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

44 CFR Requirement 201.6(c)(4): The plan maintenance process shall include a section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.

5.1.1 Responsibility for Plan Maintenance

Periodic revisions and updates of the Plan are required by Missouri SEMA to ensure that the goals and objectives for Dent County are kept current. More importantly, revisions may be necessary to ensure the plan is in full compliance with Federal regulations and state statutes. This portion of the plan outlines the procedures for completing such revisions and updates.

A key component of the ongoing plan monitoring, evaluating and updating will be the Dent County Hazard Mitigation Planning Committee (MPC). In order to carry out the activities necessary for maintaining the plan, the MPC will need to remain in place and meet periodically. The coordination of this group, as indicated in the mitigation strategy, should be a responsibility of the county EMD. On-going activities of the MPC are:

- Meet annually, and after a disaster event, to monitor and evaluate the implementation of the plan;
- Act as a forum for hazard mitigation issues;
- Disseminate hazard mitigation ideas and activities to all participants;
- Pursue the implementation of high priority, low or no-cost recommended actions;
- Maintain vigilant monitoring of multi-objective, cost-share, and other funding opportunities to help the community implement the plan's recommended actions for which no current funding exists;
- Monitor and assist in implementation and update of this plan;

- Keep the concept of mitigation in the forefront of community decision making by identifying plan recommendations when other community goals, plans, and activities overlap, influence, or directly affect increased community vulnerability to disasters;
- Report on plan progress and recommended changes to the County Board of Supervisors and governing bodies of participating jurisdictions; and
- Inform and solicit input from the public.

The MPC (or other designated responsible entity) 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 MPC (or other designated responsible entity) agrees to meet annually and after a state or federally declared hazard event, as appropriate, to monitor progress and update the mitigation strategy. The Dent County Emergency Management Director will be responsible for initiating the plan reviews and will invite members of the MPC (or other designated responsible entity) 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.

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 (or other designated responsible entity) 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 MPC (or designated responsible entity) 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 MPC (or designated responsible entity) 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 MPC (or designated responsible entity) deems appropriate and necessary. Changes will be approved by the Dent County Hazard Mitigation Planning Committee and the governing boards of the other participating jurisdictions.

5.2 Incorporation into Existing Planning Mechanisms

44 CFR Requirement §201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.

Where possible, plan participants, including school and special districts, will use existing plans and/or programs to implement hazard mitigation actions. Additionally, as jurisdictions review and update existing planning mechanisms, relevant action items and data from the HMP will be integrated. Those existing plans and programs were described in **Section 2.2** of this plan. Based on the capability assessments of the participating jurisdictions, communities in Dent 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:

- Regional Comprehensive Economic Development Strategy (CEDS) document
- General or master plans of participating jurisdictions;
- Ordinances of participating jurisdictions;
- Dent County Local Emergency Operations Plan (LEOP);
- 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 and Special 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 MPC (or designated responsible entity) members involved in updating these existing planning mechanisms will be responsible for integrating the findings and actions of the mitigation plan, as appropriate. The MPC (or designated responsible entity) 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 Dent County Emergency Management Director (EMD) will provide the updated Mitigation Strategy with current status of each mitigation action to the County (Boards of Supervisors or Commissions) as well as all Mayors, City Clerks, and School District Superintendents. The EMD 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
Unincorporated Dent County	County Emergency Operations Plan County Mitigation Plan Regional Transportation Plan Comprehensive Economic Development Strategy Land-use Plan Construction/Road & Bridge Budget	Hazard Mitigation action items were incorporated into the regional CEDS and Regional Transportation Plan by MRPC. EMD was encouraged to incorporate hazard mitigation into LEOP where applicable.	County Commission and road and bridge supervisors incorporating hazard mitigation projects into budgets and future road and bridge improvements. EMD will review LEOP again and incorporate hazard mitigation updates where applicable. CEDS and Regional Transportation Plan will be reviewed to update with revised action items.
Salem	Comprehensive Plan City Emergency Operations Plan County Mitigation Plan Debris Management Plan Regional Transportation Plan Comprehensive Economic Development Strategy Land-use Plan Critical Facilities Plan Public Works Construction Budget	Hazard Mitigation action items were incorporated into the regional CEDS and Regional Transportation Plan by MRPC. EMD was encouraged to incorporate hazard mitigation into LEOP where applicable.	City will work toward incorporating hazard mitigation projects into city budget where possible and will incorporate hazard mitigation into other plans upon revision. EMD will review LEOP again and incorporate hazard mitigation updates where applicable. CEDS and Regional Transportation Plan will be reviewed to update with revised action items.

Jurisdiction	Planning Mechanisms	Integration Process for Previous Plan	Integration Process for Current Plan
Dent-Phelps R-III	Master Plan School Emergency Plan Weapons Policy District Budget	School board and superintendent reviewed district emergency plan and district budget to see where hazard mitigation actions could be incorporated.	School board and superintendent will review Master Plan, School Emergency Plan, Weapons Policy, and district budget to update applicable areas with revised action items list. Superintendent will work toward including the certified tornado safe room(s) into the district budget.
Green Forrest R-II	Master Plan School Emergency Plan Weapons Policy District Budget	School board and superintendent reviewed district emergency plan and district budget to see where hazard mitigation actions could be incorporated.	School board and superintendent will review Master Plan, School Emergency Plan, Weapons Policy, and district budget to update applicable areas with revised action items list. Superintendent will work toward including the certified tornado safe room(s) into the district budget.
North Wood R-IV	Master Plan Capital Improvement School Emergency Plan Weapons Policy District Budget	School board and superintendent reviewed district emergency plan and district budget to see where hazard mitigation actions could be incorporated.	School board and superintendent will review Master Plan, Capital Improvement Plan, School Emergency Plan, Weapons Policy, and district budget to update applicable areas with revised action items list. Superintendent will work toward including the certified tornado safe room(s) into the district budget.
Oak Hill R-1	School Emergency Plan Weapons Policy District Budget	School board and superintendent reviewed district emergency plan and district budget to see where hazard mitigation actions could be incorporated.	School board and superintendent will review School Emergency Plan, Weapons Policy, and district budget to update applicable areas with revised action items list. Superintendent will work toward including the certified tornado safe

Jurisdiction	Planning Mechanisms	Integration Process for Previous Plan	Integration Process for Current Plan
			room(s) into the district budget.
Salem R-80	Master Plan Capital Improvement School Emergency Plan Weapons Policy District Budget	School board and superintendent reviewed district emergency plan and district budget to see where hazard mitigation actions could be incorporated.	School board and superintendent will review Master Plan, Capital Improvement Plan, School Emergency Plan, Weapons Policy, and district budget to update applicable areas with revised action items list. Superintendent will work toward including the certified tornado safe room(s) into the district budget.

Source: Jurisdiction surveys 2021

Including hazard mitigation is now routine for any planning projects or plan updates carried out by the Meramec Regional Planning Commission (MRPC). Applicable goals and action items from hazard mitigation plans have been incorporated into the regional transportation plan as well as the Community Economic Development Strategy for the region. Both of these documents are resources for cities and counties within the eight-county area and are updated on a regular basis with input from city and county representatives. This review and update process has helped city and county representatives better understand and appreciate the importance of including hazard mitigation in all applicable plans. In addition, MRPC and the hazard mitigation planning committee are also working to encourage the incorporation of hazard mitigation into the planning activities of all local governments, school districts and local entities through presentations and participation in planning activities.

5.3 Continued Public Involvement

44 CFR Requirement §201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.

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 Meramec Regional Planning Commission's website following each annual review of the mitigation plan. When the MPC 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.

44 CFR Requirement §201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

This section presents the mitigation strategy updated by the Mitigation Planning Committee (MPC) based on the updated risk assessment. The mitigation strategy was developed through a collaborative group process. The process included review of 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

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

This planning effort is the first update to Dent County's existing hazard mitigation plan originally approved by FEMA on October 30. Therefore, the goals from the original 2018 Dent County Hazard Mitigation Plan were reviewed to see if they were still valid, feasible, practical, and applicable to the defined hazard impacts. The MPC conducted a discussion session during their first 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 reviewed. The MPC reviewed the goals and decided to consolidate them from six goals to three. The following goals were established for the 2023 Dent County plan update:

Goal 1: Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.

Goal 2: Reduce the potential impact of natural disasters to property, infrastructure and the local economy.

Goal 3: Reduce the potential impact of natural disaster on the continuity of government and essential services.

4.2 Identification and Analysis of Mitigation Actions

44 CFR Requirement §201.6(c)(3)(ii): The mitigation strategy shall include a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

During the first MPC meeting, the committee discussed what needed to be updated in the risk assessment. Changes in risk since adoption of the previously approved plan were discussed. Since the last update, there have been no deaths due to natural hazard events. Action items were reviewed and suggestions made for changes to address the changes in risk. Discussions from the actions from the previous plan included completed actions, on-going actions, and actions upon which progress had not been made. The MPC discussed SEMA's identified funding priorities and the types of mitigation actions generally recognized by FEMA.

The MPC determined to include problem statements in the plan update at the end of each hazard profile, which had not been done in the previously approved plan. The problem statements summarize the risk to the planning area presented by each hazard and include possible methods to reduce that risk.

The focus of Meeting #2 was to review, prioritize and update the mitigation strategy. The MPC reviewed the list of actions proposed in the previous mitigation plan and proposed additional mitigation actions. Facilitators also provided suggestions for actions based on what some of the surrounding counties had included in their plans. Participants were also encouraged to refer to the current State Plan and 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.

During the review of the plan document, MPC members were encouraged to review the details of the risk assessment vulnerability analysis specific to their jurisdiction.

The MPC reviewed the actions from the previously approved plan for progress made since the plan had been adopted. Copies of the list of actions for each jurisdiction were provided to MPC members at planning meetings and were emailed out to all members. Action items were reviewed and the MPC provided updates on the status of action items during both planning meetings and the meeting with the road and bridge department. Each action item was reviewed and assigned one of the following:

- 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.

Based on the status updates, there were 13 completed actions, 14 deleted actions, six actions that were combined with other similar actions, and 17 continuing actions.

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
Dent County	9	13	11
Salem	9	15	12
Salem R-80 School District	5	3	3
Oak Hill R-I School District	5	3	3
Dent-Phelps R-III School District	5	3	3
North Wood R-IV School District	5	3	3
Green Forest R-II School District	5	3	3

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

Completed Actions	Completion Details (date, amount, funding source)
1.4 Monitor developments in data availability concerning the impact of levee failure, dam failure, tornados, sinkholes, land subsidence, and wildfire upon Dent County and all jurisdictions through local, state, and federal agencies.	All jurisdictions agree that this has been achieved through the plan update process. In addition, SEMA has indicated that this action item can be removed from plans.
1.6 Educate school staff on natural hazards, emergency plans, and evacuation and safety procedures.	All school districts agree that this is currently implemented and is embedded in district's policy and procedures and requirements from the Missouri Department of Elementary and Secondary Education.
1.7 Regularly review and update school emergency plans.	All school districts agree that this is currently implemented and is embedded in district's policy and procedures and requirements from the Missouri Department of Elementary and Secondary Education.
1.8 Regularly review school facilities and re-evaluate designated safe areas to insure that these areas are the safest locations to shelter students and staff.	All school districts agree that this is currently implemented and is embedded in district's policy and procedures and requirements from the Missouri Department of Elementary and Secondary Education.
1.12 Partner with local radio stations to ensure that appropriate warning of impending disasters is provided to all residents.	County and city EMDs state that this has been implemented and is embedded in policy and procedure.

Completed Actions	Completion Details (date, amount, funding source)
1.13 Disseminate information on tree trimming and dead tree removal programs and policies to residents/property owners.	Local jurisdictions stated that this action item has been implemented and is embedded in policy and procedure.
2.5 Encourage the City of Salem to develop and implement regulations for securing hazardous materials tanks and mobile homes to reduce hazards during storms and flooding.	The City of Salem stated that this action item has been implemented and is embedded in policy and ordinance.
3.5 Provide opportunities through existing meetings (Co. communications, HSOC, MRPC) for EMDs, city/county/school officials & SEMA to meet and familiarize officials with mitigation planning, implementation & budgeting for mitigation projects.	Local jurisdictions stated that this action item has been implemented and is embedded in policy.
3.6 Encourage county health department and local Red Cross Chapter to use publicity campaigns that make residents aware of proper measures to take during times of threatening conditions (e.g. drought, heat wave)	Local jurisdictions stated that this action item has been implemented and is embedded in policy and procedure.
4.3 Pool different agency resources to achieve widespread mitigation planning results.	Local jurisdictions stated that this action item has been implemented through the hazard mitigation planning process.
4.4 Encourage updated mutual aid agreements between emergency response agencies inside and outside the region.	Local jurisdictions stated that this action item has been implemented and is embedded in policy and procedures.
6.1 Work with SEMA Region I coordinator and State Hazard Mitigation Officer to learn about new mitigation funding opportunities.	Local jurisdictions stated that this action item has been implemented and is embedded in policy and procedures.
6.6 Prioritize mitigation projects, based on cost-effectiveness and starting with those sites facing the greatest threat to life, health, and property.	The local jurisdictions stated that this is being accomplished through the hazard mitigation planning process.
Deleted Actions	**Reason for Deletion**
1.11 Promote the use of weather radios by local residents and schools to insure advanced warning about threatening weather to those not served by smartphone apps.	Removed due to no longer being a high priority. Weather radio coverage is inconsistent in the planning area and there are alternative sources for information such as cell phones – which are more reliable.
1.16 Conduct a study of County Roads 2470, 4210, 6230, 5150, and 5110 to find mitigation solutions for flooding, flash flooding, and landslides.	Combined with 1.5.
1.17 Seek funding opportunities to improve phone, radio, and broadband radio reception/coverage across the county.	Combined with 1.3

Deleted Actions	Reason for Deletion
2.1 Provide information on self-inspection programs to critical facilities to assess earthquake and tornado resistance.	Removed due to no longer being a high priority.
3.1 Re-evaluate the hazard mitigation plan, merge with other community planning activities and documents, and incorporate hazard mitigation into the long-range planning and development activities of the county and each jurisdiction.	Removed as this is covered by Chapter 5 of the plan.
3.2 Distribute SEMA brochures on natural disasters at public facilities and events.	Combined with 1.1.
4.1 Encourage elected officials to disseminate information about hazard mitigation projects to the public.	Combined with 3.3.
4.2 Continue to encourage joint training (and drills) between agencies, public and private entities (including schools/businesses).	Combined with 1.2.
5.1 Provide information to the City of Salem on the benefits and costs of developing storm water management plans.	Removed due to not meeting SMART criteria and being a low priority.
5.2 Coordinate and integrate hazard mitigation activities where appropriate with emergency operations plans and procedures.	Deleted due to being included in chapter 5 of the plan.
5.3 Encourage the City of Salem to require contractor storm water management plans in all new development – both residential and commercial properties.	Removed due to not meeting SMART criteria and being a low priority.
6.2 Structure grant proposals for road/bridge upgrades so that hazard mitigation concerns are also met.	Combined with 1.5.
6.3 Work with state/local/federal agencies to include mitigation in economic & community development projects when applicable.	Removed due to not meeting SMART criteria and the MPC believing this was part of Chapter 5.
6.4 Provide information to local governments on the benefits of budgeting for and implementing hazard mitigation projects.	Removed due to not meeting SMART criteria and the MPC believing this was being achieved through the planning process.

Source: Previously approved County Hazard Mitigation Plan; MPC committee; data collection questionnaires

4.3 Implementation of Mitigation Actions

44 CFR Requirement §201.6(c)(3)(ii): The mitigation strategy shall include an action strategy describing how the actions identified in paragraph (c)(2)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefits review of the proposed projects and their associated costs.

Jurisdictional MPC members were encouraged to meet with others in their community to discuss the actions to be included in the updated mitigation strategy. Throughout the MPC 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 MPC decided to pursue implementation according to when and where damage occurs, available funding, political will, jurisdictional priority, and priorities identified in the Missouri State Hazard Mitigation Plan. The benefit/cost review at the planning stage primarily consisted of a qualitative analysis and was not the detailed process required grant funding application. 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 MPC worked together to review and assign scores. The process 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?

In addition to the STAPLEE process, each action item was also reviewed for Benefit/Cost. These two aspects of the prioritization process were scored as follows:

Benefit – two (2) points were added for each of the following avoided damages (8 points maximum = highest benefit)

- Injuries and/or casualties

- Property damages
- Loss-of-function/displacement impacts
- Emergency management costs/community costs

Cost – points were subtracted according to the following cost scale (-5 points maximum = highest cost)

- (-1) = Minimal – little cost to the jurisdiction involved
- (-3) = Moderate – definite cost involved but could likely be worked into operating budget
- (-5) = Significant – cost above and beyond most operating budgets; would require extra appropriations to finance or to meet matching funds for a grant

Note: For the Benefit/Cost Review, the benefit and cost of actions which used the word "encourage" were evaluated as if the action or strategy being encouraged was actually to be carried out.

In addition, the group considered the cost of mitigation versus the long-term savings in relation to potential lives saved and property damage avoided.

Total Score – The scores for the STAPLEE Review and Benefit/Cost Review were added to determine a Total Score for each action.

Priority Scale – To achieve an understanding of how a Total Score might be translated into a Priority Rating, a sample matrix was filled out for the possible range of ratings an action might receive on both the STAPLEE and Benefit/Cost Review. The possible ratings tested ranged between:

- A hypothetical action with "Half probably NO and half maybe YES" answers on STAPLEE (i.e. poor STAPLEE score) and Low Benefit/High Cost: Total Score = 7
- A hypothetical action with "All definitely YES" on STAPLEE and High Benefit/Little Cost: Total Score = 28

An inspection of the possible scores within this range led to the development of the following Priority Scale based on the Total Score in the STAPLEE- Benefit/Cost Review process:

20 – 28 points = High Priority
14-19 points = Medium Priority
13 points and below = Low Priority

In addition to the STAPLEE and Benefit/Cost analysis, the committee was also asked to consider **SMART** – **S**pecific, **M**easurable, **A**chievable, **R**elevant, **T**ime-bound, per FEMA. All action items were reviewed with these criteria in mind. The results of the STAPLEE process and Benefit/Cost analysis were then mailed out to all MPC members for feedback and consensus.

The final scores are listed below in the analysis of each action. Correspondence regarding the STAPLEE process is included in Appendix C: A spreadsheet with the action items and final scores is illustrated in Figure 4.1.

Jurisdictional Floodplain Management Programs

The City of Salem is the only jurisdiction within planning area that are members of the NFIP and regulate development in the floodplain by reviewing permit applications for all development including new and existing structures. Elevation certificates are required for all new construction, and existing structures with 50% or more damage following a flood are required to elevate. Floodplain maps are

available in hard copy at the city hall. Furthermore, floodplain maps can be found online through FEMA's website https://msc.fema.gov/portal. Salem does not currently participate in active monitoring activities within the floodplain.

Unincorporated Dent County is considered sanctioned because it did not join the NFIP one year after flood-prone areas were identified in 1984.

Table 4.1. Jurisdictional Floodplain Ordinance Adoption Date

Community Name	Ordinance Adoption Date
Dent County*	Not a member of the NFIP
Salem	08/01/1979

Source: FEMA's Community Status Book Report[1]; NSFHA (SEMA) *listed as not participating in the NFIP

[1] www.fema.gov/cis/mo.html

Figure 4.4 Prioritization of Mitigation Actions		3 = Def YES 2 = Maybe YES			1 = Prob NO 0 = Def NO									
Action No.	Mitigation Actions	S	T	A	P	L	E	E	STAPLEE Total	Losses Avoided (2 pts. Each)	Benefit	Cost	B/C Total	Total	Priority
1.1	Distribute brochures and publish social media posts to educate residents on personal emergency preparedness and ways to minimize the effect of natural disasters before they occur.	3	3	3	3	3	2	3	20	IC,PD,LF, EMCC	8	-1	7	27	H
1.2 3.1	Provide annual training to businesses and public entities on continuity of operation and emergency operation planning through local chambers of commerce and local emergency management agencies.	3	3	3	3	3	2	3	20	IC,PD,LF, EMCC	8	-1	7	27	H
1.3	Obtain/upgrade early warning systems and improved communication systems as funding allows.	3	2	2	3	3	2	2	17	IC,PD,LF, EMCC	8	-3	5	22	H
1.5 2.1	Upgrade road and bridges that would improve drainage, reduce flooding, and the risk to residents and property as funding allows.	3	3	3	3	3	3	2	20	IC,PD,LF, EMCC	8	-3	5	25	H
1.9	Seek funding to install additional fire doors in school buildings.	3	3	2	3	3	2	3	19	IC,PD,LF, EMCC	8	-3	5	24	H
1.10	Construct storm shelters and certified tornado safe rooms near schools and large employment centers as funding allows.	3	3	2	3	3	2	3	19	IC, LF, EMCC	6	-1	5	24	H
1.14	Establish designated shelters for residents to be used as cooling centers during extreme heat or power outages.	3	3	3	3	3	3	3	21	IC, LF, EMCC	6	-1	5	26	H
1.15	Facilities serving vulnerable population will annually review alternative locations for sheltering residents and MOUs with “sister” facilities.	3	2	2	3	3	2	3	18	IC, LF, EMCC	6	-1	5	23	H
1.18 2.5	Stabilize soil surfaces or modify hill geometry to prevent landslides resulting in road closures as funding allows.	3	2	2	3	3	3	2	18	IC,PD,LF, EMCC	8	-2	6	24	H
2.2 3.2	Obtain and install backup generators for critical infrastructure such as water systems and emergency services as funding allows.	3	3	3	3	3	2	3	20	LF, EMCC	4	-3	1	21	H
2.3	Distribute FEMA brochures and factsheets about the National Flood Insurance Program (NFIP) at public offices and community events.	2	2	2	2	3	2	3	16	IC,PD,LF, EMCC	8	-1	7	23	H

Figure 4.4 Prioritization of Mitigation Actions		3 = Def YES 2 = Maybe YES			1 = Prob NO 0 = Def NO									
Action No.	Mitigation Actions	S	T	A	P	L	E	E	STAPLEE Total	Losses Avoided (2 pts. Each)	Benefit	Cost	B/C Total	Total	Priority
2.4	Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.	2	2	2	2	3	2	3	16	IC,PD,LF, EMCC	8	-3	5	21	H
2.6	Purchase properties in the floodplain to convert land into public space/recreation areas as funds allow.	2	2	2	2	3	2	3	16	IC,PD,LF, EMCC	8	-3	5	21	H
3.3 2.7	Implement public awareness program about the benefits of adopted hazard mitigation projects, including changes to mitigation policy to keep the public abreast of changes and/or new regulations through press releases, brochures, EMD website and Facebook.	3	3	3	3	3	2	3	20	IC,PD,LF, EMCC	8	-1	7	27	H
3.4 1.19	Provide weather spotter classes throughout the county on an annual or bi-annual basis.	3	3	3	3	3	3	3	21	IC,PD,LF, EMCC	8	-1	7	28	H
3.7 1.20	Provide CERT training and distribute information on the benefits of the CERT and VOAD programs.	3	3	3	3	3	3	3	21	IC,PD,LF, EMCC	8	-3	5	26	H
6.5 2.8	Implement cost-share programs with private property owners for hazard mitigation projects that benefit the community as a whole as funding allows.	3	3	3	3	3	1	3	19	IC,PD,LF, EMCC	8	-3	5	24	H

Dent County

Goal 1: Reduce the potential impact of natural disasters o the lives and livelihoods of the citizens of the county.

Action 1.1: Distribute brochures and publish social media posts to educate residents on personal emergency preparedness and ways to minimize the effect of natural disasters before they occur.

Action Worksheet	
Name of Jurisdiction:	Dent County
Risk / Vulnerability	
Problem being Mitigated:	Residents are not always prepared to manage on their own for 72 hours following an event. This action item will improve individual household preparedness and increase knowledge of mitigation activities.
Hazard(s) Addressed:	All Hazards
Action or Project	
Action/Project Number:	1.1
Name of Action or Project:	Personal Preparedness Education/Awareness programs
Action or Project Description:	Distribute brochures and publish social media posts to educate residents on personal emergency preparedness and ways to minimize the effect of natural disasters before they occur.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	$250 - $500
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damages, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	County EMD
Action/Project Priority:	27 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP
Progress Report	
Action Status	Continuing - Revised - In Progress
Report of Progress	Lenox Fire Department does some school programs. The Health Department has brochures available. The natural gas utility frequently distributes information on home safety following service interruption. Salem Police Department is setting up tablet interface and social media posts with emergency preparedness information. A more focused and coordinated effort would help to achieve comprehensive coverage in the county.

Action 1.3: Obtain/upgrade early warning systems and improved communication systems as funding allows.

Action Worksheet	
Name of Jurisdiction:	Dent County
Risk / Vulnerability	
Problem being Mitigated:	Risks and vulnerabilities associated with need to improve warning and communications systems throughout the county.
Hazard(s) Addressed:	All Hazards
Action or Project	
Action/Project Number:	1.3
Name of Action or Project:	Obtain/upgrade early warning systems and improved communications systems
Action or Project Description:	Obtain/upgrade early warning systems and improved communication systems as funding allows.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	Unknown
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damage, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	County Commission, EMD
Action/Project Priority:	22 – High Priority
Timeline for Completion:	On-going
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP
Progress Report	
Action Status	Continuing – Revised – In Progress
Report of Progress	Weather radios do not perform well in many areas of Dent County. The need exists for a radio repeater tower to extend coverage. One storm siren was repaired. One additional siren was installed at the fairgrounds to expand coverage. 911 equipment was upgraded to be compatible with enhanced 911.

Action 1.10: Construct storm shelters and certified tornado safe rooms near schools and large employment centers as funding allows.

Action Worksheet	
Name of Jurisdiction:	Dent County
Risk / Vulnerability	
Problem being Mitigated:	Risks/vulnerabilities associated with schools and large employer facilities that do not have certified tornado safe rooms and use alternative facilities to shelter students, staff and employees in the event of high winds/tornados
Hazard(s) Addressed:	Tornadoes, Severe Weather,
Action or Project	
Action/Project Number:	1.10
Name of Action or Project:	Construct certified tornado safe rooms in schools and near areas with high populations.
Action or Project Description:	Construct storm shelters and certified tornado safe rooms near schools and large employment centers as funding allows.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	Unknown
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	County Commission and EMD
Action/Project Priority:	24 –High Priority
Timeline for Completion:	5 – 10 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOPs
Progress Report	
Action Status	Continuing – Revised - No Progress
Report of Progress	The County has made no progress to date on construction of certified tornado safe rooms.

Action 1.14: Establish designated shelters for residents to be used as heating or cooling centers during extreme heat or power outages.

Action Worksheet	
Name of Jurisdiction:	Dent County
Risk / Vulnerability	
Problem being Mitigated:	Risks/vulnerabilities associated with not having heating and cooling shelters available for residents during extreme weather events and power outages.
Hazard(s) Addressed:	Extreme Heat, Extreme Cold, Severe Weather, Tornados
Action or Project	
Action/Project Number:	1.14
Name of Action or Project:	Establish designated heating and cooling shelters.
Action or Project Description:	Establish designated shelters for residents to be used as heating or cooling centers during extreme heat or power outages.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	$250 - $500
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, loss of function/displacement impacts and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	County EMD, County Health Department
Action/Project Priority:	26 –High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP,
Progress Report	
Action Status	Continuing – Revised - In Progress
Report of Progress	Some shelters have been established in churches in the area. However, this program would benefit from executing formal MOAs, adding additional facilities to the list of potential shelters and providing training for the volunteers who would staff the shelters if opened.

Action 1.15: Facilities serving vulnerable populations will annually review alternative locations for sheltering residents and MOUs with "sister" facilities.

Action Worksheet	
Name of Jurisdiction:	Dent County
Risk / Vulnerability	
Problem being Mitigated:	Risks/vulnerabilities associated with lack of alternative shelter locations for vulnerable populations.
Hazard(s) Addressed:	All Hazards
Action or Project	
Action/Project Number:	1.15
Name of Action or Project:	Strengthen sheltering options for vulnerable populations.
Action or Project Description:	Facilities that house vulnerable populations such as disabled and elderly should review alternative locations for sheltering residents and MOUs with "sister" facilities.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	$250 - $800
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, loss of function/displacement impacts and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	County EMD, County Health Department
Action/Project Priority:	23 –High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP, Emergency Plans for Facilities housing vulnerable populations
Progress Report	
Action Status	Continuing – Revised - No Progress
Report of Progress	All three skilled nursing facilities in Dent County are owned by the same company. Although the group agreed that these facilities are required to have plans for alternative locations to care for residents during disasters, it was decided that it would be good practice to work with these facilities and others like them to ensure that those plans are being reviewed and updated regularly.

Action 3.4 [1.19]: Provide weather spotter classes throughout the county on an annual or bi-annual basis.

Action Worksheet	
Name of Jurisdiction:	Dent County
Risk / Vulnerability	
Problem being Mitigated:	Risks and vulnerabilities associated with the lack of weather spotters/training and weather spotters in the county.
Hazard(s) Addressed:	Severe Weather, Tornadoes
Action or Project	
Action/Project Number:	1.19
Name of Action or Project:	Weather spotter training
Action or Project Description:	Provide weather spotter classes throughout the county on an annual or bi-annual basis.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	$500
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damages, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	County EMD
Action/Project Priority:	28 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Local general revenue funds, private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP
Progress Report	
Action Status	Continuing - Revised – No Progress
Report of Progress	There has been no progress in this area in Dent County. The pandemic has reduced the availability of training.

Action 3.7 [1.20]: Provide CERT training and distribute information on the benefits of the CERT and VOAD programs.

Action Worksheet	
Name of Jurisdiction:	Dent County
Risk / Vulnerability	
Problem being Mitigated:	Risks and vulnerabilities associated with the lack of CERT or VOAD programs in the county.
Hazard(s) Addressed:	All hazards
Action or Project	
Action/Project Number:	1.20
Name of Action or Project:	CERT training and awareness program for CERT and VOADs.
Action or Project Description:	Provide CERT training and distribute information on the benefits of CERT and VOAD programs to the public to improve awareness.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	$1,000 - $1,500
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damages, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	EMD
Action/Project Priority:	26 – High Priority
Timeline for Completion:	1 -5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	LEOP, Hazard Mitigation Plan
Progress Report	
Action Status	Continuing – Revised – No Progress
Report of Progress	There was a CERT program in Dent County in the past. However, the pandemic resulted in the discontinuation of training and meeting of this group. The program would benefit from holding additional CERT trainings and an organized approach to distributing information CERT and VOAD.

Goal 2: Reduce the potential impact of natural disasters to property, infrastructure, and the local economy.

Action 1.5 [2.1]: Upgrade roads and bridges that would improve drainage and reduce flooding and the risk to residents and property as funding allows.

Action Worksheet	
Name of Jurisdiction:	Dent County
Risk / Vulnerability	
Problem being Mitigated:	Risks/vulnerabilities associated with flooding and inadequate road/bridge structures and impacts on residents and their property.
Hazard(s) Addressed:	Flood, Earthquake
Action or Project	
Action/Project Number:	2.1
Name of Action or Project:	Improve drainage and reduce flooding through road and bridge improvements.
Action or Project Description:	Upgrade roads and bridges to improve drainage and reduce flooding and the risk to residents and property.
Applicable Goal Statement:	Reduce the potential impact of natural disaster to property, infrastructure, and the local economy.
Estimated Cost:	Unknown
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damages, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	County Commission, Road and Bridge Department, local planners
Action/Project Priority:	25 – High Priority
Timeline for Completion:	On-going
Potential Fund Sources:	Grants, local general revenue funds, private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard mitigation plan, LEOP, county road and bridge budget, county road and bridge specifications
Progress Report	
Action Status	Continuing – Revised - In Progress
Report of Progress	The county has a policy in place to size up culverts in areas prone to flooding when replacing them. In the past five years the county has replaced culverts on CR 4160, CR 2470 and CR 5490. The county has also elevated and added a culvert to CR 6220 and replaced a low water bridge on CR 4210. The county maintains a list of high priority projects that will be completed as funding becomes available.

Action 1.18 [2.5]: Stabilize soil surfaces or modify hill geometry where possible to prevent landslides resulting in road closures as funding allows.

Action Worksheet	
Name of Jurisdiction:	Dent County
Risk / Vulnerability	
Problem being Mitigated:	Risks/vulnerabilities associated with landslides/debris flows on Dent County Roads
Hazard(s) Addressed:	Flooding, Severe Storm
Action or Project	
Action/Project Number:	2.5
Name of Action or Project:	Stabilize areas of potential landslides/debris flows.
Action or Project Description:	Stabilize soil surfaces or modify hill geometry where possible to prevent landslides resulting in road closures as funding allows.
Applicable Goal Statement:	Reduce the potential impact of natural disaster to property, infrastructure, and the local economy.
Estimated Cost:	$10,000
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damages, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	County Commission, Local Planners, County EMD, Road and Bridge Dept.
Action/Project Priority:	24 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP, Road and Bridge Budget
Progress Report	
Action Status	Continuing – Revised – No Progress
Report of Progress	There has been no progress in this area in Dent County.

Action 3.3 [2.7]: Implement public awareness program about the benefits of adopted hazard mitigation projects, including changes to mitigation policy to keep the public abreast of changes and/or new regulations through press releases, brochures, EMD website and FaceBook.

Action Worksheet	
Name of Jurisdiction:	Dent County
Risk / Vulnerability	
Problem being Mitigated:	Risks and vulnerabilities associated with a lack of awareness of hazard mitigation and best practices before hazardous events.
Hazard(s) Addressed:	All Hazards
Action or Project	
Action/Project Number:	2.7
Name of Action or Project:	Public awareness program on hazard mitigation
Action or Project Description:	Implement public awareness program about the benefits of adopted hazard mitigation projects, including changes to mitigation policy to keep the public abreast of changes and/or new regulations through press releases, brochures, EMD website and FaceBook.
Applicable Goal Statement:	Reduce the potential impact of natural disaster to property, infrastructure, and the local economy.
Estimated Cost:	$250-$500
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damages, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	County Commission, County EMD, local planners
Action/Project Priority:	27 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan
Progress Report	
Action Status	Continuing - Revised – No Progress
Report of Progress	There has been no progress in this area in Dent County.

Action 6.5 [2.8]: Implement cost-share programs with private property owners for hazard mitigation projects that benefit the community as a whole as funding allows.

Action Worksheet	
Name of Jurisdiction:	Dent County
Risk / Vulnerability	
Problem being Mitigated:	Lack of funding for mitigation projects for individuals
Hazard(s) Addressed:	All hazards
Action or Project	
Action/Project Number:	2.8
Name of Action or Project:	Implement cost-share programs between local government and private property owners.
Action or Project Description:	Implement cost-share programs with private property owners for hazard mitigation projects that benefit the community as a whole as funding allows.
Applicable Goal Statement:	Reduce the potential impact of natural disaster to property, infrastructure, and the local economy.
Estimated Cost:	Unknown
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damages, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	County Commission, Road and Bridge Supervisor
Action/Project Priority:	24 – High Priority
Timeline for Completion:	On-going
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, Capital Improvement Plans, Comprehensive Plans, Economic Development Plans
Progress Report	
Action Status	Continuing – Revised – In Progress
Report of Progress	The county currently has a cost share program on county roads for the installation of culverts on private driveways.

Goal 3: Reduce the potential impact of natural disaster on the continuity of government and essential services.

Action 1.2 [3.1]: Provide annual training to businesses and public entities on continuity of operation and emergency operation planning through local chambers of commerce and local emergency management agencies.

Action Worksheet	
Name of Jurisdiction:	Dent County
Risk / Vulnerability	
Problem being Mitigated:	Absence of emergency plans by businesses.
Hazard(s) Addressed:	All hazards.
Action or Project	
Action/Project Number:	3.1
Name of Action or Project:	Development of emergency plans by businesses.
Action or Project Description:	Provide annual training to businesses and public entities on continuity of operation and emergency operation planning through local chambers of commerce and local emergency management agencies.
Applicable Goal Statement:	Reduce the potential impact of natural disaster on the continuity of government and essential services.
Estimated Cost:	$4,000 - $5,500
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damages, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	County EMD
Action/Project Priority:	27 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP
Progress Report	
Action Status	Continuing – Revised – No Progress
Report of Progress	There has been no progress in this area in Dent County.

Action 2.2 [3.2]: Obtain and install backup generators for critical infrastructure such as water systems and emergency services as funding allows.

Action Worksheet	
Name of Jurisdiction:	Dent County
Risk / Vulnerability	
Problem being Mitigated:	Risks/vulnerabilities associated with power outages for critical infrastructure/facilities
Hazard(s) Addressed:	All Hazards
Action or Project	
Action/Project Number:	3.2
Name of Action or Project:	Acquisition and installation of backup generators for critical infrastructure.
Action or Project Description:	Obtain and install backup generators for critical infrastructure such as water systems and emergency services as funding allows.
Applicable Goal Statement:	Reduce the potential impact of natural disaster on the continuity of government and essential services.
Estimated Cost:	$25,500 – $80,000
Benefits:	Losses avoided by implementing this action include loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	County EMD, County Commission
Action/Project Priority:	21 –High Priority
Timeline for Completion:	5 – 10 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	LEOP, County Budget, Hazard Mitigation Plan, Critical Facility Budgets
Progress Report	
Action Status	Continuing – Revised – No Progress
Report of Progress	There has been no progress in this area in Dent County.

Salem

Goal 1: Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.

Action 1.1: Distribute brochures and publish social media posts to educate residents on personal emergency preparedness and ways to minimize the effect of natural disasters before they occur.

Action Worksheet	
Name of Jurisdiction:	Salem
Risk / Vulnerability	
Problem being Mitigated:	Residents are not always prepared to manage on their own for 72 hours following an event. This action item will improve individual household preparedness and increase knowledge of mitigation activities.
Hazard(s) Addressed:	All Hazards
Action or Project	
Action/Project Number:	1.1
Name of Action or Project:	Personal Preparedness Education/Awareness programs
Action or Project Description:	Distribute brochures and publish social media posts to educate residents on personal emergency preparedness and ways to minimize the effect of natural disasters before they occur.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	$250 - $500
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damages, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	City EMD
Action/Project Priority:	27 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP
Progress Report	
Action Status	Continuing – Revised - In Progress
Report of Progress	The Dent County Health Department has brochures available. The natural gas utility frequently distributes information on home safety following service interruption. Salem Police Department is setting up tablet interface and social media posts with emergency preparedness information. A more focused and coordinated effort would help to achieve comprehensive coverage in the city.

Action 1.3: Obtain/upgrade early warning systems and improved communication systems as funding allows.

Action Worksheet	
Name of Jurisdiction:	Salem
Risk / Vulnerability	
Problem being Mitigated:	Risks and vulnerabilities associated with need to improve warning and communications systems throughout the county.
Hazard(s) Addressed:	All Hazards
Action or Project	
Action/Project Number:	1.3
Name of Action or Project:	Obtain/upgrade early warning systems and improved communications systems
Action or Project Description:	Obtain/upgrade early warning systems and improved communication systems as funding allows.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	Unknown
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damage, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	Mayor, Board of Aldermen, City EMD
Action/Project Priority:	22 – High Priority
Timeline for Completion:	On-going
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP
Progress Report	
Action Status	Continuing – Revised – In Progress
Report of Progress	Weather radios do not perform well in many areas of Dent County and the city of Salem. The need exists for a radio repeater tower to extend coverage. One storm siren was repaired. One additional siren was installed at the fairgrounds to expand coverage. 911 equipment was upgraded to be compatible with enhanced 911.

Action 1.10: Construct storm shelters and certified tornado safe rooms near schools and large employment centers as funding allows.

Action Worksheet	
Name of Jurisdiction:	Salem
Risk / Vulnerability	
Problem being Mitigated:	Risks/vulnerabilities associated with schools and large employer facilities that do not have certified tornado safe rooms and use alternative facilities to shelter students, staff and employees in the event of high winds/tornados
Hazard(s) Addressed:	Tornadoes, Severe Weather,
Action or Project	
Action/Project Number:	1.10
Name of Action or Project:	Construct certified tornado safe rooms in schools and near areas with high populations.
Action or Project Description:	Construct storm shelters and certified tornado safe rooms near schools and large employment centers as funding allows.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	Unknown
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	Mayor, Board of Aldermen and City EMD
Action/Project Priority:	24 –High Priority
Timeline for Completion:	5 – 10 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOPs
Progress Report	
Action Status	Continuing – Revised - No Progress
Report of Progress	The city has made no progress to date on construction of certified tornado safe rooms.

Action 1.14: Establish designated shelters for residents to be used as heating or cooling centers during extreme heat or power outages.

Action Worksheet	
Name of Jurisdiction:	Salem
Risk / Vulnerability	
Problem being Mitigated:	Risks/vulnerabilities associated with not having heating and cooling shelters available for residents during extreme weather events and power outages.
Hazard(s) Addressed:	Extreme Heat, Extreme Cold, Severe Weather, Tornados
Action or Project	
Action/Project Number:	1.14
Name of Action or Project:	Establish designated heating and cooling shelters.
Action or Project Description:	Establish designated shelters for residents to be used as heating or cooling centers during extreme heat or power outages.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	$250 - $500
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, loss of function/displacement impacts and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	City EMD, County Health Department
Action/Project Priority:	26 –High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP,
Progress Report	
Action Status	Continuing – Revised - In Progress
Report of Progress	Some shelters have been established in churches in the city. However, this program would benefit from executing formal MOAs, adding additional facilities to the list of potential shelters and providing training for the volunteers who would staff the shelters if opened.

Action 1.15: Facilities serving vulnerable populations will annually review alternative locations for sheltering residents and MOUs with "sister" facilities.

Action Worksheet	
Name of Jurisdiction:	Salem
Risk / Vulnerability	
Problem being Mitigated:	Risks/vulnerabilities associated with lack of alternative shelter locations for vulnerable populations.
Hazard(s) Addressed:	All Hazards
Action or Project	
Action/Project Number:	1.15
Name of Action or Project:	Strengthen sheltering options for vulnerable populations.
Action or Project Description:	Facilities that house vulnerable populations such as disabled and elderly should review alternative locations for sheltering residents and MOUs with "sister" facilities.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the city.
Estimated Cost:	$250 - $800
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, loss of function/displacement impacts and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	City EMD, County Health Department
Action/Project Priority:	23 –High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP, Emergency Plans for Facilities housing vulnerable populations
Progress Report	
Action Status	Continuing – Revised - No Progress
Report of Progress	All three skilled nursing facilities in Salem are owned by the same company. Although the group agreed that these facilities are required to have plans for alternative locations to care for residents during disasters, it was decided that it would be good practice to work with these facilities and others like them to ensure that those plans are being reviewed and updated regularly.

Action 3.4 [1.19]: Provide weather spotter classes throughout the county on an annual or bi-annual basis.

Action Worksheet	
Name of Jurisdiction:	Salem
Risk / Vulnerability	
Problem being Mitigated:	Risks and vulnerabilities associated with the lack of weather spotters/training and weather spotters in the county.
Hazard(s) Addressed:	Severe Weather, Tornadoes
Action or Project	
Action/Project Number:	1.19
Name of Action or Project:	Weather spotter training
Action or Project Description:	Provide weather spotter classes in the city on an annual or bi-annual basis.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the city.
Estimated Cost:	$500
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damages, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	City EMD
Action/Project Priority:	28 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Local general revenue funds, private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP
Progress Report	
Action Status	Continuing – Revised – No Progress
Report of Progress	There has been no progress in this area in Salem.

Action 3.7 [1.20]: Provide CERT training and distribute information on the benefits of the CERT and VOAD programs.

Action Worksheet	
Name of Jurisdiction:	Salem
Risk / Vulnerability	
Problem being Mitigated:	Risks and vulnerabilities associated with the lack of CERT or VOAD programs in the city.
Hazard(s) Addressed:	All hazards
Action or Project	
Action/Project Number:	1.20
Name of Action or Project:	CERT training and awareness program for CERT and VOADs.
Action or Project Description:	Provide CERT training and distribute information on the benefits of CERT and VOAD programs to the public to improve awareness.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	$1,000 - $1,500
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damages, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	City EMD
Action/Project Priority:	26 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	LEOP, Hazard Mitigation Plan
Progress Report	
Action Status	Continuing – Revised – No Progress
Report of Progress	There was a CERT program in Salem in the past. However, the pandemic resulted in the discontinuation of training and meeting of this group. The program would benefit from holding additional CERT trainings and an organized approach to distributing information CERT and VOAD.

Goal 2: Reduce the potential impact of natural disaster to property, infrastructure, and the local economy.

Action 1.5 [2.1]: Upgrade roads and bridges that would improve drainage and reduce flooding and the risk to residents and property as funding allows.

Action Worksheet	
Name of Jurisdiction:	Salem
Risk / Vulnerability	
Problem being Mitigated:	Risks/vulnerabilities associated with flooding and inadequate road/bridge structures and impacts on residents and their property.
Hazard(s) Addressed:	Flood, Earthquake
Action or Project	
Action/Project Number:	2.1
Name of Action or Project:	Improve drainage and reduce flooding through road and bridge improvements.
Action or Project Description:	Upgrade roads and bridges to improve drainage and reduce flooding and the risk to residents and property.
Applicable Goal Statement:	Reduce the potential impact of natural disaster to property, infrastructure, and the local economy.
Estimated Cost:	Unknown
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damages, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	Mayor, Board of Aldermen, local planners
Action/Project Priority:	25 – High Priority
Timeline for Completion:	On-going
Potential Fund Sources:	Grants, local general revenue funds, private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard mitigation plan, LEOP, city budget, city road and bridge specifications
Progress Report	
Action Status	Continuing – Revised - In Progress
Report of Progress	The city has a policy in place to size up culverts in areas prone to flooding when replacing them. The city maintains a list of high priority projects that will be completed as funding becomes available.

Action 2.3: Distribute FEMA brochures and factsheets about the National Flood Insurance Program (NFIP) at public offices and community events.

Action Worksheet	
Name of Jurisdiction:	Salem
Risk / Vulnerability	
Problem being Mitigated:	Risks/vulnerabilities associated with the general public not being aware of the dangers of floodplain development and benefits of the NFIP.
Hazard(s) Addressed:	Floods
Action or Project	
Action/Project Number:	2.3
Name of Action or Project:	Floodplain education/awareness program.
Action or Project Description:	Educate Salem residents, realtors and contractors about the dangers of floodplain development and the benefits of the NFIP.
Applicable Goal Statement:	Reduce the potential impact of natural disaster to property, infrastructure, and the local economy.
Estimated Cost:	$250 – $500
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damage, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	Floodplain Manager, Mayor, Board of Aldermen
Action/Project Priority:	23– High Priority
Timeline for Completion:	On-going
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP, Floodplain Ordinance
Progress Report	
Action Status	Continuing – Revised – In Progress
Report of Progress	Salem has NFIP brochures available at city hall and a three part series press release on floodplain management is released to area media once per year.

Action 2.4: Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements in Salem.

Action Worksheet	
Name of Jurisdiction:	Salem
Risk / Vulnerability	
Problem being Mitigated:	Risks and vulnerabilities associated with the lack of enforcement of floodplain ordinances resulting in property damage.
Hazard(s) Addressed:	Floods
Action or Project	
Action/Project Number:	2.4
Name of Action or Project:	Floodplain education/awareness program.
Action or Project Description:	Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements in Salem.
Applicable Goal Statement:	Reduce the potential impact of natural disaster to property, infrastructure, and the local economy.
Estimated Cost:	$5,000
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damage, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	Floodplain Manager, Mayor, Board of Aldermen
Action/Project Priority:	21– High Priority
Timeline for Completion:	On-going
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP, Floodplain Ordinance
Progress Report	
Action Status	Continuing – in Progress
Report of Progress	Salem has contracted with the local RPC to provide technical assistance on floodplain management and help the city meet all NFIP requirements.

Action 2.6: Purchase properties in the floodplain to convert land into public space/recreation areas as funds allow.

Action Worksheet	
Name of Jurisdiction:	Salem
Risk / Vulnerability	
Problem being Mitigated:	Risks and vulnerabilities associated with repetitive loss properties in the floodplain.
Hazard(s) Addressed:	Floods
Action or Project	
Action/Project Number:	2.6
Name of Action or Project:	Floodplain buyouts
Action or Project Description:	Purchase properties in the floodplain to convert land into public space/recreation areas as funds allow.
Applicable Goal Statement:	Reduce the potential impact of natural disaster to property, infrastructure, and the local economy.
Estimated Cost:	$5,000
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damage, loss-of-function/ displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	Floodplain Manager, Mayor, Board of Aldermen
Action/Project Priority:	21– High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP, Floodplain Ordinance
Progress Report	
Action Status	New – No Progress
Report of Progress	To date, the city has not had any residents request a buyout and currently does not have the funding available to do a floodplain buyout.

Action 3.3 [2.7]: Implement public awareness program about the benefits of adopted hazard mitigation projects, including changes to mitigation policy to keep the public abreast of changes and/or new regulations through press releases, brochures, EMD website and FaceBook.

Action Worksheet	
Name of Jurisdiction:	Salem
Risk / Vulnerability	
Problem being Mitigated:	Risks and vulnerabilities associated with a lack of awareness of hazard mitigation and best practices before hazardous events.
Hazard(s) Addressed:	All Hazards
Action or Project	
Action/Project Number:	2.7
Name of Action or Project:	Public awareness program on hazard mitigation
Action or Project Description:	Implement public awareness program about the benefits of adopted hazard mitigation projects, including changes to mitigation policy to keep the public abreast of changes and/or new regulations through press releases, brochures, EMD website and FaceBook.
Applicable Goal Statement:	Reduce the potential impact of natural disaster to property, infrastructure, and the local economy.
Estimated Cost:	$250-$500
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damages, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	Mayor, Board of Aldermen, City EMD
Action/Project Priority:	27 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan
Progress Report	
Action Status	Continuing – Revised - No Progress
Report of Progress	There has been no progress in this area in Salem.

Action 6.5 [2.8]: Implement cost-share programs with private property owners for hazard mitigation projects that benefit the community as a whole as funding allows.

Action Worksheet	
Name of Jurisdiction:	Salem
Risk / Vulnerability	
Problem being Mitigated:	Lack of funding for mitigation projects for individuals
Hazard(s) Addressed:	All hazards
Action or Project	
Action/Project Number:	2.8
Name of Action or Project:	Implement cost-share programs between local government and private property owners.
Action or Project Description:	Implement cost-share programs with private property owners for hazard mitigation projects that benefit the community as a whole as funding allows.
Applicable Goal Statement:	Reduce the potential impact of natural disaster to property, infrastructure, and the local economy.
Estimated Cost:	Unknown
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damages, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	Mayor, City Council, Public Works
Action/Project Priority:	24 – High Priority
Timeline for Completion:	On-going
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, Capital Improvement Plans, Comprehensive Plans, Economic Development Plans
Progress Report	
Action Status	Continuing – Revised – In Progress
Report of Progress	The city currently has a cost share program on city streets for the installation of culverts on private driveways and on some demolition projects.

Goal 3: Reduce the potential impact of natural disaster on the continuity of government and essential services.

Action 1.2 [3.1]: Provide annual training to businesses and public entities on continuity of operation and emergency operation planning through local chambers of commerce and local emergency management agencies.

Action Worksheet	
Name of Jurisdiction:	Salem
Risk / Vulnerability	
Problem being Mitigated:	Absence of emergency plans by businesses.
Hazard(s) Addressed:	All hazards.
Action or Project	
Action/Project Number:	3.1
Name of Action or Project:	Development of emergency plans by businesses.
Action or Project Description:	Provide annual training to businesses and public entities on continuity of operation and emergency operation planning through local chambers of commerce and local emergency management agencies.
Applicable Goal Statement:	Reduce the potential impact of natural disaster on the continuity of government and essential services.
Estimated Cost:	$4,000 - $5,500
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damages, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	City EMD, Mayor, Board of Aldermen
Action/Project Priority:	27 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP
Progress Report	
Action Status	Continuing – Revised – No Progress
Report of Progress	There has been no progress in this area in Salem.

Action 2.2 [3.2]: Obtain and install backup generators for critical infrastructure such as water systems and emergency services as funding allows.

Action Worksheet	
Name of Jurisdiction:	Salem
Risk / Vulnerability	
Problem being Mitigated:	Risks/vulnerabilities associated with power outages for critical infrastructure/facilities
Hazard(s) Addressed:	All Hazards
Action or Project	
Action/Project Number:	2.2 [3.2]
Name of Action or Project:	Acquisition and installation of backup generators for critical infrastructure.
Action or Project Description:	Obtain and install backup generators for critical infrastructure such as water systems and emergency services as funding allows.
Applicable Goal Statement:	Reduce the potential impact of natural disaster on the continuity of government and essential services.
Estimated Cost:	$25,500 – $80,000
Benefits:	Losses avoided by implementing this action include loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	City EMD, Mayor, Board of Aldermen
Action/Project Priority:	21 –High Priority
Timeline for Completion:	1 - 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	LEOP, County Budget, Hazard Mitigation Plan, Critical Facility Budgets
Progress Report	
Action Status	Continuing – Revised – In Progress
Report of Progress	Salem currently has two portable generators that can be moved around the city to critical facilities. However, the city would benefit from additional, fixed generators that would serve critical facilities.

Oak Hill R-I

Goal 1: Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.

Action 1.3: Obtain/upgrade early warning systems and improved communication systems as funding allows.

Action Worksheet	
Name of Jurisdiction:	Oak Hill R-I
Risk / Vulnerability	
Problem being Mitigated:	Risks and vulnerabilities associated with need to improve warning and communications systems throughout the county.
Hazard(s) Addressed:	All Hazards
Action or Project	
Action/Project Number:	1.3
Name of Action or Project:	Obtain/upgrade early warning systems and improved communications systems
Action or Project Description:	Obtain/upgrade early warning systems and improved communication systems as funding allows.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	Unknown
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damage, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	Superintendent, School Board
Action/Project Priority:	22 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP
Progress Report	
Action Status	Continuing- Revised – No Progress
Report of Progress	Weather radios do not perform well in many areas of Dent County and the city of Salem. The district does not have a weather radio. The need exists for a radio repeater tower to extend coverage. The school has an intercom system, walkie talkies and phones which allows communication with individual classrooms.

Action 1.9: Seek funding to install additional fire doors in school buildings.

Action Worksheet	
Name of Jurisdiction:	Oak Hill R-I
Risk / Vulnerability	
Problem being Mitigated:	Onset of fire and smoke that can inhibit safe egress and damage property
Hazard(s) Addressed:	Fire
Action or Project	
Action/Project Number:	1.9
Name of Action or Project:	Fire door funding
Action or Project Description:	Seek funding to install additional fire doors in school buildings.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	$5,000
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damage, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	School Board, Superintendent
Action/Project Priority:	26 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP, School Emergency Plan
Progress Report	
Action Status	Continuing – No Progress
Report of Progress	No progress has been made on this action item.

Action 1.10: Construct storm shelters and certified tornado safe rooms near schools and large employment centers as funding allows.

Action Worksheet	
Name of Jurisdiction:	Oak Hill R-I
Risk / Vulnerability	
Problem being Mitigated:	Risks/vulnerabilities associated with schools and large employer facilities that do not have certified tornado safe rooms and use alternative facilities to shelter students, staff and employees in the event of high winds/tornados
Hazard(s) Addressed:	Tornadoes, Severe Weather,
Action or Project	
Action/Project Number:	1.10
Name of Action or Project:	Construct certified tornado safe rooms in schools and near areas with high populations.
Action or Project Description:	Construct storm shelters and certified tornado safe rooms near schools and large employment centers as funding allows.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	Unknown
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	Superintendent, School Board
Action/Project Priority:	24 –High Priority
Timeline for Completion:	5 – 10 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOPs
Progress Report	
Action Status	Continuing – Revised -No Progress
Report of Progress	The district has made no progress to date on construction of certified tornado safe rooms.

Green Forest R-II

Goal 1: Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.

Action 1.3: Obtain/upgrade early warning systems and improved communication systems as funding allows.

Action Worksheet	
Name of Jurisdiction:	Green Forest R-II
Risk / Vulnerability	
Problem being Mitigated:	Risks and vulnerabilities associated with need to improve warning and communications systems throughout the county.
Hazard(s) Addressed:	All Hazards
Action or Project	
Action/Project Number:	1.3
Name of Action or Project:	Obtain/upgrade early warning systems and improved communications systems
Action or Project Description:	Obtain/upgrade early warning systems and improved communication systems as funding allows.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	Unknown
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damage, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	Superintendent, School Board
Action/Project Priority:	22 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP
Progress Report	
Action Status	Continuing – Revised – No Progress
Report of Progress	Weather radios do not perform well in many areas of Dent County and the city of Salem. The district does have a weather radio. The need exists for a radio repeater tower to extend coverage. The school has a phone system which can provide emergency communications.

Action 1.9: Seek funding to install additional fire doors in school buildings.

Action Worksheet	
Name of Jurisdiction:	Green Forest R-II
Risk / Vulnerability	
Problem being Mitigated:	Onset of fire and smoke that can inhibit safe egress and damage property
Hazard(s) Addressed:	Fire
Action or Project	
Action/Project Number:	1.9
Name of Action or Project:	Fire door funding
Action or Project Description:	Seek funding to install additional fire doors in school buildings.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	$5,000
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damage, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	School Board, Superintendent
Action/Project Priority:	26 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP, School Emergency Plan
Progress Report	
Action Status	Continuing – No Progress
Report of Progress	No progress has been made on this action item.

Action 1.10: Construct storm shelters and certified tornado safe rooms near schools and large employment centers as funding allows.

Action Worksheet	
Name of Jurisdiction:	Green Forest R-II
Risk / Vulnerability	
Problem being Mitigated:	Risks/vulnerabilities associated with schools and large employer facilities that do not have certified tornado safe rooms and use alternative facilities to shelter students, staff and employees in the event of high winds/tornados
Hazard(s) Addressed:	Tornadoes, Severe Weather,
Action or Project	
Action/Project Number:	1.10
Name of Action or Project:	Construct certified tornado safe rooms in schools and near areas with high populations.
Action or Project Description:	Construct storm shelters and certified tornado safe rooms near schools and large employment centers as funding allows.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	Unknown
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	Superintendent, School Board
Action/Project Priority:	24 –High Priority
Timeline for Completion:	5 – 10 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOPs
Progress Report	
Action Status	Continuing – Revised - No Progress
Report of Progress	The district has made no progress to date on construction of certified tornado safe rooms.

Dent-Phelps R-III

Goal 1: Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.

Action 1.3: Obtain/upgrade early warning systems and improved communication systems as funding allows.

Action Worksheet	
Name of Jurisdiction:	Dent-Phelps R-III
Risk / Vulnerability	
Problem being Mitigated:	Risks and vulnerabilities associated with need to improve warning and communications systems throughout the county.
Hazard(s) Addressed:	All Hazards
Action or Project	
Action/Project Number:	1.3
Name of Action or Project:	Obtain/upgrade early warning systems and improved communications systems
Action or Project Description:	Obtain/upgrade early warning systems and improved communication systems as funding allows.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	Unknown
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damage, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	Superintendent, School Board
Action/Project Priority:	22 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP
Progress Report	
Action Status	Continuing – Revised – No Progress
Report of Progress	Weather radios do not perform well in many areas of Dent County and the city of Salem. Dent-Phelps R-III does not have a weather radio. The need exists for a radio repeater tower to extend coverage. The school has a PA system which allows communication with individual classrooms.

Action 1.9: Seek funding to install additional fire doors in school buildings.

Action Worksheet	
Name of Jurisdiction:	Dent-Phelps R-III
Risk / Vulnerability	
Problem being Mitigated:	Onset of fire and smoke that can inhibit safe egress and damage property
Hazard(s) Addressed:	Fire
Action or Project	
Action/Project Number:	1.9
Name of Action or Project:	Fire door funding
Action or Project Description:	Seek funding to install additional fire doors in school buildings.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	$5,000
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damage, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	School Board, Superintendent
Action/Project Priority:	26 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP, School Emergency Plan
Progress Report	
Action Status	Continuing – No Progress
Report of Progress	No progress has been made on this action item.

Action 1.10: Construct storm shelters and certified tornado safe rooms near schools and large employment centers as funding allows.

Action Worksheet	
Name of Jurisdiction:	Dent-Phelps R-III
Risk / Vulnerability	
Problem being Mitigated:	Risks/vulnerabilities associated with schools and large employer facilities that do not have certified tornado safe rooms and use alternative facilities to shelter students, staff and employees in the event of high winds/tornados
Hazard(s) Addressed:	Tornadoes, Severe Weather,
Action or Project	
Action/Project Number:	1.10
Name of Action or Project:	Construct certified tornado safe rooms in schools and near areas with high populations.
Action or Project Description:	Construct storm shelters and certified tornado safe rooms near schools and large employment centers as funding allows.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	Unknown
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	Superintendent, School Board
Action/Project Priority:	24 –High Priority
Timeline for Completion:	5 – 10 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOPs
Progress Report	
Action Status	Continuing – Revised - No Progress
Report of Progress	The district has made no progress to date on construction of certified tornado safe rooms.

North Wood R-IV

Goal 1: Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.

Action 1.3: Obtain/upgrade early warning systems and improved communication systems as funding allows.

Action Worksheet	
Name of Jurisdiction:	North Wood R-IV
Risk / Vulnerability	
Problem being Mitigated:	Risks and vulnerabilities associated with need to improve warning and communications systems throughout the county.
Hazard(s) Addressed:	All Hazards
Action or Project	
Action/Project Number:	1.3
Name of Action or Project:	Obtain/upgrade early warning systems and improved communications systems
Action or Project Description:	Obtain/upgrade early warning systems and improved communication systems as funding allows.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	Unknown
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damage, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	Superintendent, School Board
Action/Project Priority:	22 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP
Progress Report	
Action Status	Continuing – Revised – No Progress
Report of Progress	Weather radios do not perform well in many areas of Dent County and the city of Salem. The district does have a weather radio. The need exists for a radio repeater tower to extend coverage. The school has a PA system which allows communication with individual classrooms.

Action 1.9: Seek funding to install additional fire doors in school buildings.

Action Worksheet	
Name of Jurisdiction:	North Wood R-IV
Risk / Vulnerability	
Problem being Mitigated:	Onset of fire and smoke that can inhibit safe egress and damage property
Hazard(s) Addressed:	Fire
Action or Project	
Action/Project Number:	1.9
Name of Action or Project:	Fire door funding
Action or Project Description:	Seek funding to install additional fire doors in school buildings.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	$5,000
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damage, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	School Board, Superintendent
Action/Project Priority:	26 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP, School Emergency Plan
Progress Report	
Action Status	Continuing – No Progress
Report of Progress	No progress has been made on this action item.

Action 1.10: Construct storm shelters and certified tornado safe rooms near schools and large employment centers as funding allows.

Action Worksheet	
Name of Jurisdiction:	North Wood R-IV
Risk / Vulnerability	
Problem being Mitigated:	Risks/vulnerabilities associated with schools and large employer facilities that do not have certified tornado safe rooms and use alternative facilities to shelter students, staff and employees in the event of high winds/tornados
Hazard(s) Addressed:	Tornadoes, Severe Weather,
Action or Project	
Action/Project Number:	1.10
Name of Action or Project:	Construct certified tornado safe rooms in schools and near areas with high populations.
Action or Project Description:	Construct storm shelters and certified tornado safe rooms near schools and large employment centers as funding allows.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	Unknown
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	Superintendent, School Board
Action/Project Priority:	24 –High Priority
Timeline for Completion:	1 - 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOPs
Progress Report	
Action Status	Continuing – Revised – In Progress
Report of Progress	The district has applied for grant funds to construct a certified tornado safe room.

Salem R-80

Goal 1: Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.

Action 1.3: Obtain/upgrade early warning systems and improved communication systems as funding allows.

Action Worksheet	
Name of Jurisdiction:	Salem R-80
Risk / Vulnerability	
Problem being Mitigated:	Risks and vulnerabilities associated with need to improve warning and communications systems throughout the county.
Hazard(s) Addressed:	All Hazards
Action or Project	
Action/Project Number:	1.3
Name of Action or Project:	Obtain/upgrade early warning systems and improved communications systems
Action or Project Description:	Obtain/upgrade early warning systems and improved communication systems as funding allows.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	Unknown
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damage, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	Superintendent, School Board
Action/Project Priority:	22 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP
Progress Report	
Action Status	Continuing – Revised – No Progress
Report of Progress	Weather radios do not perform well in many areas of Dent County and the city of Salem. The district does not have a weather radio. The need exists for a radio repeater tower to extend coverage. The school has a PA system which allows communication with individual classrooms.

Action 1.9: Seek funding to install additional fire doors in school buildings.

Action Worksheet	
Name of Jurisdiction:	Salem R-80
Risk / Vulnerability	
Problem being Mitigated:	Onset of fire and smoke that can inhibit safe egress and damage property
Hazard(s) Addressed:	Fire
Action or Project	
Action/Project Number:	1.9
Name of Action or Project:	Fire door funding
Action or Project Description:	Seek funding to install additional fire doors in school buildings.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	$5,000
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, property damage, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	School Board, Superintendent
Action/Project Priority:	26 – High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOP, School Emergency Plan
Progress Report	
Action Status	Continuing – No Progress
Report of Progress	No progress has been made on this action item.

Action 1.10: Construct storm shelters and certified tornado safe rooms near schools and large employment centers as funding allows.

Action Worksheet	
Name of Jurisdiction:	Salem R-80
Risk / Vulnerability	
Problem being Mitigated:	Risks/vulnerabilities associated with schools and large employer facilities that do not have certified tornado safe rooms and use alternative facilities to shelter students, staff and employees in the event of high winds/tornados
Hazard(s) Addressed:	Tornadoes, Severe Weather,
Action or Project	
Action/Project Number:	1.10
Name of Action or Project:	Construct certified tornado safe rooms in schools and near areas with high populations.
Action or Project Description:	Construct storm shelters and certified tornado safe rooms near schools and large employment centers as funding allows.
Applicable Goal Statement:	Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.
Estimated Cost:	Unknown
Benefits:	Losses avoided by implementing this action include injuries and/or casualties, loss-of-function/displacement impacts, and emergency management costs/community costs.
Plan for Implementation	
Responsible Organization/Department:	Superintendent, School Board
Action/Project Priority:	24 –High Priority
Timeline for Completion:	1 – 5 years
Potential Fund Sources:	Grants, local general revenue funds, and private donations of cash, goods, or services.
Local Planning Mechanisms to be Used in Implementation, if any:	Hazard Mitigation Plan, LEOPs
Progress Report	
Action Status	Continuing – Revised – In Progress
Report of Progress	The district has applied for grant funds to construct a certified tornado safe room.

3 RISK ASSESSMENT

44 CFR Requirement §201.6(c)(2): [The plan shall include] A risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

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.

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

Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the type…of all natural hazards that can affect the jurisdiction.

The primary phase in the development of a hazard mitigation plan is to identify specific hazards which may impact the planning area. To initiate this process, the Hazard Mitigation Planning Committee (HMPC) reviewed a list of natural hazards provided by the Federal Emergency Management Agency (FEMA). From that list, the HMPC selected pertinent natural hazards of concern that have the potential to impact Dent County. These selected natural hazards are further profiled and analyzed in this plan.

3.1.1 Review of Existing Mitigation Plans

Within the State of Missouri, local hazard mitigation plans customarily include only natural hazards, as only natural hazards are required by federal regulations. Nevertheless, there is an opportunity to include man made or technical hazards within the plan. However, it was decided that only natural hazards were appropriate for the purpose of this plan. Based on past history and future probability, the Hazard Mitigation Planning Committee (HMPC) determined that the following potential hazards would be included in the Dent County Hazard Mitigation Plan:

- Dam Failure
- Drought
- Earthquake
- Extreme Temperatures
- Fires
- Flooding (Riverine and Flash)
- Land Subsidence/Sinkholes
- Severe Thunderstorms Including High Winds, Hail, and Lightning
- Tornado
- Severe Winter Weather

Hazards not occurring in the planning area, or considered insignificant were eliminated from this plan. **Table 3.1** outlines the hazards eliminated from the plan and the reasons for doing so. Additionally, some hazards were combined in the Dent County Plan to match the hazards listed in the Missouri State Hazard Mitigation Plan.

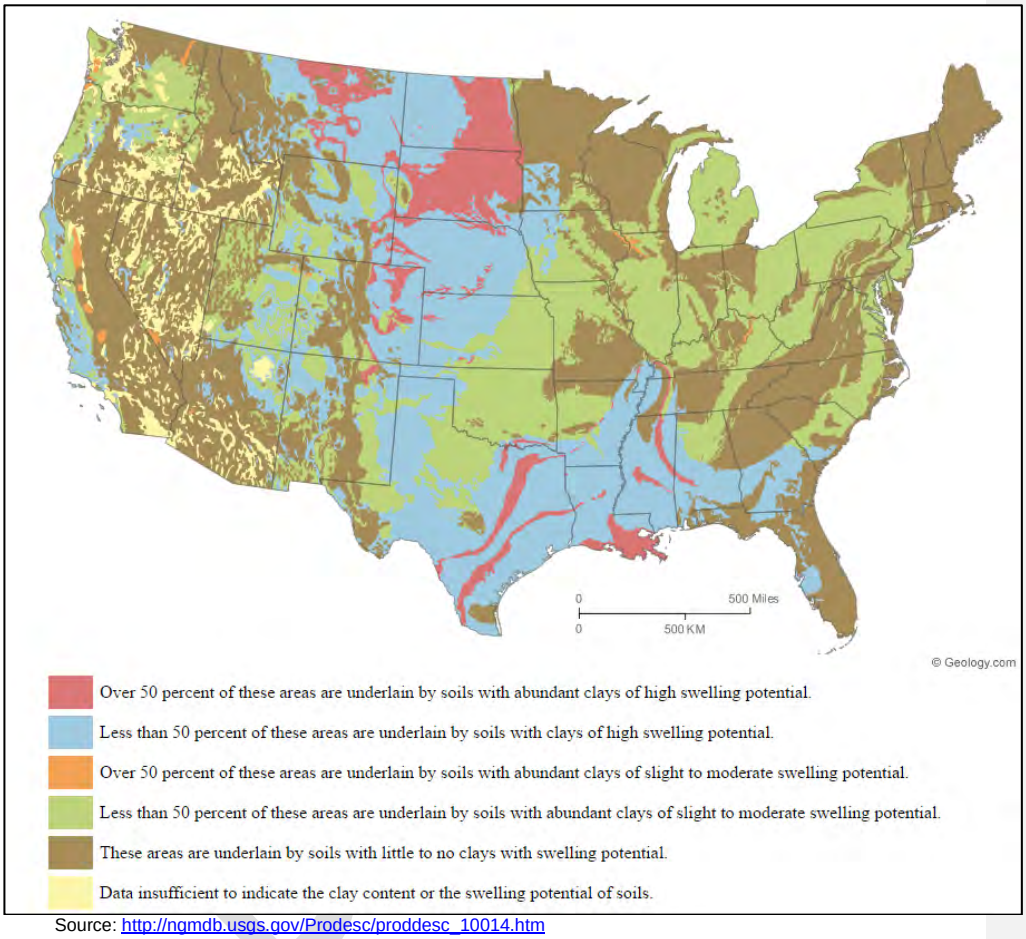
Table 3.1. Table 3.1 Hazards Not Profiled in the Plan

Hazard	Reason for Omission
Avalanche	No mountains in the planning area.
Coastal Erosion	Planning area is located in the Midwest, not on any coast.
Coastal Storm	Planning area is located in the Midwest, not on any coast.

Hazard	Reason for Omission
Debris Flow	There are no mountainous areas in the planning area where this type of event occurs.
Expansive Soils	No expansive soils exist within the planning area. According to the USGS National Geologic Map Database[1], the planning area is underlain by soils with little to no clays with swelling potential (**Figure 3.1**).
Hurricane	Planning area is located in the Midwest, not on any coast.
Levee Failure	According to the US Army Corps of Engineers' National Levee Database [2], and local officials, there are no levees located in the planning area. However, low-head agricultural levees could be present. Unfortunately, no data could be found indicating damages in the event of failure.
Volcano	There are no volcanic areas in the county.

[1] http://ngmdb.usgs.gov/Prodesc/proddesc_10014.htm
[2] http://nld.usace.army.mil/egis/f?p=471:1:0::NO

Figure 3.1. Swelling clays map of the conterminous United States



Source: http://ngmdb.usgs.gov/Prodesc/proddesc_10014.htm

3.1.2 Review Disaster Declaration History

In order to assess risk, it was logical to review the disaster declaration history for the State of Missouri and specifically for Dent County. Federal and State disaster declarations are granted when the severity and magnitude of a hazard event surpasses the ability of 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.

There are three agencies through which a federal disaster declaration can be issued – FEMA, the U.S. Department of Agriculture (USDA) and/or the Small Business Administration. A federally declared disaster generally includes long-term federal recovery programs. The type of declaration is determined by the type of damage sustained during a disaster and what types of institutions or industries are affected.

A declaration issued by USDA indicates that the affected area has suffered at least a 30 percent loss in one or more crops or livestock industries. This type of declaration provides those farmers affected with access to low-interest loans and other programs to assist with disaster recovery and mitigation.

Missouri has been especially hard hit by natural disasters in the recent past. The state has had 72 federally declared disasters since 1953. Of those, 35 have occurred since 2002. Most of these disasters have been weather related – severe wind and rain storms, tornadoes, flooding, hail, ice storms and winter storms. **Table 3.2** lists the federal disaster declarations for Dent County from 2001 through 2020.

Table 3.2. FEMA Disaster Declarations that included Dent County, Missouri, 2001-2020

Disaster Number	Description	Declaration Date Incident Period	Individual Assistance (IA) Public Assistance (PA)
DR-1412	Severe Storms, Tornadoes	Declaration Date: May 06, 2002 Incident Period: April 24, 2002 to June 10, 2002	IA, PA
DR-1463	Severe Storms, Tornadoes, Flooding	Declaration Date: May 06, 2003 Incident Period: May 04, 2003 to May 30, 2003	IA
EM-3232	Hurricane Katrina Evacuation	Declaration Date: September 10, 2005 Incident Period: August 29, 2005 to October 01, 2005	PA

Disaster Number	Description	Declaration Date Incident Period	Individual Assistance (IA) Public Assistance (PA)
EM-3267	Severe Storms	Declaration Date: July 21, 2006 Incident Period: July 19, 2006 – July 21, 2006	PA
DR-1676	Severe Winter Storms, Flooding	Declaration Date: January 15, 2007 Incident Period: January 12, 2007 to January 22, 2007	PA
EM-3281	Severe Winter Storms	Declaration Date: December 12, 2007 Incident Period: December 08, 2007 to December 15, 2007	PA
DR-1749	Severe Storms, Flooding	Declaration Date: March 19, 2008 Incident Period: March 17, 2008 to May 09, 2008	PA
EM-3303	Severe Winter Storm	Declaration Date: January 30, 2009 Incident Period: January 26, 2009 to January 28, 2009	PA
DR- 1809	Severe Storms, Flooding, and a Tornado	Declaration Date: November 13, 2008 Incident Period: September 11, 2008 – September 24, 2008	PA
DR-1847	Severe Storms, Tornadoes, Flooding	Declaration Date: June 19, 2009 Incident Period: May 08, 2009 to May 16, 2009	PA
EM-3317	Severe Winter Storm	Declaration Date: February 03, 2011 Incident Period: January 31, 2011 to February 05, 2011	PA
EM-3374	Severe Storms, Tornadoes, Straight-line Winds, Flooding	Declaration Date: January 2, 2016 Incident Period: December 22, 2015-January 9, 2016	PA
DR-4317	Severe Storms, Tornadoes, Straight-line Winds, Flooding	Declaration Date: June 2, 2017 Incident Date: April 28, 2017 to May 11, 2017	IA, PA
DR-4490	COVID-19 Pandemic	Declaration Date: March 26, 2020 Incident Period: January 20, 2020 and continuing	IA, PA

Source: Federal Emergency Management Agency: http://www.fema.gov/disasters

3.1.3 Research Additional Sources

List of the additional sources of data on locations and past impacts of hazards in the planning area:

- Missouri Hazard Mitigation Plans (2013, 2018)
- 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
- Flood Insurance Administration
- Hazards US (HAZUS)
- Missouri Department of Transportation
- Missouri Division of Fire Marshal Safety
- Missouri Public Service Commission
- National Fire Incident Reporting System (NFIRS)
- National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information (NCEI);
- Pipeline and Hazardous Materials Safety Administration
- County and local Comprehensive Plans to the extent available
- County Emergency Management
- County Flood Insurance Rate Map, FEMA
- Flood Insurance Study, 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)
- Various articles and publications available on the internet (sources are cited in the body of the Plan)

Remarkably, 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 March 2014, 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.

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

Table 3.3 lists the hazards that significantly impact each jurisdiction within the planning area and were chosen for further analysis in alphabetical order. "X" indicates the jurisdiction is impacted by the hazard, and a "-" indicates the hazard is not applicable to that jurisdiction. As Dent County is predominately rural, limited variations occur across the county. However, jurisdictions with a high percentage of housing comprised of mobile homes, for example, could be more at risk to damages from a tornado.

Table 3.3. Hazards Identified for Each Jurisdiction

Jurisdiction	Dam Failure	Drought	Earthquake	Extreme Heat	Fires (Urban/Structural and wild)	Flooding (River and Flash)	Land Subsidence/Sinkholes	Thunderstorms/High Winds/ Lightning/Hail	Tornado	Severe Winter Weather
Dent County	x	x	x	x	x	x	x	x	x	x
Salem	x	x	x	x	x	x	x	x	x	x
School Districts										
Dent-Phelps R-III	x	x	x	x	x	-	x	x	x	x
Green Forest R-II	x	x	x	x	x	-	x	x	x	x
North Wood R-IV	x	x	x	x	x	-	x	x	x	x
Oak Hill R-I	x	x	x	x	x	-	x	x	x	x
Salem R-80	x	x	x	x	x	-	x	x	x	x

3.1.5 Multi-Jurisdictional Risk Assessment

For this multi-jurisdictional hazard mitigation plan, each hazard is profiled in which the risks are assessed on a planning area wide basis. Some hazards, such as dam failure, vary in risk across the county. If variations exist within the planning area, discussion is included in each profile. Dent County is uniform across the county in terms of climate, topography, and building construction characteristics. Weather-related hazards will impact the entire county in much the same fashion, as do topographical/geological related hazards such as earthquake. Sinkholes appear in throughout the county and are localized in their effects. The focal area of urbanization includes the city of Salem. Urbanized areas have more assets at a greater density, and therefore have greater vulnerability to weather-related hazards. Rural areas include agricultural assets (livestock/crops) that are also vulnerable to damages. Differences among jurisdictions for each hazard will be discussed in greater detail in the vulnerability section of each hazard.

3.2 Assets at Risk

This section assesses the planning area's population, structures, critical facilities, infrastructure, and other important assets 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 2020 Census Bureau data. Building counts values are based on parcel data provided by the 2018 Missouri State Hazard Mitigation Plan, which can be found at the following website, https://sema.dps.mo.gov/docs/programs/LRMF/mitigation/MO_Hazard_Mitigation_Plan2018.pdf.

Table 3.4. Maximum Population and Building Exposure by Jurisdiction

Jurisdiction	2020 Population	Building Count	Building Exposure ($)	Contents Exposure ($)	Total Exposure ($)
Unincorporated Dent County	9,813	14,581	$600,375	$335,807	$936,183
Salem	4,608	2,535	$297,919	$168,536	$466,455
Total	14,421	17,220	$910,930	$510,083	$1,421,012

Sources: U.S. Census Bureau Decennial Redistricting Data; 2018 Missouri State Hazard Mitigation Plan

Table 3.5. Building Value/Exposure by Usage Type

Jurisdiction	Agriculture	Commercial	Education	Government	Industrial	Residential	Total
Dent County	$7,832	$89,759	$6,206	$5,271	$47,204	$779,911	$936,183
Salem	$40	$94,567	$13,653	$3,339	$4,866	$349,990	$466,455
Total	**$7,883**	**$186,997**	**$22,341**	**$8,610**	**$52,070**	**$1,143,111**	**$1,421,012**

Source: FEMA HAZUS, Missouri State Hazard Mitigation Plan
** All values in 1,000s of dollars.*

Table 3.6. Building Counts by Usage Type

Jurisdiction	Residential Counts	Commercial Counts	Industrial Counts	Agricultural Counts	Other (Gov't/Edu)	Total
Dent County	4,664	336	97	9,449	35	14,581
Salem	2,093	354	10	48	30	2,535
Total	6,836	700	107	9,510	67	17,220

Source: 2018 MO State Hazard Mitigation Plan

Table 3.7 below, provides additional information for school districts, including the number of buildings, building values (building exposure) and contents value (contents exposure). These numbers will represent the total enrollment and building count for the public school districts regardless of the county in which they are located.

Table 3.7. Population and Building Exposure by Jurisdiction-Public School Districts

Public School District	Enrollment	Building Count	Building Exposure ($)	Contents Exposure ($)	Total Exposure ($)
Dent-Phelps R-III	236	1	$9,771,310	$428,572	$10,199,882
Green Forest R-II	188	1	$5,200,000	$1,000,000	$6,200,000
North Wood R-IV	210	1	$6,817,710	$1,143,041	$7,960,751
Oak Hill R-I	129	1	$4,662,960	$1,350,922	$6,013,882
Salem R-80	1,413	4	$50,562,582	$8,532,728	$59,095,310

Source: https://apps.dese.mo.gov/MCDS/Reports/SSRS_Print.aspx?ReportId=152b1d45-e617-4184-acf3-82b9287ae2b4 ; 2022 Data Collection Questionnaire

3.2.2 Critical and Essential Facilities and Infrastructure

This section will include information from the Data Collection Questionnaire and other sources concerning the vulnerability of participating jurisdictions' critical, essential, high potential loss, and transportation/lifeline facilities to identified hazards. Definitions of each of these types of facilities are provided below.

- Critical Facility: Those facilities essential in providing utility or direction either during the response to an emergency or during the recovery operation.
- Essential Facility: Those facilities that if damaged, would have devastating impacts on disaster response and/or recovery.
- High Potential Loss Facilities: Those facilities that would have a high loss or impact on the community.
- Transportation and lifeline facilities: Those facilities and infrastructure critical to transportation, communications, and necessary utilities.

The table below (**Table 3.8**) provides information for critical facilities in the planning area. Specific information includes a Hazus ID if applicable, jurisdiction, building name/owner, and address. Facilities addressed include emergency, fire department, law enforcement, medical, and schools.

Table 3.8. Dent County Critical Facilities by Type and Jurisdiction

HazusID	Jurisdiction	Building Name	Address	City	State	Zip
Emergency Facilities						
	Dent Co.	Salem Memorial Hospital Ambulance	35629 Hwy 72	Salem	MO	65560
	Salem	EOC	#2 S. Main St.	Salem	MO	65560
Fire Department Facilities						
	Dent Co.	Jadwin Vol. Fire Dept.	8861 Hwy K	Jadwin	MO	65501
	Dent Co.	Lenox Rural Fire Dept.	18231 Hwy C.	Lenox	MO	65541
	Dent Co.	Dent County Fire Prot. Dist.	#2 S. Main St.	Salem	MO	65560
	Dent Co.	Montauk Rural Fire Dist.	2742 Hwy 119	Salem	MO	65560
Law Enforcement Facilities						
	Salem	Salem Police Dept.	500 N Jackson St.	Salem	MO	65560
	Dent Co.	Dent Co. Sheriff's Dept.	112 E. 5th St., Suite 7	Salem	MO	65560
Medical Facilities						
	Dent Co.	Salem Memorial District Hospital	35629 Hwy. 72	Salem	Mo	65560
	Dent Co.	Dent County Health Center	601 S. MacArthur	Salem	Mo	65560
School Facilities						
	Salem R-80	Salem R-80 School District	1409 W. Rolla Road	Salem	MO	65560
	Oak Hill R-I	Oak Hill R-I School District	6200 Hwy 19 S.	Salem	MO	65560
	Green Forest R-II	Green Forest R-II School District	6111 Hwy F	Salem	MO	65560
	Dent-Phelps R-III	Dent-Phelps R-III School District	27870 Hwy C	Salem	MO	65560
	North Wood R-IV	North Wood R-IV School District	3734 N Hwy 19	Salem	MO	65560
Childcare Facilities						
	Dent Co.	I Can Too Learning Center LLC	1607 West Franklin St.	Salem	MO	65560
	Dent Co.	Jackie's Little Britches LLC	502 County Road 5015	Salem	MO	65560
	Dent Co.	Jordan, Tanna L	1216 County Road 6160	Salem	MO	65560
	Dent Co.	Oak Hill R-I School District	6200 S Hwy 19	Salem	MO	65560
	Dent Co.	South Central Missouri Community Action Agency – Head Start	1405 S. Wines St.	Salem	MO	65560
	Dent Co.	Tasha's Tots LLC	1300 S McArthur St.	Salem	MO	65560
Nursing Homes						

HazusID	Jurisdiction	Building Name	Address	City	State	Zip
	Cuba	Ashley's Place Adult Day Health Care II	1207 Babb Lane	Salem	MO	65560
	Bourbon	Enrichment Services Of Dent County, Inc	1900 South Main, PO Box 109	Salem	MO	65560
	Cuba	Salem Care Center	1203 N. Jackson, P. O. Box 29	Salem	MO	65560
	Sullivan	Salem Memorial Hospital	P.O. Box 774, 35629 Highway 72	Salem	MO	65560
	Sullivan	Salem Residential Care	1207 E. Roosevelt	Salem	MO	65560
	Sullivan	Seville Care Center	33625 Hwy. 72, P. O. Box 746	Salem	MO	65560

Source: 2020 Data Collection Questionnaires, Missouri DHSS
https://healthapps.dhss.mo.gov/childcaresearch/, https://healthapps.dhss.mo.gov/showmeltc/default.aspx

Table 3.9 includes a summary of the inventory of critical and essential facilities and infrastructure in the planning area. The list was compiled from the 2020 Data Collection Questionnaire, the Meramec Regional Hazardous Materials Emergency Response Plan and the National Bridge Inventory.

Table 3.9. Inventory of Critical/Essential Facilities and Infrastructure by Jurisdiction

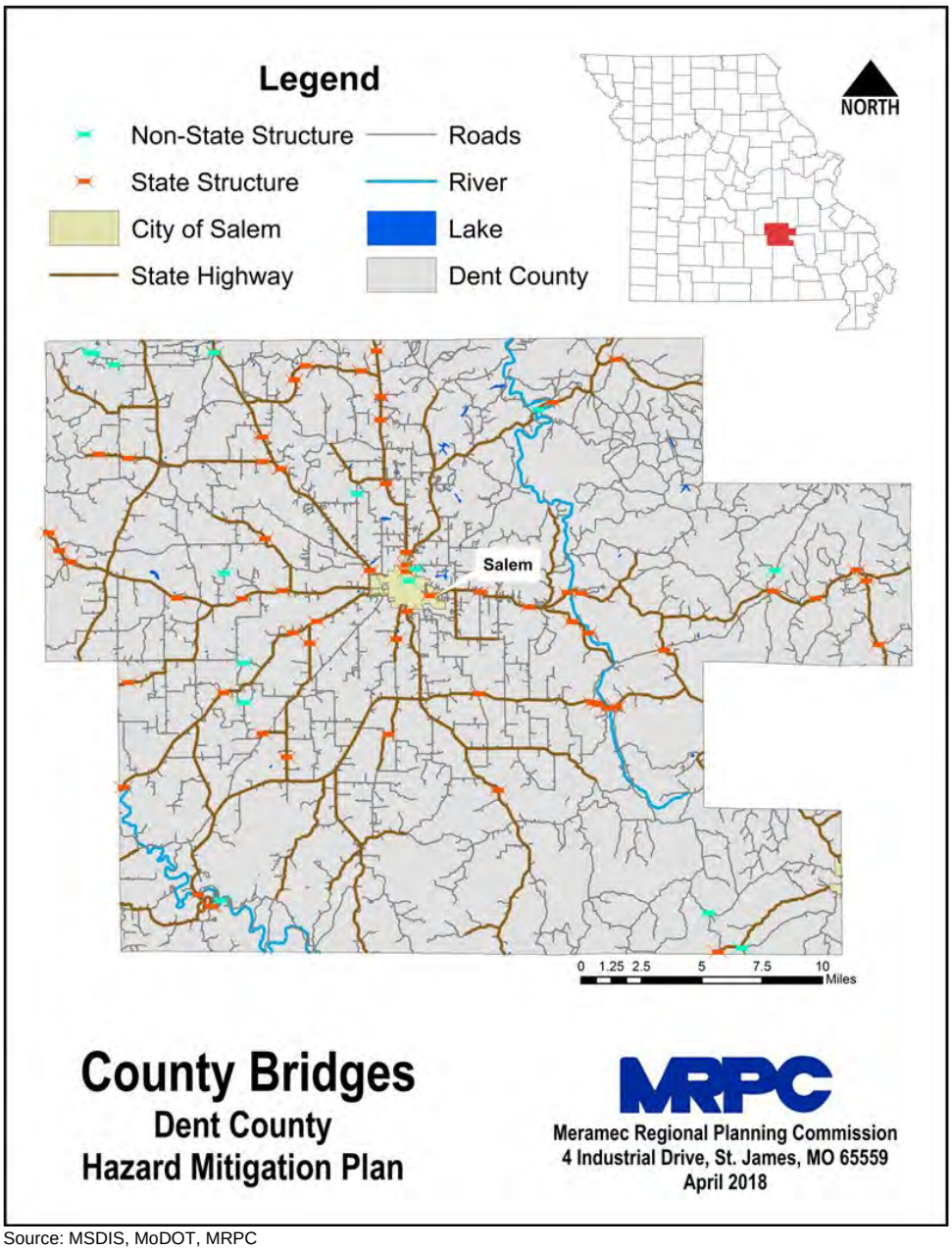
	Airport Facility	Bus Facility	Childcare Facility	Communications Tower	Electric Power Facility	Emergency Operations	Fire Service	Government	Housing	Shelters	State & Non-State Structures (Bridge)	Hospital/Health Care	Military	Pipeline/Pump Station	Nursing Homes	Police Station	Potable Water Facility	Rail	Sanitary Pump Stations	School Facilities	Stormwater Pump Stations	Tier II Chemical Facility	Wastewater Facility	Total
Unincorporated Dent County	1	0	0	8	-	0	2	30	1	1	73	0	0	1	0	1	1	0	0	4	0	4	0	127
Salem	1	0	6	1	0	2	2	10	2	0	2	5	0	0	2	2	1	0	5	5	0	29	1	76
Totals	2	0	6	9	0	2	4	40	3	1	75	5	0	1	2	3	2	0	5	9	0	33	1	203

Source: 2020 Data Collection Questionnaires, National Bridge Inventory, 2020 MREPC Hazardous Materials Emergency Response Plan

According to the National Bridge Inventory there are a total of 74 bridges in Dent County[3]. **Figure 3.2** shows the locations of State regulated bridges and non-State bridges in the planning area. Scour critical bridges were also examined. Scour critical refers to one of the database elements in the National Bridge Inventory. This element is quantified using a "scour index", which is a number indicating the vulnerability of a bridge to scour during a flood. Bridges with a scour index between 1 and 3 are considered "scour critical", or a bridge with a foundation determined to be unstable for the observed or evaluated scour condition. There are no scour critical bridges within Dent County.[4]

[3] http://www.fhwa.dot.gov/bridge/nbi/no10/county.cfm
[4] https://infobridge.fhwa.dot.gov/Data/SelectedBridges#!#OverviewTab

Figure 3.2. Dent County Bridges



Source: MSDIS, MoDOT, MRPC

3.2.3 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 a greater degree of 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.

Threatened and Endangered Species: **Table 3.10** depicts Federally Threatened, Endangered, Proposed and Candidate Species in the county.

Table 3.10. Threatened and Endangered Species in Dent County

Common Name	Scientific Name	Status
Amphibians		
Eastern Hellbender	*Cryptobranchus alleganiensis*	Endangered (F) (S)
Ozark Hellbender	*Cryptobraqnchus alleganiensis bishopi*	Endangered (F)
Insects		
Hine's Emerald Dragonfly	*Somatochlora hineana*	Endangered (F)
Fishes		
Mountain Madtom	*Noturus eleutherus*	Endangered (S)
Birds		
Bachman's Sparrow	*Peucaea aestivalis*	Endangered (S)
Flowering Plants		
Virginia Sneezeweed	*Helenium virginicum*	Threatened (F)
Eastern prairie fringed orchid	*Plantanthera leucophaea*	Endangered (S)
Mammal		
Gray bat	*Myotis grisescens*	Endangered (F) (S)
Indiana bat	*Myotis sodalis*	Endangered (F) (S)
Northern long-eared bat	*Myotis septentrionalis*	Threatened (F)
Eastern spotted skunk	*Spilogale putorius*	Endangered (S)

Note: S = State, F = Federal
Source: U.S. Fish and Wildlife Service, https://ecos.fws.gov/ecp/;
MDC, https://nature.mdc.mo.gov/status/endangered

Natural Resources: The Missouri Department of Conservation (MDC) provides a database of lands owned, leased, or managed for public use. **Table 3.11** provides the names and locations of parks and conservation areas in Dent County.

Table 3.11. Conservation Areas in Dent County

Area Name	Address	City
Brown (Gerhild and Graham) CA	From Salem at the junction of Highway 72/Route H, take Route H west 3.50 miles, then Route DD north 3 miles.	Salem
Cedar Grove CA	To the larger tract(720 acres) : From Jadwin, take Route K south 3 miles to the area To the smaller tract(160 acres) :From Salem, take Highway 19 south 16 miles, then Route WW west 1 mile to the area.	Jadwin
Clement (R F) Mem Forest and WA	From Salem take Highway 72 north, then a left on Route C west 5 miles, then right on Route O north 2 miles, and a left on Route OO west 3.50 miles.	Salem
Hyer Woods CA	From Salem, take Highway 72 north 13 miles, then left on County Road 2070 west, then an immediate right (north) on Old Highway 72 across the bridge of the Hyer Branch, then left on County Road 2060 left and the area is on the left.	Salem
Indian Trail CA	From Salem, take Highway 19 northeast 12 miles to the area.	Salem
Lenox Towersite	From Lenox, take Route C south 1 mile.	Lenox
Montauk Fish Hatchery	Montauk Fish Hatchery/Trout Park is inside Montauk State Park, southeast of Licking. From Highway 137, take Route VV east 10 miles to Highway 119, then turn right, and watch for signs to the area.	Licking
Montauk Towersite	From Salem, Take Highway 32 west out of town 11 miles , turn left on Highway 19 south 3 miles, then turn west on County Road 6020 to the tower site.	Salem
Shawnee Mac Lakes CA	From Salem, take 10th Street, which becomes County Road 4110, east 2 miles to the area.	Salem
Short Bend Access	From Salem, take Highway 19 northeast about 9 miles.	Salem

White River Trace CA	From Highway 72 in Salem, take Route H west approximately 9 miles to Dent County Road 253. Headquarters is approximately 1.30 miles south on Dent County Road 253.	Salem

Source: https://nature.mdc.mo.gov/discover-nature/find/places?area_name=&counties=All&location%5Bdistance%5D=50&location%5Borigin%5D=

Table 3.12 provides information pertaining to community owned/operated parks within Dent County.

Table 3.12. Community Owned Parks in Dent County

Park Name	Address	City
Salem City Park	Rolla Road	Salem
Roadside Park	N Main St	Salem
Al Brown Baseball Fields	Co. Rd 345	Salem
Tiger Trail	-	Salem

Source: Google Search

Historic Resources: The National Register of Historic Places is the official list of registered cultural resources worthy of preservation. It was authorized under the National Historic Preservation Act of 1966 as part of a national program. The purpose of the program is to coordinate and support public and private efforts to identify, evaluate, and protect our historic and archeological resources. The National Register is administered by the National Park Service under the Secretary of the Interior. Properties listed in the National Register include districts, sites, buildings, structures and objects that are significant in American history, architecture, archeology, engineering, and culture. **Table 3.13** provides information in regards to properties on the National Register of Historic Places in Dent County.

Table 3.13. Dent County Properties on the National Register of Historic Places

Property	Address	City	Date Listed
Dam and Spillway in the Hatchery Area at Montauk State Park	Salem vicinity off MO 119	Salem	2/26/85
Dent County Courthouse	Main and 4th St.	Salem	2/23/72
Lower Parker School	E bank of Current R. at Parker Hollow	Salem	5/31/91
Montauk State Park Open Shelter	Salem vicinity off MO 119	Salem	2/28/8
Nichols Farm District	W of CR V, N of Current River	Cedar Grove	12/27/89
Nova Scotia Ironworks Historic District	Mark Twain National Forest	Salem	8/25/03
Old Mill at Montauk State Park	Off MO 119	Salem	6/27/85
Young W.A. House	CR 513	Salem	3/30/89

Source: Missouri Department of Natural Resources – Missouri National Register Listings by County
https://mostateparks.com/page/84436/missouri-national-register-listings

Economic Resources: **Table 3.14** provides major non-government employers in the planning area.

There are approximately 325 employer establishments within the county, employing on average 11 individuals each[5].

Table 3.14. Major Non-Government Employers in Dent County

Employer Name	Product or Service	Employees
Phelps Health	Healthcare	100-249
Royal Oak	Manufacturer	100-249
Salem Memorial District Hospital	Hospital	100-249
U.S. Foods	Food Distributer	250-499
Wal-Mart	Retail	250-499

Source: https://meric.mo.gov/industry/business-locator, 2020 Data Collection Questionnaires

Agriculture plays an important role in Dent County. However, the Agribusiness Employment Location Quotient for the county is 1.72; meaning that there is a relatively high share of agribusiness employment to its share of total national employment[6]. In addition, there were 95 individuals working in the agriculture industry, comprising 2.16% of the total workforce in 2020[7]. Furthermore, the market value of products sold in 2017 was $21,818,000 million; 88% from livestock sales and 12% from crop sales.[8]

[5] https://www.census.gov/quickfacts/fact/table/dentcountymissouri,crawfordcountymissouri/HSG650219
[6] Missouri Economic Research and Information Center
[7] Ibid
[8] https://www.nass.usda.gov/Quick_Stats/CDQT/chapter/2/table/1/state/MO/county/065/year/2017

3.3 Future Land Use and Development

Table 3.15 provides population growth statistics for Dent County.

Table 3.15. Dent County Population Growth, 2010-2020

Jurisdiction	2010 Population	2020 Population	2010-2020 # Change	2010-2020 % Change
Unincorporated Dent County	10,627	9,813	-814	-4.42%
Salem	4,828	4,608	-220	-4.56%

Source: U.S. Bureau of the Census 2020 Decennial Redistricting Data, Census 2010 Summary File 1

Typically population growth or decline is generally accompanied by an increase or decrease in the number of housing units. **Table 3.16** provides the change in numbers of housing units in the planning area from 2010-2019.

Table 3.16. Change in Housing Units, 2010-2020

Jurisdiction	Housing Units 2010	Housing Units 2020	2010-2020 # Change	2010-2020 % Change
Unincorporated Dent County	4,877	4,511	-366	-7.50%
Salem	2,408	2,308	-100	-4.15%

Source: U.S. Census Bureau 2020 Decennial Redistricting Data, U.S. Bureau of the Census, Census 2010 Summary File 1

Jurisdictions reported anticipated future developments within the next five years (2021-2026). Dent-Phelps R-III did not anticipate any major future developments within the next five years.

Unincorporated Dent County is planning to replace multiple low water crossings on county roads throughout the jurisdiction. Additionally, the roads department has a standing policy of increasing the size of any culverts that are replaced throughout the county to manage stormwater and mitigate the risk of flooding.

The City of Salem anticipates the construction of various new residential structures coordinated by the Salem Housing Authority. There is currently a discussion of a bond issue for the construction of a new elementary school building for Salem R-80 school district. The city is pursing certified site status for the Salem Industrial Park. Additionally, Four Rivers Community Health Center, a federally qualified health center, is planning an expansion of their Salem clinic location.

Green Forest R-II School District is in the early stages of planning for the addition of a music/art room. They would like it to qualify as a certified tornado safe room. Currently, there are no certified tornado safe rooms that service the district.

Northwood R-IV School District recently completed renovation projects on the district's bus barn an expansion on the back of their building. The district is planning for the construction of a tornado safe room. They were selected by Missouri SEMA to submit their grant application to FEMA for the 2021-22 grant cycle and are awaiting response.

Oak Hill R-I School District is planning to remodel their stage area to increase the number of classrooms

in their building and are investigating funding for the construction of a certified tornado safe room. They also will remodel their office area. The district recently completed some security updates of windows and doors in their building. The district currently does not have access to a certified tornado safe room.

Salem R-80 School District anticipates the completion of several projects in the next five-year period. They are planning a new construction trades building as well as a gym remodel and addition. The district was selected by Missouri SEMA to submit a grant application to FEMA for the construction of a certified tornado safe room. Additionally, the district expects to construct a new building to relocate and replace their existing lower elementary building.

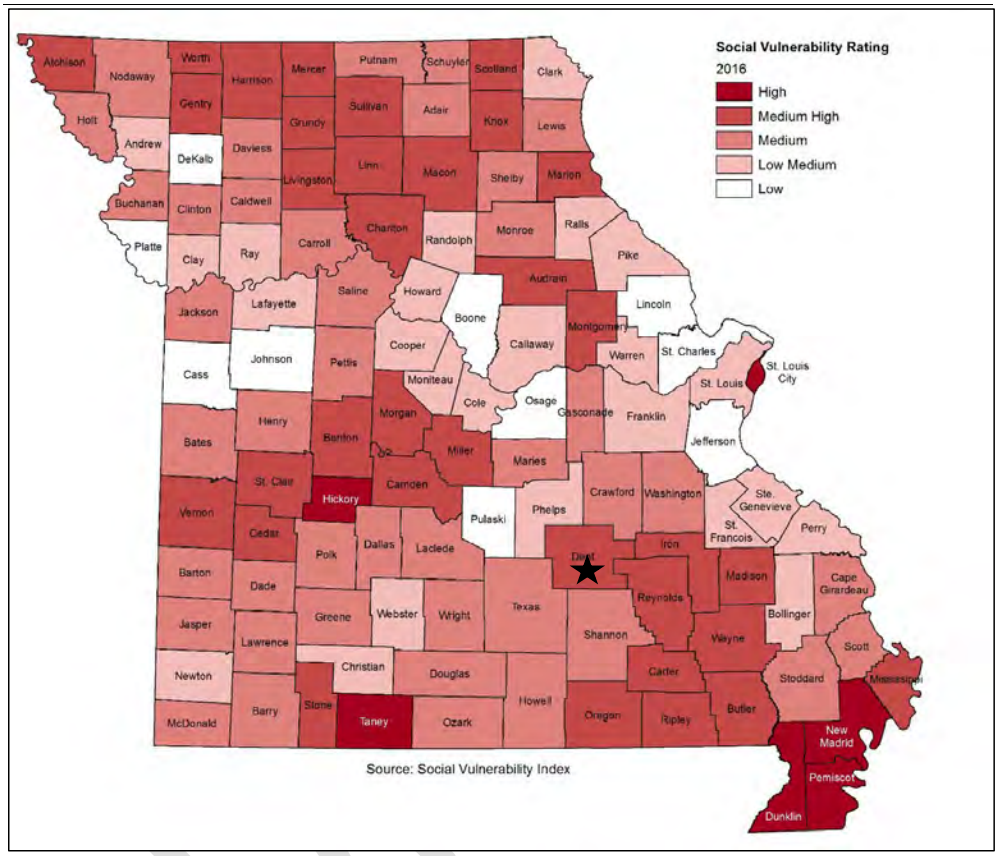
New development can impact a jurisdiction's vulnerability to natural hazards. As the number of buildings, critical facilities, and assets increase, vulnerability increases as well. For example, real estate development can increase storm water runoff, which often increases localized flooding. However, some development such as infrastructure improvements can help reduce vulnerability risks. Unfortunately, quantitative data is not available to further examine each jurisdictions new development and its correlation to natural hazard vulnerabilities.

Socioeconomic Profile

The Missouri State Hazard Mitigation Plan provides ratings for social vulnerability for each of the counties in the state based on 42 socioeconomic and built environment variables that research suggests contribute to a community's ability to prepare for, respond to and recover from hazards. Based on that data, Dent County has a "medium" social vulnerability rating (**Figure 3.3**). Furthermore, business incentives are available in the County including Missouri Works, a program for qualified job creators which enables the retention of withholding tax or tax credits that can be transferrable, refundable and/or saleable; BUILD, a financial incentive for the location or expansion of large business projects; sales tax exemptions exist for qualified manufacturers; and industrial infrastructure grants are available up to $2 million or $20,000 per job created[9].

[9] https://ded.mo.gov/programs/business/missouri-works

Figure 3.3. Social Vulnerability Rating for Dent County



Source: 2018 Missouri State Hazard Mitigation Plan
*Black star indicates Dent County

3.4 Hazard Profiles, Vulnerability, and Problem Statements

Each hazard that has been determined to be a potential risk to Dent County is profiled individually in this section of the plan document. 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

Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

Each hazard identified in Section **3.1.4** will be profiled individually in this section in alphabetical order. 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. For hazards such as drought that may have gradual onset and extended duration, probability can be based on the number of months in drought in a given time-period and expressed as the probability for any given month to be in drought.

The discussion on the probability of future occurrence should also consider changing future conditions, including the effects of long-term changes in weather patterns and climate on the identified hazards. NOAA has a new tool that can provide useful information for this purpose.

- NOAA Climate Explorer, http://toolkit.climate.gov/climate-explorer2/

Vulnerability Assessments

Requirement §201.6(c)(2)(ii) :[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.

Requirement §201.6(c)(2)(ii)(A) :The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas.

Requirement §201.6(c)(2)(ii)(B) :[The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.

Requirement §201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

Requirement §201.6(c)(2)(ii): (As of October 1, 2008) [The risk assessment] must also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged in floods.

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 (2018). With the 2018 Hazard Mitigation Plan Update, SEMA is pleased to provide online access to the risk assessment data and associated mapping for the 114 counties in the State. Through the web-based Missouri hazard Mitigation Viewer, local planners or other interested parties can obtain all State Plan datasets. This effort removes from local mitigation planners a barrier to performing all the needed local risk assessments by providing the data developed during the 2018 State Plan Update. The Missouri Hazard Mitigation viewer can be found at this link: http://bit.ly/MoHazardMitigationPlanViewer2018.

The county-level assessments in the State Plan were also based on the following additional sources:

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

The vulnerability assessments in the Dent County 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.

Within the Vulnerability Assessment, the following sub-headings will be addressed:

Vulnerability Overview: This section will include a brief review of the vulnerability of each hazard.

Potential Losses to Existing Development: This section will describe the potential impacts of each hazard – the consequences of the effect of the hazard on the jurisdiction and its assets (including types and numbers, of buildings, critical facilities, etc.).

Future Development: This section will include information on anticipated future development in the county, and how that would impact hazard risk in the planning area.

Previous and Future Development: This section will include information on how changes in development have impacted the community's vulnerability to this hazard. Describe how any changes in development that occurred in known hazard prone areas since the previous plan have increased or decreased the community's vulnerability. Describe any anticipated future development in the county, and how that would impact hazard risk in the planning area.

Problem Statements

Each hazard analysis must conclude with a brief summary of the problems created by the hazard in the planning area, and possible ways to resolve those problems. Additionally, variations in risk between geographic areas will be included.

3.4.1 Dam Failure

Some specific sources for this hazard are:

- 2018 Missouri State Hazard Mitigation Plan, Chapter 3, Section 3.3.3, Page 3.148 https://sema.dps.mo.gov/docs/programs/LRMF/mitigation/MO_Hazard_Mitigation_Plan2018.pdf
- Missouri Department of Natural Resources, Dam and Reservoir Safety, https://dnr.mo.gov/land-geology/dam-reservoir-safety
- Stanford University's National Performance of Dams Program; http://npdp.stanford.edu/
- National Inventory of Dams, https://nid.usace.army.mil/#/
- National Resources Conservation Service http://www.nrcs.usda.gov
- DamSafetyAction.org, http://www.damsafetyaction.org/MO/
- Missouri Spatial Data Information Service, http://msdis.missouri.edu
- Missouri Hazard Mitigation Viewer
  http://bit.ly/MoHazardMitigationPlanViewer2018 - Website
  https://drive.google.com/file/d/1bPkc0jgF9ofwQLnTL9N0u-oPFWi9hkst/view - User Guide
  - Total number of Missouri NID dams by County
  - Total number of High, Significant, and Low Hazard dams by County
  - Total number of State Regulated dams by County
  - Total number of Class 1, Class 2, and Class 3 dams by County
  - Total number of structures impacted by USACE dams by County
  - Total number of structures impacted by State dams by County
  - Total value of structures impacted by USACE dams by County
  - Total value of structures impacted by State dams by County
  - Total population impacted by USACE dams by County
  - Total population impacted by State dams by County

Hazard Profile

Hazard Description

A dam is defined as a barrier constructed across a watercourse for the purpose of 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.

Information regarding dam classification systems under both the Missouri Department of Natural Resources (MDNR) and the National Inventory of Dams (NID), which differ, are provided in **Table 3.17** and **Table 3.18**, respectively.

Table 3.17. MDNR Dam Hazard Classification Definitions

Hazard Class	Definition
Class I	Contains 10 or more permanent dwellings or any public building
Class II	Contains 1 to 9 permanent dwellings or 1 or more campgrounds with permanent water, sewer, and electrical services or 1 or more industrial buildings
Class III	Everything else

Source: Missouri Department of Natural Resources, Missouri Geological Survey Rolla Office

Table 3.18. NID Dam Hazard Classification Definitions

Hazard Class	Definition
Low Hazard	A dam located in an area where failure could damage only farm or other uninhabited buildings, agricultural or undeveloped land including hiking trails, or traffic on low volume roads that meet the requirements for low hazard dams.
Significant Hazard	A dam located in an area where failure could endanger a few lives, damage an isolated home, damage traffic on moderate volume roads that meet certain requirements, damage low-volume railroad tracks, interrupt the use or service of a utility serving a small number of customers, or inundate recreation facilities, including campground areas intermittently used for sleeping and serving a relatively small number of persons.
High Hazard	A dam located in an area where failure could result in any of the following: extensive loss of life, damage to more than one home, damage to industrial or commercial facilities, interruption of a public utility serving a large number of customers, damage to traffic on high-volume roads that meet the requirements for hazard class C dams or a high-volume railroad line, inundation of a frequently used recreation facility serving a relatively large number of persons, or two or more individual hazards described for significant hazard dams.

Source: National Inventory of Dams

Geographic Location

Dams in Planning Area

According to the National Inventory of Dams there are 36 recorded dams in Dent County; including 13 high hazard dams; three significant hazard dams; and 20 low hazard dams. The Missouri Department of Natural Resources also tracks dams in the state and has identified five Class 1 dams, eight Class 2 dam and twenty three Class 3 dam. **Table 3.19** provides the name of the dam, DNR hazard class and NID hazard class for each of the identified dams in Dent County. There are four state-regulated dams in Dent County. None of the dams are owned or operated by the United States Army Corps of Engineers (USACE). County dams are privately or commercially owned. **Table 3.20** provides the names, locations, and other pertinent information for all NID High Hazard Dams in the planning area.

Table 3.19. Dent County Dams Hazard Risk

Name of Dam	DNR Hazard Class	NID Hazard Class
ALLISON & HAAS LAKE DAM	3	Low
ARROWHEAD LAKE UPPER DAM	3	Low
ARROWHEAD LAKES LOWER DAM	1	High
BASS DAM	2	High
BISHOP DAM	2	High
BUBBLING SPRINGS DAM	2	High
CLARK LAKE DAM	2	High
DEEKEN DAM	3	Low
ECHO LAKE DAM #2	3	Low
GREEN DAM	3	Low
HART DEVELOPMENT LAKE DAM SECT 10	2	High
HART DEVELOPMENT LAKE DAM-SECT 15	3	Low
HONEY LAKE DAM	3	Low
HOWES MILL FISH HATCHERY	3	Low
HUZZAH HATCHERIES, INC DAM	3	Low
HUZZAH 1 (HOWES MILL LAKE)	-	High
IMPERIAL PRODUCTS DAM	3	Significant
INDIAN TRAIL FISH HATCHERY LAKE DAM	2	High
LAKE JOY DAM	3	Significant
LAKE TURNER DAM	1	High
LAKE WILLIAMS DAM	3	Significant
LAKE ZISKE DAM	1	High
LITTLE SCOTIA POND	3	Low
LOSS LAKE DAM	2	High
MASTERS DAM	1	High
METZGER DAM	3	Low
MITCHELL DAM	1	High
MONONAME 18	3	Low
MUND DAM	3	Low
PUTMAN DAM	3	Low
RYDER LAKE DAM	3	Low
SCOTIA POND DAM	3	Low

Name of Dam	DNR Hazard Class	NID Hazard Class
STREET LAKE DAM	3	Low
TEALWOOD DAM	3	Low
TIEFENTHALER LAKE DAM	2	High
WARNER LAKE DAM	3	Low
WOOD BROTHERS DAM	3	Low

Source: Missouri Department of Natural Resources, Dam and Reservoir Safety Program; National Inventory of Dams

Table 3.20. NID High Hazard Class Dams in the Dent County Planning Area

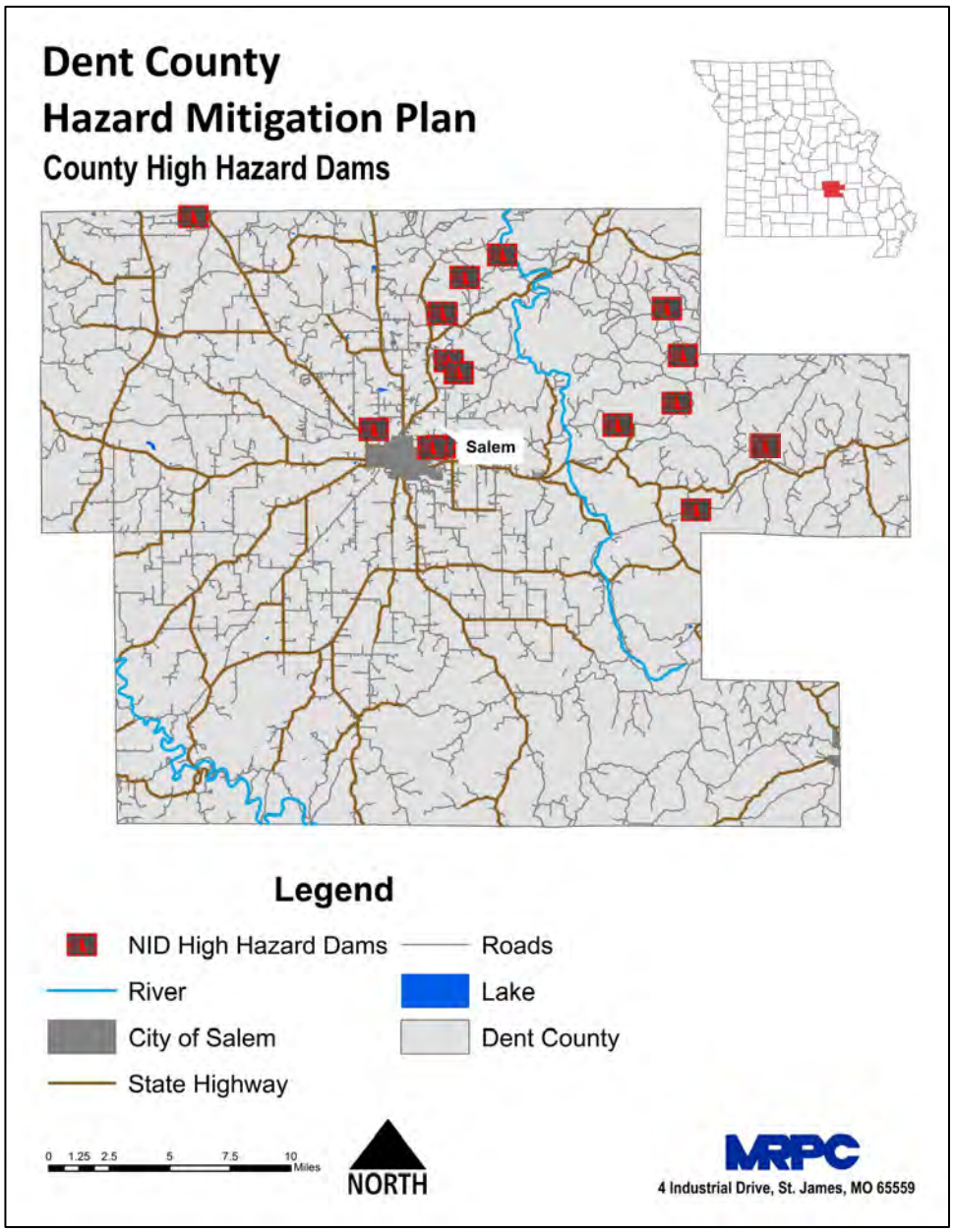
Dam Name	NIDID	Hazard Potential *	NID Height (Ft.)	NID Storage	River	Nearest City *	Distance To City (Mi.) *
ARROWHEAD LAKES LOWER DAM	MO30267	High	27	84	TR MERAMEC RIVER	COOK STATION	13
BASS DAM	MO30070	High	20	118	TR SPRING CREEK	SALEM	1
BISHOP DAM	MO31049	High	25	201	STONE HILL BRANCH	WESCO	28
BUBBLING SPRINGS DAM	MO30008	High	23	185	PETERS BRANCH	LAKE SPRING	0
CLARK LAKE DAM	MO30269	High	25	67	TR-HUTCHINS CREEK	WESCO	20
HART DEVELOPMENT LAKE DAM SECT 10	MO30264	High	30	835	LOST CREEK	COOK STATION	5
Huzzah 1 (Howes Mill Lake)	MO32005	High	21	83	HUZZAH CREEK	DILLARD	6
INDIAN TRAIL FISH HATCHERY LAKE DAM	MO30054	High	30	241	CROOKED CREEK	SLIGO	6
LAKE TURNER DAM	MO30266	High	32	274	TR SPRING CREEK	SALEM	1
LAKE ZISKE DAM	MO30071	High	24	372	TRIBUTARY TO SPRING CREEK	SALEM	2
LOSS LAKE DAM	MO30262	High	65	2,200	LOST CREEK	COOK STATION	8
MASTERS DAM	MO30065	High	33	565	LOST CREEK	WESCO	3
MITCHELL DAM	MO30268	High	31	481	TR MERAMEC RIVER	COOK STATION	12

Dam Name	NIDID	Hazard Potential *	NID Height (Ft.)	NID Storage	River	Nearest City *	Distance To City (Mi.) *
TIEFENTHALER LAKE DAM	MO31322	High	39	546	HAMILTON HOLLOW CROOKED CREEK	SALEM	0

Sources: National Inventory of Dams, http://nid.usace.army.mil/cm_apex/f?p=838:12. ; Missouri Department of Natural Resources, Dam and Reservoir Safety Program

Figure 3.4 depicts locations of NID high hazard dams located in the planning area. If a dam failure were to occur in Dent County, depending upon dam and location, the severity would range between negligible to life threatening. Road infrastructure, residential structures, commercial buildings, and public buildings are all vulnerable to losses. There are no areas of assembly in dam inundation zones within the county. Two dam inundation maps were available from the Missouri Department of Natural Resources. These State regulated dams include Loss Lake Dam and Tiefenthaler Lake Dam (**Figure 3.5** and **Figure 3.6**). No other dam inundation maps were available for the remaining NID High Hazard Dams in the county.

Figure 3.4. NID High Hazard Dam Locations in Dent County



Source: MSDIS, MRPC

Figure 3.5. Loss Lake Dam Inundation Zone

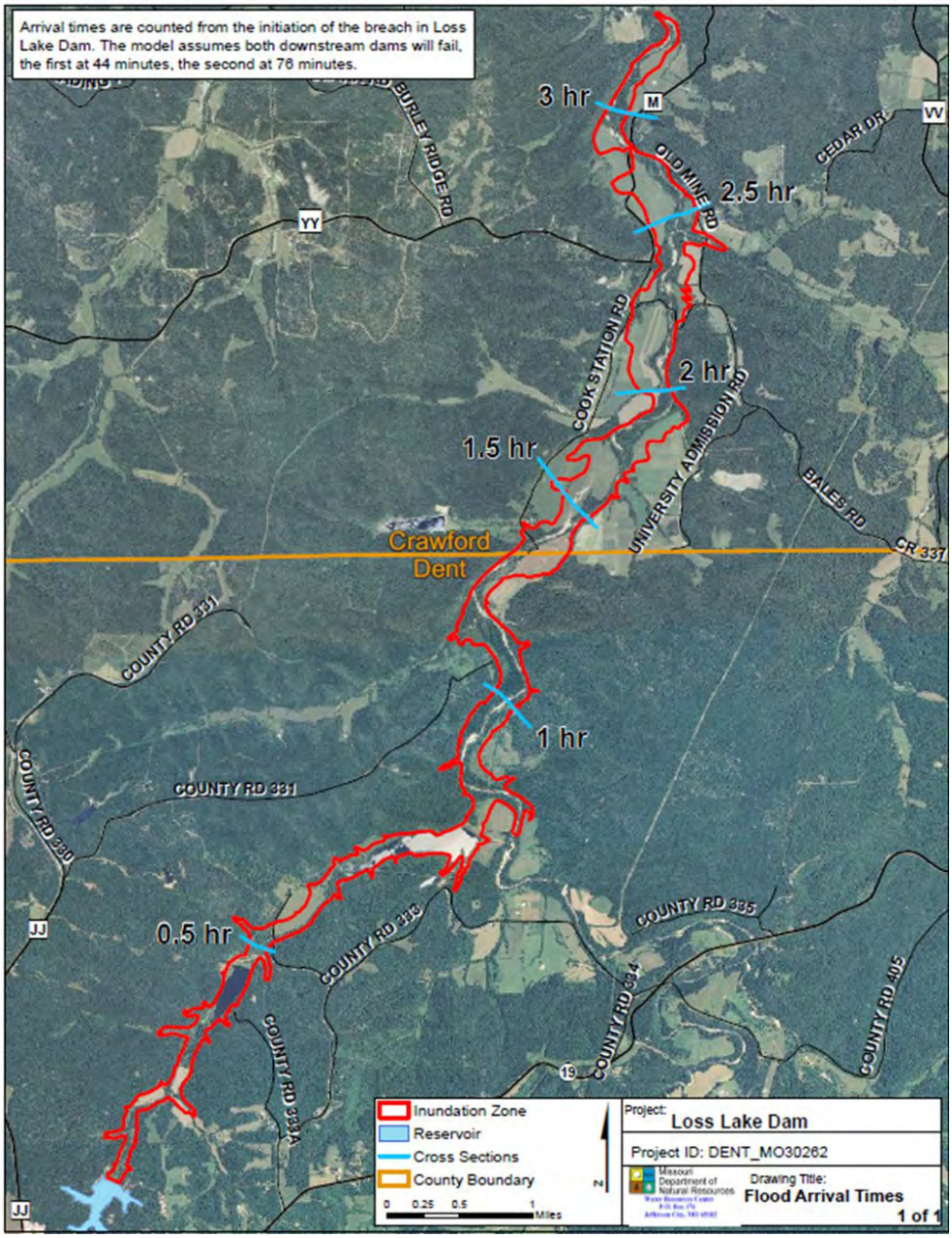
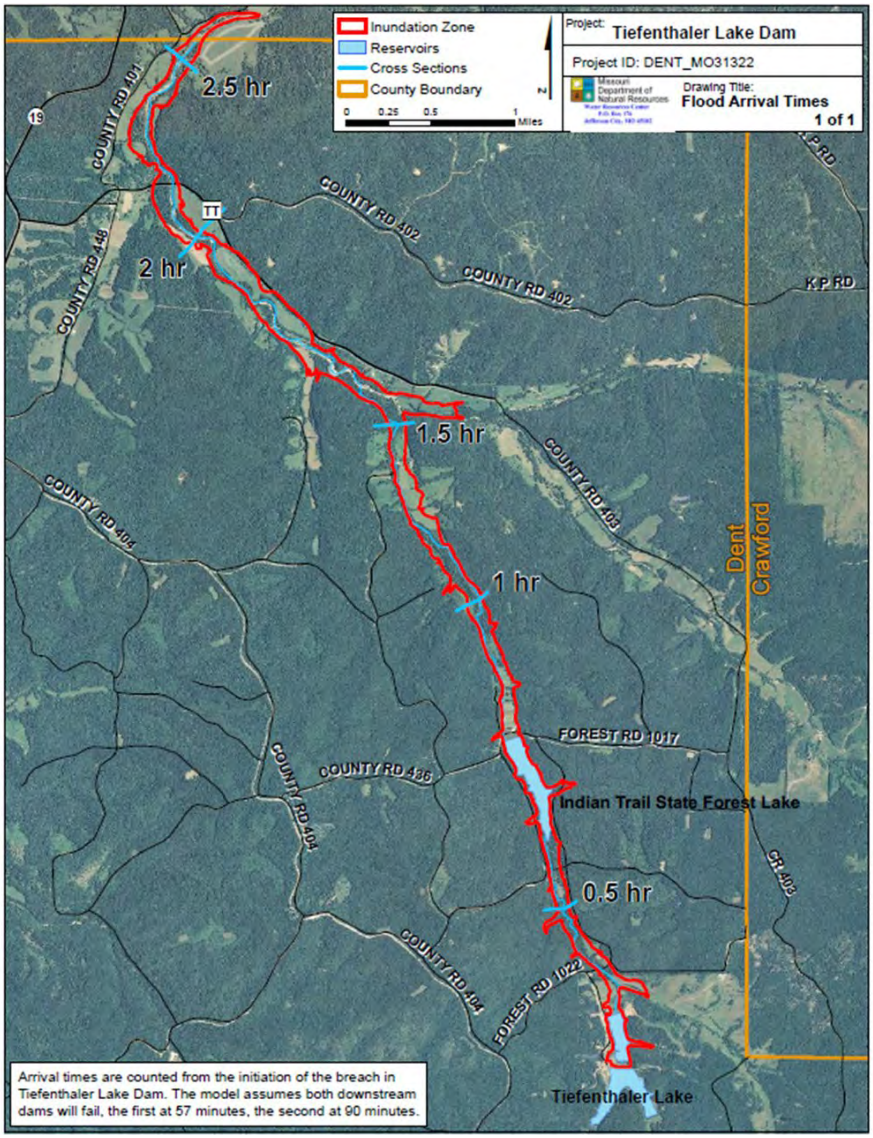


Figure 3.6. Tiefenthaler Lake, Echo Lake, and Indian Trail Fish Hatchery Lake Dam Inundation Zone

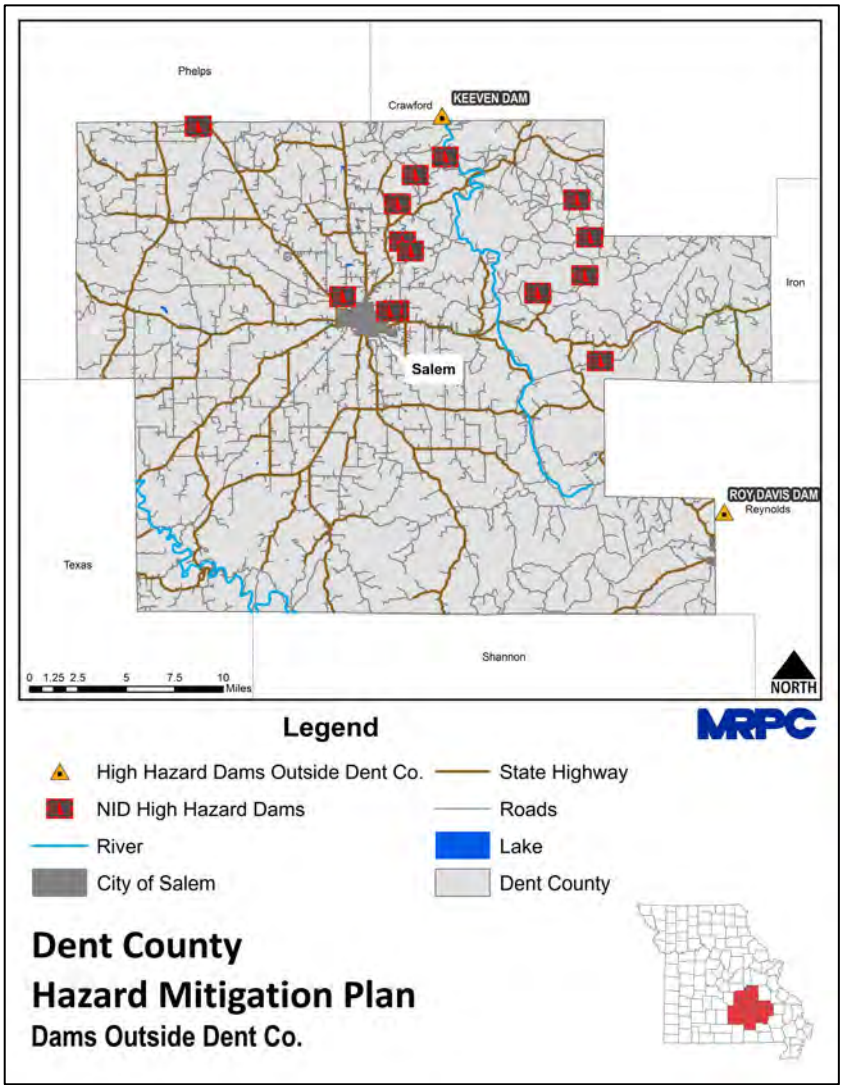


Upstream Dams Outside the Planning Area

Figure 3.7 depicts dams outside of Dent County that could impact the planning area in the event of failure. Two High Hazard dams (1 regulated) and one Low Hazard dam are located within a 1 mile buffer of the county. According to the Missouri Department of Natural Resources, Missouri Geological

Survey, Water Resources Center, there are no high hazard dams that would flow into Dent County from surrounding counties during a failure event.

Figure 3.7. Upstream Dams Outside Dent County



Source: MSDIS, MRPC

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. Worst case scenario would be a catastrophic failure at any of the high hazard class dams located in the county.

Previous Occurrences

According to Stanford University's National Performance of Dams Program and the Missouri State Emergency Management Agency, there were 86 recorded dam incidents in Missouri between 1917 and 2008. For the 42-year period from 1975 to 2016 for which dam failure statistics are available, 19 dam failures and 68 incidents are recorded. Fortunately, only one drowning has been associated with a dam failure in the state. The problem of unsafe dams in Missouri was underscored by dam failures at Lawrenceton in 1968, Washington County in 1975, Fredricktown in 1977, and a near failure in Franklin County in 1979. A severe rainstorm and flash flooding in October 1998 compromised about a dozen small, unregulated dams in the Kansas City area. But perhaps the most spectacular and widely publicized dam failure in recent years was the failure of the Taum Sauk Hydroelectric Power Plant Reservoir atop Profitt Mountain in Reynolds County, MO.

In the early morning hours of December 14, 2005, a combination of human and mechanical error in the pump station resulted in the reservoir being overfilled. The manmade dam around the reservoir failed and dumped over a billion gallons of water down the side of Profitt Mountain, into and through Johnson's Shut-Ins State Park and into the East Fork of the Black River. The massive wall of water scoured a channel down the side of the mountain that was over 6000 feet wide and 7,000 feet long that carried a mix of trees, rebar, concrete, boulders and sand downhill and into the park[10]. The deluge destroyed Johnson's Shut-Ins State Park facilities, including the campground, and deposited sediment, boulders and debris into the park. The flood of debris diverted the East Fork of the Black River into an older channel and turned the river chocolate brown. Fortunately the breach occurred in mid-winter. Five people were injured when the park superintendent's home was swept away by the flood, but all were rescued and eventually recovered. Had it been summer, and the campground filled with park visitors, the death toll could have been very high[11]. This catastrophe has focused the public's attention on the dangers of dam failures and the need to adequately monitor dams to protect the vulnerable.

Despite the significance of the immediate damage done by the Taum Sauk Reservoir dam failure, the incident also highlights the long-term environmental and economic impacts of an event of this magnitude. Four years later, the toll of the flooding and sediment on aquatic life in the park and Black River is still being investigated. Even after the removal of thousands of dump truck loads of debris and mud, the river is still being affected by several feet of sediment left in the park. The local economy, heavily reliant upon the tourism from the park and Black River, has also been hit hard[12].

Event Description

According to Stanford University's National Performance of Dams Program, no dam incidents have

[10] United States Geological Survey. Damage Evaluation of the Taum Sauk Reservoir Failure using LiDAR. https://www.researchgate.net/publication/268325451_Damage_Evaluation_of_the_Taum_Sauk_Reservoir_Failure_using_LiDAR

[11] The Alert. Spring 2006. After the Deluge…What's Ahead for Taum Sauk? By Dan Sherburne.

[12] The Alert. Spring 2006. After the Deluge…What's Ahead for Taum Sauk? By Dan Sherburne.

been recorded for Dent County[13].

Probability of Future Occurrence

Since it is unknown which dams, if any might fail at any given time, determining the probability of future occurrence is not possible[14]. In addition, dam failure within the county has not occurred according to available data.

Vulnerability

Vulnerability Overview

Data was obtained from the 2018 Missouri State Hazard Mitigation Plan for the vulnerability analysis of dam failure for Dent County. There are however data limitations regarding dams unregulated by the State of Missouri due to height requirements. These limitations hinder vulnerability analysis; nonetheless, failure potential still exists. **Table 3.21** provides vulnerability analysis data for the failure of State-regulated dams in Missouri.

Table 3.21. Vulnerability Analysis for Failure of State-regulated Dams in Missouri

County	Class 1	Class 2	Class 3	Total	Estimated # of Buildings Vulnerable	Average Exposure Value per Structure ($)	Estimated Total Potential Building Exposure ($)	Estimated Total Population Exposure	Estimated Building Losses ($)
Dent	0	2	2	4	12	$464,287	$5,571,450	3	$1,114,290

Source: 2018 Missouri State Hazard Mitigation Plan

For the vulnerability analysis of State regulated dams, the State developed the following assumptions for overview.

- Class 1 dams: the number of structures in the inundation area was estimated to be 10 or more permanent dwellings or any public building. Inspection of these dams must occur every two years.
- Class 2 dams: the area downstream from the dam that would be affected by inundation contains one to nine permanent dwellings, or one or more campgrounds with permanent water, sewer and electrical services or one or more industrial buildings. Inspection of these dams must occur once every three years.
- Class 3 dams: the area downstream from the dam that would be affected by inundation does not contain any of the structures identified for Class 1 or Class 2 dams. Inspection of these

[13] http://www.npdp.standord.edu/dam_incidents
[14] 2018 Missouri State Hazard Mitigation Plan

dams must occur once every five years.

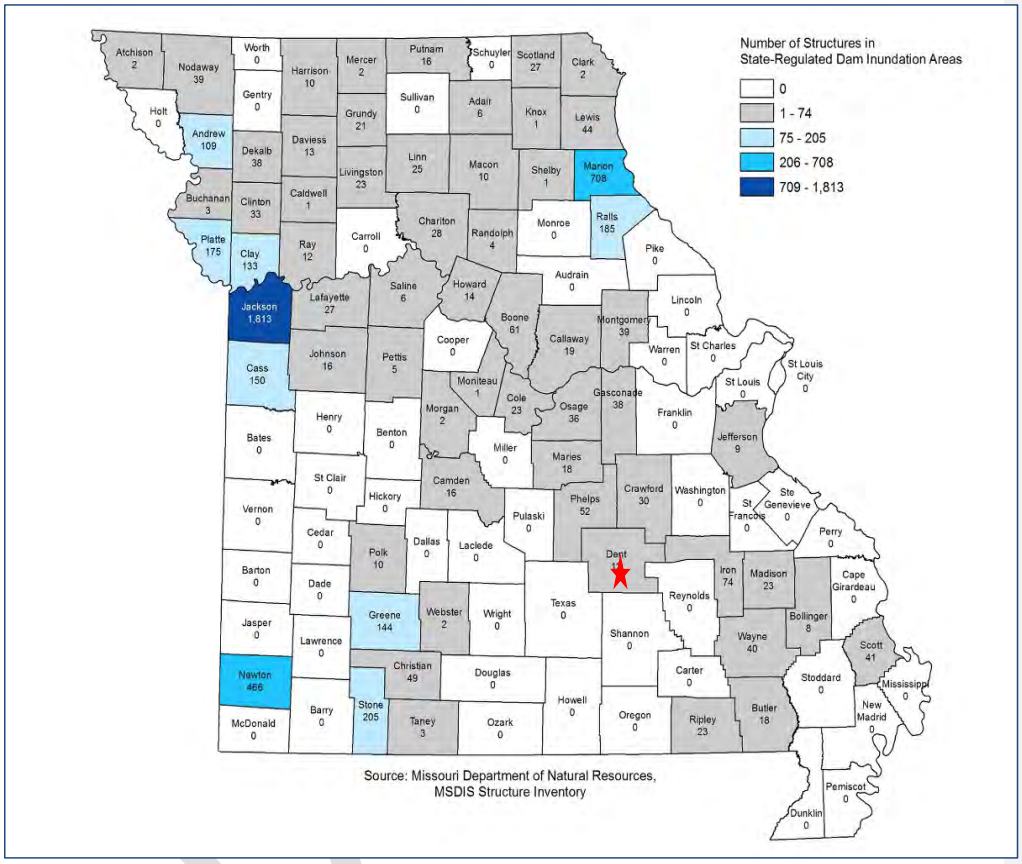
According to the 2018 Missouri State Hazard Mitigation Plan, there is an estimated 12 buildings vulnerable to failure of State-regulated dams (**Figure 3.8**) in Dent County. Furthermore, the state quantified potential loss estimates in terms of property damages. To execute the analysis, the following assumptions were utilized.

- For State-regulated Class 1 and Class 2 dams that have available inundation maps as well as USACE dams for which inundation maps were made available, GIS comparative analysis was accomplished against the building exposure data to determine the types, numbers and estimated values of buildings at risk to dam failure.
- The building exposure data was based on the structure inventory data layer available from the Missouri Spatial Data Inventory Service (MSDIS). The available dam inundation areas were compared against the structure inventory to determine the numbers and types of structures at risk to dam failure.
- To calculate estimated values of buildings at risk, buildings values available in the HAZUS census block data were used to determine an average value for each property type. This average value per property type was then applied to the number of structures in dam inundation areas by type to calculate an overall estimated value of buildings at risk by type.[15]

Figure 3.9 and **Figure 3.10** depict the total estimated building losses and population exposure by county, respectively. The estimated building losses from failure of State-regulated dams is $5,571,450 The estimated population exposure to failure of State-regulated dams is 3.

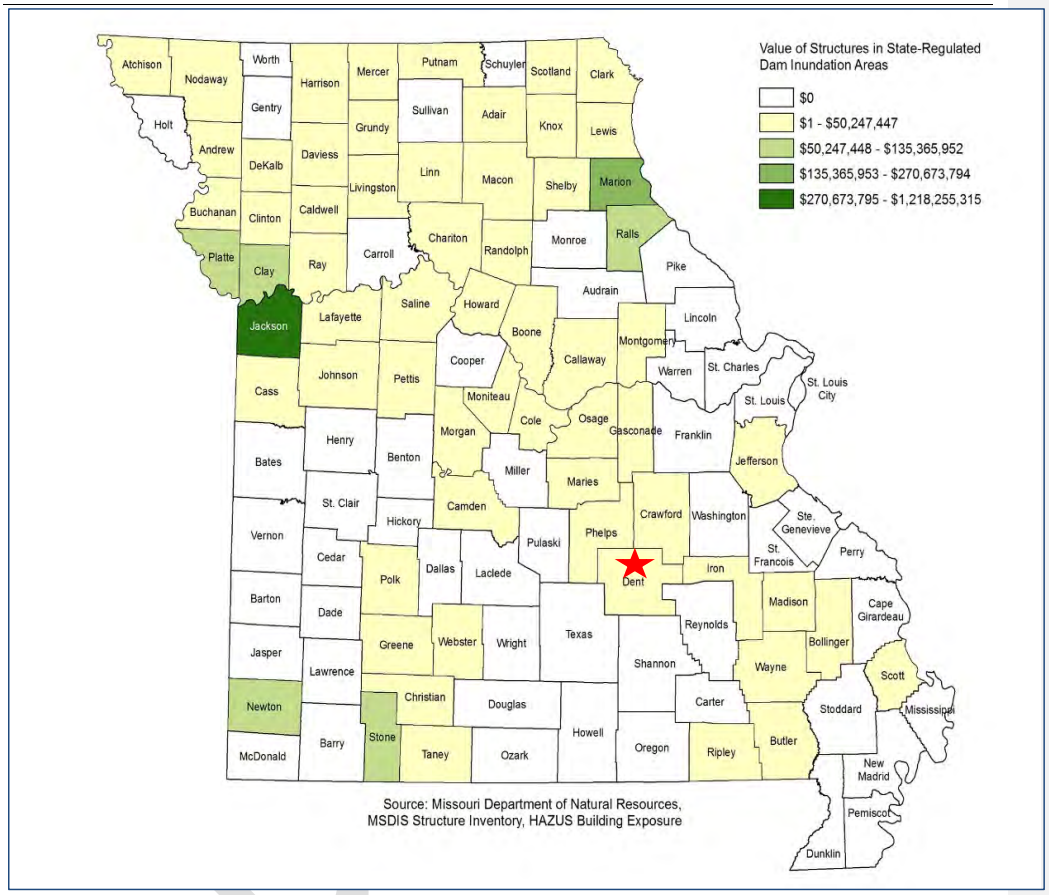
[15] 2018 Missouri State Hazard Mitigation Plan

Figure 3.8. Estimated Number of Buildings Vulnerable to Failure of State-regulated Dams



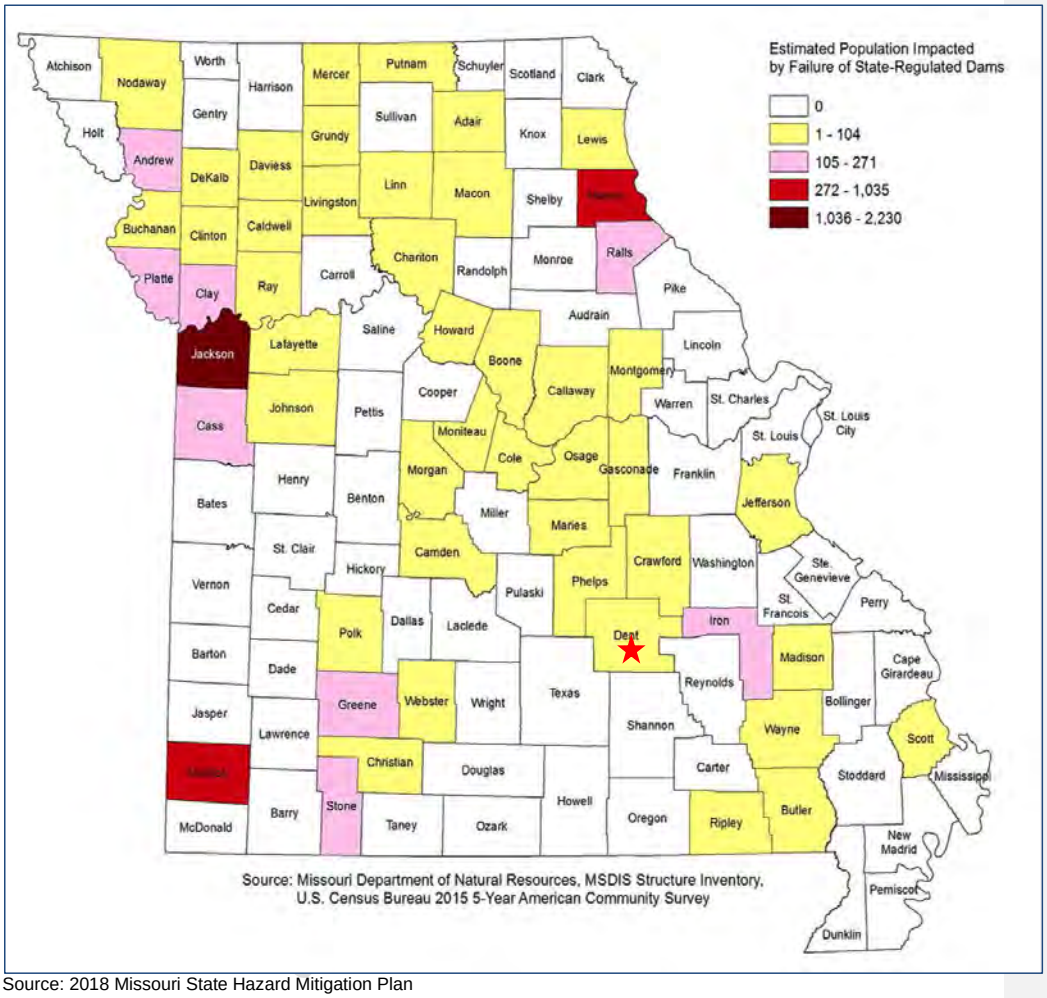
Source: 2018 Missouri State Hazard Mitigation Plan
*Red star indicates Dent County

Figure 3.9. Estimated Building Losses from Failure of State-regulated Dam



Source: 2018 Missouri State Hazard Mitigation Plan
*Red star indicates Dent County

Figure 3.10. Estimated Population Exposure to Failure of State-regulated Dams



Source: 2018 Missouri State Hazard Mitigation Plan
*Red star indicates Dent County

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

The most obvious worst case dam failure scenario would occur at any High Hazard/Class 1 dam. During a failure event, serious loss to road infrastructure, commercial and residential structures, and human life is likely. However, the majority of dams in Dent County are rural in nature.

Loss Lake Dam Downstream Crossings

- Co Rd 333B
- Co Rd 333
- Delcour Rd
- Cook Station Rd
- Bales Beach Rd
- Bales Rd
- Old Mine Rd
- Rte. M

Tiefenthalers Lake Dam Downstream Crossings

- Forest Rd 1022
- Co Rd 436
- Forest Rd 1017
- Co Rd 4030
- Rte. TT
- State Hwy 8

Impact of Future Development

Future development within the County that has potential to be influenced by dam failure includes any areas downstream of a dam within the 100 Year Floodplain. No development is planned in any floodplain or areas downstream of dams in the county or cities.

Hazard Summary by Jurisdiction

Variations in vulnerability across the planning area depend upon multiple variables. For example, with just 4 state-regulated dams and 13 NID high hazard dams, conclusions can be drawn that many of the high hazard dams in the county are un-regulated and may not be inspected/maintained appropriately. Nonetheless, Dent County school districts and special districts do not have assets located in dam breach inundation areas.

Problem Statement

In summary, the hazard risk for dam failure in Dent County ranges between high and low, dependent upon the dam. If a dam does fail, the expected impacts could vary from negligible to critical, and could potentially affect road infrastructure, residential structures, commercial buildings, public structures, and human life. It is recommended to encourage land use management practices to decrease the potential for damage from a dam collapse, including the discouragement of development in areas with the potential for sustaining damage from a dam failure. Installation of education programs to inform the public of dam safety measures and preparedness activities would be beneficial. In addition, the availability of training programs to encourage landowners how to properly inspect their dams and develop emergency action plans would be advantageous.

3.4.2 Drought

Some specific sources for this hazard are:

- 2018 Missouri State Hazard Mitigation Plan, Chapter 3, Section 3.3.6, Page 3.235
- Maps of effects of drought, National Drought Mitigation Center (NDMC) located at the University of Nebraska in Lincoln; http://www.drought.unl.edu/.
- Historical drought impacts, National Drought Mitigation Center (NDMC) located at the University of Nebraska in Lincoln; at http://droughtreporter.unl.edu/ .
- Recorded low precipitation, NOAA Regional Climate Center, (http://www.hprcc.unl.edu).
- Water shortages, Missouri's Drought Response Plan, Missouri Department of Natural Resources, https://dnr.mo.gov/water/hows-water/state-water/drought
- Populations served by groundwater by county, USGS-NWIS, http://maps.waterdata.usgs.gov/mapper/index.html
- Census of Agriculture, https://agcensus.library.cornell.edu/census_parts/2012-missouri/
- USDA Risk Management Agency, Insurance Claims, https://www.rma.usda.gov/en/Information-Tools/Summary-of-Business/Cause-of-Loss
- Natural Resources Defense Council, http://www.nrdc.org/globalWarming/watersustainability/
- Missouri Department of natural Resources (MDNR), Drought News, Conditions and Resources
- Missouri Hazard Mitigation Viewer
  http://bit.ly/MoHazardMitigationPlanViewer2018 - Website
  https://drive.google.com/file/d/1bPkc0jgF9ofwQLnTL9N0u-oPFWi9hkst/view - User Guide
    - Vulnerability to drought by County
    - Crop insurance claims due to drought by County

Hazard Profile

Hazard Description

Drought is generally defined as a condition of moisture levels significantly below normal for an extended period of time 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 2018 Missouri State Hazard Mitigation 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[16] - which impacts supply and demand of some economic commodity.

Geographic Location

All areas and jurisdictions in Dent County are susceptible to drought, but particularly cities where thousands of residents are served by the same source of water. These cities use deep hard rock wells that are 1,100 to 1,800 feet deep and can experience drought when recharge of these wells is low. The majority of individuals living in Dent County rely on groundwater resources for drinking water. Approximately 39% of the land in the county is utilized for agricultural purposes. Furthermore, livestock sales comprise 88% of the market of agricultural products sold in Dent County. A drought would directly impact livestock production and the agriculture economy in Dent County[17].

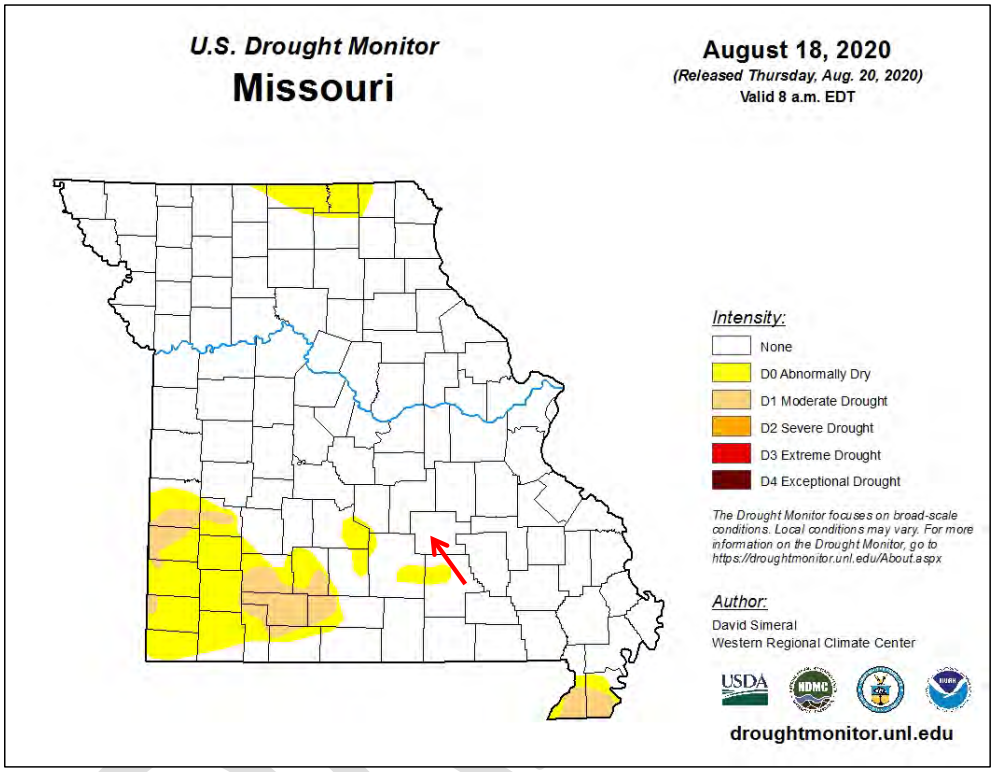
Severity/Magnitude/Extent

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[18].

Figure 3.11 depicts a U.S. Drought Monitor map of Missouri on August 18, 2020. This map illustrates the planning area, which could be in drought at any given moment in time. A red arrow indicates the location of the planning area (Dent County).

[16] http://www.drought.unl.edu/ http://droughtreporter.unl.edu/
[17] https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/Missouri/cp29065.pdf
[18] Ibid

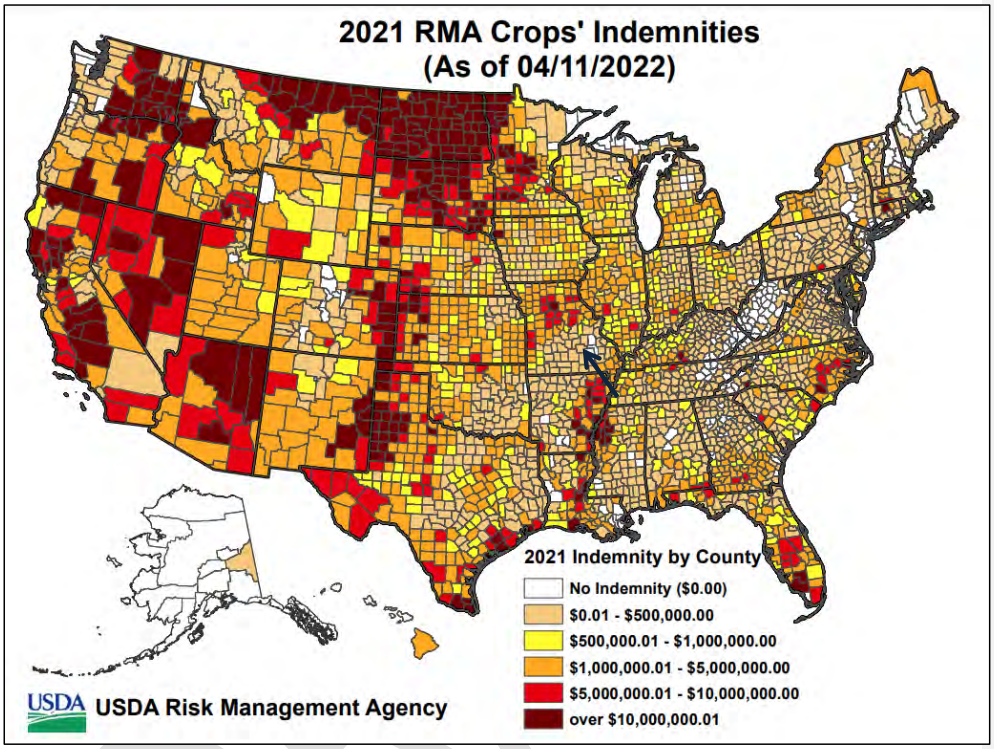
Figure 3.11. U.S. Drought Monitor Map of Missouri on August 18, 2020



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

Figure 3.12 illustrates RMA crop indemnities for 2021 across the United States. Dent County fell in the $0.01 to $500,000 category for crop indemnities.

Figure 3.12. 2021 RMA Crop Indemnities for the United States



Source: https://www.rma.usda.gov/-/media/RMA/Maps/Total-Crop-Indemnity-Maps/Crop-Year-2021/041122map.ashx
*Black arrow indicates Dent County

According to the USDA's Risk Management Agency, there have been 2 crop insurance payments due to drought in Dent County since 2001, totaling $2,592.00. **Table 3.22** illustrates the year, number of payments, and total amount of crop insurance payments.

Table 3.22. Dent County Crop Indemnity Payments (2001-2020)

Year	Number of Payments	Total
2001	-	-
2002	-	-
2003	-	-
2004	-	-
2005	-	-
2006	-	-
2007	-	-
2008	-	-

Year	Number of Payments	Total
2009	-	-
2010	-	-
2011	-	-
2012	-	-
2013	-	-
2014	-	-
2015	-	-
2016	-	-
2017	1	$903.00
2018	1	$1689.00
2019	-	-
2020	-	-
TOTAL	**2**	**$2,592.00**

Source: http://www.rma.usda.gov/en/Information -Tools/Summary-of-Business/Cause-of-Loss

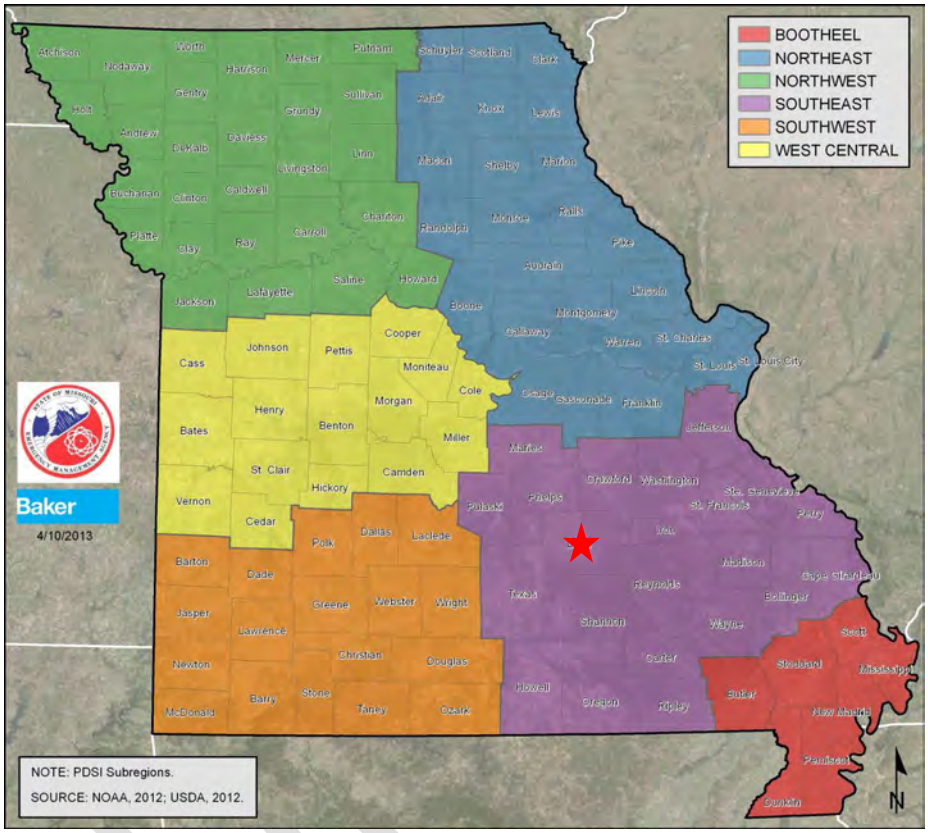
The Palmer Drought Indices measure dryness based on recent precipitation and temperature. The indices are based on a "supply-and-demand model" of soil moisture. Calculation of supply is relatively straightforward, using temperature and the amount of moisture in the soil. However, demand is more complicated 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.

Figure 3.13 illustrates the Palmer Drought Severity Index sub-regions of Missouri. Dent County is categorized under the Southeast sub-region.

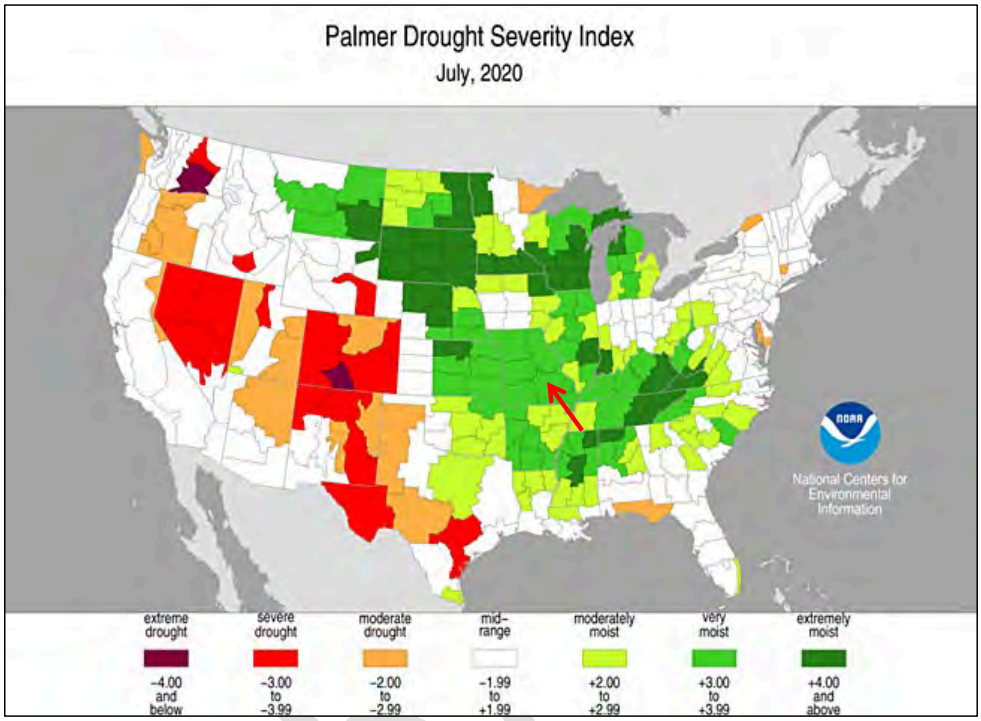
Figure 3.13. Palmer Drought Severity Index: Missouri Sub-regions



Source: 2018 Missouri State Hazard Mitigation Plan; *Red star indicates Dent County

Figure 3.14 is an example of the Palmer Modified Drought Index for the United States on July, 2020.

Figure 3.14. Palmer Modified Drought Index National Map July, 2020



*Source: http://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers/; *Red arrow indicates Dent County*

Data was collected from the Missouri Department of Natural Resources (2021 Census of Missouri Public Water Systems) to determine water source by jurisdiction. Dent County and the city of Salem utilize well water as their sole source of water (**Table 3.23**). Communities that exclusively depend upon ground water could experience hardship in the event of a long term drought.

Table 3.23. 2020 Water Source by Jurisdiction

Jurisdiction	% of source that is groundwater
Dent County	100
Salem	100

Source: Missouri Dept. of Natural Resources, 2020 Census of Missouri Public Water Systems

Previous Occurrences

Table 3.24 offers Palmer Drought Severity Index data for Dent County between 2011 and 2020. This information exemplifies drought conditions on a monthly basis for Missouri's Southeast sub-region within the United States.

Table 3.24. Palmer Drought Severity Index for Dent County, MO (2011 – 2020)

	Year									
Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Jan.	Extremely moist	Mid-range	Mid-range	Moderate Drought	Moderately moist	Extremely moist	Mid-range	Moderate drought	Mid-range	Extremely moist
Feb.	Extremely moist	Mid-range	Mid-range	Moderate Drought	Moderately moist	Very moist	Mid-range	Mid-range	Moderately moist	Very moist
March	Extremely moist	Mid-range	Mid-range	Moderate Drought	Mid-range	Very moist	Mid-range	Mid-range	Moderately moist	Very moist
April	Very moist	Mid-range	Moderately moist	Mid-range	Mid-range	Moderately moist	Mid-range	Mid-range	Moderately moist	Very moist
May	Very moist	Mid-range	Very moist	Mid-range	Mid-range	Moderately moist	Mid-range	Mid-range	Very moist	Very moist
June	Very moist	Moderate drought	Very moist	Mid-range	Very moist	Mid-range	Mid-range	Mid-range	Very moist	Very moist
July	Mid-range	Severe drought	Mid-range	Mid-range	Extremely moist	Mid-range	Mid-range	Moderate drought	Very moist	Very moist
Aug.	Mid-range	Extreme drought	Mid-range	Mid-range	Extremely moist	Very moist	Mid-range	Mid-range	Extremely moist	Very moist
Sept.	Mid-range	Severe drought	Mid-range	Moderately moist	Very moist	Very moist	Mid-range	Mid-range	Very moist	Very moist
Oct.	Moderate drought	Severe drought	Mid-range	Very moist	Moderately moist	Moderately moist	Mid-range	Mid-range	Very moist	Moderately moist
Nov.	Mid-range	Severe drought	Mid-range	Very moist	Very moist	Mid-range	Mid-range	Mid-range	Very moist	Moderately moist
Dec.	Mid-range	Severe drought	Moderate drought	Moderately moist	Extremely moist	Mid-range	Moderate drought	Mid-range	Very moist	Mid-range

Source: https://www.ncei.noaa.gov/access/monitoring/historical-palmers/maps/psi/201101-202012

Probability of Future Occurrence

To calculate the probability of future occurrence of drought in Dent County, historical climate data was analyzed. There were 32 months of recorded drought (**Table 3.25**) over a 20-year span (January, 2001 to December, 2020). The number of months in drought (32) was divided by the total number of months (240) and multiplied by 100 for the annual average percentage probability of drought (**Table 3.26**). Although drought is not predictable, long-range outlooks and predicted impacts of climate change could indicate an increase change of drought.

Table 3.25. Palmer Drought Severity Index for Dent County, MO (2001 – 2020)

	Year											
Month	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
2001												
2002												
2003	x	x	x									
2004												
2005							x				x	x
2006	x	x	x	x	x	x	x	x	x			
2007										x	x	
2008												
2009												
2010												
2011										x		
2012						x	x	x	x	x	x	x
2013												x
2014	x	x	x									
2015												
2016												
2017												x
2018	x						x					
2019												
2020												

Source: https://www.ncei.noaa.gov/access/monitoring/historical-palmers/maps/psi/200101-202012
*x indicates drought

Table 3.26. Annual Average Percentage Probability of Drought in Dent County, MO

Location	Annual Avg. % P of Drought
Dent County	13.3%

Source: NOAA National Centers for Environmental Information, Historical Palmer Drought Indices
*P = probability; see page 3.44 for definition.

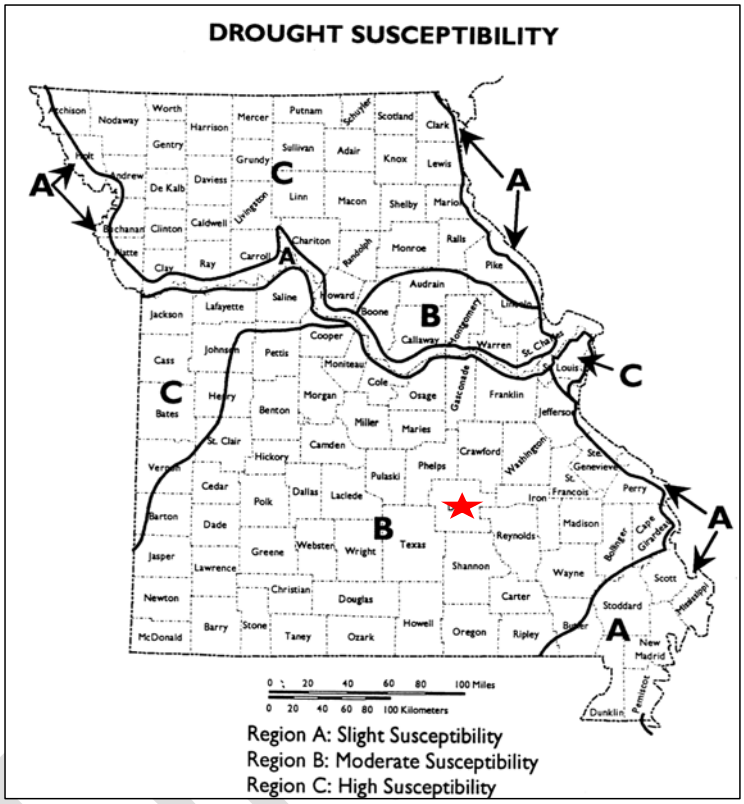
Vulnerability

Vulnerability Overview

Data was obtained from the 2018 Missouri State Hazard Mitigation Plan for the drought vulnerability analysis. **Table 3.27** depicts the ranges for drought vulnerability factor ratings created by SEMA. The array ranges between 1 (low) and 5 (high). The factors considered include social vulnerability, crop exposure ratio, annualized crop claims paid and likelihood of occurrence. Once the ranges were determined and applied to all factors considered in the analysis, the ratings were combined to determine an overall vulnerability rating for drought. Dent County is determined as having a low vulnerability to crop loss (**Table 3.28**) as a result of a drought. Additionally, SEMA has divided the State into 3 regions in regards to drought susceptibility (**Figure 3.15**). Dent County is included in Region B (Moderate Susceptibility). Region B is described as having groundwater sources that are suitable in meeting domestic and municipal water needs, but due to required well depths, irrigation wells are very expensive. Also, the topography is commonly unsuitable for row-crop irrigation[19].

[19] 2018 Missouri State Hazard Mitigation Plan

Figure 3.15. Drought Susceptibility in Missouri



Source: 2018 Missouri State Hazard Mitigation Plan; *Red star indicates Dent County

Table 3.27. Ranges for Drought Vulnerability Factor Ratings

Factors Considered	Low (1)	Medium-low (2)	Medium (3)	Medium-high (4)	High (5)
Social Vulnerability Index	1	2	3	4	5
Crop Exposure Ratio Rating	$866,000 - $10,669,000	$10,669,001 - $33,252,000	$33,252,001 - $73,277,000	$73,277.001 - $155,369,000	$155,369,001 - $256,080,000
Annualized USDA Crop Claims Paid	<$340,000	$340,000 - $669,999	$670,000 – $999,999	$1M - $1,299,999	>$1,300,000
Likelihood of Occurrence of Severe or Extreme Drought	1-1.9%	2-3.9%	4-5.9%	6-8.9%	9-10.72%
Total Drought Vulnerability Rating	7-8	9-10	11-12	13-14	15-17

Source: 2018 Missouri State Hazard Mitigation Plan

Table 3.28. Vulnerability of Dent County to Drought

SOVI index rating	USDA RMA Total Drought Crop Claims	Avg Annualized Crop Claims	USDA Claims Rating	2012 Crop Exposure	Crop Exposure Rating	Likelihood of severe drought %	Drought occurrence rating	Total Rating	Total rating (text) drought
2	$0	$0	1	$1,852,000	1	6.42	4	8	Low

Source: 2018 Missouri State Hazard Mitigation Plan

Potential Losses to Existing Development

Drought is not limited to a hazard that affects just agriculture, but can extend to encompass the nation's whole economy. Its impact can adversely affect a small town's water supply, the corner grocery store, commodity markets, or tourism. Additionally, extreme droughts have the ability to damage roads, water mains, and building foundations. On average, drought costs the U.S. economy about $7 billion to $9 billion a year, according to the National Drought Mitigation Center. Moreover, drought prone regions are also prone to increased fire hazards[20].

Impact of Future Development

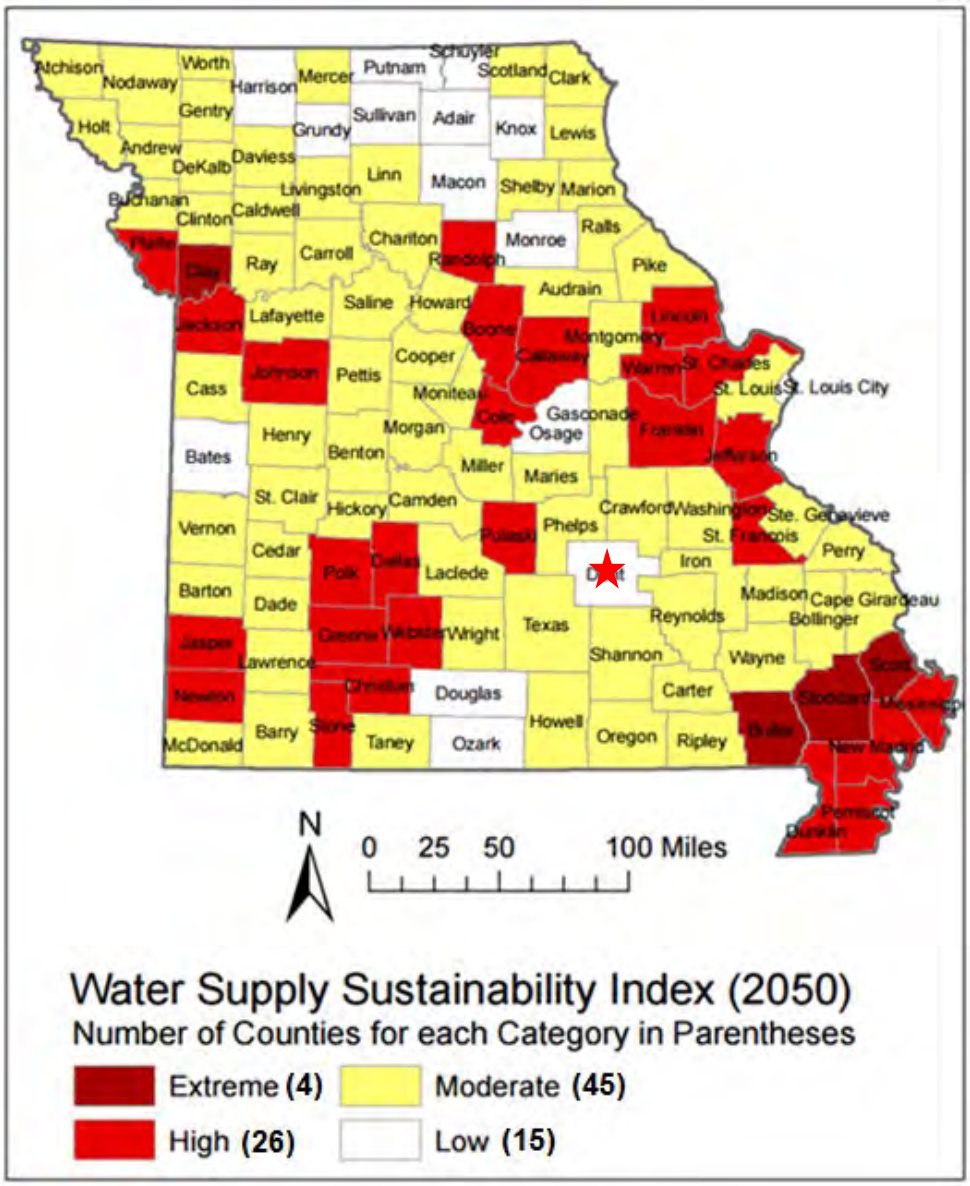
Impacts of drought on future development within Dent County would be negligible. Population projections as provided by the Missouri Office of Administration suggest that Dent County will increase by approximately 121 individuals by 2030[21]. Moreover, with an increasing population, water use and demand would be expected to increase as well; potentially straining the water supply systems. Long term drought could expose vulnerabilities during construction/upgrades of water distribution and sewer infrastructures. Furthermore, any agriculture related development in terms of crop or livestock production would also be at risk.

Impact of Climate Change

A new analysis, performed for the Natural Resources Defense Council, examined the effects of climate change on water supply and demand in the contiguous United States. The study found that more than 1,100 counties will face higher risks of water shortages by mid-century as a result of climate change. Two of the principal reasons for the projected water constraints are shifts in precipitation and potential evapotranspiration (PET). Climate models project decreases in precipitation in many regions of the U.S., including areas that may currently be described as experiencing water shortages of some degree. Dent County is predicted to experience low water shortages as a result of global warming (**Figure 3.16**) by the year 2050.

[20] https://drought.unl.edu/
[21] Missouri Office of Administration https://mcdc.missouri.edu/applications/MO-county-factsheets/?c=29065

Figure 3.16. Water Supply Sustainability Index (2050) with Climate Change Impacts



Source: Natural Resources Defense Council (NRDC), Climate Change, Water, and Risk
*Red star indicates Dent County

Hazard Summary by Jurisdiction

The variations between jurisdictions are non-existent to minimal. All communities in Dent County utilize ground/well water as their water source. In all cities, drought conditions would be the same as those experienced in rural areas, but the magnitude would be different with only lawns and local gardens impacted. Long term drought, spanning months at a time, could negatively impact the amount of potable drinking water available.

Problem Statement

In summary, drought within Dent County is considered low risk. Climate change predictions also suggest low risks by the year 2050. Dent County has some agricultural economy. Drought would impact commodities, specifically livestock and crops. Potential impacts to local economies and infrastructures are foreseeable in the event of a long-term drought.

The county and city should develop water monitoring plans as an early warning system. Each sector should inventory and review their groundwater operation plans. A water conservation awareness program should be presented to the public either through pamphlets, workshops or a drought information center. Voluntary water conservation should be encouraged to the public. The county and both cities should continually look for and fund water system improvements, new systems, and new wells.

3.4.3 Earthquakes

Some specific sources for this hazard are:

- 2018 Missouri State Hazard Mitigation Plan, Chapter 3, Section 3.3.4, Page 3.192
- U.S. Seismic Hazard Map, United States Geological Survey, https://www.usgs.gov/programs/earthquake-hazards/maps;
- Impact of Earthquakes on the Central USA http://www.cusec.org/documents/aar/NMSZ_CAT_PLANNING_SCENARIO.pdf
- Missouri Hazard Mitigation Viewer http://bit.ly/MoHazardMitigationPlanViewer2018 - Website https://drive.google.com/file/d/1bPkc0jgF9ofwQLnTL9N0u-oPFWi9hkst/view - User Guide
  - Total population impacted by earthquakes by County
  - Total number of structures impacted by earthquakes by County
  - Total value of structures impacted by earthquakes by County
  - Property loss ratio to earthquakes by County
- 6.5 Richter Magnitude Earthquake Scenario, New Madrid Fault Zone map, https://iowageologicalsurvey.org/;
- Facts about the New Madrid Seismic Zone, https://dnr.mo.gov/land-geology/hazards/earthquakes/science/facts-new-madrid-seismic-zone

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.

The closest fault to Dent County is the New Madrid Seismic Zone (NMSZ). The NMSZ is the most active seismic area in the United States east of the Rocky Mountains. Unfortunately, the faults in the NMSZ are poorly understood due to concealment by alluvium deposits. Moreover, the NMSZ is estimated to be 30 years overdue for a 6.3 magnitude earthquake[22].

Geographic Location

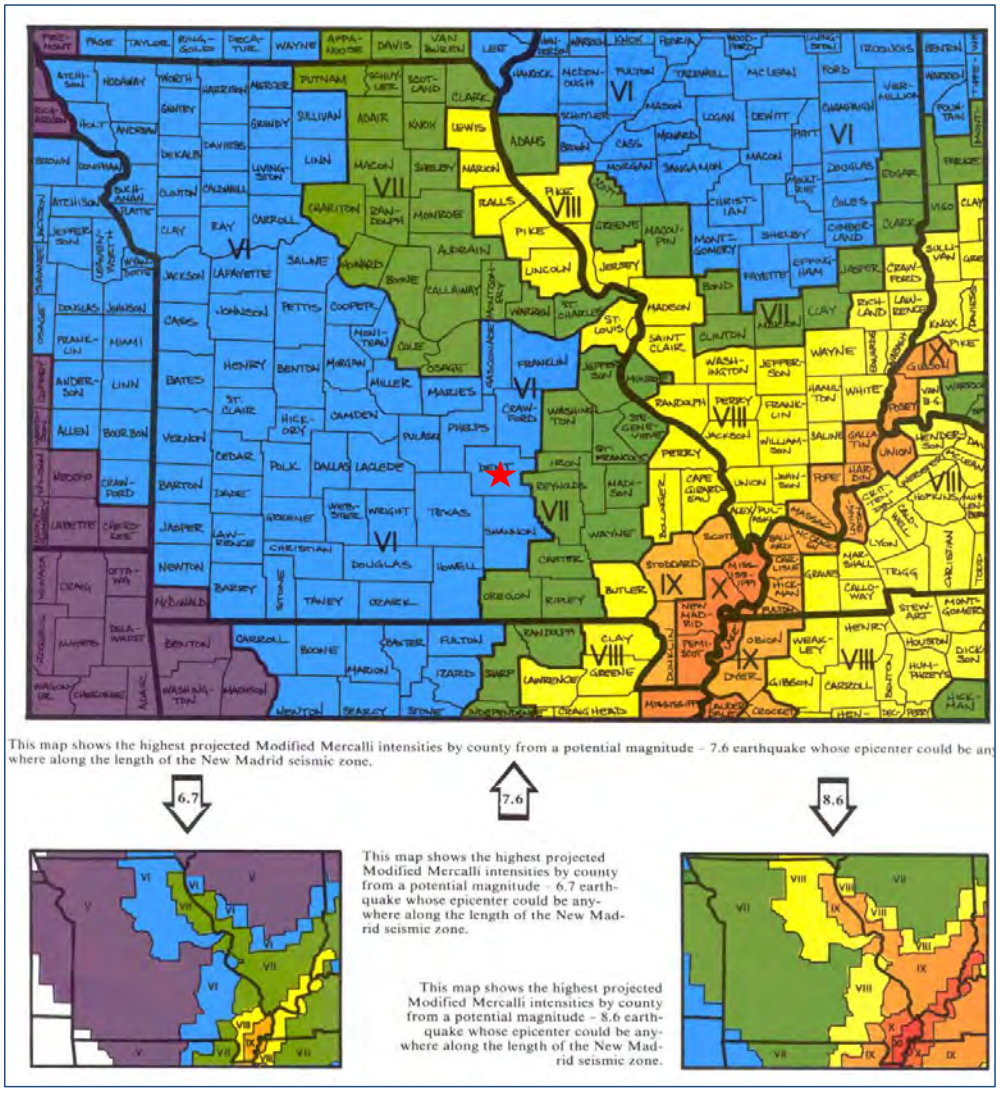
There are eight earthquake source zones in the Central United States, one of which is located within the state of Missouri—the New Madrid Fault. Other seismic zones, because of their close proximity, also affect Missourians. These are the Wabash Valley Fault, Illinois Basin, and the Nemaha Uplift. The most active zone is the New Madrid Fault, which runs from Northern Arkansas through Southeast Missouri and Western Tennessee and Kentucky to the Illinois side of the Ohio River Valley.

Figure 3.17 depicts impact zones for a magnitude 7.6 earthquake along the New Madrid Fault along with associated Modified Mercalli Intensities. Dent County is indicated by a red star. Furthermore, the

[22] Missouri Department of Natural Resources, Facts about the New Madrid Seismic Zone

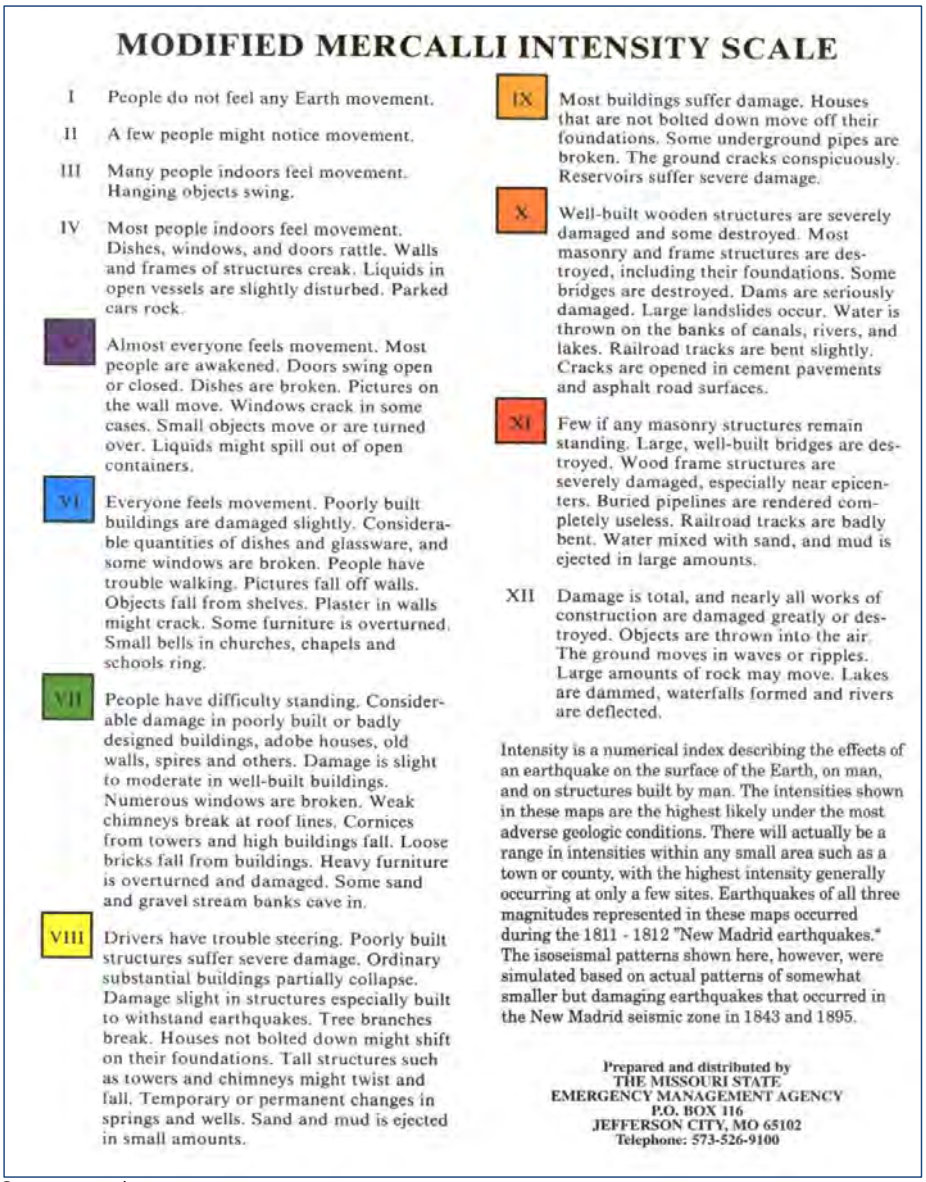
Modified Mercalli Intensities for potential 6.7 and 8.6 magnitude earthquakes are illustrated. In the event of a 6.7 magnitude earthquake, Dent County would experience a Modified Mercalli Intensity of V (**Figure 3.17**). This intensity is categorized as being almost felt by everyone. Most people are 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. Additionally, in the occurrence of 7.6 and 8.6 magnitude earthquakes; the county would experience Modified Mercalli Intensities of VI and VII respectively. There will 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. **Figure 3.18** and **Table 3.29** further define Richter Scale intensities.

Figure 3.17. Impact Zones for Earthquake Along the New Madrid Fault



Source: sema.dps.mo.gov; *Red star indicates Dent County

Figure 3.18. Projected Earthquake Intensities



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.

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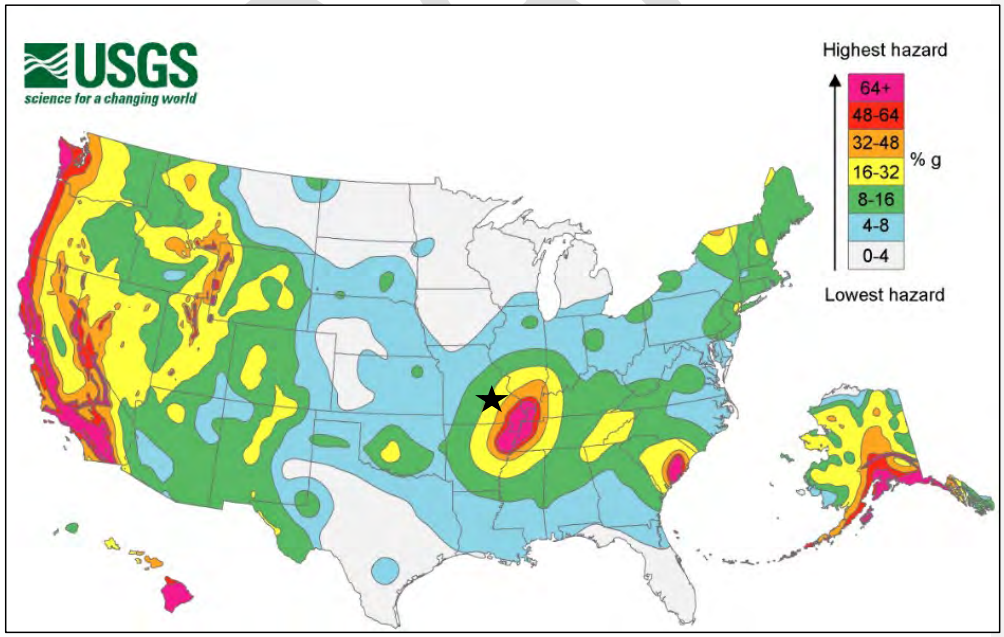
Source: sema.dps.mo.gov

Table 3.29. Richter Scale of Earthquake Magnitude

Magnitude Level	Category	Effects	Earthquake per Year
Less than 1.0 to 2.9	Micro	Generally not felt by people, though recorded on local instruments	More than 100,000
3.0-3.9	Minor	Felt by many people; no damage	12,000-100,000
4.0-4.9	Light	Felt by all; minor breakage of objects	2,000-12,000
5.0-5.9	Moderate	Some damage to weak structures	200-2,000
6.0-6.9	Strong	Moderate damage in populated areas	20-200
7.0-7.9	Major	Serious damage over large areas; loss of life	3-20
8.0 and higher	Great	Severe destruction and loss of life over large areas	Fewer than 3

Figure 3.19 illustrates the seismicity in the United States. A black star indicates the location of Dent County. The seismic hazard map displays earthquake peak ground acceleration (PGA) that has a 2% chance of being exceeded in 50 years; which has a value between 16-32% g.

Figure 3.19. United States Seismic Hazard Map



Source: USGS, http://earthquake.usgs.gov; *Black star indicates Dent County

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 as 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. Each whole number increase in magnitude represents a tenfold increase in measured amplitude; an estimate of energy. For example, comparing a 5.3 and a 6.3 earthquake shows that a 6.3 earthquake is ten times bigger than a magnitude 5.3 earthquake on a seismogram, but is 31.622 times stronger (energy release)[23].

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

Most of Missouri's earthquake activity has been concentrated in the southeast corner of the state, which lies within the New Madrid seismic zone. The written record of earthquakes in Missouri prior to the nineteenth century is virtually nonexistent; however, there is geologic evidence that the New Madrid seismic zone has had a long history of activity. The first written account of an earthquake in the region was by a French missionary on a voyage down the Mississippi River. He reported feeling a distinct tremor on Christmas Day 1699 while camped in the area of what is now Memphis, TN.

Whatever the seismic history of the region may have been before the first Europeans arrived, after Dec. 16, 1811, there could be no doubt about the area's potential to generate severe earthquakes. On that date, shortly after 2 a.m., the first tremor of the most violent series of earthquakes in the United States history struck southeast Missouri. In the small town of New Madrid, about 290 kilometers south of St. Louis, residents were aroused from their sleep by the rocking of their cabins, the cracking of timbers, the clatter of breaking dishes and tumbling furniture, the rattling of falling chimneys, and the crashing of falling trees. A terrifying roaring noise was created as the earthquake waves swept across the ground. Large fissures suddenly opened and swallowed large quantities of river and marsh water. As the fissures closed again, great volumes of mud and sand were ejected along with the water.

The earthquake generated great waves on the Mississippi River that overwhelmed many boats and washed others high upon the shore. The waves broke off thousands of trees and carried them into the river. High river banks caved in, sand bars gave way, and entire islands disappeared. The violence of

[23] Measuring the Size of an Earthquake, http://earthquake.usgs.gov/learn/topics/measure.php

the earthquake was manifested by great topographic changes that affected an area of 78,000 to 130,000 square kilometers.

On Jan. 23, 1812, a second major shock, seemingly more violent than the first, occurred. A third great earthquake, perhaps the most severe of the series, struck on Feb. 7, 1812.

The three main shocks probably reached intensity XII, the maximum on the Modified Mercalli scale, although it is difficult to assign intensities, due to the scarcity of settlements at the time. Aftershocks continued to be felt for several years after the initial tremor. Later evidence indicates that the epicenter of the first earthquake (Dec. 16, 1811) was probably in northeast Arkansas. Based on historical accounts, the epicenter of the Feb. 7, 1812, shocks was probably close to the town of New Madrid.

Although the death toll from the 1811-12 series of earthquakes has never been tabulated, the loss of life was very slight. It is likely that if at the time of the earthquakes the New Madrid area had been as heavily populated as at present, thousands of persons would have perished. The main shocks were felt over an area covering at least 5,180,000 square kilometers. Chimneys were knocked down in Cincinnati, Ohio, and bricks were reported to have fallen from chimneys in Georgia and South Carolina. The first shock was felt distinctly in Dent, D.C., 700 miles away, and people there were frightened badly. Other points that reported feeling this earthquake included New Orleans, 804 kilometers away; Detroit, 965 kilometers away; and Boston, 1,769 kilometers away.

The New Madrid seismic zone has experienced numerous earthquakes since the 1811-12 series, and at least 35 shocks of intensity V or greater have been recorded in Missouri since 1811. Numerous earthquakes originating outside of the state's boundaries have also affected Missouri. Five of the strongest earthquakes that have affected Missouri since the 1811-12 series are described below.

On Jan. 4, 1843, a severe earthquake in the New Madrid area cracked chimneys and walls at Memphis, Tennessee. One building reportedly collapsed. The earth sank at some places near New Madrid; there was an unverified report that two hunters were drowned during the formation of a lake. The total felt area included at least 1,036,000 square kilometers.

The Oct. 31, 1895, earthquake near Charleston, MO probably ranks second in intensity to the 1811-12 series. Every building in the commercial area of Charleston was damaged. Cairo, Illinois, and Memphis, Tennessee, also suffered significant damage. Four acres of ground sank near Charleston and a lake was formed. The shock was felt over all or portions of 23 states and at some places in Canada.

A moderate earthquake on April 9, 1917, in the Ste. Genevieve/St. Mary's area was reportedly felt over a 518,000 square kilometer area from Kansas to Ohio and Wisconsin to Mississippi. In the epicentral area people ran into the street, windows were broken, and plaster cracked. A second shock of lesser intensity was felt in the southern part of the area.

The small railroad town of Rodney, MO experienced a strong earthquake on Aug. 19, 1934. At nearby Charleston, windows were broken, chimneys were overthrown or damaged, and articles were knocked from shelves. Similar effects were observed at Cairo Mounds and Mound City, IL, and at Wickliff, KY. The area of destructive intensity included more than 596 square kilometers.

The Nov. 9, 1968, earthquake centered in southern Illinois was the strongest in the central United States since 1895. The magnitude 5.5 shock caused moderate damage to chimneys and walls at Hermann, St. Charles, St. Louis, and Sikeston, Missouri. The felt areas include all or portions of 23 states[i].

Small earthquakes continue to occur frequently in Missouri. Averages of 200 earthquakes are detected every year in the New Madrid Seismic Zone alone. Most are detectable only with sensitive instruments, but on an average of every 18 months, southeast Missouri experiences an earthquake strong enough to crack plaster in buildings[24].

Vulnerability

Vulnerability Overview

As stated in the 2018 Missouri Hazard Mitigation Plan, the impacts and severity of earthquakes on Missouri can be significant. The New Madrid earthquakes of 1811-1812 are among the largest that have happened on the North American continent. Losses at the time were limited due to low population and little development. However, a similar quake at this time would result in devastating damage.

The most important direct earthquake hazard is ground shaking, which affects structures close to the earthquake epicenter. However, ground shaking can also affect structures located great distances from epicenters, particularly where thick clay-rich soils can amplify ground motions. Certain types of buildings are more vulnerable to ground shaking than others. Unreinforced masonry structures, tall structures without adequate lateral resistance and poorly maintained structures are specifically susceptible to large earthquakes.

According to MDNR's Missouri Geological Survey, damage from earthquakes in the New Madrid Seismic Zone will vary depending on the earthquake magnitude, the character of the land and the degree of urbanization. Dent County is rural with few clusters of population. Infrastructure in the region such as highways, bridges, pipelines, communication lines and railroads might suffer damage, which would adversely affect Dent County, even if the county itself did not suffer heavy damage. Infrastructure could take a significant time to repair.

An important tool for homeowners to address the risk of earthquake damage to property is the purchase of earthquake insurance coverage. The Missouri Department of Insurance, Financial Institutions and Professional Registration (DIFP) prepared a report in 2017 on the state of earthquake insurance coverage in Missouri. The report notes that earthquake coverage has become less available and less affordable over the last 15 years. The cost of earthquake insurance has increased from an average of $50 per year to $149 per year. In high risk counties the increases have been more substantial – from $57 per year in 2000 to $405 per year in 2017. The number of residences covered by earthquake insurance has dropped over the last 15 years – likely due to the increased cost of premiums. In 2018 the percentage of residential policies with earthquake coverage in Dent County was 14.5 percent with the average cost of coverage at $78 per year.[25]

Probability of Future Occurrence

No earthquakes have been reported in Dent County since 1999. The county, located in south central Missouri, is a good distance from the southeast corner of the state where the New Madrid Fault resides. Should a significant earthquake occur, it would have the potential to cause moderate damage within the county.

The 2018 Missouri Hazard Mitigation Plan states that there have been 31 recorded earthquake events greater than or equal to M 4.0 in the 43-year period from 1973 to 2018. According to this data, annual probability calculates to 72 percent. Additionally, the USGS estimated in 2006 that the

[24] Missouri State Hazard Mitigation Plan 2018
[25] The State of Earthquake Coverage Report https://insurance.mo.gov/earthquake/

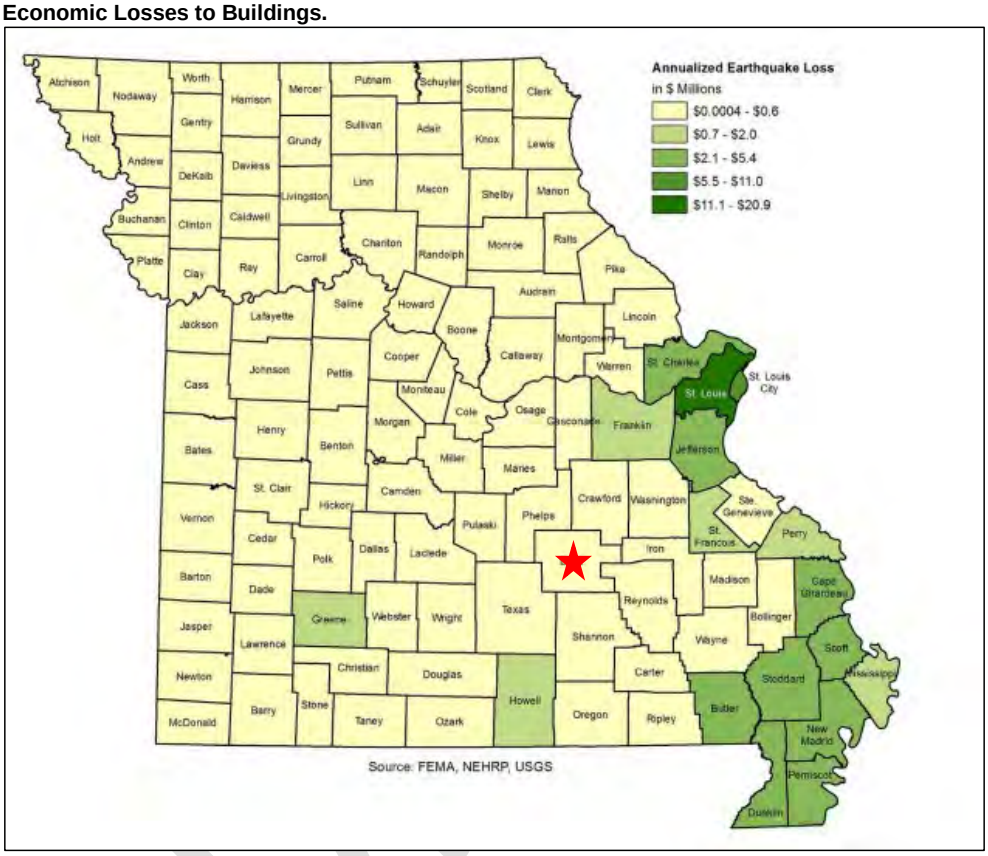
probability of a repeat of the 1811-1812 earthquakes (magnitude 7.5 – 8.0) was seven to ten percent in a 50-year time period (Source: http://pubs.usgs.gov/fs/2006/3125). Given the historical frequency of earthquake events, this hazard is determined to have a high probability of occurrence within the State.

SEMA utilized Hazus V 3.2 to analyze vulnerability and estimate losses to earthquakes. Hazus is a program developed by FEMA which is a nationally applicable standardized methodology that encompasses models for assessing potential losses from earthquakes, floods, and hurricanes. All Hazus analyses were run using Level 1 building inventory database comprised of updated demographic and aggregated data based on the 2010 census. An annualized loss scenario that enabled an "apples to apples" comparison of earthquake risk for each county was synthesized from a FEMA nationwide annualized loss study (FEMA 366 Hazus Estimated Annualized Earthquake Losses for the United States, April 2017). A second scenario, based on an event with a two percent probability of exceedance in 50 years, was done to model a worst case earthquake using a level of ground shaking recognized in earthquake-resistant design.

Annualized loss is the maximum potential annual dollar loss resulting from eight return periods (100, 200, 500, 750, 1,000, 1,500, 2,000, and 2,500 years) averaged on a 'per year' basis[26]. This is the scenario that FEMA uses to compare relative risk from earthquakes and other hazards at the county level nationwide. The Hazus earthquake loss estimation is depicted in **Figure 3.20** which shows annualized loss scenario direct economic losses to buildings. In this scenario, the annualized earthquake loss for buildings in Dent County in any one year is estimated to be $4,000 to $600,000. **Table 3.30** provides information on total estimated losses, estimated losses per capita and loss ratio. This results in the county being ranked 39th in the state for expected loss with low vulnerability for this hazard. This loss ratio indicates impacts on local economies in the event of an earthquake, and the difficulty for jurisdictions to recover from said event.[27]

[26] 2018 Missouri State Hazard Mitigation Plan
[27] Ibid

Figure 3.20. HAZUS-MH Earthquake Loss Estimation: Annualized Loss Scenario –Direct Economic Losses to Buildings.



*Source: 2018 Missouri State Hazard Mitigation Plan; *Red star indicates Dent County*

Table 3.30. HAZUS-MH Earthquake Loss Estimation-Dent County: Annualized Loss Scenario

Total Losses in $ Thousands	Loss Per Capita, In $ Thousands	Loss Ratio in $ Per Million	Statewide Ranking for Expected Losses
$317	$0.0113	$122	39th

Source: Hazus 2.1
**All $values are in thousands*
***Loss ratio is the sum of structural and nonstructural damage divided by the entire building inventory value within a county*

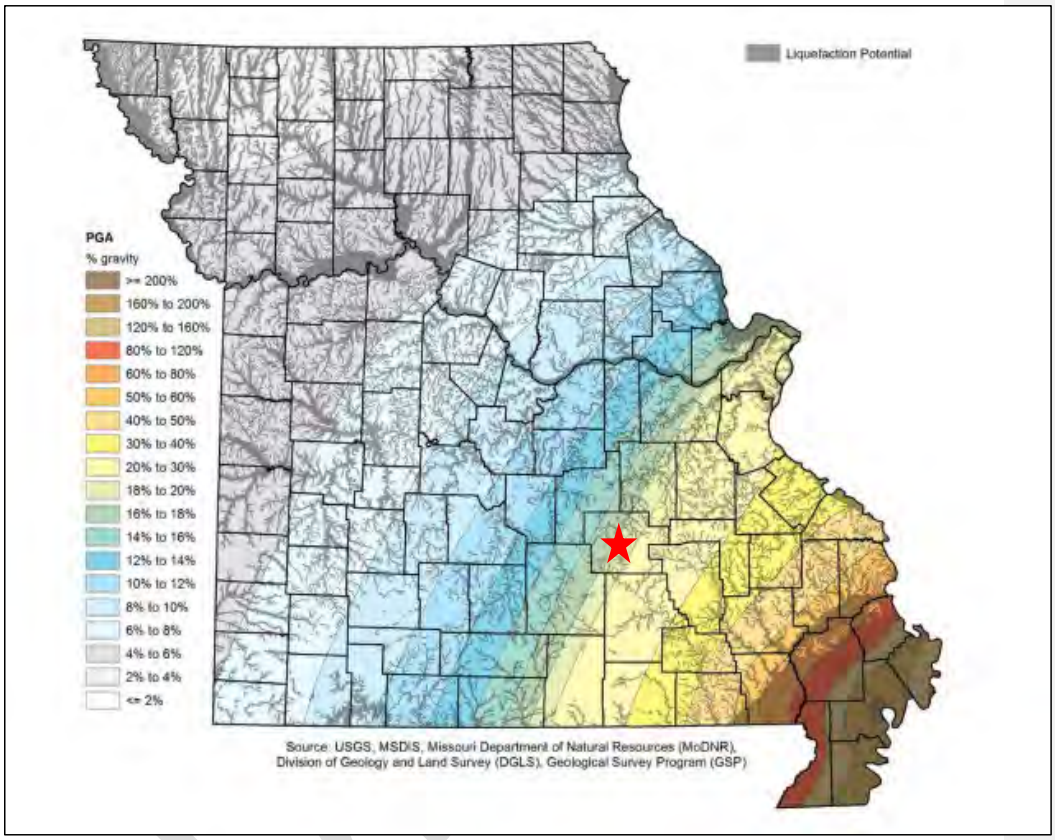
Likewise, SEMA developed a second scenario which incorporated a 2% probability of exceedance in 50 years. This model was to demonstrate a worst case scenario. This scenario is equivalent to the 2,500 year earthquake scenario in HAZUS-MH. The methodology is based on probabilistic seismic

hazard shaking grids developed by the U.S. Geological Survey (USGS) for the National Seismic Hazard Maps that are included with HAZUS-MH. The USGS updated this mapping in 2014. **Figure 3.21** illustrates direct economic loss to buildings. Dent County is anticipated to lose between $700,000 and $200,000,000 in a 50 year scenario. **Figure 3.22** provides estimates of peak ground acceleration and spectral acceleration (ground shaking potential) at intervals of 0.3 and 1.0 seconds, respectively which have a two percent probability of exceedance in the next 50 years. These acceleration events have a 2% probability of exceedance in the next 50 years. A 7.7 magnitude earthquake was utilized in this scenario, which is typically utilized for New Madrid fault planning scenarios in Missouri. Furthermore, this pattern of shaking can be seen in with corresponding potential for damage and areas with soils potentially susceptible to liquefaction. Dent County is estimated to have peak ground acceleration between 14 percent and 30 percent.

Figure 3.21. HAZUS-MH Earthquake Loss Estimation with a 2% Probability of Exceedance in 50 Years Scenario – Total Building Loss

*Source: 2018 Missouri State Hazard Mitigation Plan; *Red star indicates Dent County*

Figure 3.22. Hazus Earthquake 2% Probability of Exceedance in 50 Years – Ground Shaking and Liquefaction Potential



*Source: 2018 Missouri State Hazard Mitigation Plan; *Red star indicates Dent County*

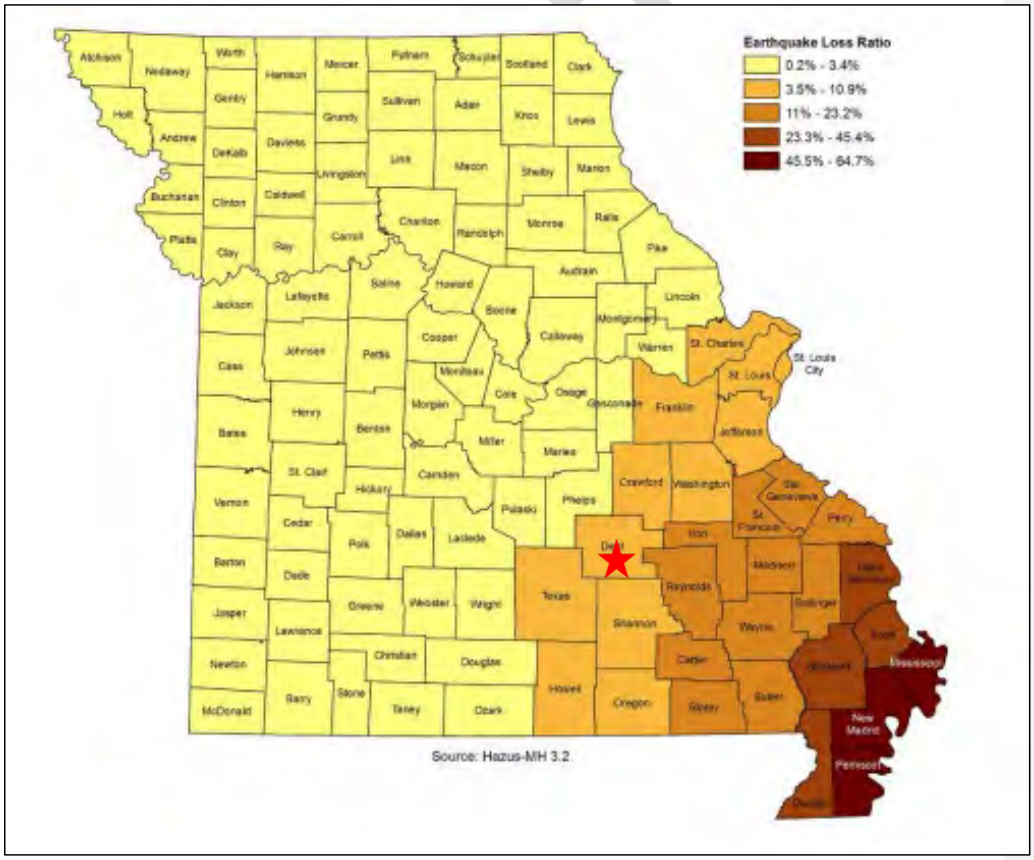
Table 3.31 provides information on estimated direct economic losses for Dent County, including structural, nonstructural, inventory, contents, relocation costs, capital related loss, wages and rental income loss. According to the 2018 Missouri Hazard Mitigation Plan, Dent County's loss ratio is 4.91 percent. Dent County ranks 41st in the state for direct economic losses in this scenario. **Figure 3.23** depicts loss ratio by county, which is the ratio of the building structure and nonstructural damage to the value of the entire building inventory. The loss ratio is a measure of the disaster impact to community sustainability, which is generally considered at risk when losses exceed 10 percent of the built environment (FEMA).

Table 3.31. HAZUS-MH Earthquake Loss Estimation 2% Probability of Exceedance in 50 Years Scenario Direct Economic Losses Results Summary for Dent County*

Cost Structural Damage	Cost Non-Structural Damage	Cost Contents Damage	Inventory Loss	Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
$18,897	$52,441	$19,313	$513	4.91	$12,100	$3,244	$4,674	$4,095	$115,277

Source: 2018 Missouri Hazard Mitigation Plan
**All values in thousands*

Figure 3.23. Hazus Earthquake Loss Estimation with a 2% Probability of Exceedance in 50 Years Scenario – Loss Ratio



*Source: 2018 Missouri State Hazard Mitigation Plan; *Red star indicates Dent County*

Changing Future Conditions Considerations

Scientists are beginning to believe that there may be a correlation between changing climate conditions and earthquakes. Changing ice caps and sea-level redistribute weight over fault lines, which could potentially have an influence on earthquake occurrences. However, currently no studies quantify the relationship to a high level of detail, so recent earthquakes should not be linked with climate change. While not conclusive, early research suggests that more intense earthquakes and tsunamis may eventually be added to the adverse consequences that are caused by changing future conditions.[28]

Impact of Previous and Future Development

Future development is not expected to increase the risk other than contributing to the overall exposure of what could be damaged as a result of an earthquake. Since the last update, there has been significant development in the City of Salem to include development of 5 commercial properties and six new single-family homes. The city is pursuing certified site status in their industrial park hoping to draw in new industrial businesses. As new development arises, minimum standards of building codes should be established in all jurisdictions to decrease the potential damage/loss should an earthquake occur.

The Revised Statutes of MO, Section 160.451 require that: The governing body of each school district which can be expected to experience an intensity of ground shaking equivalent to a Modified Mercalli Intensity of VII or above from an earthquake occurring along the New Madrid Fault with a potential magnitude of 7.6 on the Richter Scale shall establish an earthquake emergency procedure system in every school building under its jurisdiction[29].

Hazard Summary by Jurisdiction

There will be a range in intensities within any small areas such as a town or county, with the highest intensity generally occurring at only a few sites. Dent County is not near the New Madrid Seismic Zone, but it will most likely endure mild secondary effects from the earthquake, such as fire, structure damage, utility disruption, environmental impacts, and economic disruptions/losses. However, damages could differ if there are structural variations in the planning area's built environment. For example, if one community has a higher percentage of residences built prior to 1939 than the other participants, that community is likely to experience higher damages. **Table 3.32** depicts the percent of residences built prior to 1939 in Dent County. In addition, if school districts have buildings built prior to 1939, those facilities may be at higher risk of damage should an earthquake occur. If a major earthquake should occur, Dent County would likely be impacted by the number of refugees traveling through the area seeking safety and assistance.

Table 3.32. Dent County Residences Built Prior to 1939

Jurisdiction	Number of Residences Built Prior to 1939	% of Residences Built Prior to 1939
Unincorporated Dent County	316	7.9%
Salem	286	12.2%

Source: US Census Bureau 2016-2020 ACS Data

[28] Missouri State Hazard Mitigation Plan 2018

[29] https://revisor.mo.gov/main/OneSection.aspx?section=160.451

Problem Statement

In a worst-case scenario, the county is expected to encounter $115,277,000 in total economic losses to buildings. Salem has a higher risk of damage to buildings due to having a higher percentage of the homes having been built prior to 1939.

Jurisdictions should encourage purchase of earthquake hazard insurance. As well as establishing structurally sound emergency shelters in several parts of the county. In addition, stringent minimum standards of building codes should be established. Lastly, outreach and education should be utilized more frequently to prepare citizens for the next occurrence.

3.4.4 Extreme Temperatures

Hazard Profile

Some specific sources for this hazard are:

- 2018 Missouri State hazard Mitigation Plan, Chapter 3, Section 3.3.7, Page 3.253 https://sema.dps.mo.gov/docs/programs/LRMF/mitigation/MO_Hazard_Mitigation_Plan2018.pdf
- National Centers for Environmental Information, Storm Events Database, http://www.ncdc.noaa.gov/stormevents/
- Heat Index Chart & typical health impacts from heat, National Weather Service; National Weather Service Heat Index Program, https://www.weather.gov/safety/heat-index;
- Wind Chill chart, National Weather Service, http://www.nws.noaa.gov/om/cold/wind_chill.shtml ;
- Daily temperatures averages and extremes, High Plains Regional Climate Summary, https://hprcc.unl.edu/climate_extremes.php, http://climod.unl.edu/;
- Hyperthermia mortality, Missouri; Missouri Department of Health and Senior Service, http://health.mo.gov/living/healthcondiseases/hyperthermia/pdf/hyper1.pdf;
- Hyperthermia mortality by Geographic area, Missouri Department of Health and Senior Services,
- http://health.mo.gov/living/healthcondiseases/hyperthermia/pdf/hyper2.pdf;
- Missouri Hazard Mitigation Viewer
  http://bit.ly/MoHazardMitigationPlanViewer2018 - Website
  https://drive.google.com/file/d/1bPkc0jgF9ofwQLnTL9N0u-oPFWi9hkst/view - User Guide
    - Average annual occurrence for extreme heat by County
    - Vulnerability to extreme heat by County
    - Average annual occurrence for extreme cold by County
    - Vulnerability to extreme cold by County

Hazard Profile

Hazard Description

Extreme temperature events, both hot and cold, can impact human health and mortality, natural ecosystems, agriculture and other economic sectors. 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 days. 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 3.24** uses both of these factors to produce a guide for the apparent temperature or relative intensity of heat conditions. Other factors that should be taken into account include duration of exposure to high temperatures, wind and activity.

The NWS has increased its efforts to more effectively alert the general public and local authorities on the hazards of heat waves. The Heat Index (HI) is an effective tool in helping people understand the dangers of high temperatures and how temperature and relative humidity together provide a more accurate gauge of heat intensity. The HI, provided in degrees Fahrenheit, is an accurate measure of how hot it actually feels when the relative humidity is added to the air temperature. For example – using the Heat Index Chart in Figure 3.33 - if the air temperature is 96 degrees Fahrenheit, (found in the top of the table), and the relative humidity is 55 percent (found on the left of the table), the Heat Index is 112 degrees Fahrenheit (the intersection of the 96 degree row and the 55 percent column). Because

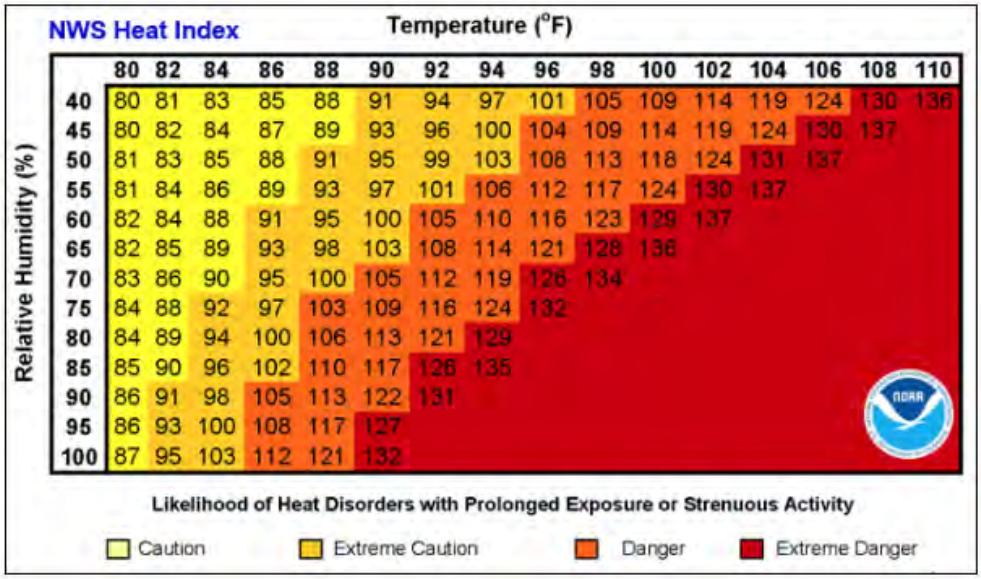
HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15 degrees Fahrenheit. Also, strong winds, particularly with very hot, dry air, can be extremely dangerous.

High humidity, a common factor in Missouri, can magnify the effects of extreme heat. While heat-related illness and death can occur from exposure to intense heat in just one afternoon, heat stress on the body has a cumulative effect. The persistence of a heat wave increases the threat to public health.

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 and furnaces. Cold temperatures can also overpower a building's heating system and cause water and sewer lines to freeze and rupture. Extreme cold also increases the likelihood for ice jams on flat rivers and 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 those who are isolated being most at risk. About 10 percent of people over the age of 65 have some kind of bodily temperature-regulating defect, and three to four percent of all hospital patients over 65 are hypothermic.

Figure 3.24. Heat Index (HI) Chart



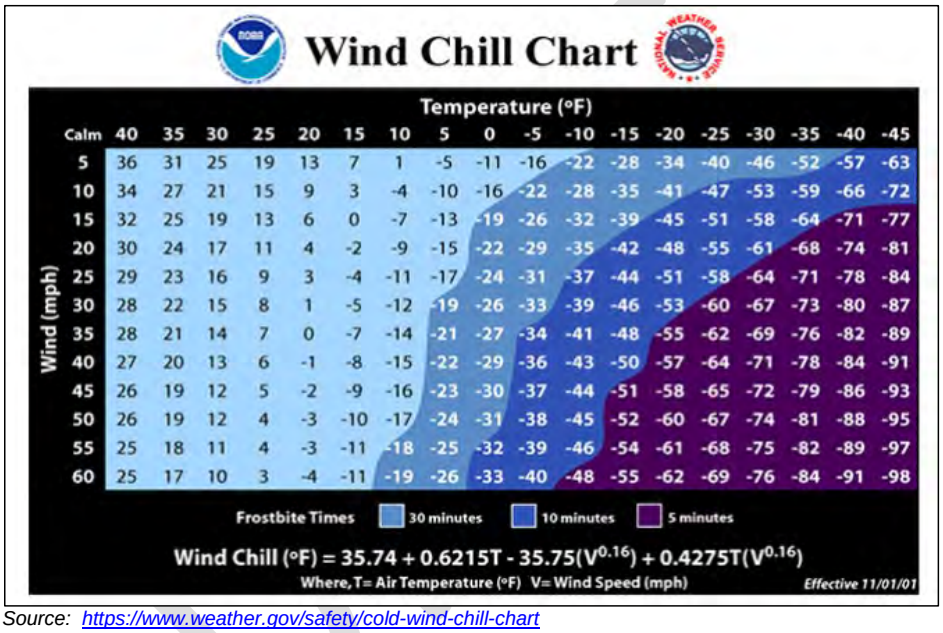
Source: National Weather Service (NWS); https://www.weather.gov/safety/heat-index
Note: Exposure to direct sun can increase Heat Index values by as much as 15°F. The shaded zone above 105°F corresponds to a HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

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 fire, which can be

caused by fireplaces and emergency heaters; and frozen/burst pipes.

The NWS Wind Chill Temperature (WCT) index, shown in **Figure 3.25,** uses advances in science, technology and computer modeling to provide an accurate understandable and useful formula for calculating the dangers from winter winds and freezing temperatures. The figure below presents wind chill temperatures which are based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Figure 3.25. Wind Chill Chart



Source: https://www.weather.gov/safety/cold-wind-chill-chart

Geographic Location

Extreme temperature is considered to be an area-wide hazard event. In such a case, the chance of variation in temperatures across Dent County is minimal to nonexistent.

Strength/Magnitude/Extent

The National Weather Service (NWS) 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.

The NWS Wind Chill Temperature (WCT) index uses advances in science, technology, and computer modeling to provide an accurate, understandable, and useful formula for calculating the dangers from winter winds and freezing temperatures. **Figure 3.25** presents wind chill temperatures which are based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Extreme heat can cause stress to crops and animals. However, according to the NOAA Storm Events Data Base and USDA Risk Management website, there were no reported agricultural losses due to heat for Dent County from 2001 - 2020. Extreme heat can also strain 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 through 2011, there were 3,496 fatalities in the U.S. attributed to summer heat. This translates to an annual average of 146 deaths. During the same time period, zero deaths were recorded in Dent County, according to NOAA Storm Events Data Base. The national Weather Service stated that among natural hazards, no other natural disaster – not lightning, hurricanes, tornadoes, floods or earthquakes – causes more deaths than excessive heat.

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

Table 3.33. 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, https://www.weather.gov/safety/heat-index

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

Table 3.34 provides data in relation to record heat events between 2001 and 2020 in Dent County.

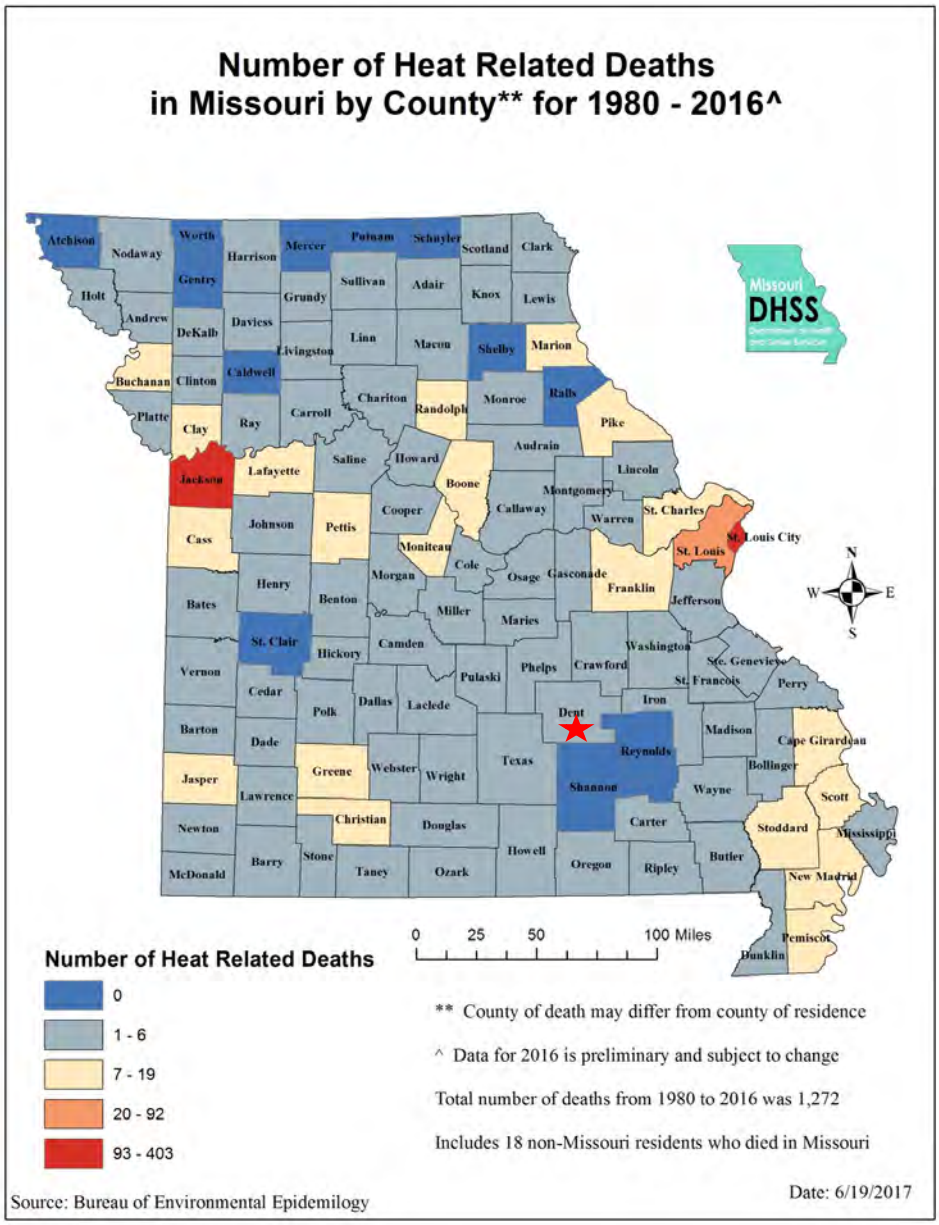
Maximum heat index values and temperatures are shown for each extreme temperature event. Fortunately, there were zero recorded injuries and fatalities during this time. In addition, **Figure 3.26** illustrates heat related deaths by county in Missouri between 1980 and 2016.

Table 3.34. Dent County Recorded Heat Events 2001 – 2020

Month, Year	# of Event Days	Fatalities	Injuries	Temperature (F°)	Heat Index Values (F°)
7/17/2001	15	0	0	90-100	100-110
8/01/2001	9	0	0	-	100-110
6/01/2012	30	0	0	90+	100+
7/01/2012	31	0	0	100	104+
8/01/2012	31	0	0	90+	106
Total	**116**	**0**	**0**	**-**	**-**

Source: http://www.ncdc.noaa.gov/stormevents/

Figure 3.26. Heat Related Deaths in Missouri 2000 - 2016

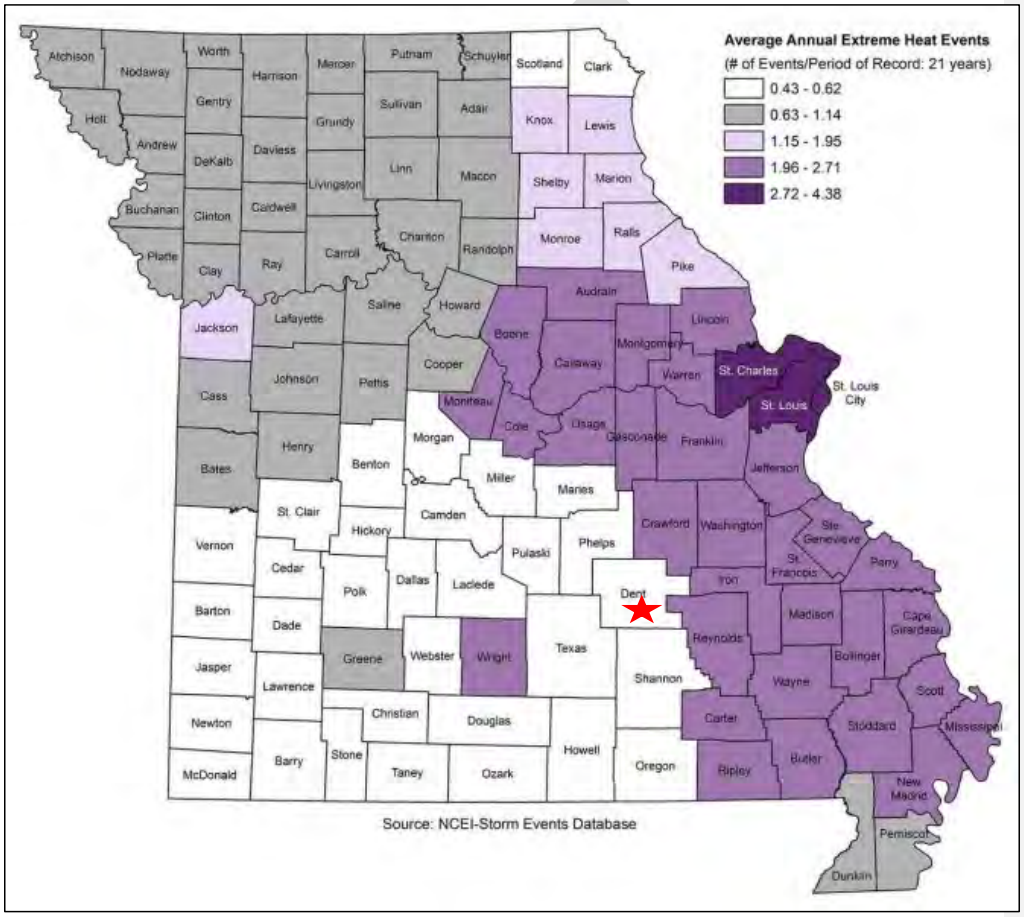


Source: https://health.mo.gov/living/healthcondiseases/hyperthermia/pdf/stat-report.pdf
*Red star indicates Dent County

Probability of Future Occurrence

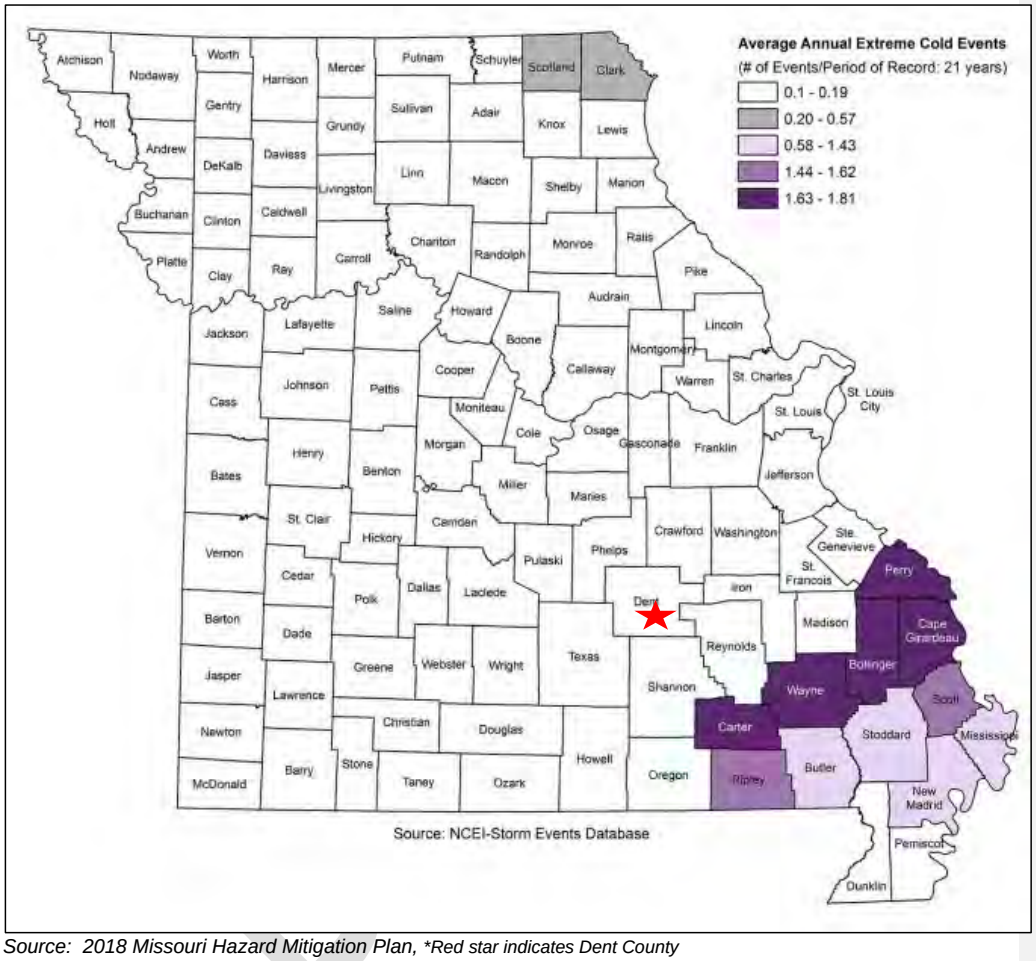
Figure 3.27 illustrates the average annual occurrence for extreme heat statewide. Based on information provided in the 2018 Missouri State Hazard Mitigation Plan, Dent County has an average of .43 to .62 events per year based on data from 21 years. **Figure 3.28** illustrates the average annual occurrence for extreme cold statewide. Dent County has an average of 0.1 to 0.19 events per year based on data from 21 years. It should be noted that there are data limitations due to underreporting of extreme heat and cold events.

Figure 3.27. Average Annual Occurrence for Extreme Heat



*Source: 2018 Missouri State Hazard Mitigation Plan; *Red star indicates Dent County*

Figure 3.28. Average Annual Occurrence for Extreme Cold



*Source: 2018 Missouri Hazard Mitigation Plan, *Red star indicates Dent County*

Changing Future Conditions Considerations

According to the 2018 Missouri Hazard Mitigation Plan, under a higher emissions pathway, historically unprecedented warming is projected by the end of the century. Even under a pathway of lower greenhouse gas emissions, average annual temperatures are projected to most likely exceed historical record levels by the middle of the 21st century. For example, in southern Missouri, the annual maximum number of consecutive days with temperatures exceeding 95 degrees F is projected to increase by up to 20 days. Temperature increases will cause future heat waves to be more intense, a concern for this region which already experiences hot and humid conditions. If the warming trend continues, future heat waves are likely to be more intense and cold spells are

projected to decrease.

Furthermore, higher temperatures are experienced more acutely by vulnerable populations such as the elderly, the very young, the homeless, the ill and disabled, and those living in poverty. Higher demands and costs for electricity to run air conditioners can stress power systems. Higher temperatures can also cause harmful algal blooms in warmer water – resulting in poor water quality.

Mitigation against the impacts of future temperature increases may include increasing education on heat stress prevention, organizing cooling centers, allocating additional funding to repair and maintain roads damaged by buckling and potholes and reducing nutrient runoff that contributes to algal blooms. Local governments should also prepare for increased demand on utility systems. Improving energy efficiency in public buildings will also present an increasingly valuable savings potential.

Vulnerability

Vulnerability Overview

Dent County, along with the rest of the state of Missouri is vulnerable to extreme heat and cold events. **Table 3.35** shows the typical health impacts of extreme heat. Jurisdictions with higher percentages of individuals below the age of 5, and above the age of 65 tend to be more at risk for extreme heat (**Table 3.38**). People who are overweight, ill or on certain medication can also be more vulnerable to high temperatures. Unincorporated Dent County has an estimated 19.9 percent of individuals are 65 or older while the city of Salem has an estimated 24.9 percent of individuals that are 65 or older. However, even young and healthy individuals are susceptible if they participate in strenuous physical activities during hot weather. The exposure to extreme temperatures of farm workers and livestock is also a major concern.

Table 3.35. 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, https://www.weather.gov/safety/heat-index

The method used by state planners to determine vulnerability to extreme temperatures across Missouri was statistical analysis of data from several sources: National Centers for Environmental Information (NCEI) storm events data (1996- December 31, 2016), percentage of population over 65 data from the U.S. Census (2015 ACS) and the calculated Social Vulnerability Index for Missouri counties from the hazards and Vulnerability Research Institute in the Department of Geography at the University of South Carolina. Four factors were considered in determining overall vulnerability to extreme temperatures – total population, percentage of population over 65, likelihood of occurrence and social vulnerability. Based on natural breaks in the data, a rating value of one through five was assigned with one being low, two being low-medium, three being medium, four being medium-high and five being high.

Table 3.36 shows the population, percent of population over 65 and social vulnerability index data for

Dent County overall.

Table 3.36. Population, Percent of Population Over 65 and SOVI Data for Dent County

County	Total Population Rating	Percentage of Population Over 65	Percent of Population Over 65 Rating	SOVI Ranking	SOVI Rating
Dent	4	19.9	3	Medium Low	2

Source: 2018 Missouri Hazard Mitigation Plan

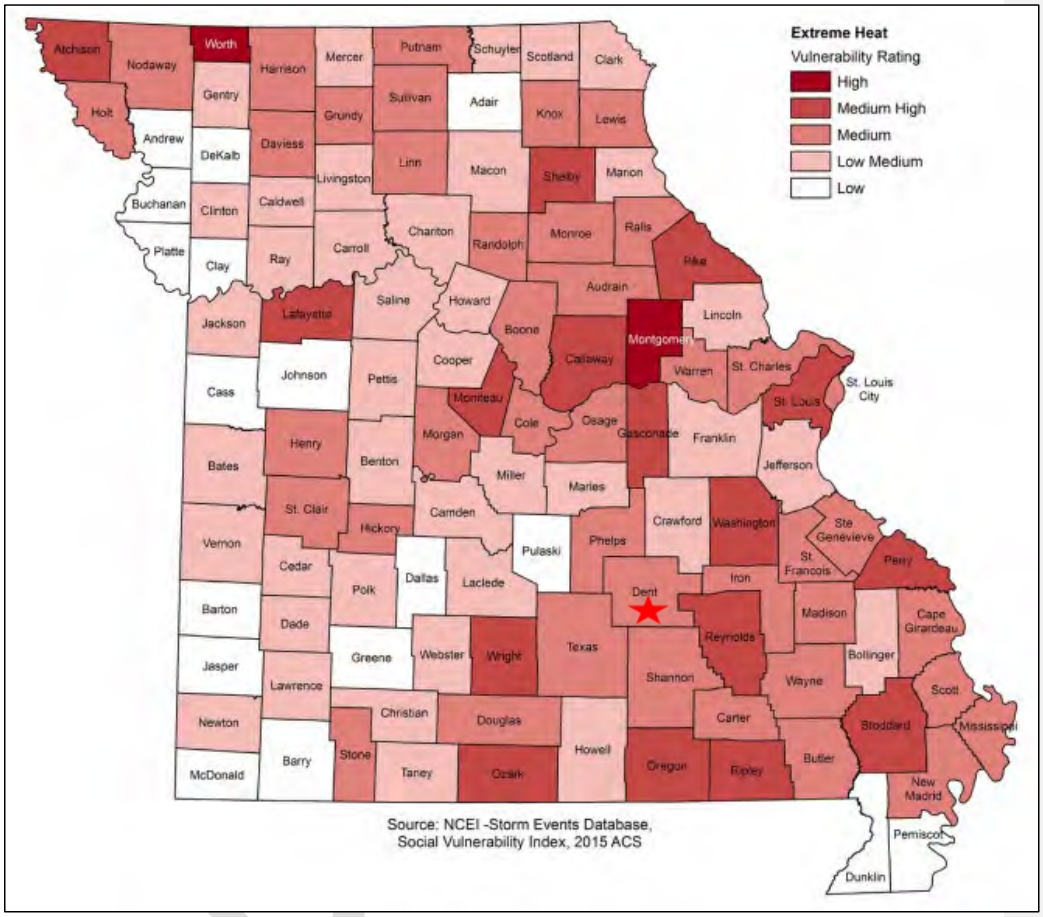
Table 3.37 illustrates the likelihood of occurrence and overall vulnerability rating for extreme temperatures for Dent County. **Figure 3.29** and **Figure 3.30** provide a vulnerability summary for extreme heat and extreme cold, respectively. Dent County has medium vulnerability for extreme heat and Medium vulnerability for extreme cold.

Table 3.37. Dent County Likelihood of Occurrence and Overall Vulnerability Rating for Extreme Temperatures

Heat					Cold				
Total Events	Likelihood of Occurrence	Likelihood Rating	Total Vulnerability	Total Vulnerability Description	Total Events	Likelihood of Occurrence	Likelihood Rating	Total Vulnerability	Total Vulnerability Description
11	0.52	1	10	Medium	3	0.14	1	10	Medium

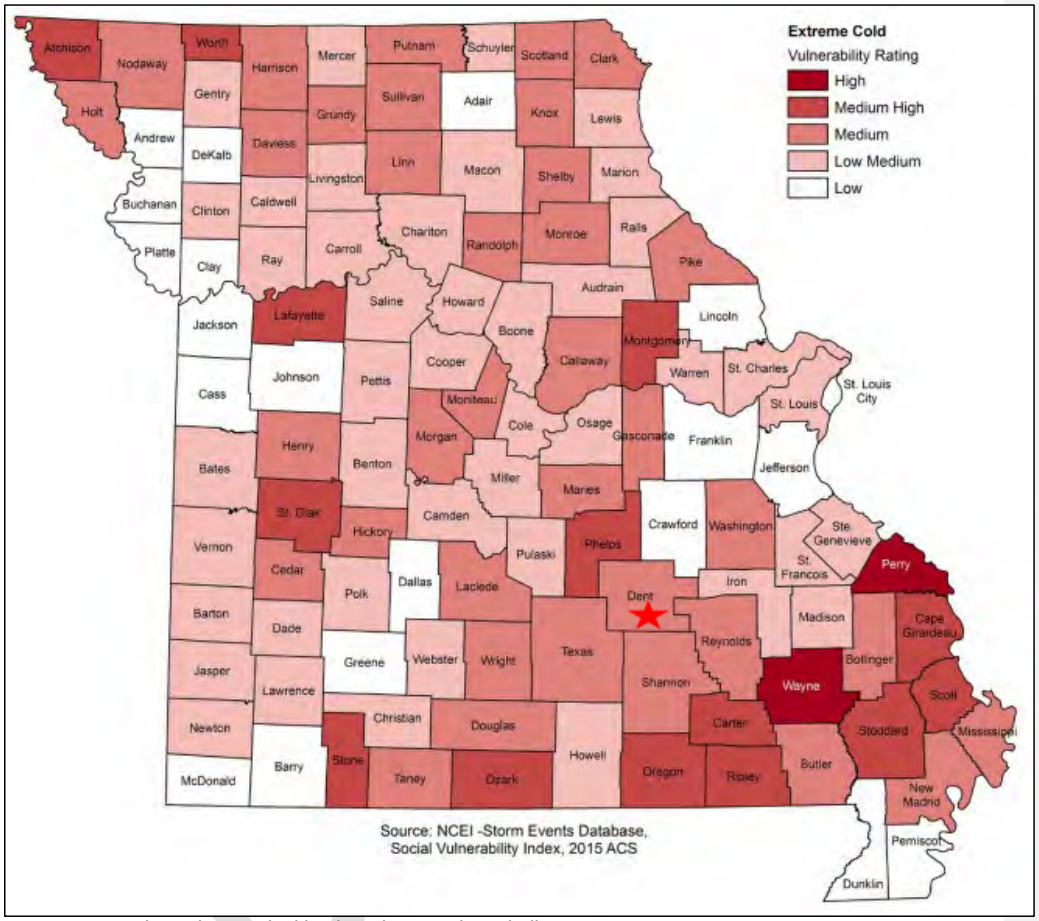
Source: 2018 Missouri Hazard Mitigation Plan

Figure 3.29. Vulnerability Summary for Extreme Heat



*Source: 2018 Missouri Hazard Mitigation Plan, *Red star indicates Dent County*

Figure 3.30. Vulnerability Summary for Extreme Cold



*Source: 2018 Missouri Hazard Mitigation Plan, *Red star indicates Dent County*

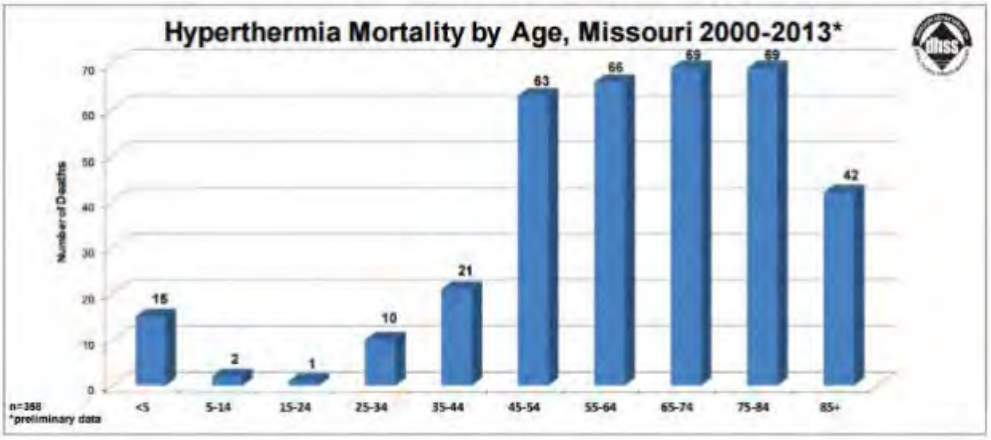
Potential Losses to Existing Development

Extreme Heat/Heat Wave

Of greatest concern during extreme heat events are hyperthermia injuries and deaths. The 2018 Missouri Hazard Mitigation plan states that there were 358 heat-related deaths reported in Missouri from 2000 through 2013. There were 217 (61%) deaths in the metropolitan areas of Kansas City and St. Louis and 141 (39%) deaths in rural parts of the state. Half of the deaths were age 65 or older. People in this demographic group are more vulnerable to this hazard for a number of reasons. Many live alone and have medical conditions that put them at higher risk. The lack of air conditioning or the refusal to use it for fear of higher utility bills further increases their risk. Deaths among children under the age of five are often linked to being left in vehicles during hot weather. Between 2000 and 2013

there were 15 (4%) heat-related deaths of children less than five years old. In the age group between 5 years and 65 years deaths are generally due to over exertion at work or in sports activities, complicating medical conditions or substance abuse. **Figure 3.31** shows the hyperthermia mortality rate by age for the 2000-2013 timeframe.

Figure 3.31. Hyperthermia Mortality of Age, Missouri 2000-2013



Source: Missouri DHSS, http://health.mo.gov/living/healthcondiseases/hyperthermia/pdf/hyper4.pdf

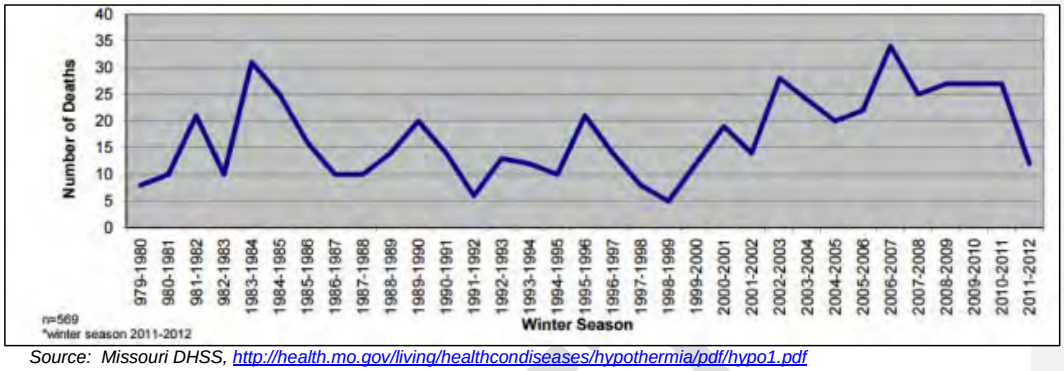
During extreme heat events structural, road, and electrical infrastructure are vulnerable to damages. Depending upon temperatures and duration of extreme heat, losses will vary.

Extreme Cold

According to the Missouri Department of Health and Senior Services, 569 people died in Missouri due to extreme cold conditions between 1979 and 2012, see **Figure 3.32**. As with extreme heat, the elderly are more vulnerable to cold-related deaths. Elderly or disabled individuals fall outside their homes and are not able to call for help or reach the safety of shelter during periods of extreme cold. According to the 2018 Missouri State Hazard Mitigation plan, during the winters of 1989-2012, a total of 414 hypothermia deaths occurred, with 186 (44.9%) being 65 years of age or older. As with extreme heat, substance abuse can be a contributing factor for people between the ages of 25 and 64. Between 1989 and 2012, substance abuse factored into the hypothermia deaths of 107 of the 208 (51.4%) deaths in this age group. Fortunately, hypothermia deaths in people under the age of 25 are rare in Missouri, accounting for only 19 (4.6%) of the total extreme cold related deaths during this timeframe. There were two (0.5%) deaths of children under the age of five. Over 72 percent of hypothermia deaths are among males – 299 of the total 414. The remaining 115 (27.8%) were female.

In regards urban versus rural, hypothermia deaths tend to be higher in rural areas than in urban communities. There were 183 (44.2%) cold related deaths in the Kansas City and St. Louis metropolitan areas, while 231 (55.8%) occurred in other parts of the state.

Figure 3.32. Hypothermia Deaths, Missouri: Winter Seasons 1979-2012



Source: Missouri DHSS, http://health.mo.gov/living/healthcondiseases/hypothermia/pdf/hypo1.pdf

Impact of Future Development

Population trends from 2010 to 2020 for Dent County indicate that the population in unincorporated areas has fallen by an estimated 4.4 percent. The city of Salem's population has decreased by a 4.5 percent. Overall, the county's population has shrunk by 7.9 percent. Population growth can result in increased age groups that are more susceptible to extreme heat and cold. Additionally, as populations increase, so does the strain on each jurisdiction's electricity and road infrastructure. Local government and local emergency management should take extreme heat and cold in consideration when upgrades occur to the local power grid.

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 or have medical conditions that make them more vulnerable. To determine jurisdictions within the planning area with populations more vulnerable to extreme heat, demographic data was obtained from the 2016-2020 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 or with medical conditions that made them more vulnerable. **Table 3.38** below summarizes vulnerable populations in the participating jurisdictions. Note that school and special districts are not included in the table because students and those working for the special districts are not customarily in these age groups.

Table 3.38. County Population Under Age 5 and Over Age 65 (2016-2020)

Jurisdiction	Population Under 5 Years	Population 65 Years and over
Unincorporated Dent County	4.6%	20.4%
Salem	7.8%	25.1%

Source: U.S. Census Bureau, 2016-2020 American Community Survey 5-Year Estimates

Due to lack of data, strategic buildings that lack air-conditioning could not be analyzed for this report. Additionally, school policy data in regard to extreme heat or cold were not available.

In summary, the risks of extreme heat or cold can impact the health/lives of citizens within the county, specifically the young and elderly. The city of Salem has a high percentage of individuals 65 and over, with 25.1 percent.

Many people do not realize how deadly a heat wave can be. Extreme heat is a natural disaster that is not as dramatic as floods or tornadoes. Working with the Dent County Health Department and EMD, local governments should encourage residents to:

- Stay indoors as much as possible and limit exposure to the sun;
- Stay on the lowest floor out of the sunshine if air conditioning is not available;
- Consider spending the warmest part of the day in public buildings such as libraries or other public or community buildings. Circulating air can cool the body by increasing the evaporation rate of perspiration;
- Eat light, well-balanced meals at regular intervals and avoid using salt tablets unless directed by a physician;
- Hydrate by drinking plenty of water. Individuals with epilepsy or heart, kidney or liver disease who are on fluid restricted diets or have problems with fluid retention should consult their physicians on liquid intake;
- Limit consumption of alcoholic beverages;
- Dress in loos-fitting, lightweight and light colored clothes that dover as much skin as possible;
- Protect your face and head by wearing a wide-brimmed hat. Wear sunscreen;
- Check on family, friends and neighbors who do not have air conditioning and are generally alone;
- Never leave children or pets in closed vehicles;
- Avoid strenuous work during the warmest part of the day and use the buddy system when working in extreme heat and take frequent breaks.

People who work outdoors should be educated about the dangers and warning signs of heat disorders. Buildings, ranging from homes (particularly those of the elderly) to factories, should be equipped with properly installed, working air conditioning units, or have fans that can be used to generate adequate ventilation. However, although fans are less expensive to operate than air conditioning, they may not be effective, and may even be harmful when temperatures are very high. As the air temperature rises, air flow is increasingly ineffective in cooling the body. At temperatures above 100° F, the fan may be delivering overheated air to the skin at a rate that exceeds the capacity of the body to get rid of this heat – even with perspiring – and the net effect is to add heat rather than to cool the body. An air conditioner is a much better option. Charitable organizations and the health department should work together to provide fans, when appropriate, to at-risk residents during times of critical heat. When temperatures are too high, however, these groups should work to get at-risk populations into cooling shelters.

Extreme Cold

Extreme cold can also be life-threatening and the following precautions should be taken when someone is suffering from hypothermia:

- Call 9-1-1 for immediate medical assistance;
- Move the victim to a warm place;
- Monitor the victim's blood pressure and breathing;

- If necessary, provide rescue breathing and CPR;
- Remove wet clothing;
- Dry off the victim;
- Take the victim's temperature;
- Warm the body core first, NOT the extremities. Warming the extremities first can cause the victim to go into shock and can also drive cold blood toward the heart and lead to heart failure;
- Do not warm the victim too fast – rapid warming may cause heart arrhythmias

Problem Statement

In summary, the risks of extreme heat and cold can impact the health/lives of citizens within the county, specifically the young and elderly. Based on the vulnerability analysis, the city of Salem has the highest risk because it has large populations of people aged 65 and over (**Table 3.38**).

All jurisdictions should make sure they have plans in place to provide both cooling and warming shelters during times of extreme temperatures. School districts should have policies in place to minimize strenuous exercise outdoors during heat waves and to consider policies for delaying or cancelling school during times of extreme cold to reduce risk to students waiting for buses.

3.4.5 Flooding (Riverine and Flash)

Some specific sources for this hazard are:

- 2018 Missouri State Hazard Mitigation Plan, Chapter 3, Section 3.3.1, Page 3.80 https://sema.dps.mo.gov/docs/programs/LRMF/mitigation/MO_Hazard_Mitigation_Plan2018.pdf
- Watershed map, Environmental Protection Agency, http://cfpub.epa.gov/surf/county.cfm?fips_code=19169
- FEMA Map Service Center, Digital Flood Insurance Rate Maps (DFIRM) for all jurisdictions, if available, https://msc.fema.gov/portal/home
- NFIP Community Status Book, http://www.fema.gov/national-flood-insurance-program/national-flood-insurance-program-community-status-book
- NFIP claims status, BureauNet, http://bsa.nfipstat.fema.gov/reports/reports.html
- Flood Insurance Administration—Repetitive Loss List (this must be requested from the State Floodplain Management agency or FEMA)
- National Centers for Environmental Information, Storm Events Database, http://www.ncdc.noaa.gov/stormevents/
- USDA Risk Management Agency, Insurance Claims, https://www.rma.usda.gov/en/Information-Tools/Summary-of-Business/Cause-of-Loss
- FEMA Data Visualization Tool, https://www.fema.gov/data-visualization-floods-data-visualization
- Missouri Hazard Mitigation Viewer
  http://bit.ly/MoHazardMitigationPlanViewer2018 - Website
  https://drive.google.com/file/d/1bPkc0jgF9ofwQLnTL9N0u-oPFWi9hkst/view - User Guide
  - Risk MAP, DFIRM, and Hazus based depth grids used in Hazus Analysis
  - Flood losses by County 1978-2018
  - Number of flood insurance claims by County
  - Total building exposure to flooding (1% annual chance) by County
  - Buildings impacted by flooding (1% annual chance) by County
  - Flood insurance coverage by County
  - Number of flood insurance policies by County
  - NFIP participation status by County
  - Number of state facilities impacted by flooding (1% annual chance) by County
  - Critical facilities impacted by flooding (1% annual chance) by County

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 failure is discussed in **Section 3.4.1.** It will not be addressed in this section.

A flash flood occurs when water levels rise at an extremely fast rate as a result 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

Riverine flooding is most likely to occur in Special Flood Hazard Areas (SFHA). Below in **Figure 3.33** is a map of Dent County showing the floodplain boundaries. Following the county-wide map are FIRMs for the city of Salem (**Figure 3.34 through Figure 3.35**). Digital data for SFHAs is not available. **Figure 3.36** shows a map of the school districts in Dent County with an overlay of the SFHA. No school districts within the county have properties located in the floodplain. **Table 3.39** shows Dent County NCEI flood events by location between 2001 and 2020.

Figure 3.33. Map of Crawford County with Special Flood Hazard Areas.

Commented [PS1]: Needs made

Commented [PS2R1]: Also need the SFHA overlaid on the School District map

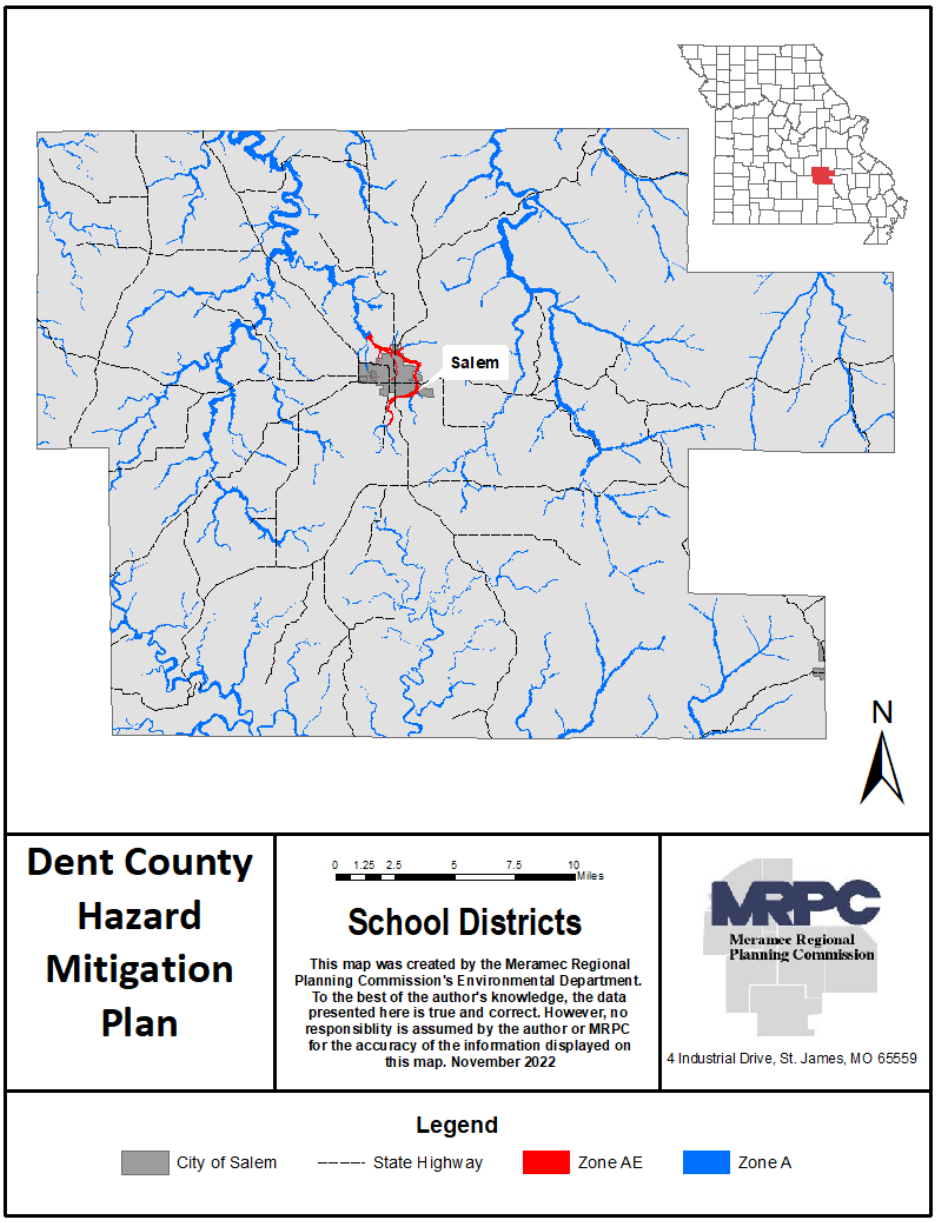


Figure 3.34. Salem, Missouri Special Flood Hazard Areas (SFHAs)

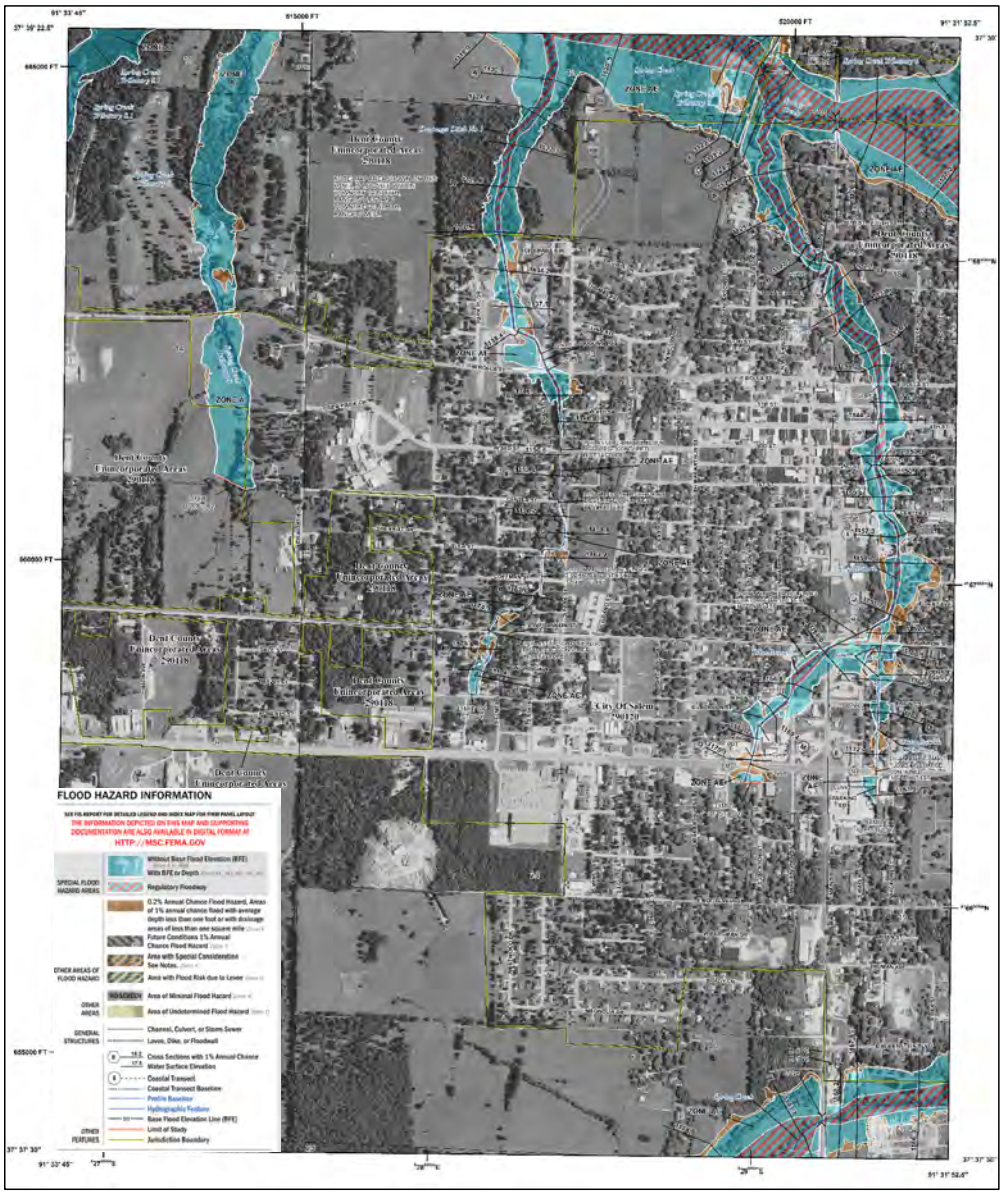


Figure 3.35. Salem, Missouri Special Flood Hazard Areas (SFHAs) continued

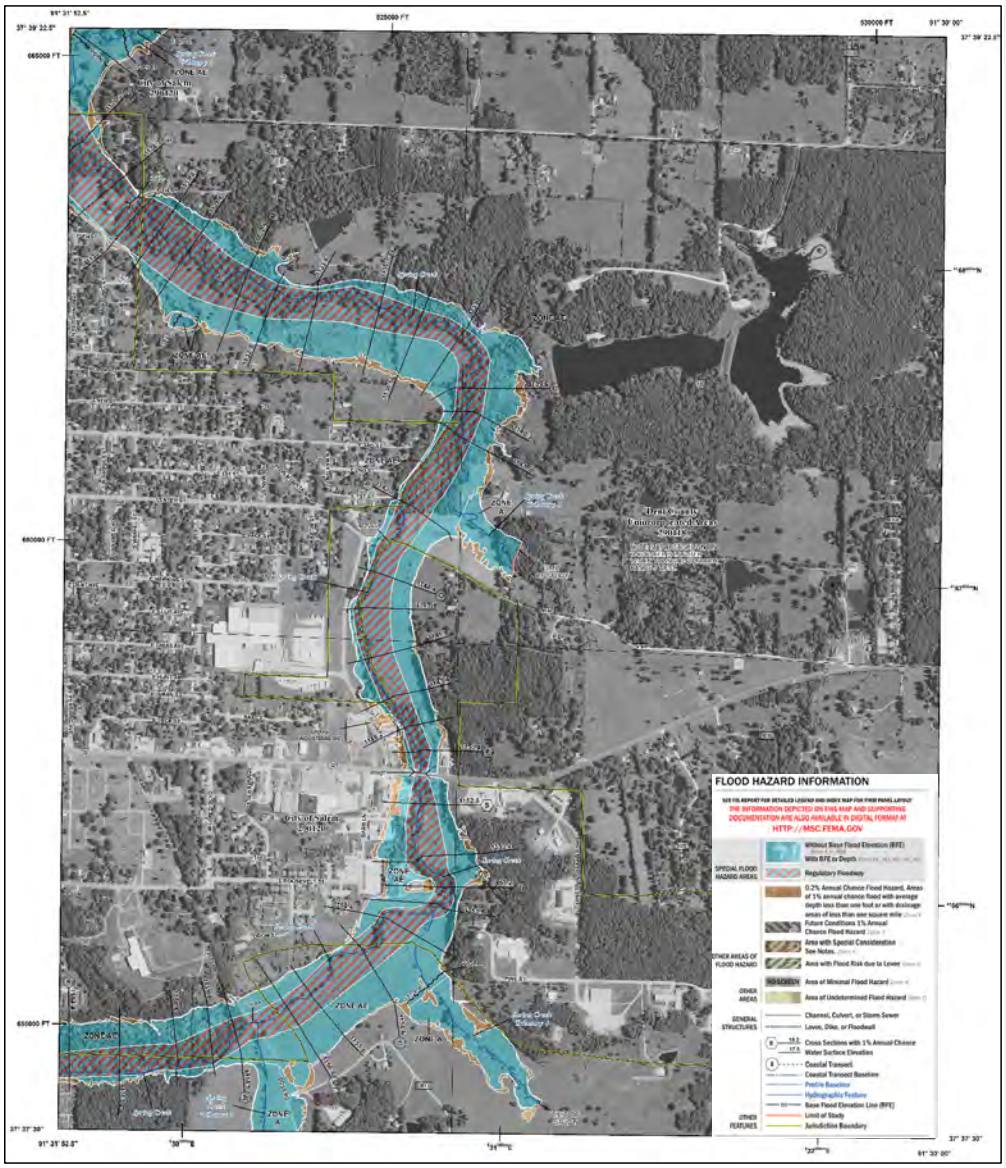


Figure 3.36. Dent County School Districts and Special Flood Hazard Areas (SFHAs)

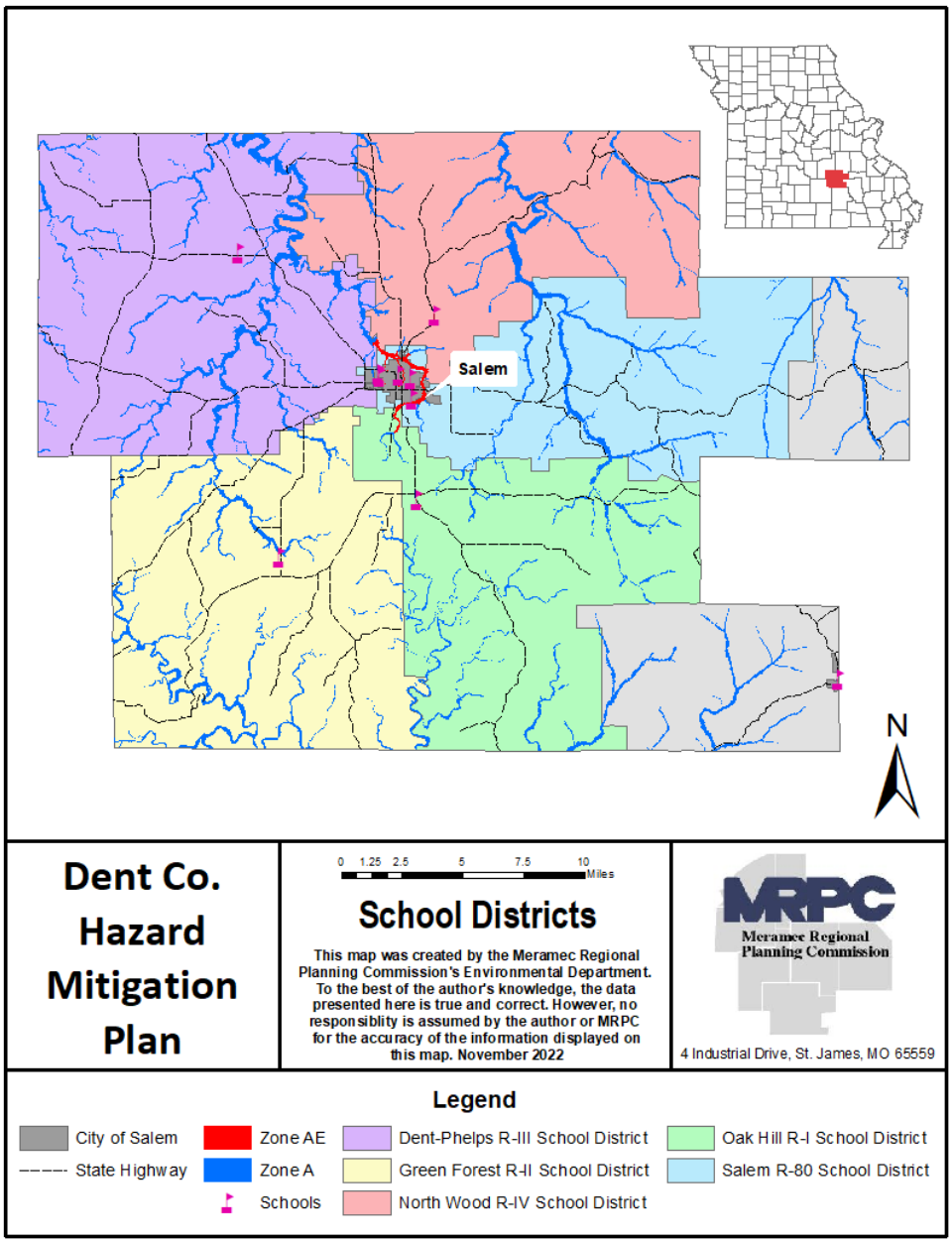


Table 3.39. Summary of Dent County NCEI Flood Events by Location, 2001-2020

Location	# of Events
Dent County	8
Hobson	2
Salem	2
Sligo	14
Stone Hill	3
Jack	1
Gladden	1

Source: National Centers for Environmental Information Storm Events Database

Flash flooding occurs in SFHAs and locations in the planning area that are low-lying. They also occur in areas without adequate drainage to carry away the amount of water that falls during intense rainfall events. After review of NCEI data, Salem is the community most prone to flash flooding events. Sligo and Montauk, unincorporated areas of the county, also have a high rate of flash flood events (both 6). **Table 3.40** provides information in regards to flash flood events between 2001 and 2020.

Table 3.40. Dent County NCEI Flash Flood Events by Location, 2001-2020

Location	# of Events
Dent County - Countywide	3
Jadwin	1
Salem	11
Sligo	6
Boss	1
Hobson	2
Gano	1
Montauk	6
Max	1
Stone Hill	3
Jack	1
Lake SPG	1
Joy	1

Source: National Centers for Environmental Information

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 as a result 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. Further information regarding scour critical bridges can be found in **Section 3.2.2**.

Between 2001 and 2020, there were no recorded flood-related crop insurance claims due to flooding within Dent County[30].

National Flood Insurance Program (NFIP) Participation

Table 3.41 depicts jurisdictions within the planning area that participate in NFIP. In addition, **Table 3.42** provides the number of policies in force, amount of insurance in force, number of closed losses, and total payments for Dent County.

Table 3.41. NFIP Participation in Dent County

Community ID #	Community Name	NFIP Participant (Y/N)	Current Effective Map Date	Regular-Emergency Program Entry Date
290120	Salem, City of	Y	09/18/20	08/01/79
290118	Dent County	N	09/18/20	-

Source: NFIP Community Status Book,, https://www.fema.gov/flood-insurance/work-with-nfip/community-status-book

Table 3.42. NFIP Policy and Claim Statistics as of 09/30/2021

Community Name	Policies in Force	Insurance in Force	Closed Losses	Total Payments
Salem	9	$2,176,000	2	$0.00

Source: NFIP Community Status Book, [11/05/2020]; SEMA
**Closed Losses are those flood insurance claims that resulted in payment.*

City of Salem is the only participating jurisdiction in the planning region.

RiskMAP

Risk mapping, assessment, and planning is a FEMA program which provides communities with flood information and tools to enhance their mitigation plan and take action to better protect their citizens. The project kick-off meeting for RiskMAP in Dent County was held in December 2017 and a flood study review meeting was held in August of 2018.

Repetitive Loss/Severe Repetitive Loss Properties

Repetitive Loss Properties (RL) are those properties with at least two flood insurance payments of

[30] http://www.rma.usda.gov/data/cause.html

$1,000 or more in a 10-year period.

Severe Repetitive Loss (SRL): A SRL property is defined it as a single family property (consisting of one-to-four residences) that is covered under flood insurance by the NFIP; and has (1) incurred flood-related damage for which four 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 amounts of such claims payments exceeding $20,000; or (2) for which at least two separate claims payments have been made with the cumulative amount of such claims exceeding the reported value of the property.

According to SEMA, as of 09/24/2021, there are no repetitive loss properties or severe repetitive loss properties in Dent County.

Previous Occurrences

Table 3.43 provides information regarding Presidential Flooding Disaster Declarations between 2001 and 2020 for Dent County.

Table 3.43. Dent County Presidential Flooding Disaster Declarations 2001 to 2020

Declaration No.	Date	State	Incident Description
DR-1463	05/06/2003	Missouri	Severe Storms, Tornadoes, and Flooding
DR-1676	01/15/2007	Missouri	Severe Winter Storms, Flooding
DR-1749	03/19/2008	Missouri	Severe Storms, and Flooding
DR-1809	11/13/2008	Missouri	Severe Storms, Flooding, and Tornado
DR-1847	06/19/2009	Missouri	Severe Storms, Tornadoes, and Flooding
EM-3374	01/02/2016	Missouri	Severe Storms, Tornadoes, Straight-Line Winds, and Flooding
DR-4317	05/24/17	Missouri	Severe Storms, Tornadoes, Straight-line Winds and Flooding

Source: FEMA, Disaster Declarations for Missouri, Flooding

Data was obtained from the NCEI regarding flash and river flooding over the last 20 years. **Table 3.44** and **Table 3.45** provide this information. Additionally, narratives available for each event are included.

Table 3.44. NCEI Dent County Riverine Flood Events Summary, 2001 to 2020

Year	# of Events	# of Deaths	# of Injuries	Property Damages ($)	Crop Damages ($)
2002	6	0	0	350.00K	0
2005	2	0	0	0	0
2007	1	1	0	0	0
2008	1	0	0	0	0
2009	2	0	0	0	0
2010	2	0	0	0	0
2011	3	0	0	500.00K	0
2013	2	0	0	0	0
2015	1	0	0	0	0
2016	1	0	0	0	0
2017	3	1	0	10.00K	0

Year	# of Events	# of Deaths	# of Injuries	Property Damages ($)	Crop Damages ($)
2018	4	0	0	0	0
2020	3	1	0	0	0
Total	**31**	**2**	**0**	**860.00K**	**0**

Source: NCEI, data accessed [10/06/2021]

Narratives on flood events:

1. **01/31/2002:** A prolonged moderate rainfall event occurred over the Ozarks from the early morning to the evening hours of January 31, 2002. One day earlier, heavy rainfall provided nearly one inch of rain over the flooded areas, which made for already wet soil conditions prior to this event.

   A shallow arctic front, which provided the focus for a large scale overrunning precipitation event, was nearly stationary along the Arkansas border during the day. The rainfall began early Thursday morning with an almost continuous influx of steady rainfall from 9 am January 31, to approximately 6 pm that evening. Rainfall rates were generally low and ranged from one half, to three quarters of an inch per hour in the heaviest downpours. However, a general one to two tenths per hour was more consistent with the overall rainfall pattern, with isolated convective activity during the afternoon hours. 24 hour rainfall totals, including Doppler radar estimates in the flooded areas, ranged from one inch, to nearly three inches in Phelps, Pulaski, Texas, Howell and Shannon Counties.

   Numerous low water crossings, streams and county roads were flooded throughout the event. Several of the county roads were closed and did not reopen until Friday morning, February 1, 2002. The hardest hit areas were in Pulaski and Shannon Counties where Cave, Spring, and Creek roadways along the Big Piney River, and Highway H between Highway 16 and 106, were closed for nearly 24 hours.

2. **02/01/2002:** This is the continuation of the flood event of January 31, 2002. Although the rainfall had ended, runoff continued which caused several roads, low water crossings, and small streams to remain flooded through the morning. Runoff from the small streams caused the Big Piney River to rise above flood stage early Friday morning. Also, the Gasconade River, North Fork, Jacks Fork, and Eleven Point Rivers of central and south central Missouri rose significantly during this event.

3. **05/08/2002:** The flash flooding event on the 7th and early 8th, became a major flooding event across all of southern and central Missouri through the early afternoon of May 9th. In addition to the numerous road closures, bridges blocked by debris, evacuations of towns, campgrounds, parks, and moderate river flooding, many communities had their worst flooding in more than 10 years. The American Red Cross set up shelters in Branson and Cassville due to evacuations. Flooded roadways forced several school districts across southwest Missouri to close for a few days. Several areas of west central Missouri also had crop damage.

4. **05/12/2002:** This is the continuation of the flooding that occurred over portions of southern Missouri on May 12th and 13th. Although numerous low water crossings, bridges, and area rivers flooded for the second time in less than a week, this area was more concentrated over portions of southwest Missouri and portions of extreme south central Missouri. One of the more significant factors this time with the flooding is that the area lakes rose to critical levels, especially Bull Shoals and Table Rock Lake, where the water rose to a few feet below the flood

pool.

This flooding event prolonged the closure of numerous roads and low water bridges over central and southern Missouri. The additional heavy rain also worsened already existing river flooding over the region. Polk County received over eight inches of rainfall during a 12 hour period which caused most of the southern part of the county to have significant road erosion. Parts of Dent County also reported significant basement flooding and road erosion.

5. **05/17/2002:** This is the continuation of the flooding from May 16th and 17th. Runoff was excessive over south central Missouri and portions of southwest Missouri where local rivers and smaller tributaries continued to rise. The runoff slowly subsided during the early morning hours of May 18th.

   During the first three weeks of May, many areas of the Ozarks and southeast Kansas received between seven and twelve inches of rainfall. Not only did this cause major flooding of roadways, rivers and creeks, this contributed to lake levels rising to near record heights. Bull Shoals Lake rose so high that it caused Highway K to flood for several weeks. It forced seven families that live along Highway K to travel to and from their homes via canoes or rafts. A city park was closed for several weeks on Lake Taneycomo and caused their local fair to be cancelled.

   The significant and widespread flooding that occurred over the region caused the President to declare the following counties in southern Missouri disaster areas; Camden, Cedar, Christian, Dent, Greene, Hickory, Jasper, Laclede, McDonald, Newton, Polk, Stone, Texas, Vernon, Wright, Barry, Barton, Dade, Dallas, Webster, Taney, Douglas, Howell, Oregon, Lawrence and Shannon counties.

6. **08/20/2002:** Runoff continued as four to eight inches of rain that fell earlier causing numerous low water crossings to remain closed through mid-morning of August 20th.

7. **01/05/2005:** Several periods of heavy rain in conjunction with little vegetation over the winter months set the stage for widespread flooding across much of extreme southeast Kansas and southern and central Missouri. In Dent County, numerous roads and low lying areas were inundated and impassable by motorists countywide.

8. **01/13/2005:** A slow moving storm system caused heavy rain to occur across much of southern and central Missouri. This event followed quickly on the heels of a previous flood event that occurred from the 4th through the 6th of January, therefore soils were nearly saturated at the onset of the event. The lack of January vegetation also contributed to increased runoff and flooding. In Dent County, the primary areas that flooded were low water crossings and low lying areas.

9. **04/14/2007:** Numerous thunderstorms produced hail and flash flooding across the Missouri Ozarks.

10. **03/19/2008:** Excessive rainfall developed over southern Missouri during the evening of 17 March. A line of training convection assumed a position roughly along a line from Anderson to Ozark to Licking. This convection expanded with time, eventually covering nearly all of extreme southeast Kansas and the Missouri Ozarks. Moderate to heavy rain continued into the overnight period and did not stop until the morning of 19 March.

11. **09/04/2009:** A low water crossing in Salem flooded.

12. **10/29/2009:** Route TT east of Route 19 was closed due to flooding.

13. **05/20/2010:** A slow moving upper level storm system, moved across the region, acting to transport significant amounts of moisture up and over a stalled frontal boundary laid out across the Ozarks. Isolated embedded thunderstorms produced small hail and locally heavy rainfall. Wide spread flooding and flash flooding occurred as a result of the duration of heavy rainfall in conjunction with isolated heavy rainfall from thunderstorms.

14. **02/24/2011:** Highway TT in northeastern Dent County was closed due to flooding.

15. **04/23/2011:** Highway 119 was closed due to high water and campers were evacuated from Montauk State Park. The low water crossing at Crooked Creek on Highway TT was closed because of flooding.

16. **02/26/2013:** MODOT reported that the low water crossing along Highway TT was flooded.

17. **11/17/2015:** Highway TT was closed approximately one mile east of Highway 19 due to flooding.

18. **05/17/2016:** Highway TT was closed approximately one mile east of Highway 19 due to flooding.

19. **04/05/2017:** Highway TT was closed approximately one mile east of Highway 19 due to flooding. Route TT at Crooked Creek was flooded and impassible. The Missouri State Highway Patrol reported that a man drowned near a low water crossing at County Road 2430 and Dry Fork Creek. The man attempted to drive across a flooded low water crossing but the car was swept away.

20. **02/24/2018:** Heavy rainfall over several days caused minor flooding across the Missouri Ozarks. Between four and eight inches of rainfall fell over the course of about a week.

21. **03/27/2018:** Several rounds of thunderstorms caused heavy rainfall and minor flooding. The road was flooded and closed at Route TT.

22. **06/02/18:** Scattered pulse severe storms produced hail and wind damage across parts of the Ozarks. Flooding of low water crossings occurred in southeastern Dent County from prolonged heavy rainfall.

23. **03/19/2020:** A persistent large upper level trough over the southwest U.S. ejected many upper level disturbances that interacted with weak surface boundaries and deep moisture over the region. On the 19th, strong storms and heavy rainfall occurred. Many flash flood reports were received as soils were saturated from earlier rainfall. A few storms produced damaging wind gusts over south central Missouri. State Highway TT was closed at Crooked Creek due to flooding.

24. **11/22/2020:** Several upper level disturbances passed over the frontal zone and interacted with increasing low level moisture to produce several rounds of moderate to heavy rainfall from the evening of the 20th to the pre-dawn hours of the 22nd. Rainfall accumulations for the 48-hour period ending at 3 AM on the 22nd ranged from one to two inches, with the highest totals over the eastern Ozarks. Localized flooding of low water crossings over southwest and south central Missouri led to two fatalities during the early morning of the 22nd. The first fatality occurred in Wright County at AB Highway north of Mansfield along Wolf Creek. An 18-year old female drove

into the flooded low water crossing at around 12:30 AM, and drowned while trying to escape her vehicle. The second fatality occurred in Dent County around 5 AM. A driver with a six-year old passenger drove into the flooded low water crossing on Highway TT at Crooked Creek northeast of Salem. The driver was able to swim to safety, but the 6-year old was swept downstream and drowned. The vehicle was swept of the low water crossing over Highway TT at Crooked Creek. A driver with a six-year old passenger drove into the flooded low water crossing northeast of Salem. The driver was able to swim to safety, but the 6-year old was swept downstream and drowned.

Table 3.45. NCEI Dent County Flash Flood Events Summary, 2001 to 2020

Year	# of Events	# of Deaths	# of Injuries	Property Damages ($)	Crop Damages ($)
2002	3	0	0	0	0
2005	4	0	0	0	0
2006	2	0	0	0	0
2008	5	0	0	1.000M	0
2009	2	0	0	0	0
2011	4	0	0	0	0
2013	6	0	0	0	0
2015	4	0	0	0	0
2016	1	0	0	0	0
2017	1	0	0	1.000M	0
2018	4	0	0	0	0
2020	2	0	0	0	0
Total	**38**	**0**	**0**	**2.000M**	**0**

Source: NCEI, data accessed [10/06/2021]

Narratives on flash flood events:

1. **05/12/2002:** Another in a series of thunderstorm complexes moved across the area producing excessive rainfall on the already saturated soils. Most of the heavy rainfall began across central Missouri Sunday morning May 12th, and then produced another round of torrential rainfall Sunday evening. By Monday morning May 13th, a large area of two inches fell north of Interstate 44, with the heaviest bands of three to six inches from Joplin northeast to Greenfield, Bolivar and Urbana. Another area of excessive rain fell over eastern Texas, northern Shannon, and southern Dent counties where locally three to six inches fell.

2. **05/16/2002:** This was the third major flood event to occur within a 10 day period. Some communities reported over a foot of rain since the beginning of May. This area of excessive rainfall fell over mostly southern Missouri, south of Interstate 44 from the night of May 16, through the morning May 17th. Over an inch of rain fell over a broad area of southern Missouri, with bands of three to six inches from Joplin to Carthage, Powell to Cassville, Ozark to Mansfield, and from Licking to Ankers in northern Shannon County. Even though there were three days of dry weather, runoff was not complete from the previous flooding event, therefore, flash flooding developed quickly.

3. **08/19/2002:** Four inches of rain fell in less than 3 hours over portions of northern Dent County and southern Phelps County. Locally five to seven inches fell near Boss in east central Dent County. Local law enforcement officers reported Highway 32 east of Salem flooded with nearly 12 inches of water flowing over the road at one point. One of the officer's car nearly floated

away due to the extremely high water level as he drove down the highway, however, he was able to get out with no injuries. Numerous low water crossings also flooded across the area with several roads closed.

4. **01/05/2005:** Several periods of heavy rain in conjunction with little vegetation over the winter months set the stage for widespread flooding across much of extreme southeast Kansas and southern and central Missouri. In Dent County, numerous roads and low lying areas were inundated and impassable by motorists countywide.

5. **01/13/2005:** A slow moving storm system caused heavy rain to occur across much of southern and central Missouri. This event followed quickly on the heels of a previous flood event that occurred from the 4th through the 6th of January, therefore soils were nearly saturated at the onset of the event. The lack of January vegetation also contributed to increased runoff and flooding. In Dent County, the primary areas that flooded were low water crossings and low lying areas.

6. **04/21/2005**: Heavy thunderstorms caused flash flooding over a section of Highway TT near the community of Sligo.

7. **08/22/2005:** Missouri Department of Transportation observed a section of Highway 32 inundated with flash flooding.

8. **05/10/2006**: Excessive rainfall caused Huzzah Creek to flood over a section of Highway AC.

9. **05/31/2006:** Excessive rainfall caused flash flooding across a low water bridge on Highway P near its intersection with County road 515.

10. **03/18/2008:** Seven to nine inches of rain fell over Dent County. Flooding caused major damage to county roads and bridges. All low areas that typically flood during periods of excessive rainfall were flooded.

11. **03/31/2008**: Saturated antecedent conditions existed prior to this period of excessive rainfall. Some regional locations experienced record rainfall totals from February and March. One to three inches of rain fell across the county causing widespread flash flooding of low water crossings, county roads, and low lying areas near creeks and rivers. Ultimately, all locations that typically flood during periods of excessive rainfall were flooded.

12. **04/10/2008:** One to three inches of rain fell over Dent County. All low areas that typically flood during periods of excessive rainfall were flooded. A section of Highway EE nine miles southeast of Salem was one specific location that flooded.

13. **09/14/2008:** Flash flooding occurred along Pidgeon Creek which caused all campers on Montauk State Park to evacuate.

14. **12/27/2008:** Excessive rain caused several city streets to flood in Salem. Creeks also flooded low areas across the county.

15. **06/03/2009:** A few low water crossings near Craig Industrial Park were flooded due to excessive rainfall.

16. **10/29/2009:** Low water crossings were flooded.

17. **04/23/2011:** The sheriff office reported several low water crossings were flooded. Highway TT was closed due to flooding.

18. **04/25/2011:** Route EE was closed due to flooding. Numerous low water crossings in rural areas were closed due to flooding.

19. **04/18/2013:** Residents were rescued from a trailer surrounded by water along the Meramec River near Highway EE. Water from Spring Creek was over the bridge on County Road 3220.

20. **08/06/2013:** Montauk State Park was evacuated due to high water. The Department of Natural Resources relayed to the NWS that Montauk State Park was flooded from the Current River. All 90 camp sites were evacuated prior to the flooding.

21. **08/07/2013:** Route TT closed in both directions due to flooding in the vicinity of Crooked Creek.

22. **06/19/2015:** State Route TT was closed due to flooding.

23. **07/01/2015:** There was flash flooding in low lying area at Montauk State Park.

24. **08/10/2015:** Route TT was closed in both directions at Crooked Creek due to flooding. Route EE was closed due to flooding of the Meramec River.

25. **09/14/2016:** Water was reported over the road several inches deep on Highway H near Barnitz Prong Creek. The highway was closed for a brief time to traffic due to the high water.

26. **04/29/2017:** Several homes and business sustained flood damage across Dent County. Numerous roads and bridges were severely damaged or washed away across the county. This report will contain the total dollar estimate for flood damage to infrastructure, businesses and homes across Dent County.

27. **05/25/2018:** Several rounds of severe thunderstorms impacted the Ozarks Region with large hail, damaging wind gusts, and heavy rainfall. There was video showing a road covered with fast flowing water.

28. **05/31/2018:** Several rounds of severe thunderstorms impacted the Ozarks Region with large hail, damaging wind gusts, and heavy rainfall. There was flash flooding at Montauk State Park.

29. **10/06/2018:** A stationary front over the Ozarks interacted with several upper level disturbances to produce showers and thunderstorms with locally heavy rainfall from the morning of the 6th to the afternoon of the 7th. There was one report of quarter sized hail with storms over Miller County during the afternoon of the 7th. As the front was lifting northward in response to pressure falls over the southern High Plains, strong to severe storms developed north of the Ozarks. On the morning of the 9th, when the main upper level system shifted eastward a final round of showers and thunderstorms moved through the region. County Road 658 flooded along Pigeon Creek and was closed.

30. **08/10/2020:** Strong to severe thunderstorms developed during the afternoon and evening of the 10th as an upper level disturbance and outflow boundary from an intense derecho over Iowa interacted with a stalled front. The strongest storms produced hail up to 2.5 inches in diameter. Strong straight line winds produced damage across the region. During the early morning hours of the 11th, another upper level disturbance generated additional storms mainly over areas along and south of Interstate 44. Numerous city streets were reported flooded and impassable.

Probability of Future Occurrence

From the data obtained from the NCEI [31], there were 31 riverine flood events (**Table 3.44)** over a period of 20 years. This information was utilized to determine the annual average percent probability of riverine flooding (**Table 3.46**). The probability of riverine flooding in Dent County per year is 100 percent (31 events/20 years x 100) with an average of 1.5 events per year. Furthermore, data was obtained for flash flooding within the county. Dent County endured 38 flash flooding events (**Table 3.45**) over a 20 year period. The probability of flash flooding in Dent County per year is 100% (38 events/20 years x 100) with an average of 1.9 events per year (**Table 3.47**).

Table 3.46. Annual Average % Probability of Riverine Flooding in Dent County

Location	Annual Avg. % P	Avg. Number of Events
Dent County	100%	1.5

*P = probability; see page 3.24 for definition.

Table 3.47. Annual Average % Probability of Flash Flooding in Dent County

Location	Annual Avg. % P	Avg. Number of Events
Dent County	100%	1.9

*P = probability; see page 3.24 for definition.

Vulnerability

Vulnerability Overview

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 can break loose or sustain a puncture as a result of flooding. 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 flood 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. Additional information on scour bridges can be found on page 3.16. Floodwaters can also cause erosion undermining roadbeds. In some instances, steep slopes that are saturated with water may cause mud or rockslides onto roadways. These damages can cause costly repairs for state, county and city road and bridge maintenance departments. When sewer

[31] http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=29%2CMISSOURI

back-up occurs, this can result in costly clean-up for home and business owners a well as present a health hazard.

For the vulnerability analysis of flooding for Dent County, data was obtained from the 2018 Missouri State Hazard Mitigation Plan. The 2018 Plan used the most recent release of Hazus, version 4.0, to model flood vulnerability and estimate flood losses due to the depth of flooding. Additional hazard data inputs were utilized, as available, to perform Hazus Level 2 analyses. This included the extensive use of the FEMA special flood hazard area data and RiskMAP flood risk datasets.

For the Hazus analysis, the flood hazard area and depth of flooding was determined for each county using one of three methods – depending on the data available for that county. Dent County does have digital FIRMS, the regulatory special flood hazard area was utilized. Next, depth grids were generated using cross sections from the FIRM database and/or hydraulic models in combination with the terrain elevation data from which the DFIRM was derived.

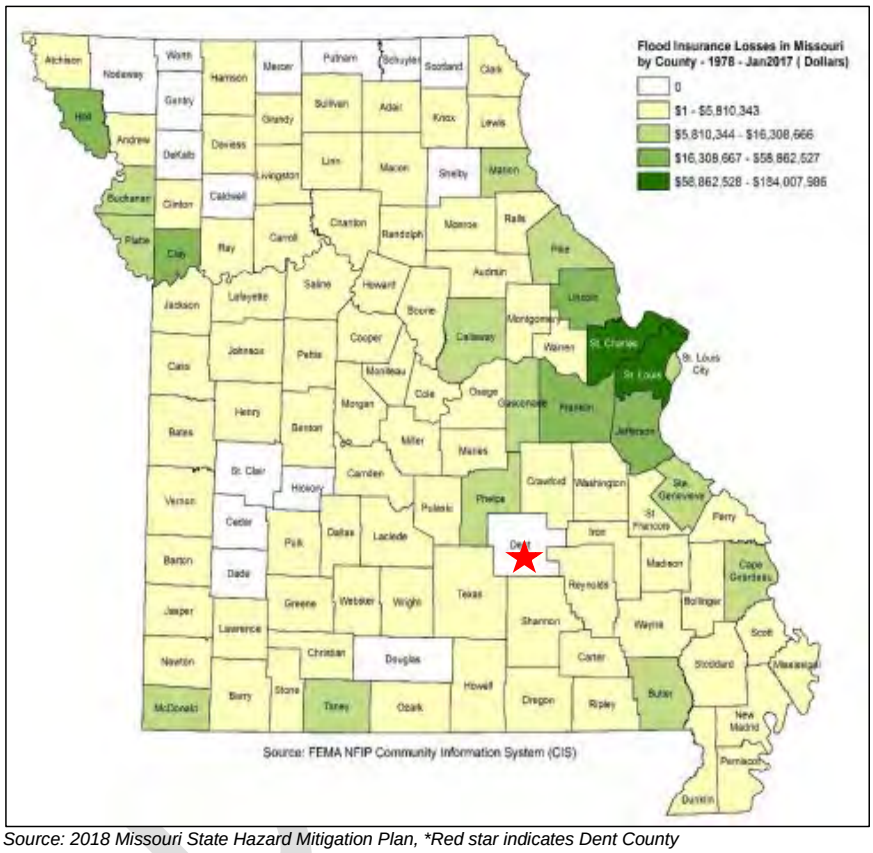
This method was preferred of the three methods, along with RiskMAP flood risk datasets.

In addition to the DFIRM, SEMA analyzed National Flood Insurance Program (NFIP) flood-loss data to determine areas of Missouri with the greatest flood risk. Missouri flood-loss information was obtained from BureauNet which documents losses from 1978 to the present (November 30, 2017 for the State Plan). With this flood-loss data there are limitations noted, including:

- Only losses to participating NFIP communities are represented
- Communities joined the NFIP at various times since 1978
- The number of flood insurance policies in effect may not include all structures at risk to flooding
- Some of the historic loss areas have been mitigated with property buyouts

Figure 3.37 depicts the amount of flood insurance losses in Missouri by county for the period 1978-January 2017. Dent County falls in the $0 range of payments.

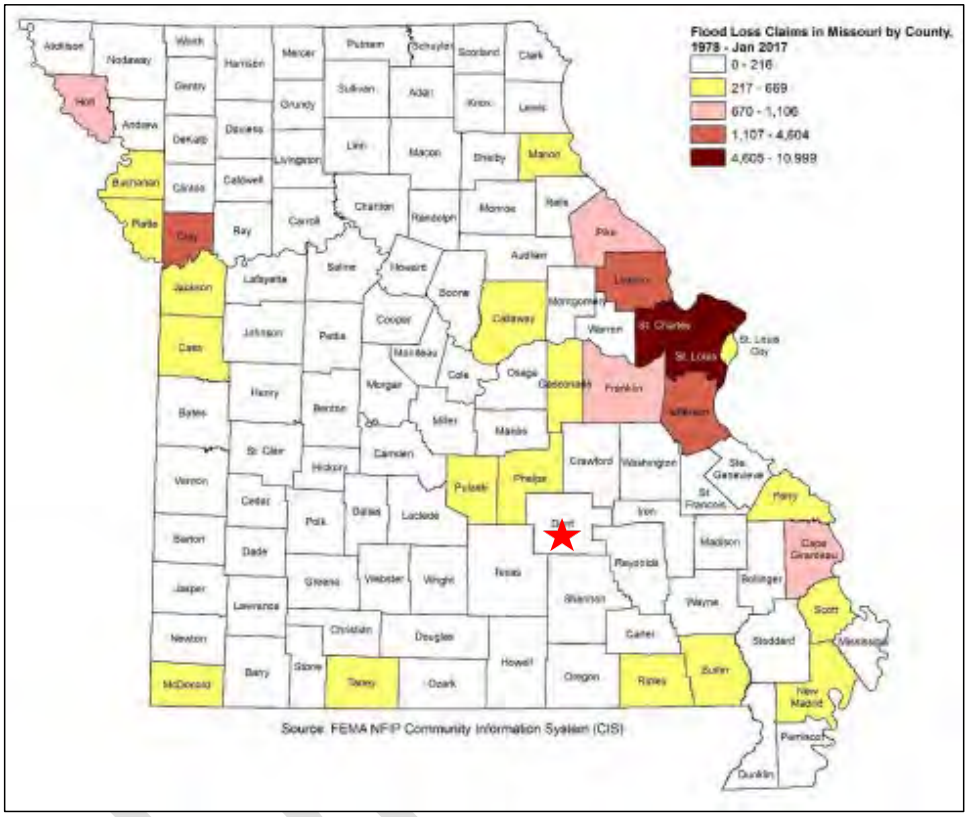
Figure 3.37. Map of Funds Paid Historically for Flood Insurance Losses in Missouri by County 1978 - January 2017



*Source: 2018 Missouri State Hazard Mitigation Plan, *Red star indicates Dent County*

Figure 3.38 illustrates the number of flood loss claims made in Missouri during the same time period. Dent County had 0 - 216 claims during that timeframe.

Figure 3.38. Flood Loss Claims in Missouri by County, 1978 – January 2017



*Source: 2018 Missouri State Hazard Mitigation Plan, *Red star indicates Dent County*

Furthermore, the state analyzed potential loss estimates to flooding. The purpose of the analysis is to determine where flood losses can occur and the degree of severity using consistent methodology. These results were generated from DFIRM data and Hazus floodplain data. **Table 3.48** provides information regarding total direct building loss and income loss to Dent County. **Table 3.49** provides information on exposure of buildings. According to the Missouri Spatial Data Information Service (MSDIS) there are 29 residential structures at risk of flood. Hazus shows the number of building exposed to flood damage at 31, with 13 potentially substantially damaged in a one percent annual chance of a flood.

Table 3.48. Total Direct Building Loss and Income Loss to Dent County

County-wide Building Loss	Structural Damage	Contents Loss	Inventory Loss	Total Direct Loss	Total Income Loss	Total Direct and Income Loss	Calc. Loss Ratio
$1,451,544,000	$17,538,000	$12,429,000	$158,000	$30,125,000	$45,000	$30,170,000	1.21

Source: 2018 Missouri State Hazard Mitigation Plan

Table 3.49. Dent County Structures Exposure

# MSDIS Residential Structures Exposed	# Hazus Buildings Exposed	# Substantially Damaged
31	29	13

Source: 2018 Missouri State Hazard Mitigation Plan

This same analysis indicates that 557 people would be displaced in Dent County and 121 would need to be sheltered in the event of a major flood.

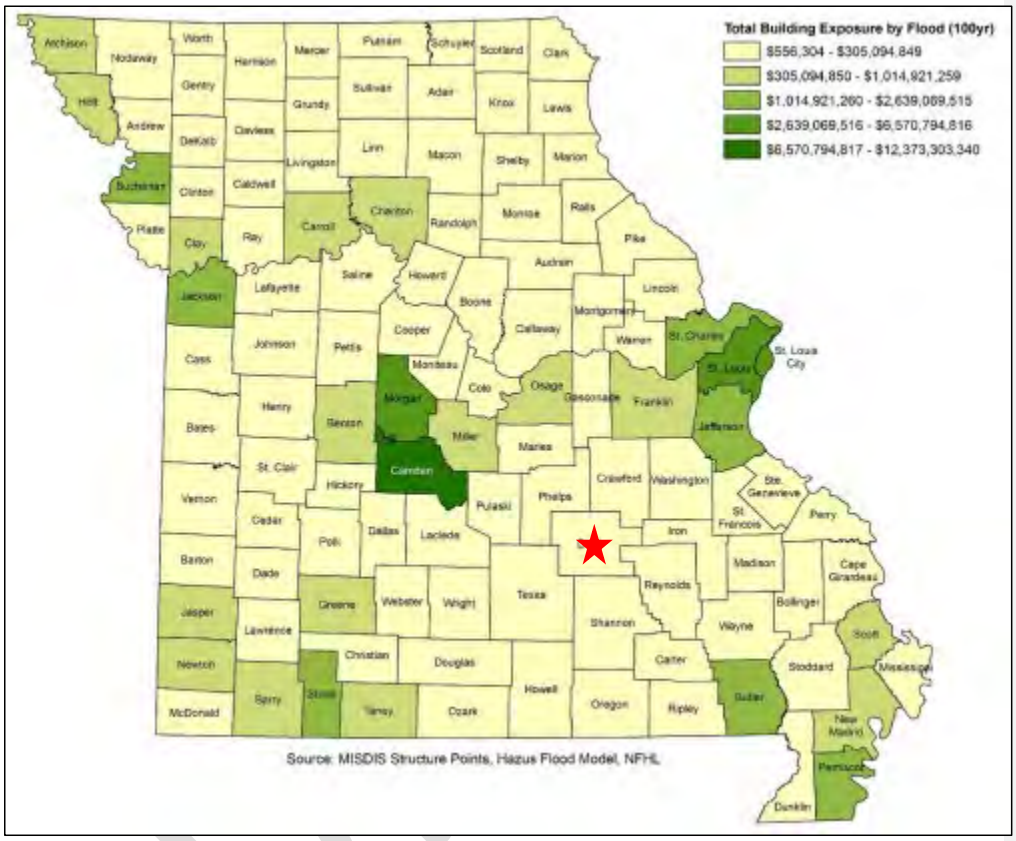
Table 3.50 presents the results of the primary indicators for Dent County – residential, agricultural, commercial, education, government and industrial. This table illustrates the number of affected structures and estimated losses. **Figure 3.39** shows the building exposure for the Hazus Base-Flood Scenario. **Figure 3.40** illustrates the building impacted ratio for a 100-year flood.

Table 3.50. Dent County Total Building Loss and Income Loss

# Residential Structures	Total $$ of Loss	# Agriculture Structures	Total $$ of Loss	# Commercial Structures	Total $$ of Loss	# of Education Structures	Total $$ of Loss	# of Government Structures	Total $$ of Loss	# of Industrial Structures	Total $$ of Loss	Total # Population Affected	Total Loss – Hazus Layer
31	$164,856	131	$463,706	38	$769,535	0	$0	0	$0	3	$1,239,762	81	$2,637,859

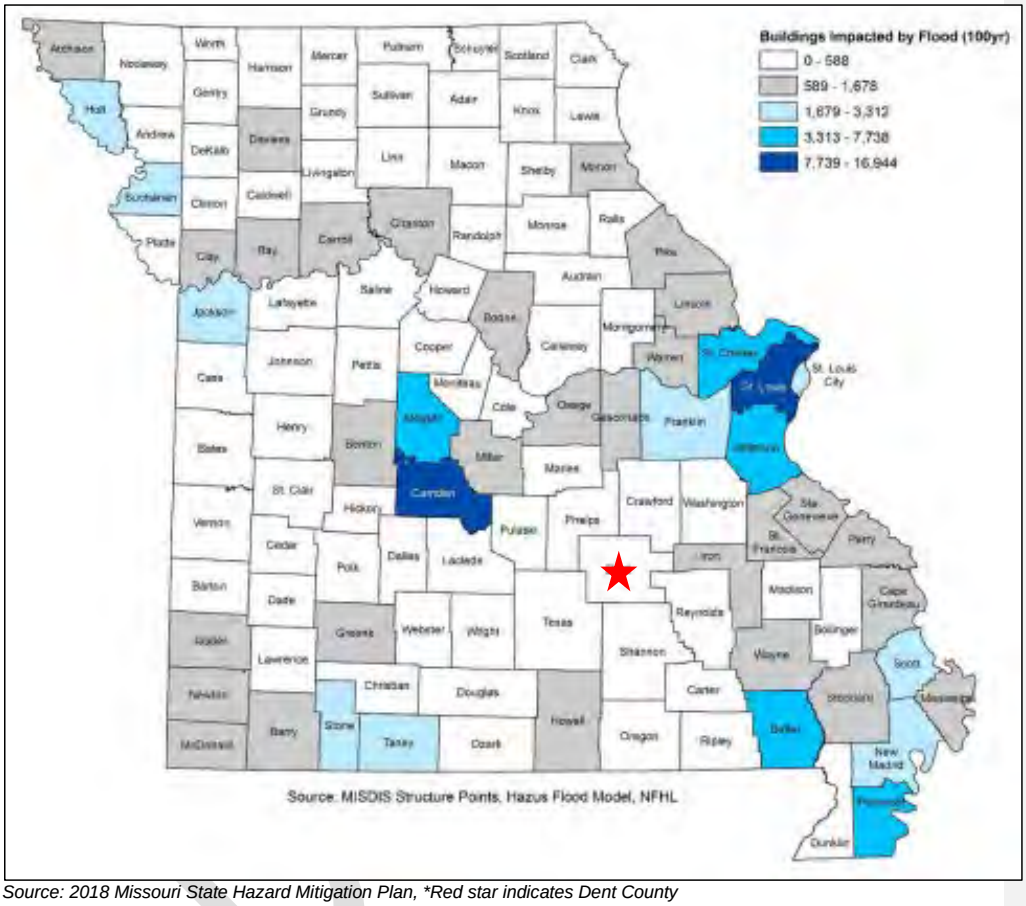
Source: 2018 Missouri State Hazard Mitigation Plan

Figure 3.39. Hazus Countywide Base-Flood Scenarios: Building Exposure



*Source: 2018 Missouri State Hazard Mitigation Plan, *Red star indicates Dent County*

Figure 3.40. Hazus Countywide Base-Flood Scenarios: Building Impacted Ratio



*Source: 2018 Missouri State Hazard Mitigation Plan, *Red star indicates Dent County*

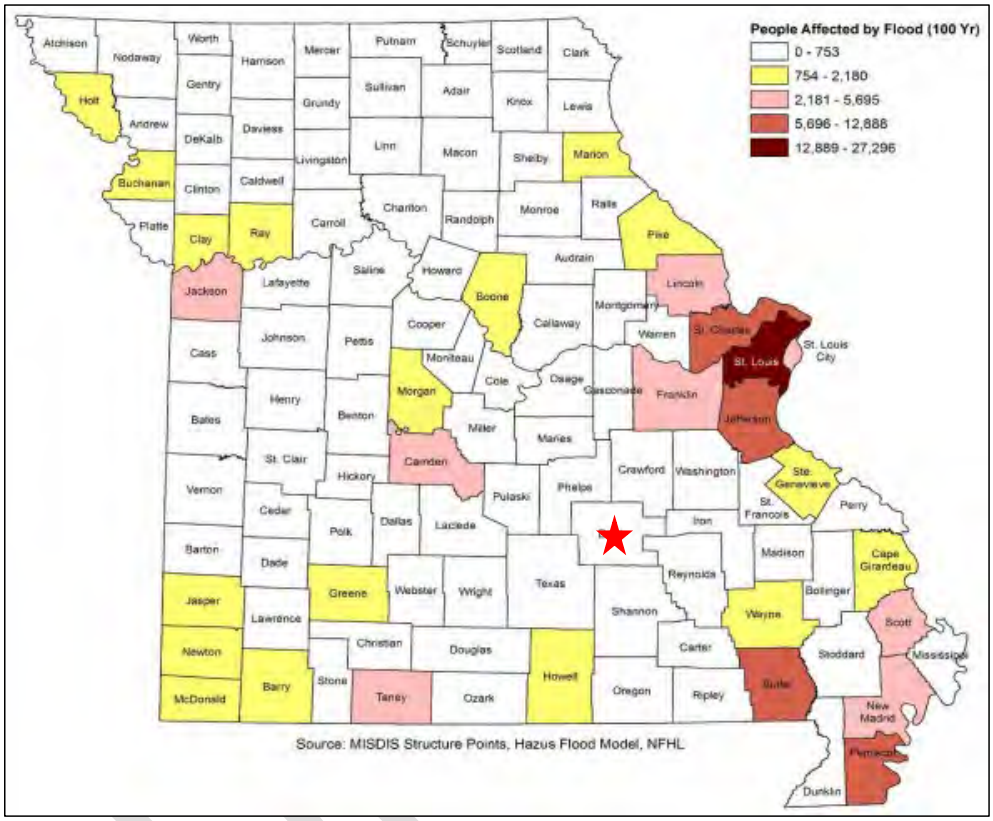
Lastly, the State determined the estimated number of displaced households and need for shelters within Dent County in the event of a 100 year flood. **Table 3.51** and **Figure 3.41** illustrate this information.

Table 3.51. Estimated Displaced People and Shelter Needs for Dent County

County	Displaced People	Displaced Population Requiring Shelter
Dent	557	121

Source: 2018 Missouri State Hazard Mitigation Plan

Figure 3.41. Hazus Countywide Base-Flood Scenarios: Displaced People



*Source: 2018 Missouri State Hazard Mitigation Plan, *Red star indicates Dent County*

Potential Losses to Existing Development

Every jurisdiction in the county contains a portion of the 100 Year Floodplain. According to the HAZUS model, Dent County has a building loss ratio of 1.21 percent for countywide base-flood scenarios. However, the unprecedented flooding in 2013 suggests that future flood events could cause significant disruption in the county. The August 2013 flash flood caused significant damages to property ($1,000,000). The statewide average building loss ratio is 1.40 which makes Dent County's ratio in the low range. With the annual average probability for flooding and for flash floods at 100 percent, Dent County's existing development is vulnerable to flood. Especially development located in low-lying areas, near rivers or streams, or where drainage systems are not adequate are prone to flooding.

Impact of Future Development

Impact of future development is correlated to floodplain management and regulations set forth by the

county and jurisdictions. Future development within low-lying areas near rivers and streams, or where interior drainage systems are not adequate to provide drainage during heavy rainfall events should be avoided. Additionally, future development would also increase impervious surface causing additional water run-off and drainage problems during heavy rainfall events.

Hazard Summary by Jurisdiction

Vulnerability to flooding varies slightly across the planning area. The jurisdictions most vulnerable to flooding include the city of Salem and the unincorporated communities of Sligo and Montauk. Since 2001 there have been 69 incidents of flooding or flash flooding in Dent County; 20 incidents in Sligo; and 13 incidents in and around Salem (**Table 3.44**). In 2017, one death was attributed to flooding near a low water crossing at County Road 2430. The county has no repetitive loss or severe repetitive loss properties.

Due to the rural nature of Dent County and topography that includes a large number of rivers and tributaries, the county has a significant number of low water crossings and gravel roads that are vulnerable to flooding and flood damage. Portions of the City of Salem reside in a SFHA. Although according to the jurisdictional questionnaires, school districts do not have assets located within an identified Special Flood Hazard Area.

The Dent County Commission reported landslides/debris flows that occur on a regular basis on Dent County Roads in District 1 (2470, 2460, 4210, 5110, and 5130) and District 2 (2070, 3180, 3030, 3050, 5260, and 5300). These events regularly occur after heavy rainfall/flooding and can completely block travel on roadways.

Problem Statement

The city of Salem has adopted a Floodplain Management Ordinance that regulates construction in the floodplain. Local governments should make a strong effort to further improve emergency warning systems to ensure that future deaths and injuries do not occur. Local governments should consider making improvements to roads and low water crossings that consistently flood by placing them on a hazard mitigation projects list, and actively seek funding to successful complete the projects.

3.4.6 Land Subsidence/Sinkholes

Some specific sources for this hazard are:

- 2018 Missouri State Hazard Mitigation Plan, Chapter 3, Section 3.3.5, Page 3.218 https://sema.dps.mo.gov/docs/programs/LRMF/mitigation/MO_Hazard_Mitigation_Plan2018.pdf
- http://www.dnr.mo.gov/geology/geosrv/envgeo/sinkholes.htm
- http://www.businessinsider.com/where-youll-be-swallowed-by-a-sinkhole-2013-3
- http://water.usgs.gov/edu/sinkholes.html
- http://pubs.usgs.gov/fs/2007/3060/
- Missouri hazard Mitigation Viewer
  http://bit.ly/MoHazardMitigationPlanViewer2018 - Website
  http://drive.google.com/file/d/1bPkc0jgF9ofwQLnTL9NOu-oPFWi9hkst/view - User Guide
    - Total number of sinkholes by County
    - Vulnerability to sinkholes by County
    - Total number of mines by County
    - Vulnerability to mines by County
    - Total value of structures impacted by sinkholes by County
    - Total population impacted by sinkholes by County

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).

Land subsidence occurs slowly and continuously over time, as a general rule. On occasion, it can occur abruptly, as in the sudden formation of sinkholes. Sinkhole formation can be aggravated by flooding.

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.

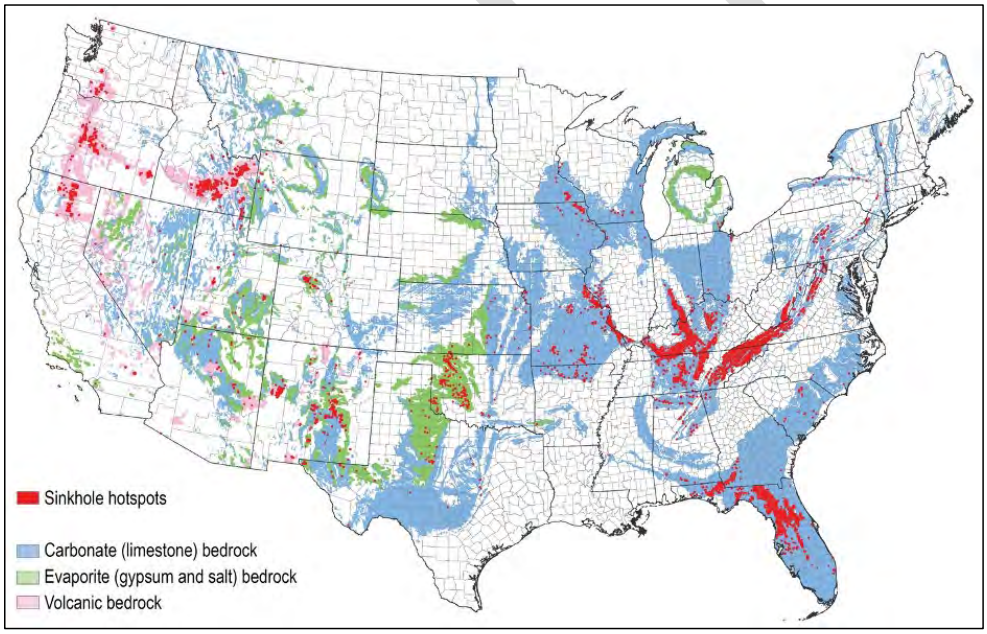
According to the U.S. Geological Survey (USGS), the most damage from sinkholes tends to occur in Florida, Texas, Alabama, Missouri, Kentucky, Tennessee, and Pennsylvania. Fifty-nine percent of Missouri is underlain by thick, carbonate rock that makes Missouri vulnerable to sinkholes. Sinkholes occur 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 in shape like shallow bowls or saucers whereas other have vertical walls. Some hold water and form natural ponds.

Geographic Location

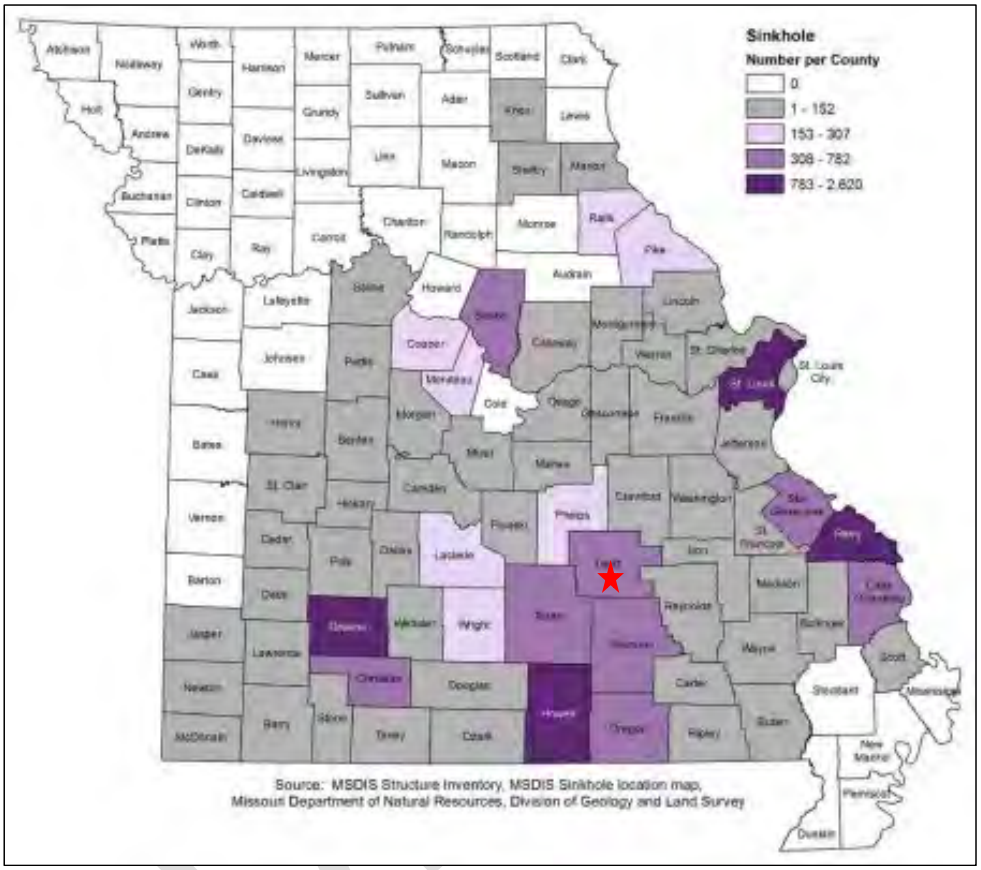
Figure 3.42 depicts karst topography across the United States. Missouri's karst topography is comprised of carbonate rocks such as limestone, dolomite, and marble. Variability in areas prone to sinkholes does not differ greatly across the county. According to the 2018 Missouri State Hazard Mitigation Plan there are 432 sinkholes that have been recorded within Dent County (**Figure 3.43**). In addition, the Plan states that there are 156 mines in Dent County - as shown in **Figure 3.44**. According to the Missouri Department of Natural Resources, Dent County primarily produces refractory clay but has deposits of barite with lead, sedimentary limonite and hematite. Activities such as mining or drilling are known to be responsible for the formation of sinkholes.

Figure 3.42. Karst Map of the Conterminous United States - 2020



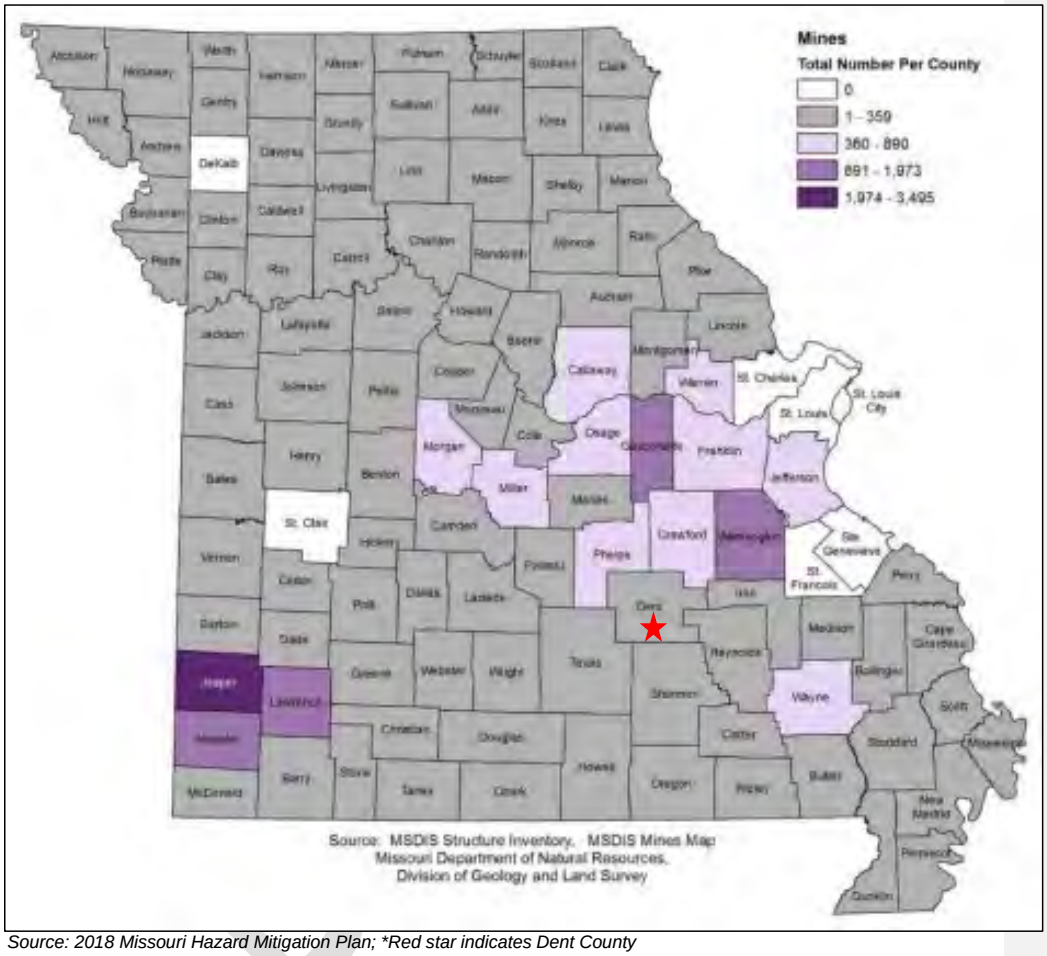
Source: https://www.usgs.gov/media/images/karst-map-conterminous-united-states-2020

Figure 3.43. Sinkholes Counts per County



*Source: 2018 Missouri Hazard Mitigation Plan; *Red star indicates Dent County*

Figure 3.44. Mines Counts Per County



*Source: 2018 Missouri Hazard Mitigation Plan; *Red star indicates Dent County*

Severity/Magnitude/Extent

Unlike earthquakes or other geologic hazards, there currently is no scale for measuring or determining the severity of sinkholes. However, geological and mining parameters can affect the magnitude and extent of sinkhole subsidence. As previously noted, natural sinkholes develop in areas where the rock below the surface is limestone, carbonate rock, salt beds or any type of rock that can naturally be dissolved by groundwater circulating through it. Artificial sinkholes form due to groundwater pumping, water main and sewer collapses and mine collapses.[32]

[32] 2018 Missouri Hazard Mitigation Plan

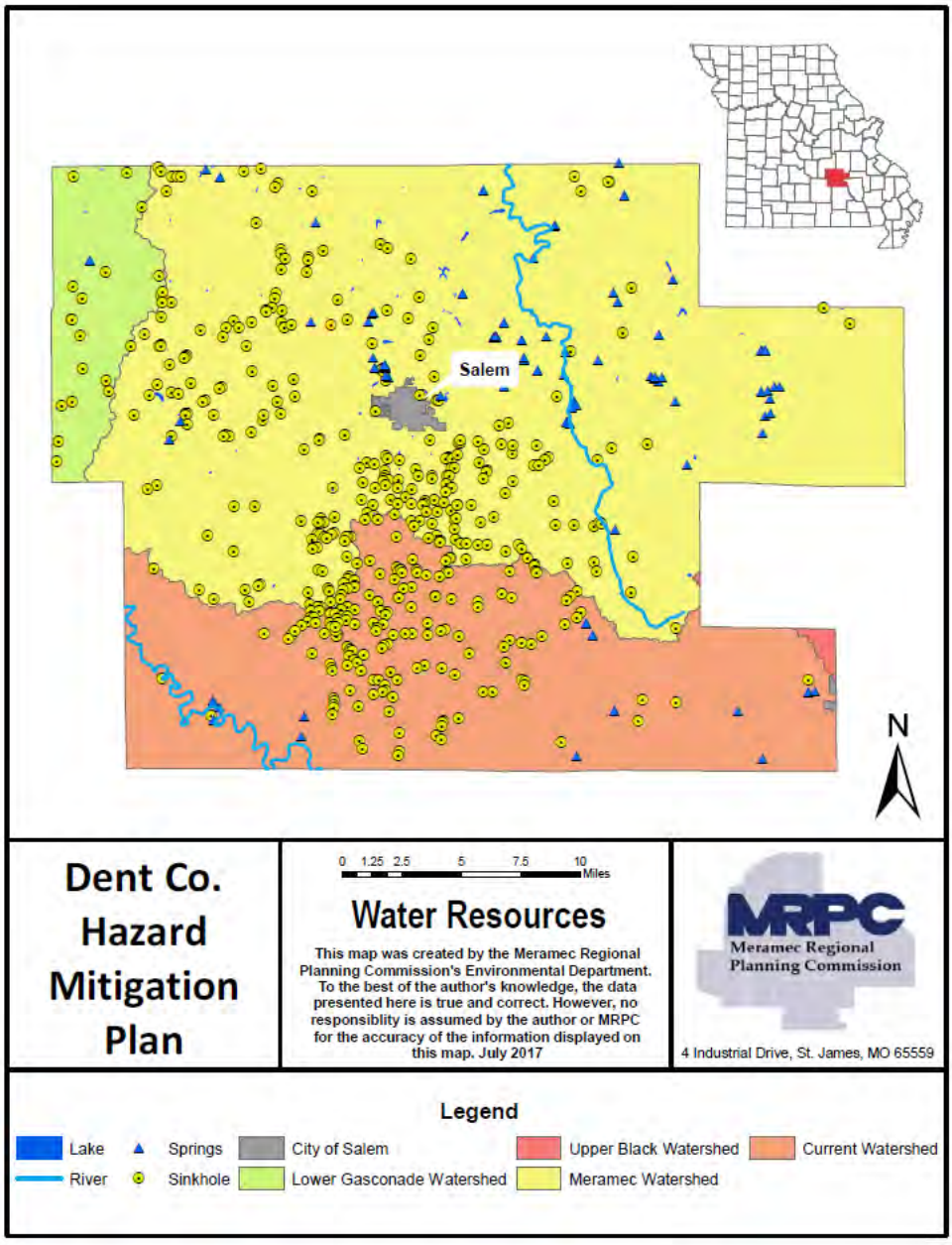
Sinkholes vary in size and location, and these variances will determine the impact of the hazard. A sinkhole could result in the loss of a personal vehicle, a building collapse, or damage to infrastructure such as roads, water, or sewer lines. Groundwater contamination is also possible from a sinkhole. 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 mentions 18 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 rarely had major impacts on development nor have they caused serious damage.

Previous Occurrences

Although there are numerous sinkholes and sinkhole areas in Dent County, there is no recorded incident of death due to sinkholes in the County even though incidents have occurred in other counties in southern Missouri. Based on the map of sinkholes in Dent County, recorded sinkholes can be found within the City of Salem, with the majority rural in nature residing within unincorporated parts of the county.

Figure 3.45. Dent County Watershed/Water Resources



Probability of Future Occurrence

Due to the lack of data for previous sinkhole events in Dent County, a probability could not be calculated.

Vulnerability

Vulnerability Overview

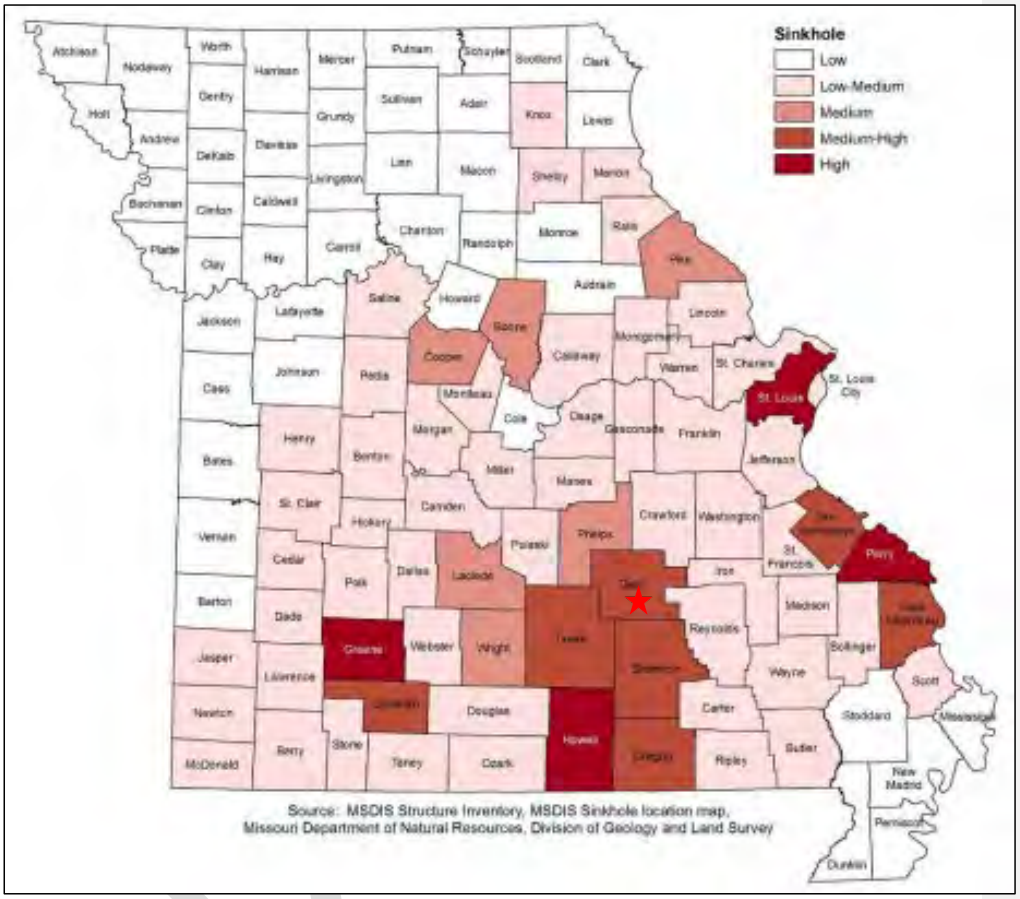
Unfortunately, no statistics are available for the number of subsurface locations that may potentially collapse in the future, forming a sinkhole. According to the state plan, if a county has 401-800 sinkholes, the risk is considered 4 – medium-high. For mines, the state plan calculates that Dent County's risk is rated as 2 – low-medium. See **Table 3.52**. **Figure 3.46** and **Figure 3.47** further illustrate the sinkhole and mining rating values respectively.

Table 3.52. Sinkhole/Mine Rating Values for Dent County

Factor	1 (Low)	2 (Low-medium)	3(Medium)	4 (Medium-high)	5 (High)
Sinkholes per county	0	1-200	201-400	401-800	801+
Mines per county	0-100	101-250	251-500	501-750	751+

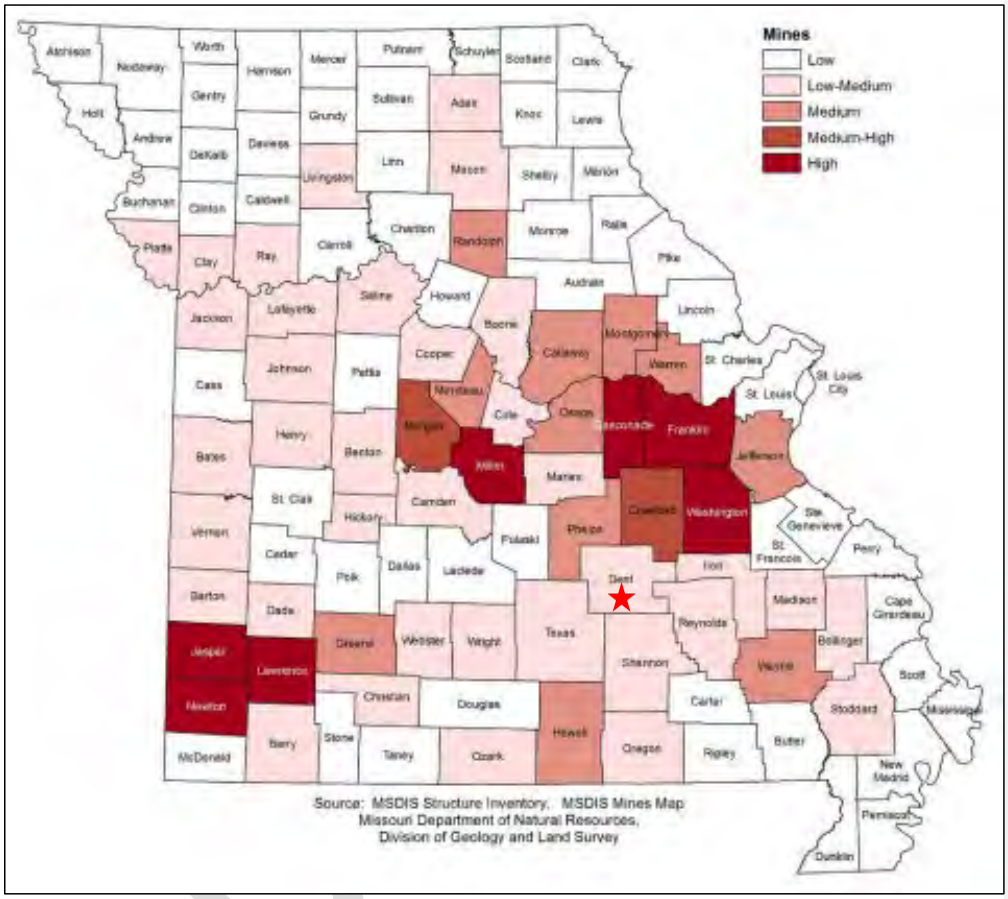
Source: 2018 Missouri Hazard Mitigation Plan, Yellow highlight shows values for Dent County

Figure 3.46. Sinkhole Rating Value by County



*Source: 2018 Missouri Hazard Mitigation Plan, *Red star indicates Dent County*

Figure 3.47. Mine Rating Value By County



*Source: 2018 Missouri Hazard Mitigation Plan, *Red star indicates Dent County*

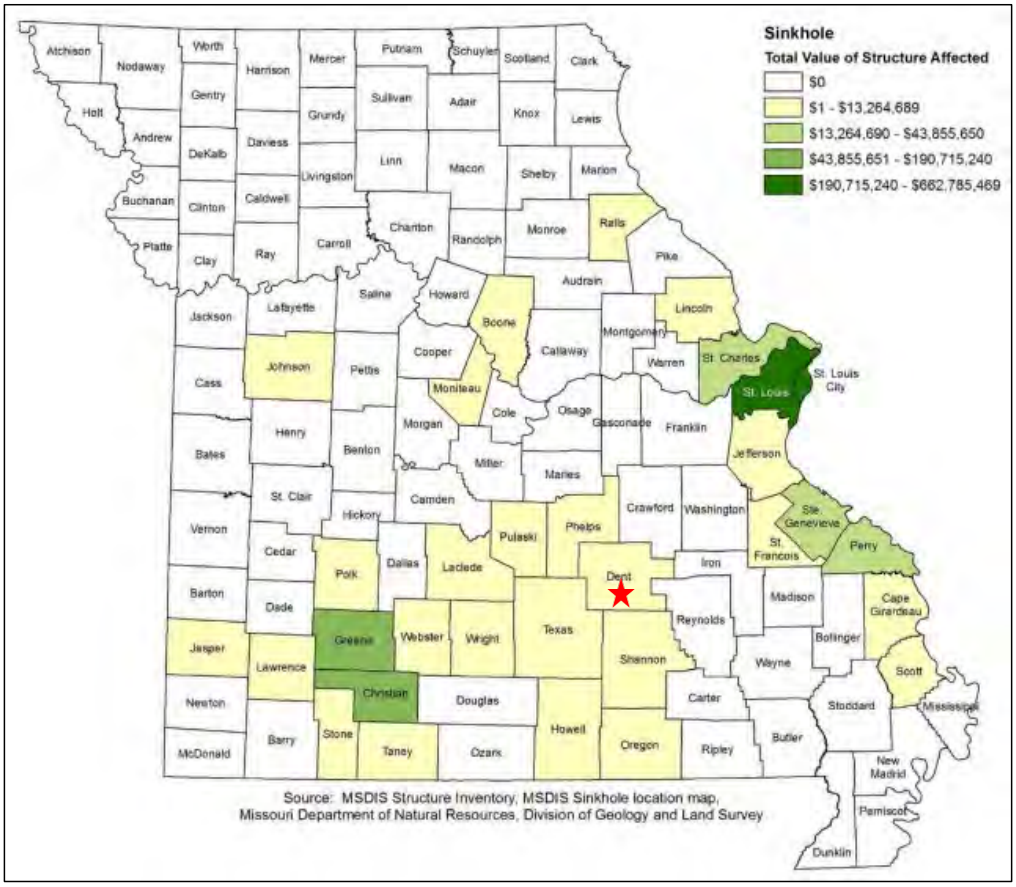
Potential Losses to Existing Development

The most likely type of damage to occur in conjunction with a sinkhole collapse is property damage related to foundation disturbance. Signs include cracks in interior and exterior walls; doors and windows that no longer sit square or open and close properly; depressions forming in the yard; cracks in the street, sidewalk, foundation or driveway; and turbidity in local well water. All of these can be early indicators that a sinkhole is forming in the vicinity[33]. In the event of a sudden collapse, an open sinkhole can form in a matter of minutes and swallow lawns, automobiles, and homes. This has occurred in some parts of Missouri, particularly in the southwest part of the state, but there have been no dramatic incidents like this in Dent County.

[33] http://sinkhole.org/commonsigns.php

The 2018 Missouri Hazard Mitigation Plan devised a method of estimating potential losses using GIS data. **Figure 3.48** shows the ranking of structures that could potentially be impacted by sinkholes by county. This map shows that Dent County has $1 -13,264,689 total value of structures affected.

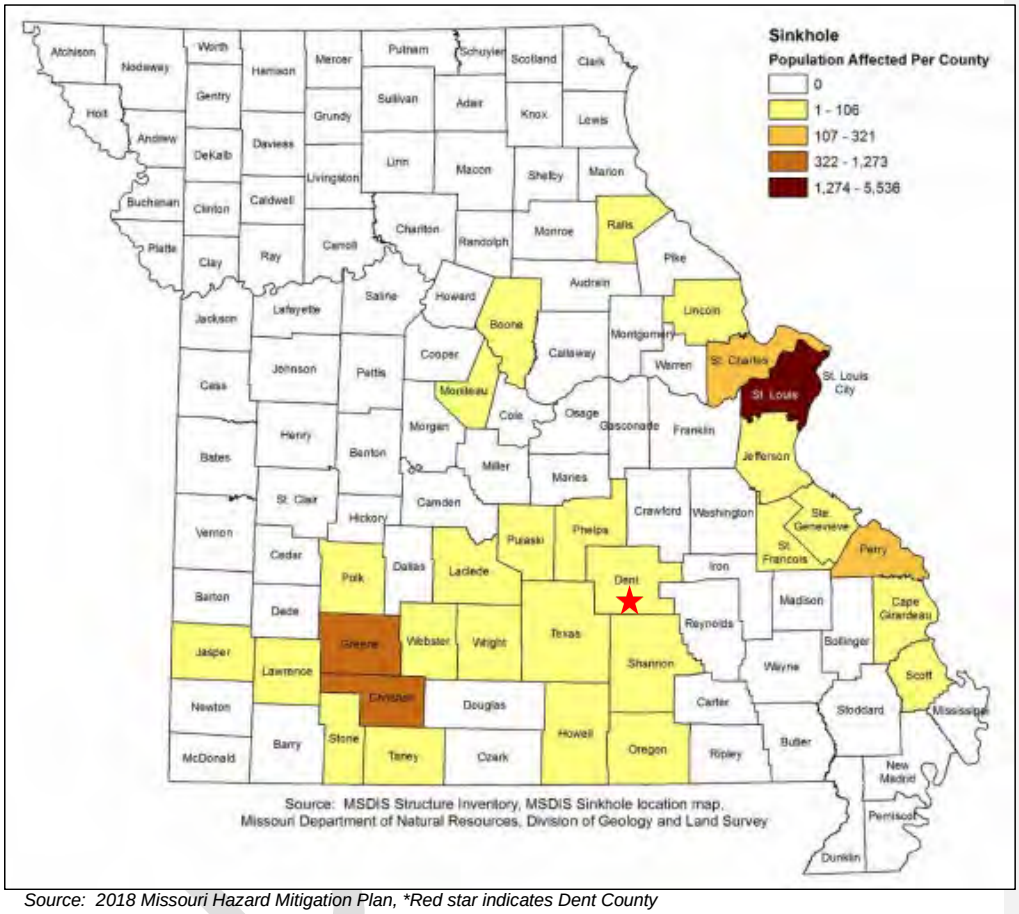
Figure 3.48. Ranking of Structures Potentially Impacted by Sinkholes by County



*Source: 2018 Missouri Hazard Mitigation Plan, *Red star indicates Dent County*

Figure 3.49 shows the population potentially impacted by sinkholes and again, Dent County shows that one to 106 people with be affected by sinkholes.

Figure 3.49. Ranking of Population Potentially Impacted by Sinkholes by County



*Source: 2018 Missouri Hazard Mitigation Plan, *Red star indicates Dent County*

Impact of Future Development

Future development over or near abandoned mines and in locations at risk of sinkhole formation will increase the hazard vulnerability. Information regarding regulations limiting construction near sinkholes is very limited. According to the state plan, Dent County's risk in regards to these hazards is moderate.

Hazard Summary by Jurisdiction

According to the state plan, Dent County's sinkhole rating is medium high while the county's mine rating is low medium. Based on the location of known sinkholes, the city of Salem and school districts have less vulnerability than the unincorporated areas of the county. These jurisdictions, both cities and school districts, are located in areas of the county where the concentration of sinkholes is much lower.

Problem Statement

Sinkholes and sinkhole/mining areas are well documented by both the US Geological Survey and the Missouri Department of Natural Resources Geologic Resources Section. The risk of sinkhole collapse can be lessened by avoiding the construction of structures in these areas and avoiding those activities that significantly alter the local hydrology, such as drilling and mining. In addition, communities should avoid leaking water and sewer lines through appropriate maintenance and monitoring. Local residents should be educated on the risks associated with sinkholes and mines and advised to avoid placing themselves and their property in danger by building in sinkhole/mining areas. Communities with building codes should include prohibitions on building in known sinkhole/mining areas.

3.4.7 Severe Thunderstorms Including High Winds, Hail, and Lightning

Some Specific Sources for this hazard are:

- 2018 Missouri State Hazard Mitigation Plan, Chapter 3, Section 3.3.8, Page 3.280 https://sema.dps.mo.gov/docs/programs/LRMF/mitigation/MO_Hazard_Mitigation_Plan2018.pdf
- FEMA 320, Taking Shelter from the Storm, 3rd edition, http://www.weather.gov/media/bis/FEMA_SafeRoom.pdf
- Lightning Map, National Weather Service, https://www.vaisala.com/sites/default/files/documents/WEA-MET-Annual-Lightning-Report-2020-B212260EN-A.pdf
- Death and injury statistics from lightning strikes, National Weather Service.
- Wind Zones in the U.S. map, FEMA, https://www.fema.gov/pdf/library/ism2_s1.pdf;
- Annual Windstorm Probability (65+knots) map U.S. 1980-1994, NSSL, http://www.nssl.noaa.gov/users/brooks/public_html/bigwind.gif
- Hailstorm intensity scale, The Tornado and Storm Research Organization (TORRO), https://www.torro.org.uk/research/hail/hscale;
- NCEI data;
- USDA Risk Management Agency, Insurance Claims, https://www.rma.usda.gov/Information-Tools/Summary-of-Business/Cause-of-Loss;
- National Severe Storms Laboratory – hail map, http://www.nssl.noaa.gov/users/brooks/public_html/bighail.gif
- Missouri Hazard Mitigation Viewer
  http://bit.ly/MoHazardMitigationPlanViewer2018 - Website
  http://drive.google.com/file/d/1bPkc0jgF9ofwQLnTL9N0u-oPFWi9hkst/view - User Guide
  - Average annual high wind events by County
  - Average annual hail events by County
  - Average annual lightning events by County
  - Vulnerability to severe thunderstorm event by County
  - Annualized property loss for high wind events by County
  - Annualized property loss for lightning events by County
  - Annualized property loss ratio for high wind events by County
  - Annualized property loss ratio for hail events by County
  - Annualized property loss ratio for lightning events by County

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 (**Section 3.4.5**) and tornadoes (**Section 3.4.9**)

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 fall 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.

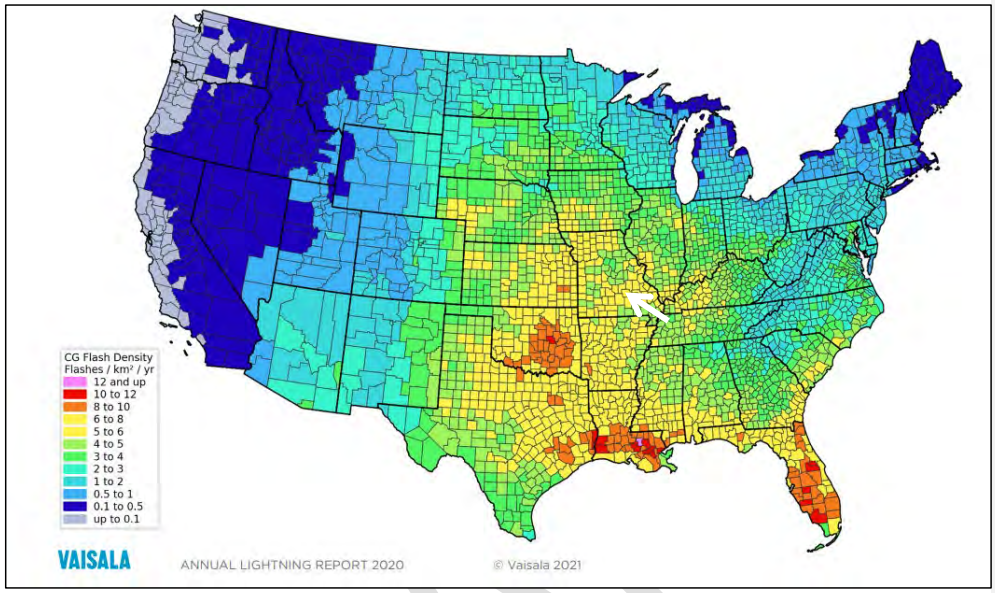
At the time when the updraft can no longer support the hailstone, it will fall down to the earth. For example, a ¼" diameter or pea sized hail requires updrafts of 24 miles per hour, while a 2 ¾" diameter or baseball sized hail requires an updraft of 81 miles per hour. According to the NOAA, the largest 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, and lightning events are an area-wide hazard that can take place anywhere across the United States. Furthermore, these events do not vary greatly across the planning area; they are more frequently reported in urbanized areas. Additionally, densely developed urban areas are more likely to experience damaging events.

Figure 3.50 depicts the location and frequency of lightning in Missouri. Additionally, the map indicates that the flash density of Dent County ranges between 12 and 20 flashes per square kilometer per year.

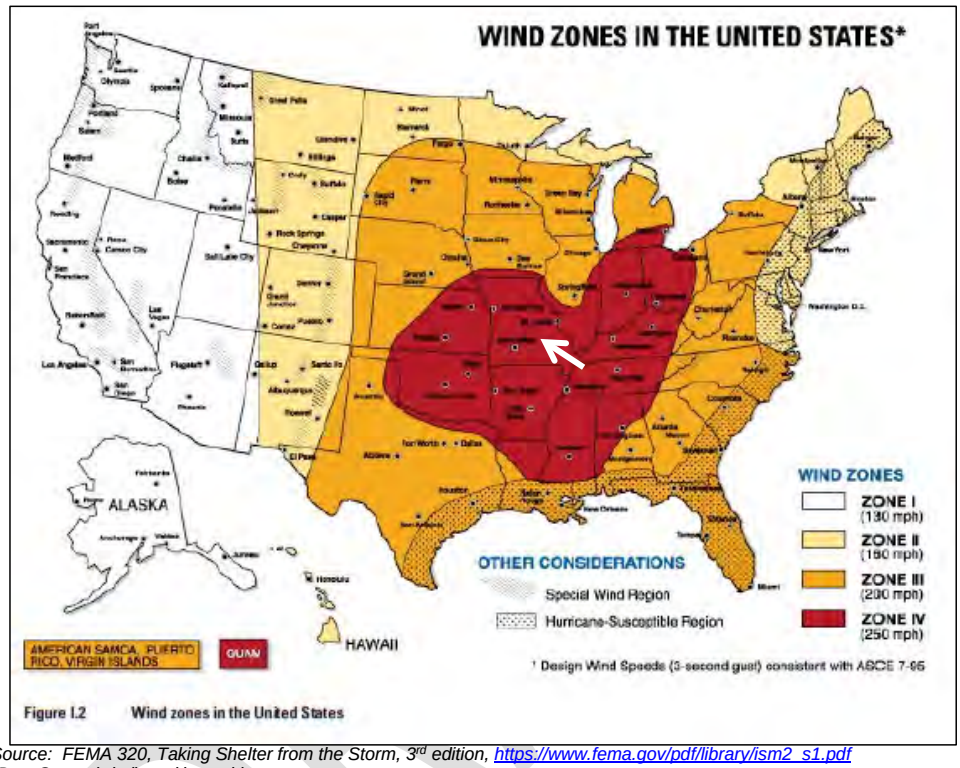
Figure 3.50. Location and Frequency of Lightning in Missouri



Source: National Weather Service, https://www.vaisala.com/sites/default/files/documents/WEA-MET-Annual-Lightning-Report-2020-B212260EN-A.pdf * Dent County is indicated by a white arrow.

There are four wind zones that are characterized across the United States. These zones range from Zone I to Zone IV. All of Missouri as well as most of the Midwest fall within Zone IV. Within Zone IV, winds can reach up to 250 mph (**Figure 3.51**).

Figure 3.51. Wind Zones in the United States



Source: FEMA 320, Taking Shelter from the Storm, 3rd edition, https://www.fema.gov/pdf/library/ism2_s1.pdf
**Dent County is indicated by a white arrow.*

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.

Based on information provided by the Tornado and Storm Research Organization (TORRO), **Table 3.53** below describes typical damage impacts of the various sizes of hail.

Table 3.53. 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, 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. https://www.torro.org.uk/research/hail/hscale

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.

Between 2001 and 2020, there were zero recorded crop insurance claims for Thunderstorms, lightning, high wind, and hail in Dent County.

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

Due to the lack of available parameters, heavy rain is utilized in the place of thunderstorms in **Table 3.54**. Moreover, thunderstorm wind and strong wind was included with high winds. NCEI data was obtained for lightning, and hail events between 2001 and 2020 as well (**Table 3.55**, **Table 3.56,** and **Table 3.57).** However, 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 3.54. NCEI Dent County Heavy Rain Events Summary, 2001 to 2020

Year	# of Events	# of Deaths	# of Injuries	Property Damages	Max Rainfall (Inch)
2009	1	0	0	0	4.20
2013	1	0	0	0	4.00
2015	2	0	0	0	5.04
2016	1	0	0	0	4.68
2017	1	0	0	0	1.00
2018	6	0	0	0	3.57
2019	5	0	0	0	5.10
Total	**17**	**0**	**0**	**0**	**-**

Source: NCEI, data accessed [10-06/2021]

Table 3.55. NCEI Dent County High Wind Events Summary, 2001 to 2020 (Thunderstorm)

Year	# of Events	# of Deaths	# of Injuries	Property Damages	Max Estimated Gust (kts.)
2001	1	0	0	-	-
2002	3	0	0	-	52
2003	3	0	0	-	65
2004	1	0	0	-	50
2005	4	0	0	7K	55
2006	9	0	0	17K	60
2008	2	0	0	15K	58
2009	2	0	0	1.05M	70

2010	1	0	0	-	52
2011	7	0	0	10K	52
2012	5	0	0	3.5K	52
2013	1	0	0	5K	52
2014	4	0	0	-	52
2017	1	0	0	25K	70
2018	6	0	0	24K	56
2019	5	0	0	26K	52
Total	**55**	**0**	**0**	**1.183M**	**-**

Source: NCEI, data accessed [10/06/2021]

Table 3.56. NCEI Dent County Lightning Events Summary, 2001 to 2020

Year	# of Events	# of Deaths	# of Injuries	Property Damages	Crop Damage
-	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**

Source: NCEI, data accessed [10/06/2021]

Table 3.57. NCEI Dent County Hail Events Summary, 2001 to 2020

Year	# of Events	# of Deaths	# of Injuries	Property Damages	Max Hail Size (inch)
2001	1	0	0	0	1.00
2002	4	0	0	10.00K	1.75
2003	4	0	0	0	2.75
2004	1	0	0	0	1.75
2005	1	0	0	0	1.00
2006	10	0	0	0	1.75
2007	3	0	0	0	2.00
2008	11	0	0	0	2.50
2009	6	0	0	0	1.75
2011	5	0	0	10.00K	1.75
2012	1	0	0	0	0.75
2014	1	0	0	0	1.50
2015	1	0	0	0	1.00
2016	7	0	0	0	1.25
2017	6	0	0	0	2.00
2018	5	0	0	0	1.00
2019	1	0	0	0	1.00
2020	3	0	0	0	1.25
Total	71	**0**	**0**	**20.00K**	**-**

Source: NCEI, data accessed [10/06/2021]

Agriculture is an important piece of the economy for Dent County. The tables below (**Table 3.58**) summarize past crop damages as indicated by crop insurance claims. The tables illustrate the magnitude of the impact on the planning area's agricultural economy. It should be noted that the USDA Risk Management Agency data does not align directly with the breakdown of hazards listed here. The claims database only listed "Excessive Moisture/Precipitation/ Rain" and "Wind/Excessive Wind" as two causes of loss categories that align with this hazard. Between 2001 and 2020 a total of 3 insurance claims were paid out for damages due to excessive moisture, precipitation. The total claims paid for this cause were $7,730.

For the time period 2001-2020, there were no crop insurance claims made for wind and excessive wind damage.

Table 3.58. Crop Insurance Claims Paid In Dent County from Excessive Moisture/ Precipitation/Rain 2001-2020

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2019	All Other Crops	Excessive Moisture/Precipitation/Rain	$4,756.00
2020	All Other Crops	Excessive Moisture/Precipitation/Rain	$2,974.00
Total	3	-	$7,730.00

Source: USDA Risk Management Agency, Insurance Claims, https://www.rma.usda.gov/Information-Tools/Summary-of-Business/Cause-of-Loss

Probability of Future Occurrence

From the data obtained from the NCEI [34], annual average percent probabilities were calculated for heavy rainfall, high winds, lightning, and hail. Heavy rainfall has a 85 percent annual average percent probability of occurrence (17 events/20 years x 100) (**Table 3.59**). Heavy rainfall events can be found in **Table 3.54**.

The annual average percent probability for high winds within the county is 100 percent (55 event/20 years * 100) with an average 2.75 events per year (**Table 3.60).** High wind events can be found in **Table 3.55.**

Lightning events have a 0 percent annual average percent probability of occurrence (0 events/20 years x 100) (**Table 3.61**) Lightning events can be found in **Table 3.56**.

Lastly, the annual average percent probability of hail occurrence is 100 percent (71 events/20 years x 100) with an average of 3.55 events per year (**Table 3.62**). Hail events can be found in **Table 3.57**.

Table 3.59. Annual Average % Probability of Heavy Rain in Dent County

Location	Annual Avg. % P
Dent County	85%

*P = probability; see page 3.24 for definition.

[34] http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=29%2CMISSOURI

Table 3.60. Annual Average % Probability of High Winds in Dent County

Location	Annual Avg. % P	Avg. # of Events
Dent County	100%	2.75

*P = probability; see page 3.24 for definition.

Table 3.61. Annual Average % Probability of Lightning in Dent County

Location	Annual Avg. % P
Dent County	0%

*P = probability; see page 3.24 for definition.

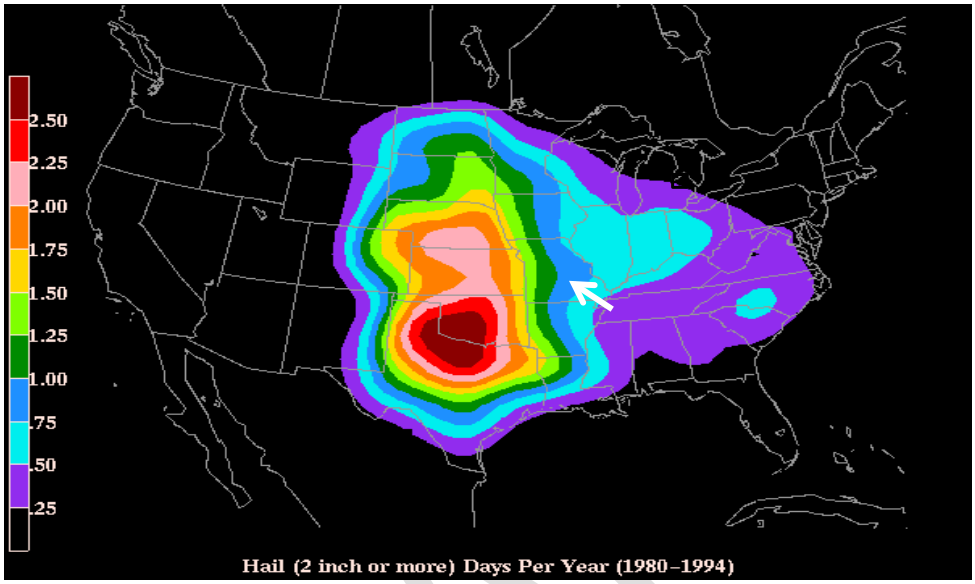
Table 3.62. Annual Average % Probability of Hail in Dent County

Location	Annual Avg. % P	Avg. # of Events
Dent County	100%	3.55

*P = probability; see page 3.24 for definition.

Figure 3.52 depicts a map based on hailstorm data from 1980-1994. It shows the probability of hailstorm occurrence (2" diameter or larger) based on number of days per year. The location of Dent County is identified with a white arrow.

Figure 3.52. Annual Hailstorm Probability (2" diameter or larger), 1980 - 1994



Source: NSSL, http://www.nssl.noaa.gov/users/brooks/public_html/bighail.gif
** White arrow indicates Dent County*

Vulnerability

Vulnerability Overview

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. [35]

Data was obtained from the 2018 Missouri State Hazard Mitigation Plan for vulnerability overview and analysis. Since severe thunderstorms occur frequently throughout Missouri, the method used to determine vulnerability to severe thunderstorms was statistical analysis of data from several sources including: National Centers for Environmental Information (NCEI) storm events data (1996 to December 31, 2016 – which will differ slightly from data collected for the Dent County plan which is 1999-2019), HAZUS Building Exposure Value data, housing density and mobile home data from the U.S. Census (2015 ACS), and the calculated Social Vulnerability Index for Missouri Counties from the Hazards and Vulnerability Research Institute in the Department of Geography at the University of South Carolina.[36]

From the data collected, six factors were considered in determining vulnerability to lightning as follows: housing density, building exposure, percentage of mobile homes, social vulnerability, likelihood of occurrence and average annual property loss. A rating value of one through five was assigned to each factor. Rating values are as follows:

1) Low
2) Low-medium
3) Medium
4) Medium-high
5) High

Table 3.63 illustrates the factors considered and ranges for the rating values assigned.

Once the ranges were determined and applied to all factors considered in the analysis for wind, hail and lightning, they were rated individually and factored together to determine an overall vulnerability rating for thunderstorms. **Table 3.64** provides the calculated ranges applied to determine overall vulnerability of Missouri counties to severe thunderstorms.

[35] http://www.vaisala.com/en/products/thunderstormandlightningdetectionsystems/Pages/NLDN.aspx
[36] 2018 Missouri Hazard Mitigation Plan

Table 3.63. Ranges for Severe Thunderstorm Vulnerability Factor Ratings

Factors Considered	Low (1)	Low Medium (2)	Medium (3)	Medium High (4)	High (5)
Common Factors					
Housing Density (# per sq. mile)	4.11-44.23	44.24-134.91	134.92-259.98	259.99-862.69	862.70-2836.23
Building Exposure ($)	$269,532-$3,224,641	$3,224,642-$8,792,829	$8,792,830-$22,249,768	$22,249,769-$46,880,213	$46,880,214-$138,887,850
Percent Mobile Homes	0.2-4.5%	4.6-8.8%	8.9-14%	14.1-21.2%	21.3-33.2%
Social Vulnerability	1	2	3	4	5
Wind					
Likelihood of Occurrence (# of events/ yrs. of data)	0.90 - 2.90	2.91 - 4.57	4.58 - 7.00	7.01 - 12.05	12.06 - 20.86
Average Annual Property Loss (annual property loss/ yrs of data)	$0.00 – $81,047.62	$81,047.63 – $200,428.57	$200,428.58 – $363,500.00	$363,500.01 – $837,242.86	$837,242.87 – $2,481,809.52
Hail					
Likelihood of Occurrence (# of events/ yrs. of data)	1.19 - 2.76	2.77 - 4.86	4.87 - 7.81	7.82 - 12.38	12.39 - 18.10
Average Annual Property Loss (annual property loss/ yrs. of data)	$0.00 - $41,547.62	$41,547.63 – $171,980.95	$171,980.96 – $467,857.14	$467,857.15 – $9,714,523.81	$9,714,523.82 – $40,594,285.71
Lightning					
Likelihood of Occurrence (# of events/ yrs. of data)	0-.05	.06-0.14	0.15-0.29	0.30-0.43	0.44-0.67
Average Annual Property Loss (annual property loss/ yrs. Of data)	$0-$476.19	$476.20-$1,904.76	$1,904.77-$7,476.19	$7,476.20-$13,142.86	$13,142.87-$57,000

Source: 2018 Missouri Hazard Mitigation Plan

Table 3.64. Ranges for Severe Thunderstorm Combined Vulnerability Rating

	Low (1)	Low Medium (2)	Medium (3)	Medium High(4)	High (5)
Severe Thunderstorm Combined Vulnerability	12-16	17-19	20-23	24-29	30-36

Source: 2018 Missouri Hazard Mitigation Plan

According to the Hazus data included in the 2018 state plan, Dent County has total building exposure to severe thunderstorms of $1,451,544,000. **Table 3.65** shows housing density, building exposure, SOVI and mobile home data for Dent County. The county's building exposure and housing density rating is medium-high, while the percent of mobile homes in the county is rated as medium-high at 20.1 percent of the housing stock. **Table 3.66**, also pulled from the state plan, provides data on the number of events and likelihood of occurrence and occurrence rating for high wind, hail and lightning.

Table 3.65. Dent County Housing Density, Building Exposure, SOVI and Mobile Home Data

Total Building Exposure (Hazus)	Building Exposure Rating	Housing Density	Housing Density Rating	SOVI Ranking	SOVI Ranking Rating	Percent Mobile Homes	Percent Mobile Homes Rating
$1,451,544,000	1	9.65	1	Medium-High	4	20.1	4

Source: 2018 Missouri Hazard Mitigation Plan

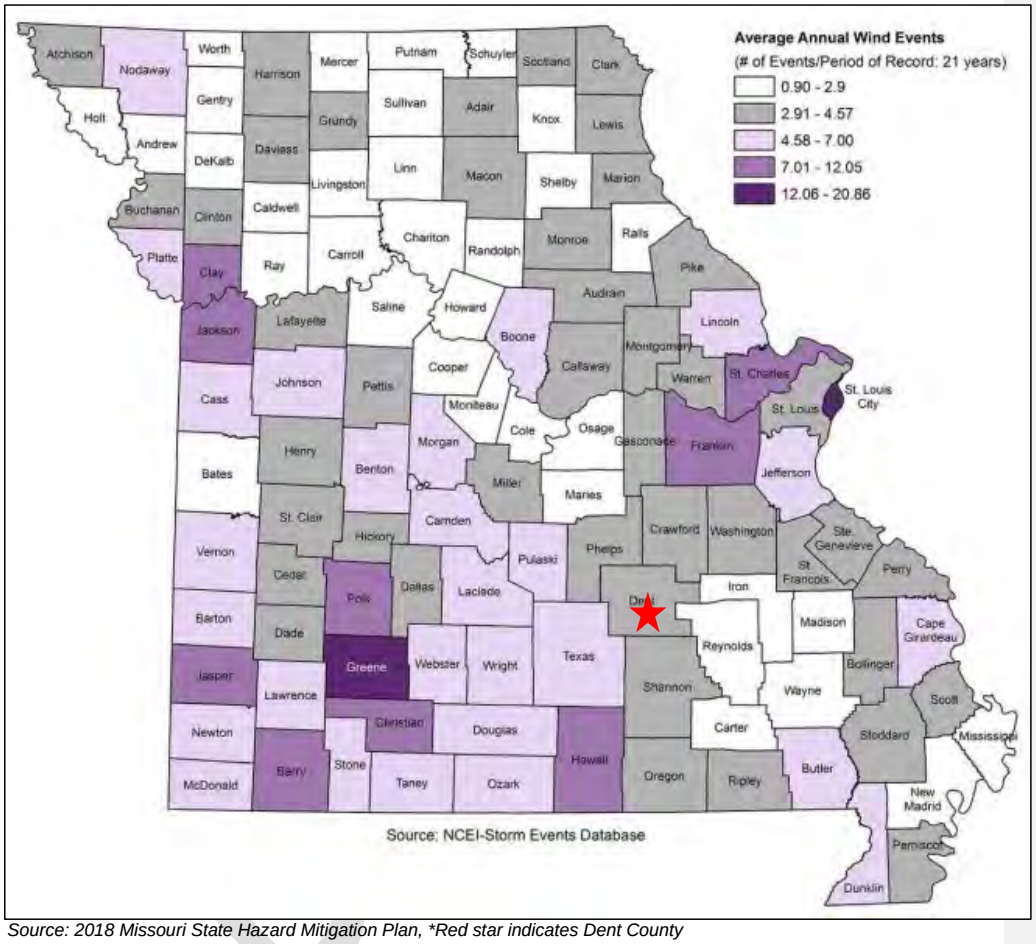
Table 3.66. Number of High Wind, Hail and Lightning Events, Likelihood of Occurrence and Associated Ratings for Dent County

High Wind			Hail			Lightning		
Total Number of Events	Likelihood of Occurrence	Likelihood of Occurrence Rating	Total Number of Events	Likelihood of Occurrence	Likelihood of Occurrence Rating	Total Number of Events	Likelihood of Occurrence	Likelihood of Occurrence Rating
63	3.000	2	78	3.714	2	0	0.000	1

Source: 2018 Missouri Hazard Mitigation Plan

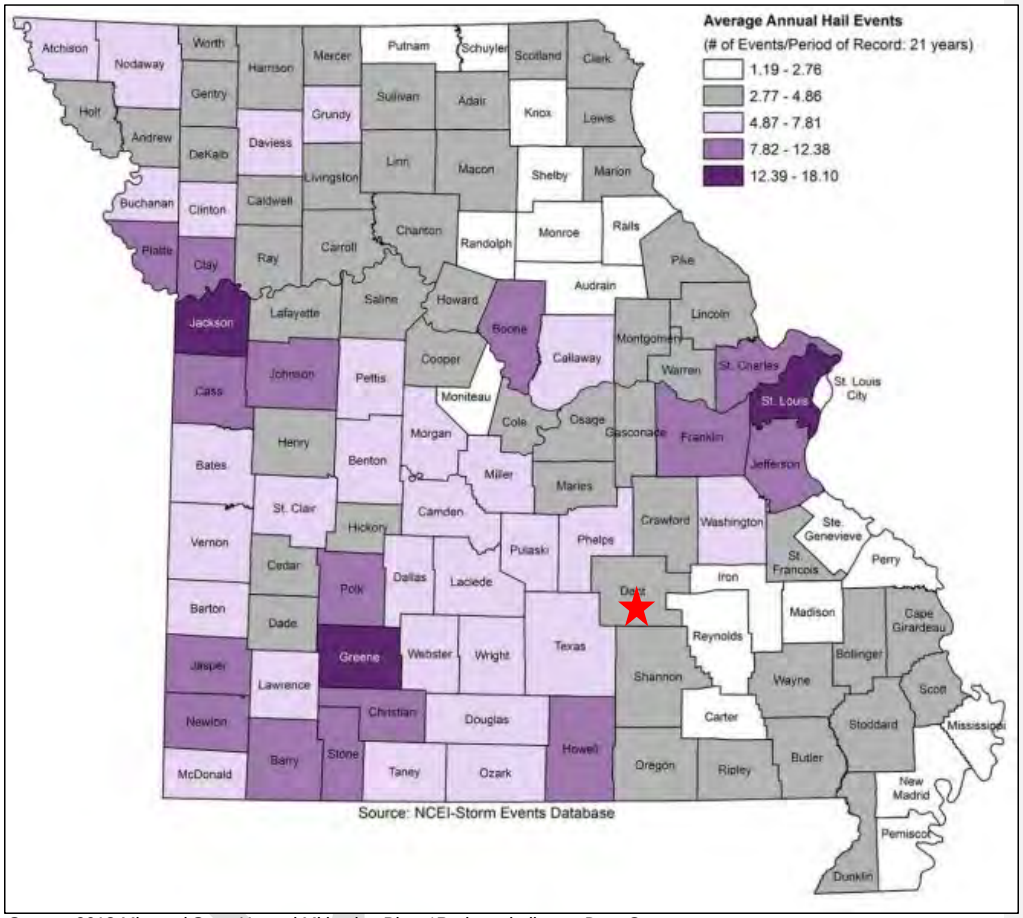
Figure 3.53 through **Figure 3.55** have been pulled from the 2018 Missouri Hazard Mitigation Plan and further depict the average annual likelihood of occurrence of high winds, hail, and lightning events in Missouri.

Figure 3.53. Average Annual High Wind Events (40 MPH and Higher)



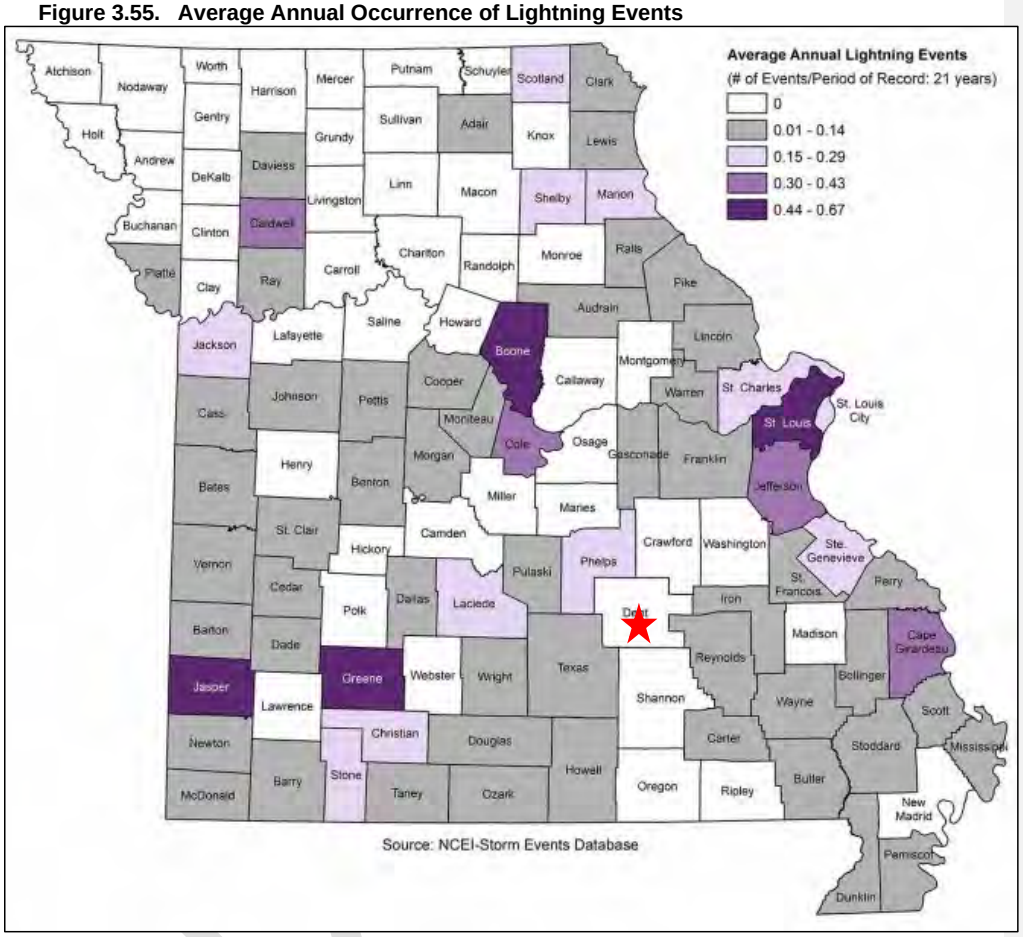
*Source: 2018 Missouri State Hazard Mitigation Plan, *Red star indicates Dent County*

Figure 3.54. Average Annual Occurrence of Damaging Hail Events



*Source: 2018 Missouri State Hazard Mitigation Plan, *Red star indicates Dent County*

Figure 3.55. Average Annual Occurrence of Lightning Events



*Source: 2018 Missouri State Hazard Mitigation Plan, *Red star indicates Dent County*

Table 3.67 provides additional data obtained from the National Centers for Environmental Information for property loss to complete the overall vulnerability analysis.

Table 3.67. Annualized Property Loss and Associated Ratings for Dent County

High Wind		Hail		Lightning	
Total Annualized Property Loss	Total Annualized Property Loss Rating	Total Annualized Property Loss	Total Annualized Property Loss Rating	Total Annualized Property Loss	Total Annualized Property Loss Rating
$58,167	1	$1,071	1	$0	1

Source: 2018 Missouri State Hazard Mitigation Plan

After ranges were applied to all factors in the analysis for wind, hail, and lightning, they were weighted equally and factored together to determine an overall vulnerability rating. Following, a combined vulnerability rating was calculated. The calculated ranges applied to determine overall vulnerability of Missouri counties to severe thunderstorms can be found in **Table 3.64**. **Table 3.68** provides the calculated vulnerability rating for the severe thunderstorm hazard. **Figure 3.56** that follows provides the mapped results of this analysis by county[37].

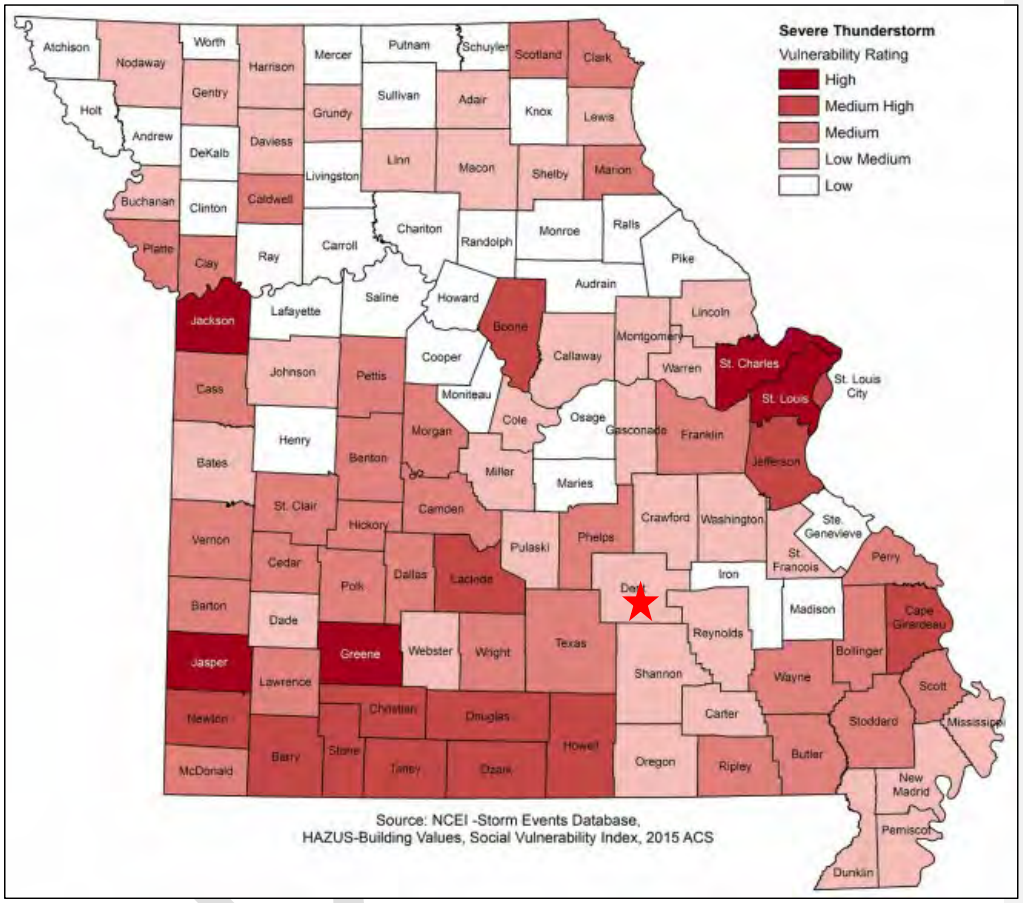
Table 3.68. Severe Thunderstorm Vulnerability Rating for Dent County

Total Sum of All Factor Ratings	Overall Vulnerability Rating for Thunderstorms	Overall Vulnerability Rating for Thunderstorms Description
18	2	Low-Medium

Source: 2018 Missouri State Hazard Mitigation Plan

[37] 2018 Missouri State Hazard Mitigation Plan

Figure 3.56. Vulnerability Summary for Severe Thunderstorms



*Source: 2018 Missouri State Hazard Mitigation Plan, *Red star indicates Dent County*

Potential Losses to Existing Development

According to the NCEI Dent County experienced approximately $1.202,000 in property damages from severe thunderstorms between 2001 and 2020. This is an average of $60,100 in losses due to this hazard per year. Most of the property damage caused by storms is covered by private insurance and data is not available. In addition, most damage from severe thunderstorms occurs to vehicles, roofs, siding, and windows. However, there is a variety of impacts from severe thunderstorms. Moreover, secondary effects from hazards, falling trees and debris, can cause destruction within the planning area.

Previous and Future Development

Population trends from 2010 to 2020 for Dent County indicate that the population in unincorporated areas has fallen by an estimated 4.42 percent. The city of Salem's population has decreased by a 4.56 percent. Overall, the county has decreased its population by 7.9 percent. It is difficult to determine future impacts, however, anticipated development in each jurisdiction will result in increased exposure. Likewise, increased development of residential structures will increase jurisdiction's vulnerability to damages from severe thunderstorms/ high winds/lightning/hail.

Hazard Summary by Jurisdiction

Although thunderstorms/high winds/lightning/hail events are area-wide, there are demographics indicating higher losses in one jurisdiction as compared to another. Jurisdictions with high percentages of housing built before 1939 are more prone to damages from severe thunderstorms. The city of Salem has a higher proportion of residences built before 1939 at 16.1 percent. However, unincorporated Dent County has a higher percentage of mobile homes and unsecured buildings at 26.3 percent, which are more prone to damages.

Problem Statement

The NCEI Storm Events Database notes over 143 thunderstorm and wind events in Dent County since 2001, with over $1,202,000.00 in property and crop damages reported. Early warnings are possibly the best hope for residents when severe weather strikes. Cities that do not already possess warning systems – whether that is storm sirens or automated email/text/phone call systems - should plan to invest in such a system. Additional public awareness also includes coverage by local media sources. Storm shelters are another important means of mitigating the effects of severe thunderstorms. A community-wide shelter program should be adopted for residents who may not have adequate shelter in their homes. Residents should also be encouraged to build their own storm shelters to prepare for emergencies. Local governments should encourage residents to purchase weather radios to ensure that everyone has sufficient access to information in times of severe weather.

3.4.8 Severe Winter Weather

Some specific sources for this hazard are:

- 2018 Missouri State Hazard Mitigation Plan, Chapter 3, Section 3.3.9, Page 3.321 https://sema.dps.mo.gov/docs/programs/LRMF/mitigation/MO_Hazard_Mitigation_Plan2018.pdf
- Wind chill chart, National Weather Service, http://www.nws.noaa.gov/om/winter/windchill.shtml;
- Average Number of House per year with Freezing Rain, American Meteorological Society. "Freezing Rain Events in the United States." http://ams.confex.com/ams/pdfpapers/71872.pdf;
- USDA Risk Management Agency, Insurance Claims, https://www.rma.usda.gov/Information-Tools/Summary-of-Business/Cause-of-Loss;
- Any local Road Department data on the cost of winter storm response efforts.
- National Centers for Environmental Information, Storm Events Database, http://www.ncdc.noaa.gov/stormevents/
- Missouri Hazard Mitigation Viewer
  http://bit.ly/MoHazardMitigationPlanViewer2018 - Website
  https://drive.google.com/file/d/1bPkc0jgF9ofwQLnTL9N0u-oPFWi9hkst/view - User Guide
  o Average annual severe winter weather events by County
  o Vulnerability to severe winter weather events by County
  o Annualized property loss for severe winter weather events by County
  o Annualized property loss for severe winter weather events by County

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.

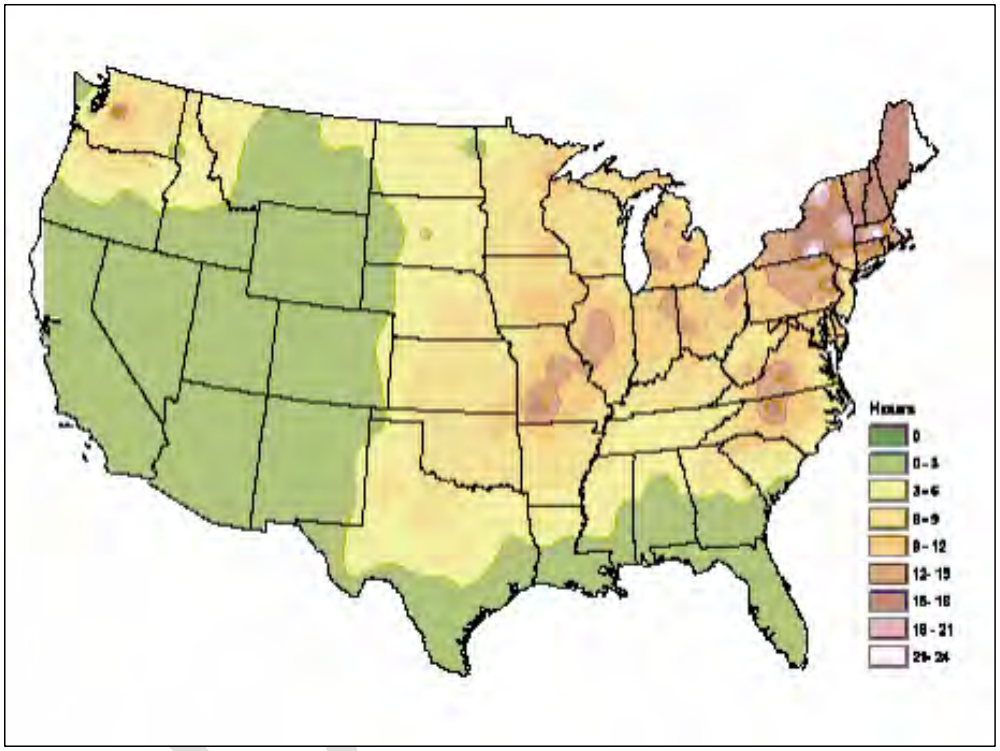
- **Blizzard**—Winds of 35 miles per hour or more with snow and blowing snow reducing visibility to less than ¼ mile for at least three hours.
- **Blowing Snow**—Wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground picked up by the wind.
- **Snow Squalls**—Brief, 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

Severe winter weather typically strikes Missouri more than once every year. Dent County receives winter weather events from heavy snows to freezing rain annually. Major snowstorms typically occur once each year, causing multiple school closings, as well as suspending business and government

activity. Dent County is vulnerable to heavy snow, ice, extreme cold temperatures and freezing rain. **Figure 3.57** illustrates statewide average number of hours per year with freezing rain. Dent County receives approximately 9 to 12 hours.

Figure 3.57. 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

Strength/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 storms can damage power 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 3.58** below shows the relationship of wind speed to apparent temperature and typical time periods for the onset of frostbite.

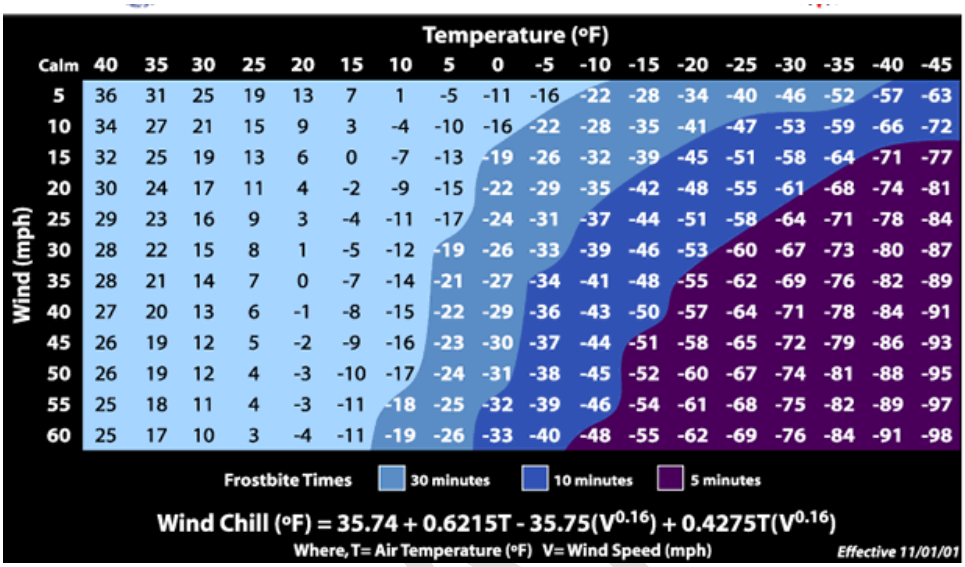
Winter storms, cold, frost, and freeze all can influence or negatively impact crop production. However, data obtained from the USDA's Risk Management Agency for insured crop losses indicates that there were no claims paid in Dent County between 2001 and 2020 for severe winter weather.

Table 3.69. Crop Insurance Claims Paid in Dent County from Winter Weather 2001-2020

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
-	-	-	-
Total	0	-	0

*Source: USDA Risk Management Agency, Insurance Claims, **https://www.rma.usda.gov/data/cause***

Figure 3.58. Wind Chill Chart



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

Previous Occurrences

Data was obtained from the NCEI for winter weather reported events and damages between 1999 and 2019 **(Table 3.70)**. This data includes variables such as blizzard, cold/wind chill, extreme cold/wind chill, heavy snow, ice storm, sleet, winter storm, and winter weather. Additionally, narratives for specific events are listed below.

Table 3.70. NCEI County A Winter Weather Events Summary, 2001 - 2020

Type of Event	Inclusive Dates	# of Injuries	Property Damages	Crop Damages
Extreme Cold/Wind	1/1/2001	0	0	0
Ice Storm	2/21/2001	0	0	0
Winter Storm	12/4/2002	0	0	0
Winter Storm	12/24/2002	0	0	0
Winter Storm	2/23/2003	0	0	0
Ice Storm	1/25/2004	0	0	0
Winter Storm	2/5/2004	0	0	0
Winter Storm	11/30/2006	0	0	0
Winter Storm	1/20/2007	0	0	0

Type of Event	Inclusive Dates	# of Injuries	Property Damages	Crop Damages
Ice Storm	12/10/2007	0	0	0
Ice Storm	2/11/2008	0	0	0
Ice Storm	2/21/2008	0	0	0
Heavy Snow	3/4/2008	0	0	0
Winter Storm	1/26/2009	0	0	0
Winter Storm	2/28/2009	0	0	0
Winter Storm	2/1/2011	0	0	0
Winter Storm	2/21/2013	0	0	0
Winter Storm	12/5/2013	0	0	0
Winter Storm	1/5/2014	0	0	0
Winter Storm	3/2/2014	0	0	0
Winter Storm	2/15/2015	0	0	0
Winter Storm	2/20/2015	0	0	0
Winter Storm	2/28/2015	0	0	0
Winter Storm	3/4/2015	0	0	0
Ice Storm	1/13/2017	0	0	0
Winter Weather	12/31/2020	0	0	0
Total	**26**	**0**	**0**	**0**

Source: NCEI, data accessed [10/06/2021]

Notable Winter Narratives:

1. **01/01/2001:** Abnormally cold temperatures continued from December into early January with readings 10 to 20 degrees below normal. Snow and ice covered fields and highways provided problems to drivers, farmers and ranchers. Temperatures managed to rise well above freezing by the end of the first week of January, allowing these problems to lessen.

2. **02/21/2001:** Sleet, freezing rain and embedded thunderstorms caused ice accumulations from one quarter, up to two inches in some places across southwest, central and south central Missouri. The heaviest ice accumulations occurred along and north of Highway 60.

3. **12/04/2002:** The first winter storm of the season dropped from 3 to 6 inches of snow across parts of South Central and Southeast Missouri. Virtually all area schools were closed through Thursday. as many rural roads remained very hazardous to travel.

4. **12/24/2002:** The second of a series of winter storms to affect the Missouri Ozarks during the cool season of 2002-2003, brought significant snow accumulations to the region. The heaviest accumulation amounts were observed in a 60 mile wide band. This area is along and 30 miles north and south of a line extending from Cassville to Salem Missouri, where accumulations ranged from 12 to 16 inches. Areas to the north and south of this band, received total accumulations of five to eight inches. Numerous vehicle accidents occurred, however, no property damages were directly correlated with the heavy snow.

5. **02/23/2003:** Yet another winter storm struck Southeast Missouri on the 23rd - 24th. Snowfall amounts ranged from 6 - 8 inches across the area. Virtually all schools were closed on Monday the 24th. Due to all the school closings over the winter, many schools in the area were going to have to remain in session well into June.

6. **01/25/2004:** A strong upper level storm system approached southern and central Missouri during the overnight hours of January 24th. Low level temperature fields assumed a structure conducive for significant accumulations of freezing rain. Accumulations ranged from less than a quarter of an inch from Joplin to West Plains, and up to an inch near the Houston and Salem areas. Numerous vehicle accidents were observed, however, no significant monetary losses can be directly related to the ice.

7. **02/05/2004:** A Strong storm system developed across the central and southern Rockies. Tremendous amounts of moisture and lift moved into the Missouri Ozarks from the afternoon of the 4th and into the 5th. A mid level band of warmer air advected in from the south causing snow to change to sleet and freezing rain at times. A mixture of freezing rain, sleet, and snow accumulations of one to eight inches were observed across the entire Ozarks region. The heaviest amounts were located along the Arkansas and Missouri border where a 50 mile wide band of seven to eight inches of accumulation occurred. One to three inches of the mixed frozen precipitation occurred along the interstate 44 corridor, however, another heavier band developed across the Osage Plains of west central Missouri where four to six inches of accumulation occurred.

8. **11/30/2006**: A major winter storm caused a combination of freezing rain, sleet, and heavy snow to fall over sections of southwest and central Missouri. The frozen precipitation began on the 30th; the precipitation type was freezing rain and sleet, with ice accumulations up to four inches in some areas. The second wave of precipitation occurred overnight causing large amount of snow to accumulate over the ice. Storm total accumulations ranging from 13 to 17 inches occurred from the Lake of the Ozarks Region, over to Vernon and Cedar counties. Meanwhile other areas north of the Interstate 44 corridor experienced storm totals ranging from seven to 12 inches. The combination of the ice and snow weighted down all exposed objects. As a matter of fact, some areas experienced disaster as many roofs on businesses, barns, outbuildings, and schools collapsed due to the weight of the accumulated precipitation. On Lake of the Ozarks and Pomme De Terre Lake, numerous docks collapsed destroying a large number of boats and causing many of them to sink.

9. **01/20/2007:** A fast moving storm system brought several forms of precipitation to extreme southeast Kansas and the Missouri Ozarks. The combination of rain, freezing rain, sleet, and snow were observed in numerous counties. For areas along and north of a line from McCune, Kansas to Eldon, Missouri, mainly snow fell with accumulations ranging from five to seven inches. Elsewhere, sleet and freezing rain accumulations ranged from one quarter of an inch to around an inch.

10. **12/10/2007:** A major ice storm impacted portions of southwest Missouri during the early morning hours of 9 December. A southwest to northeast narrow band of convection developed from northeast Oklahoma into central Missouri, which became the heaviest axis of ice accumulation. Intermittent periods of light freezing rain occurred through the morning of 10 December, which provided an additional coating of ice on exposed surfaces. The northern half of Dent County, including the city of Salem, experienced ice accumulations of around one quarter of an inch. Lighter accumulations occurred over the southern half of the county.

11. **02/11/2008:** An ice storm brought significant accumulations of sleet and freezing rain to the

Missouri Ozarks. Ice accumulations of one quarter to three quarters of an inch were common. Higher amounts of one to three inches fell between the Interstate 44 and Highway 60 corridors from east of Springfield to Houston and Rolla. These ice accumulations resulted in power outages to as many as 34,000 southern Missouri residents. The sleet and freezing rain was accompanied by thunder and lightning. One quarter to three quarters of an inch of freezing rain and sleet accumulations were observed.

12. **02/21/2008:** An ice storm brought significant accumulations of freezing rain and sleet to the Missouri Ozarks. Accumulations of one quarter to three quarters of an inch were common. The primary precipitation type was sleet and was accompanied by thunder and lightning.

13. **03/04/2008:** Narrow but heavy bands of snow affected portions of the Missouri Ozarks during the morning hours of March 4. Snow bands as narrow as 20 miles produced accumulations up to 8 inches. Nearly whiteout conditions were reported within these intense snow bands where hourly accumulations approached 2 inches per hour. Heavy snow accumulations of 4 to 7 inches fell across the county. Snowfall rates approached 1 inch per hour at the height of the event resulting in a rapid deterioration of road conditions.

14. **01/26/2009:** A significant winter storm brought a combination freezing drizzle, freezing rain, sleet and snow to the Missouri Ozarks January 26 and 27, 2009. Freezing drizzle and light freezing rain developed area wide at the onset of the event causing multiple traffic accidents. Freezing rain persisted for much of the event across far southern Missouri resulting in significant ice accretion of one half to one inch. This ice storm downed tree limbs and power lines causing numerous power outages. A significant accumulation of a wintry mix of freezing rain, sleet and snow resulted in treacherous travel conditions. Ice accretion of near one quarter inch or less was followed by 3 to 5 inches of sleet and snow.

15. **02/28/2009:** A winter storm brought heavy snowfall to portions of central and south central Missouri. Heavy snow with accumulations of four to eight inches.

16. **02/01/2011:** A major winter storm produced snow, sleet and freezing rain across southwest and south central Missouri. Snow accumulations ranged from 1 to 4 inches with significant sleet accumulations of up to 2 inches. Freezing rain accumulated up to one quarter of an inch with scattered power outages. Travel was extremely treacherous.

17. **02/21/2013:** A winter storm brought a mix of freezing rain and sleet accompanied by thunder. Sleet accumulations ranged from one half to two inches with freezing rain accumulations ranging from near one tenth to locally one quarter of an inch.

18. **12/05/2013:** A winter storm produced 5 to 8 inches of snow along with light sleet accumulations and a glaze of ice.

19. **01/05/2014:** A winter storm brought heavy snow to much of the Missouri Ozarks with accumulations of 6 to 12 inches generally along and north of the Interstate 44 corridor. The highest accumulations of 10 to 12 inches occurred across portions of central Missouri east of Lebanon through the Rolla area. Northwest winds of 20 to 35 mph resulted in significant blowing and drifting snow along with bitterly cold wind chills.

20. **03/02/2014:** A winter storm impacted the Missouri Ozarks from Saturday night through Sunday night March 2, 2014. Precipitation began as a mixture of freezing rain and sleet Saturday night across much of the area, with rain changing to freezing rain and sleet across far southern Missouri as the night progressed. Many locations across southern Missouri also saw

thunderstorms Saturday night with numerous reports of thunder sleet. Precipitation changed to snow during the day Sunday as an Arctic air mass overspread the area. Sleet accumulations around 1/2 inch with snow accumulations of 1 to 3 inches.

21. **02/15/2015:** Winter storm produced total snowfall accumulations of 4 to 7 inches.

22. **02/20/2015:** Winter storm brought significant amounts of freezing rain to portions of southern Missouri with ice accretion up to around one quarter of an inch.

23. **02/28/2015:** Winter storm brought significant snowfall with total snow accumulations of 4 to 7 inches.

24. **03/04/2015:** Winter storm produced significant accumulations of snow and sleet with total snow accumulations of 3 to 5 inches. Sleet accumulations ranged from one quarter to near one half of an inch.

25. **01/13/2017:** A significant ice storm impacted the Missouri Ozarks with sporadic power outages and some tree damage. Up to a quarter of an inch of ice accumulated on elevated objects and tree limbs across the county during the ice storm. There were no major travel impacts reported across the county.

26. **12/31/2020:** A storm system lifted northward through Arkansas and into Missouri from New Years Eve into New Years Day. Freezing rain spread into southeast Kansas and southern and central Missouri during the evening hours of Thursday, December 31. The freezing rain continued into January 1, 2021 before transitioning over to minor accumulations of snow. Ice accumulations overnight and into January 1, 2021 resulted in tree damage and scattered power outages. Widespread estimates of 0.10 to 0.25 inches of flat ice accumulation around the county. This storm continued into January 1, 2021.

Dent County has been included in four federal disaster declarations for winter weather since 2001.[38]

Probability of Future Occurrence

From the data obtained from the NCEI [39], annual average percent probabilities were calculated for winter weather within Dent County (**Table 3.71)**. There were 26 recorded events (**Table 3.70**) over a 20 year period. There is 100 percent annual average probability of winter weather occurrence (26 events/20 years)**,** with an average of 1.3 events per year.

Table 3.71. Annual Average % Probability of Winter Weather in Dent County

Location	Annual Avg. % P	Avg. # of Events
Dent County	100%	1.3

*P = probability; see page 3.24 for definition.

[38] https://www.fema.gov/data-visualization-summary-disaster-declarations-and-grants
[39] http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=29%2CMISSOURI

Vulnerability

Vulnerability Overview

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.

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.

Data was obtained from the 2018 Missouri State Hazard Mitigation Plan for vulnerability information regarding Dent County. Various data sources were utilized for statistical analysis including the following:

- National Centers for Environmental Information (NCEI) storm event data (1999 to December 31, 2019)
- HAZUS Building Exposure Value data
- Housing density data from the U.S. Census (2015 ACS)
- Calculated Social Vulnerability Index for Missouri Counties from the Hazards and Vulnerability Research Institute in the Department of Geography at the University of South Carolina

From the statistical data collected, five factors were considered in determining overall vulnerability to severe winter weather as follows: housing density, building exposure, social vulnerability, likelihood of occurrence and average annual property loss. A rating value of one through five was assigned to each factor:

1) Low
2) Low-medium
3) Medium
4) Medium-high
5) High

Table 3.72 provides the factors considered and the ranges for the rating values assigned. After the individual ratings were determined for the common factors, a combined vulnerability ratings was computed for severe winter weather. Those can be seen in **Table 3.73**. The housing density, building exposure and SOVI data for Dent County can be found in **Table 3.74**.

Table 3.72. Ranges for Severe Winter Weather Vulnerability Factor Ratings

Factors Considered	Low (1)	Low Medium (2)	Medium (3)	Medium High (4)	High (5)
Common Factors					
Housing Density (# per sq. mile)	4.11-44.23	44.24-134.91	134.92-259.98	259.99-862.69	862.70-2836.23
Building Exposure ($)	$269,532-$3,224,641	$3,224,642-$8,792,829	$8,792,830-$22,249,768	$22,249,769-$46,880,213	$46,880,214-$138,887,850
Social Vulnerability	1	2	3	4	5
Likelihood of Occurrence (# of events/ yrs. of data)	1.05-1.43	1.44-1.76	1.77-2.10	2.11-2.67	2.68-4.57
Average Annual Property Loss (annual property loss/ yrs. Of data)	$0-$143,095.24	$143,095.25-$406,666.67	$406,666.68-$1,191,000.95	$1,191,000.96-$3,184,761.90	$3,184,761.91-$5,861,666.67

Source: 2018 Missouri Hazard Mitigation Plan

Table 3.73. Ranges for Severe Winter Weather Combined Vulnerability Rating

	Low (1)	Low-medium (2)	Medium (3)	Medium-high-4	High (5)
Severe Winter Weather Combined Vulnerability	7-8	8-10	10-12	12-15	15-22

Source: 2018 Missouri Hazard Mitigation Plan

Table 3.74. Housing Density, Building Exposure and SOVI Data for Dent County

Total Building Exposure (Hazus)	Building Exposure Rating	Housing Density	Housing Density Rating	SOVI Ranking	SOVI Rating
$1,451,544,000	1	9.65	1	Medium-High	4

Source: 2018 Missouri Hazard Mitigation Plan

Table 3.75 provides the last piece of the data gathered from NCEI to complete the overall vulnerability analysis and the total overall vulnerability rating for severe winter weather. The total number of winter weather events includes blizzard, heavy snow, ice storm winter storm and winter weather events. The likelihood of occurrence is 1.42 or 100 percent per year. The total annualized property loss is $7,381, which provides a total annualized property loss rating of neo and an overall vulnerability rating of eight – which translates to an overall Low vulnerability rating for the county for severe winter weather.

Table 3.75. Additional Statistical Data Compiled for Vulnerability Analysis for Dent County

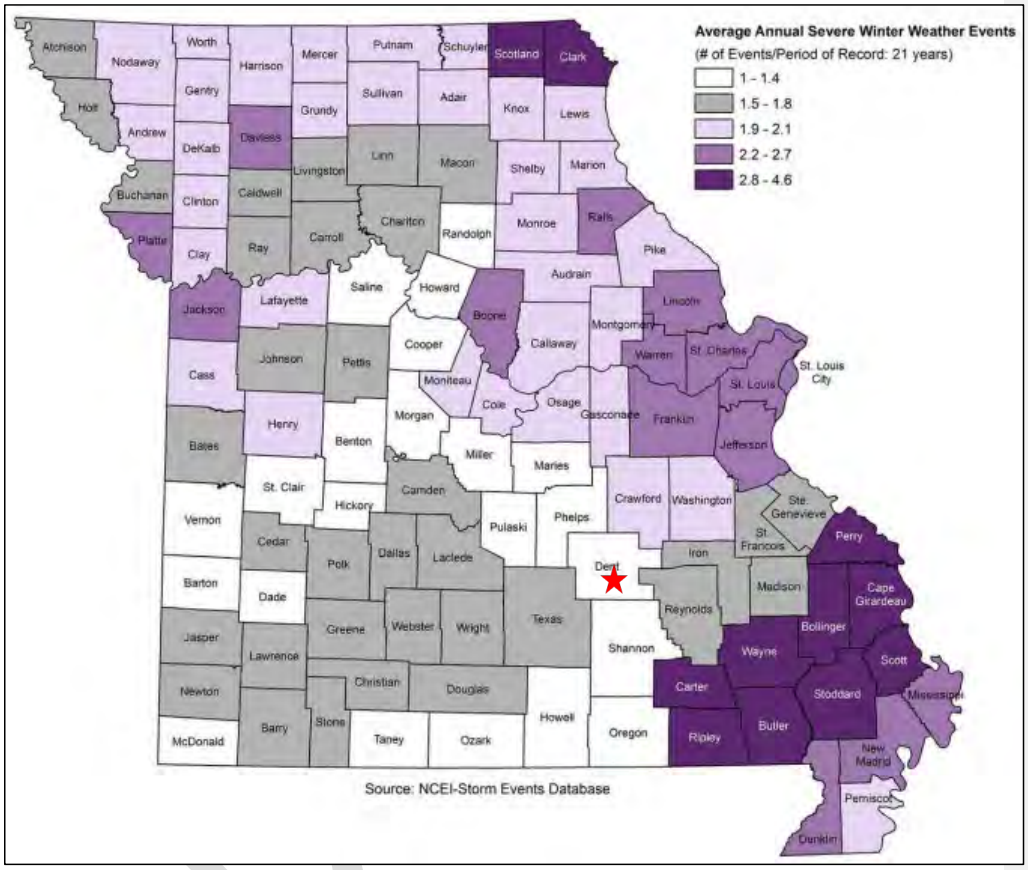
Total number of Winter Weather Events	Likelihood of Occurrence	Likelihood of Occurrence Rating	Total Annualized Property Loss	Total Annualized Property Loss Rating	Overall Vulnerability Rating	Overall Vulnerability Rating Description
30	1.4286	1	$7,381	1	8	Low

Source: 2018 Missouri Hazard Mitigation Plan

Figure 3.59 illustrates the average annual occurrence of severe winter weather statewide. Dent County falls into the Low category of 1 to 1.4 events per year.

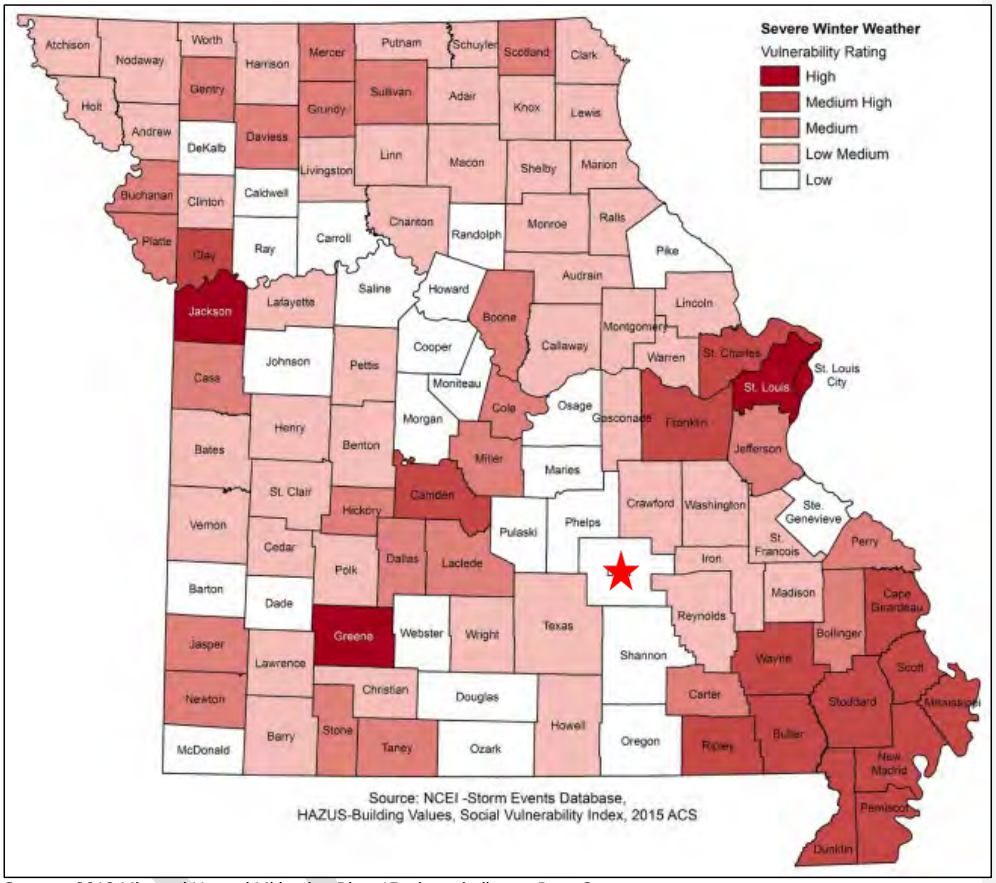
Figure 3.60 provides an illustration of the vulnerability summary of all Missouri counties for severe winter weather. Again, Dent County falls into the Low rating for overall vulnerability.

Figure 3.59. Average Annual Occurrence of Severe Winter Weather Events



*Source: 2018 Hazard Mitigation Plan, *Red star indicates Dent County*

Figure 3.60. Vulnerability Summary for Severe Winter Weather



*Source: 2018 Missouri Hazard Mitigation Plan, *Red star indicates Dent County*

Potential Losses to Existing Development

The next severe winter storm will most likely close schools and businesses for multiple days and make roadways hazardous for travel. Heavy ice accumulation may damage electrical infrastructures, causing prolonged power outages for large portions of the region. In addition, freezing temperatures make water lines vulnerable to freeze/thaw. Fallen tree limbs also pose a threat to various structures/infrastructures across the county. According to the 2018 state plan, Dent County can expect annual property losses of $7,381 due to severe winter storms.

Future Development

Data for future development for the planning area is sparse. However, winter weather will affect the county as a whole. Any future development is at risk to damages and increased exposure. In addition,

the county's population within the cities is anticipated to increase, which would increase the number of individuals at risk during a winter weather event.

Hazard Summary by Jurisdiction

Variations in impacts are not anticipated for severe winter weather across the planning area. Yet, areas with high number of mobile homes tend to experience increased damages. Unincorporated Dent County has the highest abundance of mobile homes, making the area more prone to increase exposure to damage. In addition, rural areas of the county may be more susceptible to power outages due to more power infrastructure being exposed to the risk of damage from winter storms.

Problem Statement

In summary, Dent County is expected to experience at least one severe winter weather event annually; however, the county has a low vulnerability rating. Jurisdictions should enhance their weather monitoring to be better prepared for severe weather hazards. If jurisdictions monitor winter weather, they can dispatch road crews to prepare for the hazard. County and city crews can also trim trees along power lines to minimize the potential for outages due to snow and ice. Citizens should also be educated about the benefits of being proactive to alleviate property damage as well preparing for power outages.

3.4.9 Tornado

Some specific sources for this hazard are:

- 2018 Missouri State Hazard Mitigation Plan, Chapter 3, Section 3.3.10, Page 3.355 https://sema.dps.mo.gov/docs/programs/LRMF/mitigation/MO_Hazard_Mitigation_Plan2018.pdf
- NWS Enhanced F Scale for Tornado Damage including damage indicators and degrees of damage www.spc.noaa.gov/faq/tornado/ef-scale.html;
- Tornado Activity in the U.S. map (1950-2006), FEMA 320, Taking Shelter from the Storm, 3rd edition;
- Tornado Alley in the U.S. map, http://tornadochaser.com/education/tornado-alley/
- National Centers for Environmental Information, https://www.ncdc.noaa.gov/stormevents/;
- Midwest Regional Climate Center, https://mrcc.purdue.edu/gismaps/cntytorn.htm;
- Missouri Hazard Mitigation Viewer
  http://bit.ly/MoHazardMitigationPlanViewer2018 - Website
  https://drive.google.com/file/d/1bPkc0jgF9ofwQLnTL9N0u-oPFWi9hkst/view - User Guide
  - Number of Tornadoes by County
  - Percentage of Mobile Homes in 2015 by County
  - Average annual tornado events by County
  - Vulnerability to tornado events by County
  - Annualized property loss for tornado events by County
  - Annualized property loss for tornado events by County

Hazard Profile

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 3.4.7,** Severe Thunderstorms Including High Winds, Hail, and 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

In Missouri, tornadoes occur most frequently between April and June, with April and May usually producing the most tornadoes. However, tornadoes can arise at any time of the year. While tornadoes can happen at any time of the day or night, they are most likely to occur between 3 p.m. and 9 p.m. Furthermore, tornadoes can occur anywhere across the state of Missouri, including Dent County.

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 Enhanced Fujita Scale, based on the original Fujita Scale developed by Dr. Theodore Fujita, a renowned severe storm researcher). The EF- Scale (**Table 3.76**) 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 3.76. Enhanced F Scale for Tornado Damage

Fujita Scale			Derived EF Scale		Operational Scale	
F #	Fastest 1/4 - Mile (mph)	3 Second Gust (mph)	EF #	3 Second Gust (mph)	EF #	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 3.77.** 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.

Table 3.77. 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

Table 3.78 illustrates NCEI data reported for tornado events and damages from 2001 to 2020 in the planning area.

There are 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.

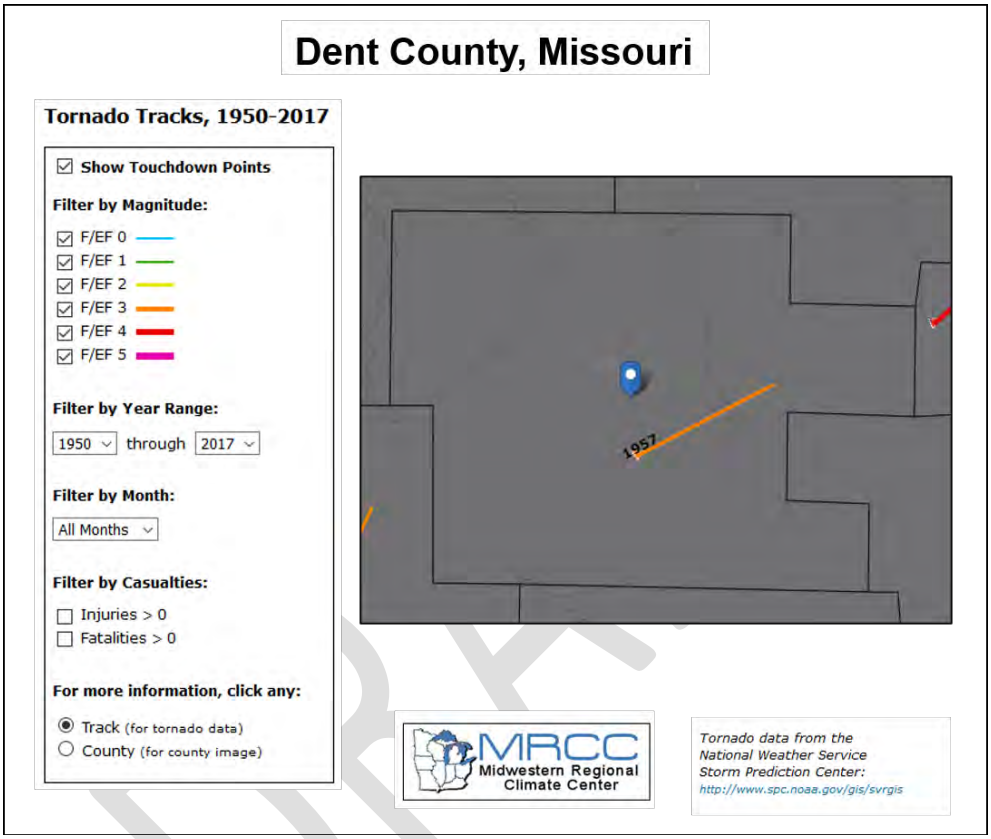
Table 3.78. Recorded Tornadoes in Dent County, 2001 – 2020

Date	Beginning Location	Ending Location	Length (miles)	Width (yards)	F/EF Rating	Death	Injury	Property Damage	Crop Damages
5/4/2003	4N Salem	4N Salem	0.2	20	F0	0	0	0	0
8/24/2007	8NNW Salem	8NNW Salem	0.1	25	EF0	0	0	0	0
12/31/2010	1ESE Lecoma	1WNW Lake Springs	1.23	100	EF1	2	0	450k	0
2/29/2012	5WNW Anutt	2ENE Lake Springs	9	75	EF1	0	0	0	0
3/29/2017	37.7304/-91.4202	1NE Short Bend	2.5	200	EF1	0	0	50K	0
5/27/2017	1S Lake Springs	1S Lake Springs	0.01	50	EF0	0	0	0	0
Total	**-**	**-**	**13.04**	**470**	**-**	**2**	**0**	**$500K**	**0**

Source: National Centers for Environmental Information, http://www.ncdc.noaa.gov/stormevents/

Figure 3.61 depicts historic tornado paths across Dent County.

Figure 3.61. Dent County Map of Historic Tornado Paths (1950 – 2017)



Source: https://mrcc.purdue.edu/gismaps/cntytorn.htm

According to the USDA Risk Management Agency's record, there were no insurance payments in Dent County for crop damages as a result of tornadoes between 2001 and 2020.

Probability of Future Occurrence

From the data obtained from the NCEI[40], an annual average percent probability was calculated for tornadoes within Dent County (**Table 3.79**). There is a 30.0 percent annual average probability of a tornado occurrence (6 events/20 years x 100). Tornado events can be found in **Table 3.78**. In addition, **Figure 3.62,** obtained from the 2018 Missouri State Hazard Mitigation Plan, also illustrates tornado probabilities across the United States and further shows Dent County's average probability of 11-20 percent.

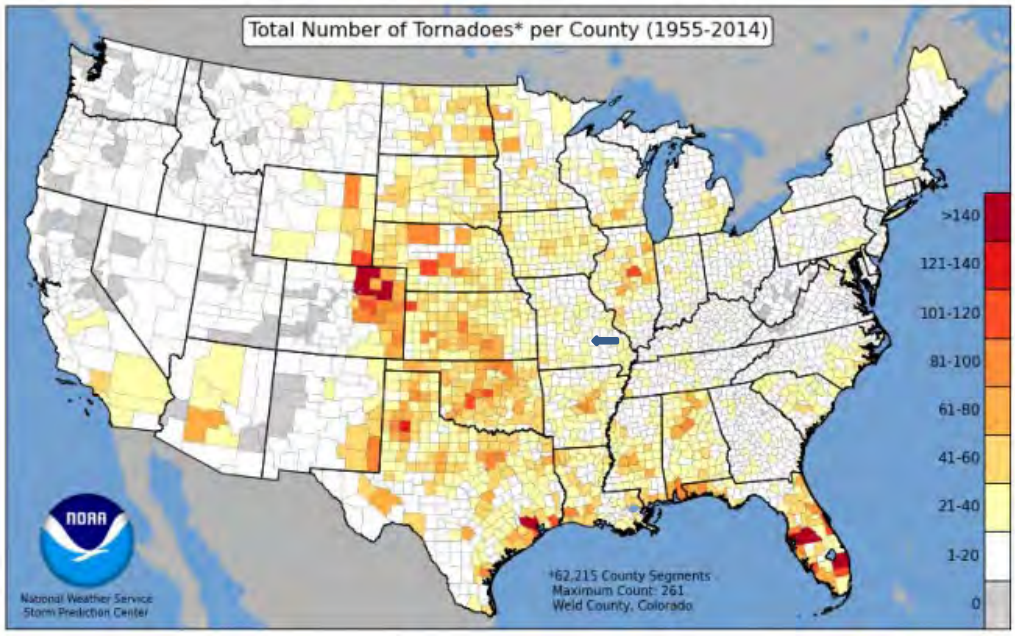
[40] http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=29%2CMISSOURI

Table 3.79. Annual Average % Probability of Tornadoes in Dent County

Location	Annual Avg. % P
Dent County	30.0%

*P = probability; see page 3.24 for definition.

Figure 3.62. Tornado Activity in the United States



*Source: 2018 Missouri State Hazard Mitigation Plan, *Blue arrow indicates Dent County*

Vulnerability

Vulnerability Overview

Many tornadoes are capable of great destruction and every tornado is a potential killer. Tornadoes can topple buildings, destroy mobile homes, uproot trees, hurl people and animals through the air for hundreds of yards and fill the air with lethal, windblown debris. Sticks, glass, roofing material and lawn furniture all become deadly missiles when driven by tornado winds.[41] Dent County resides in a region of the United States that has a high frequency of dangerous and destructive tornadoes. This region seen in **Figure 3.63** is referred to as "Tornado Alley".

[41] 2018 Missouri Hazard Mitigation Plan

The 2018 Missouri Hazard Mitigation Plan used statistical analysis of data from several sources to determine vulnerability to tornadoes across the state. HAZUS building exposure value data, population density and mobile home data from the U.S. Census (2015 ACS), the calculated Social Vulnerability Index for Missouri Counties from the Hazards and Vulnerability Research Institute in the Department of Geography at the University of South Carolina, and storm events data (1950 to December 31, 2016) from the National Centers for Environmental Information (NCEI). One limitation to the NCEI data is that many tornadoes that may have occurred in uninhabited areas and some in inhabited areas, may not have been reported. In addition, NOAA data cannot show a realistic frequency distribution of different Fujita scale tornado events, except for recent years. For these reasons a parametric model based on a combination of many physical aspects of the tornado to predict future expected losses was not used. The statistical model used for this analysis was probabilistic based purely on tornado frequency and historic losses.

Figure 3.63. Tornado Alley in the U.S.

Source: http://tornadochaser.net/

Six factors were considered in determining overall vulnerability to tornadoes as follows: building exposure, population density, social vulnerability, percentage of mobile homes, likelihood of occurrence and annual property loss. Based on natural breaks in the statistical data, a rating value of one through five was assigned to each factor. These rating values correspond to the following descriptive terms:

1) Low
2) Low-medium
3) Medium

4) Medium-high
5) High

Table 3.80 provides the factors used and ranges for the rating values assigned. Once the ranges were established and applied to all factors, the ratings were combined to determine overall vulnerability. **Table 3.81** illustrates the ranges for tornado combined vulnerability rating.

Table 3.80. Ranges for Tornado Vulnerability Factor Ratings

Factors Considered	Low (1)	Low-medium (2)	Medium (3)	Medium-High (4)	High (5)
Common Factors					
Building Exposure ($)	$269,532-$3,224,641	$3,224,642-$8,792,829	$8,792,830-$22,249,768	$22,249,769-$46,880,213	$46,880,214-$138,887,850
Population Density (#per sq. mile)	4.11-44.23	44.24-134.91	134.92-259.98	259.99-862.69	862.70-2,836.23
Social Vulnerability	1	2	3	4	5
Percent Mobile Homes	0.2-4.5%	4.51-8.8%	8.81-14%	14.01-21.2%	21.21-33.2%
Likelihood of Occurrence (# of events/ yrs. of data)	0.119 - 0.208	0.209 - 0.313	0.314 - 0.417	0.418 - 0.552	0.553 - 0.791
Total Annualized Property Loss ($ / yrs. of data)	$974 - $281,874	$281,875 - $991,825	$991,826 - $2,099,000	$2,099,001 - $5,047,474	$5,047,475 - $42,467,109

Source: 2018 Missouri Hazard Mitigation Plan

Table 3.81. Ranges for Tornado Combined vulnerability Rating

	Low (1)	Low-medium (2)	Medium (3)	Medium-High (4)	High (5)
Tornado Combined Vulnerability	7-10	11-12	13-14	15-16	17-21

Source: 2018 Missouri Hazard Mitigation Plan

Table 3.82 provides data on building exposure, population density, SOVI and mobile home data for Dent County that is used to determine overall vulnerability.

Table 3.82. Building Exposure, Population Density, SOVI and Mobile Home Data for Dent County

Total Building Exposure (Hazus)	Exposure Rating	Population Density	Population Rating	SOVI Ranking	SOVI Rating	Percent Mobile Homes	Mobile Home Rating
$1,451,544,000	1	20.71	1	Medium-High	4	20.1	4

Source: 2018 Missouri Hazard Mitigation Plan

Table 3.83 provides additional data, obtained from the National Centers for Environmental Information to complete the overall vulnerability analysis and the total overall vulnerability rating for tornadoes. **Figure 3.64** shows the percent of mobile homes per county throughout the state with Dent County

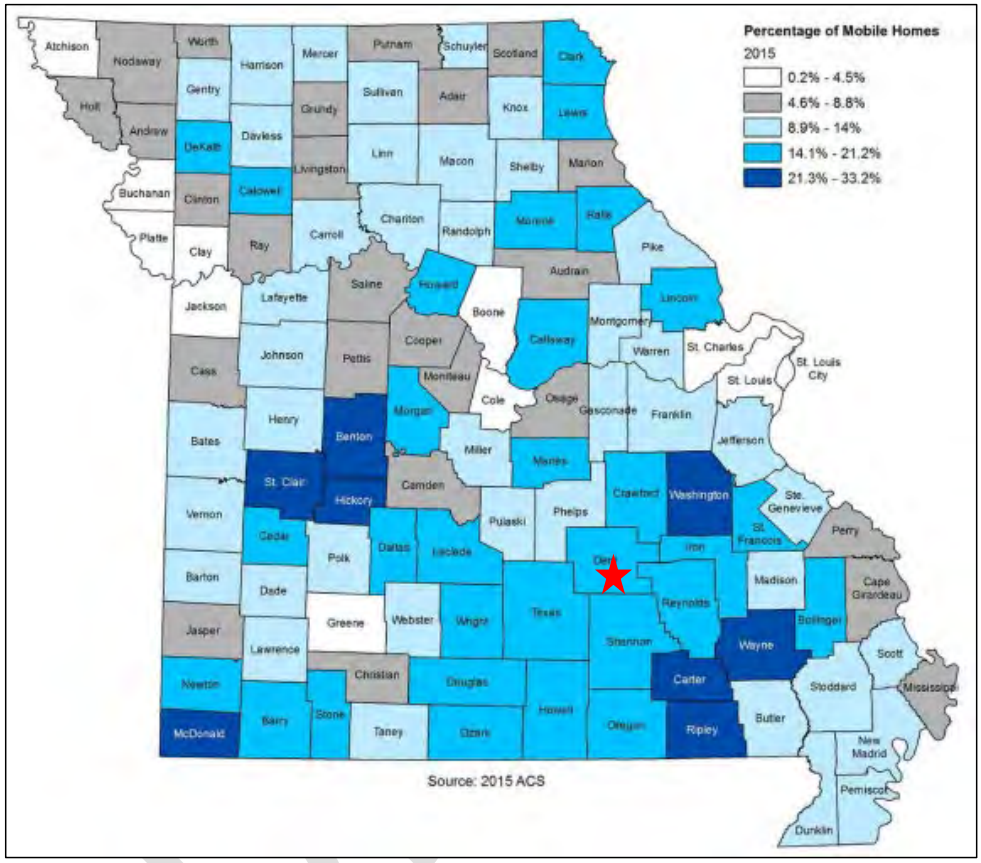
determined to have medium mobile home density at 14.1 percent to 21.2 percent. **Figure 3.65** provides the average annual occurrence of tornadoes in Missouri and illustrates that Dent County falls into the lowest quadrant for historical events – 11 to 20 percentile. Finally, **Figure 3.66** shows the county's overall vulnerability to tornadoes – Low – Medium.

Table 3.83. Likelihood of Occurrence, Annual Property Loss and Overall Vulnerability Rating for Tornadoes for Dent County

Total Number of Tornadoes	Likelihood of Occurrence	Likelihood of occurrence Rating	Total Annualized Property Loss	Total Annualized Property Loss Rating	Overall Vulnerability Rating	Overall Vulnerability Rating Description
13	0.194	1	$9,146	1	12	Low-Medium

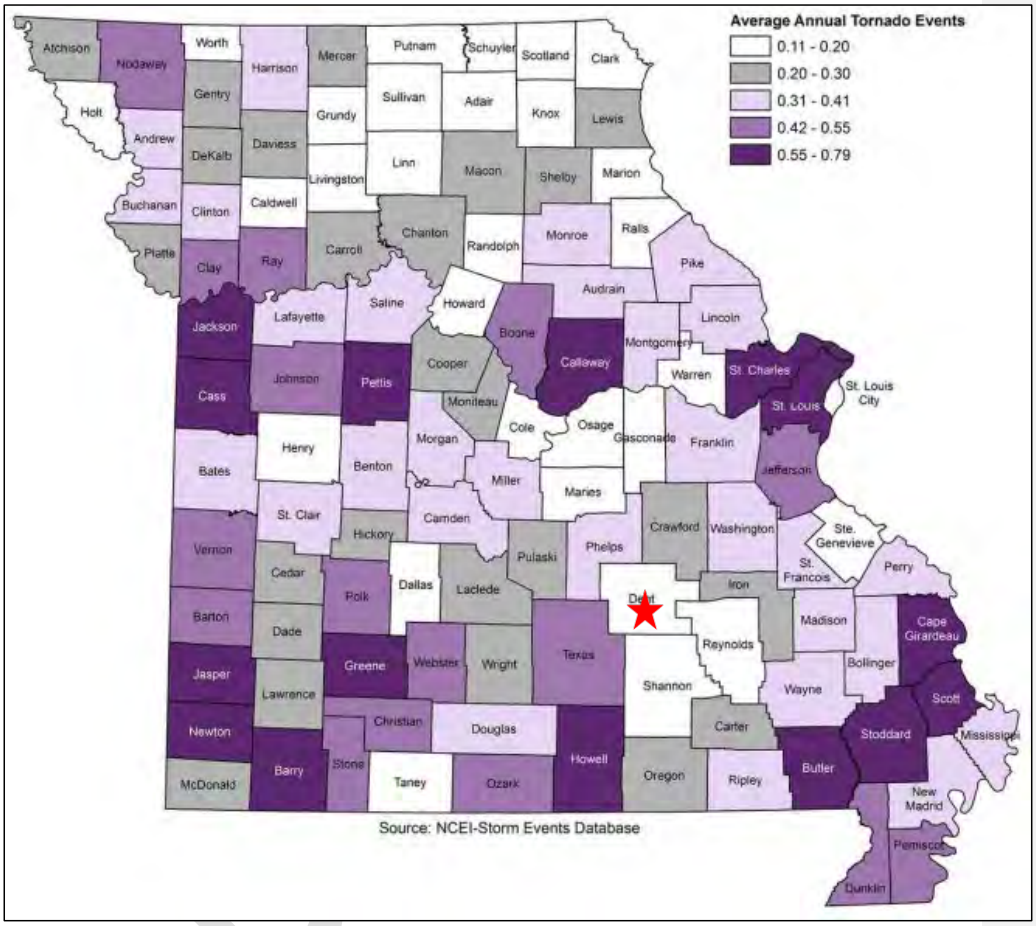
Source: 2018 Missouri Hazard Mitigation Plan

Figure 3.64. Missouri – Percent of Mobile Homes Per County



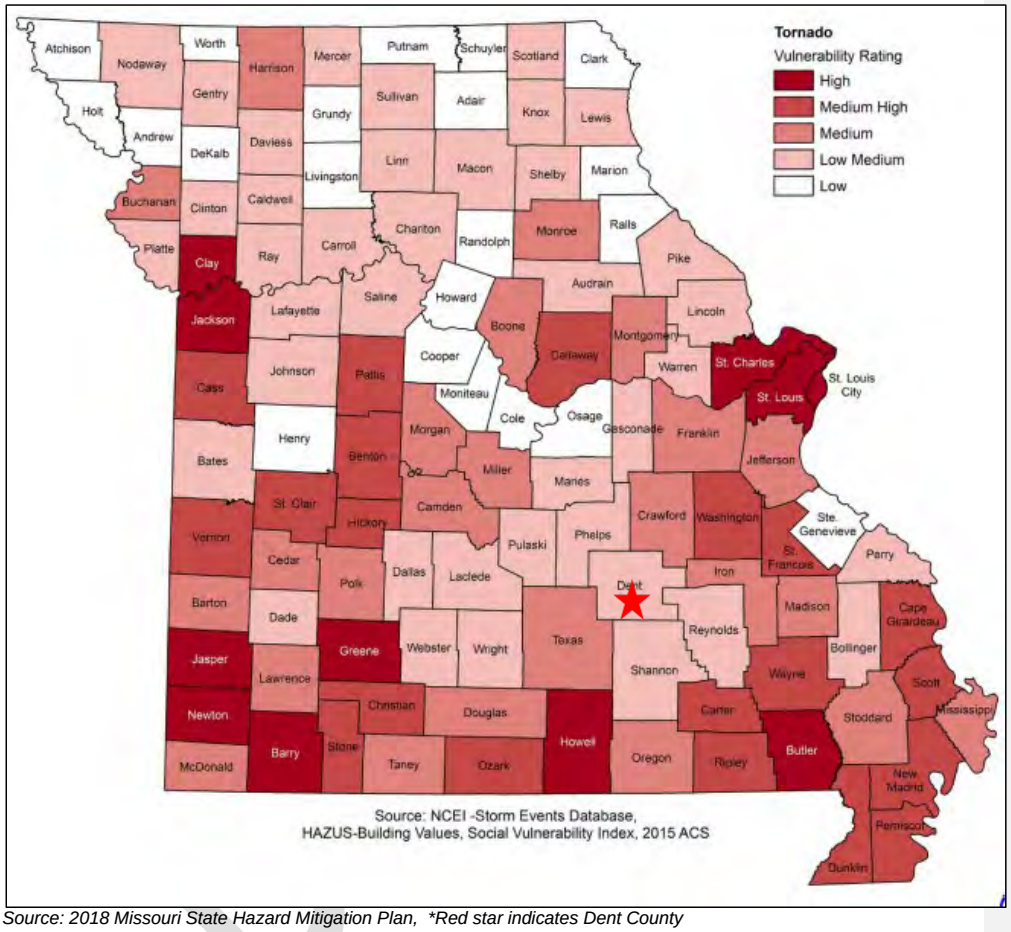
*Source: 2018 Missouri State Hazard Mitigation Plan, *Red star indicates Dent County*

Figure 3.65. Average Annual Occurrence for Tornadoes



*Source: 2018 Missouri State Hazard Mitigation Plan, *Red star indicates Dent County*

Figure 3.66. Overall Vulnerability to Tornadoes



*Source: 2018 Missouri State Hazard Mitigation Plan, *Red star indicates Dent County*

Potential Losses to Existing Development

There has been a total of $500,000 in damage due to tornadoes within Dent County and 2 deaths between 2001 and 2020 years. With this information we can estimate that each year there will be approximately $25,000 in loss to existing development. Additionally, the largest recorded tornado in the planning area has been an EF1. Utilizing this information, we can infer that there is potential for another tornado of equivalence.

Future Development

As populations and development increases across the county, the vulnerability will increase as well. In order to protect jurisdictions from increased tornado vulnerabilities future analysis, training, and implementation should be considered at the planning, engineering, and architectural design stages.

Hazard Summary by Jurisdiction

As previously stated, a tornado event could occur anywhere in the planning area. However, some jurisdictions would suffer heavier damages because of the age of housing or high concentration of mobile homes. See **Table 3.32** for jurisdictions most vulnerable to damage due to the age of the structure. Based on structure age, the city of Salem would have higher vulnerability due to 16.1 percent of its housing stock being built prior to 1939. Furthermore, data was obtained from the U.S. Census Bureau for the number of mobile homes in Dent County and its jurisdictions. From the information provided in **Table 3.84,** unincorporated Dent County, with 1,101 mobile homes – 27.4 percent of housing, is most vulnerable to losses due to the number of mobile homes residing within the jurisdiction.

Table 3.84. Percentage of Mobile Homes in Dent County, 2016-2020

Jurisdiction	Number of Mobile Homes	Percentage of Mobile Homes*
Unincorporated Dent County	1,101	27.4
Salem	112	4.8

Source: U.S. Census Bureau, 2016-2020 5-Year American Community Survey
**Number of mobile homes per jurisdiction/total occupied housing units per jurisdiction*
***Total housing units for all jurisdictions = 6,335*

Problem Statement

Early warnings are possibly the best hope for residents when severe weather strikes. While more than two hours warning is not possible for tornadoes, citizens must immediately be aware when a city will be facing a severe weather incident. Jurisdictions that do not already possess warning systems should plan to purchase a system. Storm shelters are another important means of mitigating the effects of tornadoes. Additional public awareness also includes coverage by local media sources. A community-wide shelter program should be adopted for residents who may not have adequate shelter in their homes. Residents should also be encouraged to build their own storm shelters to prepare for emergencies. Local governments should encourage residents to purchase weather radios to ensure that everyone has sufficient access to information in times of severe weather.

3.4.10 Wildfires

The specific sources for this hazard are:

- 2018 Missouri State Hazard Mitigation Plan, Chapter 3, Section 3.3.11, Page 3.390 https://sema.dps.mo.gov/docs/programs/LRMF/mitigation/MO_Hazard_Mitigation_Plan2018.pdf
- Missouri Department of Conservation Wildfire Data Search at http://mdc4.mdc.mo.gov/applications/FireReporting/Report.aspx
- Statistics, Missouri Division of Fire Safety at https://dfs.dps.mo.gov/;
- National Statistics, US Fire Administration at https://www.usfa.fema.gov/statistics/;
- Fire/Rescue Mutual Aid Regions in Missouri at https://dfs.dps.mo.gov/programs/resources/mutual-aid.php;
- Forestry Division of the Missouri Dept. of Conservation at https://mdc.mo.gov/your-property/fire-management;
- National Fire Incident Reporting System (NFIRS), http://www.dfs.dps.mo.gov/programs/resources/fire-incident-reporting-system.php
- Firewise, www.firewise.org
- University of Wisconsin Slivis Lab, http://silvis.forest.wisc.edu/maps/wui_main
- Missouri Hazard Mitigation Viewer
  http://bit.ly/MoHazardMitigationPlanViewer2018 - Website
  https://drive.google.com/file/d/1bPkcojgF9ofwQLnTL9N0u-oPFWi9hkst/view - User Guide
    - Likelihood of Occurrence of wildfire by County
    - Average annual land burned (acres) by County
    - Number of structures within the WUI Interface/Intermix Area
    - Potential loss, average annual land burned by County

Hazard Profile

Hazard Description

The fire incident types 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 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, approximately 700 rural fire departments in Missouri have mutual aid agreements with the Forestry Division to obtain assistance in wildfire protection if needed. Over 300 have mutual aid agreements with the State to obtain assistance in wildfire protection if needed. A cooperative agreement with the Mark Twain National Forest is renewed annually.

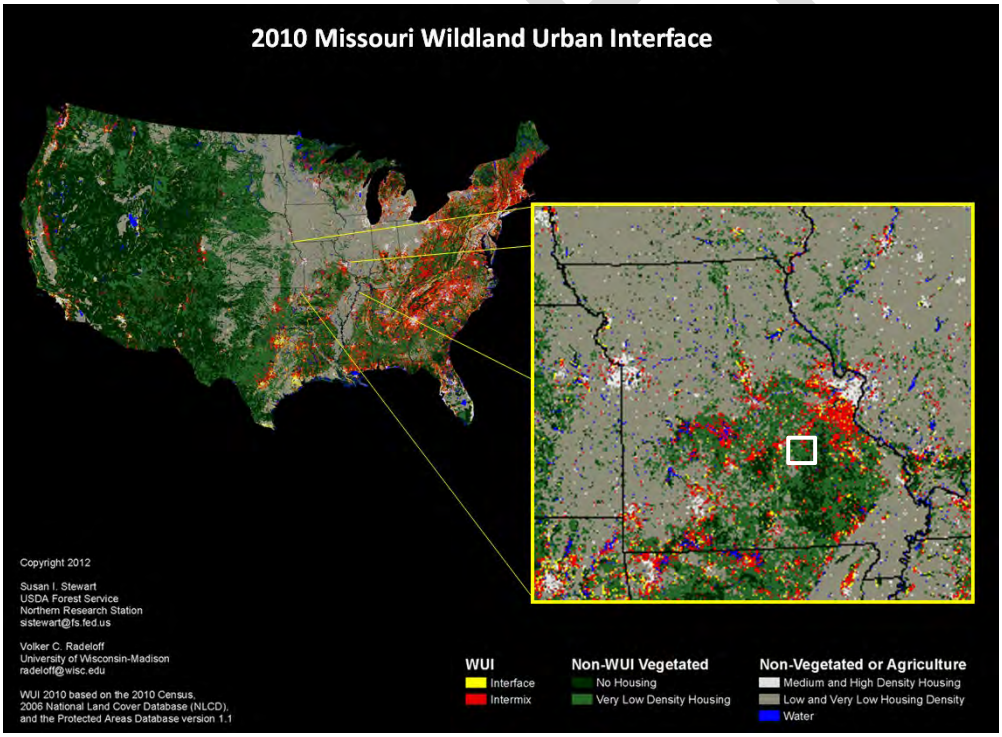
Most of Missouri fires occur during the spring season between February and May. The length and severity of both structural and wildland fires depend largely on weather conditions. Each year, an average of about 3,200 wildfires burn more than 52,000 acres of forest and grassland in Missouri. Spring in Missouri is usually characterized by low humidity and high winds. These conditions result in

higher fire danger. 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

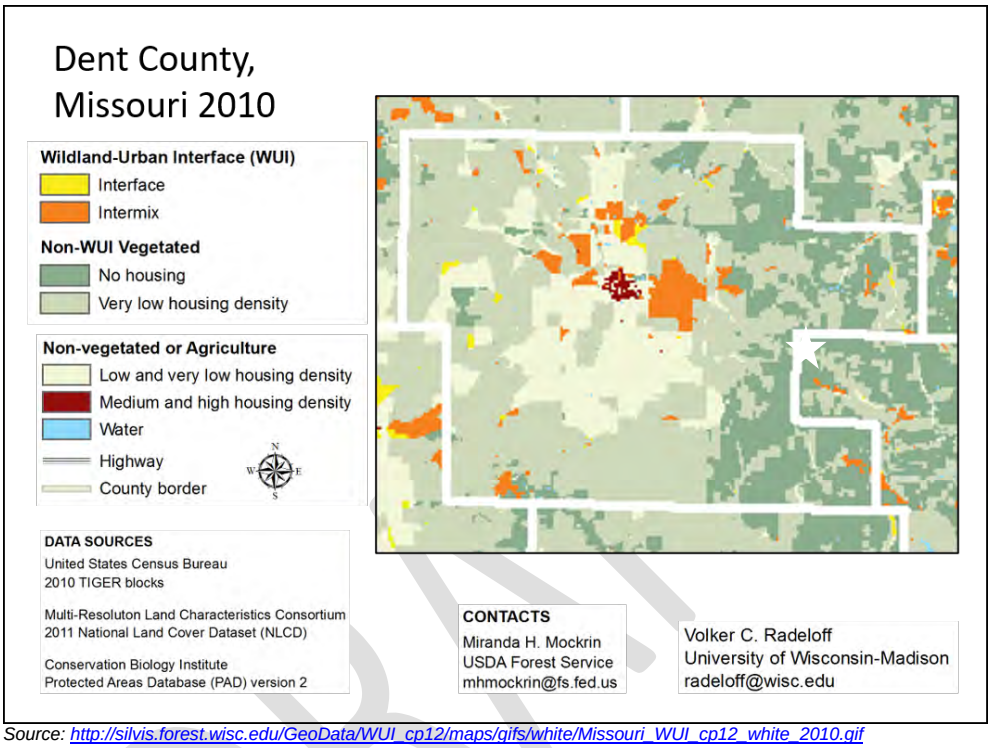
The risk of wildfire does not vary widely across the planning area. However, damages due to wildfires are expected to be higher in communities with more wildland–urban interface (WUI) areas. WUI refers to the zone of transition between unoccupied land and human development and needs to be defined in the plan. 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 3.67**). To determine specific WUI areas and variations, data was obtain from ArcGIS, Streets and SILVIS (**Figure 3.68**). According to the WUI area map of Dent County and the City of Salem partially reside in a WUI area.

Figure 3.67. 2010 Missouri Wildland Urban Interface (WUI)



Source: http://silvis.forest.wisc.edu/maps/wui; White square roughly estimates Dent County's location

Figure 3.68. Dent County Wildlife Urban Interface



Source: http://silvis.forest.wisc.edu/GeoData/WUI_cp12/maps/gifs/white/Missouri_WUI_cp12_white_2010.gif

Strength/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.

The severity of wildfires in Missouri is considered low to moderate, and wildfires in Missouri often 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. Large fires have the potential to kill people, livestock, fish and wildlife as well as destroy crops and pastures. Wildfires can destroy not only natural areas, but homes, businesses and other facilities. Loss of life due to wildfires is not common in Missouri, but injuries to residents and firefighters can include falls, sprains, abrasions or heat-related injuries such as dehydration.

Previous Occurrences

Between 2001 and 2020 there were 604 wildfires reported in Dent County, according to wildfire reporting to the Missouri Department of Conservation[42]. This is an average of 30.2 wildfires per year. The size of the fires varied from as small as .01 acre to as large as 600 acres. **Table 3.85** shows the cause of wildfires, number of wildfires and acres burned for the period 2001-2020. Debris fires account for the largest number of fires however, the greatest number of acres burned were caused from unknown sources.

Table 3.85. 2000-2018 Dent County Wildfires by Cause

Cause	Number	Acres	% Number	% Acres
Arson	37	1,899	6.13%	15.72%
Campfire	5	110	0.83%	0.91%
Children	1	10	0.17%	0.08%
Debris	309	3,785	51.16%	31.33%
Equipment	51	1,504	8.44%	12.45%
Lightning	7	24	1.16%	0.20%
Miscellaneous	69	1,287.35	11.42%	10.66%
Not Reported	8	17	1.32%	0.14%
Powerline	2	58.59	0.33%	0.48%
Smoking	6	7.51	0.99%	0.06%
Structure	1	1.89	0.17%	0.02%
Unknown	108	3,377.5	17.88%	27.96%
Totals	604	12,081	100.00%	100.00%

Records for school and special districts are not available at this time.

Probability of Future Occurrence

From the data obtained from the Missouri Department of Conservation[43] (Appendix: F), 604 wildfire events occurred in Dent County between 2001 and 2020. This information was utilized to determine the annual average percent probabilities of wildfires. Since multiple occurrences are anticipated per year (604 events/20 years), the probability of wildfires per year is 100% with an average of 30.2 events per year **Table 3.86**.

[42] http://mdc7.mdc.mo.gov/applications/FireReporting/Report.aspx
[43] http://mdc7.mdc.mo.gov/applications/FireReporting/Report.aspx

Table 3.86. Annual Average Percentage Probability of Wildfires in Dent County

Location	Annual Avg. % P	Avg. Number of Events
Dent County	100%	30.2

*P = probability; see page 3.24 for definition.

Changing Future Conditions Considerations

Higher temperatures and changes in rainfall are unlikely to substantially reduce forest cover in Missouri, although the composition of trees in the forests may change. More droughts would reduce forest productivity and changing future conditions are also likely to increase the damage from insects and diseases. But longer growing seasons and increased carbon dioxide concentrations could offset the losses from those factors. Forests cover about one-third of the state, dominated by oak and hickory trees. As the climate changes, the abundance of pines in Missouri's forests are likely to increase, while the population of hickory trees is likely to decrease.[44]

Higher temperatures will also reduce the number of days prescribed burning can be performed. Reduction of prescribed burning will allow for growth of understory vegetation – providing fuel for destructive wildfires. Drought is also anticipated to increase in frequency and intensity during summer months under projected future scenarios. Drought can lead to dead or dying vegetation and landscaping material close to structures which creates fodder for wildfires.[45]

Vulnerability

Vulnerability Overview

According to the 2018 Missouri State Hazard Mitigation Plan, the Department of Conservation historical wildfire data was the best resource for data on wildfires. The Missouri State Hazard Mitigation Plan used data from 2004-2016 and determined that Dent County should expect to have 34.31 wildfires per year, impacting 718 acres **(Table 3.87**).

The state plan also indicates that Dent County is at a higher possible likelihood for building damage from wildfires due to 1,996 buildings valued at $652,825,384 and 2,722 individuals vulnerable. **Figure 3.69** illustrates the likelihood of wildfire events based on data from 2004-2016. **Figure 3.70** provides a map that illustrates the average annual acreage burned.

Table 3.87. Statistical Data for Wildfire Vulnerability in Dent County

Number of Wildfires 2004-2016	Likelihood of Occurrence (#/year)	Total Acres Burned	Average Annual Acreage Burned
446	34.31	9,330.97	718

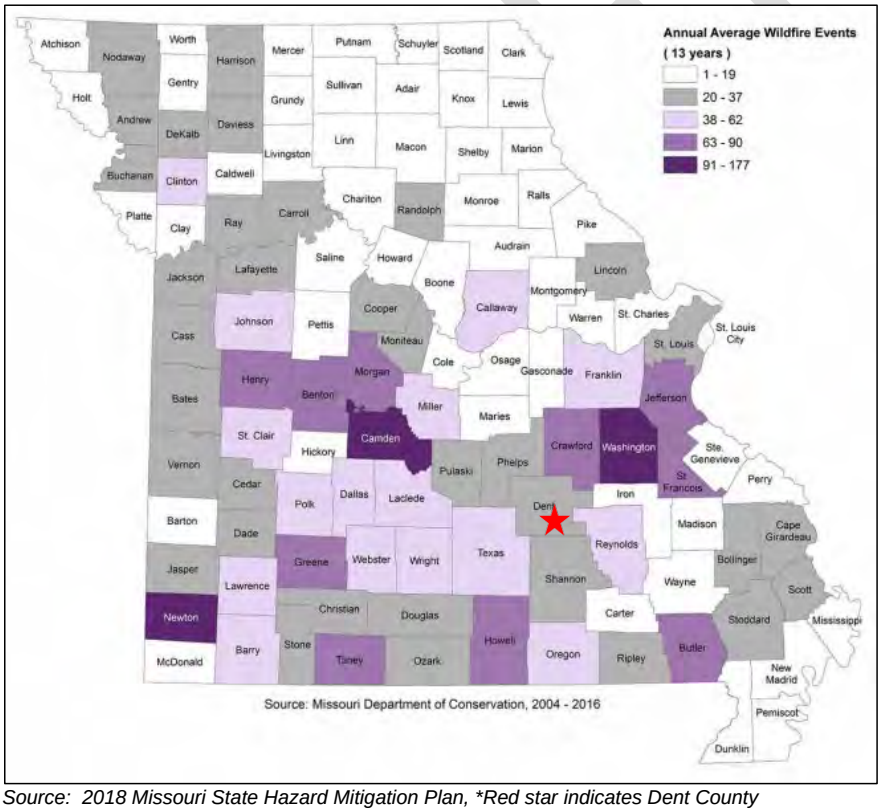
Source: 2018 Missouri State Hazard Mitigation Plan

[44] 2018 Missouri Hazard Mitigation Plan
[45] Ibid

The method used to determine vulnerability to wildfires in the 2018 Missouri Hazard Mitigation plan was a GIS comparative analysis of wildland urban interface and intermix (WUI) areas against building exposure data to determine the types, numbers and estimated values of buildings at risk to wildfire. This GIS-based analysis utilized data from several sources: the Missouri Spatial Data Inventory Service (MSDIS), HAZUS building exposure value data and wildland urban interface and intermix area data from the University of Wisconsin-Madison SILVIS Lab.

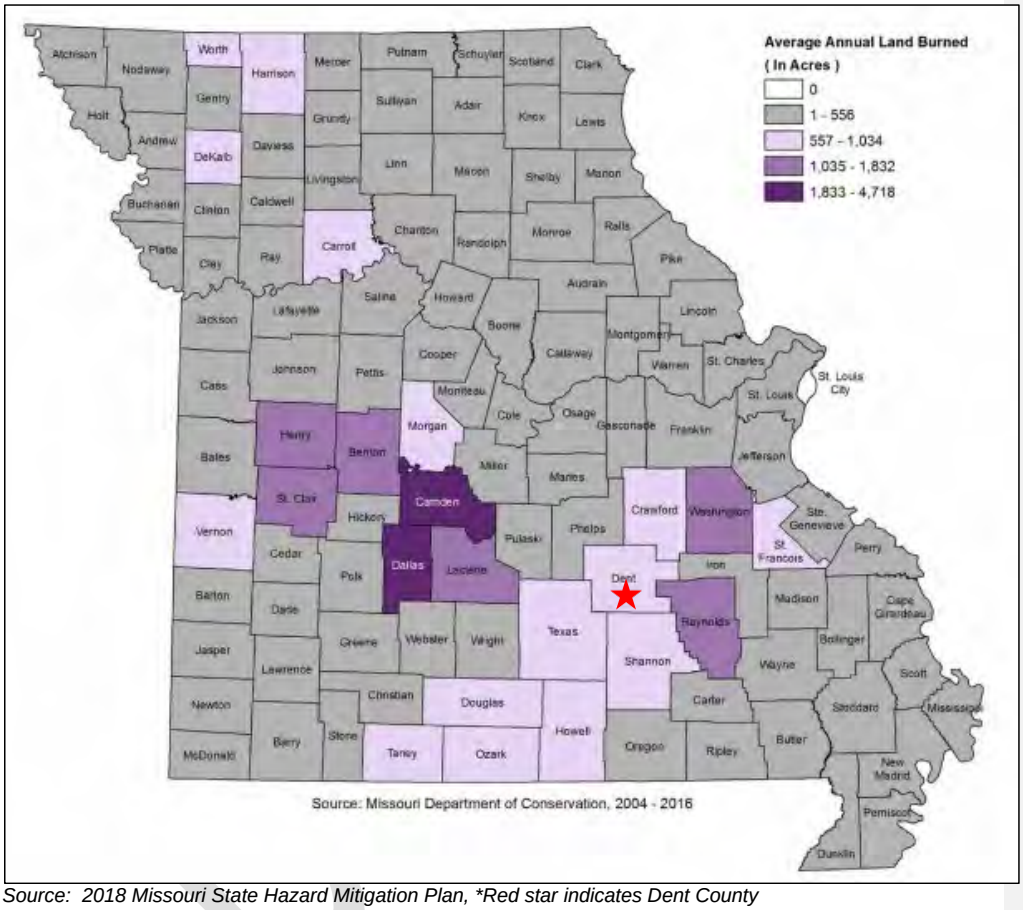
The results of that analysis, including estimated number of structures, value of structures and population are illustrated in **Table 3.88.** The total estimated number of structures vulnerable to wildfires is 1,996. The overall value of structures vulnerable to wildfire in Dent County is estimated at $652,825,384. To further illustrate vulnerability in Dent County, maps from the 2018 Missouri Hazard Mitigation plan illustrating these numbers and comparing them statewide are included. The number of structures in the WUI interface and intermix areas statewide are shown in **Figure 3.71**. **Figure 3.72** shows the estimated value of structures in the WUI interface and intermix areas. **Figure 3.73** illustrates the number of people at risk to wildfire in the WUI interface and intermix areas.

Figure 3.69. Likelihood of Wildfire Events, 2004-2016



*Source: 2018 Missouri State Hazard Mitigation Plan, *Red star indicates Dent County*

Figure 3.70. Average Annual Acreage Burned



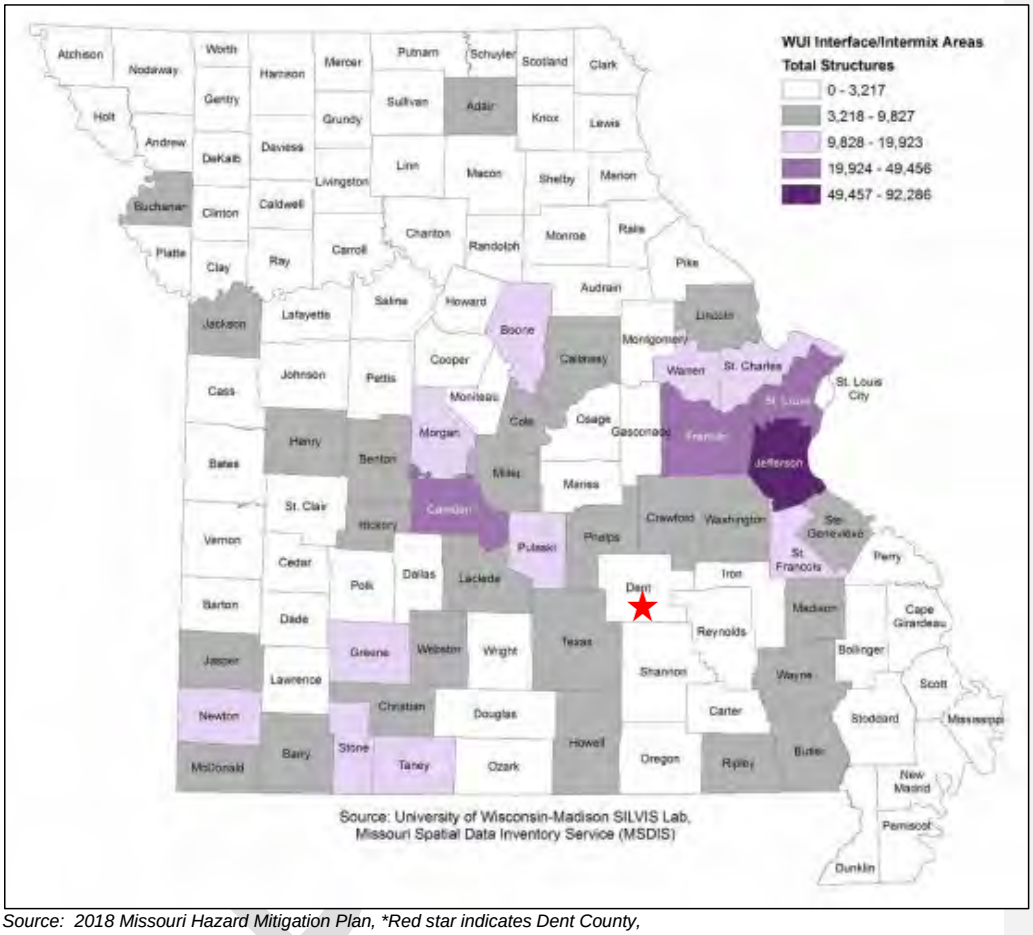
*Source: 2018 Missouri State Hazard Mitigation Plan, *Red star indicates Dent County*

Table 3.88. Estimated Numbers and Values of Structures and Population Vulnerable to Wildfire in Dent County

Dent County	Number of Structures	Value of Structures	Population
Agriculture	868	$402,496,706	
Commercial	79	$60,793,263	
Education	1	$2,792,625	
Industrial	13	$16,116,905	
Residential	1,035	$170,625,885	
Totals	**1,996**	**$652,825,384**	**2,722**

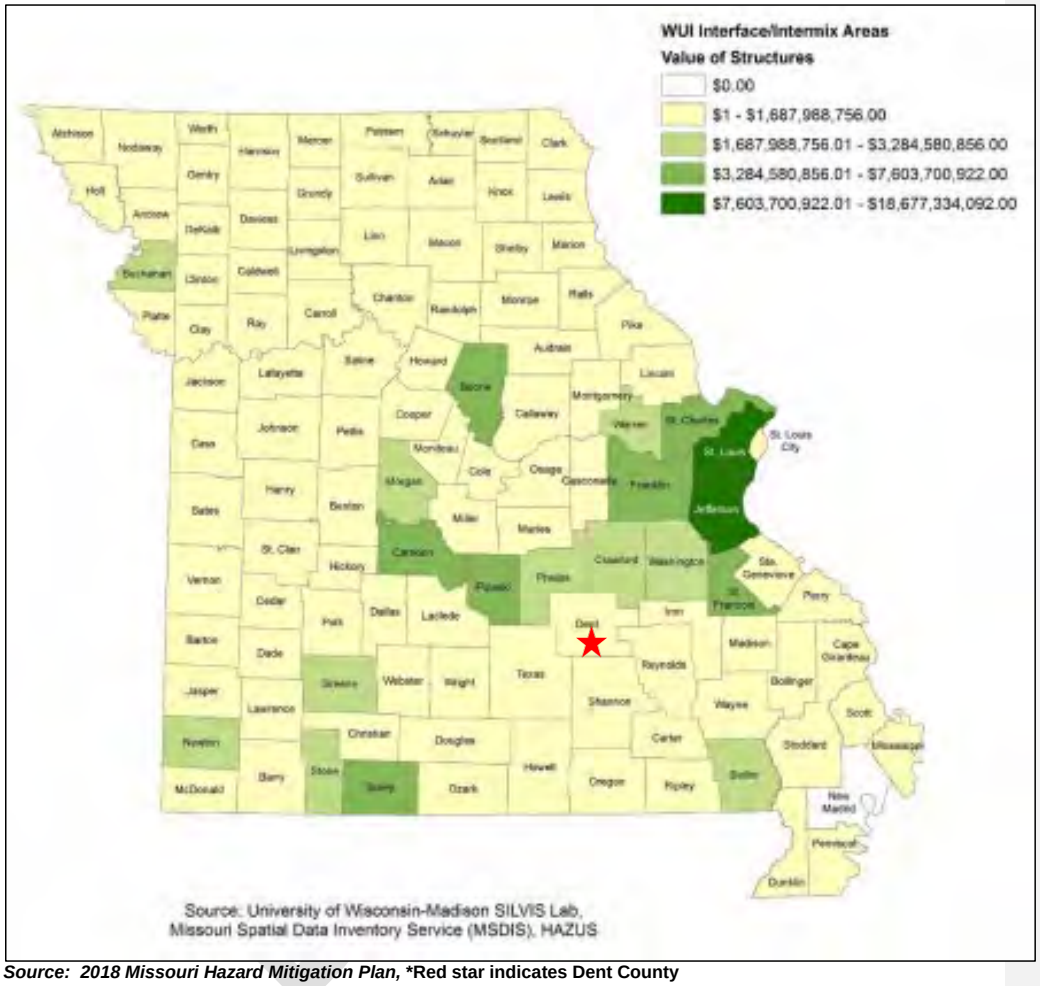
Source: 2018 Missouri State Hazard Mitigation Plan

Figure 3.71. Number of Structures in WUI Interface and Intermix Areas



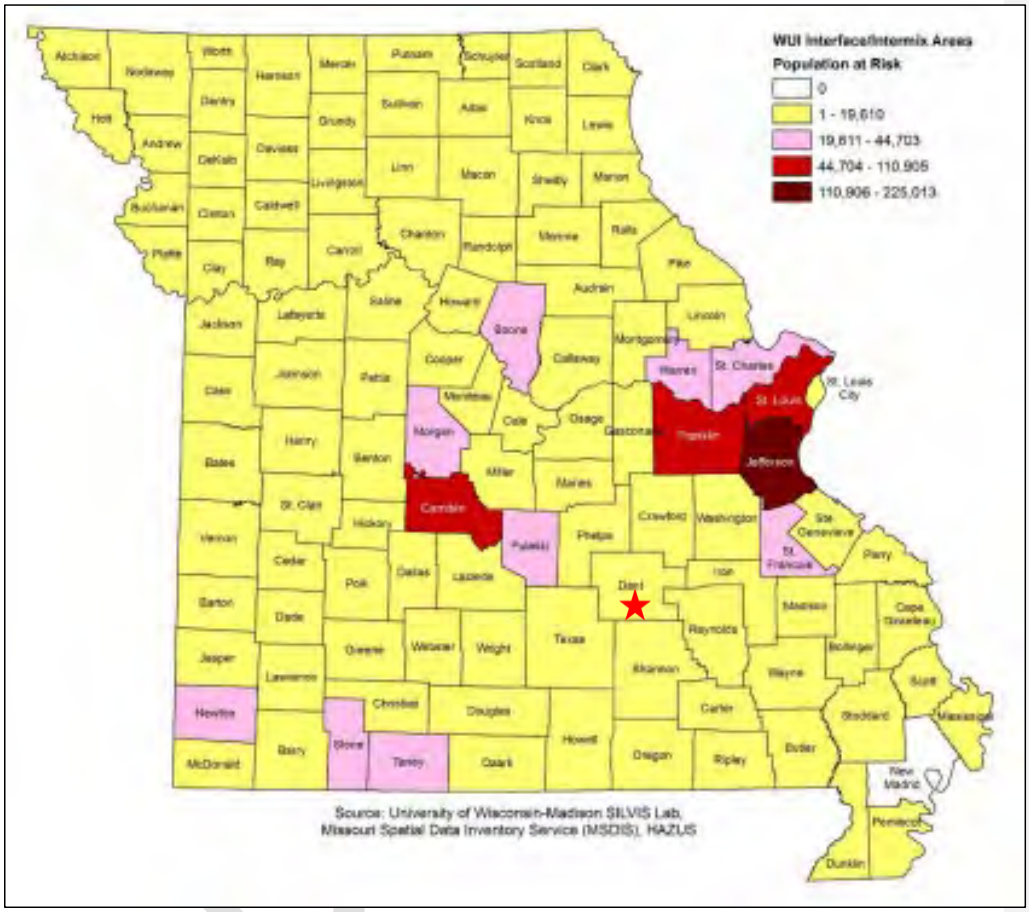
*Source: 2018 Missouri Hazard Mitigation Plan, *Red star indicates Dent County,*

Figure 3.72. Value of Structures in the WUI Interface and Intermix Areas



***Source: 2018 Missouri Hazard Mitigation Plan,* *Red star indicates Dent County**

Figure 3.73. Population at Risk to Wildfire in WUI Interface and Intermix Areas



*Source: 2018 Missouri Hazard Mitigation Plan, *Red star indicates Dent County*

Potential Losses to Existing Development

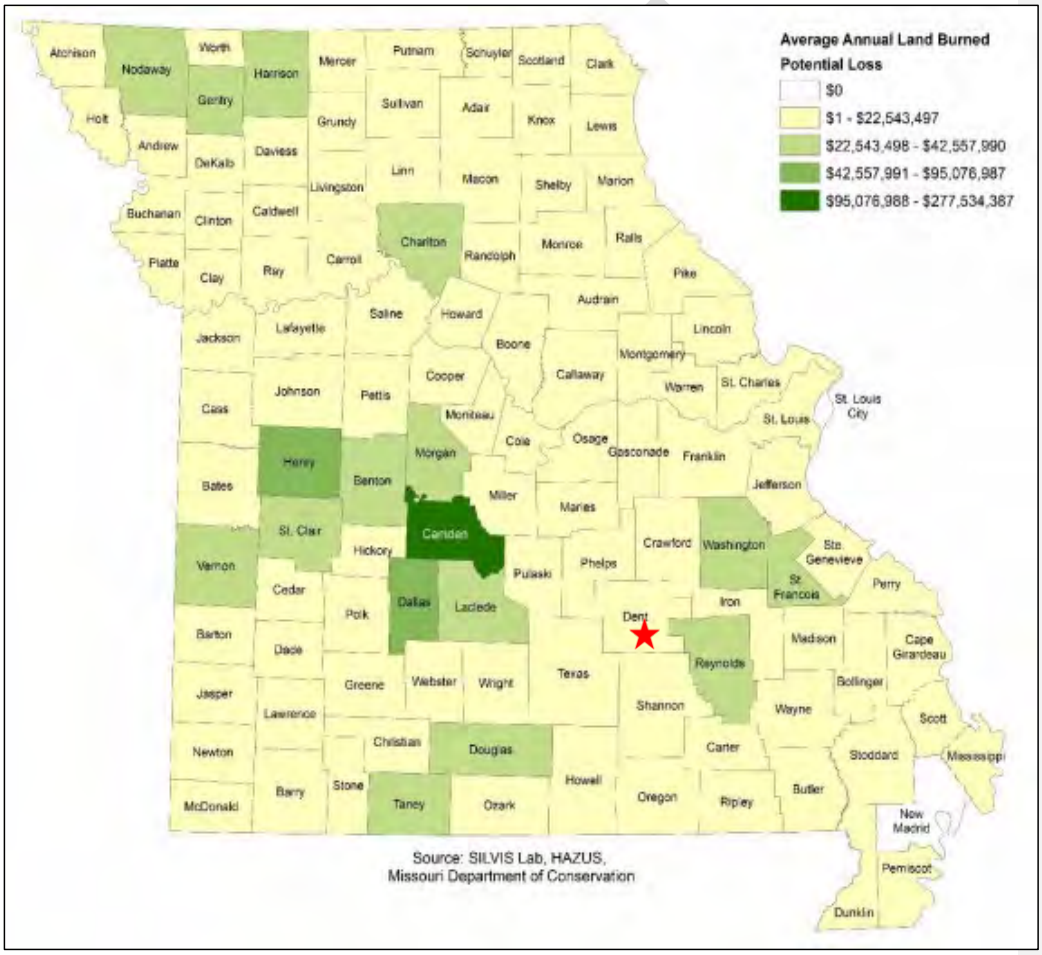
As there was not data available on Dent County specific losses, data was used from the 2018 Missouri State Hazard Mitigation Plan. The factors considered for estimating potential losses due to wildfires were average acreage burned each year per county and the average value of structures per acre in the WU-Interface/Intermix areas. **Table 3.89** and **Figure 3.74** that follows provide the potential loss figures for Dent County based on this methodology.

Table 3.89. Wildfire Potential Loss Estimates for Dent County

Total WUI Acreage	Total Structure Value Within WUI	Average Value/Acre within WUI	Average Annual Acreage Burned	Potential Loss
23,759.51	$652,825,384	$27,476	718	$19,728,046

Source: 2018 Missouri Hazard Mitigation Plan

Figure 3.74. Annualized Wildfire Damages



*Source: 2018 Missouri Hazard Mitigation Plan, *Red star indicates Dent County*

Impact of Future Development

Few future developments are anticipated in WUI areas, however due to lack of data, it is difficult to enumerate. Additionally, as previously mentioned, each jurisdiction within the county resides in a WUI area. This increases the risk of fire hazards for future development.

Hazard Summary by Jurisdiction

As long as drought conditions are not severe, future wildfires in Dent County should have a low-medium adverse impact on the community, depending on the proximity to population centers. Nonetheless, homes, businesses, and schools located in unincorporated areas are at higher risk from wildfires due to proximity to woodland and more importantly, distance from fire services. All cities and school districts are in WUI areas but are closer to fire services.

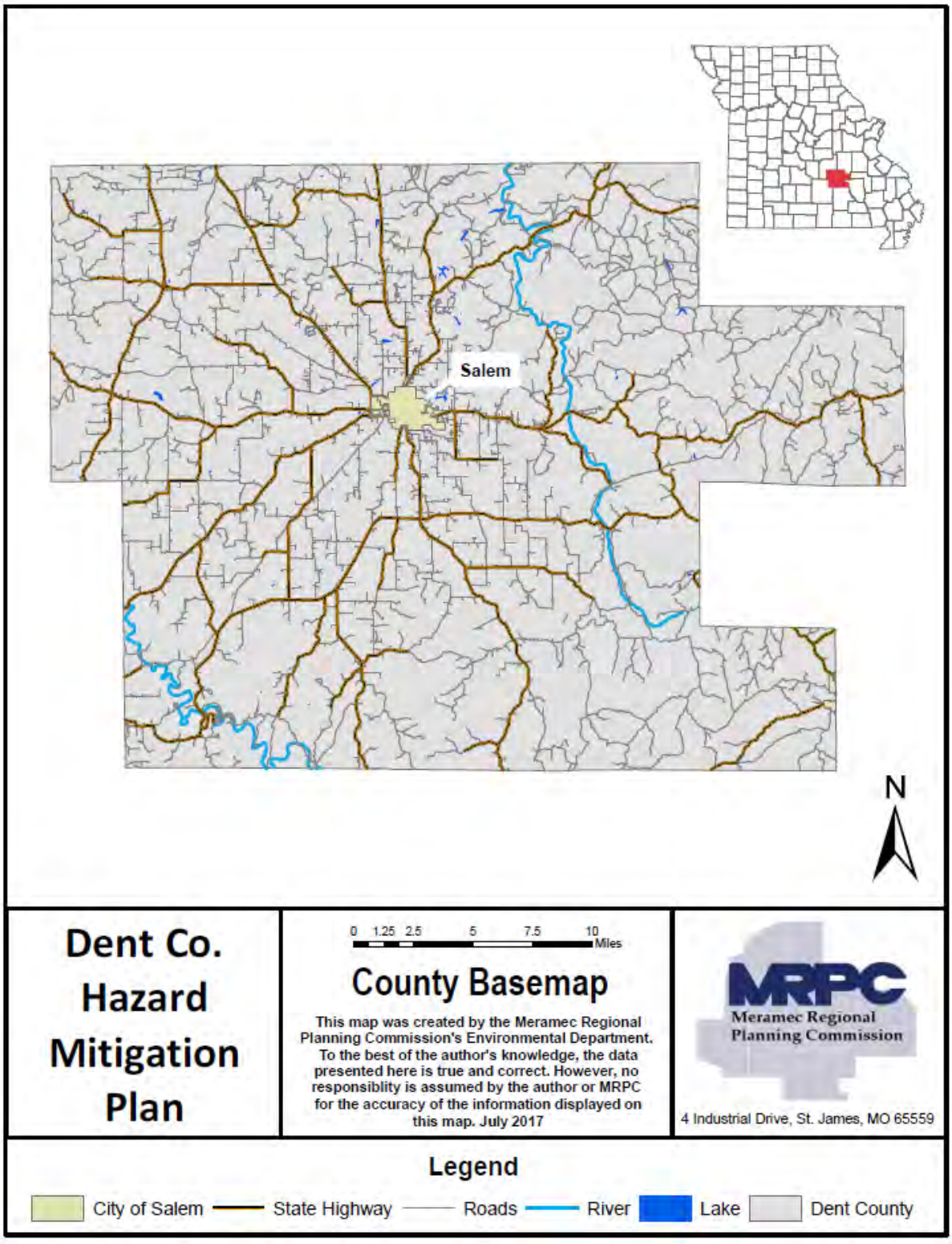
Problem Statement

An estimated 1,996 structures and 2,722 people are vulnerable to wildfires in Dent County. Wildfires are expected to occur on an annual basis. To mitigate adverse impacts a comprehensive community awareness and educational campaign on wildfire danger should be designed and implemented. This campaign should include the development of capabilities, systems, and procedures for pre-deploying fire-fighting resources during times of high wildfire hazards; training of local fire departments for wildfire scenarios; encouraging the development and dissemination of maps relating to the fire hazards (WUI areas) to help educate and assist builders and homeowners in being engaged in wildfire mitigation activities; and guidance of emergency services during response. Residents should be educated on the dangers of wildfires and what steps they can take to mitigate their vulnerability. This could include landscaping and water supply.

2 PLANNING AREA PROFILE AND CAPABILITIES

2.1 Dent County Planning Area Profile

Figure 2.1. Map of Dent County



Dent County has a population of approximately 14,421 according to the most recent census data[1]. **Table 2.1** illustrates the percentage population growth since 2010 as compared to the statewide and national population growth. The median household income and percentage growth since 1999, as compared to statewide and national figures can be found in **Table 2.2.** Furthermore**,** median house value percentage growth for Dent County, Missouri, and the United States is provided in **Table 2.3**.

Table 2.1. Percent Population Growth for County, State, and Nation 2010 - 2020

	Total Population		Change Over Period	
Demographic Region	**2010**	**2020**	**Change**	**Percent**
Missouri	5,814,785	6,154,913	340,128	5.85
United States	300,758,215	331,449,281	30,691,066	10.2
Dent County	15,455	14,421	-1,034	-6.69

Source: U.S. Census Bureau, Census 2010 Summary File 1; U.S. Census Bureau, Census 2020 Redistricting Data

Table 2.2. Median Household Income and Percentage Growth for County, State, and Nation 2010 - 2020

	Median Household Income (USD)		Change Over Period	
Demographic Region	**2010**	**2020**	**Change**	**Percent**
United States	$51,914	$64,994	$13,080	20.1
Missouri	$46,262	$57,290	$20,972	19.2
Dent County	$36,118	$42,714	$6,596	18.3

Source: U.S. Census Bureau, 2006-2010 and 2016-2020 5-Year American Community Survey

Table 2.3. Median House Value Percentage Growth for County, State, and Nation 2010 - 2020

	Median House Value (USD)		Change Over Period	
Demographic Region	**2010**	**2020**	**Change**	**Percent**
United States	$188,400	$229,800	$41,400	18.02
Missouri	$137,700	$163,600	$25,900	15.8
Dent County	$84,100	$104,900	$20,800	24.7

Source: U.S. Census Bureau, 2006-2010 and 2016-2020 5-Year American Community Survey

2.1.2 Geography, Geology and Topography

Dent County has a total land area of 755 square miles. Approximately 60 percent of the land cover in the county is deciduous forest intermixed with 30 percent of grassland. Less than one percent of the land cover within the county is cropland. The area has karst terrain, which is characterized by springs, caves, losing streams, and sinkholes. Additionally, the county is comprised of 1.7 square miles of total water area. Incorporated jurisdictions within the county include the City of Salem.

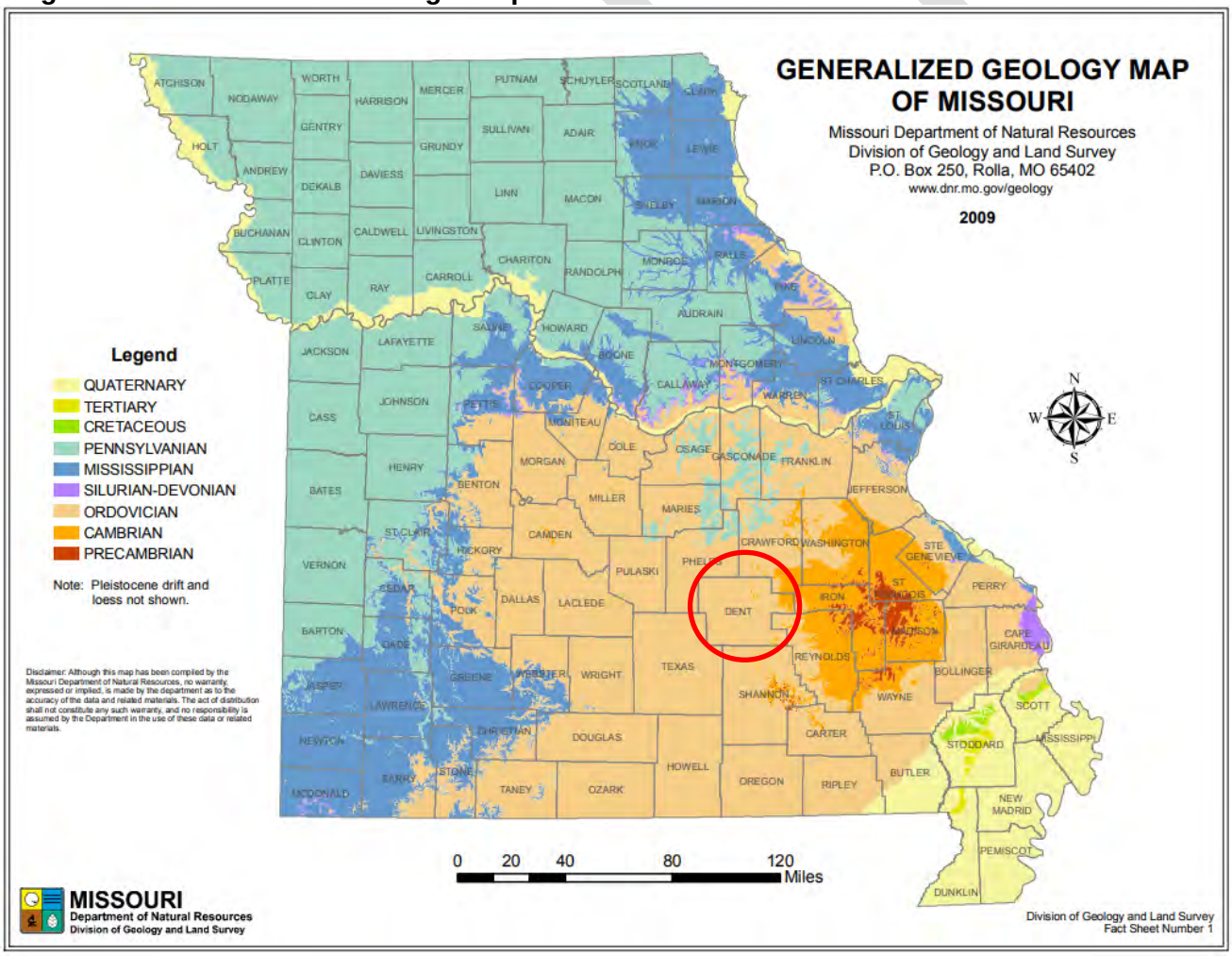
The county seat, Salem, is located in southeast central Missouri, approximately 75 miles

[1] U.S. Census Bureau, 2015-2019 American Community Survey 5-Year Estimates

southeast of the state capital of Jefferson City, approximately 100 miles northeast of Springfield, Mo. and approximately 98 miles southwest of St. Louis, Mo. The county is bordered on the north by Phelps and Crawford Counties. On the east side the county is bordered by Iron and Reynolds Counties. To the south the county is bordered by Shannon County. Texas County shares a border with Phelps to the west.

Located within the Ozark Mountains, Dent County specifically resides within the Salem Plateau and the interior Ozark Highlands. The county is located in the largest outcrop area of Ordovician-age rocks in the United States. This rock is 505 to 441 million years old and made up primarily of carbonates and thin shales with three distinctive sandstone layers: the Gunter at the base of the column, the red and white Roubidoux which is often used as a building stone and the St. Peter glass sand. This stone is the result of a time period when Missouri was covered by a shallow sea and the stone frequently produces aquatic fossils from that time period. Portions of this formation contain rock that dissolves and fractures over time from rainwater, thus resulting in the karst features found throughout the Ozarks. **Figure 2.2** depicts a generalized geologic map of Missouri and its counties.

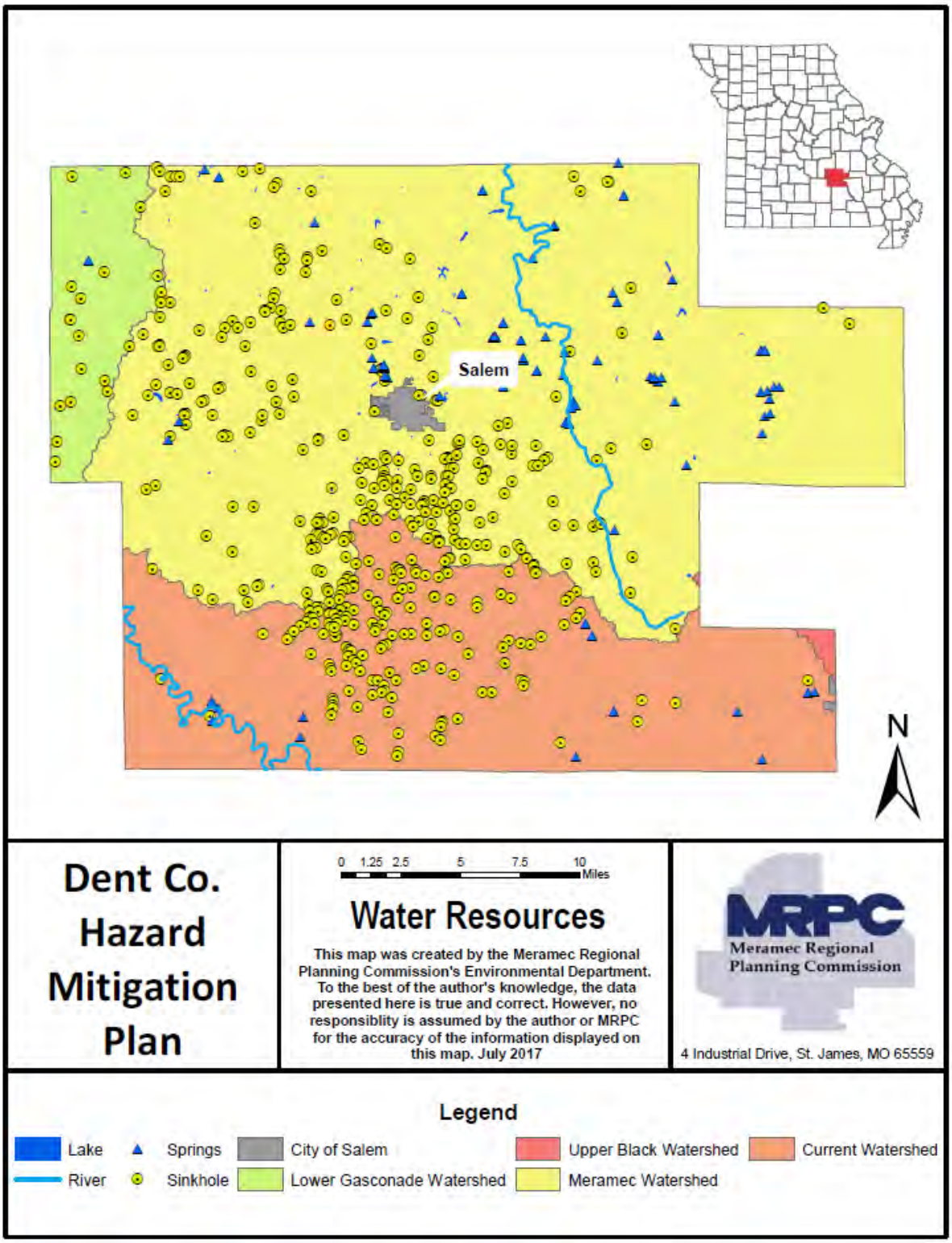
Figure 2.2. Generalized Geologic Map of Missouri



Source: https://dnr.mo.gov/document-search/generalized-geologic-map-missouri-pub2514/pub2514 **Red circle indicates Dent County*

The plateau is centered around the City of Salem with a gently rolling topography. To the east of Salem, the terrain becomes more rugged, with steep, sloping hills. The Current River Watershed area is characterized by very rough terrain and extremely steep, sloping valleys. The maximum relief is about 500 feet, with the high point on a ridge south of Salem, and the low points near the north and south borders of the county.

Figure 2.3. Dent County Watershed/Water Resources



Dent County is comprised of four HUC8 watersheds which include the Lower Gasconade, Upper Black, Meramec, and Current. Seven miles northeast of the town of Salem in Southeastern Missouri, a spring-fed brook called the Watery Fork merges with a larger wet-weather branch and becomes the source of the Meramec River. For many millions of years the Meramec has been carving its twisting, sometimes-tortuous 240-mile course into the solid rock of the Ozark Plateau, scouring its way through a deep, slowly widening valley, bordered by limestone bluffs and steep hills. It is joined along the way by innumerable springs, creeks, and four large tributaries, which transform the Meramec into a 100-yard to 200-yard wide floodplain stream at its confluence with the Mississippi River eighteen miles below St. Louis.

The Current River is the most spring-fed of all of the Ozark Rivers. The watershed drains approximately 2,621 square miles in 9 Missouri counties and 2 Arkansas counties. The Current River is formed by the emergence of Pigeon Creek and the Montauk Spring complex near Montauk, Missouri. The river flows south towards the Black River in Arkansas.

During the last 100 years, stream channels in the Ozarks have become wider and shallower and deep-water fish habitat has been lost. Historical data indicate that channel disturbances have resulted most directly from clearing of vegetation along stream channels, which decreases bank strength. Historical and stratigraphic data show that after 1830, Ozarks streams responded to land-use changes by depositing more gravel and less muddy sediment, compared to pre-settlement conditions. Because less muddy sediment is being deposited on flood plains, many stream banks now lack cohesive sediments, and, therefore, no longer support steep banks. Land use statistics indicate that the present trend in the rural Ozarks is toward increased populations of cattle and increased grazing density; this trend has the potential to continue the historical stream-channel disturbance by increasing storm-water runoff and sediment supply.

Dent County has several soil types. The northwestern part of the county is associated with Nixa-Clarksville-Lebanon-Hobson soils, which are gently sloping to moderately steep, somewhat excessively drained to moderately well drained soils that have a fragipan, a cherty subsoil, or both. Towards the eastern and southern part of the county soils part of the Clarksville-Coulstone association are located. This association is considered steep, somewhat excessively drain, and cherty. Lastly, soil associated with Huzzah Creek and Sinking Creek are categorized as Clarksville-Coulstone which is steep, somewhat excessively drained and well drained soils that have a cherty surface layer and a cherty or clayey subsoil[2].

2.1.3 Climate

Snowfall typically occurs November to March and averages about 8 to 12 inches in the Meramec Region. It is unusual for snow to stay on the ground for more than a week or two before it melts. Winter precipitation usually is in the form of rain, snow or both. Conditions sometimes borderline between rain and snow, and in these situations freezing drizzle or freezing rain occurs. Spring, summer and early fall precipitation comes largely in the form of showers or thunderstorms. Thunderstorms are most frequent from April to July. Measurable precipitation occurs on the average of less than 100 days per year. About half of these will be days with thunderstorms. The average annual precipitation is 47.21 inches. Most of the precipitation is absorbed by the soil

[2] Soil Survey, Dent County, Missouri, USDA, SCS, USFS, March 1971

and plants; however, a portion of the precipitation forms runoff and is returned to streams and other bodies of water.

Because of its inland location, Missouri and Dent County are subject to frequent changes in temperature. The average annual temperature is 57.35°F. The average annual high temperature is 68.7°F with the average annual low at 46°F. The average high and low in January is 44°F and 23°F, respectively. In August the average high and low are 90°F and 66°F, respectively.

While winters are cold and summers are hot, prolonged periods of very hot weather are unusual. Occasional periods of mild, above freezing temperatures are noted almost every winter. Conversely, during the peak of the summer season occasional periods of dry, cool weather break up stretches of hot, humid weather. In the summer, temperatures rise to 90°F or higher on average 55 to 60 days. In winter, there is an average of about 100 days with temperatures below 32 degrees. Temperatures below 0°F are infrequent with only about three days per year reaching this low temperature. The first frost occurs in mid-October, and the last frost occurs about mid-April[3].

2.1.4 Population/Demographics

Table 2.3 provides population/demographic data for Dent County between 2000 and 2020 by jurisdiction. The unincorporated area of Dent County was determined by subtracting the populations of the incorporated areas from the overall county population.

Table 2.4. Dent County Population 2010-2020 by Jurisdiction

Jurisdiction	2000 Population	2010 Population	2020 Population	2010-2020 # Change	2010-2020 % Change
Unincorporated Dent County	10,073	10,627	9,813	-814	-7.66%
Salem	4,854	4,828	4,608	-220	-4.56%

Source: U.S. Census Bureau, Census 2000 Summary File 1; Census 2010 Summary File 1; Census 2020 Redistricting Data

Table 2.4 provides information in regard to the percent of individuals under the age of 5, and over 65 for the county, State, and Nation. In addition, average household size is illustrated in **Table 2.5** including figures for Dent County, Missouri, and the U.S. In 2020 there were an estimated 6,819 households within the county[4].

Table 2.5. Percent of Individuals Under the Age of 5, and Over 65 for County, State, and Nation (2019)

Location	% Under Age of 5	% Over Age of 65
Dent County	5.6	21.9
Missouri	6.1	16.9
United States	6.0	16.0

Source: U.S. Census Bureau, 2016-2020 American Community Survey 5-Year Estimates

[3] Decker, W.L., 2017, Climate of Missouri, Missouri Climate Center, College of Agriculture, Food, and Natural Resources
[4] U.S. Census Bureau, 2020 Decennial Redistricting Data

Table 2.6. 2019 Average Household Size for County, State, and Nation

Location	Average Household Size
Dent County	2.40
Missouri	2.44
United States	2.60

Source: U.S. Census Bureau, 2016-2020 American Community Survey 5-Year Estimates

Social Vulnerability Index (SoVI ®)

The University of South Carolina developed the Social Vulnerability Index to evaluate and rank the ability to respond to, cope with, recover from, and adapt to natural disasters. The index synthesizes 30 socioeconomic variables which are primarily derived from the United States Census Bureau. **Table 2.6** depicts the Social Vulnerability Index for Dent County along with its national percentile.

Table 2.7. Social Vulnerability Index (SoVI ®)

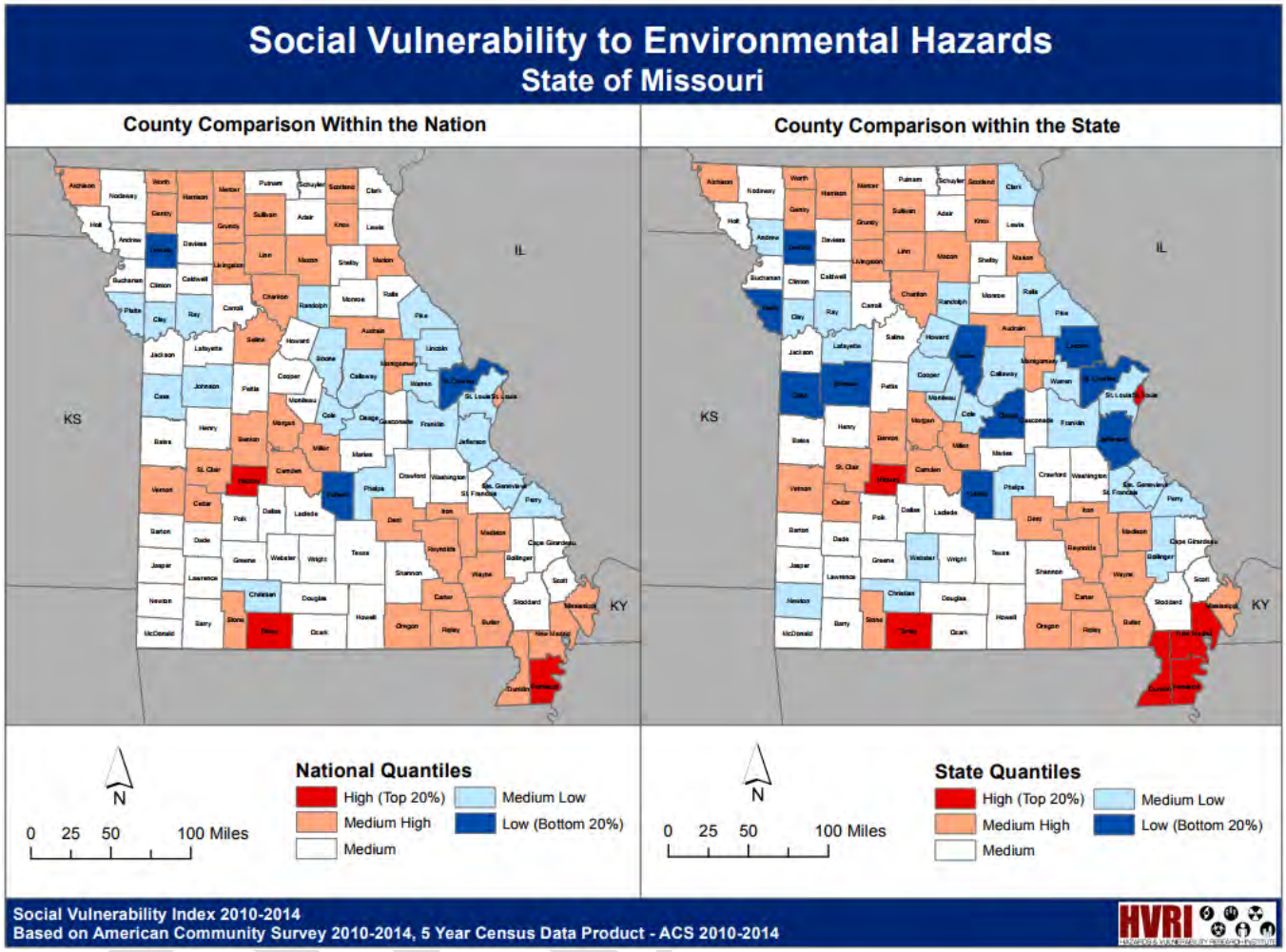
State	County	SoVI Score (10 - 14)	National Percentile (10 - 14)
Missouri	Dent County	1.950000048	80.4%

Source: http://artsandsciences.sc.edu/geog/hvri/sovi-data

The analysis of 30 socioeconomic variables includes the standardization of data, and reduction of variables into a condensed set of statistically optimized components; positive component loadings (+) are linked with amplified vulnerability, and negative component loadings (-) are linked with diminished vulnerability. Scores are represented as a numeric value, but have no inherent mathematical properties. To simplify the metrics of the SoVI ® Score, a negative number illustrates a county's resiliency to hazard events, and a positive number illustrates a decrease in resiliency[5]. Dent County's SoVI ® Score illustrates a diminished vulnerability to cope with natural disasters. Additionally, Dent County is ranked 80.4 percent nationally, for counties most vulnerable to environmental hazards. **Figure 2.4** depicts Missouri's SoVI ® to environmental hazards between 2010 and 2014. Furthermore, **Figure 2.5** depicts the Nation's SoVI ® to environmental hazards between 2010 and 2014.

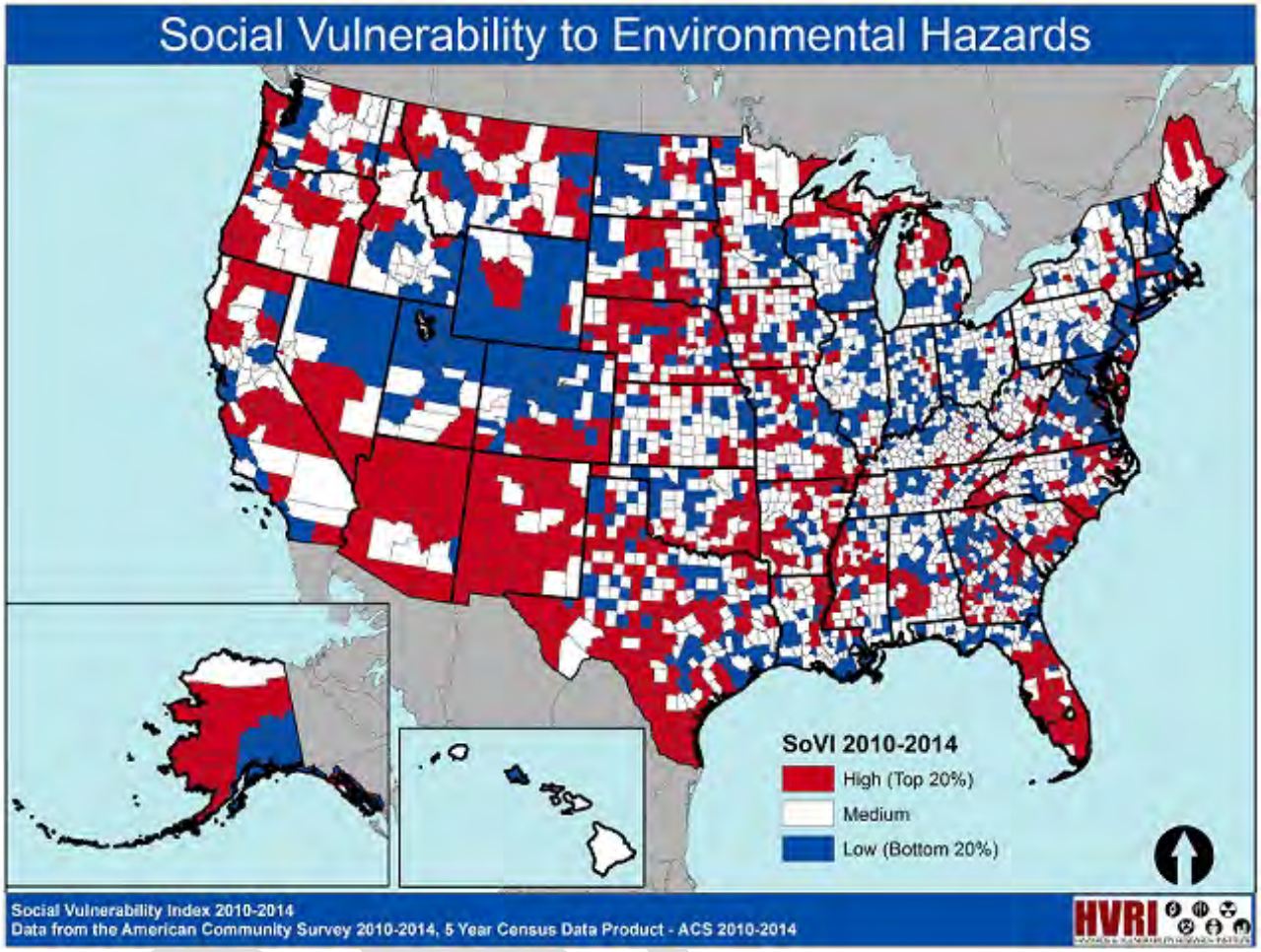
[5] http://webra.cas.sc.edu/hvri/products/sovifaq.aspx

Figure 2.4. 2010 – 2014 Missouri Social Vulnerability to Environmental Hazards (SoVI ®)



Source: http://artsandsciences.sc.edu/geog/hvri/sites/sc.edu.geog.hvri/files/attachments/MO_1014.pdf

Figure 2.5. 2010 – 2014 U.S. Social Vulnerability to Environmental Hazards (SoVI ®)



Source: http://artsandsciences.sc.edu/geog/hvri/sovi%C2%AE-0

Table 2.7 provides additional demographic and economic indicators for Dent County.

Table 2.8. 2019 Unemployment, Poverty, Education, and Language Percentage Demographics, Dent County, Missouri

Jurisdiction	% in Labor Force	% of Population Unemployed	% of Families Below the Poverty Level	High School Diploma ONLY, ages 25+ (%)	Bachelor's degree or higher, ages 25+ (%)	% of population language spoken at home other than English
Dent County	55.3	5.2	11.8	39.2	14.9	1.7
Salem	55.6	7.9	16.3	37.2	13.8	2.3

Source: U.S. Census Bureau, 2016-2020 American Community Survey, 5-Year American Community Survey

2.1.5 History

It is uncertain whether remains of mounds, earthworks, pottery and other artifacts found in Dent County were left by the pre-historic people known as Mound Builders or by earlier races of Native Americans. It is known, however, that the Native Americans who roamed the region attributed these artifacts to people who have lived long before their time.

Early records indicate that the Native Americans made little trouble for the early settlers in the area. As late as 1838, Native Americans were passing through the county on the White River Trail. The Trail became one of the branches of the Trail of Tears, which many Cherokees were forced to travel along to Oklahoma.

Henry Rowe Schoolcraft was one of the earliest visitors to Dent County. In 1818, Schoolcraft and Levi Pettibone left the Potosi area and ended up at the Current River before returning home. It wasn't until around 1829, that the first settlers came to the area. The first white settler was George Cole, who cultivated a farm on the Meramec. The site later became the location of the Nelson Mill.

Land in the county could be purchased for five cents or less an acre. William Thornton, Daniel Troutman and Daniel W. Wooliver were among the 1829 settlers, followed by William Blackwell, Elisha Nelson, Jerry Potts, Ephraim Bressie, Robert Leonard, Abner Wingfield, Lewis Dent, Wilson Craddock, Thomas Higginbotham, Jack Berry, Silas Hamby, Smith Wofford, Turkill McNeill, Dr. John Hyer, Samuel Hyer and David Lenox.

The Missouri Assembly created Dent County on February 10, 1851, reducing the size of neighboring Crawford and Shannon Counties. The county was named after Lewis Dent, who served as the first representative. The first officers in the county included G.D Breckenridge, Samuel Hyer, Jr., and Jotham Clark. Joseph Millsap and David Henderson were the sheriff and clerk, respectively.

A log courthouse, built in 1851-52, was Dent County's first, located on the Wingfield farm northeast of Salem. In 1852-53 a courthouse was built south of the present courthouse. The courthouse was used as a military headquarters until 1864. In October of that year, while federal troops were away from the area, two Dent County citizens – Simeon Richardson and James Jamison – burned the courthouse and jail. Because of the fire, the court was forced to meet in a store belonging to Judge W.P. Williams. The next courthouse built in 1864, also fell victim to fire in May 1866. The beautiful Victorian courthouse which is listed in the National Registry of Historic Places was built in 1870.

It was not until 1853 that the present site of the county seat was designated in Salem. Previously the court meetings were held either at the home of Mr. Bressie or Mr. Wingfield near what later became Salem on Spring Creek. Salem was established in 1853, and a brick courthouse erected shortly thereafter. Perhaps when the founders named the town, they had in mind the ancient biblical city of Salem in Cannan, later identified with Jerusalem. In 1860, the first mayor of Salem was elected. A year later, the Civil War came and city governments were suspended. It is likely the governments regain function starting in 1870.

Salem grew to a population of between 600 and 800 people by the opening of the Civil War. After the close of the war, Salem recuperated slowly. The construction of the railway and the opening of the mines during 1872 caused a booming growth. By the time of the panic of 1873, the population had reached approximately 1,100[6,7].

[6] Meramec Regional Planning Commission, Comprehensive Economic Development Strategy, 2013 Revision
[7] S. Charles, Edited by S. Tubbs. History of Dent County, Missouri. Accessed September 2017.

2.1.6 Occupations

Table 2.9 provides occupation statistics for the incorporated jurisdictions and incorporated county.

Table 2.9. Occupation Statistics, Dent County, Missouri

Place	% in Management, Business, Science, and Arts Occupations	% in Service Occupations	% in Sales and Office Occupations	% in Natural Resources, Construction, and Maintenance Occupations	% in Production, Transportation, and Material Moving Occupations
Dent County	28.7	24.7	16.2	10.1	20.3
Salem	28.1	22.9	15.4	8.6	25.1

Source: U.S. Census, 2016-2020 American Community Survey, 5-year Estimates.

2.1.7 Agriculture

Due to the rural nature of the area, agriculture and timber are significant factors in the local economy. According to the 2012 Census of Agriculture, the number of farms in the County was 673 encompassing 188,060 total acres[8]. In addition, the average farm was 279 acres. According to the 2017 Census of Agriculture, Dent County had increased to 694 farms encompassing 189,505 acres, with an average farm size of 273 acres[9]. Furthermore, there are approximately 40 farms with 1,000 or more acres in the County. Due to the rugged nature of the region, row crop farming is for the most part limited to the river valleys. In 2017, 20,565 acres of cropland were harvested, with forage (hay, haylage, grass silage, and greenchop) being the top crop in the County. Moreover, 34,792 cattle and calves were raised. The average sale per farm was $31,438. Lastly, the total number of hired workers in the County was 284[10] individuals comprising 4.45%[11] of the total workforce.

The Ozarks region of Missouri is the focal point of several converging ranges of plant associations. Eastern hardwoods, southern pines and western prairies and the wildlife each supports, all reach the outward limits of their range in this area. As a result, various types of forest lands and animal habitats co-exist within a limited area. Several sawmills operate in the area and the large amount of National Forest Lands in the region also contribute to the importance of timber production and logging to the local economy.

2.1.8 FEMA Hazard Mitigation Assistance Grants in Planning Area

FEMA's Hazard Mitigation Assistance (HMA) grant program provides funding for mitigation activities which have the potential to reduce disaster losses and protect life and property from future disaster damages[12]. Previous FEMA HMA Grants issued in the planning area can be found in **Table 2.9**.

[8] 2012 Census of Agriculture, USDA, National Agriculture Statistics Service
[9] Source: 2017 Census of Agriculture – County Data, USDA, National Agriculture Statistics Service
[10] https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/Missouri/
[11] U.S. Census Bureau, 2015-2019 American Community Survey
[12] https://www.fema.gov/media-library/assets/documents/103279

Table 2.10. FEMA HMA Grants in County from 1999-2019

Project Type	Sub applicant	Declaration	Project Total ($)
-	-	-	-
Total			$0

Source: Missouri SEMA, https:/www.fema.gov/openfema-dataset-hazard-mitigation-grants-v1

2.1.9 FEMA Public Assistance (PA) Grants in Planning Area

The purpose of the Public Assistance (PA) Grant Program is to support communities' recovery from major disasters by providing them with grant assistance for debris removal, life-saving emergency protective measures, and restoring public infrastructure. Local governments, states, tribes, territories and certain private nonprofit organizations are eligible to apply. Public Assistance is FEMA's largest grant program. **Table 2.10** below gives information about all Public Assistance Grant for the Planning area. It gives the Declaration number, project type and size, the applicant, and the project total. Total PA grants is $1,394,054.58.

Table 2.11. FEMA PA Grants in Dent County from 1999-2019

Disaster Declaration	Project Type	Project Size	Applicant	Project Total
1412	REPAIR BALL FIELD AND BRIDGE	Small	SALEM	$1,024.65
1412	DEBRIS REMOVAL	Small	SALEM	$4,505.52
1412	ROAD WASHOUTS	Small	DENT COUNTY	$49,779.11
1412	ROAD/CULVERT CROSSING	Small	DENT COUNTY	$42,624.76
1412	ROAD WASHOUT	Small	DENT COUNTY	$15,319.42
1412	ROAD AND BRIDGE REPAIR	Small	DENT COUNTY	$42,491.83
1412	ROADS/BRIDGE DAMAGE	Small	DENT COUNTY	$14,325.90
1412	ROADS / BRIDGE DAMAGE	Small	DENT COUNTY	$13,777.70
1412	ROAD/BRIDGE DAMAGE	Large	DENT COUNTY	$48,003.36
1749	CULVERT/ROAD WASHOUT	Small	DENT COUNTY	$19,606.50
1749	ROAD / CULVERT WASHOUT	Small	DENT COUNTY	$32,528.51
1749	CULVERT AND ROAD DAMAGES	Small	DENT COUNTY	$23,656.08
1749	ROAD WASHOUT	Small	DENT COUNTY	$45,895.47
1749	ROAD / CULVERT WASHOUT	Small	DENT COUNTY	$22,570.96
1749	ROAD WASHOUT	Small	DENT COUNTY	$14,215.50
1749	ROAD WASHOUTS	Small	DENT COUNTY	$18,640.81
1749	ROAD / CULVERT WASHOUT	Small	DENT COUNTY	$38,223.25
1749	ROAD, CULVERT & BRIDGE WASHOUT	Small	DENT COUNTY	$23,021.20
1749	ROAD AND CULVERT WASHOUT	Small	DENT COUNTY	$18,013.30
1749	ROAD EROSION	Small	DENT COUNTY	$13,721.38
1749	ROAD WASHOUT	Small	DENT COUNTY	$21,018.59

1749	ROAD WASHOUT	Small	DENT COUNTY	$23,554.67
1749	ROADS & CULVERT WASHOUTS	Small	DENT COUNTY	$3,399.99
1809	Debris-DENT-A1	Small	DENT COUNTY	$2,209.21
1809	PA Pilot DENT-A2	Small	DENT COUNTY	$2,050.35
1809	Dent C-2 Erosion	Small	DENT COUNTY	$25,679.73
1809	Rd. Dist. #1 - DENT-C1	Small	DENT COUNTY	$15,931.91
1847	CS01B-Emergency Protective Measures	Small	SALEM	$2,265.81
1847	CS01F /Distribution Lines, poles transformers, etc	Small	SALEM	$44,372.23
1847	CS01A / Debris	Large	SALEM	$111,767.47
1847	CS01E / Buildings	Small	SALEM	$1,000.00
1847	DC-A1-Debris Removal (Dist. 2)	Small	DENT COUNTY	$7,213.70
1847	DC-B1-Emergency Protective Measures (Dist. 2)	Small	DENT COUNTY	$4,559.01
1847	DCJPCO1-Aggregate County Roads	Small	DENT COUNTY	$24,202.25
1847	DC-A2 / Debris Removal (Dist. 1)	Small	DENT COUNTY	$21,818.21
1847	DCTBC02 - Aggregate County Roads	Small	DENT COUNTY	$1,843.08
1847	DCJPC03-Aggregate County Roads	Small	DENT COUNTY	$34,060.77
1847	DCTBC07 / (Dist 1) 16 Sites of County Aggregate Surf Rd	Small	DENT COUNTY	$2,505.58
1847	DCJPC05 / Aggregate County Roads, 18 Road Sites	Small	DENT COUNTY	$21,426.79
1847	DCTBC04 / 7 Sites of County Aggregate Surfaced Roads	Small	DENT COUNTY	$7,623.93
1847	DC-C1 / Roads	Small	DENT COUNTY	$34,334.60
1847	DCJPC06 / Aggregate County Roads, 24 Road Sites	Small	DENT COUNTY	$36,969.24
1847	DCJPC08 / Aggregate County Roads, 6 Road Sites	Small	DENT COUNTY	$57,256.68
1847	DCTBC09 / (Dist 9) 9 Sites of Co Aggregate Surface Rds	Small	DENT COUNTY	$4,519.93
1847	DC-C2 / Road Scouring	Small	DENT COUNTY	$44,051.64
1847	DCTBC10 - (District 1) 4 Sites of Dent County Roads	Small	DENT COUNTY	$17,771.96
1847	DCTBC14 / (District 2) 5 Sites of County Aggregate	Small	DENT COUNTY	$22,171.00

1847	DCJPC12 / Aggregate Surface Roads, 13 Road Sites	Small	DENT COUNTY	$51,784.11
1847	DCJPC13 - Chip and Seal County Roads, 11 Road Sites	Small	DENT COUNTY	$62,069.69
1847	DCJPC11 / Aggregate County Roads, 11 Road Sites	Small	DENT COUNTY	$38,473.38
1847	DCFP1B / Emergency Protective Measures	Small	DENT COUNTY FIRE PROTECTION DISTRICT	$17,330.85
3267	DEBRIS REMOVAL	Small	SALEM	$3,221.37
3267	EMERGENCY PROTECTIVE MEASURES	Small	SALEM	$6,130.61
3267	DEBRIS REMOVAL	Small	DENT COUNTY	$1,704.45
3267	EMERGENCY PROTECTIVE MEASURES	Small	DENT COUNTY FIRE PROTECTION DISTRICT	$0.00
4317	CP01890 - Dent Co., county roads division 1	Small	DENT COUNTY	$64,317.49
4317	CP02745 - Category C- Dent County Div II Roads	Small	DENT COUNTY	$51,499.09
			TOTAL	**$1,394,054.58**

Source: Federal Emergency Management Agency, 06/09/2022

2.2 Jurisdictional Profiles and Mitigation Capabilities

This section will include individual profiles for each participating jurisdiction. It will also include a discussion of previous mitigation initiatives in the planning area. There will be 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 incorporated communities, the special districts, and the public-school districts.

2.2.1 Unincorporated Dent County

Overview

The jurisdiction of Dent County includes all unincorporated areas within the county boundaries. Dent County is governed by a three-member County Commission. The Commission is composed of a presiding commissioner, representing all of the county's population who is elected for a four-year term. Two associate commissioners representing roughly half the county's population each, are elected for four-year terms. The commission meets on Mondays. Other elected county officials include the County Clerk, Associate Circuit Judge, Prosecuting Attorney, Sheriff, Circuit Court Clerk, Recorder of Deeds, Collector of Revenue, Assessor, Treasurer, County Surveyor, Coroner, and Public Administrator.

Technical and Fiscal Resources

The county government has the authority to administer county structures, infrastructure, and finances. Third class counties do not have the authority to enforce building regulations. Dent County has staff resources emergency management and transportation. The county has a 9-1-1 central dispatch center located at the Dent County Sheriff's Office. Additionally, there are no outdoor warning sires in the county.

There are four fire departments located in Dent County. Three are volunteer departments. Those departments include Jadwin Volunteer Fire Department, Lenox Rural Fire Department and Montauk Rural Fire Department. Dent County Fire Protection District is tax supported. Jadwin, Lenox, and Montauk are dues supported. The county is served by the Dent County Sheriff's Department. The county has a 9-1-1 Central Dispatch Center located at the Dent County Sheriff's Office, 112 East 5th Street, Salem, MO. The county is served by the Salem Memorial Hospital Ambulance. The Sheriff's Office has text notification to provide alerts to residents. The county owns three fixed generators.

Fiscal tools or resources that the county could potentially use to help fund mitigation activities include Community Development Block Grants, capital improvements project funding, levy taxes for specific purposes, incur debt through general obligation bonds, and incur debt through special tax bonds.

Existing Plans and Policies

The county has an Emergency Operations Plan, Economic Development Plan, Regional Transportation Plan, and Land-use Plan.

Other Mitigation Activities

The Office of Emergency Management, local fire departments, Sheriff's Department and the Dent County Health Department have attempted to raise awareness and increase preparedness among the county's population. Education has included flood recovery awareness, fire safety, storm preparedness, heat wave preparedness, and general press releases/social media outreach regarding hazards, preparedness, and mitigation. Bicycle and car seat safety education is provided by the Coalition for Roadway Safety.

The county sizes up culverts as necessary. American Rescue Plan Act (ARPA) funds were used since the last plan to purchase a UTV for search and rescue.

The unincorporated county has a higher percentage of manufactured homes at over 27 percent. A high percentage of manufactured homes leads to an increased risk of damages during a natural disaster.

Table 2.12. Demographic and Structure Risk Parameters For Unincorporated Dent County

Jurisdiction	Total Population	People With a Disability	Non-English Speaking Populations	People Below Poverty Level	Population Under 5 Yrs.	Population 65 Yrs. and Over	Residences Built Prior to 1939	Mobile Homes
Unincorporated Dent County	10,614	2,143	152	1,611	489	2,166	316	1,101

Source: U.S. Census Bureau, 2016-2020 5-Years American Community Survey

Table 2.13. Unincorporated Dent County Mitigation Capabilities

Capabilities	Status Including Date of Document or Policy
Planning Capabilities	
Comprehensive Plan	No
Builder's Plan	No
Capital Improvement Plan	No
City Emergency Operations Plan	n/a
County Emergency Operations Plan	Yes
Local Recovery Plan	No
County Recovery Plan	No
City Mitigation Plan	n/a
County Mitigation Plan	Yes - 2018
Debris Management Plan	No
Economic Development Plan	Yes – Regional CEDS 2018
Transportation Plan	Yes – Regional 2019
Land-use Plan	Yes – 5/11/1998
Flood Mitigation Assistance (FMA) Plan	No
Watershed Plan	No
Firewise or other fire mitigation plan	No
Critical Facilities Plan (Mitigation/Response/Recovery)	No
Policies/Ordinance	
Zoning Ordinance	No
Building Code	No
Floodplain Ordinance	No

Capabilities	Status Including Date of Document or Policy
Subdivision Ordinance	N/A
Tree Trimming Ordinance	No
Nuisance Ordinance	No
Storm Water Ordinance	No
Drainage Ordinance	No
Site Plan Review Requirements	No
Historic Preservation Ordinance	No
Landscape Ordinance	No
Program	
Zoning/Land Use Restrictions	No
Codes Building Site/Design	No
Hazard Awareness Program	No
National Flood Insurance Program	No
NFIP Community Rating System (CRS) Participating Community	No
National Weather Service (NWS) Storm Ready	No
FireWise Community Certification	No
Building Code Effectiveness Grading (BCEGs)	No
ISO Fire Rating	9
Economic Development Program	No
Land Use Program	No
Public Education/Awareness	No
Property Acquisition	No
Planning/Zoning Boards	No
Stream Maintenance Program	No
Tree Trimming Program	No
Engineering Studies for Streams (Local/County/Regional)	No
Mutual Aid Agreements	Yes
Studies/Reports/Maps	
Hazard Analysis/Risk Assessment (City)	N/A
Hazard Analysis/Risk Assessment (County)	Yes – Hazard Mitigation (2018) & Hazardous Materials (annual) Plans
Evacuation Route Map	Yes
Critical Facilities Inventory	Yes – Hazard Mitigation (2018) & Hazardous Materials (annual) Plans
Vulnerable Population Inventory	No
Land Use Map	No
Staff/Department	
Building Code Official	N/A
Building Inspector	No
Mapping Specialist (GIS)	No
Engineer	No
Development Planner	No
Public Works Official	No
Emergency Management Director	Yes
NFIP Floodplain Administrator	N/A
Bomb and/or Arson Squad	No
Emergency Response Team	No
Hazardous Materials Expert	No
Local Emergency Planning Committee	Yes – Regional - MLEPD
County Emergency Management Commission	No
Sanitation Department	No
Transportation Department	Yes

Capabilities	Status Including Date of Document or Policy
Economic Development Department	No
Housing Department	Yes - Phelps Co. PHA
Regional Planning Agencies	Yes - MRPC
Historic Preservation	No
Non-Governmental Organizations (NGOs)	
American Red Cross	Yes
Salvation Army	Yes
Veterans Groups	Yes
Environmental Organization	No
Homeowner Associations	Yes
Neighborhood Associations	No
Chamber of Commerce	Yes
Community Organizations (Lions, Kiwanis, etc.)	Yes
Local Funding Availability	
Ability to apply for Community Development Block Grants	Yes
Ability to fund projects through Capital Improvements funding	Yes
Authority to levy taxes for a specific purpose	Yes
Fees for water, sewer, gas, or electric services	No
Impact fees for new development	No
Ability to incur debt through general obligation bonds	Yes
Ability to incur debt through special tax bonds	Yes
Ability to incur debt through private activities	No
Ability to withhold spending in hazard prone areas	No

Source: Data Collection Questionnaire, 2022

2.2.2 City of Salem

Overview

Salem is located in the central portion of Dent County. State highways 72, 68, 19, and 32 intersect the City of Salem. Salem is incorporated as a fourth class city (1881) with a four member board of aldermen and a mayor. The city employs a City Clerk, City Attorney, City Administrator, Chief of Police, Building Inspector/Building Code Official, NFIP Floodplain Administrator, and Emergency Management Coordinator. The city population from the 2020 5-year ACS data is 4,904, in 2010 it was 4,828, which shows a slight population growth of one and a half percent.

Technical and Fiscal Resources

Ambulance service is provided by the Salem Memorial District Hospital in Salem. There is also a Volunteer Fire Department within the community. The Sherriff's Department houses and operates the 9-1-1 system located in Salem. The city operates seven warning sirens which is controlled by the Salem Police Department, Dent County EMD, City EMD, or other authorized officials. The city has almost completed the process of implementing an AMI system for city utilities. The Meramec Regional Planning Commission serves as the floodplain coordinator for the city.

Existing Plans and Policies

Salem is a participating community in the National Flood Insurance Program. The city has a Comprehensive Plan, Capital Improvement Plan, City Emergency Operations Plan, Debris Management Plan, Economic Development Plan, Regional Transportation Plan, Land-Use Plan, Critical Facilities Plan.

Other Mitigation Activities

Public education programs regarding preparations for weather events, water and energy conservation are provided locally through social media. Bicycle and car seat safety education is provided by the Coalition for Roadway Safety.

The city has higher percentages than the unincorporated county of population with disabilities, below the poverty line, under the age of 5, over the age of 65, and non-English speakers. Higher percentages of vulnerable populations increase the chances of injury or death during hazard events. In addition the city has a higher percentage of homes built prior to 1939 which increases the chance of damages during hazard events.

Table 2.14 below shows the demographic and structure statistics, and **Table 2.15** describes the mitigation capabilities of the city.

Table 2.14. Demographic and Structure Risk Parameters For Salem

Jurisdiction	Total Population	With a disability	Non-English Speaking Populations	People Below Poverty Level	Population Under 5 Yrs.	Population 65 Yrs. and Over	Residences Built Prior to 1939	Mobile Homes
Salem	4,904	1,184	103	1,154	382	1,230	286	112

Source: U.S. Census Bureau, 2016-2020 5-Years American Community Survey

Table 2.15. City of Salem Mitigation Capabilities

Capabilities	Status Including Date of Document or Policy
Planning Capabilities	
Comprehensive Plan	Yes - 2013
Builder's Plan	No
Capital Improvement Plan	Yes - 2018
City Emergency Operations Plan	Yes - 2016
County Emergency Operations Plan	Yes – 2016
Local Recovery Plan	No
County Recovery Plan	No
City Mitigation Plan	No
County Mitigation Plan	Yes – 2018
Debris Management Plan	Yes – 2016
Economic Development Plan	Yes – Regional CEDS 2018
Transportation Plan	Yes – regional updated annually
Land-use Plan	Yes – 1987
Flood Mitigation Assistance (FMA) Plan	No
Watershed Plan	No
FireWise or other fire mitigation plan	No

Capabilities	Status Including Date of Document or Policy
Critical Facilities Plan (Mitigation/Response/Recovery)	Yes – 2015
Policies/Ordinance	
Zoning Ordinance	Yes – 1987
Building Code	Yes – IBC, 2012
Floodplain Ordinance	Yes – 3/23/2020
Subdivision Ordinance	Yes – 1986
Tree Trimming Ordinance	Yes – 2000
Nuisance Ordinance	Yes – 1992
Storm Water Ordinance	No
Drainage Ordinance	No
Site Plan Review Requirements	Yes – 1986
Historic Preservation Ordinance	No
Landscape Ordinance	No
Program	
Zoning/Land Use Restrictions	Yes
Codes Building Site/Design	Yes
Hazard Awareness Program	Yes
National Flood Insurance Program	Yes
NFIP Community Rating System (CRS) Participating Community	No
National Weather Service (NWS) Storm Ready	No
Firewise Community Certification	No
Building Code Effectiveness Grading (BCEGs)	No
ISO Fire Rating	5
Economic Development Program	Yes
Land Use Program	Yes
Public Education/Awareness	Yes
Property Acquisition	No
Planning/Zoning Boards	Yes
Stream Maintenance Program	Yes
Tree Trimming Program	Yes
Engineering Studies for Streams (Local/County/Regional)	No
Mutual Aid Agreements	Yes
Studies/Reports/Maps	
Hazard Analysis/Risk Assessment (City)	No
Hazard Analysis/Risk Assessment (County)	Yes – Hazard Mitigation (2018) & Hazardous Materials (annual) Plans
Evacuation Route Map	Yes - 2016
Critical Facilities Inventory	Yes – Hazard Mitigation (2018) & Hazardous Materials (annual) Plans
Vulnerable Population Inventory	No
Land Use Map	Yes
Staff/Department	
Building Code Official	Yes
Building Inspector	Yes
Mapping Specialist (GIS)	No
Engineer	Yes
Development Planner	Yes
Public Works Official	Yes – Sewer
Emergency Management Director	Yes
NFIP Floodplain Administrator	Yes
Bomb and/or Arson Squad	No

Capabilities	Status Including Date of Document or Policy
Emergency Response Team	No
Hazardous Materials Expert	Yes
Local Emergency Planning Committee	Yes – regional MLEPD
County Emergency Management Commission	Yes
Sanitation Department	No
Transportation Department	No
Economic Development Department	Yes
Housing Department	Yes - Phelps Co. PHA
Regional Planning Agencies	Yes - MRPC
Historic Preservation	No
Non-Governmental Organizations (NGOs)	
American Red Cross	Yes
Salvation Army	Yes
Veterans Groups	Yes
Environmental Organization	No
Homeowner Associations	No
Neighborhood Associations	No
Chamber of Commerce	Yes
Community Organizations (Lions, Kiwanis, etc.)	Yes
Local Funding Availability	
Ability to apply for Community Development Block Grants	Yes
Ability to fund projects through Capital Improvements funding	Yes
Authority to levy taxes for a specific purpose	Yes
Fees for water, sewer, gas, or electric services	Yes
Impact fees for new development	No
Ability to incur debt through general obligation bonds	Yes
Ability to incur debt through special tax bonds	Yes
Ability to incur debt through private activities	No
Ability to withhold spending in hazard prone areas	Yes

Source: Data Collection Questionnaire, 2022

Table 2.21 summarizes the mitigation capabilities of Dent County and its jurisdictions.

Table 2.16. Mitigation Capabilities Summary Table

CAPABILITIES	Unincorporated Dent County	Salem
Planning Capabilities		
Comprehensive Plan	No	Yes - 2013
Builder's Plan	No	No
Capital Improvement Plan	No	Yes - 2018
City Emergency Operations Plan	N/A	Yes - 2016
County Emergency Operations Plan	Yes	Yes - 2016
Local Recovery Plan	No	No
County Recovery Plan	No	No
City Mitigation Plan	N/A	No
County Mitigation Plan	Yes – 2018	Yes – 2018
Debris Management Plan	No	Yes - 2016
Economic Development Plan	Yes – CEDS 2018	Yes – CEDS 2018
Transportation Plan	Yes – Regional 2021	Yes – Regional 2021
Land-use Plan	No	Yes - 1987
Flood Mitigation Assistance (FMA) Plan	No	No
Watershed Plan	No	No
Firewise or other fire mitigation plan	No	No
Critical Facilities Plan (Mitigation/Response/Recovery)	No	Yes - 2015
Policies/Ordinances		
Zoning Ordinance	No	Yes – 1987
Building Code	No	Yes – IBC, 2012
Floodplain Ordinance	No	Yes – 3/23/2020
Subdivision Ordinance	N/A	Yes – 1986
Tree Trimming Ordinance	No	Yes - 2000
Nuisance Ordinance	No	Yes – 1992
Storm Water Ordinance	No	No
Drainage Ordinance	No	No
Site Plan Review Requirements	No	Yes – 1986
Historic Preservation Ordinance	No	No
Landscape Ordinance	No	No
Program		
Zoning/Land Use Restrictions	No	Yes
Codes Building Site/Design	No	Yes
Hazard Awareness Program	No	Yes
National Flood Insurance Program	Yes	Yes

CAPABILITIES	Unincorporated Dent County	Salem
NFIP Community Rating System (CRS) Participating Community	No	No
National Weather Service (NWS) Storm Ready	Yes	No
Firewise Community Certification	No	No
Building Code Effectiveness Grading (BCEGs)	No	No
ISO Fire Rating	9	5
Economic Development Program	No	Yes
Land Use Program	No	Yes
Public Education/Awareness	No	Yes
Property Acquisition	No	No
Planning/Zoning Boards	No	Yes
Stream Maintenance Program	No	Yes
Tree Trimming Program	No	Yes
Engineering Studies for Streams (Local/County/Regional)	No	No
Mutual Aid Agreements	Yes	Yes
Studies/Reports/Maps		
Hazard Analysis/Risk Assessment (City)	No	No
Hazard Analysis/Risk Assessment (County)	Yes – 2018, 2022	Yes – 2018, 2022
Evacuation Route Map	Yes	No
Critical Facilities Inventory	Yes – 2018, 2022	Yes – 2018, 2022
Vulnerable Population Inventory	No	No
Land Use Map	No	Yes
Staff/Department		
Building Code Official	N/A	Yes
Building Inspector	No	Yes
Mapping Specialist (GIS)	No	No
Engineer	No	Yes
Development Planner	No	Yes
Public Works Official	No	Yes
Emergency Management Director	Yes	Yes
NFIP Floodplain Administrator	N/A	Yes
Bomb and/or Arson Squad	No	No
Emergency Response Team	No	No
Hazardous Materials Expert	No	Yes
Local Emergency Planning Committee	Yes - MLEPD	Yes - MLEPD
County Emergency Management Commission	No	Yes
Sanitation Department	No	No
Transportation Department	Yes	No

CAPABILITIES	Unincorporated Dent County	Salem
Economic Development Department	No	Yes
Housing Department	Yes - Phelps Co. PHA	Yes - Phelps Co. PHA
Regional Planning Agencies	Yes - MRPC	Yes - MRPC
Historic Preservation	No	No
Non-Governmental Organizations (NGOs)		
American Red Cross	Yes	Yes
Salvation Army	Yes	Yes
Veterans Groups	Yes	Yes
Environmental Organization	No	No
Homeowner Associations	Yes	No
Neighborhood Associations	No	No
Chamber of Commerce	Yes	Yes
Community Organizations (Lions, Kiwanis, etc.)	Yes	Yes
Financial Resources		
Ability to apply for Community Development Block Grants	Yes	Yes
Ability to fund projects through Capital Improvements funding	Yes	Yes
Authority to levy taxes for a specific purpose	Yes	Yes
Fees for water, sewer, gas, or electric services	No	Yes
Impact fees for new development	No	No
Ability to incur debt through general obligation bonds	Yes	Yes
Ability to incur debt through special tax bonds	Yes	Yes
Ability to incur debt through private activities	No	No
Ability to withhold spending in hazard prone areas	No	Yes

Source: Data Collection Questionnaires, 2022

2.2.3 Public School District Profiles and Mitigation Capabilities

The following school districts are participating jurisdictions in this plan: Dent-Phelps R-III, Green Forest R-II, North Wood R-IV, Oak Hill R-I, and Salem R-80. As public institutions responsible for the care and education of the county's children, these school districts share an interest with Dent County in public safety and hazard mitigation planning. **Figure 2.6** provides the boundaries of the school districts participating in this planning process.

Technical and Fiscal Resources

Green Forest R-II and North Wood R-IV are the only districts that have NOAA all hazard radios on site to provide early warning of hazard events. In addition, each school district (except Salem R-80) has fire alarms and intercom systems capable of providing specific instructions in the event of an emergency. Salem R-80 can do an all call within individual buildings.

Existing Plans and Policies

All five school districts have an emergency management plan and weapons policy.

Other Mitigation Activities

All schools participating in the plan conduct regular fire, earthquake, tornado drills, and lock-down security training at varying frequencies from quarterly to twice an academic year. None of the school districts have a designated safe area for tornados that meets FEMA standards.

New Construction

Dent-Phelps R-III School District has not completed any construction since the last plan and has no plans for construction in the next five years.

Green Forest R-II School District plans to construct a music/art room that would be a safe room.

North Wood R-IV School District renovated the buss barn and completed new construction behind the building since the last plan. The school district is in the process of applying for a FEMA designated saferoom and is awaiting approval.

Oak Hill R-I School District completed a 6th grade, library, and bathroom addition since the last plan. The district plans to remodel a stage into a classroom and remodel the office in the next five years.

Salem R-80 School District plans to construct a new elementary school and remodel the gymnasium in the next five years. The district has submitted a 2022 FEMA saferoom grant application.

Table 2.17. School District Buildings and Enrollment Data, 2022

District Name	Building Name	Enrollment
Dent-Phelps R-III		
	Dent-Phelps Elementary	236
Green Forest R-II		
	Green Forest Elementary	188
North Wood R-IV		
	North Wood Elementary	210
Oak Hill R-I		
	Oak Hill Elementary	129
Salem R-80		
	Salem Senior High	555
	Salem Middle	259
	William H. Lynch	274
	Salem Upper Elementary	325
	Ozark Hills School	11

Source: https://dese.mo.gov/directory

Figure 2.6. Dent County School Districts

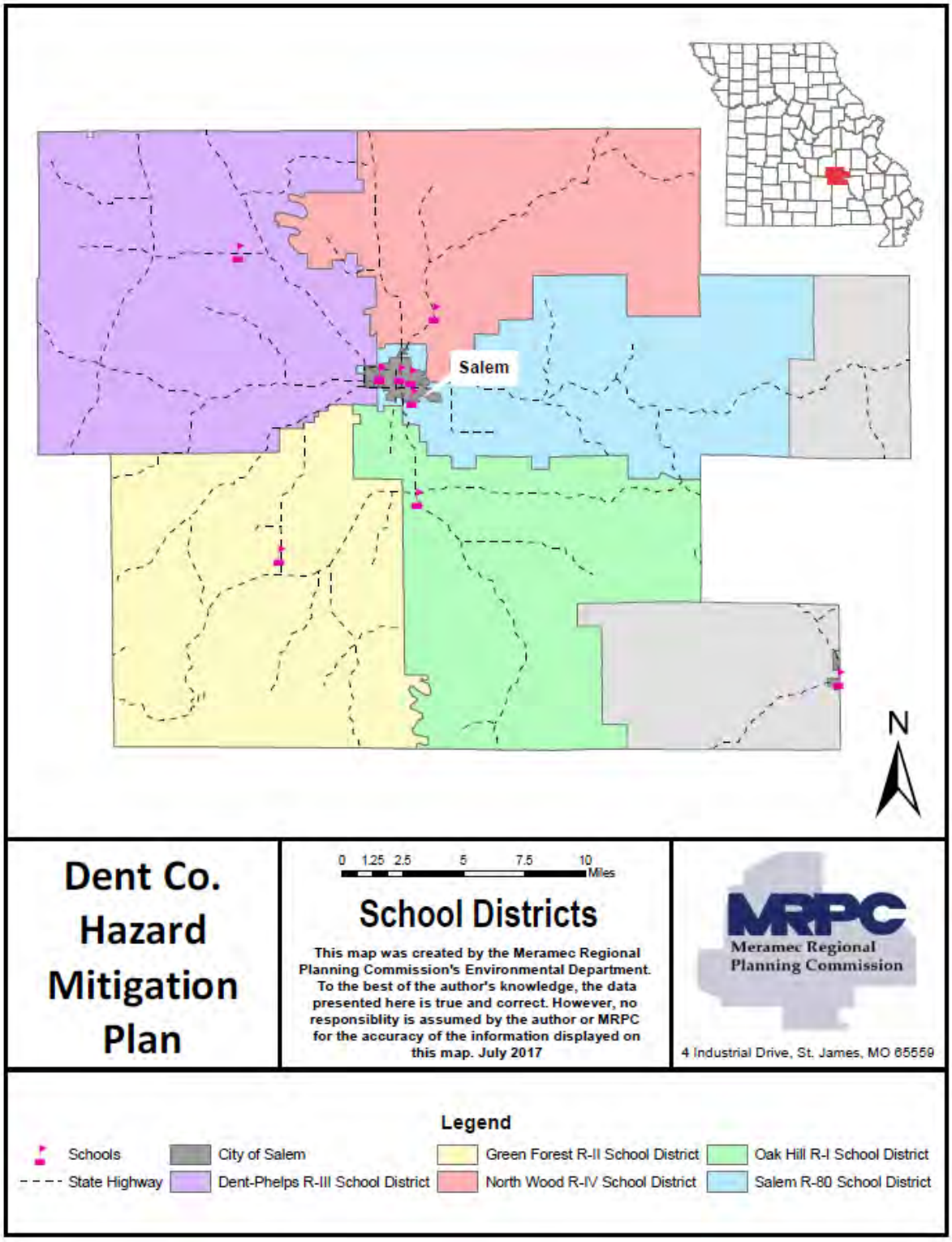


Table 2.18. Summary of Mitigation Capabilities for School Districts

Capability	Dent-Phelps R-III	Green Forest R-II	North Wood R-IV	Oak Hill R-I	Salem R-80
Planning Elements					
Master Plan/Date	Yes – March 2021	Yes – 2020	Yes – 8/22/2022	No	Yes – 2014
Capital Improvement	No	No	Yes – 8/11/2022	No	Yes – 2015
School Emergency Plan/Date	Yes – May 2022	Yes – 2021	Yes – 7/14/2022	Yes – 2022	Yes - 2014
Weapons Policy/Date	Yes – March 2021	Yes – 2006	Yes – August 2010	Yes – 2022	Yes - 2000
Personnel Resources					
Full-Time Building Official (Principal)	Yes	Yes	Yes	Yes	No
Emergency Manager	No	Yes	Yes	No	No
Grant Writer	No	No	Yes	No	No
Public Information Officer	No	Yes	No	No	No
Financial Resources					
Capital Improvements Project Funding	Yes	Yes	Yes	Yes	Yes
Local Funds	Yes	Yes	Yes	No	Yes
General Obligation	No	Yes	No	Yes	Yes
Special Tax Bonds	No	No	No	No	Yes
Private Activities/Donations	Yes	Yes	Yes	No	Yes
State and Federal Funds/Grants	Yes	Yes	Yes	No	Yes
Other					
Privately or Self-Insured?	CHUBB	Privately	MUSIC	MUSIC	MUSIC
Fire Evacuation Training	Bi-Annually	Semi-Annually	Quarterly	Bi-Annually	Bi-Annually
Tornado Sheltering Exercises	Bi-Annually	Semi-Annually	Quarterly	Bi-Annually	Bi-Annually
Public Address/Emergency Alert System	PA System	Intercom System	Intercom System	Intercom System	All Call within Individual Buildings

Capability	Dent-Phelps R-III	Green Forest R-II	North Wood R-IV	Oak Hill R-I	Salem R-80
NOAA Weather Radios	No	Yes	Yes	No	No
Lock-Down Security Training	Bi-Annually	Semi-Annually	Quarterly	Bi-Annually	Bi-Annually
Mitigation Programs	No	No	Applying for FEMA Safe Room	New windows and doors	No
Tornado Shelter/Safe-room	No	No	Awaiting Grant Application Approval	No	No
Campus Police	No	Shared Part-time School Resource Officer	Shared Part-time School Resource Officer	Shared Part-time School Resource Officer	No

Source: Data Collection Questionnaires, 2022

Southwest Baptist University is located in Bolivar, MO. The university operates a satellite campus within Dent County. The campus and location are shown in **Table 2.25**.

Table 2.19. Dent County Colleges/Universities

College/University	Location	Description
Southwest Baptist University-Salem Campus	501 S Grant St, Salem, MO 65560	Afternoon and evening classes. 9 undergraduate majors available.

Table of Contents

1.1 Purpose

Dent County and six other jurisdictions prepared this local hazard mitigation plan to guide hazard mitigation planning for the purpose of better protecting the people and property of the county from the effects of natural hazard events. Hazard mitigation is defined by FEMA as "any sustained action taken to reduce or eliminate long-term risk to human life and property from a hazard event." Hazard mitigation planning is the process through which hazards that threaten communities are identified, likely impacts of those hazards are determined, mitigation goals are set and appropriate strategies to lessen impacts are determined, prioritized and implemented.

The mission of the Dent County Hazard Mitigation Plan is to substantially and permanently reduce the county's vulnerability to natural hazards. This plan demonstrates the communities' commitment to reducing risks from hazards and serves as a tool to help decision makers direct mitigation activities and resources for the next five years. The plan is intended to promote sound public policy designed to protect citizens, critical facilities, infrastructure, private property and the natural environment. This can be achieved by increasing public awareness, documenting resources for risk reduction and loss prevention and identifying activities to guide the community towards the development of a safer, more sustainable community.

This plan was also developed to make Dent County and participating cities and school districts eligible for certain federal disaster assistance as required by the Robert T. Stafford Disaster Relief and Emergency Act (Public Law 93-288). Those programs include the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program, Pre-Disaster Mitigation Program and Flood Mitigation Assistance Program. The plan has been prepared in accordance with the requirements of the Disaster Mitigation Act of 2000 (Public Law 106-390) and developed and organized within the rules and regulations established under 44 CFR 201.6 published in the *Federal Register* on February 26, 2002 and finalized in October 31, 2007. Guidance for the development of this plan includes FEMA's Local Mitigation Planning

Handbook, March 2013 and FEMA's Local Mitigation Plan review Guide, October 1, 2011. Those jurisdictions within Dent County that do not adopt the 2021 plan will not be eligible for funding through these grant programs.

Neither Dent County, nor any cities in Dent County participate in the NFIP Community Rating System (CRS).

1.2 Background and Scope

The 2023 Dent Hazard Mitigation Plan is the first update of the original plan developed and approved in June 2018. The revised document will be valid for five years from approval by FEMA. It is a multi-jurisdictional plan that covers the participating jurisdictions within the County's borders, all of whom adopted the 2018 plan, including the following:

- Dent County
- City of Salem
- Salem R-80 School District
- Oak Hill R-I School District
- Dent-Phelps R-III School District
- North Wood R-IV School District
- Green Forest R-II School District

The information and guidance in this plan document will be used to help guide and coordinate mitigation activities and decisions for local jurisdictions and organizations. Proactive mitigation planning will help reduce the cost of disaster response and recover to local communities and residents by protecting critical infrastructure, reducing liability exposure and minimizing overall community impacts and disruptions. Dent County has been affected by natural disasters in the past and participating jurisdictions and organizations are committed to reducing the impacts of future incidents and becoming eligible for hazard mitigation-related funding opportunities.

1.3 Plan Organization

The plan contains a mitigation action listing, a discussion of the purpose and methodology used to develop the plan, a profile on Dent County, as well as the hazard identification and vulnerability assessment of natural hazards. In addition, the plan offers a discussion of the community's current capability to implement the goals, objectives and strategies identified through the planning process.

The plan is organized 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

Changes made to the 2022 plan are derailed in Table 1.1.

Table 1.1 Changes Made in Plan Update

Plan Section	Summary of Updates
Chapter 1 – Introduction and Planning Process	Updated members of the Mitigation Planning Committee (MPC) and participating jurisdictions formally adopted the MPC.
Chapter 2 – Planning Area Profile and Capabilities	Noted new GIS capabilities for participating jurisdictions, updated demographics and information provided in jurisdictional questionnaires, updated jurisdictional capabilities.
Chapter 3 – Risk Assessment	Combined extreme heat and extreme cold into one hazard: extreme temperatures. Updated data on hazards, updated demographic data.
Chapter 4 – Mitigation Strategy	The mitigation category of each action was added to the action worksheets. The action items were reviewed and updated, and progress made updated in the action worksheets.
Chapter 5 – Plan Implementation and Maintenance	Updated MPC meetings for evaluating and updating the plan quarterly.

To assist in the explanation of the above identified contents, there are several appendices included which provide more detail on specific subjects. This plan is intended to improve the ability of Dent County and the jurisdictions within to handle disasters and will document valuable local knowledge on the most efficient and effective ways to reduce loss.

1.4 Planning Process

44 CFR Requirement 201.6(c)(1): [The plan shall document] the planning process used to develop the plan, including how it was prepared, who was involved in the process and how the public was involved.

The Dent County Hazard Mitigation Planning Committee first organized in 2019 when the Missouri State Emergency Management Agency (SEMA) provided grant funds and contracted with the Meramec Regional Planning Commission (MRPC) to develop a hazard mitigation plan for the county. MRPC is a council of local governments in south central Missouri serving Crawford, Dent, Gasconade, Maries, Osage, Phelps, Pulaski and Washington counties.

MRPC's role in developing and updating the Dent County Hazard Mitigation plan included assisting in the formation of the mitigation planning committee (MPC) and facilitating the planning meetings; soliciting public input; and producing the draft and final plan for review by the MPC, SEMA and FEMA. Staff carried out the research and documentation necessary for the planning process. In addition, MRPC compiled and presented the data for the plan, helped the MPC with the prioritization process and insured that the final document met the DMA requirements established by federal regulations and the most current planning guidance.

In 2020, SEMA secured a grant to develop the Dent County Multi-Hazard Mitigation Plan and contracted with MRPC to facilitate the planning process for the plan development. MRPC staff has followed the most current planning guidance provided by FEMA for the purpose of insuring that the plan meets all of the requirements of the Disaster Mitigation Act as established by federal regulations.

The Dent County Multi-Hazard Mitigation Plan was developed as the result of a collaborative effort among Dent County, the City of Salem, Dent-Phelps R-III School District, Green Forest R-II School District, North Wood R-IV School District, Oak Hill R-I School District, Salem R-80 School District, public agencies, non-profit organizations, the private sector as well as regional, state and federal agencies. MRPC contacted and asked for volunteers to serve on the planning committee from the county and local city governments, school districts, the county health department, local businesses and utility companies. The mailing list is included in **Appendix B: Planning Process**. This cross-section of local representatives was chosen for their experience and expertise in emergency planning and community planning in Dent County. Staff worked with the Dent County MPC to collect and analyze information on hazards and disasters that have impacted the county as well as document mitigation activities that have occurred during the past five years.

Due to time and duty constraints, not all the jurisdictions that were invited to participate in the MPC were able to attend meetings. However, all of the jurisdictions provided information to develop the document, submitted questionnaires, reviewed the plan and provided input. Interviews were conducted with stakeholders from the community and several planning meetings were conducted during the plan development.

The 2022 planning process began with a meeting held at the Salem Community Center at the Armory on February 22, 2022. MRPC staff provided an overview of the hazard mitigation planning process and review of the existing hazard mitigation plan. The group reviewed and discussed hazard mitigation goals and what progress had been made on hazard mitigation action items over the past four years. The group made note of those action items that had been accomplished, those that were no longer applicable and added projects to the list. The second meeting was held on April 5, 2022. The MPC reviewed the revised list of action items and applying the STAPLEE method (Social, Technical, Administrative, Political, Legal, Economic; Environmental) and applying cost benefit analysis to best determine priorities. A full description of the prioritization process is included in Chapter 4. The group agreed to review plan chapters as they were completed through email or postings on the MRPC website. The third meeting of the MPC was held on December 13, 2022. The MPC reviewed the public survey results, participation requirements and status of participation of jurisdictions; reviewed and discussed draft chapters; reviewed plan maintenance and the adoption process.

The final list of prioritized action items were mailed out to all jurisdictions and entities that had been invited to participate on the MPC. Recipients were asked to review and provide feedback if they had concerns about how any of the projects were ranked. The draft plan was made available on-line and MPC members were notified on where to find the document and asked to review and provide feedback.

All planning committee members were provided drafts of sections of the plan as they became available. Members of the planning committee reviewed the draft chapters and provided valuable input to MRPC staff. Additionally, through public committee meetings, press releases and draft plan posting on MRPC's website, ample opportunity was provided for public

participation. An internet survey was provided for the public to provide input into the process. The results of that survey are included in the appendices. Jurisdictions in surrounding counties were also notified of where to view the revised plan and encouraged to provide input. Any comments, questions and discussions resulting from these activities were given strong consideration in the development of this plan.

Dent County further assisted in the planning process by issuing public notice of the planning meetings as well as scheduling meeting times at the Salem Community Center at the Armory in Salem. County officials attended and participated in meetings.

The MPC contributed to the planning process by:

- Attending and participating in meetings;
- Collecting data for the plan;
- Making decisions on plan content;
- Reviewing drafts of the plan document;
- Developing a list of needs:
- Prioritizing needs and potential mitigation projects; and
- Assisting with public participation and plan adoption

The MPC did not formally meet on a regular basis as recommended in the plan. However, mitigation has become a regular topic of discussion among the majority of jurisdictions included in the plan. A number of hazard mitigation projects have been completed in the county and hazard mitigation concepts are being incorporated into other planning projects
Table 1.2 provides information on who actively participated in the planning process and who they represented:

Lynn Reed participated indirectly by providing information, completing the jurisdictional questionnaire, participating in phone calls and email discussions and assisting with adoption of the plan.

Table 1.2 Jurisdictional Representatives Dent County Mitigation Planning Committee

Name	Title	Department	Jurisdiction/Agency/ Organization	Direct Participation	Indirect Participation
Darryl Skiles	Presiding Commissioner	Administration	Dent County	X	
Wes Mobray	Associate Commissioner	Administration	Dent County	X	
Gary Larson	Associate Commissioner	Administration	Dent County	X	
Jason Akins	Supervisor	Road and Bridge	Dent County	X	
Roma Jones	Assistant Administrator	Health	Dent County	X	
Ashley Peyton	Public Health Nurse	Health	Dent County	X	
Brad Nash	Chief	Fire	Dent County Fire Protection District	X	
Sally Burbridge	Director	Economic Development	Dent County, City of Salem	X	
Ray Walden	City Administrator	Administration	City of Salem	X	

Name	Title	Department	Jurisdiction/Agency/ Organization	Direct Participation	Indirect Participation
Tammy Kohler	City Clerk	Administration	City of Salem	X	
Joe Chase	Chief	Police	City of Salem	X	
Kathleen Good	-	Fire	Lenox Rural Fire Department	X	
Don Good	Chief	Fire	Lenox Rural Fire Department	X	
Aibeen Holland	Superintendent	Administration	Oak Hill R-I	X	
Conrad Pugh	Superintendent	Administration	Green Forest R-II	X	
Vicky Brooker	Superintendent	Administration	Dent-Phelps R-III	X	
Paul J. Dodson	Superintendent	Administration	North Wood R-IV	X	
Lynn Reed	Superintendent	Administration	Salem R-80		X

The expertise of MPC members in the six mitigation categories (Preventive Measures, Property Protection, Natural Resource Protection, Emergency Services, Structural Flood Control Projects and Public Information) is outlined in Table 1.3 MPC Capability with Six Mitigation Categories.

Table 1.3 MPC Capability with Six Mitigation Categories

Community Department/Office	Preventive Measures	Structure and Infrastructure Projects		Natural Resource Protection	Public Information	Emergency Services
		Property Protection	Structural Flood Control Projects			
Dent County Commission	✓	✓	✓	✓	✓	
Dent County Health Center	✓			✓	✓	✓
Dent County Fire Protection District	✓	✓		✓	✓	✓
City of Salem Administration	✓	✓	✓	✓	✓	
City of Salem Economic Development	✓	✓	✓	✓	✓	
City of Salem Clerk's Office	✓	✓	✓	✓	✓	
City of Salem Police Department	✓	✓			✓	✓
Lenox Rural Fire Department	✓	✓		✓	✓	✓
Oak Hill R-I School District Administration	✓	✓	✓		✓	

Community Department/Office	Preventive Measures	Structure and Infrastructure Projects		Natural Resource Protection	Public Information	Emergency Services
		Property Protection	Structural Flood Control Projects			
Green Forest R-II School District Administration	✓	✓	✓		✓	
Dent-Phelps R-III School District Administration	✓	✓	✓		✓	
North Wood R-IV School District Administration	✓	✓	✓		✓	
Salem R-80 School District Administration	✓	✓	✓		✓	

1.4.1 Multi-Jurisdictional Participation

44 CFR Requirement **§201.6(a)(3)**: Multi-jurisdictional plans may be accepted, as appropriate, as long as each jurisdiction has participated in the process and has officially adopted the plan.

Dent County invited incorporated cities, school districts, utility companies, medical facilities, nursing facilities, county health department, and not-for-profits to participate in the hazard mitigation planning process. Press releases were sent to media. Letters and/or emails were sent to each of the following:

- Dent County
- City of Salem
- Oak Hill R-I School District
- Green Forest R-II School District
- Dent-Phelps R-III School District
- North Woods R-IV School District
- Salem R-80 School District
- Dent County Health Center
- Dent County Sheriff's Office
- Salem Police Department
- Montauk Rural Fire Department
- Jadwin Vol. Fire Department
- Lenox Rural Fire Department
- Salem Memorial District Hospital
- Intercounty Electric Cooperative
- Crawford Electric Cooperative
- Fidelity Communications
- The Salem News
- Seville Care Center
- Salem Care Center
- Salem Residential Care
- MO Highway Patrol Troop I
- MO Department of Conservation
- MO Dept. of Transportation
- MO SEMA Floodplain Management
- U.S. Army Corps of Engineers
- U.S. Department of Agriculture
- U.S. Fish and Wildlife Service
- U.S. Department of Agriculture

A copy of the mailing list and invitation letters are included in Appendix B: Planning Process.

The Disaster Mitigation Act requires that each jurisdiction must participate in the planning process and formally adopt the plan. There were a number of criteria established for participation. In order to be considered participating in the planning process, jurisdictions needed to do at least one of the following as well as adopt the plan:

- Providing a representative to serve on the planning committee;
- Participating in at least one or more meetings of the planning committee;
- Providing data for plan development through surveys and/or interviews;
- Identify goals and mitigation actions for the plan;
- Prioritize mitigation actions/projects for the plan;
- Review and comment on the draft plan document;
- Informing the public, local officials and other interested parties about the planning process and providing opportunities for them to comment on the plan;
- Provide in-kind match documentation; and
- Formally adopt the plan prior to submittal of the final draft to SEMA and FEMA for final approval.

Not all jurisdictions were able to attend the MPC meetings. Most communities and school districts in Dent County are small and understaffed. It was not always feasible for representatives to travel to the meetings. However, all jurisdictions met at least one of the participation criteria. All jurisdictions were contacted by phone and asked to complete the data collection questionnaire. In some cases, staff assisted jurisdictions with completion of the questionnaire. All jurisdictions were also contacted via email and phone regarding completion of in-kind match forms and if there were any questions regarding the information on the data collection questionnaires. The jurisdictions that participated in the process, as well as their level of participation in the process are shown in Table 1.3. Documentation of meetings, including sign-in sheets are included in Appendix B: Planning Process.

Table 1.4 Jurisdictional Participation in the Planning Process

Jurisdiction	Meeting #1	Meeting #2	Meeting #3	Interviews	Data Collection Questionnaire/Call	Update/Develop/ Prioritize Mitigation Actions	Review/ Comment on Plan
Dent County	X	X	X	X	X	X	X
City of Salem	X	X		X	X	X	X
Dent-Phelps R-III	X	X		X	X	X	X
Green Forest R-II	X			X	X		X
North Wood R-IV		X		X	X	X	X
Oak Hill R-I	X			X	X		X
Salem R-80				X	X		X

1.4.2 The Planning Steps

Dent County and MRPC worked together to develop the plan and based the planning process in FEMA's *Local Mitigation Planning Handbook (March 2013),* the *Local Mitigation Plan Review Guide (October 1, 2011),* and *Integrating Hazard Mitigation Into Local Planning: Case Studies and Tools for Community Officials (March 1, 2013).* The planning process has included organizing the county's resources, assessing the risks to the county, developing the mitigation plan and implementing the plan and monitoring the progress of plan implementation.

The planning committee based their activities on the 10-step planning process adapted from FEMA's Community Rating System (CRS) and Flood Mitigation Assistance programs. By following the 10-step planning process, the plan met funding eligibility requirements of the Hazard Mitigation Grant Program, Building Resilient Infrastructure and Communities, Pre-Disaster Mitigation Program, Community Rating System, and Flood Mitigation Assistance Program.

Table 1.4 Dent County Planning Process

Community Rating System (CRS) Planning Steps (Activity 510)	Local Mitigation Planning Handbook Tasks (44 CFR Part 201)
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)(2) & (3)
Step 3: Coordinate	Task 4: Review Community Capabilities 44 CFR 201.6(b)(2) & (3)
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	
Step 6: Set goals	Task 6: Develop a Mitigation Strategy 44 CFR 201.6(c)(3)(i); 44 CFR 201.6(c)(3)(iii)
Step 7: Review possible activities	
Step 8: Draft an action plan	
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)

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

The planning area was determined by the boundaries of Dent County. MRPC staff provided general information on the hazard mitigation plan review process at regular MRPC board meetings – providing both written and oral reports on the review process, schedules for the various plans; which ones had been funded; described match requirements; and asked mayors and commissioners to think about who should be included on the planning committees for each respective county.

The planning team was selected by contacting the leadership of each jurisdiction, explaining the process, and asking them to send appropriate representation to the planning meetings. In addition, they were asked to provide input on who they wanted to include on the planning committee. Stakeholders such as electric cooperatives and sewer districts were also contacted

and invited. In addition, it was suggested that representatives of some of the local critical facilities be included on the planning committee, such as medical clinics and nursing homes. All meetings were also publicized to allow additional interested parties to attend and participate. The first meeting was held at the Salem Community Center at the Armory on February 22, 2022. The second meeting was convened on April 5, 2022, and the third on December 13, 2022.

At the first meeting on February 22, 2022, MRPC staff made introductions and provided an overview of the Dent County Hazard Mitigation plan. The group reviewed and discussed the goals and objectives. A good deal of the meeting was spent sharing information on what progress had been made in five years and discussing current and future needs and adding new mitigation actions to the existing list. Staff offered to help those jurisdictions present with completion of their data collection surveys. The group started working on reviewing and prioritizing the action items – using both the STAPLEE method and analyzing the cost benefit.

At the second meeting on April 5, 2022, the group reviewed the complete list of action items; determined which had been completed; which should be combined; which were no longer a high or medium priority; and determined if any needed to be added. The MPC then provided input on prioritizing each of the action items. Staff took those recommendations and developed a matrix of the action items with the STAPLEE and cost benefit scores. This matrix was emailed out to all of the individuals and organizations on the mailing list for the MPC with a request for feedback. All suggestions for changes were incorporated into the plan. MRPC staff shared the results of the public survey. It was decided that staff would share plan chapters with the MPC as they were completed.

At the third meeting on December 13, 2022, the group reviewed participation requirements and the status of all jurisdictions; reviewed and discuss those draft chapters that were completed; discussed plan maintenance and the adoption process.

Table 1.5 Schedule of MPC Meetings outlines the dates that meetings were held, and topics covered. Documentation of the planning process can be found in Appendix B: Planning Process.

Table 1.5 Schedule of MPC Meetings

Meeting	Topics	Date
Planning Meeting #1	Overview of hazard mitigation planning purpose and Dent County plan; grant programs linked to approved plan; participation requirements and public involvement; data collection questionnaires; discussion of hazards; critical facilities	February 22, 2022
Planning Meeting #2	Overview of hazard mitigation planning and Dent Co. HMP; discussion on the revision of plan goals, discussion of action items for the next 5 years; prioritization of action items; road and bridge projects;	April 5, 2022

Meeting	Topics	Date
	integration of other data, reports, studies, and plans	
Planning Meeting #3	Review of participation requirements and status of jurisdictions, review and discussion of draft chapters, plan maintenance and adoption process and next steps for the planning process and completion of the plan.	December 13, 2022

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

44 CFR Requirement 201.6(b): An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: (1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval.

The MPC followed the same process for public involvement and input as suggested by SEMA and FEMA and as was followed during earlier planning processes. The first MPC meeting was held at the Salem Community Center at the Armory. Public notices were placed at the courthouse, and press releases were done prior to the meeting to make the public aware. Meetings were also posted on the MRPC webpage. The public was notified each time the plan or sections of the plan were presented for review and discussion. A public survey was conducted, and the results shared with the MPC. A sample of the survey and the results of the survey are included in Appendix C: Public Survey. MPC members and public officials within the county as well as in surrounding counties were contacted, directed to the MRPC website (www.meramecregion.org) where a copy of the draft plan could be viewed or downloaded. The document was made available on the website on January 6, 2023. A hard copy of the draft could be obtained directly from MRPC by request. Members of the local media were invited to attend planning meetings. Information was shared by these media outlets with the public on the planning process and where to find draft copies of the plan. Copies of public notices and press release are included in Appendix B. Results of the public survey are included in Appendix C: Public Survey.

No comments were received from the public other than what was found in the public survey. These are included in the Appendices.

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

44 CFR Requirement 201.6(b): An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: (2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process. (3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

Every effort was made to encourage input from stakeholders whose goals and interests interface with hazard mitigation in Dent County including:

- Neighboring communities
- Local and regional agencies involved in hazard mitigation activities
- Agencies with the authority to regulate development
- Businesses
- Academia
- Other private and non-profit interests

Stakeholders involved in the hazard mitigation planning process included The Salem Press No federal stakeholders were involved during the planning process. Lists of the people from the jurisdictions and stakeholders who were invited to participate in the planning process follows.

Jurisdictional Representatives Invited to Participate in the Planning Process

Name	Title	Department	Jurisdiction/Agency/Organization
Darrell Skiles	Presiding Commissioner	County	Dent County
Gary Larson	Associate Commissioner	County	Dent County
Wes Mobray	Associate Commissioner	County	Dent County
Angie Curley	County Clerk	County	Dent County
Sherida Cook	Public Administrator		
Bob Wells	Sherriff	Sherriff's Dept.	Dent County
Brad Nash	EMD/Fire Chief	Emergency Management/ Fire	Dent County/ Dent County Fire Protection District
Kim Steelman	Mayor	Admin.	City of Salem
Ray Walden	City Administrator	Admin.	City of Salem
Tammy Koller	City Clerk	Admin.	City of Salem
Brent Young	Superintendent	Street Dept.	City of Salem
Joe Chase	Chief of Police	Police	City of Salem
Donnie Moore	Superintendent	Water & Sewer	City of Salem
Bryon Johns	Superintendent	Electric	City of Salem
Jonathon Counts	EMD	Emergency Management	City of Salem
Larry West	Fire Chief	Fire	Montauk Rural Fire Department
Jack Ficker	Fire Chief	Fire	Jadwin Volunteer Fire Department
Donald L. Good	Fire Chief	Fire	Lenox Rural Fire Department
Victoria Booker	Superintendent	Admin.	Dent-Phelps R-III School District
Conrad Pugh	Superintendent	Admin.	Green Forest R-II School District
Aibeen Holland	Superintendent	Admin.	Oak Hill R-I School District
Jeff Dodson	Superintendent	Admin.	North Wood R-IV School District
Lynne Reed	Superintendent	Admin.	Salem R-80 School District

Stakeholder Invited to Participate in the Planning Process

Name	Title	Agency/Organization
Jeremy Schumacher	Administrator	Seville Care Center
Lindi Schmitt	Administrator	Salem Care Center
Pamela Nash	Administrator	Salem Residential Care
Kasey Lucas	Administrator	Salem Memorial District Hospital
-	-	The Salem Press
-	-	Intercounty Electric Cooperative
-	-	Crawford Electric Cooperative
-	-	Fidelity Communications
Capt. Eddie Blaylock	Commander of Troop I MSHP	MO State Highway Patrol
-	-	Missouri Department of Conservation
-	-	Missouri Department of Transportation
-	-	Missouri SEMA Floodplain Management
Matt Shively	-	U.S. Army Corps of Engineers
Karen Herrington	Field Supervisor	U.S. Fish and Wildlife Service
Ken Sessa	-	FEMA Region VII
-	-	U.S. Department of Agriculture NRCS

Jurisdictional representatives on the MPC were asked to share and solicit information from within and outside of their jurisdictions. A broad spectrum of entities other than the jurisdictions named in the plan, were invited to participate in the planning process.

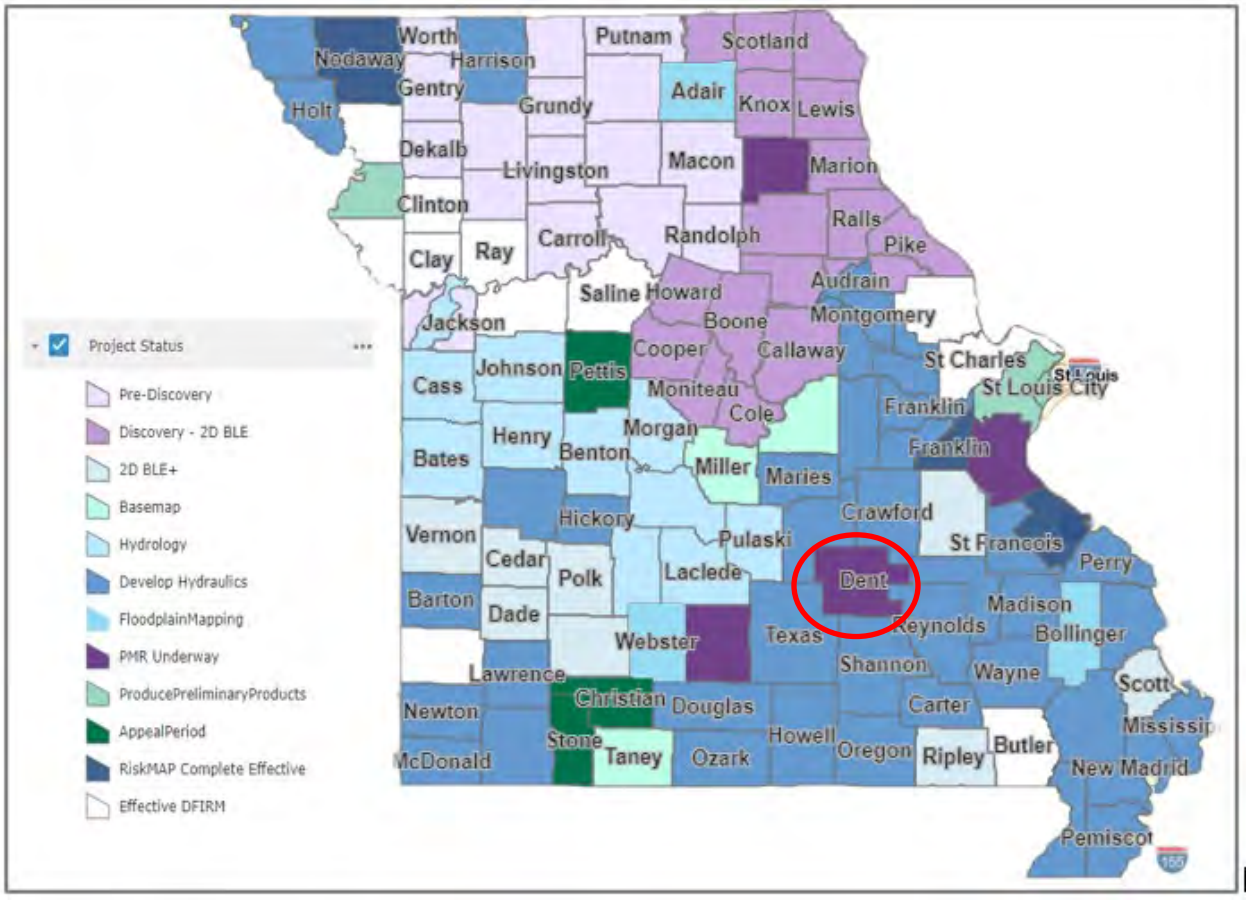
The questionnaire provided to every jurisdiction asked how mitigation actions were being incorporated into other planning documents. The county road and bridge department does a good job of incorporating mitigation projects into their regular maintenance program. Those projects have been incorporated into the plan document. Hazard mitigation goals and action items have also been incorporated, where applicable, in the Community Economic Development Strategy (CEDS).

Coordination with FEMA Risk MAP Project

The Risk MAP project has begun in Dent County. As of January 2022, SEMA was working with WOOD E&IS to complete the Post Preliminary Processing phases of the project to update the models used to develop the county's new flood risk data. Preliminary Maps were shared with stakeholders on October 29, 2021. Once completed, Risk MAP will provide mitigation planning support in a variety of ways including helping in the assessment of risks and identifying action items to reduce vulnerability. In addition, this project will provide tools to improve the understanding of risk by local officials and the general public.

Figure 1.1 illustrates the current status of Missouri counties in regard to RiskMap projects.

Figure 1.1. Map of RiskMAP Projects



Integration of Other Data, Reports, Studies and Plans

The MPC researched available plans, studies, reports and technical information during development of the Update. The intent was to identify existing data and information, shared objectives and past and ongoing activities that would add to the Update. The goal was to identify the existing capabilities and planning mechanisms to implement the mitigation strategy. Dent County is a rural area with the largest community's population at approximately 4,608. Not all of the participating communities have planning or zoning, subdivision regulations or other mechanisms for controlling the development of land. Some of the jurisdictions do have ordinances and planning documents. Following is a list of the documents that were reviewed:

- Local planning and zoning ordinances
- County EOP
- Crisis Plans (school districts)
- Comprehensive plans
- Economic development plans
- Capital improvement plans
- Regional Transportation Plan
- Floodplain management ordinances and flood Insurance Risk Maps (FIRMs)

In addition to information available from local jurisdictions, a number of data sources, reports, studies and plans were used in updating the plan. Every attempt was made to gather the best available data to develop the vulnerability assessment and identify assets in the county. The Missouri State Hazard Mitigation Plan (2018) was reviewed and referenced throughout the document. Other data sources included dam information from the Missouri Department of Natural Resources and National Inventory of Dams (NID); fire reports from state agencies; Wildland/Urban Interface and Intermix data from the SILVIS Lab – Department of Forest Ecology and Management – University of Wisconsin; the Community Economic Development Strategy (CEDS); capital improvement plans from the participating jurisdictions; historic weather data and damage estimates from the National Oceanic and Atmospheric Administration; the critical facilities inventory conducted by MRPC; and road and bridge department plans/budgets.

All documents were reviewed so that the MPC would have a broad foundation of data upon which to base the planning area's risk assessment. Information from these documents and data sources are incorporated into the plan as indicated throughout the document.

Step 4: Assess the Hazard: Identify and Profile Hazards (Handbook Task 5)

The MPC reviewed the hazards that affected Dent County at the first planning meeting on February 22, 2022 including discussions of any hazard events that occurred during the last twenty years and all of the hazards included in the Missouri Hazard Mitigation plan. A variety of sources were used to identify and profile hazards. These included U.S. Census data, GIS data, HAZUS, the Missouri Spatial Data Information Service (MSDIS), statewide datasets compiled by state and federal agencies, existing plans and reports, personal interviews with MPC members and the questionnaire completed by each jurisdiction. Every effort was made to use the most current and best data available. Additional information on the risk assessment and the conclusions drawn from the available data can be found in Chapter 3.

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

Assets for each jurisdiction were identified based on responses to the data collection questionnaire distributed to all jurisdictions, interviews with MPC members and the critical facilities inventory conducted by MRPC. Additional sources included U.S. Census, GIS data, MSDIS and HAZUS.

Losses were calculated using HAZUS and the Missouri State Hazard Mitigation plan data and the most recent U.S. census data available. Values reflected in the plan are on structures only and do not include land values.

Jurisdictions provided information on their regulatory, personnel, fiscal and technical abilities by completing the data collection questionnaire. The vulnerability assessment was completed using estimates from the 2018 State plan. For more information on planning area profiles and capabilities, please see Chapter 2.

Step 6: Set Goals (Handbook Task 6)

The goals from the initial hazard mitigation plan were reviewed at the first planning meeting on February 22, 2022. At the second planning meeting on April 5, 2022, the MPC discussed

revisions of the original goals to remove redundancy and improve coverage. The revised goals are as follows:

Goal 1: Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.

Goal 2: Reduce the potential impact of natural disasters to [property, infrastructure, and the local economy.

Goal 3: Reduce the potential impact of natural disasters on the continuity of government and essential services.

Step 7: Review Possible Mitigation Actions and Activities

Mitigation strategy and specific action items were discussed at the first and second MPC meetings. At the first MPC meeting the group reviewed the list in the existing plan and decided which actions could be eliminated; what could be combined; what needed to remain on the list; and what needed to be added. It was emphasized that any mitigation actions in the plan that were not likely to be accomplished, due to cost factors or that did not address the risks identified in the risk assessment, should be removed from the list.

Discussions also included mitigation activities that had been completed or were in process that had not been in the original plan document. Each jurisdiction and stakeholder group was asked to provide information about mitigation activities that were needed as well as those that had been accomplished over the past five years. Meeting facilitators offered to share ideas for mitigation projects from the FEMA publication *Mitigation Ideas: As Resource for Reducing Risk to Natural Hazards (January 2013)* to help stimulate ideas and discussion.

Staff received proposed road and bridge mitigation projects that needed to be addressed from the County Associate Commissioners on April 5, 2022.

In order to prioritize action items, the MPC was asked to use the STAPLEE method as well as assign a cost benefit to each activity. This allowed the group to consider a broad range of issues in order to decide which actions should be considered high, moderate or low priority. The prioritization process used by the MPC is explained as follows:

STAPLEE stands for the following:

- **Social:** Will the action be acceptable to the community? Could it have an unfair effect on a particular segment of the population?
- **Technical:** is the action technically feasible? Are there secondary impacts? Does it offer a long-term solution?
- **Administrative:** Are there adequate staffing, funding and maintenance capabilities to implement the project?
- **Political:** Will there be adequate political and public support for the project?
- **Legal:** Does your jurisdiction have the legal authority to implement the action?
- **Economic:** is the action cost-beneficial? Is there funding available: Will the action contribute to the local economy?

- **Environmental:** Will there be negative environmental consequences from the action? Does it comply with environmental regulations? Is it consistent with community environmental goals?

Each question was scored based on a 0 to 3 point value system:

3 = Definitely YES
2 = Maybe YES
1 = Probably NO
0 = Definitely NO

For the Benefit/Cost Review portion of the prioritization process, these two aspects were scored as follows:

Benefit – two (2) points were added for each of the following avoided damages (8 points maximum = highest benefit)

- Injuries and/or casualties
- Property damages
- Loss-of-function/displacement impacts
- Emergency management costs/community costs

Cost – points were subtracted according to the following cost scale (-5 points maximum = highest cost)

- (-1) = Minimal – little cost to the jurisdiction involved
- (-3) = Moderate – definite cost involved but could likely be worked into operating budget
- (-5) = Significant – cost above and beyond most operating budgets; would require extra appropriations to finance or to meet matching funds for a grant

Note: For the Benefit/Cost Review, the benefit and cost of actions which used the word "encourage" were evaluated as if the action or strategy being encouraged was actually to be carried out.

Total Score – The scores for the STAPLEE Review and Benefit/Cost Review were added to determine a Total Score for each action.

Priority Scale – To achieve an understanding of how a Total Score might be translated into a Priority Rating, a sample matrix was filled out for the possible range of ratings an action might receive on both the STAPLEE and Benefit/Cost Review. The possible ratings tested ranged between:

- A hypothetical action with "Half probably NO and half maybe YES" answers on STAPLEE (i.e. poor STAPLEE score) and Low Benefit/High Cost: Total Score = 7
- A hypothetical action with "All definitely YES" on STAPLEE and High Benefit/Little Cost: Total Score = 28

An inspection of the possible scores within this range led to the development of the following Priority Scale based on the Total Score in the STAPLEE- Benefit/Cost Review process:

20 – 28 points = High Priority
14-19 points = Medium Priority
13 points and below = Low Priority

The benefit portion of the prioritization process helped the MPC focus on long-term mitigation solutions that demonstrated the future cost savings that could be realized by completing mitigation projects that safeguard lives and protect property.

Finally, action items were reviewed to determine if they met the SMART criteria as provided by SEMA and FEMA: **S**pecific, **M**easurable, **A**chievable, **R**elevant, **T**ime-bound.

Step 8: Draft an Action Plan

The MPC reviewed the final list of action items and completed the prioritization process at the April 5, 2022 meeting. The final list was then emailed out to all jurisdictions and members of the MPC for review and approval as everyone was not able to attend the meeting. Staff was directed by the MPC to take the finalized list after allowing time for comments and draft an action plan.

Step 9: Adopt the Plan (Handbook Task 8)

When the first draft of the plan was completed, staff posted the document on the MRPC website and provided a hard copy to the county courthouse. All MPC members, jurisdictions and surrounding jurisdictions were notified on where to find a copy of the plan to review. If requested, additional hard copies of the plan document were provided. After allowing time for comments, a letter was mailed out to all jurisdictions asking them to formally adopt the plan and providing a sample adoption resolution. A deadline was provided in order to ensure receipt of adoption resolutions prior to submitting a final draft to FEMA for approval.

Step 10: Implement, Evaluate, and Revise the Plan (Handbook Tasks 7 & 9)
At all three planning meetings (February 22, 2022, April 5, 2022 and December 13, 2022) MRPC staff advised the MPC and participating jurisdictions of the importance of continuing to meet periodically to discuss implementation of the plan as well as monitoring and maintaining the plan into the future. Chapter 5 provides details on Dent County's strategy for implementation, evaluation and revising the plan.

CONTRIBUTORS

Dent County Hazard Mitigation Planning Committee

The individuals who participated in the Dent County hazard mitigation planning committee are as follows:

Jurisdictional Representatives

Name	Title	Department	Jurisdiction/Agency/Organization
Darryl Skiles	Presiding Commissioner	Administration	Dent County
Wes Mobray	Associate Commissioner	Administration	Dent County
Gary Larson	Associate Commissioner	Administration	Dent County
Jason Akins	Supervisor	Road and Bridge	Dent County
Roma Jones	Assistant Administrator	Health	Dent County
Ashley Peyton	Public Health Nurse	Health	Dent County
Brad Nash	Chief	Fire	Dent County Fire Protection District
Sally Burbridge	Director	Economic Development	Dent County, City of Salem
Ray Walden	City Administrator	Administration	City of Salem
Tammy Kohler	City Clerk	Administration	City of Salem
Joe Chase	Chief	Police	City of Salem
Kathleen Good	-	Fire	Lenox Rural Fire Department
Don Good	Chief	Fire	Lenox Rural Fire Department
Aibeen Holland	Superintendent	Administration	Oak Hill R-I
Conrad Pugh	Superintendent	Administration	Green Forest R-II
Vicky Brooker	Superintendent	Administration	Dent-Phelps R-III
Paul J. Dodson	Superintendent	Administration	North Wood R-IV

*Sign in sheets from planning meetings are included in Appendix B.

The individuals who represented stakeholders on the Dent County hazard mitigation planning committee are as follows:

Participating Stakeholder Representatives

Name	Title	Agency/Organization
Caleb Brubaker	Staff Writer	The Salem News

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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. Dent County and participating cities and school districts developed this multi-jurisdictional local hazard mitigation plan update to reduce future losses to the county and its communities and schools resulting from hazard events. The plan is an update of the original plan that was approved on October 30, 2018. The plan was prepared pursuant to the requirements of the Disaster Mitigation Act of 2000 and to achieve 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 7 jurisdictions that participated in the planning process:

- Dent County
- City of Salem
- Salem R-80 School District
- Oak Hill R-I School District
- Dent-Phelps R-III School District
- North Wood R-IV School District
- Green Forest R-II School District

Dent County and the jurisdictions listed above have developed a multi-jurisdictional Hazard Mitigation Plan that was originally approved by FEMA in 2018. This current planning effort serves as an update (hereafter referred to as the 2022 Hazard Mitigation Plan.)

The plan update process followed a methodology prescribed by FEMA, which began with the formation of a Mitigation Planning Committee (MPC) comprised of representative from Dent County and participating jurisdictions. The MPC updated the risk assessment that identified and profiled hazards that pose a risk to Dent County and analyzed the vulnerability to these hazards. The MPC also examined the capabilities in place to mitigate them. The MPC 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/ lightening/high winds and tornadoes are among the hazards that historically have had a significant impact.

Based upon the risk assessment, the MCP revised goals for reducing risk from hazards. The goals are listed below:

Goal 1: Reduce the potential impact of natural disasters on the lives and livelihoods of the citizens of the county.

Goal 2: Reduce the potential impact of natural disasters to [property, infrastructure, and the local economy.

Goal 3: Reduce the potential impact of natural disasters on the continuity of government and essential services.

To meet the identified goals, the MPC developed recommended mitigation actions, which are detailed in Chapter 4 of this plan. The MPC developed an implementation plan for each action,

which identifies priority level, responsible agency, timeline, cost estimate, potential funding sources and progress to date.

PREREQUISITES

44 CFR requirement 201.6(c)(5): The local hazard mitigation plan shall include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan. For multi-jurisdictional plans, each jurisdiction requesting approval of the plan must document that it has been formally adopted.

This plan has been reviewed by and adopted with resolutions or other documentation of adoption by all participating jurisdictions and schools districts. The documentation of adoptions is included in Appendix D.

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

- Dent County
- City of Salem
- Salem R-80 School District
- Oak Hill R-I School District
- Dent-Phelps R-III School District
- North Wood R-IV School District
- Green Forest R-II School District

Model Resolution

RESOLUTION NO. _____

A RESOLUTION TO ADOPT THE DENT COUNTY MULTI-JURISDICTION NATURAL HAZARDS MITIGATION PLAN

WHEREAS, (Government/District) 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 emphasizing the need for pre-disaster mitigation of potential hazards and made available hazard mitigation grants to state and local governments; and

WHEREAS, an adopted Multi-Jurisdiction Natural Hazards 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, (Government/District) fully participated in the FEMA prescribed mitigation planning process to prepare this Mitigation Plan; and

WHEREAS, (Government/District) desires to comply with the requirements of the Disaster Mitigation Act and to augment its emergency planning efforts by formally adopting the Dent County Multi-Jurisdiction Natural Hazards Mitigation Plan; and

WHEREAS, adoption by the governing body of (Government/District) demonstrates the jurisdiction's commitment to fulfilling the mitigation goals and objectives outlined in this Mitigation Plan; and

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

NOW, THEREFORE BE IT RESOLVED, that (Government/District) adopts the Dent County Multi-Jurisdictional Natural Hazards Mitigation Plan as an official plan and will submit this Adoption Resolution to the Missouri Emergency Management Agency and the Federal Emergency Management Agency officials to enable the plan's final approval.

_____ _____

Certifying Official Date

_____ _____

Witness Date