Minnesota State Hazard Mitigation Plan 2014

Department of Public Safety

Division of Homeland Security and Emergency Management

Approved: March 11, 2014
Adopted: March 14, 2014

Homeland Security and Emergency Management

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Office of Communications

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Office of Pipeline Safety

Office of Traffic Safety

March 14, 2014

On behalf of the State of Minnesota, the Minnesota Division of Public Safety Department of Homeland Security and Emergency Management (HSEM), is pleased to present the 2014 State of Minnesota All Hazard Mitigation Plan (Plan) Update.

The purpose of this Plan is to identify the State's major hazards, assess the vulnerability, and to reduce risk using the technical and program resources to implement mitigation projects. The Plan identifies goals and recommended actions and initiatives for state government agencies to reduce and/or prevent injury and damage from hazardous events. The intent of the Plan is to provide unified guidance for ensuring coordination of recovery-related hazard mitigation efforts following a major emergency/disaster, and to implement an on-going comprehensive state hazard mitigation strategy intended to reduce the impact of loss of life and property due to effects of natural hazards. This Plan update includes an integration of climate change considerations, risk analysis of state owned critical facilities, and an updated flood hazard analysis.

The State Hazard Mitigation Team will continue to coordinate with state agencies (Natural Resources, Transportation, Commerce, Labor and Industry, Administration) and other partners, including the Rural Electric Cooperatives to implement mitigation measures. The Recovery Mitigation Branch in coordination with other branches in HSEM will continue to cross train and work together in preparation, response, recovery and long term recovery to integrate mitigation strategies and actions. Through continued collaboration, providing technical resources through state agency staff expertise and support, and training and education, the State of Minnesota will continue to increase its resiliency to the effects of natural hazards.

Kris a Eide

Kris Eide, Director

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FEMA

MAR 2 0 2014

Ms. Kris Eide, Director
Homeland Security and Emergency Management
Minnesota Department of Public Safety
445 Minnesota Street
Suite 223
St. Paul, Minnesota 55101-6223

Dear Ms. Eide:

I am pleased to inform you that the Federal Emergency Management Agency (FEMA), within the Department of Homeland Security (DHS), formally approves the *2014 State of Minnesota All-Hazards Mitigation Plan,* officially adopted for the State of Minnesota on March 14, 2014. The plan is now in compliance with the Disaster Mitigation Act of 2000 requirements for an updated Standard State Mitigation Plan.

The approval of this plan ensures the continued availability of non-emergency Stafford Act funding for the next three years within the State of Minnesota. This includes the Pre-Disaster Mitigation Program, Flood Mitigation Assistance Program, Hazard Mitigation Grant Program (at a 15% level), Fire Management Assistance Grant Program, and Public Assistance Grants (Categories C-G). All requests for funding, however, will be evaluated individually according to the specific eligibility and other requirements of the particular program under which the application is submitted.

If you have any questions regarding the planning process, please contact Christine Stack, Mitigation Division Director, at (312) 408-5570.

Sincerely,

Janet M. Odeshoo

for Andrew Velasquez III
Regional Administrator

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RURAL ELECTRIC ANNEX

Section 1: Introduction

The authority for this document is the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended by Public Law 106-390, October 30, 2000, the Disaster Mitigation Act of 2000. This Plan conforms to the 44 Code of Federal Regulations (CFR) Parts 201 and 206: Mitigation Planning and the Hazard Mitigation Grant Program Requirements. The State will continue to comply with all applicable Federal statutes and regulations during the periods for which it receives grant funding, in compliance with 44 CFR 13.11(c), and will amend its plan whenever necessary to reflect changes in State or Federal laws and statutes as required in 44 CFR 13.11(d).

The state of Minnesota is vulnerable to a variety of potential hazards. These hazards, both natural and human-caused, threaten loss of life and property. Events such as riverine and flash flooding, wildfires, blizzards, tornados and straight-line winds, hailstorms, earthquakes, ice and severe storms, drought, and chemical, biological, radiological, nuclear, and explosive incidents have the potential for inflicting devastating economic loss and personal hardship. Natural disasters cost the state and its taxpayer's money, both directly and indirectly. Many severe weather events in the state do not warrant federal disaster designation, which often result in local governments, businesses and citizens bearing the costs of recovery. Risk and vulnerability to natural and human caused hazards may continue to increase as Minnesota's population grows.

Hazard mitigation planning is an effective instrument to reduce losses by reducing the impact of disasters upon people and property. Although mitigation efforts cannot completely eliminate impacts of disastrous events, the state shall endeavor to reduce the impacts of hazardous events to the greatest extent possible.

This Plan represents the efforts of the state of Minnesota in fulfilling the responsibility for hazard mitigation planning. The purpose of this Plan is to identify the State's major hazards, assess the vulnerability to those hazards, and take steps to reduce vulnerability using the technical and program resources of Minnesota agencies. The Plan identifies goals and recommended actions and initiatives for state government to reduce and/or prevent injury and damage from hazardous events. The intent of the Plan is to provide unified guidance for ensuring coordination of recovery-related hazard mitigation efforts following a major emergency/disaster, and to implement an on-going comprehensive state hazard mitigation strategy intended to reduce the impact of loss of life and property due to disasters.

Scope

The state aims to focus on natural hazards and projects that make the state and its people and property more resilient to the effects of natural hazards. The Plan evaluates and ranks the major natural and human caused hazards affecting the state of Minnesota as determined by frequency of event, economic impact, deaths and injuries. The Plan assesses hazard risk, reviews current state and local hazard mitigation capabilities, develops mitigation strategies and identifies state agency and other interagency working group's actions to address mitigation needs. The Plan does not attempt to develop local mitigation plans or projects. Mitigation recommendations are based on input from state and local agencies and national best practices. The Plan identifies existing resources and may be used as a tool to assist communities to succeed in their mitigation efforts. This is accomplished by establishing statewide mitigation policies, providing technical resources through state agency staff expertise and support, providing financial assistance through various programs, training and education and other agency initiatives.

Mitigation Definition

Hazard mitigation may be defined as any action taken to eliminate or reduce the future risk to human life and property from natural and human caused hazards. Potential types of hazard mitigation measures include the following:

- Structural hazard control or protection projects
- Retrofitting of facilities
- Acquisition and relocation of structures
- Development of mitigation standards, regulations, policies, and programs
- Public awareness and education programs
- Development or improvement of warning systems

Benefits

The benefits of hazard mitigation include the following:

- Saving lives, protecting the health of the public, and reducing injuries
- Preventing or reducing property damage
- Reducing economic losses
- Minimizing social dislocation and stress
- Reducing agricultural losses
- Maintaining critical facilities in functioning order
- Protecting infrastructure from damage
- Protecting mental health
- Reducing legal liability of government and public officials

In line with goals of hazard mitigation planning in the state of Minnesota Homeland Security and Emergency Management vision is Keeping Minnesota Ready through collaboration and coordination at all levels of government

Minnesota Homeland Security and Emergency Management

Vision: Keeping Minnesota Ready

The mission of HSEM is to help Minnesota prevent, prepare for and recover from natural and human caused disaster. Our team develops and maintains partnerships; collects and shares information; plans, trains and educates; coordinates response resources; and provides technical and financial assistance.

Authority Minnesota Statute, Chapter 12, Emergency Management

12.09 Subdivision 7. **Hazard mitigation plan.** The division shall develop and maintain a comprehensive hazard mitigation plan for this state, with the plan integrated into and coordinated with the hazard mitigation plans of the federal government to the fullest possible extent. The division shall coordinate the preparation of hazard mitigation plans by the political subdivisions, with the plans integrated into and coordinated with the hazard mitigation plan of this state to the fullest possible extent.

Governor's Executive Order On November 26, 2013 the revised Governor's Executive Order 13-13 rescinded the Governor's Executive Order 11-03 and assigned emergency responsibilities to state agencies. This document clarified the roles and responsibilities of state agencies in emergencies and is included in the appendices. Homeland Security and Emergency Management (HSEM) is directed to do the following Recovery/Hazard Mitigation activities:

> A. Each state agency that has a role in emergency management shall participate in the development of hazard mitigation strategies to reduce or eliminate the vulnerability of life and property to the effects of emergencies and disasters.
>
> B. Following a presidential declaration of a major disaster, state agencies shall be responsible for carrying out the hazard mitigation responsibility assignments contained in this Executive Order and elaborated upon in the State All-Hazard Mitigation Plan.
>
> C. Each state agency shall, when requested by the Division of Homeland Security and Emergency Management, provide appropriate personnel to assist with the damage assessment activities associated with the Public Assistance, Individual Assistance, and Hazard Mitigation programs. They shall also provide personnel to serve on an Interagency Hazard Mitigation Team or Hazard Mitigation Survey Team, when requested.
>
> D. Each agency shall, when requested by the Division of Homeland Security and Emergency Management, provide appropriate personnel to serve on the Minnesota Recovers Task Force, and be prepared to commit and combine resources toward the long-term recovery/mitigation effort.

XX. DEPARTMENT OF PUBLIC SAFETY

Section 2008 The Division of Homeland Security and Emergency Management shall designate personnel to serve as the State Hazard Mitigation Officer (SHMO). The SHMO is responsible for ensuring that the hazard mitigation requirements contained in the federal Stafford Act (Public Law 93-288, as amended) including implementation and administration of the Hazard Mitigation Grant Program are carried out.

Section 2009 The Division of Homeland Security and Emergency Management shall facilitate long term recovery by: chairing the Minnesota Recovers Task Force, coordinating with local long term recovery and unmet needs committees, communicating with local officials and evaluating state recovery services.

Section 2010 The Division of Homeland Security and Emergency Management shall facilitate hazard mitigation efforts statewide by: coordinating maintenance of the State All-Hazard Mitigation Plan and working with local jurisdictions to develop and enhance mitigation plans and projects.

As part of the mitigation programs implementation, the Hazard Mitigation Grant Program (HMGP) is narrated by the Hazard Mitigation Grant Program Administrative Plan and the Sub-grantee handbook. These documents give directions to sub-grantees regarding management of their grants.

Hazard Mitigation Assistance Administrative Plan and Procedures

The state of Minnesota Hazard Mitigation Assistance Administrative Plan and Procedures is required as Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 93-288 as amended, and the Disaster Mitigation Act of 2000, Public Law 106-390, establishes a cost-sharing Hazard Mitigation Assistance (HMA) grant programs to be used to fund state and local hazard mitigation projects. This section is closely tied to the post-disaster hazard mitigation plans defined and required in Section 409 of the Act and the Disaster Mitigation Act of 2000. Sections 322 and 404 in combination with several other state and federal programs and activities help to form an overall pre-and-post disaster hazard mitigation strategy for the State of Minnesota and affected local governments in the state. The purpose of the administrative plan is to describe the organization, staffing, and procedures the State of Minnesota will use when implementing the Section 404 Hazard Mitigation Grant Program in both the post and pre-disaster mitigation environment. This manual is updated to reflect changes in policy, lessons learned administering the plan and procedures, post disaster after action reports, and input from the Minnesota Recovers Task Force. This document is updated for each Presidential Disaster Declaration.

Hazard Mitigation Assistance Sub-grantee Handbook

As part of the Hazard Mitigation Assistance (HMA) grant programs, the purpose of the sub-grantee handbook is both to provide general HMA information and to summarize specific sub-grantee responsibilities relative to the program. Under the Section 404 HMGP, Federal Emergency Management Agency (FEMA) hazard mitigation monies are provided to the state. In Minnesota, these monies are awarded to the Minnesota Division of Homeland Security and Emergency Management (HSEM) which serves as the grantee. Potentially eligible sub-grantees (applicants) include: state and local governments, certain private non-profit organizations or institutions, and Indian tribes or authorized tribal organizations

1.1 Hazard Mitigation Programs

FEMA offers three hazard mitigation assistance programs–although all three programs have unique statutory authorities, program requirements and triggers for funding, all of the programs also have the common goal of providing funds to States and local communities to reduce the loss of life and property from future natural hazard events. In 2009, FEMA integrated the guidance for the three hazard mitigation programs into one document, the Hazard Mitigation Assistance (HMA) Unified Guidance.

The HMA grant programs provide funding opportunities for pre- and post-disaster mitigation. While the statutory origins of the programs differ, all share the common goal of reducing the risk of loss of life and property due to natural hazards. Brief descriptions of the HMA grant programs are listed below. For more information on the individual programs see

http://www.fema.gov/government/grant/hma/index.shtm

Hazard Mitigation Grant Program (HMGP)

HMGP assists in implementing long-term hazard mitigation measures following Presidential disaster declarations. Funding is available to implement projects in accordance with State, Tribal, and local priorities.

Pre-Disaster Mitigation (PDM)

PDM provides funds on an annual basis for hazard mitigation planning and the implementation of mitigation projects prior to a disaster. The goal of the PDM program is to reduce overall risk to the population and structures, while at the same time, also reducing reliance on Federal funding from actual disaster declarations

Flood Mitigation Assistance (FMA)

FMA provides funds on an annual basis so that measures can be taken to reduce or eliminate risk of flood damage to buildings insured under the National Flood Insurance Program (NFIP).

1.2 Plan Organization

Each section in the plan has been revised and updated by state hazard mitigation staff and the Minnesota Silver Jackets. Changes to the previous Plan include the incorporation of the Hazard Identification and Risk Assessment into one section, and climate change adaptation has been incorporated into each hazard.

Section One: Introduction Purpose, scope and a description of changes included in the Plan Update.

Section Two: The Planning Process Description of how the Plan was updated utilizing the state and federal collaborative risk management group, the Silver Jackets. Other trainings, outreach and educational opportunities HSEM mitigation staff utilized to promote the mitigation are summarized in this section. The Plan Maintenance section has been moved to this section, to outline the continued planning participation process for the five year update.

Section Three: State Profile Geographic, climatic and demographic characteristics. How mitigation relates to development trends and climate change adaptation.

Section Four: Hazard Identification and Risk Assessment: In an effort to organize the risk assessment by individual hazard (as opposed to including information about all hazards within each required section), the State of Minnesota has elected to combine the data previously organized within the Section 4: Risk Assessment -Identify and Profile Hazards, and Section 5: Risk Assessment - Vulnerability Assessment. The State of Minnesota believes this approach will allow each hazard to be evaluated with a single review of all data available in one central location organized by hazard. All maps in this document have been updated as of August 2013 with the most recent data available, unless otherwise noted. This section provides information on the nature of each hazard that the State of Minnesota is susceptible to, a history of the hazard in the state and the probability of its occurrence in the future.

Section Five: Mitigation Goals, Objectives, Strategies and Actions. This section was totally revised into two broad goals, with specific agencies mitigation objectives and strategies. The six mitigation strategies and the actions are broad enough for any jurisdiction to utilize them in the development of mitigation plans. An assessment of state and local capabilities, pre- and post-disaster funding programs and the severe and repetitive loss strategy requirement are addressed.

The Inventory of Hazard Mitigation Programs, Policies, and Funding Resources section provides information on resources available to assist with hazard mitigation planning and project implementation. Many organizations have capabilities that may assist local jurisdictions or the state to increase resiliency to hazards. A comprehensive list of federal, state agencies and other related organizations that may assist in mitigation projects is included.

The Mitigation Strategy states goals, objectives, actions, and projected funding sources to guide the mitigation program. The State Capability Assessment lists the programs and the funding sources that are used in statewide mitigation efforts and addresses gaps.

Section Six: Coordination of Local Planning A description of how the state prioritizes local jurisdictions funding and technical assistance is explained. This section describes how local mitigation planning and projects are prioritized, coordinated and funded. Local Funding and Technical Assistance is available from the local, state, and federal levels. Local planning capabilities differ but a lack of capability does not exclude a community from any of the grant programs.

Local Plan Integration portrays the importance of having a FEMA approved and locally adopted mitigation plan at the time of a disaster. Prior to or shortly after the request for the declaration of a presidential disaster, the FEMA regional office routinely confirms the plan status for counties potentially included in the disaster declaration.

1.3 Hazard Mitigation Funding

The past three years at Homeland Security and Emergency Management (HSEM) have been very busy. There have been six presidential disaster declarations since approval of the previous State Plan in March of 2011. Staffing at HSEM has changed, with a new the State Hazard Mitigation Officer (SHMO) and the hiring of two new mitigation planners. A fully staffed and trained hazard mitigation section has led to the submittal of nearly 100% of available funds for DR-4069. With continued targeted outreach and training we aim to continue this success rate to utilize all available post-disaster funding.

In an effort to streamline the Hazard Mitigation Grant Program process, FEMA requires states to develop their mitigation plans before disaster strikes. This allows for two courses of action. Pre-Disaster Mitigation (PDM) grants are offered so that communities may mitigate the effects of a hazard prior to a disaster. Communities affected by disaster are eligible to participate in both HMGP and PDM grants since the mitigation measures are built into plans to rebuild the community. The 2011 Minnesota All-Hazard Mitigation Plan meets the FEMA requirement that state mitigation plan be revised every three years to update hazard and risk analysis in the state. FEMA also has a requirement that local communities have plans that are revised in five-year cycles to qualify for mitigation grant funding.

State and local community mitigation plans essentially review the potential hazards in their respective jurisdictions and how those hazards may affect residents, infrastructure, services, business and industry. The planning then identifies the priorities and techniques to mitigate the effects from a particular hazard. Some techniques may be low cost and can be done at the local level while other measures may need the assistance of state and federal funding.

The difference between the Minnesota All-Hazard Mitigation Plan and local (multi-jurisdictional) plans is that the state plan contains strategies on how to support mitigation planning and programs statewide. The goals do not recommend specific mitigation techniques for a specific location but outline support for local governments with technical assistance and grant funding from state and federal agencies in regards to mitigation planning and projects. The state program goals also point to how mitigation planning needs a broad base of input from state agencies, regional development commissions, universities, private sector and communities.

The following is a summary of mitigation grants (obligated or expended) by type and 75% federal funding expended through December 2013. The majority of funding for these projects falls under HMGP and PDM grants. These totals do not take into account the most available funding for two disasters (DR-4113-MN and DR-4131-MN) in 2013 as applications are in review and have not been obligated (DR-4069-MN is partially included as some projects have been obligated).

Post-disaster funding in the state from DR-929-MN (1991) through DR-4069-MN (2012) has resulted in the following federal HMGP expenditures and obligations for:

- Acquisition projects over $52.6 million
- Electric Distribution over $19.9 million
- Mitigation Planning over $3.3 million
- Drainage projects over $11.8 million
- Wildfire projects over $2.3 million

From 2002 through 2011, the State of Minnesota received over $27 million through the Pre-Disaster Mitigation program, both through the annual competitive program and Congressional Earmarks for the following:

- Acquisition projects over $14.4 million
- Mitigation Planning over $1.6 million
- Drainage projects over $2.75 million
- Wildfire projects over $8.1 million

Section 2: Planning Process

2.1 Plan Update Process

Each section of the Plan was reviewed and revised by state hazard mitigation staff and multiple state and federal agency staff. The Silver Jackets were the leading committee to review the Plan and provide input. The Membership on the Silver Jackets team includes members of federal and state agencies. An opportunity for the public, businesses and other organizations to review and comment will be provided during the posting of the Plan on the MN HSEM website.

The following list documents important milestones, outreach activities and plan review activities relevant to the state plan update:

March 25, 2011	Minnesota All-Hazard Mitigation Plan Update approved
May 10, 2011	DR-1982-MN declared for severe storms and flooding.
June 7, 2011	DR-1990-MN declared for severe storms and tornadoes.
July 28, 2011	DR-4009-MN declared for severe storms, and tornadoes.
January 25, 2012	HSEM Region 4 Meeting: briefed county emergency management directors on mitigation planning and safe rooms.
January 25, 2012	HSEM Region 4 Meeting: briefed county emergency management directors on mitigation planning and safe rooms
January 26, 2012	HSEM Region 3 Meeting: briefed county emergency management directors on mitigation planning and safe rooms.
January 30, 2012	Nicollet County: met with county planning staff to develop application for acquisition.
February 2, 2012	Met with State Department of Administration, Building and Construction Services regarding State Flood Risk Assessment and Mitigation Actions
February 1, 2012	HSEM Region 5 Meeting: briefed county emergency management directors on mitigation planning and safe rooms.
February 2, 2012	HSEM Region 1 Meeting: briefed county emergency management directors on mitigation planning and safe rooms.
February 2, 2012	MN Rural Electric Cooperatives Association: outreach to vendors and suppliers on electric power line mitigation construction and funding.
February 7, 2012	MN Rural Electric Cooperatives Association Bi-Annual Conference: outreach cooperative members about electric power line mitigation construction and funding.

February 9, 2012	HSEM Region 4 Meeting: briefed county emergency management directors on mitigation planning and safe rooms.
February 22, 2012	Minnesota Risk Management: State Flood Risk Assessment & Mitigation Actions
February 23, 2012	Regional Flood Risk Management Teleconference
July 6, 2012	DR-4069-MN declared for severe storms, flooding, and tornadoes.
August 1, 2012	Mitigation Planning Workshop: Workshop provided by Region 5 Staff
August 16, 2012	Floodplain Management Training: NFIP Training provided by DNR
September 25-27, 2012	L212-HMA Application Development Course: Training
October 10-11, 2012	BCA Workshop: Workshop by FEMA Region 5 covering Safe Room and Damage Frequency Assessment modules
October 20, 2012	Tribal Planning Workshop: Workshop provided by FEMA Region 5 Staff
November 29, 2012	Redwood County Risk MAP Discovery Meeting: Mitigation plans and flood projects- Map review
November 29, 2012	Nobles County Risk MAP Discovery Meetings: Mitigation plans and flood projects-map review
January 29, 2013	Pine County Public Meeting- Acquisitions: HSEM part of presentation to residents affected by flood.
March 19, 2013	Norman County: Risk MAP Meeting
March 20, 2013	Mahnomen County: Risk MAP Meeting
April 16, 2013	Kandiyohi County and City Officials: Risk MAP Official Meeting
May 3, 2013	DR-4113-MN declared for severe winter storm.
May 5, 2013	Silver Jacket: State Plan Hazard and Risk Identification
May 25, 2013	HSEM Regional Meetings: Region 6 (Metro) - briefed county emergency management directors on mitigation planning and safe rooms
May 29, 2013	McLeod County elected officials and staff: Discussed mitigation actions for all hazards and HMA program
May 30, 2013	Mille Lacs County elected officials and staff: Discussed mitigation actions for all hazards and HMA programs

June 17, 2013	Silver Jacket Meeting
July 3, 2013	Paynesville Area School Board: Formal kick-off meetings for safe room (DR-1900.02)
July 25, 2013	Wadena Highway Department –Fairgrounds: Discussion on future mitigation projects (safe room for fairgrounds)
July 25, 2013	DR-4131-MN declared for severe storms, straight-line winds, and flooding.
August 13, 2013	Minnesota Rural Electric Association & FEMA Joint Field Office (JFO) staff as well as FEMA Region 5 staff attended: Rural electric cooperative annex for State plan & outreach to association members regarding mitigation projects
August 14, 2013	Manufactured & Modular Home Association of Minnesota (MMHA) and the Department of Labor and Industry- Construction Code Division, FEMA JFO staff as well as FEMA Region 5 staff attended: Outreach on safe rooms to MMHA, outreach on training for safe room courses, insight into MMHA upcoming conferences
August 21, 2013	Silver Jackets Meeting - Silver Jacket Meeting - State All Hazard Mitigation Plan Update
September 4, 2013	Present at 4th Annual MnWARN (Minnesota Rural Water Association) on Hazard Mitigation programs
September 4-6, 2013	Present at 2013 REMA (Rural Electric Management Association) CEO’s Fall Conference, Ottertail, Minnesota on Hazard Mitigation programs and solicit input for Rural Electric Cooperative Annex
September 24, 2013	First meeting of State All-Hazard Mitigation Plan Climate Change Subcommittee. Outline FEMA requirements for State Plan, discuss list of hazards, which hazards to address, how to approach climate change adaptation and review other State’s approach.
September 30, 2013	Present State Plan, Climate Change Adaptation and Hazard Mitigation programs at Interagency Climate Adaptation Team meeting
October 15-16, 2013	Presentation “Silver Jackets Pilot Project Flood Inundation Warning System for the Mississippi River in Saint Paul, Minnesota” at Minnesota Water Resources Conference
October 30, 2013	Second meeting of State All-Hazard Mitigation Plan Climate Change Subcommittee. Review draft of climate change adaptation included in each hazard.

September 24, 2013	Silver Jackets Meeting – State All Hazard Mitigation Plan Update
October 30, 2013	Silver Jackets Meeting - State All Hazard Mitigation Plan Update
November 7, 2013	HSEM staffs attend “Preparing Minnesota for Climate Change: a Conference on Climate Adaptation”
November 5, 2013	FEMA Region V Benefit Cost Analysis: Electrical Utility Training held at Emergency Management Training Center (EMTC) at Camp Ripley
November 11, 2013	FEMA Region V Benefit Cost Analysis: Safe Room Training held at Emergency Management Training Center (EMTC) at Camp Ripley,
November 20, 2013	Present at Environmental Quality Board (EQB) on HSEM and ICAT regarding Climate Change adaptation and State Hazard Mitigation Plan (See Appendix)
November 20-22, 2013	Attend and present on Silver Jackets Pilot Project Flood Inundation Warning System for the Mississippi River in Saint Paul Minnesota at the Association of Floodplain Managers 2013 Annual Conference: SPAM “Successful Planning And Management” for Improved Flood Resilience in Austin, Minnesota
November 26, 2013	Silver Jackets Meeting - State All Hazard Mitigation Plan Update, review Draft
January 24, 2014	Submit Plan to FEMA V for review.
January 24, 2014	Post Plan on HSEM website for public comment, publicize availability via Department of Public Safety social media sites and send out to potentially interested parties.
March 2014	Review and incorporate changes to Plan and resubmit to FEMA V for approval – if required.
March 2014	Obtain Governor’s and other state agencies’ Commissioners signatures. Submit signatures to FEMA V for formal adoption.

The state will submit the Plan to the FEMA Region V office for review and approval before a formal adoption process is pursued. Once approved, the Plan will be adopted via signature: director of HSEM, Governor, state agency commissioners involved with mitigation activities, and from those with shared interests in the Plan.

Once the Plan has been approved, an official notice announcing the approval will be posted in the State Register and on HSEM website. This step will inform stakeholders of the Plans’ success and encourage the implementation of mitigation strategies in the community and it will welcome ongoing feedback on the Plan.

2.2 Agency Coordination

Requirement §201.4(b): *The [State] mitigation planning process* **should** *include coordination with other State agencies, appropriate Federal agencies, and interested groups.*

Mitigation plans, policies and programs are directed by federal legislation (CFR 44 Emergency Management and Assistance), and Executive Orders (19988 and 19900). The state takes its role very seriously regarding emergency management. HSEM and other state agencies that participate in preparedness, recovery, response and mitigation abide by the following policies and executive orders. The Governor's Executive Order is in Appendix D. This policy indicates the importance of coordination with federal, other state agencies and locals in emergency management.

The MN State Statute Chapter 12 Emergency Management Policy Declaration (12.02):

> *It is further declared to be the purpose of this chapter and the policy of the state that all emergency management functions of this state be coordinated to the maximum extent with the comparable functions of the federal government, including its various departments and agencies, of other states and localities, and of private agencies of every type, to the end that the most effective preparations and use may be made of the nation's labor supply, resources, and facilities for dealing with any disaster that may occur.*

Governor's Executive Order, Section 1864

> *HSEM shall have overall responsibility for supporting both local government emergency operations planning and all-hazards mitigation planning. This responsibility includes the development and maintenance of prototype emergency operations plans, mitigation plans and supporting documents, as well as planning requirements guidance.*

The following interagency groups exemplify how planning goals can be achieved and how mitigation planning and project implementation can be integrated into existing efforts. Hazard Mitigation staff have developed and continue to strengthen relationships with state and federal agency partners.

The Minnesota Silver Jackets

The Minnesota Silver Jackets are a natural hazards risk management team. This group is the leading committee to review the Plan and provide input. Membership on the Silver Jackets includes members of federal and state agencies. The name Silver Jackets comes from the different colored jackets, which various agencies wear when responding to disasters, such as, USACE personnel wear red and FEMA personnel wear blue. The "Silver" Jackets represents a unified interagency team. While Silver Jackets typically provide information on flooding, the Minnesota group is all-hazard oriented. The Silver Jackets website holds monthly meeting to share information. The website: http://www.nfrmp.us/state/factMinnesota.cfm. Core agencies and representatives include:

- U.S. Army Corps of Engineers
  - St. Paul and Detroit Districts
- Federal Emergency Management Agency (FEMA) Region V
  - Hazard Mitigation, Risk Analysis and Insurance
- Minnesota Homeland Security and Emergency Management

    - Hazard Mitigation Program, Disaster Recovery Coordinator, Individual Assistance, Community Long Term Recovery, Education and Outreach
- Minnesota Department of Natural Resources
    - Water and Ecological Resources, Dams
- U.S. Geological Survey
- National Weather Service
    - Twin Cities/Chanhassen, Grand Forks and LaCrosse, Wisconsin
- Minnesota Department of Labor and Industry
- Minnesota Board of Water and Soil Resources
- Minnesota Department of Commerce
- U.S. Department of Agriculture - National Resource Conservation
- Minnesota Department of Transportation
- University of Minnesota – Duluth
- Minnesota Pollution Control Agency

Minnesota Recovers Task Force

The Minnesota Recovers Task Force (MRTF) formed in response to the Great Flood of 1993, when the Mississippi and Missouri Rivers and their tributaries overflowed, causing one of the most costly and devastating floods in the history of the United States. The task force's purpose is to combine government resources toward long-term recovery efforts and hazard mitigation activities. The MRTF helps get funds and assistance directly to those areas most affected by a recent disaster. This approach is an example of how funds, ideas and resources can cross agency and political boundaries to accomplish mitigation actions. Based on type, severity and extent of disaster, different subcommittees are formed to assist individuals and communities in need.

Following a major disaster, state disaster relief funds MAY be allocated to assist local units of government in their disaster recovery. These funds are appropriated to address those needs, which are not met by other disaster assistance programs. In a presidentially declared disaster, this is typically grant assistance from the FEMA Public Assistance and Individual Assistance Programs, and loan assistance from the Small Business Administration.

Funds are typically allocated to the different state agencies, and their programs, to acquire and to better publicly owned land and buildings and for other public improvements of a capital nature.

In some instances, funds may become available to assist local homeowners, businesses, and non-profit organizations. In these cases, the impact on the community will be weighed when funding decisions are made. The local unit of government should apply on behalf of these groups when a significant impact exists.

While this group is mainly recovery focused, mitigation actions are often funded, including acquisitions and drainage and infrastructure improvements. Funding the local match for mitigation projects has been a priority for the subcommittee as the local share has been identified as an unmet need for many communities post-disaster.

The Presidential Disaster Declarations DR-4069-MN for flooding in Northeast and metro areas brought together the Housing, Infrastructure, Mitigation/Natural Resources, Business and Human

Services subcommittees. Subcommittees formed, met and reported to the task force as a whole. The State legislature allotted additional funds for the Disasters DR-4113-MN and DR-4131-MN did not lead to additional state funding, however the task force met informally to address unmet needs**.**

Minnesota Interagency Climate Adaptation Team (ICAT)

The state agency collaborative effort began meeting in 2009 and has produced several reports. Most recently the 2013 report, *Adapting to Climate Change in Minnesota*, highlights how state government is working to adapt to the changing climate, reduce risks and impacts, and increase the resilience of our communities. HSEM had input into the document that shares a summary of observed and projected climate impacts, outlines state agency activities and responses, and identifies opportunities for future action and interagency collaboration. HSEM mitigation will continue to work with this group to incorporate mitigation ideas and planning for a more disaster resilient future.

2.4 Monitoring, Evaluating, and Updating the Plan

Requirement §201.4(c)(5)(i): *[The Standard State Plan Maintenance Process* ***must*** *include an] established method and schedule for monitoring, evaluating, and updating the plan.*

Provisions for monitoring, evaluating, and updating the Plan are located in the Code of Federal Regulations (44 CFR). The 44 CFR regulations require that the state "must review and revise its Plan to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities, and resubmit it for approval to the appropriate Regional Director every three (3) years."

HSEM serves as the lead agency for preparation of the State Plan and serves as lead agency for monitoring, evaluating, and updating the Plan. The State Hazard Mitigation Officer (SHMO) is responsible for coordinating Plan updates and maintenance. This position is located within HSEM and also serves as the lead coordinator of the State Hazard Mitigation Team (SHMT). Significant input into all phases of the planning process is derived from the SHMT, State Stakeholders, and the Silver Jackets Team.

Projecting into the future, the SHMT will be regularly involved in monitoring, evaluating, and updating of the Plan over the next five years during each quarter beginning with the first quarter following approval of this Plan as indicated in the table below. Triggers for Plan updates include, but are not limited to:

- If a disaster requires HSEM to reassess its goals and objectives
- If a reassessment indicates that some adjustments are needed on goals and objectives, the SHMT will coordinate that process
- If changes in federal or state laws require revisions, the SHMT and appropriate State Stakeholder Agencies will be consulted for advice on how to conform to new legislation

Table 1 Plan Monitoring, Evaluating and Updating Matrix

MONITORING, EVALUATING, AND UPDATING ACTIVITY	RESPONSIBILITY	QUARTERLY	ANNUAL	3-YEARS
Review and update the Hazard Analysis and Risk Assessment	HSEM, SHMT			•
Evaluate progress on mitigation actions and projects	SHMT		•	
Agency Report to SHMT	State Agencies	•		
Identification of implementation issues	HSEM, SHMT	•		
Evaluate participation by stakeholders in mitigation planning	HSEM		•	
Provide briefings on updates	SHMT	•		
State Capability Assessment Updates	SHMT		•	
Plan review and approval	SHMT, State Agencies,			•
Plan Adoption by State of Minnesota	HSEM			•
Plan Approval by FEMA	HSEM, FEMA			•

As part of the monitoring, evaluating and updating component, the update evaluation will use the following criteria:

- Do the goals and objectives still address current and expected conditions?
- What were the nature and the magnitude of problems encountered and changes that have occurred?
- Were the current resources appropriate for implementing the Plan?
- What implementation problems occurred, as technical, political, legal, or coordination issues?
- Were the outcomes as expected?
- Did the agencies participate as originally proposed?

This process will require the SHMT to participate in updating all parts of the Plan. Approval of the updated Plan will be required by all State Agency Administrators and the Governor.

Multiple activities will be addressed differently for future monitoring, evaluating, and updating efforts for the state mitigation Plan. More frequent (quarterly) review of implementation issues, stakeholder participation, and the capability assessment will assist Minnesota in keeping its mitigation planning on track and ensure measures and capabilities are in-line with needs. Reviews of the hazards, Risk Assessment and associated mitigation actions and projects will also keep Minnesota’s efforts on track. Addressing the above items in a regular and consistent manner will allow for enhanced adaptability to new federal and state guidance and Plan adoption.

For the next update the update process will be further refined and simplified to allow for a more efficient process for the collection and update of hazard specific information, local data integration, and agency specific capabilities and mitigation measures.

2.5 Monitoring Progress of Mitigation Activities

Requirement §201.4(c)(5)(ii): *[The Standard State Plan Maintenance Process* ***must*** *include a] system for monitoring implementation of mitigation measures and project closeouts.*
§201.4(c)(5)(iii): *system for reviewing progress on achieving goals as well as activities and projects in the Mitigation Strategy.*

The Plan is a living document and requires regular monitoring, review, and evaluation. Also, the Federal Hazard Mitigation Planning regulations require the Plan to be updated and submitted for approval to the Regional Director of FEMA every three years. The Plan will be reviewed annually by the Silver Jackets as described below. Mitigation staff will initiate planning to update the Plan 18 months before FEMA approval is required to integrate input from federal, state, local agencies and the public.

The Silver Jackets will meet formally on an annual basis (approximately 12 months following Plan approval) to conduct a review of the Plan. If political or hazard events change and dictate an earlier review, then the members will be solicited via telephone or e-mail contact for their input to these changes. The Silver Jackets will:

- Review the goals and action items to determine their relevance to changing situations in the state.
- Review the Risk Assessment as necessary to incorporate current information, including updated hazard profiles and any new data on vulnerable state facilities.
- Monitor progress on mitigation actions and projects in the Plan by reviewing quarterly progress reports. The database of all local plans and local action items will be reviewed as part of the process.
- Evaluate mitigation actions and projects in the Plan by reviewing the final quarterly progress report.
- Identify implementation problems (technical, political, legal and financial) based on quarterly progress reports and input by the public and partners.
- Evaluate the effectiveness of the planning effort by using FEMA Worksheet #2: Evaluate Your Planning Team.
- Consider recommendations by the Silver Jackets members to increase hazard mitigation involvement by federal agency representatives, state agencies and local jurisdictions.
- Discuss changes in policies, priorities, programs and funding that alter the Plan’s goals and objectives, projects and timelines.

Should the mitigation staff determine during the annual meeting that the Plan should be updated; a meeting will be scheduled for updating the Plan. A list of recommendations or enhancements compiled during the annual meeting will be used to update the Plan. The State will update its Plan as necessary to reflect:

- Hazards addressed in the Plan – All of the natural and human-caused hazards that have been identified as posing a threat to the state of Minnesota have been included in the Plan. As situations change or new information becomes available 1) the hazards currently included in the Plan will be updated and 2) new hazards identified as a threat will be added to the Plan.
- State owned structures – A state owned and other Critical Facilities Database is still a priority, though funding is lacking. This database inventories all state owned structures and will be maintained, as necessary.
- County and City owned structures – funding for geocoding county and city critical facilities was not completed for the 2011 or the 2014 Plan due to funding issues. A database will be pursued as funds become available.
- New mitigation actions and projects – Additional actions and projects may be identified during the Plan evaluation.
- Problem identification and resolution – Recommendations developed to overcome problems (technical, political, legal and financial) may affect the mitigation strategy.
- Review and update will involve all of the original participants in the planning process and others identified as important for the Plan update. This process will occur, as needed, or at a minimum every three years. The Plan will be resubmitted to FEMA for their review as required by the federal DMA 2000 planning guidelines.
- The State Hazard Mitigation Officer (SHMO) has the overall authority and responsibility for maintenance of the Plan. The updated Plan will be submitted to FEMA for review. Once FEMA has determined the Plan is approved- pending adoption, the updated Plan must be submitted for approval by the Governor no later than three months after the conclusion of the Plan update meeting.

Disasters provide an opportunity to evaluate the effects of the disaster, to improve resistance to the hazard, review the accuracy of hazard specific sections and to determine if the planning efforts affected damage reduction. In the case of a disaster declaration in the State, the Plan can be updated if HSEM believes this necessary. A post-disaster review may replace an annual review depending upon the severity of the disaster event.

The Mitigation Section of HSEM is responsible for reviewing all Local Mitigation Plans based on the criteria established in 44 CRF 201.6 within 30 days of the arrival date and either certify or supply comments, as needed.

Plan Distribution

The Plan, and any changes to it, will be available in an electronic format on the HSEM website. Revised portions of the Plan will be annotated with the date of the revision. Digital and/or hard copies of the Plan will be distributed to State and Federal agencies as requested. HSEM will maintain a distribution list for hard copies provided to such agencies to facilitate the distribution of Plan revisions.

2.6 Acknowledgements

The State Hazard Mitigation Team would like to acknowledge and thank those individuals, agencies, and organizations that provided guidance, input and support in the development of the State Hazard Mitigation Plan. The intent of the Plan is to provide unified guidance for ensuring coordination of recovery-related hazard mitigation efforts following a major emergency or disaster, and to implement an on-going comprehensive State Hazard Mitigation Strategy, the Silver Jackets is the primary force behind the review and coordination of the Plan.

Coordinating Agency:

Department of Public Safety, Division of Homeland Security and Emergency Management

State Hazard Mitigation Planning Teams:

Silver Jackets & Technical Review Team

Agency	**Representatives**
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Metropolitan Airport Commission	Kristi Rollwagen
Minnesota Board of Water and Soil Resources	Al Kean
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	Zu
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State Hazard Mitigation Climate Adaption Review Team

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National Weather Service	Michael Lukes
United States Army Corps of Engineers	Terry Zien
United States Geological Survey	James Fallon
University of Minnesota Duluth	Stacey Stark

Minnesota Rural Electric Cooperative Hazard Mitigation Review Team

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Beltrami Electric Cooperative	Richard Riewer
BENCO Electric Cooperative	Lori Read
Connexus Energy	Rod Morton, Nick Loehlein
Dakota Electric Association	Luke Choudek
East Central Energy	Dave Waletski, Vern Johnson
Federated Rural Electric Association	Chris Gallaway
Freeborn-Mower Cooperative Services	Lori Read
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Lake Country Power	Derek Howe
Lyon-Lincoln Electric Cooperative	Gary Heffele, Timothy O'Leary, Lyle Lamonte
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Red River Valley Co-op Power Assn.	Loren Brorby, Gary Shulstad
Redwood Electric Cooperative	Chad Nelson
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Sioux Valley Energy	Michele Nielson
South Central Electric Association	Mark Anderson & Rod Sykora
Stearns Co-op Electric Assn.	
Steele-Waseca CE	Lori Read, Kristi Robinson
Wild Rice Electric Cooperative	Steven Haaven
Wright-Hennepin Co-op Electric Assn.	Lance Hovland

Section 3: State Profile

3.1 Geographic Characteristics

Minnesota is located in the north central United States. Near the geographic center of North America, it is bordered on the north by the Canadian provinces of Manitoba and Ontario, on the west by North Dakota and South Dakota, on the south by Iowa, and on the east by Wisconsin and Lake Superior. Minnesota entered the Union on May 11, 1858, as the 32nd state.

Figure 1 Minnesota Location Map

Minnesota covers 86,943 square miles, of which 4,780 square miles are inland waters and 2,546 square miles consist of a portion of Lake Superior under the state's jurisdiction. Of the 50 states, Minnesota ranks 12th in total land area. From north to south the state measures 406 miles, and from east to west it measures 358 miles at its maximum extent and about 180 miles at its narrowest point.

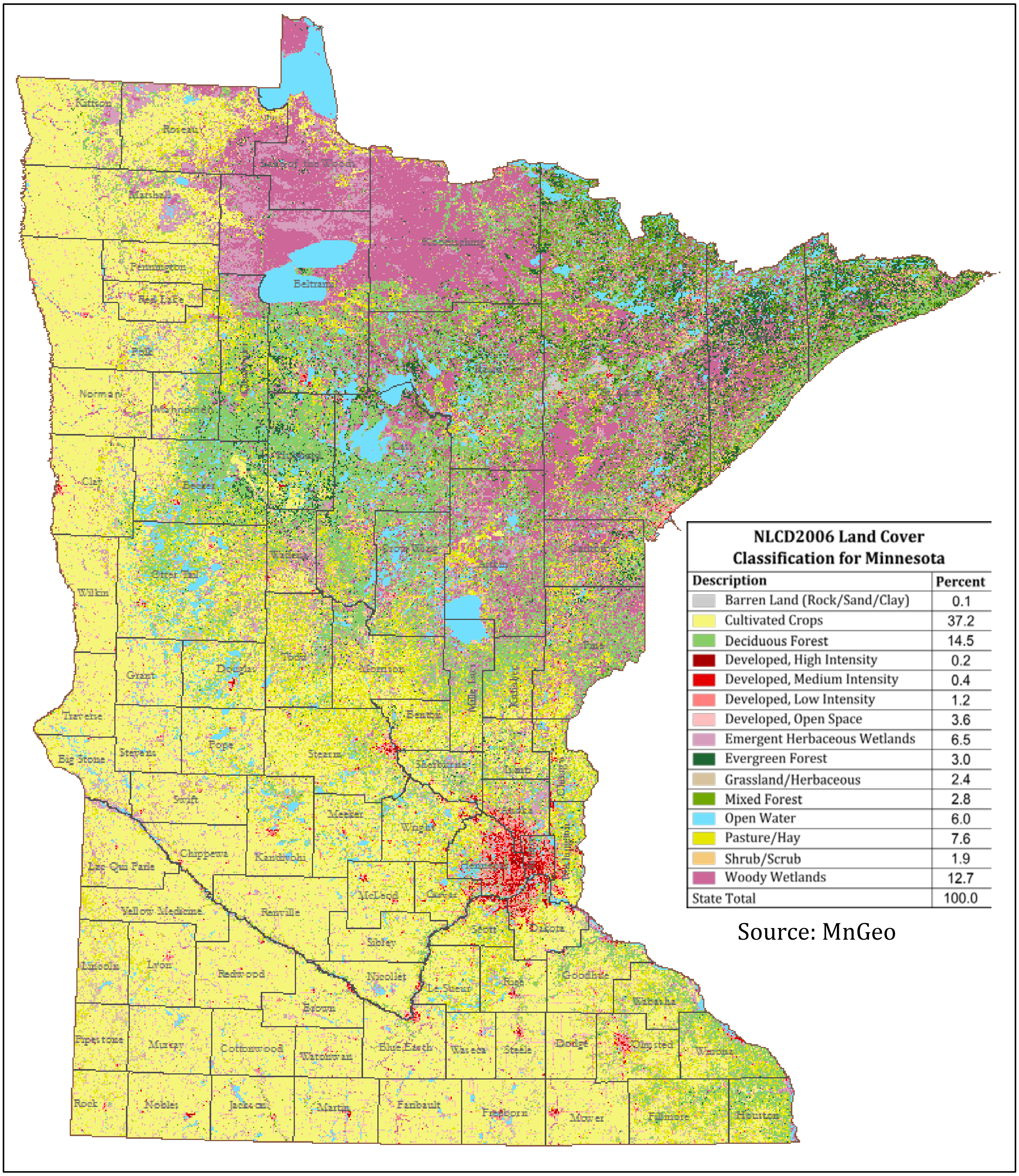
The mean elevation is approximately 1,200 feet. Three areas in the state reach higher than 1,600 feet: the Iron Range (paralleling the north shore of Lake Superior), the Coteau Des Prairies (also known as Buffalo Ridge), and a small area in the Lake Itasca region. The highest point in the state is Eagle Mountain in the extreme northeast, at 2,031 feet. The lowest elevation is 602 feet along the shores of Lake Superior.

The natural environment of the state is broken into three distinct biomes. The coniferous forest in Minnesota is found in the northern half of the state, but grades into the deciduous forest then prairie grassland in the northwestern part of the state. The deciduous forest biome extended in a diagonal line from the southeastern part of the state to the northwest. Most of these forests were cleared and converted to farmland during Minnesota's first 50 years of statehood. The State once had 18 million acres of prairie that stretched across the southern portion of the state and northward along the western border. Like the deciduous forest, the vast majority of the prairie biome has been converted to agricultural land (Figure 2).

As Minnesota’s climate changes, weather fluctuations between drought and extreme rain events and increasing temperatures will lead to changes in forest composition or distribution. The northern boreal forest may give way to more deciduous forests or grassland, with a period of dying or diseased trees during the transition. This weather fluctuation can lead to dry conditions that can cause increased fire risk in both grassland and forest environments.

The composition of Minnesota’s forests is expected to change as rising temperatures drive habitats for many tree species northward.

Figure 2 Land Cover in Minnesota



3.2 Climate

Minnesota has a continental-type climate and is subject to frequent outbreaks of continental polar air throughout the year, with occasional Arctic outbreaks during the cold season. Occasional periods of prolonged heat occur during summer, particularly in the southern portion of Minnesota, when warm air pushes northward from the Gulf of Mexico and the southwestern United States. Pacific Ocean air masses that move across the western United States produce comparatively mild and dry weather at all seasons.

Mean annual temperatures in Minnesota range from 38 degrees Fahrenheit (°F) in the extreme north to 47°F along the Mississippi River in the southeast. State temperature extremes range from -60°F to 115°F (Greg Spoden, State Climatology Office - Minnesota Department of Natural Resources, personal communication, November 18, 2013).

Maximum temperatures in July, Minnesota's hottest month, average near 85° F in southwestern counties. During Minnesota's coldest month, January, minimum temperatures average near -7° F in far northern Minnesota. Due to the modifying influence of the large water body, average temperatures for locations near Lake Superior are five to 10 degrees warmer in the winter and 5 to 10 degrees cooler in the summer than locations just a few miles inland.

Although total annual precipitation is important, its distribution during the growing season is more significant. For the most part, native vegetation grows for seven months (April to October) and row crops grow for five months (May through September). During the crop growing period, approximately two-thirds of the annual precipitation occurs. Mean annual precipitation is 37 inches in extreme southeast Minnesota gradually decreasing to 21 inches in far northwest Minnesota. Since 1895, Minnesota's two driest years were 1910 and 1976, while the two wettest years were 1977 and 2010.

Seasonal snowfall averages near 70 inches in the highlands along the north shore of Lake Superior in northeast Minnesota and gradually decreases to 36 inches along the Iowa border in the south and along the North Dakota and South Dakota borders in the west.

Heavy snowfalls of greater than four inches are common anytime from mid-November through mid-April. Heavy snowfalls with blizzard conditions affect the State on average about two times each winter.

The diverse nature of the air masses impacting Minnesota's climate leads to a high degree of variability across space and time. At times, this variability leads to periods of precipitation shortfalls and uncommonly warm temperatures. Therefore, drought is part of Minnesota's climate history. All Minnesota counties have encountered episodes of severe drought since statehood, with droughts being more frequent in southwest Minnesota than in northeast Minnesota.

3.3 Demographic Characteristics

According to the 2010 U.S. Census Bureau data, Minnesota's total population on April 1, 2010 was 5,303,925. The Minnesota State Demographic Center estimates the state's population in 2012 to be 5,379,139. This is a 1.42% increase from 2010 to 2012.

Since the 2000 Census, Minnesota has grown by 459,660 people, ranking 23rd among states in the percent of growth. Minnesota remains one of the fastest-growing states in the Midwest. Minnesota continues to rank among the leading states in income level, educational attainment, and labor force participation according to a 2007 report from the Minnesota State Demographic Center. Minnesota's rankings include:

- 1st in home ownership (75.8% owner-occupied)
- 2nd in labor force participation (72.2% for ages 16 and over)
- 10th lowest in unemployment as of March of 2013 (United States Department of Labor)
- 3rd in high school completion (91.3% for ages 25 and over)
- 4th lowest poverty rate (9.8% of all people)
- 11th highest per capita income ($46,227).

The population density based on 2010 U.S. Census blocks is illustrated in Figure 3 State of Minnesota Population Density The breakdown of population for state of Minnesota by age group:

Under 19 Years	1,429,307
20 to 24 Years	357,208
25 to 34 Years	705,809
35 to 54 Years	1,501,767
55 to 74 Years	955,346
75 Years and Over	327,553
Total	5,278,190

U.S. Census Bureau. American Fact Finder. ACS Demographic and Housing Estimates. Retrieved May 30, 2013

Population projections indicate that the strongest areas of growth will remain the outer ring suburbs within the seven county metropolitan areas surrounding the twin cities of Minneapolis and St. Paul. Strong increases are also projected for the Rochester and St. Cloud areas. By 2020, 68% of Minnesota's population will live in one of these three metropolitan areas, including their suburban and exurban areas. The lakes area of north central Minnesota is also projected to experience a considerable increase. 2025 projections indicate significant growth in the counties immediately adjacent to the seven county metro areas and in counties across the state possessing high lake densities. Counties located in western and southwestern Minnesota are projected to lose population in the coming decades. These projections indicate that 19 of the state's 87 counties will experience population increases. A majority of the counties with projected population declines are spread throughout the southwestern region of the state, with a few counties in the northeastern region and a few in the northwestern region.

Figure 3 State of Minnesota Population Density

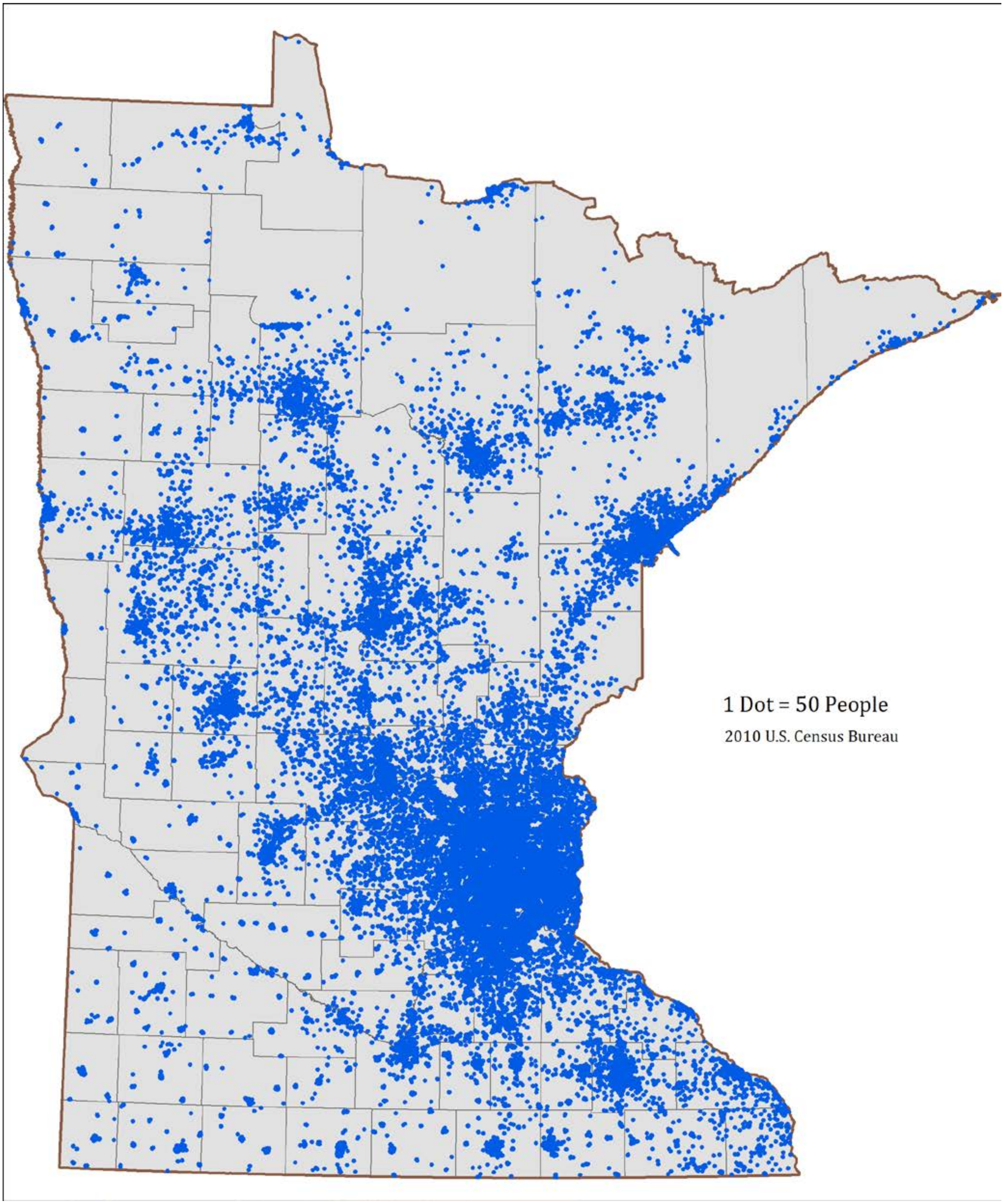
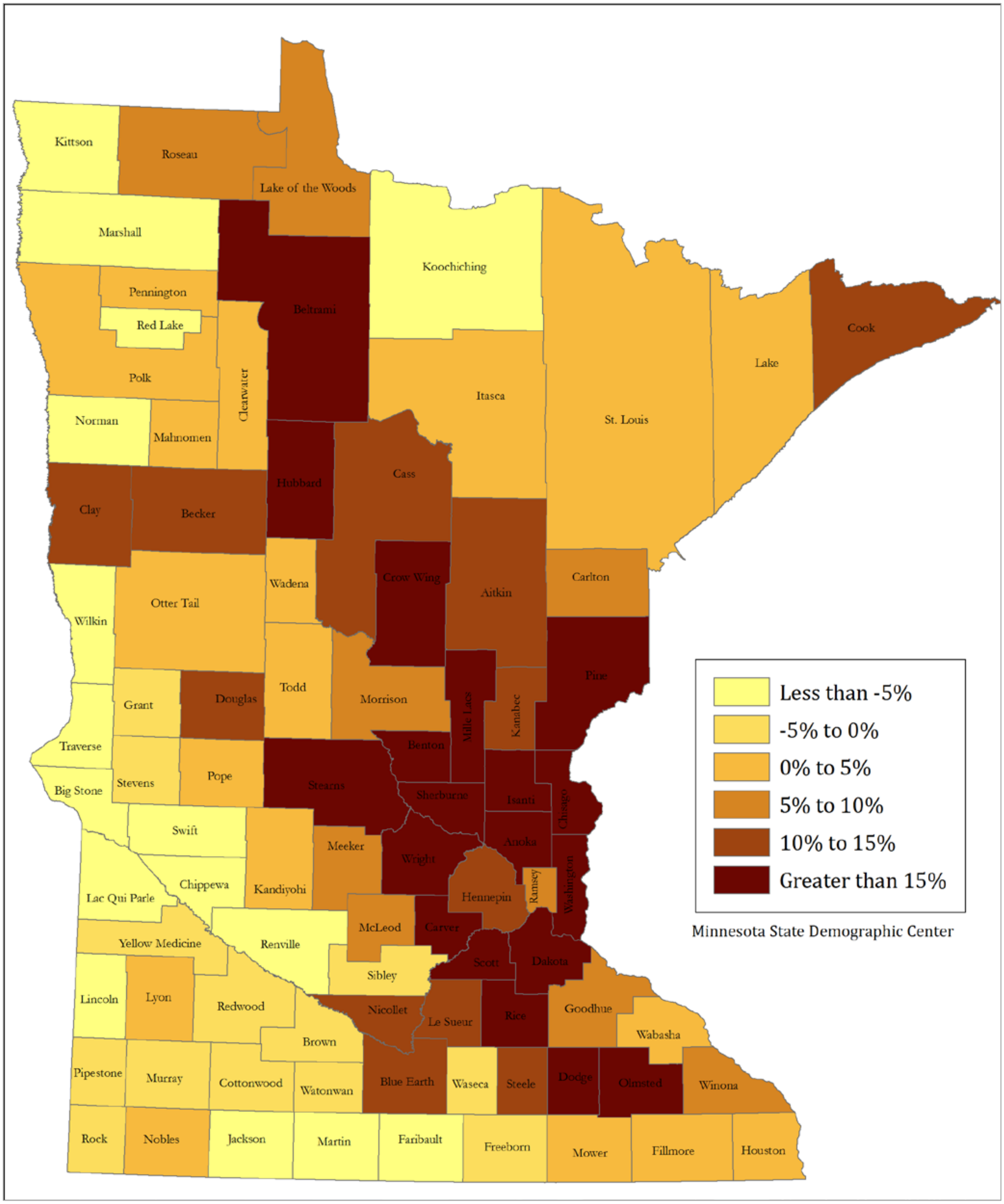


Figure 4 Projected Population Change for 2010-2025



Minnesota currently ranks 9th in the nation with 19 Fortune 500 Companies. The 19 companies in Minnesota had combined total revenues of $465 billion in 2013. Minnesota's corporations also compete in the private sector – one of these companies (Cargill) had $2.13 billion in revenues in 2013.

Minnesota is the fifth largest agricultural producer in the nation with 81,000 farms covering 27.5 million acres, generating $15.14 billion in 2010. Minnesota ranks first in the nation in production of sugar beets, turkeys, sweet corn for processing, and green peas for processing. Eighty percent of agricultural jobs are located off the farm. Agriculture supports many other industries, such as manufacturing, transportation, wholesale and retail trade, services, construction, banking, insurance, and real estate. The economic contribution of Minnesota’s agricultural industry reaches far beyond the agricultural sector due to the “multiplier effect.”

Minnesota’s agricultural sector provides over 340,000 jobs in the state, creating $75 billion in economic activity (Minnesota Department of Agriculture, 2012). The average size of farm in 2007 was 332 acres, and for that year the market value of agricultural products sold was over $13 billion dollars (USDA Census of Agriculture, 2007). Family farms have declined in numbers since the 1970s, but many are finding success in organic farming and other specialty niches. Approximately half of Minnesota farmers are either hobbyists, rural residents with some farm income, or specialty crop farmers near urban areas who combine farmers with other professions (Egerstrom, 2011).

Tourism is also a key section of Minnesota's economy, comparable to agriculture in its contribution to the gross state product. Leisure and hospitality in Minnesota generated $11.9 billion in gross annual sales and $769 million in state sales taxes in 2011, and the industry employed nearly 254,000 full- and part-time workers in 2011 (Explore Minnesota, 2013). In 2012, the annual number of travelers (in person-trips) in Minnesota was 71 million, over thirteen times the total population of the state (Explore Minnesota, 2012).

3.4 Development Trends

Overall, the state is showing growth in both population and industry. One on-going challenge associated with this growth is maintaining a balance between development and natural resource protection. Each community is responsible for ensuring ordinances that protect residents from flooding, wildfire and other hazards are enforced. Communities with floodplain ordinances and communities that participate in FireWise are more resistant to associated hazards. Comprehensive plans, land-use plans, watershed management plans and all types of long-term community planning are a local responsibility. Hazard mitigation plans requiring federal funding aim to give incentives to these communities to reduce vulnerability to all hazards for existing properties. The state does not dictate how communities grow; however, the current participation of all Minnesota’s counties (and some tribes and cities) in all-hazard mitigation planning is a positive step towards making the state and its residents disaster resistant.

In each community, risk assessments are based on past damages to existing structures. The risk assessment addresses the hazards with the highest potential for loss. Addressing hazards for the increased potential for flood damages and areas vulnerable to tornados/winds with intense development pressures is identified for each community based on its risk assessment.

In addition, counties in the northern portion of the state are encouraged to address growth and the proximity of (typically second) homes near lakes and in heavily forested areas to utilize best management practices for the wildland-urban interface, such as thinning projects, defensible space, and utilization of federally funded sprinklers for wildfire protection.

The growing population in Minnesota along rivers, lakes and forested areas must be done with potential hazards in mind. Utilizing land use and comprehensive planning resources will ensure Minnesota remains safe for its residents, as well as environmentally and economically sound. It is up to local jurisdictions to enforce existing regulations, and work with communities to develop and grow sustainably, and out of harm's way, to the maximum extent possible.

3.5 Climate Change

3.5.1 Historical Trends

Minnesota's climate is currently changing in ways that will affect the environment, the economy and everyday life. Climate change is already occurring. A preliminary assessment of global temperatures during the first nine months of 2013 indicates that this year will likely be among the 10 warmest years since global records began in 1850 (Freedman, 2013). Historical weather data show changing trends in some weather phenomenon over the past few decades, and future changes are likely. Definite predictions are difficult to make, as changes may vary depending on geographical location, even within Minnesota. Intense study of these topics is ongoing.

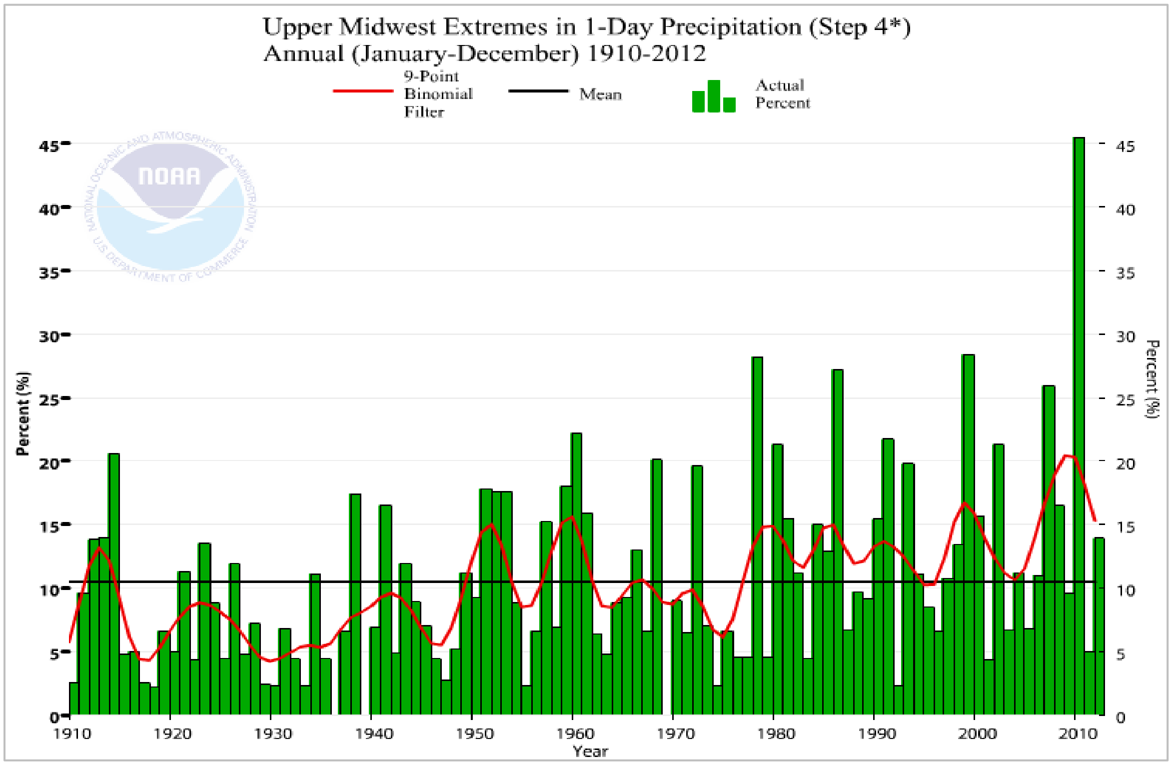
The NOAA Technical Report NESDIS 142-3 "Regional Climate Trends and Scenarios for the U.S. National Climate Assessment" provides physical climate information for use by the authors of the Third National Climate Assessment (NCA) report, in draft form as of late 2013.One section summarizes historical conditions in the U.S. Midwest and trends in temperature and precipitation metrics that are important in the region. The historical climate conditions are meant to provide a perspective on what has been happening in each region and what types of extreme events have historically been noteworthy, to provide a context for assessment of future impacts. Some key characteristics of the Midwest historical climate identified in this report that relate to the All Hazard Mitigation Plan include:

- *Climatic and hydroclimatic phenomena that have major impacts on the Midwest include floods, severe thunderstorms, summer drought, heat, excess rain, heat waves, Great Lakes water levels, and winter storms.*
- *Historical, annual temperatures increased during the early 20th century to a peak in the 1930s, decreased into the 1960s/1970s, and increased thereafter. Annual temperatures have generally been well above the 1901-1960 average since the late 1990s and the decade of the 2000s is the warmest on record.*

- *Precipitation has been near or above the 1901-1960 average for most years during the last 4 decades, and there have been no years with major precipitation deficiencies during the last 2 decades. The overall trend in annual precipitation is upward and statistically significant.*
- *The frequency and intensity of extreme precipitation has increased, as indicated by multiple metrics of extremes, including the number of 5-year storms and total accumulated precipitation during the top 10 wettest days of the year.*
- *Shoreline areas of Lakes Superior, Michigan, and Huron have all experienced a statistically significant upward trend in annual snowfall totals during the period 1890-2004.*
- *Frequency of intense cold waves has been very low since the mid-1990s. Freeze-free season length averaged about 155-160 days before the 1930s; increased to about 160 days from the 1930s to 1980s; and since the 1980s has increased gradually and now averages about one week longer than during the 1930s to 1980s.*
- *Frequencies of summertime minimum temperatures of 70°F or greater have increased in many of the larger urban areas in the region, equaling very high nighttime humidity. Statistically significant positive trends were found for five cities from 1950 to 2009.*
- *Recent heat waves, such as the 1995 event in Chicago which led to 700 fatalities, have been accompanied by very high humidity levels and high nighttime temperatures, but not quite as extreme daytime high temperatures (Kunkel et al. 1996; Rogers et al. 2007).*

Figure 5 shows Upper Midwest annual extremes in 1-day precipitation trends (% of land mass with 1-day rain events with amounts in upper 10th percentile) based on the U.S. Climate Extremes Index (CEI). The curved red line is a nine-point binomial filter which shows the decadal-scale variations. Extreme precipitation events are clearly increasing over past decades.

Figure 5 Upper Midwest Precipitation Extremes, 1910-2012



Source: NOAA National Climatic Data Center

3.5.2 Climate Change Risks

It is clear that temperatures are rising and weather patterns are changing, with an increase in severe weather events and extreme precipitation, with associated damage and flooding.

Winter weather may include more ice storms, leading to dangerous driving conditions and power outages due to downed power lines (Seeley presentation, 2013). Increased drought is possible, with associated fire and other health risks. Even factors such as higher night-time temperature lows in the winter may lead to reduced or unsafe ice cover on Minnesota's lakes, increasing risk in winter recreational activities such as snowmobiling and ice fishing.

Every four years, the United States Global Change Research Program publishes a National Climate Assessment Report. The next update will be available in early 2014. The report highlights likely impacts to the Midwest due to climate change (www.ncadac.globalchange.gov). The key messages in the 2013 draft federal multi-agency report related to the All Hazard Mitigation Plan are summarized here:

- Increased heat wave intensity and frequency, degraded air quality, reduced water quality and more flooding events will increase public health risks.
- Extreme rainfall events and flooding have increased during the last century, and these trends are expected to continue, causing erosion, declining water quality, and negative impacts on transportation, agriculture, human health, and infrastructure.

- In the next few decades, longer growing seasons and rising carbon dioxide levels may increase yields of some crops, though those benefits will be increasingly offset by the occurrence of extreme events.
- Climate change will exacerbate a range of risks to the Great Lakes region, including changes in the range and distribution of important commercial and recreational fish species, increased invasive species, declining beach health, and harmful blooms of algae. Declines in ice cover will continue to lengthen the commercial navigation season (but also lead to increased danger in ice-based recreation activities.)

It is likely that climate change will have different effects in different parts of the country or even within the state of Minnesota. Some areas may see higher increases in relative temperature or larger changes in precipitation trends. Models tend to show predictions for larger geographical areas than one state or a region of a state, but there is recent effort by researchers to downscale modeling to provide more specific predictions.

3.5.3 Climate Change Adaptation

As Minnesota's climate changes, increased risks from natural disasters of all sorts will require increased emergency preparedness to the most likely risks associated with climate change. Efforts to reduce greenhouse gas emissions in order to mitigate the magnitude of future climate change are still valuable and being addressed at many levels of government, but the purpose of this plan is to prepare and adapt to the likely coming changes.

In 2009, Minnesota developed an Interagency Climate Adaptation Team (ICAT). Staff from state agencies, including the Department of Public Safety and Hazard Mitigation staff, collaborates on climate adaptation efforts. In November of 2013, the ICAT published an updated report "Adapting to Climate Change in Minnesota" that shares a summary of observed and projected climate impacts, outlines state agency activities and responses, and identifies opportunities for future action and interagency collaboration. That report is available at:

http://www.pca.state.mn.us/index.php/topics/climate-change/climate-change-in-minnesota/adapting-to-a-changing-climate.html.

The Minnesota Health Department offers materials for educating the public about climate change risks as well as resources for emergency managers such as the Extreme Heat Toolkit to help create extreme heat response plans.

Minnesota also has a Climate Adaptation Partnership (CAP) coordinated by the University of Minnesota Extension and the U of M Water Resources Center to bring together federal and state agencies, academic researchers, organizations and individuals statewide with an interest in climate adaptation.

An economic perspective of Climate Change is offered from the Insurance Federation of Minnesota (IFM), a nonprofit state insurance trade association. IFM data indicates Minnesota was projected to be the second highest state with catastrophic losses in 2013. A severe storm that caused widespread wind and hail damage on August 6 generated $800 million in claims. Previously, Minnesota ranked number two in the nation in 2007 with $747 million in claims and number three in 2008 with $1,583 million in estimated insurance loss. According to the insurance data, Minnesota and the Upper Midwest are starting to eclipse the hurricane states in claims. Homeowner rates were 267 percent higher between 1997 and 2010. The President of the

IFM characterizes Minnesota's changing landscape as "growingly unstable" and the catastrophic loss levels as "unsustainable" leading to a "Minnesota Meltdown" in the insurance sector.

Climate change adaptation planning may be daunting, especially considering the far-reaching consequences of increased severe weather and changing weather patterns to everything from electricity to clean water supplies to mosquito populations. However, advance planning and preparation to the extent possible will help prevent loss of life or greater challenges in the future.

Section 4: Natural Hazards Risk Assessment

§201.4(c)(2): *[The State plan must include a risk assessment] that provides the factual basis for activities proposed in the strategy portion of the mitigation plan. Statewide risk assessments must characterize and analyze natural hazards and risks to provide a statewide overview. This overview will allow the State to compare potential losses throughout the State and to determine their priorities for implementing mitigation measures under the strategy, and to prioritize jurisdictions for receiving technical and financial support in developing more detailed local risk and vulnerability assessments.*

201.4(c)2)(i) – *The risk assessment shall include an overview of the type of all natural hazards that can affect the state.*

This section of the Plan is a result of a risk and vulnerability assessment conducted for the State of Minnesota. The risk assessment is part of the State Hazard Mitigation Plan and is intended to support the State's long-term hazard mitigation planning efforts. It was prepared to satisfy the requirements of the Disaster Mitigation Act (DMA) of 2000 and to provide a statewide overview of natural hazards and their risks. This Plan also assesses human-caused hazards such as: fire, hazardous materials spills, radiological emergencies, critical infrastructure failure, and water supply contamination.

The framework of the risk assessment was developed to provide a basis for activities proposed during the State's mitigation planning effort and should be used by state and local officials to plan and prioritize resource allocations. The risk assessment results should be used to identify and prioritize appropriate mitigation actions to minimize potential losses from hazards identified in this study.

The hazards profiled in the Minnesota Risk Assessment were selected from the comprehensive list of natural hazards FEMA identified in the 1997 publication, *Multi-Hazard Identification and Risk Assessment: A Cornerstone of the National Mitigation Strategy* (MHIRA).

The original risk assessment was based on input from published sources such as the U.S. National Oceanographic and Atmospheric Administration (NOAA), the U.S. Geological Survey (USGS), the U.S. Army Corps of Engineers (USACE), the U.S. Department of Agriculture (USDA), the Minnesota Department of Natural Resources (MNDNR), and the Minnesota Division of Homeland Security and Emergency Management, among others.

This portion of the Risk Assessment identifies and profiles natural hazards. All 20 hazards that potentially affect the state are described, as is the nature of each hazard, history, location of occurrence, and probability of future occurrence.

4.1 Organizational Update

In an effort to organize the risk assessment by individual hazard (as opposed to including information about all hazards within each required section), the State of Minnesota has elected to combine the data previously organized within the Section 4: Risk Assessment -Identify and

Profile Hazards, and Section 5: Risk Assessment - Vulnerability Assessment. The state of Minnesota believes this approach will allow each hazard to be evaluated with a single review of all data available in one central location organized by hazard. All maps in this document have been updated as of August 2013 with the most recent data available, unless otherwise noted.

The following sections provide information on the nature of each hazard that the state of Minnesota is susceptible to, a history of the hazard in the state and the probability of its occurrence in the future.

4.2 Presidential Disaster Declaration History

The state of Minnesota has been granted Presidential Disaster Declarations 51 times between 1957 and 2013 (56 years). Of those declarations, 42 involved flooding in 31 different years. Those numbers translate into approximately a 55% chance of a major flood annually somewhere in the state. Disaster Declarations for the last three years are listed below.

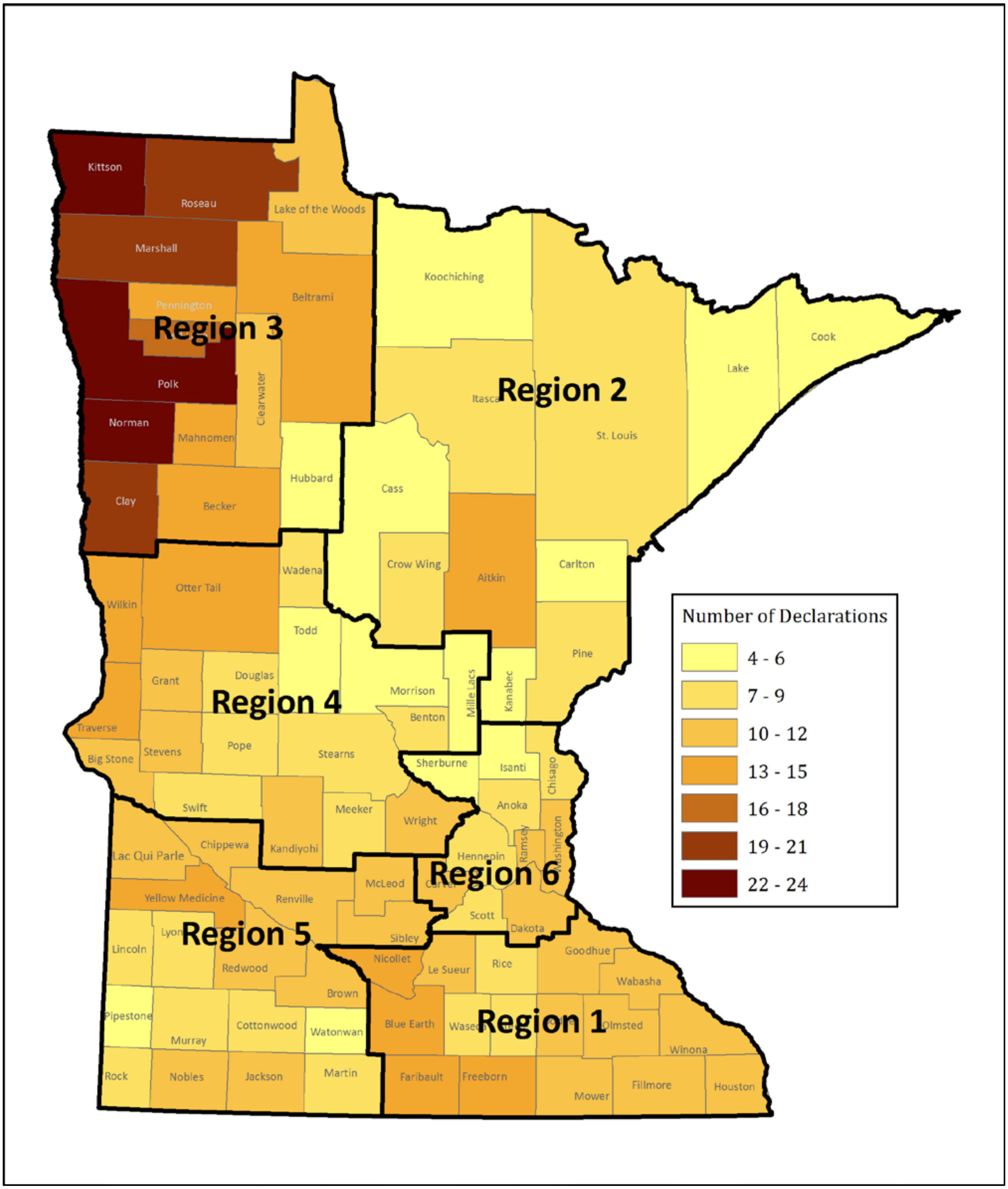
Table 2 FEMA disaster declarations, 2011-2013

Date	DR Number	Designated Counties	Incident Description	Total Public Assistance
7/25/2013	4131	Benton, Big Stone, Douglas, Faribault, Fillmore, Freeborn, Grant, Hennepin, Houston, McLeod, Morrison, Pope, Sibley, Stearns, Stevens, Swift, Traverse and Wilkin	Severe Storms, Straight-line Winds, Flooding	$1,726,876.26
5/3/2013	4113	Cottonwood, Jackson, Murray, Nobles and Rock	Severe Winter Storm	$8,049,373.32
7/6/2012	4069	Aitkin, Carlton, Cass, Cook, Crow Wing, Dakota, Fond du Lac Indian Reservation, Goodhue, Grand Portage Indian Reservation, Itasca, Kandiyohi, Lake, Lake of the Woods, Meeker, Mille Lacs Indian Reservation, Pine, Rice, Saint Louis and Sibley	Severe Storms, Flooding	$43,670,296.26
7/28/2011	4009	Chisago, Isanti, Kanabec, Kandiyohi, Lincoln, Lyon, McLeod, Meeker, Mille Lacs, Pine, Pipestone, Redwood, Renville, Stearns and Yellow Medicine	Severe Storms, Flooding, Tornadoes	$12,200,073.78
6/7/2011	1990	Anoka and Hennepin	Severe Storms, Tornadoes	$4,431,349.34
5/10/2011	1982	Becker, Beltrami, Big Stone, Blue Earth, Brown, Carver, Chippewa, Clay, Grant, Kittson,	Severe Storms, Flooding	$20,831,270.76

Date	DR Number	Designated Counties	Incident Description	Total Public Assistance
		Lac qui Parle, Le Sueur, Lyon, Marshall, McLeod, Nicollet, Norman, Otter Tail, Polk, Ramsey, Red Lake, Redwood, Renville, Roseau, Scott, Sibley, Stevens, Swift, Traverse, Washington, Wilkin, Wright and Yellow Medicine		

Each of the 87 counties in the state has been included in a Presidential Disaster Declaration. A Chronological History of Minnesota Disasters is located in Appendix H. It contains information on the type of programs - Public Assistance, Individual Assistance, and number of applicants for Individuals and Household Program, Other Needs Assessment, Small Business Administration disaster loan program, state match, if any, and total dollar amounts where available. Minnesota Disaster History 2008-2010 includes disaster information since the previous version of the Plan. It bears repeating that all jurisdictions in the state are vulnerable to natural hazards, especially flooding and severe storms. Figure 6 shows FEMA disaster declarations by region, 1964-2013.

Figure 6. FEMA Disaster Declarations by Region, 1964-2013.



A summary of FEMA Disaster Declarations by County is shown in the following figures

Figure 7 Region 1, FEMA Disaster Declarations by County

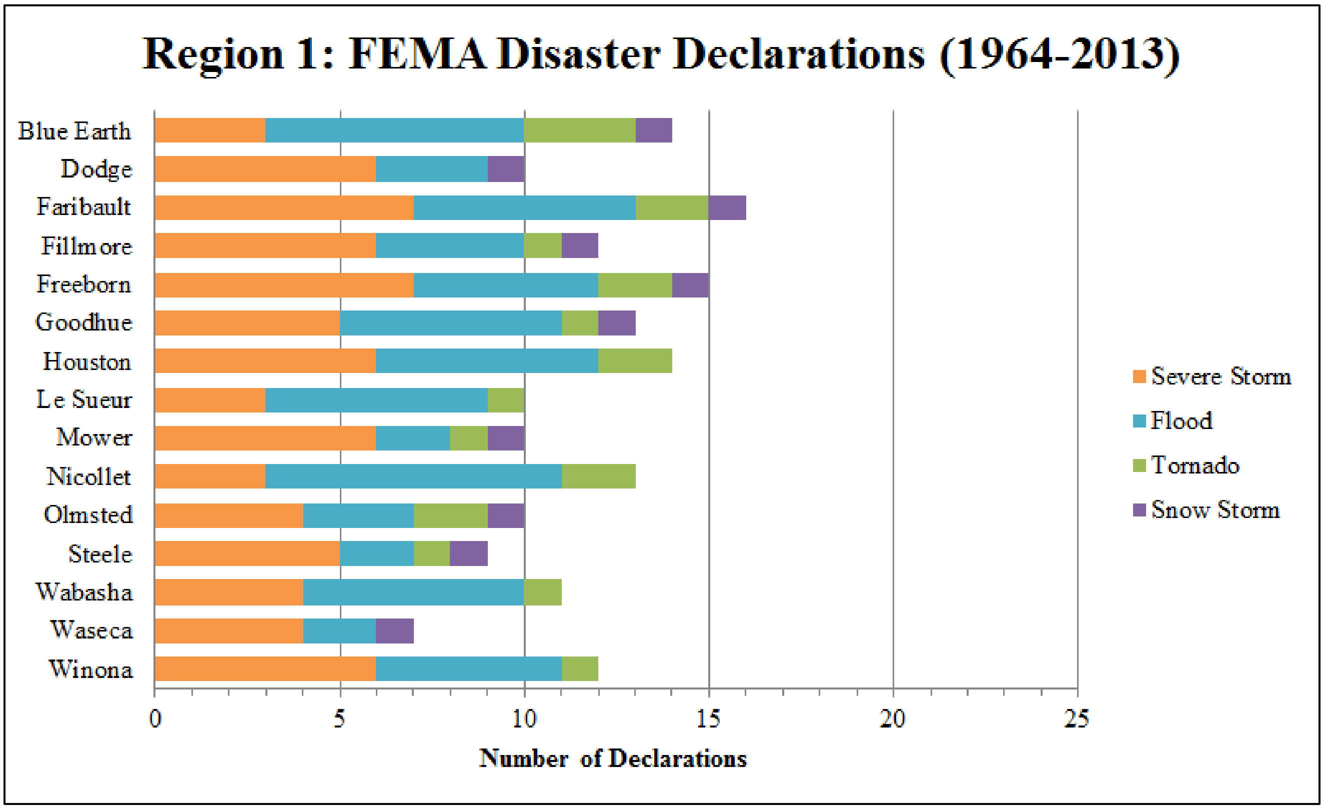


Figure 8 Region 2, FEMA Disaster Declarations by County

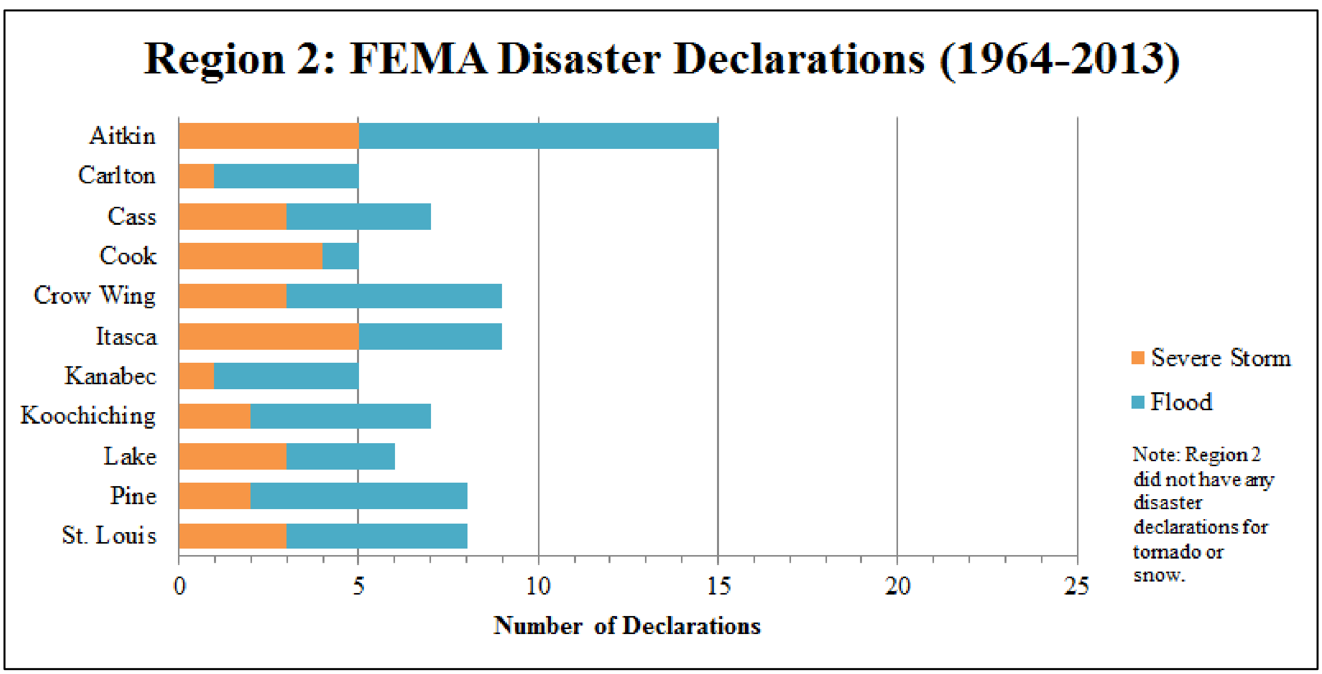


Figure 9 Region 3, FEMA Disaster Declarations by County

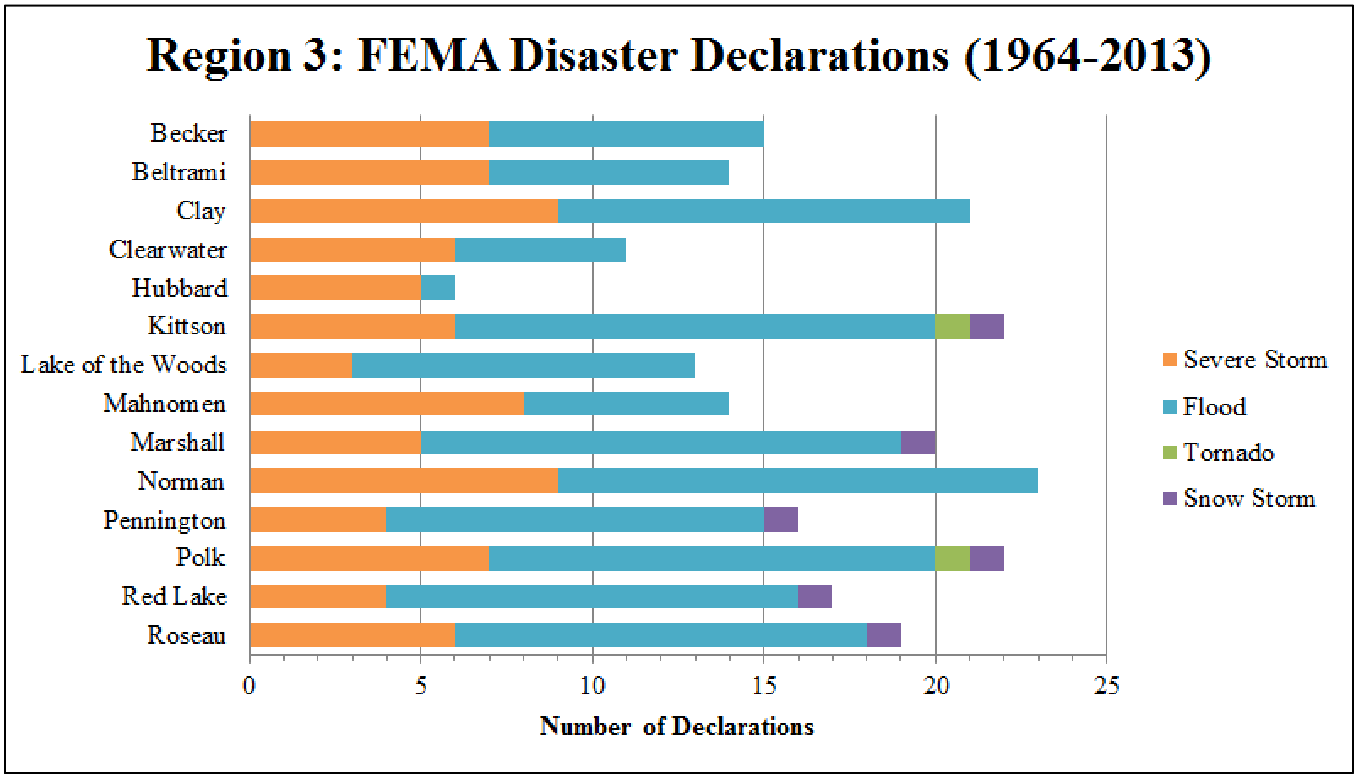


Figure 10 Region 4, FEMA Disaster Declarations by County

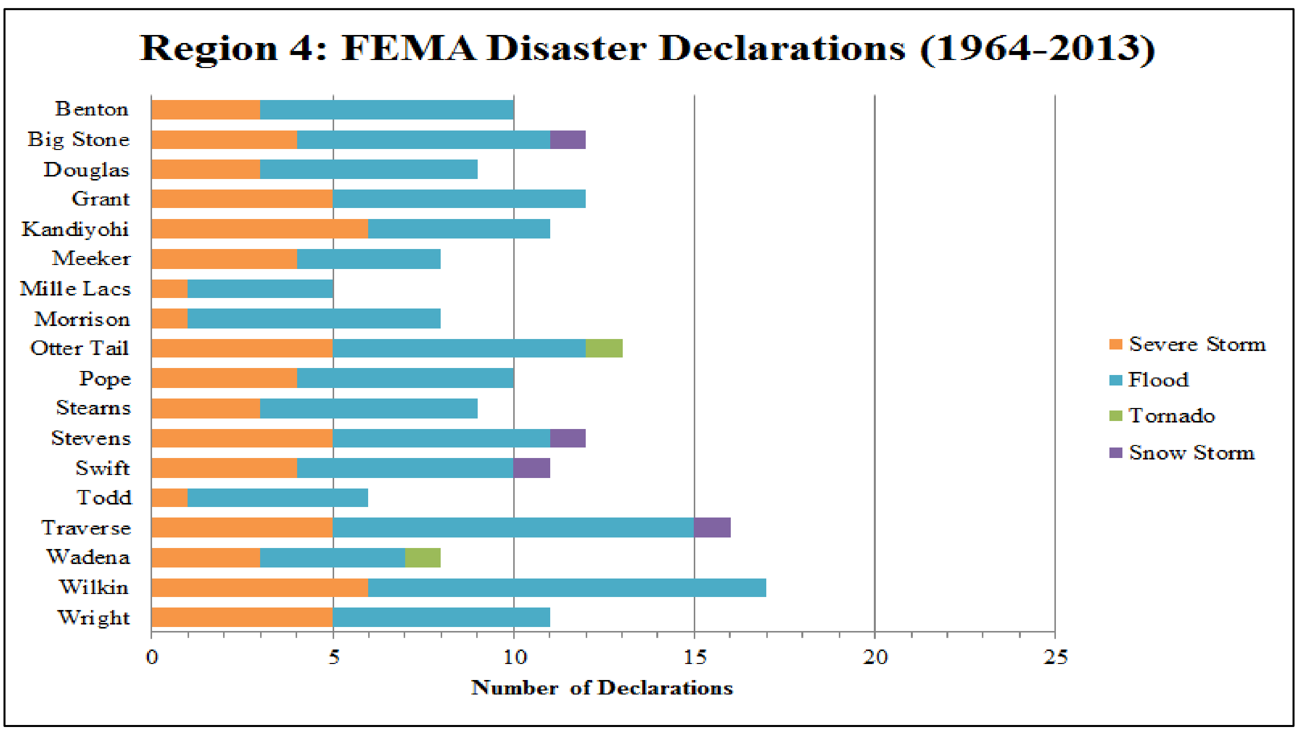


Figure 11 Region 5, FEMA Disaster Declarations by County

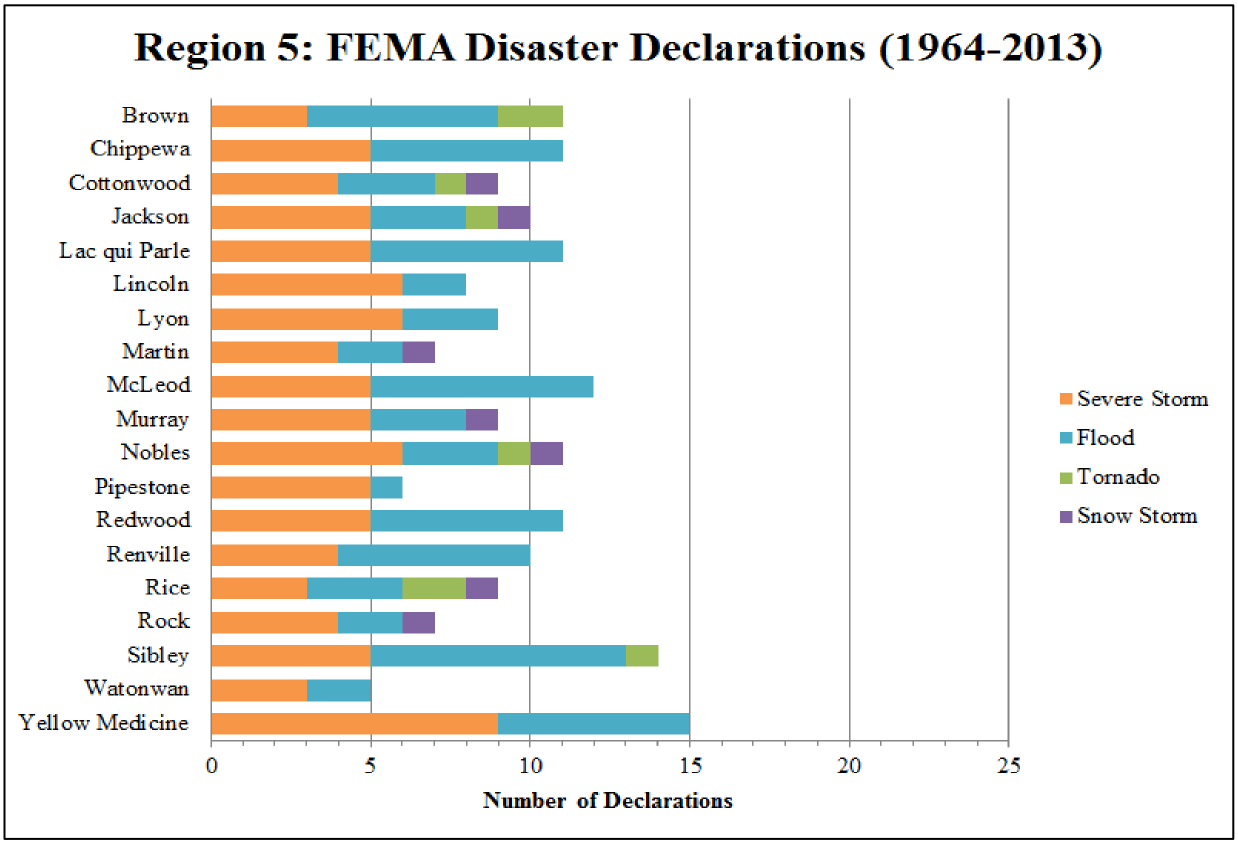
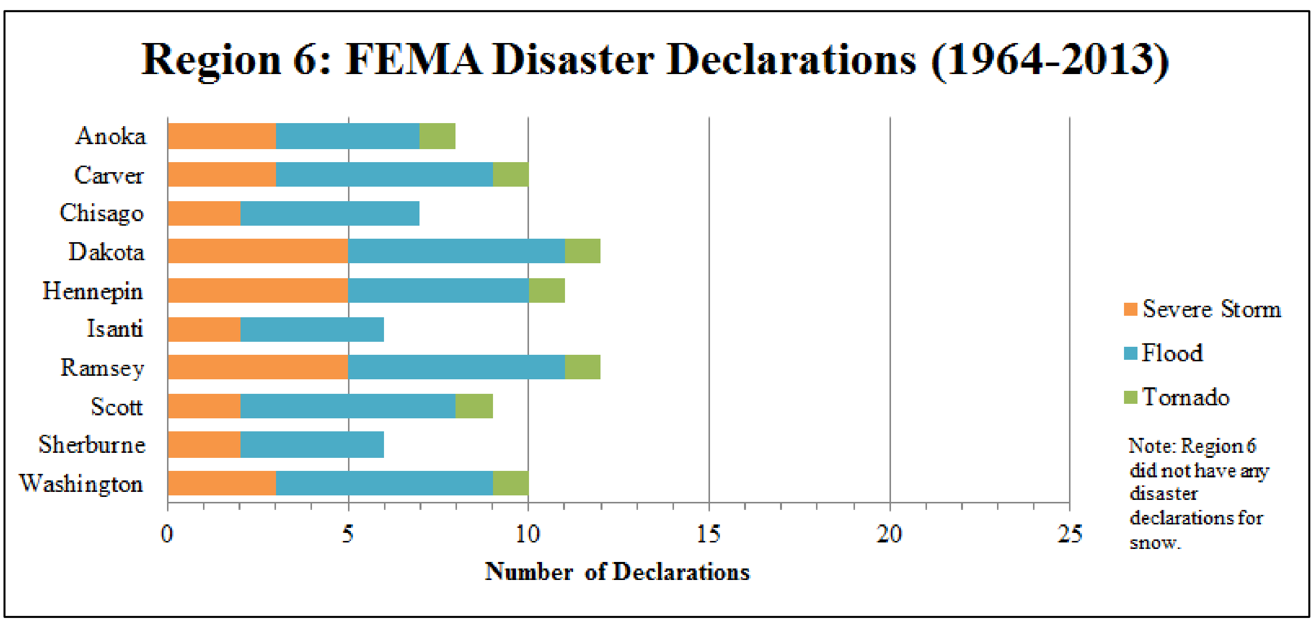


Figure 12 Region 6, FEMA Disaster Declarations by County



4.3 Identifying Hazards

Requirement §201.4(c)(2)(i): *The State risk assessment shall include an overview of the location of all natural hazards that can affect the State, including information on previous occurrences of hazard events, as well as the probability of future hazard events, using maps where appropriate.*

This section of the state plan profiles the potential hazards that pose the greatest threat to the state of Minnesota. As part of the 2014 revision, a comprehensive list of hazards was compiled from the review of the following sources:

- Review of the state's most recent Hazard Mitigation Plan (2011)
- Review of historical data of events that occurred over the past 3 years, including input from subject matter experts and lessons learned from previous years
- Review of hazards identified in guidance materials provided by the FEMA Region V Office on identifying hazards
- Assessment of National Climatic Data Center information about natural hazards
- Review of the vulnerability and risk analyses contained in the approved Local Mitigation Strategies for Florida counties
- Review of the draft National Climate Assessment(NCA) report
- Review of past state and federal disaster declarations
- Research of historical records and Web sites
- Research from the current Statewide Regional Evacuation Studies
- Input from Silver Jackets committee

Many of the identified hazards are related in the sense that other hazards may result from a disaster event, such as sinkholes stemming from flooding; in such instances, these hazards are not listed separately but concurrently.

The 2014 Plan identifies a slightly different list of hazards than in the 2011 plan. Coastal Erosion and Landslides were further clarified as 1) Erosion of field, streambank, ravine, shoreline, or bluff – caused primarily by flowing water or wave action and 2) Landslides and Mudslides of hillsides, coastal shoreline or bluff – caused primarily by oversaturation of soil. Extreme temperatures are divided into Extreme Heat and Extreme Cold, due to their vastly different impacts in Minnesota.

Based on the above sources, historical data, public perception and technical requirements, the following 14 hazards were considered for analysis:

Natural Hazards

1. Flooding (riverine and flash flood)
2. Dam / Levee Failure
3. Wildfire
4. Windstorms
5. Tornadoes
6. Hail
7. Lightning
8. Winter Storms
9. Erosion
10. Land Subsidence
11. Earthquake
12. Drought
13. Extreme Heat
14. Extreme Cold

Other Hazards:

1. Terrorism
2. Infectious Disease Outbreak
3. Fires (Structures and Vehicles)
4. Nuclear Generating Plant Incidents
5. Hazardous Materials Incidents
6. Transportation Incidents
7. Ground and Surface Water Supply Contamination

The DMA of 2000 and supporting requirements in the Interim Final Rule (IFR) requires states to first identify hazards that may affect them, and then perform a comprehensive multi-hazard assessment, which includes a review of detailed information concerning hazard characteristics, past occurrences and probability of future occurrences. The initial hazard identification cataloged potential hazards statewide and determined which have the most chance of significantly affecting the State and its citizens. The hazards include those that have occurred in the past as well as those that may occur in the future. A variety of sources were used in the investigation, as noted earlier.

4.3.1 Methodology for Ranking Hazards

The qualitative ranking system rated each of the 20 hazards by its probability and potential for mitigation. This ranking is not intended to supplant detailed risk assessment, but rather to allow time and technical resources to be focused on the most significant hazards.

Defined in the tables below, each hazard was determined to have a high, medium or low ranking for probability and mitigation potential. Each of the ranking levels has several criteria. These criteria were used as general guidelines so in some cases the rankings were weighted toward one or two of the criteria rather than all of them.

Table 3 Probability Ranking and Criteria for Hazard Identification

RANKING	CRITERIA
High	The hazard has impacted the State annually, or more frequently The hazard is widespread, generally affecting regions or multiple counties in each event There is a reliable methodology for identifying events and locations
Medium	The hazard impacts the State occasionally, but not annually The hazard is somewhat localized, affecting only relatively small or isolated areas when it occurs The methodology for identifying events is not well-established, or is not applied across the entire State
Low	The hazard occurs only very infrequently, generally less than every five years on a large scale, although localized events may be more frequent The hazard is generally very localized and on a small scale (i.e. sub-county level) A methodology for identifying event occurrences and/or severities is poorly established in the State, or is available only on a local basis.

Table 4 Mitigation Potential Ranking and Criteria for Hazard Identification and Disposition

RANKING	CRITERIA
High	Methods for reducing risk from the hazard are technically reliable The State or Counties have experience in implementing mitigation measures Mitigation measures are eligible under Federal grant programs There are multiple possible mitigation measures for the hazard The mitigation measure(s) are known to be cost-effective The mitigation measures protect lives and property for a long period of time, or are permanent risk reduction solutions
Medium	Mitigation methods are established The State or Counties have limited experience with the kinds of measures that may be appropriate to mitigate the hazard Some mitigation measures are eligible for Federal grants There is a limited range of effective mitigation measures for the hazard Mitigation measures are cost-effective only in limited circumstances Mitigation measures are effective for a reasonable period of time
Low	Methods for reducing risk from the hazard are not well-established, are not proven reliable, or are experimental The State or Counties have little or no experience in implementing mitigation measures, and/or no technical knowledge of them Mitigation measures are ineligible under Federal grant programs There is a very limited range of mitigation measures for the hazard, usually only one feasible alternative The mitigation measure(s) have not been proven cost effective and are likely to be very expensive compared to the magnitude of the hazard The long-term effectiveness of the measure is not known, or is known to be relatively poor.

The Hazard Identification and Disposition table below lists the name of the hazard, the relative rankings for probability and mitigation potential. Guidance provided by FEMA in the document served as the basis for selecting the natural hazards profiled in the report. The probability and mitigation potential have not changed since the 2011plan.

Table 5 Hazard Identification and Disposition

HAZARD	PROBABILITY	MITIGATION POTENTIAL
Flooding	High	High
Tornadoes	High	High
Wind Storms	High	High
Wildfire	High	High
Hail	High	Medium
Dam Failure	Medium	Medium
Drought	High	Low
Earthquakes	Low	Low
Extreme Heat	High	Low
Erosion	Medium	Low
Land Subsidence	Medium	Low
Lightning	High	Low
Winter Storms	High	Low
Fire (Structure and Vehicle)	Medium	Low
Ground and Surface Water Supply	Medium	Medium
Hazardous Materials	Medium	Low
Nuclear Incidents	Low	Low
Infectious Disease Outbreak	Low	Low
Transportation	Low	Low

As expected, the classification process provided a clear stratification of the hazards based on these criteria. The State has identified floods, tornadoes, straight-line winds and wildfire as the hazards that present highest risk to the State and the most potential for mitigation based on this limited assessment. In the sections that follow, these hazards are afforded detailed risk assessments in order to identify the areas of the State that are most at risk, and this information is in turn used as the basis for determining appropriate actions to reduce the risks.

As discussed earlier, this ranking system is not intended to supersede more detailed and focused risk assessment procedures. As the State re-evaluates and updates this Plan, it may be appropriate to revisit this ranking methodology and perform full risk assessments for additional hazards.

It is important to understand the meanings of several terms that appear in both the Federal hazard mitigation planning rules and this Plan. The terms **probability, vulnerability and risk** appear many times in both places, and those terms and others are defined below and given some context in terms of this plan.

Probability is the likelihood that events of particular severities will occur. The ability to calculate probability varies considerably depending on the hazard in question. In many areas of the country, flood studies of various kinds can provide reasonably accurate estimates of how often water will reach particular places and elevations. On the other hand, tornadoes are notoriously difficult to predict, although general areas of impact can be determined (it is also possible to predict the seasons of the year that are most likely to produce tornadoes). Probability is a key element of risk because it determines how often the events are likely to happen. Climate change may also affect these probabilities in unknown ways.

It is important to note that risk is cumulative. This means that although natural hazards may not affect a place in any particular year, the probability of one or more events (in some places multiple events) occurring "adds up" over time. Risk calculations incorporate all expected future events – usually with some limit on the time horizon that is considered – in order to account for both repetitive events and for the probabilities that accumulate over time. So, over time the possibility of the hazard event happening increases.

Vulnerability can be defined as to the extent to which people will experience harm and property will be damaged from a hazard. Vulnerability is be the susceptibility of people to injury as the result of a hazardous event and the susceptibility of the things people value to damage as the result of a hazardous event. Some add the concept of resilience to the definition of vulnerability (Buckle, 1999). Buckle identifies potential social, economic, and environmental effects and introduces the notion that vulnerability is associated with an ability to recover.

Risk is often expressed in dollar costs of future expected losses. Although the concept may generate disagreement, it is possible to assign a value to many community "assets" including physical components such as buildings and infrastructure, functional ones such as government or business operations, and even injuries and casualties.

It is calculated in this way so that different kinds of losses can be adequately compared. For example, without a common basis for comparison, it would be virtually impossible to determine if the risk of injury from future tornadoes is greater than damage to vehicles in future floods. When the expected losses are converted to and expressed in dollars, the damages can be compared and prioritized. In combination with the concepts discussed above, almost any kind of hazard can be quantified and its risk expressed. The exceptions to this idea are infrequent or highly unpredictable events such as meteors impacting the earth, or manmade hazards such as terrorism. In these cases, the element of probability is virtually impossible to characterize, and the risk calculus cannot be accurate without it.

4.4 Vulnerability Assessment by County

Requirement §201.4(c)(2)(ii): *[The State risk assessment* ***shall*** *include an] overview and analysis of the State's vulnerability to the hazards described in this paragraph (c)(2), based on estimates provided in local risk assessments as well as the State risk assessment. The State* ***shall*** *describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events.*

The State has continually provided guidance and technical support to the local mitigation plans and has encouraged the sharing of information both between local planning projects and with the State. The

State has brought this information directly to the local planning efforts via statewide workshops and planning forums. Additional technical assistance will be provided in the future and will include:

- Providing GIS maps, tables and text necessary to assess risks.
- Compiling statewide dataset of critical facilities.
- County HAZUS-MH reports for flooding risk assessment.

Once local planning data and information is compiled and analyzed in a comprehensive manner, a greater understanding of where the highest risks are across the state will be obtained; with this, the State will be better prepared to decide where and how mitigation resources can be most effective. Data from the statewide flood risk assessment has been made available to counties and local jurisdictions for their review and incorporation into local hazard mitigation plans, land use planning and mitigation projects. In addition, local jurisdictions may update the critical infrastructure/facilities database for inclusion in a future more detailed analysis.

4.4.1 Local Hazard Mitigation Plan Collection and Integration

During the 2013 revision and update process, the analysis team focused on producing a statewide vulnerability analysis, which included information provided by the County Multi-Hazard Mitigation Plans. Only approved and active (not expired) plans were reviewed. The risk assessment sections from the 84 MHMP plans (78 counties and 6 other jurisdictions) considered during the update process included the following:

- Hazard identification and ranking (usually subjective)
- Hazard probability, extent, and magnitude
- Hazard impacts
- Local vulnerabilities
- Locally estimated losses

Vulnerability Assessment for Schools, Hospitals, Fire and Police Stations

Schools, hospitals, fire and police station facilities data was compiled from MnGeo databases. The site-specific inventory was updated using the best available statewide information. Sources, assumptions, and processes used to update the site-specific data sets are detailed in Appendix B. The table below shows the differences between the database compiled for the 2011 analysis and for the 2014 analysis. The exposure is the total value of the buildings.

Table 6 Statewide Database for Facilities

Feature Class	2010 Records	2013 Records	2010 Exposure	2013 Exposure
Schools	3,850	4,361	$20,927,347,000	$30,842,383,000
Hospitals	557	552	$5,387,400,000	$5,871,140,000
Police	531	329	$1,015,260,000	$816,156,000
Fire	987	847	$1,011,000,000	$710,380,000
Emergency Operations Centers	46	(not re-estimated)	$51,520,000	(not re-estimated)

The State of Minnesota has provided GIS layers for state-owned properties. These property locations were compiled into a single dataset from a “State Structures” dataset of State employee work locations provided by MnGeo, and the completed state buildings dataset used in the 2011 State MHMP updated with 2012 schools and correctional facilities data and locations (also provided by MnGeo).

Local Hazard Risk Assessment

Each of 84 current jurisdictional multi-hazard mitigation plans was reviewed for hazard ranking. Not every county ranked hazards. Fifty-six counties included an indication of ranking (though did not necessarily specify a method) for the hazards. The ranking for the natural hazards included in this plan are summarized in Table 7 (H = high, M = moderate, L = low; blanks not assessed by county).

Table 7. County Perceived Risk of Natural Hazards (if available)

County	Flooding	Wildfire	Tornado	Winter Storm	Windstorm	Ice Storm	Drought	Summer Storm	Hail	Lightning	Extreme Temp	Extreme Cold	Extreme Heat	Erosion	Landslide	Land Subsidence	Dam Failure
Becker	H	M	H	H		M	M	M	M							M	M
Benton	M		M		M			M	M	M							
Carlton		M										M					
Carver	H	M	H				H	H									H
Chippewa	M	M	M	M		M						M					
Chisago	H	M		H				H			H	H	H				
Cook		H		M			M	M									
Cottonwood	M		H	M	H				M								M
Crow Wing	M		M	H		M	M	M			M						
Faribault			M					M									
Hennepin	M		H	M			L	M			H						L
Houston	H	H	H	H	H		H			H	H	H	H	H	M	M	M
Hubbard	M	H	H	M	M												M

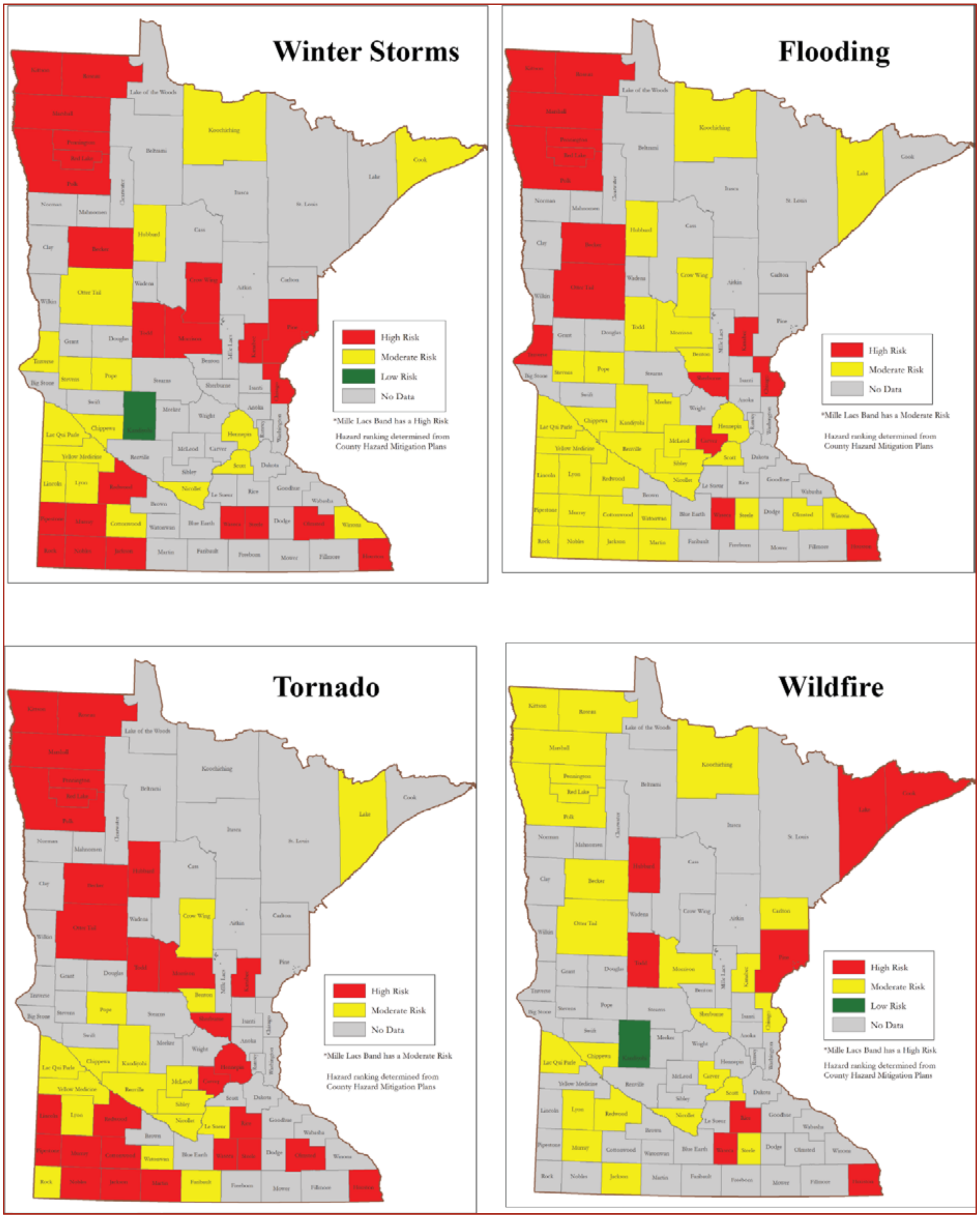
County	Flooding	Wildfire	Tornado	Winter Storm	Windstorm	Ice Storm	Drought	Summer Storm	Hail	Lightning	Extreme Temp	Extreme Cold	Extreme Heat	Erosion	Landslide	Land Subsidence	Dam Failure
Jackson	M	M	H	H	M	M	M		M	M	M	M	M				
Kanabec	H	M	H	H				H	H	H		H	H				
Kandiyohi	M	L	M	L	L	L	L	L	L	L		L	L				L
Kittson	H	M	H	H		M	M	M	M							M	M
Koochiching	M	M		M				M				M					
Lac Qui Parle	M	M	M	M	M	M		M	M	M	M	M	M				
Lake	M	H	M		M			M	M	M	M	M	M				
Le Sueur			M		M			M	M	M							
Lincoln	M		H	M	H	H											
Lyon	M	M	M	M	M	H	M				M	M	M				
Marshall	H	M	H	H		M	M	M	M							M	
Martin	M		H		M			M	M	M							
McLeod	M		M														
Meeker	M																
Mille Lacs Band	M	H	M	H		H		M	M	M			M				
Morrison	M	M	H	H	M		H		M	M							M
Murray	M	M	H	H	H												
Nicollet	M	M	M	M	M		M		M	M	M	M	M				
Nobles	M		H	H	H		M		M								
Olmsted	M		H	H			M		H	H	M	M	M			H	
Otter Tail	H	M	H	M		M	L	H	M							M	M
Pennington	H	M	H	H		M	M	M	M							M	M
Pine		H		H		H		M	M	M			M				
Pipestone	M		H	H	H		M										
Polk	H	M	H	H		M	H	M	M							H	M
Pope	M		M	M	M			M		M	M	M	M				
Red Lake	H	M	H	H		M	H	M	M							H	M
Redwood	M	M	H	H	H		M									M	
Renville	M		M														
Rice		H	H					H	H	H	M	M	M				
Rock	M		M	H	H		M	H	H	H	M	M	M				
Roseau	H	M	H	H		M	M	M	M							M	M
Scott	M	M		M	H		M										
Sherburne	H	M	H				H	M									H
Sibley	M		M		M			M	M	M							

County	Flooding	Wildfire	Tornado	Winter Storm	Windstorm	Ice Storm	Drought	Summer Storm	Hail	Lightning	Extreme Temp	Extreme Cold	Extreme Heat	Erosion	Landslide	Land Subsidence	Dam Failure
Steele	M	M	H	H	H			H			H	H	H				
Stevens	M			M				H				M	H				
Todd	M	H	H	H	H		M	M	H	M			H				
Traverse	H			M				M			M	M	M				
Waseca	H	H	H	H	H		M	H									
Watonwan	M		M		M			M	M	M							
Winona	M			M											M	M	
Yellow Medicine	M		M	M	M	M		M	M	M	M	M	M				

The Counties stating identified hazard rankings and their perceived risks are shown in Appendix B.

Figure 13 shows the perceived risk of counties identifying risk ranking for the top four Minnesota hazards.

Figure 13 County perceived risk of top four Minnesota Natural Hazards



4.5 Natural Hazards

4.5.1 Flooding

Flooding is the accumulation of water within a water body (e.g., stream, river, lake, or reservoir) and the overflow of excess water onto adjacent floodplains. Floodplains are lowlands, adjacent to water bodies that are subject to recurring floods. Floods are natural events that are considered hazards only when people and property are affected. Nationwide, hundreds of floods occur each year, making it one of the most common hazards in all 50 states and U.S. territories (FEMA, 1997).

There are a number of categories of floods in the U.S., including the following:

- Riverine flooding, including overflow from a river channel
- Flash Floods
- Fluctuating lake levels
- Coastal flooding on the North Shore of Lake Superior
- Debris flow

While there is no sharp distinction between riverine floods, flash floods, ice jam floods, and dam-break floods, these types of floods are widely recognized and may be helpful in considering the range of flood risk and appropriate responses.

Riverine Flooding

The most common type of flooding event is riverine flooding, also known as overbank flooding. Riverine floodplains range from narrow, confined channels in the steep valleys of mountainous and hilly regions, to wide, flat areas in plains and coastal regions. The amount of water in the floodplain is a function of the size and topography of the contributing watershed, the regional and local climate, and land use characteristics. In steep valleys, flooding is usually rapid and deep, but of short duration, while flooding in flat areas is typically slow, relatively shallow, and may last for long periods of time.

The cause of flooding in large rivers is typically prolonged periods of rainfall from weather systems covering large areas. These systems may saturate the ground and overload the rivers and reservoirs in numerous smaller basins that drain into larger rivers. Localized weather systems (i.e., thunderstorms) may cause intense rainfall over smaller areas, leading to flooding in smaller rivers and streams. Annual spring floods, due to the melting of snowpack, may affect both large and small rivers and areas.

Flash Flooding

Flash flood is a term in wide use by experts and the general population, but there is no single definition or clear means of distinguishing flash floods from other riverine floods. Flash floods involve a rapid rise in water level, high velocity, and large amounts of debris, which can lead to significant damage that includes the tearing out of trees, undermining of buildings and bridges, and scouring new channels. The intensity of flash flooding is a function of the intensity and duration of rainfall, steepness of the watershed, stream gradients, watershed vegetation, natural and artificial flood storage areas, and configuration of the streambed and floodplain. Dam failure and ice jams may also lead to flash flooding. Urban areas are increasingly subject to flash flooding due to the removal of vegetation, covering of ground cover with impermeable surfaces, and construction of drainage systems. Local flash flooding can be very destructive along the steep bluffs of Lake Superior and the hilly terrain and narrow valleys of southeast Minnesota; however, flash flooding can occur anywhere in Minnesota. Typically, a flash flood occurs within six hours of a rain event, or after a dam or levee failure, or following a sudden release of water held by an ice or debris jam. Flash floods often catch people unprepared.

Flash flood definition*: - a rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within six hours of the causative event (e.g., intense rainfall, dam failure, ice jam). However, the actual time threshold may vary in different parts of the country. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters.* (National Weather Service, 2012).

The definition of a flash flood per the Minnesota Climatology Working Group is "*the occurrence of 6 inches or more rainfall within a 24 hour period.*" The size of a flash flood is measured via area in square miles over which a 4-inch or more rainfall occurs. The rationale for using this criteria is that a rainfall of six inches in a 24-hour period will produce a river flow in equivalent to that in a the 100-year return period in Minnesota and that 4-inch and greater rainfall generally leads to reports of increased erosion or other economic damages.

Ice jam floods usually occur in the spring and are most likely to occur where the channel slope naturally decreases, when culverts freeze solid, in reservoir headwaters, near natural channel constructions (e.g., bends and bridges), and along shallows.

In the publication "Sixteen Year Study of Minnesota Flash Floods" (DNR, State Climatology Office and University of Minnesota Soil Sciences Department, 1988), it is noted that Minnesota averages five flash floods annually. The earliest flash floods have occurred in May. The monthly distribution of flash floods shows June with the greatest number of events and the flash flood "season" continuing through September. Analysis of Minnesota's flash flood history has revealed that over 50 percent occur in the evening between 6 p.m. and 11 p.m. and 27 percent of flash floods occur from midnight through 7 a.m. The counties of Lyon, Mower, Olmsted, St. Louis, Stearns, and Winona have experienced the greatest number of storm events capable of producing flash flooding, averaging at least one every five years. Olmsted County has experienced the greatest number of events (8) and averages one flash flood every 3.1 years. The National Weather Service (NWS) notes that nearly half of all flash flood fatalities are auto related. They further note that people in automobiles are most at risk from flooding in general.

According to "Floodplain Management: A Handbook for Local Officials" (DNR, Division of Waters, January 1993) the State of Minnesota experiences an average annual direct flood loss of at least $60 - 70 million. Average annual direct flood loss figures of this type have historically included:

- Direct loss to the individual homeowner, business, and agricultural interests (e.g., structural and contents damage, damage to motor vehicles, crop loss, etc.)
- Damage to the community infrastructure (storm sewers, roads, bridges, etc.)
- Costs associated with the flood fight and clean up

- There is increased national awareness that the indirect losses due to flooding are very dramatic, affecting individuals living in and out of the floodplain. Taxpayers are burdened with a significant portion of the cost of responding to unwise floodplain development. These indirect costs may, in fact, equal or exceed the direct costs.

The indirect losses related to flooding include:

- Lost profits to businesses closed during floods
- Wage losses and unemployment benefits
- Federally subsidized flood insurance payments via the National Flood Insurance Program (NFIP)
- Income tax deductions for flood losses not covered by insurance
- Low-interest disaster relief loans

The flood risk assessment considers hazards over the entire State of Minnesota, though it does not estimate the probability of occurrence. Flood probability and magnitude are highly location-specific, so it is not possible to characterize these generally across the State in a meaningful way. Statewide, floods are rated High for probability in the qualitative ranking. The Report provides information for each county (and city) based on best available data.

The National Weather Service in coordination with the MN DNR has been working to improve flood forecasting. The USGS and DNR have river gages throughout the state that provide real-time information regarding river height. While improvements have been made to forecasting riverine flooding, flash flooding is more difficult to predict. Watches, warnings and advisories for flooding are improving with each flood the State experiences, including regions that have been flooded annually. For example, the Flood Forecast Display Tool is available for the Red River of the North via the Red River Basin Decision Information Network.

Local drainage floods may occur outside of recognized drainage channels or delineated floodplains due to a combination of locally heavy precipitation, a lack of infiltration, inadequate facilities for drainage and stormwater conveyance, and increased surface runoff. Such events frequently occur in flat areas, particularly during winter and spring in areas with frozen ground, and in urbanized areas with large impermeable surfaces. High groundwater flooding and/or flooding resulting from rainfall on nearly saturated or saturated soils is a seasonal occurrence in some areas, but may occur in other areas after prolonged periods of above-average precipitation. Losses associated with local drainage are most significant when they occur with other hazards described in this document, such as widespread flooding and thunderstorms; therefore, they are not analyzed as a distinct hazard.

Historical Occurrence of Floods

Notable Floods in Minnesota since March of 2011 (State Hazard Mitigation Plan approval) are summarized below.

Table 8. Major Minnesota Floods, 2011-2013

Year	Areas Affected	Remarks	Total Public Assistance	Statewide per capita impact
2013	Benton, Big Stone, Douglas, Faribault, Fillmore, Freeborn, Grant, Hennepin, Houston, McLeod, Morrison, Pope, Sibley, Stearns, Stevens, Swift, Traverse, and Wilkin.	FEMA-4131-DR was declared on July 25, 2013, due to severe storms, straight-line winds, and flooding during the period of June 20-26, 2013.	$17,855,840	$3.37
2012	Aitkin, Carlton, Cook, Crow Wing, Dakota, Goodhue, Kandiyohi, Lake, Meeker, Pine, Rice, Sibley, St. Louis, and the Fond du Lac Band of Lake Superior Chippewa, Grand Portage Band of Lake Superior Chippewa, and the Mille Lacs Band of Ojibwe.	FEMA-4069-DR was declared on July 6, 2012, in response to the severe storms and flooding during the period of June 14-21, 2012.	$44,700,611	$8.31
2011	Chisago, Isanti, Kandiyohi, Lincoln, Lyon, McLeod, Meeker, Mille Lacs, Pine, Pipestone, Redwood, Renville, Stearns, and Yellow Medicine Counties and the Mille Lacs Band of Ojibwe.	FEMA-4009-DR was declared on July 28, 2011, due to severe storms, flooding, and tornadoes during the period of July 1-11, 2011.	$19,186,379	$3.62
2011	Big Stone, Blue Earth, Brown, Carver, Chippewa, Clay, Grant, Lac qui Parle, Le Sueur, Lyon, McLeod, Nicollet, Redwood, Renville, Scott, Sibley, Stevens, Traverse, Wilkin, and Yellow Medicine.	FEMA-1982-DR was declared on May 10, 2011, in response to the severe storms and flooding during the period of March 16 to May 25, 2011.	$10,773,895	$2.19

The following description is taken from the "Floods of June 2012 in northeastern Minnesota: U.S. Geological Survey Scientific Investigations Report" by Czuba, Fallon, and Kessler.

During June 19–20, 2012, heavy rainfall, as much as 10 inches locally reported, caused severe flooding across northeastern Minnesota. The floods were exacerbated by wet antecedent conditions from a relatively rainy spring, with May 2012 as one of the wettest Mays on record in Duluth. The June 19–20, 2012, rainfall event set new records in Duluth, including greatest 2-day precipitation with 7.25 inches of rain. The heavy rains fell on three major watersheds: the Mississippi Headwaters; the St. Croix, which drains to the Mississippi River; and Western Lake Superior, which includes the St. Louis River and other tributaries to Lake Superior. Widespread flash and river flooding that resulted from the heavy rainfall caused evacuations of residents, and damages to residences, businesses, and infrastructure. In all, nine counties in northeastern Minnesota were declared Federal disaster areas as a result of the flooding.

Peak-of-record stream flows were recorded at 13 U.S. Geological Survey stream gages as a result of the heavy rainfall. Flood-peak gage heights, peak stream flows, and annual exceedance probabilities were tabulated for 35 U.S. Geological Survey stream gages. Flood-peak stream flows in June 2012 had annual exceedance probabilities estimated to be less than 0.002 (0.2 percent; recurrence interval greater than 500 years) for five stream gages, and between 0.002 and 0.01 (1 percent; recurrence interval greater than 100 years) for four stream gages.

Repetitive Loss Properties (RL) Federal, state, and local funding has resulted in the acquisition of a significant number of repetitive loss structures. The NFIP Repetitive Loss Mitigated (in Appendix E) indicates 224 properties have been acquired. The total for these properties for building payments was over $7.2 million, contents payments were over $1.2 million for a total of $8.7 million in losses. The top five counties that have acquired Repetitive Loss Properties and the number of properties acquired are:

- Mower 86
- Clay 34
- Marshall 18
- Chippewa 15
- Hennepin 13

The definition of a repetitive loss property for Flood Mitigation Assistance (FMA) is a structure covered by a contract for flood insurance made available under the NFIP that:

(a) Has incurred flood-related damage on 2 occasions, in which the cost of the repair, on the average, equaled or exceeded 25 percent of the market value of the structure at the time of each such flood event; and

(b) At the time of the second incidence of flood-related damage, the contract for flood insurance contains increased cost of compliance coverage.

Currently there are 41 repetitive loss properties in Minnesota per the Repetitive Loss Properties Eligible for HMA Funding in Appendix E. These structures have accounted for building payments of approximately $2.0 million and contents payments of over $267,000. The 2011 mitigation plan updated reported that there were 433 properties on the repetitive loss list for the state. The reduction is attributed in changes to the NFIP program due to the definition of repetitive loss property in Biggert-Waters Act of 2012. A list of properties that fit the prior definition is still being tracked since they show vulnerability to flooding and relate to other NFIP policy. SRL & Repetitive Loss Properties Not Eligible for HMA Funding in Appendix E shows how these properties are being tracked by community. There are 349 properties on this list for totally payments of over $9.8 million. Tracking repetitive loss properties that are either eligible or not eligible for HMA funding gives planners a broader insight to the risk found in communities.

Severe Repetitive Loss (SRL) Properties The National Flood Insurance Program (NFIP) is the federal program of flood insurance coverage and floodplain management administered under the Act and applicable Federal regulations promulgated in Title 44 of the Code of Federal Regulations, Subchapter B. Flood insurance is available to reduce the impact due to potential floods to residential and non-residential structures per program policy. Statewide NFIP policy coverage as of December 2013 is summarized as:

- Number of Policies – 12,091
- Total Coverage – $2,582,910,900
- Total Premium – $9,411,038
- Total Claims Since 1978 – 10,996
- Total Paid Since 1978 - $136,295,972

Acquisition of property where the structures are demolished or relocated out of the floodplain works hand in hand with enforcement of the NFIP regulations. Acquisition of repetitively damaged properties breaks the cycle of construction, destruction, and reconstruction. SRL properties are the most costly to the NFIP fund due the number and magnitude of sustained damages. The Biggert-Waters Act of 2012 revised the definition of SRL properties:

(a) Is covered under a contract for flood insurance made available under the NFIP; and

(b) Has incurred flood related damage –

(i) For which 4 or more separate claims payments have been made under flood insurance coverage with the amount of each such claim exceeding $5,000, and with the cumulative amount of such claims payments exceeding $20,000; or

(ii) For which at least 2 separate claims payments have been made under such coverage, with the cumulative amount of such claims exceeding the market value of the insured structure.

Prior to 2013, only two SRL properties were located in Minnesota. The SRL list as of November 2013 shows 33 properties with building payments of over $4.2 million and contents losses of approximately $941 thousand. The expansion is due to the new Biggert-Waters Act of 2012 definition for Flood Mitigation Assistance (FMA). Eleven of the properties are located in Mower County and the City of Austin, located in Mower County. This accounts for 33% of the SRL properties. One or two properties are listed for the remaining thirteen jurisdictions.

HSEM's mitigation program continues to contacts the local jurisdiction to start the process of acquiring the property. Severe Repetitive Loss Properties Eligible for HMA Funding in Appendix E shows details by jurisdiction.

Statewide Risk Assessment

The Minnesota Statewide Flood Risk Assessment Report was completed in January of 2011, and was an initial step in identifying and quantifying flood risks throughout the state. The Report compiled the results of the county flood risk assessments as a primary update for the 2011 Minnesota State All Hazard Mitigation Plan. The county assessment reports were distributed to each county emergency director to be included in the local multi-jurisdictional mitigation plans.

The statewide flood assessment is a step toward identifying and quantifying flood risks for the express purpose of mitigation planning. The risk assessment uses existing available information, including Geographic Information System (GIS) data with HAZUS-MH.

County Risk Assessment

The loss estimation was performed using HAZUS-MH, a risk mitigation tool developed by FEMA. This process reflects a Level 1+ approach to flood modeling. The Level 1+ approach uses default data while referencing additional data. As indicated above, the loss estimation process used supplementary essential facility information for the purpose of improving the accuracy of the model predictions.

HAZUS-MH 100-year flood return interval analysis was performed for each county using DFIRM or Q3 flood boundaries (DFIRM being preferable) whenever they were available. Prototyping prior to the commencement of the project indicated that a “Hydraulics and Hydrology” (H&H) method available in HAZUS-MH (Release MR4-Patch 1 Aug 2009) and using Flood Insurance Studies to calibrate flow provided loss estimates consistent with traditional methods. The counties that had DFIRMs available for this process that only had Q3s available in 2010 are the following: Carver, Fillmore, Freeborn, Kittson, Mahnomen, Marshall, Mower, Norman, Roseau, and Wilkin.

For counties without DFIRM or Q3 boundaries, HAZUS-MH was used to generate new 100-year flood boundaries and flood depth grids. Hydrology and Hydraulic analysis was performed at one square mile intervals on all reaches generated from USGS 30-meter DEMs.

Table 9 Flood Risk Calculation Methods for 2013 and 2011

Sources	Counties (2013)	Ratio (2013)		Counties (2011)	Ratio (2011)
DFIRM/PreDFIRM	47	54%		33	38%
Q3	21	24%		32	37%
H&H + FIS Discharge Values	19	22%		22	25%
Total	**87**	**100%**		**87**	**100%**

A Global Summary Report is available for each county. The analysis includes:

General Building Stock: Building losses, Number buildings damaged by occupancy and building type, Shelter requirements**,** Building, content, and inventory losses

Site-Specific - Essential Facilities: Number buildings damaged by type

In addition each County received a flood analysis risk assessment that includes:

Census block level economic loss analysis

Site-Specific - Essential Facilities: Image of flood boundary for those in the flood boundary

Site-Specific - State Properties: Building and content losses and Image of flood boundary for those in the flood boundary

Figure 14 Statewide Flood Risk Assessment: Flood Boundary Analysis Source.

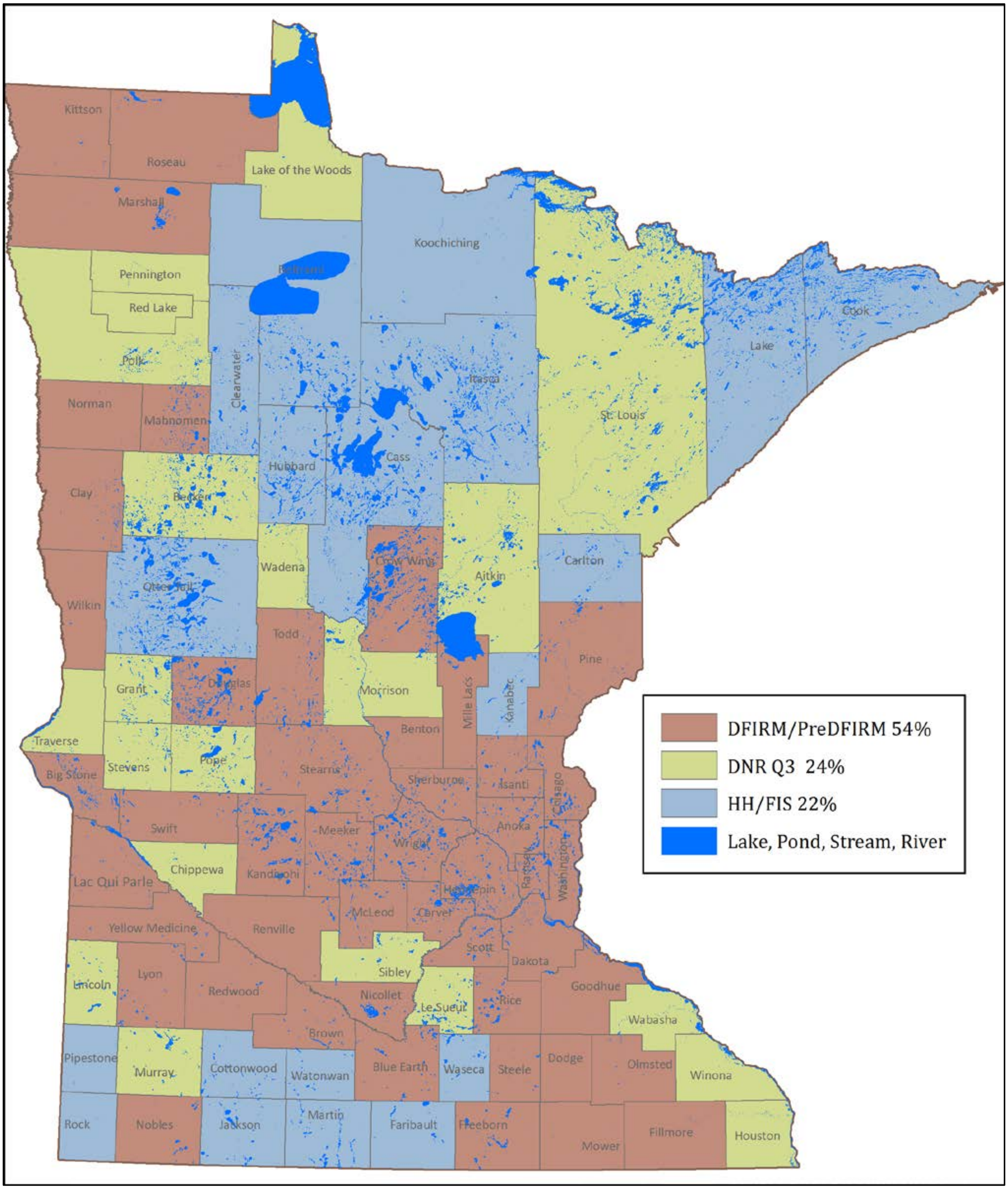
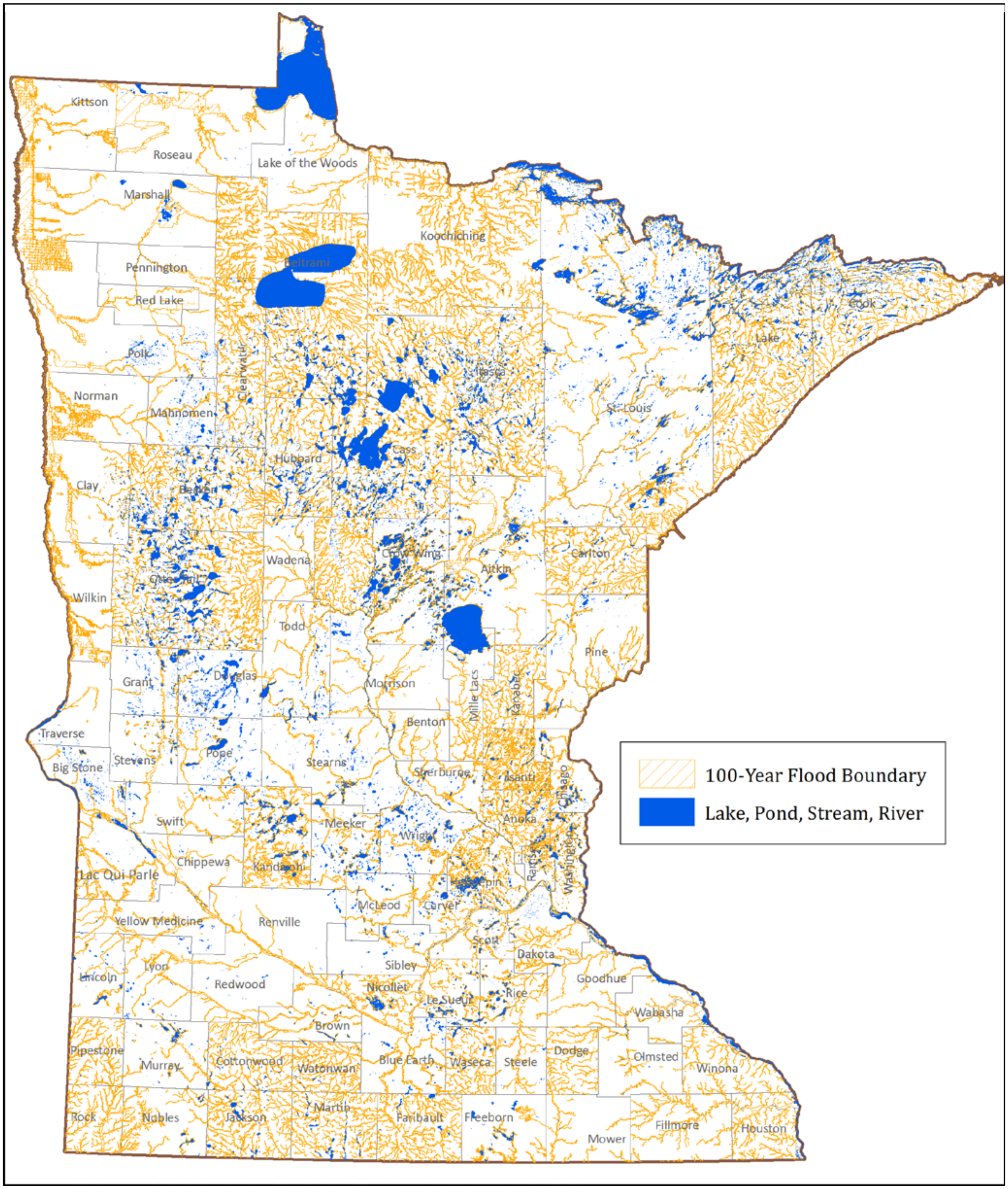


Figure 15 100-year floodplains in Minnesota, as defined by DFIRM, Q3, or HAZUS Model



Flood Vulnerability of Structures by Building Class

Estimating building losses for all counties is aggregated by occupancy class. These losses are calculated from the General Building Stock inventory. The General Building Stock inventory provided with the HAZUS-MH tool did not change from 2010 to 2013 when the analysis was run. The 100-yr flood boundaries changed, however, when ten counties loss estimates were recalculated using new DFIRMs in Carver, Fillmore, Freeborn, Kittson, Mahnomen, Marshall, Mower, Norman, Roseau, and Wilkin Counties. Tables showing the statewide flood risk assessment results using updated flood boundary data in 2013 are found in Appendix B. In summary, 10,678 structures or 0.5 of the total building stock in the state were found to be a potentially damaged as a result of the new analysis. The estimated total building loss is estimated to be $3,360,275,000 or 0.8% of the total building value in the state.

Flood Vulnerability of Schools, Hospitals, Fire Stations and Police Stations

The most recent facilities database for the State of Minnesota includes schools, hospitals, fire stations and police stations. The updated state data was used in the 2013 100-yr HAZUS flood analysis. Data per county is found in Appendix B. A total of 6,089 structures were in the data base with 180 of these structures to be found in the in the 100-year floodplain. Approximately 3% of the profiled structures were found to be in the floodplain. This may be an overestimation since the analysis did not take into account elevation and data errors.

Table 10 Minnesota Schools, Hospitals, Fire Stations and Police Station Facilities Loss Estimates

County	Total Facilities	Facilities in 100-year floodplain	Total Exposure of Facilities
Aitkin	25	1	$90,551,000
Anoka	206	16	$1,896,248,000
Becker	65	0	$193,013,000
Beltrami	76	3	$404,474,000
Benton	32	0	$177,184,000
Big Stone	20	0	$57,739,000
Blue Earth	71	0	$644,319,000
Brown	48	0	$196,958,000
Carlton	67	2	$263,171,000
Carver	95	1	$577,014,000
Cass	59	4	$151,204,000
Chippewa	23	1	$83,079,000
Chisago	57	5	$278,474,000
Clay	56	0	$505,120,000
Clearwater	18	0	$73,017,000
Cook	30	0	$38,419,000
Cottonwood	29	1	$98,580,000

County	Total Facilities	Facilities in 100-year floodplain	Total Exposure of Facilities
Crow Wing	62	1	$392,205,000
Dakota	261	3	$2,252,727,000
Dodge	24	0	$120,335,000
Douglas	60	0	$274,972,000
Faribault	34	0	$111,145,000
Fillmore	39	4	$145,143,000
Freeborn	44	0	$158,490,000
Goodhue	66	1	$306,884,000
Grant	24	0	$55,679,000
Hennepin	1043	8	$9,364,585,000
Houston	42	9	$165,754,000
Hubbard	31	0	$97,953,000
Isanti	43	0	$181,785,000
Itasca	72	10	$258,645,000
Jackson	22	1	$72,702,000
Kanabec	15	0	$69,492,000
Kandiyohi	55	1	$328,231,000
Kittson	22	2	$57,013,000
Koochiching	29	2	$102,699,000
Lac qui Parle	19	0	$72,694,000
Lake	17	0	$75,176,000
Lake of the Woods	12	0	$35,193,000
Le Sueur	39	3	$148,066,000
Lincoln	23	0	$67,676,000
Lyon	53	1	$324,423,000
Mahnomen	21	0	$45,784,000
Marshall	31	3	$58,272,000
Martin	39	0	$143,587,000
McLeod	54	2	$199,838,000
Meeker	32	0	$130,973,000
Mille Lacs	47	6	$216,661,000
Morrison	62	1	$212,816,000
Mower	57	0	$295,378,000

County	Total Facilities	Facilities in 100-year floodplain	Total Exposure of Facilities
Murray	22	0	$68,581,000
Nicollet	53	1	$298,773,000
Nobles	44	5	$155,799,000
Norman	22	4	$74,036,000
Olmsted	137	4	$988,126,000
Otter Tail	97	4	$510,388,000
Pennington	23	1	$173,375,000
Pine	48	0	$164,406,000
Pipestone	29	0	$96,586,000
Polk	64	10	$294,320,000
Pope	27	0	$73,177,000
Ramsey	494	2	$3,795,521,000
Red Lake	16	0	$32,493,000
Redwood	45	0	$146,772,000
Renville	35	0	$144,396,000
Rice	75	0	$442,257,000
Rock	24	0	$87,197,000
Roseau	28	6	$123,517,000
Saint Louis	284	10	$1,481,115,000
Scott	112	3	$692,619,000
Sherburne	65	0	$438,655,000
Sibley	33	2	$105,837,000
Stearns	173	1	$1,467,300,000
Steele	38	0	$229,001,000
Stevens	23	0	$102,633,000
Swift	26	0	$85,787,000
Todd	41	1	$120,220,000
Traverse	16	2	$49,770,000
Wabasha	34	8	$145,418,000
Wadena	24	0	$127,093,000
Waseca	32	4	$128,231,000
Washington	169	0	$1,503,521,000
Watonwan	24	1	$81,623,000

County	Total Facilities	Facilities in 100-year floodplain	Total Exposure of Facilities
Wilkin	21	6	$63,347,000
Winona	66	11	$582,187,000
Wright	121	1	$716,067,000
Yellow Medicine	33	1	$178,376,000
Grand Total	**6089**	**180**	**$38,240,059,000**

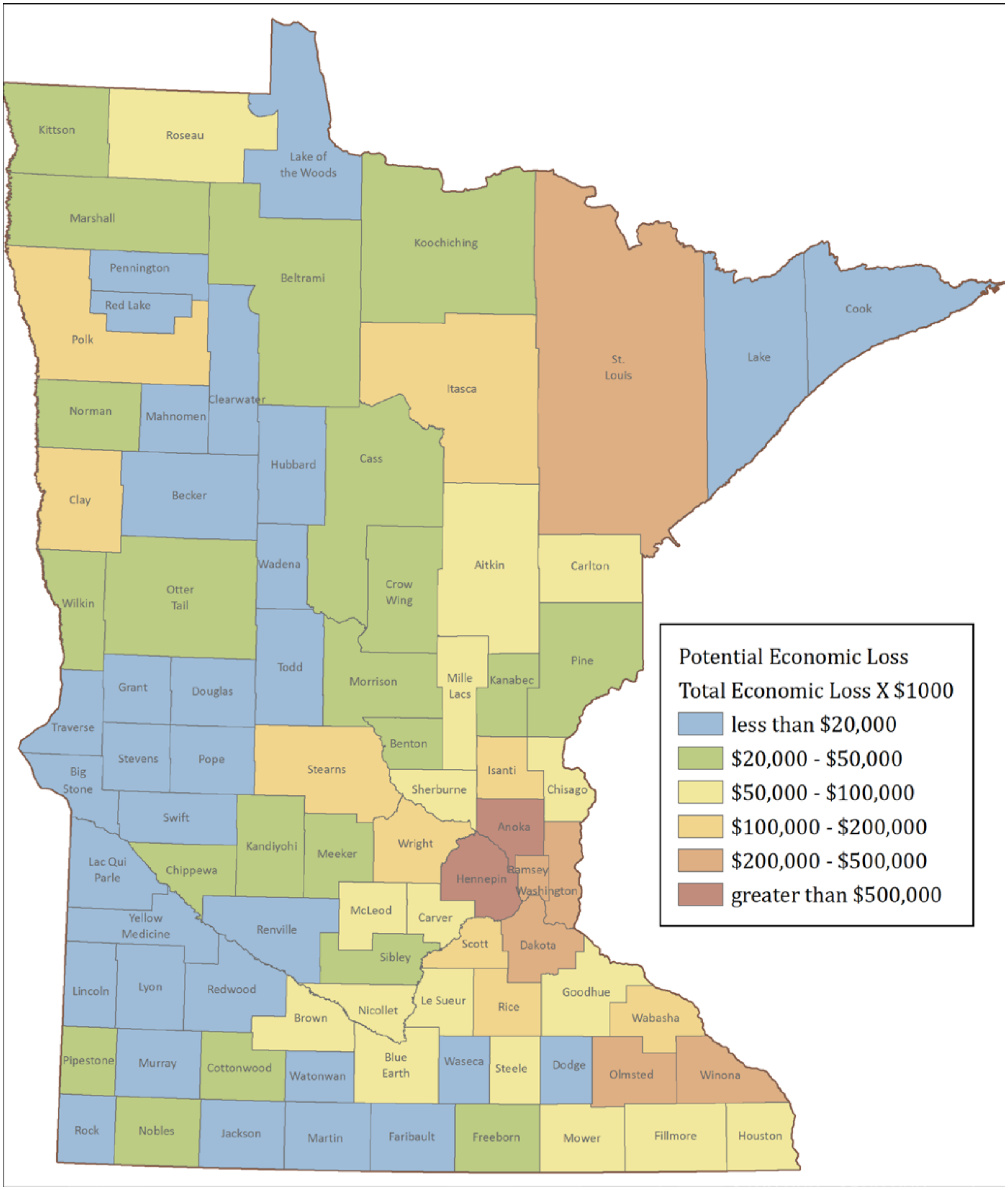
Economic Loss Estimation by County for General Building Stock

HAZUS-MH flood modeling was performed one county at a time. The HAZUS-MH flood model performs an area-weighted and occupancy type-weighted assessment of flood damage to each census block. The result is used to estimate damage at a flood depth determined by the generated flood grid for each occupancy class in each census block. Buildings are considered a total loss once they reach the 50% damage threshold. Fire and police stations, hospitals, and schools are evaluated by their specific coordinates.

All portions of the State of Minnesota are subject to flooding. Some locations, however, are more susceptible to severe, repeated flooding than others. As noted by the Minnesota Department of Natural Resources (DNR), Division of Waters, one river that has flooded consistently nearly every other or every third year is the Red River of the North. Repeated flooding at this location is due primarily to two factors: (1) The river flows north, often into areas that have not yet thawed, hence the water backs up; (2) Flat terrain around the river allows flooding above the banks to go on for miles (much further than most rivers in Minnesota).

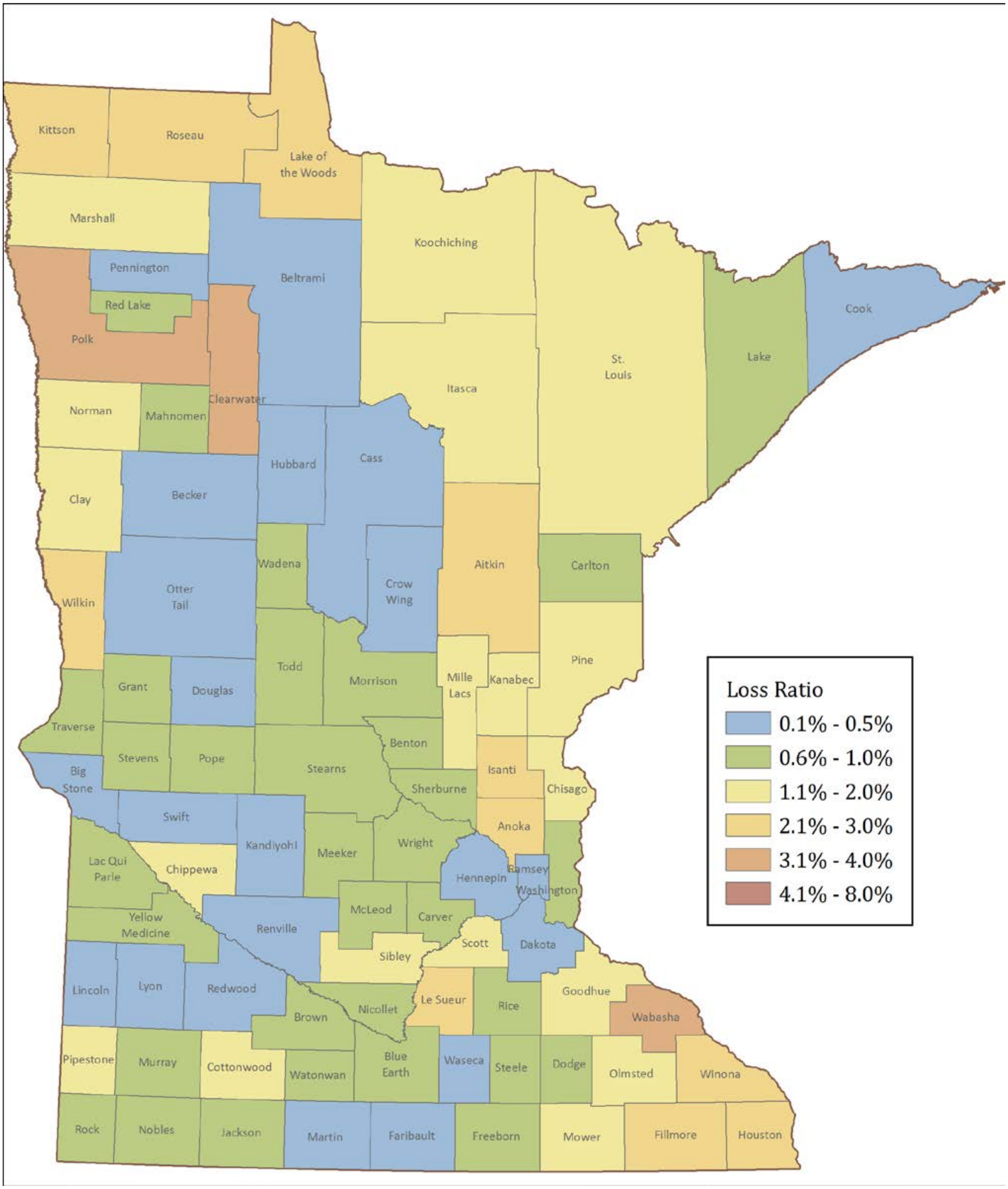
The map that follows demonstrates potential economic loss by county for a 100-year flood as estimated by the HAZUS-MH model.

Figure 16 Potential Economic Loss by County, 100-year flood



The map below demonstrates potential building loss as a percent of total building exposure by county for a 100-year flood as estimated by the HAZUS-MH model.

Figure 17 Potential Estimated Building Loss to Total Building Exposure by County, 100-year flood



County Flood Vulnerability of Structures by Building Class

The estimated building loss for all counties is aggregated by occupancy class. These losses are calculated from the General Building Stock inventory. The General Building Stock inventory provided with the HAZUS-MH tool did not change from 2010 to 2013 when the analysis was run. The 100-yr flood boundaries changed, however, when ten counties loss estimates were recalculated using new DFIRMs in Carver, Fillmore, Freeborn, Kittson, Mahnomen, Marshall, Mower, Norman, Roseau, and Wilkin Counties.. In summary, 10,678 structures or 0.5 of the total building stock in the state were found to be a potentially damaged as a result of the new analysis. The estimated total building loss is estimated to be $3,360,275,000 or 0.8% of the total building value in the state.

Table 11 Summary of Estimated Total Building Loss 2010 vs. 2013

General Occupancy	Estimated Total Buildings 2010 and 2013	Total Damaged Buildings, 2010	Total Damaged Buildings, 2013	Building Loss 2010	Building Loss 2013
Agricultural	15,479	1	2	$42,185,000	$42,163,000
Commercial	107,802	130	165	$499,612,000	$502,981,000
Education	3,502	0	4	$23,227,000	$23,610,000
Government	3,795	51	52	$29,574,000	$29,157,000
Industrial	34,374	28	74	$278,055,000	$279,841,000
Religious/ Nonprofit	8,584	3	3	$39,522,000	$39,495,000
Residential	1,965,256	6,927	10,468	$2,421,654,000	$2,443,028,000
Total	2,138,792	7,140	10,768	$3,333,829,000	$3,360,275,000

Table 12 Flood Vulnerability by County

County	Estimated Total Buildings	Total Damaged Buildings	Total Building Exposure X $1000	Total Economic Loss X $1000	Building Loss X $1000
Aitkin	15581	167	$1,650,061	$77,779	$42,056
Anoka	107417	2935	$24,167,867	$1,130,017	$586,056
Becker	20533	2	$2,486,468	$13,953	$5,127
Beltrami	19993	12	$2,549,782	$22,552	$9,341
Benton	13779	71	$2,692,232	$41,223	$19,724
Big Stone	4304	1	$370,709	$1,759	$962
Blue Earth	23631	85	$4,239,055	$59,941	$30,160
Brown	11151	65	$2,176,076	$71,418	$26,888
Carlton	16547	29	$2,367,614	$53,094	$17,767
Carver	28691	26	$6,263,045	$32,473	$15,741

County	Estimated Total Buildings	Total Damaged Buildings	Total Building Exposure X $1000	Total Economic Loss X $1000	Building Loss X $1000
Cass	26619	39	$2,879,718	$32,735	$12,810
Chippewa	7805	72	$852,476	$33,212	$15,612
Chisago	18724	102	$3,053,754	$83,473	$40,175
Clay	21,367	217	$2,999,882	$100,004	$46,501
Clearwater	5100	3	$543,512	$4,902	$19,626
Cook	7308	6	$735,155	$9,086	$3,355
Cottonwood	7058	48	$868,473	$30,378	$11,285
Crow Wing	39989	26	$5,457,342	$37,726	$20,476
Dakota	130840	339	$30,381,418	$204,651	$88,117
Dodge	8633	15	$1,291,386	$17,770	$8,840
Douglas	12447	5	$2,861,924	$5,795	$2,978
Faribault	10670	23	$1,109,127	$14,181	$5,537
Fillmore	11888	94	$1,353,034	$88,188	$34,188
Freeborn	17476	29	$2,569,111	$36,136	$13,010
Goodhue	21210	44	$3,567,229	$85,242	$35,725
Grant	4739	28	$458,674	$6,074	$3,807
Hennepin	382511	1175	$113,913,965	$927,776	$420,842
Houston	10910	69	$1,292,366	$76,082	$34,843
Hubbard	14267	4	$1,579,205	$10,296	$4,722
Isanti	14522	84	$2,710,615	$127,366	$64,068
Itasca	29403	131	$3,713,059	$197,278	$66,224
Jackson	6702	31	$629,412	$13,286	$5,912
Kanabec	8488	45	$1,061,942	$31,015	$14,395
Kandiyohi	21536	17	$3,245,275	$20,204	$10,137
Kittson	4177	30	$336,073	$20,123	$8,344
Koochiching	9680	17	$1,156,631	$25,170	$13,485
Lac Qui Parle	5346	1	$468,008	$5,426	$2,906
Lake	8,532	7	$1,173,659	$18.074	$9,414
Lake of the Woods	4299	148	$381,700	$14,697	$8,113
Le Sueur	13384	138	$1,921,377	$87,363	$40,168
Lincoln	4499	8	$379,477	$2,102	$1,358
Lyon	11987	14	$1,790,121	$16,840	$5,753
Mahnomen	3623	0	$358,753	$5,129	$2,014
Marshall	7976	34	$583,449	$22,059	$7,501

County	Estimated Total Buildings	Total Damaged Buildings	Total Building Exposure X $1000	Total Economic Loss X $1000	Building Loss X $1000
Martin	11848	4	$1,516,376	$16,210	$4,385
McLeod	16718	45	$3,144,760	$68,731	$26,318
Meeker	12881	29	$1,768,183	$21,897	$10,927
Mille Lacs	12782	60	$1,693,977	$59,862	$24,880
Morrison	17667	79	$2,344,240	$47,190	$22,013
Mower	19794	134	$2,522,554	$98,912	$36,897
Murray	6627	53	$581,843	$10,928	$5,511
Nicollet	12808	32	$2,596,985	$57,540	$21,468
Nobles	11028	26	$1,138,189	$39,916	$8,546
Norman	5799	25	$456,405	$31,211	$10,123
Olmsted	47734	355	$10,224,072	$236,685	$106,039
Otter Tail	40854	20	$4,846,688	$48,217	$19,608
Pennington	7439	3	$1,010,049	$10,673	$4,336
Pine	17210	12	$1,880,697	$46,190	$25,977
Pipestone	6159	13	$609,595	$22,386	$6,809
Polk	17828	314	$2,062,480	$154,662	$72,648
Pope	7758	26	$833,801	$8,548	$4,674
Ramsey	169390	176	$46,438,181	$244,098	$58,554
Red Lake	3290	0	$275,599	$3,268	$1,905
Redwood	11886	9	$1,193,751	$11,192	$5,729
Renville	11334	0	$1,265,786	$8,103	$2,253
Rice	22249	69	$4,621,430	$113,909	$43,304
Rock	5832	10	$547,354	$12,191	$4,779
Roseau	9441	47	$1,070,790	$78,165	$25,868
St. Louis	101776	1101	$17,545,854	$465,710	$245,893
Scott	36365	184	$8,014,343	$192,952	$82,838
Sherburne	25542	147	$5,254,784	$89,268	$48,945
Sibley	8218	52	$1,216,782	$33,649	$19,259
Stearns	55661	171	$10,625,977	$144,480	$66,746
Steele	15497	83	$2,822,446	$53,307	$24,792
Stevens	5541	5	$789,003	$16,442	$7,113
Swift	6609	2	$814,576	$7,253	$2,893
Todd	14361	39	$1,555,337	$19,924	$10,868
Traverse	3384	1	$286,290	$4,675	$1,708
Wabasha	11826	212	$1,606,448	$100,255	$49,892

County	Estimated Total Buildings	Total Damaged Buildings	Total Building Exposure X $1000	Total Economic Loss X $1000	Building Loss X $1000
Wadena	7961	2	$1,013,164	$19,310	$7,806
Waseca	9095	11	$1,453,845	$14,951	$5,124
Washington	77175	325	$17,154,765	$258,893	$130,153
Watonwan	6586	7	$815,118	$15,649	$5,054
Wilkin	4450	29	$439,697	$20,473	$8,551
Winona	21510	251	$3,848,179	$259,503	$96,359
Wright	40318	130	$7,981,311	$128,034	$63,410
Yellow Medicine	7204	4	$631,804	$8,558	$3,983
Totals	2,149,311	10,733	$426,328,059	$7,233,589	$3,275,117

The Brown and Dakota counties Level 2 HAZUS analysis information was used to update the 2011 statewide flood assessment data. The differences in between the tables are due to incorporating the results from theses counties.

Analyzing this data, the highest ranked counties vulnerable to floods based on building loss are:

- Anoka - $586,056,000
- Hennepin - $420,842,000
- St. Louis - $245,893,000
- Washington - $130,153,000
- Olmsted - $106,039,000
- Winona - $96,359,000
- Dakota - $88,117,000
- Polk - $72,746,000

Stearns, Itasca, Isanti, and Wright counties came in next with projected building loss averaging $65 million each.

Total Economic Loss includes socio-economic losses due to business closure and other interruptions due to flooding. The highest ranked counties for total economic loss are:

- Anoka - $1,130,017,000
- Hennepin - $927,776,000
- St. Louis - $465,710,000
- Winona - $259,503,000
- Washington - $258,893,000

- Ramsey - $244,098,000
- Olmsted - $236,685,000
- Dakota - $204,651,000
- Itasca - $197,278,000

Scott, Polk, Stearns, and Wright counties were the next counties ranked with economic losses ranging from $192 million down to $128 million.

In general, Dakota County changed in ranking since the Level 2 HAZUS assessment used the county's assessor data and used FIRM data provided by the county. These two changes refined the assessment resulting in an assessment that showed a decrease in vulnerability. Rankings for some counties changed between total economic losses and building loss. The difference may be that more commercial/industrial structures in a floodplain result in higher economic impacts than residential/agricultural.

Most of the cities listed either have developed cities or are part of a metropolitan area that is becoming more developed. The exceptions of Isanti, Itasca, and Polk counties have to be looked into further in the future.

Another way of assessing vulnerability is by the number of Severe Repetitive Loss (SRL) and Repetitive Loss Structures per county. A list of combined number of SRL and RL properties per county:

- Mower County - 125
- Marshall County - 95
- Washington County – 56
- Clay County – 34
- Chippewa County - 32
- Hennepin County – 24
- Polk County – 22
- Goodhue County – 16

The SRL/RL list includes counties from previous lists but adds several smaller counties. The City of Austin is at the confluence of five streams and has been installing flood controls and acquiring properties for green space over the past fifteen years. The cities of Oslo and Warren in Marshall County are engaged in extensive flood control projects to reduce flood damage to their cities. Clay County and the City of Moorhead have been very active in flood control and acquisition. Chippewa County is developing flood controls for the City of Montevideo and has been active in acquisition. Goodhue County has acquired properties to mitigate flooding along the Cannon River and its tributaries. These and other jurisdictions with SRL/RL properties are working to mitigation flood losses in their communities.

The following events characterize flash flood events characterized as historic mega rain events by the Minnesota Climatology Office. In this case, record high amounts of rainfall are characterized to show unusually high amounts of damage to communities. In each of the cases a Presidential Disaster Declaration was made. Minnesota Mega Rain Events lists the events by date, gives a description and links the event to Declaration Number. Not all flash flood events require Public Assistance since county and/or statewide thresholds are not met. Not meeting these thresholds indicates that the rainfall event was localized and/or did not cause extensive damage to public infrastructure.

Table 13 Minnesota Mega Rain Events

Date	Description	Declaration Number
July 21-22, 1972	10.84 inches fell in 24 hours at Fort Ripley. This was the state record for a highest 24 hour total at a National Weather Service station until Hokah broke the record in 2007.	DR-347
June 28-29 and July 1-2, 1975	Geographically extensive and intense rains fall on eastern North Dakota and Northwest Minnesota in two separate events	DR-473
July 23-24	Greatest calendar day precipitation on record for Twin Cities International Airport with 9.15 inches.	DR-797
June 9-10, 2002	48 hour rainfall totals topped 12 inches in some areas of Roseau and Lake of the Woods counties.	DR-1419
September 14-15, 2004	More than ten inches of rain fell in a 36 hour period in Faribault and Freeborn Counties.	DR-1569
August 18-20, 2007	The 15.10 inches measured one mile south of Hokah still stands as the record 24 hour rainfall at a Minnesota National Weather Service Cooperative station. The three day total for this station was 16.27 inches.	DR-1717
September 22-23	The National Weather Service site in Amboy measured 9.48 inches on September 23, with 10.68 inches for the event.	DR-1941
June 19-20, 2012	The two day total at Duluth was 7.24 inches. The St. Louis River at Scanlon set a new record crest at 16.62 feet, rising 10 feet in 24 hours.	DR-4069

The intention of the mega storm data is not to establish a probability for flash floods. The meteorology for each event varies as well as location. Flash floods due to mega rain events impact both urban and agricultural areas. Vulnerability to structures and critical facilities correlates with population density as seen in the State’s Population Density.

The focus is on the vulnerability of stormwater systems due to flash floods initiated by mega rain events. The resulting floods from the above rainfall events may be characterized in greater than 500 year return periods but the stormwater systems are often designed for a fraction of this conveyance. The cost effectiveness of designing and installing systems to higher standards is not cost effective due to the lack of frequency of the events. Communities often mitigation stormwater problems as a result of experience and public input.

An example of how a community addressed its flash flood issues is found in the Steele County mitigation plan. The City of Owatonna was originally built on the Straight River and continued developing into the moraine hills surrounding the valley. Residential and commercial structures were being flooded after both spring snow thaw and flash floods in both the valley and the hills. The city developed a stormwater plan in 2007 and identified improvements to the stormwater system plus the addition of retention/detention ponds. The implementation of this plan should eliminate flooding in the hill area plus reduce impacts to structures in the valley by slowly releasing water from the ponds after flooding has subsided.

Erosion of bridge abutments is another issue with extreme flash floods that may not be seen with other types of flood events. Several road and railroad bridges were replaced in Winona County due to the volume and hydrostatic force of water coming down from the bluff areas in the 2007 flooding. Per MNDOT sources, scour critical is a classification for bridges that are susceptible to erosion of the streambed or approach embankment during flood events. Each of these bridges has a Scour Action Plan, which requires monitoring (and potential closure) during periods of high water. The breakdown in ownership Of the 429 Scour Critical bridges is:

- MNDOT - 49
- Local Agencies – 376
- DNR – 2
- Corps of Engineers – 1
- Railroad – 1

Damages to crops from floods are another dataset that conclusions regarding jurisdictional vulnerability can be drawn from. The total indemnity claims due to floods for 2000-2013 time period was over **$35** million with losses to the to all counties reporting losses listed in Indemnity Claims for Flood on Crops. 2000-2013. Data is from Business with Month of Loss, USDA Risk Management Agency, see **http://www.rma.usda.gov/data/cause.html.**

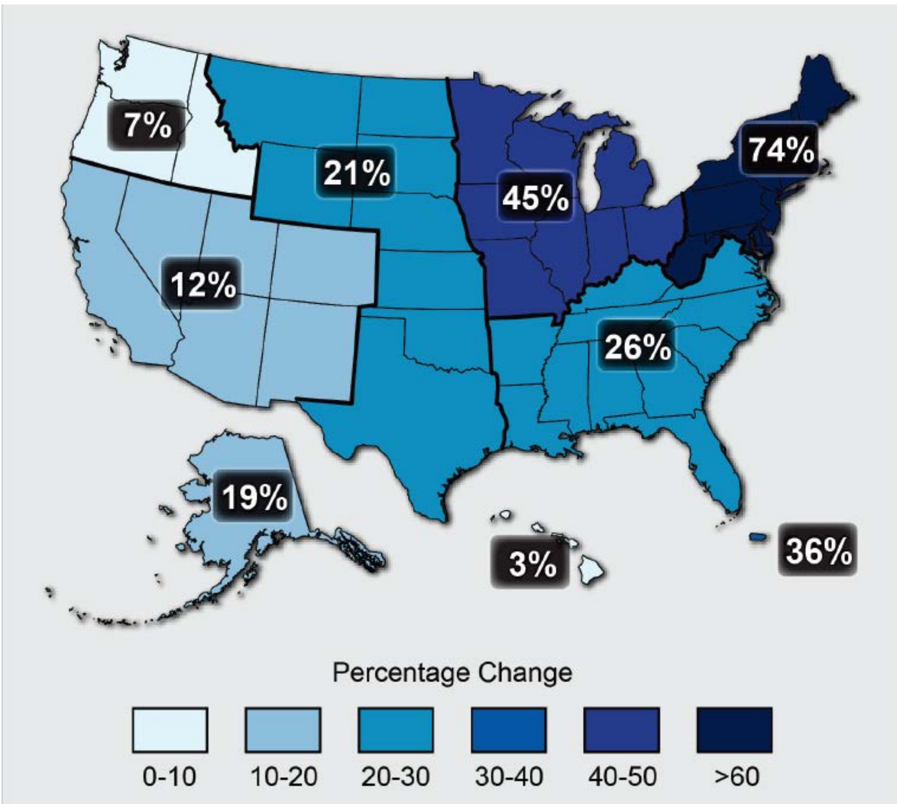
Table 14 Indemnity Claims for Flood on Crops 2000-2013

County	Claims
Carver	$3,011,638
Sibley	$2,336,755
Norman	$2,319,245
Yellow Medicine	$2,268,091
Mower	$2,216,109
Marshall	$1,964,648
Lac qui Parle	$1,867,014
Watonwan	$1,618,392
Freeborn	$1,581,698
Nicollet	$1,519,161
Kittson	$1,144,449
Roseau	$1,128,978
Aitkin	$1,113,900
Scott	$1,058,361
Carlton	$1,009,750
Goodhue	$712,960
Nobles	$650,718
Meeker	$588,185
Faribault	$583,505
McLeod	$577,614
Houston	$448,410
Swift	$393,269
Clay	$379,454
Le Sueur	$349,020
Rice	$305,051
Brown	$286,807
Murray	$270,017
Jackson	$268,240
Blue Earth	$267,502
Grant	$258,745
Renville	$248,351
Cottonwood	$230,319
Martin	$202,365
Pennington	$181,771
Wilkin	$180,067
Polk	$171,170
Fillmore	$139,955
Redwood	$138,223
Wabasha	$137,371
Lyon	$83,794
Wright	$82,041
Kandiyohi	$81,376
Mille Lacs	$56,525
Steele	$55,769
Olmsted	$53,907
Pipestone	$52,227
Stevens	$48,130
Pope	$44,229
Rock	$41,437
Dodge	$37,600
Pine	$33,225
Lake of the Woods	$29,575
Big Stone	$27,038
Hennepin	$26,350
Waseca	$26,140
Lincoln	$20,615
Mahnomen	$17,931
Winona	$17,199
Traverse	$13,092
Otter Tail	$8,749
Benton	$8,395
Todd	$7,763
Isanti	$7,475
Stearns	$5,233
Anoka	$4,949
Beltrami	$4,405
Washington	$3,545
Dakota	$3,118
Becker	$1,517
Red Lake	$1,395
Morrison	$773
TOTAL	$35,032,795

Flooding and Climate Change

As Minnesota's climate changes, the quantity and character of precipitation is changing. Average precipitation has increased in the Midwest since 1900, with more increases in recent years. According to the Draft National Climate Assessment (NCA), (http://ncadac.globalchange.gov/), the Midwest has seen a 45% increase in very heavy precipitation (defined as the heaviest 1% of all daily events) from 1958 to 2011.

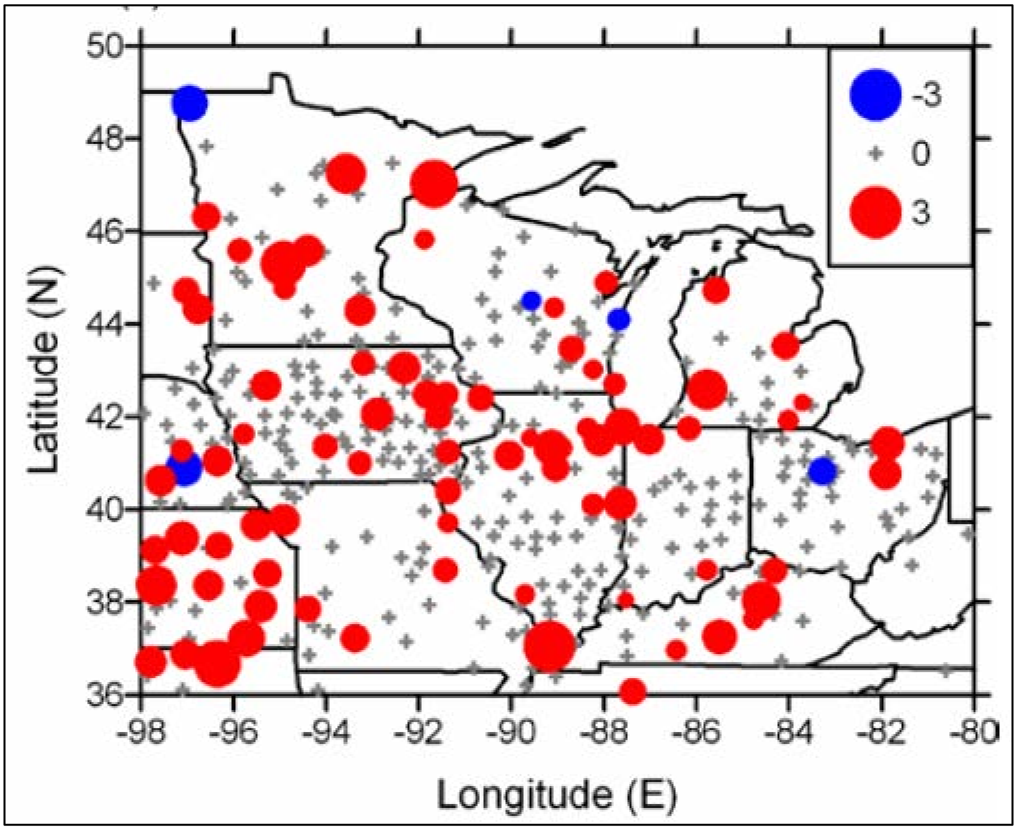
Figure 18 Percent increase in very heavy precipitation from 1958-2011



Source: NCA

This precipitation change has led to increased magnitude of flooding. Figure 19 shows a trend in the sum of the top 10 wettest days in a year for 1901- 2000, expressed in a percent per decade, for the Midwest region. A red circle indicates that the station showed a statistically significant increase through time; a blue circle indicates a statistically significant decrease. A plus symbol indicates that the trend was not significant (shown as 0 in the legend). The diameter of the circle scales linearly with the trend magnitude. Most stations with statistical significance show upward trends. Only stations with 80 years of precipitation data between 1895 and 2002 are shown (Pryor et al. 2009b).

Figure 19 Percent per decade trend in the sum of the top 10 wettest days in a year for 1901- 2000.



Source: NOAA Technical Report NESDIS 142-3: Part 3. Climate of the Midwest U.S.

Increased precipitation may also show seasonal changes, trending toward wet springs and dryer summers and falls. An example of a recent year with this character was 2012, when many MN counties were eligible for federal disaster assistance for drought, while others were eligible for flooding conditions, and seven were eligible for both in the same year (Seeley, 2013).

4.5.2 Dam / Levee Failure

Dams and levees are an important part of the infrastructure of Minnesota. Dams maintain lake levels and impound water for flood control, power production and water supply. Levees are used to increase cultivation in agriculture and to protect population and structures from floods. Both structures are artificial barriers that have the ability to impound water, wastewater, or any liquid borne material for the purpose of storage or the control of water. The concern of profiling dams and levees as part of the flooding section is the damage that may result due to a failed structure or overtopping. There are many factors that affect the impact of a failure such as how much liquid is being impounded, location of structures and critical facilities, intended purpose and type of construction of the dam or levee. Failure may occur for one or a combination of the following reasons:

- Prolonged periods of rainfall and flooding;
- Inadequate spillway capacity, resulting in excess overtopping flows;
- Internal erosion caused by embankment or foundation leakage or piping;

- Improper maintenance, including failure to remove trees, repair internal seepage problems, replace lost material from the cross section of the dam and abutments, or maintain gates, valves, and other operational components;
- Improper design, including the use of improper construction materials and construction practices;
- Improper operation, including the failure to remove or open gates or valves during high flow periods;
- Failure of upstream dams on the same waterway that release water to a downstream dam;
- Earthquakes, which typically cause longitudinal cracks at the tops of the embankments that can weaken entire structures.

Dams are complicated structures, and it can be difficult to predict how a structure will respond to distress. The modes and causes of failure are varied, multiple, and often complex and interrelated, *i.e.*, often the triggering cause may not have resulted in failure had the dam not had a secondary weakness. These causes illustrate the need for careful, critical review of all facets of a dam. (National Research Council,1983).

A levee is any artificial barrier that will divert or restrain the flow of a stream or other body of water for the purpose of protecting an area from inundation by flood waters. Generally, a levee is subjected to water loading during a few days or weeks in a given year; unlike a dam that is retaining water most days in the same year.

A levee breach results when a portion of the levee breaks away, providing an opening for water to flood the landward side of the structure. Such breaches can be caused by surface erosion due to water velocities, or they can be the result of subsurface actions. Subsurface actions usually involve sand boils whereby the upward pressure of water flowing through porous soil under the levee exceeds the static pressure of the soil weight above it (*i.e.*, under seepage). These boils can indicate instability of the levee foundation given the liquefied substrate below it, leading way to breaching. Levee overtopping is similar to dam overtopping in that the flood waters simply exceed the design capacity of the structure, thus flowing over the lowest crest of the system. Such overtopping can lead to erosion on the landward side which may then lead to breaching. In order to prevent this type landward erosion, many levees are reinforced or armored with rocks or concrete. The concern with levees is that they may fail when exposed to floodwaters for an unusually long period of time. The prolonged hydraulic forces may weaken the structure to the point of failure unless monitoring and reinforcement measures are being taken.

History of dam failure in Minnesota

Notable incidents relating to dams since 1909 are found in Appendix F. There were 85 events of all types in that period. These events show different modes of how important design, operation, maintenance, and nature play a role in potential failures. Regulation plays a critical role in dam safety. The history does not provide impact in dollars as hazard event data from other sources.

A recently chronicled event show potential impact due to a high rainfall and high river levels. Large portions of the state experienced heavy rainfall on June 20, 2012. Carlton County saw record rainfalls in a 24 hour period that fell on already saturated ground. The St. Louis River at Scanlon rose 11 feet and hit a record crest of 16.62 feet, breaking the old record of 15.8 feet that was set on May 9, 1950. Some evacuation of homes was necessary. An earthen dike on Forebay Lake that feeds the Thomson Hydro-Power Dam was saturated with water and gave way during heavy rains. The flooded Forebay washed out a 100-foot deep gap in Highway 210 (MPR, 2012).These waters flowed through Jay Cook State Park and also damaged Highway 210. High water at Thomson Dam overtopped the Thomson reservoir but did not fail. Operators of the dam activated the Emergency Action Plan averting injuries. The alarm was sounded due to the channel collapse as opposed to concerns about catastrophic failure of the dam. This event is unusual in Minnesota since approximately $3 million in damages to public structures were recorded based on FEMA and MnDOT records. The recorded damages were impacted by three different dynamics: extreme rain with previously saturated ground, structural failure, and designed overtopping.

Figure 20 depicts dams by owner type, with the dams maintaining Emergency Action Plans highlighted.

The number of dams by owner:

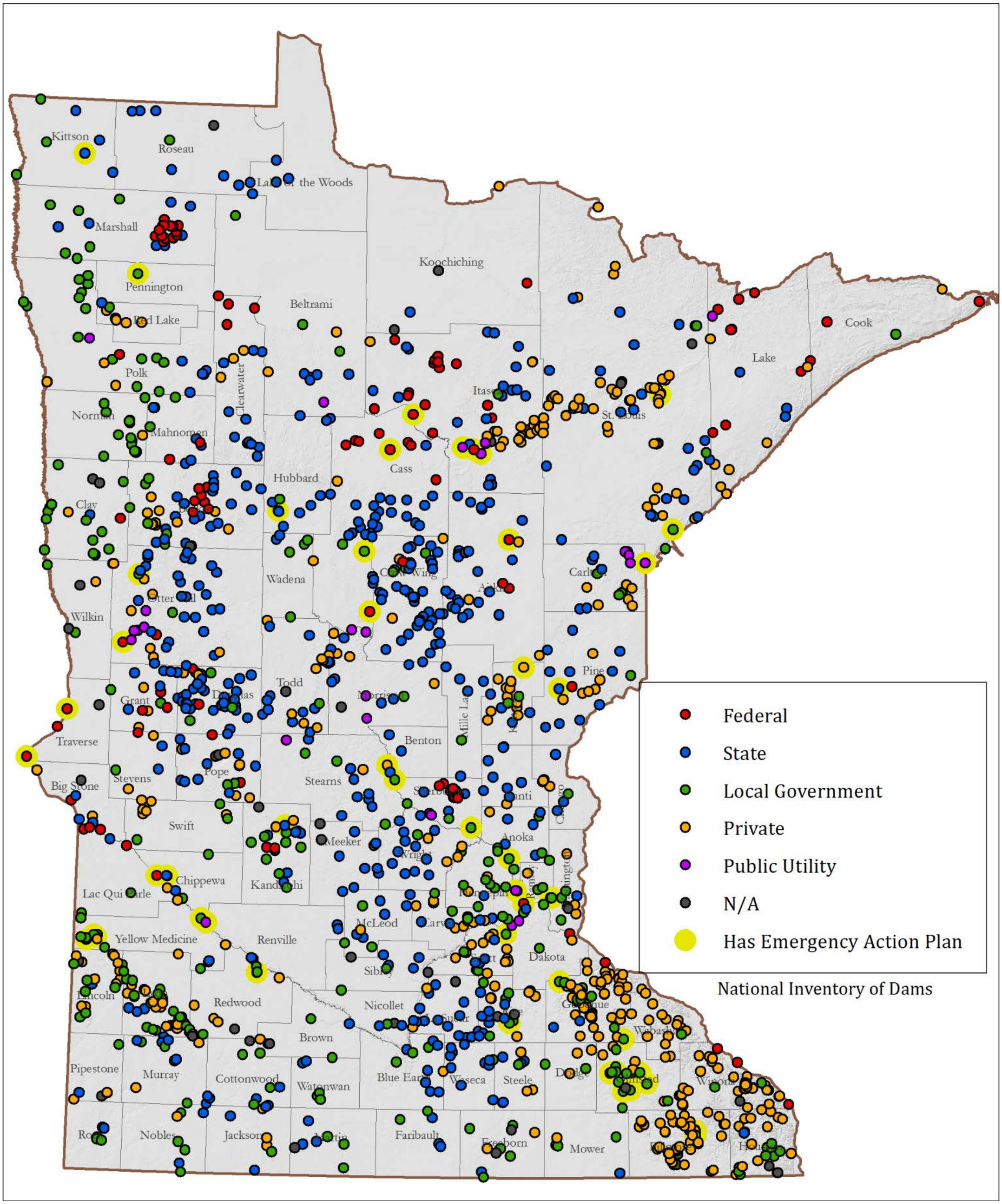
Private:	402
State:	244
Federal:	124
Local Government:	248
Public Utility:	55
Not Listed:	5
Total:	1,078

Source: National Inventory of Dams, USACE, 2013

The agencies with regulatory authority of dams in Minnesota are:

- DNR Dam Safety Program has the mission protecting the life and safety of people in Minnesota by ensuring that dams are safe. Minnesota's program sets minimum standards for dams and regulates the design, construction, operation, repair and removal of dams. Both privately and publicly-owned dams are regulated.
- U.S. Army Corp of Engineers (USACE) maintains the lock and dam system on the Mississippi River and has regulatory authority over the flood control dams that the USACE owns. USACE also participates with local communities in all phases of flood control that includes dams, levees, or other means of flood control
- Federal Energy Regulatory Commission (FERC) regulates non-federal hydroelectric power projects that effect navigable waters, occupy E.S. lands, use water or water power at a government dam, or affect the interests of interstate commerce. Including the Federal Power Act, Public Utility Regulatory Policies Act, the Electric Consumers Act of 1986 and the Energy Policy Act of 1992.

Figure 20 Dams by Owner Type in Minnesota



The authorities vary between agencies but the overall design, construction, operation, and maintenance of dams come under their authority. They also classify dams for emergency response purposes. This classification system does not imply that the dam is unsafe. Regulatory agencies require Emergency Action Plans (EAP) for all High Hazard dams. The hazard classifications for dams are as follows:

- **High** - any loss of life or serious hazard, or damage to health, main highways, high-value industrial or commercial properties, major public utilities, or serious direct or indirect, economic loss to the public;
- **Significant** - possible health hazard or probable loss of high-value property, damage to secondary highways, railroads or other public utilities, or limited direct or indirect economic loss to the public other than that described in Class III (Low); and
- **Low** - property losses restricted mainly to rural buildings and local county and township roads which are an essential part of the rural transportation system serving the area involved.

The dams that are not regulated by USACE or FERC are regulated by the Minnesota Dam Safety Program. The following statistics are for 2013:

- Number of state-regulated high-hazard potential dams: 23
- Number of non-state regulated high-hazard potential dams:16
- Number of state-regulated significant hazard potential dams: 124
- Number of state-regulated low hazard potential dams: 991

Source: National Inventory of Dams, USACE, 2013; and; Minnesota Dam Safety Program, 2013

Most of the public dams are more than 50 years old and require ongoing or emergency repairs and reconstruction to maintain their structural integrity. Through state bonding, the DNR spends approximately $1 million annually on repairs and reconstruction. An estimated $114 million is needed over the next 20 years to assure public dams remain in a safe and usable condition.

History of levee failure in Minnesota

Levees garnered attention after the devastation in New Orleans as a result of Hurricane Katrina in 2005. There is no official historical source for failed levees in Minnesota. Failed levees for the protection of life and property have been reported as part of Presidential Disaster Declarations in Minnesota. The most notable event due to flood waters overtopping a levee was the 1997 flood in East Grand Forks (DR-1175). Extensive damages were due to water cresting over earthen levees. The Red River crested at 54.32 feet. The earthen levees in place were designed to protect to level of a 100-year flood plus three feet of freeboard, or, 52 feet. Three and one half million sandbags plus many cubic yards of clay and gravel were used during the flood fight. The river rise of one inch per hour (two feet per day) overcame the reinforcement efforts.

A significant amount of resources go into providing flood forecasts so that the appropriate flood fighting measures may be taken. NOAA provides flood forecasts based on extensive surveys of snow cover Communities use the NOAA forecasts to activate the flood fight plans to ensure all levee components are in place. Engineers determine the height and width of sandbags to be added to a levee. Patrols walk the levees to determine leaks or degradation to the levee. All of these actions usually prevent losses however three are extreme conditions that may not be overcome. The East Grand Forks example shows how the freeze/thaw cycle overcame that city’s defenses. The other situation is where levees are exposed to high levels of water and hydraulic pressure for an extended period of time. Even though spring floods are an annual event the probability of catastrophic failure is low due to the on-going planning and response efforts by local, state, and federal agencies.

Levee Regulation

Levees for agricultural purposes are permitted by watershed districts or county soil and water conservation districts administered by the Board of Soil and Water Resources (BWSR). The number of levees for agriculture is not known at the time of the plan update. Agricultural levees funded by the U.S. Natural Resources Conservation Service are not regulated by the state and are handed over to the property owners after construction is complete. The Minnesota Silver Jackets is taking on a project to identify levees at several communities in Minnesota to assess the location and impact of levees.

The National Flood Insurance Program (NFIP) is responsible for identifying flood risks behind levees through flood analysis and mapping projects. FEMA has criteria for recognizing levees as providing protection against the one-percent-annual-chance flood. The three types of levees are Accredited Levees, Provisionally Accredited Levees and Emergency Levees

A levee that is an Accredited Levee is certified if evidence-typically a statement by a licensed professional engineer or Federal agency responsible for levee design-has been presented showing the structure meets current design, construction, maintenance, and operation standards to provide protection from the one-percent-chance flood. The levee owner is responsible for ensuring that the levee is being maintained and operated properly and for providing evidence of certification. If it can be shown that a levee provides the appropriate level of protection, then FEMA will “accredit,” or recognize, the levee as providing adequate protection on flood hazard maps and the area behind it will be shown as moderate risk zone. FEMA accredits levees that meet the criteria and maps areas behind them as having a certain risk level, but does not preform the actual certifications. The five accredited levees in Minnesota are:

- Black Bear Levee, Crow Wing County
- Pig’s Eye Levee, Dakota County
- Hastings, Dakota County
- East Grand Forks, Polk County
- Valley Fair Levee, Scott County

The inability to provide full and prompt documentation of a levee’s status does not necessarily mean that the levee no longer provides the level of protection for which it was designed. It also does not mean that the flood hazard map should show the levee as providing protection against the one-percent-annual-chance (100-year) flood. FEMA has created the Provisionally Accredited Levee (PAL) designation to facilitate the certification process for communities whose levees are reasonable expected to continue to provide protection from the one-percent-annual-chance flood. Current levee certification status follows.

Table 15 FEMA Provisionally Accredited Levees

Levee Description	City	County	Levee Status
Minneapolis Water Treatment Plant	Fridley	Anoka	Decertified
Mankato Levee	Mankato	Blue Earth	PAL
LeHillier Levee		Blue Earth	PAL
Carver Levee	Carver	Carver	Not offered PAL
Chaska Levee	Chaska	Carver	PAL
Montevideo Levee	Montevideo	Chippewa	Not offered PAL
Hastings	Hastings	Dakota	PAL-confirmed
South St. Paul	South St Paul	Dakota	PAL-confirmed
Preston WWTP Levee	Preston	Fillmore	PAL
Rushford Levee	Rushford	Fillmore	PAL
Minnehaha levee	Minneapolis	Hennepin	Not offered PAL
Marshall 1963 Segment	Marshall	Lyon	PAL
Marshall Stage 2	Marshall	Lyon	PAL
Minnesota	Minnesota	Lyon	PAL
Alvarado Levee	Alvarado	Marshall	PAL
Argyle Levee	Argyle	Marshall	PAL
Oslo Levee	Oslo	Marshall	PAL
North Mankato	North Mankato	Nicollet	PAL
Halstad		Norman	146 protected; COE
Rochester levee	Rochester	Olmsted	PAL
St. Paul Levee Floodwall	St Paul	Ramsey	PAL
Roseau WMA		Roseau	Not offered PAL
Granite Falls	Granite Falls	Yellow Medicine	PAL

Non-Certified Emergency Levees

Emergency levees are built when floods are predicted. This class of levee protection is not a sound structure unless sandbags or other augmentation is added. Usually emergency levees are removed after the flood event to receive Public Assistance funding under Category B. Some communities may have earthen works in place that were constructed before the flood event.

Table 16 Emergency Levees

Name	County	Name	County
Aitkin	Aitkin	St Peter	Nicollet
Fridley	Anoka	Norman County	Norman
New Ulm	Brown	Perley	Norman
Springfield	Brown	Crookston	Polk
Carver	Carver	Fisher	Polk
Watertown	Carver	Duxby	Roseau
Moorhead	Clay	Roseau	Roseau
Windom	Cottonwood	Elk River	Sherburne
Inver Grove Heights	Dakota	Lake City	Wabasha
Blue Earth	Faribault	Wabasha	Wabasha
Peterson	Fillmore	Wabasha county	Wabasha
Preston	Fillmore	Afton	Washington
Cannon Falls	Goodhue	Lake St Croix Beach	Washington
Bradford Twp	Isanti	Newport	Washington
Jackson	Jackson	St Mary's Point	Washington
Hallock	Kittson	Stillwater	Washington
St Vincent	Kittson	Elba	Winona
Kasota	LeSueur	Delano	Wright
Hutchinson	McLeod	Otsego	Wright

Probability of Occurrence

A general probability for dam or levee failure cannot be determined since each structure is unique in its engineering, construction, maintenance, and the intensity of the flooding that may cause damage.

Vulnerability

Communities down stream of high risk dams and those protected by emergency levees are seen as being the most vulnerable to flooding. High risk dams are required to have Emergency Action Plans so this regulatory component that marks the vulnerability of flooding. Emergency levees are a different case since they are not regulated. Communities do not maintain emergency levees to and they are not provisionally accredited. Therefore, the communities emergency levees are intended to protect are more vulnerable to flooding than provisionally accredited or accredited levees.

Dam/Levee Failure and Climate Change

Dams are designed based on assumptions about a river's annual flow behavior that will determine the volume of water behind the dam and flowing through the dam at any one time. Changes in weather patterns due to climate change may change the hydrograph, or expected flow pattern. Spillways are put in place on dams as a safety measure in the event of the reservoir filling too quickly. Spillway overflow events are a mechanism that also results in increased discharges downstream. It is conceivable that bigger rainfalls at earlier times in the year could threaten a dam's designed margin of safety, causing dam operators to release greater volumes of water earlier in a storm cycle in order to maintain the required margins of safety. Such early releases of increased volumes can increase flood potential downstream.

While climate change will not increase the probability of catastrophic dam failure, it may increase the probability of design failures. Minnesota had a dam failure due to a large storm event in June 2012. The Forebay canal had operated as designed for nearly 100 years. The intensity of the 2012 rain event caused a failure of the canal wall which caused significant damage.

Climate change is adding a new level of uncertainty that needs to be considered with respect to assumptions made during the dam construction.

4.5.3 Wildfire

A wildfire is an uncontrolled fire spreading through vegetative fuels, exposing and possibly consuming structures. They often begin unnoticed, spread quickly, and are usually signaled by dense smoke that may fill the area for miles around. Wildfires can be human-caused through acts such as arson or campfires, or can be caused by natural events such as lightning. Wildfires can be categorized into four types:

- **Wildland fires** are fueled primarily by natural vegetation in grasslands, brush lands and forests.
- **Firestorms** occur during extreme weather (e.g., high temperatures, low humidity, and high winds) with such intensity that fire suppression is virtually impossible. These events typically burn until the conditions change or the fuel is exhausted.
- **Interface or intermix fires** occur in areas where both vegetation and structures provide fuel. These are also referred to as wildland/urban interface fires.
- **Prescribed fires** and prescribed natural fires are intentionally set or natural fires that are allowed to burn for beneficial purposes.

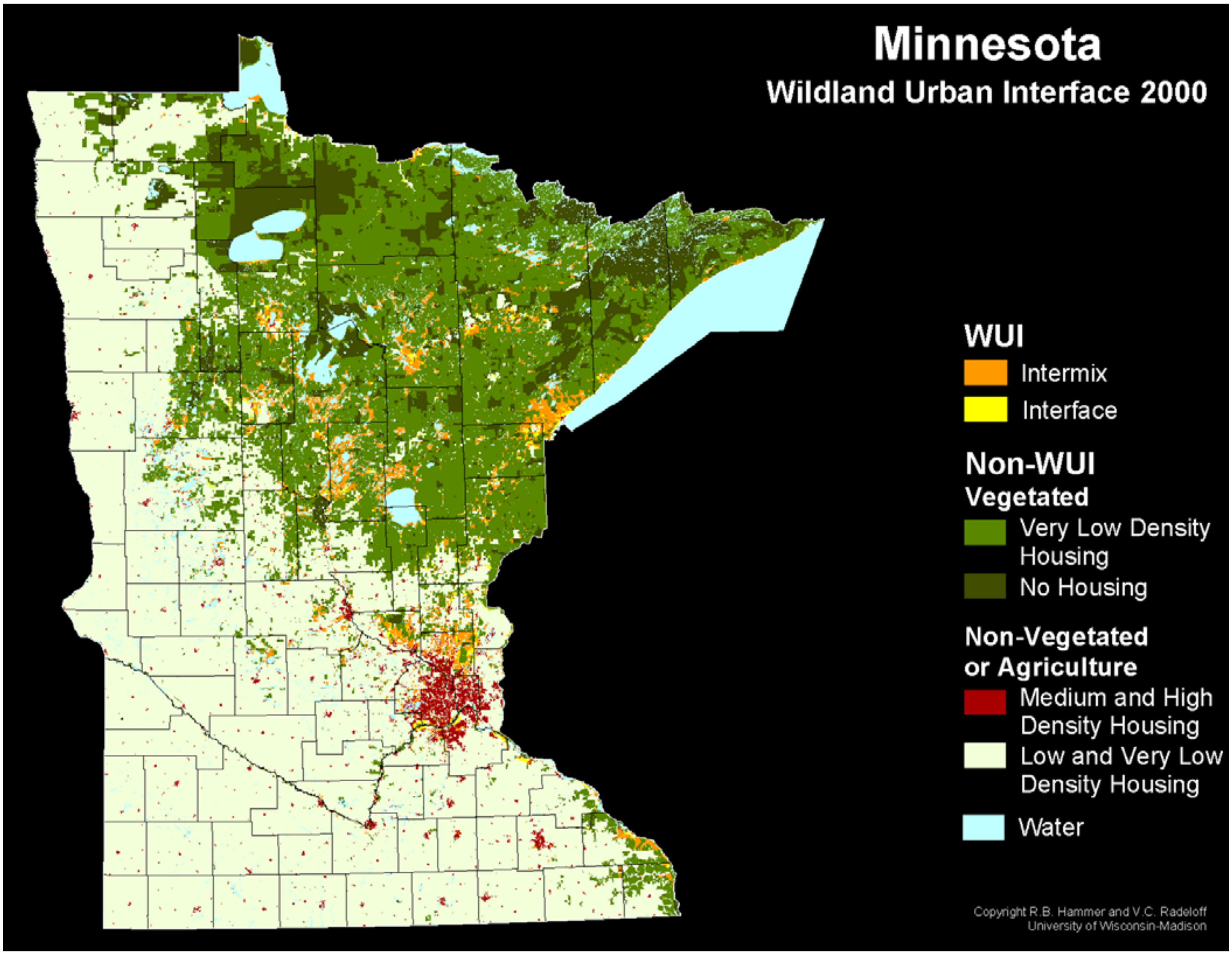
The following factors contribute significantly to wildfire behavior:

- **Topography**: As slope increases, that is, the divergence of the terrain from horizontal, the rate of wildfire spread increases. South facing slopes are also subject to greater solar radiation, making them drier and thereby intensifying wildfire behavior. However, ridge tops may mark the end of wildfire spread, since fire spreads more slowly or may even be unable to spread downhill.
- **Fuel**: Size class, moisture content and volume are the methods of classifying fuel, with volume also referred to as fuel loading (measured in tons of vegetative material per acre). As fuel loading increases, fire intensity (energy released) and flame length increase, making fire suppression more difficult. Fuels with low moisture content ignite easier that wet fuels. The fuel's continuity is also an important factor, both horizontally and vertically.
- **Weather**: The most variable factor affecting wildfire behavior is weather. Important weather variables are temperature, humidity, wind, and lightning. Weather events ranging in scale from localized thunderstorms to large fronts can have major effects on wildfire occurrence and behavior. Extreme weather, such as high temperatures and low humidity, can lead to extreme wildfire activity. By contrast, cooling and higher humidity often signals reduced wildfire occurrence and easier containment.

Fires in Minnesota can be classified by their fuel source and setting: Forest wildfires, prairie fires, and peat fires occur in distinct regions throughout the state. A wildland fire potential map produced by the Firelab.org from a raster geospatial model result that integrates estimates of burn probability (BP) and conditional probabilities of fire intensity levels (FILs) generated for the national interagency Fire Program Analysis system (FPA) using a simulation modeling system called the Large Fire Simulator (FSim; Finney et al. 2011). The specific objective of the 2012 WFP map is to depict the relative potential for wildfire that would be difficult for suppression resources to contain, based on past fire occurrence, 2008 fuels data from LANDFIRE, and 2012 estimates of wildfire likelihood and intensity from FSim. Areas with higher WFP values, therefore, represent fuels with a higher probability of experiencing high-intensity fire with torching, crowning, and other forms of extreme fire behavior under conducive weather conditions. (http://www.firelab.org/fmi/data-products/229-wildland-fire-potential-wfp). This model interestingly predicts peat lands as one of the most dangerous and likely areas to burn. The forested areas in Northeast Minnesota are of lower risk in this model - probably because it does not account for seasonal weather conditions or fuel moisture conditions. Similarly, the agricultural areas of southern Minnesota are not burnable using this type of resource model, further emphasizing that it is the introduction of fire by prescription, machines, or lightning that ignite most wildland fires in southern Minnesota.

The University of Wisconsin – Schools of Forest, Ecology, and Management produced a nationwide study related to the wildland-urban interface areas for each state. The map from the University of Wisconsin study shows the areas in the Wildland-Urban Interface (WUI) zones, using the 2000 census, and continues to be the most current map available. WUI zones are defined as areas where homes are built near or among lands that are prone to wildfire. WUIs may also represent a mix of fuel sources. For example, the Carlos Avery Management Area located in Anoka and Chisago counties, was the site of fires in 2000 and 2009 that burned approximately 2,900 acres and four homes. The management area is a mix of 2/3 wetland and 1/3 upland.

Figure 21 Minnesota Wildland Urban Interface 2000



The study from which the below map above is Radeloff, V. C., R. B. Hammer, S. I Stewart, J. S. Fried, S. S. Holcomb, and J. F. McKeefry. 2005. The Wildland-Urban Interface in the United States. Ecological Applications 15:799-805.

Forest Wildfire

The immediate danger from wildfire is the destruction of timber, property, wildlife, and injury or loss of life to persons who live in the affected area or who are using recreational facilities in the area. Long-term effects include large amounts of scorched and barren land, which may not return to its pre-fire condition for many years. Major fires can completely destroy ground cover, which can in turn cause erosion. Flash floods, landslides, and mudflows can occur if heavy rains follow a major fire. A large blowdown, such as the event of 1999 in the BWCAW, make losses due to wildfire is greater now than in the past. The causes of wildfire vary.

As wildfires affect more people, active public involvement becomes integral to the success of any wildfire management initiative. The Lake County CWPP (Community Wildfire Protection Plan) is an example of a community-based plan with two objectives. First, to identify and prioritize Wildland Urban

Interface (WUI) areas within Lake County (including State, County, federal and nonfederal lands) for hazardous fuels reduction treatments and recommends methods for achieving hazardous fuels reductions. Second, the plan outlines measures for reducing fire danger to structures throughout Lake County in at-risk communities.

Peat Fires

Peat is partially decayed plant matter found in ancient bogs and swamps. Minnesota has approximately six million acres of peatland, the highest total acreage in the contiguous United States, concentrated primarily in northern Minnesota.

Peat fires are deep-rooted fires that burn underground, lasting for weeks, months, or even years. They can smolder during winter months beneath the snow, surfacing again in the spring to burn above ground. Peat ignites when its moisture content is low, and then it supports combustion rather than flame. Once started, combustion is persistent because peat contains oxygen and needs little or no outside oxygen to continue burning. Peat's insulating qualities mean the fire loses little heat. As the peat dries, it becomes water repellent. These factors result in long-lasting fires that require extensive operations to extinguish.

In 1988, peat fires burned 45,000 acres starting in the spring near Warroad and Baudette on the northern border of Minnesota, one of the largest peat fires. However, in recent years, peat fires are still common. In December 2011, the MN DNR noted a high incidence of peat fires across the state, warning landowners to take caution in burning brush and grasses. Peat fires are normally rare in the middle of winter, but the lack of precipitation in the fall of 2011 made conditions just right. The photo of firefighters was taken in the winter of 2011-12.

Figure 22 Firefighters at a Peat Fire in Gully, MN

Source: Star Tribune

Marcotty, J. (2012, January 13). Fire underground. *Star Tribune.* Retrieved http://www.startribune.com/local/blogs/137305898.html

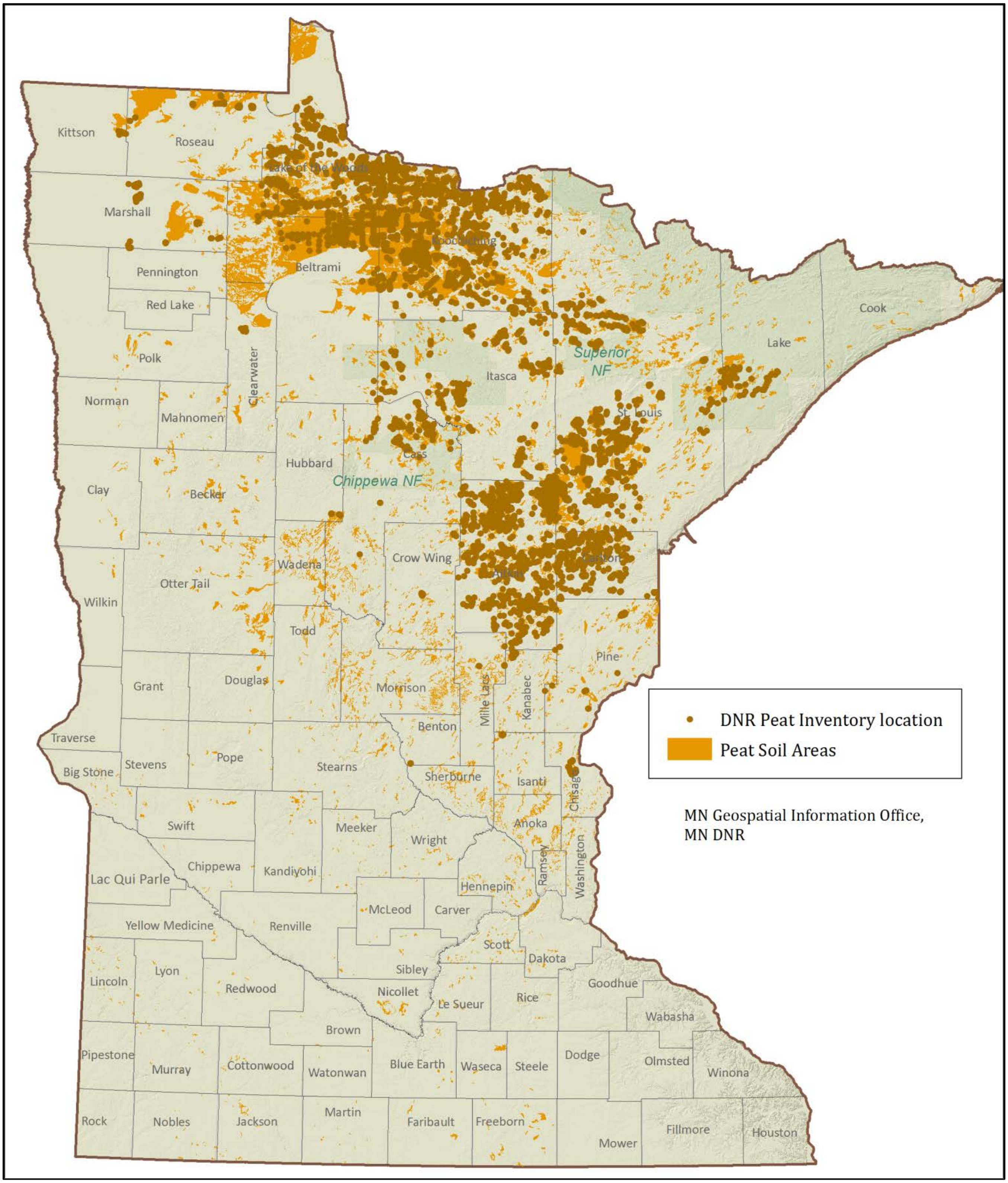
In March of 2012, dry conditions and sparks from a train ignited a peat bog in a remote area near Brainerd. Over 20 firefighters were dispatched, but the location was too rugged to reach with their vehicles (http://brainerddispatch.com/news/2012-03-15/train-sparks-fire-peat-bog).

Peat fires can be extremely difficult to battle because the fire smolders beneath the ground as a glowing combustion rather than as an open flame. Pumping water on a peat fire is often ineffective. Heavy equipment may be needed to alternately work and pack the soil, exposing hot pockets and then sealing them off from surface oxygen. A peat fire can take weeks or months to extinguish, and costs to fight the fire can be substantial. (MnDNR).

Prairie Fires

Brushland or prairie fires are the primary type of wildland fire in the agricultural areas of southern Minnesota. As stated before, it is the introduction of fire by prescription, sparks from machines, or lightning that ignite most prairie wildland fires. These fires are usually less of a risk to large populations, infrastructure or wildlife because of the nature of them being in an agricultural or other sparsely populated prairie area. Additionally, many of these fires will occur on private lands and historical records related to their occurrence are difficult to find.

Figure 23. Peatlands and peatland inventory data in Minnesota

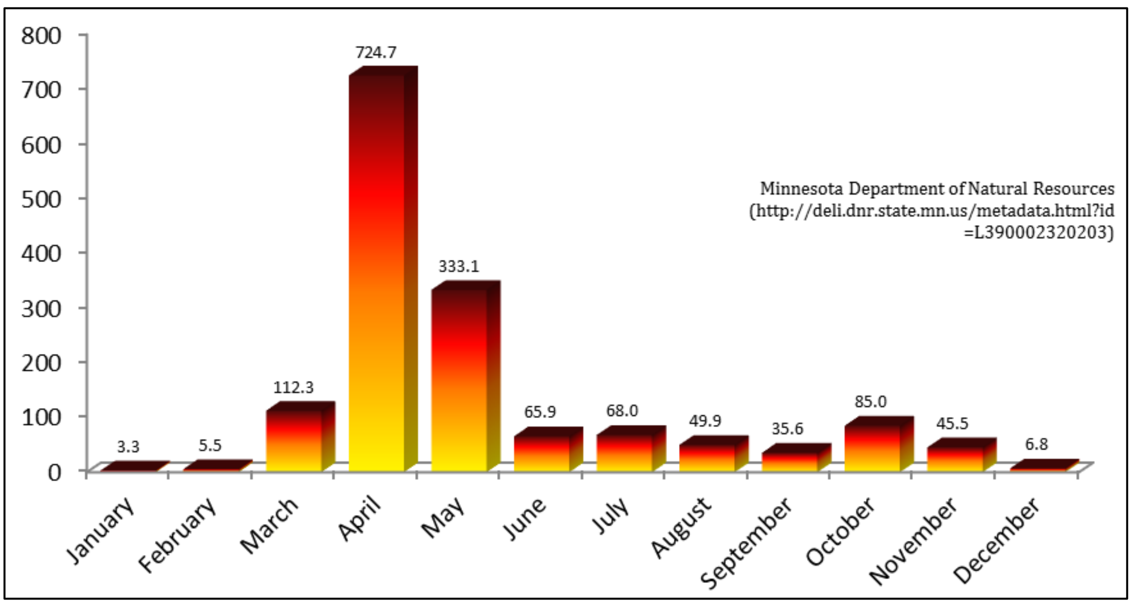


If not promptly controlled, wildfires may grow into an emergency or disaster. Even small fires can threaten lives, resources, and destroy improved properties. It is also important to note that in addition to affecting people, wildfires may severely affect livestock and pets. Such events may require the emergency watering/feeding, shelter, evacuation, and even burying of animals.

The indirect effects of wildfires can also be catastrophic. In addition to stripping the land of vegetation and destroying forest resources, large, intense fires can harm the soil and waterways. Soil exposed to intense heat may lose its capability to absorb moisture and support life. Exposed soils erode quickly and enhance siltation of rivers and streams thereby increasing flood potential, harming aquatic life and degrading water quality. Lands stripped of vegetation are also subject to increased landslide hazards.

Wildfires can occur at any time of day and during any month of the year; however, the greatest wildland fire activity usually occurs from snow melt in March or April, through green-up in late May or early June. Careless fire use, arson, equipment use and weather conditions such as wind, low humidity, and lack of precipitation are the chief factors determining the number of fires and acreage burned. Generally, fires are more likely when vegetation is dormant or after extended drought periods.

Figure 24 Average wildfires per Month in Minnesota, 1985-2012



Wildland fires are capable of causing significant injury, death, and damage to property. A recent inventory showed that 46% of the state (16 million acres) is covered with forests. The potential for property damage from fire increases each year as more recreational properties are developed on wooded land and increased numbers of people use these areas. Fires can extensively impact the economy of an affected area, especially the logging, recreation and tourism industries, upon which many northern counties depend. There can be major direct costs associated with timber salvage and the restoration of the burned area. Burned woodlands and grasslands may need to be replanted quickly to prevent the possibility of widespread soil erosion, landslides, mudflows, and floods which could compound the damage.

It must be noted that in the residential setting the leading causes of wildland fires are debris burning, arson, and equipment use. However, as the urban-rural interface in Minnesota increases, the fire ignition sources become less clear. Urban fires can result from wildland fires in the wildland urban interface where wildland fires usually result from human rather than natural causes. Only 2% of Minnesota wildfires are a result of lightning compared to 85% that result from human causes. Nationally, lightning causes an estimated 16% of wildland fires.

For fires outside urban areas, vulnerabilities are dependent upon fuel sources and availability. As for wildfire, one major example of property wildfire vulnerabilities is the area impacted by the July 4, 1999 massive windstorm. This windstorm raked northeastern Minnesota with straight-line winds exceeding 90 miles per hour. In less than 30 minutes, the storm cut an unbroken fuel pathway (10 - 12 miles long and 40 miles wide) through the Boundary Waters Canoe Area Wilderness (BWCAW) in the Superior National Forest, along the Gunflint Trail outside Grand Marais, with an estimated 80 - 120 tons of fuel per acre on over 477,000 acres. Much of this land cannot be legally, cost-effectively, or safely salvaged or cleared. Downed trees and outbreaks of insects and disease previous to the blowdown storm of July 4, 1999 have significantly increased the fire risk in the area. The task of mitigating fire risk and managing any fires that may occur is complicated by: the remoteness and inaccessibility of the area; the number of government entities that have responsibility for land within the area; the extent of the area affected; constraints on the type of activity that can take place within the BWCAW; and the large number of permanent and seasonal residents and tourists that may be affected by a fire in the area. The size and severity of the “Ham Lake” and “Cavity Lake” fires can be attributed to the unique fuel conditions in that part of the state. Following the 1999 blowdown, several mitigation projects occurred in the affected area, including: construction of helipads and safety zones, development of an evacuation plan for the Gunflint Trail, fuel reduction projects, development of the Northeastern Minnesota Wildfire Integrated Response Plan, Community Wildfire Protection Plans, FireWise programs, and defensible space and sprinkler projects around structures.

Wildfire History in Minnesota

The Minnesota Department of Natural Resources (DNR) annually responds to an average of 1,710 fires that burn 44,735 acres. The DNR is the lead state agency for wildland fire prevention and response. However, other agencies also respond to fires in designated protection areas including local fire departments and Federal agencies such as the Bureau of Indian Affairs, Forest Service, Fish and Wildlife Service, and the National Park Service. The following table has information on the most significant fires in Minnesota during the last three years. The following figures indicate the size and causes of wildfires in the state in 2012 as reported by the DNR.

Table 17 Notable Minnesota Fires from 2011 - 2013

Year	Event
2013	The Green Valley Fire burned 7100 acres. 58 buildings were destroyed including 12 residences & 3 commercial with an additional 8 buildings damaged.
2012	Highway 1 Fire (Ely, MN) burned over 175 acres. The fire was started due to a downed power line a quarter of a mile south of Ely along highway 1. It took 102 personnel and 3 days to extinguish the fire.
2011	The Pagami Creek Fire started approximately 13 miles east of Ely, on August 18, 2011 and burned 92,682 acres. The fire was caused by lightning. The cost of the Pagami Creek fire was approximately $23 million. Over 800 personnel were assigned to the incident at its peak. While this fire did not result in individual or public FEMA assistance, and the USDA bore the responsibility for the majority of the cost.

Figure 25 Size and Cause of Wildfire in 2012: Campfire, Equipment, Arson/Incendiary, Railroad, and Smoking

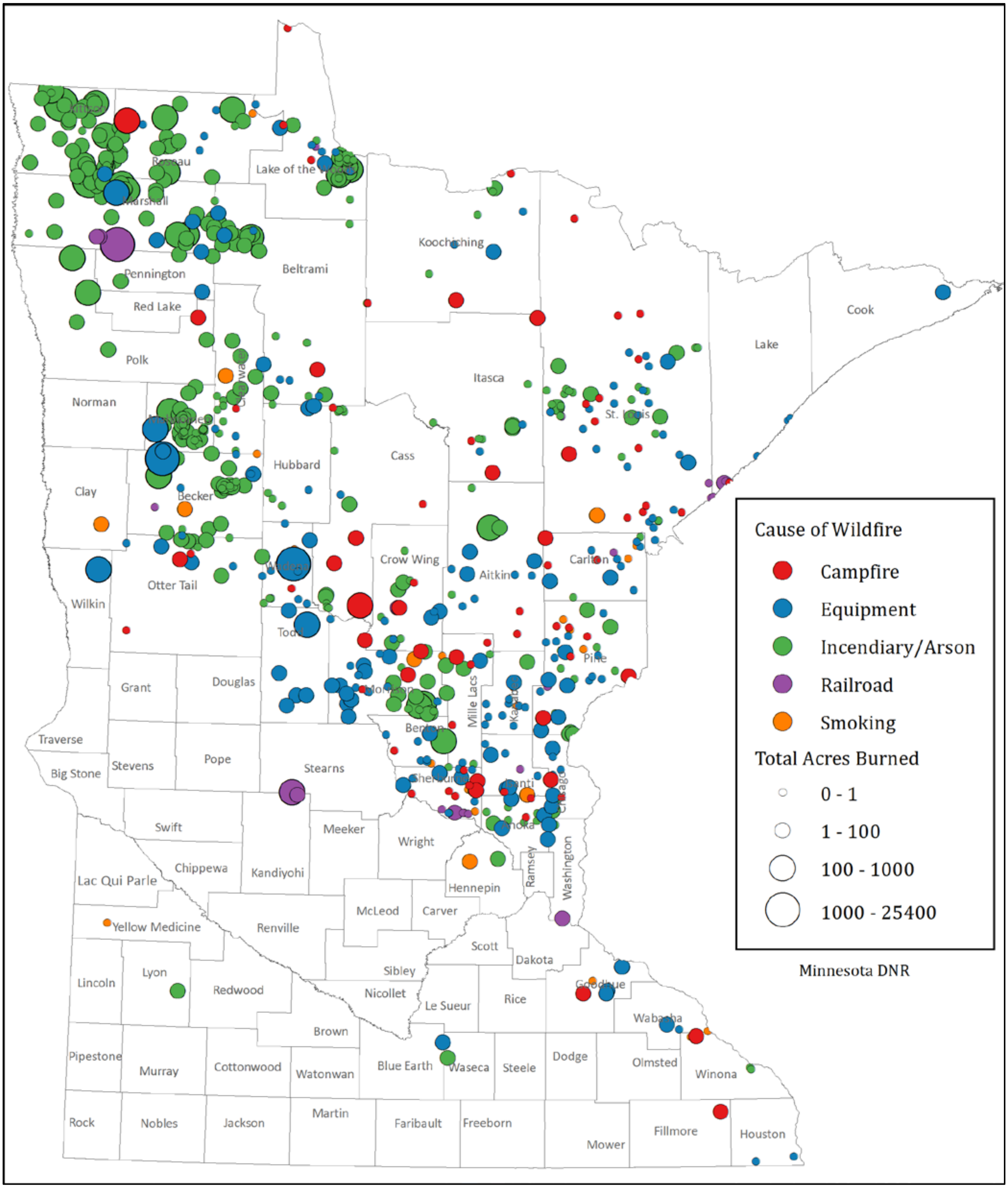


Figure 26 Size and Cause of Wildfire in 2012: Debris, Lightning, Power line, Misc. and Unknown

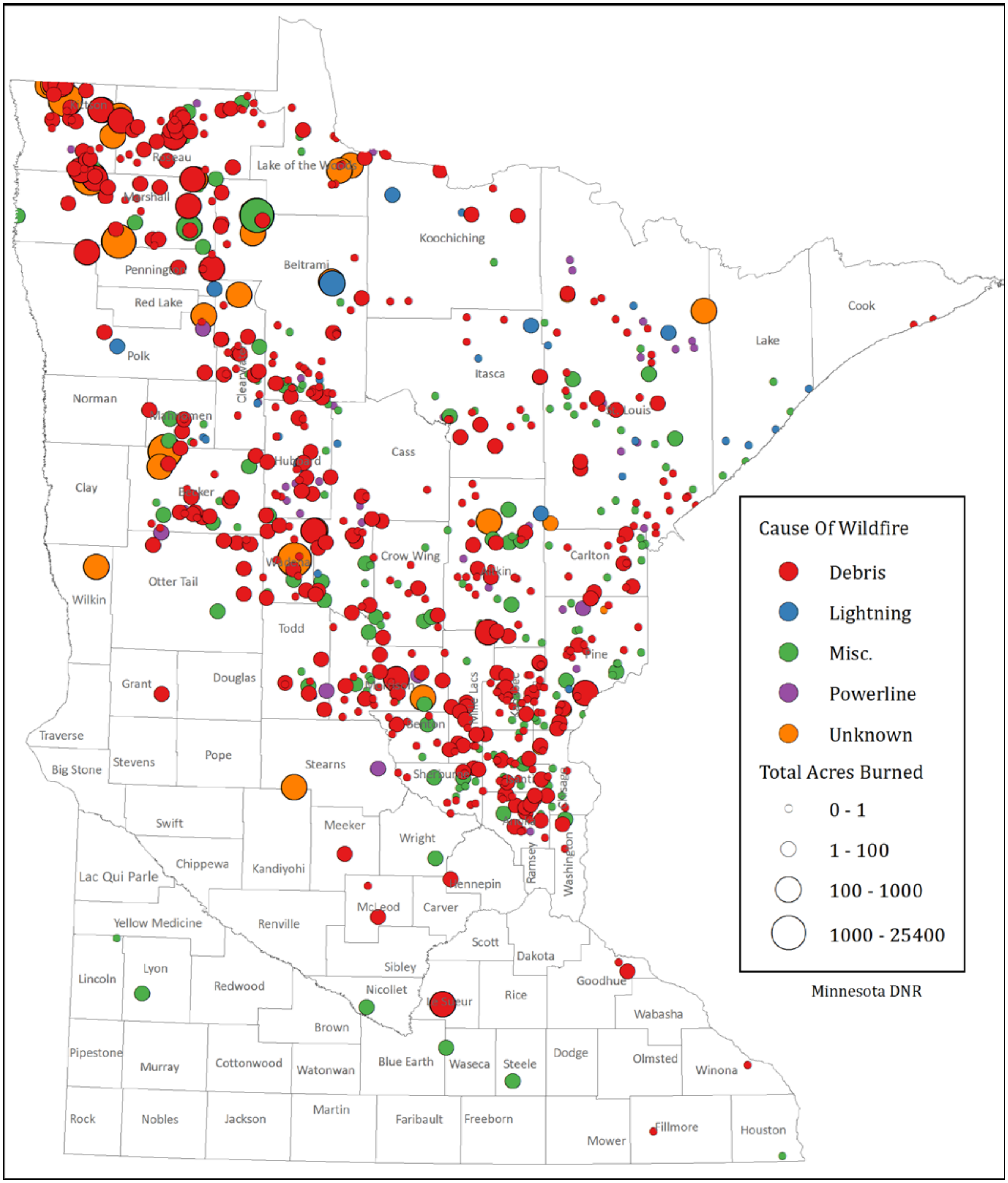


Figure 27 Losses from wildfire by county, 2003-2012

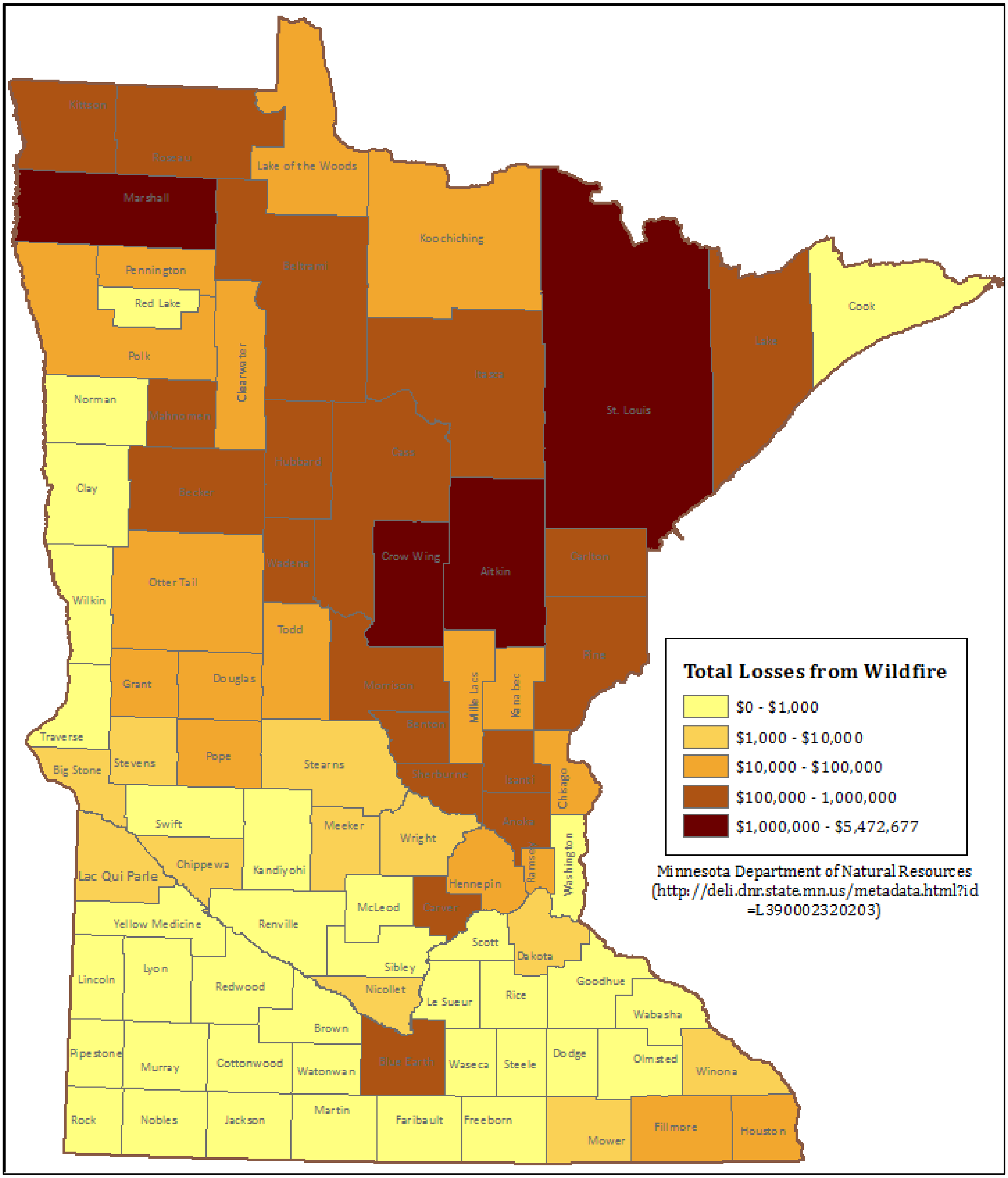


Figure 27 illustrates costs by county due to losses of timber, agriculture, personal property and other expenses resulting from wildfire in 2003-2012, as recorded by the Minnesota DNR. From this data, it is possible to develop potential loss estimation, but due to the many variables that lead to wildfires it is not necessarily a useful calculation. For additional wildfire data see the Federal Incident Information site (http://www.inciweb.org/)

The following graphics illustrate data from the Minnesota DNR, Forestry Division. The charts below indicates the average number of acres burned each year for the past twenty-eight years and the average number of wildfires per year with 1987 and 1988 showing the highest incidence of wildfires.

Figure 28. Acres burned by year in Minnesota, 1985-2012

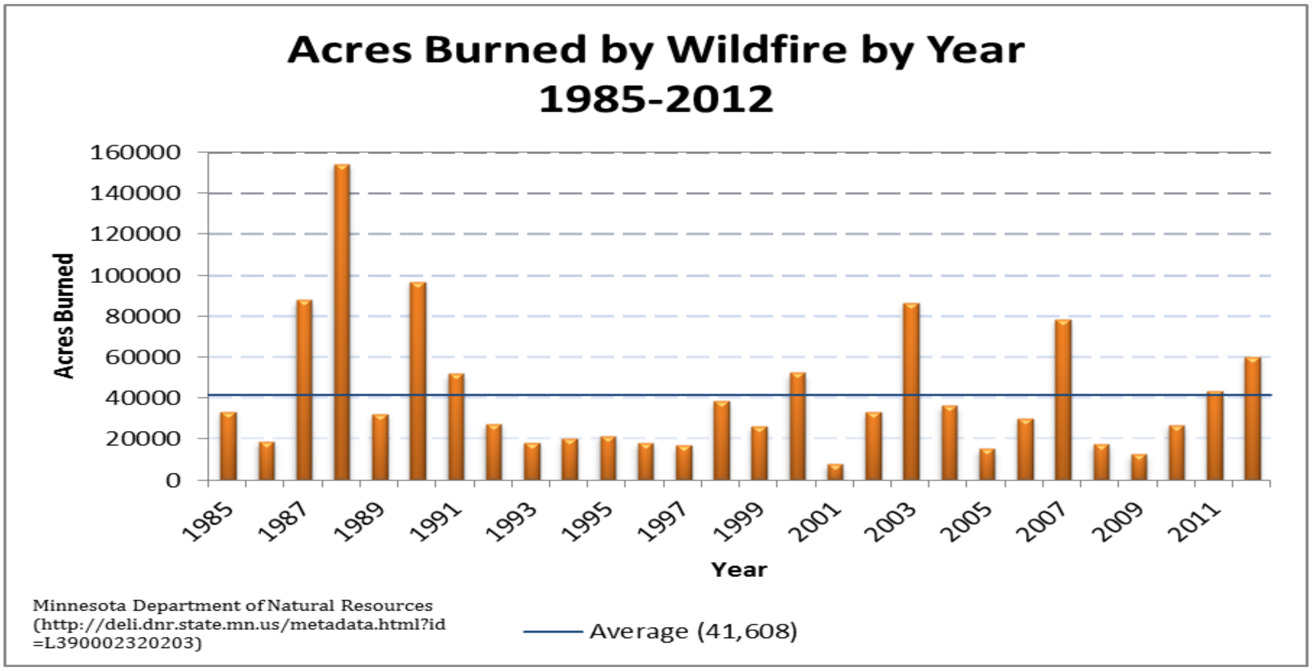
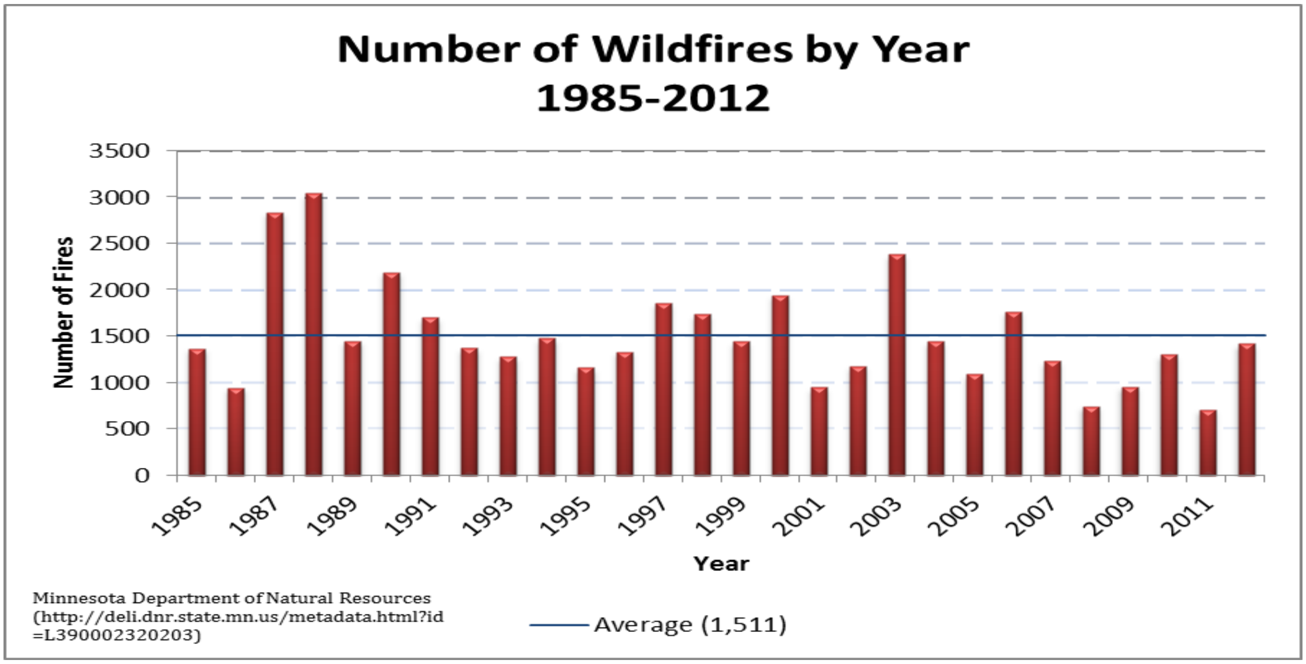


Figure 29 Number of wildfires by year in Minnesota, 1985-2012



See www.usfa.fema.gov/nfdc/ for national trends and other general Minnesota information on this hazard. Fires on Federally protected lands and some fires suppressed by fire departments are not included in these statistics.

Probability of Occurrence

Like most weather-related phenomena, wildfire probability cannot be accurately predicted in the short-term. It is reasonable to assume that wildfire incidence will remain stable over the long-term, bearing in mind that weather patterns (in particular periods of drought and very low humidity); fuel load, insect infestations and human behavior can all greatly influence near-term probabilities. The qualitative probability is rated High for the state, although the rating is only intended for general comparison to other hazards that are being considered for this stage of the planning process. The MN DNR Wildfire Information Center provides daily fire weather forecasts, current data on wildfire conditions and burning restrictions throughout the state.

Vulnerability

Structures in jurisdictions that interface or mix with forests, peat bogs, and prairies are vulnerable to damages to wildfire statewide. Even counties with higher population densities are not completely "built out" and have large wildland or agriculture tracts. Structural damage due to wildfire also depends on the location of the structure in relation to the fuel source. Economic activity and the environment are also vulnerable to wildfire damages Loss of jobs and revenue associated with the lumber industry and tourism may be depressed for years since timber stands take time to grow back. Peat is considered a non-renewable fossil fuel so permanent damage may take place due to wildfire.

Wildfire cost statistics were identified in the 2011 state plan update and continued in this plan. These costs are compiled by the DNR for non-federal funded wildfire containment operations. New data compared with the data from the 2011 plan wildfire is found below. The normalized cost represents potential costs of wildfire over any ten year period.

Table 18 Wildfire Vulnerability Assessment

County	Avg. Fires/ Year	Avg. Acres/ Fire	Avg. Acres/ Year	Avg. Cost/ Acre	2003-2013 Total Cost	2000-2010 Total Cost	Normalized Cost
	Data 10/14/2003 thru 10/13/2013						
Aitkin	44	12	513	$12,549	$5,471,468	$9,010,856	$7,241,162
Becker	54	27	1455	$11,696	$6,316,069	$3,469,628	$4,892,849
Crow Wing	52	2	117	$2,588	$1,351,054	$5,538,095	$3,444,575
St. Louis	157	3	402	$1,032	$1,620,140	$4,163,400	$2,891,770
Sherburne	35	1	51	$321	$110,808	$5,106,745	$2,608,777
Morrison	58	17	1002	$426	$248,082	$3,695,222	$1,971,652
Anoka	25	19	485	$1,627	$409,972	$3,163,682	$1,786,827
Otter Tail	13	12	158	$547	$71,688	$3,276,849	$1,674,269
Benton	29	4	127	$439	$128,611	$3,212,129	$1,670,370
Todd	14	12	172	$111	$15,638	$3,278,219	$1,646,929
Kandiyohi	1	13	6	N/A	N/A	$3,048,379	$1,524,190
Clay	1	67	54	N/A	N/A	$3,002,210	$1,501,105
Pine	71	7	520	$792	$564,539	$2,215,919	$1,390,229
Itasca	46	3	119	$398	$182,488	$1,622,905	$902,697
Marshall	28	134	3766	$3,877	$1,093,249	$312,061	$702,655
Beltrami	53	84	4425	$343	$181,273	$944,388	$562,831
Carlton	41	2	68	$745	$306,073	$679,537	$492,805
Isanti	23	4	89	$1,562	$354,583	$628,021	$491,302
Cass	49	5	258	$223	$108,234	$859,543	$483,889
Cook	2	0	1	$37	$850	$960,044	$480,447
Roseau	33	237	7716	$400	$130,055	$812,532	$471,294
Kittson	35	166	5873	$479	$169,018	$743,474	$456,246
Koochiching	20	4	77	$310	$60,798	$816,512	$438,655
Hubbard	24	3	82	$732	$177,874	$540,989	$359,432
Wadena	22	12	277	$1,241	$275,415	$436,633	$356,024
Carver	0	97	39	$81,250	$325,000	$353,170	$339,085
Lake	12	2	21	$2,811	$345,809	$294,910	$320,360
Kanabec	30	8	237	$244	$74,315	$392,505	$233,410
Chisago	11	5	56	$588	$65,234	$401,068	$233,151

County	Avg. Fires/ Year	Avg. Acres/ Fire	Avg. Acres/ Year	Avg. Cost/ Acre	2003-2013 Total Cost	2000-2010 Total Cost	Normalized Cost
	Data 10/14/2003 thru 10/13/2013						
Mahnomen	38	30	1119	$444	$166,378	$236,507	$201,443
Hennepin	1	29	26	$2,245	$20,202	$308,739	$164,471
Lake of the Woods	23	15	357	$270	$62,891	$261,769	$162,330
Mille Lacs	22	9	199	$125	$27,035	$235,520	$131,278
Blue Earth	2	146	307	$10,786	$226,501	$19,234	$122,868
Big Stone	0	3668	734	$7,054	$14,107	$226,435	$120,271
Clearwater	28	13	383	$149	$42,401	$173,954	$108,178

Source: MN DNR Division of Forestry

Vulnerability assessment for wildfire rankings are based on a variety of factors:

High – Counties with potentially high structural and economic loss are characterized as highly vulnerable. Future development of recreational homes in forested areas is a concern taken into account with this assessment. Economic loss is related to potential losses due to decreased tourism and development due to prolong times to reforest affected areas. Peat bogs are essentially a lost resource when wildfire occurs.

Counties with significant forest cover or Wildland Urban Interface areas are represented as a High ranking. Minnesota Wildland Urban Interface 2000 was the primary source for this ranking. Peat bogs are also associated with this area. Losses from wildfire by county was used to verify structural vulnerability with losses. Several counties in the northwest and east central part of the state were added to the list based on historic damages. This High ranking assessment does not indicate that one county is more vulnerable than another since federal costs are not included in the Normalized Fire Costs. Local mitigation plans show that Cook, Itasca, Lake, Pine and St. Louis counties have approved Community Wildfire Protection Plans (CWPPs) and are active in MN DNR's Firewise program. Cook County is very active in providing structural wildfire sprinkler systems as a mitigation project and may be result in lower damages due to wildfire.

Medium – The counties included in the Medium ranking are based on different factors than the High ranking. In general, these are counties with very low to high density housing. The assumption being made is that the vegetated areas are mainly agriculture and prairie grass with some forests if not highly developed. The Medium ranking is based on Normalized Costs Per as reported by MNDNR. Kandiyohi and Clay counties costs are reported as being high since they reports were for only one ten year period as compared as two for the other counties. Le Sueur, Martin, Rice and Yellow Medicine counties are ranked as a medium risk due to reported agriculture losses.

Low – The counties that are ranked low is primarily due to Normalized Fire Costs per Year under $1,000. These counties have the same very low to high density housing as does the Medium ranking but the costs do not substantiate a higher ranking.

Table 19 Total Building Exposure Vulnerability Assessment

County	Total Building Exposure	Normalized Cost	Ranking
Aitkin	$1,650,061,000	$7,241,162	High
Becker	$2,486,468,000	$4,892,849	High
Lake	$1,173,659,000	$320,360	High
St. Louis	$17,545,854,000	$2,891,770	High
Crow Wing	$5,457,342,000	$3,444,575	High
Sherburne	$5,254,784,000	$2,608,777	High
Morrison	$2,344,240,000	$1,971,652	High
Anoka	$24,167,867,000	$1,786,827	High
Otter Tail	$4,846,688,000	$1,674,269	High
Benton	$2,692,232,000	$1,670,370	High
Todd	$1,555,337,000	$1,646,929	High
Pine	$1,880,697,000	$1,390,229	High
Itasca	$3,713,059,000	$902,697	High
Marshall	$583,449,000	$702,655	High
Beltrami	$2,549,782,000	$562,831	High
Carlton	$2,367,614,000	$492,805	High
Isanti	$2,710,615,000	$491,302	High
Cass	$2,879,718,000	$483,889	High
Cook	$735,155,000	$480,447	High
Roseau	$1,070,790,000	$471,294	High
Kittson	$336,073,000	$456,246	High
Koochiching	$1,156,631,000	$438,655	High
Hubbard	$1,579,205,000	$359,432	High
Wadena	$1,013,164,000	$356,024	High
Kanabec	$1,061,942,000	$233,410	High
Mahnomen	$358,753,000	$201,443	High
Lake of the Woods	$381,700,000	$162,330	High

County	Total Building Exposure	Normalized Cost	Ranking
Mille Lacs	$1,693,977,000	$131,278	High
Clearwater	$543,512,000	$108,178	High
Kandiyohi	$3,245,275,000	$1,524,190	Medium
Clay	$2,999,882,000	$1,501,105	Medium
Carver	$6,263,045,000	$33,909	Medium
Chisago	$3,053,754,000	$233,151	Medium
Hennepin	$113,913,965,000	$164,471	Medium
Blue Earth	$4,239,055,000	$122,878	Medium
Big Stone	$370,709,000	$120,271	Medium
Douglas	$2,861,924,000	$91,731	Medium
Houston	$1,292,366,000	$86,531	Medium
Polk	$2,062,480,000	$78,420	Medium
Dakota	$30,381,418,000	$71,630	Medium
Pennington	$1,010,049,000	$69,720	Medium
Stearns	$10,625,977,000	$61,120	Medium
Pope	$833,801,000	$43,110	Medium
Winona	$3,848,179,000	$35,070	Medium
Brown	$2,176,076,000	$28,940	Medium
Grant	$458,674,000	$28,650	Medium
Wright	$7,981,311,000	$26,710	Medium
Ramsey	$46,438,181,000	$23,450	Medium
Chippewa	$852,476,000	$17,502	Medium
Lac Qui Parle	$468,008,000	$14,930	Medium
Washington	$17,154,765,000	$11,600	Medium
Le Sueur	$1,921,377,000	$10,000	Medium
Martin	$1,516,376,000	$6,650	Medium
Rice	$4,621,430,000	$2,500	Medium
Yellow Medicine	$631,804,000	$1	Medium

County	Total Building Exposure	Normalized Cost	Ranking
Wilkin	$439,697,000	$864	Low
Wabasha	$1,606,448,000	$839	Low
Norman	$456,405,000	$525	Low
Lyon	$1,790,121,000	$500	Low
Mower	$2,522,554,000	$457	Low
Meeker	$1,768,183,000	$419	Low
Nicollet	$2,596,985,000	$350	Low
Scott	$8,014,343,000	$279	Low
Stevens	$789,003,000	$278	Low
Stevens	$789,003,000	$278	Low
Goodhue	$3,567,229,000	$168	Low
Waseca	$1,453,845,000	$125	Low
Olmsted	$10,224,072,000	$69	Low
Freeborn	$2,569,102,000	$35	Low
Pipestone	$609,595,000	$25	Low
Renville	$1,265,786,000	$9	Low
Red Lake	$275,599,000	$1	Low
Lincoln	$379,477,000	$1	Low
Rock	$547,354,000	$1	Low
Murray	$581,843,000	$1	Low
Jackson	$629,412,000	$1	Low
Swift	$814,576,000	$1	Low
Watonwan	$815,118,000	$1	Low
Cottonwood	$868,473,000	$1	Low
Faribault	$1,109,127,000	$1	Low
Nobles	$1,138,189,000	$1	Low
Redwood	$1,193,751,000	$1	Low
Sibley	$1,216,782,000	$1	Low

County	Total Building Exposure	Normalized Cost	Ranking
Dodge	$1,291,386,000	$1	Low
Fillmore	$1,353,034,000	$1	Low
Steele	$2,822,446,000	$1	Low
McLeod	$3,144,760,000	$1	Low

Damages to crops from wildfire are another dataset that conclusions regarding jurisdictional vulnerability can be drawn from. The total indemnity claims due to wildfire for 2000-2013 time period was over $2.3 million with losses to the counties listed below. Data is from Business with Month of Loss, USDA Risk Management Agency. Indemnity data for all hazards may be found in Appendix I.

Table 20 Indemnity Claims Due to Wildfire on Crops 2000-2013

County	Claims
Big Stone	$708,150
Blue Earth	$79,900
Lac Qui Parle	$105,200
Le Sueur	$420,125
Martin	$224,850
Pipestone	$685
Redwood	$100
Rice	$352,125
Swift	$2,750
Wabasha	$1,440
Yellow Medicine	$419,125
Total	$2,314,450

Data Deficiency: a vulnerability assessment similar to that for riverine flooding is not possible due to the lack of data of the fuel sources.

Wildfire and Climate Change

According to the Minnesota Forest Ecosystem Vulnerability Assessment and Synthesis by the U.S.D.A. Forest Service and Northern Institute of Applied Climate Science,

National and global studies agree that wildfire risk will increase in the region, but few studies have *specifically looked at wildfire potential in the assessment area. At a global scale, the scientific consensus is that fire risk will increase by 10 to 30 percent due to higher summer temperatures (IPCC*

2007). For the early part of the 21st century, there is low agreement in this trend across climate models (Moritz et al. 2012). Most models project an increase in wildfire probability by the end of the century, however, particularly for boreal forests, temperate coniferous forests, and temperate broadleaf forests. Studies from southern Canada also project more active wildfire regimes in the future (Drever et al. 2009, Flannigan et al. 2009, Le Goff et al. 2009). In addition to the direct effects of temperature and precipitation, increases in fuel loads from pest-induced mortality or blowdown events could also increase fire risk, but the relationship between these factors can be complex (Hicke et al. 2012). Forest fragmentation and unknown future wildfire management decisions also make fire projections more uncertain for the assessment area. Additionally, we do not have clear projections of how the nature of the fire regimes in Minnesota may change – the proportion of surface fires to crown fires, for example. (Handler et al., 2013).

Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities emphasizes the influence of climate on wildfires:

Changes in temperature and precipitation affect fuel amount, structure, and availability over the long-term by influencing vegetation type and growth, as well as over the short term by affecting fuel moisture during the fire season. Climate, through its influence on snowpack and summer water balance deficit, also affects the length of the fire season (e.g., Westerling et al. 2006), during which existing fuels become available to burn (e.g., Littell, McKenzie, et al. 2009). (Dalton et al., 2013).

Droughts and associated fires have been happening throughout Minnesota’s history. While there was no apparent change in drought duration in the Midwest over the past century (Dai 2010), the average number of days without precipitation is projected to increase in the future (Kunkel, K.E. et al, 2013). Temperatures are predicted to rise, which could lead to more extreme heat events and associated wildfire risks.

As Minnesota’s climate changes, weather fluctuations between drought and extreme rain events and increasing temperatures will lead to changes in forest composition and/or distribution. The northern boreal forest may give way to more deciduous forests or grassland, with a period of dying or diseased trees during the transition. This weather fluctuation can lead to dry conditions that may cause increased fire risk in both grassland and forest environments.

4.5.4 Windstorms

FEMA defines winds in excess of 58 miles per hour, excluding tornadoes, as windstorms. Straight-line winds and windstorms are used interchangeably in the Plan. This hazard is treated as a different category than Tornadoes (which may also include high winds). Windstorms are among the nation's most severe natural hazards in terms of both lives lost and property damaged.

Severe winds can damage and destroy roofs, toss manufactured homes off their pier foundations, and tear light-framed homes apart. There are several different types of windstorms. A “downburst” is defined as a strong downdraft with an outrush of damaging winds on or near the earth's surface. When people experience property damage from a downburst, they often do not believe that “just wind” could have caused the damage, and they assume that they were hit by a tornado. Downbursts may have wind gusts up to 130 mph and are capable of the same damage as a medium-sized tornado. A “gust front” is the leading edge of the thunderstorm downdraft air. It is most prominent near the rain-free cloud base and on the leading edge of an approaching thunderstorm and is usually marked by gusty, cool winds and sometimes by blowing dust. The gust front often precedes the thunderstorm precipitation by several minutes. Straight-line winds, when associated with a thunderstorm, are most frequently found with the gust front. These winds originate as downdraft air reaches the ground and rapidly spreads out, becoming strong horizontal flow.

Table 21 Effects of Wind Speed

Wind Speed	Effects
25-31 mph	Large branches in motion, whistling in telephone wires
32-38 mph	Whole trees in motion
39-54 mph	Twigs break off of trees, wind impedes walking
55-72 mph	Damage to chimneys and TV antennas, pushes over shallow rooted trees
73-112 mph	Roof surfaces peel off, windows break, trailer houses overturn
113+ mph	Roofs torn off houses, weak buildings and trailer houses destroyed, large trees uprooted

Windstorm History in Minnesota

According to the National Climatic Data Center, there have been 8,961 high wind events between 1/1/1955 to 8/31/2013. This number is misleading because the same storm data may have been reported at multiple locations. However, due to these events there were 10 deaths and approximately $881 million dollars in property damages. A description and graphic of notable wind events in Minnesota follow.

Figure 30 Reported sustained winds or wind gusts 65+ knots, 1955-2012

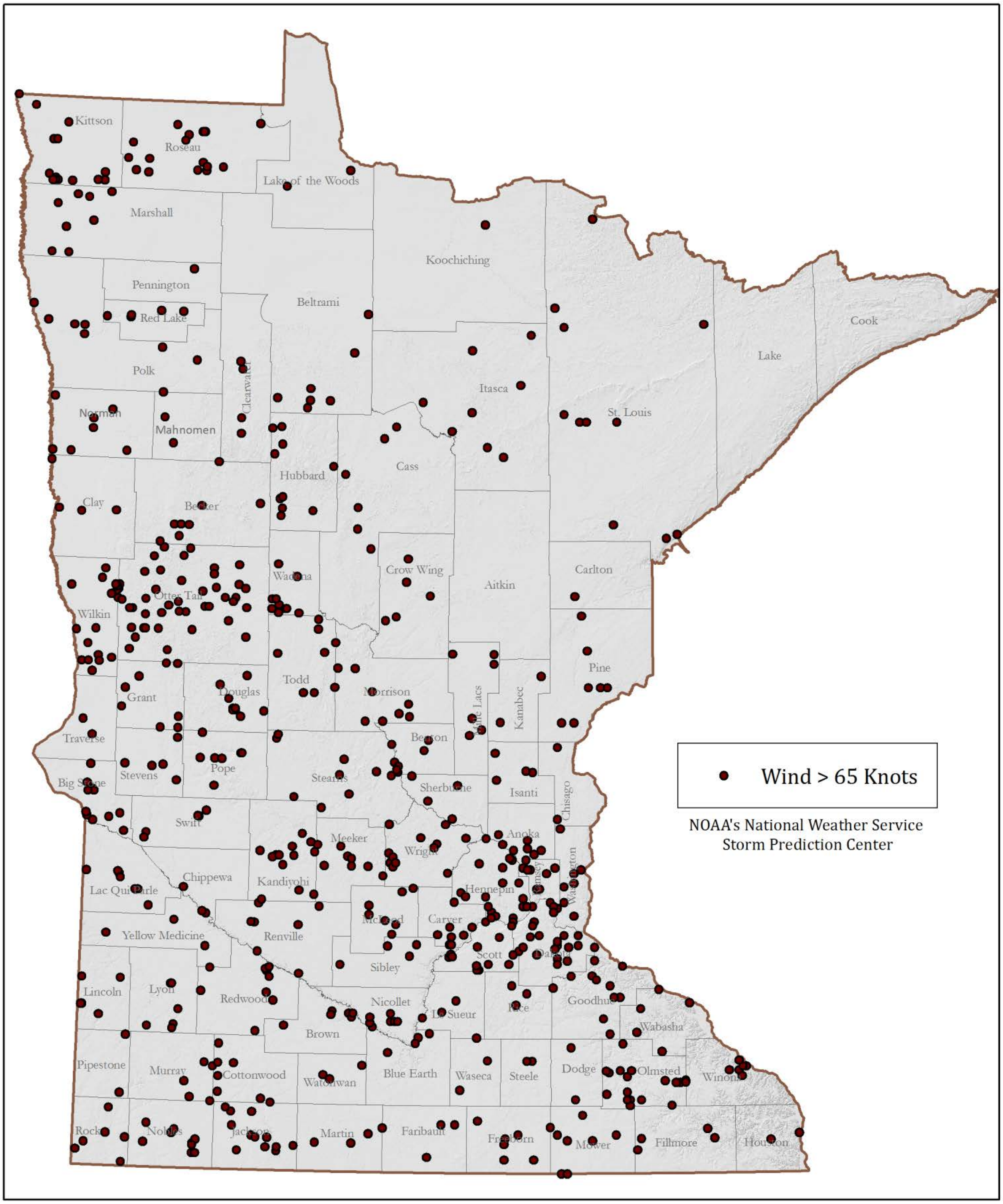


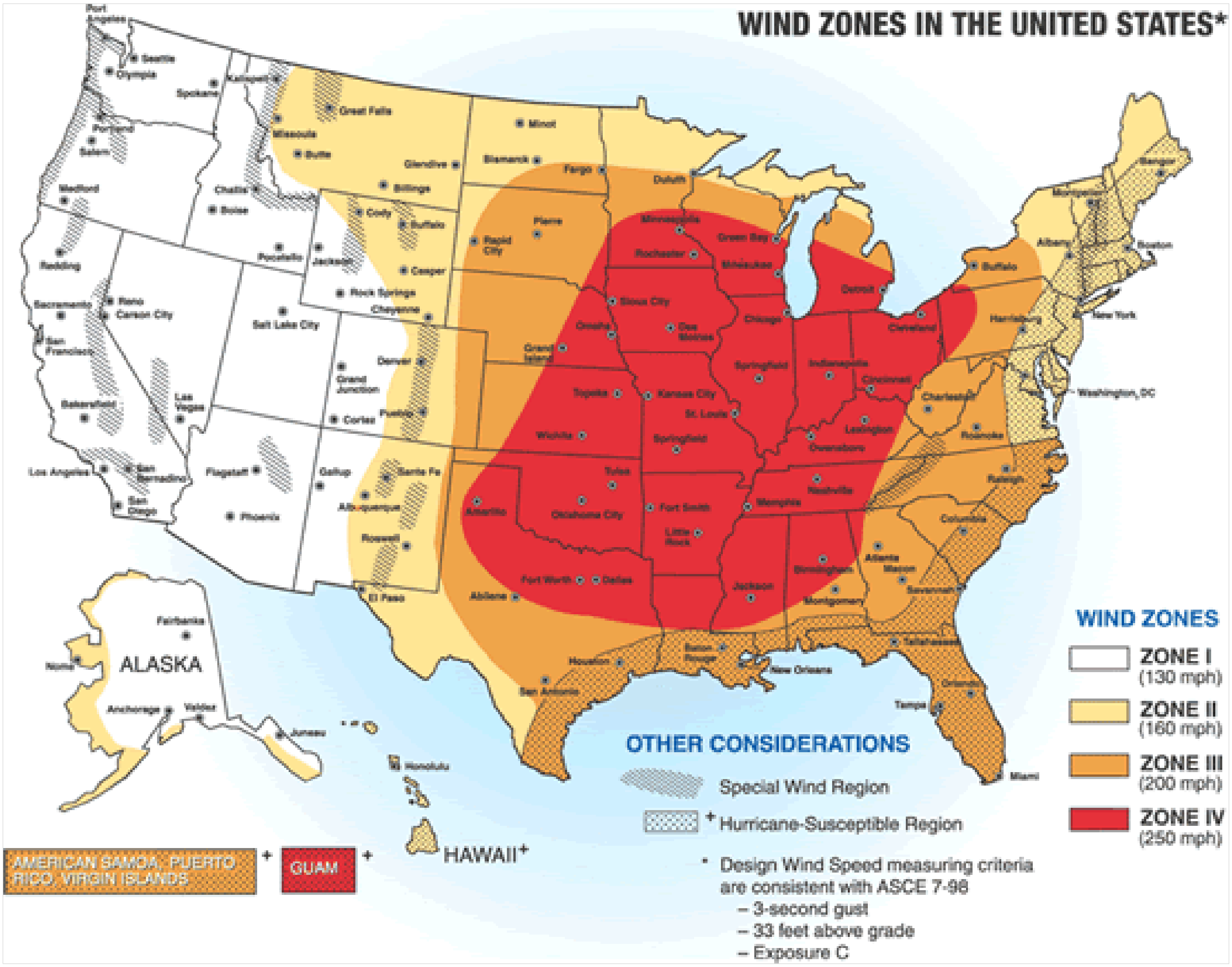
Table 22 Recent Notable Windstorms in Minnesota, April 2010 - September 2013

Month/Year	Location	Remarks
July 2013	Northwestern Minnesota	Peak winds estimated at 100-110 mph, $50 K in property damage
June 2013	Central Minnesota	74 knot wind gust recorded at Benson airport, total property damage of $3.5 million.
July 2012	Northern Minnesota	74 mph wind gusts in Grand Rapids, 1 fatality when boat capsized due to high wind and waves
July 2011	Central Minnesota	65-75 mph gusts in Mille Lacs County, large trees uprooted one approximately 3 feet in diameter.
July 2011	Central Minnesota	79 mph wind gusts in Douglas County, many trees uprooted.
July 2011	Central Minnesota	78 mph wind gusts reported in Redwood County, widespread severe wind damage throughout Central Minnesota.
August 2010	Central and Southern Minnesota	81 mph wind gust reported in Benton County, lots of flash flooding and wind damage.
August 2010	Central and Western Minnesota	70 mph wind gusts reported in Douglas County, large trees downed, heavy wind damage.
July 2010	Central Minnesota	71 mph wind gusts reported in Stearns County, accompanied by tornados and heavy wind damage.
July 2010	Central Minnesota and Twin Cities Metro Area	81 mph wind gusts reported in Morrison County, 76 mph gusts reported in Wright County, several large trees downed, widespread wind damage and flash flooding.
July 2010	Southeast Minnesota	62 mph wind gusts reported in Dakota County, several trees down, semi-trucks blown off road, widespread damage to property.
July 2010	Western Minnesota	60 mph wind gusts reported in Lac Qui Parle County, power outages due to downed poles.
June 2010	Southern Minnesota	72 mph wind gust reported in Scott County, widespread wind damage, many trees down, accompanied by flash floods and tornados.
June 2010	Southern and Central Minnesota, Twin Cities Metro Area	58 mph sustained winds and 71 mph wind gust reported in Brown County, 70 mph wind gusts reported in Nicollet County, Wind damage reported in Twin Cities Metro Area

Source: NOAA, NCDC

The United States is divided into four wind zones; the southern third of the state is in Zone IV, the middle third in Zone III and the northern third in Zone II.

Figure 31 Wind Zones in the United States

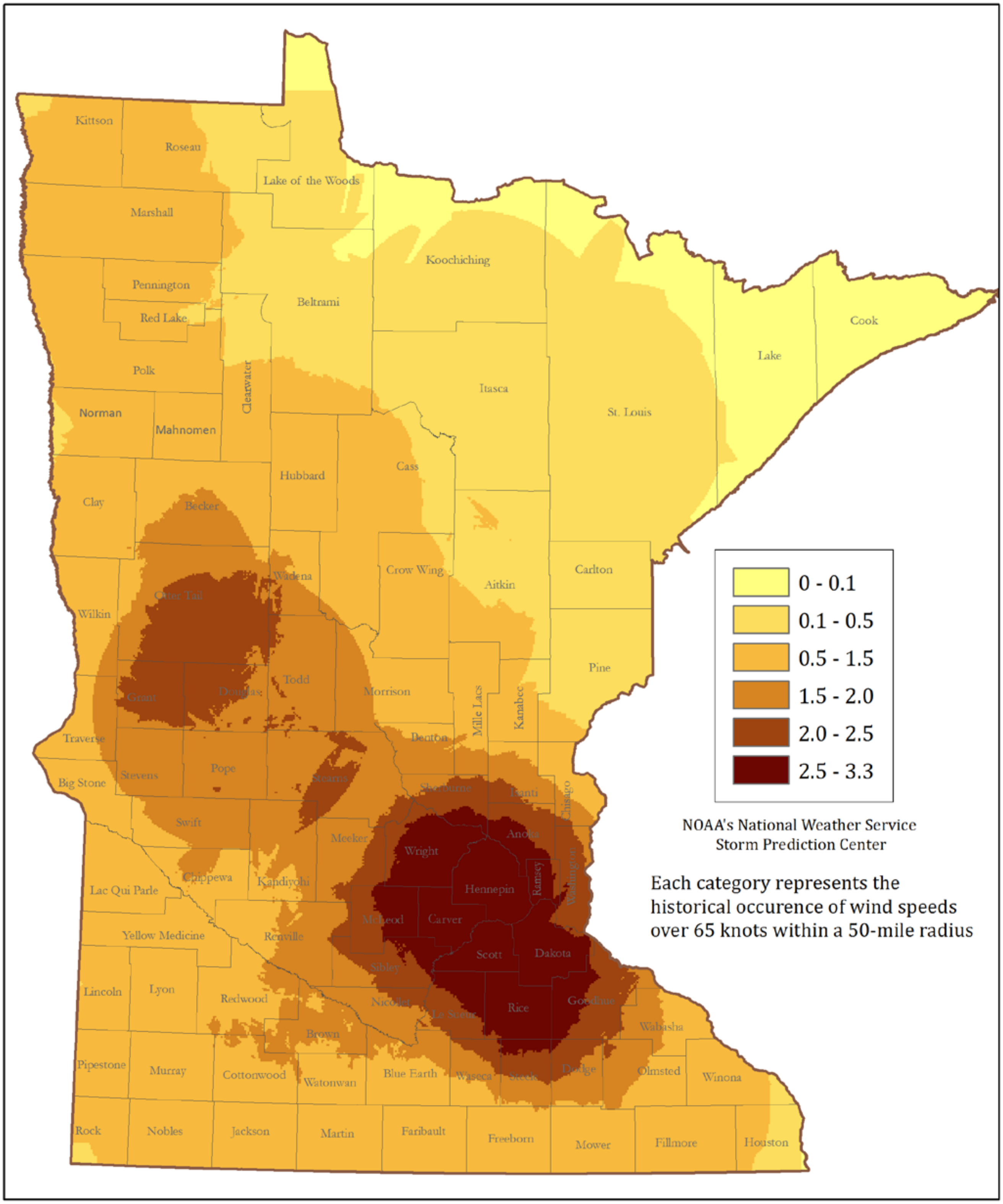


Source: FEMA

Probability of Occurrence

Windstorms can occur throughout the State of Minnesota, at any time of year. Most occur during the months of April through September. This recurrence is expected to remain relatively stable, although there will be year-to-year fluctuations. Long-term changes in weather patterns may also influence the number of windstorms that occur. Figure 32 shows the annual frequency of wind speeds greater than 65 knots. Each category represents the historical occurrence within a 50-mile radius.

Figure 32 Annual Frequency of Wind Speeds greater than 65 Knots, 1955-2012



The frequency data was summarized for each county, and these data were used to represent vulnerability of the county to windstorms. The ten counties with the greatest vulnerability to windstorms based on the historical data are shown below.

Table 23 Ten Minnesota Counties with the Greatest Frequency of Severe Windstorms

County	Frequency	Rank in the State
Scott	3.12	1
Carver	3.09	2
Hennepin	2.9	3
Rice	2.83	4
Wright	2.72	5
Dakota	2.72	5
McLeod	2.56	6
Ramsey	2.55	7
Le Sueur	2.45	8
Anoka	2.44	9
Goodhue	2.36	10

Probability and Vulnerability

The probability of a high wind event in Minnesota is at least annually. To determine a vulnerability ranking, the frequency data and building exposure was compared for each county.

High – In general, these counties have large building exposures and are located in portions of the state where high winds are most frequent.

Medium – This ranking reflects a moderate vulnerability based less than two wind events per year and compared to building exposure.

Low - This ranking reflects less vulnerability based on, in general, less than one wind event per year and compared to building exposure. Relatively low building exposure accounts for counties with more than one wind event.

Further supporting data may be found in appendices A and G.

Table 24 County High Wind Vulnerability Assessment

County	Events / Year Greater Than 65 Knots	Building Exposure	Ranking
Hennepin	2.9	$113,913,965,000	High
Ramsey	3.12	$46,438,181,000	High
Dakota	2.72	$30,381,418,000	High
Anoka	2.44	$24,167,867,000	High
Washington	2.23	$17,154,765,000	High

County	Events / Year Greater Than 65 Knots	Building Exposure	Ranking
Scott	3.12	$8,014,343,000	High
Wright	2.72	$7,981,311,000	High
Stearns	1.92	$10,625,977,000	High
Carver	3.09	$6,263,045,000	High
Olmsted	1.53	$10,224,072,000	High
Rice	2.83	$4,621,430,000	High
Sherburne	2.24	$5,254,784,000	High
Otter Tail	1.97	$4,846,688,000	High
Goodhue	2.36	$3,567,229,000	High
McLeod	2.56	$3,144,760,000	High
Blue Earth	1.41	$4,239,055,000	High
Le Sueur	3.09	$1,921,377,000	High
Steele	2.09	$2,822,446,000	High
Douglas	2.06	$2,861,924,000	High
Kandiyohi	1.68	$3,245,275,000	Medium
Isanti	1.76	$2,710,615,000	Medium
Nicollet	1.8	$2,596,985,000	Medium
Crow Wing	0.83	$5,457,342,000	Medium
Benton	1.59	$2,692,232,000	Medium
Chisago	1.38	$3,053,754,000	Medium
Winona	0.94	$3,848,179,000	Medium
Becker	1.4	$2,486,468,000	Medium
Meeker	1.92	$1,768,183,000	Medium
Brown	1.55	$2,176,076,000	Medium
St. Louis	0.19	$17,545,854,000	Medium
Morrison	1.41	$2,344,240,000	Medium
Mower	1.23	$2,522,554,000	Medium
Clay	1.02	$2,999,882,000	Medium
Todd	1.88	$1,555,337,000	Medium
Sibley	2.3	$1,216,782,000	Medium
Freeborn	1.07	$2,569,102,000	Medium
Waseca	1.71	$1,453,845,000	Medium
Dodge	1.91	$1,291,386,000	Medium
Wabasha	1.5	$1,606,448,000	Medium
Cass	0.77	$2,879,718,000	Medium

County	Events / Year Greater Than 65 Knots	Building Exposure	Ranking
Mille Lacs	1.2	$1,693,977,000	Medium
Renville	1.6	$1,265,786,000	Medium
Lyon	1.11	$1,790,121,000	Medium
Redwood	1.4	$1,193,751,000	Medium
Wadena	1.6	$1,013,164,000	Medium
Martin	1.04	$1,516,376,000	Medium
Pope	1.77	$833,801,000	Medium
Hubbard	0.92	$1,579,205,000	Medium
Fillmore	1.04	$1,353,034,000	Medium
Stevens	1.73	$789,003,000	Medium
Swift	1.66	$814,576,000	Medium
Itasca	0.35	$3,713,059,000	Medium
Polk	0.63	$2,062,480,000	Medium
Cottonwood	1.42	$868,473,000	Medium
Chippewa	1.41	$852,476,000	Medium
Watonwan	1.39	$815,118,000	Medium
Nobles	0.98	$1,138,189,000	Medium
Faribault	0.97	$1,109,127,000	Medium
Grant	2.11	$458,674,000	Medium
Beltrami	0.37	$2,549,782,000	Low
Kanabec	0.85	$1,061,942,000	Low
Aitkin	0.46	$1,650,061,000	Low
Pennington	0.71	$1,010,049,000	Low
Pine	0.38	$1,880,697,000	Low
Murray	1.22	$581,843,000	Low
Yellow Medicine	1.11	$631,804,000	Low
Jackson	1.05	$629,412,000	Low
Houston	0.5	$1,292,366,000	Low
Carlton	0.25	$2,367,614,000	Low
Roseau	0.55	$1,070,790,000	Low
Wilkin	1.32	$439,697,000	Low
Pipestone	0.81	$609,595,000	Low
Lac Qui Parle	1.05	$468,008,000	Low
Marshall	0.79	$583,449,000	Low
Big Stone	1.04	$370,709,000	Low

County	Events / Year Greater Than 65 Knots	Building Exposure	Ranking
Rock	0.68	$547,354,000	Low
Clearwater	0.62	$543,512,000	Low
Mahnomen	0.89	$358,753,000	Low
Norman	0.67	$456,405,000	Low
Lincoln	0.71	$379,477,000	Low
Kittson	0.63	$336,073,000	Low
Red Lake	0.6	$275,599,000	Low
Koochiching	0.14	$1,156,631,000	Low
Lake of the Woods	0.21	$381,700,000	Low
Lake	0.04	$1,173,659,000	Low
Cook	0.01	$735,155,000	Low
Traverse	1.39	$0	Low

Damages to crops from windstorms are another dataset that conclusions regarding jurisdictional vulnerability can be drawn from. The total indemnity claims due to windstorms for 2000-2013 time period was over $431 million with losses to the counties listed below. Data is from Business with Month of Loss, USDA Risk Management Agency. Indemnity data for all hazards may be found in Appendix I.

Table 25 Indemnity Claims for Wind on Crops 2000-2013

County	Wind/Excess Losses
Aitkin	$89,373
Anoka	$21,208
Becker	$61,354
Beltrami	$586,166
Benton	$648,343
Big Stone	$29,803,640
Blue Earth	$1,676,976
Brown	$5,492,125
Carlton	$0
Carver	$16,356
Cass	$2,322
Chippewa	$3,729,750
Chisago	$25,802

County	Wind/Excess Losses
Clay	$603,087
Clearwater	$170,762
Cottonwood	$1,132,584
Crow Wing	$434,520
Dakota	$263,526
Dodge	$840,493
Douglas	$10,882,296
Faribault	$2,339,166
Fillmore	$23,731,194
Freeborn	$455,863
Goodhue	$765,316
Grant	$40,484,163
Hennepin	$4,973
Houston	$3,944,280
Hubbard	$1,278,011
Isanti	$725,475
Jackson	$765,316
Kanabec	$5,306
Kandiyohi	$8,053,331
Kittson	$13,937,900
Lac Qui Parle	$34,601,445
Lake of the Woods	$123,085
Le Sueur	$4,586,162
Lincoln	$4,050,168
Lyon	$33,703,068
Mahnomen	$28,799
Marshall	$897,761
Martin	$3,809,554
McLeod	$1,906,492
Meeker	$875,576
Mille Lacs	$1,974,487
Morrison	$1,096,916
Mower	$7,406,288
Murray	$4,755,208
Nicollet	$4,764,388
Nobles	$1,962,678

County	Wind/Excess Losses
Norman	$329,469
Olmsted	$57,248
Otter Tail	$4,282,376
Pennington	$1,326,009
Pine	$0
Pipestone	$978,973
Polk	$837,936
Pope	$17,133,957
Red Lake	$183,766
Redwood	$39,249,887
Renville	$32,797,697
Rice	$571,415
Rock	$1,002,458
Roseau	$1,685,203
Scott	$208,941
Sherburne	$2,384,450
Sibley	$9,291,746
Stearns	$6,808,933
Steele	$208,034
Stevens	$4,145,146
Swift	$10,535,435
Todd	$40,445
Traverse	$13,875,353
Wabasha	$1,414,359
Wadena	$89,944
Waseca	$448,101
Washington	$22,516
Watonwan	$1,141,766
Wilkin	$2,445,231
Winona	$1,212,540
Wright	$807,228
Yellow Medicine	$17,092,753
Total	$431,357,051

Windstorms and Climate Change

According to the Federal Advisory Committee Draft National Climate Assessment (NCA), winter storms have increased slightly in frequency and intensity, and their tracks have shifted northward over the U.S. Lack of high-quality long-term data sets make assessment of changes in wind speeds very difficult (Kunkel, K.E. et al, 2013). One analysis generally found no evidence of significant changes in wind speed distribution. Other trends in severe storms, including the numbers of hurricanes and the intensity and frequency of tornadoes, hail, and damaging thunderstorm winds are uncertain (NCA, page 26). Since the impact of more frequent or intense storms can be larger than the impact of average temperature, "climate scientists are actively researching the connections between climate change and severe storms" (NCA, page 59).

4.5.5 Tornadoes

Tornadoes are defined as violently-rotating columns of air extending from thunderstorms to the ground, with wind speeds between 40-300 mph. They develop under three scenarios: (1) along a squall line; (2) in connection with thunderstorm squall lines during hot, humid weather; and (3) in the outer portion of a tropical cyclone. Funnel clouds are rotating columns of air not in contact with the ground; however, the column of air can reach the ground very quickly and become a tornado.

Since 2007, tornado strength in the United States is ranked based on the Enhanced Fujita scale (EF scale), replacing the Fujita scale introduced in 1971. The EF scale uses similar principles to the Fujita scale, with six categories from 0-5, based on wind estimates and damage caused by the tornado. The EF Scale is used extensively by the NWS in investigating tornadoes (all tornadoes are now assigned an EF Scale number), and by engineers in correlating damage to buildings and techniques with different wind speeds caused by tornadoes. The Fujita Scale, the derived EF Scale and the operational EF Scale are included. Though the Enhanced Fujita scale itself ranges up to EF28 for the damage indicators, the strongest tornadoes max out in the EF5 range (262 to 317 mph).

Table 26 Fujita Scale, Derived EF Scale, and Operational EF Scale

Fujita Scale			Derived EF Scale		Operational EF Scale	
F Scale	Fastest ¼-mile (mph)	3-second Gust (mph)	EF Scale	3-second Gust (mph)	EF Scale	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	>200

http://www.spc.noaa.gov/faq/tornado/ef-scale.html

Tornado History in Minnesota

Minnesota lies along the north edge of the region of maximum tornado occurrence in the United States. Tornado Alley, as that part of the central United States has come to be known, reaches across parts of Texas, Oklahoma, Kansas, Missouri, East Nebraska, and West Iowa. In Minnesota, tornadoes have occurred in every month from March through November. The earliest verified tornado in Minnesota occurred on March 18, 1968, north of Truman, and the latest in any year on November 16, 1931, east of Maple Plain.

Despite a higher number of tornadoes reported in recent years, the number of fatalities and injuries due to tornadoes has been decreasing. This is thanks in part to better National Weather Service tools in detecting tornadoes, namely the NEXRAD Doppler radar network installed in the mid-1990s. Also, the ability of alerting the public has improved with more National Weather Service radio transmitters and a close relationship with media outlets. An energetic spotter network has also been a key to alerting the public in Minnesota. The increasing number of tornadoes reported may be a direct result of improved communication networks, public awareness, warning systems and training.

Table 27 Recent Tornado Events in Minnesota, EF2 or greater, January 2010 – September 2013

County	Date	Magnitude	Deaths	Injuries	Property Damage	Length in miles	Width in yards
Clearwater	22-Jul-13	EF2	0	0	750 K	N/A	N/A
Mahnomen	22-Jul-13	EF2	0	0	1 M	N/A	N/A
Lincoln	01-Jul-11	EF2	0	0	100 K	1	440
Houston	22-May-11	EF2	0	0	240 K	10	150
Houston	22-May-11	EF2	0	0	240 K	10	150
Fillmore	22-May-11	EF2	0	0	250 K	15	225
Fillmore	22-May-11	EF2	0	0	250 K	15	225
Wilkin	07-Aug-10	EF4	0	0	0 K	3	600
Brown	25-Jun-10	EF2	0	0	0 K	0	50
Blue Earth	25-Jun-10	EF2	0	0	0 K	1	50
Nicollet	25-Jun-10	EF2	0	0	0 K	4	75
Blue Earth	25-Jun-10	EF2	0	0	0 K	2	40
Freeborn	17-Jun-10	EF3	0	0	0 K	11	1320
Polk	17-Jun-10	EF3	1	2	0 K	9	150
Wadena	17-Jun-10	EF4	0	20	0 K	8	1936
Steele	17-Jun-10	EF3	0	0	0 K	4	440
Pine	17-Jun-10	EF2	0	2	283 K	7	400
Freeborn	17-Jun-10	EF4	1	14	0 K	17	1760
Otter Tail	17-Jun-10	EF4	0	0	0 K	2	1936
Red Lake	17-Jun-10	EF3	0	0	0 K	6	150
Steele	17-Jun-10	EF2	0	0	0 K	7	880
Freeborn	17-Jun-10	EF3	0	0	0 K	5	600
Faribault	17-Jun-10	EF2	0	0	0 K	3	50
Faribault	17-Jun-10	EF2	0	0	0 K	1	50
Steele	17-Jun-10	EF2	0	1	0 K	2	100

County	Date	Magnitude	Deaths	Injuries	Property Damage	Length in miles	Width in yards
Otter Tail	17-Jun-10	EF4	1	5	0 K	38	2288

Source: NCDC

Probability of Occurrence

According to the NCDC, Minnesota experienced an average of 27 tornadoes per year between 1950 and 2012. These hazardous events caused 99 deaths, 1,976 injuries and nearly $1.5 billion dollars in property damage. This equates to a yearly average of 1.6 deaths, 32 injuries, and nearly $23 million in property damage per annum. From the 62-year state total of 1,655 tornadoes, 27 were ranked at F4 or F5. Tornado touchdown points and tracks for the state of Minnesota from 1950-2012, are included, as is the historical frequency of tornadoes based on a 50-mile radius.

Although tornadoes can occur at any time of year, in Minnesota the peak months of occurrence are June, May, and July (in that order). The typical time of day for tornadoes in Minnesota ranges between 4:00 P.M. and 7:00 P.M. Most of these are minor tornadoes, with wind speeds under 125 M.P.H. A typical Minnesota tornado lasts approximately ten minutes, has a path length of five to six miles, is nearly as wide as a football field, has a forward speed of about thirty-five miles an hour, and affects less than one-tenth of 1 percent of the county warned.

Most of the deadly and damaging tornadoes occur in groups of outbreaks that often last from 6 to 12 hours. One of the worst outbreaks in Minnesota occurred on June 28, 1979, when 16 tornadoes slashed across the state, from northwest to southeast, in a 6½-hour period. Two additional tornadoes occurred in eastern North Dakota with this system. Many such outbreaks have occurred, including the April 30, 1967 cluster in south central and southeast Minnesota.

2010 was a historic year for tornadoes in Minnesota, with 126 recorded by the NCDC. There were three deaths and 46 injuries (all were on June 17 except one injury on August 13). This year beat previous records of 74 tornadoes in 2001 and 27 in one day on June 16, 1992 (June 17, 2010 had 60 on one day). 2011 witnessed 44 tornadoes in the state, while 2012 saw 38.

The storm frequency maps were created using a GIS density estimation technique. This is sometimes known as a "hotspot" analysis. The GIS tool "smooth's" the data from discrete points to capture important patterns while leaving out noise or other fine-scale phenomena. While storms are recorded as discrete events at a particular point in space, their frequency in a region does not actually abruptly change at a county line. The frequency maps were created by using a circular "kernel" of data, continuously across a dataset, to calculate the "density" of storms in every "kernel". The result is a continuous surface of data, illustrating the high and low frequency of storms over a period of time.

The frequency data was summarized for each county, and these data were used to represent vulnerability of the county to tornados. Tornadoes in the state ranked EF2 or greater, 2010-2013 are include here. A listing of all tornado events recorded by the NCDC can be found in Appendix A.

Figure 33 Tornado Tracks and Touchdowns, 1950-2012

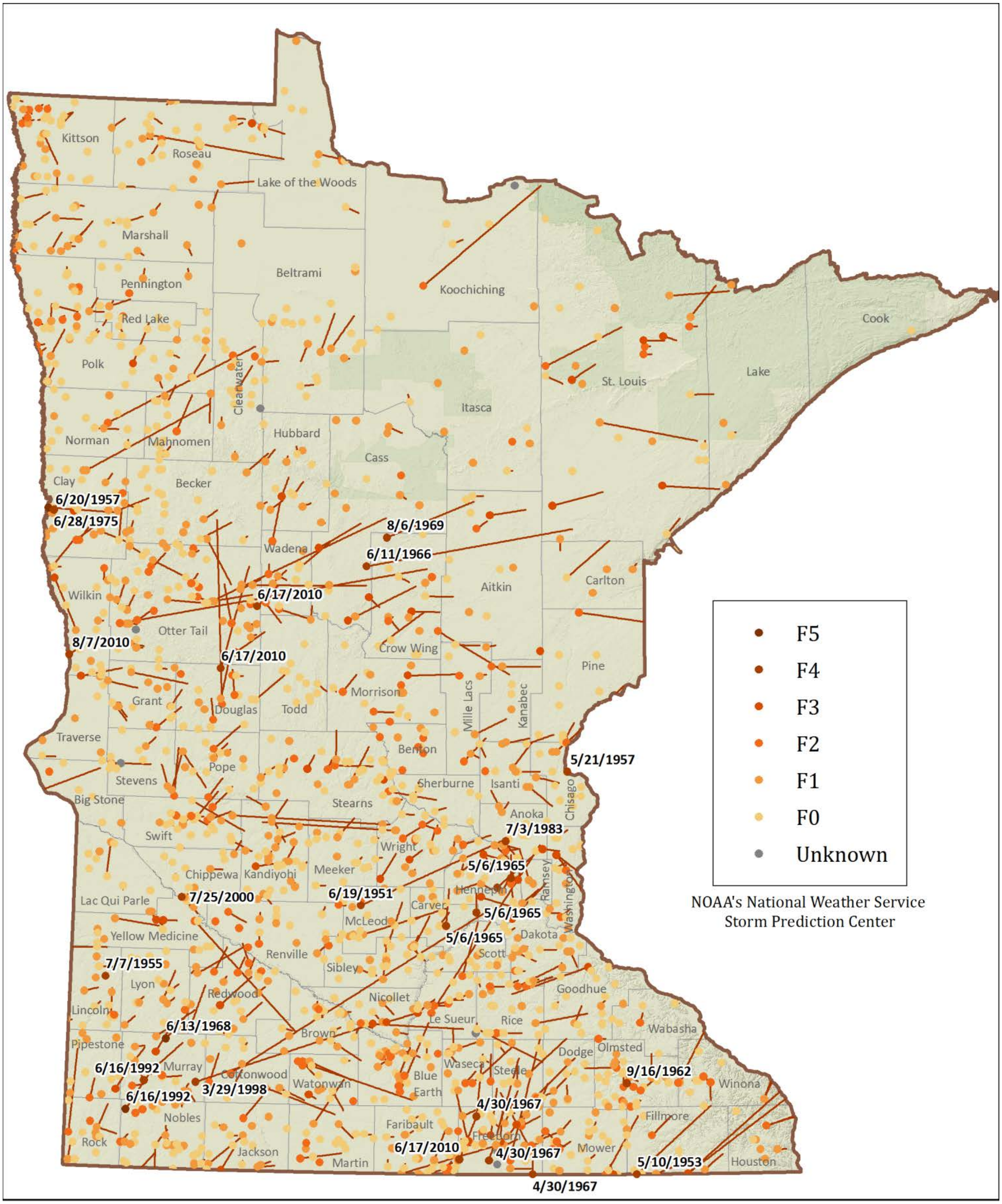


Figure 34 Historical Tornado Frequency per Year, 1950-2012

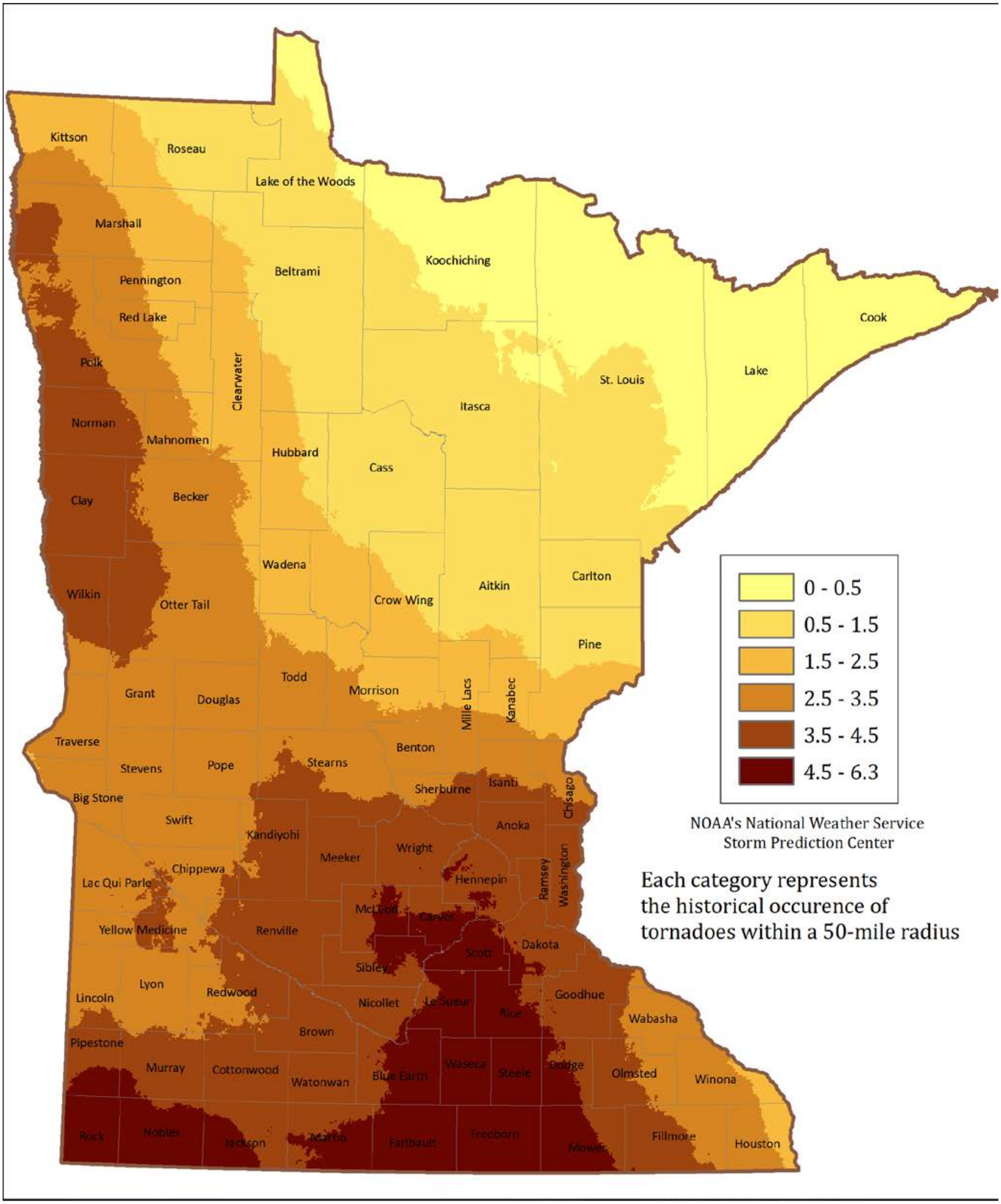


Table 28 Mean Tornado Frequency by County, 1950-2012

Rank	County	Frequency (Events per Year)
1	Rock	5.41
2	Freeborn	5.32
3	Steele	5.10
4	Waseca	5.06
5	Nobles	4.99
6	Faribault	4.92
7	Rice	4.76
8	Mower	4.75
9	Le Sueur	4.71
10	Blue Earth	4.68
11	Scott	4.66
12	Dodge	4.53
13	Carver	4.52
14	Martin	4.51
15	Jackson	4.50
16	McLeod	4.41
17	Hennepin	4.40
18	Sibley	4.38
19	Dakota	4.33
20	Pipestone	4.30
21	Ramsey	4.29
22	Nicollet	4.19
23	Wright	4.13
24	Washington	4.11
25	Goodhue	4.05
26	Anoka	4.03
27	Watonwan	4.03
28	Murray	4.01
29	Meeker	3.96
30	Clay	3.95
31	Cottonwood	3.88
32	Norman	3.87
33	Renville	3.82
34	Brown	3.80
35	Wilkin	3.79

Rank	County	Frequency (Events per Year)
36	Kandiyohi	3.74
37	Olmsted	3.63
38	Fillmore	3.62
39	Sherburne	3.55
40	Redwood	3.51
41	Stearns	3.41
42	Isanti	3.41
43	Chippewa	3.41
44	Yellow Medicine	3.38
45	Chisago	3.32
46	Lincoln	3.32
47	Lyon	3.30
48	Grant	3.28
49	Swift	3.27
50	Lac Qui Parle	3.24
51	Otter Tail	3.22
52	Pope	3.21
53	Polk	3.16
54	Wabasha	3.14
55	Stevens	3.13
56	Douglas	3.12
57	Traverse	3.03
58	Big Stone	2.95
59	Becker	2.94
60	Benton	2.91
61	Mahnomen	2.74
62	Winona	2.73
63	Todd	2.69
64	Marshall	2.67
65	Houston	2.64
66	Red Lake	2.63
67	Morrison	2.43
68	Pennington	2.42
69	Mille Lacs	2.40
70	Kittson	2.27
71	Kanabec	2.15

Rank	County	Frequency (Events per Year)
72	Wadena	2.10
73	Clearwater	1.96
74	Hubbard	1.73
75	Crow Wing	1.54
76	Pine	1.51
77	Cass	1.31
78	Roseau	1.22
79	Beltrami	1.20
80	Aitkin	1.04
81	Carlton	0.71
82	Itasca	0.66
83	Lake of the Woods	0.63
84	St. Louis	0.47
85	Koochiching	0.42
86	Lake	0.26
87	Cook	0.06

Vulnerability

Vulnerability to injury from tornadoes decreases with adequate warnings, warning time, and sheltering in a reinforced structure. Damages to structures are equally susceptible by a tornado in any given jurisdiction but vulnerability depends upon construction of the building and force of the tornado. Structures and power lines in the vicinity of mature trees are also vulnerable since limbs and fallen trees may cause damage. High winds may also down power lines and cause extensive outages.

Total building exposure from HAZUS and other sources gives an idea of the value of the structures that are at risk in a given county to a tornado. Tornadoes are not county wide events. History shows that high damages are incurred when a tornado strikes a densely populated area. In addition, government services may be interrupted since the structures and infrastructure for those services are impacted by the tornado.

Modeling the impact of tornadoes in terms of injuries, deaths and property damage is continued from the previous plan update. The model was extended to cover the years from 1950 thru 2013. The purpose of extending period of the model was to include devastating tornadoes not covered in a ten year period. The impetus was that several EF-4 tornadoes were recorded in 2010 only one of which caused major damage within a city. On June 17, 2010, Wadena was hit by an EF-4 tornado damaging at least 230 homes, demolishing a community center, and severely damaging the high school. This event showed that damage has to do with path of the tornado and the density of the building stock. An example of a devastating tornado that had greater impact was the St. Peter EF-3 tornado in 1998. This tornado also damaged both county and city government infrastructure which impacted both response and recovery. The intent of Table 28 Tornado Injuries, Deaths, and Damages 1950–2013 is intended to expand the scope of history to compare damages to counties longer term vulnerability. The top ten counties are listed based on total damages.

Table 29 Tornado Injuries, Deaths, and Damages 1950 – 2013

County	Total Events	# of Deaths x $5,800,000	# Injury x $90,000	Property Damage	Total Damages	Total Building Exposure
Hennepin	28	$81,200,000	$27,630,000	$382,800,000	$491,630,000	$113,913,965,000
Ramsey	6	$5,800,000	$15,120,000	$225,300,000	$246,220,000	$46,438,181,000
Freeborn	48	$81,200,000	$8,280,000	$150,800,000	$240,280,000	$2,569,111,000
Nicollet	18	$5,800,000	$900,000	$126,500,000	$133,200,000	$2,596,985,000
Waseca	19	$34,800,000	$2,160,000	$78,900,000	$115,860,000	$1,453,845,000
Carver	16	$17,400,000	$16,830,000	$80,100,000	$114,330,000	$6,263,045,000
Murray	22	$5,800,000	$3,690,000	$55,800,000	$65,290,000	$581,843,000
Sibley	27	$5,800,000	$5,130,000	$51,400,000	$62,330,000	$1,216,782,000
Steele	22	$0	$90,000	$53,300,000	$53,390,000	$2,822,446,000
Brown	23	$5,800,000	$2,070,000	$49,300,000	$57,170,000	$2,176,076,000

FEMA Standard for casualties and treat and release injuries were used. The NCDC data does not specify the extent of the injury so the median value for treat and release was used. Overall, reported deaths and injuries are reduced in numbers in the past ten years. This is attributed to increased public awareness due to warnings via multi-media and warning sirens coupled with public education. Property loss was not adjusted to 2013 dollars. The top six counties that experienced significant tornado damages are seen below.

Table 30 Comparison of Damage Due to Tornadoes

County	Date	Magnitude (E/EF)	Property Damage (Year of Report)	Property Damage (2013 Adjusted)	Total Building Exposure	% of Total Building Exposure
Hennepin	22-May-11	1	$166 M	$173 M	$113,913,965,000	0.15
Ramsey	15-May-98	1	$150 M	$213 M	$46,438,181,000	0.45
Nicollet	29-Mar-98	3	$120 M	$171 M	$2,596,985,000	6.59
Freeborn	30-Apr-67	3	$100 M	$698 M	$2,569,111,000	27.17
Waseca	30-Apr-67	4	$75 M	$523 M	$115,860,000	35.99
Carver	6-May-65	4	$75 M	$522 M	$114,330,000	8.33

The next step was to characterize these events with more detail per information found at The Minnesota Climatology Working Group's webpage Minnesota Tornado History and Statistics. One tornado event that did not list tornado damage was for the City of Wadena in Otter Tail County on June 17, 2010. The city's community center was destroyed, the high school was severely damaged and hundreds of structures had varying digress of damage due to this EF-4 event. The following is a summary of the other events:

- The Hennepin County EF-1 tornado touched down in the northwest part of Minneapolis and moved toward St. Michael. Most of the damaged occurred in an established city residential section with a high density of population.
- The Ramsey County EF-1 tornado touched down in Roseville and traveled straight north lifting off in the City of Blaine, Anoka County. Seven houses destroyed with 102 severely damaged. Damage estimate for the entire county including widespread wind driven hail.
- The Nicollet County EF-3 event damaged or destroyed residential, commercial, religious, K-12 education and college facilities in the City of St. Peter. City and county facilities were also significantly damaged which impacted response and recovery.
- The Freeborn County event was the result of a front where at least four tornadoes were tracked in the county with EF-3 the largest. The City of Albert Lea and several other communities were damaged.
- The paths of three tornadoes were tracked in Carver County one of which was an EF-4. Chanhassen and other communities in the county received damage from these tornadoes. Overall, thirteen people were killed and 683 people were injured due to five tornadoes in the Minneapolis metropolitan area. One of the tornadoes was an EF-2 that traveled through Fridley in Anoka County. “Many credit the announcers of WCCO-AM with saving countless lives. It was also the first time in Twin Cities' history that civil defense sirens were used for severe weather.”

Vulnerability of humans and structures are two different discussions based on the above observations. The year 1965 was used noted as an important milestone since it marked the start of public warning in the Twin Cities. A review of the NCDC records was done to determine the impact of warning in Minnesota. This review is not a study since simple parameters. Between 1950 and 1980, there were 531 tornado events resulting in 80 deaths and 1,498 injuries. There have been 1,257 tornado events reported from 1981 to 2013 with 19 deaths and 528 injuries. There seems to be correlation that warning saves lives and reduces injuries but there may be other influencing factors such as the intensity of the tornado reports and the increase of EF-0 tornadoes that were previously classified as high wind events. Warning via mass-media, NOAA weather radio, warning sirens coupled with public education are on-going activities that are needed to ensure the safety of the public.

The vulnerability to structures depends upon the strength and path of the tornado. The NCDC records show no damages for 1,034 events out of a total 1,790 records. The remaining records escalate damages from the low thousands of dollars up to just over $100 million. The insight gained from this assessment is that densely developed jurisdictions will experience higher levels of damage than rural communities. The table below indicates each county’s vulnerability by showing historical frequency compared to building exposure.

Table 31 Frequency and Building Exposure to Tornadoes

County	F/EF 0	F/EF 1	F/EF 2	F/EF 3	F/EF 4	F/EF 5	Total Events	Total Building Exposure
Aitkin	7	2	3	2	1	0	15	$1,650,061,000
Anoka	10	7	3	1	3	0	24	$24,167,867,000
Becker	19	10	2	0	0	0	31	$2,486,468,000
Beltrami	19	8	0	0	0	0	27	$2,549,782,000
Benton	1	1	2	0	0	0	4	$2,692,232,000
Big Stone	3	1	1	1	0	0	6	$370,709,000
Blue Earth	14	12	9	0	1	0	36	$4,239,055,000
Brown	13	6	3	0	1	0	23	$2,176,076,000
Carlton	3	2	1	0	0	0	6	$2,367,614,000
Carver	10	3	1	0	2	0	16	$6,263,045,000
Cass	5	9	2	3	1	0	20	$2,879,718,000
Chippewa	8	5	0	0	0	0	13	$852,476,000
Chisago	12	2	1	0	0	0	15	$3,053,754,000
Clay	13	15	2	1	1	1	33	$2,999,882,000
Clearwater	9	7	4	0	0	0	20	$543,512,000
Cook	2	0	0	0	0	0	2	$735,155,000
Cottonwood	8	4	3	1	0	0	16	$868,473,000
Crow Wing	9	3	4	3	3	1	23	$5,457,342,000
Dakota	14	11	3	0	0	0	28	$30,381,418,000
Dodge	10	7	0	0	0	0	17	$1,291,386,000
Douglas	9	1	5	0	0	0	15	$2,861,924,000
Faribault	22	10	3	0	0	0	35	$1,109,127,000
Fillmore	5	2	3	1	1	0	12	$1,353,034,000
Freeborn	18	15	5	6	4	0	48	$2,569,111,000
Goodhue	14	3	1	1	0	0	19	$3,567,229,000
Grant	8	8	1	1	0	0	18	$458,674,000
Hennepin	9	8	5	4	2	0	28	$113,913,965,000
Houston	1	5	2	1	0	0	9	$1,292,366,000
Hubbard	8	9	1	1	0	0	19	$1,579,205,000
Isanti	5	7	1	0	0	0	13	$2,710,615,000
Itasca	3	4	1	0	0	0	8	$3,713,059,000
Jackson	10	9	1	1	0	0	21	$629,412,000
Kanabec	3	5	2	2	0	0	12	$1,061,942,000
Kandiyohi	18	23	0	1	0	0	42	$3,245,275,000

County	F/EF 0	F/EF 1	F/EF 2	F/EF 3	F/EF 4	F/EF 5	Total Events	Total Building Exposure
Kittson	17	8	5	1	0	0	31	$336,073,000
Koochiching	10	1	1	0	0	0	12	$1,156,631,000
Lac Qui Parle	7	4	0	0	0	0	11	$468,008,000
Lake	1	4	0	0	0	0	5	$1,173,659,000
Lake of the Woods	6	4	1	0	0	0	11	$381,700,000
Le Sueur	12	2	5	2	0	0	21	$1,921,377,000
Lincoln	8	7	2	0	0	0	17	$379,477,000
Lyon	13	8	1	1	1	1	25	$1,790,121,000
Mahnomen	12	1	3	0	0	0	16	$358,753,000
Marshall	15	15	1	0	0	0	31	$583,449,000
Martin	11	4	3	0	0	0	18	$1,516,376,000
McLeod	7	6	1	0	1	0	15	$3,144,760,000
Meeker	15	3	1	0	0	0	19	$1,768,183,000
Mille Lacs	6	5	3	1	0	0	15	$1,693,977,000
Morrison	9	7	4	1	0	0	21	$2,344,240,000
Mower	14	7	4	1	0	0	26	$2,522,554,000
Murray	3	11	3	2	1	2	22	$581,843,000
Nicollet	8	5	2	2	1	0	18	$2,596,985,000
Nobles	19	10	6	0	0	1	36	$1,138,189,000
Norman	10	3	1	0	0	0	14	$456,405,000
Olmsted	14	8	6	0	2	0	30	$10,224,072,000
Otter Tail	26	25	12	1	2	0	66	$4,846,688,000
Pennington	2	3	2	0	0	0	7	$1,010,049,000
Pine	8	1	2	0	0	0	11	$1,880,697,000
Pipestone	5	3	2	0	0	0	10	$609,595,000
Polk	35	15	8	1	0	0	59	$2,062,480,000
Pope	9	5	3	1	0	0	18	$833,801,000
Ramsey	1	2	0	2	1	0	6	$46,438,181,000
Red Lake	11	3	2	1	0	0	17	$275,599,000
Redwood	7	12	6	2	0	1	28	$1,193,751,000
Renville	12	6	7	0	0	0	25	$1,265,786,000
Rice	10	3	3	1	0	0	17	$4,621,430,000
Rock	1	5	2	0	0	0	8	$547,354,000
Roseau	18	12	2	1	0	0	33	$1,070,790,000

County	F/EF 0	F/EF 1	F/EF 2	F/EF 3	F/EF 4	F/EF 5	Total Events	Total Building Exposure
Scott	11	3	1	0	0	0	15	$8,014,343,000
Sherburne	11	0	1	0	0	0	12	$5,254,784,000
Sibley	16	8	2	1	0	0	27	$1,216,782,000
St. Louis	14	10	4	6	0	0	34	$17,545,854,000
Stearns	25	13	4	1	0	0	43	$10,625,977,000
Steele	8	7	3	3	1	0	22	$2,822,446,000
Stevens	8	3	1	0	0	0	12	$789,003,000
Swift	18	7	6	0	0	0	31	$814,576,000
Todd	13	1	1	1	0	0	16	$1,555,337,000
Traverse	5	4	0	2	0	0	11	$0
Wabasha	4	0	2	0	0	0	6	$1,606,448,000
Wadena	6	4	5	0	1	0	16	$1,013,164,000
Waseca	7	6	4	1	1	0	19	$1,453,845,000
Washington	12	4	3	2	0	0	21	$17,154,765,000
Watonwan	6	5	4	1	1	0	17	$815,118,000
Wilkin	14	8	2	2	4	0	30	$439,697,000
Winona	5	2	3	1	1	0	12	$3,848,179,000
Wright	8	11	4	2	0	0	25	$7,981,311,000
Yellow Medicine	10	6	1	2	1	0	20	$631,804,000

Damages to crops from tornadoes are another dataset that conclusions regarding jurisdictional vulnerability can be drawn from. The total indemnity claims due to tornadoes for 2000-2013 time period was over $3.5 million with losses to the counties listed below. Data is from Business with Month of Loss, USDA Risk Management Agency. This data indicates crops in the southern portion of the state are vulnerable. Indemnity data for all hazards may be found in Appendix I.

Table 32 Indemnity Claims for Flood on Crops 2000-2013

County	**Tornado Claims**
Pipestone	$2,546,475
Renville	$472,875
Le Sueur	$223,871
Meeker	$28,578
Sibley	$17,083
Lincoln	$14,775

County	Tornado Claims
Wilkin	$10,863
Nicollet	$13,469
Redwood	$10,075
Roseau	$7,160
Kandiyohi	$2,382
Faribault	$1,633
Jackson	$1,240
Freeborn	$842
Total	**$3,351,271**

Tornadoes and Climate Change

Tornadoes and other severe thunderstorm phenomena frequently cause as much annual property damage in the U.S. as do hurricanes, and often cause more deaths. Although recent research has yielded insights into the connections between global warming and the factors that cause tornados and severe thunderstorms, such as atmospheric instability and increases in wind speed with altitude (Del Genio et al. 2007), these relationships remain mostly unexplored, largely because of the challenges in observing thunderstorms and tornadoes and simulating them with computer models (NCA, page 60).

4.5.6 Hail

A hailstorm is an outgrowth of severe thunderstorms and develops within an unstable air mass. Warm moist air rises rapidly into the upper atmosphere and subsequently cools, leading to the formation of ice crystals. These are bounced about by high velocity updraft (or strong) winds and accumulate into frozen droplets, falling as precipitation after developing enough weight (FEMA, 1997).

Hailstorms cause millions in property, livestock, and crop damage each year. Severe hailstorms cause considerable damage to buildings, automobiles, and airplanes. Significant property damage does not occur until hailstone size reaches about 1.5 inches in diameter. This size will cause damage to cars, windows, and siding. When hailstones get larger and approach three inches in diameter, roofs start to experience major damage. Combined property and crop damage annual totals for recent years in Minnesota were $2.4 million (2012), $817,000 (2011), and $11.5 million (2010) (NCDC).

The National Weather Service (NWS) defines severe thunderstorms as those with downdraft winds in excess of 58 miles an hour and/or hail 1 inch in diameter or greater. While only about 10% of thunderstorms are classified as severe, all thunderstorms are dangerous because they produce numerous dangerous conditions, including one or more of the following: hail, strong winds, lightning, tornadoes, and flash flooding. The land area affected by individual hail events, an average of 15 miles in diameter around the center of the storm, is similar to the area affected by the parent thunderstorm. Hail risk at a point or over an area is a function of the target at risk (property or crop) and the hail frequency, intensity and size.

The size of hailstones varies and is a direct consequence of the severity of the thunderstorm. Hail quarter size (1 inch in diameter) or larger is considered severe.

Hailstorms occur most frequently during the late spring and early summer, when the jet stream moves northward across the Great Plains. During this period, extreme temperature changes occur from the surface up to the jet stream, resulting in the strong updrafts required for hail formation.

Table 33 Estimating Hail Size (NWS)

Size	Inches in Diameter
Pea	1/4 inch
Marble/mothball	1/2 inch
Dime/Penny	3/4 inch
Nickel	7/8 inch
Quarter	1 inch
Ping-Pong Ball	1 1/2 inches
Golf Ball	1 3/4 inches
Tennis Ball	2 1/2 inches
Baseball	2 3/4 inches
Tea cup	3 inches
Grapefruit	4 inches
Softball	4 1/2 inches

Hail History in Minnesota

The National Climatic Data Center (NCDC) maintains a list of weather-related disasters in the United States over the past 21 years, in which overall damages and costs reached or exceeded $1 billion, including direct and indirect damages, costs, and deaths. One of these billion-dollar disasters is the Minnesota Severe Storms/Hail in May 1998, in which damaging severe thunderstorms with large hail fell over wide areas of Minnesota, resulting in over $1.5 billion damage/costs and 1 death. The NWS reports hail events based on specific geographic areas or distances. Therefore, a single thunderstorm that produces hail over a broad area may be listed as multiple, separate hail events. The table below summarizes a number of notable hail events occurring from 2010 to September 2013.

Table 34 Notable Hail Events in Minnesota, 2010 - September 2013

Date	Location	Remarks
August 6, 2013	Central and Southeastern Minnesota	Hail damage resulted in over $800 million in private insurance claims.
July 22, 2013	Fillmore County	Hail up to 2.75 inches
June 18, 2013	Southwestern Minnesota	Hail up to 2.5 inches, crop damage near Springfield
June 12, 2013	South Central Minnesota	Hail up to 2.75 inches, $275k in damage
May 17, 2013	Southwestern Minnesota	Hail up to 2 inches, damaged vehicles, siding, roofs, and windows
September 4, 2012	Southeastern Minnesota	Hail up to 2.5 inches, $745k in damage
July 18, 2012	Dodge County	Hail up to 3 inches, causing $70k in damage

Date	Location	Remarks
June 19, 2012	Lyon County	Hail up to 2.75 inches, damaging roofs, vehicles, and crops
June 18, 2012	Rice County	Hail up to 2.5 inches in diameter, 78 mph winds at the Appleton Airport
May 28, 2012	Stearns County	Hail up to 2.5 inches in diameter
May 5, 2012	Big Stone County	Hail up to 2 inches in diameter
May 2, 2012	Southern Minnesota	Hail up to 2.5 inches diameter in Nicollet County, $452k in damage
May 1, 2012	Central Minnesota	Hail up to 2 inches diameter, accumulated up to 7 inches deep in some areas in the city of Freeport, $785k in damage
July 1, 2011	Central Minnesota	Hail up to 4.25 inches in Meeker County
May 10 , 2011	Central Minnesota and Twin Cities Metro Area	Hail up to 2.75 inches in Wright County, large hail fell throughout Hennepin County including near Target Field
September 21, 2010	Twin Cities Metro Area	Hail up to 1.5 inches in city limits; street signs, power poles and trees down
July 17, 2010	Central Minnesota and Twin Cities Metro Area	Hail up to 4.25 inches in Stearns County
June 25, 2010	Southern and Central Minnesota, Twin Cites Metro Area	Hail up to 4.25 inches in Nicollet and Waseca County

Source: NCDC and Insurance Federation of Minnesota

Note: the $800 million dollars in private claims is the only citation from the Insurance Federation of Minnesota

The following figures depict the number and frequency of hail events by county, from 1955 to 2012. The storm frequency maps were created using a GIS density estimation technique. This is sometimes known as a "hotspot" analysis. The GIS tool "smooth’s" the data from discrete points to capture important patterns while leaving out noise or other fine-scale phenomena. While storms are recorded as discrete events at a particular point in space, their frequency in a region does not actually abruptly change at a county line. The frequency maps were created by using a circular "kernel" of data, continuously across a dataset, to calculate the "density" of storms in every "kernel". The result is a continuous surface of data, illustrating the high and low frequency of storms over a period of time.

Figure 35 Severe Hail Events by County, 1955-2012

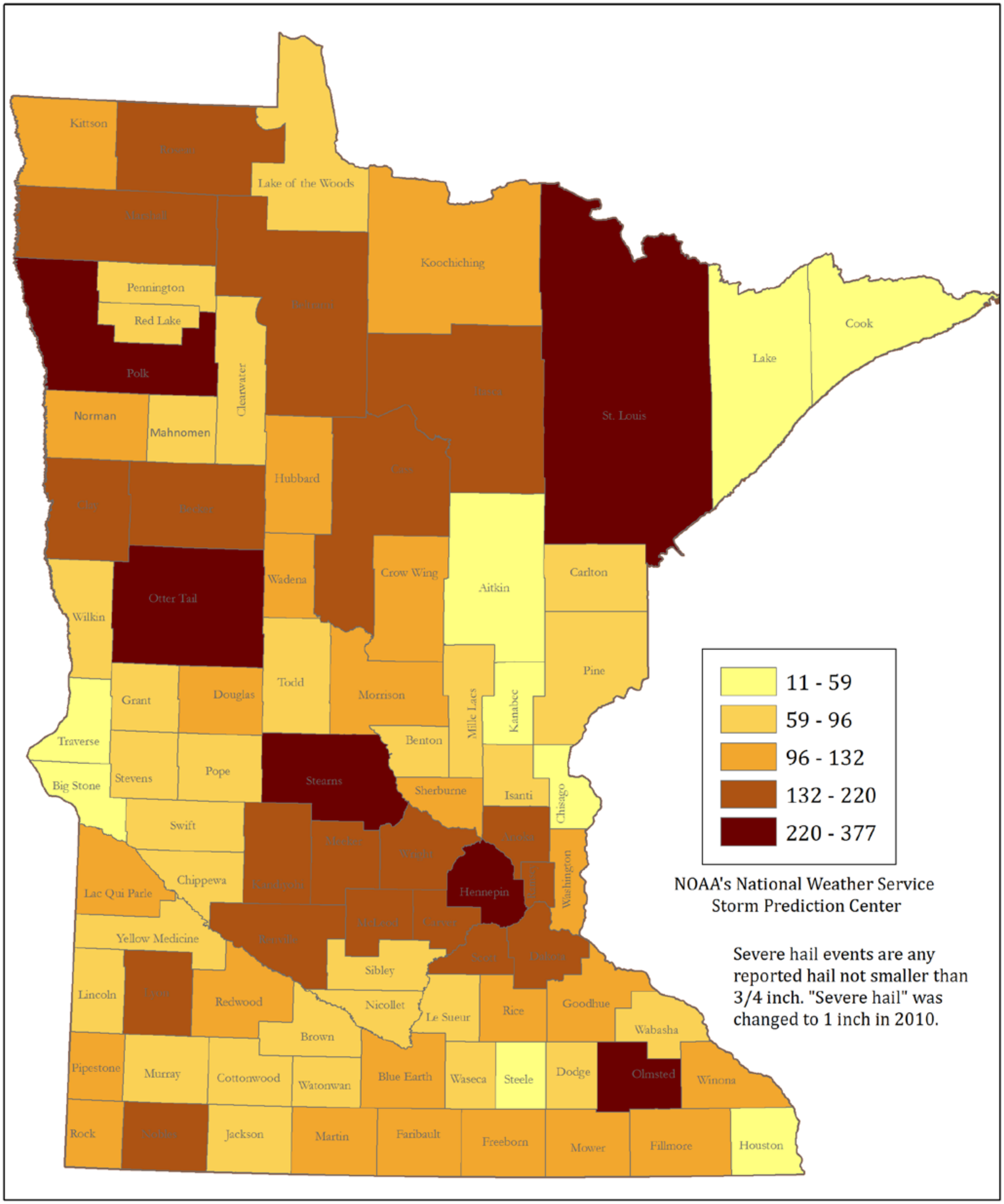
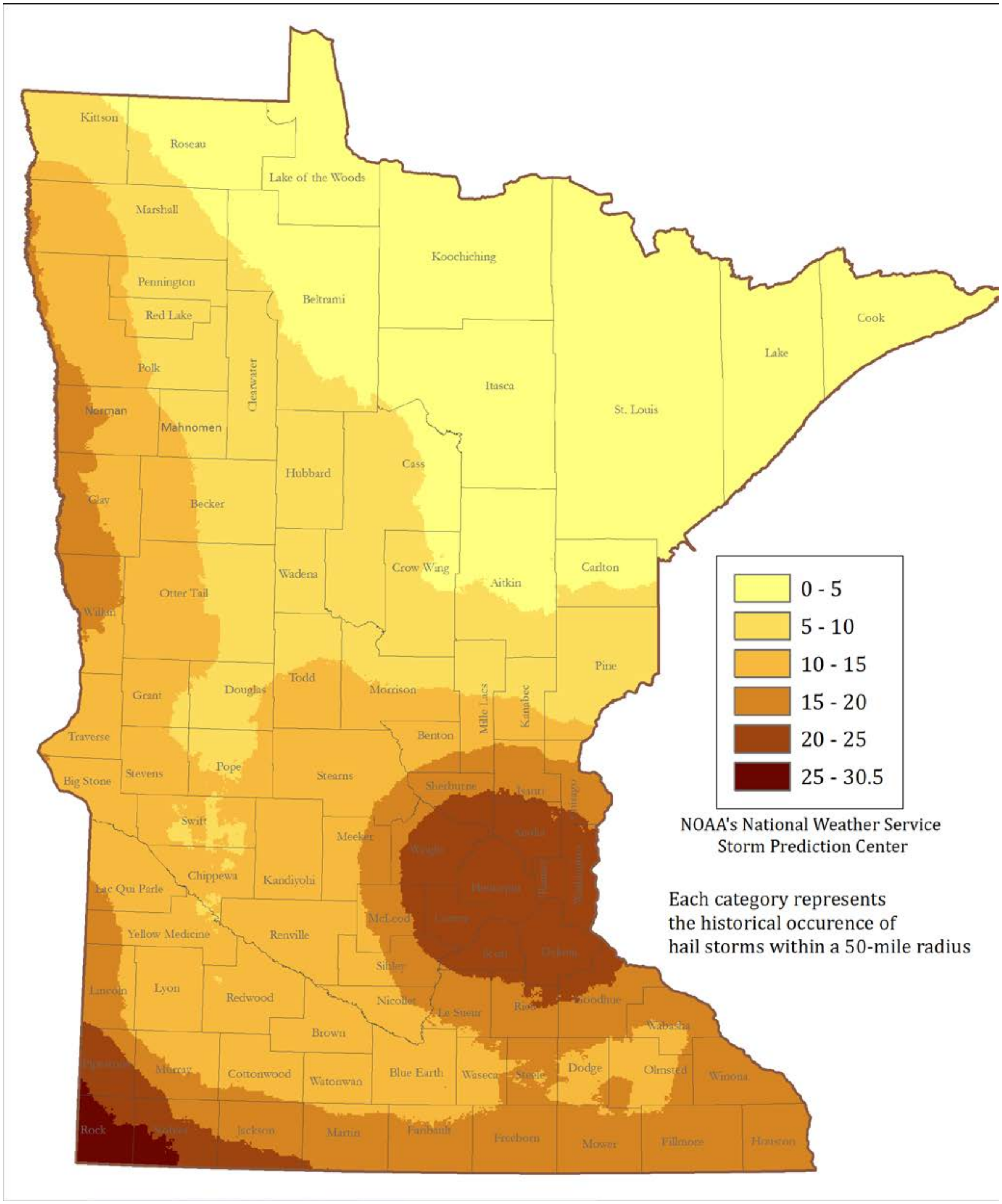


Figure 36 Severe Hail Event Frequency, 1955-2012



Probability of Occurrence

Minnesota experienced an annual average of 462 hail events during the 5-year period between 2008 and 2012. The total amount of recorded property and crop damage due to hail during this time was $21.6 million dollars, or an annual average of $4.3 million dollars.

Between 2008 and 2012, the month with the most hail was May, with July next, followed by June. During these three months, 81% of the hail occurred; May had 32%, July had 28%, and June had 21%. The size of the hail reported is generally in the pea to dime-sized category, with several reports annually of baseball-size and larger.

The annual probability of hail occurring somewhere in the State is clearly high. However, the site-specific incidence of hail is considered low because of the localized nature of the hazard.

The hailstorm frequency data was summarized for each county, and these data were used to represent vulnerability of the county to hailstorms. The ten counties with the greatest vulnerability to hailstorms

Vulnerability

The vulnerability of damage due to hail is statewide. Table 35 ranks the vulnerability by comparing the solely on building exposure. Impact of Extreme Damage Due to Hail shows that impact due to one event may be very large. The assumption for ranking is that given the same size hail event the building exposure is the determining factor in determining vulnerability.

High – building exposure over $3 billion.

Medium – building exposure is less than or equal to $3 billion but exceeds $1 billion.

Low – building exposure is less than or equal to $1 billion.

Table 35 County Hail Vulnerability Assessment

County	Events / Year	Building Exposure	Ranking
Hennepin	22.25	$113,913,965,000	High
Ramsey	21.53	$46,438,181,000	High
Dakota	21.44	$30,381,418,000	High
Anoka	21.15	$24,167,867,000	High
St. Louis	2.74	$17,545,854,000	High
Washington	20.82	$17,154,765,000	High
Stearns	13.15	$10,625,977,000	High
Olmsted	14.7	$10,224,072,000	High
Scott	21.49	$8,014,343,000	High
Wright	21.23	$7,981,311,000	High

County	Events / Year	Building Exposure	Ranking
Carver	21.72	$6,263,045,000	High
Crow Wing	6.29	$5,457,342,000	High
Sherburne	19.32	$5,254,784,000	High
Otter Tail	10.86	$4,846,688,000	High
Rice	18.61	$4,621,430,000	High
Blue Earth	13.37	$4,239,055,000	High
Winona	17.05	$3,848,179,000	Medium
Itasca	3.31	$3,713,059,000	Medium
Goodhue	18.68	$3,567,229,000	Medium
Kandiyohi	11.8	$3,245,275,000	Medium
McLeod	17.5	$3,144,760,000	Medium
Chisago	17.27	$3,053,754,000	Medium
Clay	15.01	$2,999,882,000	Medium
Cass	5.82	$2,879,718,000	Medium
Douglas	9.63	$2,861,924,000	Medium
Steele	15.46	$2,822,446,000	Medium
Isanti	17.76	$2,710,615,000	Medium
Benton	13.71	$2,692,232,000	Medium
Nicollet	13.64	$2,596,985,000	Medium
Freeborn	16.36	$2,569,102,000	Medium
Beltrami	4.17	$2,549,782,000	Medium
Mower	17.24	$2,522,554,000	Medium
Becker	9.91	$2,486,468,000	Medium
Carlton	4.87	$2,367,614,000	Medium
Morrison	10.09	$2,344,240,000	Medium
Brown	11.16	$2,176,076,000	Medium
Polk	11.39	$2,062,480,000	Medium
Le Sueur	16.97	$1,921,377,000	Medium
Pine	7.81	$1,880,697,000	Medium

County	Events / Year	Building Exposure	Ranking
Lyon	12.2	$1,790,121,000	Medium
Meeker	14.83	$1,768,183,000	Medium
Mille Lacs	11.05	$1,693,977,000	Medium
Aitkin	4.85	$1,650,061,000	Medium
Wabasha	15.76	$1,606,448,000	Medium
Hubbard	7.06	$1,579,205,000	Medium
Todd	10.17	$1,555,337,000	Medium
Martin	17.14	$1,516,376,000	Medium
Waseca	14.58	$1,453,845,000	Medium
Fillmore	17.69	$1,353,034,000	Medium
Houston	17.58	$1,292,366,000	Medium
Dodge	14.83	$1,291,386,000	Medium
Renville	11.63	$1,265,786,000	Medium
Sibley	16.01	$1,216,782,000	Medium
Redwood	10.73	$1,193,751,000	Medium
Lake	1.41	$1,173,659,000	Medium
Koochiching	2.17	$1,156,631,000	Medium
Nobles	22.54	$1,138,189,000	Medium
Faribault	15.96	$1,109,127,000	Medium
Roseau	3.87	$1,070,790,000	Medium
Kanabec	9.83	$1,061,942,000	Medium
Wadena	8.3	$1,013,164,000	Medium
Cottonwood	13.45	$868,473,000	Low
Chippewa	10.46	$852,476,000	Low
Pope	10.06	$833,801,000	Low
Watonwan	12.92	$815,118,000	Low
Swift	10.2	$814,576,000	Low
Stevens	10.8	$789,003,000	Low
Cook	0.28	$735,155,000	Low

County	Events / Year	Building Exposure	Ranking
Jackson	18.84	$629,412,000	Low
Pipestone	21.66	$609,595,000	Low
Marshall	9.19	$583,449,000	Low
Murray	15.27	$581,843,000	Low
Rock	26.52	$547,354,000	Low
Clearwater	6.72	$543,512,000	Low
Lac Qui Parle	12.91	$468,008,000	Low
Grant	11.04	$458,674,000	Low
Norman	14.24	$456,405,000	Low
Wilkin	15.19	$439,697,000	Low
Lake of the Woods	2.25	$381,700,000	Low
Lincoln	16.3	$379,477,000	Low
Big Stone	12.64	$370,709,000	Low
Mahnomen	8.98	$358,753,000	Low
Kittson	7.68	$336,073,000	Low
Red Lake	8.58	$275,599,000	Low
Traverse	13.04	$0	Low

May 15-19, 1998 and August 24, 2006 hail were the most damaging hail events in the NCDC records. This data forms the basis for an impact assessment shown in Table 36. This assessment shows that counties large and small can sustain significant damages due to hail.

Table 36 Impact of Extreme Damage Due to Hail

City	County	Date	Property Damage	2010 Population City Population
Bloomington	Hennepin	5/16/1998	$450,000,000	82,893
Burnsville	Dakota	5/17/1998	$100,000,000	60,306
Northfield	Rice	8/27/2006	$50,000,000	20,007
New Prague	Le Sueur	5/15/1998	$20,000,000	7,321
Anoka	Anoka	8/24/2006	$20,00,000	17,142
Dayton	Hennepin	8/24/2006	$20,00,000	4,671
Forest Lake	Washington	5/18/1998	$10,000,000	18,375
Apple Valley	Dakota	8/26/2006	$10,000,000	49,084

New Prague	Scott/Le Sueur	8/28-29/2006	$11,000,000	7,321
St. Michael	Wright	8/25/2006	$5,000,000	16,399
International Falls	Koochiching	5/19/1998	$3,000,000	6,424

Hail and Climate Change

According to the Draft National Climate Assessment (NCA), winter storms have increased slightly in frequency and intensity, and their tracks have shifted northward over the U.S. Other trends in severe storms, including the numbers of hurricanes and the intensity and frequency of tornadoes, hail, and damaging thunderstorm winds are uncertain (NCA, 2013, p. 26). Since the impact of more frequent or intense storms can be larger than the impact of average temperature, climate scientists are actively researching the connections between climate change and severe storms (NCA, 2013, p. 59).

The occurrence of very heavy precipitation has increased in Minnesota in recent decades and future projections also indicate this will continue (Interagency Climate Adaptation Team, 2013, p. 14). While it is unknown if this precipitation will occur during severe storms that produce hail, the possibility has not been ruled out.

4.5.7 Lightning

Lightning typically occurs as a by-product of a thunderstorm. In only a few millionths of a second, the air near a lightning strike is heated to 50,000°F, a temperature hotter than the surface of the sun.

The hazard posed by lightning is significant. High winds, rainfall, and a darkening cloud cover are the warning signs for possible cloud-to-ground lightning strikes. While many lightning casualties happen at the beginning of an approaching storm, more than half of lightning deaths occur after a thunderstorm has passed. Lightning has been known to strike more than 10 miles from the storm in an area with clear sky above.

According to the National Oceanic and Atmospheric Administration (NOAA), 30 million points on the ground are struck on average each year in the U.S. (NOAA, Severe Weather 101).

Lightning is the most dangerous and frequently encountered weather hazard that most people in the United States experience annually. Lightning is the second most frequent killer in the U.S., behind floods and flash floods, with nearly 100 deaths and 500 injuries annually. The lightning current can branch off to strike a person from a tree, fence, pole, or other tall object. In addition, an electrical current may be conducted through the ground to a person after lightning strikes a nearby tree, antenna, or other tall object. The current may also travel through power lines, telephone lines, or plumbing pipes to damage property or fires.

Lightning History in Minnesota

From 1/1/1996 to 8/31/2013, there were 210 lightning strikes in Minnesota, causing 9 fatalities and 60 injuries, according to the NCDC. Lightning caused over $16.5 million in property damages and $65,000 in crop damages.

During a measured period of years in Minnesota (1959-1992), 31% of lightning deaths occurred in open fields, ball parks and open spaces; 25% occurred under trees; 10% occurred during boating, fishing or other water related activities; 12% occurred near tractors and heavy road equipment; and 2% occurred on golf courses (4% occurred at telephones; and 17% occurred at various other and unknown locations).

During that same time period, 13% of lightning injuries occurred in open fields, ball parks and open spaces; 18% occurred under trees; 6% occurred during boating, fishing or other water related activities; 5% occurred near tractors and heavy road equipment; and 11% occurred on golf courses (10% occurred at telephones; and 36% occurred at various other and unknown locations). Most lightning injuries in Minnesota have occurred between April and August.

Between 1997 and 2012, Minnesota ranked number 33 out of the United States continental states and DC in terms of cloud-to-ground lightning flash densities with a value of 4.6 flashes per square mile per year.

Table 37 Lightning injuries reported in Minnesota, 2008 – August 2013

Location or County	Date	Injuries
Duluth Sky Harbor Airport	8/18/2012	4
Nopeming, St. Louis County	7/27/2010	1
Waite Park, Stearns County	5/6/2009	1
Monticello, Wright County	7/10/2008	1
Mora, Kanabec County	6/27/2008	1
Minneapolis/St. Paul, Hennepin County	4/22/2008	3
Total:		11

Source: NOAA

The number of deaths due to lightning strikes in Minnesota from 6/19/1994-8/31/2013 is listed below.

Table 38 Lightning Deaths Reported in Minnesota, 1994 – August 2013

Location or County	Date	Deaths
Sturgeon Lake	8/26/2013	1
Duluth Sky Harbor Airport	8/18/2012	1
Stillwater, Washington County	7/21/2009	1
Waite Park, Stearns County	5/6/2009	1
Bowstring, Itasca County	6/8/2007	1
White Bear Lake	8/9/1998	1
Meire Grove	6/26/1998	1
Grand Marais	8/6/1996	1
Ely	6/28/1996	1
Forest Lake	8/11/1995	1
Newfound Lake	7/13/1995	1
Erskine	6/19/1994	1
Total:		12

Source: NOAA

Probability of Occurrence

The probability of lightning occurring in the state is high. However, the site-specific incidence of lightning is considered low because of the localized nature of the hazard. The annual incidence of lightning across the state is presumed to remain stable, although year-to-year fluctuations are expected.

Vulnerability

All humans and structures in the state are vulnerable to damage from lightening.

Lightning and Climate Change

According to the Draft National Climate Assessment (NCA), the projected possible intensity and frequency of tornadoes, hail, and damaging thunderstorm winds, the conditions likely associated with lightning are uncertain (NCA, 2013, p. 26). Severe rain events are becoming more common and may include an additional risk of lightning.

4.5.8 Winter Storms

Winter storms vary in size and strength and include heavy snowstorms, blizzards, freezing rain, sleet, ice storms and blowing and drifting snow conditions. Extremely cold temperatures accompanied by strong winds can result in wind chills that cause bodily injury such as frostbite and death.

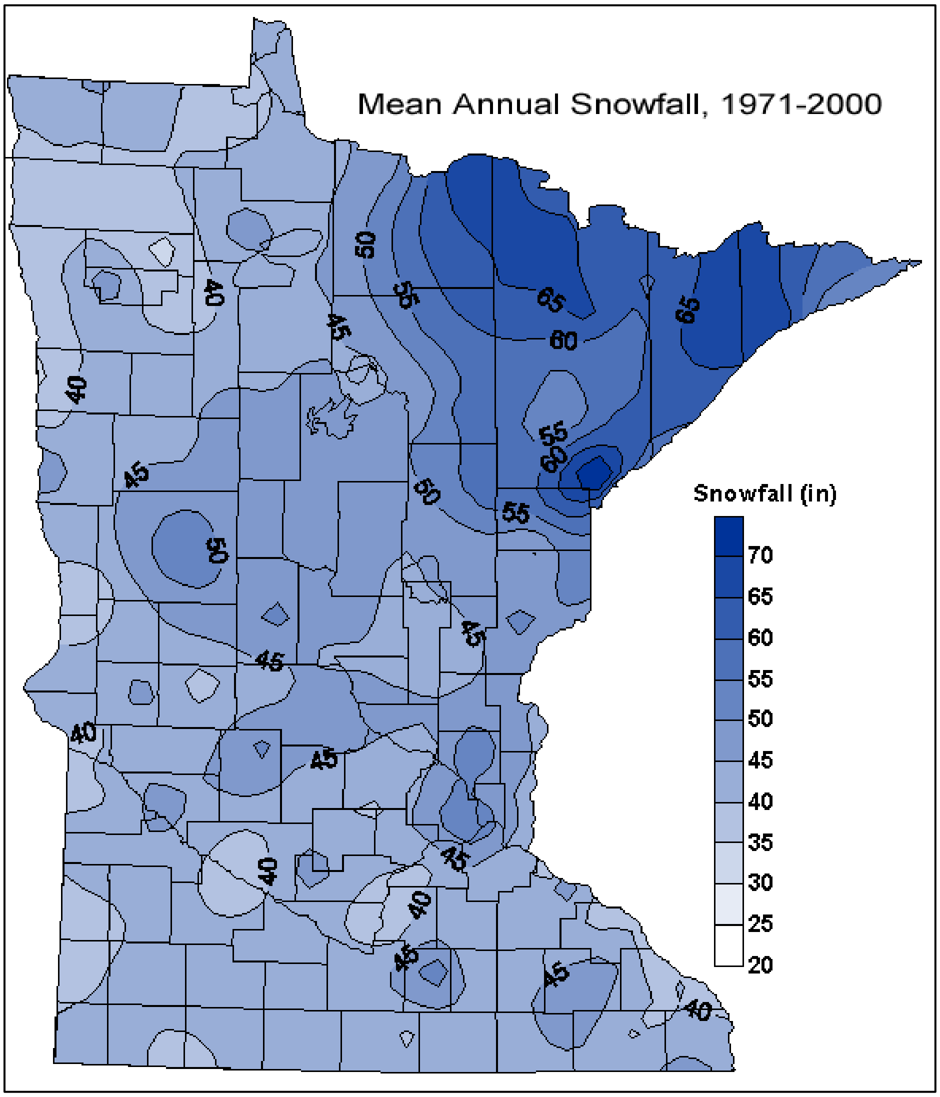
Winter storm occurrences tend to be very disruptive to transportation and commerce. Trees, cars, roads, and other surfaces develop a coating or glaze of ice, making even small accumulations of ice extremely hazardous to motorists, bicyclists, and pedestrians. The most prevalent impacts of heavy accumulations of ice are slippery roads and walkways that lead to vehicle and pedestrian accidents; collapsed roofs from fallen trees and limbs and heavy ice and snow loads; and felled trees, telephone poles and lines, electrical wires, and communication towers. As a result of severe ice storms, telecommunications and power can be disrupted for days. Heavy snow or accumulated ice can also isolate people from assistance or services.

The NWS issues a Wind Chill Advisory for Minnesota when widespread wind chills of -40°F or lower with winds of at least 10 miles per hour (mph) expected. In some parts of southern Minnesota, the threshold may be -35°F. A Wind Chill Warning is issued when widespread wind chills of -40°F in northern Minnesota and -35°F in southern with winds greater than 10 mph are expected.

Winter Storm History in Minnesota

The topography, land-use characteristics and winter climate of western and southern Minnesota cause this area to be particularly vulnerable to blowing and drifting snow. The number of days with potential problems ranges from 115 in the south to 155 in the north. For an average winter season, taxpayers in Minnesota spend approximately $100 million in snow removal costs, with MnDOT expending $41 million. In the event of a winter season with anomalously high snowfall and exceedingly strong winds, as was the case for much of the state during the winter of 1996-97, the cost of snow removal can soar to $215 million. Twenty-one counties have had federal declarations issued**Error! Reference source not found.**. See mean annual snowfall of 1971-2000.

Figure 37 Mean Annual Snowfall in Minnesota



Source: Minnesota Climatology Working Group

Blizzards

Minnesota has experienced many severe blizzards. Most notable are the “Armistice Day Blizzard” in November 1940 in which there were 49 deaths; “The Storm of the Century” in January 1975 in which there were 14 deaths; the blizzard in February 1984 in which there were 16 deaths; the “Halloween Monster Storm” of 1991 which did not result in any deaths, but set staggering snowfall records; and the unprecedented series of blizzards in November 1996 through January 1997 which resulted in a Presidential Disaster Declaration (DR-1158-MN).

The total seasonal snowfall at Fargo-Moorhead was 117 inches in the winter of 1996-97, setting up the record-setting flood of 1997 in the Red River Valley.

More recently, 2010 had numerous snowfall events. The December 10-11th Blizzard was the 5th largest snowstorm on record for the Twin Cities since 1891. This was the largest snowfall for the Twin Cities since the 1991 Halloween Blizzard (17.1 inches). The highest snowfall total found in the state was 23 inches measured at Winona Dam. The roof of the 64,000-seat Metrodome in Minneapolis collapsed under the weight of the snow. Three additional inches fell with a lighter snow storm on December 9th at Winona and is not included with the total. Between December 15th and 16th an additional 6 inches fell in central and southern Minnesota. The fourth snowstorm for December 20-21, 2010 added to the deepening snowpack across Minnesota.

In late February of 2012, heavy snow fell in northern Minnesota, with 9-15” of snow in Duluth and Silver Bay and 20” in Hinckley. At the Duluth harbor the winds heavily damaged the roof of a 157,000 square foot building owned by the Seaway Port Authority, causing $1 million in damage. Gusts of 68 mph were recorded near downtown Duluth.

In April of 2013, heavy ice, sleet and snow accumulated across southwestern Minnesota. Trees and power lines were severely damaged and both vehicles and homes suffered destruction from falling trees, limbs and branches. Both urban areas and rural electric cooperatives suffered major power line damage, with the rural cooperatives alone reporting $16 million in damages. Thousands were without power, and travel was impossible in many areas, resulting in schools and businesses closing. As of this writing in 2013, Minnesota is experiencing severe storm that closed Duluth area schools for three days and will likely result in snowfall records being set.

These recent events are summarized in the following table, with a complete historical listing in Appendix A.

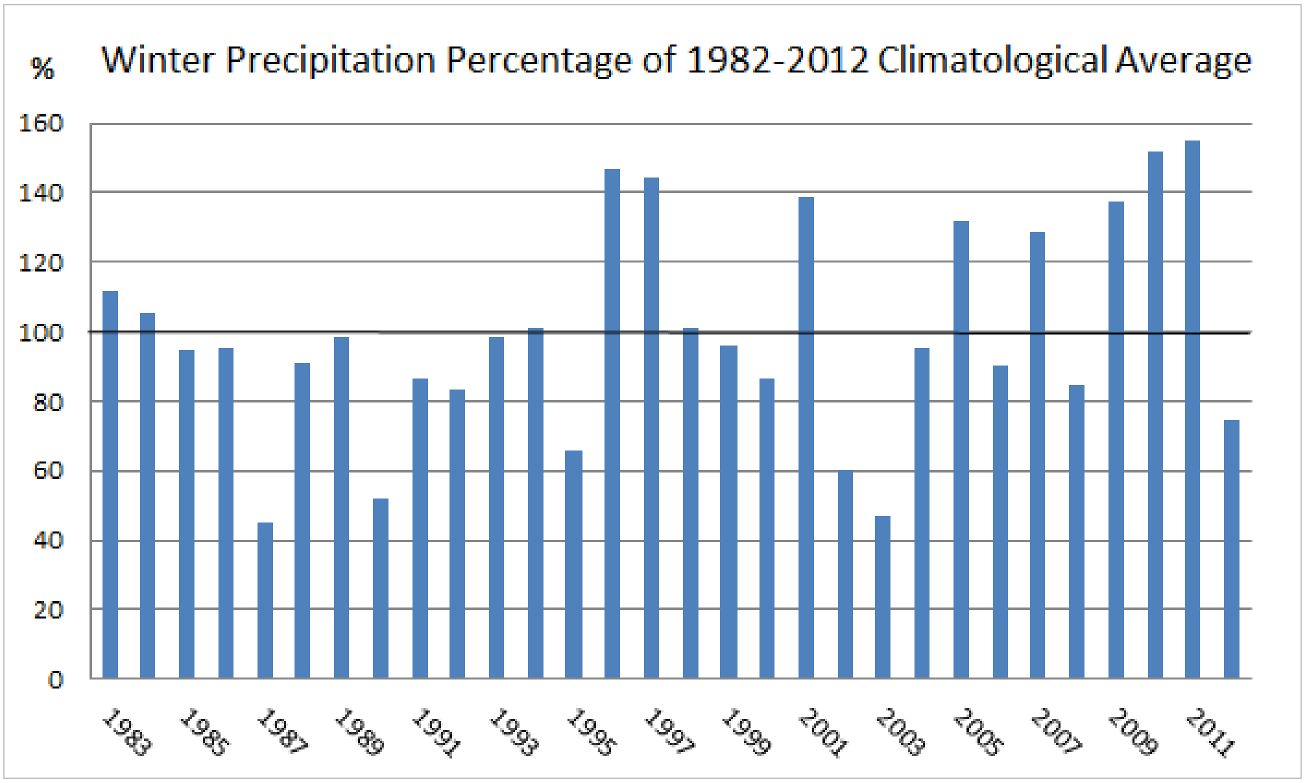
Table 39 Notable Winter Storms and Blizzards in Minnesota, 2010-2013

Date	Location	Remarks
4/9/2013	Southwestern Minnesota	FEMA Disaster Declaration DR-4113. Heavy snow, sleet and freezing rain across the region resulted in major power outages and $71 million in property damage.
2/29/2012	Southern St. Louis/Carlton Counties	Blizzard resulted in 9-15” of snow in the Duluth area with winds gusting up to 68 mph. 20” in Hinckley. $1 million in damage.
12/20-21/2010	Rochester, MN	On December 20th, 6.1” of snow fell, raising the December total to 37.8”, making it not only the snowiest December on record, but also the snowiest month ever. The previous snowiest December received 35.3” in 2000. Normally, Rochester MN receives 52.7” during an entire snow season.
12/10-11/2010	Various	The largest snowfall for the Twin Cities since the 1991 Halloween Blizzard brought 17.1” of snow to the Twin Cities International Airport, causing temporary closure. Largest December snowstorm on record for the Twin Cities. The Metrodome collapsed under the weight of the snow. School was cancelled for two days in St. Paul and Minneapolis.
12/3-4/2010		A widespread area of snowfall impacted southern and central Minnesota. Widespread reports of 9” to 12”of snow, with the maximum observed snowfall being 11.7” near Lakeville, MN.
11/29-30/2010	Multiple	Portions of the state saw 5-10”of snow. Total for the month of November was 9.8” in the Twin Cities. Redwood County saw 10” of snowfall.
11/13/2010	Multiple	Three days after a record high temperature of 68° in the Twin Cities, 8” of snow was observed at the Minneapolis/St. Paul International Airport. This was the largest November snowfall for the Twin Cities since the “Halloween Blizzard” of 1991.

Source: NCDC, Minnesota Climatology Working Group

The graph below indicates winter (December, January, and February) precipitation as a percentage of the 30-year average (1982-2012).

Figure 38 Winter Precipitation Percentage of 1982-2012 Climatological Average



Ice and Sleet Storms

The most notable ice storm in the period between 2010 and 2013 in Minnesota occurred in April of 2013 in the southeastern corner of the state. A quarter inch of ice accumulated in parts of Winona County and schools in Olmsted County closed. Two injuries resulted from an accident on Interstate 90, and several other accidents and $20,000 in property damage occurred due to icy conditions. This storm resulted in a Presidential Declaration: DR 4113. For a listing of notable ice and sleet storms since 1993, see Appendix A.

The effects of DR-4113 were overwhelmingly felt by rural electric cooperatives in the Southwest Minnesota and were the key to justifying Minnesota a Presidentially Declared Disaster. This was not a single incident; rural electric cooperatives were significantly damaged in DR-4009, DR-1921, and DR-1283. These events and the vulnerability of the rural electric cooperatives in Minnesota to high winds and ice storms has lead HSEM to partner with Minnesota Association of Rural Electric Cooperatives in developing an Annex to this plan. The Rural Electric Cooperative Annex follows the same planning process as the State Hazard Mitigation Plan and how each hazard affects electric cooperatives. Mitigation strategies are crucial to the Annex and will help in identifying potential HMGP projects.

Probability of Occurrence

As shown in the section above, Minnesota experiences a variety of severe winter weather events annually. Although it is impossible to predict probabilities for this type of event over short periods of time, that the State can probably expect one ice and ice/snow storm every year on average and one major blizzard per year.

Vulnerability

Transportation systems, electrical distribution systems, and structures are vulnerable to winter storms throughout the entire state. These vulnerabilities impact human safety, disrupt distribution of government services, cause economic disruptions and damage structures. Dollar amounts have been stated in the disaster history but total damages and vulnerability cannot be assessed since reporting on all of the relevant factors does not occur. Overall, both the public and private sector understand the risks of winter storms anticipate their potential impacts.

Winter Storms and Climate Change

Historically, winter storms have had a large impact on public safety in Minnesota. This will continue, with a possible increase in snowstorm frequency and annual total snowfall. Winter weather is often a cause of power outages. Pressures on energy use, reduced reliability of services, potential outages and potential rise in household costs for energy are major climate change risks to public health.

The number of heavy snowfall years for the Midwest has fluctuated throughout the 1900-2006 time

period. The periods of 1900-1920 and 1960-1985 had numerous years with snowfall totals over the 90th percentile. In the recent three decades, the number of heavy seasonal snowfall totals has been much lower. Despite these generally lower seasonal snowfall totals, some areas of the Midwest have still experienced significant snow totals in the most recent decade. The 100-year linear trends based on decadal values show that the upper Midwest had statistically significant (1% level) upward linear trends in snowstorm frequency from 1901 to 2000 (Kunkel, K.E. et al, 2013).

4.5.9 Erosion

Erosion is a broad subject and is being addressed differently than in the previous version of the state mitigation plan. Coastal erosion along the Lake Superior and landslides was discussed in detail in the previous plan (Coastal erosion along Lake Superior will be discussed after the other geological hazards). Streambank and bluff erosion were mostly associated with flood or heavy rain conditions. The perspective that caused a shift to look at erosion differently:

Rivers are still adjusting to late glacial events.

- Recent increases in flow lead to more rapid adjustment.
- Certain reaches of rivers are more sensitive to changes in flow.

Areas that are well beyond and high above the flood plain are susceptible to episodic failure.

Human caused runoff and sediment add to the natural process.

- Policy makers and homeowners need to look beyond the flood plain and understand and predict bank and bluff failure along the entire meander belts of our rivers.

A different aspect about erosion was presented in the 2013 update of the Blue Earth County mitigation plan. The county consulted with the National Center for Earth Surface Dynamics, University of Minnesota to study the effects of riverine erosion in the Mid Minnesota Watershed which consists of the Le Sueur and Minnesota rivers and their tributaries. The sources for coastal erosion are as cited.

Definitions

To describe erosion hazards, a number of definitions are needed to profile this hazard. The Blue Earth County mitigation plan offered these definitions.

Erosion hazard as stated in the 1999 FEMA Riverine Erosion Hazard Mapping Feasibility Study, erosion hazard area is defined by Section 577 of National Flood Insurance Reform Act (NIFRA): "Erosion hazard area means, based on erosion rate information and other historic data available, an area of erosion or avulsion is likely to result in damage or loss of property or infrastructure within a 60 year period."

Stream banks are the portions of the river or stream channel which restrict lateral movement of water. Stream bank erosion is a natural process, but acceleration of this natural process leads to land loss, stream channel instability, increased sediment, habitat loss and other adverse effects. EPA Stream Channel Erosion EPA, WARSSS, Channel Processes:

Bluffs are tall steep features distinguished from stream banks based on height. Bluffs are defined as features with greater than 10 feet of relief in 20 foot by 30 foot area. The vertical nature of bluffs makes them susceptible to sudden and catastrophic failure. (Day, Stephanie, 2013, Special Hazard Mitigation Risk Assessment of Near Channel Riverine Erosion Hazards in Blue Earth County – Streambanks, Bluffs and Ravines)

During periods of moderate and high flow, bluffs are eroded by the river in deeply incised channels lacking a floodplain. Bluffs also fail due to landslides and mass wasting. The river removes the soils deposited by mass wasting and landslides. As a result the eroded, nearly vertical slope cannot stabilize and reestablish itself with vegetation.

Landslides – Mass Wasting The USGS definition of landslides includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over-steepened slope is the primary reason for a landslide, there are other contributing factors:

- erosion by rivers create over steepened slopes
- rock and soil slopes are weakened through saturation by snowmelt or heavy rains
- excess weight from accumulation of rain or snow, or from man-made structures may stress weak slopes to failure and other structures

Slope materials that become saturated with water may develop a debris flow or mud flow. The resulting slurry of rock and mud may pick up trees, houses, and cars, thus blocking bridges and tributaries causing flooding along its path.

The EPA defines mass wasting as: "The erosional processes associated with mass wasting include two primary types:

- shallow, fast movements of debris avalanche/debris torrents and mudflows that generally move only once, and
- slow, deep-seated slump/earthflow erosional processes that move intermittently over varying time scales in response to infrequent events and/or disturbance factors.

Erosion associated with mass wasting processes is extremely difficult to predict due to the episodic nature of climatic events that initiate movement. Often landslides occur many years following vegetation and land use changes due to complex interactions of root mass decay and soil saturation from major storms." (EPA, Hillslope Processes: Mass Wasting

http://water.epa.gov/scitech/datait/tools/warsss/wasting.cfm

Landslides often occur together with other major natural disasters, thereby exacerbating relief and reconstruction efforts

Flows are a form of rapid mass movement by loose soils, rocks, and organic matter, together with air and water that form slurry flowing rapidly downhill. Flows are distinguished from slides by high water content and velocities that resemble those of viscous liquids.

Lateral spreads are large movements of rock, fine-grained soils (i.e., quick clays), or granular soils, distributed laterally. Liquefaction may occur in loose, granular soils, and can occur spontaneously due to changes in pore-water pressure or due to earthquake vibrations.

Falls and topples are masses of rocks or material that detach from a steep slope or cliff that free-fall, roll, or bounce. Movements are typically rapid to extremely rapid. Earthquakes commonly trigger rock falls.

Floods and landslides are closely related and both involve precipitation, runoff, and ground saturation that may be the result of severe thunderstorms or tropical storms.

Earthquakes may cause landslides ranging from rock falls and topples, to massive slides and flows.

Landslides into a reservoir may indirectly compromise dam safety or a landslide may even affect the dam itself.

Wildfires may remove vegetation from hillsides, significantly increasing runoff and landslide potential

However, landslides take place over time and often take place when no natural disaster is evident.

Coastal Erosion is defined as the wearing away of land and the loss of beach, shoreline, or dune material over a period of time as a result of natural coastal processes or human influences. Characteristics such as supply of sand and processes such as sea level change, currents, tides, waves, and wind are natural factors that contribute to the rate of erosion. Human-caused contributors to erosion include dredging tidal entrances, jetty and groin construction, hardening shorelines with seawall, beach nourishment, and construction of harbors and sediment-trapping dams.

As high lake levels increase, bluff recession rates also increase. Increasing assaults by wave action against the base of the bluff cause erosion and beach-building sediments. Navigational improvements and dredge-material disposal practices deplete both tributary and shore land sources of sediment; removing these sediments from the shore system contributes to erosion. Ice ridges that form and break up each winter along the shoreline cause erosion by trapping sand in floating fragments of ice that are carried offshore into deep water. This continual natural process is one of the principal mechanisms by which sand is lost from the near shore system (USGS, 1992).

Coastal erosion is usually a gradual process, and sudden incidents prompting emergency action are rare. Such rare events include strong storms with high winds or heavy wave action that can cause sudden failure of bluffs.

Coastal property owners are acutely aware of hazards during periods of high water levels and especially right after a damaging storm or a bluff failure, but this awareness can fade over time if low lake levels slow the erosion rate.

Streambank Erosion/Channel Enlargement

Bank erosion takes place by two processes, channel migration and channel widening (Day, 2013):

Enlargement of channels can be caused by combined processes of incision, bank erosion and direct modification by construction activities. Lateral erosion may occur in stable streams, but the point bar follows at the same rate, thus the stream does not get wider over time. This contrasts with enlargement, where the width of the stream gets wider over time due to lateral erosion, often concurrently on both banks. The results of enlargement are increased erosion from stream bed and banks, increased deposition due to decreased shear stress and stream power, loss of habitat, increased water temperatures, and a shift in evolutionary state of morphological stream types. Increased flows due to watershed changes, storm drains from urban runoff, power generation due to "ramping flows" from reservoir releases and contraction scour below culverts and bridges can all contribute to channel enlargement. Combined processes of incision, degradation, aggradation, and lateral accretion can be associated with enlargement. EPA, Channel Processes: Channel Enlargement

The following figures are examples of river bluff and streambed erosion. The bluff erosion example shows how structures become at risk due to the combination of long term processes and floods. The bridge abutments in the streambed erosion example were washed out in 2010 and the 2011 photo shows how the stream channel migrated. The stream bank was fortified with rip-rap to mitigation future damages.

Figure 39 Example of Bluff Erosion

Figure 40 Example of Streambank erosion before event and after restoration, Rapidan Township

Natural and human caused changes in hydrology play a critical role in the failure of stream banks, bluffs and ravines, as more water is entering ravines and rivers. Land use changes have increased runoff to rivers from urban and agricultural land uses while infiltration and evapotranspiration has been reduced. Vegetation changes, such as conversion of native prairie, pastures and wetlands to row crops and removing trees and vegetated buffers, reduce soil stability, reduce evapotranspiration and increase runoff. Drainage of surface and subsurface soils for crop production alter hydrology by increasing runoff. Climate and changing summer storm intensity also results in increased runoff and higher flows which worsening near channel erosion

Sediment from erosion and run-off from agriculture is a statewide impact. This section does not address sediment although it effects both environment and economy. An example is the process needed to clean up the sediment at the confluence of the Minnesota and Mississippi rivers. The Minnesota Pollution Control Agency publishes newsletters for this project. The estimated cost for this project is five to ten million dollars.

Erosion History

Bank-failure problems are caused by gravity acting on earth materials resting on a slope. In the case of failure, gravitational forces exceed the forces holding the sediment together. Failures can take several forms depending on sediment type, sediment layering, and moisture content. Red River Valley bank failures are typically the result of slumping in which a block of earth moves downward along a curved failure plane, commonly with a backward rotation of the slump block. The fundamental reason why deposits in this area rupture and sag is because they consist of clay rather than sand, silt, or gravel.

Clays are present in northwestern Minnesota because the Red River Valley is the floor of ancient glacial Lake Agassiz, a large lake that formed at the edge of a retreating ice-age glacier (Clayton and Moran, 1982; Fenton and others, 1983). Both glacial and lake sediments were deposited and these clays are exposed along the rivers of the Red River Valley. Riverbanks particularly vulnerable to slumping are those that consist of an upper, relatively competent layer of sediment called the Sherack Formation resting on more easily deformable clays of the Huot and Brenna Formations.

On May 22, 2013, 2 children died in a landslide at Lilydale Regional Park in St. Paul. Two others were injured. The park lies on the Mississippi River, where gravel saturated by recent heavy rains gave way. Engineers investigating the landslide said that groundwater played a major role and that all bluff areas like Lilydale have similar risks.

The Blue Earth County plan lists 23 events between 1960 and present day where structures and infrastructure were impacted.

Coastal Erosion - Northeast Minnesota has 189 miles of Lake Superior shoreline and a coastal population of over 252,000 (2010). The boundary of Minnesota's coastal zone includes area roughly 6 miles inland from Lake Superior, following the nearest township boundaries. Erosion along 36 miles of unstable, tall clay shoreline is a particular problem. Typically, shorelines are quite high—often greater than 25 feet—and erosion and bluff instability can harm the aquatic zone near the shore.

Probability of Occurrence

Erosion is a statewide hazard and depends on the geology and other facts unique to the location. Coastal erosion is well studied and documented. All streams in Minnesota susceptible to erosion with damaging erosion occurring during a flash flood caused by a heavy rain event or up to sixty years of the hydraulic pressure exerted on its banks. Research into the exact locations of the other forms of erosion will be done for the next plan update.

Vulnerability

Human life and safety, structures, and infrastructure are all vulnerable to landslides. Since the geographic locations have not been accurately characterized a vulnerability assessment cannot be performed. HSEM mitigation staff will work with mitigation partners to better identify the locations of these risk for the plan update.

Continued shoreline development is inevitable and contributes to erosion problems. Erosion rates can accelerate with increases in impervious surfaces, changing and eliminating vegetation cover, and alterations to beach makeup. Serious situations are rare but massive/fast erosion can occur during one storm event leaving houses dangling from cliffs or beginning to slide down hillsides. The effective management of areas with high erosion potential is necessary to protect property owners, and provide measures for reducing erosion.

The Blue Earth mitigation plan identified eighty properties that are vulnerable in the county. The plan suggested that setbacks in local planning ordinance for streambank and bluff erosion is necessary based on development trends. The Blue Earth County Environmental Department developed a mitigation action to work on the technical basis for the setbacks.

For coastal erosion, Minnesota’s Department of Natural Resources administers the Lake Superior Coastal Program, which provides grants from the federal government’s Coastal Zone Management Program. The North Shore Management Board (NSMB) has published an “Erosion Hazard Area Planning Process Definition” document. The NSMB is responsible for the North Shore Management Plan (NSMP) to address and update the Erosion Hazard Map Area. The Lake Superior shoreline is prone to erosion, due to large fluctuation of water levels and the wave volume and force that can quickly destroy and relocate shorelines. Erosion continues to be an important topic because it can cause dangerous living conditions, property destruction, and affect values on lakeshore properties. As the North Shore continues to grow in popularity, there continues to be more development focused on the lakeshore.

The NSMP sets standards that are aimed at reducing stormwater runoff, which has a large impact on bluff deterioration. The NSMP advocates for stormwater runoff plans conducted by professionals, vegetation management, and managing soil when performing construction activities. The other way the NSMP protects property owners from the direct effects of erosion is through lake setbacks. The current riparian setback from the permanent vegetation line of Lake Superior is 40 feet or 75 feet from the average water level, whichever is greater. This provides a buffer from the bluffline to protect the structures. The NSMP also has structure setbacks for erosion hazard areas.

4.5.10 Land Subsidence (Sinkholes and Karst)

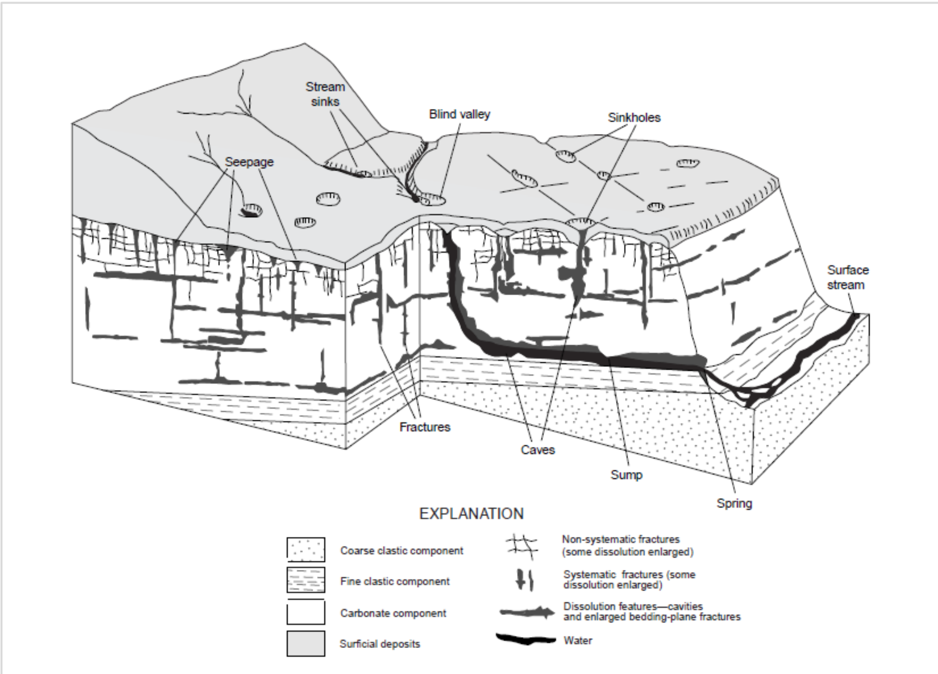
There are three types of potential problems associated with the existence or formation of sinkholes: subsidence, flooding, and pollution. The term subsidence commonly involves a gradual sinking, but it also refers to an instantaneous or catastrophic collapse. In Minnesota, limestone and dolostone underlie the southeastern corner of the state which includes the Minneapolis-St. Paul Metropolitan Area. Similar rocks are also found deep beneath the surface in northwestern Minnesota. In southeastern Minnesota, carbonate rocks from the Cedar Valley Group down through the bottom of the Prairie du Chien Group contain caves and other karst features. Because most of Minnesota is buried beneath a thick cover of glacial sediments, the karst landscape may not be apparent. In parts of southeastern Minnesota, erosion has removed most of this glacial cover and exposed the carbonate bedrock. Counties known for karst features include parts of Dakota, Rice, Dodge, and Mower, and most of Goodhue, Olmstead, Winona, Wabasha, Houston, and Fillmore. Fillmore County has more caves, sinkholes, and disappearing streams than all other Minnesota counties combined.

The change in the local environment affecting the soil mass causing subsidence and sinkholes collapse is called a triggering mechanism. Water is the main factor affecting the local environment that causes subsidence. The main triggering mechanisms for subsidence are water level decline, changes in groundwater flow, increased loading, and deterioration (abandoned coal mines). Water level decline can happen naturally or be human induced. Factors in water decline are pumping water from wells, localized drainage from construction, dewatering, and drought. Changes in the groundwater flow include an increase in the velocity of groundwater movement, increase in the frequency of water table fluctuations, and increased or reduced recharge. Increased loading causes pressure in the soil leading to failure of underground cavities and spaces. Vibrations caused by an earthquake, vibrating machinery and blasting can cause structural collapse followed by surface settlement.

Sinkholes and subsidence are also common in those areas of the state underlain by old abandoned coal and iron mines. Pillows left for roof support in the mines generally deteriorate over time and eventually collapse, removing roof support. This is particularly a problem where mines underlie more recently developed residential areas and roads.

In Minnesota, the primary natural causes of land subsidence are karst landforms. Karst landforms develop on or in limestone, dolomite, or gypsum by dissolution and are characterized by the presence of features such as sinkholes, underground (or internal) drainage through solution-enlarged fractures (joints), and caves. Karst landforms can be hazardous because of the sinkholes that form there and for the ease with which pollutants can infiltrate into the water supply. The following figures illustrate a cross-section of karst drainage and related landforms, karst features in Minnesota, and karst lands in southwestern corner of the state.

Figure 41 Karst Drainage and Related Landforms



Source: Alexander and Lively (1995) in Minnesota Geological Survey, Caves in Minnesota

Figure 42 Karst Features in Minnesota

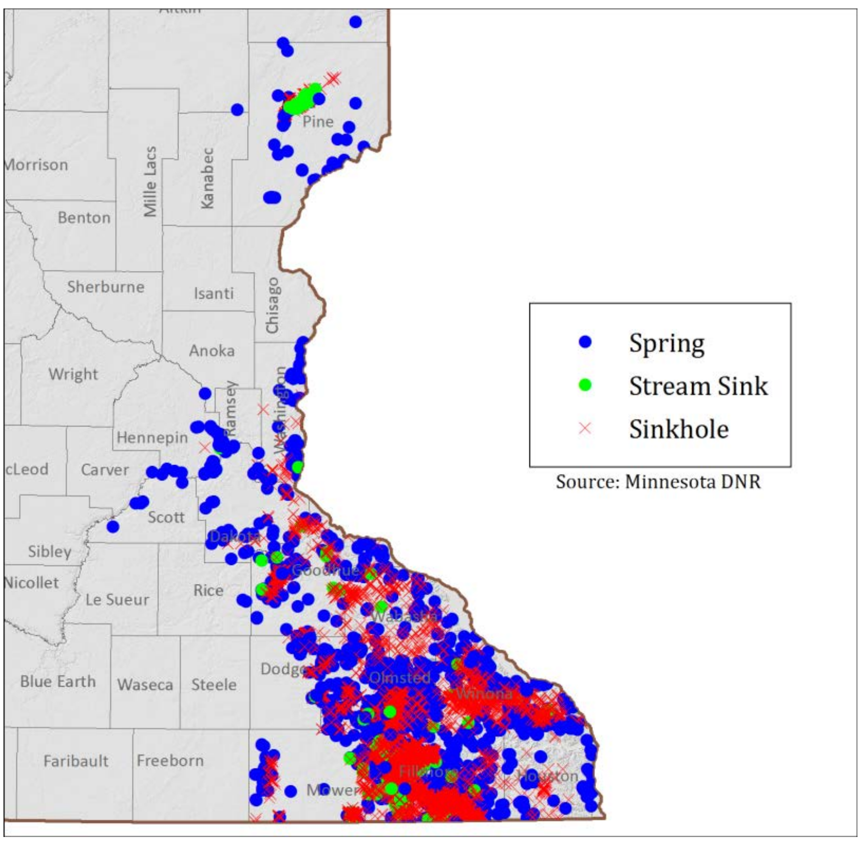
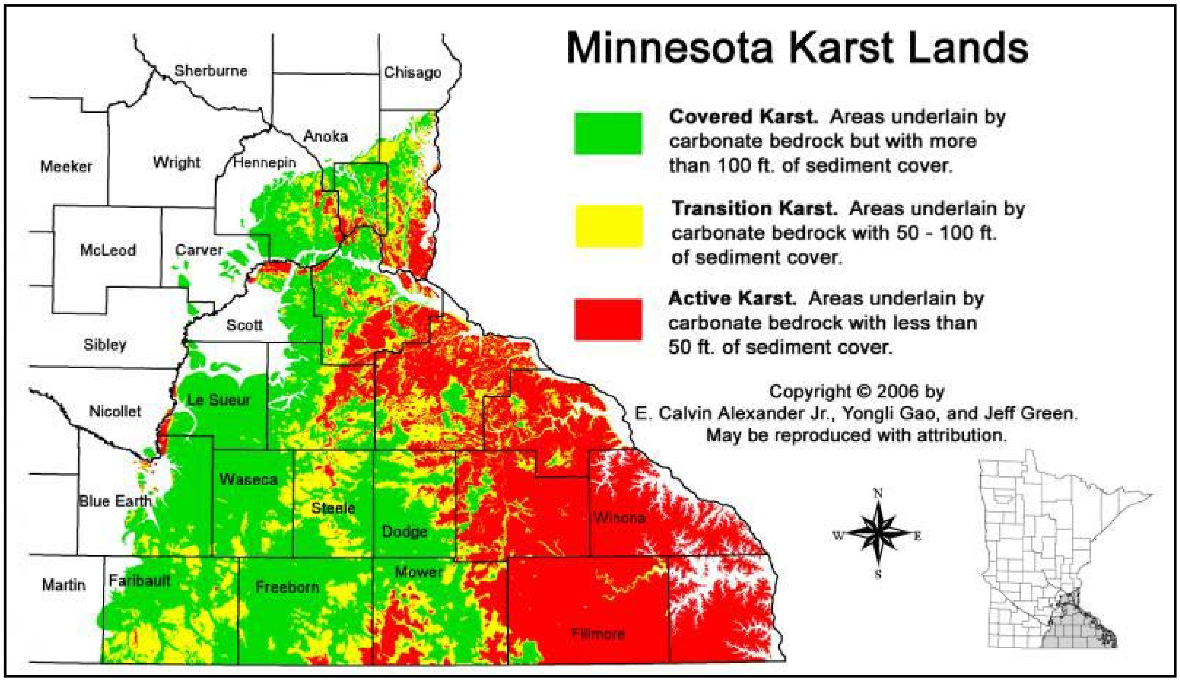


Figure 43 Karst Landforms in Minnesota



Source: E. Calvin Alexander Jr., Yongli Gao, and Jeff Green, 2006

Sinkhole and Land Subsidence History in Minnesota

Southeastern Minnesota's subsurficial geology make the area's ground water supplies vulnerable to petroleum and other chemicals released from underground storage. Agricultural spills and fertilizers can quickly and unpredictably appear in the source water. As the area's limestone is dissolved by infiltrating rainwater, pathways can form, creating a fast transportation network between pollution sources and fresh water. This results in common hydrogeologic tools such as well-monitoring becoming fairly useless (Minnesota Pollution Control Agency, 2011).

The environmental problems that occur in Minnesota's karst country are vast, including the pollution of both drinking water wells and surface water due to quickly traveling pollution and the transmission between above and below-ground water sources; and the collapse of carbonate bedrock beneath liquid storage basins, which has been reported in Minnesota. Since 1976, three communities in the Southeast (Altura, Bellechester, and Lewiston) have had municipal sewage lagoons collapse, resulting in millions of gallons of sewage being released into a nearby aquifer (Minnesota Pollution Control Agency, 2011).

In 2001 it was cited that some people in Fillmore County had not been able to drink their water in 20 years, due to its vulnerability to pollution in the sinkhole prone area. County residents found high concentrations of nitrates in their water, in addition to E. coli, fecal coliform bacteria, and oil products. One-quarter to one-third of the Fillmore County private wells were found to have nitrates above standard, with another third containing bacteria (Druley, 2001).

East central Minnesota also contains karst sinkholes, with 250 mapped in Pine County. Sinkholes developed close to the town of Askov's sewage treatment ponds. The sinkholes were discovered when the Minnesota Pollution Control Agency began the review process for upgrading the forty-year old sewage treatment ponds. The result has been a building moratorium in Askov, keeping new homes and businesses from joining the town (Hemphill, 2004).

University of Minnesota Professor Calvin Alexander notes that dozens, probably hundreds, of new sinkholes form every year, including some in the Twin Cities. Seven Oaks Park in Minneapolis is a sinkhole, and in 2010 a man walking down a sidewalk in St. Paul feel into a 15-foot deep sinkhole (Tellier, 2013).

Probability of Occurrence

The probability of sinkholes and land subsidence in Minnesota is directly related to local landscape conditions and triggers likely to produce these conditions. Sinkhole probability is highly site-specific, and cannot be accurately characterized on a statewide basis, except in the most general sense. In Minnesota, karst features are most widespread in the southeast. Table 40 shows the vulnerability of Minnesota Counties to land subsidence due to sinkholes and karst features. The counties of Fillmore, Olmsted, and Winona have the highest vulnerability.

Vulnerability

The counties of Fillmore, Olmsted, and Winona have the highest vulnerability based on the number of stream sinks and sinkholes.

Table 40 Top Ten Minnesota Counties with Significant Karst Features

County with Karst Features	Number of Springs	Number of Stream Sinks	Number of Sinkholes	Approx. Percent of County covered in Active Karst
Dakota	69	0	36	25-50%
Dodge	59	1	85	10-25%
Fillmore	870	140	6,137	75-100%
Goodhue	159	9	372	75-100%
Houston	71	0	64	75-100%
Mower	94	18	301	25-50%
Olmsted	534	6	956	75-100%
Wabasha	45	2	197	75-100%
Washington	138	1	44	25-50%
Winona	305	12	664	75-100%

Land Subsidence and Climate Change

The increased magnitude and frequency of flooding events that may result from climate change may in turn increase the risk of land subsidence in Minnesota if associated geological conditions exist.

4.5.12 Drought

A state of drought occurs when a region experiences a decline in expected precipitation over an extended period of time, typically one or more seasons in length. Drought is a “creeping phenomenon” due to the gradual nature of a drought’s onset and end. Defining droughts is complex due to regional differences in normal precipitation and climate conditions. Drought is a normal part of virtually every climate on the planet, including areas of both high and low normal rainfalls. Drought can be further defined and described by the following four categories:

Meteorological drought – the level of the departure of actual precipitation from normal or expected amounts.

Agricultural drought – a situation where the amount of moisture in the soil fails to meet the water demands of plant life or a particular crop.

Hydrological drought – occurs when deficient precipitation leads to below normal water supplies in stream flows and reservoir, lake, and groundwater levels.

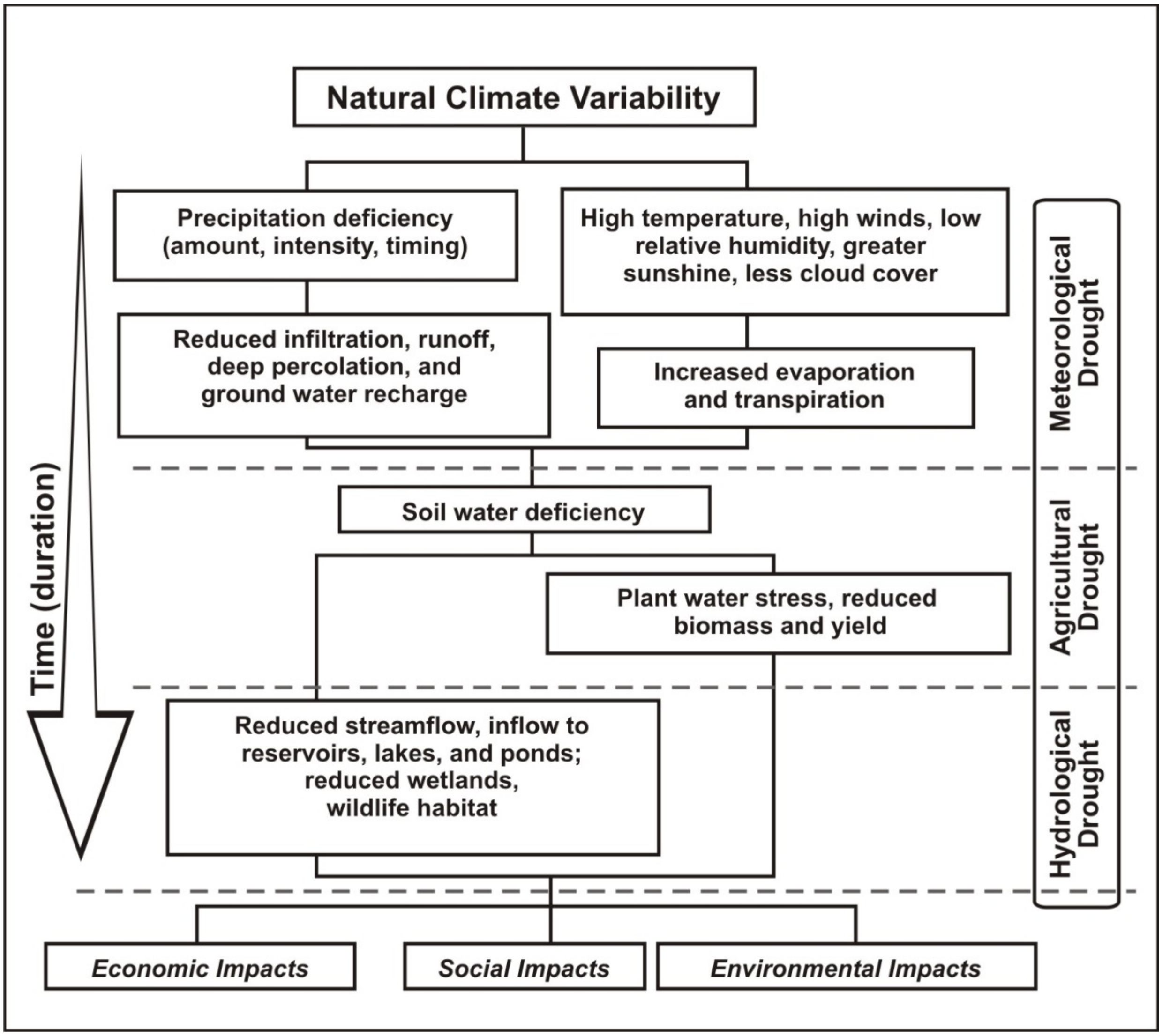
Socioeconomic drought – occurs when the demand for water exceeds the supply due to deficient precipitation and/or poor water management and affects people in terms of economic goods or services.

A drought’s severity depends on numerous factors, including duration, intensity, and geographic extent as well as regional water supply demands by humans and vegetation. Due to its multi-dimensional nature, drought is difficult to define in exact terms and poses difficulties in terms of comprehensive risk assessments. The illustration that follows shows the sequence of drought occurrence and the impacts of various drought types.

Drought differs from other natural hazards in three ways. First, the onset and end of a drought are difficult to determine due to the slow accumulation and lingering effects of an event after its apparent end. Second, the lack of an exact and universally accepted definition adds to the confusion of its existence and severity. Third, in contrast with other natural hazards, the impact of drought is less obvious and may be spread over a larger geographic area. These characteristics have hindered the preparation of drought contingency or mitigation plans by many governments.

Droughts may cause a shortage of water for human and industrial consumption, hydroelectric power, recreation, and navigation. Water quality may also decline and the number and severity of wildfires may increase. Severe droughts may result in the loss of agricultural crops and forest products, undernourished wildlife and livestock, lower land values, and higher unemployment.

Figure 44 Sequence of drought occurrence and impacts for commonly accepted drought types.

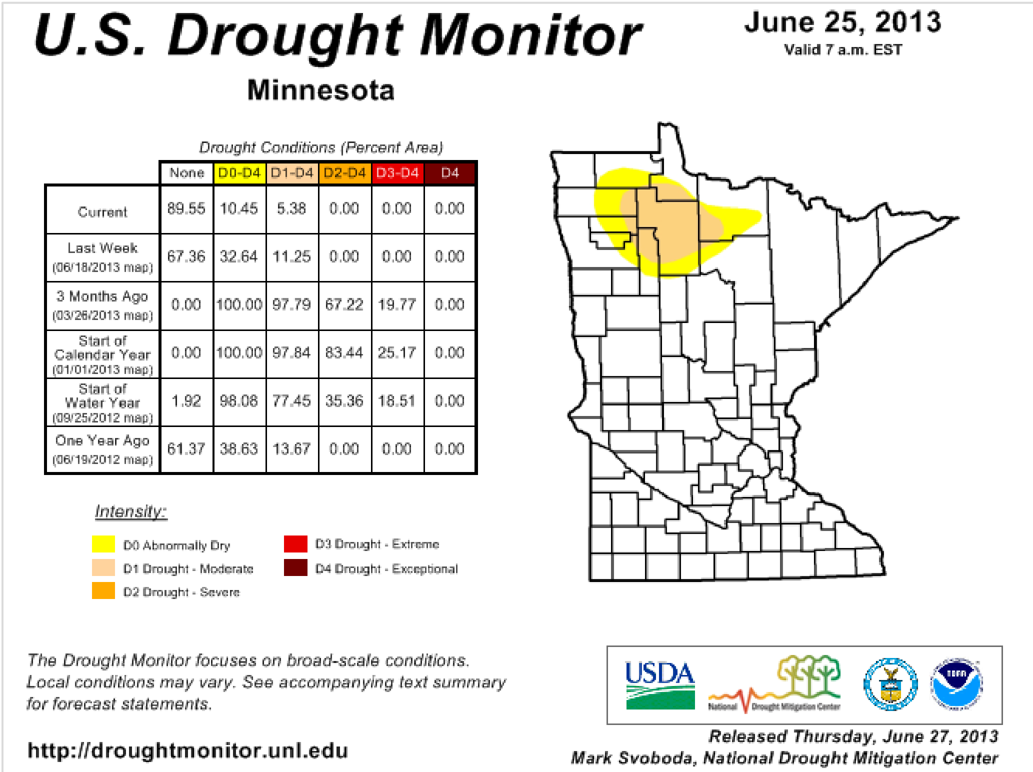


Source: National Drought Mitigation Center, University of Nebraska-Lincoln.

All droughts originate from a deficiency of precipitation or meteorological drought but other types of drought and impacts cascade from this deficiency (National Drought Mitigation Center).

The magnitude of a drought’s severity in terms of its impact on society, the environment, and the economy depend on the intensity, duration, and spatial extent of the drought, combined with other factors such as prolonged high winds and low relative humidity. The U.S. Drought Monitor, a weekly index depicting the location and intensity of drought conditions, is used for defining drought phases by blending quantitative and qualitative indicators. Maps prepared by the Drought Monitor are shown for Minnesota for June 25, 2013.

Figure 45 U.S. Drought Monitor for Minnesota, June 25, 2013

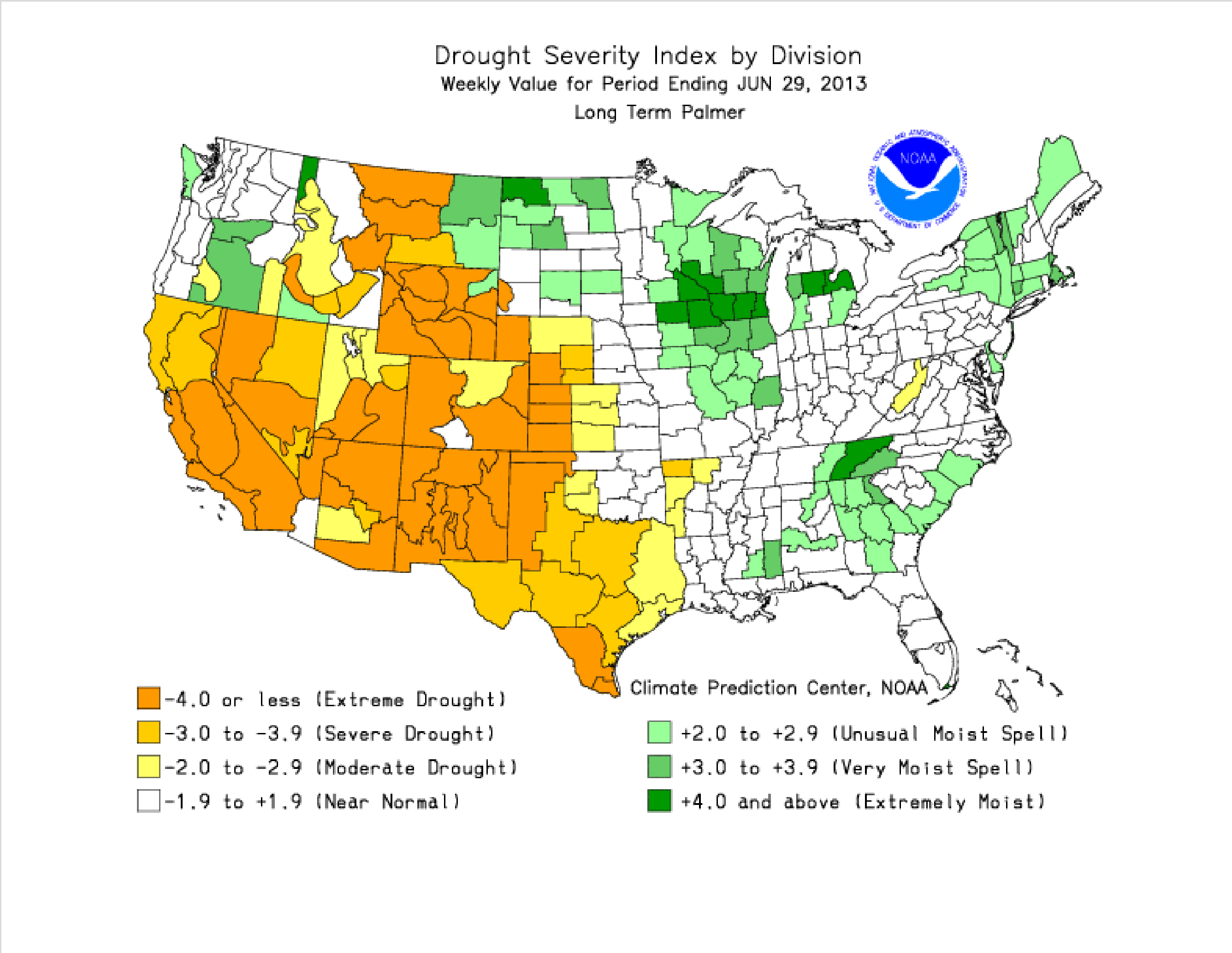


	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	89.55	10.45	5.38	0.00	0.00	0.00
Last Week (06/18/2013 map)	67.36	32.64	11.25	0.00	0.00	0.00
3 Months Ago (03/26/2013 map)	0.00	100.00	97.79	67.22	19.77	0.00
Start of Calendar Year (01/01/2013 map)	0.00	100.00	97.84	83.44	25.17	0.00
Start of Water Year (09/25/2012 map)	1.92	98.08	77.45	35.36	18.51	0.00
One Year Ago (06/19/2012 map)	61.37	38.63	13.67	0.00	0.00	0.00

Another measurement of drought in the U.S. is the Palmer Drought Severity Index, a water balance index accounting for water supply (precipitation), demand (evapotranspiration), and loss (runoff). It uses temperature and rainfall information to determine dryness in a given area based on the local climate. Long Term Palmer to map drought severity by division (June 2013) is published weekly.

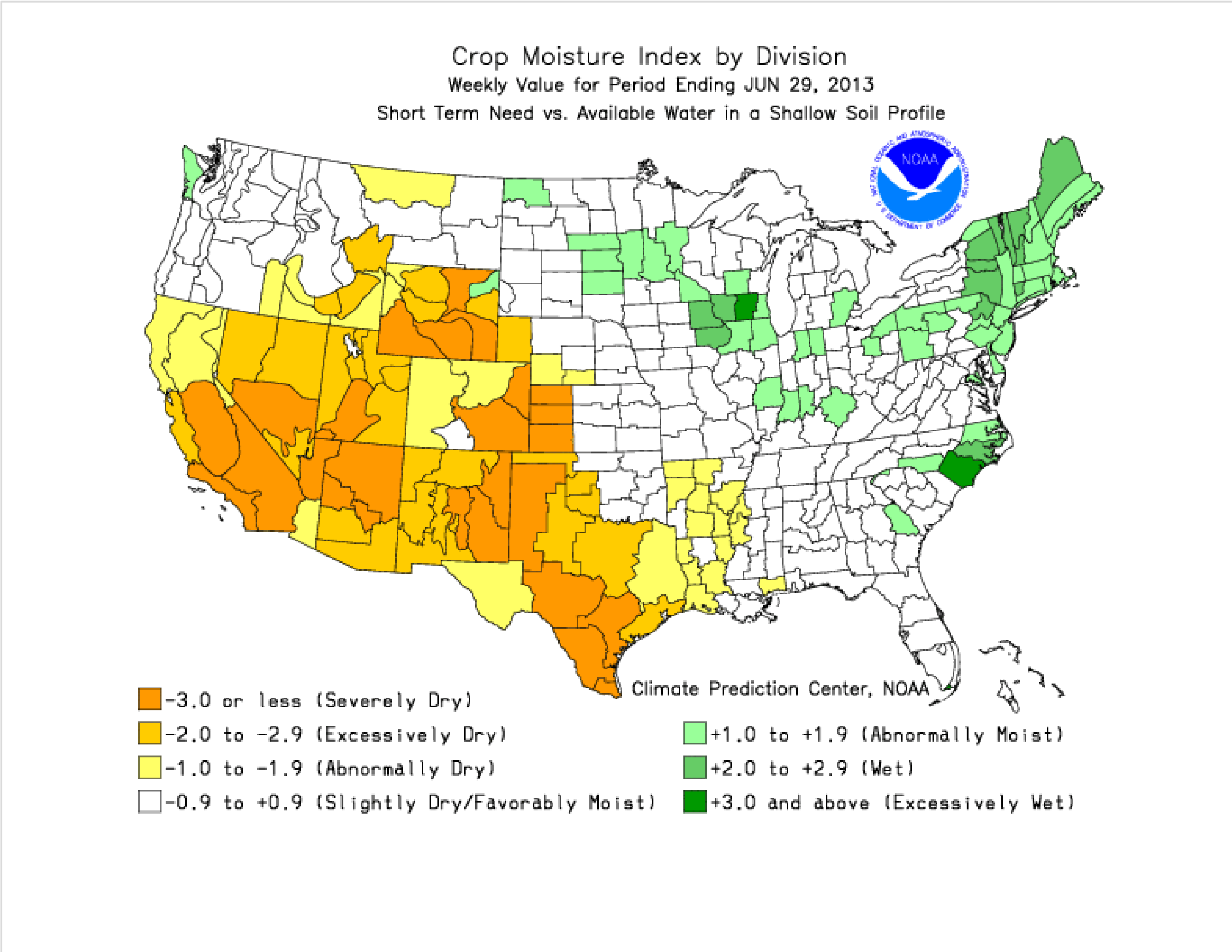
The Crop Moisture Index or CMI uses the Palmer Index in a more short-term measurement of drought conditions in an area where weekly precipitation and temperature levels are directly affecting agriculture.

Figure 46 Drought Severity Index by Division, Week of June 29, 2013



Crop moisture index by division for the week of June 29, 2013, indicating Minnesota's high moisture levels during this time.

Figure 47 Crop Moisture Index by Division, Week of June 29, 2013



Drought History in Minnesota

During the 1987-1989 droughts, a State Drought Task Force was convened by the Minnesota Department of Natural Resources (DNR), Director of the Division of Waters. The State Drought Task Force brought together local, state, and federal officials to share information and coordinate drought response strategies.

In addition to the Palmer Drought Severity Index, the Division of Waters uses actual precipitation, stream flow, lake level, ground water level, and water use data to assess the status of hydrologic conditions in Minnesota. On a weekly basis, the Division of Waters produces maps of stream flow, precipitation, and seasonal departures from normal.

Crop loss by county from 2003-2012 are seen on the figure that follows. Notable droughts from 2010-2013 are listed in Table 41.

Figure 48 Estimated amount of crop loss in dollars due to drought, by county, 2010-2012

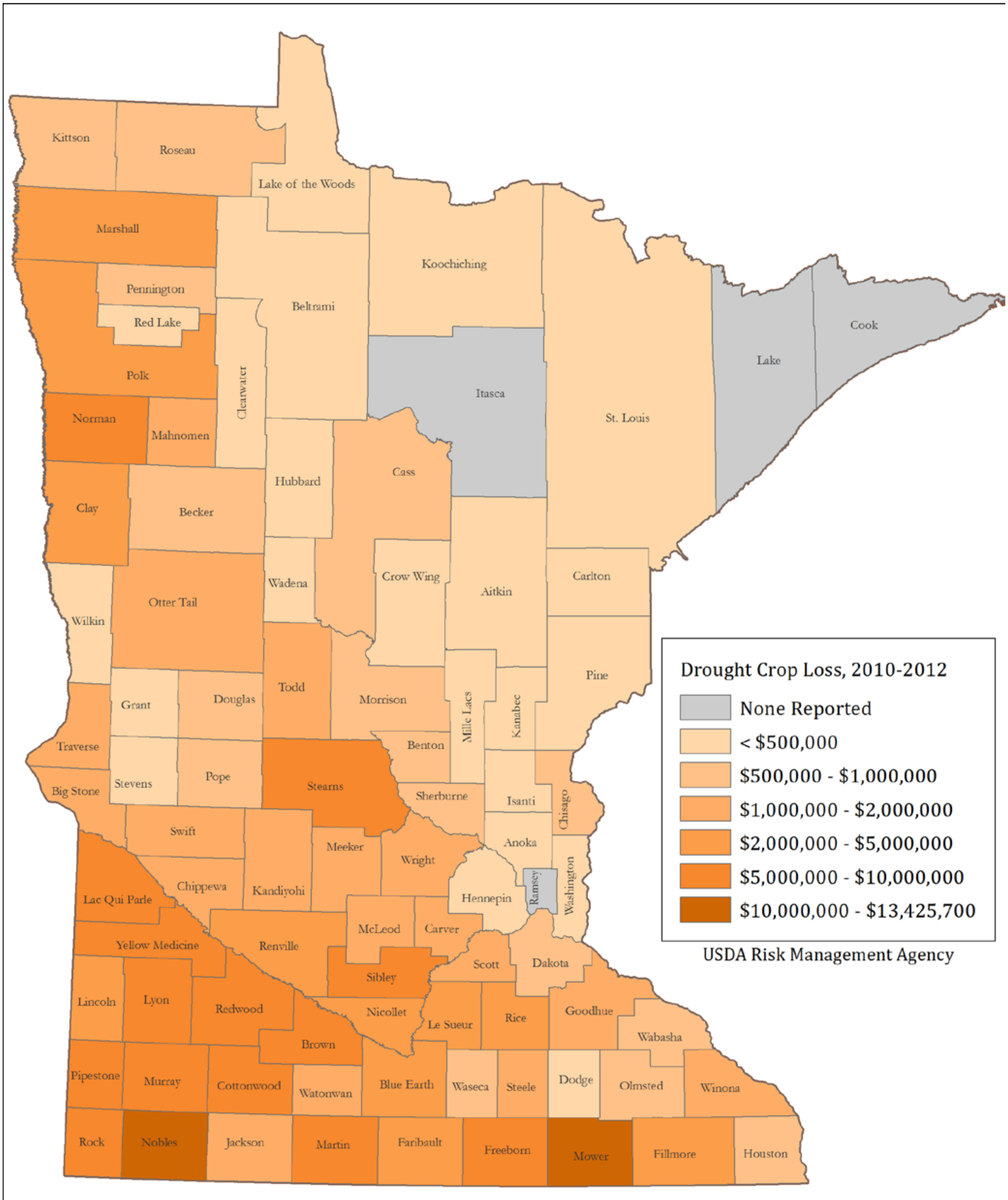


Table 41 Notable Minnesota Droughts, 2010-2013

Dates	Location	Remarks
September 2012 – April 2013	Statewide	The entire state experienced drought conditions including sizable areas classified as (D3) Extreme Drought by the U.S. Drought Monitor.
January – March 2012	Statewide	96% of the state in moderate or severe drought.
Autumn 2011	Twin Cities	Driest meteorological autumn in the Twin Cities since record-keeping began in 1871. In November over 20% of the state was in Severe Drought (D2) conditions, which increased in December (24%) and continued into 2012.
August 2010	Northern Cook / Northern Lake, Southern Cook	A lack of appreciable rain led to a continuation of the Severe (D3) drought conditions across parts of the Arrowhead, according to the U.S. Drought Monitor.
July 2010	Central St. Louis, Northern Cook / Northern Lake	Precipitation was slightly below normal for the Arrowhead region of northeast Minnesota, leading to a continuation of Severe (D2) drought conditions in July. Drought conditions expanded further southwest throughout the month to include portions of central St. Louis County, including the Iron Range.
June 2010	Northern Cook / Northern Lake, Southern Cook, Southern Lake	Severe (D2) drought conditions persisted through August in Lake and Cook counties, according to the U.S. Drought Monitor. Precipitation was near to slightly below normal for the month.
May 2010	Northern Cook / Northern Lake, Southern Lake, Southern St. Louis / Carlton	Severe (D3) drought conditions continued through May across the Arrowhead of Minnesota, due to lack of appreciable precipitation. The area covered Cook, Lake, and far southeast St. Louis counties.
April 2010	Central St. Louis, Northern Cook / Northern Lake, Southern Cook, Southern Lake, Southern St. Louis / Carlton	Very little rain fell across the Arrowhead of Minnesota during the month of April. Precipitation totals were only 10 to 25 percent of normal for the month. This lack of rain allowed for severe (D2) drought conditions to develop by the end of the month across Cook, Lake, and far southeastern St. Louis counties, according to the U.S. Drought Monitor.

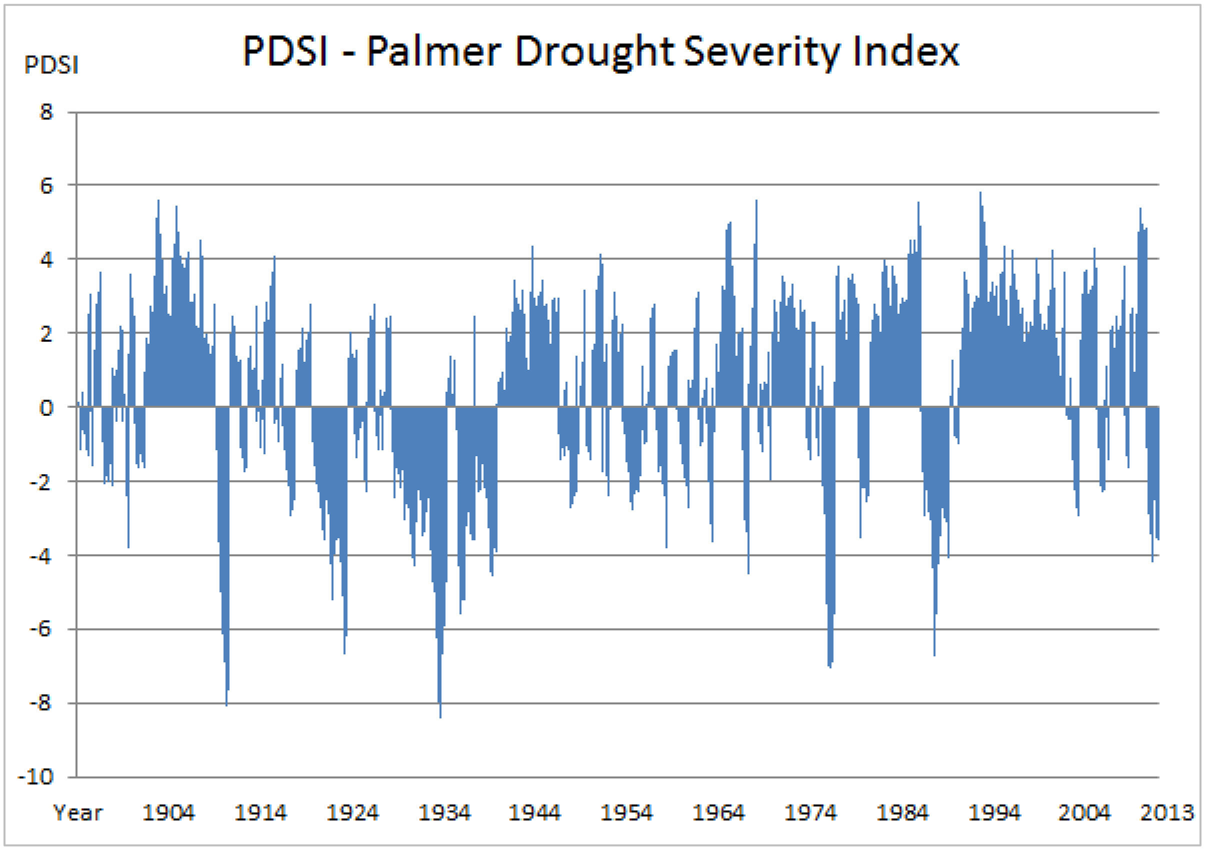
Below is an update from the Minnesota Climatology Working Group regarding the drought outlook for the state (August 2013):

> The *U. S. Drought Monitor*, released on August 1, places small portions of northwest and north central Minnesota in the *Moderate Drought* category. The latest release also places a swath of southwest and central Minnesota in the *Abnormally Dry* category. Just two percent of Minnesota's landscape is in *Moderate Drought*, a substantial improvement over early April when 67 percent of Minnesota was experiencing *Extreme Drought* or *Severe Drought*. The expansion of the *Abnormally Dry* area is due to July rainfall shortfalls of two to four inches. Subsoil moisture reserves and cool late-July weather have alleviated serious drought concerns thus far.

> *Subsoil moisture* across 28 percent of Minnesota's landscape is said to be *Short* or *Very Short*. Thirty-eight percent of recent reports indicate *Short* or *Very Short* topsoil moisture.

Figure 49 shows the Palmer Drought Severity Index. Values of -1.9 to +1.9 are considered normal. All values above +1.9 represent increasing moistness, with +4.0 and above classified as “Extremely Moist.” All values below -1.9 are considered drought conditions, with -4.0 or less being “Extreme Drought.”

Figure 49 Palmer Drought Severity Index for Minnesota



Source: NOAA National Climatic Data Center

Probability of Occurrence

The future incidence of drought is highly unpredictable, and may also be localized, making it difficult to determine probability with any accuracy. Interpreting what is “too dry” or what is “too long” is difficult. What we do know is that when a serious hydrologic imbalance occurs in Minnesota, soil moisture reserves, groundwater supplies, lake levels, and stream flows are negatively influenced. Water-dependent industries including agriculture, public utilities, forestry, and tourism are profoundly affected. Because long-term (months/years) climate variations are unpredictable, drought is also largely unpredictable. The State probability ranking for drought is High, and is ranked as having Low mitigation potential.

Vulnerability

Drought presents vulnerabilities to the entire state of Minnesota. Estimated amount of crop loss in dollars due to drought, by county, 2010-2012 shows the counties where crops are vulnerable to damage from drought. The drying effect of drought on vegetation also increases the risk of wildfire and the vulnerability of structures located in wild lands to damage. Water supply in the form of lowered inventory in aquifers is also vulnerability

Drought and Climate Change

Droughts have been happening throughout Minnesota's history and it is not yet clear how climate change may impact this (Interagency Climate Adaptation Team, 2013, p. 13). While there was no apparent change in drought duration in the Midwest over the past century (Dai, 2011), the average number of days without precipitation is projected to increase in the future (National Climate Assessment Development Advisory Committee, p. 630).

Even in areas where precipitation does not decrease, projected higher air temperatures will cause increases in surface evaporation and loss of water from plants, leading to drier soils. As soil dries out, a larger proportion of the incoming heat from the sun goes into heating the soil and adjacent air rather than evaporating its moisture, resulting in hotter summers under drier climatic conditions (Mueller & Seneviratne, 2012).

4.5.13 Extreme Heat

Extreme summer heat is the combination of very high temperatures and exceptionally humid conditions. If such conditions persist for an extended period of time, it is called a heat wave (FEMA, 1997). Heat stress can be indexed by combining the effects of temperature and humidity, as shown in

Table 42. The index estimates the relationship between dry bulb temperatures (at different humidity) and the skin's resistance to heat and moisture transfer - he higher the temperature or humidity, the higher the "feels like" temperature. The major human risks associated with extreme heat are as follows:

Heatstroke: Considered a medical emergency, heatstroke is often fatal. It occurs when the body's responses to heat stress are insufficient to prevent a substantial rise in the body's core temperature. While no standard diagnosis exists, a medical heatstroke condition is usually diagnosed when the body's temperature exceeds 105°F due to environmental temperatures. Rapid cooling is necessary to prevent death, with an average fatality rate of 15%, even with treatment.

Heat Exhaustion: While much less serious than heatstroke, heat exhaustion victims may complain of dizziness, weakness, or fatigue. Body temperatures may be normal or slightly to moderately elevated. The prognosis is usually good with fluid treatment.

Heat Syncope: This refers to sudden loss of consciousness and is typically associated with people exercising who are not acclimated to warm temperatures. Causes little or no harm to the individual.

Heat Cramps: May occur in people unaccustomed to exercising in the heat and generally ceases to be a problem after acclimatization.

In addition to affecting people, severe heat places significant stress on plants and animals. The effects of severe heat on agricultural products may include reduced yields and even loss of crops.

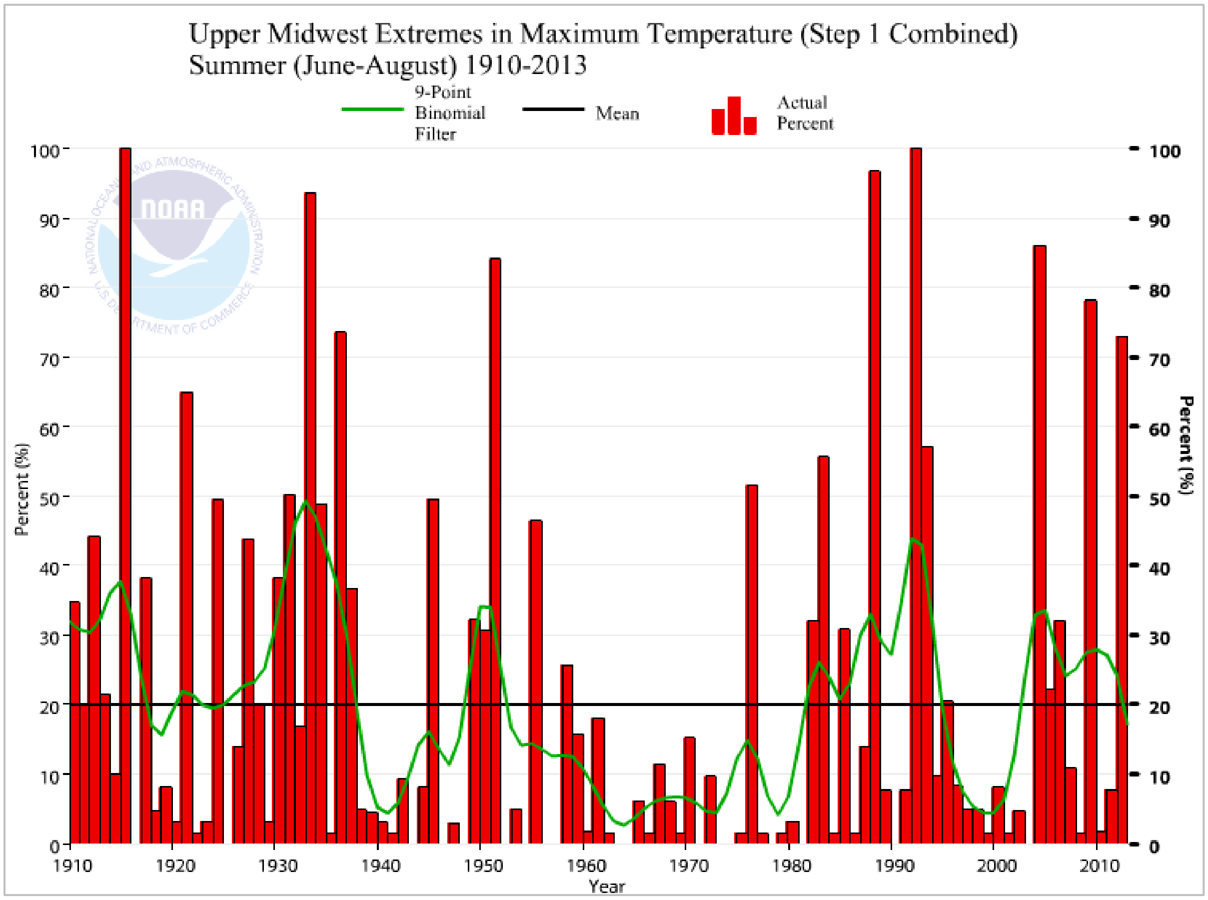
Table 42 Heat Index and Disorders

Danger Category		Heat Disorders	Apparent Temperatures (°F)
IV	Extreme Danger	Heatstroke or sunstroke imminent.	>130
III	Danger	Sunstroke, heat cramps, or heat exhaustion likely; heat stroke possible with prolonged exposure and physical activity.	105-130
II	Extreme Caution	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and physical activity.	90-105
I	Caution	Fatigue possible with prolonged exposure and physical activity.	89-90

Extreme Heat History in Minnesota

Figure 50 shows Upper Midwest maximum summer (June through August) temperature trends (% of land mass with highs in upper 10th percentile) based on the U.S. Climate Extremes Index (CEI). The curved green line is a nine-point binomial filter which shows the decadal-scale variations. Annual average temperatures across the Midwest show a trend towards increasing temperature. The trend calculated over the period 1895-2010 is equal to an increase of 1.5°F.

Figure 50 Upper Midwest Maximum Temperature Extremes, 1910-2013



Source: NOAA National Climatic Data Center

Extreme temperature events (both heat and cold) have caused 20 deaths and $2.5 million in damages in Minnesota from 1995-2012. There was one heat related death from 2008-2012. In 1995, approximately $2 million in property damage and two deaths were reported from high temperatures. Dew points in the 70°s to around 80° combined with temperatures in the middle 90°s to low 100°s to produce heat indices in the 105° to 120° range. Table 43 shows recent extreme heat events in Minnesota (2010-2013).

Table 43 Extreme Heat History in Minnesota, 2010-2013

Year	Location	Comment
August 2013	Twin Cities and southern Minnesota	Dangerously high heat and humidity. One of the hottest State Fairs in MN history, where 4 people were transported to hospitals for heat-related illness.
July 16, 2012	Rock, Pipestone, Nobles, Cottonwood, Lyon, Lincoln, Jackson, Murray	A combination of high heat and humidity consisted of daytime temperatures reaching the 90°s, and dew points in the 70°s. The heat index went as high as 105°.
July 2-6, 2012	Cottonwood, Rock, Jackson, Lincoln, Nobles, Murray, Lyon, Pipestone	Daytime temperatures reached the 90°s to just above 100°, and dew points were in the 70°s. The heat

Year	Location	Comment
		index went as high as 110°. 3 heat-related deaths occurred in Hennepin County.
June 27, 2012	Murray, Pipestone, Lyon, Rock, Lincoln, Jackson, Nobles, Cottonwood	A combination of high heat and humidity, with temperatures reaching the 90°s and dew points in the 70°s, pushed the heat index over 100°.
July 18-20, 2011	Watonwan, Redwood, Renville, Martin, Faribault, Rice, Ramsey, Pope, Sherburne, Benton, Anoka, Steele, Stearns, Waseca, Chippewa, Sibley, Mille Lacs, Meeker, McLeod, Goodhue, Freeborn, Washington, Dakota, Chisago, Isanti, Hennepin, Le Sueur, Lac Qui Parle, Nicollet, Scott, Brown, Carver, Wright, Swift, Stevens, Yellow Medicine, Blue Earth, Douglas, Kandiyohi, Kanabec, Todd, Morrison	Oppressive heat and humidity developed. The heat wave broke records for temperature, dew point, and heat indices across the region. Maximum heat index values of 115° to 125° were common.
July 17-20, 2011	Dodge, Mower, Wabasha, Olmsted, Winona, Houston, Fillmore	Heat indices topped out between 110° and 120°. Most of the counties across southeast Minnesota opened cooling centers with Winona County reporting a total of 46 people using the cooling center. Several farmers lost livestock due to the heat. Rochester set known records for highest heat index ever (118°) and highest dew point (83°).
July 16-20, 2011	Clay, West Polk, West Otter Tail, Wilkin, East Becker, Hubbard, South Clearwater, Norman, East Polk, Mahnomen, West Becker, Red Lake, Grant, Wadena, East Otter Tail	The temperature at Moorhead, Minnesota, peaked at 93° with a dew point of 88°, which gave it a heat index of 130°. Reported to be one of the hottest places on earth.
July 15-20, 2011	Nobles, Rock, Jackson, Lincoln, Murray, Pipestone, Lyon, Cottonwood	Heat indices rose above 115° during the day, with temperatures reaching the 90°s and dew points remaining in the 70°s to lower 80°s. There were several reports of livestock deaths.
June 7, 2011	Ramsey, Hennepin	Temperatures soared in the Twin Cities, passing the 100° mark and breaking an all-time record for June 7. The National Weather Service recorded a temperature of 103° at the Minneapolis-St. Paul International Airport. The high fell one degree short of the all-time June record of 104° in 1934.
August 12, 2010	Dodge County	Maximum apparent temperature of 109°.

Source: NOAA, NCDC

Probability of Occurrence

The annual probability of extreme temperatures occurring is clearly quite high, although most year-to-year temperature extremes will be within normal statistical bounds.

The National Climate Assessment draft report predicts increased heat wave intensity and frequency, with associated health and infrastructure risks. In Minnesota, there has been a noticeable increase in tropical dew points (over 70 degrees) which leads to very high heat indexes (Seeley presentation, 2013). Humidity increases the health risks of heat for many vulnerable populations such as the elderly, children, outdoor workers and those living without air conditioning.

Extreme Heat and Climate Change

Minnesota's average temperature has increased more than 1.5 degrees F since recordkeeping began in 1895, with increased warming happening in recent decades (Interagency Climate Adaptation Team, p. 4). Annual temperatures in the Midwest have generally been well above the 1901-1960 average since the late 1990s, with the decade of the 2000s being the warmest on record (Kunkel, K.E. et al, 2013).

The Midwest has experienced major heat waves and their frequency has increased over the last six decades (Perera et al. 2012). For the U.S., mortality increases 4% during heat waves 2 compared with non-heat wave days (Anderson and Bell 2011). During July 2011, 132 million people across the U.S. were under a heat alert – and on July 20 the majority of the Midwest experienced temperatures in excess of 100°F. Heat stress is projected to increase as a result of both increased summer temperatures and humidity (Schoof 2012).

4.5.14 Extreme Cold

Wintertime in Minnesota can be a brutal time, and especially dangerous for disabled citizens and outdoor workers. Record temperature lows and arctic-like wind chill factors can cause cold-related illnesses such as frostbite and hypothermia, which can be deadly. The two major human risks associated with extreme cold are as follows:

Frostbite: Frostbite occurs when skin tissue and blood vessels are damaged from exposure to temperatures below 32°F. The most susceptible parts of the body are fingers, toes, ear lobes, or the tip of the nose. Symptoms include a loss of feeling in the extremity and a white or pale appearance. The area should be slowly rewarmed.

Hypothermia: Hypothermia occurs when body temperature falls below 95°F. Young children under the age of two and the elderly, those more than 60 years of age, are most susceptible to hypothermia. Anyone who is exposed to severe cold without enough protection can develop hypothermia. Hypothermia is the greatest and most life-threatening cold weather danger.

In Minnesota, cold winter weather can have severe or fatal impacts. Wind chill factors can increase the risk of frostbite or hypothermia. The wind chill factor describes what happens to a body when it is cold and windy outside. As wind increases, heat is carried away from the body at a faster rate, driving down both skin temperature (which can cause frostbite) and eventually the internal body temperature (which can cause hypothermia). The NWS issues "Extreme cold" warnings when it feels like -30°F or colder across a wide area for several hours. Extreme cold watches are issued a day or two before the conditions are expected.

Below zero temperatures occur almost every winter for a period of time. January is the coldest month, with daytime highs averaging 20°F and nighttime lows averaging 2°F. However, these averages do not tell the whole story. Maximum temperatures in January have been as high as 61°F and minimums as low as -36°F.

Extreme cold temperatures affect the state nearly every year. A new record low temperature for Minnesota was set in the town of Tower on February 2, 1996, at -60°F. Numerous record low temperatures were set during the period at St. Cloud, Rochester and the Twin Cities. Minneapolis/St. Paul set three new record low temperatures as well as recording the second coldest day on record on

February 2, 1996. A mean temperature of -25°F was measured that day with a high of -17°F and a low of -32°F in the Twin Cities. This was within two degrees of tying the all-time record low temperature set in the Twin Cities and the coldest temperature recorded this century. Many central and southern Minnesota locations set new record low temperatures the morning of the 2nd. The governor closed all schools that day.

Extreme Cold History in Minnesota

Extreme temperature events (both heat and cold) have caused 20 deaths and $2.5 million in damages in Minnesota from 1995-2012. There were two cold related deaths from 2008-2012. Table 44 shows extreme cold events in Minnesota between 2011 and 2013.

Table 44 Extreme Cold History in Minnesota, 2011-2013

Year	Location	Comment
January 31, 2013	Big Stone, Traverse	Temperatures in the single digits to the teens below zero occurred, with wind chill values ranging between -35° and -40°.
January 20-22, 2013	East Becker, East Otter Tail, South Clearwater, North Clearwater, Mahnomen, East Polk, Red Lake, Pennington, South Beltrami, North Beltrami, East Marshall, Lake of the Woods, Roseau, Grant, West Otter Tail, Wilkin, Clay, Norman, West Polk, West Marshall, Kittson, Wadena, Hubbard, West Becker	Morning lows ranged from -15° to -25°, while daytime highs mainly stayed below zero. In combination with winds of 10 to 20 mph, wind chill readings dropped to -40° and -50° at times.
January 20-21, 2013	Big Stone, Traverse	Extreme wind chill values between -35° and -40°.
2012	Red Lake, West Polk, Roseau, East Marshall, West Marshall, Pennington	Morning lows dipped into the -10° to -20° range. Wind chills ranged from -30° to -35°.
February 10, 2012	Roseau, Norman, West Polk, Lake of the Woods, North Beltrami, East Marshall, West Marshall, South Beltrami, Red Lake, Pennington, East Polk, South Clearwater, North Clearwater, Mahnomen, Kittson	Temperatures dropped to the -10° to -20° range. Along with steady north winds of 10 to 20 mph, wind chill temperatures dipped into the -30° to -40° range.
January 19, 2012	Big Stone, Traverse	Extreme wind chills from -30° to -35° in west central Minnesota.
January 19, 2012	Southern Cass, Southern Lake, Southern St. Louis/Carlton, Northern Cook/Northern Lake, Koochiching, Southern Cook, Southern Itasca, Northern Itasca, Northern Cass, Crow Wing, Central St. Louis, Northern St. Louis	Wind chills in the -40° to -50° range occurred in most of northeast Minnesota. -53° in Grand Marais by Lake Superior. Other wind chills included -51° in Grand Portage, -45° in Little Fork, -43° in Brainerd, -42° in Duluth, and -40° in Grand Rapids.
January 18-19, 2012	West Marshall, Kittson, Wadena, Hubbard, South Beltrami, South Clearwater, East Becker, East Otter Tail, Wilkin, West Becker, West Otter Tail, Grant, Lake of the Woods, Roseau, Mahnomen, North Clearwater, Red	Low temperatures ranged from -15° to -25°. Combined with stiff northwest winds, temperatures felt like -35° to -45°.

Year	Location	Comment
	Lake, Pennington, East Polk, West Polk, North Beltrami, East Marshall, Clay, Norman	
February 8, 2011	Wilkin, Clay, Norman, Red Lake, Kittson, West Marshall, East Marshall, Pennington, Roseau, West Polk	Wind chills dropped to -40° over the Red River Valley region. A station by McHenry dipped to -49° below and Baker hit -46°.
February 8, 2011	Big Stone, Traverse	Wind chills of -35° to -40° across west central Minnesota.
February 2, 2011	Yellow Medicine, Chippewa, Lac Qui Parle, Stevens, Renville, Redwood, Watonwan, Nicollet, Brown, Swift, Pope, Kandiyohi	Wind chill values between -35° and -45° across west central and portions of southwest and south central Minnesota.
February 2, 2011	Big Stone, Traverse	Wind chills of -35° to -45.
February 1-2, 2011	West Otter Tail, Kittson, West Becker, Clay, Pennington, East Polk, West Polk, Mahnomen, Norman, Red Lake, Grant, East Marshall, West Marshall, Roseau, Wilkin	Combined with temperatures in the teens to lower 20s below zero, wind chill values plummeted to values of -40° or lower. The lowest wind chill reading was -44° in southwest Roseau County.
February 1-2, 2011	Jackson, Nobles, Rock, Lincoln, Murray, Pipestone, Lyon, Cottonwood	Wind chills reached -35° to -40° despite slowly decreasing winds, as temperatures fell further below zero.
January 21, 2011	Mahnomen, East Polk, Red Lake, Pennington, North Beltrami, East Marshall, South Beltrami, Roseau, Wadena, Hubbard, East Becker, South Clearwater, North Clearwater, Lake of the Woods	-40° measured at the Agassiz Refuge in eastern Marshall County, at Waskish in northern Beltrami County, and at Park Rapids in Hubbard County.

Source: NOAA, NCDC

Extreme Cold and Climate Change

There is not yet any observable trend related to extreme cold events and climate change in Minnesota. Cold temperatures have always been a part of Minnesota's climate and extreme cold events will continue. However, an increase in extreme precipitation or storm events such as ice storms as the climate changes could lead to a higher risk of residents being exposed to cold temperatures during power outages or other storm-related hazards during extreme cold.

4.5.15 Earthquake

An earthquake is a sudden motion or trembling caused by an abrupt release of accumulated strain in the tectonic plates that comprise the earth's crust. These rigid plates are some 50 to 60 miles in thickness and move slowly and continuously over the earth's interior. The plates meet along their edges, where they move away, past or under each other at rates varying from less than a fraction of an inch up to five inches per year. While this movement sounds minimal, at a rate of two inches per year a distance of 30 miles would be covered in approximately one million years (FEMA, 1997).

The tectonic plates continually bump, slide, catch, and hold as they move past each other which causes stress to accumulate along faults. When this stress exceeds the elastic limit of the rock, an earthquake occurs, immediately causing ground motion and seismic activity. Secondary hazards may also occur, such as surface faulting, sinkholes, and landslides. While the majority of earthquakes occur near the edges of the tectonic plates, earthquakes may also occur at the interior of plates.

The vibration or shaking of the ground during an earthquake is described by ground motion. The severity of ground motion generally increases with the amount of energy released and decreases with distance from the fault or epicenter of the earthquake. Ground motion causes waves in the earth's interior, also known as seismic waves, and along the earth's surface, known as surface waves. The following are the two kinds of seismic waves:

P (primary) waves are longitudinal or compressional waves similar in character to sound waves that cause back-and-forth oscillation along the direction of travel (vertical motion), with particle motion in the same direction as wave travel. They move through the earth at approximately 15,000 mph.

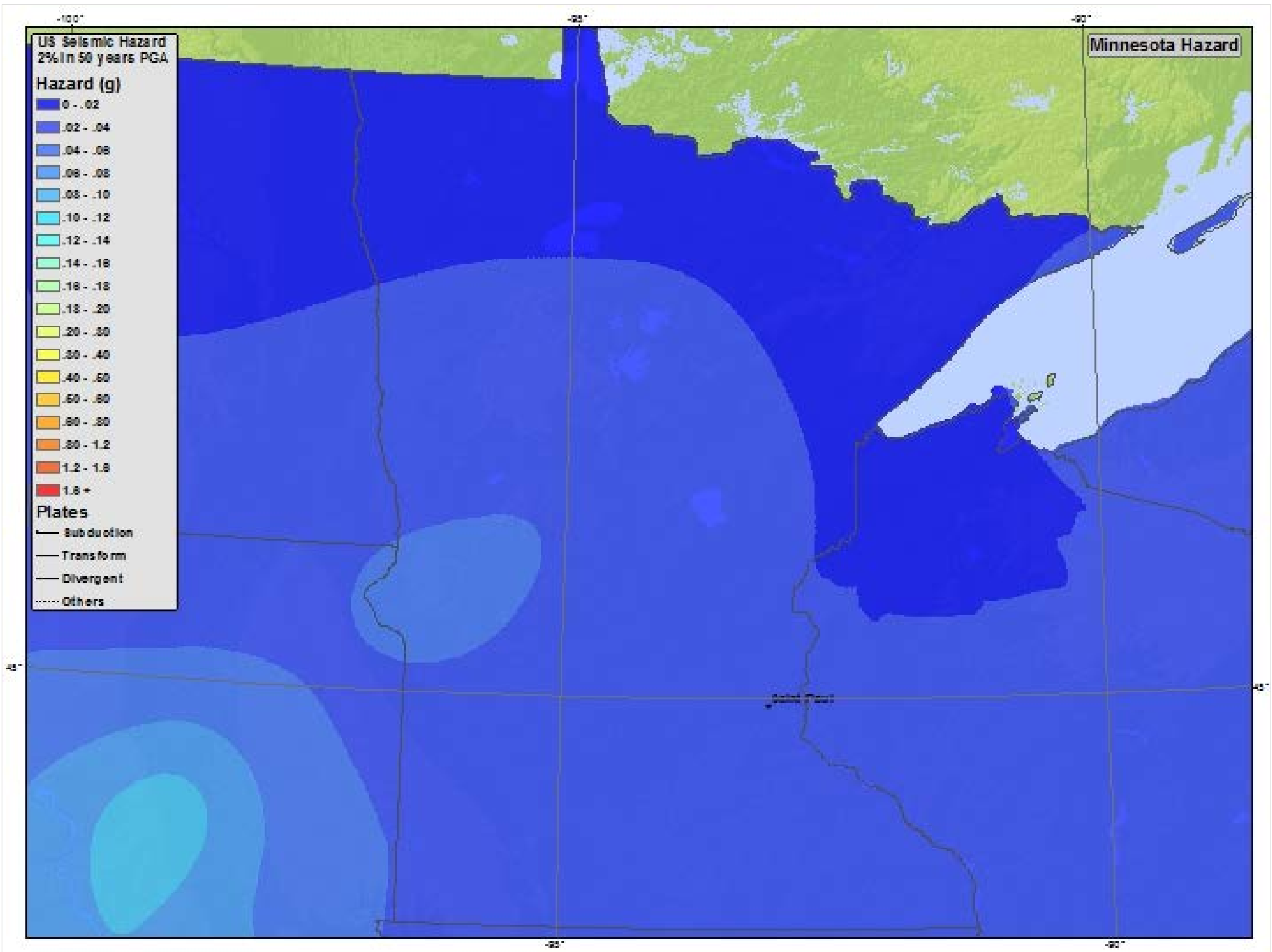
S (secondary) waves, also known as **shear waves**, are slower than P waves and cause structures to vibrate from side-to-side (horizontal motion) due to particle motion at right-angles to the direction of wave travel. Unreinforced buildings are more easily damaged by S waves.

There are also two kinds of surface waves, Raleigh waves and Love waves. These waves travel more slowly and typically are significantly less damaging than seismic waves.

Seismic activity is described in terms of magnitude and intensity. *Magnitude* (M) describes the total energy released by the seismic wave, commonly referred to using the Richter scale, and *Intensity* (I) subjectively describes the effects at a particular location. Although an earthquake has only one magnitude, its intensity varies by location. Magnitude is expressed on a logarithmic scale, meaning that an increase in value of one digit equates to a 10-fold increase that may in turn equate to approximately 30 times more energy. The largest known earthquakes have had magnitudes around 9.0, and the famous San Francisco earthquake of 1906 had a magnitude near 8.3. Although there have been notable exceptions, earthquakes with magnitudes less than 5.5 usually do not cause major damage or injuries. Intensity is a measure based on people's observations or felt reports at a particular location, and is expressed by the Modified Mercalli Intensity (MMI) scale.

Another way of expressing an earthquake's severity is to compare its acceleration to the normal acceleration due to gravity (Figure 51). If an object is dropped while standing on the surface of the earth (ignoring wind resistance), it will fall towards earth and accelerate faster and faster until reaching terminal velocity. The acceleration due to gravity is often called “g” and is equal to 9.8 meters per second squared (980 cm/sec/sec). This means that every second something falls towards earth, its velocity increases by 9.8 meters per second. Peak Ground Acceleration (PGA) measures the rate of change of motion relative to the rate of acceleration due to gravity. For example, acceleration of the ground surface of 244 cm/sec/sec equals a PGA of 25.0 percent.

Figure 51 Peak Ground Acceleration with 2% probability of exceedance in 50 years



Source: USGS

It is possible to approximate the relationship between PGA, the Richter scale, and the MMI. The relationships are, at best, approximate, and also depend upon such specifics as the distance from the epicenter and depth of the epicenter. An earthquake with 10.0 percent PGA would roughly correspond to an MMI intensity of V or VI, described as being felt by everyone, overturning unstable objects, or moving heavy furniture.

Table 45. Earthquake PGA, Magnitude, and Intensity Comparison

PGA (%g)	Magnitude (Richter)	Intensity (MMI)	Description (MMI)
<0.17	1.0 - 3.0	I	*I*. Not felt except by a very few under especially favorable conditions.
0.17 - 1.4	3.0 - 3.9	II – III	*II*. Felt only by a few persons at rest, especially on upper floors of buildings. *III*. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck.
1.4 - 9.2	4.0 - 4.9	IV – V	*IV*. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rock noticeably. *V*. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
9.2 - 34	5.0 - 5.9	VI – VII	*VI*. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight. *VII*. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
34 - 124	6.0 - 6.9	VII – IX	*VIII*. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. *IX*. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
>124	7.0 and higher	VIII or higher	*X*. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent. *XI*. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly. *XII*. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Source: Wald, Quitoriano, Heaton, and Kanamori, 1999.

Earthquake-related ground failure, due to liquefaction, is a common potential hazard from strong earthquakes in the central and eastern United States. Liquefaction occurs when seismic waves pass through saturated granular soil, distorting its granular structure and causing some of the empty spaces between granules to collapse. Pore-water pressure may also increase sufficiently to cause the soil to behave like a fluid for a brief period and cause deformations. Liquefaction causes lateral spreads (horizontal movement commonly 10-15 feet, but up to 100 feet), flow failures (massive flows of soil, typically hundreds of feet, but up to 12 miles), and loss of bearing strength (soil deformations causing structures to settle or tip). Sands blows were common following major New Madrid earthquakes in the central United States.

Earthquake History in Minnesota

The Midwest is far from any plate margin, but even here, earthquakes do occasionally happen. Although the earthquake-generating mechanism in the Midwest is incompletely understood, it may be related to the westward drift of the North American plate away from its spreading center, the Mid-Atlantic ridge, toward the subduction and transform zones along the Pacific coast. This westward drift sets up a subtle but pervasive compression that is oriented roughly east-west for most of North America, and this stress can reactivate minor movement along some ancient faults. The great forces that originally formed these ancient faults have long since ceased, but the faults themselves remain as zones of weakness that, if oriented appropriately to the modern stress field, could be slightly reactivated.

Minnesota has one of the lowest occurrence levels of earthquakes in the United States, but a total of 20 small to moderate earthquakes have been documented since 1860. Although the two earliest earthquakes may have had magnitudes of 4.7 to 5.0, the 1917 Staples earthquake documented a 4.3 magnitude. The largest earthquake on record in Minnesota occurred in 1975, with a magnitude of 4.6 and intensity of VI Also felt in Iowa and the Dakotas, the earthquake damaged walls and basement foundations in the town of Morris, located in Stevens County. Although less dramatic than the Staples or Morris events, the 1993 Dumont earthquake and the 1994 Granite Falls earthquake are more typical of those that occur in Minnesota. The magnitude 4.1 Dumont earthquake was felt over 26,873 square miles and was associated with intensity V-VI near the epicenter. The shaking near the epicenter was accompanied by a loud, explosive noise that alarmed many people, but no injuries or serious damage occurred. In contrast to the Dumont event, the much weaker Granite Falls earthquake (magnitude 3.1) was felt over only 4,478 square miles, and although intensity V may have occurred locally near the epicenter, most reported intensities were III to IV.

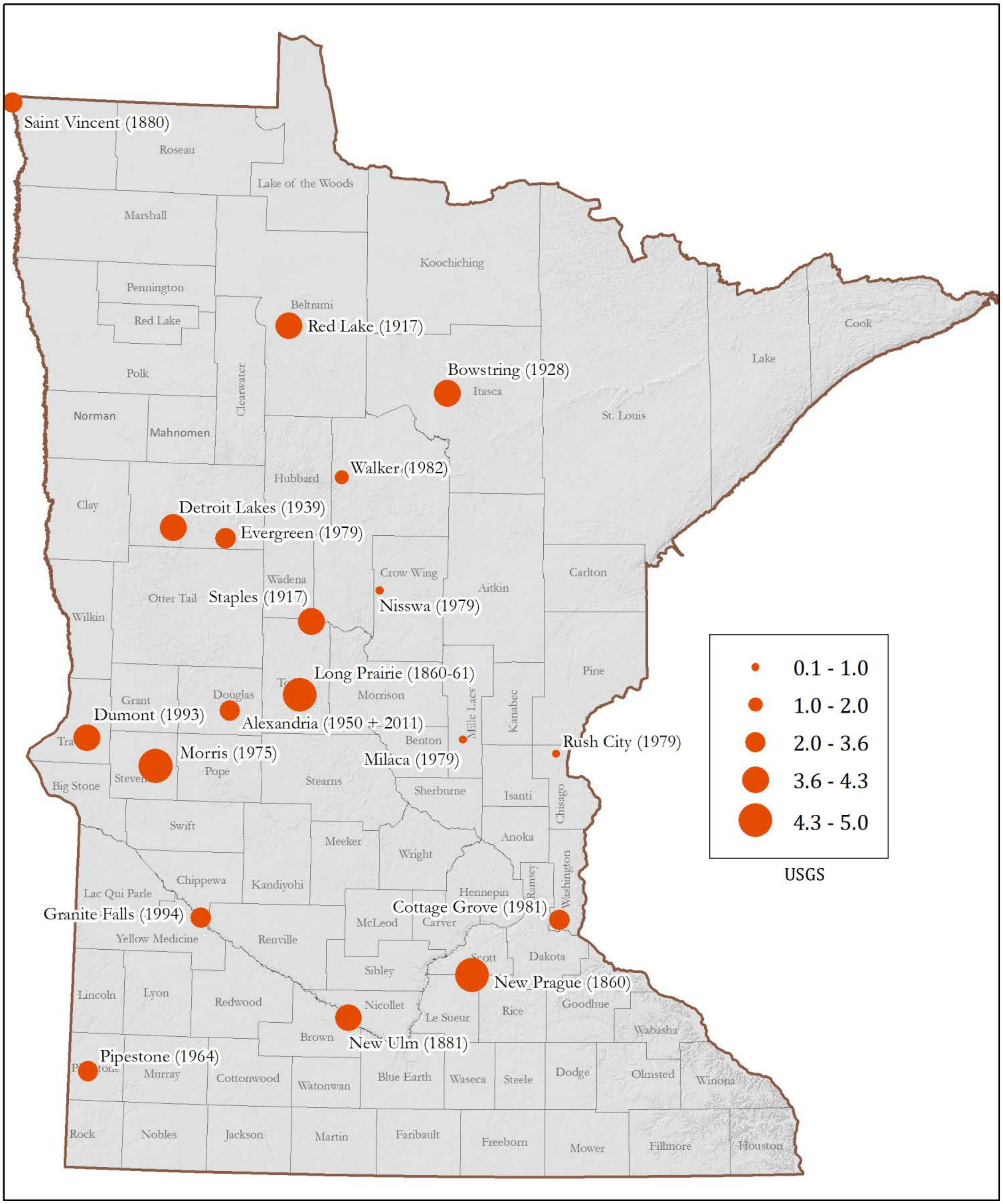
The most recent earthquake in Minnesota occurred in 2011 near Alexandria, with a magnitude of 2.5. However, there were no reports of damage or injury. The table and figure below document Minnesota's earthquake history.

Table 46 Earthquakes in Minnesota, 1860-2013

Epicenter (Nearest Town)	Date	Maximum Intensity	Magnitude
Alexandria	04-29-2011	N/A	2.5
Granite Falls	02-09-1994	V	3.1
Dumont	06-04-1993	V-VI	4.1
Walker	09-27-1982	II	2.0
Cottage Grove	04-24-1981	III-IV	3.6
Nisswa	07-26-1979	III	1.0
Rush City	05-14-1979	N/A	0.1
Evergreen	04-16-1979	N/A	3.1
Milaca	03-05-1979	N/A	1.0
Morris	07-09-1975	VI	4.7
Pipestone	09-28-1964	N/A	3.4
Alexandria	02-15-1950	V	3.6
Detroit Lakes	01-28-1939	IV	3.9
Bowstring	12-23-1928	IV	3.8
Staples	09-03-1917	VI-VII	4.3
Red Lake	02-06-1917	V	3.8
New Ulm	02-12-1881	VI	3.0-4.0
St. Vincent	12-28-1880	II-IV	3.6
New Prague	12-16-1860	VI	4.7
Long Prairie	(Date unknown) 1860-61	VI-VII	5.0

Source: USGS

Figure 52 Historical Earthquake Magnitudes on the Richter Scale



Several earthquakes occurring outside of Minnesota have still been felt in the state. On November 15, 1877, two earthquakes 45 minutes apart occurred in eastern Nebraska. The shocks caused damage in

North Platte and Columbus, Nebraska and in Sioux City, Iowa. Felt zones from these earthquakes encompassed an elliptical area roughly 600 by 300 miles, including the southwestern part of Minnesota.

A strong earthquake centered in Illinois occurred on May 26, 1909, affecting an area of approximately 500,000 square miles, including parts of Minnesota. Intensity VII effects were noted over a considerable area from Bloomington, Illinois to Platteville, Wisconsin. Many chimneys fell in Aurora, Illinois. Although details are lacking, this shock was probably felt at intensity IV or V in southeastern Minnesota. (Note that earthquakes with magnitudes less than 5.5 usually do not cause major damage or injuries)

An earthquake on February 28, 1925, centered in the St. Lawrence River region near La Malbaie, Quebec, Canada, was felt widely in the Northeastern United States. The shock was lightly felt in Minneapolis.

Ten years later, on November 1, 1935, another strong earthquake occurred near Timiskaming, Canada and was felt over an area of the United States estimated at one million square miles. This tremor was also lightly felt in Minneapolis.

In the autumn of 1968 an earthquake in Illinois was strong enough to be felt throughout the Twin Cities area and southern Minnesota, with a maximum intensity of I-IV.

Probability of Occurrence

Probabilistic ground motion maps are typically used to assess the magnitude and frequency of seismic events. These maps measure the probability of exceeding a certain ground motion, expressed as peak ground acceleration (PGA), over a specified period of years. The magnitudes of earthquakes are generally measured using the Richter scale. The severity of earthquakes is site specific and influenced by proximity to the epicenter and soil type, among other factors.

According to the Minnesota Geological Survey (MGS), Minnesota has one of the lowest occurrence levels of earthquakes in the United States; only 20 small to moderate earthquakes have been documented since 1860. MGS further notes that although weak to moderate earthquakes do occur occasionally in Minnesota, a severe earthquake is very unlikely. Average recurrence rates for Minnesota earthquakes have been estimated by the MGS (Mooney, 1979) as follows:

Magnitude 4.0 - 10 years

Magnitude 4.5 - 30 years

Magnitude 5.0 - 89 years

Magnitude 5.5 - 266 years

The absence of major earthquakes, together with the infrequency of earthquakes in general, implies a low risk level for Minnesota. (This statement, however, must be tempered in light of the brief span of historical record.) An earthquake history for the state has significant implications for public policy. For example, the location and design of nuclear power plants must be guided by an assessment of the probability of a damaging earthquake. Minnesota has two nuclear plants in operation, at Prairie Island (near Red Wing) and Monticello. The Monticello plant lies within the probable felt areas of three Minnesota earthquakes. The Prairie Island plant probably lies within the felt area of one Minnesota earthquake, as well as within the felt areas of several earthquakes with epicenters outside of Minnesota.

Building construction codes present another aspect of public policy dependent upon earthquake history. Certain standards of construction must be met depending upon earthquake zoning classification. The Uniform Building Code of the International Conference of Building Officials assigns every location in the United States to a five-grade Seismic Risk Zone (0 = least risk; 4 = greatest risk); Minnesota rates in Seismic Risk Zone 0. North Dakota and Wisconsin are also in Zone 0 in their entirety, in addition to most of Iowa and South Dakota.

Current data and knowledge indicates that, although weak to moderate earthquakes do occur occasionally in Minnesota, a severe earthquake is very unlikely. Although a zero probability of a damaging earthquake occurring in the time span of a human life cannot be assigned, the threat is very small compared to other natural hazards such as flooding and tornadoes. There is no known increased risk of earthquakes due to climate change.

Earthquakes and Climate Change

There is no evidence that climate change will increase the risk of earthquakes in Minnesota.

4.6 Other Hazards

4.6.1 Terrorism

In Minnesota, agencies such as the Minnesota Fusion Center, the Federal Bureau of Investigation's Joint Terrorism Task Force and regional law enforcement working groups work with the FBI in gathering evidence, making arrests, sharing intelligence, and working to prevent terrorist attacks. The Federal Bureau of Investigation, as the lead agency in terrorism investigations, use the U.S. Code of federal regulations 18 U.S.C. § 2331 definition of terrorism as either domestic or international, depending on the origin, base, and objectives of the terrorist organization.

U.S. Code 18 U.S.C. § 2331 defines Domestic Terrorism activities as acts that:

- Involve acts dangerous to human life that violate federal or state law;
- Appear intended (i) to intimidate or coerce a civilian population; (ii) to influence the policy of a government by intimidation or coercion; or (iii) to affect the conduct of a government by mass destruction, assassination. or kidnapping; and
- Occur primarily within the territorial jurisdiction of the U.S

U.S. Code 18 U.S.C. § 2331 defines International Terrorism activities as acts that:

- Involve violent acts or acts dangerous to human life that violate federal or state law;
- Appear to be intended (i) to intimidate or coerce a civilian population; (ii) to influence the policy of a government by intimidation or coercion; or (iii) to affect the conduct of a government by mass destruction, assassination, or kidnapping; and
- Occur primarily outside the territorial jurisdiction of the U.S., or transcend national boundaries in terms of the means by which they are accomplished, the persons they appear intended to intimidate or coerce, or the locale in which their perpetrators operate or seek asylum

U.S. Code 18 U.S.C. § 2331 defines the term "federal crime of terrorism" as an offense that:

- Is calculated to influence or affect the conduct of government by intimidation or coercion, or to retaliate against government conduct; and
- Is a violation of one of several listed statutes, including § 930(c) (relating to killing or attempted killing during an attack on a federal facility with a dangerous weapon); and § 1114 (relating to killing or attempted killing of officers and employees of the U.S.)

The FBI divides terrorist-related activity into three categories:

- A terrorist incident is a violent act or an act dangerous to human life, in violation of the criminal laws of the United States, or of any state, to intimidate or coerce a government, the civilian population, or any segment thereof.
- A suspect terrorist incident is a potential act of terrorism to which responsibility cannot be attributed at the time to known or suspected terrorist group or individual.
- Terrorism prevention is a documented instance in which a violent act by a known or suspected terrorist group or individual with the means and a proven propensity for violence is successfully interdicted through investigative activity.

History of Terrorism in Minnesota

Domestic Terrorism:

The Federal Bureau of Investigation defines domestic terrorist organizations into four (4) broad categories; special interest, rightwing, leftwing, and lone wolf/homegrown violent extremists.

May 3rd 2013, Buford "Bucky" Rogers was arrested in Montevideo Minnesota while in the planning stages of what the FBI is calling a terror plot. Rogers was charged as a felon in possession of a firearm and on three counts of possessing unregistered destructive devices. The criminal complaint against Rogers alleges that Buford has planned on carrying out an attack on the Montevideo Police Department, but that attack was thwarted by law enforcement.

May 2012, two Minnesota men were arrested before they could carry out their plot to drive a truck loaded with gasoline and oil into the Mexican Consulate in St. Paul and then set the liquids on fire with a road flare. The duo was infiltrated by an undercover officer who discovered that the two men conducted reconnaissance, collected license plates numbers on vehicles with Obama stickers, videotaped parades along the May Day parade route to identify parade participants, and solicited an associate to collect addresses of customers of a left-leaning bookstore.

In June of 2013, a FBI press release ranked Minnesota 13th in the United States for Sex Trafficking, which has been exploited by Somali gangs who raise funds for the State Department identified terrorist group Al-Shabaab. Other domestic extremists groups known to have active members in Minnesota are: Hells Angels MC, Sons of Silence MC, Outlaws MC, Warlocks MC, Animal Liberation Front, Earth Liberation Front, and Sovereign Citizens.

International Terrorism:

The Director of National Intelligence James Clapper testified in March of 2013 that the al-Qa'ida affiliated terrorist group Al-Shabaab poses a threat to the US and Western interests where they could leverage its operatives and networks in these locales for attacks. Minnesota is home to a very diverse national and international population. With the largest population of Somalis outside of Somalia, recent estimates put that number over 70,000 in Minnesota.

In May of 2013, two women of Somali decent were charged with sending money overseas to Al-Shabaab. Since Minnesota resident and American citizen Shirwa Ahmed carried out the first known suicide attack perpetrated by an American Citizen back in 2008, more than 20 Somali youth have been recruited by Al-Shabaab and left the Twin Cities to fight in Somali.

In August of 2001, French citizen Zacarias Moussaoui took flight simulator training in Eagan, Minnesota and paid his tuition in cash. His flight instructor Clarence Prevost notified the FBI of Moussaoui's suspicious nature which led to the arrest of Moussaoui on immigration fraud. Mousssaoui was later identified as part of the 9/11 plot.

Created in the wake of 9/11, the Terrorist Screening Center (TSC) maintains the TSC Watch list as a single nationwide database which identifies information about those known or reasonably suspected of being involved in terrorist activity who try to obtain visas, enter into the country, board aircraft, or engage in suspicious activities. While there are over 20,000 contacts with watch listed people per year nationwide, Minnesota ranks 2nd in the United States with Hennepin County having the most watch listed encounters of any county in the United States.

The most common nexus to international terrorism in Minnesota comes along our 545 miles of international border with Canada, eight points of entry, and more than 150 miles of unpatrolled open water along Lake Superior. The highest threat along the border has been the illicit trade of guns and cocaine by organized crime in Minnesota with organized crime in Canada in exchange for high grade marijuana and ecstasy. From the south, The 35 Interstate has been identified as a primary corridor for drug and human trafficking to the Midwest from Mexico. In April of 2013, the Hennepin County Violent Offender Task Force made their agencies largest seizure after recovering 12 pounds of methamphetamine associated with the Mexican drug cartel.

Future Perspectives:

In terms of national consequence to Homeland Security, Minnesota is the home to over 34 Fortune 500 companies, Mall of America has over 40 million visitors annually, statewide agricultural revenues exceed $114 billion per year, and our international airport is the 16th busiest in the United States. While terrorism is difficult to predict, there have been over 40 terrorist plots disrupted since 9/11. Minnesota is at an increased risk from terrorism as a target of economic strategic value with financial centers, agri-business, and an international airport located in our borders.

Sources of Information:

2013 Worldwide Threat Assessment of the US Intelligence Community for the Senate Select Committee on Intelligence

Minnesota Fusion Center

www.Fbi.gov

Various Open Source Internet sites

4.6.2 Infectious Disease Outbreak

Infectious diseases have the potential to affect any form of life. Some infectious diseases that were thought to have been eradicated have re-emerged. New strains of some infectious diseases, such as the flu, present seasonal threats to the populace and require continuous monitoring. Widespread epidemics are almost non-existent in the United States. An “epidemic” is defined as a disease that occurs suddenly in numbers clearly in excess of normal expectancy, especially infectious diseases, but is applied also to any disease, injury, or other health-related event occurring in such outbreaks. If an epidemic event were to occur, deaths could be in the many hundreds of thousands across the nation. If the health of the general public is perceived to be threatened on a large scale, riots or states of lawlessness are a possibility.

In the years following World War II, life-threatening bacterial diseases such as tuberculosis and typhoid fever were cured by antibiotics. Dreaded diseases such as polio, whooping cough, and diphtheria could be conquered through vaccination. Thus, it became possible to imagine a world without infectious diseases. We now know that such optimism was premature. New strains of influenza have greater resistance to antibiotics. Many new infectious diseases, such as Acquired Immunodeficiency Syndrome [AIDS], are constantly emerging. In 1997, an avian strain of influenza (H5N1) that had never before attacked humans began to kill previously healthy people in Hong Kong. This crisis raised the specter of an influenza pandemic similar to the one that killed 20 million people in 1918. Although no cases of animal or human illness have been identified in the U.S., the avian H5N1 influenza virus is spreading rapidly in birds and animals in other parts of the world. Such examples remind us that we are barely one step ahead of the microbes and underscore our need for a strong and vigilant public health system.

Infectious disease in domestic livestock has significant impacts to human populations that rely on their animals as a source of food or work. Historically, when a village depended on livestock for food and work, a disease impacting their animals could result in their starvation. People began to coordinate efforts to control diseases in animals to preserve their food supply.

Infectious Disease History in Minnesota

Between the middle of 1918 and the middle of 1919, the worldwide Spanish Influenza pandemic killed at least 21 million human beings -- well over twice the number of combat deaths in World War I. The “Spanish" flu had first appeared in America in spring 1918. All over the world, Spanish Influenza ravaged civilian populations. One-quarter of all Americans suffered bouts of influenza. More than 600,000 Americans died, 10,000 of them were Minnesotans. The city of St. Paul saw more than 1,000 deaths and Minneapolis more than 1,300. In recent years, the State of Minnesota has not had an infectious disease outbreak that reached epidemic proportion.

HIV (human immunodeficiency virus) is the virus that causes AIDS. HIV can spread from person to person during anal, vaginal, or less commonly, during oral sex. HIV can also be spread while sharing needles or reusing equipment to inject drugs, tattoo or body pierce. HIV can also be passed from an infected mother to her baby during pregnancy, childbirth or breastfeeding. Since MDH began tracking AIDS in 1982 and HIV in 1985, a total of 7,824 cases have been reported, including 2,772 that have died. MDH received a new reported HIV case every 29 hours in 2005. There are an estimated 5,233 people who are aware of their HIV status and are currently living in Minnesota.

West Nile virus (WNV) disease is transmitted to people and horses through the bite of infected mosquitoes. The virus is maintained in a transmission cycle involving several species of mosquitoes and birds. WNV was historically found in Africa and southern Europe. The virus was first reported in North America during a 1999 outbreak of encephalitis in New York City.

Since 1999, WNV moved rapidly to 48 states, the District of Columbia, and much of Canada and Mexico. WNV was first detected in Minnesota in July, 2002. From 1999-2012, 37, 088 (1,549 deaths) human WNV cases were reported in the United States. Of these, 535 (16 deaths) were Minnesota residents.

Government supervision and regulation was a logical outcome of the need and interest to control disease in livestock and the Minnesota legislature created the Live Stock Sanitary Board for this purpose in 1903. This agency was renamed the Board of Animal Health in 1980. Diseases of concern in livestock at the beginning of the 20th century included glanders and equine infectious anemia in horses, anthrax, rabies, and tuberculosis. These diseases often caused illness and death in animals. Where chronic disease occurred, animals were of limited usefulness or not suitable for food. Although science had not yet advanced to identify the causative agents of these diseases, measures were taken to identify affected animals, remove them from the population and control movement of livestock to limit spread of disease. These methods were effective in reducing and often eliminating many diseases. Scientific advances in the early 1900s provided additional tools of testing and vaccination to control disease.

In the mid-1900s the US government selected specific livestock diseases for eradication from the US livestock population. These diseases were selected for eradication because they were transmissible to people and/or had a major impact on animal production, and effective methods were available to detect and control the transmission of the disease. These diseases included brucellosis in cattle and swine, and pseudorabies and hog cholera in swine. The table below summarizes some of the significant diseases in Minnesota livestock and poultry since the early 1900s.

Table 47 Infectious Disease of Livestock and Poultry in Minnesota

DATE	CAUSE	LOCATION	IMPACT	CONTAINMENT METHOD
1800s - 1930	Glanders in horses	Statewide	Disease of respiratory tract and skin. Can be fatal or cause chronic disease in horses which limits horse's ability to perform. Transmissible to people.	-Elimination of public watering troughs -test and euthanize positive animals
1894-1972	Hog cholera in swine	Statewide	Fatal viral disease of swine. Animals die of disease and can't be used as food.	-Swine movement restrictions -vaccination - federal (USDA) / state eradication program
1880s – 1976 Recurred 2005 in NW MN	Tuberculosis in cattle	Statewide	Chronic disease of cattle that is transmissible to people. Cause for condemnation of animal as food at slaughter	-test and slaughter test positives - federal (USDA)/ state eradication program
1800s - 1984	Brucellosis in cattle and swine	Statewide	Chronic disease of cattle and swine that is transmissible to people. Causes abortions in animals	-test and slaughter -vaccination -federal (USDA) / state eradication program
1920s - 1975	Pullorum Disease in poultry	Statewide	A bacterial disease caused by one type of salmonella Causes death especially in young chickens and turkeys	-testing and improved sanitary measures in flocks -test and remove -national poultry improvement plan to classify farms according to disease presence

Preparedness for Infectious Animal Disease

The Board of Animal Health has the responsibility to protect the health of the domestic animals of the state through their authorities in state statute. The Board works with partners such as the Minnesota Department of Agriculture, US Department of Agriculture (USDA), Minnesota Veterinary Diagnostic

Laboratory, other local, state and federal agencies, and industry organizations to prepare to respond to an animal disease emergency. Assets available to support an animal disease emergency include:

- A Minnesota agriculture incident management team
- State and federal animal health employees trained as responders in outbreak control
- Minnesota Veterinary Medical Reserve Corps – an organization of veterinary professionals with a subset of their membership trained in animal disease response
- USDA financial support, resources and national regulatory authority for disease response

Current response plans are exercised periodically to provide training for staff and partners. Training workshops for counties are planned for the upcoming year to assist local agencies in developing their plans to support a foreign animal disease response.

Future Perspectives

As expected, with our abundant mosquito and bird populations, WNV rapidly became established in Minnesota. Similar to other endemic mosquito-transmitted diseases in Minnesota (LaCrosse encephalitis, Western equine encephalitis, and Eastern equine encephalitis), WNV will likely continue to cause sporadic disease outbreaks in humans (especially elderly people) and horses. WNV has served as an important reminder to public health officials that they need to continually consider the possibility of exotic pathogen introduction and establishment. For Example, Minnesota has mosquito species that would likely be able to transmit the agents of Rift Valley fever and Chikungunya.

According to the U.S. HIV/AIDS Surveillance Report, year-end 2004, Minnesota has 4.3 AIDS cases per 100,000. The overall US rate is 15 cases per 100,000 people. People over 50 years of age and people with compromised immune systems have the highest risk of developing a severe illness from the virus.

Bovine Spongiform Encephalopathy (BSE) occurrences are rare in the US. However, more than 183,000 cases of BSE were confirmed in the UK alone in more than 35,000 herds through the end of November 2003. The risk to human health from BSE in the US is regarded by the Centers for Disease Control and Prevention (CDC) as extremely low.

The US has been free of Foot-and-Mouth Disease (FMD) since 1929, when the last of nine U.S. outbreaks was eradicated. Since FMD spreads widely and rapidly and because it has grave economic as well as clinical consequences, FMD is one of the animal diseases that livestock owners dread most.

Infectious disease is predicted to become increasingly significant as people and goods move more readily around the globe, organisms become resistant to our treatments and control methods, and livestock and people encroach on natural habitat. New diseases are discovered when they move from wildlife populations and impact people and livestock, and diseases are found in new places with the movement of people and goods around the world. In Minnesota as well as the US, there has been a recurrence of bovine tuberculosis (TB) in cattle. Highly infectious diseases of livestock such as foot and mouth disease are found in new parts of the world each year. Minnesota must be prepared to respond to these diseases if they are found in livestock in our state or country.

Sources of Information

http://www.bah.state.mn.us/

http://www.bah.state.mn.us/bah/emergency-planning/

http://www.aphis.usda.gov/animal_health/animal_diseases/

http://www.aphis.usda.gov/animal_health/emergency_management/

MN Department of Health, 2007.

Centers for Disease Control, National Center for Infectious Diseases, 2007

4.6.3 Fires (Structures and Vehicles)

This section addresses fires to property that is not considered a wildfire. The two types of property fires are classified as:

- Structure Fires
  - Residential single family dwellings, apartments, manufactured homes, hotels, motels.
  - Public and mercantile: stores, restaurants, grocery stores, institutions, churches, public facilities, education.
  - Industrial, Manufacturing, Other Buildings: basic industry, manufacturing, storage, residential garages, vacant buildings, unknown.
- Vehicle Fires
  - Mobile Property: aircraft, automobiles, trucks, trains, buses, boats.

Fires have many causes: cooking, heating, open flame and arson are the typical leading causes each year. Other causes include careless smoking, misuse of materials, improper storage, equipment / appliance malfunctions, improper building wiring, industrial mishaps, and instances such as train derailments or transportation collisions.

Fire History in Minnesota

In 2012 there was one fire reported every 32 minutes in Minnesota. One structure fire was reported every 1.4 hours. Rural structure fires occurred every 3.0 hours and metro structure fires occurred every 2.5 hours. One arson fire was reported every 6.6 hours. Total dollar loss from structure fires exceeded $292 million; approximately $800,769 per day, $33,365 per hour, and $556 per minute.

Table 48 represents the total deaths, injuries, and property loss resulting from fires from 2007 to 2012. In the past 29 years, 1,625 people have died due to fires in Minnesota. In 2012, the per capita death rate due to fire was 0.93 deaths per 100,000 people. One county in Minnesota has remained fatality free for 29 years: Traverse County.

Table 48 Civilian Deaths, Injuries, and Dollar Loss Due to Fire

Year	Classification	Civilian Deaths	Civilian Injuries	Dollar Loss (in millions)
2012	Residential	29 (58%)	97 (81%)	$111.1
	Other	21 (42%)	23 (19%)	$181.1
	Total	50	120	$292.2

Year	Classification	Civilian Deaths	Civilian Injuries	Dollar Loss (in millions)
2011	Residential	45 (80%)	84 (83%)	$94.4
	Other	11 (20%)	17 (17%)	$57.6
	Total	56	101	$152.0
2010	Residential	34 (87%)	121 (83%)	$96.9
	Other	5 (13%)	16 (17%)	$55.3
	Total	39	137	$152.2
2009	Residential Structure	24 (69%)	105 (88%)	$100.6
	Other	11 (31%)	15 (12%)	$94.4
	Total	35*	120	$195.0
2008	Residential Structure	38 (73%)	114 (79%)	$104.1
	Other	14 (27%)	30 (21%)	$94.6
	Total	52	144	$198.7
2007	Residential Structure	31 (78%)	102 (87%)	$112.0
	Other	9 (22%)	15 (13%)	$46.3
	Total	40	117	$158.3

***= Lowest number of fire deaths on record.**

Future Perspectives

Funding for fire suppression and education is available through the federal Assistance to Firefighters Grant (AFG), Staffing for Adequate Fire and Emergency Response (SAFER) Grants, Fire Prevention and Safety (FP&S) Grants, and the Assistance to Firefighters Station Construction (SCG) Grant programs. Firefighter training grants are available through the Minnesota Board of Firefighter Training and Education.

Secondary Consideration Related to Natural Hazards

Flood, tornado, and high winds may cause structural fires in their aftermath. Downed power lines, natural gas leaks or other sources of ignition initiated by natural hazards may spark fire in structures. Routes to structures may be restricted due to flooding or debris from storms. Blizzards and ice storms may also impair the movement of response vehicles. Operation of critical response facilities located in flood hazard zones may be impaired if they become inundated with flood waters.

Sources of Information

Minnesota Department of Public Safety, State Fire Marshal Office. Fire in Minnesota, 2012.

4.6.4 Nuclear Generating Plant Incidents

Nuclear generating plants use the heat from nuclear fission in a contained environment to convert water to steam, which powers generators to produce electricity. The design, construction, and operation of these facilities are closely monitored by the U.S. Nuclear Regulatory Commission (NRC). In addition, the Minnesota Department of Health performs environmental monitoring as a way of assessing and trending exposure to the public.

The potential danger from an accident at a nuclear generating plant is exposure to radiation. This exposure would most probably come from the release of radioactive material from the plant to the environment. The release may be characterized by a plume (cloud-like formation) of radioactive gasses and particles. The major hazards to the people in the vicinity of the plume are radiation exposure to the body from the cloud and particles deposited on the ground, inhalation of radioactive materials, and ingestion of radioactive materials.

The effects of radiation exposure depend on the intensity and length in time of exposure to radiation. Low exposure, comparable to chest x-rays, may slightly increase the risk of cancer. Much higher exposures can cause radiation exposure or death.

Nuclear generating plants do not explode like nuclear detonation devices since the fuel is of low enrichment. There is no risk of a nuclear explosion with the associated physical mass destruction.

Nuclear Generating Plant History in Minnesota

The Monticello Nuclear Generating Plant (MNGP) located in Monticello, Minnesota, is owned by Xcel Energy Inc. It is a one-unit, boiling water reactor, rated at 553 megawatt capacity. MNGP completed a nine-year process of virtually rebuilding the plant to increase its generation an additional 71 megawatts. Major equipment was installed during the refueling/power uprate outages in 2009, 2011 and 2013.

MNGP began commercial operation in June 1971. In 2006, the Nuclear Regulatory Commission (NRC) renewed MNGP's license for 20 years, which will allow operations until 2030. Currently there are 15 casks of spent fuel being stored in the owner controlled area. The dry casks will be shipped to a depository when one opens.

Prairie Island 1 & 2 Nuclear Generating Plants are located in Red Wing, Minnesota and are owned by Xcel Energy Inc. Both units are pressurized water reactors rated at 538 (550 for a total of 1,100) megawatts electric and began operation in 1973 and 1974. In 2011, the NRC renewed for 20 years the plant's original operating licenses, authorizing the Prairie Island units to continue generating electricity to 2033 and 2034Storage of spent nuclear fuel in dry casks at PINGP began in 1995. Currently there are 35 casks of spent fuel being stored in the owner controlled area. The dry casks will be shipped to a depository when one opens.

On December 7, 1979, following the March 1979 Three-Mile Island nuclear power plant accident in Pennsylvania, President Carter transferred the Federal lead role in off-site radiological emergency planning and preparedness activities from the NRC to Federal Emergency Management Agency (FEMA). FEMA established the Radiological Emergency Preparedness (REP) Program to [1] ensure that the public health and safety of citizens living around commercial nuclear power plants would be adequately protected in the event of a nuclear power station accident and [2] inform and educate the public about radiological emergency preparedness. FEMA's REP Program responsibilities encompass only "off-site" activities, that is State and local government emergency preparedness activities that take place beyond the nuclear power plant boundaries. Onsite activities continue to be the responsibility of the NRC.

Annual exercises are held so the NRC and FEMA may evaluate the utility, local, and state response organization. In addition, FEMA evaluates the local and state plans and preparation activities annually and issues a letter of certification if the planning for a response to an incident provides reasonable assuredness of safety to the public.

Future Perspectives

Local and state off-site response organizations have not been activated due to an actual incident at one of the nuclear generating plants since the program's inception in 1981. No General Emergency activations which would start evacuation of the public have ever occurred in the state. The last General Emergency activation in the nation was during the Three Mile Island Accident in 1979.

The NRC has provided increased regulation and oversight to make nuclear reactors safer since 1979. Power plants also have robust security programs mandated by the NRC to deter and repel terrorists.

There are three state critical facilities in the Emergency Planning Zones for each plant. They are:

- Bureau of Corrections: Minnesota Correctional Facility-Red Wing with a replacement cost of $25,688,000.
- Department of Transportation: Truck Station-Monticello with a replacement cost of $871,920.
- Department of Transportation: Truck Station-Red Wing with a replacement cost of $574,200.

Sources of Information

Information supplied by Radiological Emergency Preparedness staff, Division of Homeland Security and Emergency Management, 2011

4.6.5 Hazardous Material Incidents

Approximately 6,000 facilities in Minnesota report their storage of hazardous chemicals to the Minnesota Department of Public Safety's EPCRA Program and their local fire department. Facilities meeting the reporting criteria submit this information annually as required under Section 312 of the federal Emergency Planning and Community Right-to-Know Act (EPCRA). The information is used by emergency planners and responders to plan for and respond to hazardous chemical emergencies.

Over 400 facilities in Minnesota report their routine chemical emissions and on and off-site chemical management activities to the Minnesota Department of Public Safety's EPCRA Program and the U.S. Environmental Protection Agency (EPA). Facilities meeting the reporting criteria submit this information annually as required under Section 313 of the federal EPCRA and is known as the Toxic Release Inventory (TRI). TRI data can be used to prioritize environmental regulatory efforts and promote pollution prevention and waste reduction.

Nearly 400 facilities in Minnesota submit Risk Management Plans (RMP's) to EPA summarizing procedures they have implemented to prevent accidental releases of certain chemicals into the air. Facilities meeting the reporting criteria submit this information every five years as required under Section 112r of the Clean Air Act Amendments of 1990. The information is used by emergency planners and responders to plan for and respond to hazardous chemical emergencies.

The Office of Pipeline Safety oversees pipeline operations throughout the state since 1987. The main office is located in St. Paul, with field offices located in Grand Rapids, Detroit Lakes, and Mankato. The Office of Pipeline Safety is in the Minnesota Department of Public Safety.

Profile of Pipeline Operators in Minnesota

- 93 Pipeline operators.
- Nearly 1.5 million gas meters.
- Over 65,000 miles of pipeline.
- 900 to 1000 inspection days annually.

Hazard History

Hazardous material releases may occur from any of the following:

- Fixed site facilities (e.g., refineries, chemical plants, storage facilities, manufacturing, warehouses, wastewater treatment plants, swimming pools, dry cleaners, automotive sales/repair, gas stations);
- Highway and rail transportation (e.g., tanker trucks, chemical trucks, railroad tankers and intermodal containers);
- Marine transportation (e.g., bulk liquefied gas carriers, oil tankers, tank barges);
- Air transportation (e.g., cargo packages); and
- Pipeline transportation (liquid petroleum, natural gas, other chemicals).

The following table shows significant events in Minnesota for all Hazardous Material modes including pipelines.

Table 49 Minnesota Hazardous Material Incidents 2002-2012

SEVERITY	TYPE OF INCIDENT	INCIDENT SUMMARY DESCRIPTION
MEDIUM	PIPELINE	**July 4, 2002** An underground 34 inch transmission pipeline discharged approximately 50 barrels of crude oil. The pipeline was in a remote swampy area located 0.5 miles from Cohasset. The total spill amount was 6,000 barrels. All of the material was contained in the swampy area. Clean up crews used insitu burning to dispose of the material. There was no threat to any navigable waterways or environmentally sensitive areas.
POTENTIAL MAJOR	FIXED	**February 19, 2003** Fire at an oil storage facility in Barnesville. The entire facility was consumed in fire. The facility contained twenty 4,000 gallon lube oil tanks, three 12,000 gallon lube oil tanks, two 4,000 ethylene glycol tanks, and one tanker trailer with 7,000 gallons of lube oil. In addition, the facility had floor drains which lead to a 2,000 gallon waste tank. The tank, located outside of the facility, overflowed and released material into a ditch but no

SEVERITY	TYPE OF INCIDENT	INCIDENT SUMMARY DESCRIPTION
		waterways were impacted. No injuries, fatalities, or evacuations were reported.
MEDIUM	PIPELINE	**November 5, 2003** A pipeline discharge in Brandon Township was reported. The incident resulted from third party damage to a pipeline. A farmer plowing his fields, crossed over a pipeline right-of-way, and damaged an underground gasoline pipe. This caused an estimated 50-100 barrels of gasoline to be discharged into soil. The spill occurred below the surface and no waterways were impacted.
MEDIUM	RAILROAD	**October 20, 2004** A storage tank spilled 5,000 gallons of lube oil at a railyard in St. Paul. The tank leaked oil onto the ground and into a nearby water dike. The cause of the leak was equipment failure. No injuries, no community impact, and no water supply contamination resulted.
UNKNOWN	PIPELINE	**December 28, 2004** An explosion leveled a two story building in Ramsey. The cause of the incident was due to a natural gas leak from a faulty connection. Three fatalities and one severe burn injury resulted. MN State Highway 10 was closed in all directions following the blast.
MEDIUM	MOBILE	**August 13, 2005** A 2000 gallon gasoline spill in St. Louis Park occurred. The material was released into Minnehaha Creek which leads to the Mississippi River. The cause of the incident was a stuck valve on the cargo hold of a tanker truck. No fires, fatalities, or evacuations were reported.
MEDIUM	PIPELINE	**May 3, 2006** A pipeline discharge resulted in 30 barrels of crude oil being spilled onto the ground at refinery located in Cottage Grove. The spill was due to a faulty gravitometer. There was no offsite or community impact or injuries.
UNKNOWN	PIPELINE	**November 28, 2007** Two welders were killed when an oil pipeline near Clearbrook exploded. The explosion was due to an oil mist that escaped from a coupling combined with nearby ignition sources.
MAJOR	PIPELINE	**December 4, 2009** 3500 barrels of crude oil containing 58,000 pounds of benzene spilled. The released material was into an excavation site from Line 2 of the Minnesota Pipeline stopple fitting on a main line due to equipment problems. No injuries or fatalities were reported. Most of the oil stayed within the excavation with some entering nearby woods.
MAJOR	MOBILE	**March 31, 2012** at Plummer Minnesota. A semi-truck colliding with a Canadian Pacific train on highway 59 near Plummer Minnesota. The semi knocked three tanker cars off

SEVERITY	TYPE OF INCIDENT	INCIDENT SUMMARY DESCRIPTION
		the tracks and caused a 40,000 gallon leak of Benzine Dic yclopentiene that pooled in the ditch. The leak was cleaned up, however, the driver of the semi was killed, five people were hospitalized with respiratory symptoms and the main highway was closed for soil clean-up and reconstruction for about a month. The entire town of Plummer was evacuated.
MEDIUM	MOBILE	**March 27, 2012** A fourteen car derailment of crude oil. The spill was estimated At approximately 30,000 gallons with three cars leaking.

Source: Environmental Protection Agency, National Response Center, 2010 WCCO News, 2010.

Future Perspectives

Accidental hazardous material releases, such as an unintended release from a pressure valve or a transportation accident, may cause the release of hazardous materials and complicate response activities. The impact of earthquakes on fixed facilities may be particularly bad due to the impairment of the physical integrity or even failure of containment facilities. The threat of any hazardous material event may be magnified due to restricted access, reduced fire suppression and spill containment, and even complete cut-off of response personnel and equipment. In addition, the risk of terrorism involving hazardous materials is considered a major threat due to the location of hazardous material facilities and transport routes throughout communities and the oftentimes limited anti-terrorism security at these facilities.

Sources of Information

Office of Pipeline Safety, Minnesota Department of Public Safety, 2010.

4.6.6 Transportation Incidents

The areas of transportation discussed in this section are:

- Highways
- Railroads
- Commercial Waterways
- Aeronautics

Highways

The primary mode of transportation in Minnesota is highways. Minnesota has the fifth largest highway system in the United States. Minnesota has nearly 132,000 miles of streets and highways and 19,600 bridges. The Minnesota Department of Minnesota (MnDOT) is directly responsible for the trunk highway system and its bridges. The trunk highway system is comprised of 4,668 bridges and the roads are characterized as:

Principal Arterials 5,150 miles

Minor Arterials 5,565 miles

Collectors 1,205 miles

Local 13 miles

Total 11,933 miles

Even though state highways and interstates only make up about nine percent of the total statewide system mileage, they carry about 61 percent of the annual vehicle miles of travel. The remaining roads are under the jurisdiction of local governments.

MnDOT also has jurisdiction over all signs within trunk highway rights-of-way, all billboards along the trunk highways, and all ramp-metering devices in the metro area.

2012 Crash Facts

- 395 traffic deaths — A 7 percent increase from the 368 deaths in 2012.
- 131 alcohol related deaths — Accounting for one-third of all traffic deaths, matching historical trends.
- 28,418 motorists arrested for DWI — in all, one in seven Minnesota drivers has been arrested for DWI.
- Just 129 of the 276 vehicle occupant deaths were known to be belted; 54 percent of the unbelted deaths were ejected from the vehicle.
- The primary seat belt law helped state reach record-high daytime belt compliance rate of 94 percent (up from 93 percent), and resulted in fewer unbelted deaths.
- 55 motorcyclist deaths — a 31 percent increase from the 42 deaths in 2011.

Source: Office of Traffic Safety, Minnesota Department of Public Safety, 2013.

Table 50 Traffic Safety Performance Measures for Minnesota

	2008	2009	2010	2011	2012
Total Traffic Fatalities	455	421	411	368	395
Fatalities Per 100 Million Miles Driven	0.79	0.74	0.72	0.65	0.69
Passenger Vehicle Occupant Fatalities (All seat positions)	325	302	305	271	276
Alcohol Impaired Driving Fatalities (BAC=0.08+)	137	112	121	111	104
Speeding Related Fatalities	134	85	86	83	74
Motorcyclist Fatalities	71	53	45	42	55
Pedestrian Fatalities	26	41	36	40	40

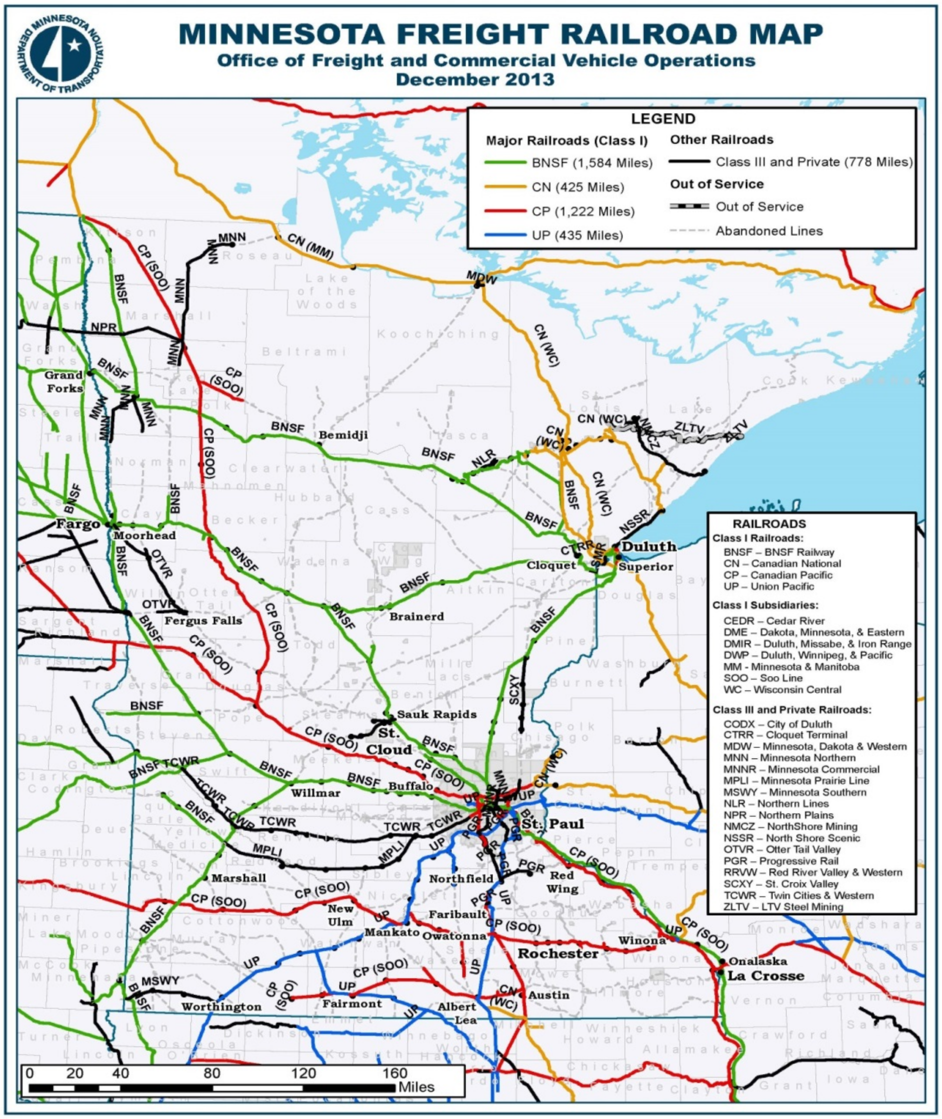
Railroads

Minnesota currently has 4,444 route miles of railroads serviced by 20 freight railroad companies. Northstar commuter rail operates on 40 miles of existing track and right-of-way owned by the BNSF

Railway between Big Lake and Minneapolis. Amtrak operates the only intercity passenger rail service in Minnesota on the Empire Builder route connecting Seattle with Chicago.

Minnesota has one operating light rail line between downtown Minneapolis and the Mall of America in Bloomington. This 12-mile line is owned and operated by Metro Transit. A second 11-mile light rail line is scheduled to open in 2014 between downtown Minneapolis and downtown St. Paul.

Figure 53 Minnesota Freight Railroad Map



Goods between Chicago and ports in the northwest are hauled through Minnesota on railroads. These goods move in both traditional rail cars and increasingly in shipping containers loaded directly onto flatbed rail cars. Grain and lumber are also transported between the Midwest and the rest of the nation and the world. Growth of the oil industry in North Dakota has increased shipments of commodities into, out of and through Minnesota by rail. These commodities include sand, crude oil and various other products. Ethanol and propane are also transported by railroads in the state. Iron ore and coal are raw materials transported through Minnesota to other parts of the country and the world via rail. Minnesota is fourth in the nation in total tons of commodities originating in the state and eighth in total tons of commodities terminating in the state.

Commercial Waterways

The Mississippi River System

The Mississippi River System stretches over 222 miles in Minnesota and supports five port areas whose combined 2012 tonnage was 10.7 million net tons. The River accounts for over 50 percent of Minnesota's agricultural exports.

Minnesota's largest river tonnage commodities are agricultural products such as corn, soybeans and wheat. In 2012, Minnesota shipped over 4.4 million tons of grain down the river. River ports also handle other dry commodities such as fertilizer, cement, sand and gravel, salt, coal, steel and scrap metals for recycling. Liquid products include petroleum, caustic soda, vegetable oils, molasses and anhydrous ammonia.

The Mississippi River Navigation System is maintained by the U.S. Corps of Engineers. They dredge the width and depth of the channel to accommodate 9-foot deep barges, and they operate the 29 locks and dams on the Upper Mississippi. The locks are also used by recreational boaters at no cost. The commercial barge operators on the River pay a user fee of 20 cents per gallon of fuel purchased. These dollars are used to pay for half of major federal lock structure improvements.

Table 51 Annual Minnesota River Port Tonnage

PORT	2012	2011	2010	2009	2008	2007	2006
Minneapolis	671,691	645,445	592,404	545,840	781,155	795,372	1,069,238
St. Paul	5,551,737	5,247,992	5,160,120	5,071,864	3,469,383	5,126,732	5,511,445
Savage	1,921,603	1,844,711	2,411,361	2,777,677	1,705,650	3,201,406	3,214,351
Red Wing	836,497	924,060	807,021	735,417	631,870	851,692	920,610
Winona	1,697,955	1,969,712	1,922,462	1,672,630	1,573,239	2,099,746	2,204,375
Total	10,679,483	10,631,920	10,893,368	10,803,428	8,160,297	12,074,948	12,920,019

•Annual tonnages will vary due to seasonal flooding, freight rates and foreign grain demand

Lake Superior / Great Lakes / St. Lawrence Seaway

Minnesota has four ports on Lake Superior including Taconite Harbor, Silver Bay, Two Harbors and Duluth/Superior. Their combined waterway tonnage for 2012 was just over 61 million tons, about 1.2 million tons more than 2011. World steel production is improving, which is increasing taconite demand on the Great Lakes. Great Lakes taconite shipped from Minnesota amounted to over 40 million tons in 2012, a 2.4 million ton increase over 2011. Taconite amounted to 67% of Minnesota's Great Lakes tonnage in 2012. Taconite is mined in northeast Minnesota and shipped via the Great Lakes to steel mills in Indiana, Ohio and Pennsylvania. The Port of Two Harbors is the leading taconite export dock in Minnesota at 16,547,843 net tons in 2012.

Western coal is the second leading commodity shipped from Duluth/Superior in 2012 at 14,129,546 net tons. This is down about 1.3 million tons from 2011, reflecting a switch to natural gas for some power plants in the system. This trend will continue, but more coal will now be shipped to fill overseas demand.

Other commodities handled by the Port of Duluth/Superior include over 1 million tons of grain shipped out, as well as cement, salt, steel, limestone and wind generator components.

The U.S. Corps of Engineers operates three of the 16 locks on the Great Lakes/St. Lawrence Seaway and maintains a 29-foot deep channel throughout this system. The Canadian government operates and maintains the other 13 locks.

Ships that operate only on the Great Lakes are called “Lakers”. Some of the Lakers range to over 1,000 feet long, 105 feet wide and have a capacity of 65,000-70,000 net tons at 26’6” draft – the maximum draft allowed. Since 1999, lake levels on the Great Lakes System have been low, primarily due to drought, which has restricted ship tonnage by as much as 6,000 tons per trip. Less tonnage per trip results in higher freight costs per ton, both to the carrier and to the shipper.

Table 52 Annual Minnesota Great Lakes Port Tonnage

PORT	2012	2011	2010	2009	2008	2007	2006
Duluth/Superior	36,673,052	37,101,554	39,804,806	31,210,918	45,640,001	47,858,484	47,234,022
Two Harbors	16,547,843	16,070,740	13,892,225	6,222,014	13,302,382	13,736,351	14,447,328
Silver Bay	7,142,154	5,818,286	6,617,247	3,384,622	7,217,823	5,487,958	4,814,261
Taconite Harbor	657,700	806,000	663,934	709,108	895,868	914,022	939,065
Total	61,020,749	59,796,580	60,978,212	41,526,662	67,056,074	67,996,815	67,434,676

•Annual tonnages will vary due to low water, ice conditions and commodity demand

Aeornautics:

The National Transport Safety Board makes statistics available on a national basis in regards to flight safety. Minnesota specific information was not available. However, the national data indicates that the level of risk for flying is less than land travel in terms of fatalities per 100,000 miles. The impact of an incident involving a large aircraft may be large and involve an integrated response between Fire, EMS, Law Enforcement plus other agencies. Aircraft parked on the tarmac at airports are vulnerable to damage during high wind or hail storm events.

4.6.7 Ground and Surface Water Supply Contamination

Water is prized resource in Minnesota for many reasons. The “Land of 10,000 Lakes” is a motto that reflects the pride of residing in an area with an abundance of pristine natural water resources. Water resources are also the basis for robust agri-business and a diverse recreational industry. An ample supply of clean water is important in a world where water supply issues are blocking economic development and becoming issues in the international community.

There are many ways water supplies, aquifers, and wells may become contaminated. Examples are:

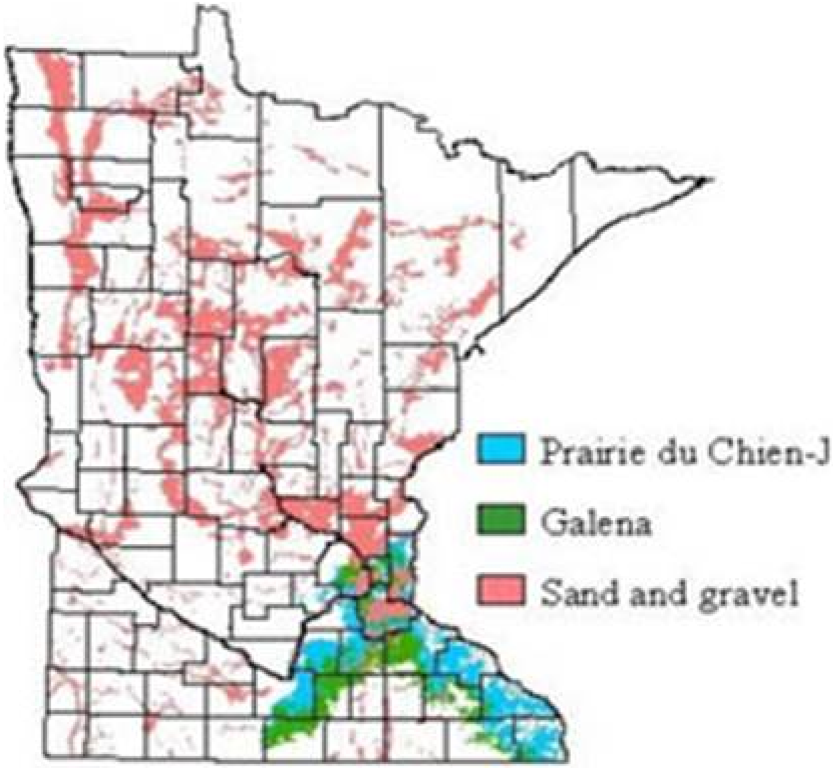
- Sewage, Partially Treated Waste Water, Sludge
- Leakage from Underground Storage Tanks
- Storm water Runoff
- Runoff from Construction Sites
- Mines, Tailings, and Spoils
- Landfills and Dumps
- Industrial Effluents and Dumps
- Pesticides
- Animal Production Wastes
- Agricultural Run-Off from Crops

The Minnesota Department of Health, Department of Natural Resources, and the Pollution Control Agency have regulatory responsibility in regards to water pollution through the Board of Water and Soil Resources. The USDA Natural Resources Conservation Service also provides conservations programs that reduce water pollution. Many communities are located in Watershed Districts. Information about the programs these agencies provide may be found through local contacts or their websites.

Some of the secondary impacts due to floods are:

- Contaminated wells
- Inoperable sewage or water treatment plants
- Contaminated water supplies
- Runoff due to scouring of river banks

Figure 54 Vulnerable Aquifers in Minnesota



Source: Minnesota Pollution Control Agency 20.

History

The federal Clean Water Act requires states to:

- Assess all waters of the state to identify and list impairments
- Conduct Total Maximum Daily Load (TMDL) studies in order to set pollutant reduction goals

Implement corrective measures to meet TMDLs pollutant reduction goals and restore waters to standards.

On November 4, 2008, Minnesota voters approved the Clean Water, Land and Legacy Amendment to the constitution to: protect drinking water sources; to protect, enhance, and restore wetlands, prairies, forests, and fish, game, and wildlife habitat; to preserve arts and cultural heritage; to support parks and trails; and to protect, enhance, and restore lakes, rivers, streams, and groundwater.

The Amendment increases the sales and use tax rate by three-eighths of one percent on taxable sales, starting July 1, 2009, continuing through 2034. Of those funds, approximately 33 percent is dedicated to the Clean Water Fund to protect, enhance, and restore water quality in lakes, rivers, streams, and groundwater.

Protecting Minnesota's waters is a joint effort between seven partner agencies, who collaborate and partner on Minnesota's water resource management activities under the Clean Water Fund:

- Minnesota Pollution Control Agency (MPCA)

- Minnesota Department of Natural Resources
- Minnesota Department of Agriculture
- Minnesota Department of Health
- Minnesota Board of Water and Soil Resources
- Minnesota Public Facilities Authority
- Metropolitan Council

Additionally, these agencies collaborate with the University of Minnesota's Water Resources Center.

Table 53 Clean Water Funding

FY 2012-2013 Clean Water Fund	Outcomes
Monitoring: $16.5 million	$14.8M will be used to complete 20 percent of the needed statewide assessments of surface water quality and trends. *Other monitoring and assessment funds*: $200k for grants to the Red River Watershed Management Board to enhance and expand the existing water quality and watershed monitoring river watch activities in the schools in the Red River of the North.$1.5M to fund a wild rice standards study. The scientific information developed will be used by the MPCA in its decision as to whether or not a change to the existing standard is necessary.
Water quality study development: $21.9 million	$18.8M will be used to develop 20 percent of TMDLs, protection strategies, and implementation plans for waters listed on the U.S. EPA approved impaired waters list. In past years, the agency addressed these impairments water body by water body through TMDL projects. *Other tool development funds*: $2.3M for the second phase of TMDL research and database development. $800k for storm water research and guidance.
Restoration & Protection: $5.1 million	$2M will be used to administer the Clean Water Partnership grant program. Other restoration and protection funds will be used for: $1.5M to be used on the St. Louis River restoration project. The project will assess sediment and benthic community health in critical locations of the area of concern, remediate and restore habitat impairments and clean-up contaminated hotspots within the lower estuary. This appropriation must be matched at a rate of 65 percent nonstate money to 35 percent state money. $1.6M will be used for wastewater and storm water implementation efforts
Groundwater assessment and drinking water protection: $4.27 million	$2.25M will be used for groundwater assessment, including enhancing the ambient monitoring network, modeling, and continuing to assess contaminants of emerging concern. *Other groundwater funds will be used for:* $450k to be transferred to the Environmental Quality Review Board in cooperation with the United States Geological Survey to characterize groundwater flow and aquifer properties in the I-94 corridor in cooperation with local units of government. $1.570M to be used for groundwater protection or prevention of groundwater degradation activities

FY 2012-2013 Clean Water Fund	Outcomes
	through enhancing the county-level delivery systems for subsurface sewage treatment systems (SSTS).

http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/clean-water-fund/index.html

Non-point source pollutants in public groundwater and/or surface water supplies are being more accurately identified and trended. More water treatment may be needed in the future to emerging characterization of pollution in groundwater and aquifers. An assumption based on the above examples is that water treatment is a growing area of public investment. Water treatment and storm sewers can be damaged by the rush of flood waters.

Table 54 Community Water Supply Systems in Minnesota

Public Water System Type	Number of Systems
Municipal	726
Non-municipal	244
TOTAL	970

*Does not include wells used for drinking water.

Storm drains are susceptible to damage during floods. The hydraulic forces on a system may cause damage. If storage for flow is inadequate, buildings in the area may be flooded.

Future Perspectives

As the commitment to clean water grows, the investment in treatment facilities and monitoring will also grow. Wastewater treatment plants, storm sewers, water supply/purification/distribution systems, runoff holding ponds and other pollution control devices are susceptible to damage during natural disasters. These systems may also be a source of damage during flooding. An example is storm sewers that do not have the capacity to move water in sufficient quantities thus cause flooding of neighborhoods. There may be treatment plants in floodplains close to a discharge point on a river. It is difficult to determine risk when the location of the facility is not readily available.

Sources of Information

Clean Water Legacy Act, 2007. Clean Water Legacy Act: Restoring and Protecting Minnesota's Waters, Case Studies and Examples; Board of Water and Soil Resources, February 2007

Federal Emergency Management Agency, Grand Forks 1997 Flood Recovery and Minnesota Severe Storms/Flooding April 1997

Homeland Security and Emergency Management, 2007. Preliminary Estimates Received for Public Assistance by December 1, 2007 at HSEM.

Minnesota Pollution Control Agency, 2007a. Minnesota's Ground Water Condition, A Statewide View, September 2007.

Minnesota Pollution Control Agency, 2007b. Minnesota Stormwater Manual, Chapter 2: General Stormwater Background and the Minnesota Perspective
www.pca.state.mn.us/water/stormwater/stormwater-manual.html

Minnesota Pollution Control Agency, 2007b. Vulnerable Aquifers,
www.pca.state.mn.us/water/groundwater/gwmap/gw-conditionmonitoring.html

Minnesota Department of Health, 2007a. Safe Drinking Water in Minnesota: A Reliable Tradition. June 2007. www.health.state.mn.us/divs/eh/water/com/dwar/report06.html

Minnesota Department of Health, 2007b. Community Water Supply Systems in Minnesota.
www.health.state.mn.us/divs/eh/water/com/index.htm

Minnesota Public Safety Homeland Security Emergency Management, 2005. Minnesota All-Hazard Mitigation Plan.

Minnesota State Demographic Center. 2000 Census SF1 and SF3: Report and Mapping Menu, Summary Report, County at a Glance, or City at a Glance

www.lmic.state.mn.us/datanetweb/php/census2000/c2000_menu.php

http://www.pca.state.mn.us/index.php/water/water-types-and-programs/clean-water-fund/clean-water-fund.html

4.7 Vulnerability of State Facilities

Requirement §201.4(c)(2)(iii): *[The State risk assessment* ***shall*** *include an] overview and analysis of potential losses to the identified vulnerable structures, based on estimates provided in local risk assessments as well as the State risk assessment. The State* ***shall*** *estimate the potential dollar losses to State owned or operated buildings, infrastructure, and critical facilities located in the identified hazard areas.*

44 CFR 201.4(c)(2)(iii) *State owned or operated critical facilities located in the identified hazard areas shall also be addressed.*

State owned and operated facilities are important centers that link the government of the State of Minnesota to the public it serves. These facilities range from the State Capitol building in St. Paul to storage buildings for transportation centers throughout the state. These facilities are hubs for everything from administrative activities to public safety functions and every conceivable role in between. Should these facilities be rendered inoperable by an incident, the public would lose a vital link with their government and the services it provides.

The focus of this assessment is state owned structures. Agencies whose properties are insured by Minnesota Risk Management were invited to participate in the vulnerability assessment for the state mitigation plan update. Risk Management insures state facilities for natural hazards and includes a rider for flood as part of the insurance. One caveat is that MN DNR is self-insured and does not participate in the Risk Management program. The State of Minnesota leases many facilities to accomplish its missions but are not included in this assessment. Leased properties are not included in this review. A vulnerability assessment of a large cohort of structures is being started with the update of the state's mitigation plan.

Hazard Mitigation Statutes and Programs

Hazard mitigation is practiced routinely by state agencies per state statute or program reviews. The following is a short listing to validate the above statement:

- Minnesota Statute 326B subd 2 and 8 refer to the building codes to be used for construction and remodeling. The Real Estate and Construction Services Group, Department of Administration (ADMIN) serves as the State's owner's representative on construction projects for Minnesota state agencies. Manuals and guidelines for construction are provided by this agency.
- Minnesota Statute 462.357 Subdivision 1 and 1e(c) has information pertaining to construction and the National Flood Insurance Program. Use of land is typically governed by municipal zoning laws; and if a municipality is in the NFIP, the State construction would fall under the municipality's zoning laws and would be enforced by the municipality's permitting process.
- Minnesota's Critical Infrastructure (CI) Protection Program was developed to mitigate the impact of a terror attack or natural disaster against the state's most critical infrastructure and key resources. The strategy was developed to identify, prioritize, and assess the vulnerabilities of thousands of critical infrastructure and key resources in the state, and develop effective strategies for strengthening their security and protection. State agencies, local jurisdiction, and the private sector participate in this program. Reports and data are protected and not available for use in this plan.

- Continuity of Operations Planning (COOP) ensures that state agencies are able to continue performance of essential functions under a broad range of circumstances. Vulnerabilities to facilities are reviewed to determine alternate locations for essential facilities in order to reduce impacts to the state.

State Owned Facility Inventory and Vulnerability Assessment Methodology

The state owned facilities included in the vulnerability assessment for the plan update include individual structures, sites of structures and radio towers/communication facilities. Each of these are counted as a structure based on the data sources provided for the purposes of insurance and/or general building inventory by the Department of Administration. The term ‘building exposure’ is used as a general term to estimate the amount of funds needed to replace the structure. It is also a term that is used in FEMA’s HAZUS estimates. Some reports used the term ‘replacement costs’. Building exposure is not an absolute amount due to variables in the accounting of this estimate. For example, some structures are reported with no value for its replacement value. Contents and building value were used when available. Building exposure values are used for the purposes of vulnerability as an indicator but not the absolute value for building replacement costs

Dams and levees are discussed in a separate section due to their inherent risks. Roads, bridges, culverts, and other infrastructure are reported broad terms since there are restrictions based on participation in the HSEM Critical Infrastructure Program.

Agencies whose properties are insured by Minnesota Risk Management or are self-insured were invited to participate in the vulnerability assessment for the state mitigating plan update. Risk Management insures state facilities for natural hazards and includes a rider for flood as part of the insurance. The State of Minnesota leases many facilities to accomplish its missions but are not included in this assessment. Leased properties are not included in this review. The participating state agencies are:

- Department of Administration (ADMIN)
- Department of Correction (DOC)
- Department of Human Services (DHS)
- Department of Natural Resources (MN DNR)
- Metropolitan Airport Commission (MAC)
- Minnesota Historical Society (MNHS)
- Minnesota State Colleges and Universities (MNSCU)

The vulnerability assessment started after the 2011 Statewide HAZUS Flood Assessment was finalized. This assessment found 113 structures in the 100 year flood plain. The ortho-photos from the study were compared to NFIP rate maps and discussed with state agencies. HAZUS methodology basically determined that the entire site or park was in floodplain since elevation was not part of the analysis. Overall, it was found that for most agencies the HAZUS results were an overestimate for a variety of reasons:

- The inventory listed the structure as a state facility when it was actually owned by another jurisdiction or a private party.

- The property was mapped in the floodplain but no structures were found to be in the floodplain.

- In the case of MN DNR, sites were listed but the properties were not evaluated individually as part of the statewide flood assessment. MN DNR is taking on a project to list critical facilities that will be done as part of plan maintenance.

The draft risk assessment was available in November 2013 and reviewed with a combination of emergency managers and facility staff from each of the participating agencies. The risk assessment was presented accompanied by discussions about the hazard mitigation program, building inventory and potential mitigation projects. The relationship between applications for HMA funds and capital improvement projects were discussed. The participants reviewed the mitigation projects in comparison to the risk assessment for their facilities. The results are mitigation strategies for each agency listed in Section 5. It was noted that most agencies wish to do a more detailed assessment in the future to determine specific projects for specific structures.

The following is a description of state owned structures by department:

- ADMIN owns a total of 23 structures located in three cities. The most notable location is the State Capitol Complex that included the Capitol Building, the governor's residence, and major state office buildings.
- DOC owns a total of 332 structures with locations in seven counties.
- DHS owns or insures 69 treatment facilities and group homes in twenty counties.
- MN DNR owns and operates 2697 structures that provide different types of functions located in state parks, hatcheries, and office facilities throughout the state. DNR also maintains campgrounds, roads trails, small bridges, stormwater controls, riverbank erosion controls and power distribution.
- MAC owns and operates seven airports in the metropolitan Minneapolis-St. Paul region including the Minneapolis/St. Paul Airport.
- MNHS owns 75 office and historical structures throughout the state.
- MNDOT owns 209 structures and sites in Minnesota with an additional 346 radio towers and communication facilities along with 74 structures at rest stops of undetermined value. In addition, Minnesota has the fifth largest highway system in the United States. Minnesota has nearly 132,000 miles of streets and highways and 19,600 bridges. MNDOT is directly responsible for the trunk highway system and its bridges. The trunk highway system is comprised of 4,668 bridges and the roads are characterized as:

Principal Arterials	5,150 miles
Minor Arterials	5,565 miles
Collectors	1,205 miles
Local	13 miles
Total	11,933 miles

  Even though state highways and interstates only make up about nine percent of the total statewide system mileage, they carry about 61 percent of the annual vehicle miles of travel. The remaining roads are under the jurisdiction of local governments. MnDOT also has jurisdiction over all signs within trunk highway rights-of-way, all billboards along the trunk highways, and all ramp-metering devices in the metro area.

MnDOT was one of 19 Climate Resilience Pilot projects selected by the Federal Highway Administration (FHWA) as part of an effort to evaluate the FHWA Climate Change & Extreme Weather Vulnerability Assessment Framework. The purpose of the Flash Flood Vulnerability and Adaptation Assessment Pilot Project is to assess infrastructure damage and economic losses associated with flash flooding and identify adaption options that can help with decision-making. The project has two phases, a system-wide vulnerability assessment and a more focused and detailed adaptation analysis of high-risk specific high-risk facilities that were identified in the vulnerability assessment. The project is analyzing MnDOT owned bridges, culverts, and road segments on the trunk highway system in MnDOT District 1 in Northeast and District 6 in Southeast Minnesota. The project will use the current condition of assets, hydrologic, and hydraulic factors to assess how well the asset will perform during 24-hr 100yr precipitation event. The assets will also be scored on how well they adapt to scenario 24-hr 100yr storm event in the year 2100. Essentially, what is the system vulnerability today and what is at risk over the next 50 – 100 years. The results of the vulnerability assessment will be used as an example in Minnesota's first Transportation Asset Management Plan.

- MNSCU owns approximately 787 structures on 54 campuses. A special note is that MNSCU is eligible for funding as a state agency participating in this plan since it is a state agency per statute 16B.4821 Subdivision 2 .

In summary, over 4630 structures worth over $479 billion in building exposure are part of the vulnerability assessment. Highways and bridges, and similar infrastructure are not profiled due data limitations but will be covered topically under the vulnerability assessment for applicable hazards. Over 90% of the structures listed in available records are represented in the vulnerability assessment. The exposure value for state owned facilities is shown below:

Table 55 State Owned Facility Exposure by County

County	Exposure Value
Aitkin	$8,548,935
Anoka	$401,359,775
Becker	$100,066,383
Beltrami	$524,883,578
Benton	$448,923
Big Stone	$3,480,194
Blue Earth	$771,443,043
Brown	$10,327,821
Carlton	$205,329,075
Carver	$10,328,242
Cass	$7,213,369
Chippewa	$4,909,145
Chisago	$137,778,979
Clay	$519,058,331
Clearwater	$32,781,968
Cook	$6,078,782
Cottonwood	$20,441,060
Crow Wing	$219,655,797
Dakota	$327,889,139
Dodge	$3,420,002
Douglas	$135,385,992
Faribault	$2,621,054
Fillmore	$16,058,909
Freeborn	56552900
Goodhue	$123,237,906
Grant	$0
Hennepin	$13,152,230,882
Houston	$2,707,952
Hubbard	$8,246,953
Isanti	$31,548,440
Itasca	$34,072,293
Jackson	$30,590,984
Kanabec	$1,286,785

County	Exposure Value
Kandiyohi	$167,201,233
Kittson	$5,989,505
Koochiching	$36,714,062
Lac Qui Parle	$2,445,592
Lake	$24,315,732
Lake of the Woods	$8,573,327
Le Sueur	$6,622,672
Lincoln	$2,311,987
Lyon	$454,658,221
Mahnomen	$1,209,769
Marshall	$8,221,182
Martin	$1,064,455
Mc Leod	$64,493,534
Meeker	$5,077,045
Mille Lacs	$13,998,742
Morrison	$6,769,761
Mower	$130,966,989
Murray	$3,718,075
Nicollet	$4,706,287
Nobles	$46,381,780
Norman	$795,678
Olmsted	$304,950,825
Otter Tail	$73,437,531
Pennington	$100,579,911
Pine	$75,007,014
Pipestone	$28,169,875
Polk	$69,802,364
Pope	$5,083,624
Ramsey	$2,167,991,906
Red Lake	$0

County	Exposure Value
Redwood	$1,911,083
Renville	$4,202,233
Rice	278055537
Rock	$5,263,542
Roseau	$7,459,790
Scott	$83,333,947
Sherburne	$5,767,894
Sibley	$1,144,128
St. Louis	$452,315,111
Stearns	$1,180,280,718
Steele	$28,024,397
Stevens	$11,796,665
Swift	$3,673,649
Todd	$65,168,999
Traverse	$571,182
Wabasha	$3,002,119
Wadena	$42,563,965
Waseca	$1,181,700
Washington	$454,069,338
Watonwan	$4,491,760
Wilkin	$752,156
Winona	$739,568,452
Wright	5401662
Yellow Medicine	$53,769,730
Total	$24,165,012,026

Sources: MN Risk Management Cope Report and Construction and Building Services ARCIBUS Report

Flood Vulnerability and Potential Losses of State Facilities

The 2011 Statewide HAZUS Flood Risk Assessment Report cited 53 sites with 113 structures located in the 100- year floodplain (or 1 percent annual chance of flooding). State building locations were reviewed to differentiate between sites and structures: in some cases multiple structures were reported for one location. The 2011 flood risk assessment was the foundation for reviewing flood risk with state agencies. The input not only explained structures listed in the report but also added other facilities for consideration.

ADMIN – The property at 5420 Old Highway 8 in Arden Hills was reported to be vulnerable to floods by facilities staff. The property was found to be in a Zone A floodplain. The structure was not in the floodplain and the entrances to the building are elevated.

DOC – The Minnesota Correction Facility Lino Lakes at 7525 4th Avenue, Lino Lakes was reported in the floodplain. The NFIP map shows a drainage canal on the property with no DOC structures in the mapped Zone A. HAZUS reported thirty three structures plus a MNDOT radio tower as being vulnerable. DOC staff stated that the canal is monitored and maintained.

DHS – HAZUS reported three structures in the floodplain. The structures are group homes owned by private individuals or are no longer operational.

MAC – The Downtown St. Paul Airport was reported in HAZUS to be in the floodplain. The MAC installed a moveable flood wall in 2009 to mitigate the flooding of runways and hangers. The wall was used two times in 2010 due to the rise Mississippi River. Some flight operations are curtailed when moveable wall is put in place over runways but the structures are protected from water. Previously, occupants either moved the contents from the hangers to another field or protected the facility with an emergency levee. The moveable floodwall is an economic benefit since state agencies and companies do not have to move air operations when the airport is threatened with floods.

MN DNR – A GIS analysis was completed by MN DNR and 64 facilities were found to be located in the 100 year floodplain and another 7 located in the 500 year floodplain for a total of 71 facilities. This clarifies the 2011 Statewide Flood Assessment that identified twenty-nine sites as being potentially flooded by HAZUS. The difference is that a site in the 2011 report included all of the facilities at one site which resulted hundreds of potential facilities identified in the floodplain.

Also, HSEM staff performed a closeout for the installation of river and rain gages at Whitewater State Park funded under DR-1921. The park was inundated by flash flood in 2007 stranding the campers. The park manager and staff receive electronic messages if there is a rapid accumulation of rainfall in the gages. The gages coupled with sirens installed by the county are part of an ‘early warning’ system to allow more time for warning and evacuation. Bridges in the park and the entrance highway were elevated to allow for evacuation as flood waters rise. These efforts should mitigate life and safety issues due to flash flood in Whitewater State Park.

MNDOT – Seven sites were identified by HAZUS but only three were found to be in found in floodplains. The maintenance facility in Ada and Lake City were found to be in Zone A floodplains. MNDOT staff reviewed the rate maps and determined that the structures may be elevated above the floodplain. The replacement value of the eight structures is $766 thousand. Staff is continuing to review the status of these structures. The Driver Exam Station located in Eagan is owned by MNDOT but under the custody of DPS. The rate map showed a drainage canal on the property but no structures in the Zone A. DPS staff reported that there have be no damage due to floods.

MNDOT staff is looking at the vulnerability to bridges, culverts, and roads in depth as part of their overall mission. Staff reported that funding was obtained to mitigation Highway 169 in Nicollet County from both flood and river bank erosion. Highway 101 in Shakopee is also being mitigated due to frequent floods. Reconstruction of facilities has mitigation in mind. An example is the Highway 120 bridge in Carlton County that was damaged due to the overflow of the Thomson Dam in 2012. The original culvert was replaced with a section of bridge designed for the overflow of the dam.

MNHS – Two properties were reported by HAZUS to be in floodplains. The Split Rock Lighthouse historic structures near Two Harbors were constructed above the floodplain. The Traverse des Sioux Historic Site in Nicollet County is located in the floodplain. The Treaty Site History Center is owned by the Nicollet County Historic Society and is elevated above the floodplain. MNHS staff identified that Historic Forestville in Preston is prone to flood. Seven structures are vulnerable with replacement values of $1.6 million.

MNSCU – The following vulnerability is based on MNSCU risk management records:

- Minnesota West Community and Technical College, Worthington – One structure valued at $944,000.
- Northland Community and Technical College, East Grand Forks – Three structures valued at $5.83 million.
- Northland Community and Technical College, Thief River Falls – Eight structures valued at $5.28 million.
- Northland Community and Technical College Airport Campus, East Grand Forks – One structure valued at $11.35 million.
- Minnesota State College – Southwest Technical, Winona – Five structures valued at $7.96 million.

In summary, thirty-three structures with a replacement value of approximately $33.7 million were identified as part of the review of the 2011 report. These findings are not conclusive since more research is needed to determine the specific vulnerability by some agencies.

Wildfire Vulnerability

Structures in jurisdictions that interface or mix with forests, peat bogs, and prairies are vulnerable to damages to wildfire statewide. The state agencies participating in the plan update discussed vulnerability of their facilities to wildfire. Detailed assessment for vulnerability of damages was not done as part of the meetings with state agencies. No facilities were reported to be damaged by wildfire. Most agencies stated that most of the facilities are located in developed sections of cities. Several agencies stated that more information is needed to locate structures in relation to fuel sources. It was not assumed that a structure located in a Wildland area is vulnerable to wildfire since fire reduction techniques such as defensible space may be in place. However, the 2011 state mitigation plan vulnerability assessment ranked the counties using the entire value of state facilities in the county. Based on the meetings with the state agencies a more accurate representation is to use the facilities that are used for recreational purposes by county for the purposes of ranking. State Facility Wildfire Vulnerability Assessment is for the purpose of ranking only and does not represent the actual value of vulnerable structures to wildfire.

High – Counties with state facilities located in forested areas as defined by Minnesota Wildland Urban Interface 2000, Figure 21, and have exposure values greater than or equal to $1.9 million.

Medium – Counties with state facilities located in all types of vegetated areas as defined by Minnesota Wildland Urban Interface 2000, Figure 21, and have exposure values less than $1.9 million but greater than or equal to $1.0 million.

Low – Counties with state facilities located in all types of vegetated areas as defined by Minnesota Wildland Urban Interface 2000, Figure 21, and have exposure values less $1.0 million.

Note: Only 66 counties have state facilities where state owned recreational facilities are located. The remaining counties are not ranked.

Table 56 State Facility Wildfire Vulnerability Assessment

County	# of Structures	Exposure Value	Ranking
St. Louis	202	$43,100,000	High
Clearwater	131	$30,600,000	High
Beltrami	58	$27,600,000	High
Pine	124	$23,600,000	High
Lake	109	$16,600,000	High
Winona	82	$16,100,000	High
Crow Wing	56	$15,100,000	High
Fillmore	84	$11,300,000	High
Otter Tail	50	$8,700,000	High
Anoka	3	$8,200,000	High
Hubbard	65	$7,100,000	High
Marshall	45	$6,700,000	High
Mille Lacs	63	$6,600,000	High
Lake of the Woods	60	$6,400,000	High
Roseau	53	$6,100,000	High
Carlton	49	$6,100,000	High
Itasca	4	$6,000,000	High
Koochiching	33	$3,900,000	High
Cass	37	$3,800,000	High
Isanti	7	$3,700,000	High
Becker	19	$3,000,000	High
Wright	20	$1,900,000	High
Hennepin	45	$56,800,000	Medium
Kandiyohi	59	$9,300,000	Medium
Brown	35	$8,700,000	Medium
Chisago	54	$5,900,000	Medium
Washington	46	$5,900,000	Medium
Cottonwood	21	$5,300,000	Medium

County	# of Structures	Exposure Value	Ranking
Douglas	26	$4,900,000	Medium
Le Sueur	32	$4,200,000	Medium
Pope	32	$4,100,000	Medium
Scott	3	$4,100,000	Medium
Olmsted	12	$4,000,000	Medium
Murray	33	$3,700,000	Medium
Freeborn	31	$3,700,000	Medium
Big Stone	12	$2,800,000	Medium
Lyon	27	$2,600,000	Medium
Nicollet	20	$2,600,000	Medium
Faribault	4	$2,600,000	Medium
McLeod	2	$2,600,000	Medium
Wabasha	31	$2,200,000	Medium
Clay	16	$2,100,000	Medium
Blue Earth	19	$2,000,000	Medium
Watonwan	3	$2,000,000	Medium
Goodhue	28	$1,900,000	Medium
Rice	13	$1,900,000	Medium
Steele	13	$1,800,000	Medium
Yellow Medicine	17	$1,700,000	Medium
Aitkin	2	$1,600,000	Medium
Lac Qui Parle	18	$1,600,000	Medium
Houston	14	$1,500,000	Medium
Jackson	8	$1,300,000	Medium
Pipestone	11	$1,200,000	Medium
Morrison	14	$1,100,000	Medium
Cook	2	$1,100,000	Medium
Polk	10	$1,100,000	Medium
Sherburne	7	$700,000	Low

County	# of Structures	Exposure Value	Ranking
Pennington	1	$600,000	Low
Wadena	4	$400,000	Low
Kanabec	3	$350,000	Low
Stearns	4	$210,000	Low
Todd	3	$200,000	Low
Mower	13	$900,000	Low
Swift	8	$800,000	Low
Renville	5	$400,000	Low
Rock	23	$300,000	Low

Dam/Levee Vulnerability and Potential Losses of State Facilities

The only state infrastructure identified are in Carlton County, The MNDOT Highway 210 bridge and highway is downstream of the Thomson Dam other dams. MN DNR's Jay Cook State Park is downstream of several dams

Windstorm Vulnerability of State Facilities

The state agencies participating in the plan update discussed the vulnerability to their facilities to windstorms. Based on general discussion, structures such as office buildings and structures built to the latest codes should be damaged to winds of less than or equal to 65 knots. This represents quite a large amount of the building stock. Specific facilities will be reviewed in the future to determine their specific vulnerability.

Tornado Vulnerability of State Facilities

The vulnerability of state building stock was discussed in general with state agencies as part of the state plan update. Damages to EF3 and above tornadoes are a concern since the force of these tornadoes may cause catastrophic failure of a building. Probability was also discussed briefly in some meetings since some facilities managers did not remember the presence of a tornado near their complexes. The discussions took into account the potential loss of life. Specific vulnerability is assumed to be all structures in the state inventory characterized in Table 56. Further reviews with state agencies will provide a more accurate account of vulnerability.

Hail Damage of State Facilities

In general, state facilities are vulnerable to damage by hail. Several agencies stated that build to building code are impacted less. All state facilities will be considered vulnerable to hail until a more accurate assessment is complete.

Geological Vulnerabilities of State Facilities

The hazards covered in this section:

- Erosion
- Landslide / Mudslide (hillside, coastal, bluff)
- Land Subsidence (Sinkholes and Karst)
- Earthquakes

Several agencies had concerns about facilities due to erosion or subsidence due to specific examples that were discussed. These examples investigated in future assessments.

Information from the risk assessment was provided that significant damage from earthquakes is possible if the current trends will continue. All state agencies stated state facilities are not vulnerable to major damage due to earthquakes.

Other Natural Hazard Vulnerability

The hazards profiled in this section are:

- Lightening
- Winter Storms
- Drought
- Extreme Heat
- Extreme Cold

Information from the risk assessment was reviewed. Overall, these hazards were not seen as having impacts since the facilities were already built with them in mind or there are maintenance/operations procedures that cover how to address these hazards.

State Facility Vulnerability Summary

The focus of the vulnerability assessment for state facilities was for floods since the 2011 Statewide Flood Assessment provided a list of facilities to assess. The state agencies researched the list and also reported facilitates that they found to be at risk. The other hazards were discussed using the updated information for this plan update and general responses were given. The state agencies also chose potential projects based on a list of Hazard Mitigation Assistance (HMA) eligible projects. The list of potential projects is intended to make the agencies eligible for HMA projects and is found is in Section 5 of this plan.

Data Deficiency: Vulnerability assessments for each facility for all natural hazards were not done as part of this plan update. Accurate vulnerability assessments for each facility with input from state agencies will continue as part of the future plan update process.

Section 5: Mitigation Strategy

§201.4(c)(3) *To be effective the plan must include a Mitigation Strategy that provides the State's blueprint for reducing the losses identified in the risk assessment.*

(i): *The State mitigation strategy shall include a description of State goals to guide the selection of activities to mitigate and reduce potential losses.*

(iii): *The State plans shall include an identification, evaluation, and prioritization of cost-effective, environmentally sound, and technically feasible mitigation actions and activities the State is considering and an explanation of how each activity contributes to the overall mitigation strategy. This section should be linked to local plans, where specific local actions and projects are identified.*

201.4(d): *Plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities.*

Hazard mitigation, as defined by the Disaster Mitigation Act of 2000, is any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards. Studies on hazard mitigation show that for each dollar spent on mitigation, society saves an average of four dollars in avoided future losses. (Multihazard Mitigation Council, 2005) Mitigation can take many different forms from construction projects to public education.

MN HSEM Vision and Mission: Keeping Minnesota Ready

The mission of HSEM is to help Minnesota prevent, prepare for, respond to and recover from natural and human caused disaster. Our team develops and maintains partnerships; collects and shares information; plan; train and educates; coordinates

The development of a mitigation strategy allows the State of Minnesota to create a vision for preventing future disasters, establish a common set of mitigation goals across state, tribal, and local agencies, prioritize actions, and evaluate the success of such actions. The Minnesota Mitigation Strategy is based on the results of the statewide risk assessment, local and tribal risk assessments and mitigation strategies, and additional recommendations by mitigation stakeholders. The goals are broad, forward-looking statements that outline in general terms what the state would like to accomplish in collaboration with its partners.

5.1 Update

The goals and objectives for the 2014 Plan have been revised by the SHMP team. The 2014 plan goals take into account Hazard Mitigation's role at the center of implementing Hazard Mitigation programs. However we have added HSEM's Recovery Branch, (which includes Public Assistance, Individual Assistance, Voluntary Agencies, Community and Long-Term Recovery staff and programs), other branches in HSEM, including Operations and Response, Hazardous Materials, Critical Infrastructure, Radiological Emergency Preparedness, All Hazards Planning, Training, Field staff (Regional Program Coordinators) and Finance and Grants staff – all of which whom coordinate with Hazard Mitigation.

The next ring in the circle of influence is other State Agencies (SA) that coordinates and collaborates on Hazard Mitigation projects and plans. State agencies include other Divisions in the Department of Public Safety: State Fire Marshal, Office of Communications, and Office of Pipeline Safety. We coordinate with the Departments of Transportation (MDOT), Labor and Industry (DOLI), Administration, Agriculture (MDA), Board of Water and Soil Resources (BWSR), Employment and Economic

Development (DEED), Health (MDH), Housing Finance Agency (MFHA), Human Services (DHS), Metropolitan Council, Metropolitan Airport Commission, Natural Resources (MnDNR)- specifically Division of Waters and Ecological Resources, Dam Safety, Facilities, Forestry, State Climatology Office; Pollution Control Agency (PCA)-specifically the Interagency Climate Adaptation Team, Minnesota Historical Society, Minnesota State Colleges and Universities (MNSCU) and the University of Minnesota. The Plan contains links and a description of each of the agencies' roles and programs hazard mitigation may coordinate and collaborate with.

The simplified, straightforward and implementable goals and objectives for the state are provided below.

State of Minnesota Hazard Mitigation Goals and Objectives:

Goal 1. Enhance the State's capacity to make Minnesota more resilient to the effects of all hazards.

Goal 2. Build and support local capacity and commitment to increase resiliency to all hazards.

- Increase awareness and knowledge of hazard mitigation principles and practice among local public officials.
- Provide direct technical assistance to local public officials and help communities obtain funding for mitigation planning and project activities.
- Encourage communities to update and implement local hazard mitigation plans and incorporate with other land use planning mechanisms.
- Improve compliance with State floodplain regulations and encourage participation in the National Flood Insurance Program (NFIP), and Community Rating System (CRS)
- Provide training and assist jurisdictions in developing and implementing cost-beneficial mitigation projects.
- Maximize available post-disaster "windows of opportunity" to implement major mitigation outreach initiatives, including social media

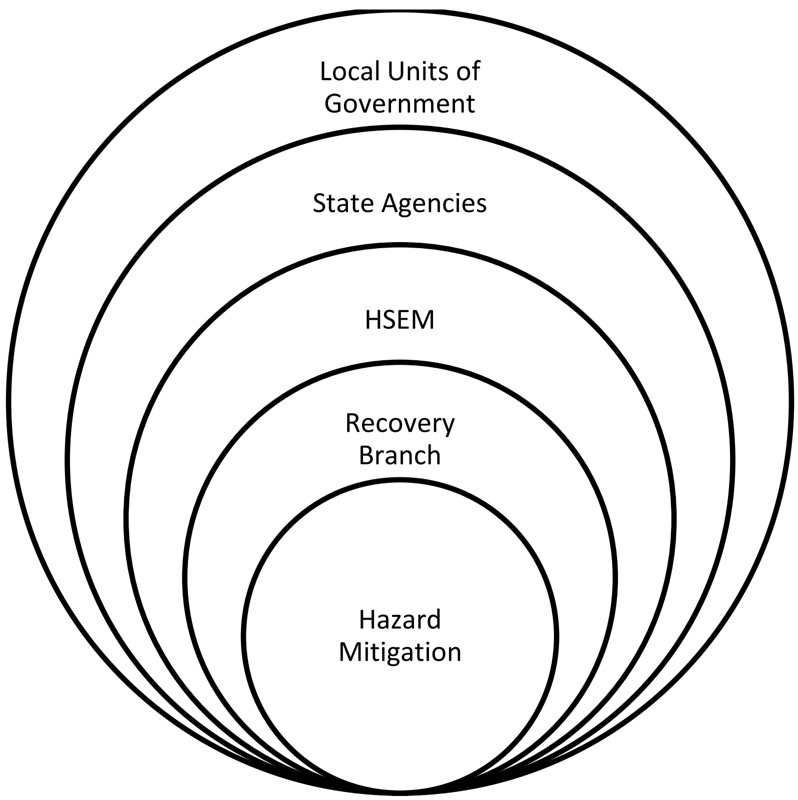
Since the 2011 Plan, a new State Hazard Mitigation Officer and two new hazard mitigation project officers have been hired, leading to a full staff of one SHMO and three project officers for the first time. The Hazard Mitigation staff is dedicated to the ongoing implementation of mitigation planning and projects to reduce exposure of the State's population to natural hazards. The Minnesota State All-Hazard Mitigation Plan continues to be the central document to direct the implementation of the mitigation programs statewide. Due to full staffing and comprehensive outreach applications for DR-4069 have been submitted for nearly 100% of available funding.

Hazard mitigation staff continues to collaborate with agencies and partnerships. The Minnesota Silver Jackets is a collaborative federal/state partnership that has successfully implemented mitigation activities during the past three years and has additional mitigation projects on the horizon. A new partnership is with the Minnesota Interagency Climate Adaptation Team. Another is with the Department of Labor and Industry, specifically the manufactured housing regulatory agency. The Department of Commerce, disaster recovery and insurance fraud connection has been made to streamline information available at post Disaster Recovery Centers.

The goals, strategies and actions from the 2011 Plan were revised by state mitigation staff. The majority of strategies and actions for Goal One are inherent in HSEM operations to include state mitigation staff responsibilities and are included in the Department of Public Safety and HSEM mission.

'The Goals, Objectives, Strategies and Actions' section has been reviewed and revised and is summarily updated. 'Projected Funding', 'Rational for Action' and 'How Action Contributes to Mitigation Strategy' have been deleted as these are covered elsewhere in the plan as is the progress the state has made in making the state more disaster resistant. Rational for changes is included in Appendix K. The timeframe for the majority of actions was and will continue to be ongoing as funding opportunities become available post-disaster or annually.

5.2 State Plan Goals, Strategies and Actions



- HAZARD MITIGATION – HM (collaboration with federal agencies through MN SJ)
- RECOVERY BRANCH - Public Assistance, Long Term and Community Recovery, Individual Assistance and Volunteer Organizations Active in Disaster (VOAD)
- HSEM - Operations and Response, Hazardous Materials, Radiological Emergency Preparedness, Training, Field Services – including Regional Planning Coordinators, Grants, Homeland Security - Critical Infrastructure and Key Resources, School Safety Center
- State Agencies - SA
- Local Units of Government – Tribal governments, counties, cities, rural electric cooperatives, school districts, etc. eligible sub-applicants to FEMA and other mitigation grant programs**.**

Goal 1. Enhance the State's capacity to make Minnesota more resilient to the effects of all hazards.

- Institutionalize Hazard Mitigation – **HM**
  - Provide high quality training.
  - Attract and retain qualified, experienced hazard mitigation professionals
  - Encourage professional development and certification through outside continuing education courses.
  - Support development of statewide tracking system for mitigation projects
  - During 2014-2019 HSEM will pursue establishing a state disaster fund
  - Support the update of building and fire codes with mitigation standards for adoption by local governments.
  - Consult with state agencies, planning associations, and regional development commissions regarding how mitigation standards may be adopted by counties.
- Maintain and implement a State All-Hazard Mitigation Plan that fosters innovation, advances public support, and gains long-term commitments for pre-disaster mitigation from the State of Minnesota. **HM, Recovery, HSEM & SA**
  - Work with MN DNR mitigation grant staff to ensure available mitigation funds are leveraged to the greatest extent possible.
  - Use Silver Jackets as a standing committee for the review and maintenance of the state plan
  - When local jurisdictions' mitigation plans are approved, HM staff review proposed mitigation projects and solicit applications from eligible entities.
  - Continually upgrade statewide spatial data maintained in-house through multiple data sources ex. State owned and operated facilities
  - Evaluate emerging technologies and upgrade through hardware/software acquisition and training where appropriate and feasible.
  - Work with State and federal agencies to ensure all current hazards are identified.
  - Continually review new data sources and data trends for changes in hazard prone areas and potential projects (Atlas 14, climate change, soil/bluff erosion issues)
  - Expand State Hazard Mitigation Plan review team to include state agencies
  - Coordinate with mitigation branch in providing technical disaster recovery assistance to impacted communities.
  - Identify local impacts during the initial and preliminary damage assessment process
  - Identify unmet needs
  - Create guidance for local long-term recovery needs and present at community meetings as a public outreach and education activity.
  - Conduct post-disaster assessment of resource deployments and activities and communicate areas for improvement.
  - Ensure mitigation efforts are appropriately represented and acknowledged at Joint Field Offices (JFO).
- Coordinate and communicate with other Branches within the HSEM Division to support mitigation efforts. **HSEM**
  - Jointly develop procedures with the Public Assistance Section to maximize the use of Section 406 Mitigation Funding following a declared disaster event.

  - Improve coordination and communication with Regional Program Coordinators by consulting them in the application process and notifying them of grant approval.
  - Maximize the utilization of best technology.
  - Incorporate geographic information system (GIS) as a tool in decision making. (HSEM)
  - Participate in Preliminary Damage Assessment (PDA) activities immediately following a disaster to support mitigation through 406 & 404 programs
  - Integrate Threat and Hazard Identification and Risk Assessment (THIRA) of local communities in mitigation planning.
  - Incorporate functional needs planning in decision making.
  - Work with Emergency Preparedness Response Committee to find common planning tools available in supporting mitigation.
- Coordinate and communicate with state agencies to support mitigation efforts within and for State Government. **HM, Recovery, HSEM & SA**
  - Coordinate with Minnesota Recovers Task Force when special state legislative appropriations are funded. (MNRTF includes SA)
  - Encourage communities to adopt strong local floodplain regulations to reduce future flood losses. (MN DNR)
  - Improve compliance with State floodplain regulations and encourage participation in the National Flood Insurance Program (NFIP).
  - Encourage participation in the Community Rating System (CRS) for NFIP Communities
  - Work with HSEM and MN DNR to identify flood prone areas in incorporated municipalities where stronger regulations would be appropriate.
  - Work FEMA and DNR's Risk MAP effort (digital floodplain mapping) to increase flood hazard awareness, risk reduction and identify new flood hazard areas and project identification.
  - Notify communities with new flood risks and encourage them to adopt local floodplain regulations and seek mitigation alternatives.
  - Encourage and assist communities to develop GIS parcel maps and DFIRMs to identify at-risk properties in flood hazard areas.
  - Support the Minnesota Association of Floodplain Managers (MNAFPM) programs, including education and communication.
  - Promote and distribute model Floodplain Management Ordinances and Floodplain Management Series Information sheets. (MN DNR)
  - Develop and maintain community floodplain management information database.
  - Identify and assess repetitive loss properties for possible projects. (MN DNR and HSEM)
  - Support development of statewide tracking system for repetitive loss structures.
  - Assist other state agencies in identifying structures located in hazardous areas. (HSEM and MNDNR)
  - Work with SHPO to identify elevations of historic structures in the floodplain.
  - Work with state agencies to identify the elevations of state owned/operated facilities in the floodplain.

Goal 2. Build and support local capacity and commitment to increase resiliency to all hazards.

- **HM**
  - Provide federal HMA Planning and Project Grants to communities willing to provide a (up to) 25% local match, and based upon established criteria.
  - When available, allocate federal and state grant funding to eligible subgrantees for the purposes of identifying risk and developing local mitigation plans and projects, using adopted plans as guides for projects.
  - Hold meetings with Key Elected Officials, or city staff to educate the importance of mitigation projects and explain HMGP.
  - Continuously demonstrate the importance of pre-disaster mitigation planning to local public officials and promote the availability of Pre-Disaster Mitigation (PDM) resources.
  - Encourage communities to develop, adopt, and implement local hazard mitigation plans.
  - Support the Minnesota Association of Floodplain Managers (MNAFPM) programs, including education and communication.
  - Coordinate education activities with MNAFPM and support annual conference.
  - Coordinate with key local officials to determine local issues and concerns as well as local, state and federal actions previously taken.
  - Assist colleges and universities in applying for Pre-Disaster grant funds.
- HSEM (and federal agencies)
  - Publicize hazard mitigation program successes (FEMA, HSEM, DNR, USGS, USACE, NWS, NRCS, local jurisdictions), through news media and on the web
  - Promote the Mitigation House as a tool for local use
  - Improve coordination and communication with Regional Program Coordinators by consulting them in the application process and notifying them of grant approval.
  - Encourage communities to develop, adopt, and implement local hazard mitigation plans.
  - Increase public understanding, support, and demand for hazard mitigation
  - Outreach strategy:
    - Develop hazard mitigation success stories for HSEM and FEMA websites
    - Heighten public awareness of natural hazards.
    - Launch or participate in awareness campaigns and special events. (HSEM)
    - Participate in Winter Hazard Awareness Week.
    - Participate in Severe Weather Awareness Week.
    - Promote FloodSmart.Gov the official website of the NFIP
    - Promote the National Weather Service (NWS) Storm Ready Program and NOAA Turn around Don’t Drown.
    - Support and promote the DNR FireWise program.
    - Publicize and encourage the use of a variety of tools for warning systems. (NWS and HSEM)
    - Encourage local jurisdictions to establish and maintain warning systems (e.g., Emergency Alert System (EAS), outdoor warning sirens, and Reverse 911) capable of alerting residents in a timely manner.
    - Work to improve the capability to warn special populations, particularly those with hearing or visual impairments

        - Promote the use of ARMER interoperable radio and Disaster LAN critical incident software.
        - Promote the advantages of weather radios to the general public.
        - Encourage jurisdictions to keep outdoor warning sirens in good condition.
        - Encourage jurisdictions to warn at-risk population groups of the dangers of extreme temperatures and ways to avoid the danger.
- State Agencies (and federal agencies)
    - Publicize hazard mitigation program successes (FEMA, HSEM, DNR, USGS, USACE, NWS, NRCS, local jurisdictions), through news media and on the web
    - Promote NFIP compliance as a prerequisite for all communities with an identified Special Flood Hazard Zone considering hazard mitigation projects.
    - Continue to work with the Interagency Climate Adaptation Team (ICAT) on climate change and adaptation strategies.
    - Support DNR's effort to
        - Ensure communities not in good standing with the NFIP understand that they will remain ineligible for any mitigation funding.
        - Encourage communities to adopt strong local floodplain regulations to reduce future flood losses. (MN DNR)
        - Maintain awareness of new municipal incorporations and encourage participation in the NFIP. (MN DNR)
        - Continue to work with MN DNR to conduct floodplain management and flood mitigation workshops. (HSEM)
        - Encourage participation in Community Rating System (CRS) and improve ratings of communities. (MN DNR and HSEM)
        - Identify potential CRS communities and encourage enrollment.
        - Ensure minimum flood protection standards are met and promote higher floodplain management standards in all jurisdictions.
    - Work with communities, NWS and USGS to identify flood risks and establish flood gauges and early warning systems.
    - Encourage the use of the MDH Health Alert Network to all eligible communities.
    - Support the Minnesota Association of Floodplain Managers (MNAFPM) programs, including education and communication.
    - Support ASFPM administration of the Certified Floodplain Manager (CFM) program. (MN DNR)
    - Support MN Department of Labor and Industry with providing accurate building code information for potential mitigation projects

5.3 Natural Hazard Mitigation

The following table is intended to further specify what type of mitigation strategies can be utilized to reduce deaths, injuries, property losses and other losses due to *natural hazards*. Mitigation strategies may be utilized alone or in combination to address natural hazards, depending upon the potential threat and potential for mitigation. The goal is to reduce the deaths, injuries, property loss and economic disruption due to natural hazards that impact the state of Minnesota and its' communities. Communities should utilize these strategies and implementation of objectives as a guide to develop their local mitigation plans. The following objectives are examples of successful types of mitigation projects.

Communities must weigh the cost-effectiveness, environmental impacts and technological feasibility prior to implementation.

The six strategy tools provide guidance for the state and local jurisdictions to develop hazard mitigation plans. The overriding strategy is to eliminate or significantly reduce loss of life and damages to property from all hazards. Actions in a mitigation strategy may fall under one or more of the following six categories: 1) Prevention, 2) Property Protection, 3) Public Education and Awareness, 4) Natural Resource Protection, 5) Emergency Services and 6) Structural Improvements.

The following tools provide guidance for the state and local jurisdictions to develop actions to include in hazard mitigation plans. Potential funding sources and time frame have been added to this table to reduce redundancy from the 2011 plan.

Strategies and objectives was updated by HSEM staff and reviewed by the Silver Jackets team and includes a wide variety of potential mitigation activities. Many mitigation strategies are not eligible for FEMA funding. Local communities are encouraged to utilize all possible avenues of funding to make their communities more disaster resistant. The following table is offered to locals to use as a template or starting point for mitigation activities.

Table 57 Natural Hazard Mitigation Goals, Strategies and Actions (High Priority in RED)

MITIGATION STRATEGY	MITIGATION ACTIONS	POTENTIAL FUNDING SOURCES	TIMEFRAME
FLOODING GOAL: Reduce deaths, injuries, property loss, and economic disruption due to all types of flooding (riverine, flash, coastal, and dam/levee failure).			
Prevention:	Planning, technical studies, training, adoption of ordinances and legislation, acquisition and use of equipment, establishing shelters, and encouraging participation in NFIP and CRS will be used to prevent or reduce risks to lives and property from flooding.	HMGP-Planning, PDM-Planning, FMA, EMPG	Ongoing, as required
Property Protection:	Acquisition, repair, or retrofitting of property and acquisition and use of equipment will be used to prevent or reduce risks to property from flooding.	HMGP, FMA, PDM, MN DNR, BWSR,	Pre- and post-disaster
Public Education and Awareness:	Utilize existing and promote public education campaigns (ex. Turn Around Don't Drown and FloodSmart.gov) Access to information will be used to raise public awareness of risks from flooding in order to prevent or reduce those risks.	HMGP-5%, NWS, USGS	Ongoing, pre- and post-disaster
Natural Resource Protection:	Stream corridor protection projects and restoration and soil erosion control projects will be used to prevent or reduce risks and increase the protection of natural resources from flooding.	MN DNR, BWSR, USDA-NRCS-FSA	Post-disaster, ongoing
Emergency Services:	Technological improvements, warning systems, responder training, emergency response services,	SHSP	Annually

MITIGATION STRATEGY	MITIGATION ACTIONS	POTENTIAL FUNDING SOURCES	TIMEFRAME
	acquisition and use of equipment, and planning will provide emergency services to prevent or reduce the risks to lives and property from flooding.		
TORNADO GOAL: Reduce deaths, injuries, property loss, and economic disruption due to tornadoes.			
Prevention:	Adoption of ordinances and legislation, acquisition and use of equipment, planning, conducting technical training, studies, and retrofit or construction of safe rooms will be used to prevent or reduce risks to lives, property, and economic activity from tornadoes.	HMGP, PDM	Pre- and post-disaster, ongoing
Property Protection:	Constructing safe rooms and storm shelters, and retrofits will be used to prevent or reduce risks to property from tornadoes.	HMGP, PDM	Post-disaster, annually
Public Education and Awareness:	Warning systems, IPAWS, public education, and access to information will be used to raise public awareness of risks from tornadoes in order to prevent or reduce those risks.	HMGP-5%, NWS, USGS	Ongoing, Pre- and post-disaster
Emergency Services:	Warning systems, technological improvements, responder training, planning, emergency response services, and acquisition and use of equipment will provide emergency services to prevent or reduce risks from tornadoes.	SHSP	Annually
Structural Improvements:	Construction of storm shelter and safe rooms and maintenance of other structural projects will be used to prevent or reduce risks from tornadoes.	HMGP, PDM	Post-disaster, annually
WILDFIRE GOAL: Reduce deaths, injuries, property loss, natural resource and economic disruption due to wildfires (forest, prairie, grass, and peat bogs).			
Prevention:	Enforcement of regulations, adoption of ordinances, technical studies, and planning will be used to prevent or reduce wild land fires and the risks they pose to lives, property, and the natural environment.	HMGP-Planning, PDM-Planning, EMPG	Ongoing, as required
Property Protection:	Vegetation management, defensible space, water treatment measures (for example: sprinklers) will be used to prevent or reduce the risk of wild land fires.	MN-DNR, USFS	As funding allows
Public Education and Awareness:	Public education and access to information will be used to raise public awareness of risks from wild land fires in order to prevent or reduce those risks, specifically the FireWise program.	HMGP-5%, NWS, DNR, USFS	Ongoing, Pre- and post-disaster

MITIGATION STRATEGY	MITIGATION ACTIONS	POTENTIAL FUNDING SOURCES	TIMEFRAME
Emergency Services:	Planning, responder training, acquisition and use of equipment, evacuations, warning systems, technological improvements, and emergency response services will provide emergency services to prevent or reduce risks to lives and property from wild land fires.	SHSP	Annually
Structural Improvements:	New or retrofit construction utilizing fire resistant building materials and installation and maintenance of sprinkler and warning systems will be used to prevent or reduce the risk of wild land fires.	HMGP, PDM	Ongoing, Pre- and post-disaster
WINDSTORMS GOAL: Reduce deaths, injuries, property loss, and economic disruption due to windstorms.			
Prevention:	Planning, training, technical studies, acquisition and use of equipment, adoption of ordinances and legislation, and construction new or retrofit safe rooms will be used to prevent or reduce risks from windstorms to lives, property, and economic activity.	HMGP, PDM	Post-disaster, annually
Property Protection:	Constructing safe rooms and storm shelters, retrofitting, and vegetation management will be used to prevent or reduce risks to the protection of property from windstorms.	HMGP, PDM	Post-disaster, annually
Public Education and Awareness:	Public education, warning systems, and access to information will be used to raise public awareness of risks from windstorms in order to prevent or reduce those risks.	HMGP-5%, NWS, USGS	Ongoing, pre- and post-disaster
Emergency Services:	Warning systems, responder training, emergency response services, technological improvements, and response and recovery planning will provide emergency services to prevent or reduce risks from windstorms.	SHSP	Annually
Structural Improvements:	Construction of storm shelters and safe rooms and maintenance of other structural projects will be used to prevent or reduce risks from windstorms.	HMGP, PDM	Pre- and post-disaster, annually
WINTER STORMS GOAL: Reduce deaths, injuries, property loss, and economic disruption due to winter storms (blizzard, ice, and ice storm).			
Prevention:	Acquisition and use of equipment, adoption and enforcement of ordinances and legislation, planning, training, and technical studies will be used to prevent or reduce risk to the protection of lives, property, and economic activity from the	HMGP-Planning, PDM-Planning, EMPG	Ongoing, as required

MITIGATION STRATEGY	MITIGATION ACTIONS	POTENTIAL FUNDING SOURCES	TIMEFRAME
	risks from severe winter storms.		
Property Protection:	Acquisition and use of equipment and vegetation management will be used to prevent or reduce risks to property from the risks from severe winter storms.	MN DNR, USFS, MN DOT	As funding allows
Public Education and Awareness:	Public education, warning systems, access to information, and outreach projects will be used to raise public awareness of the risks from severe winter storms in order to reduce those risks.	HMGP-5%, NWS, USGS	Ongoing, pre- and post-disaster
Emergency Services:	Acquisition and use of equipment, emergency response services, warning systems, technological improvements, planning, and responder training will provide emergency services to prevent or reduce risks from severe winter storms.	SHSP	Annually
Structural Improvements:	Structural projects for critical infrastructure will be implemented and maintained to prevent or reduce risks from severe winter storms.	HMGP, PDM	Pre- and post-disaster, ongoing
LIGHTNING GOAL: Reduce deaths, injuries, property losses, loss of services, and economic disruption due to lightning.			
Prevention:	Planning, technical studies, acquisition and use of equipment, adoption of ordinances and legislation, and establishing shelters will be utilized to prevent or reduce the risks from lightning.	HMGP-Planning, PDM-Planning, EMPG	Ongoing, as required
Property Protection:	Retrofits and construction of safe rooms and storm shelters will be used to prevent or reduce the risks to property from lightning.	HMGP, PDM	Ongoing, pre- and post-disaster
Public Education and Awareness:	Public education, outreach projects, and access to information will be used to raise public awareness of risks from lightning in order to prevent or reduce those risks.	HMGP-5%, NWS	Ongoing, pre- and post-disaster
Emergency Services:	Responder training, warning systems, emergency response services, planning, acquisition and use of equipment, and technological improvements will provide emergency services to prevent or reduce risks to lives and property from lightning.	SHSP	Annually
Structural Improvements:	The construction of safe rooms, shelters, and underground utility lines as well as maintenance of structural projects will be used to prevent or reduce risks from lightning.	HMGP-5%, PDM	Ongoing, pre- and post-disaster

MITIGATION STRATEGY	MITIGATION ACTIONS	POTENTIAL FUNDING SOURCES	TIMEFRAME
HAIL GOAL: Reduce deaths, injuries, property damage, and economic disruption due to hailstorms			
Prevention:	Planning, technical studies, and adoption of ordinances and legislation will be used to prevent or reduce risks to life, property, and economic activity from hailstorms.	HMGP-Planning, PDM-Planning, EMPG	Ongoing, as required
Public Education and Awareness:	Public education and access to information will be used to raise awareness of the risks of hailstorms in order to prevent or reduce those risks.	HMGP-5%, NWS, USGS	Ongoing, pre- and post-disaster
Emergency Services:	Warning systems, responder training, technological improvements, and planning will be used to provide emergency services to prevent or reduce the risks from hailstorms.	SHSP	Annually
Structural Improvements:	Retrofit critical facilities and maintenance of existing structures will be used to prevent or reduce the risks from hailstorms.	HMGP, PDM	Ongoing, pre- and post-disaster
DROUGHT GOAL: Reduce economic loss and environmental impacts due to drought			
Prevention:	Planning, acquisition and use of equipment, and technical studies will be used to prevent or reduce risks from drought.	HMGP-Planning, PDM-Planning, EMPG	Ongoing, as required
Property Protection:	Water treatment measures will be used to prevent or reduce risks to property from drought.	MN DNR	As funding allows
Public Education and Awareness:	Public education and access to information will be used to raise public awareness of risks from drought in order to prevent or reduce those risks.	HMGP-5%, NWS, USGS	Ongoing, pre- and post-disaster
Natural Resource Protection:	Planning and implementing watershed plans will be used to prevent or reduce risks from drought.	MN DNR	As funding allows
Structural Improvements:	Technological improvements and acquisition of equipment for structural projects will be used to prevent or reduce risks from drought.	USDA MDA	Ongoing, pre- and post-disaster
EXTREME HEAT GOAL: Reduce deaths, injuries, and economic disruption due to extreme heat.			
Prevention:	Planning and the acquisition and use of equipment will be used to prevent or reduce risks from extreme heat.	HMGP-Planning, PDM-Planning, EMPG	Ongoing, as required
Property Protection:	Acquisition and use of equipment will be used to prevent or reduce risks to property and economic disruption from extreme heat.	EMPG	Ongoing, as required
Public Education and Awareness:	Public education and access to information will be used to raise public awareness of the risks from extreme heat in order to prevent or reduce	HMGP-5%, NWS, USGS	Ongoing, pre- and post-

MITIGATION STRATEGY	MITIGATION ACTIONS	POTENTIAL FUNDING SOURCES	TIMEFRAME
	those risks.		disaster
Structural Improvements:	Planning, responder training, warning systems, establishing shelters, and technological improvements will provide emergency services to prevent or reduce risks from extreme heat.	EMPG	Ongoing, as required
EXTREME COLD GOAL: Reduce deaths, injuries, property loss, and economic disruption due to extreme cold.			
Prevention:	Planning and the acquisition and use of equipment will be used to prevent or reduce risks from extreme cold.	HMGP-Planning, PDM-Planning, EMPG	Ongoing, as required
Property Protection:	Acquisition and use of equipment will be used to prevent or reduce risks to property and economic disruption from extreme cold.	EMPG	Ongoing, as required
Public Education and Awareness:	Public education and access to information will be used to raise public awareness of the risks from extreme cold temperatures in order to prevent or reduce those risks.	HMGP-5%, NWS, USGS	Ongoing, pre- and post-disaster
Structural Improvements:	Planning, responder training, warning systems, establishing shelters, and technological improvements will provide emergency services to prevent or reduce risks from extreme cold.	EMPG	Ongoing, as required
EROSION GOAL: Reduce deaths, injuries, property loss, and economic disruption due to field, stream bank, ravine, shoreline, bluff: caused primarily by flowing water or wave action.			
Prevention:	Planning, technical studies, implementing watershed plans, implementing land use plans, adoption of setback ordinances, buyout or relocation of properties and adoption of building codes will be used to prevent or reduce risks from erosion.	HMGP, PDM, MN DNR, BWSR, USDA-NRCS-FSA, SWCDs	Ongoing, as required
Public Education and Awareness:	Public education and access to information will be used to raise public awareness of risks from erosion in order to prevent or reduce those risks.	HMGP-5%, NWS, USGS	Ongoing, pre- and post-disaster
Emergency Services:	Planning to implement emergency services will be used to prevent or reduce risks from landslides.	SHSP	Annually
LANDSLIDE/MUDSLIDE GOAL: Reduce deaths, injuries, property loss, and economic disruption due to (hillside, coastal, bluff: caused primarily by oversaturation of soil).			
Prevention:	Planning, technical studies, land use plans, adoption of setback ordinances, buyout or relocation of properties and adoption of building codes will be used to prevent or reduce risks from landslides/mudslides.	HMGP, PDM, MN DNR, BWSR, USDA-NRCS-FSA, SWCDs	Ongoing, as required

MITIGATION STRATEGY	MITIGATION ACTIONS	POTENTIAL FUNDING SOURCES	TIMEFRAME
Public Education and Awareness:	Public education and access to information will be used to raise public awareness of risks from landslides/mudslides in order to prevent or reduce those risks.	HMGP-5%, NWS, USGS	Ongoing, pre- and post-disaster
Emergency Services:	Planning to implement emergency services will be used to prevent or reduce risks from landslides.	SHSP	Annually
SUBSIDENCE GOALS: Reduce the threat to public health, property loss, and damages to structures and infrastructure due to sinkholes and karst.			
Prevention:	Planning, technical studies, and building/development regulations will be used to prevent or reduce risks from sinkholes and karst.	HMGP, PDM, MN DNR, BWSR, USDA-NRCS-FSA, SWCDs	Ongoing, as required
Property Protection:	Measures to reduce the volume of water passing into a sinkhole will be used in order to reduce financial loss, property damage, and threats to the public health and safety.	MN DNR, HMGP-5%	Pre-and post-disaster, ongoing
Public Education and Awareness:	Outreach efforts, public education and access to information will be employed to raise public awareness in order to reduce financial loss and risks to lives and property from subsidence.	MN DNR, BWSR, USDA-NRCS-FSA, SWCDs, HMGP-5%, NWS, USGS	Pre- and post-disaster, ongoing
Emergency Services:	Planning to implement emergency services will be used to prevent or reduce risks from subsidence.	SHSP	Annually
EARTHQUAKE GOALS: Limit property damage, economic loss, and disruptions in commercial and industrial activities in Minnesota due to earthquake.			
Prevention:	Planning, building code adoptions and management programs will be used to prevent or reduce risks to property and economic activity from earthquakes.	HMGP-Planning, PDM-Planning, EMPG	Ongoing, as required
Property Protection:	Repair and retrofitting of structures will be used to prevent or reduce risks from earthquakes.	HMGP, PDM, EMPG	Ongoing, as required
Public Education and Awareness:	Public education and access to information will be used to raise awareness of the risks from earthquakes in order to prevent or reduce those risks.	HMGP-5%, NWS, USGS	Ongoing, pre- and post-disaster
Emergency Services:	Planning, responder training, alert systems, establishing shelters, and technological improvements will provide emergency services to prevent or reduce risks from earthquakes.	SHSP	Annually
LANDSLIDE GOAL: Decrease damage to structures, roads, highways, and bridges from landslides will be			

MITIGATION STRATEGY	MITIGATION ACTIONS	POTENTIAL FUNDING SOURCES	TIMEFRAME
decreased.			
Prevention:	Planning, technical studies, and adoption of building codes will be used to prevent or reduce risks from landslides.	HMGP-Planning, PDM-Planning, EMPG, MN DNR, BWSR, USDA-NRCS-FSA, SWCDs	Ongoing, as required
Public Education and Awareness:	Public education and access to information will be used to raise awareness of the risks from landslides in order to prevent or reduce those risks.	HMGP-5%, NWS, USGS	Ongoing, pre- and post-disaster
Emergency Services:	Planning to implement emergency services will be used to prevent or reduce risks from landslides.	SHSP	Annually

The natural hazard goals, strategies and actions are broad enough, yet specific enough that local communities can utilize items that are most important to them. Based on local priorities and funding availability the tools above can guide communities to develop an overall mitigation strategy and implement projects to make their communities more disaster resistant.

Funding is typically available post-disaster as HMGP funds, or annually with the release of the HMA guidance. Mitigation and other strategic planning documents are typically due for review on a set schedule; state mitigation plans every three years, local hazard mitigation plans every five years. Other planning documents may be created or updated dependent upon funding availability. Additionally with the widened scope of available planning activities eligible under the new FEMA Guidance, local jurisdictions may increase their scope of threats (including effects of climate change) and potential mitigation activities.

Flood mitigation projects remain the highest priority in the state due to the high occurrence and high mitigation potential. Tornadoes, severe/ice/wind storms and wildfire mitigation measures are also higher risk as demonstrated by the hazard analysis and risk assessment process, and while damages can be reduced, not all damages can be completely mitigated. Depending upon the funding source - disaster or non-disaster - project priority is subject to an evaluation process. The HMGP and annual HMA grants project funding priority is subject to a different priority process.

With each project evaluation the benefit-cost ratio, feasibility, and environmental review issues are analyzed. Only projects that meet the criteria - of being cost-beneficial, feasible and pass NEPA review are selected for further review, and implementation. Based on the states past mitigation successes the following discussion of high priority actions considers and explains how each activity contributes to the overall mitigation strategy of the state. The state aims to geographically disperse funds and maximize the number of people protected to ensure available funding is used responsibly.

Based on the state mitigation program history and FEMA eligibility requirements, planning measures are a high priority. Generally, public education and various types of hazard or risk reduction training and education measures are also a high priority. The state has successfully administered and implemented planning, property acquisitions, electrical utility system and infrastructure retrofit/hardening, wildfire sprinklers, defensible space and wildfire resistant construction materials and community tornado safe-rooms. These project types have been, and will continue to be our priorities in the future. Disaster specific events and associated disaster response and recovery measures can result in the prioritization of specific mitigation measures that contribute to the disaster recovery process. In Minnesota, this holds true in particular for acquisition of repetitive loss residential and commercial structures as well as flood retrofitting projects for critical facilities and infrastructure. Along with hazard mitigation planning, the acquisition of flood prone homes, electrical utility retrofits, and wildfire sprinklers are a few of the state's high priority actions.

The State of Minnesota continues to experience many long-term successes with mitigation. During the last three years, multiple mitigation measure projects continue to coincide with the objectives and goals in the State Hazard Mitigation Plan to prevent and reduce the risks to lives, property, and economic activity from the effects of all hazards. Minnesota communities continue to benefit from mitigation activities through the implementation of actions in their local hazard mitigation plans: damaged property acquisitions, rural and municipal electrical retrofits, community tornado safe rooms, and through various training, workshops and mitigation related outreach. These mitigation measures are making communities across the state safer and more secure against the negative impacts of natural and human-made hazards. The State of Minnesota continues to effectively implement mitigation programs towards achieving its goals as identified in this Plan.

Since the last Plan was approved in March 2011 the State of Minnesota has received five Presidential Declared Disasters, (DRs 4131, 4113, 4069, 4009, 1990). These disasters have emphasized the vulnerabilities and obstacles the state faces in relation to natural hazards such as flooding, severe storms, straight-line winds and ice storms. In the previous update of the plan 2008-2011 the state was also declared five times, DRs 1900, 1982, 1941, 1921, 1830. The multitude of these disasters has offered opportunities for the state to strengthen its mitigation capabilities through the availability of HMA funding. Federally approved and funded mitigation projects are being administered by the state mainly through post-disaster HMGP and to a lesser extent the non/pre-disaster PDM programs, whose funding is not predictable. However we have utilized both of these programs to implement projects that address the State's hazard mitigation goals and objectives meeting the priorities and criteria outlined in the Mitigation Strategy.

In addition to federal programs, several programs at the state level support the goals and objectives outlined and are utilized in advancing mitigation statewide. The State Capability Assessment provides some of the programs and initiatives currently supporting mitigation in Minnesota. Further, this assessment demonstrates the success of the State's mitigation programs administered by both federal and state agencies. The pilot projects funded through the Silver Jackets in the past three years have been very successful, as have the MN DNR FDR program. Risk MAP is another planning process that is very important to the State. However, no funding is available from this branch of FEMA for projects.

In evaluation of all measures identified and prioritized, it was determined that the 2014 State Hazard Mitigation Plan measures including planning, electrical utility system retrofit/hardening, wildfire retrofit, property acquisitions, and community tornado safe rooms are considered high priorities for the State of Minnesota. The action descriptions listed below are the primary actions the state supports for addressing the hazards analyzed in this Plan (not an inclusive list of all actions supported).

State Agency Potential Mitigation Projects

State agencies were invited to participate in a hazard assessment and designate potential mitigation projects. The projects are based on the current FEMA Hazard Mitigation Assistance Guidance and are in line with the overall mitigation actions of the state. The potential projects were discussed with their initiating hazard. Agencies provided or were in contact with facilities staff to participate in the review. Future reviews will include more details for each facility. A ‘Yes’ response means that the agency agreed that the potential mitigation project was relevant while a ‘No’ response correlated that no risk the project did not apply to their facilities.

Table 58 State Agency Potential Mitigation Projects

Natural Hazard	Potential Mitigation Project	ADMIN	DOC	DHS	MAC	MN DNR	MN DOT	MNHS	MNSCU
Flood	Acquisition/ Relocation Demolition	No	Yes	No	Yes	Yes	Yes	Yes	No
Flood	Dry Flood-proofing	No	Yes	No	Yes	Yes	Yes	Yes	No
Flood	Minor Localized Flood Reduction Projects	No	Yes	No	Yes	Yes	Yes	Yes	Yes
Multiple	Structural Retrofit of Existing Buildings	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Tornado/ High Wind	Safe Room	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Multiple	Infrastructure Retrofit	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Multiple	Burial of Power Transmission Lines	No	Yes	No	Yes	Yes	Yes	Yes	Yes
Erosion	Soil Stabilization	No	Yes	No	Yes	Yes	Yes	Yes	Yes
Wildfire	Structural Sprinkler Systems	No	Yes	No	Yes	Yes	Yes	Yes	Yes
Wildfire	Defensible Space	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wildfire	Ignition Resistant Construction	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
General	Generators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
General	Warning Systems	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
All	Integrate Mitigation into Policies and Procedures	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

5.4 Mitigation Project Implementation

Requirement §201.4(c)(3(v): *In addition, the plan must describe the strategy the State has to ensure that local jurisdictions with severe repetitive loss properties take actions to reduce the number of these properties, including the development of local mitigation plans.*

Priority Mitigation Action: **Hazard Mitigation Planning**

Planning mitigation measures address multiple objectives in the State Plan that largely impact the state goals for the prevention and reduction of risks to lives, property, and economic activity from the effects of all hazards. Hazard Mitigation Planning is a high priority mitigation measure for implementation in the State of Minnesota. These local plans offer communities the opportunity to identify and evaluate hazards, assess risk, probability, vulnerability, impact, and develop mitigation goals and actions for the prevention and preparation of future hazard events. Of the 87 counties in the state, 67 have approved plans, the remaining 21 are updating either independently (4) or have FEMA planning grants (17). In addition, two cities have local plans. Two tribal governments have an approved plan, one has a planning grant to develop a plan, and another is developing a plan independently.

Priority Mitigation Action: **Acquire flood prone (repetitively and severely repetitively damaged) properties and convert to open space/green space**

Approximately 1,650 acquisition projects have been completed and are in development following catastrophic flooding in the state. The Hazard Mitigation Grant Program currently provides funding for acquisition/demolition of properties with additional properties being acquired through FDR funding by the Minnesota Department of Natural Resources.

Mitigation measures providing property acquisitions directly address objectives for river and flash flooding and infrastructure failure hazards. Acquisitions are an important way to reduce the risk of future disasters. Property acquisition is one of many forms of hazard mitigation and it is the most permanent form. It removes people from harm's way indefinitely, and reduces risks to property from riverine and flash flooding. It is a terrific opportunity for people who live on or near hazard areas to get to safer ground.

Flooding is the highest ranked hazard in this Plan. Acquisition for demolition is ranked as a high priority for mitigation measures in this Plan. Property acquisitions for homes in special flood hazard areas will directly reduce deaths, injuries, property loss, and economic disruption from river flooding future events. The Austin Loss Avoidance Study demonstrated the impact that mitigation actions for acquiring property and converting to open/green space have had positive impacts in and for the community. Elevation and relocation of structures in the Special Flood Hazard Area is a lower priority, but still a potential mitigation strategy.

Requirement §201.4(c)(3(v): *In addition, the plan must describe the strategy the State has to ensure that local jurisdictions with severe repetitive loss properties take actions to reduce the number of these properties, including the development of local mitigation plans.*

HSEM mitigation staff coordinates with local jurisdictions that are eligible to acquire the RL and SRL properties. Jurisdictions are given the property information and the procedure to document proposals to the property owner. HSEM also coordinates potential acquisitions with MnDNR’s Flood Damage Reduction program to determine if funding is available for the local share. HMGP or FMA funding for potential SRL properties will be determined at the time of application. With the new FMA guidelines and property eligibility requirements, HSEM will take this as initiative to reach out to those LGUs once again to make program availability know.

***Priority Mitigation Action:* Construct or retrofit community tornado safe rooms**

Construction of safe rooms and reinforcement of structures will be used to prevent or reduce risks to life and property from the hazards of tornadoes, thunderstorm and lightning, hailstorms, and windstorms. Safe rooms are long-term hazard mitigation measures implemented to reduce the loss of life and property, lessen the impact to local communities due to natural disasters, and enable recovery after a disaster. Overall, safe rooms are ranked high for the prioritized mitigation measures for Minnesota.

Priority applicants are 1) unprotected populations; camp grounds, parks, recreational areas, and, 2) areas with insufficient protection; manufactured home parks, vulnerable populations: schools, eldercare and day care centers, government facilities, critical facilities

***Priority Mitigation Action:* Electrical utility retrofit/hardening**

Minnesota has experienced a great number of ice, windstorms, and severe weather events that adversely have affected rural electric cooperatives. HSEM has worked in partnership with rural electric cooperatives to develop and fund projects to limit the loss of electrical services to Minnesotans. However, continued work needs to be done. Minnesota's rural electrical cooperatives serve an average of 5.9 customers per mile, less than the U.S. average (7.4 customers per mile). HSEM has done extensive outreach and training to rural electric cooperatives across the state, the result is a great interest in mitigation activities for the cooperatives. Rural electric cooperatives are working on applications to upgrade and strengthen conductors, increase pole size, reduce pole spans, convert overhead electrical distribution lines to underground power lines, and ensure a more reliable supply of power to critical facilities. These projects reduce the future risk of life safety and health, property loss and economic disruption effected by hazards from severe winter storms, wind storms, power failure, tornadoes, and lightning.

Electrical utility retrofit/hardening mitigation measures are a high priority for the state. Mitigation measures are evident in these projects by strengthening and improving the reliability of the existing electrical lines or structures, which contribute to the overall reduced negative effects of natural hazards. State, in partnership with the Minnesota Rural Electric Association and rural electric cooperatives across the state have developed an Annex to this plan – Rural Electric Cooperative Hazard Mitigation Annex. The annex will aid in the development of project proposals statewide and will help develop a partnership between rural electric cooperatives and the HSEM.

***Priority Mitigation Action:* Wildfire mitigation**

Mitigate the at-risk structures and associated loss of life from the threat of wildfire through defensible space activities, vegetation management, use of ignition-resistant building materials and external sprinkler systems. Wildfire sprinkler systems are a proven mitigation action that has protected numerous structures in the forested northeastern portions of the state of Minnesota. Utilizing sprinkler systems in combination with defensible space activities and other FireWise community wildfire fuel reduction methods is a high priority project type. Success stories have been written on this type of project. The use of fire resistant building materials combined with defensible space is also advocated.

***Mitigation Action:* Installation of early warning and communication systems.**

Working with the MN DNR, USGS and the National Weather Service (NWS) and other agencies installation of river flood warning systems has been a success in Minnesota. Warning sirens for unprotected populations are eligible under the FEMA guidance under the 5% Initiative.

Mitigation Actions: Generators

Permanent back-up power generators for critical facilities are potentially eligible under two of FEMAs programs, the regular program: requires a Benefit –Cost Analysis and the 5% Initiative.

***Mitigation Action:* Drainage and flood control mitigation**

The state and eligible communities throughout the State have worked in partnership to develop infrastructure mitigation projects. These mitigation projects are broadly defined as drainage and flood control type mitigation. Mitigation projects in development are intended to retrofit existing drainage systems to more effectively handle riverine and overland flooding, protect commercial, residential, and governmental facilities critical to the health, safety and welfare of the populations they serve, and reduce and/or eliminate the long term risk to people and property from natural hazards. These projects involve storm sewer systems, sanitary sewer systems, potable water treatment facilities, wastewater treatment, buildings, equipment and life safety. Proposed projects from local jurisdictions are the result of local mitigation plan updates, Risk MAP meetings and Public Assistance/Hazard Mitigation outreach. State agencies recognize potential project through the vulnerability review process and review of capital improvement plans.

***Mitigation Action:* Risk MAP**

FEMA continues to collaborate with local, state, regional, tribal, national and other federal partners in communicating these objectives and implementing Risk MAP. Meetings and Resilience Reports have been published for 19 counties in the past three years, four in 2012 and fifteen in 2013.

Resilience Reports provide information to help local or tribal officials, floodplain managers, planners, emergency managers, and others better understand their risk, take steps to mitigate those risks, and communicate those risks to their citizens and local businesses. This Resilience Report is intended to provide the community a reference for management and mitigation of flood and other risks.

In Minnesota, FEMA has funded both floodplain mapping for the Wild Rice River, Red Lake River, Root River and Whitewater River watersheds, and Norman, Polk, Houston and Winona Counties. Digital Flood Insurance Rate Maps are completed for Redwood, Mower, Mil Lacs, and Nobles (LFD 19 Nov 2013) Counties. In addition, the DNR continues to work with FEMA to assess the validity of the current flood hazard data. Risk MAP had discovery scoping meeting for the Zumbro River and the Mississippi River – Twin Cities. MN DNR also participated in the Discovery meetings for the Lower Big Sioux, the East Fork of the Des Moines and the West Fork of the Des Moines in partnership with Iowa. Funding was provided to develop Base Flood Elevations (BFEs) and delineate the associated floodplain for the Minnesota portions of the three watersheds, approximately 60% complete with floodplain delineations.

FY2012 also included funding for outreach for the Great Lakes Coastal Flood Risks; however, FEMA has not started outreach for Lake Superior as of 2013. See http://www.fema.gov/risk-mapping-assessment-planning

Minnesota Silver Jackets

The Vision of the Minnesota Silver Jackets is to “Create, maintain, and integrate comprehensive partnerships to reduce risk associated with natural hazards in Minnesota”. The Mission is “To establish an inter-agency working group with State and Federal Agencies to: 1) Enable the effective and efficient sharing of information, 2) Identify and promote the sharing and coordination of available agency resources, and 3) Promote natural hazard risk education and information dissemination throughout the state of Minnesota. See http://www.nfrmp.us/state/factMinnesota.cfm

The Silver Jackets worked on and continues to implement a variety of mitigation projects and collaborate across agencies. The team has implemented/supported or in the process of implementing/supporting a number of pilot projects and since they first started meeting in 2011.

- Participation in State Hazard Mitigation Planning
- Development of a GIS methodology to use existing LiDAR data sets to locate undocumented levees
- Mississippi River at St. Paul flood inundation mapping - hydraulic modeling is complete and the inundation map library is complete
- Catastrophic bluff erosion and collapse issue – science-based method to assist zoning officials with reducing risk.
- Emergency Action Plan Guide Book Template
- Red River of the North Pre-Flooding Planning Information Package Documentation
- Red River Basin-wide Nonstructural Flood Risk Management Measures Guidance Manual for Owners and Residents (Ring Levees)

Summary

Funding for mitigation planning and projects primarily comes from federal grants. However, the state continues to pursue additional funding sources to assist locals. The following sections contain the State and Local Capability Assessment, which provides information on the funding source, description of the type of funding and monetary capabilities. Mitigation measures identified in local hazard mitigation plans reflect the reliance on federal and state resources to assist with these measures.

5.5 Inventory of Hazard Mitigation Programs, Policies, and Funding

Requirement §201.4(c)(3)(iv): *[The State mitigation strategy* ***shall*** *include an] identification of current and potential sources of Federal, State, local, or private funding to implement mitigation activities.*

In addition to the HMGP and PDM programs, there are additional funding sources available to the state and local jurisdictions for mitigation information, planning and projects. A listing of federal, state and other agencies resources is contained in this section. The site summary and agencies have all-hazard mitigation information and potential funding capabilities.

Federal Agencies and Programs

U.S. Department of Homeland Security

Federal Emergency Management Agency (FEMA)

General information on mitigation planning, hazards, disaster assistance programs, current disasters, etc.

Hazard Mitigation Grant Program (HMGP)

HMGP assists in implementing long-term hazard mitigation measures following Presidential disaster declarations. Funding is available to implement projects in accordance with State, Tribal, and local priorities.

Pre-Disaster Mitigation (PDM)

PDM provides funds on an annual basis for hazard mitigation planning and the implementation of mitigation projects prior to a disaster. The goal of the PDM program is to reduce overall risk to the population and structures, while at the same time, also reducing reliance on Federal funding from actual disaster declarations.

Flood Mitigation Assistance (FMA)

FMA provides funds on an annual basis so that measures can be taken to reduce or eliminate risk of flood damage to buildings insured under the National Flood Insurance Program (NFIP).

National Flood Insurance Plan

Detailed information on the National Flood Insurance Program and other mitigation activities.

Hazard Mitigation Funding Under Section 406 (Public Assistance)

Section 406 provides discretionary authority to fund mitigation measures in conjunction with the repair of the disaster-damaged facilities.

U.S. Department of Agriculture (USDA)

Natural Resources Conservation Service (NRCS)

To provide leadership in a partnership effort to help conserve, improve, and sustain our natural resources and environment.

Community Facility Grants

Assistance for the development of essential community facilities. Grant funds can be used to construct, enlarge, or improve community facilities for health care, public safety, and community and public services.

Emergency Watershed Protection (EWP)

Program is for emergency measures, including the purchase of flood plain easements, for runoff retardation and soil erosion prevention to safeguard lives and property from floods, drought, and the products of erosion on any watershed whenever fire, flood or any other natural occurrence is causing or has caused a sudden impairment of the watershed.

Environmental Quality Incentives Program (EQIP)

Provides technical assistance, cost share payments, and incentive payments to assist crop, livestock, and other agricultural producers with environmental and conservation improvements to their operations.

Wetlands Reserve Program

Voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. Provides technical and financial support to help landowners.

Conservation Easements

In cooperation with Minnesota BWSR funding for conservation easements on frequently flooded lands is available. One of many Reinvest in Minnesota (RIM) - NRCS partnerships.

Farm Service Agency (FSA)

- Disaster Assistance Programs available, includes:
- Conservation Loans
- Conservation Reserve Program
- Emergency Conservation Program
- Non-Insured Crop Disaster Assistance Program
- Emergency Farm Loans

U.S. Department of Commerce (DOC)

Economic Development Administration (EDA)

To generate jobs, help retain existing jobs, and stimulate industrial and commercial growth in economically distressed areas of the U.S.

U.S. Census Bureau

Profile of Minnesota and each Minnesota county.

National Oceanic and Atmospheric Administration (NOAA)

NOAA, Coasts

Provides detailed information on coastal water issues, including the Great Lakes.

NOAA, National Climatic Data Center

Current and historical archive of climatic data and information.

NOAA, Drought Information Center

Updated drought conditions including monitors and outlooks

NOAA, National Severe Storms Laboratory

Comprehensive information on severe weather research.

NOAA, National Weather Service (NWS)

Provides all available weather information including warning updates.

Advanced Hydrologic Prediction Service (AHPS)

A program designed to provide improved river and flood forecasting and water information. AHPS provides a suite of graphical and numeric products over the Internet to assist community leaders and emergency managers in making better life- and cost-saving decisions about evacuations and movement of property before flooding occurs.

Flood Inundation Mapping

This interactive web page shows the spatial extent of possible or expected flooding in a given area. It can be used to show if roadways and structures will be impacted by floodwaters. At the limited number of forecast locations where inundation maps are currently available, this web page is accessed by clicking on the inundation mapping tab on the hydrograph web page. In collaboration with partners, this product will be expanded to new locations.

Flash Flood Guidance

The North Central River Forecast Centers issues Flash Flood Guidance throughout the day for every county in their area. The river forecast centers determine 1- 3- and 6-hour flash flood guidance values for all counties, and 12- and 24-hour values for parts of the eastern United States. Flash Flood Guidance estimates the average number of inches of rainfall for given durations required to produce flash flooding in the indicated county.

North Central River Forecast Center

Contains a variety of seasonal products including the Spring Hydrologic Outlook

U.S. Army Corps of Engineers (USACE)

Planning programs include Flood Risk Management, Planning Assistance to States, Flood Plain Management Services, and Silver Jackets.

Planning Assistance to States (PAS)

Funded annually by Congress. Federal allotments for each State or Tribe from the nation-wide appropriation are limited to $2,000,0000 annually, but typically are much less. Individual studies, of which there may be more than one per State or Tribe per year, generally cost $25,000 to $75,000. The studies may be phased over several years and cover a wide range of water resource planning activities. PAS studies are cost shared on a 50 percent Federal-50 percent non-Federal basis. The entire local sponsor contribution may be work in kind, and WRDA 2007, Section 2013 provided authority for 100 percent Federal funded PAS studies for hydrologic, economic, and environmental data and analyses.

Floodplain Management Services

A full range of technical services and planning guidance on flood and floodplain issues is provided upon request. These services are generally made available to other federal, state, and local agencies, but some may also be used by nongovernmental organizations and individuals and are 100 percent Federally funded.

Regional Flood Risk Management Team

This Regional Flood Risk Management Team (RFRMT) will integrate pre-flood mitigation with a long-term strategy to plan and implement pre- and post-flood emergency actions, while developing promising nonstructural alternatives and other flood risk mitigation actions recognized to reduce future flood risk within the region.

Cold Regions Research and Engineering Laboratory (CRREL)

Engineering and technology for use in cold regions.

Flood Damage Reduction Studies & Projects

Flood damage reduction is one of the primary missions of the U.S. Army Corps of Engineers. As such, the Corps of Engineers may undertake studies and build projects to reduce and/or minimize flood damages. The Corps of Engineers may investigate flooding problems and opportunities in response to directives, called authorizations, from the Congress. Congressional authorizations are contained in public laws and in resolutions of either the House Public Works and Transportation Committee or the Senate Environment and Public Works Committee.

Continuing Authorities Program

Under the Continuing Authorities Program (CAP) legislation authorizes the Corps of Engineers to plan, design, and construct certain types of water resource and ecosystem restoration projects without additional and specific congressional authorization. The purpose is to implement projects of limited scope and complexity. Each authority has specific implementation guidelines, total program and per-project funding limits.

Funding: Studies are cost shared 50/50 during feasibility. Most projects are cost shared 65 percent Federal and 35 percent local during implementation, unless otherwise noted.

- Small Flood Control Projects authorized by Section 205 of the 1948 Flood Control Act. Per-project: Federal funding limit of $7 million. Designed to implement projects that reduce overland flood damages. Projects must be engineering sound, economically justified, and environmentally acceptable.
- Emergency Streambank Protection Projects authorized by Section 14 of the 1946 Flood Control Act. Per-project Federal funding limit of $1.5 million. Designed to protect essential public facilities threatened by flood-induced erosion.
- Aquatic Ecosystem Restoration authorized by Section 206 of the 1996 Water Resources Development Act. Per-project Federal funding limit of $5 million. Designed to develop aquatic ecosystem restoration and protection projects that improve the quality of the environment, are in the public interest, and are cost effective.
- Project Modifications for the Improvement of the Environment authorized by Section 1135 of the 1986 Water Resources Development Act. Federal funding limit of $5 million. Designed to modify existing Corps projects for the purpose of improving environmental quality.

Section 524 of the Water Resources Development Act of 2000: Minnesota Dams

Provides for inventory, inspection, modification and/or rehabilitation of dams originally constructed by the Civilian Conservation Corps, Works Progress Administration, and Works Projects Administration (WPA) in Minnesota. Oversight of 361 of the original 417 WPA dams falls to the Minnesota Department of Natural Resources (DNR) through the office of the State Dam Safety Engineer. The rest are owned and operated by individual counties and the National Park Service.

Federal Energy Regulatory Commission (FERC)

Regulates dams that generate electric hydropower.

U.S. Geologic Survey (USGS)

Excellent source of natural disaster information (earthquakes, drought, floods, etc.).

Real-Time Data for Minnesota Streamflow

Users can select data from multiple sites using a broad set of filters, such as by State, county, watershed and a latitude/longitude box. This new web service can benefit users with programs that download tab-delimited real-time data from 138 gages.

These data are also available in coordination with NWS-AHPS and the Corps of Engineers web sites, although USGS quality assures and maintains the data.

WaterWatch

Site displays maps, graphs, and tables describing real-time, recent, and past streamflow conditions for the United States. The real-time information generally is updated on an hourly basis. The stream gage-based maps shows conditions for real-time, average daily, and 7-day average streamflow. The real-time streamflow maps highlight flood and high flow conditions. WaterWatch also includes tables of current streamflow information and locations of flooding.

Flood Watch

In coordination with USGS's WaterWatch Web site the state map shows the location of stream gages where the water level is above flood or at high flow. High flow conditions are expressed as percentiles that compare the current (i.e., within the past several hours) instantaneous flow value to historical daily mean flow values for all days of the year.

Water Alert

The U.S. Geological Survey WaterAlert service sends e-mail or text messages when certain parameters measured by a USGS data-collection station exceed user-definable thresholds.

StreamStats

A Web-based Geographic Information System (GIS) that provides users with access to an assortment of analytical tools that are useful for water-resources planning and management, and for engineering design applications.

USGS Programs in Minnesota

Details USGS activities in Minnesota.

Earthquake Hazards Program
Up- to-date information on world seismicity.

U.S. Department of Housing and Urban Development (HUD)

Community Development Block Grants

Disaster grants are used to rebuild resilient communities after a disaster.

Disaster Recovery Assistance

Disaster relief and recovery assistance in the form of special mortgage financing for rehabilitation of impacted homes.

Neighborhood Stabilization Program

Funding for the purchase and rehabilitation of foreclosed and vacant property in order to renew neighborhoods devastated by the economic crisis.

U.S. Department of Transportation (DOT)

Federal Highway Administration (FHWA)

Provides funding for mitigation activities such as snow fences and living snow fences as part of construction funding

U.S. Small Business Administration (SBA)

Provides training and advocacy for small firms.

Another valuable resource is the Catalog of Federal Domestic Assistance (CFDA). It provides a full listing of all Federal programs available to State and local governments; federally recognized Indian tribal governments; domestic public, quasi- public, and private profit and nonprofit organizations and institutions; specialized groups; and individuals.

State Agencies and Programs

This section is an inventory of State programs that are important to mitigation efforts statewide. Additional information for agencies with programs that may assist in mitigation efforts are listed with applicable programs and funding the program may offer. The following also lists programs utilized by the state of Minnesota to assist with implementation of mitigation actions. A brief description of each program follows, as does funding information.

Minnesota Department of Administration (ADMIN)

Provides services to government agencies: information technology, facilities and property management, graphic and geographic information systems data and software.

Minnesota Department of Agriculture (MDA)

Responsible for the regulation of pesticides, fertilizers, food safety and feed including emergency response, state Superfund authority and financial assistance for agricultural entities.

Minnesota Board of Water and Soil Resources (BWSR)

Assist local governments to manage and conserve water and soil resources.

Program: *Reinvest In Minnesota (RIM)*

Funding: Minnesota's premier conservation easement program on privately owned lands.

Program: *Reinvest In Minnesota -Wetlands Reserve Program, RIM-WRP*

Funding: Administered by the USDA Natural Resources Conservation Service (NRCS). The RIM-WRP partnership is implemented by local Soil and Water Conservation Districts. Conservation easements on frequently flooded lands.

Minnesota Department of Commerce (COMM)

The Market Assurance Division in the Department of Commerce regulates insurance companies & agents, banks, and real estate.

The Office of Energy Security within the Department of Commerce manages energy assistance funds and provides information and assistance to consumers and businesses on home improvements, financial assistance, renewable technologies, and utility regulations.

Program: *Consumer Response Team(CRT)*

The Minnesota Department of Commerce Consumer Response Team (CRT) is comprised of investigators who respond to consumer phone calls specifically about insurance. The CRT attempts to resolve disputes between consumers and the insurance industry informally. In the Twin Cities metro area call (651) 296-2488 or statewide toll free at 800-657-3602.

Program: *Weatherization Assistance Program (WAP)*

Assists income eligible households with emergency repair and replacement services. The Weatherization Assistance Program (WAP) uses energy conservation techniques to reduce the cost of home energy. Correcting health and safety hazards and potentially life-threatening conditions is the first consideration in WAP activities.

Households where one or more members have received TANF (Temporary Assistance for Needy Families) or SSI (Supplemental Security Income) within the last 12 months.

Households at or below 200% of Federal Poverty Income Guidelines are income eligible for WAP.

Homeowners and renters may be income eligible for WAP.

Priority is given to households with at least one elderly or disabled member and to customers with the highest heating costs.

Funding: Federally funded through the U.S. Department of Energy and the Department of Health and Human Services.

Program: *Energy Assistance Program (EAP)*

The Energy Assistance Program (EAP) helps pay home heating costs. Households with the lowest incomes and highest energy costs receive the greatest benefit.

Households who are at or below 50 percent of the state median income are eligible

Size of grant is based on household size, income, fuel type and energy usage

Households with the lowest income and highest fuel costs receive the highest grants

Funds are available for renters or homeowners

Funding: Federally funded through the U.S. Federally funded through U.S. Department of Human Services

Program: *Office of Energy Security (OES)*

The OES works to communicate the preparedness actions of utilities that serve areas affected by disasters. The OES and Public Utilities Commission (PUC) coordinate responses from utilities with regard to restoration activities and typically work through single points of contact at utilities and utility associations.

The OES makes information available through its Energy Information Center on energy conservation measures that homeowners may pursue in the event of an emergency that affects the supply or distribution of energy to an area of the state.

Minnesota Emergency Medical Services Regulatory Board (EMSRB)

Provides leadership for emergency medical care for the people of Minnesota.

Minnesota Department of Employment and Economic Development (DEED)

To advance the economic vitality of Minnesota through trade and economic development, including the provision of employer and labor market information.

Program: *Public Facilities Authority (PFA)* The authority administers and oversees the financial management of three revolving loan funds and other programs that help local units of government construct facilities for clean water (including wastewater, stormwater and drinking water) and other kinds of essential public infrastructure projects

Funding: Provides municipal financing programs and expertise to help communities build public infrastructure that preserves the environment, protects public health, and promotes economic growth.

Program: *Small Cities Development Program*

Purpose is to provide decent housing, a suitable living environment and expanding economic opportunities, principally for persons of low-and-moderate income to cities and townships with populations under 50,000 and counties with populations under 200,000.

Funding: Provides federal grants from the U.S. Department of Housing and Urban Development (HUD) to local units of government. State program rules subdivide grant funds into three general categories: Housing Grants, Project Facility Grants, and Comprehensive Grants. Public Facility Grants could include projects involving storm sewer projects and flood control projects.

Program: *Greater Minnesota Business Development Public Infrastructure Grant Program*

Purpose is to stimulate new economic development, create or retain jobs in Greater Minnesota, through public infrastructure investments.

Funding: Provides grants to cities of up to 50% of the capital costs of the public infrastructure necessary, which expand or retain jobs in the area, increase the tax base, or which expand or create new economic development. Eligible projects include, but not limited to wastewater collection and treatment, drinking water, storm sewers, utility extensions, and streets.

Program: *Minnesota Redevelopment Grant Program*

Purpose is to provide grants to assist development authorities with costs related to redeveloping blighted industrial, residential or commercial properties.

Funding: Grants pay up to 50% of eligible redevelopment costs for a qualifying site, with a 50% local match. Grants can pay for land acquisition, demolition, infrastructure improvements, stabilizing unstable soils, ponding, environmental infrastructure, building construction, design and engineering and adaptive reuse of buildings.

Minnesota Management & Budget (MMB)

Expedite fiscal management during a state disaster. Assist with funding issues when federal assistance is not provided.

Minnesota Department of Health (MDH)

Detailed information on services and current events affecting the citizens of Minnesota.

Minnesota’s State Historic Preservation Office (SHPO)

Review and Compliance: The SHPO consults with federal and state government agencies to identify historic properties in government project areas and advise on ways to avoid or reduce adverse effects on those properties.

Minnesota Housing Finance Agency (MHFA)

Provides low- and moderate-income housing and resources.

Minnesota Department of Human Services (DHS)

Provides health care, economic assistance, and other services for those in need.

Minnesota Department of Labor & Industry (DLI)

Assist with investigations when workers are injured, and detect air contaminants caused by chemical or geological agents, and assessing hazards. Statewide building codes and construction planning and inspection.

Metropolitan Council

Provides information on economic development and planning for anticipated growth in the seven county metro areas –Anoka, Carver, Dakota, Ramsey, Scott and Washington Counties.

Program: *Livable Communities Grant Program*

The Council awards grants to participating communities in the seven-county area to help them, among other things, create development or redevelopment that demonstrates efficient and cost-effective use of land and infrastructure, a range of housing types and costs, commercial and community uses, walkable neighborhoods and easy access to transit and open space.

Funding: Four different accounts to enable communities through the region to carry out their development plans, and leverage millions of dollars in private and public investment while providing jobs and business growth.

Minnesota Department of Military Affairs - National Guard **(DMA)**

Information on the capabilities of the Minnesota National Guard.

Minnesota Department of Natural Resources (MN DNR)

The Financial Assistance Directory provides summary level information on all of the Department of Natural Resources' financial assistance programs. The department offers a wide variety of financial assistance programs to cities, counties, townships, non-profits, schools, private individuals and others. See MN DNR website. Categories include:

Aquatic Invasive Species

Enforcement (snowmobile & OHV safety)

Fire Protection Programs

Forest management

Gifts and donations

Habitat improvement

Land conservation

Recreation (general, trails, and water)

Road Improvements

Water

MN DNR Division of Ecological and Water Resources

The conservation of natural systems and the maintenance of biodiversity. Water education information is available on and discusses floodplain management, flood mitigation, drought/water supply, dam safety, flood warning, climatology, and lake and stream gaging.

Program: *Flood Hazard Mitigation Grant Assistance: Flood Damage Reduction (FDR) Program*

To provide technical and financial assistance to local governmental units for conducting flood damage reduction studies and for planning and implementing flood damage reduction measures.

Funding: A maximum of 50% of total eligible project costs up to $150,000 with grants more than $150,000 requiring approval by the Legislature.

Program: *Dam Safety Grants*

To improve the safety and condition of publicly owned dams and water level control structures.

Funding: Reimbursement of costs, up to 50% for repairs, up to 100% for removals. Grants ranged from $25,000 to $1,000,000

Program: *Wetland Tax Exemption Program*

To provide a financial incentive to maintain wetlands in their natural state and to promote an awareness of wetland values.

Funding: Qualifying areas are exempt from property taxes that remain in effect as long as wetland meets the requirements set forth in the statutes.

Program: *FireWise in Minnesota*

The Minnesota FireWise Project is working with local communities by passing federal Fire Plan funds through to local communities as grants for various "on-the-ground" activities including homeowner, mitigation education, home site assessment, access improvement, and dry hydrants. It involves community groups including fire and emergency services, local schools, city staff (i.e. foresters, planners), and local interest groups.

Funding: Grant request for 50:50 cost-share funding for assessment & planning, education & mitigation activities. Initial grant request may be for a small amount ($15,000) until FireWise Action Plan is developed. Second grants are available to implement additional actions.

Program: *Forest Stewardship Program*

To provide technical advice and long-range forest management planning to interested landowners. All aspects of the program are voluntary. Plans are designed to meet landowner goals while maintaining the sustainability of the land. The entire property except active farming

Funding: For the state's cost share program to help defer the costs of implementation of forest management activities. Must enroll forested lands into the Sustainable Forestry Incentive Act or 2c Managed Forest Land to be eligible for property tax relief programs

Program: *Minnesota State Climatology Office*

The State Climatology Office workgroups exists to study and describe the climate of Minnesota. Each of its members concentrates its efforts on specific topical areas in which climate plays a significant role.

Minnesota Pollution Control Agency (PCA)

Provides pollution control information for Minnesota.

Program: *Stormwater Program*

Minnesota Pollution Control Agency (MPCA) is the delegated permitting authority for Minnesota of the U.S. Environmental Protection Agency's (EPA) National Pollutant Discharge Elimination System (NPDES). Permits are required for most construction activities designed to limit polluted discharges and implement best management practices.

Funding: The Clean Water Revolving Fund, also known as the Clean Water State Revolving Fund or simply SRF, is established under the Federal Clean Water Act and state law to make loans to for both point source (wastewater and stormwater) and nonpoint source water pollution control projects. The PFA prepares an annual Intended Use Plan (IUP) based on a Project Priority List developed by the MPCA. The IUP describes the projects and activities eligible for funding during the state fiscal year.

Program: *Interagency Climate Adaptation Team*

A collaboration of state agencies with the purpose of addressing climate change issues in the state.

Other MPCA work related to mitigation:

- Preparing for homes and businesses for floods
- Preparing wastewater treatment plants for floods
- Preparing feedlots for floods

Minnesota Department of Public Safety (DPS)

State Fire Marshal, Office of Communications, Office of Pipeline Safety Team, State Patrol, Office of Justice Programs, Bureau of Criminal Apprehension, Alcohol and Gambling, Enforcement and Office of Traffic Safety.

MN DPS Homeland Security and Emergency Management (HSEM)

This site contains information on Emergency Management.

Program: *Minnesota Recovers Task Force: Minnesota's Official Disaster Information Center*

Minnesota Recovers is the state's clearinghouse for all information about floods, tornadoes and other natural disasters that strike Minnesota communities. Information about federal, state and local government disaster-assistance efforts is available on this website.

Funding: Application for community financial assistance is available. Depending upon disaster, different types of funding become available. Flood-Control Grants, Small Cities Development Program and Public Facilities Authority funding information is available here.

Minnesota Office of the State Archaeologist

Conduct research into the prehistoric and historic archaeology of Minnesota.

Minnesota State Colleges and Universities (MNSCU)

Provide information about Higher education in Minnesota.

Minnesota Department of Transportation (DOT)

Comprehensive transportation issues in Minnesota.

University of Minnesota

University of Minnesota's mission of education, research, and public engagement; our academic scope; and our statewide presence are marks of distinction and position us well to address the critical problems of this new century.

Other Organizations

The following is a list of associations and organizations that may fund, educate or in some way assist mitigation in the state. The list is a resource for local mitigation planners and has been utilized by the state in the update of this Plan.

American Red Cross

Provide relief to victims of disasters and help people prevent, prepare for, and respond to emergencies.

American Water Works Association

Information on safe water resources.

League of Minnesota Cities

A membership organization dedicated to promoting excellence in local government. The League serves its more than 800 member cities through advocacy, education and training, policy development, risk management, and other services.

Association of Minnesota Counties

A broad range of services to its members, including education, communications, and intergovernmental relations. AMC works closely with the legislative and administrative branches of government in seeing that legislation and policies favorable to counties are enacted.

Association of State Dam Safety Officials

General Information about dams and dam safety in the US.

Mid-America Earthquake Center (MAE)

One of three national earthquake engineering research centers established by the National Science Foundation.

Minnesota Geological Survey (MGS)

The University outreach center for the science and technology of earth resources in Minnesota.

Minnesota Association of Watershed Districts (MAWD)

Provides educational opportunities, information and training for watershed district managers and staff through yearly tours, meetings and quarterly newsletters.

Minnesota Association of Soil and Water Conservation Districts (MASWCD)

Provide voluntary, incentive driven approaches to landowners for better soil and cleaner water. Provide private landowners with technical assistance to implement a wide variety of conservation practices.

Minnesota Independent Insurance Agents

See calendar for NFIP training.

National Association of Counties (NACO)

NACo is the only nation-wide organization representing county governments.

Minnesota Natural Resource Conservation Service

Locally based NRCS staff work directly with farmers, ranchers, and others, to provide technical and financial conservation assistance.

National Drought Mitigation Center

Information on drought preparation and risk management.

National Emergency Management Association (NEMA)

NEMA is the professional association of state, pacific, and Caribbean insular state emergency management directors.

Natural Hazard Mitigation Association

NHMA is an association for those in the hazard mitigation profession by offering workshop and brining expertise and experience to organizations, communities or regions with mitigation planning, training, outreach and implementation.

Association of Minnesota Emergency Managers (AMEM)

AMEM is the professional association of emergency managers in Minnesota.

National Energy Foundation

This is site for kids, parents and teachers, with a focus on water conservation in the home.

National Fire Protection Association (NFPA)

Provides scientifically based fire codes and standards, research, training, and education.

National Lightning Safety Institute

Independent, non-profit consulting, education and research organization focusing on lightning safety.

Natural Hazards Center at the University of Colorado

Clearinghouse for natural hazards information. Publishes the Natural Hazards Observer.

WeatherREADY

The goal of Weather Ready is to raise national awareness of the need to prepare for severe weather. Sponsored by The Weather Channel

Societal Aspects of Weather-Injury and Damage Statistics

Contains societal impact data for weather related disasters.

The Disaster Center

Provides news and information on current disasters, and the emergency management field.

The Disaster Research Center (University of Delaware)

Research center for the preparation and mitigation of natural and technological disaster for groups, organizations and communities.

The Tornado Project

Offers tornado books, posters, and videos.

United Nations International Strategy for Disaster Reduction

Increase public awareness of hazard and risk issues for the reduction of disasters in modern societies, motivate public administration policies and measures to reduce risks, and improve access of science and technology for risk reduction in local communities.

University of Wisconsin Disaster Management Center

The center's goal is to help improve the emergency management performance of non-governmental organizations, local and national governments, and international organizations, through a comprehensive professional development program in disaster management.

Figure 55 shows the mitigation project funding by county. Figure 56 and Figure 57 show the types of projects funded in each county as a proportion of that counties total funding.

Figure 55 Mitigation project funding in Minnesota to date

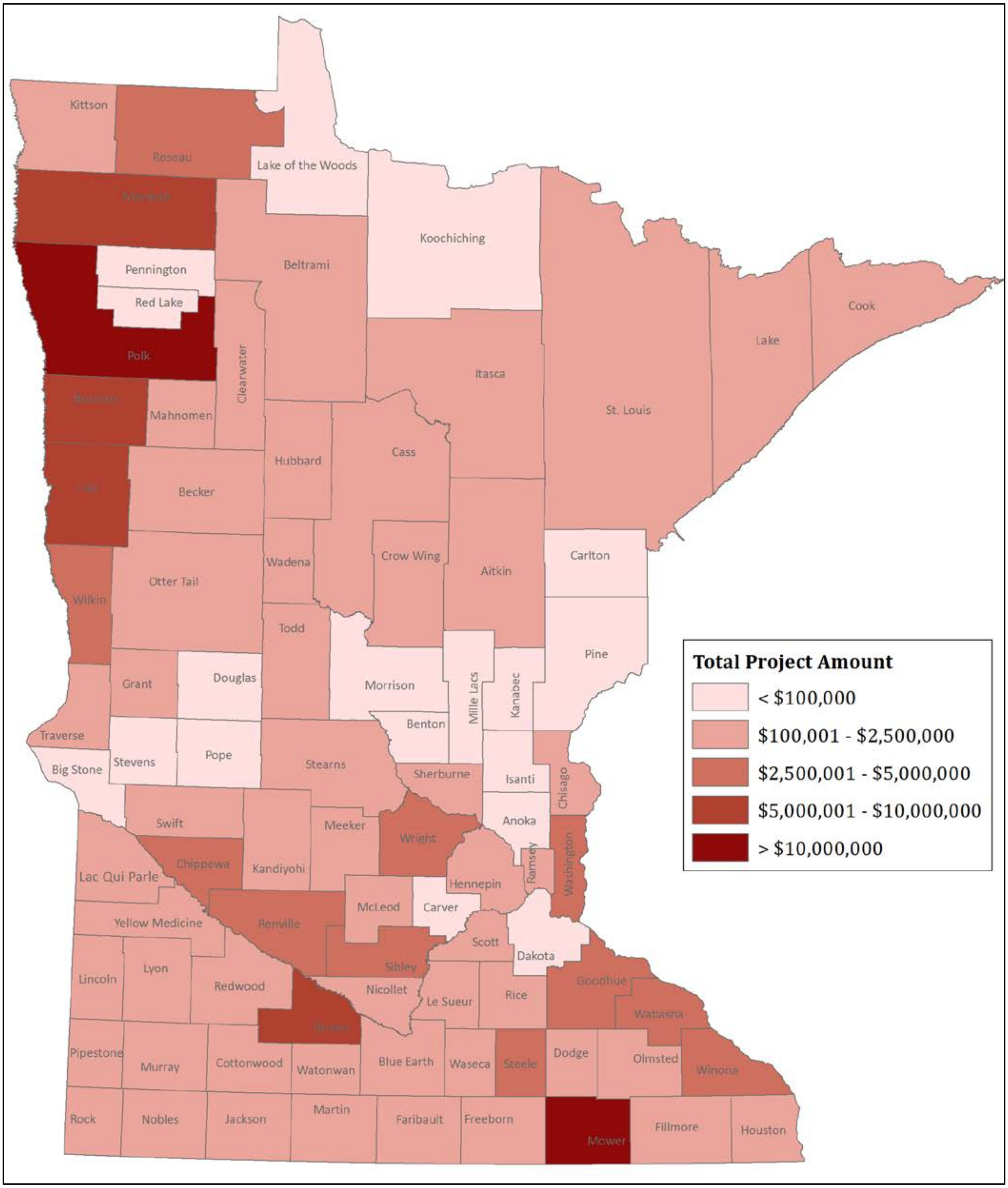


Figure 56 Mitigation Funding for Counties by Project Type to date

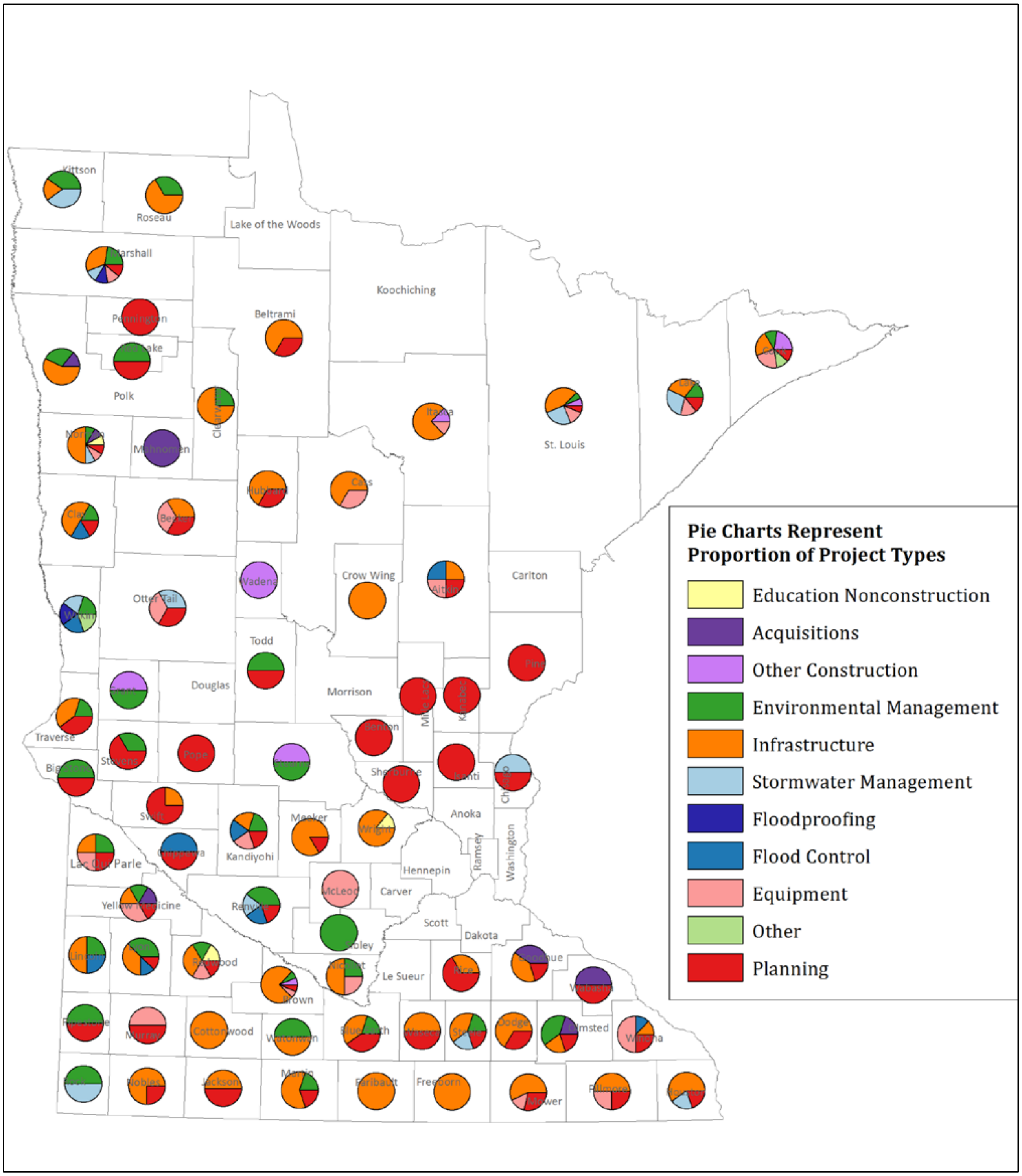
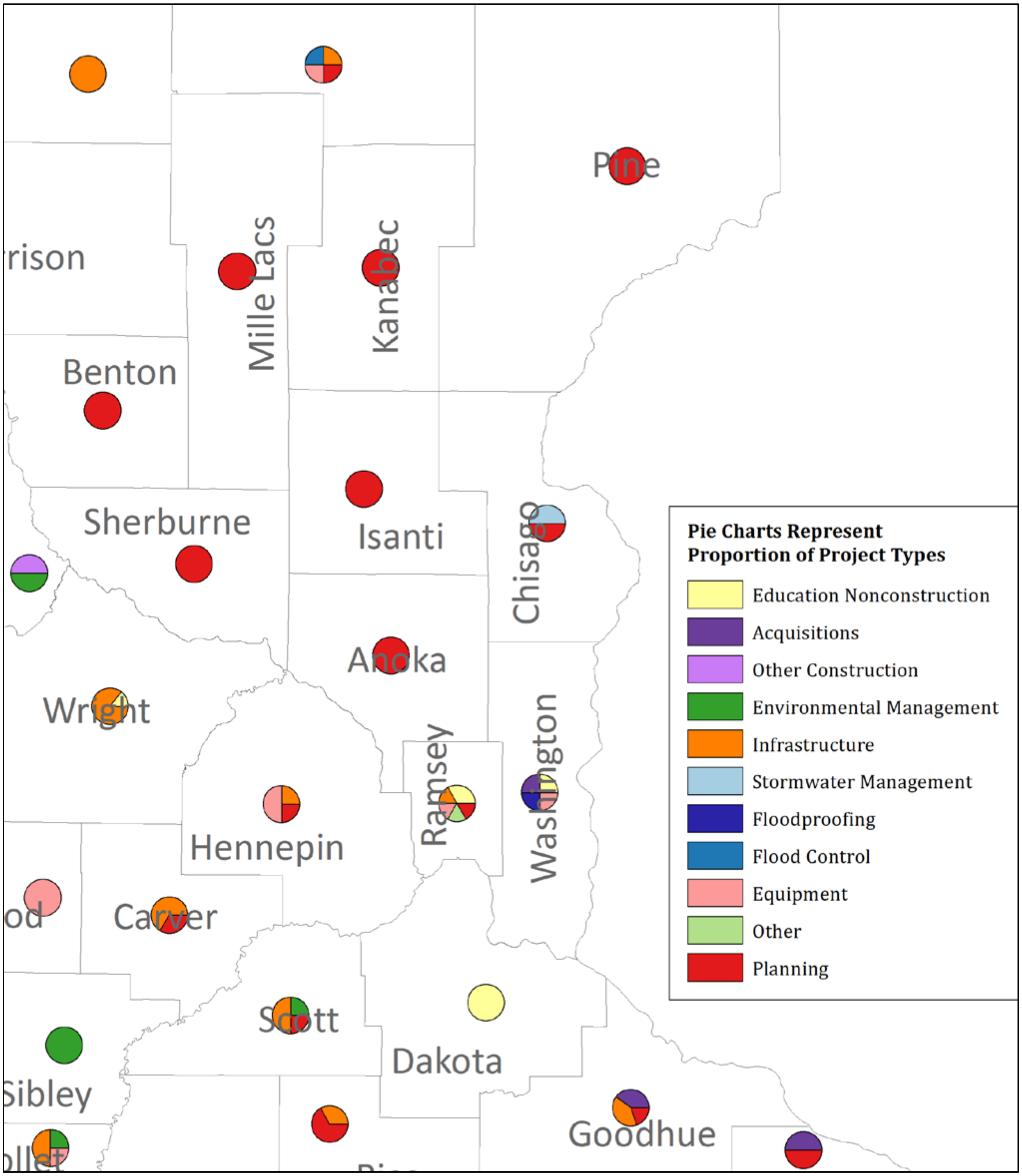


Figure 57 Metro Area Counties and Mitigation Project Types to date



5.6 State Capability Assessment

Requirement §201.4(c)(3)(ii): *[The State mitigation strategy **shall** include a] discussion of the State's pre-and post-disaster hazard management policies, programs, and capabilities to mitigate the hazards in the area, including: an evaluation of State laws, regulations, policies, and programs related to hazard mitigation as well as to development in hazard-prone areas [and] a discussion of State funding capabilities for hazard mitigation projects.*

The state of Minnesota has the legal authority to engage in pre- and post-disaster mitigation activities via federal programs. MN HSEM is continually pursuing ways to improve programs, plans and policies for hazard mitigation to become incorporated into other types of planning, programs and policies. The Minnesota Recovers Task Force (MRTF) is a group of federal, state and local agencies working together to prioritize and coordinate the disaster recovery efforts by its member agencies. The State Hazard Mitigation Officer (SHMO) coordinates mitigation outreach and prioritizes funding for mitigation projects with this task force with the goal of building long term disaster resilience into communities. Continued coordination and integration of planning and hazard mitigation make the state of Minnesota more disaster resistant. The Minnesota Silver Jackets brings state and federal agencies together to advise the SHMO on natural hazards, collaborate on resource coordination, and to participate in joint projects aimed towards making Minnesota more disaster resilient on the local level.

An evaluation of federal and state programs indicates the successes of mitigation efforts. However, as mitigation is a relatively new field, much more can be done to integrate mitigation into existing planning efforts. The following is an assessment of existing programs, projects and policies that should be pursued to further increase mitigation efforts and results. Contribution to and participation in existing initiatives and coordinated efforts will strengthen mitigation planning at the state and local level and will continue to integrate hazard mitigation planning at all levels.

Led by HSEM, the Minnesota Recovers Task Force (MRTF) is a group of federal, state and local agencies working together to prioritize and coordinate the disaster recovery efforts by its member agencies. It was created to provide a one-stop-shop for local governments to seek recovery assistance following a disaster.

Recent MRTF activities:

Southwest Minnesota Ice Storm (DR-4113)

Governor Dayton has signed into law a bill passed by the Minnesota state legislature that appropriates $1.5 million for HSEM to match federal public assistance disaster grants for the severe winter ice storm on April 9 -11, 2013, in southwest Minnesota.

The counties of Murray, Cottonwood, Rock, Nobles and Jackson were designated as a Presidential Major Disaster on May 3, 2013. Federal public assistance disaster grants require a 25% state and local funding match.

In addition, $250,000 was also appropriated to cover costs related to debris removal and to provide long-term recovery assistance to the communities affected by the severe winter storm.

Northeast and Central Minnesota Flooding (DR-4069)

On August 24, Governor Mark Dayton signed a $167 million disaster relief bill. It includes $25 million in state funds to match FEMA Public Assistance funds to repair public infrastructure for the federally declared disaster area which includes 15 counties and three tribal nations.

It also includes funding for various state agencies which are members of the Minnesota Recovers Task Force (MRTF). Those agencies work with local units of government and tribal communities which apply on behalf of individuals, businesses and certain private not for profit organizations. The Task Force ensures applicants meet the eligibility criteria to receive state assistance funds.

The agencies listed below have received funding.

Department of Public Safety

- $500,000 for debris removal and disposal in the federally declared disaster area.
- $500,000 Long-term Recovery Assistance in the federally declared disaster area.

Department of Health

- $565,000 for behavioral health and affected water systems.

Department of Education

- $761,000 for enrollment impact aid and disaster relief facilities grants.

Public Facilities Authority

- $6 million for infrastructure repair not covered under the Federal Emergency Management Agency.

Minnesota Board of Water & Soil Resources

- Up to $12.5 million to repair flood-damaged land, streams and related infrastructure.

Department of Agriculture

- $600,000 for farm assistance.

Minnesota Historical Society

- $250,000 for historic resource recovery.

Department of Natural Resources

- $18.85 million for damage, debris removal and flood hazard mitigation.

Department of Employment and Economic Development

- $15 million for the Minnesota Investment Fund to aid business owners.

Department of Transportation

- $79 million for state trunk highways and bridges, local road and bridge reconstruction.

Minnesota Housing Finance Agency

- $12.2 million for the Quick Start Disaster Recovery Program.

National Flood Insurance Program (NFIP)

The Floodplain Management Unit with the MN DNR, Division of Ecological and Water Resources oversees the administration of the state Floodplain Management Program by promoting and ensuring sound land use development in floodplain areas in order to promote the health and safety of the public, minimize loss of life, and reduce economic losses caused by flood damages. This unit also exists to oversee and administer the National Flood Insurance Program (NFIP) for the state of Minnesota. See

NFIP Community Status Book at http://www.fema.gov/fema/csb.shtm for a list of communities that participate in the program. The following tables summarize community participation in the NFIP.

Table 59 Communities Participating in NFIP

	2011 UPDATE	2014 UPDATE
Total In Flood Program	551	585
Total In Emergency Program	34	30
Total In the Regular Program	517	555
Total In Regular Program with No Special Flood Hazard	91	91
Total In Regular Program But Minimally Flood Prone	69	78

Source: FEMA Community Status Book Report – Minnesota; 11/07/2013

Table 60 Summary of Communities NOT Participating in NFIP

	2011 UPDATE	2014 UPDATE
Total Not in Flood Program	94	84
Total Suspended from Emergency Program	0	0
Total Suspended from Regular Program	1	0
Total Withdrawn Communities Not In Program	1	1
Total Not In Program With Hazard Area Identified	94	84
Total Not In Program With Hazard Area Identified < 1 Year	4	0

Source: FEMA Community Status Book Report – Minnesota; 11/07/2013

Table 61 Minnesota NFIP Policy Coverage Summary

Total Number of Policies	12,212
Total Coverage	$2,609,630,400
Total Claims Since 1978	10,990
Total Paid Since 1978	$136,131,293

Source: FEMA NFIP Insurance Report – Minnesota; 11/07/2013

Community Rating System (CRS) The goals of the CRS are to reduce flood losses, to facilitate accurate insurance rating, and to promote the awareness of flood insurance. The CRS was developed to provide incentives for communities to go beyond the minimum floodplain management requirements to develop extra measures to provide protection from flooding. Participation in CRS is voluntary and the incentives are in the form of premium discounts.

Table 62 Minnesota Community Rating System Participants

COMMUNITY NAME	CRS ENTRY DATE	CURRENT EFFECTIVE DATE	CURRENT CLASS	% DISCOUNT FOR SFHA	% DISCOUNT FOR NON-SFHA
Austin, City of	10/1/91	5/1/08	5	25	10
Granite Falls, City of	5/1/13	5/1/13	5	25	10
Lake St. Croix Beach, City of	10/1/95	10/1/11	6	20	10
Montevideo, City of	5/1/10	5/1/10	5	25	10
Moorhead, City of	5/1/10	5/1/10	7	15	5
Mower County	10/1/95	4/1/00	8	10	5

Source: Community Rating System, November 2013

The City of Granite Falls is new to the program with an entry date of May 1, 2013. The CRS Resource Center is now available.

State mitigation planners will continue to encourage local communities to update their mitigation plans, and prioritize mitigation actions according to jurisdictions risks. HSEM will continue to promote participation in the NFIP, CRS and identify funding for the local share for acquisitions of repetitively damaged homes.

NFIP Flood Rate Maps and Studies NFIP mapping is an important tool in determining vulnerability to floods for mitigation planning and projects. An important advancement is digital NFIP rate maps. Converting the maps from paper copies affords for greater degrees of accuracy and convenience. Community participation in the mapping processes results in digital maps with a higher degree of accuracy. MN DNR's Floodplain Management Unit coordinates the map revision process between FEMA and local jurisdictions. As of June 7/2013, 26 counties have been digitally mapped with another 23 counties planned for this upgrade.

The vision for FEMA Risk MAP (Risk Mapping, Assessment and Planning) is to deliver quality data that increases public awareness and leads to action that reduces risk to life and property. Risk MAP builds on flood hazard data and maps produced during the Flood Map Modernization program. Risk MAP goes beyond providing the regulatory rate maps required for the NFIP program. Communities are asked to review areas of high flood risk during Risk MAP meetings then develop potential mitigation projects.

The meetings are coordinated by DNR's Floodplain Management Unit with input on hazard mitigation from HSEM mitigation staff. Representatives from the U. S. Army Corp of Engineers and National Weather Service participate as part of the MN Silver Jackets local outreach. County Emergency Management directors are invited to attend these meeting since the potential projects and participants should be integrated into the local multi-jurisdictional mitigation plan processes. The estimated FEMA Map Modernization status in Minnesota current schedule is available here.

The FEMA Risk Map Progress website is an interactive geoportal that was developed to provide transparency and communicate FEMA's investments towards achieving its vision and goals for Risk MAP.

Cost Effective Methods to Acquire Flood Prone Structures One of the primary goals of FEMA's Hazard Mitigation Assistance program is to reduce future flood damage, particularly to structures located in floodplains. Acquisition projects must show that the benefits of the project outweigh the costs. This section covers different methods to acquire properties through FEMA's Hazard Mitigation Assistance program that show that they are cost effective. The project will not be eligible for funding if the criteria of one of the three methods are not met.

- **Acquisitions Using FEMA's Benefit Cost Analysis (BCA)** The recommended method is to gather damage histories, replacement values, and other data to determine if the structure acquisition is meets the Benefit Cost Ratio of 1.0 or greater. Applications to acquire property and structures may be submitted to FEMA if the BCA criteria are met. Alternate methods are available if the project does not meet the BCA.
- **Acquisition of Substantially Damaged Structures** FEMA's HMA program allows for substantially damaged structures due to flood may be funded without a BCA. Structures located in the floodplain of jurisdictions participating in the NFIP that receive damages that exceed 50% of the value of the structure are considered "substantially damaged". The structure must either be demolished or re-built above the base flood elevation. Rebuilding in the floodway is not allowed in Minnesota. This degree of loss and the potential additional expense of coming into compliance make it an economic disaster for the flood victims. By acquiring the property for pre-flood fair market value, the economic suffering of the disaster victims may be eased. Acquiring substantially damaged structures is a strong program for the state of Minnesota hazard mitigation programs through the federal mitigation assistance and the state FDR program.
- **Cost Effective Determination for Property Acquisition** FEMA has determined that the acquisition of a structure located in the 100-year floodplain (as delineated on the Flood Insurance Rate Map or based on best available data) that costs less than or equal to the amount of $276,000 is considered cost effective. Costs of purchasing the property, demolition, and other items are included in this determination.
- **Cost Effective Determination for Property Elevation** FEMA has determined that the elevation of a structure located in the 100-year floodplain (as delineated on the Flood Insurance Rate Map or based on best available data) that costs less than or equal to the amount of $175,000 is considered cost effective.
- **Match for Property Acquisition** the Hazard Mitigation Assistance program provides federal funds for 75% of the eligible project. The remaining 25% of the funds are provided by state or local match. The match may be shared by several agencies or borne alone by the local jurisdiction applying for the funding. The Minnesota Recovers Task Force assists communities by identifying potential match sources as part of the recovery process. This section provides some detail on the local match requirement may be met.
- **Local Jurisdiction** The local jurisdiction provides all or part of the 25% of the match depending if other sources of funding are available. The seller may be willing to provide a portion of the match if the pre-flood event value is favorable. The jurisdiction may see if matching funds may be provided by local private and public organizations.
- Flood Damage Reduction (FDR) The Flood Damage Reduction Grant Assistance Program was created by the Minnesota Legislature in 1987 to provide technical and financial assistance to local government units for reducing the damaging effects of floods. Under this program the state

can make cost-share grants to local units of government for up to 50 percent of the total cost of a project. The goal of existing regulations and programs for flood damage reduction is to minimize the threat to life and property from flooding. The efforts of local governments to enforce their zoning ordinances, to sponsor flood mitigation public improvement projects, and to acquire or relocate flood-prone buildings have significantly helped to reduce risk to lives and flood damages across the state.

Firewise

The Minnesota Firewise Project administered by MnDNR works with local communities by passing federal Fire Plan funds through to local communities as grants for various on-the-ground activities including local Firewise plans, mitigation education, home site assessment, access improvement, and dry hydrants. Firewise does not provide funds to make structures fire resistant.

Community Wildfire Protection Plans (CWPP) is the foundation to make structures in Wildland Urban Interface (WUIs) areas more resilient to the wildfire hazard. Regional Firewise coordinators work with county emergency management directors, fire departments, local elected officials, federal agencies and community members to develop a CWPP. The plans cover the development and enforcement of building codes, establishing defensible space around structures, and other measures. CWPPs are used to determine funding for Firewise eligible projects.

Pre-Disaster Mitigation and Hazard Mitigation Grant Program funds have been used to install wildfire sprinkler systems to protect structures from wildfire. Several hundred sprinkler systems have been installed in Cook, Lake, and St. Louis counties. Wildfire sprinkler systems combined with defensible space have proved to be effective mitigation techniques. Water is spayed over structures and surrounding property to increase the moisture content. Wildfires burn around treated areas and the sprinklers extinguish any embers that may fly into the treated area. The net effect is that structures sustain only minimal damage at worst and the workload for fire crews can be focused on controlling the fire instead of trying to save structures. Wildfire sprinklers systems may even inhibit the spread of fire over larger areas. The technology has been changing to accommodate a variety of water source conditions.

County emergency management directors are encouraged to participate in the Firewise program depending on the county's vulnerability to wildfire. HSEM mitigation staff takes the opportunity to point out the Firewise program as part of local multi-jurisdictional plan updates.

Disaster Recovery

Coordination of mitigation during long term recovery is essential for communities to become resilient to future disasters. HSEM has expanded disaster recovery roles and support materials as follows:

Disaster Recovery Coordinator The role of the Disaster Recovery Coordinator is provide coordination between local, state and federal agencies during the recovery phase of the numerous disasters declared in Minnesota. The Disaster Recovery Coordinator oversees the Minnesota Recovers Task Force, which provides state assistance in recovery. Coordinates long-term recovery efforts from State, County and local levels... The state offers multiple Disaster Recovery Workshops to local emergency managers and other interested parties.

Community Recovery Coordinator The role of the Community Recovery Coordinator is to provide technical assistance to local jurisdictions, counties, tribal governments, regional consortiums and non-profit organizations to provide assistance in coordinating long-term recovery activities following a major disaster or emergency. This position also assists in the coordination of voluntary resources in long-term recovery efforts and acts as the state's Individual Assistance Officer.

Volunteer Resource Coordinator The role of the Volunteer Resource Coordinator is to coordinate on an ongoing basis with state government, local government and voluntary agencies on response issues, to ensure that the public and private sectors work together to address these issues in a coordinated manner, and that volunteer resources are incorporated into local disaster response and recovery plans to the greatest extent possible.

The **Minnesota Disaster Management Handbook** is a tool local jurisdictions are encouraged to utilize in times of disaster. The four phases of emergency management – mitigation, preparedness, response, and recovery – are ongoing, interdependent, and to some degree, overlapping. To ignore the actions required by any one of the four phases jeopardizes the jurisdiction's overall ability to "manage" disasters and emergencies. The purpose of the handbook is to provide a variety of tools to help emergency managers mitigate hazards, prepare for emergencies, and enhance the response and recovery phases of any emergency. The handbook contains damage and impact assessment forms for the state, county and local officials.

5.7 Repetitive and Severe Repetitive Loss

Requirement §201.4(c)(3)(v): *A State may request the reduced cost share authorized under §79.4(c)(2) of this chapter for the FMA and SRL programs, if it has an approved State Mitigation Plan … that also identifies specific actions the State has taken to reduce the number of repetitive loss properties (which must include severe repetitive loss properties), and specifies how the State intends to reduce the number of such repetitive loss properties.*

Acquisition of Severe Repetitive Loss (SRL) Properties Acquisition of property where the structures are demolished or relocated out of the floodplain works hand in hand with enforcement of the NFIP regulations. Acquisition of repetitively damaged properties breaks the cycle of construction, destruction, and reconstruction. SRL properties are the most costly to the NFIP fund due the number and magnitude of sustained damages. The Biggert-Waters Act of 2012 revised the definition of SRL properties:

(a) Is covered under a contract for flood insurance made available under the NFIP; and
(b) Has incurred flood related damage –
    (i) For which 4 or more separate claims payments have been made under flood insurance coverage with the amount of each such claim exceeding $5,000, and with the cumulative amount of such claims payments exceeding $20,000; or
    (ii) For which at least 2 separate claims payments have been made under such coverage, with the cumulative amount of such claims exceeding the market value of the insured structure.

Prior to 2013, only two SRL properties were located in Minnesota. The SRL list as of November 2013 shows 33 properties with building payments of over $4.2 million and contents losses of approximately $941 thousand. The expansion is due to the new Biggert-Waters Act of 2012 definition for Flood Mitigation Assistance (FMA). Eleven of the properties are located in Mower County and the City of Austin, located in Mower County. This accounts for 33% of the SRL properties. One or two properties are listed for the remaining thirteen jurisdictions.

The procedure is that HSEM's mitigation program contacts the local jurisdiction to start the process of acquiring the property. Severe Repetitive Loss Properties Eligible for HMA Funding in Appendix O shows details by jurisdiction.

Acquisition of Repetitive Loss Properties Federal, state, and local funding has resulted in the acquisition of a significant number of repetitive loss structures. The NFIP Repetitive Loss Mitigated (in Appendix O) indicates 224 properties have been acquired. The total for these properties for building payments was over $7.2 million, contents payments were over $1.2 million for a total of $8.7 million in losses. The top five counties in number of Repetitive Loss Properties acquired is listed below:

Table 63 Top Counties for acquisition of Repetitive Loss Properties

County	# of RPL Properties Acquired
Mower County	86
Clay	34
Marshall	18
Chippewa	15
Hennepin	13

The definition of a repetitive loss property for Flood Mitigation Assistance (FMA) structures covered by a contract for flood insurance made available under the NFIP that:

> (a) Has incurred flood-related damage on 2 occasions, in which the cost of the repair, on the average, equaled or exceeded 25 percent of the market value of the structure at the time of each such flood event; and
>
> (b) At the time of the second incidence of flood-related damage, the contract for flood insurance contains increased cost of compliance coverage.

Currently there are 41 repetitive loss properties in Minnesota per the Repetitive Loss Properties Eligible for HMA Funding in Appendix O. These structures have accounted for building payments of approximately $2.0 million and contents payments of over $267 thousand. The 2011 mitigation plan updated reported that there were 433 properties on the repetitive loss list for the state. The reduction is attributed in changes to the NFIP program due to the definition of repetitive loss property in Biggert-Waters Act of 2012. A list of properties that fit the prior definition is still being tracked since they show vulnerability to flooding and relate to other NFIP policy. SRL & Repetitive Loss Properties Not Eligible HMA Funding in Appendix O shows how these properties are being tracked by community. There are 349 properties on this list for totally payments of over $9.8 million. Tracking repetitive loss properties that are either eligible or not eligible for HMA funding gives planners a broader insight to the risk found in communities.

5.8 Local Capability Assessment

A review of all 87 County, 6 Tribal, and 2 City Hazard Mitigation Plans was completed to better understand the capability of all the counties in the State. Appendix F contains a full listing of Minnesota county capabilities (plans, policies, and staff). If the hazard mitigation plan mentioned a specific plan, policy or staff member as a capability is was included in the table.

The following table depicts the highest percentage of specific plans that counties identified as a capability in their hazard mitigation plan. 75 out of the 94 (79.8%) jurisdictional hazard mitigation plans identified, Emergency Response/Management Plans as a capability of the County, the highest planning capability in the state.

Table 64 Local Planning Capabilities

Capabilities (plans) Cited in County Hazard Mitigation Plan	Number of Counties with Capability	Counties without	Percentage of counties with capability
Emergency Response/Management Plan	75	19	79.8%
Water / Watershed Management Plan	71	22	76.3%
Comprehensive Plan	46	48	48.9%
Critical Facilities Inventory	45	49	47.9%
Land-use Plan	43	51	45.7%
Pandemic or Public Health Incident Response Plan	30	64	31.9%
National Flood Insurance Program (NFIP)	29	65	30.9%
Wellhead Protection Plan	25	68	26.9%
Capital Improvement Plan	18	76	19.1%
Contingency Plan	11	83	11.7%

Jurisdictional hazard mitigation plans were also reviewed for county policy capabilities. The majority (64.9%) of plans identified Land Use, Planning, & Zoning Ordinances as a capability for the county. This was closely followed by Floodplain & Soil Erosion Ordinances and Building Code ordinances.

Table 65 Local Policy Capabilities

Capabilities (policies) Cited in County Hazard Mitigation Plan	Number of Counties with Capability	Number of Counties without Capability	Percentage of Counties with Capability
Land Use, Planning, & Zoning Ordinance	61	33	64.9%
Floodplain & Soil Erosion Ordinance	56	38	59.6%
Building Code	39	55	41.5%
Subdivision Ordinance	26	68	27.7%
Methamphetamine Lab Ordinance	19	75	20.2%
Fire Code	10	83	10.8%

Jurisdictional hazard mitigation plans were also reviewed for county staff capabilities. The majority (80.4%) of plans identified Emergency Management Coordinators/Emergency Management Program as a capability in the hazard mitigation plan.

Table 66 Local Staff Capabilities

Capabilities (staff) Cited in County Hazard Mitigation Plan	Number of Counties with Capability	Number of Counties without Capability	Percentage of Counties with Capability
Emergency Mgmt. Coordinator / Emergency Mgmt. Program	74	18	80.4%
Mapping Specialist (GIS)	45	35	56.3%
Public Health Coordinator/Department	48	40	54.5%
Sheriff/Police Department	41	35	53.9%
MN Department of Natural Resources	30	36	45.5%
Schools Staff	34	43	44.2%
Planning Consultant	38	55	40.9%

Section 6: Coordination of Local Mitigation Planning

6.1. Local Funding and Technical Assistance

Requirement §201.4(c)(4)(i): *[The section on the Coordination of Local Mitigation Planning* ***must*** *include a] description of the State process to support, through funding and technical assistance, the development of local mitigation plans.*

Funding for local hazard mitigation programs and technical assistance is available through federal, state, government and other agencies, as listed in this Plan. The PDM and HMGP are two grant programs available to assist locals in their hazard mitigation plan development. PDM grant funding provides funds to states, territories, Indian Tribal governments, and communities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations. The PDM is a competitive grant program that is ranked via a national ranking process. Under the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 it is the responsibility of the state to identify and select hazard mitigation projects to be recommended to the Federal Emergency Management Agency for final approval and funding of the Hazard Mitigation Grant Program.

Local all-hazard mitigation plans are consistent with and incorporate information from the state Plan. Local hazard mitigation plans are encouraged to incorporate other local planning mechanisms, thus providing a unified mitigation strategy throughout all levels and aspects of government within Minnesota. The state has continually provided guidance and technical support to the local mitigation plans and has encouraged the sharing of information both between local planning projects and with the state.

This section summarizes the funding and technical assistance given to local jurisdictions for the purpose of mitigation planning. Since the approval of the State Plan in April of 2011, approximately 40 planning applications have been submitted to FEMA and FEMA V has successfully approved 36 plans.

Mitigation Plan Tracking

Mitigation plan status is tracked on a spreadsheet to give mitigation staff a synopsis of all local and multijurisdictional mitigation plans. The spreadsheet includes the jurisdiction of the plan and its funding source with the grant approval date and ending date.

Tracking for various stages of the review include when the state receives the plan for review, when it was sent to FEMA, local adoption, and plan approval date. The five-year review is listed so that project officers can contact the local jurisdiction and provide assistance in developing an application for funding an updated mitigation plan. HSEM verifies this spreadsheet with FEMA's County Status Spreadsheet on an as needed basis.

Mitigation Planning Workshops/Training Opportunities

The Local Hazard Mitigation Plan Training Aid was developed in 2012 to provide local emergency managers an example of how FEMA mitigation plan requirements may be met. The training aid was provided to emergency managers, local officials, regional development commissions and contracted consultants upon request.

Following DR-4069, HSEM, requested technical planning assistance from FEMA for potential applicants. Following a survey of local emergency managers the number one barrier to completing hazard mitigation projects using FEMA funding through the HMA program was developing and completing HMA applications. HSEM, in partnership with FEMA, provided training to state planners, emergency managers, rural electric cooperatives, regional development commissions and others on Unified Hazard Mitigation Grant Assistance Application Development Course (L212), 19 people attended the course. 32 of the 87 counties were represented at the training; members of regional development commissions (RDC) attended the meeting – RDC's represent multiple counties. The application development course was held over a three day period in St. Paul.

During the fall of 2012 HSEM, in partnership with FEMA, provided a Benefit-Cost Analysis Course (E276), 11 students attended the course in St. Paul. The course was taught by FEMA and was part of the Disaster Field Training Operations. Because the BCA software is complex, HSEM will continue to provide assistance to applicants with the software during application development.

In August of 2012 HSEM hosted a day-long workshop at Camp Ripley – Mitigation Planning for Local and Tribal Communities, 28 students across the state attended the course. The course provided participants with information on the hazard mitigation planning process and funding hazard mitigation plans. The workshop also had specific breakout sessions that provided participants with more information on either tribal planning requirements or mitigation project application development.

Because DR-4069 was a flood event, floodplain management training was provided to local officials, surveyors, insurance agents, realtors, emergency managers and response and recovery team members at the State. The Minnesota Department of Natural Resources taught the course and 28 students participated in the training.

In anticipation of the open application period for the 2013 Pre-Disaster Mitigation (PDM), funding, FEMA provided webinar training - Mitigation Application Development. HSEM advertised the course to potential PDM and HMGP applicants. Because this was a provided online 13 participants from all across the State attended. The course provided participants with information on how to develop quality planning and project applications and ensuring the application contains all the required elements.

In response to DR-4113, which significantly damaged rural electric cooperatives in Southwestern Minnesota, HSEM requested training from FEMA for four courses: Benefit Cost Analysis Entry Level Training (L276), Unified Hazard Mitigation Assistance Program – Developing Quality Application Elements (L212), Unified Hazard Mitigation Assistance Program – Application Review and Evaluation (L213, and Unified Hazard Mitigation Assistance Program – Project Implementation and Programmatic Closeout. These courses provided participants with a start to finish overview of the HMA program and funding. The targeted audience was rural electric cooperatives as well as entities that expressed interest in applying for safe room funding. A large number of participants attended all four of the courses. 34 participants attended the trainings held over the course of 3 weeks.

In the summer of 2013, DR-4131 was declared affecting 28 counties in the State. HSEM requested technical planning assistance from FEMA for two benefit cost analysis courses. The courses were shortened versions of FEMA's standard L276 course but were targeted to rural electric cooperatives for power line retrofit projects and to applicant interested in applying for safe room funding. The courses were both taught at Camp Ripley in central Minnesota. The BCA course tailored for rural electric cooperatives had 22 participants from all across the state. The BCA course specifically designed for safe room applicants had 12 participants from all across the state.

Additional outreach and training specifics are outlined in section 2 of this plan. Sample outreach materials are located in Appendix M.

HSEM Regional Meetings

During the 2013 Governor's Conference, mitigation staff presented at each Emergency Management Regional Program Coordinators (RPC) break-out meeting. The intent of the presentation was to introduce new emergency managers to new mitigation staff and relay plan status and grant opportunities to emergency managers. HSEM mitigation staff frequently contact local emergency managers to develop their applications and mitigation plans. HSEM staff periodically reaches out directly to regions through regional meetings. Hazard Mitigation staff will again attend the RPC meetings at the 2014 Governor's Conference. The Governor's Conference is attended by nearly 100% of all emergency managers in the State and provides the best opportunity for mitigation staff to network and connect with emergency managers on mitigation plans and projects.

Individualized Support

Mitigation staff keeps in contact with the development of mitigation plans in several ways. If a planning grant has been awarded to a local jurisdiction the project officer reviews quarterly reports to determine the progress. The quarterly narrative requires grant recipients to report on specific components of the plan (planning process, risk assessment, mitigation actions, public review, state/FEMA review, and local adoption) project officers monitor the progress and conduct follow-up meetings to discuss any potential problems or inactivity in the grant status. In addition to quarterly reporting project officers field phone calls and emails from grant recipients requesting technical assistance in plan development.

For planning efforts being completed without FEMA funding mitigation staff reaches out to staff responsible for plan development. Mitigation staff met in person with individual county planners and tribal emergency managers/planners on a couple of occasions in 2013.

Mitigation plans sent for state review also initiate dialogue between mitigation staff and plan developers. Differences in the plan and planning requirements are often resolved by use of the phone and e-mail. However, larger issues may require in person meetings to discuss issues.

Application development for mitigation plans is another opportunity for mitigation staff to communicate with local planners. HSEM developed a customized application to meet HMA requirements for PDM and HMGP. HSEM supported the use of e-grants for PDM sub-applications by encouraging the participation in FEMA training.

HAZUS-MH Support

An effort to integrate HAZUS loss estimates due to floods began in 2008. The main effort was to supply a statewide estimate plus estimate losses for state facilities for the 2011 Minnesota State All-Hazard Mitigation Plan. As the project plan developed, HSEM determined that a HAZUS analysis would be done for each county and that the county report would be shared with the counties for use in mitigation plans. The original plan was to train planners in counties and Regional Development Commissions to perform HAZUS analysis. A trial with one local planner showed that HAZUS was infrequently used. The time investment to keep up to date and to use HAZUS was not cost effective. Sharing the county reports from the state flood reports is cost effective.

The county HAZUS flood loss estimation reports will continue to be shared with all counties in the state. HSEM staff attended HAZUS training at EMI in 2013, staff is able to better understand the intricacies required for a HAZUS analysis at the County level. Staff has provided technical assistance to a few counties in 2013 on the use of HAZUS or the incorporation of HAZUS reports into local mitigation plans.

Future Local Mitigation Plan Support

Support for local mitigation planning is a high priority. The program benchmarks activities in other states to learn how to better support the local planning effort and how to make the plans living, useful tools. Advice from FEMA R-V is both sought and considered with the goal of supporting communities to the best of HSEM's abilities. Many of the same activities listed above will be used either routinely or when needed. By dividing the state into regions and having each mitigation project officer concentrate on two regions, HSEM has set the stage for providing quality technical planning support to mitigation planning efforts across the state.

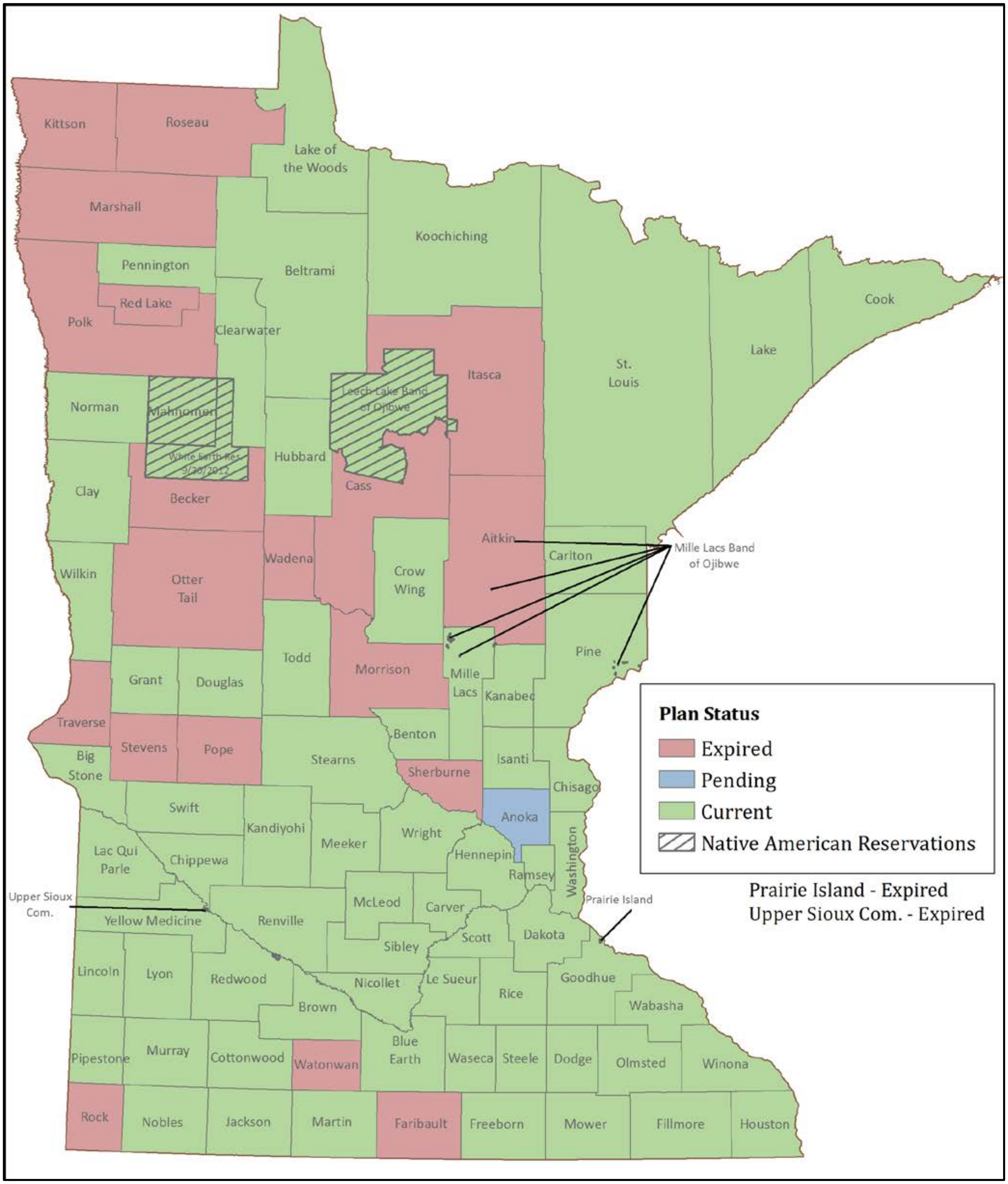
6.2 Local Mitigation Plan Updates

Up to 7% of the HMGP funds may be used for planning for the State All Hazard Mitigation Plan or local, multi-jurisdictional mitigation plans. Planning grant funding from HMGP and PDM are used for the majority of local jurisdictional planning efforts.

The counties in the state are encouraged to develop multi-jurisdictional plans since the beginning of the mitigation plan requirement. Of the 87 counties in the state, 67 have approved plans, the remaining 21 are updating either independently (4) or have FEMA planning grants (17). In addition, two cities have local plans. Two tribal governments have an approved plan, one has a planning grant to develop a plan, and another is developing a plan independently. Technical assistance and funding for updates are provided through both pre and post-disaster mitigation grants.

The Planning Grant Status in Appendix C lists all jurisdictions' (counties, cities and tribes) plan status. The document is revised as plans are funded, submitted for review, approved pending adoption or are formally approved. County emergency management directors are aware that it is the responsibility of the jurisdiction to complete plans prior to their expiration date in order to be eligible for HMA funding.

Figure 58 Status of Local Hazard Mitigation Plans.



6.3 Mitigation Success Stories in Minnesota

Success stories illustrate how mitigation projects have worked to reduce damages to people and property, and keep Minnesota and its population safe. Utilizing existing programs, funding mitigation programs, and coordinating with other planning efforts, losses can be even further reduced. Promoting how mitigation is successful in our local communities is important to the state mitigation program. Publicizing success stories via press releases in the local media, posting on the FEMA website and other methods of transmitting the message of how mitigation helps locals is a priority for the state. In addition to written success stories, best practices, and case studies, FEMA has assisted the state in producing loss avoidance studies. Since the 2010 plan, mitigation publications include:

Loss Avoidance Studies provide a quantitative approach to assess performance of mitigation measures, in this case, property acquisitions. Working with the state and local jurisdictions, data is collected for the study and multiple analyses are conducted to determine if there were measurable avoided losses since the projects' completion. The reports contain project descriptive information and the impacts of those projects. Read the full 2013 Austin Loss Avoidance Report here.

Table 67 Summary of losses avoided due to acquisitions in Austin, MN

Funding Sources	Total Acquisition Cost	Total Losses Avoided	% of Losses Avoided to Acquisition Cost	Return On Investment (ROI)
58 bldgs. - HUD (after 1978)	$7,112,759	$20,351,726	286.10%	2.86
4 bldgs. - sec. 1362 FEMA (after 1988)	$270,797	$1,521,651	561.90%	5.62
101 bldgs. – HMGP FEMA (after 1993)	$7,042,430	$16,400,693	232.90%	2.33
Totals and total averages	$14,425,986	$38,274,070	265.30%	2.65

(Note: Dollars normalized to the year 2001 for all acquisition projects. The discount rate used for this normalization is 7 %.)

The DPS Office of Communications worked in conjunction to develop three stories to highlight the successes of the Hazard Mitigation program. One story was on the acquisitions post DR-1941 flooding, another on the Moorhead Public Service Pumping

Success stories illustrate how mitigation projects have worked to reduce damages to people and property, and keep Minnesota and its population safe. Utilizing existing programs, funding mitigation programs, and coordinating with other planning efforts, losses can be even further reduced. The examples listed here provide information and documentation of the value of a comprehensive hazard mitigation program.

Zumbro Falls Acquisition Project

Every summer, a small town in southeastern Minnesota welcomes visitors who enjoy the Zumbro River for canoeing, tubing and fishing. But that same scenic waterway has repeatedly caused major flooding in Zumbro Falls. Homes — many of which were located on the aptly named "Water Street" — flooded year after year until a successful hazard mitigation project removed the houses and provided the community with an attractive green space. Read the Zumbro Falls acquisition project story.

Moorhead Pumping Station

When residents in the western Minnesota communities of Moorhead, Dilworth and Oakport faced spring flooding from the Red River of the North, they also faced the possibility of losing their primary source of clean drinking water.

Every year, the leaves, sticks, and other debris in the river clogged a crucial intake screen, reducing the amount of river water that could be pumped into the treatment facility. The solution involved a new pumping station, a deeper intake screen placed in the center of the river, and bursts of air. This hazard mitigation project, completed in 2013, has provided peace of mind and a steady supply of drinking water to more than 40 thousand people. Read the full Moorhead Pumping Station success story.

Wadena-Deer Creek High School Safe Room

It was June 17, 2010. Students were enjoying summer break, but about 25 people were inside the Wadena-Deer Creek School building. Some were making last minute preparations for a class reunion as an EF 4 tornado approached. Thanks to NOAA weather radios, outdoor warning sirens, and a look out the window, those in the school were able to find shelter in a basement or interior space. No one was seriously hurt — but the school was destroyed. Read the full Wadena-Deer Creek safe room story.

Minnesota DNR's Flood Damage Reduction Grant Program

Since Minnesota's Flood Damage Reduction (FDR) Grant Assistance Program was established by the State Legislature in 1987, communities and citizens across the state have incurred far less damage from floods than they would otherwise have experienced. Working in partnership with local, state and federal resources, incidents of repetitive loss to structures and communities have been significantly reduced due to planning and implementation of flood mitigation measures.

Many communities around Minnesota have taken initial steps to protect their homes and businesses from flood damage. They have floodplain ordinances, and some home and business owners have purchased flood insurance. But many communities can look at their own flooding histories and can predict that a catastrophic event will occur unless further preventive steps are taken. One frequently used step is to begin removing structures from harm's way by removing all structures from the floodplain. DNR has worked with partner agencies to acquire and remove over 600 homes from the floodplain in the town of East Grand Forks alone. When the record flood of 2009 occurred, the flood fight was essentially non-existent because so many homes had been cleared from low-lying areas, and an engineered levee constructed to an elevation exceeding the 100-year flood level. Statewide, to date, over 3,500 flood prone structures have been removed from the floodplain with assistance for the FDR program

The City of Austin lies at the confluence of the Cedar River, Turtle Creek and Dobbins Creek and has suffered from a history of flooding. By partnering with different agencies, including the State, the City has removed over 200 homes from the floodplain and has reduced the risk of flood through the construction of levees and flood walls, and improved pumping stations. In 2010, the City experienced one of its highest flood levels, but due to the flood mitigation work accomplished to that point, took the flood in stride with minimal damage or emergency preparation.

Yet another example of flood mitigation success is the flood mitigation efforts of the city of Granite Falls. Historically a high repetitive loss community, the city, in partnership with the DNR, is nearing completion of its comprehensive flood risk reduction project that includes acquisition and relocation of at-risk structures, levee and floodwall construction, relocation of a sanitary lift station, and improvements to local drainage. When complete, the project will significantly reduce flood risk to the community.

Because of the large number of rivers and lakes in Minnesota, there are dozens of flood mitigation projects – large and small - waiting for funding. No community can fund large, expensive flood mitigation projects on its own. The partnership of federal, state and local dollars makes it possible. Our weather history shows that floods will occur, and that large, catastrophic storm events are trending upward.

Emergency Watershed Program

The Emergency Watershed Program (EWP) is used to correct watershed impairment caused by a sudden natural event that threatens life or property. The Minnesota NRCS is part of the Minnesota Recovers Task Force which is made up of government agencies and other organizations who have a role in disaster recovery. Our EWP projects are coordinated through the Task Force.

In 2013Minnesota entered into nine agreements including one exigency, meaning loss of life or property is imminent. One project is complete; work is currently underway on the remaining eight. The exigent project in Houston County protected from a landslide, the single family home of a young couple and their two small children. One project repairs the drawdown pipe of the principal spillway and sinkholes in the emergency spillway of a PL566 watershed dam in Goodhue County. Another project will address erosion control around a lake on the Fond Du Lac Band of Lake Superior Chippewa Reservation. The remaining projects address debris removal and stream bank stabilization related to the Duluth floods of 2012 (DR-4069). In all cases the sponsors used the EWP program for 75% of the funding. All projects are contracted locally as opposed to federally led contracting.

With the exception of the exigent project, these projects are all previously wait listed projects from past floods. There have been additional floods this year (2013) damage survey reports have been completed and several projects have been waitlisted again.

6.4 Funding Update

The following is a summary of mitigation grants (obligated or expended) by type and 75% federal funding expended through December 2013. The majority of funding for these projects falls under HMGP and PDM grants. These totals do not take into account the most available funding for two disasters (DR-4113-MN and DR-4131-MN) in 2013 as applications are in review and have not been obligated (DR-4069-MN is partially included as some projects have been obligated).

Post-disaster funding in the state from DR-929-MN (1991) through DR-4069-MN (2012) has resulted in the following federal HMGP expenditures and obligations for:

Acquisition projects over $52.6 million

Electric Distribution over $19.9 million

Mitigation Planning over $3.3 million

Drainage projects over $11.8 million

Wildfire projects over $2.3 million

Table 68 Hazard Mitigation Grant Program (HMGP) Funding Summary

Funding Summary							
Federal Expended and Obligated Funds							
Funding	Property Acquisition	Electrical Distribution	Plans	Drainage	Wildfire	5% Initiative	State Mgt. Costs
DR 834	$ 280,000					$ 211,845	$ -
DR-929	$ -	$ 440,638	$ -	$ -	$ -	$ 97,000	$ -
DR-993	$ 7,370,000	$ 157,500	$ -	$ 3,684,655	$ -	$ 640,238	$ 169,590
DR-1078	$ -	$ 557,695	$ -	$ -	$ -	$ -	$ -
DR-1116	$ 96,750	$ 249,497	$ -	$ 330,512	$ -	$ 608,412	$ -
DR-1151	$ -	$ 1,637,745	$ -	$ -	$ 186,499	$ 45,000	$ -
DR-1175	$ 23,267,887	$ 3,864,370	$ -	$ 690,568	$ -	$ 1,297,831	$ 73,341
DR-1187	$ 1,269,775	$ 501,750	$ -	$ -	$ -	$ 69,361	$ -
DR-1212	$ -	$ 2,406,392	$ -	$ 1,870,223	$ -	$ 160,928	$ -
DR-1225	$ 211,865	$ 2,551,039	$ -	$ 600,206	$ -	$ 85,578	$ -
DR-1283	$ 50,301	$ 1,171,957	$ -	$ 286,945	$ 943,736	$ 120,721	$ 67,891
DR-1288	$ -	$ 1,233,787	$ -	$ -	$ -	$ -	$ 86,268
DR-1333	$ 1,867,396	$ 2,048,990	$ -	$ 230,668	$ -	$ 237,375	$ 70,042
DR-1370	$ 4,116,662	$ 437,540	$ 410,183	$ -	$ -	$ 33,942	$ -
DR-1419	$ 309,451	$ 712,082	$ 408,633	$ 3,568,997	$ -	$ 75,000	$ -
DR-1569	$ -	$ 434,400	$ 42,000	$ -	$ -	$ -	$ 124,792
DR-1648	$ 346,125	$ -	$ 22,500	$ -	$ -	$ -	$ -
DR-1717	$ 1,983,460	$ 374,501	$ 696,480	$ 591,263	$ 1,171,500	$ 206,501	$ 128,332
DR-1772	$ -	$ 438,750	$ 45,225	$ -	$ -	$ 30,000	$ 45,906
DR-1830	$ 1,801,438	$ 684,077	$ 405,120	$ -	$ -	$ 153,975	$ 101,884
DR-1900	$ 63,180	$ -	$ 67,189	$ -	$ -	$ 15,296	$ 93,668
DR-1921	$ 2,862,259	$ -	$ 82,425	$ -	$ -	$ 193,079	$ 206,828
DR-1941	$ 227,664	$ -	$ 264,102	$ -	$ -	$ 177,166	$ 206,482
DR-1982	$ -	$ -	$ 76,107	$ -	$ -	$ 107,173	$ 151,811
DR-1990	$ -	$ -	$ 78,533	$ -	$ -	$ 15,668	$ 68,508
DR-4009	$ -	$ -	$ 158,546	$ -	$ -	$ 58,956	$ 105,852
DR-4069	$ 6,559,027	$ -	$ 604,173	$ -	$ -	$ -	$ 326,498
DR-4113	$ -	$ -	$ -	$ -	$ -	$ -	$ -
DR-4131	$ -	$ -	$ -	$ -	$ -	$ -	$ -

From 2002 through 2011, the State of Minnesota received over $27 million through the Pre-Disaster Mitigation program, both through the annual competitive program and Congressional Earmarks for the following:

Acquisition projects over $14.4 million

Mitigation Planning over $1.6 million

Drainage projects over $2.75 million

Wildfire projects over $8.1 million

Table 69 Pre-Disaster Mitigation (PDM) Grant Program Funding Summary

Funding Summary							
Federal Expended and Obligated Funds							
Funding	Property Acquisition	Electrical Distribution	Plans	Drainage	Wildfire	5% Initiative	State Mgt. Costs
PDM-2002	$ -	$ -	$ 274,445	$ -	$ -	$ -	$ 78,200
PDM-2003	$ -	$ -	$ 284,361	$ -	$ -	$ -	$ -
PDM-2005	$ 14,440,837	$ -	$ 74,250	$ -	$ -	$ -	$ -
PDM-2007	$ -	$ -	$ 139,650	$ -	$ -	$ -	$ -
PDM-2008	$ -	$ -	$ -	$ -	$ 5,944,365	$ -	$ -
LPDM-2008	$ -	$ -	$ -	$ 51,828	$ 450,000	$ -	$ -
PDM-2009	$ -	$ -	$ 453,056	$ -	$ -	$ -	$ -
PDM-2010	$ -	$ -	$ 305,892	$ 2,701,119	$ -	$ -	$ -
PDM-2011	$ -	$ -	$ 96,000	$ -	$ 1,727,437	$ -	$ -

Additional Technical Assistance and Public Education

While mitigation funding data is not available for the disasters that took place in 2013, education outreach and technical assistance for local units of governments took place in the state, for specific outreach efforts see section two, and for specific outreach material see Appendix M. The following information is from Hazard Mitigation Strategy documents put together by FEMA Region V, Joint Field Office and state mitigation staff. The document is created as a strategy or action plan to guide FEMA staff while they are 'in town' in response to a presidential disaster declaration. The document summarizes mitigation activities that took place post-disaster. It documents activities at the local level specifically public education, outreach and training. In addition it highlights NFIP outreach and education led by experts in the field.

DR-1982-MN

Hazard Mitigation Grants and Planning:

- Provide assistance to the State of MN of HM planning projects
- Provide technical assistance on Local HM plans
- Review and approve local HM plans submitted by State of MN
- Provide technical assistance for Tribal multi-hazard mitigation planning
- Provide data collection support for critical facilities
- Provide assistance to State in identifying completed and potential Rural Electric Cooperative power-line mitigation projects.

Floodplain Management and Insurance

- Provide technical assistance to the State relating to floodplain management compliance and insurance
- Identify sanctioned communities and send a letter to materials encouraging participation in the NFIP
- Research violates files for known potential NFIP non-compliant public development
- Coordinate with PA to assist with flood map and insurance data

DR-1990-MN

Hazard Mitigation Grants and Planning:

- Assist the State and Communities in Planning and Mitigation Projects
- Provide technical assistance to State and local officials to administer HMGP using the F2010
- Perform review of HMGP applications to ensure completeness
- State of MN will update and submit HMGP Administrative Plan
- State will submit applications for State Management Costs

Floodplain Management and Insurance

- FEMA and MN DNR will identify communities with potential structural damage in the SFHA
- FEMA and MN DNR will notify communities of NFIP regulations related to substantially damaged buildings
- FEMA will provide NFIP data to other agencies as requested
- FEMA and MN DNR will provide technical support for substantial damage regulations to community officials upon request

Hazard Mitigation Assistance (HMA) programs:

- Information regarding the HMGP will be distributed during the public Assistance applicant kickoff briefings
- Follow up meetings with agencies expressing interest in pursuing funding
- The State will choose a HMA program that is best suited for the requested project

<u>State priority for funding</u>:

- Acquisitions or relocation of all flood prone structures from identifies flood hazard areas
- Construction of tornado safe rooms per FEMA's 361 guidelines.
- Hazard Mitigation Planning
- Electrical Utility Retrofit and/or burial projects
- All other eligible hazard mitigation projects

DR-4009-MN

Hazard Mitigation Grants and Planning

- Assist the State and Communities in planning & Mitigation projects
- Present information on HMA programs at applicant briefings
- Meet with local communities that express interest in any HMA programs to collect information for project development

- Perform the initial review of the HMGP applications to ensure that all information and documentation is provided
- Review/approve updated Disaster administrative plan submitted by State
- Assist communities to update their Hazard Mitigation Plan
- Provide technical assistance to Tribes to update their Hazard Mitigation Plan

Floodplain Management and Insurance

- Provide technical assistance to the State relating to floodplain management compliance and insurance
- Identify communities with potential structural damage in the SFHA
- Notify communities of NFIP regulations related to substantially damage buildings
- Provide technical support for substantial damage regulations to community officials upon request

Hazards and Performance Analysis (HPA)

- Provide building science technical assistance to the State
- Perform outreach related to single-use/multi-use tornado safe room projects
- Provide building science technical support to community officials
- Develop State outreach strategy to educate communities about the development of Tornado Safe Room projects

Hazard Mitigation Assistance (HMA) programs:

- Information regarding the HMGP will be distributed during the public Assistance applicant kickoff briefings
- Follow up meetings with agencies expressing interest in pursuing funding
- The State will choose a HMA program that is best suited for the requested project

State priority for funding:

- Acquisitions or relocation of all flood prone structures from identifies flood hazard areas
- Construction of tornado safe rooms per FEMA's 361 guidelines.
- Hazard Mitigation Planning
- Electrical Utility Retrofit and/or burial projects
- All other eligible hazard mitigation projects

DR-4069-MN

Hazard Mitigation Grants and Planning

- Develop a one-page HMGP fact sheet with Minnesota specific information to distribute to communities interested in HMGP
- Outreach to local communities regarding HMGP applications
- Conduct a three-day application development (E212) training for JFO staff, MN State staff & local officials
- Conduct a two-day Benefit Cost workshop
- Update Disaster Administrative Plan for FEMA

Mitigation Planning

- Conduct outreach and provide technical assistance to designated counties for the purpose of updating the Local and Tribal Hazard Mitigation plans
- Conduct outreach to counties with FEMA approved Local Hazard Mitigation Plans that did not get the participating jurisdictions to adopt the Local Hazard Mitigation plan
- Assist FEMA regional staff with the Mitigation Planning training session planned for August 1 at Camp Ripley

Floodplain Management and insurance

- Raise awareness in the public area regarding the availability and benefits of flood insurance by coordinating with External Affairs, to develop press releases and respond to the media
- Coordinate with External Affairs to conduct social media outreach to NFIP sanctioned communities
- Conduct multiple NFIP overview workshops for State/ FEMA
- Three are currently planned in St. Cloud (9/5), Apple Valley (9/26), and Thief River Falls (8/21 or 22)
- Inform communities of the benefits of participating in the NFIP and how to join the program
- Notify NFIP participating communities (floodplain managers) of the role and responsibilities regarding substantially damaged structures
- Meet with State insurance commissioners staff to encourage ongoing engagement in NFIP
- Conduct reviews of identified Repetitive Loss structures and document findings in the National Flood Mitigation Data Collection

Hazards and Performance Analysis

- Support FEMA and State Public Assistance 406 Mitigation by providing technical assistance upon request
- Coordinate with State of Minnesota Silver Jacket to determine areas of interest in performing risk assessment activities
- Collect data on high water marks, rain frequencies, and stream gauge discharge to determine impacts to affected areas in coordination with other State and Federal partners
- Conduct an analysis of collected data in support of flood inundation mapping needs
- Develop a comprehensive summary report of the record flood event based on data collected and analysis completed
- Facilitate GIS for Emergency Managers (E190) training for State and FEMA staff
- Facilitate HAZUS-MH for flood module (E172) training
- Facilitate basic HAZUS-MH (E313)
- Facilitate application of HAZUS-MH in Risk Assessment (E296)

DR-4113-MN

Hazard Mitigation Grants and Planning

- Currently 74 of 87 Counties have local mitigation plan that are adopted or pending adoption

- Within the next twelve months, 33 county hazard mitigation plans will need to be updated- Outreach is needed
- Six tribal communities have developed a Hazard Mitigation plan
- Assist the State and communities Hazards Mitigation Grant Applications
- Update DR-4113 Administrative plan
- Conduct L-276: Benefit Cost Analysis Entry Level
- Conduct E212: Unified Hazards Mitigation Assistance- Developing Quality Application Elements
- Conduct E213: Unified Hazard Mitigation Assistance-Application Review and Evaluation
- Conduct E214: Unified Hazard Mitigation Assistance: Project Implementation and Programmatic Closeout
- Develop a GIS database of all power line burial projects
- Sandy Recovery and Improvement Act (SRIA) of 2013 directs FEMA to Streamline HMGP activities and implement the program in a timelier manner
- Establish a process for soliciting interested from eligible sub-applicants to apply for HMGP funds
- Organize and conduct a coordination meeting with the MN municipal Utilities Association

Flood Plain Management and Insurance

- Provide data and floodplain regulation assistance for the selection of HMGP projects
- Provide insurance data and analysis
- Provide community floodplain management and regulation analysis

Hazard Performance and Analysis (HPA)

- Provide hazard mitigation expertise on disaster-specific mitigation issues
- Provide in-house training to PA staff on 406 Mitigation
- Provide workshops on mitigation opportunities for overheard electrical transmission and distribution systems upon request

DR-4131-MN

Hazard Mitigation Grants and Planning

- Currently 69 of 87 counties have local hazard mitigation plans that are adopted, or are pending adoption.
- There are six tribal communities that have developed their own Hazard Mitigation Plan
- Conduct solicitation to generate interest in HMGP
- Create a new HMGP application for sub applicants to use
- Provide two Benefit Cost Analysis Workshops for potential sub applicants (Safe Room/Power line retrofit)
- Conduct L212 course for local officials interested in applying for HMGP under DR-4131-MN
- Provide technical assistance on Local Hazard Mitigation plans that will expire in the next 12 months

- Organize and conduct coordination meetings with the Minnesota Rural Electrical Association and Minnesota Municipal Utilities Association
- Develop an Annex for the rural electrical cooperative

Floodplain Management and Insurance

- Promote effective floodplain management through outreach and data analysis, and the provision of technical assistance to the State
- Provide data analysis, floodplain management, and regulation assistance as requested by State
- Provide substantial damage outreach, as requested, to communities statewide
- Create substantial damage webinar ready slide deck
- Provide NFIP outreach to non-participating communities including Tribal Nations
- Provide Community rating systems outreach to targeted NFIP communities with excellent floodplain management programs
- Provide CRS outreach to targeted NFIP communities by letter, email, and/or webinar presentation

Hazard Performance and Analysis (HPA)

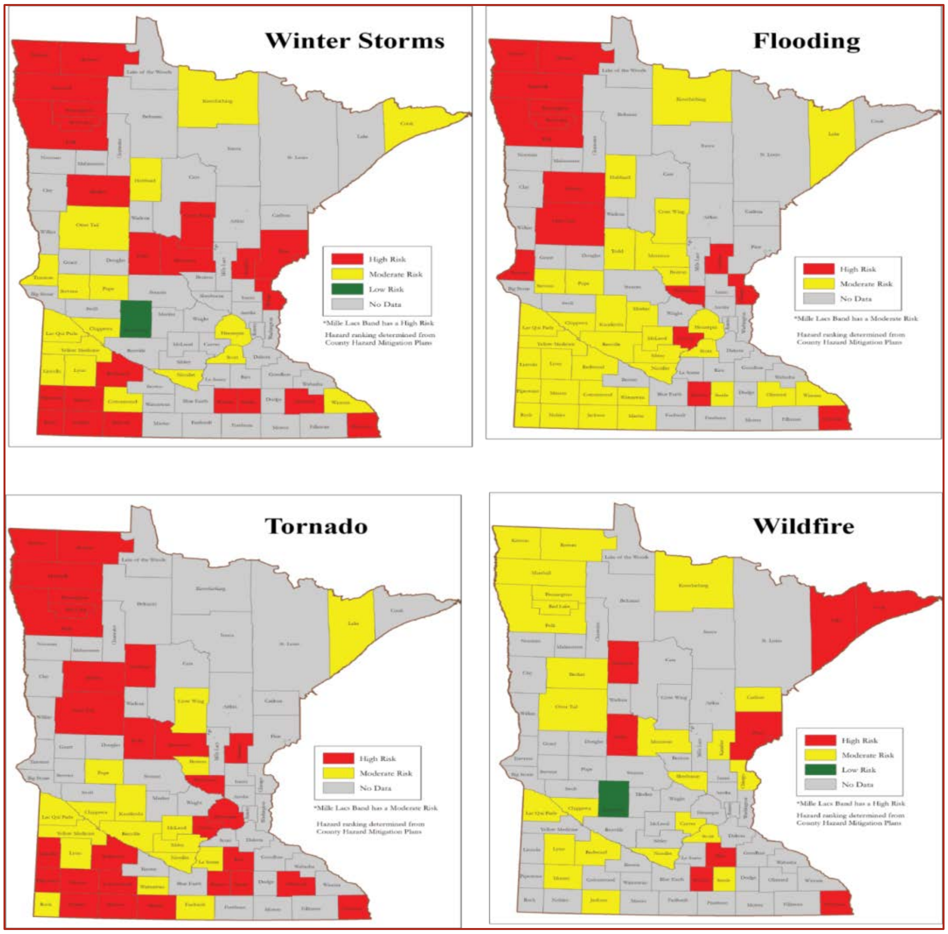
- Provide technical assistance to PA for mitigation opportunities as request
- Provide technical assistance in the development of reduced flood flow confinement and increased flood plain conveyance mitigation opportunities
- Provide in-house training for PA staff on 406 Mitigation
- Provide technical and outreach assistance to the State, focusing on community safe rooms and mitigation of electrical utilities and roadways
- Provide training to local emergency managers, engineers, and architects titled “Preparing a successful Safe Room Grant Application”
- Training to local emergency managers, engineers and architects titles, “Design and Construction of Safe Rooms for Architects and Engineers”
- Update loss avoidance study for Mower County

6.5 Local Plan Integration

Requirement §201.4(c)(4)(ii): *[The section on the Coordination of Local Mitigation Planning* ***must*** *include a] description of the State process and timeframe by which the local plans will be reviewed, coordinated, and linked to the State Mitigation Plan.*

HSEM has developed a local plan integration process that enables local mitigation planning into the state plan and the identification of potential projects. The process is completed during the update of the state plan and periodically throughout the 3-5 year update period.

During the State’s update of their hazard mitigation plan, staff and/or a consultant reviews all the counties plans for perceived risk and county capabilities (Appendix C and F). This review enables staff to understand the risks and capabilities in each of the counties across the state. The top four perceived risks (winter storms, flooding, tornado, and wildfire) are mapped for visual representation and project identification (see figure below).



The state integrates this information into the state goals, objectives and strategies of the plan. The review occurs every three to five years depending on federal requirements for the state plan updates; it is coordinated by HSEM mitigation staff in partnership with a hired consultant (when appropriate) and the information is directly linked/inserted into the State Mitigation Plan.

Prior to sending local plans to FEMA for compliance with the Federal Regulations, project officers review local plans. The project officer reviews are completed not only to ensure Federal Regulations are met, but to identify potential projects, identify potential new risks and to integrate into the State Mitigation Plan. When project officers identify a potential mitigation project that could be funded through either PDM or HMGP, the officer discusses the options with the local emergency manager or appropriate county staff person. Natural hazards are reviewed and if deviation from previous hazards occurs the project officer discusses the deviation with the County to get a better sense of the new or outdated hazard. The integration of this information into the State Mitigation Plan comes through continued discussion with the project officer and the SHMO during mitigation staff meetings.

Local Natural Hazard Ranking and Mitigation Strategy Summaries

Each of 84 current jurisdictional multi-hazard mitigation plans was reviewed for hazard ranking. Not every county ranked hazards the same. Fifty-six counties included an indication of ranking (though did not necessarily specify a method) for the hazards. The ranking for the natural hazards included in this plan are summarized below. H = high, M = moderate, L = low; blanks not assessed by county). A summary of the full ranking system is provided below (full table in

Appendix C), the rankings are consistent with the natural hazards identified in the State Mitigation Plan. Out of the counties that were assessed, flooding, wildfire, tornado, and winter storms rank the highest risk. This information is consistent and integrated into the State Mitigation Plan and our high priority projects typically fall under this category (see below)

Table 70 Hazards and State Priority Projects

Top Ranking Hazard by Counties	Related State Priority Project
Flooding	Property acquisition
Wildfire	Wild fire protection projects
Tornado	Safe rooms
Winter storms	Power line retrofit/hardening projects

Table 71 County Hazard Ranking

Natural Hazard	Number of Counties that Identified Risk as High	Number of Counties that Risk as Moderate	Counties Identified Risk as Low OR did not identify Risk
Flooding	15	35	6
Wildfire	9	24	23
Tornado	28	18	10
Winter Storms	24	17	15
Windstorms	12	14	30
Ice Storms	4	13	39
Drought	6	18	32
Summer Storms	9	26	21
Hail	5	23	28
Lighting	5	15	36
Extreme Temp.	4	12	40
Extreme Cold	4	15	37
Extreme Heat	6	13	37
Erosion	1	0	55
Landslide	0	2	54
Land subsidence	3	9	44
Dam Failure	2	11	43

6.6 Prioritizing Local Assistance

Requirement §201.4(c)(4)(iii): *[The section on the Coordination of Local Mitigation Planning must include] criteria for prioritizing communities and local jurisdictions that would receive planning and project grants under available funding programs, which should include consideration for communities with the highest risks, repetitive loss properties, and most intense development pressures.*

Further, that for non-planning grants, a principal criterion for prioritizing grants shall be the extent to which benefits are maximized according to a cost benefit review of proposed projects and their associated costs.

The application process, project review, ranking and selection criteria for mitigation planning and projects are described below. PDM grant applications are evaluated at the regional and national level once approved by the state for application. All other HMA grant program funds are evaluated first by state mitigation staff and then forwarded to regional FEMA staff for review. The Hazard Mitigation Assistance Unified Guidance is available at FEMA's website.

As part of a Presidential Disaster Declaration, the State is required to submit an Administrative Plan. This document details how the State will administer the Hazard Mitigation Grant funds made available by the disaster declaration. The state's FEMA approved HMGP Administrative Plan describes the organization, staffing, and procedures to be used when implementing the Section 404 Hazard Mitigation Grant Program in both the post and pre-disaster mitigation environment.

Applicant eligibility criteria will be in accord with federal statutes and regulations. Specifically, potentially eligible applicants will include: state agencies, local governments, private non-profit organizations (or institutions that own or operate a private non-profit facility as defined in 44 CFR 206.2211(e), and Indian tribes. Any questions regarding the eligibility of an applicant will be resolved by the SHMO, or, if necessary, by the Governor's Authorized Representative or his/her designee.

Projects may be of any nature that will result in the reduction or elimination of potential natural hazards and the protection of life and property. Specific types of eligible projects include, but are not limited to:

- Development of comprehensive multi-hazard/multi-jurisdictional hazard mitigation plans.
- Acquisition, elevation, or relocation of floodplain properties; and
- Tornado Safe Room Construction or Retrofit projects;
- Retrofitting of facilities, including burying or retrofitting of power lines;
- Flood reduction and flood control projects;
- Wild fire protection programs

Non-Duplication of Programs – HMGP funds cannot be used as a substitute or replacement to fund projects or programs that are available under other federal authorities, except under limited circumstances in which there are extraordinary threat to life, public health, safety or improved property. Other federal program authorities that should be looked into before requesting use of HMGP monies are, for example: Section 406 of the Stafford Act, Federal Insurance Administration Programs, the U.S. Army Corps of Engineers, the Small Business Administration, and the Natural Resources Conservation Service.

Project criteria: projects must be in conformance with the State Hazard Mitigation Plan developed as a requirement of Section 409 of the Stafford Act and Section 322 of the Disaster Mitigation Act of 2000. Projects must have a beneficial impact upon the designated disaster area. Projects do not have to be located in the designated disaster area, funding is made available statewide. Projects must be in conformance with 44 CFR Part 9, Floodplain Management and Protection of Wetlands, and 44 CFR Part 10, Environmental Considerations. Projects must solve a problem independently or constitute a functional portion of a solution where there is assurance that the project as a whole will be completed. Projects that merely identify or analyze hazards or problems are not eligible.

Projects must be cost-effective and substantially reduce the risk of future damage, hardship, loss, or suffering resulting from a major disaster. The sub-grantee must demonstrate this by documenting that the project:

- Addresses a problem that has been repetitive or a problem that poses a significant risk if left unsolved.
- Will not cost more than the anticipated value of the reduction in both direct damages and subsequent negative impacts to the area if future disasters were to occur. Both costs and benefits will be computed on a net present value basis.
- Has been determined to be the most practical, effective, and environmentally sound alternative after consideration of a range of options.
- Contributes, to the extent practicable, to a long-term solution to the problem it is intended to address.
- Considers long-term changes to the areas and entities it protects and has manageable future maintenance and modification requirements.
- Environmental Considerations: Projects funded under the HMGP must comply with all appropriate environmental requirements. These include the National Environmental Policy Act (NEPA), P.L. 91-190, as amended; Executive Order 11988, Floodplain Management; Executive Order 12898, Environmental Justice in Minority and Low-Income Populations, and Executive Order 11990, Protection of Wetlands. (Minnesota is a NEPA - compliant state.). The SHMO will ensure through coordination that all required environmental review is performed. The extent of such review will depend upon (1) the nature of a project, (2) environmental contractor assistance, if any, made available by FEMA or funded by the state, and/or (3) the environmental requirements imposed by other agencies participating in a project (if any). Approval to initiate a project will not be granted, nor will any HMGP monies be expended prior to the completion and satisfactory outcome of a required environmental review.

Information acquired during the Preliminary Damage Assessment (PDA) process may be used if completed by Mitigation in identifying potential projects. In the event of an expedited presidential declaration request, mitigation may not be included in the PDA. The SHMO will review the existing State Mitigation Plan for identification of potential statewide projects for HMGP funding. Following a presidential disaster declaration but prior to the establishment of a JFO, the SHMO will confer with the federal HMO on a number of issues. Among these will be early indications of potential HMGP applicants. The Public Assistance Project Worksheet teams may also discover potential hazard mitigation projects. Projects that include the acquisition of properties that have repetitive flood-insurance claims will be of high priority**.**

Shortly following submission of the Governor's request for a presidential declaration, the state PA Program Officer and the SHMO will jointly meet with the affected county emergency management directors to briefly review both the PA Program and the HMGP if possible. In the event of an expedited presidential declaration, the SHMO will schedule meetings with each individual county emergency management director when it is deemed an appropriate time by both the SHMO and the county.

During Applicant Briefing(s) and individual meetings, potential applicants will be given directions as to how pre-applications for potential hazard mitigation projects can be submitted to the SHMO. At the discretion of the SHMO and in coordination with the federal HMO, press release(s) describing the program may be developed and issued. Such press release(s) would include a point of contact for obtaining additional program information. The release could also include an announcement of HMGP briefings or meetings to be held in the area, should the SHMO decide to hold such briefings. At the discretion of the SHMO and in coordination with the federal HMO, mitigation information describing the program may be disseminated to communities and the public through Disaster Recovery Centers (DRC's) and/or public meetings held by local officials of the disaster-impacted area.

Shortly after the presidential declaration of disaster, the SHMO determines if a separate HMGP briefing (in addition to that given at the Applicant Briefing) would be beneficial, and if so, could be scheduled. Depending on the scope of a disaster, the Minnesota Recovers Task Force (MRTF) may hold a consolidated, multi-agency applicant briefing. Such briefing(s) would include the following: general program overview; eligibility; application process; and technical assistance.

The SHMO is responsible for ensuring that HMGP application forms and other informational documents are made available to potential applicants. Depending on the magnitude of a disaster and the number of agencies participating in the recovery/mitigation process, a preliminary HMGP application form may be utilized and/or a multi-agency, multi-program application form may be developed. Such forms may be disseminated at the Applicant's Briefing(s), and/or at a special HMGP briefing, if such a briefing is held.

In Minnesota, applicants for HMGP funds will be required to submit a completed application form (or preliminary application form) within a time frame established by the SHMO. If an applicant is unable to submit a fully completed application form within the required time period, it will need to notify the SHMO. The deadline to submit applications to FEMA is 12 months from the date of declaration with a possibility for two-three month time extensions totaling up to an additional six months.

The SHMO will make an initial review of all application forms to determine if the minimum required project information and eligibility criteria have been met. If they have not, the applicant(s) will be notified of the need to provide additional information.

HSEM may request state management costs from FEMA to fund one or more staff positions. The principal responsibility of the positions would be to facilitate the timely development and submission of project applications.

Once an application or Notice of Interest is received by HSEM, it is brought to the attention of the MRTF (assuming it is activated). At this time, a consensus is obtained as to which agency represented on the MRTF, if any, can/should fund the project.

For projects being considered for HMGP funding, the SHMO will perform an initial review of submitted application forms and determine if: all questions on the form have been adequately addressed, FEMA's minimum project criteria and any additional state criteria have been met and if all relevant information about the project has been provided.

If more project information is needed, the SHMO will obtain it in one or both of the following ways: by requesting the appropriate staff person to ask local officials for it, or by contacting applicants directly and asking for the additional project information.

HSEM staff will perform a benefit-cost analysis for the project or assist the sub-applicant in doing so. When necessary, HSEM staff will request that the State Historic Preservation Office (SHPO) perform a review for historical concerns. HSEM staff will work with the Minnesota Department of Natural Resources (DNR) and FEMA to ensure that the community in which a project is located is compliant with the National Flood Insurance Program (NFIP) and local floodplain ordinances if applicable.

HSEM/FEMA staff will determine the level of environmental review necessary. When needed and as required, the SHMO will request the Minnesota DNR or FEMA to conduct an environmental and floodplain management review relative to specific proposed hazard mitigation projects. When necessary, HSEM staff will initiate consultation with both the U.S. Army Corps of Engineers (USACE) and the Minnesota Department of Transportation (MN DOT) for project review and concurrence if no future agency projects are scheduled in the project action area.

Review of the application forms by the SHMO may reveal that several eligible projects are competing for insufficient hazard mitigation funding. Should this be the case, projects will be prioritized or ranked in accord with FEMA and state criteria. These criteria are as follows:

1. Measures that best fit within an overall plan for development and/or hazard mitigation in the community, disaster area, or state.

2. Measures that, if not taken, will have a severe detrimental impact on the applicant such as potential loss of life, loss of essential services, damage to critical facilities, or economic hardship on the community.

3. Measures that have the greatest potential impact on reducing future disaster losses.

4. Measures that are designed to accomplish multiple objectives, including damage reduction, environmental enhancement, and economic recovery.

5. Measures that are in accordance with any overall hazard mitigation project priorities established by the State Mitigation Plan.

6. Additional state criteria that may be considered

- Geographic distribution of projects

- Projected cost of proposed project
- Relative cost-effectiveness of projects
- Conformity of project with existing local hazard mitigation plans and land use/building regulations in the communities. Sub-grantees who do not have a plan will be required to develop an all-hazard mitigation plan.
- Applicant's level of interest and demonstrated degree of commitment to hazard mitigation actions and programs.
- Communities with most intense development pressures.

Process for Integrating State and Local Mitigation Measures

Identification of proposed mitigation measures within each local jurisdiction are the responsibility of the local community. The process of identification should take place during the local hazard mitigation planning process, but it may take place post disaster. The transition between identifying potential mitigation projects and submitting applications for funding of those projects is accomplished through the following process;

The State notifies potential applicants of Hazard Mitigation Assistance (HMA) program funding availability and program requirements.

Following notification, applicants will submit a Notice of Interest (NOI) declaring their intent to apply to HSEM by the established deadline. At a minimum, the NOI will include the name of the applicant, a brief description of the proposed project(s) including time frames for completion, title of Local Hazard Mitigation Plan and date of FEMA plan approval, mitigation measure from the approved plan that corresponds with the proposed project, approximate cost of the proposed project, and its precise location.

HSEM mitigation staff review NOI's to determine initial eligibility and whether the sub-applicant will be invited to complete a full HMA application. The review will consider the level of funding available under the grant; how the proposed project fits within an overall plan for development and/or hazard mitigation in the community and how the project addresses the State's priorities.

All NOI's received by HSEM are tracked in the General Project Tracking Spreadsheet and are utilized for current and future funding opportunities. The NOI's are tracked by project type and include the sub-grantee, county, project type, total cost, and other pertinent information for the sub-grantee. A tracking sheet is maintained for acquisitions, planning, and all other projects.

If all eligibility requirements are met and funding is available then a formal invitation to apply for FEMA funding will be sent to the sub-applicant.

Each project lead is responsible for coordinating and tracking all project activities with the sub-applicant. The project lead will make reports on the weekly mitigation report outlining all relevant activities relating to the projects being submitted to the State. The SHMO sends these reports to HSEM management, appropriate FEMA staff, and other stakeholders in an effort to keep all parties informed of significant mitigation project developments.

State project leads and project officers will provide technical assistance and guidance throughout project and application development.

Upon application completion, the sub-applicant will submit the application to the State for review, approval, and submittal to FEMA.

All activities specific to the submitted project application are tracked by the project lead using the Project Officer Report. This report tracks such items as total applications submitted, total project cost and application submittal dates.

The State has several Hazard Mitigation funding opportunities available. The following is a list of programs that have provided FEMA funding for hazard mitigation projects to complete proposed mitigation measures since the last update period.

- The Hazard Mitigation Grant Program (HMGP) has been available and open over the last three years due to multiple Presidential Disaster Declarations.
- The Pre Disaster Mitigation Program (PDM) has an annual funding stream, which guarantees a minimum amount of funding to each state.

Minnesota All Hazard Mitigation Plan Rural Electric Annex

Introduction

Electric Cooperatives are private, locally operated electric utility businesses that provide service to Minnesota customers. Electric cooperatives are owned and regulated by their customers and governed by a board of directors elected from the membership of the customers. The board of directors set policies, procedures, and rates that are implemented by the cooperative's professional staff. Electrical cooperatives pride themselves in providing near-cost electric service to members. Nationally, investor-owned utilities maintain approximately 73% of all customers, municipally owned utilities maintain 14% and cooperatives maintain approximately 13% of all customers[i]

History

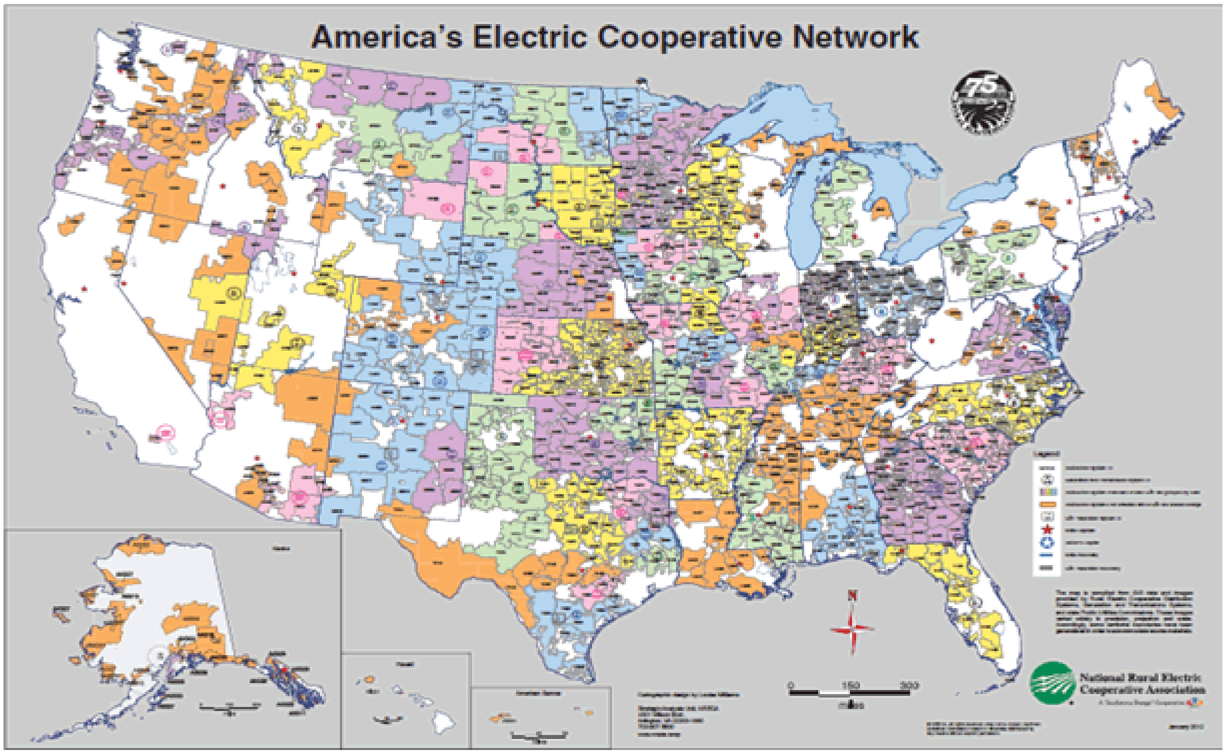
The establishment of electric cooperatives was the result of a lack of electrical service to rural areas of the United States. The 1930's rural areas across America were still without electricity – an estimated nine out of ten rural homes were without electricity[ii]. Investor-owned utility companies not willing to provide service to rural areas throughout the country. Investor-owned utilities believed there would be insufficient revenue in rural areas to support the needed infrastructure investments. The Rural Electrification Administration, established under Franklin Delano Roosevelt's "New Deal", was created on May 11th 1935, with the primary goal of promoting rural electrification.

America's Electric Cooperative Network

The electrical transmission network of the United States is complicated and involves three main sections (Eastern Interconnection, Texas Interconnection and the Western Interconnection). These sections supply power to the U.S. which cooperative networks (G & T and Distribution) are consumers or providers to the network.

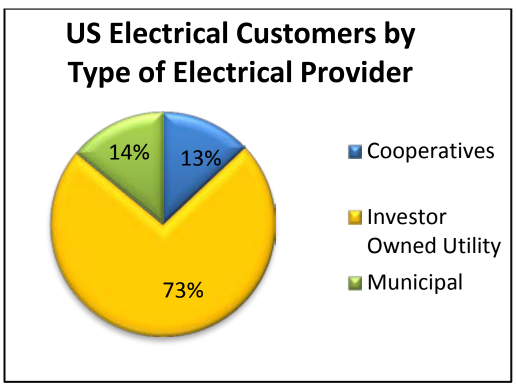
According to the U.S. Energy Information Administration (EIA) there are 812 cooperatives in the United States. Of these cooperatives, some are generation and transmission and some are solely distribution cooperatives. Typically, generation and transmission cooperatives serve a large number of distribution cooperatives who in turn serve consumers.

Figure 1 America's Electric Cooperative Network



Consumers are served by; cooperatives, investor owned utility companies, or municipalities. According to the National Rural Electrical Cooperative Association cooperatives serve approximately 13% of the U.S. electrical customers.

Figure 2 U.S. Electrical Customers by Type of Electrical Provider



The original intent of cooperatives was to serve rural areas so it is no surprise that cooperatives make up a significant portion (42%) of electrical distribution lines (Figure 3). Cooperatives also by their rural nature are more inclined to serve residential customers and not commercial or industrial service sectors. This is evident when comparing cooperatives percentage sales by kWh to municipal and investor owned providers (Figure 4). Co-ops are more likely to serve residential customers in rural parts of the U.S. compared to municipal and investor owned providers. This creates large networks for cooperatives to manage and maintain with less customers. When comparing revenue per mile it is clear that rural electric cooperatives are at a significant economic disadvantage to investor owned and municipal distribution providers (Figure 4).

Figure 3 Percentage of Miles of Distribution Lines

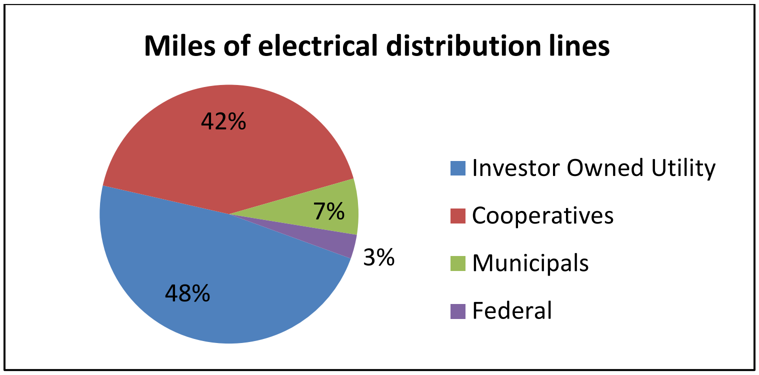


Figure 4 Percentage of Sales by kWh

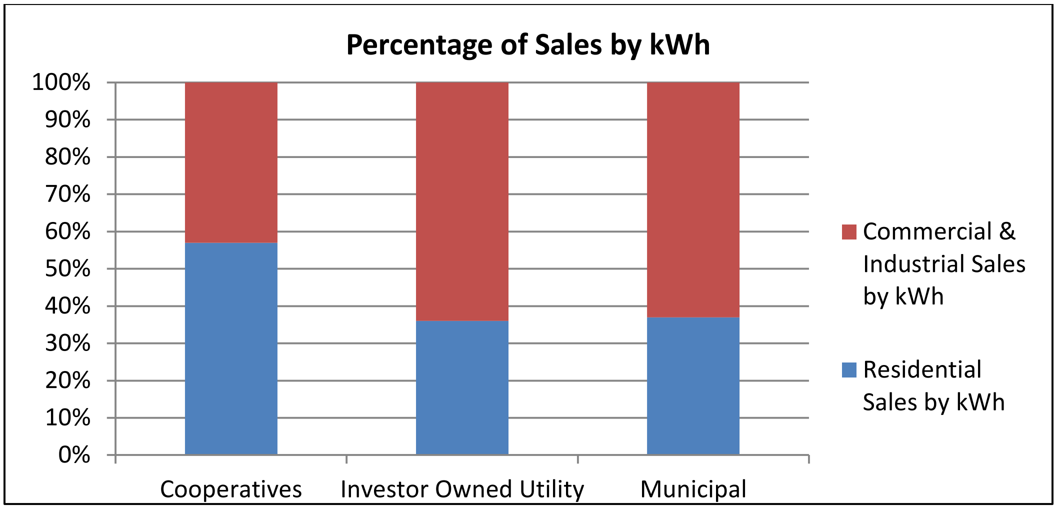
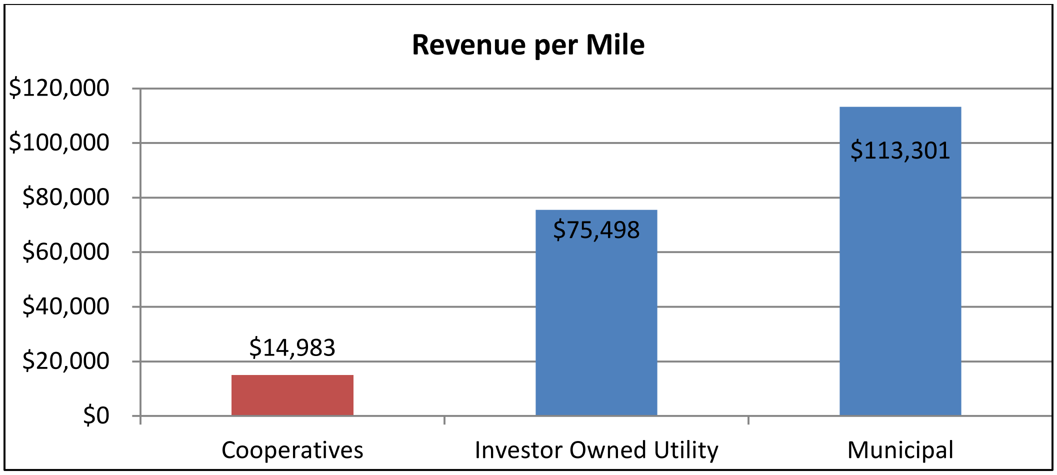


Figure 5 Revenue per Mile for Electrical Distribution Providers

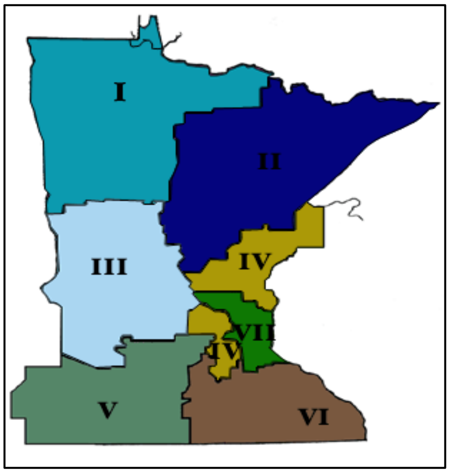


Minnesota Cooperatives

Minnesota electrical cooperatives are very similar to cooperatives nationwide. Cooperatives are split into two categories, electric distribution cooperatives and generation and transmission (G & T) cooperatives. Generation & Transmission Cooperatives generate electricity and transmit it to distribution cooperatives. Distribution cooperatives purchase wholesale power (usually from a generation & transmission cooperative) and deliver it to members. There are six generation and transmission cooperatives and forty-four electric distribution cooperatives that serve Minnesota.

The Minnesota Rural Electric Association has split the state into seven regions to better serve its cooperative members.

Figure 6 MN Rural Electric Association Regions



All cooperative businesses adhere to seven guiding principles:

1. Voluntary and Open Membership -- Cooperatives are voluntary organizations, open to all persons able to use their services and willing to accept the responsibilities of membership, without gender, social, racial, political or religious discrimination.
2. Democratic Member Control -- Cooperatives are democratic organizations controlled by their members, who actively participate in setting policies and making decisions. The elected representatives are accountable to the membership. In primary cooperatives, members have equal voting rights (one member, one vote) and cooperatives at other levels are organized in a democratic manner.
3. Members' Economic Participation -- Members contribute equitably to, and democratically control, the capital of their cooperative. At least part of that capital is usually the common property of the cooperative. Members usually receive limited compensation, if any, on capital subscribed as a condition of membership. Members allocate surpluses for any or all of the following purposes: developing the cooperative, possibly by setting up reserves, part of which at least would be indivisible; benefiting members in proportion to their transactions with the cooperative; and supporting other activities approved by the membership.
4. Autonomy and Independence -- Cooperatives are autonomous, self-help organizations controlled by their members. If they enter into agreements with other organizations,

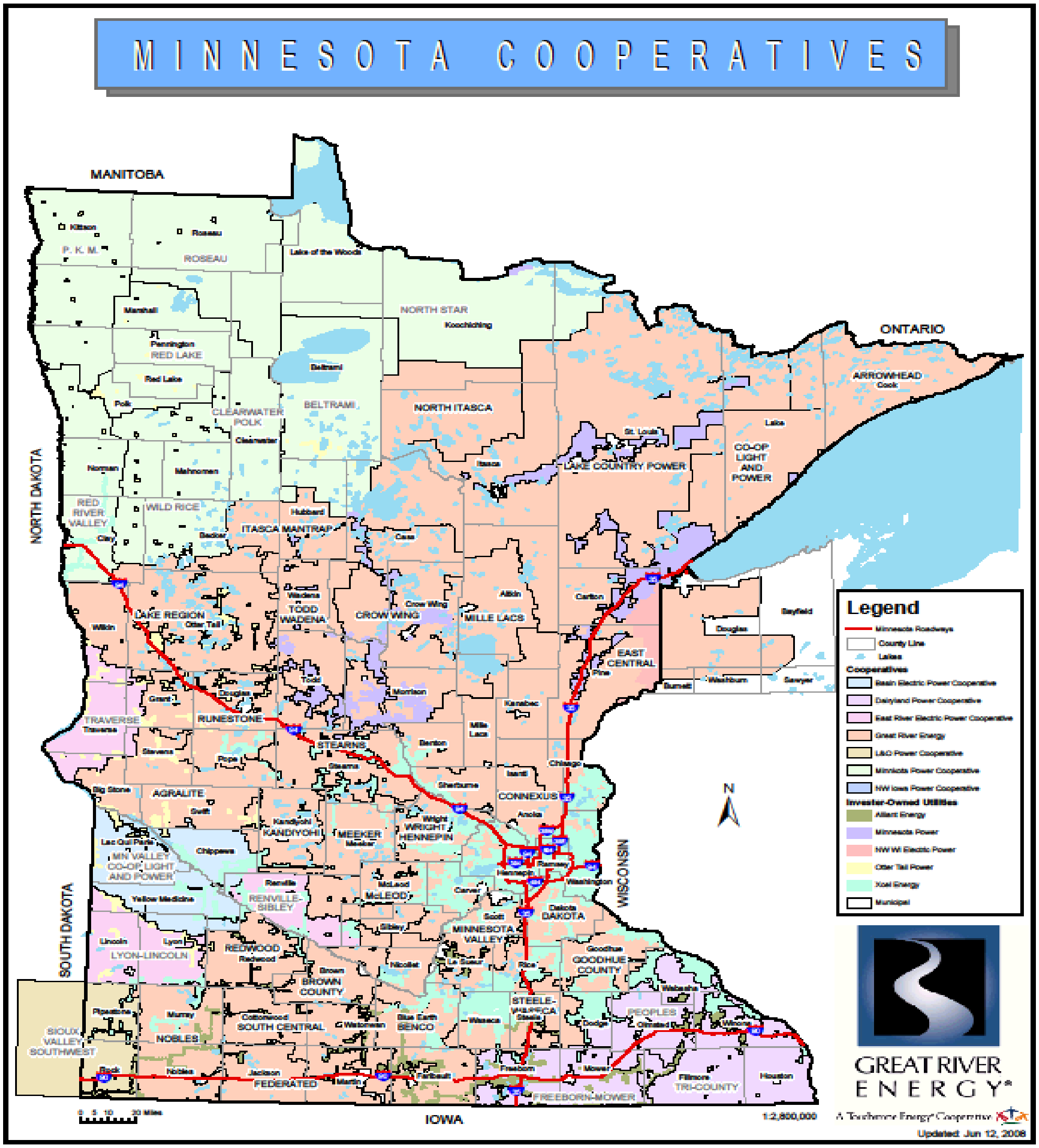
including governments, or raise capital from external sources, they do so on terms that ensure democratic control by their members and maintain their cooperative autonomy.

5. Education, Training, and Information -- Cooperatives provide education and training for their members, elected representatives, managers and employees so they can contribute effectively to the development of their cooperatives. They inform the general public, particularly young people and opinion leaders, about the nature and benefits of cooperation.
6. Cooperation Among Cooperatives -- Cooperatives serve their members most effectively and strengthen the cooperative movement by working together through local, national, regional and international structures.
7. Concern for Community – …focusing on member needs, cooperatives work for the sustainable development of their communities through policies accepted by their members.

Minnesota is served by six generation and transmission cooperatives, five investor owned utilities and a number of smaller municipal operations. Figure 7 depicts the service area of all generation and transmission companies in Minnesota. Generation and Transmission companies can serve all or a part of a distribution company. Minnesota is also served by forty-four distribution cooperatives (Figure 8). Nearly all distribution cooperatives serve more than one county and very few are the only service provider for a county. Together the distribution cooperatives employ approximately 2,400 people in Minnesota, serve approximately 760,000 customer meters (about 1.9 million people, 35% of the state's population) and cover 85% of the geographic area of Minnesota[iii].

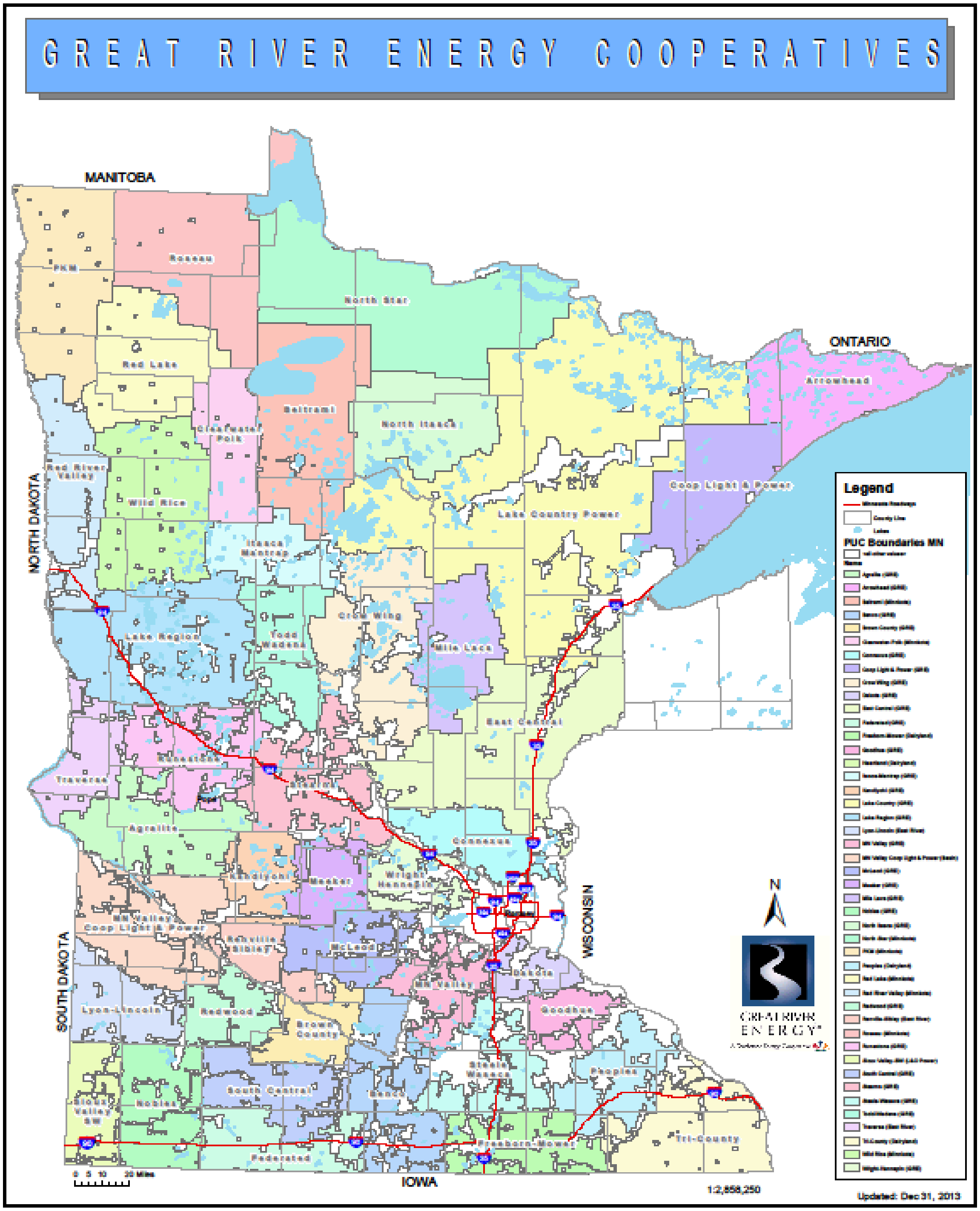
Total cooperative sales per kWh are approximately 18% (13.3 billion kWh) of the state total about $1 billion in revenues. The distribution cooperatives in Minnesota have the largest network in the state with more than 121,000 miles of electric distribution lines (Xcel has approximately 28,718 miles).[iv] Electric distributors in the state also have far fewer consumers per mile, 6 compared to 38 consumers for investor owned electric utilities and 48 per mile for municipal electric utilities[v]

Figure 7 Minnesota Generation and Transmission Cooperatives



Source: Great River Energy

Figure 8 Minnesota Distribution Cooperatives



Source: Great River Energy

Plan Participants

Twenty-five of the forty-four Minnesota Rural Electric Distribution Cooperatives participated in the Rural Electric Cooperative Annex to the Minnesota Hazard Mitigation Plan. Of the twenty-five distribution cooperatives that participated in the planning effort they serve all or a portion of 47 out of the 87 counties. The cooperatives that participated in the planning effort combine for a total of 83,101 miles of distribution lines that serve approximately 544,596 customers in Minnesota. Two generation and transmission cooperatives (Great River Energy and Minnetonka Power) also participated in the planning process and provide electricity to over half of the state.

The following table lists the participating cooperative, the counties in which they operate, the miles of distribution line and the number of customers per mile.

Table 1 Rural Electric Cooperative Participation and Service Area

Cooperative Name	Serving the Counties of	Miles of Distribution Line	Number of Customers	Customers Per Mile
Distribution Cooperatives				
Agralite Electric Cooperative	Big Stone, Stevens, Pope, Swift	2,405	5,089	2.12
Beltrami Electric Cooperative	Beltrami, Cass, Clearwater, Hubbard, Itasca, Koochiching	3,371	20,290	6.02
BENCO Electric Cooperative	Blue Earth, Nicollet, Faribault	3,210	14,192	4.42
Connexus Energy	Anoka, Chisago, Hennepin, Isanti, Ramsey, Sherburne, Washington	8,920	126,913	14.23
Dakota Electric Association	Dakota, Goodhue, Scott, Rice	4,011	101,995	25.43
East Central Energy	Kanabec, Pine, Isanti, Aitkin, Mille Lacs, Morrison,	8,231	52,770	6.41
Federated Rural Electric Association	Jackson, Martin	2,252	4,998	2.22
Freeborn-Mower Cooperative Services	Freeborn, Mower	1,990	5,968	3.00
Goodhue County Co-op Electric Assn.	Goodhue	1,288	4,922	3.82
Itasca-Mantrap Electric Cooperative	Hubbard, Becker, Cass, Clearwater, Wadena	2,050	11,391	5.56
Lake Country Power	Aitkin, Carlton, Cass, Itasca, Koochiching, Lake, Pine, and St. Louis	8,217	48,786	5.94
Lyon-Lincoln Electric Cooperative	Lyon, Lincoln	1,638	3,959	2.42
McLeod Co-op Power Assn.	McLeod, Renville, Sibley, Carver	1,889	6,607	3.50
Minnesota Valley Co-op L&P	Lac Qui Parle, Yellow Medicine, Lyon, Chippewa	3,020	5,245	1.74
Nobles Co-op Electric	Nobles	2,146	5,088	2.37

People's Cooperative Services	Olmsted, Dodge, Fillmore, Mower, Wabasha, Winona	2,565	14,545	5.67
Red River Valley Co-op Power Assn.	Norman, Polk, Clay	1,849	4,700	2.54
Redwood Electric Cooperative	Redwood, Brown, Murray, Lyon, Cottonwood	1,216	2,455	2.02
Renville-Sibley Cooperative Power Association	Renville, Sibley	1,140	1,920	1.68
Sioux Valley Energy	Rock, Pipestone	5,900	2,977	0.50
South Central Electric Association	Watonwan, Cottonwood, Martin, Jackson, Brown, Blue Earth	2,003	3,890	1.94
Stearns Co-op Electric Assn.	Stearns, Todd, Morrison, Kandiyohi, Pope, Douglas	4,009	24,850	6.20
Steele-Waseca CE	Steele, Waseca	2,022	9,582	4.74
Wild Rice Electric Cooperative	Becker, Clay, Mahnomen, Norman, Polk	3,923	13,828	3.52
Wright-Hennepin Co-op Electric Assn.	Hennepin, Wright	3,836	47,636	12.42
Generation and Transmission Cooperatives				
Great River Energy	28 cooperatives (Figure 7)	4,625		
Minnkota Power Coop.	11 cooperatives (Figure 7)	3,055		

Disaster Mitigation Act of 2000

The development of an electric cooperative annex to the State of Minnesota Hazard Mitigation is in response to the passage of the Disaster Mitigation Act of 2000 (DMA2K), which was signed into law by the U.S. Congress on October 30, 2000. The goal of the legislation includes reducing losses and future public and private expenditures, and improving response and recovery from disasters. Public Law 106-390 amended the Robert T. Stafford Relief and Emergency Assistance Act. The Act requires that local governments, tribal organizations, and states prepare an all-hazard mitigation plan in order to be eligible for funding from the FEMA Pre-Disaster Mitigation (PDM) Assistance Program, Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA) Grant Program. Sub-applicants, such as electric cooperatives, are only eligible for funding provided their projects are included in a local or state all-hazards mitigation plan approved by the Federal Emergency Management Agency. The Act requires that natural hazards, such as flooding or severe weather, be addressed in the risk assessment and vulnerability analysis sections of the all-hazard mitigation plan.

Importance of Developing an Annex for Rural Electric Cooperatives

From 1999-2011 FEMA provided approximately $31 million dollars to private non-profits in Minnesota for disaster recovery efforts. Of the $31 million dollars, approximately $24 million was provided to electric cooperatives (15 cooperatives) to repair utility lines, clean-up debris or for protective measures. Rural electric cooperatives span the entire state and based on historical public assistance damage data cooperatives statewide are vulnerable to storms. In fact, some

Presidentially Declared Disasters probably would not have occurred had rural electric cooperatives and municipal cooperatives not been damaged (DR-4113, DR-4009, DR-1921, DR-1283) – damage would have occurred during the storm however, the State might not have met its threshold for a disaster declaration without the cooperatives. All four disaster events occurred within the past 15 years, with three of the four occurring in the past three years. Rural electric cooperatives are vulnerable and could very well be becoming more vulnerable without mitigating against future damages.

Public/Private Costs of Electrical Power Outages

Power outages caused by winter storms, high winds, and tornadoes can have significant economic impacts. These events may force the closure of businesses, schools and government offices. Homeowners may see food spoiled, move to a temporary shelter, experience flooding inside of their homes, or have their pipes burst all due to the lack of power.

Large-scale power outages due to extreme weather may require state and local governments to open shelter facilities and to care for people displaced from their homes. Events that reach the level of a Presidentially Declared Disaster, FEMA may allow local governments to recover some costs but in smaller events all the cost will be borne by the local government.

Power outages caused by weather may make vulnerable populations more vulnerable. People recovering from illnesses, the elderly, children, and low-income populations may be more vulnerable to the impacts of power outages than others. Frequently, the first calls to emergency responders come from hospitals, nursing homes, and other care facilities that have suddenly lost power.

Public agencies are frequently responsible for debris removal and clean-up in the event of a storm or tornado. Police and fire personnel may be responsible for public safety in the event that power lines come down and are determined to be dangerous to nearby residents.

Plan Development

Minnesota Division of Homeland Security and Emergency Management initiated the planning process in partnership with the rural electric cooperatives across the state. The annex is needed so that rural electric cooperatives are covered under the State All-Hazard Mitigation Plan and are eligible for FEMA's Hazard Mitigation Assistance (HMA) Program.

Hazard mitigation activities will be pursued by rural electric cooperatives so future natural disasters will have less of an impact of electric cooperatives and residents of the State of Minnesota.

In the most recent two Presidential Disaster Declarations, rural electric cooperatives were affected and part of the public assistance program. This has lead HSEM staff to pursue and develop, with guidance from FEMA, an Annex to the State Plan that provides a concerted effort to help electric cooperatives become less vulnerable to natural hazards.

The need for electric cooperatives to be covered under the state plan is apparent when viewing Appendix C. Table C-1 in the State Hazard Mitigation Plan where 25% of Minnesota Counties (22 counties) do not have an approved and adopted hazard mitigation plan making electric cooperatives ineligible for hazard mitigation assistance under their plan. Through the development of this Annex even if a county hazard mitigation plan is expired rural electric cooperatives will still be eligible for FEMA funding under the state plan.

Benefits of Hazard Mitigation Planning

A cooperative hazard mitigation approach that includes Minnesota HSEM and electric cooperatives will result in consensus on action plans to reduce or eliminate long-term risks to human life and property from natural hazards.

This plan is intended to:

- Increase awareness of risks and utility infrastructure vulnerabilities to natural hazards
- Establish hazard mitigation goals
- Identify strategies to help implement mitigation measures
- Establish priorities for the use of cooperative and public resources to mitigate hazards
- Enable cooperative, as sub-applicants, to seek hazard mitigation funding from the Federal Emergency Management Agency
- Improve recovery efforts related to natural disasters
- Minimize public safety concerns and power supply disruptions to persons served by electric cooperatives.

Hazard mitigation funding has been provided to a number of rural electric cooperatives in the past. From 1996 to 2012 an estimated eighty-four (84) mitigation projects have been approved and/or closed at FEMA. The projects range in scope from rebuilding lines with heavier poles and shorter spans, converting overhead to underground lines, replacing guy wire grips, to converting from copper wire to T-2 lines. Sixty-two (62) of the eighty-four (84) projects involved converting overhead lines to underground lines. The total cost of the projects in this time period was approximately $26 million dollars.

HSEM intends to share the State All-Hazards Mitigation Plan as well as this specific Rural Electric Cooperative Annex with County Emergency Managers and Rural Electric Cooperatives. The importance of sharing and discussing the State Plan and this Annex are paramount to the success of creating a more resilient Minnesota.

Planning Overview

HSEM initiated the hazard mitigation planning process for rural electric cooperatives by contacting the Minnesota Rural Electric Association as the primary point of contact, conducting outreach to Minnesota Rural Electric Cooperative members at their annual Chief Executive Officer (CEO) meeting as well as the annual engineering conference and line superintendent's meeting. HSEM also sought cooperative feedback through meetings, an online survey, and the review of a draft plan.

Table 2 Rural Electric Cooperative Planning Meetings

Date	Discussion Topics	Meeting Attendees
8/13/13	Preliminary discussion on developing partnership to establish Rural Electric Annex	Minnesota Rural Electric Association, FEMA R-V, FEMA

	to State Mitigation Plan	JFO, and HSEM
9/5/13	Presentation at REMA CEO Conference	Rural Electric Cooperative CEOs, HSEM
9/19/13	Presentation at REMA Engineering Conference	Rural Electric Cooperative CEOs, HSEM
11/5/13	Benefit Cost Analysis Course specific to rural electric cooperatives	Rural electric cooperatives, FEMA, HSEM
12/4/13	Plan development and input	Rural electric cooperatives, FEMA, HSEM
10/10/13-12/31/13	Online survey	Sent to rural electric cooperatives from MN Rural Electric Association
1/5/14	Presentation at REMA Line Superintendent's Annual Meeting	Rural Electric Cooperative Superintendents and HSEM
2/28/14 – 3/14/14	Minnesota Rural Electric Association & Electric Cooperative Review of Rural Electric Cooperative Annex	MREA distributed web-link of the plan to cooperatives across the state. MN HSEM posted to website

The December 4th meeting was a productive meeting which provided rural electric cooperative members an overview of the planning process and ways in which they can continue to participate. Members of the meeting were asked to provide a list of potential mitigation projects that they were considering and would like to include in the Annex.

Counties in Minnesota are quite often served by more than one electricity provider, cooperative or investor owned. In Minnesota every county is served by at least one electric cooperative (Figure 8). During the planning process 47 counties were represented by electric cooperatives that serve them, not all areas in the county were represented however, a vast majority of the service area participated in the planning process.

Table 3 County Representation through Rural Electrical Cooperatives

Counties Represented through Rural Electric Cooperative Annex			
Anoka	Dakota	Lincoln	Redwood
Beltrami	Faribault	Lyon	Rice
Big Stone	Fillmore	Martin	Scott
Blue Earth	Freeborn	Mower	Stevens
Brown	Goodhue	Murray	Swift
Cass	Hennepin	Nicollet	Waseca
Chippewa	Hubbard	Nobles	Winona

Chisago	Isanti	Norman	Wabasha
Clay	Itasca	Olmstead	Washington
Clearwater	Jackson	Polk	Wright
Cottonwood	Koochiching	Pope	Yellow Medicine
Dodge	Lac Qui Parle	Ramsey	

Hazard Profiles

During the planning process, HSEM discussed hazard threats with cooperatives through meetings, an online survey and informal discussions. HSEM identified 15 potential natural hazards that might affect the cooperatives based on the State Hazard Mitigation Plan (flooding, dam/levee failure, wildfire, windstorm, tornado, hail, erosion, winter storms, landslide/mudslide, land subsidence, earthquake, drought, extreme heat, and extreme cold). Of these natural hazards four (flooding, windstorms, tornado, and winter storm) were the greatest concerns for electric cooperatives and have affected/damaged them the most. Because of this, only these hazards will be profiled in the Annex, all other hazards are profiled in the State All-Hazard Mitigation Plan.

Flooding

Flooding is the accumulation of water within a water body (e.g., stream, river, lake, or reservoir) and the overflow of excess water onto adjacent floodplains. Floodplains are lowlands, adjacent to water bodies that are subject to recurring floods. Floods are natural events that are considered hazards only when people and property are affected. Nationwide, hundreds of floods occur each year, making it one of the most common hazards in all 50 states and U.S. territories (FEMA, 1997).

Flooding History in Minnesota

Flooding was identified by cooperative survey participants as having affected/damaged critical electrical infrastructure for 59% of survey respondents. Flooding has the potential to damage buildings and utility infrastructure. Disaster events that involved flooding and high winds have the potential to significantly limit cooperatives from recovery efforts.

Two recent flooding and wind events (DR 1717 & 4009) affected cooperative buildings and utility infrastructure, making recovery efforts much more difficult. DR 1717 damaged 4.9 million dollars' worth of buildings for two cooperatives in the state but only affected the utility infrastructure of the cooperatives by approximately $195,000. DR 4009 saw the reverse effect on the buildings and utility infrastructure damaging buildings much less (approx. $367,000) than utility infrastructure (7.6 million).

The following table depicts the most recent flooding events in Minnesota. Three of the past four flooding disasters have resulted in damage to cooperatives resulting in participation in the disaster and recovery efforts through the Public Assistance program.

Table 4 Major Minnesota Floods Affecting Cooperatives (2011-2013)

Year	Disaster Number	Areas Affected	Cooperatives Affected
2013	DR 4131	Benton, Big Stone, Douglas, Faribault, Fillmore, Freeborn, Grant, Hennepin, Houston, McLeod,	Yes

		Morrison, Pope, Sibley, Stearns, Stevens, Swift, Traverse, and Wilkin.	
2012	DR 4069	Aitkin, Carlton, Cook, Crow Wing, Dakota, Goodhue, Kandiyohi, Lake, Meeker, Pine, Rice, Sibley, St. Louis, and the Fond du Lac Band of Lake Superior Chippewa, Grand Portage Band of Lake Superior Chippewa, and the Mille Lacs Band of Ojibwe.	Yes
2011	DR 4009	Chisago, Isanti, Kandiyohi, Lincoln, Lyon, McLeod, Meeker, Mille Lacs, Pine, Pipestone, Redwood, Renville, Stearns, and Yellow Medicine Counties and the Mille Lacs Band of Ojibwe.	Yes
2011	DR 1982	Big Stone, Blue Earth, Brown, Carver, Chippewa, Clay, Grant, Lac qui Parle, Le Sueur, Lyon, McLeod, Nicollet, Redwood, Renville, Scott, Sibley, Stevens, Traverse, Wilkin, and Yellow Medicine.	No

Probability of Occurrence to Flooding

Flood probability and magnitude are highly location-specific, so it is not possible to characterize these generally across the State in a meaningful way. Statewide, floods are rated High for probability in the qualitative ranking. The State-Wide Flood Assessment (2011) provides information for each county (and city) based on best available data.

Vulnerability of Electric Cooperatives to Floods

Of the electric cooperatives that participated in the mitigation survey 59% indicated that flooding has adversely affected/damaged critical infrastructure in their service area. Over the past four years cooperatives have been damaged in three of the four Presidentially Declared Disasters that had a flooding component. 44% of cooperatives surveyed indicated that the potential impact of flooding to critical electrical infrastructure was low; 39% indicated a medium impact and only 17% indicated a high impact to critical infrastructure. This does not necessarily indicate that cooperatives across the state are highly vulnerable to flooding however; it does indicate a strong correlation between flooding and damage to electric cooperatives.

Even though Presidentially Declared Disasters and responses to our survey indicate that flooding has affected cooperatives it is difficult to determine the vulnerability of each cooperative with respect to electrical infrastructure and flooding. Even though an area's roads and buildings might be susceptible to flooding, electrical utility infrastructure sometimes does not get damaged. Overhead electrical lines are protected from flood waters however, vulnerable to debris floating in the flood waters. The debris might damage the infrastructure immediately or decrease the life of the pole, which might not be recognized until another event – possibly high wind knocks down the pole later. Underground electrical lines are highly resistant to flooding however, flood debris can damage transformers knocking out power.

The removal of infrastructure from the 100 and 500 year flood plain is a highly desirable mitigation effort thus removing vulnerable structures from floating debris and damaging waters. A state-wide analysis to determine the number of structures in the flood plain would be nearly impossible; however, the identification of key infrastructure (substation, buildings, transformers etc.) is possible, but likely unrealistic due to the vast scope of facilities across the state and limited staff. A more likely approach would be educational outreach to electric cooperatives with the intent of any future development of critical infrastructure to be placed outside of 100 and 500 year flood zones.

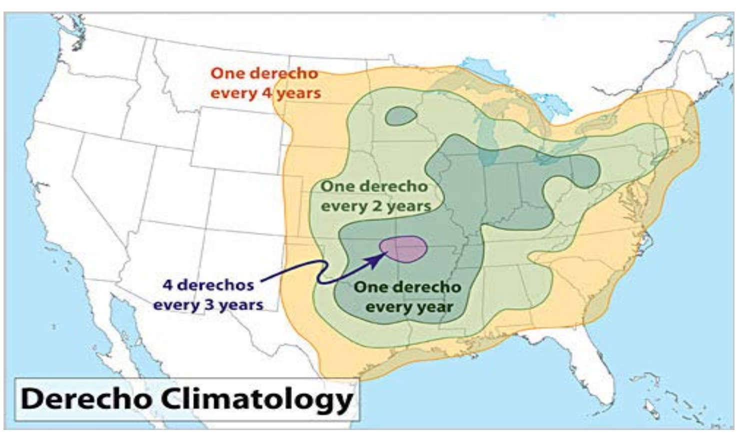
Windstorms

FEMA defines winds in excess of 58 miles per hour, excluding tornadoes, as windstorms. Straight-line winds and windstorms are used interchangeably in the Plan. This hazard is treated as a different category than Tornadoes (which may also include high winds). Windstorms are among the nation's most severe natural hazards in terms of both lives lost and property damaged.

Severe winds can damage and destroy roofs, toss manufactured homes off their pier foundations, and tear light-framed homes apart. There are several different types of windstorms. A "downburst" is defined as a strong downdraft with an onrush of damaging winds on or near the earth's surface. When people experience property damage from a downburst, they often do not believe that "just wind" could have caused the damage, and they assume that they were hit by a tornado. Downbursts may have wind gusts up to 130 mph and are capable of the same damage as a medium-sized tornado. A "gust front" is the leading edge of the thunderstorm downdraft air. It is most prominent near the rain-free cloud base and on the leading edge of an approaching thunderstorm and is usually marked by gusty, cool winds and sometimes by blowing dust. The gust front often precedes the thunderstorm precipitation by several minutes. Straight-line winds, when associated with a thunderstorm, are most frequently found with the gust front. These winds originate as downdraft air reaches the ground and rapidly spreads out, becoming strong horizontal flow.

A long-term wind storm that exceeds 58 mph and extends for more than 240 miles is a windstorm that can be classified as a derecho storm. Because derecho storms are long lived and travel great distances, Minnesota rural electric cooperatives are highly vulnerable. Derechos are most common in the late spring until late summer. Severe wind event research of this kind is relatively new. However, research from the NOAA from the 1980's to 2001 showed that Minnesota is subject to derecho events at different levels across the state, with the most indicating one derecho event every year.

Figure 9 Derecho Occurrences Factor Based on Data from 1980-2001



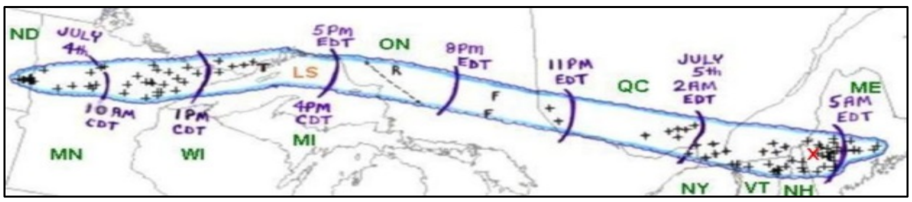
Source: http://www.spc.noaa.gov

Windstorm History in Minnesota

According to the National Climatic Data Center, there have been 8,961 high wind events between 1/1/1955 to 8/31/2013. This number may be misleading because the same storm data may have been reported at multiple locations. However, due to these events there were 10 deaths and approximately $881 million dollars in property damage.

The Boundary Waters-Canadian Derecho on July 4-5th of 1999 is an example of how derecho systems are large (traveling from North Dakota to Maine - 1,300 miles) and can have damaging effects to states and regions. This system produced wind estimates from 80-100 mph and damaged at least 7 counties in northeastern Minnesota causing destruction to buildings and blowing down tens of millions of trees.

Figure 10 Boundary Waters-Canadian Derecho Path (1999)



Source: http://www.spc.noaa.gov

Table 5 Major Minnesota Wind Storm Event Affecting Cooperatives (2011-2013)

Year	Disaster Number	Areas Affected	Cooperatives Affected
2013	DR 4131	Benton, Big Stone, Douglas, Faribault, Fillmore, Freeborn, Grant, Hennepin, Houston, McLeod, Morrison, Pope, Sibley, Stearns, Stevens, Swift, Traverse, and Wilkin.	Yes
2013	DR 4113	Jackson, Murray, Nobles, Pipestone, Rock	Yes
2012	DR 4069	Aitkin, Carlton, Cook, Crow Wing, Dakota, Goodhue, Kandiyohi, Lake, Meeker, Pine, Rice, Sibley, St. Louis, and the Fond du Lac Band of Lake Superior Chippewa, Grand Portage Band of Lake Superior Chippewa, and the Mille Lacs Band of Ojibwe.	Yes
2011	DR 4009	Chisago, Isanti, Kandiyohi, Lincoln, Lyon, McLeod, Meeker, Mille Lacs, Pine, Pipestone, Redwood, Renville, Stearns, and Yellow Medicine Counties and the Mille Lacs Band of Ojibwe.	Yes
2011	DR 1990	Anoka and Hennepin	No
2011	DR 1982	Big Stone, Blue Earth, Brown, Carver, Chippewa, Clay, Grant, Lac qui Parle, Le Sueur, Lyon, McLeod, Nicollet, Redwood, Renville, Scott, Sibley, Stevens, Traverse, Wilkin, and Yellow Medicine.	No

Probability of Occurrence Windstorms

Windstorms can occur throughout the State of Minnesota, at any time of the year. Most occur during the months of April through September. This recurrence is expected to remain relatively stable, although there will be year-to-year fluctuations. Long-term changes in weather patterns may also influence the number of windstorms that occur.

Vulnerability of Electric Cooperatives to windstorms

Windstorms can be widespread and highly damaging or result in limited site specific problems for electric cooperatives. Of the cooperatives that participated in the mitigation survey all respondents indicated that they have had electrical infrastructure adversely affected/damaged by windstorms. 83% of respondents also indicated that windstorms have a high potential to impact to electrical infrastructure, the second only to winter storms (89%). Since 2011, electric cooperatives have been damaged in four of the past six wind-related Presidentially Declared Disasters.

The most vulnerable electrical structures to wind events are overhead utility lines and the poles. Of the 46 distribution cooperatives in the state, only 5 cooperatives have more miles of underground lines than overhead lines[vi], making them only slightly less vulnerable. State-wide there is an estimate 127,669 miles of distribution lines, of which only 35% (45,372) are underground and less vulnerable to windstorms. The resulting 64.5% (82,297) of the overhead distribution lines owned and maintained by the cooperatives are vulnerable to damage from windstorms.

In order to create a less vulnerable system to windstorms, more overhead lines would need to be converted to underground or strengthened to withstand high wind events. However, to implement such a mitigation effort both FEMA and fiscally responsible cooperatives would need to support construction efforts that are cost beneficial. In most rural parts of the State, the number of customers per mile does not support a cost beneficial mitigation strategy. Cooperatives in very rural parts of the state have a per mile customer rate of less than 1. The statewide average for the 46 cooperatives is 4.94 customers per mile.

Tornados

Tornadoes are defined as violently-rotating columns of air extending from thunderstorms to the ground, with wind speeds between 40-300 mph. They develop under three scenarios: (1) along a squall line; (2) in connection with thunderstorm squall lines during hot, humid weather; and (3) in the outer portion of a tropical cyclone. Funnel clouds are rotating columns of air not in contact with the ground; however, the column of air can reach the ground very quickly and become a tornado.

Since 2007, tornado strength in the United States is ranked based on the Enhanced Fujita scale (EF scale), replacing the Fujita scale introduced in 1971. The EF scale uses similar principles to the Fujita scale, with six categories from 0-5, based on wind estimates and damage caused by the tornado. The EF Scale is used extensively by the NWS in investigating tornadoes (all tornadoes are now assigned an EF Scale number), and by engineers in correlating damage to buildings and techniques with different wind speeds caused by tornadoes. The table below outlines the Fujita Scale, the derived EF Scale and the operational EF Scale. Though the Enhanced Fujita scale itself ranges up to EF28 for the damage indicators, the strongest tornadoes max out in the EF5 range (262 to 317 mph).

Table 6 Fujita Scale, Derived EF Scale, and Operational EF Scale

Fujita Scale			Derived EF Scale		Operational EF Scale	
F Scale	Fastest ¼-mile (mph)	3-second Gust (mph)	EF Scale	3-second Gust (mph)	EF Scale	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	>200

http://www.spc.noaa.gov/faq/tornado/ef-scale.html

Tornado History in Minnesota

In Minnesota, tornadoes have occurred in every month from March through November. The earliest spring verified tornado in Minnesota occurred on March 18, 1968, north of Truman, and the latest fall tornado was on November 16, 1931, east of Maple Plain.

Despite a higher number of tornadoes reported in recent years, the number of fatalities and injuries due to tornadoes has been decreasing. This is thanks in part to better National Weather Service tools in detecting tornadoes, namely the NEXRAD Doppler radar network installed in the mid-1990s. Also, the ability of alerting the public has improved with more National Weather Service radio transmitters and a close relationship with media outlets. An energetic spotter network has also been a key to alerting the public in Minnesota. The increasing number of tornadoes reported may be a direct result of improved communication networks, public awareness, warning systems and training.

Table 7 Major Minnesota Tornado Events Affecting Cooperatives (2010-2013)

Year	Disaster Number	Areas Affected	Cooperatives Affected
2011	DR 4009	Chisago, Isanti, Kandiyohi, Lincoln, Lyon, McLeod, Meeker, Mille Lacs, Pine, Pipestone, Redwood, Renville, Stearns, and Yellow Medicine Counties and the Mille Lacs Band of Ojibwe.	Yes
2011	DR 1990	Anoka and Hennepin	No
2010	DR 1921	Faribault, Freeborn, Olmsted, Otter Tail, Polk, Steele, and Wadena	Yes

Probability of Occurrence to Tornados

According to the NCDC, Minnesota experienced an average of 27 tornadoes per year between 1950 and 2012. These hazardous events caused 99 deaths, 1,976 injuries and nearly $1.5 billion dollars in property damage. This equates to a yearly average of 1.6 deaths, 32 injuries, and nearly $23 million in property damage per annum. From the 62-year state total of 1,655 tornadoes, 27 were ranked at F4 or F5.

Although tornadoes can occur at any time of year, in Minnesota the peak months of occurrence are June, May, and July (in that order). The typical time of day for tornadoes in Minnesota ranges between 4:00 P.M. and 7:00 P.M. Most of these are minor tornadoes, with wind speeds under 125 M.P.H. A typical Minnesota tornado lasts approximately ten minutes, has a path length of five to six miles, is nearly as wide as a football field, has a forward speed of about thirty-five miles an hour, and affects less than one-tenth of 1 percent of the county warned.

Most of the deadly and damaging tornadoes occur in groups of outbreaks that often last from 6 to 12 hours. One of the worst outbreaks in Minnesota occurred on June 28, 1979, when 16 tornadoes slashed across the state, from northwest to southeast, in a 6½-hour period. Two additional tornadoes occurred in eastern North Dakota with this system. Many such outbreaks have occurred, including the April 30, 1967 cluster in south central and southeast Minnesota.

2010 was a historic year for tornadoes in Minnesota, with 126 recorded by the NCDC. There were three deaths and 46 injuries (all were on June 17 except one injury on August 13). This year beat previous records of 74 tornadoes in 2001 and 27 in one day on June 16, 1992 (June 17, 2010 had 60 on one day). 2011 witnessed 44 tornadoes in the state, while 2012 saw 38.

Vulnerability of Electric Cooperatives to Tornadoes

Electric cooperatives are highly vulnerable to tornados due to the vast expansive network, weak infrastructure - relative to tornados, and the fact that the majority of electrical distribution lines are not underground and protected from high winds.

Nearly all (94%) of cooperative surveyed indicated that they have been affected/damaged by a tornado in the past. 72% survey respondents indicated that tornados have a potential high impact to critical electric infrastructure. Mitigation efforts to limit the vulnerability of electrical infrastructure to tornados are limited to strengthening infrastructure and burying of overhead lines. As noted in the windstorm vulnerability section the majority of distribution lines are currently overhead and highly vulnerable to tornadoes. The vulnerability of underground lines to tornadoes exists as well. The electrical cabinets that support the underground system are almost always above ground. These cabinets can be damaged by debris that tornadoes cause even in the small events.

Winter storms

Winter storms vary in size and strength and include heavy snowstorms, blizzards, freezing rain, sleet, ice storms and blowing and drifting snow conditions. Extremely cold temperatures accompanied by strong winds can result in wind chills that cause bodily injury such as frostbite and death.

Winter storm occurrences tend to be very disruptive to transportation and commerce. Trees, cars, roads, and other surfaces develop a coating or glaze of ice, making even small accumulations of ice extremely hazardous to motorists, bicyclists, and pedestrians. The most prevalent impacts of heavy accumulations of ice are slippery roads and walkways that lead to vehicle and pedestrian accidents; collapsed roofs from fallen trees and limbs and heavy ice and snow loads; and felled trees, telephone poles and lines, electrical wires, and communication towers. As a result of severe ice storms, telecommunications and power can be disrupted for days. Heavy snow or accumulated ice can also isolate people from assistance or services.

The NWS issues a Wind Chill Advisory for Minnesota when widespread wind chills of -40°F or lower with winds of at least 10 miles per hour (mph) expected. In some parts of southern Minnesota, the threshold may be -35°F. A Wind Chill Warning is issued when widespread wind chills of -40°F in northern Minnesota and -35°F in southern with winds greater than 10 mph are expected.

Winter Storm History in Minnesota

The topography, land-use characteristics and winter climate of western and southern Minnesota cause this area to be particularly vulnerable to blowing and drifting snow. The number of days with potential problems ranges from 115 in the south to 155 in the north. For an average winter season, taxpayers in Minnesota spend approximately $100 million in snow removal costs, with MnDOT expending $41 million. In the event of a winter season with anomalously high snowfall and exceedingly strong winds, as was the case for much of the state during the winter of 1996-97, the cost of snow removal can soar to $215 million.

Probability of Occurrence to Winter Storms

Minnesota experiences a variety of severe winter weather events annually. Although it is impossible to predict probabilities for this type of event over short periods of time, the State can probably expect one ice and ice/snow storm on average and one major blizzard per year.

Vulnerability of Electric Cooperatives to Winter Storms

Electric cooperatives are highly vulnerable to winter storms due to their expansive network across the state and the frequency of winter storms. 88% of electrical cooperative respondents indicated that their electrical infrastructure had been affected/damaged by winter storms. When asked what type of impact a winter storm has to potentially damage their infrastructure, 89% responded that that winter storms posed a high potential, the most out of all natural hazards. As noted in the windstorm and tornado vulnerability sections the majority of distribution lines are currently overhead and highly vulnerable to winter storms.

Winter storms pose additional challenges that put crews and equipment in danger. Very often with winter storms come decreased suitable winter driving conditions putting crews on icy or wind drifted snow roads. And in the case of ice storms and extreme cold winter temps - crews are subject to harsh conditions when repairing utility lines.

Climate Change – Impacts of Severe Weather on Minnesota's Electric Cooperative Network

The State All-Hazard Mitigation Plan includes a description of natural hazards and the effects of climate change on those hazards which are consistent with this Annex. However, the impacts of increased severe weather patterns on the electrical distribution network are already being felt by electrical consumers across Minnesota.

As noted in the "Economic Benefits of Increasing Electric Grid Resilience to Weather Outages" published by the Executive Office of the President[vii] - Severe weather is the single leading cause of power outages in the United States. Outages caused by severe weather such as thunderstorms, hurricanes and blizzards account for 58 percent of outages observed since 2002 and 87 percent of outages affecting 50,000 or more customers (U.S. DOE, Form OE-417). Furthermore, according to the National Climate Assessment, the incidence and severity of extreme weather will continue to increase due to climate change. This increase in severe weather may have a profound impact on rural electric cooperatives across the State.

Mitigation Goals and Strategies

The development of an Annex to the Minnesota Hazard Mitigation Plan specific for rural electric cooperatives is to create a vision for preventing future disasters, establish a common set of mitigation goals across state, prioritize actions, and evaluate the success of such actions.

In addition to meeting the State's mitigation goals of (1) enhancing the State's capacity to make Minnesota more resilient to the effects of all hazards and (2) building and supporting local capacity and commitment to increase resiliency to all hazards. The state will continue to work with cooperatives to:

- Increase awareness of risks and utility infrastructure vulnerabilities to natural hazards
- Establish hazard mitigation goals

- Identify strategies to help implement mitigation measures
- Establish priorities for the use of cooperative and public resources to mitigate hazards
- Enable cooperatives, as sub-applicants, to seek hazard mitigation funding from the Federal Emergency Management Agency
- Improve recovery efforts related to natural disasters
- Minimize public safety concerns and power supply disruptions to persons served by electric cooperatives.

Mitigation Strategies

Electric cooperatives provided input into the development of site specific mitigation strategies and are included in the mitigation strategy table. In addition to these site specific strategies, through conversations with cooperatives, meetings and research of best practices, HSEM developed a list of mitigation strategies that could be applied to all electrical cooperatives through the support of this plan. The table identifies the anticipated hazard of concern, a mitigation measure/solution, an estimated cost, priority ranking, a projected timetable and a cooperative responsible for the strategy.

Table 8 Mitigation Strategies

Hazards of Concern	Mitigation Measures	Estimated Cost	Project Location	Responsible Party	Priority Ranking (H, M, L)	Projected Timetable
High winds, ice storms, blizzard, and tornadoes	Convert overhead lines to underground lines in areas that have been subject to repetitive damage.	$10,000 to $10 million	State-wide	Cooperatives responsible for distribution lines being converted	H	Ongoing
Flooding	Remove (acquisition of property) critical infrastructure from 100 and 500 year flood zones	$10,000 to $10 million	State-wide	Cooperatives responsible for critical infrastructure	H	Ongoing
Flooding	Remove (relocation) critical infrastructure from 100 and 500 year flood zones	$10,000 to $10 million	State-wide	Cooperatives responsible for critical infrastructure	L	Ongoing
Flooding	Dry flood-proofing of non-residential critical facilities that are subject to flood damage or within the 100, 500 year flood zones	$10,000 to $10 million	State-wide	Cooperatives responsible for critical infrastructure	H	Ongoing
Flooding	Elevate critical facilities to remove from flood hazard areas	$10,000 to $10 million	State-wide	Cooperatives responsible for critical infrastructure	M	Ongoing

Flooding	Protect critical facilities through minor localized flood reduction projects	$10,000 to $10 million	State-wide	Cooperatives responsible for critical infrastructure	M	Ongoing
High winds and tornadoes	Construct new safe rooms or retrofit existing structures in critical facilities protecting employees and critical infrastructure from damaging winds and tornadoes	$10,000 to $10 million	State-wide	Cooperatives responsible for critical infrastructure	H	Ongoing
High winds and tornadoes	Construct community new safe rooms or retrofit existing structures in critical facilities protecting employees, neighboring residents, and critical infrastructure from damaging winds and tornadoes	$10,000 to $10 million	State-wide	Cooperatives responsible for critical infrastructure	H	Ongoing
Erosion	Protect critical infrastructure by installing soil stabilization systems in areas prone to erosion	$10,000 to $10 million	State-wide	Cooperatives responsible for critical infrastructure	H	Ongoing
High winds, tornadoes, flooding, erosion, wildfire, winter storms, ice storms	Implement unproven mitigation techniques, technologies, methods, procedures or products that will aid electric cooperatives in becoming more disaster resilient	$10,000 to $10 million	State-wide	Cooperatives responsible for critical infrastructure	M	Ongoing
High winds, tornadoes, flooding, erosion, wildfire, winter storms, ice storms	Implement hazard identification or mapping and related equipment for the implementation of mitigation activities	$10,000 to $10 million	State-wide	Cooperatives responsible for critical infrastructure	H	Ongoing
High winds, tornadoes, flooding, erosion, wildfire, winter storms, ice storms	Implement GIS software, hardware, and data acquisition whose primary aim is mitigation	$10,000 to $10 million	State-wide	Cooperatives responsible for critical infrastructure	H	Ongoing

Wildfire	Protect critical facilities through the use of defensible space, structural protection through ignition-resistant construction activities, and hazardous fuels reduction activities.	$10,000 to $10 million	State-wide	Cooperatives responsible for critical infrastructure	H	Ongoing
High winds, ice storms, blizzard, and tornadoes	Anoka Substation Circuits 3 & 4 Project -- Convert 1.2 miles of double circuit overhead distribution to one circuit overhead and one circuit underground. Line has history of wind-related outages. It presently shares structures with its alternate feed (double-circuit). Project would enhance system reliability by providing redundancy. Circuits serve 1,890 consumers.	$460,000	Anoka	Connexus Energy	H	2015
High winds, ice storms, blizzard, and tornadoes	Coopers Corner Substation Circuit 6 Project -- Convert approximately 0.7 miles of single phase overhead line located in back lot lines in a heavily wooded area with difficult access to underground and relocating the facilities along the roadway. This line has experienced multiple outages and very long restoration times in recent years.	$40,000	Anoka	Connexus Energy	H	2014
High winds, ice storms, blizzard, and tornadoes	Anoka Substation Circuits 5 & 6 Project -- Convert 0.7 miles of double circuit overhead distribution to one circuit overhead and one circuit underground. Line presently shares structures with its alternate feed (double-circuit). Project would enhance system reliability by providing redundancy. Circuits serve 1,025 consumers.	$250,000	Anoka	Connexus Energy	M	2015
High winds, ice storms, blizzard, and tornadoes	Forest Lake Circuit 4 Project -- Establish a metered tie point with Xcel Energy. This overhead feeder is a nine mile long radial with about three miles in private property with limited access and a freeway crossing. Having a tie point will provide an alternate feed to most of the loads served by this line in the event of a system disturbance.	$200,000	Forest Lake	Connexus Energy	M	2015
High winds, ice storms, blizzard, and tornadoes	May Circuit 1 Project --Establish a metered tie point with Xcel Energy. This overhead feeder is a five mile long radial. Having a tie point will provide an alternate feed to most of the loads served by this line in the event of a system disturbance.	$200,000		Connexus Energy	M	2015

High winds, ice storms, blizzard, and tornadoes	Circle Pines Substation Circuits 4 & 5 Project -- Convert 0.5 miles of double circuit overhead distribution line to one underground and one overhead feeder. Line has history of weather-related outages, is challenging to restore due to its double-circuit construction, and is under-capacity. Project would enhance system reliability. Circuits serve 1,150 consumers.	$192,000	Circle Pines	Connexus Energy	M	2015
High winds, ice storms, blizzard, and tornadoes	Bowers Drive Project -- Convert 0.75 miles overhead radial line to a looped underground tap. The area around this line is heavily wooded. This line has experienced several outages as a result of high winds. Due to the nature of the route, access is difficult during these conditions and restoration time is well above average.	$125,000	Anoka	Connexus Energy	M	2015
High Winds	Convert 7.5 miles of three-phase overhead distribution line to three-phase underground line. This line was hit hard in a July 2012 wind storm and this is a critical feeder line for businesses and organizations in the Cass Lake area.	$1,360,000	Hubbard County and Cass County	Beltrami Electric Cooperative, Inc.	H	2015
High winds, ice storms, tornados	Project AL-A/B upgrade of 3-phase main feeder of Alden Substation Circuit 1 with 3-phase 4/0 aluminum underground. Parts of line are 65+ years old. Line is part of the backbone of the system and will improve system performance during normal maintenance and emergency situations. Circuit is a backup to Bancroft and Freeborn Substations and serves 132 homes and 900kW peak load.	$393,250	Freeborn County Alden Substation Circuit 1	Freeborn Mower Cooperative Services	H	2014
High winds, ice storms, tornados	Project CO-2—convert 2.0 miles of 6A CWC single phase overhead distribution with 3-phase 4/0 aluminum underground to improve reliability on feeder to 60 homes. Will allow back-feeding from other substation.	$132,000	Freeborn County Corning Substation Circuit 2NE	Freeborn Mower Cooperative Services	H	2014
High winds, ice storms, tornados	Project CO-3—convert 2.3 miles of 8A and 6A CWC with 3-phase 4/0 aluminum underground to provide better service and reliability to local manufacturer. Will allow back-feeding from other substation.	$151,800	Freeborn County Corning Substation Circuit 2NE	Freeborn Mower Cooperative Services	H	2014

High winds, ice storms, tornados	Project CO-C—convert 4.3 miles of 8A CSC with new single phase 1/0 aluminum underground line. This will include a short tie-line across 890 Ave South of Oakland to provide loop. This line is the main line through the area and will enable load transfers and improve system reliability during maintenance and emergency situations.	$141,900	Freeborn County Corning Substation Oakland Twp.	Freeborn Mower Cooperative Services	H	2015
High Winds, tornados, Ice storms	Project CO-D—convert 3-phase 1/0 ACSR feed of main Circuit 5S with new 3-phase 4/0 aluminum underground line. Line is part of the backbone of the system and a new feed main will improve system performance along with improving reliability to 145 members with 550 kW peak load. This will provide additional capacity for the backup to the Lerdal Substation.	$286,000	Freeborn County Corning Substation	Freeborn Mower Cooperative Services	H	2015
High winds, ice storms & Excessive Heat	Tie Project--convert 2.8 miles of single phase #6A CWC overhead line to new three phase 4/0 Al. underground line. Lines serve 110 consumers and an entire campground.	$217,560	Goodhue County – Hay Creek Twp. Sect 19 & 20	Goodhue County Cooperative Electric Association	H	2014
High Winds, Ice Storms	The Project – Convert 3 miles of single phase #8A CWC overhead to 1/0 Al. underground line. Line serves 30 consumers on remote end of system that becomes difficult to access in storm conditions.	$104,400	Goodhue County – Vasa Twp. Sect 4, 5, & 6	Goodhue County Cooperative Electric Association	H	2015
High Winds, Ice Storms	The Project – Convert 8 miles of single phase overhead distribution line to underground – area is highly vulnerable to wind and snow/ice storms; service to 50 consumers, majority are farms with livestock	$270,000	Goodhue and Steele Counties – Kenyon and Richland Twp.	Goodhue County Cooperative Electric Association	H	2015
High Winds, Ice Storms, Heavy Snow	Convert approx. 2.3 miles of single phase overhead distribution to single phase underground distribution. Enhancement will limit overhead exposure on the upstream recloser and provide a tie for another single phase line.	$82,800	Nobles County	Nobles Cooperative Electric	H	2017
High Winds, Ice Storms, Heavy Snow	Convert approximately 1.5 miles of 1 phase radial overhead to underground to limit overhead exposure.	$54,000	Nobles County	Nobles Cooperative Electric	H	2015

High Winds, Ice Storms, Heavy Snow	Convert approximately 3 miles of single phase overhead to underground. Enhancement will limit overhead exposure to the elements This line is used as a tie to another line.	$108,000	Nobles County	Nobles Cooperative Electric	H	2015
High Winds, Ice Storms, Heavy Snow	Convert approximately 2 miles of single phase overhead to single phase underground. Enhancement will limit overhead exposure to the elements This line is used as a tie to another two lines.	$72,000	Nobles County	Nobles Cooperative Electric	H	2017
High Winds, Ice Storms, Heavy Snow	Convert approximately 1 mile of two phase overhead line to two phase underground. Enhancement will limit overhead exposure to the elements This line is used as a tie to another line.	$53,400	Nobles County	Nobles Cooperative Electric	H	2016
High Winds, Ice Storms, Heavy Snow	Convert approximately 5 miles of single phase overhead to single phase underground. Enhancement will limit overhead exposure to the elements This line is used as a tie to another line.	$180,000	Nobles County	Nobles Cooperative Electric	H	2015
High Winds, Ice Storms, Heavy Snow	Tie Project--Convert approximately 1.5 miles of single phase overhead to single phase underground. Add approximately 0.25 miles to back up an additional line. Enhancement will limit overhead exposure to the elements This existing line is used as a tie to another line.	$64,800	Nobles County	Nobles Cooperative Electric	H	2015
High Winds, Ice Storms, Heavy Snow	Tie Project--Convert approximately 2.5 miles of radial overhead single phase line to single phase underground line. Add approximately 0.5 miles to create a tie to another line. Enhancement will limit overhead exposure to the elements	$108,000	Nobles County	Nobles Cooperative Electric	H	2017
High Winds, Ice Storms, Heavy Snow	Tie Project—Convert approximately 2 miles of single phase overhead to single phase underground. Add approximately 0.25 miles to provide backup for an additional line. Enhancement will limit overhead exposure to the elements. This line is used as a as a tie to another 2 lines.	$82,800	Nobles County	Nobles Cooperative Electric	H	2017
High Winds, Ice Storms, Heavy Snow	Convert approximately 0.5 miles of single phase overhead to single phase underground. Enhancement will limit overhead exposure to the elements.	$18,000	Murray County	Nobles Cooperative Electric	H	2017
High Winds, Ice Storms, Heavy Snow	Convert approximately 2 miles of 2 phase overhead to 2 phase underground. Enhancement will limit overhead exposure to the elements.	$106,800	Jackson County	Federated Rural Electric Association	H	2015
High Winds, Ice Storms, Heavy Snow	Convert approximately 5 miles of 3 phase overhead to 3 phase underground. Enhancement will limit overhead exposure to the elements. This line is used as a main feeder as well as a tie between substations.	$398,500	Jackson County	Federated Rural Electric Association	H	2015

High Winds, Ice Storms, Heavy Snow	Convert approximately 2 miles of 2 phase overhead to 2 phase underground. Enhancement will limit overhead exposure to the elements.	$106,800	Jackson County	Federated Rural Electric Association	H	2015
High Winds, Ice Storms, Heavy Snow	Tie Project--Convert approximately 4.5 miles of single phase overhead to single phase underground. Add approximately 1 mile to as back up to Talcott Lake. Enhancement will limit overhead exposure to the elements.	$180,000		Federated Rural Electric Association	H	2016
High Winds, Ice Storms, Heavy Snow	Convert approximately 5 miles of 3 phase overhead to 3 phase underground. Enhancement will limit overhead exposure to the elements.	$398,500	Jackson County	Federated Rural Electric Association	H	2016
High Winds, Ice Storms, Heavy Snow	Convert approximately 10 miles of single phase overhead to single phase underground. Enhancement will limit overhead exposure to the elements. This line is used as a tie to two other lines.	$360,000	Jackson County	Federated Rural Electric Association	H	2015
High Winds, Ice Storms, Heavy Snow	Tie Project--Convert approximately 4.75 miles of single phase overhead to single phase underground. Add approximately 0.5 miles to create a tie. Enhancement will limit overhead exposure to the elements.	$190,800	Jackson County	Federated Rural Electric Association	H	2016
High Winds, Ice Storms, Heavy Snow	Convert approximately 6.5 miles of single phase overhead to single phase underground. Enhancement will limit overhead exposure to the elements. This line is used as a tie to another line and serves the town of Bergen.	$234,000	Jackson County	Federated Rural Electric Association	H	2017
High Winds, Ice Storms, Heavy Snow	Convert approximately 3.5 miles of single phase overhead to single phase underground. Enhancement will limit overhead exposure to the elements. This line is used as a tie to another line.	$126,000	Jackson County	Federated Rural Electric Association	H	2017
High Winds, Ice Storms, Heavy Snow	Convert approximately 2.5 miles of single phase overhead to single phase underground. Enhancement will limit overhead exposure to the elements.	$90,000	Jackson County	Federated Rural Electric Association	H	2017
High Winds, Ice Storms, Heavy Snow	Convert approximately 4 miles of 3 phase overhead to 3 phase underground. Enhancement will limit overhead exposure to the elements. This line is used as a main feeder as well as a tie between substations	$318,800	Jackson County	Federated Rural Electric Association	H	2017
High Winds, Ice Storms, Heavy Snow	Tie Project--Convert approximately 6 miles of single phase overhead to single phase underground. Add approximately 1 mile to create a tie to two additional lines. Enhancement will limit overhead exposure to the elements.	$252,000	Jackson County	Federated Rural Electric Association	H	2016

High Winds, Ice Storms, Heavy Snow	Convert approximately 6 miles of single phase overhead to single phase underground. Enhancement will limit overhead exposure to the elements. This line is used as a tie to another line.	$216,000	Jackson County	Federated Rural Electric Association	H	2016
High Winds, Heavy Snow Events, Tornados and Ice Storms	Tie Project – install 0.75 miles on new 3 phase underground distribution. Addition would provide an underground tie between two three phase circuits that serve parts of the City of Medford and the City of Owatonna. Existing three phase circuits are located in private right of way which can extend outage restoration durations. Existing circuits serve 700 consumers including a high school.	$75,000	Steele County, Medford Twp.	Steele-Waseca Cooperative Electric	H	2015
High Winds, Heavy Snow Events, Tornados and Ice Storms	Overhead to Underground Conversion Project – covert 3.5 miles of three phase overhead distribution circuit to three phase underground distribution circuit. Area of the existing distribution line is in a heavily treed private right of way area. This distribution line is a section of a tie line between two substations. Number of consumers that would benefit - 360.	$325,000	Rice County, Bridgewater Twp.	Steele-Waseca Cooperative Electric	H	2016
High Winds, Ice Storms, Lightning and Tornadoes	Tie Project – convert 5.75 miles of single phase overhead distribution line to three phase underground distribution line. This conversion will allow for the ability to tie two circuits together that are now long radials, (8+ miles). The circuits serve 150 agriculturally based consumers.	$450,000	Dodge County, Claremont, Concord, Ellington and Wasioja Twp.	Steele-Waseca Cooperative Electric	M	2015
High Winds, Blizzards, Ice Storms, Tornadoes, Floods, Heavy Snow Events, Lightning Storms	Technology - Update SCADA system in 17 distribution substations to allow for transfer of substation information to crews in the field, not just dispatchers in the offices. Also enables further SCADA applications such as automation at major points on a distribution circuit down line of a substation. These substations serve 9,850 consumers.	$350,000	Parts of Blue Earth, Dodge, Faribault, Freeborn, Goodhue, Le Sueur, Rice, Steele and Waseca Counties	Steele-Waseca Cooperative Electric	H	2014-2016

Red River Line Crossing	Replace existing structures in the flood plain with steel structures to reduce ice floe damage during spring flooding. This will reduce outage time.	$50,000	Various Locations	Minnkota Power Cooperative, Inc.	M	2015
Blink Outage Mitigation	Add a breaker at Sand Hill to reduce the number of miles of line exposed to faults and mitigate extended outages and blink outages.	$350,000	Sand Hill, MN	Minnkota Power Cooperative, Inc.	H	2015
Line Outages	Service disruption in the Oslo/Thief River Falls area has increased after construction of a 115 kV line in 1999. The addition of a breaker at Oslo will improve service by reducing outages.	$1,100,000	Oslo, MN	Minnkota Power Cooperative, Inc.	H	2014
Power Quality	Expand the existing Hallock substation to provide for the addition of three breakers needed to improve service to the surrounding area. Blink outages have negatively impacted a large commercial customer as well as residential customers in that vicinity.	$920,000	Hallock, MN	Minnkota Power Cooperative, Inc.	H	2014
Provide Alternate Service	Construction of a transmission line that will provide looped service to the area around Hawley, MN. At this time radial lines support the load and extended outages have occurred due to the fact that there is no alternate feed. A looped transmission line will improve the quality of service and reduce outage times.	$3,400,000	Audubon, Christensen, Hawley,	Minnkota Power Cooperative, Inc.	H	2014-2015
High winds, ice storms and floods	Convert 2miles of east/west overhead 3 phase lines to underground. Approximately 270 customers are served, including the City of Hendrum and Norman County West Elementary School and several businesses	$100,000	Norman County, Hendrum Twp.	Red River Valley Co-op	H	2014/2015
High winds and ice storms	Convert 5 miles of overhead 3 phase line to underground. Approximately 100 customers are served by this line.	$450,000	Polk County, Bygland Twp.	Red River Valley Co-op	H	2014/2015

High winds, ice storms and floods	Convert 3 miles of overhead 2 phase line to 3 phase underground line. Approximately 30 customers are served by this line including a transmitter tower owned by the FFA that is considered to be critical infrastructure for a large airport – Hector International in Fargo, ND	$228,000	Clay County, Kragness Twp.	Red River Valley Co-op	H	2014/2015
High Winds, tornado and winter storms	Install dead-end pole structures on 230kV lines, to limit cascading effects when poles are damaged. Alternate methods would be considered if feasible.	10,000-10,000,000	Central & Northern Minnesota	Great River Energy	H	2015-2020

Survey Results and Analysis

HSEM conducted a survey of Minnesota rural electric cooperatives and their perceptions, past experiences, and concerns regarding natural hazards affects to their utility systems. The survey asked 25 questions ranging from concern that service will be interrupted by natural hazards to how often cooperatives coordinate and plan with local response personnel. The survey was completed by 40% of distribution cooperatives across the state.

Survey highlights include:

- 89% of survey responses "extremely concerned" that services provided by the rural electric cooperative will be interrupted or otherwise impacted by a natural hazard.
- 83% of survey responses "extremely concerned" that the electrical infrastructure will be impacted by a natural hazard.
- 77% of survey respondents have conducted a hazard analysis and risk assessment in the past 10 years (50% in the past five years)
- The top natural hazards that have "affected/damaged critical infrastructure in the cooperative service area" – flooding, windstorms, tornados, and winter storms
- The top potential high impact from natural hazards to critical electrical infrastructure was identified as windstorm, tornado, and winter storms
- Almost 50% of survey respondents identified that the cooperative has a high capability to respond to the same natural hazards (windstorms, tornados, and winter storms) that were identified as potential high impact.
- 94% of survey respondents identified substations, distribution lines, and transmission lines as highly critical to the electrical infrastructure, with transformers, human capital and vehicles also identified as highly critical (89%, 78%, 72% respectively)
- 100% of survey respondents have taken mitigation action steps to reduce vulnerability
- Underground burial projects, vegetative management, and pole replacement are the three top potential mitigation actions that survey respondents identified as high potential to be completed
- 73% of survey respondents have participated in local, regional, or state-level emergency planning (28% identified "possibly, but not certain")
- Only 39% have participated in in local, regional, or state-level emergency response exercises (22% identified "possibly, but not certain")
- 73% have participated in local, regional, or state-level emergency response activities during actual natural hazard events (11% identified "possibly, but not certain")
- 63% have worked with local emergency managers to identify mitigation measures
- 75% of respondents identified that they needed additional mitigation information for windstorms and winter storms.

Incorporated Plans, Studies, Reports, and Technical Data

Minnesota Hazard Mitigation Plan (2011 & 2014)

Minnesota Rural Electric Association Emergency Work Plan

Extreme Ice Thickness from Freezing Rain[viii]

Severe Storms in the Midwest[ix]

Electrical Transmission and Distribution Mitigation: Loss Avoidance Study (FEMA, 2008)

Economic Benefits of Increasing Electric Grid Resilience to Weather Outages - published by the Executive Office of the President

Survey Results

On the following pages

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[i] NRECA – U.S. Electrical Utility Overview - http://www.nreca.coop/about-electric-cooperatives/co-op-facts-figures/u-s-co-ops-by-the-numbers/

[ii] http://www.nreca.coop/about-electric-cooperatives/history-of-electric-co-ops/

[iii] Minnesota Rural Electric Association - http://www.mrea.org/about-electric-cooperatives/

[iv] Minnesota Rural Electric Association - http://www.mrea.org/about-electric-cooperatives/

[v] Minnesota Rural Electric Association - http://www.mrea.org/about-electric-cooperatives/

[vi] Data from Minnesota Rural Electric Association on cooperative member statistics.

[vii] Economic Benefits of Increasing Electric Grid Resilience to Weather Outages. Executive Office of the President, 2013. http://energy.gov/sites/prod/files/2013/08/f2/Grid%20Resiliency%20Report_FINAL.pdf

[viii] Kathleen Jones, "Extreme ice thickness from freezing rain (Report for Federal Emergency Management Agency and National Institute of Building Sciences", 28 May 2004.

[ix] Kunkel, K. E., and S.A. Changnon, 2009: Severe Storms in the Midwestern USA. Chapter 20, Understanding Climate Change, Indiana Univ. Press, 225-235.