by the NWS. Those using information from NCEI should be cautious as the NWS does not guarantee the accuracy or validity of the information.

The NCEI damage amounts are estimates received from a variety of sources, including those listed above in the Data Sources section. For damage amounts, the NWS makes a best guess using all available data at the time of the publication. Property and crop damage figures should be considered as a broad estimate. Damages reported are in dollar values as they existed at the time of the storm event. They do not represent current dollar values.

The database currently contains data from January 1950 to December 2019, as entered by the NWS. Due to changes in the data collection and processing procedures over time, there are unique periods of record available depending on the event type. The following timelines show the different time spans for each period of unique data collection and processing procedures.

1. Tornado: From 1950 through 1954, only tornado events were recorded.
2. Tornado, Thunderstorm Wind and Hail: From 1955 through 1992, only tornado, thunderstorm wind and hail events were keyed from the paper publications into digital data. From 1993 to 1995, only tornado, thunderstorm wind and hail events have been extracted from the Unformatted Text Files.
3. All Event Types (48 from Directive 10-1605): From 1996 to present, 48 event types are recorded as defined in NWS Directive 10-1605.

Note that injuries and deaths caused by a storm event are reported on an area-wide basis. When reviewing a table resulting from an NCEI search by county, the death or injury listed in connection with that county search did not necessarily occur in that county.

3.1.4 Hazards Identified

Through the hazard identification review process, 11 natural hazards that have the potential to significantly affect the planning area were chosen for further analysis in the risk assessment. The hazards identified for this plan update are shown in Table 3.2. Although 11 hazards were identified, not all hazards impact every jurisdiction. In addition to listing the hazards selected for this plan, Table 3.2 also provides a summary of the jurisdictions impacted by each hazard. An “X” indicates the jurisdiction is impacted by the hazard, while a “-“ indicates the hazard is not applicable to that jurisdiction.

Table 3.2. Hazards Identified for Each Jurisdiction

Hazard	Bollinger County	Meadow Heights R-II	Woodland R-IV
Dam Failure	X	-	-
Drought	X	-	-
Earthquake	X	X	X
Extreme Heat	X	-	-
Flash & Riverine Flooding	X	-	-
Levee Failure	X	-	-
Severe Thunderstorm	X	X	X
Severe Winter Weather/Cold	X	X	X
Sinkhole	X	-	-
Tornado	X	X	X
Wild Fire	X	X	X

3.1.5 Multi-Jurisdictional Risk Assessment

For this multi-jurisdictional plan, the risks are assessed for each jurisdiction where they deviate from the risks facing the entire planning area. The planning area is fairly uniform in terms of climate and topography as well as building construction characteristics. Accordingly, the geographic areas of occurrence for weather-related hazards do not vary greatly across the planning area for most hazards. The more urbanized areas within the planning area have more assets that are vulnerable to the weather-related hazards and varied development trends impact the future vulnerability. These differences are discussed in greater detail in the vulnerability sections of each hazard.

The hazards that have the potential to vary across the planning area in terms of geographic areas at risk include dam/levee failure, flash & riverine flooding, sinkhole, and wild fire.

3.2 Assets at Risk

This section assesses the population, structures, critical facilities, and other important assets in the planning area that may be at risk to hazards.

3.2.1 Total Exposure of Population and Structures

Unincorporated County and Incorporated Cities

In the following three tables, population data is based on 2017 Census Bureau data. Building counts are based on the University of Missouri Structures Count and building exposure values are HMPC and SEMO RPC estimates based on median home values in each jurisdiction. Contents exposure values were calculated by factoring a multiplier to the building exposure values based on usage type. The multipliers were derived from the HAZUS MH 2.1 and are defined below in Table 3.3. Land values have been purposely excluded from consideration because land remains following disasters, and subsequent market devaluations are frequently short term and difficult to quantify. Another reason for excluding land values is that state and federal disaster assistance programs generally do not address loss of land (other than crop insurance). It should be noted that this valuation methodology is an estimate only and will not equal other estimates or calculations (e.g. Assessor data) due to variations in the methodologies.

Table 3.3 shows the total population, building count, estimated value of buildings, estimated value of contents and estimated total exposure for the unincorporated county and each participating incorporated city. Table 3.4 that follows provides the building value exposures for the county and each participating city in the planning area broken down by usage type. Finally, Table 3.5 provides the building count total for the county and each participating city in the planning area broken out by building usage types (residential, commercial, industrial, and agricultural).

Table 3.3. Maximum Population and Building Exposure by Jurisdiction - Communities

Jurisdiction	2017 Population	Building Count	Building Exposure	Contents Exposure	Total Exposure
Unincorporated County	10,292	4,625	$532,409,350	$322,257,358	$854,666,708
Total	10,292	4,625	$532,409,350	$322,257,358	$854,666,708

Sources: Population, 2017 Census; Building Count, SEMO RPC data; Building Exposure, HMPC and SEMO RPC data; Contents Exposure derived by applying multiplier to Building Exposure based on HAZUS MH 2.1 standard contents multipliers per usage type as follows: Residential (50%), Commercial (100%), Industrial (150%), Agricultural (100%).

Table 3.4. Building Values/Exposure by Usage Type

Jurisdiction	Residential	Commercial	Industrial	Agricultural	Total
Unincorporated County	$446,664,664	$9,592,093	$26,360,680	$49,791,913	$532,409,350
Total	$446,664,664	$9,592,093	$26,360,680	$49,791,913	$532,409,350

Table 3.5. Building Counts by Usage Type

Jurisdiction	2017 Population	Residential	Commercial	Industrial	Agricultural	Total
Unincorporated County	10,292	4,068	44	60	453	4,625
Total	10,292	4,068	44	60	453	4,625

Based on the data that is available from the districts' completion of the Data Collection Questionnaire and district maintained websites, the number of enrolled students at the participating public school districts is provided in Table 3.6 below. Additional information includes the number of buildings, building values (building exposure) and contents value (contents exposure).

Table 3.6. Population and Building Exposure by Jurisdiction-Public School Districts

Public School District	Enrolment	Building Count	Building Exposure ($)	Contents Exposure ($)	Total Exposure ($)
Meadow Heights R-II	543	6	17,000,000	2,300,000	19,300,000
Woodland R-IV	857	6	20,500,000	3,600,000	24,100,000

Source: Enrollment - http://mcds.dese.mo.gov/quickfacts/Pages/District-and-School-Information.aspx. Building Count, Building Exposure, Contents Exposure, and Total Exposure amounts - Public School Districts.

3.2.2 Other Assets

Assessing the vulnerability of the planning area to disaster also requires data on the natural, historic, cultural, and economic assets of the area. This information is important for many reasons.

- These types of resources warrant more protection due to their unique and irreplaceable nature and contribution to the overall economy.
- Knowing about these resources in advance allows for consideration immediately following a hazard event, which is when the potential for damages is higher.
- The rules for reconstruction, restoration, rehabilitation, and/or replacement are often different for these types of designated resources.
- The presence of natural resources can reduce the impacts of future natural hazards, such as wetlands and riparian habitats which help absorb floodwaters.
- Losses to economic assets like these (e.g., major employers or primary economic sectors) could have severe impacts on a community and its ability to recover from disaster.

Table 3.7. Threatened and Endangered Species

Common Name	Scientific Name	Status
Clams		
Curtis pearlymussel	Epioblasma florentina curtisii	Endangered
Snuffbox mussel	Epioblasma triquetra	Endangered
Flowering Plants		
Small whorled pogonia	Isotria medeoloides	Threatened
Mammals		
Indiana bat	Myotis sodalis	Endangered
Gray bat	Myotis grisescens	Endangered
Northern Long-Eared Bat	Myotis septentrionalis	Threatened

Source: U.S. Fish and Wildlife Service

Although there are many structures in Bollinger County of significant historic importance, there are currently only two properties/sites in the county listed on the National Register of Historic Places. These National Register properties, along with other historic structures, are most vulnerable to damage which could be caused by earthquakes, tornadoes or severe thunderstorms.

- Will Mayfield College of Arts and Science Building (listed May 25, 2005)
- Will Mayfield College Campus (listed January 14, 2013)

Table 3.8. Major Employers

Crader Distributing Co.
Meadow Heights R-II School Dist.
Woodland R-IV School Dist.
Country Mart

Bollinger County Coop
Bollinger County
City of Marble Hill

3.3 Future Land Use and Development

County and Municipalities

As discussed in previous chapters, Bollinger County has experienced no appreciable changes in population and new building starts over the past five years. This trend is expected to continue, with the county seeing little, if any population growth. In fact, population decline is as likely as growth. Given the area's rural nature, there is little impact expected on hazards and mitigation actions due to future growth.

School District's Future Development

The school districts anticipate only minor changes in student population and do not expect any future building development in the next five years, with the exception of saferooms, should funding become available.

3.4 Hazard Profiles, Vulnerability, and Problem Statements

Each hazard will be analyzed individually in a hazard profile. The profile will consist of a general hazard description, location, severity/magnitude/extent, previous events, future probability, a discussion of risk variations between jurisdictions, and how anticipated development could impact risk. At the end of each hazard profile will be a vulnerability assessment, followed by a summary problem statement.

Hazard Profiles

The level of information presented in the profiles will vary by hazard based on the information available. With each update of this plan, new information will be incorporated to provide better evaluation and prioritization of the hazards that affect the planning area. Detailed profiles for each of the identified hazards include information categorized as follows:

Hazard Description: This section consists of a general description of the hazard and the types of impacts it may have on a community or school/special district.

Geographic Location: This section describes the geographic location of the hazard in the planning area. Where available, use maps to indicate the specific locations of the planning area that are vulnerable to the subject hazard. For some hazards, the entire planning area is at risk.

Severity/Magnitude/Extent: This includes information about the severity, magnitude, and extent of a hazard. For some hazards, this is accomplished with description of a value on an established scientific scale or measurement system, such as an EF2 tornado on the Enhanced Fujita Scale. Severity, magnitude, and extent can also include the speed of onset and the duration of hazard events. Describing the severity/magnitude/extent of a hazard is not the same as describing its potential impacts on a community. Severity/magnitude/extent defines the characteristics of the hazard regardless of the people and property it affects.

Previous Occurrences: This section includes available information on historic incidents and their impacts. Historic event records form a solid basis for probability calculations.

Probability of Future Occurrence: The frequency of recorded past events is used to estimate the likelihood of future occurrences. Probability was determined by dividing the number of recorded events by the number of years and multiplying by 100. This gives the percent chance of the event happening in any given year. For events occurring more than once annually, the probability will be reported 100% in any given year, with a statement of the average number of events annually.

Vulnerability Assessments

Following the hazard profile for each hazard will be the vulnerability assessment. The vulnerability assessment further defines and quantifies populations, buildings, critical facilities, and other community assets at risk to damages from natural hazards. The vulnerability assessments will be based on the best available county-level data, which is in the Missouri Hazard Mitigation Plan (2013). The county-level assessments in the State Plan were based on the following sources:

- Statewide GIS data sets compiled by state and federal agencies; and
- FEMA's HAZUS-MH loss estimation software.

The vulnerability assessments in the plan will also be based on:

- Written descriptions of assets and risks provided by participating jurisdictions;
- Existing plans and reports;
- Personal interviews with planning committee members and other stakeholders; and
- Other sources as cited.

Detailed profiles for each of the identified hazards include information categorized as follows:

Vulnerability Overview

This section consists of a general overview narrative of the planning area's vulnerability to the hazard. Within this section, the magnitude/severity of the hazard is discussed. The magnitude of the impact of a hazard event (past and perceived) is related directly to the vulnerability of the people, property, and the environment it affects. This is a function of when the event occurs, the location affected, the resilience of the community, and the effectiveness of the emergency response and disaster recovery efforts.

Potential Losses to Existing Development

This section provides the potential losses to existing development. Where data is available, this section provides estimated financial losses as well as the methodology used. For hazards with an overall "Low" rating, potential losses may not be discussed.

Future Development

This section provides information on how vulnerability to this hazard will be impacted by planned future development as well as information for jurisdictions to consider in planning future development.

Hazard Summary by Jurisdiction

For hazards that vary by jurisdiction, this section will provide an overview of how the hazard varies, followed by a table indicating the probability, magnitude, warning time, and duration rankings for each jurisdiction with the resulting hazard score and level.

Problem Statement

Provides a summary of the hazard's probability, potential impacts on each jurisdiction, and mitigating factors or actions being taken or considered.

3.4.1 Dam Failure

Hazard Profile

Hazard Description

A dam is defined as a barrier constructed across a watercourse for storage, control, or diversion of water. Dams are typically constructed of earth, rock, concrete, or mine tailings. Dam failure is the uncontrolled release of impounded water resulting in downstream flooding, affecting both life and property. Dam failure can be caused by any of the following:

1. Overtopping - inadequate spillway design, debris blockage of spillways or settlement of the dam crest.
2. Piping: internal erosion caused by embankment leakage, foundation leakage and deterioration of pertinent structures appended to the dam.
3. Erosion: inadequate spillway capacity causing overtopping of the dam, flow erosion, and inadequate slope protection.
4. Structural Failure: caused by an earthquake, slope instability or faulty construction.

Dams in the NID are classified according to hazard potential, an indicator of the consequences of dam failure. A dam's hazard potential classification, presented in Table 3.10, does not indicate its condition. Dams assigned the high hazards potential classification are those where failure will potentially result in loss of human life. Significant hazard potential are those dams where failure results in no probable loss of human life but can cause economic loss. Dams assigned the low hazard potential classification are those where failure will result in no probable loss of human life and low economic or environmental losses. Losses are principally limited to the owner's property.

Table 3.9. MDNR Dam Hazard Classification Definitions

Hazard Class	Definition
Class I	The area downstream from the dam that would be affected by inundation contains ten (10) or more permanent dwellings or any public building. Inspections of these dams must occur every two years.
Class II	The area downstream from the dam that would be affected by inundation contains one to nine permanent dwellings, or one (1) or more campgrounds with permanent water, sewer and electrical services or one (1) or more industrial buildings. Inspections of these dams must occur once every three years.
Class III	The area downstream from the dam that would be affected by inundation does not contain any of the structures identified for Class I or Class II dams. Inspections of these dams must occur once every five years.

Source: Missouri Department of Natural Resources, http://dnr.mo.gov/env/wrc/docs/rules_reg_94.pdf

Table 3.10. NID Dam Hazard Classification Definitions

Hazard Class	Definition
Low Hazard	Failure results in only minimal property damage
Significant Hazard	Failure could possibly result in the loss of life and appreciable property damage
High Hazard	If the dam were to fail, lives would likely be lost and extensive property damage would result

Source: National Inventory of Dams

There is not a direct correlation between the State Hazard classification and the NID classifications. However,

most dams that are in the DNR's Class I and Class II are considered NID High Hazard Dams.

The following table shows the 36 National Inventory of Dams listings within the county, with 8 being rated High Hazard Potential.

Table 3.11. National Inventory of Dams Listing

Dam Name	NIDID	Hazard potential	Owner Type	NID Height (Ft.)	NID Storage	River	City	Distance
LAKE OF THE HILLS DAM	MO30077	High	Private	37	1143	TR CANE CREEK	DONGOLA	7
BARKS LAKE DAM	MO30622	Low	Private	25	40	TR-PERKINS CREEK	ZALMA	7
DRUM DAM	MO30624	Low	Private	20	428	TR ROCKY CREEK	MCGEE	0
SWEET ASYLUM HOLLOW DAM	MO30626	Low	Private	30	48	TR-BRUSH CREEK	WHITEWATER	25
MULENEX LAKE DAM	MO30627	Low	Private	25	67	TR-BRUSH CREEK	KINDER	11
ACUFF & AYERS LAKE DAM	MO30628	High	Private	30	80	TR-SLAGLE CREEK	IDLEWILD	7
SHERMAN LAKE DAM	MO30839	High	Private	25	241	TR-CASTOR RIVER	ZALMA	1
MASTERS LAKE DAM	MO30840	Low	Private	28	65	TR-DRY CREEK	DONGOLA	-
HABLE DAM	MO30842	Low	Private	26	42	TR-CANE CREEK	DONGOLA	8
WHIPPOORWILL DAM	MO30843	Low	Private	25	108	TR-CANE CREEK	DONGOLA	-
LUKEFAHR LAKE DAM	MO30844	Low	Private	30	130	TR-HOG CREEK	NONE	-
MONONAME 632	MO30856	Low	Private	15	112	TR LITTLE CROOKED CREEK	GLENALLEN	0
MARQUIS DAM	MO30857	Low	Private	22	180	TR-PERKINS CREEK	ZALMA	-
GRINDSTAFF DAM	MO30858	Low	Private	15	88	TR-LITTLE WHITEWATER RIVER	PATTON	0
WRIGHT DAM	MO31062	Low	Private	26	50	TR-GIMLET CREEK	GLEN ALLEN	-
SHRUM LAKE DAM	MO31073	Low	Private	22	118	TR-DRUNKEN CREEK	DONGOLA	18
BAYLESS TAYLOR DAM	MO31091	Low	Private	21	160	VIRGIN CREEK	NONE	-
FULTON DAM	MO31248	Low	Private	25	66	TR-CONRAD CREEK	BURFORDVILLE	-
DESTITUTE ACRES LAKE DAM	MO31249	Low	Private	25	94	TR-WHITEWATER RIVER	MILLERSVILLE	0
SHAW LAKE DAM	MO31269	Low	Private	25	40	TR-CROOKED CREEK	GLEN ALLEN	-
BOLLINGER LAKE DAM	MO31371	High	Private	25	107	TR-DRUNKEN CREEK	WHITEWATER	0
LONA LOU LAKE DAM	MO31372	High	Private	30	144	WOLF CREEK	MILLERSVILLE	7
RICHARDET DAM	MO31374	High	Private	22	27	TR-SCHRAWN CREEK	BURFORDVILLE	25
SHADOW LAKE DAM	MO31375	Low	Private	30	160	TR-BUCK CREEK	BURFORDVILLE	22
MCMINN LAKE #1 DAM	MO40197	High	Private	43.5	443	TRIB LITTLE WHITE	PATTON	3.5
MCMINN LAKE #2 DAM	MO40198	High	Private	55	1275	TRIB. LITTLE WHITE RIVER	PATTON	2.4
RON LUTES	MO50443	Low	Private	35	109	TR-CHICKEN CREEK	MARBLE HILLL	-
GARY COOK	MO50445	Low	Private	38	132	CEDAR BRANCH	MARBLE HILL	-
MILLER DAM	MO50568	Low	Private	27	85	TR-BRUSH CREEK	IDLEWILD	-
DR. CHARLES S. PEWITT	MO50597	Low	Private	29	188	TR-VIRGIN CREEK NONE	MARBLE HILL	-
GLEN LAUDEWEC	MO50608	Low	Private	40	129	CASTOR RIVER	LEOPOLD	-
RANDY POGUE	MO50662	Low	Private	31	104	TR-CHICKEN CREEK	MARBLE HILL	-
LIMBAUGH LANDS INC	MO51006	Low	Private	32	62	TR-LITTLE MUDDY	MILLERSVILLE	-
JAMES ISRAEL	MO51182	Low	Private	26	128	TR-WHITEWATER	NONE	-

RICK FIELDS DAM	MO51505	Low	Private	23	62	UNNAMED TR-LITTLE CROOKED CRK	GLEN ALLEN	-	
BRIAN COLLIER	MO51613	Low	Private	24.9	58.9	TR-PUNCH	GLEN ALLEN		16

Table 3.12. State Regulated Dams in Planning Area

Missouri Department of Natural Resources

Missouri Dam Report by County

Regulated
Agriculture Exempt

BOLLINGER

ID Number	Location	Year Complete	Height (ft)	Length (ft)	Drainage Area (acre)	Lake Area (acre)	Hazard Class	Permit Number
ACUFF & AYERS LAKE DAM								
MO30628	S01 T28N R08E	1968	30.00	Unknown	100.00	5.00	2	
BARKS LAKE DAM								
MO30622	S06 T29N R09E	1970	25.00	Unknown	45.00	3.00	3	
BOLLINGER LAKE DAM								
MO31371	S01 T30N R10E	1800	25.00	Unknown	200.00	8.00	2	
DESTITUTE ACRES LAKE DAM								
MO31249	S09 T33N R09E	1975	25.00	Unknown	120.00	7.00	3	
DR. CHARLES S. PEWITT								
MO50597		1997	21.00	850.00	1.00	18.00		
DRUM DAM								
MO30624	S17 T28N R8EE	1972	20.00	Unknown	125.00	40.00	3	
FULTON DAM								
MO31248	S05 T33N R09E	1975	25.00	Unknown	110.00	4.00	3	
GARY COOK								
MO50445		1997	30.00	434.00	0.00	9.00		
GLEN LAUDEWEC								
MO50608		1995	32.00	438.00	1.00	8.00		
GRINDSTAFF DAM								
MO30858	S23 T33N R09E	1968	15.00	Unknown	160.00	11.00	3	
HABLE DAM								
MO30842	S28 T30N R09E	1975	26.00	Unknown	45.00	3.00	3	
JAMES ISRAEL								
MO51182		2003	24.00	310.00	0.00	4.00		
LAKE OF THE HILLS DAM								
MO30077	S23 T30N R09E	1960	37.00	800.00	4,923.00	73.00	2	R-415
LIMBAUGH LANDS INC								
MO51006		1998	26.00	513.00	0.00	5.00		
LONA LOU LAKE DAM								
MO31372	S01 T32N R10E	1975	30.00	Unknown	120.00	9.00	2	
LUKEFAHR LAKE DAM								
MO30844	S07 T30N R11E	1971	30.00	Unknown	170.00	15.00	3	
MARQUIS DAM								
MO30857	S18 T30N R09E	1973	22.00	Unknown	60.00	16.00	2	
MILLER DAM								
MO50568		1979	27.00	460.00	1.00	1.00		
MISTERS LAKE DAM								
MO30840	S10 T29N R10E	1966	28.00	Unknown	130.00	7.00	2	
MONONAME 468								
MO30625	S13 T28N R8EE	1971	12.00	Unknown	25.00	6.00	3	
MONONAME 632								
MO30856	S05 T30N R9EE	1970	15.00	Unknown	90.00	14.00	3	
MULENEX LAKE DAM								
MO30627	S05 T28N R08E	1972	25.00	Unknown	50.00	5.00	3	
RANDY POGUE								
MO50662		1996	24.00	386.00	0.00	8.00		
REED DAM								
MO30859	S04 T30N R9EE	1967	20.00	Unknown	51.00	3.00	3	
RICHARDET DAM								
MO31374	S05 T33N R10E	1800	22.00	Unknown	12.00	2.00	2	

BOLLINGER

ID Number	Location	Year Complete	Height (ft)	Length (ft)	Drainage Area (acre)	Lake Area (acre)	Hazard Class	Permit Number
RON LUTES								
MO50443		1997	27.00	536.00	0.00	10.00		
SHADOW LAKE DAM								
MO31375	S20 T33N R10E	1975	30.00	Unknown	270.00	10.00	3	
SHAW LAKE DAM								
MO31269	S24 T32N R08E	1971	25.00	Unknown	170.00	6.00	2	
SHERMAN LAKE DAM								
MO30839	S31 T29N RO9E	1964	25.00	Unknown	551.00	18.00	1	
SHRUM LAKE DAM								
MO31073	S35 T31N R10E	1975	22.00	Unknown	220.00	10.00	3	
SWEET ASYLUM HOLLOW DAM								
MO30626	S04 T28N R08E	1965	30.00	Unknown	50.00	3.00	3	
TAYLOR BAYLESS DAM								
MO31091	S10 T29N R09E	1975	23.00	Unknown	430.00	15.00	1	
WARD DAM								
MO30623	S05 T28N R9EE	1970	22.00	Unknown	123.00	2.00	3	
WHIPPOORWILL DAM								
MO30843	S25 T30N R09E	1959	25.00	Unknown	155.00	13.00	2	
WRIGHT LAKE DAM								
MO31062	S05 T30N R09E	1972	27.00	Unknown	34.00	4.00	1	

SUMMARY

Regulated Dams: **1**	Total:		**8,542.00**	**375.00**
Total Dams: **35**	Average:	**24.91**	**244.06**	**10.71**

Severity/Magnitude/Extent

The severity/magnitude of dam failure would be similar in some cases to the impacts associated with flood events (see the flood hazard vulnerability analysis and discussion). Based on the hazard class definitions, failure of any of the High Hazard/Class I dams could result in a serious threat of loss of human life, serious damage to residential, industrial or commercial areas, public utilities, public buildings, or major transportation facilities. Catastrophic failure of any high hazard dams has the potential to result in greater destruction due to the potential speed of onset and greater depth, extent, and velocity of flooding. Note that for this reason, dam failures could flood areas outside of mapped flood hazards. Also note that inundation areas have not been mapped for these dams; however, the expected inundation area is generally considered greater than the SFHA near the dam, decreasing down to equaling the SFHA further from the dam, and then eventually lying within the SFHA.

Previous Occurrences

There have been no previous occurrences of dam failures in the past 25 years.

Probability of Future Occurrence

There are no documented dam failures in the county in the past 25 years. This makes a calculation of probability difficult. However, regulated dams are inspected regularly, which greatly reduces the chances of a failure.

Vulnerability

Vulnerability Overview

According to the 2018 State Hazard Mitigation Plan, there are approximately 8 agricultural structures in the county vulnerable to a failure of a state-regulated dam. There are, of course, other non-regulated dams in the county, but estimates are difficult due to data limitations.

Potential Losses to Existing Development: (including types and numbers, of buildings, critical facilities, etc.)

The 2018 State Hazard Mitigation Plan estimates potential losses due to the failure of state-regulated dams at approximately $5,300,000. As with the number of buildings exposed, it is difficult to make any estimates for non-regulated dams due to data limitations.

Impact of Future Development

Future development will be most prominent around the urbanized areas of the county, which have no major dams upstream. Therefore, over the next five years, little development is anticipated in the estimated inundation areas of local dams.

Hazard Summary by Jurisdiction

Development density (low) in the presumed inundation zones for all dams in the county are similar across the county. Only the county would be expected to be impacted by a dam failure, as no other jurisdiction has any significant dam structures nearby.

Problem Statement

Dam failures primarily pose a problem for unincorporated areas of the county, which are generally less densely populated and have far less commercial or industrial development. While this limits the magnitude of potential loss of life due to a dam failure, damage to homes and agricultural assets still represent significant problems for county residents. Continued inspection of dams will help alleviate the chance of dam failure, and future mapping of inundation areas will help identify what structures are vulnerable.

3.4.2 Drought

Hazard Profile

Hazard Description

Drought is generally defined as a condition of moisture levels significantly below normal for an extended period over a large area that adversely affects plants, animal life, and humans. A drought period can last for months, years, or even decades. There are four types of drought conditions relevant to Missouri, according to the State Plan, which are as follows.

- Meteorological drought is defined in terms of the basis of the degree of dryness (in comparison to some "normal" or average amount) and the duration of the dry period. A meteorological drought must be considered as region-specific since the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region.

- Hydrological drought is associated with the effects of periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply (e.g., streamflow, reservoir and lake levels, ground water). The frequency and severity of hydrological drought is often defined on a watershed or river basin scale. Although all droughts originate with a deficiency of precipitation, hydrologists are more concerned with how this deficiency plays out through the hydrologic system. Hydrological droughts are usually out of phase with or lag the occurrence of meteorological and agricultural droughts. It takes longer for precipitation deficiencies to show up in components of the hydrological system such as soil moisture, streamflow, and ground water and reservoir levels. As a result, these impacts also are out of phase with impacts in other economic sectors.

- Agricultural drought focus is on soil moisture deficiencies, differences between actual and potential evaporation, reduced ground water or reservoir levels, etc. Plant demand for water depends on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth, and the physical and biological properties of the soil.

- Socioeconomic drought refers to when physical water shortage begins to affect people.

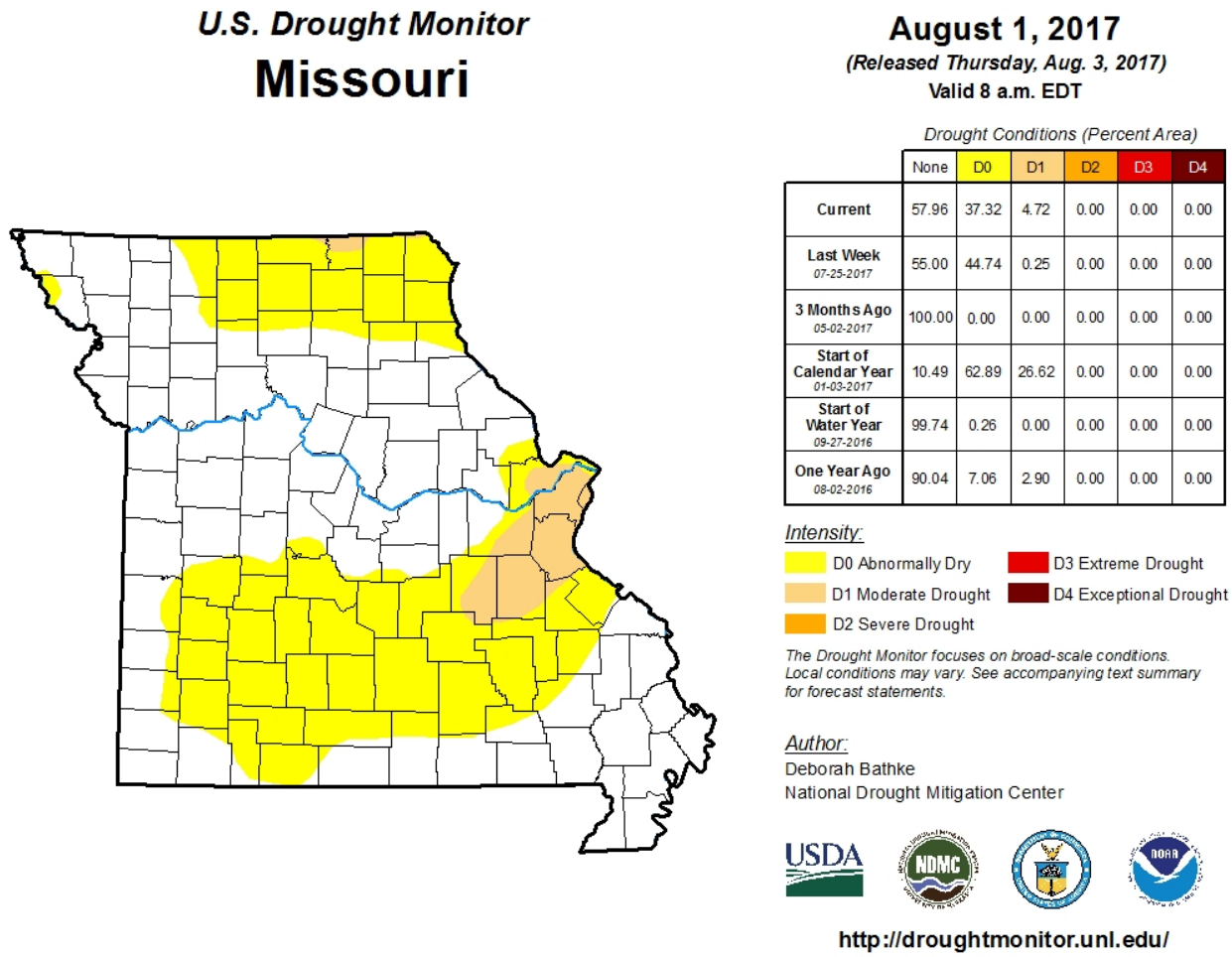
Geographic Location

Given the nature of droughts, the entire county is equally exposed to this hazard. Droughts do tend to have greater impact on agricultural activities and would therefore have more impact in the unincorporated county than the more urbanized areas.

Severity/Magnitude/Extent

The National Drought Monitor Center at the University of Nebraska at Lincoln summarized the potential severity of drought as follows. Drought can create economic impacts on agriculture and related sectors, including forestry and fisheries, because of the reliance of these sectors on surface and subsurface water supplies. In addition to losses in yields in crop and livestock production, drought is associated with increases in insect infestations, plant disease, and wind erosion. Droughts also bring increased problems with insects and disease to forests and reduce growth. The incidence of forest and range fires increases substantially during extended droughts, which in turn place both human and wildlife populations at higher levels of risk. Income loss is another indicator used in assessing the impacts of drought because so many sectors are affected. Finally, while drought is rarely a direct cause of death, the associated heat, dust and stress can all contribute to increased mortality.

Figure 3.1. U.S. Drought Monitor Map of Missouri on 8/1/2017



	None	D0	D1	D2	D3	D4
Current	57.96	37.32	4.72	0.00	0.00	0.00
Last Week 07-25-2017	55.00	44.74	0.25	0.00	0.00	0.00
3 Months Ago 05-02-2017	100.00	0.00	0.00	0.00	0.00	0.00
Start of Calendar Year 01-03-2017	10.49	62.89	26.62	0.00	0.00	0.00
Start of Water Year 09-27-2016	99.74	0.26	0.00	0.00	0.00	0.00
One Year Ago 08-02-2016	90.04	7.06	2.90	0.00	0.00	0.00

Source: U.S. Drought Monitor, http://droughtmonitor.unl.edu/Home/StateDroughtMonitor.aspx?MO

The Palmer Drought Indices measure dryness based on recent precipitation and temperature. The indices are based on a "supply-and-demand model" of soil moisture. Calculation of supply is relatively straightforward, using temperature and the amount of moisture in the soil. However, demand is more complicated as it depends on a variety of factors, such as evapotranspiration and recharge rates. These rates are harder to calculate. Palmer tried to overcome these difficulties by developing an algorithm that approximated these rates, and based the algorithm on the most readily available data — precipitation and temperature.

The Palmer Index has proven most effective in identifying long-term drought of more than several months. However, the Palmer Index has been less effective in determining conditions over a matter of weeks. It uses a "0" as normal, and drought is shown in terms of negative numbers; for example, negative 2 is moderate drought, negative 3 is severe drought, and negative 4 is extreme drought. Palmer's algorithm also is used to describe wet spells, using corresponding positive numbers.

Palmer also developed a formula for standardizing drought calculations for each individual location based on the variability of precipitation and temperature at that location. The Palmer index can therefore be applied to

any site for which sufficient precipitation and temperature data is available.

Previous Occurrences

Since 1995, there have been 10 significant drought events to affect the county. The most severe was a 7 month-long event in the summer and fall of 2012, followed by a 5 month-long event in the summer and fall of 1999.

Probability of Future Occurrence

Over the last 25 years there have been 10 major drought occurrences in the County. This equals a 40% annual chance of a drought.

Vulnerability

Vulnerability Overview

According to the 2018 State HMP, the county has a Low vulnerability to drought compared to other areas of the State. The 2018 Missouri State Hazard Mitigation Plan indicates the county had $247,000 in annualized crop insurance claims due to drought between 2007 and 2016.

Potential Losses to Existing Development

Much of the impact would be felt by agricultural activities, especially for crop related uses. While most of the county's agricultural land use is in crops, the county's annualized crop insurance claims are relatively low compared to the rest of the state. Potential losses to existing development, mostly crops, are expected to be similar during future events. Impacts on the cities and other districts will be far less significant.

Impact of Future Development

Given the small amount of growth the County is expected to experience over the next 5 years, impacts to future development will be almost identical to those on existing development.

Hazard Summary by Jurisdiction

All jurisdictions are equally exposed to a drought, but given the greater amount of agricultural activities in the County it has a greater vulnerability to drought than any of the other jurisdictions.

Problem Statement

While droughts have regional impacts, within the county the most vulnerable areas are the agricultural assets in the unincorporated county. Droughts have little to no impact on the schools.

3.4.3 Earthquakes

Hazard Profile

Hazard Description

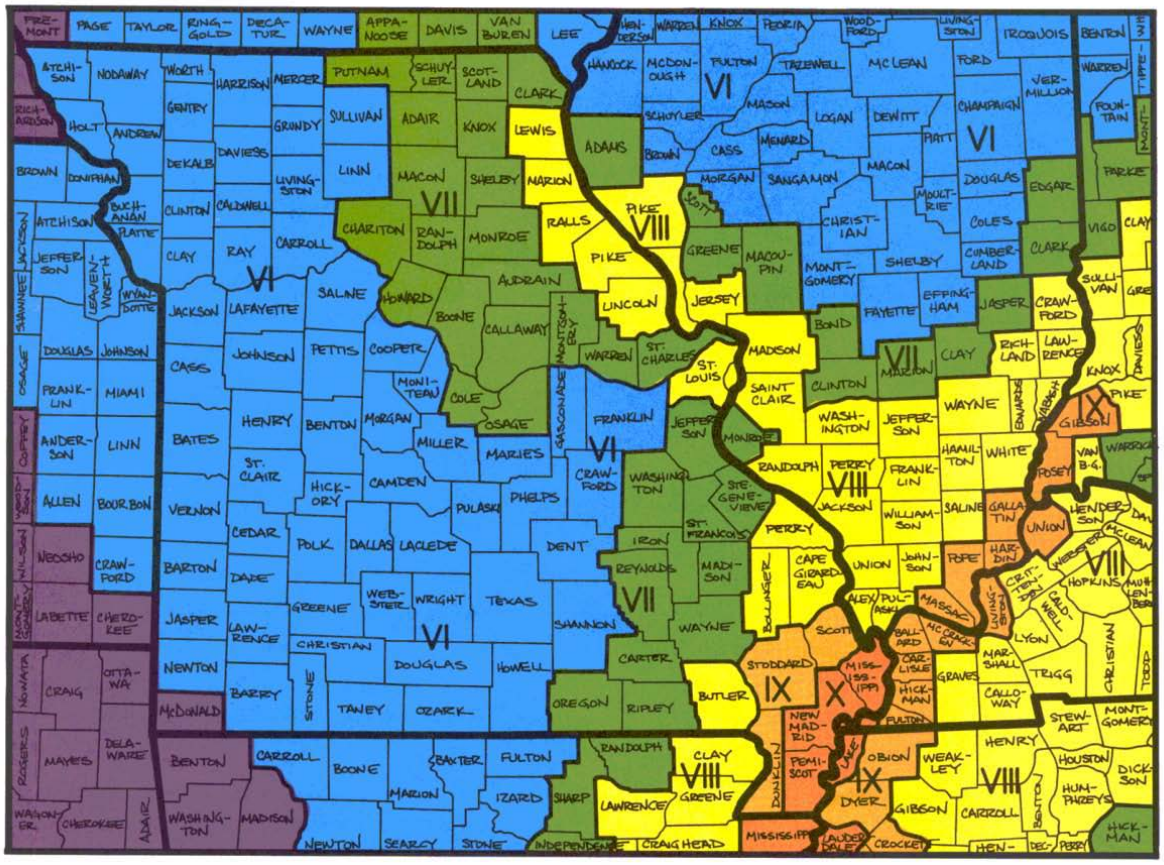
An earthquake is a sudden motion or trembling that is caused by a release of energy accumulated within or along the edge of the earth's tectonic plates. Earthquakes occur primarily along fault zones and tears in the earth's crust. Along these faults and tears in the crust, stresses can build until one side of the fault slips, generating compressive and shear energy that produces the shaking and damage to the built environment. Heaviest damage generally occurs nearest the earthquake epicenter, which is that point on the earth's surface directly above the point of fault movement. The composition of geologic materials between these points is a major factor in transmitting the energy to buildings and other structures on the earth's surface.

Geographic Location

Bollinger County is located approximately 60 miles northwest of the New Madrid Fault. This fault was responsible for the famous 1811 earthquakes that registered up to 7.9 on the Richter Scale and rang church bells in Boston, MA.

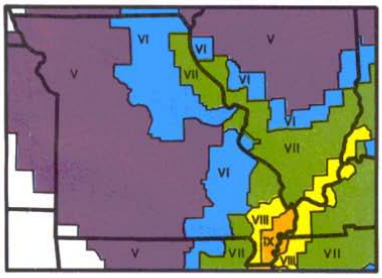
The following Figures illustrate the potential impact the New Madrid Fault could have on the county.

Figure 3.2. Impact Zones for Earthquake Along the New Madrid Fault



This map shows the highest projected Modified Mercalli intensities by county from a potential magnitude – 7.6 earthquake whose epicenter could be anywhere along the length of the New Madrid seismic zone.

6.7

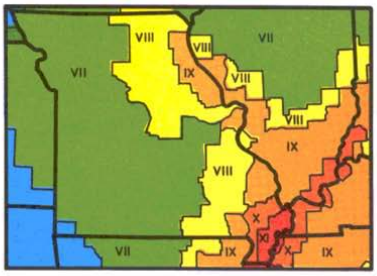


7.6

This map shows the highest projected Modified Mercalli intensities by county from a potential magnitude – 6.7 earthquake whose epicenter could be anywhere along the length of the New Madrid seismic zone.

This map shows the highest projected Modified Mercalli intensities by county from a potential magnitude – 8.6 earthquake whose epicenter could be anywhere along the length of the New Madrid seismic zone.

8.6



Source:
http://sema.dps.mo.gov/docs/programs/Planning,%20Disaster%20&%20Recovery/State%20of%20Missouri%20Hazard%20Analysis/2012-State-Hazard-Analysis/Annex_F_Earthquakes.pdf

MODIFIED MERCALLI INTENSITY SCALE

I People do not feel any Earth movement.

II A few people might notice movement.

III Many people indoors feel movement. Hanging objects swing.

IV Most people indoors feel movement. Dishes, windows, and doors rattle. Walls and frames of structures creak. Liquids in open vessels are slightly disturbed. Parked cars rock.

V Almost everyone feels movement. Most people are awakened. Doors swing open or closed. Dishes are broken. Pictures on the wall move. Windows crack in some cases. Small objects move or are turned over. Liquids might spill out of open containers.

VI Everyone feels movement. Poorly built buildings are damaged slightly. Considerable quantities of dishes and glassware, and some windows are broken. People have trouble walking. Pictures fall off walls. Objects fall from shelves. Plaster in walls might crack. Some furniture is overturned. Small bells in churches, chapels and schools ring.

VII People have difficulty standing. Considerable damage in poorly built or badly designed buildings, adobe houses, old walls, spires and others. Damage is slight to moderate in well-built buildings. Numerous windows are broken. Weak chimneys break at roof lines. Cornices from towers and high buildings fall. Loose bricks fall from buildings. Heavy furniture is overturned and damaged. Some sand and gravel stream banks cave in.

VIII Drivers have trouble steering. Poorly built structures suffer severe damage. Ordinary substantial buildings partially collapse. Damage slight in structures especially built to withstand earthquakes. Tree branches break. Houses not bolted down might shift on their foundations. Tall structures such as towers and chimneys might twist and fall. Temporary or permanent changes in springs and wells. Sand and mud is ejected in small amounts.

IX Most buildings suffer damage. Houses that are not bolted down move off their foundations. Some underground pipes are broken. The ground cracks conspicuously. Reservoirs suffer severe damage.

X Well-built wooden structures are severely damaged and some destroyed. Most masonry and frame structures are destroyed, including their foundations. Some bridges are destroyed. Dams are seriously damaged. Large landslides occur. Water is thrown on the banks of canals, rivers, and lakes. Railroad tracks are bent slightly. Cracks are opened in cement pavements and asphalt road surfaces.

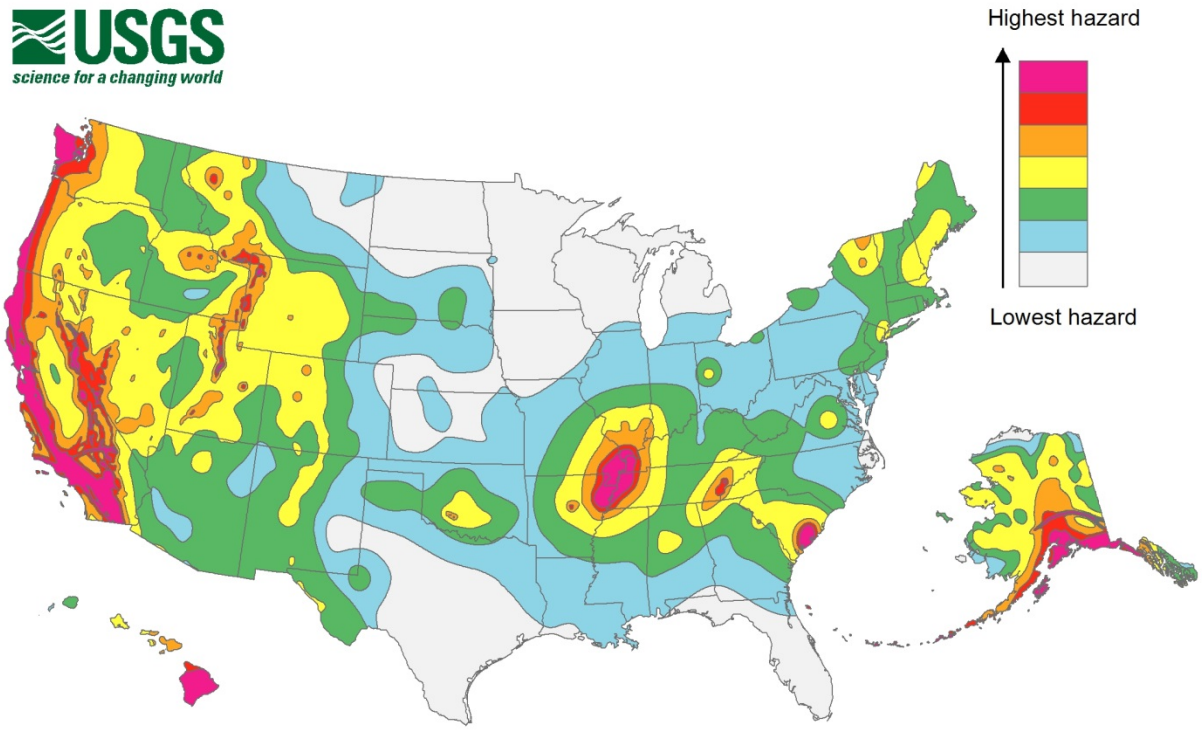
XI Few if any masonry structures remain standing. Large, well-built bridges are destroyed. Wood frame structures are severely damaged, especially near epicenters. Buried pipelines are rendered completely useless. Railroad tracks are badly bent. Water mixed with sand, and mud is ejected in large amounts.

XII Damage is total, and nearly all works of construction are damaged greatly or destroyed. Objects are thrown into the air. The ground moves in waves or ripples. Large amounts of rock may move. Lakes are dammed, waterfalls formed and rivers are deflected.

Intensity is a numerical index describing the effects of an earthquake on the surface of the Earth, on man, and on structures built by man. The intensities shown in these maps are the highest likely under the most adverse geologic conditions. There will actually be a range in intensities within any small area such as a town or county, with the highest intensity generally occurring at only a few sites. Earthquakes of all three magnitudes represented in these maps occurred during the 1811 - 1812 "New Madrid earthquakes." The isoseismal patterns shown here, however, were simulated based on actual patterns of somewhat smaller but damaging earthquakes that occurred in the New Madrid seismic zone in 1843 and 1895.

Prepared and distributed by
THE MISSOURI STATE
EMERGENCY MANAGEMENT AGENCY
P.O. BOX 116
JEFFERSON CITY, MO 65102
Telephone: 573-526-9100

Figure 3.3. United States Seismic Hazard Map



Source: United States Geological Survey at http://earthquake.usgs.gov/hazards/products/conterminous/2014/HazardMap2014_lg.jpg

Severity/Magnitude/Extent

The extent or severity of earthquakes is generally measured in two ways: 1) the Richter Magnitude Scale is a measure of earthquake magnitude; and 2) the Modified Mercalli Intensity Scale is a measure of earthquake severity. The two scales are defined a follows.

Richter Magnitude Scale

The Richter Magnitude Scale was developed in 1935 as a device to compare the size of earthquakes. The magnitude of an earthquake is measured using a logarithm of the maximum extent of waves recorded by seismographs. Adjustments are made to reflect the variation in the distance between the various seismographs and the epicenter of the earthquakes. On the Richter Scale, magnitude is expressed in whole numbers and decimal fractions. For example, comparing a 5.3 and a 6.3 earthquake shows that the 6.3 quake is ten times bigger in magnitude. Each whole number increase in magnitude represents a tenfold increase in measured amplitude because of the logarithm. Each whole number step in the magnitude scale represents a release of approximately 31 times more energy.

Modified Mercalli Intensity Scale

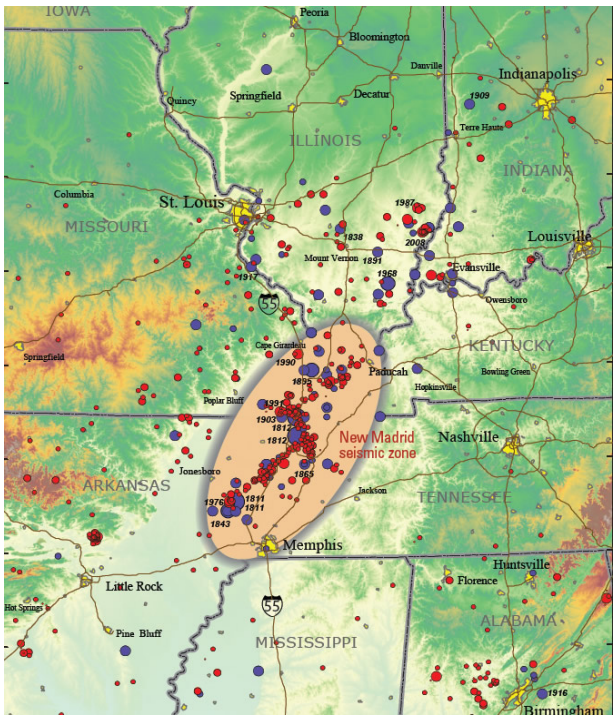
The intensity of an earthquake is measured by the effect of the earthquake on the earth's surface. The intensity scale is based on the responses to the quake, such as people awakening, movement of furniture, damage to chimneys, etc. The intensity scale currently used in the United States is the Modified Mercalli (MM) Intensity

Scale. It was developed in 1931 and is composed of 12 increasing levels of intensity. They range from imperceptible shaking to catastrophic destruction, and each of the twelve levels is denoted by a Roman numeral. The scale does not have a mathematical basis, but is based on observed effects. Its use gives the laymen a more meaningful idea of the severity.

Previous Occurrences

According to the NCEI, from 1811 to 1985 (most recently available dataset) there were 2,495 earthquakes in the State of Missouri. Additionally, earthquakes from 1699 through 2009 throughout the multi-state region are presented below (Figure 3.4). In recent years, according to the NCEI and USGS, there have been earthquakes recorded in the county ranging in magnitude from 1 to 3, but no known serious damage has resulted.

Figure 3.4. Regional Historical Earthquakes, USGS



The New Madrid Seismic Zone experiences more than 200 measurable earthquakes a year. Earthquakes of magnitude 2.5 to 3 on the Richter scale are felt annually, with a quake of 4 or more being released every 18 months. An earthquake of 5.0 or greater on the Richter scale occurs about once per decade.

Probability of Future Occurrence

As stated previously, the County typically experiences at least one earthquake per year, while an earthquake of 5.0 or greater on the Richter scale has an annual probability of approximately 10%.

Vulnerability

Vulnerability Overview

Bollinger County has a higher than average loss ratio for earthquake damages compared to the rest of the State due to its close proximity to the New Madrid Seismic Zone.

Potential Losses to Existing Development

According to the 2018 State HMP, given a scenario of 2% probability of exceedance in 50 years, the county would be projected to suffer approximately $326,000,000 in total economic loss to buildings. Such an economic loss in a rural county could be catastrophic and devastate the population for decades.

Impact of Future Development

Future development is not expected to increase the risk of an earthquake other than by contributing to the overall exposure of what could become damaged as a result of an event. Given the small growth anticipated in the County, even this increase in exposure is small.

Hazard Summary by Jurisdiction

Earthquake intensity will not vary in any meaningful way across the county; therefore, all jurisdictions are equally exposed to an earthquake, and the impacts are expected to be similar for all jurisdictions, given similar development patterns and types.

Problem Statement

Earthquakes pose a serious threat to all jurisdictions in the county. A sufficiently strong earthquake will likely damage numerous private and public structures and facilities, including utility distribution and supply infrastructure. The disruption to transportation, water, sewer, electricity, and natural gas will leave residents, businesses, and schools unable to function reliably for potentially weeks after the event. Seismic retrofitting can help, but is often cost prohibitive, and seismic requirements for new development can drive costs up and stymie the growth of communities. Emergency generators can help alleviate the potential loss of power presented by an event.

3.4.4 Extreme Heat

Hazard Profile

Hazard Description

Extreme temperature events, both hot and cold, can impact human health and mortality, natural ecosystems, agriculture and other economic sectors. The remainder of this section profiles extreme heat. Extreme cold events are profiled in combination with Winter Storm. According to information provided by FEMA, extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Ambient air temperature is one component of heat conditions, with relative humidity being the other. The relationship of these factors creates what is known as the apparent temperature. The Heat Index chart shown in **Figure 3.5** uses both of these factors to produce a guide for the apparent temperature or relative intensity of heat conditions.

Figure 3.5. Heat Index (HI) Chart

Temperature (°F)

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

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Source: National Weather Service (NWS)
Note: Exposure to direct sun can increase Heat Index values by as much as 15°F. The shaded zone above 105°F corresponds to a HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

Geographic Location

Extreme heat is an area-wide hazard event, the risk of extreme heat does not vary across the planning area.

Severity/Magnitude/Extent

Extreme heat can strain crops, livestock, and human health, as well as electricity delivery infrastructure overloaded during peak use of air conditioning during extreme heat events. Another type of infrastructure damage from extreme heat is road damage. When asphalt is exposed to prolonged extreme heat, it can cause buckling of asphalt-paved roads, driveways, and parking lots.

From 1988-2011, there were 3,496 fatalities in the U.S. attributed to summer heat. This translates to an annual national average of 146 deaths. Thankfully, during the same period, no deaths were recorded in the planning area, according to NCEI data. The National Weather Service stated that among natural hazards, no other natural disaster—not lightning, hurricanes, tornadoes, floods, or earthquakes—causes more deaths.

Those at greatest risk for heat-related illness include infants and children up to five years of age, people 65 years of age and older, people who are overweight, and people who are ill or on certain medications. However, even young and healthy individuals are susceptible if they participate in strenuous physical activities during hot weather. In agricultural areas, the exposure of farm workers, as well as livestock, to extreme temperatures is a major concern.

Table 3.13 lists typical symptoms and health impacts due to exposure to extreme heat.

Table 3.13. Typical Health Impacts of Extreme Heat

Heat Index (HI)	Disorder
80-90° F (HI)	Fatigue possible with prolonged exposure and/or physical activity
90-105° F (HI)	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and/or physical activity
105-130° F (HI)	Heatstroke/sunstroke highly likely with continued exposure

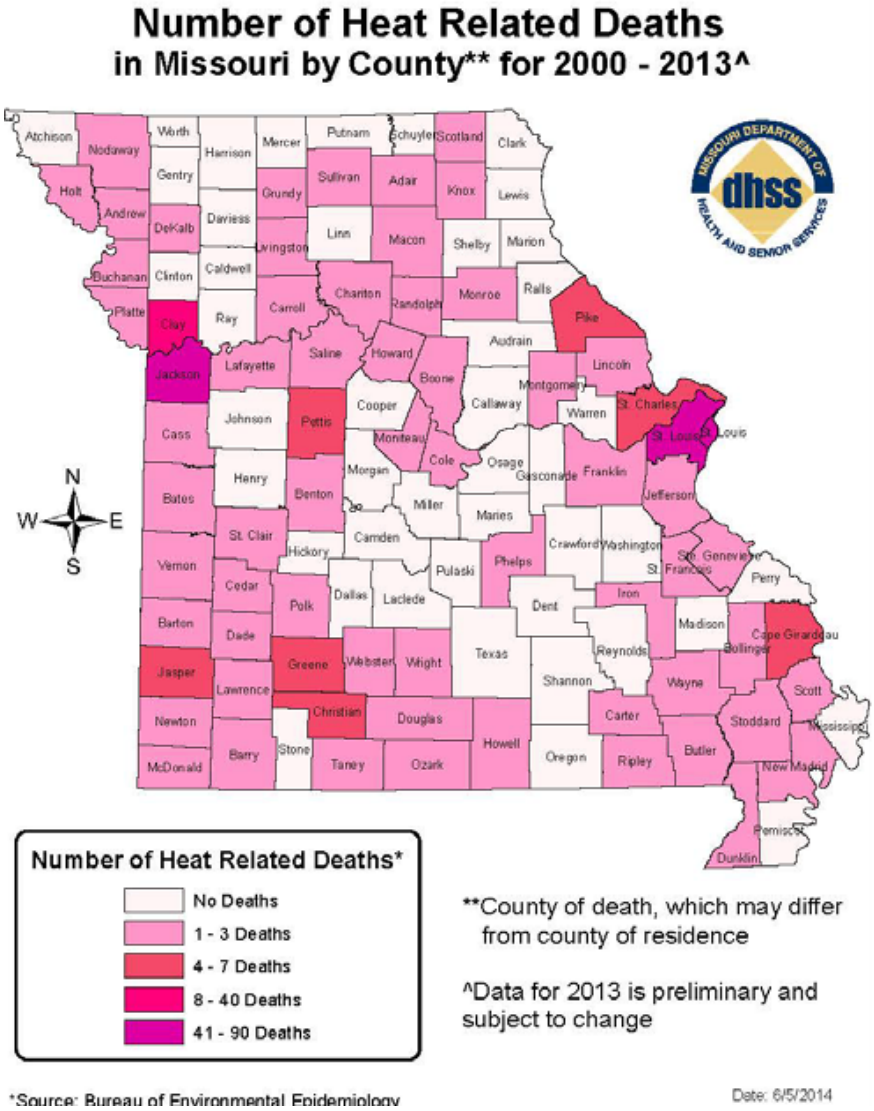
Source: National Weather Service Heat Index Program, www.weather.gov/os/heat/index.shtml

The National Weather Service has an alert system in place (advisories or warnings) when the Heat Index is expected to have a significant impact on public safety. The expected severity of the heat determines whether advisories or warnings are issued. A common guideline for issuing excessive heat alerts is when for two or more consecutive days : (1) when the maximum daytime Heat Index is expected to equal or exceed 105 degrees Fahrenheit (°F); and the night time minimum Heat Index is 80°F or above. A heat advisory is issued when temperatures reach 105 degrees and a warning is issued at 115 degrees.

Previous Occurrences

The NCEI lists 11 recorded events in the past 25 years, with no deaths reported. However, Figure 3.6 shows there have been up to three heat-related deaths in the county between 2000 and 2013.

Figure 3.6. Heat Related Deaths in Missouri 2000 - 2013



Probability of Future Occurrence

While Extreme Heat events can potentially be under-reported in the NCEI, a total of 11 reported events in 25 years calculates to an annual probability of an event of 44%.

Vulnerability

Vulnerability Overview

The State HMP lists concentrations of elderly populations as one of the best indicators of vulnerability to extreme Heat events. For Bollinger County, the adults age 65 and older make up 17% of the population. This puts the County near the median of all counties in the state. This moderate percentage of elderly in the county, along with 1-3 reported deaths in the past 25 years due to extreme heat, indicate the county has a low vulnerability to extreme heat events.

Potential Losses to Existing Development

Given the limited number of heat related deaths in the past quarter century and the median concentration of elderly in the County, the potential losses to existing development are minimal.

Impact of Future Development

Population growth can result in increases in the age-groups that are most vulnerable to extreme heat. Population growth also increases the strain on electricity infrastructure, as more electricity is needed to accommodate the growing population. While no jurisdictions are expected to experience major growth, the aging of the Baby Boomers is likely to lead to a growth in the percentage of elderly in the County.

Hazard Summary by Jurisdiction

Those at greatest risk for heat-related illness and deaths include children up to five years of age, people 65 years of age and older, people who are overweight, and people who are ill or on certain medications. To determine jurisdictions within the planning area with populations more vulnerable to extreme heat, demographic data was obtained from the 2017 census on population percentages in each jurisdiction comprised of those under age 5 and over age 65. Data was not available for overweight individuals and those on medications vulnerable to extreme heat. Table 3.14 below summarizes vulnerable populations in the participating jurisdictions. Note that school and special districts are not included in the table.

Table 3.14. County Population Under Age 5 and Over Age 65, 2010 Census Data

Jurisdiction	Population Under 5 yrs	Population 65 yrs and over
Bollinger County	7%	17%

Source: U.S. Census Bureau

Problem Statement

Extreme heat is most problematic for the elderly and youth in the entire county. While schools host much of the youth population for a period of time each day, the buildings are temperature controlled and offer a reprieve to students from the heat if they lack air conditioning at home. Likewise, the senior center offers an oasis for senior residents seeking a break from extreme heat.

3.4.5 Wildfires

Hazard Profile

Hazard Description

The incident types considered for wildfires include: 1) natural vegetation fire, 2) outside rubbish fire, 3) special outside fire, and 4) cultivated vegetation, crop fire.

The Missouri Division of Fire Safety (MDFS) indicates that approximately 80 percent of the fire departments in Missouri are staffed with volunteers. Whether paid or volunteer, these departments are often limited by lack of resources and financial assistance. The impact of a fire to a single-story building in a small community may be as great as that of a larger fire to a multi-story building in a large city.

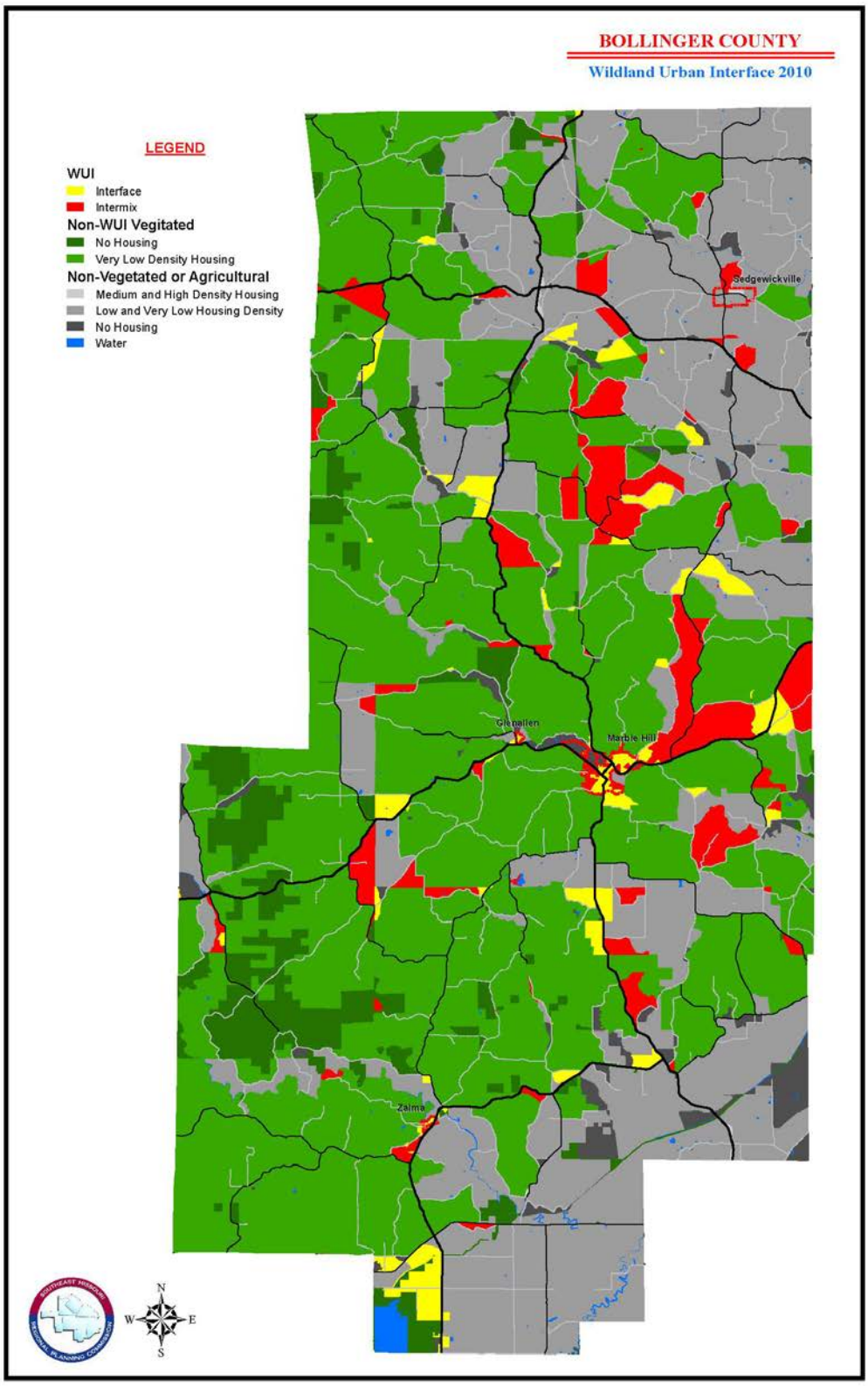
The Forestry Division of the Missouri Department of Conservation (MDC) is responsible for protecting privately owned and state-owned forests and grasslands from wildfires. To accomplish this task, eight forestry regions have been established in Missouri for fire suppression. The Forestry Division works closely with volunteer fire departments and federal partners to assist with fire suppression activities. Currently, more than 900 rural fire departments in Missouri have mutual aid agreements with the Forestry Division to obtain assistance in wildfire protection if needed.

Most of Missouri fires occur during the spring season between February and May. The length and severity of both structural and wildland fires depend largely on weather conditions. Spring in Missouri is usually characterized by low humidity and high winds. These conditions result in higher fire danger. In addition, due to the recent lack of moisture throughout many areas of the state, conditions are likely to increase the risk of wildfires. Drought conditions can also hamper firefighting efforts, as decreasing water supplies may not prove adequate for firefighting. It is common for rural residents burn their garden spots, brush piles, and other areas in the spring. Some landowners also believe it is necessary to burn their forests in the spring to promote grass growth, kill ticks, and reduce brush. Therefore, spring months are the most dangerous for wildfires. The second most critical period of the year is fall. Depending on the weather conditions, a sizeable number of fires may occur between mid-October and late November.

Geographic Location

The risk of structural fire does not vary widely across the planning area. However, damages due to wildfires are likely to be higher in communities with more wildland–urban interface (WUI) areas. WUI refers to the zone of transition between unoccupied land and human development. Within the WUI, there are two specific areas identified: 1) Interface and 2) Intermix. The Interface areas are those areas that abut wildland vegetation and the Intermix areas are those areas that intermingle with wildland areas. Figure 3.7 illustrates the most vulnerable areas of the county based on Interface and Intermix.

Figure 3.7. Woodland-Urban Interface Map



Severity/Magnitude/Extent

Wildfires damage the environment, killing some plants and occasionally animals. Firefighters have been injured or killed, and structures can be damaged or destroyed. The loss of plants can heighten the risk of soil erosion and landslides. Although Missouri wildfires are not the size and intensity of those in the Western United States, they could impact recreation and tourism in and near the fires.

Wildland fires in Missouri have been mostly a result of human activity rather than lightning or some other natural event. Wildfires in Missouri are usually surface fires, burning the dead leaves on the ground or dried grasses. They do sometimes "torch" or "crown" out in certain dense evergreen stands like eastern red cedar and shortleaf pine. However, Missouri does not have the extensive stands of evergreens found in the western US that fuel the large fire storms seen on television news stories.

While very unusual, crown fires can and do occur in Missouri native hardwood forests during prolonged periods of drought combined with extreme heat, low relative humidity, and high wind. Tornadoes, high winds, wet snow and ice storms in recent years have placed a large amount of woody material on the forest floor that causes wildfires to burn hotter and longer. These conditions also make it more difficult for fire fighters suppress fires safely. See ***http://www.firewisemissouri.org/wildfire-in-missouri.html***

Often wildfires in Missouri go unnoticed by the general public because the sensational fire behavior that captures the attention of television viewers is rare in the state. Yet, from the standpoint of destroying homes and other property, Missouri wildfires can be quite destructive.

Information on severity of damages from wildfires is not currently available.

Previous Occurrences

The Missouri Department of Conservation lists 421 instances of wildfires in the county from 2010 to 2019, with 90 of these burning 10 acres or more.

Probability of Future Occurrence

Based on 421 instances in 10 years, there is a 100% chance of a wildfire in the county in any given year.

Vulnerability

Vulnerability Overview

While the 2018 State HMP does not make such a determination on a county by county basis, the 2013 State HMP indicated Bollinger County had a "Medium" vulnerability to wildfires.

Potential Losses to Existing Development

The 2018 State HMP estimates the county has 2,440 structures vulnerable to a wildfire, with a value of $975 million.

Impact of Future Development

Future development is most likely to occur in areas of Intermix on the WUI map. This will increase the number of structures in the area while also reducing the amount of vegetation to serve as fuel. These two factors are expected to balance one another, leading to no significant impact from future development.

Hazard Summary by Jurisdiction

There is little "Intermix" area throughout the county, indicating a moderate vulnerability to wildfires. The County certainly has more forest cover than the cities, but the lower population density minimizes the impacts of a wildfire on human life and structures in the county.

Problem Statement

Wildfires are a common occurrence in the county, though the vast majority of these events are small, impacting 5 acres or less. Approximately 1/4 of the historical events referenced above impacted 1 acre or less. However, any wildfire does pose the threat to grow quickly and impact a much larger area if not addressed quickly. Local fire departments are equipped and trained to handle these common events.

3.4.6 Flooding (Flash and River)

Hazard Profile

Hazard Description

A flood is partial or complete inundation of normally dry land areas. Riverine flooding is defined as the overflow of rivers, streams, drains, and lakes due to excessive rainfall, rapid snowmelt, or ice. There are several types of riverine floods, including headwater, backwater, interior drainage, and flash flooding. Riverine flooding is defined as the overflow of rivers, streams, drains, and lakes due to excessive rainfall, rapid snowmelt or ice melt. The areas adjacent to rivers and stream banks that carry excess floodwater during rapid runoff are called floodplains. A floodplain is defined as the lowland and relatively flat area adjoining a river or stream. The terms "base flood" and "100- year flood" refer to the area in the floodplain that is subject to a one percent or greater chance of flooding in any given year. Floodplains are part of a larger entity called a basin, which is defined as all the land drained by a river and its branches.

Flooding caused by dam and levee failure is discussed in the Dam and Levee Failure section. It will not be addressed in this section.

A flash flood occurs when water levels rise at an extremely fast rate because of intense rainfall over a brief period, sometimes combined with rapid snowmelt, ice jam release, frozen ground, saturated soil, or impermeable surfaces. Flash flooding can happen in Special Flood Hazard Areas (SFHAs) as delineated by the National Flood Insurance Program (NFIP) and can also happen in areas not associated with floodplains.

Ice jam flooding is a form of flash flooding that occurs when ice breaks up in moving waterways, and then stacks on itself where channels narrow. This creates a natural dam, often causing flooding within minutes of the dam formation.

In some cases, flooding may not be directly attributable to a river, stream, or lake overflowing its banks. Rather, it may simply be the combination of excessive rainfall or snowmelt, saturated ground, and inadequate drainage. With no place to go, the water will find the lowest elevations – areas that are often not in a floodplain. This type of flooding, often referred to as sheet flooding, is becoming increasingly prevalent as development outstrips the ability of the drainage infrastructure to properly carry and disburse the water flow.

Most flash flooding is caused by slow-moving thunderstorms or thunderstorms repeatedly moving over the same area. Flash flooding is a dangerous form of flooding which can reach full peak in only a few minutes. Rapid onset allows little or no time for protective measures. Flash flood waters move at very fast speeds and can move boulders, tear out trees, scour channels, destroy buildings, and obliterate bridges. Flash flooding can result in higher loss of life, both human and animal, than slower developing river and stream flooding.

In certain areas, aging storm sewer systems are not designed to carry the capacity currently needed to handle the increased storm runoff. Typically, the result is water backing into basements, which damages mechanical systems and can create serious public health and safety concerns. This combined with rainfall trends and rainfall extremes all demonstrate the high probability, yet generally unpredictable nature of flash flooding in the planning area.

Although flash floods are somewhat unpredictable, there are factors that can point to the likelihood of flash floods occurring. Weather surveillance radar is being used to improve monitoring capabilities of intense rainfall. This, along with knowledge of the watershed characteristics, modeling techniques, monitoring, and advanced warning systems has increased the warning time for flash floods.

Geographic Location

River flooding is most likely to occur in SFHAs. The following maps illustrate the SFHAs for the participating jurisdictions.

Figure 3.8. Bollinger County SFHAs

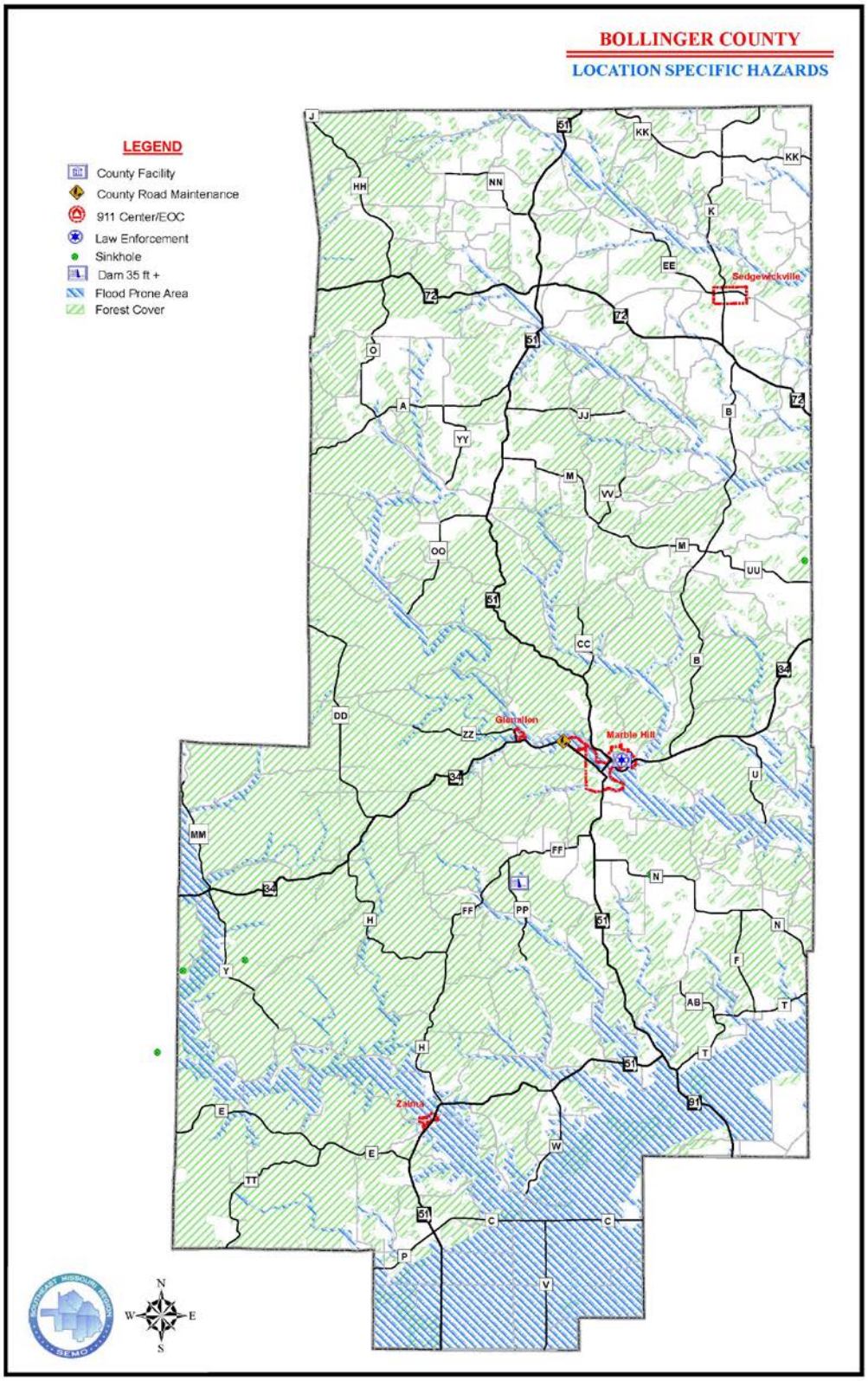


Figure 3.9. Meadow Heights R-II School Dist. SFHA

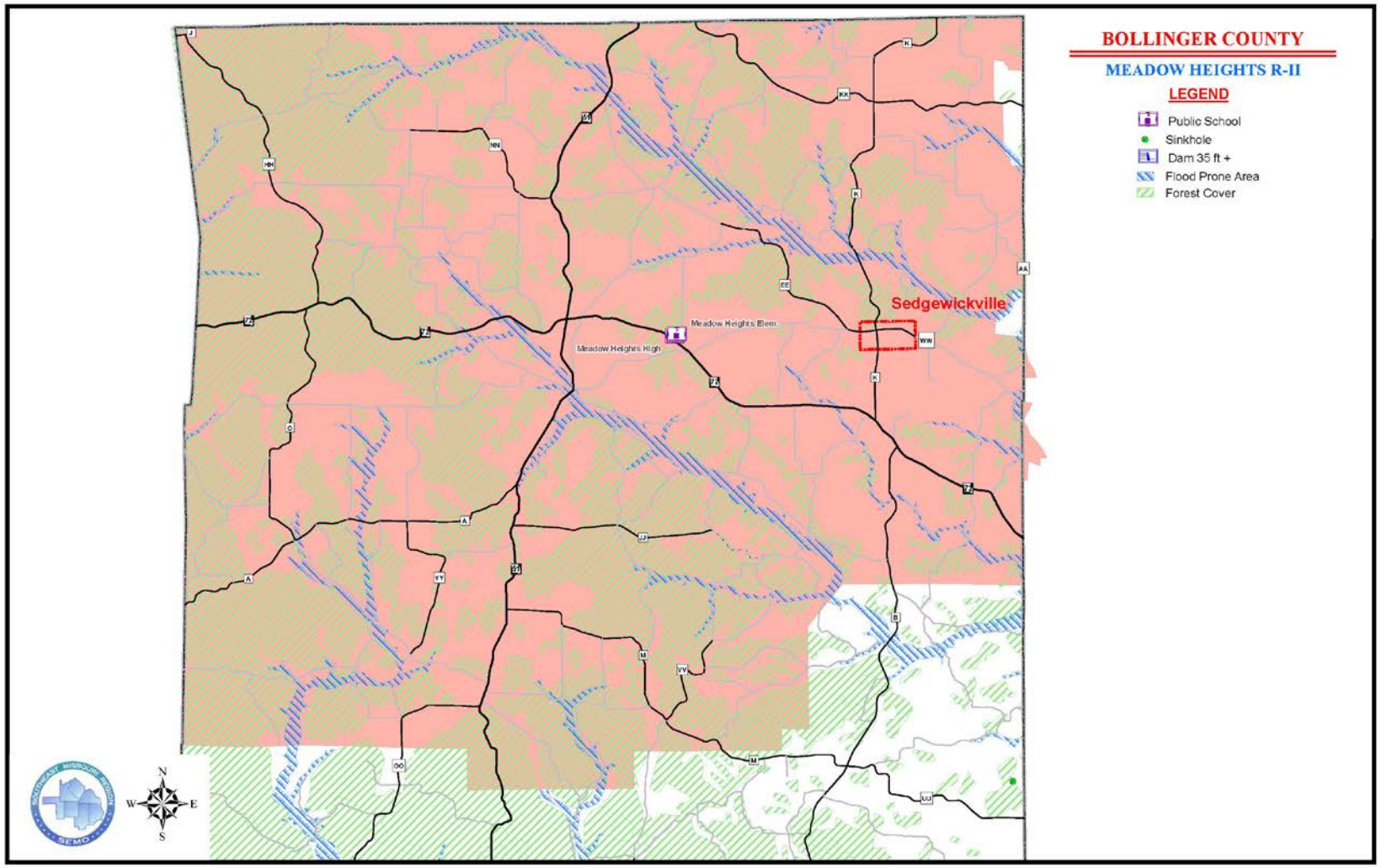
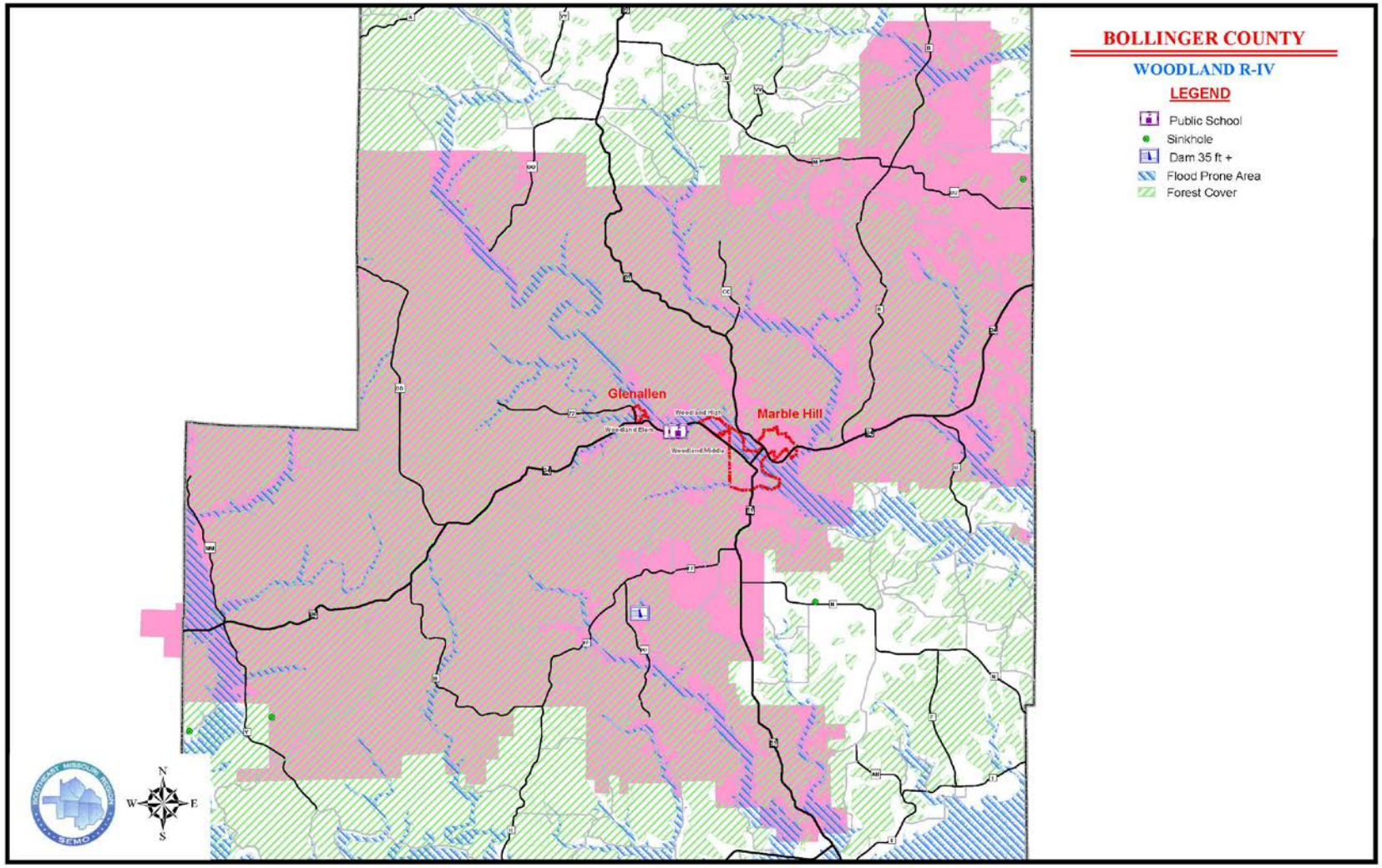


Figure 3.10. Woodland R-IV School Dist. SFHA



Severity/Magnitude/Extent

Missouri has a long and active history of flooding over the past century, according to the 2018 State Hazard Mitigation Plan. Flooding along Missouri's major rivers generally results in slow-moving disasters. River crest levels are forecast several days in advance, allowing communities downstream sufficient time to take protective measures, such as sandbagging and evacuations. Nevertheless, floods exact a heavy toll in terms of human suffering and losses to public and private property. By contrast, flash flood events in recent years have caused a higher number of deaths and major property damage in many areas of Missouri.

Flooding presents a danger to life and property, often resulting in injuries, and in some cases, fatalities. Floodwaters themselves can interact with hazardous materials. Hazardous materials stored in large containers could break loose or puncture because of flood activity. Examples are bulk propane tanks. When this happens, evacuation of citizens is necessary.

Public health concerns may result from flooding, requiring disease and injury surveillance. Community sanitation to evaluate flood-affected food supplies may also be necessary. Private water and sewage sanitation could be impacted, and vector control (for mosquitoes and other entomology concerns) may be necessary.

When roads and bridges are inundated by water, damage can occur as the water scours materials around bridge abutments and gravel roads. Floodwaters can also cause erosion undermining road beds. In some instances, steep slopes that are saturated with water may cause mud or rock slides onto roadways. These damages can cause costly repairs for state, county, and city road and bridge maintenance departments. When sewer back-up occurs, this can result in costly clean-up for home and business owners as well as present a health hazard.

National Flood Insurance Program (NFIP) Participation

Table 3.15 shows the participation status of all jurisdictions in the planning area, regardless of participation status in this plan. Note that the Village of Zalma has dis-incorporated since the previous planning process and is now adopted by ordinance into the county. Table 3.16 shows the NFIP policy and claim statistics of participating jurisdictions of this plan.

Table 3.15. NFIP Participation

Community ID #	Community Name	NFIP Participant (Y/N)	Current Effective Map Date	Regular-Emergency Program Entry Date
290787#	Bollinger County	Y	8/15/90	8/15/90
290885#	Glen Allen	Y	8/15/90	8/15/90
290032#	Marble Hill	Y	8/15/90	8/15/90

Source: NFIP Community Status Book, 2/1/2020; BureauNet, http://www.fema.gov/national-flood-insurance-program/national-flood-insurance-program-community-status-book; M= No elevation determined – all Zone A, C, and X: NSFHA = No Special Flood Hazard Area; E=Emergency Program

Table 3.16. NFIP Policy Statistics as of 9/30/2018

Community Name	Policies In-force	Insurance In-force	Written Premium In-force
Bollinger County	36	$3,288,800	$23,450
Glen Allen	5	$268,300	$3,545
Marble Hill	12	$2,630,900	$40,417

Source: NFIP Community Status Book, 9/30/2018; BureauNet, https://bsa.nfipstat.fema.gov/reports/1011.htm#MOT

Repetitive Loss/Severe Repetitive Loss Properties

Repetitive Loss Properties, according to the State Hazard Mitigation Officer, are those properties with at least two flood insurance payments of $1,000 or more in a 10 year period.

Severe Repetitive Loss Properties are defined, by the National Flood Insurance Reform Act of 2004, as: a single family property (consisting of 1 to 4 residences) that is covered under flood insurance by the NFIP and has incurred flood-related damage for which 4 or more separate claims payments have been paid under flood insurance coverage, with the amount of each claim payment exceeding $5,000 and with cumulative amount of such claims payments exceeding $20,000; or for which at least 2 separate claims payments have been made with the cumulative amount of such claims exceeding the reported value of the property.

The SRL data was obtained from the 2018 MO State Hazard Mitigation Plan and the RL data was provided by SEMA and current as of 9/30/2019; however at the time of request, the state was unable to obtain more recent data and could not provide property type data due to Federal data restrictions.

Note there are no SRL listed in Bollinger County.

Table 3.17. Repetitive Loss Properties

Community Name	Total Losses	Properties	Total Building Payments	Total Contents Payments	Total Payments	Average Payments
County Total	44	20	$921,970	$146,220	$1,068,190	$24,277
Bollinger County	8	4	$133,265	$37,622	$170,886	$21,361
Glen Allen	2	1	$13,492	$5,810	$19,302	$9,651
Lutesville	8	4	$27,937	$5,597	$33,534	$4,192
Marble Hill	26	11	$747,276	$97,192	$844,468	$32,480

Source: S E M A

Table 3.18. County Severe Repetitive Loss Properties

Community	SRL Properties	NFIP Paid Claims	Total Paid Losses
Bollinger County	0	0	$0

Previous Occurrences

Table 3.19 shows flash flood events in the county from the past 25 years. Table 3.20 shows riverine flood events in the County for the same time period.

Table 3.19. NCEI County Flash Flood Events Summary, 1995 to 2019

LOCATION	DATE	DEATHS	INJURIES	DAMAGE-PROPERTY	DAMAGE-CROPS
MARBLE HILL	4/22/1996	0	0	20000	0
MARBLE HILL	3/1/1997	0	0	0	0
MARBLE HILL	5/26/1997	0	0	100000	0
MARBLE HILL	6/17/1997	0	0	0	0
BESSVILLE	7/8/1997	0	0	5000	0
MARBLE HILL	8/10/1998	0	0	5000	0

COUNTYWIDE	1/21/1999	0	0	0	0
COUNTYWIDE	4/3/1999	0	0	0	0
COUNTYWIDE	4/3/1999	0	0	0	0
MARBLE HILL	6/17/2000	0	0	0	0
GRASSY	6/17/2000	0	0	50000	0
COUNTYWIDE	3/25/2002	0	0	0	0
COUNTYWIDE	5/8/2002	0	0	0	0
COUNTYWIDE	5/12/2002	1	0	500000	0
COUNTYWIDE	5/16/2002	0	0	0	0
PATTON	4/29/2003	0	0	0	0
COUNTYWIDE	5/6/2003	0	0	0	0
GRASSY	8/3/2003	0	0	0	0
COUNTYWIDE	4/24/2004	0	0	0	0
MARBLE HILL	5/1/2004	0	0	0	0
COUNTYWIDE	11/15/2005	0	0	750000	0
COUNTYWIDE	3/9/2006	0	0	0	0
GRASSY	4/3/2008	0	0	0	0
MARBLE HILL	5/1/2010	0	0	0	0
PATTON	3/15/2012	0	0	0	0
GIPSY	12/21/2013	0	0	50000	0
LUTESVILLE	4/27/2014	0	0	0	0
SCOPUS	8/5/2016	0	0	0	0
LUTESVILLE	9/15/2016	0	0	0	0
DONGOLA	4/30/2017	0	0	500000	0
SEDGEWICKVILLE	11/30/2019	3	2	50000	0

Source: NCEI, data accessed 1/24/20

Table 3.20. NCEI Riverine Flood Events Summary, 1995 to 2019

LOCATION	DATE	DEATHS	INJURIES	DAMAGE-PROPERTY	DAMAGE-CROPS
MARBLE HILL	7/8/1997	0	0	0	0
ZALMA	8/14/1997	0	0	0	0
ZALMA	3/17/1998	0	0	0	0
COUNTYWIDE	4/3/1999	0	0	10000	0
MARBLE HILL	7/12/2002	0	0	0	0
COUNTYWIDE	12/18/2002	0	0	0	0
PATTON	3/18/2008	1	0	4800000	0
MARBLE HILL	4/10/2008	0	0	0	0
MARBLE HILL	2/11/2009	0	0	5000	0
LEOPOLD	10/30/2009	0	0	0	0
HURRICANE	12/24/2009	0	0	0	0
ALLIANCE	4/24/2011	0	0	0	0
ALLIANCE	5/1/2011	0	0	350000	0
HAHN	1/13/2013	0	0	0	0

PATTON JCT	12/21/2013	0	0	0	0
MARBLE HILL	5/11/2015	0	0	0	0
CASTOR	12/28/2015	0	0	0	0
MAYFIELD	8/14/2016	0	0	0	0
SANK	4/21/2017	0	0	0	0
LUTESVILLE	5/17/2018	0	0	0	0

Source: NCEI, data accessed 1/24/20

Probability of Future Occurrence

For flash flood events, NCEI reports 31 events in the past 25 years, equaling an annual chance of 100%. Ten events resulted in damages or losses, equaling a 40% chance of occurrence in a year, with annualized damages of $92,000. There were also 4 recorded deaths in the 25-year period equaling a 16% chance each year. For river flooding, there are 20 reported events in the past 25 years, for an annual chance of 80%. There were four events in that time with property damage, equaling a 16% chance, with annualized property damage of $206,600 per year. One death due to riverine flooding was reported in the 25-year period.

Vulnerability

Vulnerability Overview

The County has limited amounts of areas designated as SFHAs, except for the areas around the Upper and Lower Castor River, and the Headwater Diversion Channel. The Castor River Levee System protects the southern tip of the county, which is almost exclusively agricultural development. The two school districts are not vulnerable to flooding.

Potential Losses to Existing Development

Table 3.21 shows the number of buildings in the floodplain in the participating jurisdictions. The table also shows the value of those buildings and their contents. The school districts have no structures in floodplains.

Table 3.21. Maximum Potential Flood Losses

Jurisdiction	Building Count	Building Exposure	Contents Exposure	Total Exposure
Unincorporated County	246	$ 28,347,140	$ 17,157,990	$ 45,505,130
Total	246	$ 28,347,140	$ 17,157,990	$ 45,505,130

Sources: Population, 2017 Census; Building Count, SEMO RPC data; Building Exposure, HMPC and SEMO RPC data; Contents Exposure derived by applying multiplier to Building Exposure based on HAZUS MH 2.1 standard contents multipliers per usage type as follows: Residential (50%), Commercial (100%), Industrial (150%), Agricultural (100%).

Impact of Future Development

Future development which occurs in floodplains, low-lying areas near rivers or streams or where drainage systems are not adequate to provide drainage during heavy rainfall events will face a much higher risk of flooding. Additionally, future development will also increase impervious surfaces, leading to additional run off, putting more strain on existing drainage systems.

Hazard Summary by Jurisdiction

GIS analysis of data from the University of Missouri of structures in the County indicates the County has approximately 137 residences, 8 commercial structures, 1 industrial structure, and 100 agricultural structures in SFHAs. The school districts have no structures in the floodplain.

Problem Statement

Due to the hilly terrain of the county, flood prone areas are primarily relegated to limited areas immediately adjacent to the county's rivers, except for the floodplain area along the Castor Rivers and the Diversion Channel, which is extensive. Other than roadways, there is no critical infrastructure in the SFHA.

3.4.7 Sinkholes

Hazard Profile

Hazard Description

Sinkholes are common where the rock below the land surface is limestone, carbonate rock, salt beds, or rocks that naturally can be dissolved by ground water circulating through them. As the rock dissolves, spaces and caverns develop underground. The sudden collapse of the land surface above them can be dramatic and range in size from broad, regional lowering of the land surface to localized collapse. However, the primary causes of most subsidence are human activities: underground mining of coal, groundwater or petroleum withdrawal, and drainage of organic soils. In addition, sinkholes can develop as a result of subsurface void spaces created over time due to the erosion of subsurface limestone (karst).

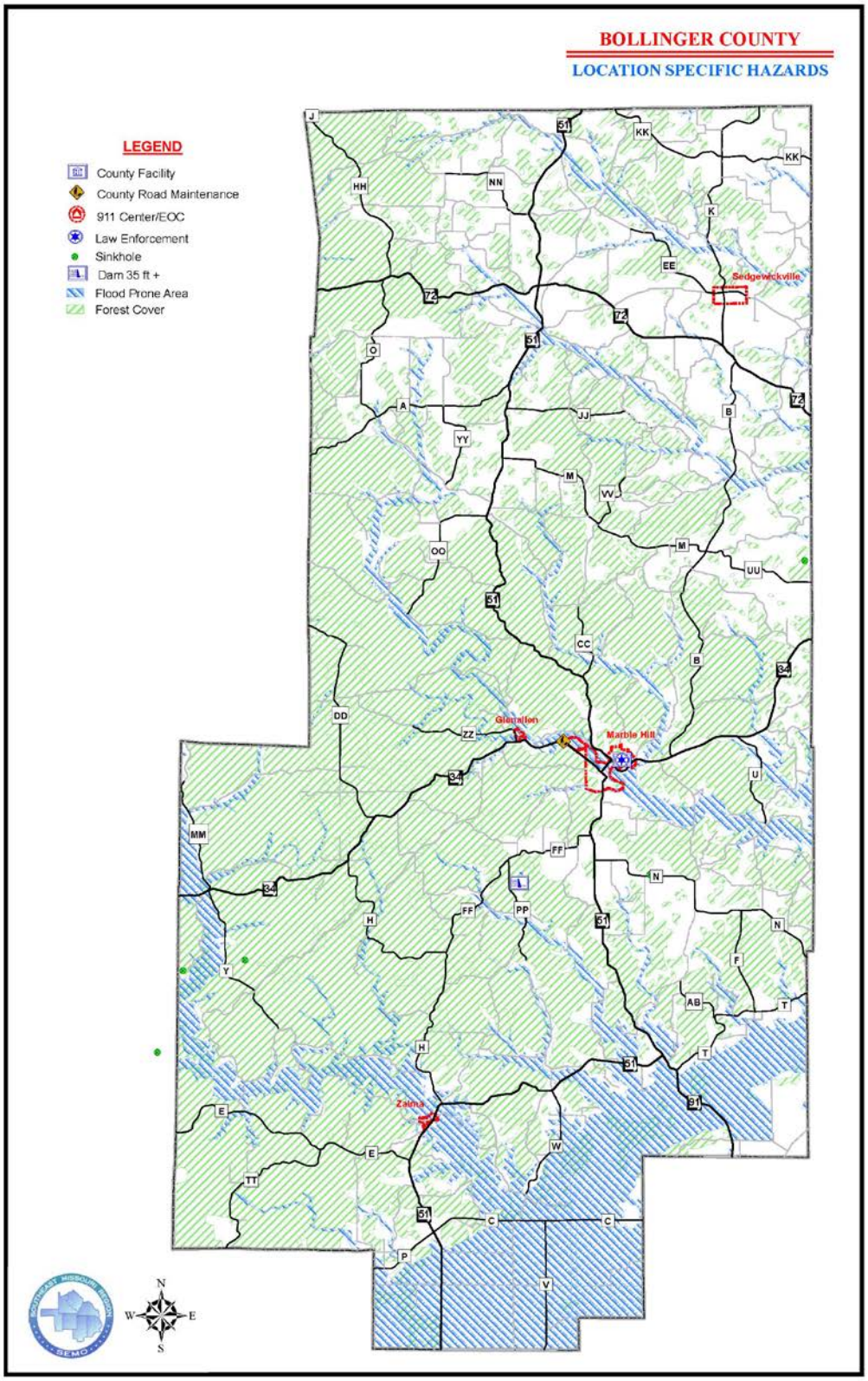
In the case of sinkholes, the rock below the surface is rock that has been dissolving by circulating groundwater. As the rock dissolves, spaces and caverns form, and ultimately the land above the spaces collapse. In Missouri, sinkhole problems are usually a result of surface materials above openings into bedrock caves eroding and collapsing into the cave opening. These collapses are called “cover collapses” and geologic information can be applied to predict the general regions where collapse will occur. Sinkholes range in size from several square yards to hundreds of acres and may be quite shallow or hundreds of feet deep.

According to the U.S. Geological Survey (USGS), the most damage from sinkholes tends to occur in Florida, Texas, Alabama, Missouri, Kentucky, Tennessee, and Pennsylvania. Fifty-nine percent of Missouri is underlain by thick, carbonate rock that makes Missouri vulnerable to sinkholes. Sinkholes occur in Missouri on a fairly frequent basis. Most of Missouri‘s sinkholes occur naturally in the State‘s karst regions (areas with soluble bedrock). They are a common geologic hazard in southern Missouri, but also occur in the central and northeastern parts of the State. Missouri sinkholes have varied from a few feet to hundreds of acres and from less than one to more than 100 feet deep. The largest known sinkhole in Missouri encompasses about 700 acres in western Boone County southeast of where Interstate 70 crosses the Missouri River. Sinkholes can also vary is shape like shallow bowls or saucers whereas other have vertical walls. Some hold water and form natural ponds.

Geographic Location

There are only 3 known sinkholes in the county. The locations of all known sinkholes in the county are shown in Figure 3.11.

Figure 3.11. Sinkhole Locations



Severity/Magnitude/Extent

Sinkholes vary in size and location, and these variances will determine the impact of the hazard. A sinkhole could result in the loss of a personal vehicle, a building collapse, or damage to infrastructure such as roads, water, or sewer lines. Groundwater contamination is also possible from a sinkhole. Because of the relationship of sinkholes to groundwater, pollutants captured or dumped in sinkholes could affect a community's groundwater system. Sinkhole collapse could be triggered by large earthquakes. Sinkholes located in floodplains can absorb floodwaters but make detailed flood hazard studies difficult to model.

The 2018 State Plan included only seven documented sinkhole "notable events". The plan stated that sinkholes are common to Missouri and the probability is high that they will occur in the future. To date, Missouri sinkholes have historically not had major impacts on development nor have they caused serious damage. Thus, the severity of future events is likely to be low.

Previous Occurrences

There are 3 known sinkholes in the County, with no significant events related to them.

Probability of Future Occurrence

It is difficult to predict the probability of future occurrence of sinkholes given the complexities involved with bedrock conditions and the unknown "start" dates of the existing sinkholes. Given the topography of the county, additional sinkholes are considered to have a slight possibility.

Vulnerability

Vulnerability Overview

With 3 known sinkholes and no significant events associated with them, the County's vulnerability to such events is low.

Potential Losses to Existing Development

There are no structures in the county within 100 ft. of a known sinkhole. The occurrence of new sinkholes is possible, but it is virtually impossible to predict the exact location at this time, making potential losses impractical to estimate.

Impact of Future Development

Additional future development will statistically increase the risk of damage to development, though not in any significant amount.

Hazard Summary by Jurisdiction

Sinkholes, while present and possible, pose little threat to any jurisdiction.

Problem Statement

Sinkholes do occur in the county in small numbers. Development of new sinkholes may occur, but there is no way to predict precisely where, especially given the current distribution of existing sinkholes, or to what magnitude.

3.4.8 Levee Failure

Hazard Profile

Hazard Description

Levees are earth embankments constructed along rivers and coastlines to protect adjacent lands from flooding. Floodwalls are concrete structures, often components of levee systems, designed for urban areas where there is insufficient room for earthen levees. When levees and floodwalls and their appurtenant structures are stressed beyond their capabilities to withstand floods, levee failure can result in injuries and loss of life, as well as damages to property, the environment, and the economy.

Levees can be small agricultural levees that protect farmland from high-frequency flooding. Levees can also be larger, designed to protect people and property in larger urban areas from less frequent flooding events such as the 100-year and 500-year flood levels. For purposes of this discussion, levee failure will refer to both overtopping and breach as defined in FEMA's Publication "So You Live Behind a Levee" (http://content.asce.org/ASCELeveeGuide.html). Following are the FEMA publication descriptions of different kinds of levee failure:

> **Overtopping: When a Flood Is Too Big**
> Overtopping occurs when floodwaters exceed the height of a levee and flow over its crown. As the water passes over the top, it may erode the levee, worsening the flooding and potentially causing an opening, or breach, in the levee.
>
> **Breaching: When a Levee Gives Way**
> A levee breach occurs when part of a levee gives way, creating an opening through which floodwaters may pass. A breach may occur gradually or suddenly. The most dangerous breaches happen quickly during periods of high water. The resulting torrent can quickly swamp a large area behind the failed levee with little or no warning.

Earthen levees can be damaged in several ways. For instance, strong river currents and waves can erode the surface. Debris and ice carried by floodwaters—and even large objects such as boats or barges—can collide with and gouge the levee. Trees growing on a levee can blow over, leaving a hole where the root wad and soil used to be. Burrowing animals can create holes that enable water to pass through a levee. If severe enough, any of these situations can lead to a zone of weakness that could cause a levee breach. In seismically active areas, earthquakes and ground shaking can cause a loss of soil strength, weakening a levee and possibly resulting in failure. Seismic activity can also cause levees to slide or slump, both of which can lead to failure.

Geographic Location

Missouri is a state with many levees. Currently, there is no single comprehensive inventory of levee systems in the state. Levees have been constructed across the state by public entities and private entities with varying levels of protection, inspection oversight, and maintenance. The lack of a comprehensive levee inventory is not unique to Missouri.

There are two concurrent nation-wide levee inventory development efforts, one led by the United State Army Corps of Engineers (USACE) and one led by Federal Emergency Management Agency (FEMA). The National Levee Database (NLD), developed by USACE, captures all USACE related levee projects, regardless of design levels of protection. The Midterm Levee Inventory (MLI), developed by FEMA, captures all levee data (USACE and non-USACE) but primarily focuses on levees that provide 1% annual-chance flood protection on FEMA Flood Insurance Rate Maps (FIRMs).

It is likely that agricultural levees and other non-regulated levees within the planning area exist that are not inventoried or inspected. These levees that are not designed to provide protection from the 1-percent annual chance flood would overtop or fail in the 1-percent annual chance flood scenario. Therefore, any associated losses would be taken into account in the loss estimates provided in the Flood Hazard Section.

There is one levee system listed in the USACE NLD in the County, the Castor River Levee System. From the NLD:

> This levee system consists of a single segment, beginning at high ground in southern Bollinger County, MO. The levee follows the right (southern) bank of the Castor River Diversion Channel from the Mingo National Wildlife Refuge to high ground at Missouri Hwy. N. The levee pick up again at high ground approximately 0.75 miles to the east and runs along the north side of Missouri Hwy N until it ties into high ground again at County Rd 252. The system consists of approximately 14.6 miles of earthen levee embankment.
>
> The levee system is part of the Mississippi River and Tributaries (MR&T) project. The MR&T project was authorized by the 1928 Flood Control Act. In the wake of the devastating 1927 flood, it was deemed necessary to put into place a comprehensive, unified system of public works within the lower Mississippi Valley that would provide unprecedented flood risk management and an equally efficient navigation channel. The MR&T project continues to be one of the world's most comprehensive and successful flood risk reduction projects.

Severity/Magnitude/Extent

Levee failure is typically an additional or secondary impact of another disaster such as flooding or earthquake. The main difference between levee failure and losses associated with riverine flooding is magnitude. Levee failure often occurs during a flood event, causing destruction in addition to what would have been caused by flooding alone. In addition, there would be an increased potential for loss of life due to the speed of onset and greater depth, extent, and velocity of flooding due to levee breach.

As previously mentioned, agricultural levees and levees that are not designed to provide flood protection from at least the 1-percent annual chance flood likely do exist in the planning area. However, none of these levees are shown on the Preliminary DFIRM, nor are they enrolled in the USACE Levee Safety Program. As a result, an inventory of these types of levees is not available for analysis. Additionally, since these types of levees do not provide protection from the 1-percent annual chance flood, losses associated with overtopping or failure are captured in the Flood Section of this plan.

The USACE regularly inspects levees within its Levee Safety Program to monitor their overall condition, identify deficiencies, verify that maintenance is taking place, determine eligibility for federal rehabilitation assistance (in accordance with P.L. 84-99), and provide information about the levees on which the public relies. Inspection information also contributes to effective risk assessments and supports levee accreditation decisions for the National Flood Insurance Program administered by the Federal Emergency Management Agency (FEMA).

The USACE now conducts two types of levee inspections. Routine Inspection is a visual inspection to verify and rate levee system operation and maintenance. It is typically conducted each year for all levees in the USACE Levee Safety Program. Periodic Inspection is a comprehensive inspection led by a professional engineer and conducted by a USACE multidisciplinary team that includes the levee sponsor. The USACE typically conducts this inspection every five years on the federally authorized levees in the USACE Levee Safety Program.

Both Routine and Periodic Inspections result in a rating for operation and maintenance. Each levee segment receives an overall segment inspection rating of Acceptable, Minimally Acceptable, or Unacceptable. Figure 3.12 below defines the three ratings.

Figure 3.12. Definitions of the Three Levee System Ratings

Levee System Inspection Ratings	
Acceptable	All inspection items are rated as Acceptable.
Minimally Acceptable	One or more levee segment inspection items are rated as Minimally Acceptable or one or more items are rated as Unacceptable and an engineering determination concludes that the Unacceptable inspection items would not prevent the segment/system from performing as intended during the next flood event.
Unacceptable	One or more levee segment inspection items are rated as Unacceptable and would prevent the segment/system from performing as intended, or a serious deficiency noted in past inspections (previous Unacceptable items in a Minimally Acceptable overall rating) has not been corrected within the established timeframe, not to exceed two years.

Previous Occurrences
There have been no levee failures in the county in past 25 years.

Probability of Future Occurrence
Zero past occurrences in 25 years equals a 0% chance of levee; however, the county believes the true probability is not zero, but rather a small fraction of a percent.

Vulnerability

Vulnerability Overview
The NLD's Risk Characteristics for the levee is rated as Low.

Potential Losses to Existing Development
The NLD lists 2,112 people and 1,784 structures at risk to a failure of the Castor River Levee System, with the property value of the impacted area estimated at $2.5 million and crop damage would be significant as seen in the flood assessment of this chapter. However, approximately half the inundation area is outside Bollinger County, with the majority of the residents and structures due to the City of Advance, which is in Stoddard County, being in the inundation zone.

Impact of Future Development
Little if any new development is expected in Bollinger County in the inundation area of the levee, as this land is currently in agricultural use. Therefore, no significant additional development is expected in this area.

Hazard Summary by Jurisdiction
Only a small portion of the county, almost entirely farm land, is threatened by a levee failure. The school districts have no structures in the levee inundation zones.

Problem Statement
Levee failure is a possibility for the county, though there have been no previous occurrences.

3.4.9 Thunderstorm/High Winds/Lightning/Hail

Hazard Profile

Hazard Description

Thunderstorms

A thunderstorm is defined as a storm that contains lightning and thunder which is caused by unstable atmospheric conditions. When cold upper air sinks and warm moist air rises, storm clouds or 'thunderheads' develop resulting in thunderstorms. This can occur singularly, as well as in clusters or lines. The National Weather Service defines a thunderstorm as "severe" if it includes hail that is one inch or more, or wind gusts that are at 58 miles per hour or higher. At any given moment across the world, there are about 1,800 thunderstorms occurring. Severe thunderstorms most often occur in Missouri in the spring and summer, during the afternoon and evenings, but can occur at any time. Other hazards associated with thunderstorms are heavy rains resulting in flooding and tornadoes (discussed separately).

High Winds

A severe thunderstorm can produce winds causing as much damage as a weak tornado. The damaging winds of thunderstorms include downbursts, microbursts, and straight-line winds. Downbursts are localized currents of air blasting down from a thunderstorm, which induce an outward burst of damaging wind on or near the ground. Microbursts are minimized downbursts covering an area of less than 2.5 miles across. They include a strong wind shear (a rapid change in the direction of wind over a short distance) near the surface. Microbursts may or may not include precipitation and can produce winds at speeds of more than 150 miles per hour. Damaging straight-line winds are high winds across a wide area that can reach speeds of 140 miles per hour.

Lightning

All thunderstorms produce lightning which can strike outside of the area where it is raining and has been known to strike more than 10 miles away from the rainfall area. Thunder is simply the sound that lightning makes. Lightning is a huge discharge of electricity that shoots through the air causing vibrations and creating the sound of thunder.

Hail

According to the National Oceanic and Atmospheric Administration (NOAA), hail is precipitation that is formed when thunderstorm updrafts carry raindrops upward into extremely cold atmosphere causing them to freeze. The raindrops form into small frozen droplets. They continue to grow as they come into contact with super-cooled water which will freeze on contact with the frozen rain droplet. This frozen droplet can continue to grow and form hail. As long as the updraft forces can support or suspend the weight of the hailstone, hail can continue to grow before it hits the earth.

At the time when the updraft can no longer support the hailstone, it will fall down to the earth. For example, a ¼" diameter or pea sized hail requires updrafts of 24 miles per hour, while a 2 ¾" diameter or baseball sized hail requires an updraft of 81 miles per hour. According to the NOAA, the largest hailstone in diameter recorded in the United States was found in Vivian, South Dakota on July 23, 2010. It was eight inches in diameter, almost the size of a soccer ball. Soccer-ball-sized hail is the exception, but even small pea-sized hail can do damage.

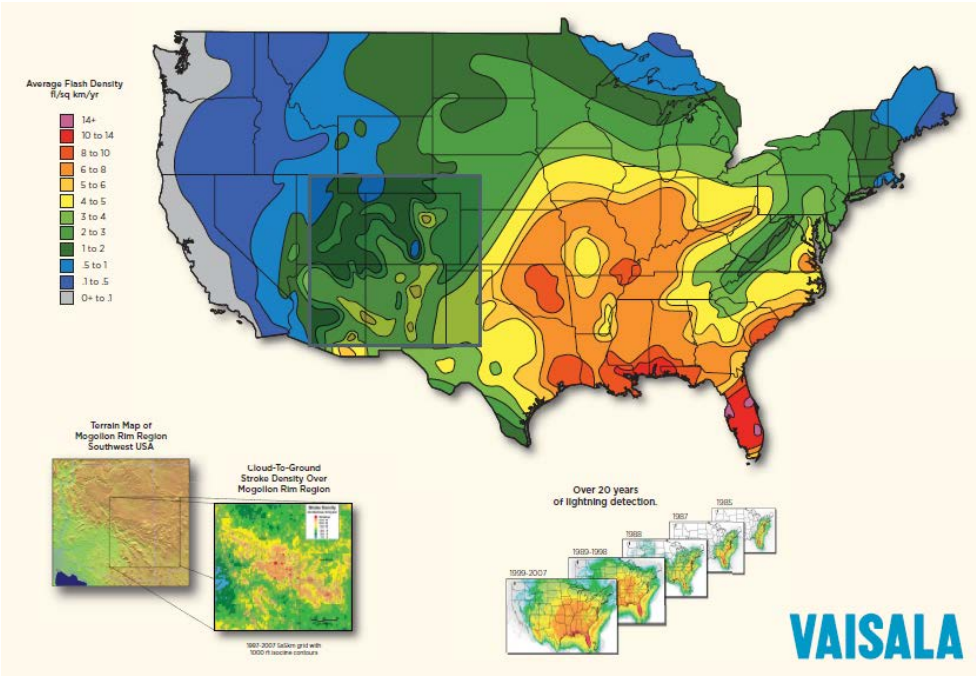
Geographic Location

Thunderstorms/high winds/hail/lighting events are an area-wide hazard that can happen anywhere in the county. Although these events occur similarly throughout the planning area, they are more frequently

reported in more urbanized areas. In addition, damages are more likely to occur in more densely developed urban areas.

Figure 3.13 shows lightning frequency in the state, with the County located in the 6 to 8 category.

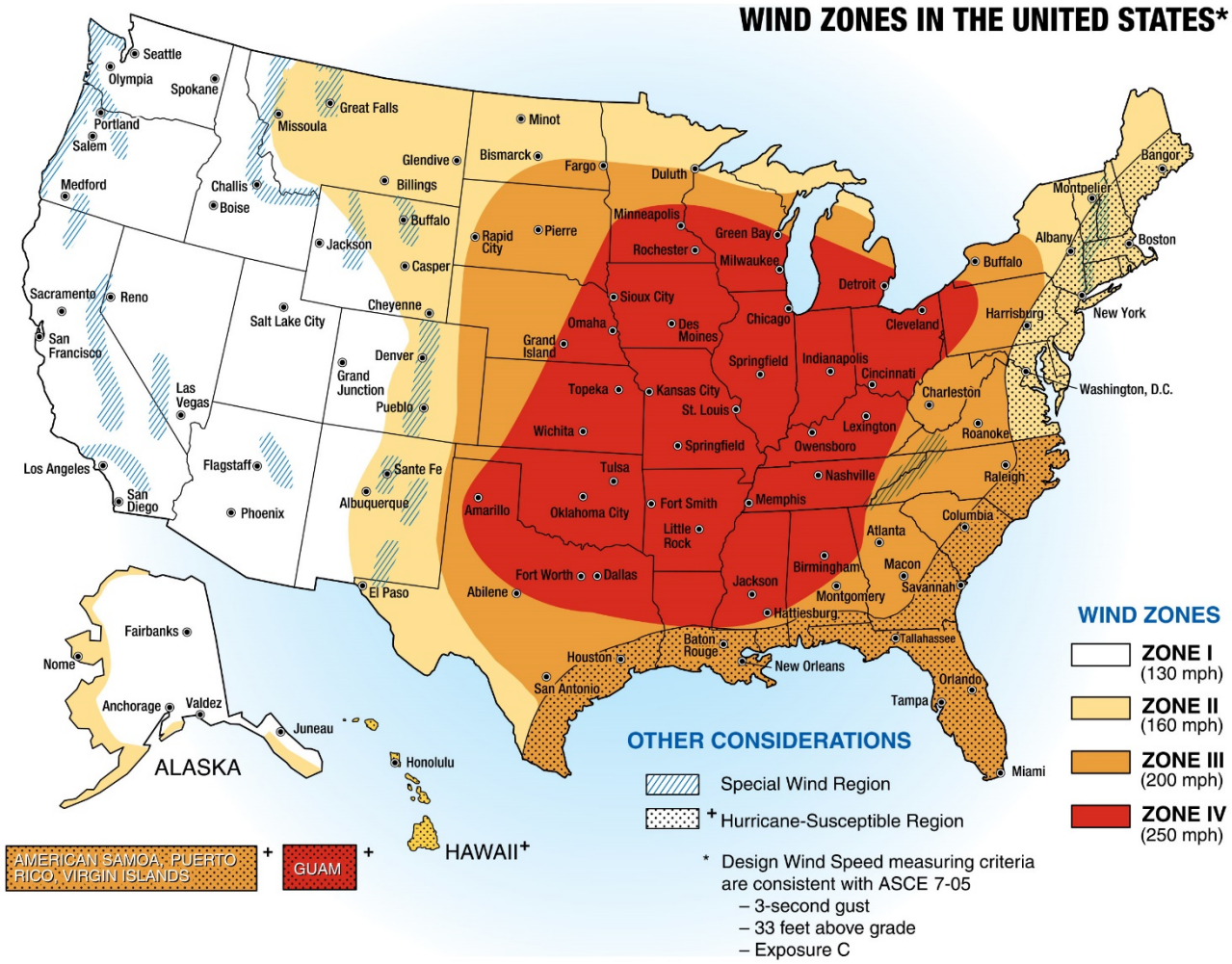
Figure 3.13. Location and Frequency of Lightning in Missouri



Source: National Weather Service, http://www.lightningsafety.noaa.gov/stats/08_Vaisala_NLDN_Poster.pdf. Note: indicate location of planning area with a colored square or arrow.

Figure 3.14 shows the wind zones in the nation, with the county located in Zone 4.

Figure 3.14. Wind Zones in the United States



Source: FEMA 320, Taking Shelter from the Storm, 3rd edition, http://www.weather.gov/media/bis/FEMA_SafeRoom.pdf

Severity/Magnitude/Extent

Severe thunderstorm losses are usually attributed to the associated hazards of hail, downburst winds, lightning and heavy rains. Losses due to hail and high wind are typically insured losses that are localized and do not result in presidential disaster declarations. However, in some cases, impacts are severe and widespread and assistance outside state capabilities is necessary. Hail and wind also can have devastating impacts on crops. Severe thunderstorms/heavy rains that lead to flooding are discussed in the flooding hazard profile. Hailstorms cause damage to property, crops, and the environment, and can injure and even kill livestock. In the United States, hail causes more than $1 billion in damage to property and crops each year. Even relatively small hail can shred plants to ribbons in a matter of minutes. Vehicles, roofs of buildings and homes, and landscaping are also commonly damaged by hail. Hail has been known to cause injury to humans, occasionally fatal injury.

In general, assets in the County vulnerable to thunderstorms with lightning, high winds, and hail include people, crops, vehicles, and built structures. Although this hazard results in high annual losses, private property insurance and crop insurance usually cover the majority of losses. Considering insurance coverage as a recovery capability, the overall impact on jurisdictions is reduced.

Most lightning damages occur to electronic equipment located inside buildings. But structural damage can

also occur when a lightning strike causes a building fire. In addition, lightning strikes can cause damages to crops if fields or forested lands are set on fire. Communications equipment and warning transmitters and receivers can also be knocked out by lightning strikes.
http://www.lightningsafety.noaa.gov/stats/08_Vaisala_NLDN_Poster.pdf and
http://www.lightningsafety.noaa.gov/

Based on information provided by the Tornado and Storm Research Organization (TORRO), **Table 3.22** below describes typical damage impacts of the various sizes of hail.

Table 3.22. Tornado and Storm Research Organization Hailstorm Intensity Scale

Intensity Category	Diameter (mm)	Diameter (inches)	Size Description	Typical Damage Impacts
Hard Hail	5-9	0.2-0.4	Pea	No damage
Potentially Damaging	10-15	0.4-0.6	Mothball	Slight general damage to plants, crops
Significant	16-20	0.6-0.8	Marble, grape	Significant damage to fruit, crops, vegetation
Severe	21-30	0.8-1.2	Walnut	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
Severe	31-40	1.2-1.6	Pigeon's egg > squash ball	Widespread glass damage, vehicle bodywork damage
Destructive	41-50	1.6-2.0	Golf ball > Pullet's egg	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
Destructive	51-60	2.0-2.4	Hen's egg	Bodywork of grounded aircraft dented, brick walls pitted
Destructive	61-75	2.4-3.0	Tennis ball > cricket ball	Severe roof damage, risk of serious injuries
Destructive	76-90	3.0-3.5	Large orange > Soft ball	Severe damage to aircraft bodywork
Super Hailstorms	91-100	3.6-3.9	Grapefruit	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
Super Hailstorms	>100	4.0+	Melon	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

Source: Tornado and Storm Research Organization (TORRO), Department of Geography, Oxford Brookes University
Notes: In addition to hail diameter, factors including number and density of hailstones, hail fall speed and surface wind speeds affect severity. http://www.torro.org.uk/site/hscale.php

Straight-line winds are defined as any thunderstorm wind that is not associated with rotation (i.e., is not a tornado). It is these winds, which can exceed 100 miles per hour, which represent the most common type of severe weather. They are responsible for most wind damage related to thunderstorms. Since thunderstorms do not have narrow tracks like tornadoes, the associated wind damage can be extensive and affect entire (and multiple) counties. Objects like trees, barns, outbuildings, high-profile vehicles, and power lines/poles can be toppled or destroyed, and roofs, windows, and homes can be damaged as wind speeds increase.

The onset of thunderstorms with lightning, high wind, and hail is generally rapid. Duration is less than six hours and warning time is generally six to twelve hours. Nationwide, lightning kills 75 to 100 people each year. Lightning strikes can also start structural and wildland fires, as well as damage electrical systems and equipment.

Previous Occurrences

Table 3.23, Table 3.24, and Table 3.25 show the previous occurrences of high wind events, lightning events, and hail events in the County. All data is from the NCEI.

Limitations to the use of NCEI reported lightning events include the fact that only lightning events that result

in fatality, injury and/or property and crop damage are in the NCEI.

Table 3.23. High & Strong Wind Events 1995-2019

LOCATION	DATE	EVENT TYPE	SPEED (KTS)	DEATHS	INJURIES	DAMAGE-PROPERTY	DAMAGE-CROPS
County	4/30/1997	High Wind	52	0	0	0	0
County	11/10/1998	High Wind	50	0	0	0	0
County	1/8/2006	Strong Wind	41	0	0	1000	0
County	1/29/2008	High Wind	52	0	0	5000	0
County	2/17/2008	Strong Wind	43	0	0	1000	0
County	5/11/2008	Strong Wind	46	0	0	1000	0
County	9/14/2008	High Wind	50	0	0	1000000	0
County	3/8/2009	Strong Wind	40	0	0	1000	0
County	2/20/2014	Strong Wind	45	0	0	1000	0
County	11/18/2017	Strong Wind	40	0	0	1000	0
County	4/12/2018	Strong Wind	43	0	0	1000	0
County	3/13/2019	Strong Wind	43	0	0	1000	0

Table 3.24. Lighting Events 1995-2019

LOCATION	DATE	DEATHS	INJURIES	DAMAGE-PROPERTY	DAMAGE-CROPS
PATTON	6/12/2000	0	0	10000	0

Table 3.25. Hail Events 1in. and Greater 1995-2019

LOCATION	DATE	MAGNITUDE (IN.)	DEATHS	INJURIES	DAMAGE-PROPERTY	DAMAGE-CROPS
DONGOLA	1/4/1997	1	0	0	0	0
ZALMA	6/13/1997	1.75	0	0	0	0
PATTON	4/15/1998	1.5	0	0	0	0
MARBLE HILL	8/10/1998	1	0	0	0	0
MARBLE HILL	2/27/1999	1.75	0	0	0	0
ZALMA	4/16/2000	2.75	0	0	0	0
PATTON	5/23/2000	1.75	0	0	0	0
SEDGEWICKVILLE	5/23/2000	1	0	0	0	0
MARBLE HILL	5/23/2000	2.75	0	0	1000000	0
MARBLE HILL	5/23/2000	1.75	0	0	0	0
SCOPUS	10/23/2001	1	0	0	0	0
GLENALLEN	4/19/2002	2.5	0	0	50000	0
ZALMA	4/24/2002	1.75	0	0	0	0
MARBLE HILL	4/30/2002	1	0	0	0	0
MARBLE HILL	11/9/2002	1	0	0	0	0
MARBLE HILL	5/6/2003	1.25	0	0	0	0
CASTOR	5/6/2003	1	0	0	0	0

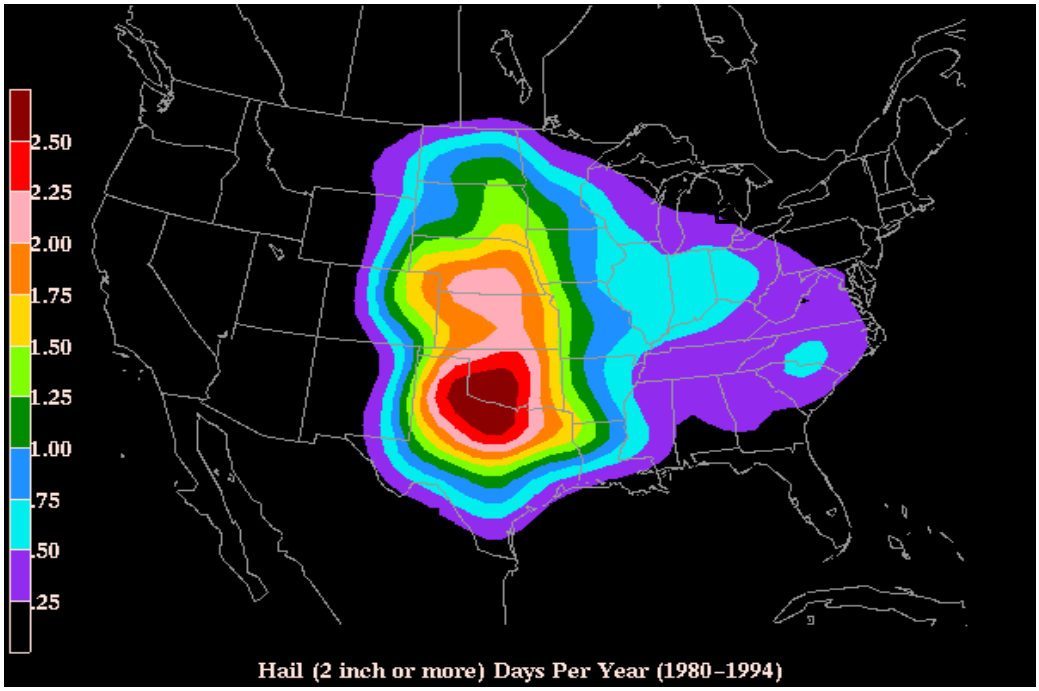
MARBLE HILL	5/14/2003	1	0	0	0	0
GLENNON	5/15/2003	1.75	0	0	0	0
PATTON JCT	10/18/2004	2.5	0	0	50000	0
ZALMA	8/26/2005	1	0	0	0	0
MARBLE HILL	4/2/2006	1.75	0	0	0	0
ARAB	4/30/2006	2.75	0	0	350000	0
ZALMA	4/30/2006	2.75	0	0	50000	0
GREENBRIER	5/25/2006	2.5	0	0	0	0
MARBLE HILL	9/27/2006	1	0	0	0	0
MARBLE HILL	4/3/2007	1.25	0	0	0	0
GRASSY	3/27/2008	1	0	0	0	0
ALLIANCE	4/30/2010	1	0	0	0	0
ZALMA	4/22/2011	1.25	0	0	0	0
ZALMA	4/27/2011	1	0	0	0	0
GIPSY	8/6/2011	1.25	0	0	0	0
SEDGEWICKVILLE	2/29/2012	2.5	0	0	0	0
SEDGEWICKVILLE	3/14/2012	1	0	0	0	0
ZALMA	8/3/2012	1.75	0	0	0	0
MARBLE HILL	2/20/2014	1	0	0	0	0
ZALMA	5/9/2014	1	0	0	0	0
SEDGEWICKVILLE	5/9/2014	1	0	0	0	0
SCOPUS	8/19/2014	2.75	0	0	0	0
LEOPOLD	7/15/2016	1	0	0	0	0
GRASSY	4/28/2017	2	0	0	0	0
MARBLE HILL	5/27/2017	1	0	0	0	0
ARAB	3/16/2018	1	0	0	0	0
PATTON	3/24/2018	1	0	0	0	0

Probability of Future Occurrence

Twelve events of high or strong winds in past 25 years are listed in the NCEI, leading to a probability of 48%. While only 1 lighting event is listed in the NCEI, data limitations are the leading factor in this phenomenon, not the lack of actual events. The HMPC believes it is safe to assume that at least one lightning strike will occur each year in the County.

NCEI lists 38 events of hail of 1” or greater in the past 25 years, which equals a probability of 100%. Additionally, NOAA’s NSSL indicates hail of 2” diameter or more is likely to occur 1 day every 16 months in the County (see Figure 3.15)

Figure 3.15. Annual Hailstorm Probability (2'' diameter or larger), U 1980- 1994



Source: NSSL, http://www.nssl.noaa.gov/users/brooks/public_html/bighail.gif Note:

Vulnerability

Vulnerability Overview

Based on the state's 2018 HMP, the county has a summarized thunderstorm vulnerability rating of "Medium."

Potential Losses to Existing Development

Available data indicates only small losses due to any element of a severe thunderstorm, though anecdotal evidence exists indicating that roof and vehicle damage do often result during very strong thunderstorms.

Future Development

Additional development will result in the exposure of more structures to damages from severe thunderstorms.

Hazard Summary by Jurisdiction

The county is the most exposed and vulnerable to Thunderstorms given its size and population compared to the school districts, though all jurisdictions have some level of exposure and vulnerability.

Problem Statement

Impacts from these events are typically property related, with debris, falling trees, and hail damage. Advanced warnings typically keep residents inside during such events which limits potential injuries and loss of life. While all jurisdictions can be impacted by these events, the county is most affected due to its size compared to the relatively small campuses of the school districts.

3.4.10 Tornado

HazardProfile

Hazard Description

The NWS defines a tornado as "a violently rotating column of air extending from a thunderstorm to the ground." It is usually spawned by a thunderstorm and produced when cool air overrides a layer of warm air, forcing the warm air to rise rapidly. Often, vortices remain suspended in the atmosphere as funnel clouds. When the lower tip of a vortex touches the ground, it becomes a tornado.

High winds not associated with tornadoes are profiled separately in this document in Section 3.4.9**,** Thunderstorm/High Wind/Hail/Lightning.

Essentially, tornadoes are a vortex storm with two components of winds. The first is the rotational winds that can measure up to 500 miles per hour, and the second is an uplifting current of great strength. The dynamic strength of both these currents can cause vacuums that can overpressure structures from the inside.

Although tornadoes have been documented in all 50 states, most of them occur in the central United States due to its unique geography and presence of the jet stream. The jet stream is a high-velocity stream of air that separates the cold air of the north from the warm air of the south. During the winter, the jet stream flows west to east from Texas to the Carolina coast. As the sun moves north, so does the jet stream, which at summer solstice flows from Canada across Lake Superior to Maine. During its move northward in the spring and its recession south during the fall, the jet stream crosses Missouri, causing the large thunderstorms that breed tornadoes.

A typical tornado can be described as a funnel-shaped cloud in contact with the earth's surface that is "anchored" to a cloud, usually a cumulonimbus. This contact on average lasts 30 minutes and covers an average distance of 15 miles. The width of the tornado (and its path of destruction) is usually about 300 yards. However, tornadoes can stay on the ground for upward of 300 miles and can be up to a mile wide. The National Weather Service, in reviewing tornadoes occurring in Missouri between 1950 and 1996, calculated the mean path length at 2.27 miles and the mean path area at 0.14 square mile.

The average forward speed of a tornado is 30 miles per hour but may vary from nearly stationary to 70 miles per hour. The average tornado moves from southwest to northeast, but tornadoes have been known to move in any direction. Tornadoes are most likely to occur in the afternoon and evening, but have been known to occur at all hours of the day and night.

Geographic Location

Tornadoes can occur at any location in the planning area with equal probability.

Severity/Magnitude/Extent

Tornadoes are the most violent of all atmospheric storms and are capable of tremendous destruction. Wind speeds can exceed 250 miles per hour and damage paths can be more than one mile wide and 50 miles long. Tornadoes have been known to lift and move objects weighing more than 300 tons a distance of 30 feet, toss homes more than 300 feet from their foundations, and siphon millions of tons of water from water bodies. Tornadoes also can generate a tremendous amount of flying debris or "missiles," which often become airborne shrapnel that causes additional damage. If wind speeds are high enough, missiles can be thrown at a building with enough force to penetrate windows, roofs, and walls. However, the less spectacular damage is much more common.

Tornado magnitude is classified according to the EF- Scale (or the Enhance Fujita Scale, based on the original Fujita Scale developed by Dr. Theodore Fujita, a renowned severe storm researcher). The EF- Scale (see **Table 3.26**) attempts to rank tornadoes according to wind speed based on the damage caused. This update to the original F Scale was implemented in the U.S. on February 1, 2007.

Table 3.26. Enhanced F Scale for Tornado Damage

FUJITA SCALE			DERIVED EF SCALE		OPERATIONAL EF SCALE	
F Number	Fastest ¼-mile (mph)	3 Second Gust (mph)	EF Num	3 Second Gust (mph)	EF Number	3 Second Gust (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

Source: The National Weather Service, www.spc.noaa.gov/faq/tornado/ef-scale.html

The wind speeds for the EF scale and damage descriptions are based on information on the NOAA Storm Prediction Center as listed in **Table 3.27**. The damage descriptions are summaries. For the actual EF scale it is necessary to look up the damage indicator (type of structure damaged) and refer to the degrees of damage associated with that indicator. Information on the Enhanced Fujita Scale's damage indicators and degrees or damage is located online at www.spc.noaa.gov/efscale/ef-scale.html.

Table 3.27. Enhanced Fujita Scale with Potential Damage

Enhanced Fujita Scale			
Scale	Wind Speed (mph)	Relative Frequency	Potential Damage
EF0	65-85	53.5%	Light. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e. those that remain in open fields) are always rated EF0).
EF1	86-110	31.6%	Moderate. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	10.7%	Considerable. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes complete destroyed; large trees snapped or uprooted; light object missiles generated; cars lifted off ground.
EF3	136-165	3.4%	Severe. Entire stores of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	0.7%	Devastating. Well-constructed houses and whole frame houses completely levelled; cars thrown and small missiles generated.
EF5	>200	<0.1%	Explosive. Strong frame houses levelled off foundations and swept away; automobile-sized missiles fly through the air in excess of 300 ft.; steel reinforced concrete structure badly damaged; high rise buildings have significant structural deformation; incredible phenomena will occur.

Source: NOAA Storm Prediction Center, http://www.spc.noaa.gov/efscale/ef-scale.html

Enhanced weather forecasting has provided the ability to predict severe weather likely to produce tornadoes days in advance. Tornado watches can be delivered to those in the path of these storms several hours in

advance. Lead time for actual tornado warnings is about 30 minutes. Tornadoes have been known to change paths very rapidly, thus limiting the time in which to take shelter. Tornadoes may not be visible on the ground if they occur after sundown or due to blowing dust or driving rain and hail.

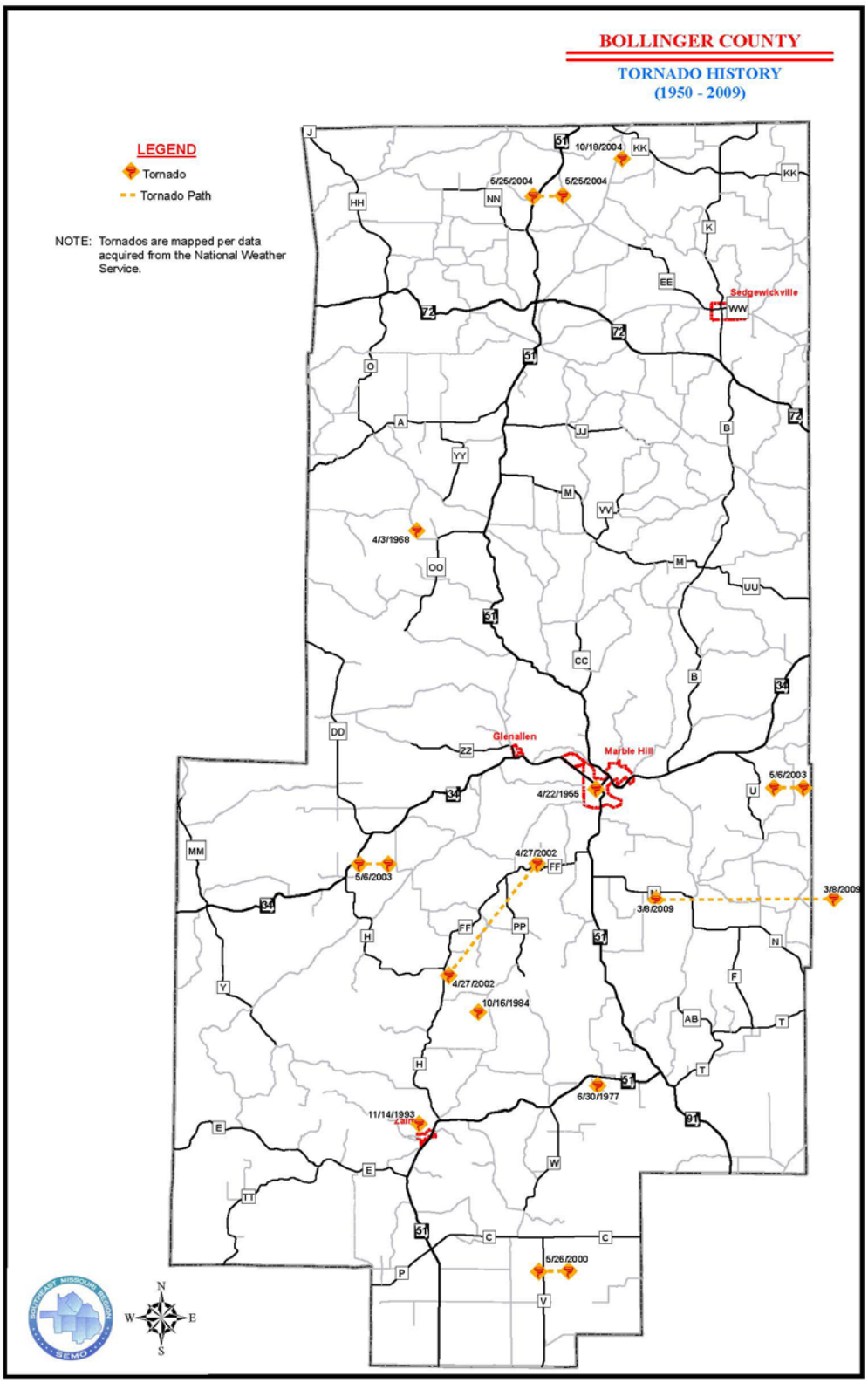
Previous Occurrences

The NCEI lists 14 tornadoes in the county from 1995-2019. Prior to 1993, only very destructive tornadoes were recorded. It is necessary to go back as far as possible due to the random and intermittent nature of tornado events, but data limitations hinder this.

There are additional limitations to the use of NCEI tornado data that must be noted. For example, one tornado may contain multiple segments as it moves geographically. A tornado that crosses a county line or state line is considered a separate segment for the purposes of reporting to the NCEI. Also, a tornado that lifts off the ground for less than 5 minutes or 2.5 miles is considered a separate segment. If the tornado lifts off the ground for greater than 5 minutes or 2.5 miles, it is considered a separate tornado. Tornadoes reported in Storm Data and the Storm Events Database are in segments.

Figure 3.16 shows the approximate paths of all NCEI listed tornadoes in the County from 1950 to 2009.

Figure 3.16. Historic Tornado Events



Source: National Climatic Data Center, http://www.NCEI.noaa.gov/stormevents/

Probability of Future Occurrence

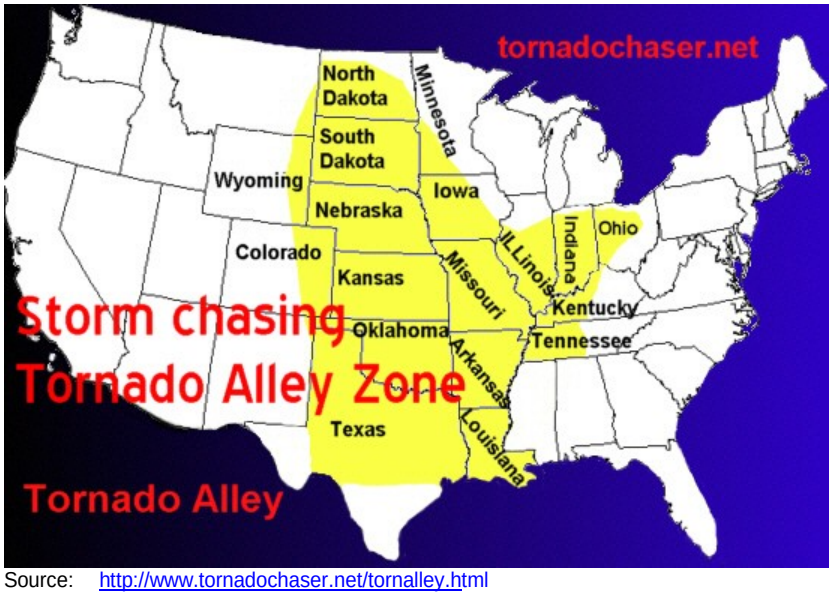
There have been 14 NCEI listed tornadoes in the County over the past 25 years. This equals an annual probability of 56% of a tornado event.

Vulnerability

Vulnerability Overview

Bollinger County is located in the region of the country known as "Tornado Alley," a region of the nation with a high frequency of dangerous and destructive tornadoes (Figure 3.17). This high frequency leads to an elevated vulnerability to tornadoes for the County, but the rural nature of the County limits the amount of damage done by any single event. Because of this, the 2018 State HMP rates the county with a "Low Medium" tornado vulnerability.

Figure 3.17. Tornado Alley in the U.S.



Source: http://www.tornadochaser.net/tornalley.html

Potential Losses to Existing Development

According to the 2018 State HMP, the county has annualized tornado damages of $87,701.

Future Development

Additional development in any jurisdiction will lead to greater exposure of structures to a tornado event. Given the low growth projection of the county though, increases are expected to be minimal.

Hazard Summary by Jurisdiction

A tornado event is equally likely to happen in any area of the county.

Problem Statement

Any participant can be affected by a tornado. The school districts' dense population during session leads to higher vulnerability during the day. The county has early warning sirens to alert residents to approaching tornadoes. Given the low population density in the county, saferooms are not typically cost effective, unless developed on a county property in one of the communities.

3.4.11 Winter Weather/Snow/Ice/Severe Cold

Hazard Profile

Hazard Description

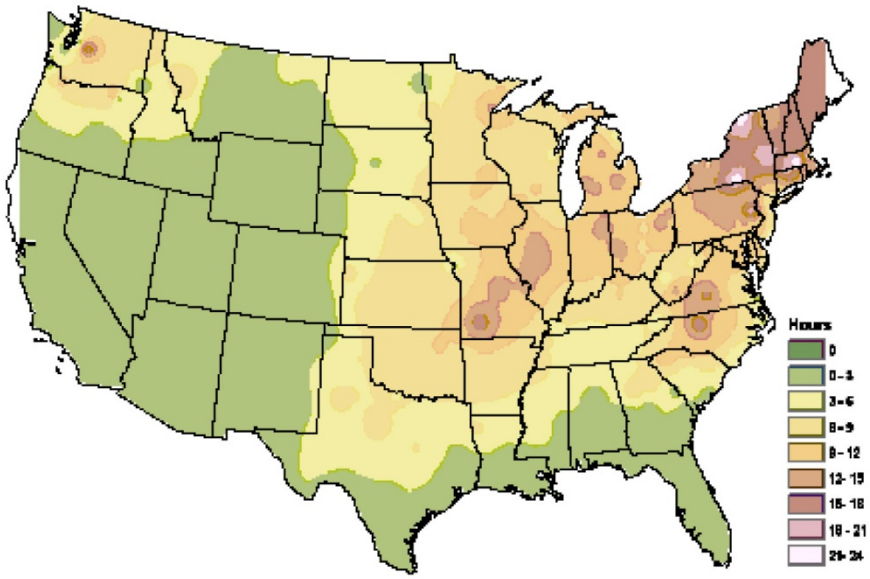
A major winter storm can last for several days and be accompanied by high winds, freezing rain or sleet, heavy snowfall, and cold temperatures. The National Weather Service describes different types of winter storm events as follows.

Blizzard—Winds of 35 miles per hour or more with snow and blowing snow reducing visibility to less than ¼ mile for at least three hours.
Blowing Snow—Wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground picked up by the wind.
Snow Squalls—Brief, intense snow showers accompanied by strong, gusty winds. Accumulation may be significant.
Snow Showers—Snow falling at varying intensities for brief periods of time. Some accumulation is possible.
Freezing Rain—Measurable rain that falls onto a surface with a temperature below freezing. This causes it to freeze to surfaces, such as trees, cars, and roads, forming a coating or glaze of ice. Most freezing-rain events are short lived and occur near sunrise between the months of December and March.
Sleet—Rain drops that freeze into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects.

Geographic Location

The entire county is vulnerable to heavy snow, ice, freezing rain, and extreme cold temperatures. Figure 3.18 shows the average number of hours per year with freezing rain, with the County sitting on the line between 9-12 hours and 12-15 hours.

Figure 3.18. NWS Statewide Average Number of Hours per Year with Freezing Rain



Source: American Meteorological Society. "Freezing Rain Events in the United States." http://ams.confex.com/ams/pdfpapers/71872.pdf

Severity/Magnitude/Extent

Severe winter storms include extreme cold, heavy snowfall, ice, and strong winds which can push the wind chill well below zero degrees in the planning area. Heavy snow can bring a community to a standstill by inhibiting transportation (in whiteout conditions), weighing down utility lines, and by causing structural collapse in

buildings not designed to withstand the weight of the snow. Repair and snow removal costs can be significant. Ice buildup can collapse utility lines and communication towers, as well as make transportation difficult and hazardous. Ice can also become a problem on roadways if the air temperature is high enough that precipitation falls as freezing rain rather than snow.

Extreme cold often accompanies severe winter storms and can lead to hypothermia and frostbite in people without adequate clothing protection. Cold can cause fuel to congeal in storage tanks and supply lines, stopping electric generators. Cold temperatures can also overpower a building's heating system and cause water and sewer pipes to freeze and rupture. Extreme cold also increases the likelihood for ice jams on flat rivers or streams. When combined with high winds from winter storms, extreme cold becomes extreme wind chill, which is hazardous to health and safety.

The National Institute on Aging estimates that more than 2.5 million Americans are elderly and especially vulnerable to hypothermia, with the isolated elders being most at risk. About 10 percent of people over the age of 65 have some kind of bodily temperature-regulating defect, and 3-4 percent of all hospital patients over 65 are hypothermic.

Also at risk are those without shelter, those who are stranded, or who live in a home that is poorly insulated or without heat. Other impacts of extreme cold include asphyxiation (unconsciousness or death from a lack of oxygen) from toxic fumes from emergency heaters; household fires, which can be caused by fireplaces and emergency heaters; and frozen/burst pipes.

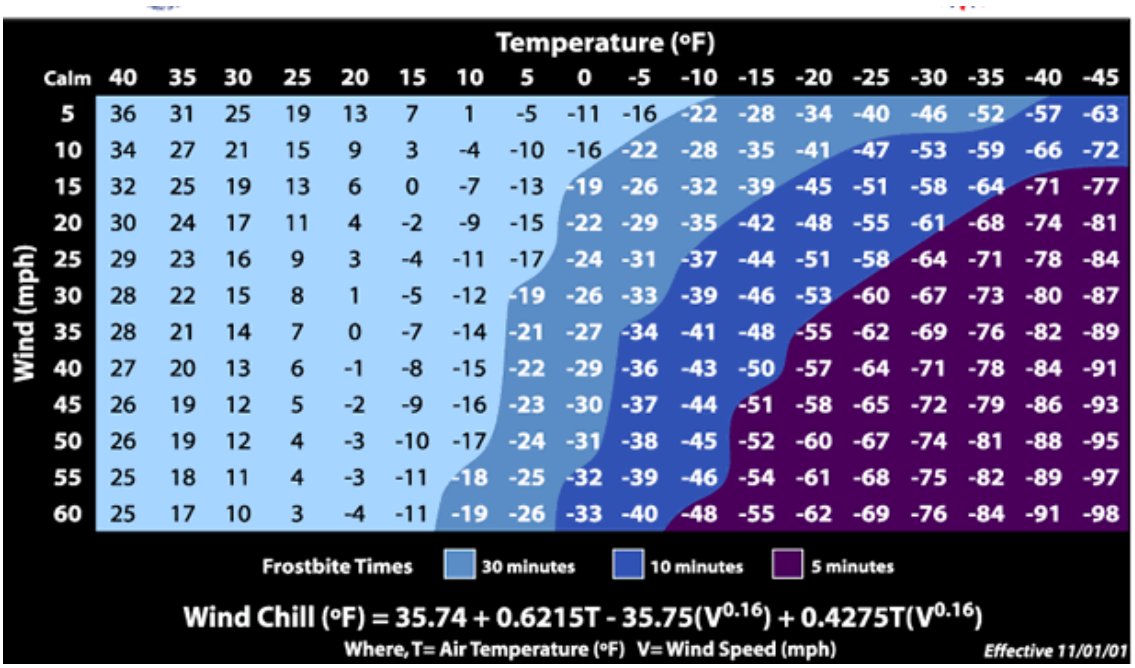
Buildings with overhanging tree limbs are more vulnerable to damage during winter storms when limbs fall. Businesses experience loss of income as a result of closure during power outages. In general heavy winter storms increase wear and tear on roadways though the cost of such damages is difficult to determine. Businesses can experience loss of income as a result of closure during winter storms.

Overhead power lines and infrastructure are also vulnerable to damages from winter storms. In particular ice accumulation during winter storm events damage to power lines due to the ice weight on the lines and equipment. Damages also occur to lines and equipment from falling trees and tree limbs weighted down by ice. Potential losses could include cost of repair or replacement of damaged facilities, and lost economic opportunities for businesses.

Secondary effects from loss of power could include burst water pipes in homes without electricity during winter storms. Public safety hazards include risk of electrocution from downed power lines. Specific amounts of estimated losses are not available due to the complexity and multiple variables associated with this hazard. Standard values for loss of service for utilities reported in FEMA's 2009 BCA Reference Guide, the economic impact as a result of loss of power is $126 per person per day of lost service.

Wind can greatly amplify the impact of cold ambient air temperatures. Provided by the National Weather Service, Figure 3.19 below shows the relationship of wind speed to apparent temperature and typical time periods for the onset of frostbite.

Figure 3.19. Wind Chill Chart



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

Source: National Weather Service, http://www.nws.noaa.gov/om/winter/windchill.shtml

Previous Occurrences

The National Centers for Environmental Information lists 39 winter weather events in the past 25 years. Table 3.28 provides a list of the events.

Table 3.28. NCEI Winter Weather Events Summary, 1995-2019

LOCATION	DATE	EVENT TYPE	DEATHS	INJURIES	DAMAGE-PROPERTY	DAMAGE-CROPS
County-wide	1/2/1996	Winter Storm	0	0	0	0
County-wide	12/16/1996	Winter Storm	0	0	0	0
County-wide	1/8/1997	Winter Storm	0	0	0	0
County-wide	1/15/1997	Ice Storm	0	0	0	0
County-wide	1/1/1999	Ice Storm	0	0	50000	0
County-wide	3/13/1999	Heavy Snow	0	0	0	0
County-wide	1/28/2000	Heavy Snow	0	0	0	0
County-wide	12/12/2000	Extreme Cold/Wind Chill	0	0	0	0
County-wide	12/13/2000	Winter Storm	0	0	0	0
County-wide	1/1/2001	Extreme Cold/Wind Chill	0	0	0	0
County-wide	2/21/2001	Winter Storm	0	0	0	0
County-wide	1/18/2002	Heavy Snow	0	0	0	0
County-wide	2/6/2002	Heavy Snow	0	0	0	0
County-wide	12/4/2002	Winter Storm	0	0	0	0
County-wide	12/23/2002	Heavy Snow	0	0	0	0
County-wide	1/16/2003	Winter Storm	0	0	0	0
County-wide	2/6/2003	Heavy Snow	0	0	0	0

County-wide	2/16/2003	Winter Storm	0	0	0	0
County-wide	2/23/2003	Heavy Snow	0	0	0	0
County-wide	1/25/2004	Ice Storm	0	0	0	0
County-wide	2/5/2004	Heavy Snow	0	0	0	0
County-wide	12/22/2004	Winter Storm	0	0	0	0
County-wide	1/31/2008	Winter Storm	0	0	0	0
County-wide	2/1/2008	Winter Storm	0	0	0	0
County-wide	2/11/2008	Winter Storm	0	0	2000000	0
County-wide	2/21/2008	Ice Storm	0	0	0	0
County-wide	3/3/2008	Winter Storm	0	0	50000	0
County-wide	12/15/2008	Winter Storm	0	0	0	0
County-wide	1/15/2009	Extreme Cold/Wind Chill	0	0	0	0
County-wide	1/26/2009	Winter Storm	0	0	50000	0
County-wide	1/29/2010	Heavy Snow	0	0	0	0
County-wide	2/21/2013	Ice Storm	0	0	100000	0
County-wide	12/5/2013	Winter Storm	0	0	0	0
County-wide	2/4/2014	Winter Storm	0	0	0	0
County-wide	3/2/2014	Winter Storm	0	0	0	0
County-wide	2/15/2015	Heavy Snow	0	0	0	0
County-wide	2/20/2015	Winter Storm	0	0	0	0
County-wide	3/4/2015	Winter Storm	0	0	0	0
County-wide	1/19/2019	Heavy Snow	0	0	0	0

Source: NCEI

Probability of Future Occurrence

With 39 events in 25 years, the County is projected to experience at least one winter storm event every year.

Vulnerability

Vulnerability Overview

The 2018 State HMP lists the county with a “Medium” vulnerability to winter storm events. This determination is made based on multiple factors, including housing density, likelihood of the event, property and crop losses, and social vulnerability.

Potential Losses to Existing Development

According to the 2018 State HMP, the county has had property annualized losses of $107,143 per year.

Future Development

Additional development will increase a jurisdiction’s exposure to the hazard by adding structures and people to the study area. The minor projected growth rate of the county indicates little future impact due to development trends.

Hazard Summary by Jurisdiction

All jurisdictions are equally exposed to severe winter weather, though the event will have different impacts on different jurisdictions. Schools are typically closed during these events, making property damage their primary

concern. While the county has far less population density compared to the communities, county residents can far more easily have transportation and communications severed by winter storms, leaving them isolated for days or even weeks in extreme cases.

Problem Statement

Winter weather can affect any of the participants. While the school districts typically close during severe events, in some cases children are present when an event occurs sooner or stronger than expected. Transportation of students during such an event can be dangerous, and power failures are also possible. The density of development in the county limits its exposure, but residents are also further from emergency services when compared to urban residents. Because of this, each jurisdiction is impacted by these events in a slightly different manner.

This section presents the mitigation strategy updated by the HMPC based on the updated risk assessment. The mitigation strategy was developed through a collaborative group process. The process included review of updated general goal statements to guide the jurisdictions in lessening disaster impacts as well as specific mitigation actions to directly reduce vulnerability to hazards and losses. The following definitions are taken from FEMA's *Local Hazard Mitigation Review Guide (October 1, 2012)*.

- **Mitigation Goals** are general guidelines that explain what you want to achieve. Goals are long-term policy statements and global visions that support the mitigation strategy. The goals address the risk of hazards identified in the plan.

- **Mitigation Actions** are specific actions, projects, activities, or processes taken to reduce or eliminate long-term risk to people and property from hazards and their impacts. Implementing mitigation actions helps achieve the plan's mission and goals.

4.1 Goals

This planning effort is an update to Bollinger County's existing hazard mitigation plan approved by FEMA in 2014. Therefore, the goals from the previous HMP were reviewed to see if they were still valid, feasible, practical, and applicable to the defined hazard impacts. The HMPC conducted a discussion session during their second meeting to review and update the plan goals. To ensure that the goals developed for this update were comprehensive and supported State goals, the 2018 State Hazard Mitigation Plan goals were also reviewed. SEMO RPC also presented common goals from other county HMPs.

After discussion, the HMPC decided the 2014 goals were still valid. The goals for this plan update are:

1. Protect the health, safety, and welfare of residents and students.
2. Ensure the operation of critical facilities and services.
3. Protect public and private property.
4. Enhance informed decision making of mitigation actions.

4.2 Identification and Analysis of Mitigation Actions

During the second HMPC meeting, the results of the risk assessment update were provided to the HMPC members for review and the key issues were identified for specific hazards. Changes in risk since adoption of the previously approved plan were discussed. The second meeting concluded with the distribution of a list of possible mitigation actions to prompt discussions within and among the jurisdictions. The discussions occurred during jurisdictional break-out meetings. The list included possible new mitigation actions, as well as actions from the previously approved plan. Actions from the previous plan included completed actions, on-going

actions, and actions upon which progress had not been made. The HMPC discussed SEMA's identified funding priorities and the types of mitigation actions generally recognized by FEMA.

The HMPC then updated the mitigation strategy of each jurisdiction during Meeting 2 and through electronic correspondence afterward. For a comprehensive range of mitigation actions to consider, the HMPC reviewed the following information:

- A list of actions proposed in the previous mitigation plan, the current State Plan, and approved plans in surrounding counties,
- Key issues from the risk assessments,
- State priorities established for Hazard Mitigation Assistance grants, and
- Public input during meetings, responses to Data Collection Questionnaires, and other efforts to involve the public in the plan development process.

Individual jurisdictions, including school districts, then developed final mitigation strategies for inclusion in the plan. They were encouraged to review the details of the risk assessment vulnerability analysis specific to their jurisdiction. They were also provided a link to the FEMA's publication, *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards (January 2013).* This document was developed by FEMA as a resource for identification of a range of potential mitigation actions for reducing risk to natural hazards and disasters.

The MPC reviewed the actions from the previously approved plan for progress made since the plan had been adopted, using worksheets included in the appendix of this plan. Each jurisdiction was instructed to provide information regarding the "Action Status" with one of the following status choices:

- Completed, with a description of the progress,
- Not Started/Continue in Plan Update, with a discussion of the reasons for lack of progress,
- In Progress/Continue in Plan Update, with a description of the progress made to date or
- Deleted, with a discussion of the reasons for deletion.

Table 4.1 provides a summary of the action statuses for each jurisdiction:

Table 4.1. Action Status Summary

Jurisdiction	Completed Actions	Continuing Actions (ongoing or modify)	Deleted Actions
Bollinger County	0	7	19
Meadow Heights R-II School Dist.	0	4	6
Woodland R-IV School Dist.	0	4	6

Table 4.2 provides a summary of the completed and deleted actions from the previous plan.

Table 4.2. Summary of Completed and Deleted Actions from the Previous Plan

Deleted Actions	Reason for Deletion
Emphasize county planning and zoning and building codes	County has no planning or zoning

Enforce floodplain regulations and boundaries	Included in NFIP actions
Assist in updating of FIRMs	Included in NFIP actions
Require permits for development in a floodplain	Included in NFIP actions
Buyout repetitive loss properties	No potential properties identified at this time
Issue evacuation orders	Not a mitigation action
Regularly inspect, repair, and improve dams	No dams under jurisdictions' control
Encourage mobile home owners to anchor homes	Jurisdictions felt action was weak
Retrofit, where possible, buildings and bridges for seismic resistance	No structures identified at this time
Clear brush and debris from around buildings	On-going maintenance, weak action
Retain green space and reduce hard surface areas	Jurisdictions chose to focus on other actions
Encourage reinforcement of towers	Jurisdictions have no control over towers, weak action
Maintain mutual aid agreements	General practice of jurisdictions, weak action
Monitor weather	General practice of jurisdictions, weak action
Confirm equipment is in usable condition	General practice of jurisdictions, weak action
Provide emergency shelters	Included in Safe Room actions
Maintain GIS system	General practice of jurisdictions, weak action
Make pertinent data available	General practice of jurisdictions, weak action

4.3 Implementation of Mitigation Actions

Jurisdictions were encouraged to meet with others in their community to finalize the actions to be submitted for the updated mitigation strategy. Throughout the HMPC consideration and discussion, emphasis was placed on the importance of a benefit-cost analysis in determining project priority. The Disaster Mitigation Act requires benefit-cost review as the primary method by which mitigation projects should be prioritized. The HMPC decided to pursue implementation according to when and where damage occurs, available funding, political will, and jurisdictional priority. The benefit/cost review at the planning stage primarily consisted of a qualitative analysis and was not the detailed process required for grant funding applications. For each action, the plan sets forth a narrative describing the types of benefits that could be realized from action implementation. The cost was estimated as closely as possible, with further refinement to be supplied as project development occurs.

FEMA's STAPLEE methodology was used to assess the costs and benefits, overall feasibility of mitigation actions, and other issues impacting project. During the prioritization process, the HMPC used worksheets to assign scores. The worksheets posed questions based on the STAPLEE elements as well as the potential mitigation effectiveness of each action. Scores were based on the responses to the questions as follows:

Definitely yes = 3 points
Maybe yes = 2 points
Probably no = 1
Definitely no = 0

The following questions were asked for each proposed action.

S: Is the action socially acceptable?
T: Is the action technically feasible and potentially successful?
A: Does the jurisdiction have the administrative capability to successfully implement this action?
P: Is the action politically acceptable?
L: Does the jurisdiction have the legal authority to implement the action?
E: Is the action economically beneficial?
E: Will the project have an environmental impact that is either beneficial or neutral? (score "3" if positive

and “2” if neutral)

Will the implemented action result in lives saved?
Will the implanted action result in a reduction of disaster damage?

A blank STAPLEE worksheet is shown in Figure 4.1

Figure 4.1. Blank STAPLEE Worksheet

XXXXXX COUNTY
MULTI-JURISDICTIONAL
LOCAL HAZARD MITIGATION PLAN

Action Title:	**Jurisdiction:**
Action ID:	

STAPLEE Criteria	Evaluation Rating Definitely YES = 3 Maybe YES = 2 Probably NO = 1 Definitely NO = 0	Score
S: Is it Socially acceptable?		
T: Is it Technically feasible and potentially successful?		
A: Does the jurisdiction have the administrative capacity to execute this action?		
P: Is it Politically acceptable?		
L: Is there Legal authority to implement?		
E: Is it Economically beneficial?		
E: Will the project have either a neutral or positive impact on the natural environment? (score a 3 if positive impact, 2 if neutral impact)		
Will historic structures be saved or protected?		
Could it be implemented quickly?		
STAPLEE Score		

Mitigation Effectiveness Criteria	**Evaluation Rating**	**Score**
Will the implemented action result in lives saved?	Assign from 5-10 points based on the likelihood that lives would be saved.	
Will the implemented action result in a reduction of disaster damages?	Assign from 5-10 points based on the relative reduction of disaster damages.	
Mitigation Effectiveness Score		

Total Score (STAPLEE Score + Mitigation Effectiveness Score): _____

Priority Level: ☐ High (30+ points) ☐ Medium (25-29 points) ☐ Low (less than 25 points)

Completed by (name/title/phone #): _____

Figure 4.2. Bollinger County New and Continuing Actions

Action Worksheet	
Name of Jurisdiction:	Bollinger County
Risk / Vulnerability	
Hazard(s) Addressed:	Tornado, Extreme Heat, Winter Weather/Severe Cold
Problem being Mitigated:	Lack of safe locations for some residents
Action or Project	
Applicable Goal Statement:	Protect the health, safety, and welfare of residents.
Action/Project Number:	BC1
Name of Action or Project:	Construct Safe Room
Mitigation Category:	Structure and Infrastructure Projects
Action or Project Description:	Construct a safe room in county
Estimated Cost:	$5-$20 million
Benefits:	Provide safe location for residents to take shelter during a tornado or other hazards
Plan for Implementation	
Responsible Organization/Department:	County Commission
Supporting Organization/Department:	
Action/Project Priority:	23/Low
Timeline for Completion:	5 years
Potential Fund Sources:	FEMA Grant, General Revenue
Local Planning Mechanisms to be Used in Implementation, if any:	Annual Budget Process
Progress Report	
Action Status:	Continuing-not started
Report of Progress:	None, funding constraints

Action Worksheet	
Name of Jurisdiction:	Bollinger County
Risk / Vulnerability	
Hazard(s) Addressed:	Tornado
Problem being Mitigated:	Lack of advanced warning
Action or Project	
Applicable Goal Statement:	Protect the health, safety, and welfare of residents and students.
Action/Project Number:	BC2
Name of Action or Project:	Construct emergency warning sirens
Mitigation Category:	Structure and Infrastructure Projects
Action or Project Description:	Construct emergency warning sirens throughout county
Estimated Cost:	$100,000-$250,000
Benefits:	Provide advanced warning to residents during a tornado event
Plan for Implementation	
Responsible Organization/Department:	EMA
Supporting Organization/Department:	County Commission
Action/Project Priority:	38/Medium
Timeline for Completion:	5 years
Potential Fund Sources:	FEMA Grant, General Revenue
Local Planning Mechanisms to be Used in Implementation, if any:	Annual Budget Process
Progress Report	
Action Status:	Continuing-not started
Report of Progress:	None, funding constraints

Action Worksheet	
Name of Jurisdiction:	Bollinger County
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding
Problem being Mitigated:	Development in floodplain
Action or Project	
Applicable Goal Statement:	Protect the health, safety, and welfare of residents.
Action/Project Number:	BC3
Name of Action or Project:	NFIP Participation
Mitigation Category:	Prevention
Action or Project Description:	Enforce floodplain management ordinances, regulate new construction in SFHA, work with residents to identify flood prone areas, assist residents with map amendment process.
Estimated Cost:	$10,000-$20,000
Benefits:	Reduce development in SFHA, protect floodplain.
Plan for Implementation	
Responsible Organization/Department:	EMA
Supporting Organization/Department:	County Commission
Action/Project Priority:	30/High
Timeline for Completion:	Ongoing
Potential Fund Sources:	General Revenue
Local Planning Mechanisms to be Used in Implementation, if any:	Floodplain Ordinances
Progress Report	
Action Status:	Continuing
Report of Progress:	Ongoing

Action Worksheet	
Name of Jurisdiction:	Bollinger County
Risk / Vulnerability	
Hazard(s) Addressed:	Tornado, Earthquake, Winter Weather, Severe Thunderstorm, Extreme Heat
Problem being Mitigated:	Loss of power and response capabilities
Action or Project	
Applicable Goal Statement:	Ensure the operation of critical facilities and services.
Action/Project Number:	BC4
Name of Action or Project:	Emergency Generators
Mitigation Category:	Structure and Infrastructure Projects
Action or Project Description:	Purchase and install emergency generators at county facilities
Estimated Cost:	$50,000-$100,000
Benefits:	Keep facilities and services operational during and after an event.
Plan for Implementation	
Responsible Organization/Department:	EMA
Supporting Organization/Department:	County Commission
Action/Project Priority:	25/Medium
Timeline for Completion:	5 years
Potential Fund Sources:	FEMA Grant, General Revenue, Homeland Security
Local Planning Mechanisms to be Used in Implementation, if any:	EOP
Progress Report	
Action Status:	Continuing-not started
Report of Progress:	None, funding constraints

Action Worksheet	
Name of Jurisdiction:	Bollinger County
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding
Problem being Mitigated:	Impediment to transportation and emergency services
Action or Project	
Applicable Goal Statement:	Ensure the operation of critical facilities and services.
Action/Project Number:	BC5
Name of Action or Project:	Low water crossings/culvert improvements
Mitigation Category:	Structure and Infrastructure Projects
Action or Project Description:	Raise low water crossings in the county/improve culverts
Estimated Cost:	$25,000-$500,000
Benefits:	Keep transportation routes open to allow residents to travel as needed and allow emergency services to reach residents.
Plan for Implementation	
Responsible Organization/Department:	Road and Bridge
Supporting Organization/Department:	County Commission
Action/Project Priority:	23/Low
Timeline for Completion:	5 years
Potential Fund Sources:	General Revenue, MoDOT BRO
Local Planning Mechanisms to be Used in Implementation, if any:	Annual Budget Process
Progress Report	
Action Status:	Continuing-not started
Report of Progress:	None, funding constraints

Action Worksheet	
Name of Jurisdiction:	Bollinger County
Risk / Vulnerability	
Hazard(s) Addressed:	Dam Failure
Problem being Mitigated:	Flooding and damage due to dam failure
Action or Project	
Applicable Goal Statement:	Protect public and private property
Action/Project Number:	BC6
Name of Action or Project:	Inspect dams
Mitigation Category:	Prevention
Action or Project Description:	Continue inspection programs of dams to prevent failure and flooding
Estimated Cost:	$10,000-$50,000
Benefits:	Reduce risk of flooding due to dam failure
Plan for Implementation	
Responsible Organization/Department:	EMA
Supporting Organization/Department:	Dam Owners
Action/Project Priority:	30/High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Dam owners, FEMA
Local Planning Mechanisms to be Used in Implementation, if any:	EOP
Progress Report	
Action Status:	Continuing
Report of Progress:	Ongoing

Action Worksheet	
Name of Jurisdiction:	Bollinger County
Risk / Vulnerability	
Hazard(s) Addressed:	Sinkholes
Problem being Mitigated:	Property damage due to sinkholes
Action or Project	
Applicable Goal Statement:	Protect public and private property
Action/Project Number:	BC7
Name of Action or Project:	Sinkhole study
Mitigation Category:	Prevention
Action or Project Description:	Develop study of potential sinkholes
Estimated Cost:	$20,000-$40,000
Benefits:	Prevent development near potential future sinkholes
Plan for Implementation	
Responsible Organization/Department:	EMA
Supporting Organization/Department:	
Action/Project Priority:	23/Low
Timeline for Completion:	5 years
Potential Fund Sources:	FEMA, EDA, DNR
Local Planning Mechanisms to be Used in Implementation, if any:	Annual Budget Process
Progress Report	
Action Status:	New
Report of Progress:	New

Figure 4.3. Meadow Heights R-II School Dist. New and Continuing Actions

Action Worksheet	
Name of Jurisdiction:	Meadow Heights R-II
Risk / Vulnerability	
Hazard(s) Addressed:	Tornado
Problem being Mitigated:	Lack of safe locations for students
Action or Project	
Applicable Goal Statement:	Protect the health, safety, and welfare of residents.
Action/Project Number:	MH-1
Name of Action or Project:	Construct Safe Room
Mitigation Category:	Structure and Infrastructure Projects
Action or Project Description:	Construct a safe room on school property
Estimated Cost:	$2-$5 million
Benefits:	Provide safe location for students to take shelter during a tornado
Plan for Implementation	
Responsible Organization/Department:	Emergency Manager
Supporting Organization/Department:	
Action/Project Priority:	33/Medium
Timeline for Completion:	2 years
Potential Fund Sources:	FEMA Grant
Local Planning Mechanisms to be Used in Implementation, if any:	CIP, Master Plan
Progress Report	
Action Status:	Continuing-not started
Report of Progress:	None, funding constraints

Action Worksheet	
Name of Jurisdiction:	Meadow Heights R-II
Risk / Vulnerability	
Hazard(s) Addressed:	Tornado, Earthquake, Winter Storm, Severe Thunderstorm
Problem being Mitigated:	Loss of power and response capabilities
Action or Project	
Applicable Goal Statement:	Ensure the operation of critical facilities and services.
Action/Project Number:	MH-2
Name of Action or Project:	Emergency Generators
Mitigation Category:	Emergency Services
Action or Project Description:	Purchase and install emergency generators at school facilities
Estimated Cost:	$100,000-$200,000
Benefits:	Keep facilities and services operational during and after an event.
Plan for Implementation	
Responsible Organization/Department:	Emergency Manager
Supporting Organization/Department:	
Action/Project Priority:	33/High
Timeline for Completion:	3 years
Potential Fund Sources:	FEMA Grant, General Revenue
Local Planning Mechanisms to be Used in Implementation, if any:	CIP
Progress Report	
Action Status:	Continuing-not started
Report of Progress:	None, funding constraints

Figure 4.1. Woodland R-IV School Dist. New and Continuing Actions

Action Worksheet	
Name of Jurisdiction:	Woodland R-IV
Risk / Vulnerability	
Hazard(s) Addressed:	Tornado
Problem being Mitigated:	Lack of safe locations for students
Action or Project	
Applicable Goal Statement:	Protect the health, safety, and welfare of residents.
Action/Project Number:	WSD-1
Name of Action or Project:	Construct Safe Room
Mitigation Category:	Structure and Infrastructure Projects
Action or Project Description:	Construct a safe room on school property
Estimated Cost:	$2.3 million
Benefits:	Provide safe location for students to take shelter during a tornado
Plan for Implementation	
Responsible Organization/Department:	Emergency Manager
Supporting Organization/Department:	
Action/Project Priority:	33/High
Timeline for Completion:	1-2 years
Potential Fund Sources:	FEMA Grant
Local Planning Mechanisms to be Used in Implementation, if any:	CIP, Master Plan
Progress Report	
Action Status:	Continuing-not started
Report of Progress:	None, funding constraints

Action Worksheet	
Name of Jurisdiction:	Woodland R-IV
Risk / Vulnerability	
Hazard(s) Addressed:	Tornado, Earthquake, Winter Storm, Severe Thunderstorm
Problem being Mitigated:	Loss of power and response capabilities
Action or Project	
Applicable Goal Statement:	Ensure the operation of critical facilities and services.
Action/Project Number:	WSD-2
Name of Action or Project:	Emergency Generators
Mitigation Category:	Emergency Services
Action or Project Description:	Purchase and install emergency generators at school facilities
Estimated Cost:	$25,000-$50,000
Benefits:	Keep facilities and services operational during and after an event.
Plan for Implementation	
Responsible Organization/Department:	Emergency Manager
Supporting Organization/Department:	
Action/Project Priority:	28/Medium
Timeline for Completion:	2 years
Potential Fund Sources:	FEMA Grant, General Revenue
Local Planning Mechanisms to be Used in Implementation, if any:	CIP
Progress Report	
Action Status:	Continuing-not started
Report of Progress:	None, funding constraints

5 PLAN MAINTENANCE PROCESS

This chapter provides an overview of the overall strategy for plan maintenance and outlines the method and schedule for monitoring, updating and evaluating the plan. The chapter also discusses incorporating the plan into existing planning mechanisms and how to address continued public involvement.

5.1 Monitoring, Evaluating, and Updating the Plan

5.1.1 Responsibility for Plan Maintenance

The HMPC is an advisory body and can only make recommendations to county, city, town, or district elected officials. Its primary duty is to see the plan successfully carried out and to report to the community governing boards and the public on the status of plan implementation and mitigation opportunities. Other duties include reviewing and promoting mitigation proposals, hearing stakeholder concerns about hazard mitigation, passing concerns on to appropriate entities, and posting relevant information in areas accessible to the public.

5.1.2 Plan Maintenance Schedule

The HMPC agrees to meet annually and after a state or federally declared hazard event as appropriate to monitor progress and update the mitigation strategy. The county Emergency Management Director will be responsible for initiating the plan reviews and will invite members of the MPC to the meeting.

In coordination with all participating jurisdictions, a five-year written update of the plan will be submitted to the Missouri State Emergency Management Agency (SEMA) and FEMA Region VII per Requirement §201.6(c)(4)(i) of the Disaster Mitigation Act of 2000, unless disaster or other circumstances (e.g., changing regulations) require a change to this schedule. The Southeast Missouri Regional Planning Commission and the County Emergency Management Director will initiate the five-year update.

5.1.3 Plan Maintenance Process

Progress on the proposed actions can be monitored by evaluating changes in vulnerabilities identified in the plan. The MPC, during the annual meeting, should review changes in vulnerability identified as follows:

- Decreased vulnerability as a result of implementing recommended actions,
- Increased vulnerability as a result of failed or ineffective mitigation actions,

- Increased vulnerability due to hazard events, and/or
- Increased vulnerability as a result of new development (and/or annexation).

Future 5-year updates to this plan will include the following activities:

- Consideration of changes in vulnerability due to action implementation,
- Documentation of success stories where mitigation efforts have proven effective,
- Documentation of unsuccessful mitigation actions and why the actions were not effective,
- Documentation of previously overlooked hazard events that may have occurred since the previous plan approval,
- Incorporation of new data or studies with information on hazard risks,
- Incorporation of new capabilities or changes in capabilities,
- Incorporation of growth data and changes to inventories, and
- Incorporation of ideas for new actions and changes in action prioritization.

In order to best evaluate any changes in vulnerability as a result of plan implementation, the participating jurisdictions will adopt the following process:

- Each proposed action in the plan identified an individual, office, or agency responsible for action implementation. This entity will track and report on an annual basis to the jurisdictional HMPC member on action status. The entity will provide input on whether the action as implemented meets the defined objectives and is likely to be successful in reducing risk.
- If the action does not meet identified objectives, the jurisdictional HMPC member will determine necessary remedial action, making any required modifications to the plan.

Changes will be made to the plan to remedy actions that have failed or are not considered feasible. Feasibility will be determined after a review of action consistency with established criteria, time frame, community priorities, and/or funding resources. Actions that were not ranked high but were identified as potential mitigation activities will be reviewed as well during the monitoring of this plan. Updating of the plan will be accomplished by written changes and submissions, as the HMPC deems appropriate and necessary. Changes will be approved by the governing boards of the participating jurisdictions.

5.2 Incorporation into Existing Planning Mechanisms

Where possible, plan participants, including school districts, will use existing plans and/or programs to implement hazard mitigation actions. Based on the capability assessments of the participating jurisdictions, communities in the county will continue to plan and implement programs to reduce losses to life and property from hazards. This plan builds upon the momentum developed through previous and related planning efforts and mitigation programs and recommends implementing actions, where possible, through the following plans:

- General or master plans of participating jurisdictions;
- Ordinances of participating jurisdictions;
- County Emergency Operations Plan;
- Capital improvement plans and budgets;
- Other community plans within the County, such as water conservation plans, storm water management plans, and parks and recreation plans;

- School District plans and budgets; and
- Other plans and policies outlined in the capability assessment sections for each jurisdiction in Chapter 2 of this plan.

The HMPC members involved in updating these existing planning mechanisms will be responsible for integrating the findings and actions of the mitigation plan, as appropriate. The HMPC is also responsible for monitoring this integration and incorporation of the appropriate information into the five-year update of the multi-jurisdictional hazard mitigation plan.

Additionally, after the annual review of the Hazard Mitigation Plan, the Emergency Management Director will provide the updated Mitigation Strategy with current status of each mitigation action to the County Commission as well as all Mayors, City Clerks, and School District Superintendents. The Emergency Manager Director will request that the mitigation strategy be incorporated, where appropriate, in other planning mechanisms.

Table 5.1 below lists the planning mechanisms by jurisdiction into which the Hazard Mitigation Plan will be integrated.

Table 5.1. Planning Mechanisms Identified for Integration of Hazard Mitigation Plan

Jurisdiction	Planning Mechanisms	Integration Process for Previous Plan	Integration Process for Current Plan
Bollinger County	County Emergency Operations Plan	County officials identified actions relating to emergency operations that were included in the update to the EOP	County officials identified new or ongoing actions relating to emergency operations that will be included in the next update to the EOP
Bollinger County	Annual Budget Process	County officials identified actions that were included in the annual budget process	County officials identified new or ongoing actions that will be discussed during the next annual budget process
Meadow Heights R-II School Dist.	Master Plan	School representatives identified actions relating to infrastructure and development that were included in Master Plan update	School representatives identified new or ongoing actions relating to future development that will be included in the next Master Plan update
Meadow Heights R-II School Dist.	Capital Improvement Program	School representatives identified actions relating to infrastructure that were included in annual update to CIP	School representatives identified new actions or ongoing actions relating to infrastructure that will be included in annual update to CIP
Meadow Heights R-II School Dist.	School Emergency Plan	School representatives identified actions	School representatives identified new actions or

		relating to emergency procedures that were included in previous update to Emergency Plan	ongoing actions relating to emergency procedures that will be included in the next update to the Emergency Plan
Woodland R-IV School Dist.	Master Plan	School representatives identified actions relating to infrastructure and development that were included in Master Plan update	School representatives identified new or ongoing actions relating to future development that will be included in the next Master Plan update
Woodland R-IV School Dist.	Capital Improvement Program	School representatives identified actions relating to infrastructure that were included in annual update to CIP	School representatives identified new actions or ongoing actions relating to infrastructure that will be included in annual update to CIP
Woodland R-IV School Dist.	School Emergency Plan	School representatives identified actions relating to emergency procedures that were included in previous update to Emergency Plan	School representatives identified new actions or ongoing actions relating to emergency procedures that will be included in the next update to the Emergency Plan

5.3 Continued Public Involvement

The hazard mitigation plan update process provides an opportunity to publicize success stories resulting from the plan's implementation and seek additional public comment. Information about the annual reviews will be posted in the local newspaper as well as on the county website following each annual review of the mitigation plan. When the HMPC reconvenes for the five-year update, it will coordinate with all stakeholders participating in the planning process. Included in this group will be those who joined the MPC after the initial effort, to update and revise the plan. Public notice will be posted and public participation will be actively solicited, at a minimum, through available website postings and press releases to local media outlets, primarily newspapers.

APPENDIX A: ADOPTION RESOLUTIONS

1.1 Adoption Resolutions

Bollinger County, Missouri RESOLUTION NO. 2019-2

A RESOLUTION OF THE BOLLINGER COUNTY COMMISSION ADOPTING THE BOLLIGNER COUNTY ALL-HAZARD MITIGATION PLAN (UPDATED 2019)

WHEREAS Bollinger County recognizes the threat that natural hazards pose to people and property within the Bollinger County; and

WHEREAS Bollinger County has participated in the preparation of a multi- hazard mitigation plan, hereby known as the *Bollinger County All-Hazard Mitigation Plan (Updated 2019),* hereafter referred to as the *Plan,* in accordance with the Disaster Mitigation Act of 2000; and

WHEREAS the *Plan* identifies mitigation goals and actions to reduce or eliminate long-term risk to people and property in Bollinger County from the impacts of future hazards and disasters; and

WHEREAS Bollinger County recognizes that land use policies have a major impact on whether people and property are exposed to natural hazards, the Bollinger County will endeavor to integrate the *Plan* into the comprehensive planning process and

WHEREAS adoption by Bollinger County demonstrates their commitment to hazard mitigation and achieving the goals outlined in the *Plan*

NOW THEREFORE, BE IT RESOLVED BY BOLLINGER COUNTY, in the State of Missouri, THAT:

Section 1. Bollinger County adopts the final FEMA-*approved plan.*

ADOPTED by a vote of 3 in favor and 0 against, and 0 abstaining, this 28th day of October, 2019

By (Sig): _____

Print name: Leo Arnzen

ATTEST:

By (Sig.): _____

Print name: ROY GARNER

APPROVED AS TO FORM:

By (Sig.): _____

Print name: _____

The following resolution was adopted by Meadow Heights R-II on September 9, 2019.

A RESOLUTION OF INTENT TO CONTINUE TO PARTICIPATE IN NATURAL HAZARD MITIGATION AND TO WORK TOWARD BECOMING A SAFER COMMUNITY.

WHEREAS, Meadow Heights R-II School District recognizes that no community is immune from natural hazards whether it be tornado/severe thunderstorm, flood, severe winter weather, drought, extreme heat or cold, earthquake, dam or levee failure, sinkholes, or wildfire and recognizes the importance of enhancing its ability to withstand natural hazards as well as the importance of reducing the human suffering, property damage, interruption of public services and economic losses caused by those hazards; and,

WHEREAS, Meadow Heights R-II School District may have previously pursued measures such as building codes, fire codes, floodplain management regulations, zoning ordinances, and storm water management regulations to minimize the impact of natural hazards; and,

WHEREAS, the Federal Emergency Management Agency and the State Emergency Management Agency have developed a natural hazard mitigation program that assists communities in their efforts to become Disaster-Resistant Communities which are sustainable communities after a natural disaster that focus, not just on disaster relief, but also on recovery and reconstruction that brings the community to at least pre-disaster conditions in an accelerated, orderly and preplanned manner; and,

WHEREAS, by participating in the Natural Hazards Mitigation program, Meadow Heights R-II School District will be eligible to apply for post-disaster mitigation funds; and,

WHEREAS, Meadow Heights R-II School District desires to commit to working with government partners and community partners to implement the Natural Hazards Mitigation Plan; and,

WHEREAS, Meadow Heights R-II School District will implement pertinent precepts of the mitigation plan by incorporation into other plans and mechanisms where appropriate; and,

WHEREAS, Meadow Heights R-II School District will participate in the evaluation and review of the Plan after a disaster, as well as complete a mandated five-year update submitted to the State Emergency Management Agency and the Federal Emergency Management Agency for review and approval;

NOW, THEREFORE BE IT RESOLVED BY [Executive/Administrative Body] OF Meadow Heights R-II School District AS FOLLOWS:

Meadow Heights R-II School District here by approves and adopts the Bollinger County Multi-Jurisdictional Natural Hazard Mitigation Plan attached hereto for the purpose of building a safer community by reducing natural hazard vulnerability.

Board President _____

Date 9/9/19

WOODLAND R-IV SCHOOL DISTRICT, Missouri

RESOLUTION NO. 11-11-2019

A RESOLUTION OF THE WOODLAND R-IV SCHOOL DISTRICT ADOPTING THE BOLLINGER COUNTY ALL-HAZARD MITIGATION PLAN (UPDATED 2019)

WHEREAS the WOODLAND R-IV SCHOOL DISTRICT recognizes the threat that natural hazards pose to people and property within the WOODLAND R-IV SCHOOL DISTRICT; and

WHEREAS the WOODLAND R-IV SCHOOL DISTRICT has participated in the preparation of a multi-hazard mitigation plan, hereby known as the *Bollinger County All-Hazard Mitigation Plan (Updated 2019),* hereafter referred to as the *Plan,* in accordance with the Disaster Mitigation Act of 2000; and

WHEREAS the *Plan* identifies mitigation goals and actions to reduce or eliminate long-term risk to people and property in the WOODLAND R-IV SCHOOL DISTRICT from the impacts of future hazards and disasters; and

WHEREAS the WOODLAND R-IV SCHOOL DISTRICT recognizes that land use policies have a major impact on whether people and property are exposed to natural hazards, the WOODLAND R-IV SCHOOL DISTRICT will endeavor to integrate the *Plan* into the comprehensive planning process and

WHEREAS adoption by the WOODLAND R-IV SCHOOL DISTRICT demonstrates their commitment to hazard mitigation and achieving the goals outlined in the *Plan*

NOW, THEREFORE, BE IT RESOLVED BY THE WOODLAND R-IV SCHOOL DISTRICT, in the State of Missouri, THAT:

Section 1. In accordance with (local rule for adopting resolutions), theWOODLAND R-IV SCHOOL DISTRICT adopts the final FEMA-*approved plan*.

ADOPTED by a vote of ____ in favor and ____ against, and____ abstaining, this 11th day of November, 2019..

By (Sig): Jeff Scott
Print name: Jeff Scott

ATTEST:
By (Sig.): Megan Baker
Print name: Megan Baker

APPROVED AS TO FORM:
By (Sig.): Michael Kiehne
Print name: Michael Kiehne

APPENDIX B: MEETING AND NOTICE MATERIALS

1.1 Meeting and Notice Materials

PUBLIC NOTICE

Bollinger County and Participating Jurisdictions, along with the Southeast Missouri Regional Planning Commission (SEMO RPC) are beginning the plan update process for the
2020 Bollinger County Hazard Mitigation Plan.

This process is open to the public.

Meeting notices will be posted at this location, the County Courthouse, participating jurisdictions City Halls/offices, at the SEMO RPC office, and on the RPC's website: www.semorpc.org.
Public participation is encouraged to help develop the best plan possible. All meetings are open to the public and any comments, concerns, ideas, or suggestions are welcome at any time during this plan update, regardless of meeting attendance.
The draft plan can be found at:
http://www.semorpc.org/hazard_mitigation_planning.html
For more information or to provide comments or feedback on the draft, please contact:

Drew Christian
Deputy Director
Southeast Missouri Regional Planning Commission
1 W. St. Joseph Street
P.O. Box 366 Perryville, MO 63775
Phone: 573-547-8357 ext 315
Fax: 573-547-7283
dchristian@semorpc.org
www.semorpc.org

PUBLIC NOTICE

Bollinger County and Participating Jurisdictions, along with the Southeast Missouri Regional Planning Commission (SEMO RPC), are holding a **Hazard Mitigation Planning Committee meeting** for the **2020 Bollinger County Hazard Mitigation Plan** on

Thursday, October 17th, 2019 at 9:00 a.m. at the Bollinger County Courthouse
204 High St.
Marble Hill, MO 63764.

This meeting is open to the public.

Public participation is encouraged to help develop the best plan possible. The draft plan can be found at: http://www.semorpc.org/hazard_mitigation_planning.html
For more information or to provide comments or feedback on the draft, please contact:

Drew Christian
Deputy Director
Southeast Missouri Regional Planning Commission
1 W. St. Joseph Street
P.O. Box 366 Perryville, MO 63775
Phone: 573-547-8357 ext 315
Fax: 573-547-7283
dchristian@semorpc.org
www.semorpc.org

PUBLIC NOTICE

Bollinger County and Participating Jurisdictions, along with the Southeast Missouri Regional Planning Commission (SEMO RPC), are holding a **Hazard Mitigation Planning Committee meeting** for the **2020 Bollinger County Hazard Mitigation Plan** on

Thursday, October 31st, 2019 at 9:00 a.m. at the Bollinger County Courthouse
204 High St.
Marble Hill, MO 63764.

This meeting is open to the public.

Public participation is encouraged to help develop the best plan possible. The draft plan can be found at: http://www.semorpc.org/hazard_mitigation_planning.html
For more information or to provide comments or feedback on the draft, please contact:

Drew Christian
Deputy Director
Southeast Missouri Regional Planning Commission
1 W. St. Joseph Street
P.O. Box 366 Perryville, MO 63775
Phone: 573-547-8357 ext 315
Fax: 573-547-7283
dchristian@semorpc.org
www.semorpc.org

Bollinger County HMPC Meeting

Place: Bollinger Co Courthouse
Date: 10/17/2019
Time: 9:00 a.m.

RSVP'ed			
Name	Title	Agency	Present
Leo Arnzen	Presiding Commissioner	Bollinger Co	✓
Roy Garner	Commissioner	Bollinger Co	X
Kevin Cooper	EMD	Bollinger Co	X
Brittany Howard	Clerk	Bollinger Co	✓
Donna Bristow	Superintendent	Meadow Heights R-II	✓
Matt Britt	Superintendent	Leopold R-III	X
Michael Kiehne	Superintendent	Woodland R-IV	X
Mike Henson	Lt./SRO	Bollinger Co/Zalma R-V	✓

Other Attendees			

Bollinger County HMPC Meeting

Place: Bollinger Co Courthouse
Date: 10/31/2019
Time: 9:00 a.m.

RSVP'ed			
Name	Title	Agency	Present
Leo Arnzen	Presiding Commissioner	Bollinger Co	
Roy Garner	Commissioner	Bollinger Co	
Kevin Cooper	EMD	Bollinger Co	X
Brittany Howard	Clerk	Bollinger Co	
Donna Bristow	Superintendent	Meadow Heights R-II	✓
Matt Britt	Superintendent	Leopold R-III	X
Michael Kiehne	Superintendent	Woodland R-IV	X
Mike Henson	Lt./SRO	Bollinger Co/Zalma R-V	✓

Other Attendees			