520 Lafayette Road
St. Paul, MN 55155-4194

MINNESOTA ENVIRONMENTAL QUALITY BOARD

Phone: 651-757-2873
Fax: 651-297-2343
www.eqb.state.mn.us

June 14, 2017

Meeting Location: Waseca Community Conference and Training Room
303 S. State Street - Waseca, Minnesota
5:30 p.m. – 8:00 p.m.

AGENDA

General
This month's meeting will take place in the Waseca Community Conference and Training Room at 303 S. State Street in Waseca. A recording of the Environmental Quality Board (EQB or Board) meeting will be available following the meeting at www.eqb.state.mn.us.

There is free parking available at this location.

Public comment is taken on all agenda items. Time allocated for discussion is at the discretion of the Board Chair.

I. *Adoption of Consent Agenda
Proposed Agenda for June 14, 2017 Board Meeting
April 19, 2017, Meeting Minutes

II. Introductions

III. Chair's Report

IV. Executive Director's Report

V. Climate Trends

VI. Waseca Flooding Overview

VII. Waseca Emergency Response

VIII. Climate Adaptation

IX. Public Comment

X. Adjournment

** Items requiring discussion may be removed from the Consent Agenda*
***Denotes action may be taken*

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June 14, 2017

Meeting Location: Waseca Community Conference and Training Room
303 S. State Street - Waseca, Minnesota
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ANNOTATED AGENDA

General

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I. *Adoption of Consent Agenda

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II. Introductions

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V. Climate Trends

Presenters: Luigi Romolo
State Climatologist
State Climatology Office, MN Department of Natural Resources
Luigi.Romolo@state.mn.us

** Items requiring discussion may be removed from the Consent Agenda*
***Denotes action may be taken*

Pete Boulay
Climatologist
State Climatology Office, MN Department of Natural Resources
peter.boulay@state.mn.us

Issue before the Board: Informational Item

Background:
Climate trends in Southern Minnesota have seen an increase in heavy rain flooding events, especially in the 21st century. Both regional and statewide climate trends will be discussed.

VI. Flooding Overview

Presenters: Danny Lenz
City Administrator
City of Waseca

Mark Duchene
City Engineer
City of Waseca

Sheriff Brad Milbrath
Waseca County Sheriff
Brad.milbrath@co.waseca.mn.us

Issues before the Board: Informational Item

Background: The City of Waseca and surrounding area received 10.16 inches of rain in a 48 hour time period in the fall of 2016. City staff will present on the effects this amount of rainfall had on the City of Waseca, pointing out why the flooding was so intense in the community. A discussion of the damage that the flooding caused to residents, businesses, and city infrastructure, including the economic impacts to the area will be included. The County Sheriff will provide an overview to the county ditch system impacts.

VII. Waseca Emergency Response

Presenters: Nancy Lageson
Former Emergency Management Director
Waseca County
nancy.lageson@gmail.com

Jen Nelson
State Hazard Mitigation Officer (SHMO)
Minnesota Homeland Security and Emergency Management (HSEM)
jennifer.e.nelson@state.mn.us

Angela Brown
Disaster Recovery Coordinator
Minnesota Homeland Security and Emergency Management (HSEM)
Angela.D.Brown@state.mn.us

Wayne Lamoreaux
Public Assistance Officer
Minnesota Homeland Security and Emergency Management (HSEM)
wayne.lamoreaux@state.mn.us

Materials enclosed:

· Disaster Recovery-4290 Summary Charts

Issues before the Board: Informational Item

Background: The potential for severe flooding in the fall 2016 Waseca flooding event, emergency management personnel responded rapidly to the situation. In these localized weather events, the county emergency management staff are responsible for providing an on-call state of readiness 24/7. Staff and volunteers responded to the event immediately, following protocol laid out by the previously coordinated Waseca County Emergency Operations Plan.

The flooding that Waseca observed was severe enough to require assistance from the Minnesota Homeland Security and Emergency Management (HSEM) office. The HSEM helps Minnesotans prevent, prepare for, respond to and recover from disasters and works to keep Minnesota secure from acts of terrorism. HSEM staff will be available to discuss FEMA Individual Assistance, Hazard Mitigation and the Public Assistance processes and program.

VIII. Climate Adaptation and Recovery

Presenters:

Nancy Lageson
Former Emergency Management Director
Waseca County
nancy.lageson@gmail.com

Scott Reiten
Regional Emergency Management Planner
Region 9 Development Commission

Ashley Aukes
Communications Specialist
Region 9 Development Commission

Paul Moss
Climate Adaptation Coordinator
Minnesota Pollution Control Agency
paul.moss@state.mn.us

Materials enclosed:
- South Central Minnesota: Climate Change Vulnerability Assessment & Adaptation Plan
- 2017 ICAT Report, "Adapting to Climate Change in Minnesota" summary page

Issues before the Board: Informational Item

Background:
Waseca County Long Term Recovery Committee
Following the immediate response of the fall 2016 Waseca flooding, the Waseca County Long Term Recovery Committee was formed to minister to the unmet needs of Waseca County residents adversely impacted by the disaster. The committee's work included:
- Provide service and support to promote healing and recovery
- Provide assistance to affected individuals that did not have adequate personal resources, whether financial or physical, for addressing needs resulting from the disaster
- Provide services to those 'special cases' that may lie outside of these borders where there is no recovery committee available
- Provide coordinated management of community resources for long term recovery of individuals, families, and rehabilitation of households
- To collect donations and distribute to those who have unmet disaster related needs within the community
- To become a sustainable collaboration to assist in future disasters

Region Nine Development Commission
The Region Nine Development Commission (RNDC) works on behalf of counties, cities, townships, and schools in the nine counties of South Central Minnesota. RNDC works in the areas of economic development, business development, healthy communities, transportation, community development, emergency management planning and leveraging regional resources.

In May, RNDC released the "South Central Minnesota Climate Change Vulnerability Assessment & Adaptation Plan." The report was created through the Region Nine Climate Change Adaptation Task Force in coordination with state and local governments, the University of Minnesota, nonprofits, and business partners. Using the National Adaptation Assessment as a model, the report outlines the impacts climate change has on the region and the sectors that are vulnerable to those impacts.

The report details that Waseca County as a whole faces high risk of Natural Hazards and flooding is one of those risks, as proven in the 2016 flooding event. In the region, "nearly

11% of communities citied annual flooding as a determinant to community operations, 46% indicated that flooding impacted their communities every two-five years." Another "58% of communities indicated that flooding created a loss of accessibility. This includes accessibility to roads, businesses, work places, and critical facilities."

Region Nine will discuss the planning process, highlight a few key insights in the plan and outline next steps

Interagency Climate Adaptation Team
The State of Minnesota has been working for the past several years on climate adaptation efforts in response to the changes in climate that Minnesota is experiencing and faces in the future. The Interagency Climate Adaptation Team (ICAT) was formed in 2009 to facilitate collaboration among state agencies. In May 2017, ICAT released the updated report, "Adapting to Climate Change in Minnesota" which describes observed and projected climate impacts in Minnesota, outlines Minnesota state agency activities that are helping to adapt to climate change, and provides recommendations for future state action and interagency collaboration.

IX. Public Comment

X. Adjournment

MINNESOTA ENVIRONMENTAL QUALITY BOARD
MEETING MINUTES

Wednesday, April 19, 2017
Minnesota State Capitol Room G-23
75 Rev. Dr. Martin Luther King Jr. Boulevard
St. Paul, Minnesota

EQB Members Present: Dave Frederickson, John Saxhaug, Charlie Zelle, Tom Landwehr, Julie Goehring, Kristin Eide-Tollefson, Gerald VanAmburg, Kate Knuth, Matt Massman, John Linc Stine, Adam Duininck

EQB Members Absent: Dr. Ed Ehlinger, Shawntera Hardy, Mike Rothman, Tom Moibi

Staff Present: Will Seuffert, Courtney Ahlers-Nelson, Erik Dahl, Mark Riegel, Katie Pratt, Kelly Scanlan, Kristin Mroz-Risse

I. Adoption of Consent Agenda and Minutes

II. Introductions

III. Chair's Report

IV. Executive Director's Report
Shared logistics of upcoming Board meetings.

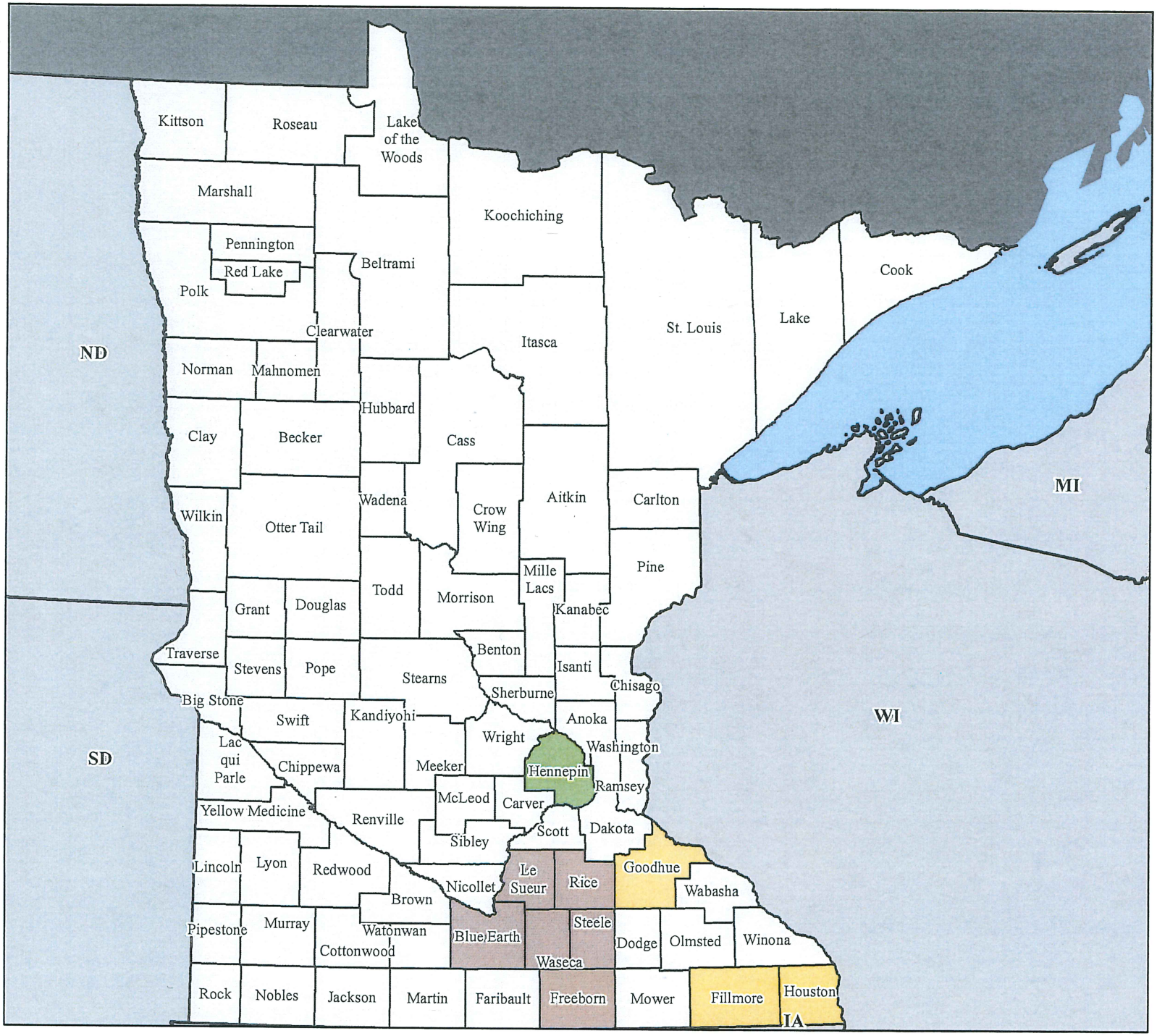
V. Approval of GreenCorps Application
The Resolution was adopted to allow the EQB to enter into a host site agreement with the MPCA and authorize the Executive Director to sign the grant agreement on its behalf.

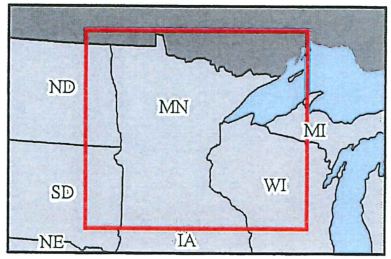
VI. 25% by 2025 Water Quality Goal
Governor Mark Dayton and Lieutenant Governor Tina Smith set forth an ambitious goal of achieving a 25% improvement in Minnesota's water quality by the year 2025. Presenters discussed why the 25% by 2025 effort is important to Minnesotans, offered ideas for moving the project forward, and highlighted opportunities for collaboration.

The audio recording of the meeting is the official record and can be found at this link:
ftp://files.pca.state.mn.us/pub/EQB_Board/

FEMA-4290-DR, Minnesota Disaster Declaration as of 11/30/2016

FEMA





Data Layer/Map Description:
The types of assistance that have been designated for selected areas in the State of Minnesota.

All designated areas in the State of Minnesota are eligible to apply for assistance under the Hazard Mitigation Grant Program.

Designated Counties

- No Designation
- Individual Assistance
- Public Assistance
- Individual Assistance and Public Assistance

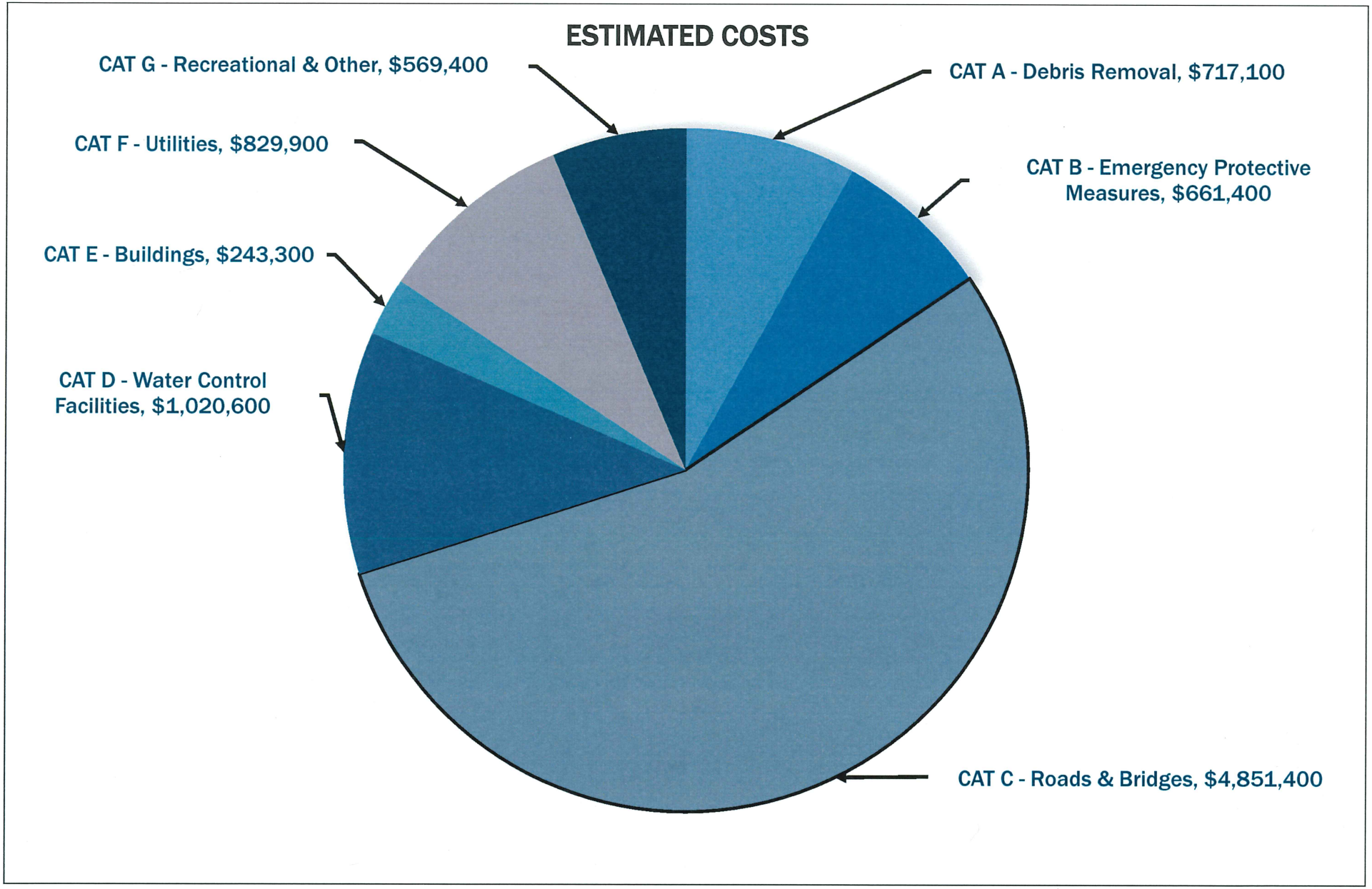
N
W E
S

0 20 40 60 80 Miles

Data Sources:
FEMA, ESRI;
Initial Declaration: 11/02/2016
Disaster Federal Registry Notice:
Amendment #1 - 11/29/2016
Datum: North American 1983
Projection: Lambert Conformal Conic

MapID 3c28c0f4f6e1130160815hqprod

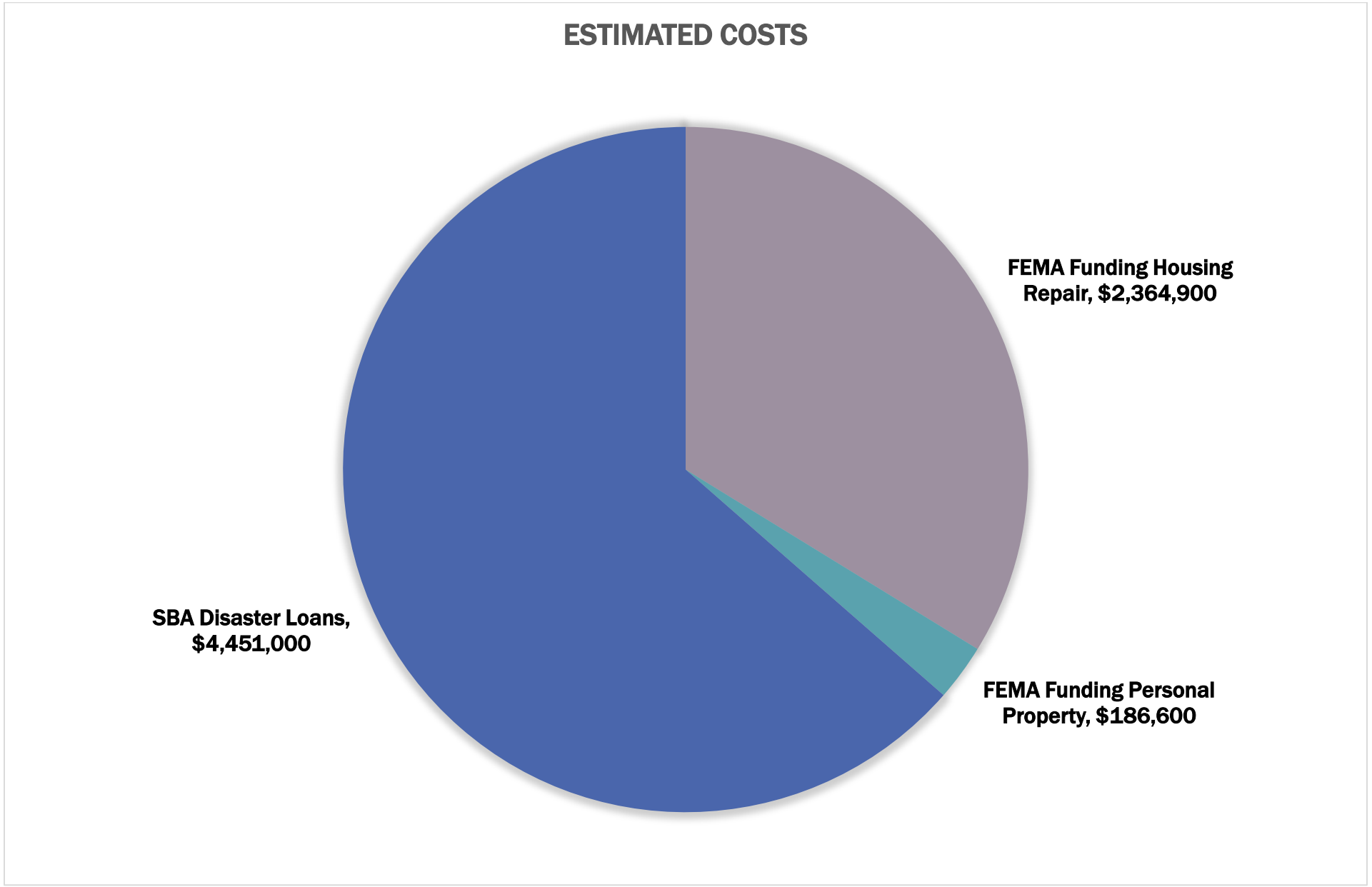
2016 FEMA Public Assistance Summary (DR – 4290)



TOTAL ESTIMATED COSTS BY CATEGORY = $8,893,100
(9 Counties / 146 Applicants / 264 Project Worksheets)

FEMA CATEGORIES AND EXAMPLES OF COMMON ELIGIBLE WORK

A	B	C	D	E	F	G
Debris Removal	**Emergency Protective Measures**	**Roads & Bridges**	**Water Control Facilities**	**Buildings & Equipment**	**Utilities**	**Parks, Recreation, & Other**
Debris removal must be in the public interest and necessary to: • Eliminate immediate threats to lives, public health & safety; • Eliminate immediate threats of significant damage to improved public or private property Trees and Woody Debris Building Components Sand, Mud, Silt, & Gravel Removal of Temporary Levees	Search & Rescue Security Emergency Pumping Sandbagging Detour & Warning Signs EOC Activation Emergency & Temporary Repairs Overhead Power Lines Emergency Medical Facilities Emergency Evacuations Activities undertaken before, during and following a disaster to save lives, protect improved property	Roads • Surfaces • Bases • Shoulders • Ditches • Drainage Structures • Low Water Crossings Bridges • Decking & Pavement • Piers • Girders • Abutments • Slope Protection • Approaches Slope Failures	Dams and Reservoirs Levees Engineered drainage Channels Canals Aqueducts Sediment Basins Shore Protective Devices Irrigation Facilities Pumping Facilities	Buildings Structural Components Interior Systems • Electrical • Mechanical • Contents	Water Treatment Plants Power Generation & Distribution Facilities • Natural Gas Systems • Wind Turbines • Generators • Substations • Power Lines	Playground Equipment Swimming Pools Bath Houses Tennis courts Boat Docks Piers Picnic Tables Golf Courses Fish Hatcheries Mass Transit Facilities



TOTAL ESTIMATED COSTS FOR INDIVIDUAL ASSISTANCE = $7,002,500 (March 2017)
(7 Counties / 1407 Registered Applicants)

Region Nine
Development Commission

South Central Minnesota

Climate Change Vulnerability Assessment & Adaptation Plan

Table of Contents

This document and planning process were created in partnership and with the support from the Minnesota Pollution Control Agency.

The Health Impact Assessment was created in partnership with the Minnesota Department of Health.

June 2017

Executive Summary

The National Climate Assessment provides a detailed assessment of climate change and the impacts it has on the United States. It explores regions of the nation by sectors: water; energy; transportation; agriculture; forests; ecosystems; human health, energy, water, and land; urban; indigenous peoples; land use and land cover change; and biogeochemical cycles. In order to create some symmetry, Region Nine Development Commission, working in tandem with a Climate Change Adaptation Task Force (CCATF), identified the seven top priority sectors to prioritize its planning process (and added one: business and economy): agriculture, water, human health, energy, transportation, forests, and ecosystems.

In addition to those key sectors, certain impacts were identified and cross-referenced with hazard mitigation plans as priorities in south central Minnesota: flooding, drought, extreme summer and winter storms, infectious diseases, and fire and land subsidence. Among all, flooding had the greatest impact on the region, to the sum of $1.9-billion of potential risk to critical facilities, and the problem is increasing. As precipitation increases across the region, so does flooding. After more than two decades with no major floods, there have been twelve presidential disaster declarations involving flooding since 1990.

Drought also has a major impact on the region's large agricultural land and economy. There have been two major drought events in the past century that impacted large portions of the nation, particularly the Midwest states: the dust bowl of the 1930's and the drought of the late 1980's. Since then, there have been minor flare-ups across the region, most notably around 2003 – 04 and 2012 – 13. This is a dichotomy created by climate change, the notion of flooding, extreme moisture, extreme heat, and drought that can occur in the same calendar year. Meteorologist Paul Huttner stated during a presentation at a climate change convening at South Central College in Mankato in September of 2015: "When it rains, it rains in chutes." This rainfall comes down fast and hard, washes away essential topsoil, creating soil quality issues and flash flooding and is often followed by prolonged periods of drought. Unpredictable weather patterns like this are a key indicator of climate change.

Increased temperatures are also a key indicator of climate change. The average temperatures in Region Nine have varied considerably since 1895 but have regularly been higher than the long-term average of 44.4°F over the last 10 years. In fact, 2012 and 2016 were both among the five warmest years on record. Now, extreme heat events are a near annual occurrence.

According to Mark Seeley of the Minnesota State Climatology Office, Minnesota has experienced heat waves as a regular occurrence since the mid-1990's. While many of these heat waves are dew-point driven, the increased frequency has resulted in more heat advisories issued by the National Weather Service. Of the 30 historic heat waves across the state, 11 have occurred in the past 20 years. The consequences of these heat waves include:

- Increased stress on livestock, due primarily to change in feed ration, water, and weight gain, which also impacts milk production.
- The seasons of greater populations of pathogens, parasites, insects, and microorganism has increased.
- Increased demand for health care for heat related illnesses.
- Increased demand for heating, ventilation, air conditioning and other environmental controls.

With these major changes happening, townships, cities, and counties across the region are noticing the impacts on day-to-day operations. Over half of the communities in Region Nine responding to a survey indicated that winter storms impacted their community on an annual basis. Approximately 40 percent indicated that annual summer storms impacted their operations. These impacts range from a loss of accessibility to critical facilities, key portions of their community, key infrastructure and utilities and major roads to evacuate the community (in extreme situations). Additionally, Region Nine's jurisdictions cited that these impacts have a major cost component: flooding, summer storm damage, and drought. In order to best adapt, Region Nine's communities need funding, repair, and prevention support.

This assessment led to an intensive planning process that engaged subject matter experts, the CCATF, and key stakeholders to help contribute their insights. The result of the planning process was real, actionable strategies with the following objectives:

As an addition to Objective 1, Region Nine worked with the Minnesota Department of Health (MDH) to perform a rapid Health Impact Assessment (HIA) to determine the net impact on human health. In doing so, an HIA Advisory Committee, with representation from the CCATF, created specific recommendations to the CCATF to increase soil and water conservation efforts while maintain human health.

Planning Process

Find a Model that Works

Conducting a climate change vulnerability assessment and adaptation plan is a blend of data compilation, analysis, and conventional planning frameworks. For this vulnerability assessment, several models conducted nationally and by Minnesota state departments served as a useful guide. Two models, the Minnesota Department of Health's *Minnesota Climate Change Vulnerability Assessment 2014* and the National Climate Assessment, were chosen because of their thorough insights and concise layout. These two assessments also had relevant content to south central Minnesota. Additionally, having a similar model to other national assessments will allow for relatively simple comparisons with other parts of the nation and will allow for uniform future updates. Having a model also set out the foundation by which health informed the assessment, planning processes and subsequent Health Impact Assessment on the strategies developed.

Create a Project Charter

A project charter lays out the need for the project, defines what is in-scope and out of scope, and sets clear success indicators and outcomes in the front-end of the project. Other components that may be include in a project charter are: project description, defining roles, outlining measurable impacts, identifying issues and risks that could delay the project, critical assumptions, and proposed solutions to potential barriers. A project is better set up for success when these elements are identified and understood by the project and its stakeholders. Crafting a project charter is recommended when working on climate change planning due to the vast number of sectors climate change impacts. Without a project charter scope creep (a continuous or uncontrolled growth in a project's scope) may occur which can stretch resources too thin, delay delivery of the plan, and exhaust the project budget.

Create a Critical Path Worksheet

A critical path worksheet is a timeline for a project with key milestones or tasks identified and estimated completion times for those tasks. Due to the complexity of climate change and the continuous updating of new information, Region Nine employed an agile timeline, capable of changing deadlines when necessary and not setting the project behind.

Assemble a Well-Rounded Task Force

Region Nine created a task force of regional experts with a wide swath of skills and knowledge to help inform the plan, guide the planning process, and share insights along the way. Region Nine's task force, the CCATF, included both public and private sector representatives, as well as service providers. Representation included: academics (Gustavus Adolphus College and Minnesota State University, Mankato), State of Minnesota departments (Department of Natural Resources, Pollution Control Agency, Department of Transportation, and Employment and Economic Development), county emergency managers, Region Nine commissioners, local community and economic developers, Minnesota River Area Agency on Aging, Xcel Energy, county public schools and public health, county commissioners, and private sector finance.

Identify Most Important Impact Sectors

Using the National Climate Assessment's sector-based model and the impacts it identified, Region Nine and the CCATF streamlined the sectors and impacts relevant to south central Minnesota. The chosen sectors were: agriculture, ecosystems, energy, forestry, human health, water, and transportation. The CCATF also added economic and business development as a critical sector (this sector was not identified in the National Climate Assessment). Identifying and defining sectors also saves time and expense when gathering insights specific to the State of Minnesota and the region.

Identify Impacts

Once the sectors were defined, Region Nine began conducting research to connect the climate change impacts, identified in the National Climate Assessment, to the sectors. This included gathering information to determine how they impacted each of the sectors and which had the greatest impact. Using this data, the CCATF selected which impacts were most significant to guide the planning process. Those impacts were: flooding, drought, extreme summer and winter storms, and infectious disease. Wildfire, earthquake, and land subsidence impacts were not considered as significant and later subject matter expert interviews and surveys of the cities, counties, and townships in Region Nine would validate this.

Conduct Research

Using internal and external data, as well as secondary state and federal data sources such as the National Oceanic and Atmospheric Administration and the 2014 Minnesota Statewide All-Hazard Mitigation Plan, Region Nine built a profile of vulnerability in south central Minnesota exacerbated by climate change.

Review Hazard Mitigation Plans

Hazard mitigation plans provide a wealth of information on natural disasters that are intensified by climate change. Hazard mitigation plans include vulnerability assessments and strategies to lessen the impact of hazards. Adaptation is a form of mitigation; however, a key difference is that adaptation focuses less on strong intervention for mitigated outcomes and more on adjustment to a changing climate. Both play a critical role in reducing the negative effects climate change has on a person, place, or thing; however, mitigation is more of a direct response while adaptation seeks to create less vulnerability to a threat. The framework and content of hazard-mitigation plans was a key resource in the development of the Region Nine Climate Change Vulnerability Assessment. Hazard-mitigation plans provided composite information regarding flood vulnerability of critical infrastructure and general building stocks, local perceptions of risk associated with natural hazards, and data that quantified the economic loss and risk of exposure as well as basic insurance claims for flood-damaged crops.

Gather Insights from Subject Matter Experts

Region Nine interviewed specific subject matter experts to dig deeper into the issue of climate change vulnerability. The experts were asked to self-identify which the sectors they felt their expertise best represented. They were then given a questionnaire based on their area of expertise. Experts could self-identify with more than one area of expertise, but they were always asked a consistent base of information and could expand "off script" as needed. The experts ranged from city administrators, engineers, planners, government program specialists, service providers, academics, specialty sciences and other specialized knowledge providers in economic development, soil and water conservation, ecology, biodiversity, agriculture, healthcare, forestry, and more. Climatologists and emergency managers were interviewed independently due to their close connection with climate change and natural disasters across all sectors. Their feedback, independent of self-identified sectors, helped shape the research and highlight the critical issues on a regional, statewide, national, and global scale.

Gather Insights for Local Government

In addition to subject matter expert interviews, cities, counties, townships, and school districts across the region were asked questions about how the impacts of climate change have affected their communities. Their responses helped guide Region Nine in prioritizing which impacts were most important to the region and should be the focus of the plan.

Create Actionable Solutions

Once Region Nine gathered the information and began to share the vulnerability of the region with the task force, phase two of the work plan began. Working directly with the CCATF, Region Nine facilitated three meetings to help scale the insights and the data gathered into meaningful overarching objectives connected to each of the sectors. Objectives could cross sectors but could not deviate from the information provided. The seven objectives that arose from the planning discussions were: maximize soil and water conservation; increase cover crops; manage infrastructure; increase adaptive capacity in health systems to respond to disease events; expand risk management and management planning across planning platforms; special focus on resilience sector strategies; increase livestock and human capacity to respond to extreme weather; and utilize locally sourced foods and crops to ensure sustainability. Each of these objectives was then refined into very specific strategies to meet those objectives. Finally, the strategies were then given specific action steps that, if taken, will make the strategy work and meet the objective.

Review and Adoption

Once the vulnerability assessment and adaptation plan was complete, subject matter experts reviewed the plan and provided additional insights and clarification. The plan was then posted on Region Nine's website for public comment. The revised plan was subsequently reviewed by the CCATF and a recommendation was made to the Region Nine Development Commission Board of Directors, to adopt the plan as the official climate change plan for the region.

Implementation

A local champion was identified who will implement the strategies in their community. Foundations and state agencies were contacted to request additional funding to create an implementation committee that will examine the feasibility of implementing sector and site-specific strategies in communities of interest.

The Sectors

Using the National Climate Assessment as a model, Region Nine Development Commission, working in tandem with the CCATF, identified eight critical sectors within the region that are vulnerable to the impacts created by climate change. Those sectors are:

Agriculture: Changes to precipitation and temperatures impact the ability of farmers to grow crops for human and livestock production, manage pests that affect the health of livestock, and create undue stress on animal health. Agriculture and agricultural related manufacturing have a large direct and indirect component to the health of the economy in south central Minnesota.

Water: Surface and groundwater quality are essential components to the health and well-being of south central Minnesota's ecosystem. Water quality of the region's lakes and rivers is impacted by changes in precipitation, flooding, runoff caused by rain and melting snow, as well as consumption that can increase in times of drought or to manage changing soil conditions.

Human Health: Human Health is the health and well-being of the 231,040[1] residents of Region Nine. Humans are affected physically, mentally, and emotionally to many impacts exacerbated by climate change.

Energy: The energy supply in south central Minnesota includes electricity generation and renewable energy (wind, solar, biofuels). Changes to the natural and built environment due to climate change will cause disruptions and potential damage to infrastructure.

Transportation: The ability to transport goods and commodities and people across the region is critical to the health and well-being of the regional economy. Extreme weather events caused by climate change can bring transportation to a stop due to flooded or snow-packed transportation systems and damaged infrastructure caused by flooding, ice, and extreme wind.

Forests: Forests include green canopy, trees, and undergrowth. Forests capture tourism in parks across the region, provide relief from the sun for livestock and humans, and are vulnerable to extreme weather conditions enhanced by climate change, including: drought, ecosystem changes, flooding, and extreme winds.

Ecosystems: Climate change impacts all systems, but perhaps none more so than ecosystems. Algae growth in lakes is accelerated in extreme climates which can suffocate fish and other aquatic life. Rapid changes to ecosystems can cause some species to die or relocate to other more hospitable climates. This can have lasting changes on the entire life cycle of south central Minnesota.

Business and Economy: The ability of a business or major employer to locate in a region is paramount to the social equity and well-being of humans to afford a certain quality of life. Without jobs, a regional economy would falter leading to outflight of populations, gentrification, and poverty. This has a negative impact on human mental and physical health. Businesses may choose to locate in more predictable or hospitable climates. The damage to one business caused by climate change related impacts can have a sizeable financial impact on the business itself, but also those who work for the business, and the economy of the region.

[1] U.S. Census Bureau American Community Survey 5-Year Estimates 2015 (B01003)

The Impacts

In addition to the sectors, Region Nine identified seven impacts intensified by climate change. These impacts could happen in south central Minnesota as a direct result of climate change and might have an effect on the various sectors identified. The impacts are:

Flooding: Flooding is caused by extreme summer and winter storms. According to many Minnesota climatologists, torrential rains have increased in intensity and when it rains, it rains in chutes. This causes potential flash flooding.

Drought: Drought is a period of dryness and a shortage of water, often caused when there is low rainfall over an extended course of time. Some climatologists have indicated that one outcome of a changing climate is that extreme rainfall events can occur in a short span of time followed by long periods of drought. This has a negative impact on growing many crops.

Extreme Summer and Winter Storms: According to the National Climate Assessment both winter storms have increased in frequency and intensity since the 1950s. Severe summer storms (tornadoes, hail and thunderstorms) have as well.

Infectious Diseases: Viruses, bacteria, protozoa, and multicellular parasites that can be transported either through direct contact, air, or water are infectious disease. According to the Center for Disease Control and Prevention, rainfall can influence the transport and dissemination of infectious agents while temperature affects their growth and survival. Contaminated drinking water, recreation water, and food can also spread waterborne infections as well as flood waters caused by excess precipitation.

Wildfire and Land Subsidence: The Environmental Protection Agency attributes increased frequency of wildfires as a climate change indicator because increased temperatures and drought conditions threaten to increase the intensity and frequency of wildfires.[2] Land subsidence is a gradual settling of sudden sinking of the earth's surface due to subsurface movement of earth materials, potentially caused by declining groundwater levels. Neither fire or land subsidence were identified as significantly impacting Region Nine by the CCATF, cities, counties and townships in Region Nine or subject matter experts interviewed. As a result, early planning conversations included these two impacts but later information gathering did not.

[2] United States Environmental Protection Agency, Climate Change Indicators in the United States, https://www3.epa.gov/climatechange/science/indicators/ecosystems/wildfires.html

An Assessment: Impacts by the Numbers

Region Nine gathered some preliminary information to help assess the vulnerability of the region to the various impacts enhanced by climate change on the region as a whole, and on the sectors identified. Statewide hazard mitigation plans provided some useful information.

In local multi-hazard mitigation plans, counties were asked to identify hazards and whether they were high risk (H), moderate risk (M), or low risk (L). Those rankings were included in local plans and compiled in the 2014 Statewide Hazard Mitigation Plan. (*See Table 1*) Of the eight counties that included this information in their plans, Waseca County had identified the highest number of high risk impacts. Primarily, the counties perceived risks were: flooding, extreme storms (tornado, winter storm, windstorm, summer storm, hail, and lightning) and extreme temperatures (extreme cold and extreme heat).

Most counties in Region Nine do not consider themselves highly vulnerable to natural hazards, with the exception of Waseca.

Table 1. County Perceived Risk of Natural Hazards

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
Blue Earth*	M	M	M	H	M		M		M	M	M	M	M		L	L	L
Brown																	
Faribault			M					M									
Le Sueur			M		M			M	M	M							
Martin	M		H		M			M	M	M							
Nicollet	M	M	M	M	M		M		M	M	M	M	M				
Sibley	M		M		M			M	M	M							
Waseca	H	H	H	H	H		M	H									
Watonwan	M		M		M			M	M	M							

Source: Minnesota All-Hazard Mitigation Plan (2014)
**Pulled directly from County Hazard Mitigation Plan*

Flooding

According to the Federal Emergency Management Association (FEMA), typical critical facilities are hospitals, fire stations, police stations, places that store critical information and records, and similar types of facilities. Ultimately, a critical facility should not be located in a place that would expose it to undue risk – such as a floodplain. Regulation and crafting of floodplain management plans that exclude building these types of critical facilities in floodplains is essential.

While development in floodplains of these facilities is a problem, changes to weather patterns caused by a changing climate have resulted in high rainfall events and increased flash floods. Essentially, this makes all 373 of south central Minnesota's critical facilities potentially vulnerable to flooding. In all, these facilities represent $1.9-billion of risk to potential flooding, including flash flooding. *(See Table 2)*

$1.9 Billion
at risk to potential flooding

Impact: High

Highest Sectors Impacted

Of the 2.1 million estimated total buildings in Minnesota identified in the General Building Stock inventory reported in the State of Minnesota's 2014 All-Hazard Mitigation Plan, total building losses due to flooding reached $3.4-billion statewide. In Region Nine, there were 417 total damaged buildings of 107,391(0.39 percent). This percentage was slightly better than the state as a whole. Damage differed across the region, with Le Sueur County accounting for a percentage of building damage at twice that of the state (1.03 percent) and among the highest total building losses statewide (9th). Sibley County also suffered significant building damage (.63 percent). In total, Le Sueur and Sibley Counties tallied nearly half (45.6 percent) of all buildings in Region Nine located in a 100-year floodplain.

Table 2. Flood Vulnerability of Schools, Hospitals, Fire Stations and Police Stations

Flood Vulnerability of General Building Stock

County	Total Facilities	Facilities in 100-year Floodplain	Total Exposure of Facilities	Estimated Total Buildings	Total Building Exposure x$1,000
Blue Earth	71	0	$644,319,000	23,631	$4,239,055
Brown	48	0	$196,958,000	11,151	$2,176,076
Faribault	34	0	$111,145,000	10,670	$1,109,127
Le Sueur	39	3	$148,066,000	13,384	$1,921,377
Martin	39	0	$143,587,000	12,808	$2,596,985
Nicollet	53	1	$298,773,000	11,848	$1,516,376
Sibley	33	2	$105,837,000	8,218	$1,216,782
Waseca	32	4	$128,231,000	9,095	$1,453,845
Watonwan	24	1	$81,623,000	6,586	$815,118
Region Nine	373	11	$1,858,539,000	107,391	$17,044,741

Source: Minnesota All-Hazard Mitigation Plan (2014)

Higher than average losses of crop production due to flooding in Region Nine has a significant impact to the regional economy.

Region Nine represents a high volume of agriculture production. Nearly 20 percent of all private sector employment in Region Nine is agriculture. Uncaptured small agriculture production brings that number even higher. Crop production is a key component to the agriculture industry in south central Minnesota and flooding of fields represents lost equity for farmers in the region. Three counties (Sibley, Watonwan, and Nicollet) experienced high numbers of indemnity claims for crop flooding from 2000 to 2013. Every county in Region Nine, with the exception of Waseca County, ranked in the top half of the state in flood damage claims to crops. In sum, $7.2 million in total indemnity claims were submitted by Region Nine crop farmers from 2000 to 2013 which represents 20 percent of total state losses ($35 million). *(See Table 3)*

Table 3. Indemnity Claims for Flood on Crops (2000-2013)

County	Claims	State Rank
Sibley	$2,336,755	2
Watonwan	$1,618,392	8
Nicollet	$1,519,161	10
Faribault	$583,505	19
Le Sueur	$349,020	24
Brown	$286,807	26
Blue Earth	$267,502	29
Martin	$202,365	33
Waseca	$26,140	55

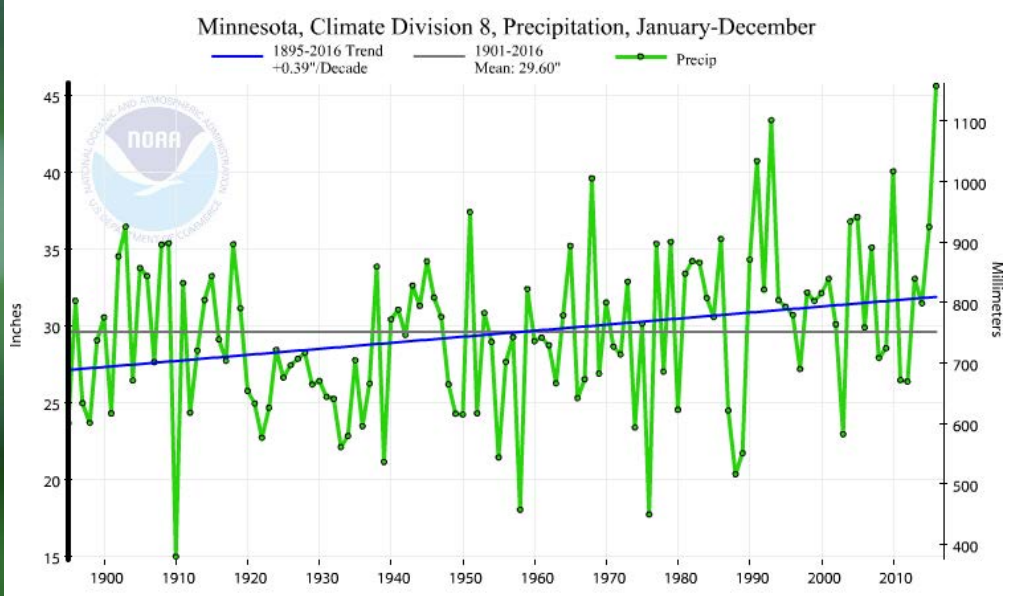
Source: USDA Risk Management

Flood levees are an attempt to reduce the risk of flooding to a community. Non-certified emergency levees are built when there is a high probability of flooding. Accredited levees are recognized by FEMA as providing adequate protection against flooding in a high-risk area identified by a flood hazard map. Provisionally Accredited Levees (PALs) are levees that may not have been certified by a licensed professional engineer but are reasonably expected to provide protection from a one-percent-annual-chance flood and have been recognized by FEMA as such. Analysis of these levees helps determine the level to which communities in a region are at risk, anecdotally. There are no accredited levees in Region Nine, but there are three PALs: Mankato Levee and Le Hillier Levee, both in Blue Earth County, and a levee located in North Mankato in Nicollet County.

The presence of non-certified emergency levees illustrates predictive behavior. Emergency levees must be reinforced with sandbags or other augmentation to be effective, and are often temporary. The following emergency levees were outlined in the *2014 State All-Hazard Mitigation Plan*: New Ulm and Springfield in Brown County, Blue Earth in Faribault County, Kasota in Le Sueur County, and St. Peter in Nicollet County. While these levees are a response to potential flood control, climate change impacts how effectively new designs of levees and dams are at controlling flood waters.[3] Flooding, and the likelihood and ability of communities, businesses, and individuals to respond to it, is one of the most significant impacts that climate change will have on a community.

Overall annual precipitation recorded across Region Nine has fluctuated significantly across the 20th century, reaching a minimum of 14.94" in 1910 - 14.66" below the 1895-2016 average (29.48"). In general, precipitation has increased at an average rate of 0.39" per decade, with annual precipitation increasing by over 4.76" from 1895 to 2016. This increase may be due in part to the presence of the protracted dry period of the Dust Bowl during the first half of the 20th century.

Over the past 10 years, Region Nine has experienced fairly moist conditions with an average annual precipitation of 33.08" that exceeds the 1895-2016 average by 3.60". The wettest year on record was 2016 (45.59"), while 2015 and 2010 also ranked among the top 10. Not surprisingly, all of these years were among the moistest on the Palmer Drought Severity Index scale despite being above average in temperature.



Region Nine's exposure to flooding seems to mirror the trend of increasing moisture. After more than two decades with no major flooding, Region Nine received three presidential disaster declarations involving flooding in the 1990s, two in the 2000s, and seven during the 2010s.

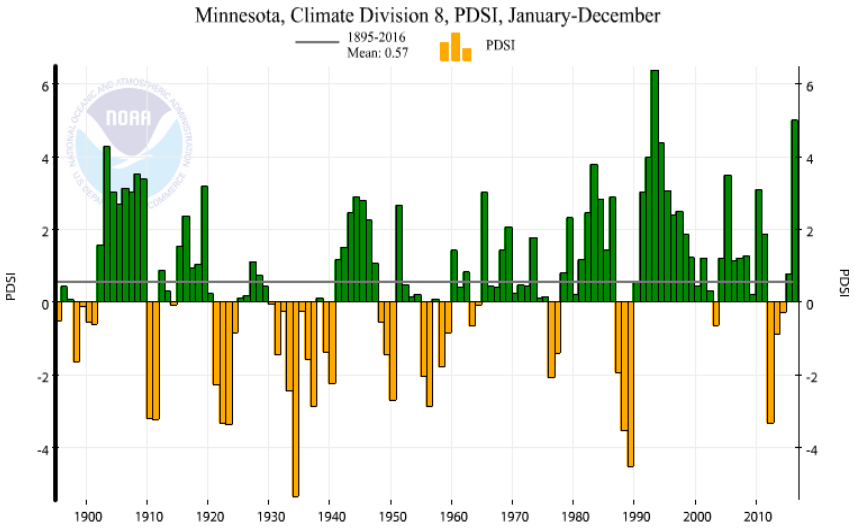
With the increase in rainfall, flooding has also increased and so have disastrous flood events.

[3] Minnesota State Hazard Mitigation Plan 2014, Section 4: Natural Hazards Risk Assessment, Page 83, https://dps.mn.gov/divisions/hsem/hazard-mitigation/Documents/State%20Plan%20Final%202014.pdf

Drought

One indicator of flood potential is the Palmer Drought Severity Index (PDSI). PDSI data is found at the National Oceanic and Atmospheric Administration Climate Prediction Center under *Drought Monitoring*.[4] It uses temperature and precipitation data to calculate water supply and demand, factors in soil moisture, and includes all the essential elements of soil moisture: evapotranspiration, soil recharge, runoff, and moisture loss from the surface. It primarily reflects long-term drought and is often used to guide drought relief programs. While the PDSI offers a standardized measure of moisture conditions, it does not capture human impacts on water/soil balance, making it most effective for unirrigated cropland. The Palmer Classifications are outlined on the right.

Using this model, there have been two extreme droughts in Region Nine measured since precipitation information began being recorded that would eventually feed into the model: 1934 (-5.33 PDSI) and 1988-to-1989 (-3.54 PDSI in '88 and -4.51 in '89). Additionally, there have been five other periods of severe drought (see appendix page 65): 1923 (-3.36 PDSI), 1922 (-3.32), 2012 (-3.31), 1911 (-3.21), and 1910 (-3.2). Combined, these represent eight of the driest years the PDSI has recorded.



Drought has a negative impact on growing many crops.

Impact: Variable

Highest Sectors Impacted

Palmer Drought Severity Index Classifications

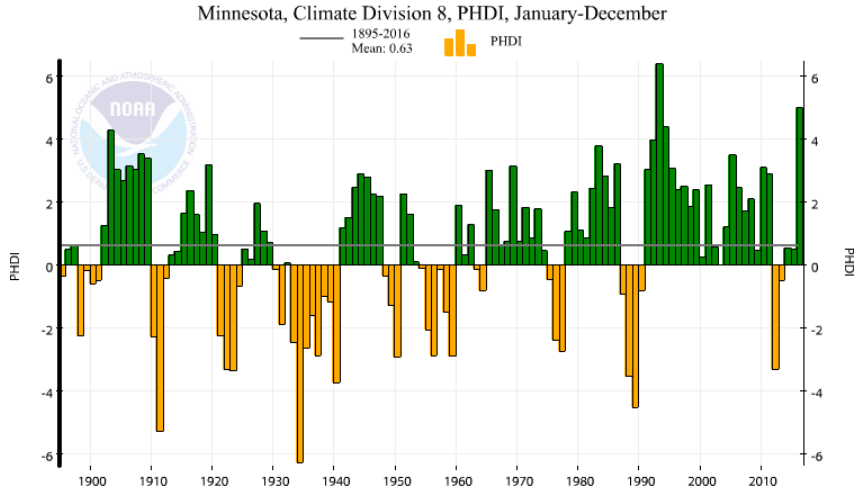
4.0 or more	Extremely wet
3.0 to 3.99	Very wet
2.0 to 2.99	Moderately wet
1.0 to 1.99	Slightly wet
0.5 to 0.99	Incipient wet spell
0.49 to -0.49	Near normal
-0.5 to -0.99	Incipient dry spell
-1.0 to -1.99	Mild drought
-2.0 to -2.99	Moderate drought
-3.0 to -3.99	Severe drought
-4.0 or less	Extreme drought

Source: http://drought.unl.edu/Planning/Monitoring/ComparisonofIndicesIntro/PDSI.aspx

[4] National Weather Service, Climate Prediction Center, *Drought Monitoring*, http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml

The 1934 drought occurred during a decade of nationwide drought, known as the "Dust Bowl", and caused significant ecological and agricultural damage. One of the causes of this drought was decades of farming without crop rotation or planting cover crops to prevent erosion. The 1989 drought was also part of a two-year drop that began in 1988 and impacted the entire nation, damaged crops, and lead to heavy water restrictions. Dry conditions spurred wildfires in the Midwest, including Yellowstone National Park, and lead to an estimated $120 billion in damage to agriculture crops, and livestock, and residential and commercial infrastructure.

Whereas PDSI measures the meteorological impacts of wet and dry spells, the Palmer Hydrological Drought Index (PHDI) measures hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) which take longer to develop and longer to recover. This long-term drought index was developed to quantify these hydrological effects and it responds more slowly to changing conditions than the PDSI. The key difference is PDSI measures weather related and PHDI measures moisture supply.



Palmer Hydrological Index Classifications

4.0 or more	Extremely moist
3.0 to 3.99	Very moist
2.0 to 2.99	Moderately moist
-1.0 to 1.99	Mid-range
-2.0 to -2.99	Moderate drought
-3.0 to -3.99	Severe drought
-4.0 and below	Extreme drought

Source: https://www.ncdc.noaa.gov/sotc/service/drought/phd/201109.gif

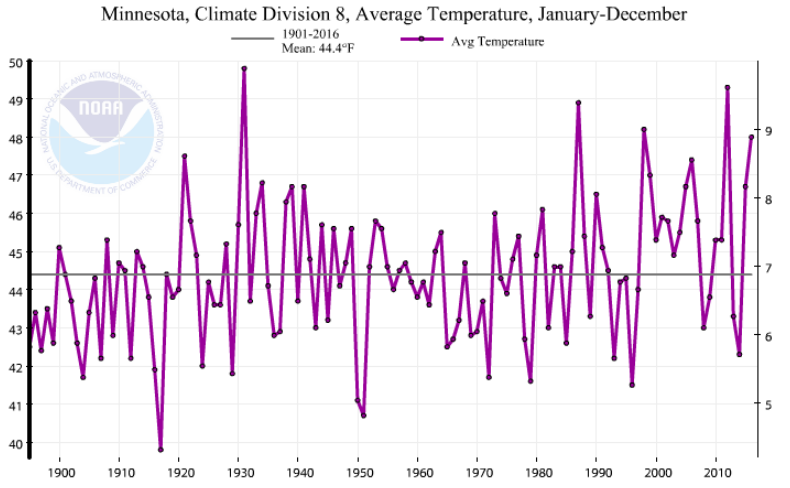
Using the PHDI data, the same extreme drought events stand out with one notable addition. The drought in 1911 was considered a severe drought on the PDSI due to meteorological conditions; however, the same drought was considered an extreme drought on the PHDI based on low levels of groundwater and low reservoirs. Historical PHDI (see appendix page 67) in Region Nine over the past 10 years have ranged from the 8th driest to the 114th driest. Essentially, over the past 10 years, south central Minnesota has experienced some of the moistest years on record and one of the driest.

Extreme Summer and Winter Weather

High rainfall events, coupled with prolonged periods of dryness are an observed result of a changing climate. According to State Climatologist Jim Zandlo[5], the amount of large precipitation events has been increasing for decades and is slightly lower than it was a century ago.

The overall precipitation recorded in millimeters annually has fluctuated across Region Nine, while the lowest level of precipitation was 14.35" below the average precipitation levels from 1895 – 2014 (29.29"). Over the past ten years, precipitation in Region Nine has typically exceeded the average – with a peak of 40.04" in 2010 and 37.06" in 2005. Not surprisingly, each of those years were among the lowest on the PDSI while ranking quite high in average temperature. *(See page 11)*

Average temperatures in Region Nine have varied considerably since 1895 but have regularly been higher than the long-term average of 44.4°F over the last ten years, leading to an average of 48°F for this decade. In fact, 2012 and 2016 were both among the five warmest years on record.



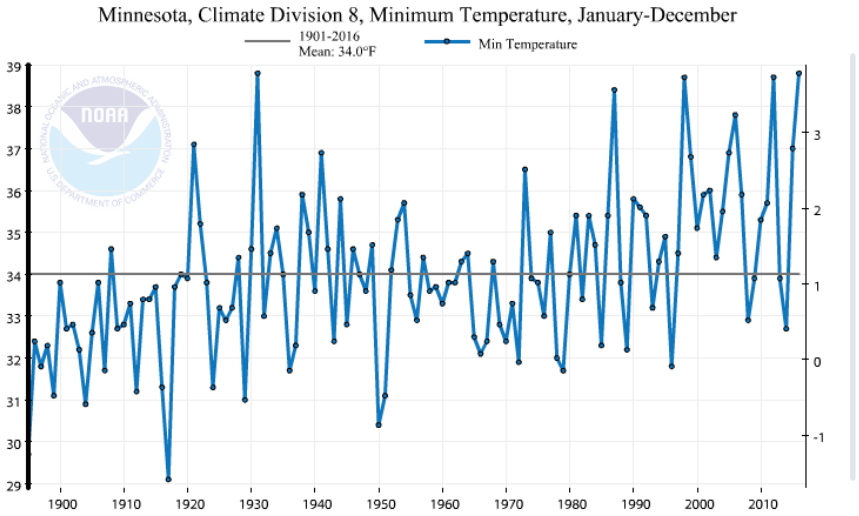
average **48°F** for this decade

Impact: Moderate-to-High

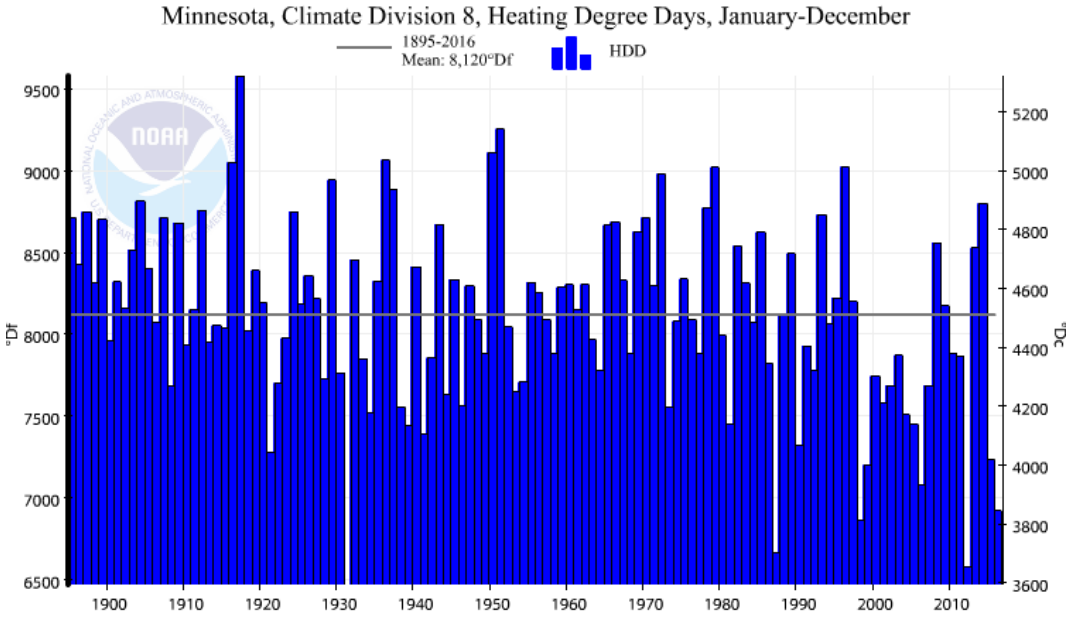
Highest Sectors Impacted

[5] Minnesota Climatology Working Group, *Climate Change and the Minnesota State Climatology Office: Observing the climate.*, http://climate.umn.edu/climateChange/climateChangeObservedNu.htm

A warming trend is even more noticeable for Region Nine's coldest temperatures. Average minimum temperatures have increased at a rate of 0.30°F since 1895, for an overall average increase of nearly 3.7°F. Since 2000, the years with the lowest minimum temperatures have been nearly as warm as those with the highest minimum temperatures during the first decade of the 20th century.



Increasing minimum temperatures appear to have a strong affect on Region Nine's heating degree days. Heating degree days are measure by calculating the number of degrees below 65°F of each day's average temperature and then sums these average across the course of an entire year.[6] This generates a figure that represents the total amount of energy required for heating. Since 1895, Region Nine's heating degree days have fallen by a rate of 46.44°F per decade and as of 2016, the average winter now has 567 fewer heating degree days than in 1895.



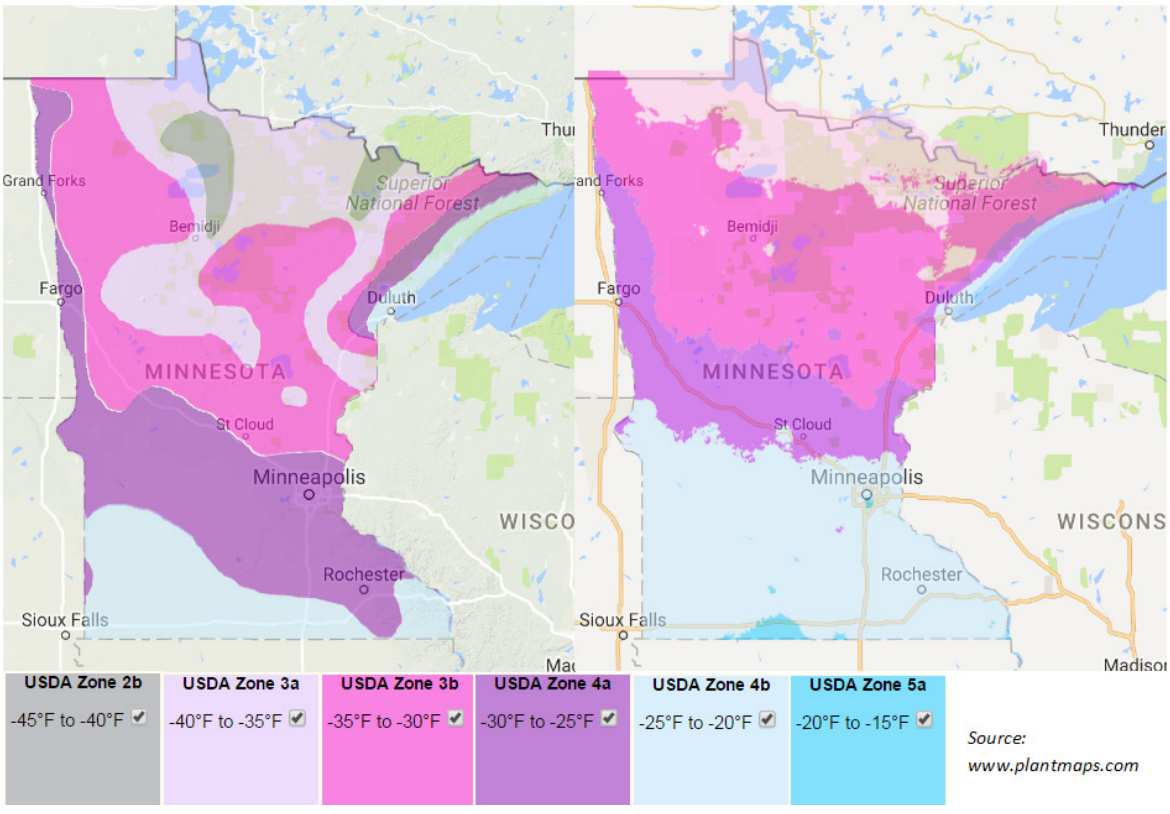
[6] Independent Statistic & Analysis U.S. Energy Information Administration, *Energy Units and Calculators Explained: Degree Days*, http://www.eia.gov/energyexplained/index.cfm?page=about_degree_days

Changes pose the risk of disrupting food supplies or destabilizing Minnesota's agricultural business model.

While milder winters may seem like a positive development for human comfort, they also represent the major changes in Minnesota's growing season. This can be problematic for farmers as planting and harvesting periods must be readjusted and crop selections may eventually change as the environment becomes suitable for different plants. All of these changes pose the risk of disrupting food supplies or destabilizing Minnesota's agricultural business model. More severe may be the effect on local ecology as plant and animal species find themselves no longer adapted to climate conditions and unable to move because of habitat fragmentation and man-made barriers such as highways.

Rising winter temperatures are vividly illustrated by recent updates to the plant hardiness zones published by the United States Department of Agriculture (USDA). These plant hardiness zones represent an average of the coldest temperature a given region could expect to face during its winter. In 2012, the USDA released maps based on data running through 2005, while their 1990 edition had only used data through 1986.[7] The new map shows major changes to Minnesota's hardiness zones. Many regions shifted half a zone, representing increases of around five degrees in their minimum temperatures. Some locations even shifted a full zone, representing increases of 10 degrees or more. Within Region Nine, areas in Nicollet, Le Sueur, and Sibley Counties, which had originally been in Zone 4a, shifted to 4b. In The southernmost part of the region, Martin County become mild enough to qualify as Zone 5a.

Comparison of 1990 and 2012 USDA Zones for Minnesota



[7] USDA Agricultural Research Service, *USDA Unveils New Plant Hardiness Zone Map*, https://www.ars.usda.gov/news-events/news/research-news/2012/usda-unveils-new-plant-hardiness-zone-map/

Infectious Diseases

Warmer winters can contribute significantly to the spread of infectious disease. Many infectious diseases, such as West Nile Virus and Zika Virus, are spread by insect vectors. Milder temperatures and longer growing seasons give more time for insects to spread to new areas and wetter weather increases the reproductive rate of species like mosquitoes that lay their eggs in water. West Nile Virus first appeared in New York City in 1999[8] and by 2002 was already present in birds in every county of Region Nine, with one case of human transmission reported in Martin county[9].

According to the CDC, climate change likely accelerated this rapid invasion. Increased temperatures and precipitation directly contributed to the growth of mosquito populations while increased wind could have helped blow infected mosquitoes into new areas. Even droughts brought on by increased precipitation variability may have helped spread West Nile Virus by breaking up large bodies of water into small standing puddles that proved ideal for mosquito breeding.

Research published by London's Royal Society suggests that by mid-century, Region Nine may even face threats from diseases formerly considered to be tropical, such as the Zika Virus which can cause severe birth defects, such as microcephaly among newborns.

By the period of 2045-2054, climate projections predict that southern Minnesota may be as much as 20 to 30 percent suitable for the breeding of the Asian tiger mosquito, which along with the yellow fever mosquito, represents one of the primary vectors of Zika.

Rainfall can influence the transport and dissemination of infectious agents while temperature affects their growth and survival.

Impact: Moderate-to-Low

Highest Sectors Impacted

[8] CDC, MMWR, *Outbreak of West Nile-Like Viral Encephalitis --New York*, 1999, https://www.cdc.gov/mmwr/preview/mmwrhtml/mm4838a1.htm

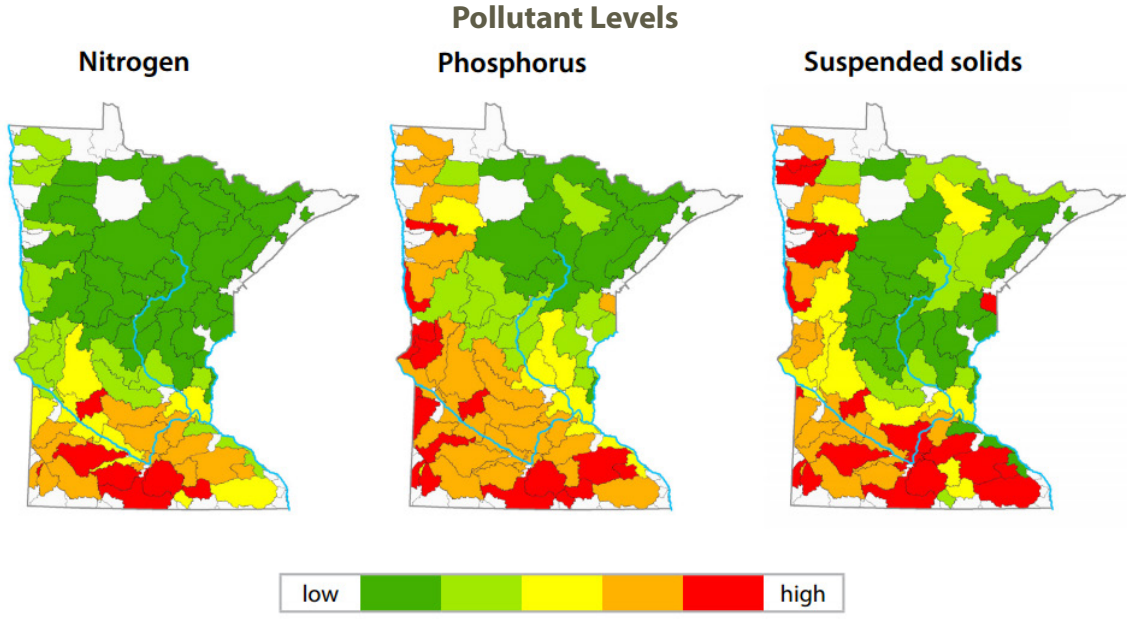
[9] Minnesota Department of Health, West Nile Virus Map and Statistics, http://www.health.state.mn.us/divs/idepc/diseases/westnile/statistics.html#archive

The elevated temperature and increased standing water associated with climate may also increase the risk of water contamination and waterborne illness. Warm stagnant lake water creates ideal conditions for the formation of algal blooms. According to the Minnesota Pollution Control Agency, these sudden growth of blue-green algae not only emit foul odors, but can be toxic for humans and pets depending on the species. Symptoms of toxic exposure can range from nausea and skin irritation to convulsions and death.

The conditions that lead to algal blooms can also support a number of dangerous parasites, such as the so-called "brain-eating" amoeba Naegleria fowleri. These protozoans thrive in warm murky water rich in suspended solids. Infections, which enter through the nose before spreading to the brain, are rare but deadly, with a 97 percent fatality rate. While once confined to the southern states, their range may be expanding due to climate change as they reproduce most quickly in temperatures up to 115°F. The probability of infection in Minnesota seemed remote until in 2010 a first case occurred in Washington County's Lily Lake, over 500 miles north of any previous case. Since then, Minnesota has experienced two more fatalities stemming from Naegleria fowleri as reported by the Center for Disease Control and Prevention.

As temperatures continue to rise, Region Nine is likely to face increasing threats from algal blooms and parasites like Naegleria fowleri. South central Minnesota's watersheds already suffer from high levels of nitrogen, phosphorous, and suspended solids[10]. Warmer water will only serve to compound the effects of these contaminants in creating ideal conditions for the expansion of algae and other protozoans.

3 **cases of infection from Naegleria fowleri in MN**



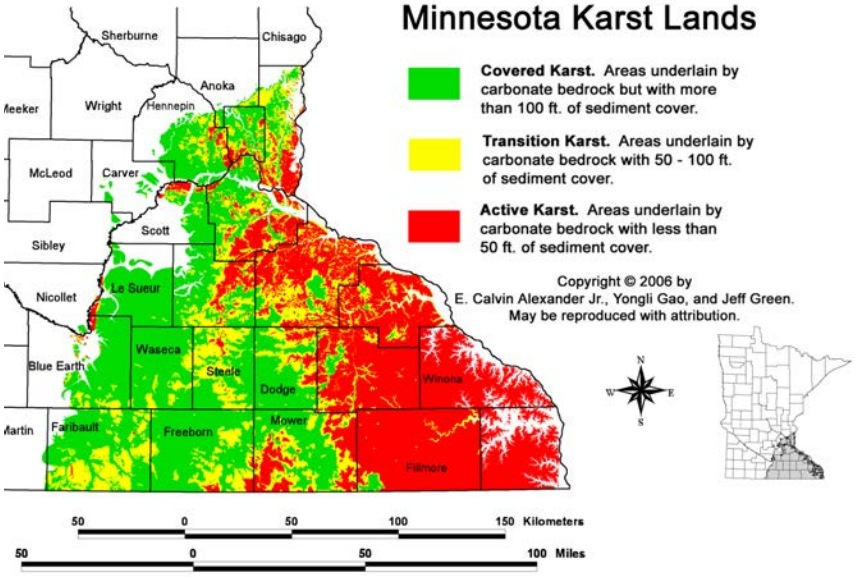
[10] Minnesota Pollution Control Agency

Wildfire and Land Subsidence

Water is the main factor in land subsidence–water level decline cause by utilizing/pumping groundwater and drought are two triggering mechanisms. Any changes to groundwater flow can also cause the ground to collapse.

Minnesota's most common natural cause of land subsidence are karst landforms – caves and underground drainage and sinkholes are found where these develop. These can cause water contamination because the pockets can allow pollutants to enter into groundwater supplies.

In Region Nine, karst lands include most of Le Sueur, Faribault, and Waseca counties and parts of Blue Earth and Nicollet counties. Martin, Nicollet, Sibley, western Blue Earth, Brown, and Watonwan Counties are not identified as karst land.



Neither fire or land subsidence were identified as significantly impacting Region Nine

Impact: Low

Highest Sectors Impacted

Neither fire or land subsidence were identified as significantly impacting Region Nine by the CCATF, cities, counties and townships in Region Nine or subject matter experts interviewed. As a result, early planning conversations included these two impacts but later information gathering did not.

How Impacts Affect Community Operations

Between August 2015 and November 2015, Region Nine sent out a survey to each of the 147 townships, 72 cities, and nine counties in the region and asked some basic questions about the impact climate change has had on their communities. The survey asked respondents to indicate the frequency of the climate impacts and how the impacts have affected their community operations.

The following information is a summary of the results and the key insights that were derived.

Survey Respondents:

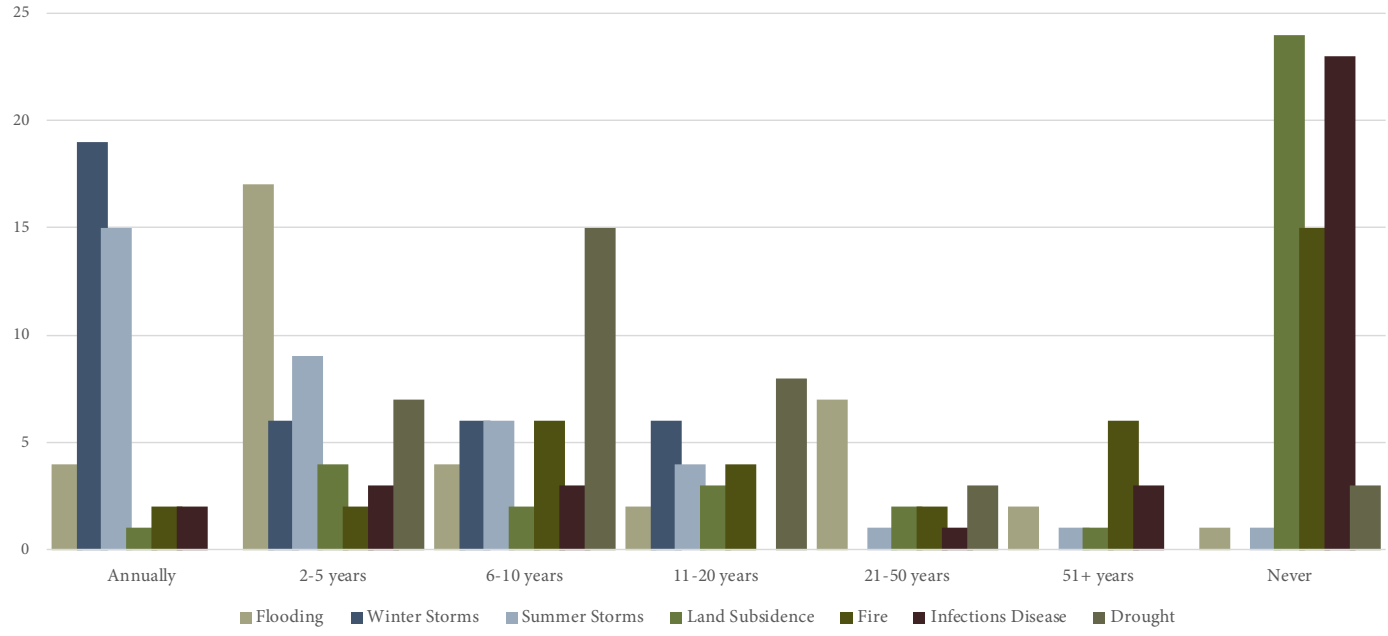
41% Townships

30% Cities

22% School Districts

8% Counties

Frequency the Impacts Have on Community Operations



Over half of communities surveyed indicated winter storms impacted their community on an annual basis, while approximately 41 percent indicated annual summer storms impacted their community operations.

Nearly 11 percent of communities cited annual flooding as a detriment to community operations, 46 percent indicated that flooding impacted their communities every two - five years.

Drought impacted communities most between two – 20 years, significantly every six – 10 years.

Land subsidence, fire, and infectious disease were cited as impacts least likely to impact communities in Region Nine.

How Impacts Affect Community Operations

Loss of Accessibility

Flooding **58%**

Winter Storm **75%**

Building Damage

Summer Storm **57%**

Flooding **36%**

Insurance Rates

Summer Storm **25%**

Flooding **19%**

Stress on Utilities

Winter Storm **53%**

Summer Storm **51%**

Cost/Economic Impact

Drought **66%**

Summer Storm **57%**

No Impact

Infectious Disease **84%**

Land Subsidence **76%**

Fire **71%**

Approximately 58 percent of communities indicated that flooding created a loss of accessibility. This includes accessibility to roads, businesses, work places, and critical facilities. This has an impact on the ability for emergency response and disaster relief as well as additional support to reach the community. Building damage and stress on infrastructure and utilities was also cited as a major impact of flooding. All of these affects have a major cost component.

The primary impacts of winter storms were loss of accessibility and stress on utilities, with an overall high cost of replacing damaged utilities. Summer storms lead to building damage, stress on utilities and have an overall high cost and economic impact. High cost and economic impact are primarily due to downed operations and utilities as well as business downtime while commercial facilities are being repaired.

The impact of drought on community operations has a huge economic impact, since the agriculture sector is extremely valuable to the economy in south central Minnesota. Additionally, stress on utilities was cited as an impact of drought because stress on water and wastewater utilities are exacerbated by drought.

Over 75 percent of jurisdictions surveyed indicated a need for government assistance if any of the climate change impacts affected them. The major themes that percolated to the top were FEMA, funding, repair, and prevention.

FEMA Prevention **Funding** Assistance **Repairs**

To supplement the public data research, and local government unit feedback, Region Nine interviewed subject matter experts. These experts aligned directly with the sectors identified in the vulnerability assessment and National Climate Assessment. The following statements were from the interviews and more can be found in the appendix.

"Cannot design our way out of a 500-year flood [plain]...too costly. Instead, adopt a regional upgrade strategy where one infrastructure project or upgrade coordinates with others."

"Figure out a mechanism to get relief dollars to impacted businesses and home owners more quickly."

"Look at developing a high level regional strategy"

"Local foods systems/urban gardens to mitigate heat island effect and provide sustainable foods."

"Analyze trends in data to determine the best places to put plows, flood walls, diverse soils, etc."

"Develop more annual crops like pennycress to utilize soils year around and do less mono-cropping and more rotation of crops."

Adaptation Plan

Objective 1:
Maximize Soil and Water Conservation

Increase conservation best management practices.

Strategy 1.1

Action Item 1.1a: Manage drainage to optimize crop production during drought and high-water events while protecting soil and water quality, dependent on topography, partnerships with farmers, require restructuring field drainage systems or retrofitting – need funding and education/ certification, such as Minnesota's Ag Water Quality Certification program.

Action Item 1.1b: Support local Soil and Water Conservation District's work with additional funding.

HIA Recommendation 1.1

Manage tile drainage during extreme precipitation events by replacing/retrofitting older, conventional tiling systems with controlled systems or denitrifying bioreactors to decrease chemical and nutrient loss. Each county's drainage authority and/or watershed district authority, along with the Minnesota Department of Agriculture (MDA), should partner with area farmers and landowners over the next five years to discuss funding and design options that are available to implement improved conservation drainage systems in their fields.

Strategy 1.2

Retain topsoil and agriculture productivity during extreme rain, drought, and freezing events.

Action Item 1.2a: Create vegetated buffers to come into compliance with legislative agreement that lands adjacent to Region Nine public waters be an average of 50 feet with a 30-foot minimum and 16.5 feet in all public drainage ditches so that essential ecosystems and water resources are protected from soil nitrate runoff while banks are stabilized from erosion, and essential greenspace is planted.

Action Item 1.2b: Partner with private landowners to conduct engagement sessions that create solutions for compliance for private ditches.

Action Item 1.2c: Create a multi-tiered approach to in-field and edge-of-field erosion control that incorporates grassed waterways, fielder borders, grass filter strips and contour buffer strips so that farmers have multiple options to control water drainage.

Action Item 1.2d: Establish a consortium comprised of Minnesota Department of Natural Resources (DNR), county environmental services, Minnesota Pollution Control Agency, watershed districts, county and city law enforcement, and key stakeholders. The consortium will enforce action items 1.2a to 1.2c effectively to ensure they are implemented and water quality, ecosystems, and soil nutrients and topsoil quality is maintained.

Action Item 1.2.e: Reduce tillage by incentivizing crop residue management in other ways such as cover crops with long roots to pull nutrients back up top, crop rotation to eliminate pest and disease problems, and subsidize research and development programs that enhance soil quality and eliminate residue without tillage.

HIA Recommendation 1.2

Create vegetative buffers along public drainage ditches and waterways to come into compliance with Minnesota law. The Minnesota DNR has released the buffer map that indicates the type and location of each required buffer strip. The implementation deadline for 30-50 foot buffers along public waters is November 1, 2017. The implementation deadline for 16.5 foot buffers along DNR identified public ditches is November 1, 2018. As the current buffer law is mandatory, next steps should involve county extension services and Minnesota DNR outreach to area landowners on best practice implementation and increasing landowner's return on investment regarding buffer strips.

Reduce tillage by encouraging alternative residue management methods such as cover crops and crop rotation. The MDA and each county's Soil and Water Conservation District, should reach out to landowners and farmers in Region Nine to determine if there are ways to incorporate conservation tillage practices into their business. The goal of this outreach is to not only increase conservation tillage and reduce soil erosion, but also to help farmers determine best practices on a case-by-case basis. The results being beneficial not only to Region Nine soil and water quality, but financially beneficial as well for Region Nine farmers. This recommendation should be implemented within the next five years, with a priority on new farmers entering the agriculture business as baby boomers retire.

Strategy 1.3

Manage impact of flooding.

Action Item 1.3a: Develop subsidized perennial vegetation planting and clean-up program so that more perennials are planted in the appropriate areas, so that soil is stabilized year round in critical areas and so that surface flooding is slowed and a filter system is created for trapping floating debris.

Action Item 1.3b: Build flood walls and restore flood plains so that flood waters are kept out of flood-prone areas, such as central business districts, residential, and critical infrastructure areas.

Action Item 1.3c: Where necessary and applicable, relocate development out of flood zones and elevate major highways above the flood plain.

Action Item 1.3d: Diversify the National Flood Insurance Program (NFIP) to encourage structure movement out of the flood plain to reduce long-term costs and exposure of first responders to flood issues.

Action Item 1.3e: Diversify the NFIP to include renters and contents for renters and eliminate claims caps so that any person living in a flood plain has protection from flood damage. Incentivize communities not participating in NFIP to adopt ordinances that meet FEMA requirements for NFIP. Incentive communities that are participating to adopt ordinances that exceed FEMA requirements to reduce flood risk so that when floods happen, insurance claims can help communities rebuild quicker.

Action Item 1.3f: Enhance floodplain development and management planning activities. Set a goal for counties to keep floodplain maps updated every three to four years. Invite the Minnesota Association of Floodplain Managers board of directors and/or committee chairs into communities located along major floodplains to promote public awareness.

Action Item 1.3g: Adopt floodplain management programs directly in line with county Flood Insurance Studies. Where Flood Insurance Studies are in need of updating, work with NFIP/FEMA/emergency management/local planning agencies to update the floodplain boundaries so that every community has a point of reference and key contacts for responding to extreme flooding.

Action Item 1.3h: Implement outreach strategies from 1.3e in all other communities, with special emphasis on flash flooding.

Action Item 1.3: Enhance wetland banking options, such as wetland banking credits, and grants, and create conservation easements, and promote the use of these resources through the Minnesota Board of Water & Soil Resources.

HIA Recommendation 1.3

Build flood walls in flood-prone areas and restore flood plains. Short-term flood mitigation along critical infrastructure and vulnerable populations should be prioritized until long-term flood control methods can be established. This may include strategically placed pumping stations where flooding occurs. Each county's emergency management and environment services department, along with each watershed management district, should utilize NFIP and FEMA county studies and current hazard mitigation plans to create a detailed plan of each flood-prone area within the county and determine a course of action to prevent flooding from occurring. Once a prioritized lists of flood-prone areas are completed, county officials can determine if there is grant funding available for flood mitigation projects through the Minnesota DNR and Minnesota Homeland Security and Emergency Management compatible with their needs. With torrential rain and flooding issues becoming more common, this recommendation should be implemented within the next two-three years, with the knowledge that projects may take longer to implement due to funding and changes in conditions. The ultimate goal of this recommendation is to maintain watershed integrity and natural flood plains as much as possible, while understanding that there are some instances where levees may be most appropriate.

Strategy 1.4

Promote water conservation.

Action Item 1.4a: Collect rainwater (rain barrels, etc.) and dew so that it can be used to water plants and gardens instead of fresh water supplies that may be needed to mitigate the effects of extreme heat and drought (fire and dry fields with no crop yields) and promote usage of rainwater collection methods.

Action Item 1.4b: Install steel roofs to create dew runoff so that it can be captured and used to water plants and gardens instead of fresh water supplies that may be needed to mitigate the effects of extreme heat and drought (fire and dry fields with no crop yields).

Action Item 1.4c: Create and retrofit buildings to improve water efficiency so that fewer freshwater supplies are utilized that may be needed to mitigate the effects of extreme heat and drought (fire and dry fields with no crop yields).

Action Item 1.4d: Incentives to encourage reuse of treated waste water – funding available, for the extra capital outlays.

Action Item 1.4e: Create and/or distribute templates for towns to use for water conservation best practices in a variety of areas from yard care to city park maintenance.

HIA Recommendation 1.4

Promote water harvesting/collection so rainwater can be used for landscaping and gardens in order to conserve groundwater supplies and mitigate extreme heat/drought events. City public utilities (water) departments or Municipal Separate Storm Sewer Systems (MS4s) in Region Nine should partner with the Minnesota Pollution Control Agency (MPCA) and their watershed management districts to promote rainwater harvesting best practices to homeowners and facilities managers. There should be a strong focus on homeowners with extensive landscaping and/or underground sprinkler systems, like subdivisions and homeowner association communities. Outreach to facilities could include schools with athletic fields to maintain, parks, and larger venues such as hotels, event centers or malls. Rainwater harvesting workshops could be promoted through local environmental outreach groups to increase awareness. This recommendation should begin after the MPCA updates their rainwater harvesting best practices and would be ongoing in each community.

Decrease impacts from extreme storms.

Strategy 1.5

Action Item 1.5a: Expand role of conservation districts support with additional funding for personnel, outreach and incentives.

Action Item 1.5b: Promote practices that slow water, capture, and infiltrate water such as increasing rain garden requirements, green roofs, and culvert sizing.

Manage the floodplain.

Strategy 1.6

Action Item 1.6a: Support funding to restore floodplains.

Action Item 1.6b: Explore/expand wetland banking options. Some banking options are already available through existing laws, etc. Counties could make these more lucrative or require increased acreage for replacement than already exists.

Objective 2: Expand Alternative Genetics and Crop Choices

Increase cover crops and invest in diversified cropping.

Strategy 2.1

Action Item 2.1a: Incentivize and educate farmers to plant perennial crops (hazelnuts, etc.) so that farmers can increase return on investment year around, keep the soil fertile, and decrease erosion.

Action Item 2.1b: Increase planting of perennial food and fiber crops (hazelnuts and others) so that crops are produced year round to offset potential summer losses due to drought, flooding, extreme summer storms.

Action Item 2.1c: Encourage farmers to increase annual crops to sustain lessening yields due to warming temperatures and faster development cycles.

Action Item 2.1d: Increase annual cover crops.

Investment and development strategies.

Strategy 2.2

Action Item 2.2a: Support the continued research and development of genetics and production practices to make resilient crops.

Objective 3: Infrastructure Management

Strategy 3.1

Limit power outages.

Action Item 3.1a: Build power service lines underground so that extreme weather events caused by climate change do not knock out power to homes, businesses, and critical infrastructure (hospitals, police stations, fire stations, utilities, energy infrastructure, and staging of disaster response).

Action Item 3.1b: Route electrical grid in low risk areas so that the impacts of power outages due to extreme heat, winter, and flooding are minimal.

Action Item 3.1c: Conduct vulnerability assessment of utility infrastructure.

Strategy 3.2

Maintain transportation and traffic flow.

Action Item 3.2a: Plant walls of corn or other vegetation near heavily trafficked roadways to keep snow off roads so that the impact of extreme winter weather such as ice storms is minimized.

Action Item 3.2b: Support state infrastructure plans geared towards transportation resilient infrastructure such as MnDOT's climate change adaptation plans for MnDOT District 1 and 6.

Action Item 3.2c: Retrofit airports, roads, rail and other transportation delivery systems for higher volume in case other modes are disabled so that there are more ways to transport goods, services, and emergency responses to and from destinations of importance in the event of extreme flooding.

Strategy 3.3

Support regional transportation initiatives (biking, walking, autos)

Action Item 3.3a: Decrease number of cars on roadways so that air quality/flow is improved and increase public transportation so that fewer cars are on the road and roadways are clear for disaster response.

Objective 4:
Increase Adaptive Capacity for Livestock and Human Health

Strategy 4.1

Increase immunization.

Action Item 4.1a: Fund research and development for livestock vaccinations.

Action Item 4.1b: Increase immunization clinics for humans.

Strategy 4.2

Keep livestock cool in extreme heat.

Action Item 4.2a: Develop more silvopasture farmland.

Silvopasture combines trees with forage and livestock production. The trees are managed for high-value sawlogs and at the same time provide shade and shelter for livestock and forage, reducing stress, and sometimes increasing forage production.

Objective 5:
Expand Risk Management and Management Planning Across Planning Platforms

Strategy 5.1

Utilize airports for disaster planning.

Action Item 5.1a: Identify areas in the region located above the flood plain, such as airports, so that staging areas can be identified. Staging area can be a gathering spot for resources during a disaster.

Action Item 5.1b: Gain access to these airports for staging of disasters by working with municipally-owned, county-owned, regional, and international airports to implement disaster staging.

Strategy 5.2

Add extreme weather into emergency planning.

Action Item 5.2a: Update county hazard mitigation plans so that extreme weather events and climate change are included.

Action Item 5.2b: Increase community emergency alert systems at strategic places for maximum efficiency (sirens, CodeRed, portable antennas).

Strategy 5.3

Include climate change in local, regional, statewide, and national plans.

Action Item 5.3a: Include climate change strategies planning in regional transportation plans so that impacts on transportation planning are planned for and implemented in the case of extreme flooding.

Action Item 5.3b: Include climate change strategies in the Comprehensive Economic Development Strategy, under disaster resiliency, so that federal economic development and disaster relief dollars can be funneled into effected communities to help them recover more swiftly to the impacts of extreme flooding, winter and summer storms, and drought.

Action Item 5.3b: Incorporate vulnerability to flood, drought, extreme summer, and winter into land use planning so that all land is developed with climate change impacts in mind.

Objective 6:
Special Focus on Resilience Sector Strategies

Strategy 6.1

Implement urban resiliency strategies.

Action Item 6.1a: Develop subsidized tree planting programs for residential properties so that more shade is created and less flooding occurs inside cities.

Action Item 6.1b: Promote urban forestry in public and commercial development so that the urban heat island affect is diminished.

Action Item 6.1c: Reduce the usage of air conditioning and increase natural cooling design in buildings and public spaces.

Strategy 6.2

Focus on renewable energy programs and initiatives by diversifying electricity generation.

Action Item 6.2a: Develop alternate ways to generate electricity in different terrains and climates.

Action Item 6.2b: Increase the number of solar panels on rooftops by 10 percent by the year 2025 so that the 25 percent renewable energy mandate (such as solar, wind, and geothermal) is met and is resistant to flooding.

Strategy 6.3

Implement conservation of energy practices.

Action Item 6.3a: Create an appliance trade in municipal program so that homes are more energy efficient and less reliant on the demands of energy generation.

Action Item 6.3b: Retrofit residential, commercial and industrial buildings to maximize energy efficiency so that energy is conserved and the demands on energy caused by extreme heat, winter, and flooding are minimized.

Action Item 6.3c: Align Local Government Unit policies with national and international energy conservation standards so that the demands of energy caused by extreme heat, winter, and flooding are minimized.

Action Item 6.3d: Increase and promote the installation of power saving appliances in lighting, and heating, ventilation and air conditioning systems in residential, commercial, and public buildings.

Objective 7:
Strengthen Local Food Production

Strengthen local food production.

Strategy 7.1

Action Item 7.1a: Change zoning within cities to allow truck farming and potentially small animal husbandry in several areas or zones around and within cities/towns.

Action Item 7.1b: Offer incentives and added support for Community Supported Agriculture farms. These farm sell directly to families, restaurants, schools and sometimes grocery stores. These farms often do not qualify for federal farm subsidies such as row crop farms do qualify.

Action Item 7.1c: Support reduced property tax levels on the above properties.

Action Item 7.1d: Support or partner with local University of Minnesota Extension Office, community education programs, and community garden programs to increase education about and participation in food gardening.

Action Item 7.1e: Support necessary infrastructure investments in processing and distribution to reduce cost for local businesses: hubs, USDA meat processing facilities, accessible financing options, institutional food processing facilities.

Local food availability may become an issue, especially with droughts more common in west and southeast U.S. Strategies to strengthen local food production and reduce reliance on foods shipped in from outside the state will be critical to creating sustainability.

Credits

Region Nine Climate Change Adaptation Task Force

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Ann Hendricks, Mankato Area Public Schools School Board
Cathi Fouchi, Minnesota Department of Natural Resources
Dr. Louis Schwartzkopf, Minnesota State University, Mankato, Environmental Committee and Climate Action Plan Initiative
Drew Campbell, Blue Earth County and Region Nine Commissioner
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Jim Dontje, Gustavus Adolphus College Johnson Center for Environmental Innovation
Nancy Lageson, Waseca County Emergency Management
Pam Meyer, Minnesota Pollution Control Agency and Region Nine Commissioner
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Ronda Allis, Minnesota Department of Transportation
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Climatologists:
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Kenny Blumenfeld, Ph.D. – Minnesota State Climatology Office

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Karen Moritz, Brown County Public Health
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Special Acknowledgments

Clark Johnson, Minnesota House of Representatives
Jothsna Harris, Climate Generation: A Will Steger Legacy
Nicole Rom, Climate Generation: A Will Steger Legacy
Paul Moss, Minnesota Pollution Control Agency

Appendix

Appendix I - Surveys Used During Planning

Agriculture Livestock and Crop

Name: _____ **Title: _____**

Organization: _____ **Date: _____**

Your Service Area: _____

1. Which climate change impacts have affected agriculture production (livestock and/or crops) in the past 20 years? How so? Please elaborate in as much detail as you can.

- Flooding _____
- Drought _____
- Summer Storms Events _____
- Infectious Disease _____
- Fire (Wild) _____
- Land Subsidence _____
- Winter Storms Events _____

2. To the best of your knowledge have any impact events occurred prior to the past 20 years that have affected or changed agriculture production (livestock and/or crops) in the region?

3. How do you foresee climate change impacting your service area?

4. How would you rate public awareness about the impacts of climate change on agriculture production (livestock and/or crops) in your service area? Please elaborate in as much detail as you can.

- Considerable
- Some
- Little to None

5. In your opinion, is agriculture production (livestock and/or crops) in your service area consistently vulnerable to this impact? How consistent? How is it vulnerable?

6. As applicable, please indicate the variables impacting agriculture production (livestock and/or crops) within each county? (Climate change impact or variables: Flooding, Severe Summer Storms, Severe Winter Storms, Fire and Drought)

County	Climate change variables impacting agriculture production (livestock and/or crops)
Blue Earth	
Brown	
Faribault	
Le Sueur	
Martin	
Nicollet	
Sibley	
Waseca	
Watonwan	

7. Based on your professional experiences, what are some ways that your service area, stakeholders, clients, and communities are adapting to the impacts of climate change?

8. If you could choose one of these adaptation strategies that would help your service area, stakeholders, clients, and communities adapt to climate change, which would you choose and why?

9. Is there anything you feel advances the discussion of climate change vulnerability related to agriculture production (livestock and/or crops) that we have not discussed?

10. Do you have any recommendations for agriculture production (livestock and/or crops) climate related source data?

11. Would you like to be involved in our climate change adaptation planning process as:

- A task force member
- Health Impact Assessment (HIA) planning
- A community organizer/civic engagement volunteer
- Resource
- Stakeholder

Thank you very much for your time!

Region Nine Development Commission

Economic Development and Business Development/Infrastructure

Name: _____ **Title: _____**

Organization: _____ **Date: _____**

Your Service Area: _____

1. Which climate change impacts have affected business and economic development or business infrastructure in the region during the past 20 years? How so? Please elaborate in as much detail as you can.

- Flooding _____
- Drought _____
- Summer Storms Events _____
- Infectious Disease _____
- Fire (Wild) _____
- Land Subsidence _____
- Winter Storms Events _____

2. To the best of your knowledge have any impact events occurred prior to the past 20 years that have affected economic development or business development and infrastructure in the region?

3. How do you foresee climate change impacting your service area?

4. How would you rate public awareness about the impacts of climate change on economic and business development in your service area? Please elaborate in as much detail as you can.

- Considerable
- Some
- Little to None

5. In your opinion, is economic development and business development/infrastructure in your service area consistently vulnerable to this impact? How consistent? How is it vulnerable?

6. As applicable, please indicate the climate change variables impacting economic development, business development and/or business infrastructure within each county? (Climate change impact or variables: Flooding, Severe Summer Storms, Severe Winter Storms, Fire and Drought)

County	Climate change variables impacting economic development and business development and/or infrastructure
Blue Earth	
Brown	
Faribault	
Le Sueur	
Martin	
Nicollet	
Sibley	
Waseca	
Watonwan	

7. Based on your professional experiences, what are some ways that your service area, stakeholders, clients, and communities are adapting to the impacts of climate change?

8. If you could choose one of these adaptation strategies that would help your service area, stakeholders, clients, and communities adapt to climate change, which would you choose and why?

9. Is there anything you feel advances the discussion of climate change vulnerability related to economic and business development and/or infrastructure that we have not discussed?

10. Do you have any recommendations for economic development and business development/infrastucture climate related source data?

11. Would you like to be involved in our climate change adaptation planning process as:

- A task force member
- Health Impact Assessment (HIA) planning
- A community organizer/civic engagement volunteer
- Resource
- Stakeholder

Thank you very much for your time

Region Nine Development Commission

Climate Change Planning Team

Brent: 507-389-8867

Jacob: 507-389-8873

Ecosystems and Biodiversity

Name: _____ **Title: _____**

Organization: _____ **Date: _____**

Your Service Area: _____

1. Which climate change impacts have affected or changed ecosystems in the region during the past 20 years? How so? Please elaborate in as much detail as you can.

- Flooding _____
- Drought _____
- Summer Storms Events _____
- Infectious Disease _____
- Fire (Wild) _____
- Land Subsidence _____
- Winter Storms Events _____

2. To the best of your knowledge have any impact events occurred prior to the past 20 years that have affected or changed ecosystems in the region?

3. How do you foresee climate change impacting your service area?

4. How would you rate public awareness about the impacts of climate change on ecosystems in your service area? Please elaborate in as much detail as you can.

- Considerable
- Some
- Little to None

5. In your opinion, are ecosystems in your service area consistently vulnerable to this impact? How consistent? How is it vulnerable?

6. As applicable, please indicate the variables impacting ecosystems within each county? (Climate change impact or variables: Flooding, Severe Summer Storms, Severe Winter Storms, Fire and Drought)

County	**Climate change variables impacting ecosystems**
Blue Earth	
Brown	
Faribault	
Le Sueur	
Martin	
Nicollet	
Sibley	
Waseca	
Watonwan	

7. Based on your professional experiences, what are some ways that your service area, stakeholders, clients, and communities are adapting to the impacts of climate change?

8. If you could choose one of these adaptation strategies that would help your service area, stakeholders, clients, and communities adapt to climate change, which would you choose and why?

9. Is there anything you feel advances the discussion of climate change vulnerability related to ecosystems water resources, supply, and/or quality that we have not discussed?

10. Do you have any recommendations for ecosystems climate related source data?

11. Would you like to be involved in our climate change adaptation planning process as:

- A task force member
- Health Impact Assessment (HIA) planning
- A community organizer/civic engagement volunteer
- Resource
- Stakeholder

Thank you very much for your time

Region Nine Development Commission

Energy Supply and Use

Name: _____ **Title: _____**

Organization: _____ **Date: _____**

Your Service Area: _____

1. Which climate change impacts have caused energy supply and production disruptions in the region during the past 20 years? How so? Please elaborate in as much detail as you can.

- Flooding _____
- Drought _____
- Summer Storms Events _____
- Infectious Disease _____
- Fire (Wild) _____
- Land Subsidence _____
- Winter Storms Events _____

2. To the best of your knowledge have any impact events occurred prior to the past 20 years that have affected energy supply and production in the region?

3. How do you foresee climate change impacting your service area?

4. How would you rate public awareness about the impacts of climate change on energy supply and production in your service area? Please elaborate in as much detail as you can.

- Considerable
- Some
- Little to None

5. In your opinion, is energy supply and production in your service area consistently vulnerable to disruptions caused by these impacts? How consistent? How is it vulnerable?

6. As applicable, please indicate the variables impacting energy supply and use within each county? (Climate change impact or variables: Flooding, Severe Summer Storms, Severe Winter Storms, Fire and Drought)

County	**Climate change variables impacting energy supply and use**
Blue Earth	
Brown	
Faribault	
Le Sueur	
Martin	
Nicollet	
Sibley	
Waseca	
Watonwan	

7. Based on your professional experiences, what are some ways that your service area, stakeholders, clients, and communities are adapting to the impacts of climate change?

8. If you could choose one of these adaptation strategies that would help your service area, stakeholders, clients, and communities adapt to climate change, which would you choose and why?

9. Is there anything you feel advances the discussion of climate change vulnerability related to energy supply and use that we have not discussed?

10. Do you have any recommendations for climate related source data focused on energy supply and use?

11. Would you like to be involved in our climate change adaptation planning process as:

- A task force member
- Health Impact Assessment (HIA) planning
- A community organizer/civic engagement volunteer
- Resource
- Stakeholder

Thank you very much for your time!

Region Nine Development Commission

Forests

Name: _____ **Title: _____**

Organization: _____ **Date: _____**

Your Service Area: _____

1. Which climate change impacts have affected forests in the region during the past 20 years? How so? Please elaborate in as much detail as you can.

- Flooding _____
- Drought _____
- Summer Storms Events _____
- Infectious Disease _____
- Fire (Wild) _____
- Land Subsidence _____
- Winter Storms Events _____

2. To the best of your knowledge have any impact events occurred prior to the past 20 years that have affected forests in the region?

3. How do you foresee climate change impacting your service area?

4. How would you rate public awareness about the impacts of climate change on forests in your service area? Please elaborate in as much detail as you can.

- Considerable
- Some
- Little to None

5. In your opinion, are forests in your service area consistently vulnerable to this impact? How consistent? How is it vulnerable?

6. As applicable, please indicate the variables impacting forestry and urban forestry within each county? (Climate change impact or variables: Flooding, Severe Summer Storms, Severe Winter Storms, Fire and Drought)

County	**Climate change variables impacting forestry and urban forestry***
Blue Earth	
Brown	
Faribault	
Le Sueur	
Martin	
Nicollet	
Sibley	
Waseca	
Watonwan	

* *Urban Forests are forests primarily located in cities and urban areas that are far more impacted by man-made disturbances than rural forests*

7. Based on your professional experiences, what are some ways that your service area, stakeholders, clients, and communities are adapting to the impacts of climate change?

8. If you could choose one of these adaptation strategies that would help your service area, stakeholders, clients, and communities adapt to climate change, which would you choose and why?

9. Is there anything you feel advances the discussion of climate change vulnerability related to forests that we have not discussed?

10. Do you have any recommendations for forests related climate change source data?

11. Would you like to be involved in our climate change adaptation planning process as:

- A task force member
- Health Impact Assessment (HIA) planning
- A community organizer/civic engagement volunteer
- Resource
- Stakeholder

Thank you very much for your time

Region Nine Development Commission

Human Health

Name: _____ **Title: _____**

Organization: _____ **Date: _____**

Your Service Area: _____

1. Which climate change impacts have affected human health in the region during the past 20 years? How so? Please elaborate in as much detail as you can.

- Flooding _____
- Drought _____
- Summer Storms Events _____
- Infectious Disease _____
- Fire (Wild) _____
- Land Subsidence _____
- Winter Storms Events _____

2. To the best of your knowledge have any impact events occurred prior to the past 20 years that have affected human health in the region?

3. How do you foresee climate change impacting your service area?

4. How would you rate public awareness about the impacts of climate change on human health in your service area? Please elaborate in as much detail as you can.

- Considerable
- Some
- Little to None

5. In your opinion, is human health in your service area consistently vulnerable to this impact? How consistent? How is it vulnerable?

6. As applicable, please indicate the variables impacting human health within each county? (Climate change impact or variables: Flooding, Severe Summer Storms, Severe Winter Storms, Fire and Drought)

County	**Climate change variables impacting human health**
Blue Earth	
Brown	
Faribault	
Le Sueur	
Martin	
Nicollet	
Sibley	
Waseca	
Watonwan	

7. Based on your professional experiences, what are some ways that your service area, stakeholders, clients, and communities are adapting to the impacts of climate change?

8. If you could choose one of these adaptation strategies that would help your service area, stakeholders, clients, and communities adapt to climate change, which would you choose and why?

9. Is there anything you feel advances the discussion of climate change vulnerability related to human health that we have not discussed?

10. Do you have any recommendations for climate related source data focused on human health?

11. Would you like to be involved in our climate change adaptation planning process as:

- A task force member
- Health Impact Assessment (HIA) planning
- A community organizer/civic engagement volunteer
- Resource
- Stakeholder

Thank you very much for your time

Region Nine Development Commission

Transportation

Name: _____ **Title: _____**

Organization: _____ **Date: _____**

Your Service Area: _____

1. Which climate change impacts have affected transportation in the region during the past 20 years? How so? Please elaborate in as much detail as you can.

- Flooding _____
- Drought _____
- Summer Storms Events _____
- Infectious Disease _____
- Fire (Wild) _____
- Land Subsidence _____
- Winter Storms Events _____

2. To the best of your knowledge have any impact events occurred prior to the past 20 years that affected transportation in the region?

3. How do you foresee climate change impacting your service area?

4. How would you rate public awareness about the impacts of climate change on transportation in your service area? Please elaborate in as much detail as you can.

- Considerable
- Some
- Little to None

5. In your opinion, is transportation in your service area consistently vulnerable to this impact? How consistent? How is it vulnerable?

6. As applicable, please indicate the specific mode(s) of transportation or a network linking various transportation modes and logistics centers within each county that are vulnerable to climate change? (Climate change impact or variables: Flooding, Severe Summer Storms, Severe Winter Storms, Fire and Drought)

County	Mode of transportation	Logistics Centers*	Climate Change Impact or variables
Blue Earth			
Brown			
Faribault			
Le Sueur			
Martin			
Nicollet			
Sibley			
Waseca			
Watonwan			

* *Warehouse, distribution center, a transportation node, bus stop, rail spur, other*

7. Based on your professional experiences, what are some ways that your service area, stakeholders, clients, and communities are adapting to the impacts of climate change?

8. If you could choose one of these adaptation strategies that would help your service area, stakeholders, clients, and communities adapt to climate change, which would you choose and why?

9. Is there anything you feel advances the discussion of climate change vulnerability related to transportation that we have not discussed?

10. Do you have any recommendations for transportation climate related source data?

11. Would you like to be involved in our climate change adaptation planning process as:

- A task force member
- Health Impact Assessment (HIA) planning
- A community organizer/civic engagement volunteer
- Resource
- Stakeholder

Thank you very much for your time

Region Nine Development Commission

Water Resources, Supply and/or Quality

Name: _____ **Title: _____**

Organization: _____ **Date: _____**

Your Service Area: _____

1. Which climate change impacts have affected water resources, supply and/or quality in the region during the past 20 years? How so? Please elaborate in as much detail as you can.

- Flooding _____
- Drought _____
- Summer Storms Events _____
- Infectious Disease _____
- Fire (Wild) _____
- Land Subsidence _____
- Winter Storms Events _____

2. To the best of your knowledge have any impact events occurred prior to the past 20 years that have affected water resources, supply, and/or quality in the region?

3. How do you foresee climate change impacting your service area?

4. How would you rate public awareness about the impacts of climate change on water resources, supply, and/or quality in your service area? Please elaborate in as much detail as you can.

- Considerable
- Some
- Little to None

5. In your opinion, are water resources, supply, and/or quality in your service area consistently vulnerable to this impact? How consistent? How is it vulnerable?

6. As applicable, please indicate the variables impacting water resources, supply, and/or quality within each county? (Climate change impact or variables: Flooding, Severe Summer Storms, Severe Winter Storms, Fire and Drought)

County	Climate change variables impacting water resources, supply, and/or quality
Blue Earth	
Brown	
Faribault	
Le Sueur	
Martin	
Nicollet	
Sibley	
Waseca	
Watonwan	

7. Based on your professional experiences, what are some ways that your service area, stakeholders, clients, and communities are adapting to the impacts of climate change?

8. If you could choose one of these adaptation strategies that would help your service area, stakeholders, clients, and communities adapt to climate change, which would you choose and why?

9. Is there anything you feel advances the discussion of climate change vulnerability related to water resources, supply, and/or quality that we have not discussed?

10. Do you have any recommendations for water resources, supply, and/or quality climate related source data?

11. Would you like to be involved in our climate change adaptation planning process as:

- A task force member
- Health Impact Assessment (HIA) planning
- A community organizer/civic engagement volunteer
- Resource
- Stakeholder

Thank you very much for your time!

Region Nine Development Commission

Appendix II - Health Impact Assessment

Appendix III - NOAA

Average Annual Temperature in South Central Minnesota, 1895 - 2014

Year	Average Temp.	Rank	Above/Below average base period of 44.4°F
1895	42.5°F	16	-1.9°F
1896	43.4°F	35	-1.0°F
1897	42.4°F	15	-2.0°F
1898	43.5°F	37	-0.9°F
1899	42.6°F	18	-1.8°F
1900	45.1°F	85	0.7°F
1901	44.4°F	63	0.0°F
1902	43.7°F	41	-0.7°F
1903	42.6°F	18	-1.8°F
1904	41.7°F	6	-2.7°F
1905	43.4°F	35	-1.0°F
1906	44.3°F	59	-0.1°F
1907	42.2°F	11	-2.2°F
1908	45.3°F	90	0.9°F
1909	42.8°F	23	-1.6°F
1910	44.7°F	75	0.3°F
1911	44.5°F	66	0.1°F
1912	42.2°F	11	-2.2°F
1913	45.0°F	83	0.6°F
1914	44.6°F	71	0.2°F
1915	43.8°F	45	-0.6°F
1916	41.9°F	9	-2.5°F
1917	39.8°F	1	-4.6°F
1918	44.4°F	63	0.0°F
1919	43.8°F	45	-0.6°F
1920	44.0°F	50	-0.4°F
1921	47.5°F	117	3.1°F
1922	45.8°F	103	1.4°F
1923	44.9°F	80	0.5°F
1924	42.0°F	10	-2.4°F
1925	44.2°F	55	-0.2°F
1926	43.6°F	38	-0.8°F
1927	43.6°F	38	-0.8°F
1928	45.2°F	86	0.8°F
1929	41.8°F	8	-2.6°F
1930	45.7°F	99	1.3°F
1931	49.8°F	122	5.4°F
1932	43.7°F	41	-0.7°F
1933	46.0°F	106	1.6°F
1934	46.8°F	114	2.4°F
1935	44.1°F	53	-0.3°F
1936	42.8°F	23	-1.6°F
1937	42.9°F	26	-1.5°F
1938	46.3°F	108	1.9°F
1939	46.7°F	113	2.3°F
1940	43.7°F	41	-0.7°F
1941	46.7°F	113	2.3°F
1942	44.8°F	77	0.4°F
1943	43.0°F	28	-1.4°F
1944	45.7°F	99	1.3°F
1945	43.2°F	31	-1.2°F
1946	45.6°F	97	1.2°F
1947	44.1°F	53	-0.3°F
1948	44.7°F	75	0.3°F
1949	45.6°F	97	1.2°F
1950	41.1°F	3	-3.3°F
1951	40.7°F	2	-3.7°F
1952	44.6°F	71	0.2°F
1953	45.8°F	103	1.4°F
1954	45.6°F	97	1.2°F
1955	44.6°F	71	0.2°F
1956	44.0°F	50	-0.4°F
1957	44.5°F	66	0.1°F
1958	44.7°F	75	0.3°F
1959	44.2°F	55	-0.2°F
1960	43.8°F	45	-0.6°F
1961	44.2°F	55	-0.2°F
1962	43.6°F	38	-0.8°F
1963	45.0°F	83	0.6°F
1964	45.5°F	94	1.1°F
1965	42.5°F	16	-1.9°F
1966	42.7°F	21	-1.7°F

Average Annual Temperature in South Central Minnesota, 1895 - 2014 *(con't)*

Year	Average Temp.	Rank	Above/Below average base period of 44.4°F
1967	43.2°F	31	-1.2°F
1968	44.7°F	75	0.3°F
1969	42.8°F	23	-1.6°F
1970	42.9°F	26	-1.5°F
1971	43.7°F	41	-0.7°F
1972	41.7°F	6	-2.7°F
1973	46.0°F	106	1.6°F
1974	44.3°F	59	-0.1°F
1975	43.9°F	49	-0.5°F
1976	44.8°F	77	0.4°F
1977	45.4°F	92	1.0°F
1978	42.7°F	21	-1.7°F
1979	41.6°F	5	-2.8°F
1980	44.9°F	80	0.5°F
1981	46.1°F	107	1.7°F
1982	43.0°F	28	-1.4°F
1983	44.6°F	71	0.2°F
1984	44.6°F	71	0.2°F
1985	42.6°F	18	-1.8°F
1986	45.0°F	83	0.6°F
1987	48.9°F	120	4.5°F
1988	45.4°F	92	1.0°F
1989	43.3°F	33	-1.1°F
1990	46.5°F	109	2.1°F
1991	45.1°F	85	0.7°F
1992	44.5°F	66	0.1°F
1993	42.2°F	11	-2.2°F
1994	44.2°F	55	-0.2°F
1995	44.3°F	59	-0.1°F
1996	41.5°F	4	-2.9°F
1997	44.0°F	50	-0.4°F
1998	48.2°F	119	3.8°F
1999	47.0°F	115	2.6°F
2000	45.3°F	90	0.9°F
2001	45.9°F	104	1.5°F
2002	45.8°F	103	1.4°F
2003	44.9°F	80	0.5°F
2004	45.5°F	94	1.1°F
2005	46.7°F	113	2.3°F
2006	47.4°F	116	3.0°F
2007	45.8°F	103	1.4°F
2008	43.0°F	28	-1.4°F
2009	43.8°F	45	-0.6°F
2010	45.3°F	90	0.9°F
2011	45.3°F	90	0.9°F
2012	49.3°F	121	4.9°F
2013	43.3°F	33	-1.1°F
2014	42.3°F	14	-2.1°F
2015	46.7°F	113	2.3°F
2016	48.0°F	118	3.6°F

Source: National Oceanic and Atmospheric Administration National Climatic Data Center, "Climate at a Glance" database: http://www.ncdc.noaa.gov/cag/time-series/us

Maximum Annual Temperature in South Central Minnesota, 1895 - 2016

Year	Average Temp.	Rank	Above/Below average high of 54.8°F
1895	55.4°F	74	0.6°F
1896	54.4°F	51	-0.4°F
1897	53.1°F	21	-1.7°F
1898	54.8°F	64	0.0°F
1899	54.0°F	41	-0.8°F
1900	56.4°F	99	1.6°F
1901	56.0°F	93	1.2°F
1902	54.5°F	55	-0.3°F
1903	53.0°F	20	-1.8°F
1904	52.5°F	9	-2.3°F
1905	54.0°F	41	-0.8°F
1906	54.7°F	60	-0.1°F
1907	52.7°F	14	-2.1°F
1908	56.0°F	93	1.2°F
1909	52.9°F	18	-1.9°F
1910	56.7°F	108	1.9°F
1911	55.7°F	85	0.9°F
1912	53.2°F	23	-1.6°F
1913	56.5°F	102	1.7°F
1914	55.8°F	88	1.0°F
1915	53.8°F	37	-1.0°F
1916	52.5°F	9	-2.3°F
1917	50.6°F	2	-4.2°F
1918	55.2°F	72	0.4°F
1919	53.5°F	29	-1.3°F
1920	54.2°F	47	-0.6°F
1921	57.8°F	117	3.0°F
1922	56.5°F	102	1.7°F
1923	56.1°F	94	1.3°F
1924	52.7°F	14	-2.1°F
1925	55.2°F	72	0.4°F
1926	54.4°F	51	-0.4°F
1927	54.0°F	41	-0.8°F
1928	55.9°F	91	1.1°F
1929	52.6°F	12	-2.2°F
1930	56.8°F	109	2.0°F
1931	60.9°F	122	6.1°F
1932	54.5°F	55	-0.3°F
1933	57.4°F	115	2.6°F
1934	58.6°F	119	3.8°F
1935	54.1°F	44	-0.7°F
1936	53.8°F	37	-1.0°F
1937	53.4°F	25	-1.4°F
1938	56.7°F	108	1.9°F
1939	58.4°F	118	3.6°F
1940	53.9°F	39	-0.9°F
1941	56.6°F	105	1.8°F
1942	55.0°F	67	0.2°F
1943	53.6°F	32	-1.2°F
1944	55.6°F	80	0.8°F
1945	53.5°F	29	-1.3°F
1946	56.6°F	105	1.8°F
1947	54.2°F	47	-0.6°F
1948	55.7°F	85	0.9°F
1949	56.4°F	99	1.6°F
1950	51.9°F	8	-2.9°F
1951	50.3°F	1	-4.5°F
1952	55.2°F	72	0.4°F
1953	56.3°F	95	1.5°F
1954	55.6°F	80	0.8°F
1955	55.7°F	85	0.9°F
1956	55.0°F	67	0.2°F
1957	54.6°F	58	-0.2°F
1958	55.8°F	88	1.0°F
1959	54.7°F	60	-0.1°F
1960	54.2°F	47	-0.6°F
1961	54.5°F	55	-0.3°F
1962	53.4°F	25	-1.4°F
1963	55.6°F	80	0.8°F
1964	56.5°F	102	1.7°F
1965	52.5°F	9	-2.3°F
1966	53.4°F	25	-1.4°F

Maximum Annual Temperature in South Central Minnesota, 1895 - 2016 *(con't)*

Year	Average Temp.	Rank	Above/Below average high of 54.8°F
1967	53.9°F	39	-0.9°F
1968	55.1°F	68	0.3°F
1969	52.8°F	16	-2.0°F
1970	53.4°F	25	-1.4°F
1971	54.2°F	47	-0.6°F
1972	51.5°F	5	-3.3°F
1973	55.6°F	80	0.8°F
1974	54.7°F	63	-0.1°F
1975	54.1°F	44	-0.7°F
1976	56.6°F	105	1.8°F
1977	55.9°F	91	1.1°F
1978	53.3°F	24	-1.5°F
1979	51.5°F	5	-3.3°F
1980	55.8°F	88	1.0°F
1981	56.7°F	108	1.9°F
1982	52.6°F	12	-2.2°F
1983	53.7°F	35	-1.1°F
1984	54.4°F	51	-0.4°F
1985	52.9°F	18	-1.9°F
1986	54.6°F	58	-0.2°F
1987	59.5°F	120	4.7°F
1988	57.0°F	111	2.2°F
1989	54.4°F	51	-0.4°F
1990	57.2°F	113	2.4°F
1991	54.7°F	63	-0.1°F
1992	53.6°F	32	-1.2°F
1993	51.1°F	3	-3.7°F
1994	54.1°F	44	-0.7°F
1995	53.7°F	35	-1.1°F
1996	51.1°F	3	-3.7°F
1997	53.5°F	29	-1.3°F
1998	57.6°F	116	2.8°F
1999	57.2°F	113	2.4°F
2000	55.5°F	76	0.7°F
2001	55.9°F	91	1.1°F
2002	55.7°F	85	0.9°F
2003	55.4°F	74	0.6°F
2004	55.5°F	76	0.7°F
2005	56.4°F	99	1.6°F
2006	57.0°F	111	2.2°F
2007	55.7°F	85	0.9°F
2008	53.1°F	21	-1.7°F
2009	53.6°F	32	-1.2°F
2010	55.2°F	72	0.4°F
2011	54.9°F	65	0.1°F
2012	59.9°F	121	5.1°F
2013	52.8°F	16	-2.0°F
2014	51.8°F	7	-3.0°F
2015	56.4°F	99	1.6°F
2016	57.3°F	114	2.5°F

Source: National Oceanic and Atmospheric Administration National Climatic Data Center, "Climate at a Glance" database: http://www.ncdc.noaa.gov/cag/time-series/us

Minimum Annual Temperature in South Central Minnesota, 1895 - 2016

Year	Average Temp.	Rank	Above/Below average min. of 33.9°F
1895	29.7°F	2	-4.3°F
1896	32.4°F	24	-1.6°F
1897	31.8°F	14	-2.2°F
1898	32.3°F	21	-1.7°F
1899	31.1°F	6	-2.9°F
1900	33.8°F	58	-0.2°F
1901	32.7°F	30	-1.3°F
1902	32.8°F	33	-1.2°F
1903	32.2°F	19	-1.8°F
1904	30.9°F	4	-3.1°F
1905	32.6°F	29	-1.4°F
1906	33.8°F	58	-0.2°F
1907	31.7°F	11	-2.3°F
1908	34.6°F	86	0.6°F
1909	32.7°F	30	-1.3°F
1910	32.8°F	33	-1.2°F
1911	33.3°F	45	-0.7°F
1912	31.2°F	8	-2.8°F
1913	33.4°F	48	-0.6°F
1914	33.4°F	48	-0.6°F
1915	33.7°F	55	-0.3°F
1916	31.3°F	9	-2.7°F
1917	29.1°F	1	-4.9°F
1918	33.7°F	55	-0.3°F
1919	34.0°F	72	0.0°F
1920	33.9°F	68	-0.1°F
1921	37.1°F	116	3.1°F
1922	35.2°F	94	1.2°F
1923	33.8°F	64	-0.2°F
1924	31.3°F	9	-2.7°F
1925	33.2°F	42	-0.8°F
1926	32.9°F	37	-1.1°F
1927	33.2°F	42	-0.8°F
1928	34.4°F	79	0.4°F
1929	31.0°F	5	-3.0°F
1930	34.6°F	86	0.6°F
1931	38.8°F	122	4.8°F
1932	33.0°F	40	-1.0°F
1933	34.5°F	82	0.5°F
1934	35.1°F	93	1.1°F
1935	34.0°F	72	0.0°F
1936	31.7°F	11	-2.3°F
1937	32.3°F	21	-1.7°F
1938	35.9°F	109	1.9°F
1939	35.0°F	91	1.0°F
1940	33.6°F	52	-0.4°F
1941	36.9°F	114	2.9°F
1942	34.6°F	86	0.6°F
1943	32.4°F	24	-1.6°F
1944	35.8°F	106	1.8°F
1945	32.8°F	33	-1.2°F
1946	34.6°F	86	0.6°F
1947	34.0°F	72	0.0°F
1948	33.6°F	52	-0.4°F
1949	34.7°F	88	0.7°F
1950	30.4°F	3	-3.6°F
1951	31.1°F	6	-2.9°F
1952	34.1°F	73	0.1°F
1953	35.3°F	96	1.3°F
1954	35.7°F	104	1.7°F
1955	33.5°F	51	-0.5°F
1956	32.9°F	37	-1.1°F
1957	34.4°F	79	0.4°F
1958	33.6°F	52	-0.4°F
1959	33.7°F	55	-0.3°F
1960	33.3°F	45	-0.7°F
1961	33.8°F	64	-0.2°F
1962	33.8°F	58	-0.2°F

Minimum Annual Temperature in South Central Minnesota, 1895 - 2016 *(con't)*

Year	Average Temp.	Rank	Above/Below average min. of 33.9°F
1963	34.3°F	76	0.3°F
1964	34.5°F	82	0.5°F
1965	32.5°F	28	-1.5°F
1966	32.1°F	18	-1.9°F
1967	32.4°F	24	-1.6°F
1968	34.3°F	76	0.3°F
1969	32.8°F	33	-1.2°F
1970	32.4°F	24	-1.6°F
1971	33.3°F	45	-0.7°F
1972	31.9°F	16	-2.1°F
1973	36.5°F	111	2.5°F
1974	33.9°F	68	-0.1°F
1975	33.8°F	64	-0.2°F
1976	33.0°F	40	-1.0°F
1977	35.0°F	91	1.0°F
1978	32.0°F	17	-2.0°F
1979	31.7°F	11	-2.3°F
1980	34.0°F	72	0.0°F
1981	35.4°F	100	1.4°F
1982	33.4°F	48	-0.6°F
1983	35.4°F	100	1.4°F
1984	34.7°F	88	0.7°F
1985	32.3°F	21	-1.7°F
1986	35.4°F	100	1.4°F
1987	38.4°F	118	4.4°F
1988	33.8°F	58	-0.2°F
1989	32.2°F	19	-1.8°F
1990	35.8°F	106	1.8°F
1991	35.6°F	102	1.6°F
1992	35.4°F	100	1.4°F
1993	33.2°F	42	-0.8°F
1994	34.3°F	76	0.3°F
1995	34.9°F	89	0.9°F
1996	31.8°F	14	-2.2°F
1997	34.5°F	82	0.5°F
1998	38.7°F	120	4.7°F
1999	36.8°F	112	2.8°F
2000	35.1°F	93	1.1°F
2001	35.9°F	109	1.9°F
2002	36.0°F	110	2.0°F
2003	34.4°F	79	0.4°F
2004	35.5°F	101	1.5°F
2005	36.9°F	114	2.9°F
2006	37.8°F	117	3.8°F
2007	35.9°F	109	1.9°F
2008	32.9°F	37	-1.1°F
2009	33.9°F	68	-0.1°F
2010	35.3°F	96	1.3°F
2011	35.7°F	104	1.7°F
2012	38.7°F	120	4.7°F
2013	33.9°F	68	-0.1°F
2014	32.7°F	30	-1.3°F
2015	37.0°F	115	3.0°F
2016	38.8°F	122	4.8°F

Source: National Oceanic and Atmospheric Administration National Climatic Data Center, "Climate at a Glance" database: http://www.ncdc.noaa.gov/cag/time-series/us

Annual Precipitation in South Central Minnesota, 1895 - 2016

Year	Average Temp.	Rank	Above/Below average precipitation of 29.48"
1895	23.63"	14	-5.97"
1896	31.60"	81	2.00"
1897	24.93"	25	-4.67"
1898	23.65"	15	-5.95"
1899	29.02"	59	-0.58"
1900	30.52"	68	0.92"
1901	24.27"	18	-5.33"
1902	34.49"	104	4.89"
1903	36.43"	114	6.83"
1904	26.42"	36	-3.18"
1905	33.73"	98	4.13"
1906	33.21"	95	3.61"
1907	27.61"	44	-1.99"
1908	35.26"	107	5.66"
1909	35.36"	110	5.76"
1910	14.94"	1	-14.66"
1911	32.76"	91	3.16"
1912	24.32"	20	-5.28"
1913	28.35"	52	-1.25"
1914	31.65"	83	2.05"
1915	33.22"	96	3.62"
1916	29.09"	60	-0.51"
1917	27.70"	46	-1.90"
1918	35.29"	108	5.69"
1919	31.12"	75	1.52"
1920	25.73"	29	-3.87"
1921	24.92"	24	-4.68"
1922	22.68"	9	-6.92"
1923	24.64"	23	-4.96"
1924	28.42"	53	-1.18"
1925	26.61"	39	-2.99"
1926	27.41"	43	-2.19"
1927	27.82"	48	-1.78"
1928	28.22"	51	-1.38"
1929	26.15"	30	-3.45"
1930	26.38"	35	-3.22"
1931	25.35"	28	-4.25"
1932	25.22"	26	-4.38"
1933	22.07"	8	-7.53"
1934	22.80"	10	-6.80"
1935	27.73"	47	-1.87"
1936	23.44"	13	-6.16"
1937	26.21"	32	-3.39"
1938	33.84"	99	4.24"
1939	21.11"	5	-8.49"
1940	30.40"	67	0.80"
1941	31.03"	74	1.43"
1942	29.38"	63	-0.22"
1943	32.59"	90	2.99"
1944	31.28"	77	1.68"
1945	34.17"	101	4.57"
1946	31.81"	85	2.21"
1947	30.55"	70	0.95"
1948	26.16"	31	-3.44"
1949	24.24"	17	-5.36"
1950	24.20"	16	-5.40"
1951	37.38"	117	7.78"
1952	24.28"	19	-5.32"
1953	30.82"	73	1.22"
1954	28.92"	57	-0.68"
1955	21.41"	6	-8.19"
1956	27.62"	45	-1.98"
1957	29.22"	62	-0.38"
1958	18.00"	3	-11.60"
1959	32.36"	89	2.76"
1960	28.97"	58	-0.63"
1961	29.20"	61	-0.40"
1962	28.71"	56	-0.89"

Annual Precipitation in South Central Minnesota, 1895 - 2016 *(con't)*

Year	Average Temp.	Rank	Above/Below average precipitation of 29.48"
1963	26.23"	33	-3.37"
1964	30.66"	71	1.06"
1965	35.18"	106	5.58"
1966	25.26"	27	-4.34"
1967	26.50"	38	-3.10"
1968	39.58"	118	9.98"
1969	26.86"	40	-2.74"
1970	31.49"	79	1.89"
1971	28.61"	55	-0.99"
1972	28.11"	50	-1.49"
1973	32.86"	92	3.26"
1974	23.36"	12	-6.24"
1975	30.12"	66	0.52"
1976	17.69"	2	-11.91"
1977	35.32"	109	5.72"
1978	26.99"	41	-2.61"
1979	35.45"	111	5.85"
1980	24.51"	22	-5.09"
1981	33.36"	97	3.76"
1982	34.18"	102	4.58"
1983	34.09"	100	4.49"
1984	31.78"	84	2.18"
1985	30.55"	70	0.95"
1986	35.63"	112	6.03"
1987	24.46"	21	-5.14"
1988	20.31"	4	-9.29"
1989	21.68"	7	-7.92"
1990	34.29"	103	4.69"
1991	40.71"	120	11.11"
1992	32.33"	88	2.73"
1993	43.37"	121	13.77"
1994	31.64"	82	2.04"
1995	31.21"	76	1.61"
1996	30.68"	72	1.08"
1997	27.15"	42	-2.45"
1998	32.15"	87	2.55"
1999	31.59"	80	1.99"
2000	32.10"	86	2.50"
2001	33.05"	94	3.45"
2002	30.07"	65	0.47"
2003	22.92"	11	-6.68"
2004	36.78"	115	7.18"
2005	37.06"	116	7.46"
2006	29.86"	64	0.26"
2007	35.08"	105	5.48"
2008	27.88"	49	-1.72"
2009	28.51"	54	-1.09"
2010	40.04"	119	10.44"
2011	26.44"	37	-3.16"
2012	26.34"	34	-3.26"
2013	33.05"	94	3.45"
2014	31.44"	78	1.84"
2015	36.42"	113	6.82"
2016	45.59"	122	15.99"

Source: National Oceanic and Atmospheric Administration National Climatic Data Center, "Climate at a Glance" database: http://www.ncdc.noaa.gov/cag/time-series/us

Annual Average Cooling Degree Days in South Central Minnesota, 1895 - 2016

Date	Value	Rank	Departure from Mean (642°DF)
1895	561°Df	34	-83°Df
1896	589°Df	50	-55°Df
1897	554°Df	32	-90°Df
1898	535°Df	24	-109°Df
1899	576°Df	40	-68°Df
1900	802°Df	108	158°Df
1901	853°Df	111	209°Df
1902	439°Df	10	-205°Df
1903	401°Df	5	-243°Df
1904	383°Df	3	-261°Df
1905	571°Df	37	-73°Df
1906	557°Df	33	-87°Df
1907	421°Df	6	-223°Df
1908	540°Df	28	-104°Df
1909	619°Df	58	-25°Df
1910	609°Df	56	-35°Df
1911	708°Df	83	64°Df
1912	463°Df	17	-181°Df
1913	694°Df	78	50°Df
1914	698°Df	81	54°Df
1915	306°Df	1	-338°Df
1916	683°Df	73	39°Df
1917	458°Df	16	-186°Df
1918	572°Df	38	-72°Df
1919	689°Df	76	45°Df
1920	585°Df	46	-59°Df
1921	933°Df	116	289°Df
1922	769°Df	103	125°Df
1923	721°Df	88	77°Df
1924	389°Df	4	-255°Df
1925	627°Df	59	-17°Df
1926	601°Df	53	-43°Df
1927	430°Df	9	-214°Df
1928	548°Df	31	-96°Df
1929	563°Df	35	-81°Df
1930	734°Df	94	90°Df
1931	954°Df	119	310°Df
1932	735°Df	95	91°Df
1933	960°Df	120	316°Df
1934	944°Df	117	300°Df
1935	727°Df	93	83°Df
1936	1,054°Df	122	410°Df
1937	872°Df	113	228°Df
1938	775°Df	105	131°Df
1939	839°Df	110	195°Df
1940	694°Df	78	50°Df
1941	785°Df	107	141°Df
1942	537°Df	26	-107°Df
1943	672°Df	70	28°Df
1944	629°Df	61	-15°Df
1945	426°Df	7	-218°Df
1946	532°Df	21	-112°Df
1947	749°Df	97	105°Df
1948	727°Df	93	83°Df
1949	858°Df	112	214°Df
1950	451°Df	14	-193°Df
1951	447°Df	13	-197°Df
1952	635°Df	62	-9°Df
1953	698°Df	81	54°Df
1954	648°Df	65	4°Df
1955	946°Df	118	302°Df
1956	642°Df	63	-2°Df
1957	664°Df	68	20°Df
1958	532°Df	21	-112°Df
1959	780°Df	106	136°Df
1960	596°Df	51	-48°Df
1961	582°Df	43	-62°Df
1962	540°Df	28	-104°Df

Annual Average Cooling Degree Days in South Central Minnesota, 1895 - 2016 *(con't)*

Date	Value	Rank	Departure from Mean (642°DF)
1963	701°Df	82	57°Df
1964	695°Df	79	51°Df
1965	532°Df	21	-112°Df
1966	609°Df	56	-35°Df
1967	428°Df	8	-216°Df
1968	536°Df	25	-108°Df
1969	578°Df	42	-66°Df
1970	685°Df	74	41°Df
1971	584°Df	44	-60°Df
1972	531°Df	20	-113°Df
1973	677°Df	71	33°Df
1974	586°Df	48	-58°Df
1975	717°Df	87	73°Df
1976	725°Df	90	81°Df
1977	768°Df	102	124°Df
1978	679°Df	72	35°Df
1979	542°Df	30	-102°Df
1980	712°Df	84	68°Df
1981	587°Df	49	-57°Df
1982	574°Df	39	-70°Df
1983	884°Df	114	240°Df
1984	648°Df	65	4°Df
1985	503°Df	19	-141°Df
1986	597°Df	52	-47°Df
1987	821°Df	109	177°Df
1988	1,025°Df	121	381°Df
1989	650°Df	66	6°Df
1990	607°Df	55	-37°Df
1991	717°Df	87	73°Df
1992	334°Df	2	-310°Df
1993	456°Df	15	-188°Df
1994	539°Df	27	-105°Df
1995	714°Df	85	70°Df
1996	482°Df	18	-162°Df
1997	577°Df	41	-67°Df
1998	739°Df	96	95°Df
1999	667°Df	69	23°Df
2000	585°Df	46	-59°Df
2001	687°Df	75	43°Df
2002	722°Df	89	78°Df
2003	603°Df	54	-41°Df
2004	446°Df	12	-198°Df
2005	773°Df	104	129°Df
2006	727°Df	93	83°Df
2007	764°Df	100	120°Df
2008	584°Df	44	-60°Df
2009	445°Df	11	-199°Df
2010	756°Df	98	112°Df
2011	757°Df	99	113°Df
2012	902°Df	115	258°Df
2013	660°Df	67	16°Df
2014	570°Df	36	-74°Df
2015	628°Df	60	-16°Df
2016	765°Df	101	121°Df

Source: National Oceanic and Atmospheric Administration National Climatic Data Center, "Climate at a Glance" database: http://www.ncdc.noaa.gov/cag/time-series/us

Annual Average Heating Degree Days in South Central Minnesota, 1895 - 2016

Date	Value	Rank	Departure from Mean (8,120°DF)
1895	8,713°Df	104	593°Df
1896	8,426°Df	89	306°Df
1897	8,748°Df	107	628°Df
1898	8,319°Df	79	199°Df
1899	8,701°Df	102	581°Df
1900	7,962°Df	46	-158°Df
1901	8,320°Df	80	200°Df
1902	8,163°Df	64	43°Df
1903	8,516°Df	92	396°Df
1904	8,813°Df	112	693°Df
1905	8,405°Df	87	285°Df
1906	8,077°Df	56	-43°Df
1907	8,713°Df	104	593°Df
1908	7,683°Df	23	-437°Df
1909	8,681°Df	100	561°Df
1910	7,935°Df	44	-185°Df
1911	8,149°Df	62	29°Df
1912	8,758°Df	109	638°Df
1913	7,953°Df	45	-167°Df
1914	8,052°Df	53	-68°Df
1915	8,042°Df	51	-78°Df
1916	9,051°Df	118	931°Df
1917	9,579°Df	122	1,459°Df
1918	8,020°Df	50	-100°Df
1919	8,389°Df	86	269°Df
1920	8,194°Df	67	74°Df
1921	7,279°Df	9	-841°Df
1922	7,702°Df	26	-418°Df
1923	7,974°Df	48	-146°Df
1924	8,750°Df	108	630°Df
1925	8,186°Df	66	66°Df
1926	8,356°Df	85	236°Df
1927	8,218°Df	69	98°Df
1928	7,728°Df	28	-392°Df
1929	8,943°Df	114	823°Df
1930	7,766°Df	30	-354°Df
1931	6,470°Df	1	-1,650°Df
1932	8,457°Df	90	337°Df
1933	7,851°Df	34	-269°Df
1934	7,522°Df	16	-598°Df
1935	8,325°Df	81	205°Df
1936	9,066°Df	119	946°Df
1937	8,889°Df	113	769°Df
1938	7,555°Df	18	-565°Df
1939	7,445°Df	12	-675°Df
1940	8,413°Df	88	293°Df
1941	7,391°Df	11	-729°Df
1942	7,856°Df	35	-264°Df
1943	8,672°Df	99	552°Df
1944	7,633°Df	21	-487°Df
1945	8,336°Df	83	216°Df
1946	7,566°Df	19	-554°Df
1947	8,295°Df	73	175°Df
1948	8,092°Df	60	-28°Df
1949	7,885°Df	40	-235°Df
1950	9,110°Df	120	990°Df
1951	9,255°Df	121	1,135°Df
1952	8,044°Df	52	-76°Df
1953	7,654°Df	22	-466°Df
1954	7,707°Df	27	-413°Df
1955	8,318°Df	78	198°Df
1956	8,257°Df	71	137°Df
1957	8,090°Df	59	-30°Df
1958	7,882°Df	38	-238°Df
1959	8,286°Df	72	166°Df
1960	8,302°Df	75	182°Df
1961	8,154°Df	63	34°Df
1962	8,306°Df	76	186°Df

Annual Average Heating Degree Days in South Central Minnesota, 1895 - 2016 *(con't)*

Date	Value	Rank	Departure from Mean (8,120°DF)
1963	7,969°Df	47	-151°Df
1964	7,780°Df	32	-340°Df
1965	8,666°Df	98	546°Df
1966	8,685°Df	101	565°Df
1967	8,330°Df	82	210°Df
1968	7,887°Df	42	-233°Df
1969	8,626°Df	97	506°Df
1970	8,714°Df	105	594°Df
1971	8,300°Df	74	180°Df
1972	8,982°Df	115	862°Df
1973	7,551°Df	17	-569°Df
1974	8,078°Df	57	-42°Df
1975	8,337°Df	84	217°Df
1976	8,089°Df	58	-31°Df
1977	7,883°Df	39	-237°Df
1978	8,771°Df	110	651°Df
1979	9,019°Df	116	899°Df
1980	7,994°Df	49	-126°Df
1981	7,452°Df	14	-668°Df
1982	8,540°Df	94	420°Df
1983	8,311°Df	77	191°Df
1984	8,074°Df	55	-46°Df
1985	8,622°Df	96	502°Df
1986	7,824°Df	33	-296°Df
1987	6,666°Df	3	-1,454°Df
1988	8,120°Df	61	0°Df
1989	8,492°Df	91	372°Df
1990	7,324°Df	10	-796°Df
1991	7,929°Df	43	-191°Df
1992	7,778°Df	31	-342°Df
1993	8,731°Df	106	611°Df
1994	8,063°Df	54	-57°Df
1995	8,223°Df	70	103°Df
1996	9,024°Df	117	904°Df
1997	8,199°Df	68	79°Df
1998	6,862°Df	4	-1,258°Df
1999	7,201°Df	7	-919°Df
2000	7,743°Df	29	-377°Df
2001	7,577°Df	20	-543°Df
2002	7,688°Df	24	-432°Df
2003	7,871°Df	37	-249°Df
2004	7,508°Df	15	-612°Df
2005	7,450°Df	13	-670°Df
2006	7,082°Df	6	-1,038°Df
2007	7,688°Df	24	-432°Df
2008	8,561°Df	95	441°Df
2009	8,174°Df	65	54°Df
2010	7,886°Df	41	-234°Df
2011	7,869°Df	36	-251°Df
2012	6,578°Df	2	-1,542°Df
2013	8,527°Df	93	407°Df
2014	8,800°Df	111	680°Df
2015	7,237°Df	8	-883°Df
2016	6,921°Df	5	-1,199°Df

Source: National Oceanic and Atmospheric Administration National Climatic Data Center, "Climate at a Glance" database: http://www.ncdc.noaa.gov/cag/time-series/us

Annual Palmer Drought Severity Index in South Central Minnesota, 1895 - 2016

Year	Average Temp.	Rank	Above/Below average 0.57 PDSI
1895	-0.52	33	-1.09
1896	0.43	58	-0.14
1897	0.07	41	-0.5
1898	-1.64	19	-2.21
1899	-0.11	37	-0.68
1900	-0.53	32	-1.1
1901	-0.6	30	-1.17
1902	1.57	88	1
1903	4.28	119	3.71
1904	3.03	108	2.46
1905	2.69	101	2.12
1906	3.13	112	2.56
1907	3.04	109	2.47
1908	3.53	116	2.96
1909	3.39	114	2.82
1910	-3.2	8	-3.77
1911	-3.21	7	-3.78
1912	0.88	70	0.31
1913	0.31	54	-0.26
1914	-0.07	39	-0.64
1915	1.54	87	0.97
1916	2.37	95	1.8
1917	0.95	71	0.38
1918	1.04	72	0.47
1919	3.19	113	2.62
1920	0.24	52	-0.33
1921	-2.25	13	-2.82
1922	-3.32	5	-3.89
1923	-3.36	4	-3.93
1924	-0.84	26	-1.41
1925	0.12	45	-0.45
1926	0.18	48	-0.39
1927	1.12	74	0.55
1928	0.74	66	0.17
1929	0.44	61	-0.13
1930	-0.05	40	-0.62
1931	-1.45	21	-2.02
1932	-0.26	35	-0.83
1933	-2.44	12	-3.01
1934	-5.33	1	-5.9
1935	-0.26	35	-0.83
1936	-1.57	20	-2.14
1937	-2.87	9	-3.44
1938	0.11	44	-0.46
1939	-1.37	24	-1.94
1940	-2.23	14	-2.8
1941	1.17	77	0.6
1942	1.52	86	0.95
1943	2.46	98	1.89
1944	2.9	105	2.33
1945	2.8	102	2.23
1946	2.26	93	1.69
1947	1.07	73	0.5
1948	-0.54	31	-1.11
1949	-1.43	22	-2
1950	-2.68	11	-3.25
1951	2.67	100	2.1
1952	0.48	64	-0.09
1953	0.15	46	-0.42
1954	0.21	49	-0.36
1955	-2.05	16	-2.62
1956	-2.87	9	-3.44
1957	0.09	42	-0.48
1958	-1.78	18	-2.35
1959	-0.84	26	-1.41
1960	1.43	85	0.86
1961	0.42	57	-0.15
1962	0.83	69	0.26

Annual Palmer Drought Severity Index in South Central Minnesota, 1895 - 2016 *(con't)*

Year	Average Temp.	Rank	Above/Below average 0.57 PDSI
1963	-0.66	28	-1.23
1964	-0.08	38	-0.65
1965	3.02	106	2.45
1966	0.43	58	-0.14
1967	0.4	56	-0.17
1968	1.43	85	0.86
1969	2.06	92	1.49
1970	0.24	52	-0.33
1971	0.47	63	-0.1
1972	0.43	58	-0.14
1973	1.78	89	1.21
1974	0.1	43	-0.47
1975	0.16	47	-0.41
1976	-2.07	15	-2.64
1977	-1.39	23	-1.96
1978	0.8	68	0.23
1979	2.32	94	1.75
1980	0.21	49	-0.36
1981	1.16	76	0.59
1982	2.45	97	1.88
1983	3.78	117	3.21
1984	2.84	103	2.27
1985	1.43	85	0.86
1986	2.89	104	2.32
1987	-1.92	17	-2.49
1988	-3.54	3	-4.11
1989	-4.51	2	-5.08
1990	0.55	65	-0.02
1991	3.03	108	2.46
1992	3.98	118	3.41
1993	6.38	122	5.81
1994	4.39	120	3.82
1995	3.07	110	2.5
1996	2.4	96	1.83
1997	2.49	99	1.92
1998	1.87	90	1.3
1999	1.23	81	0.66
2000	0.45	62	-0.12
2001	1.22	80	0.65
2002	0.32	55	-0.25
2003	-0.63	29	-1.2
2004	1.21	78	0.64
2005	3.49	115	2.92
2006	1.14	75	0.57
2007	1.22	80	0.65
2008	1.28	82	0.71
2009	0.22	51	-0.35
2010	3.1	111	2.53
2011	1.88	91	1.31
2012	-3.31	6	-3.88
2013	-0.89	25	-1.46
2014	-0.28	34	-0.85
2015	0.79	67	0.22
2016	5	121	4.43

Source: National Oceanic and Atmospheric Administration National Climatic Data Center, "Climate at a Glance" database: http://www.ncdc.noaa.gov/cag/time-series/us

Annual Palmer Hydrological Drought Index in South Central Minnesota, 1895-2016

Year	Average Temp.	Rank	Above/Below average 0.63 PHDI
1895	-0.36	36	-0.99
1896	0.49	53	-0.14
1897	0.65	58	0.02
1898	-2.26	18	-2.89
1899	-0.16	38	-0.79
1900	-0.6	31	-1.23
1901	-0.48	33	-1.11
1902	1.25	72	0.62
1903	4.28	119	3.65
1904	3.03	106	2.4
1905	2.69	99	2.06
1906	3.13	111	2.5
1907	3.04	107	2.41
1908	3.53	116	2.9
1909	3.39	114	2.76
1910	-2.27	17	-2.9
1911	-5.28	2	-5.91
1912	-0.43	35	-1.06
1913	0.31	48	-0.32
1914	0.44	50	-0.19
1915	1.64	77	1.01
1916	2.37	91	1.74
1917	1.6	75	0.97
1918	1.04	66	0.41
1919	3.19	112	2.56
1920	0.98	65	0.35
1921	-2.25	19	-2.88
1922	-3.32	7	-3.95
1923	-3.36	6	-3.99
1924	-0.68	30	-1.31
1925	0.52	55	-0.11
1926	0.18	46	-0.45
1927	1.96	85	1.33
1928	1.09	68	0.46
1929	0.72	60	0.09
1930	-0.13	39	-0.76
1931	-1.89	21	-2.52
1932	0.06	44	-0.57
1933	-2.44	15	-3.07
1934	-6.27	1	-6.9
1935	-2.64	14	-3.27
1936	-1.6	22	-2.23
1937	-2.87	11	-3.5
1938	-1	26	-1.63
1939	-1.16	25	-1.79
1940	-3.73	4	-4.36
1941	1.19	70	0.56
1942	1.52	74	0.89
1943	2.46	96	1.83
1944	2.9	103	2.27
1945	2.8	100	2.17
1946	2.26	88	1.63
1947	2.2	87	1.57
1948	-0.34	37	-0.97
1949	-1.29	24	-1.92
1950	-2.92	9	-3.55
1951	2.27	89	1.64
1952	1.63	76	1
1953	0.1	45	-0.53
1954	-0.1	42	-0.73
1955	-2.05	20	-2.68
1956	-2.87	11	-3.5
1957	-0.12	41	-0.75
1958	-1.51	23	-2.14
1959	-2.9	10	-3.53
1960	1.9	84	1.27
1961	0.32	49	-0.31
1962	1.29	73	0.66

Annual Palmer Hydrological Drought Index in South Central Minnesota, 1895-2016 *(con't)*

Year	Average Temp.	Rank	Above/Below average 0.63 PHDI
1963	-0.13	39	-0.76
1964	-0.8	29	-1.43
1965	3.02	104	2.39
1966	1.77	79	1.14
1967	0.65	58	0.02
1968	0.75	62	0.12
1969	3.13	111	2.5
1970	0.74	61	0.11
1971	1.83	82	1.2
1972	0.86	64	0.23
1973	1.78	80	1.15
1974	0.46	51	-0.17
1975	-0.46	34	-1.09
1976	-2.37	16	-3
1977	-2.74	13	-3.37
1978	1.06	67	0.43
1979	2.32	90	1.69
1980	1.12	69	0.49
1981	0.85	63	0.22
1982	2.45	94	1.82
1983	3.78	117	3.15
1984	2.84	101	2.21
1985	1.81	81	1.18
1986	3.21	113	2.58
1987	-0.93	27	-1.56
1988	-3.54	5	-4.17
1989	-4.51	3	-5.14
1990	-0.81	28	-1.44
1991	3.03	106	2.4
1992	3.98	118	3.35
1993	6.38	122	5.75
1994	4.39	120	3.76
1995	3.07	108	2.44
1996	2.4	93	1.77
1997	2.49	97	1.86
1998	1.87	83	1.24
1999	2.39	92	1.76
2000	0.27	47	-0.36
2001	2.55	98	1.92
2002	0.58	57	-0.05
2003	0.02	43	-0.61
2004	1.21	71	0.58
2005	3.49	115	2.86
2006	2.46	96	1.83
2007	1.72	78	1.09
2008	2.1	86	1.47
2009	0.48	52	-0.15
2010	3.1	109	2.47
2011	2.9	103	2.27
2012	-3.31	8	-3.94
2013	-0.49	32	-1.12
2014	0.54	56	-0.09
2015	0.49	53	-0.14
2016	5	121	4.37

Source: National Oceanic and Atmospheric Administration National Climatic Data Center, "Climate at a Glance" database: http://www.ncdc.noaa.gov/cag/time-series/us

Annual Palmer Modified Drought Index in South Central Minnesota, 1895-2016

Year	Average Temp.	Rank	Above/Below Average 6.32 PMDI
1895	-5.52	33	-11.84
1896	5.6	58	-0.72
1897	4.38	56	-1.94
1898	-23.39	19	-29.71
1899	-1.02	39	-7.34
1900	-6.05	32	-12.37
1901	-2.02	37	-8.34
1902	19.52	86	13.2
1903	49.64	120	43.32
1904	33.74	106	27.42
1905	31.19	103	24.87
1906	36.64	112	30.32
1907	34.81	108	28.49
1908	36.95	113	30.63
1909	38.71	115	32.39
1910	-32.65	10	-38.97
1911	-53.99	2	-60.31
1912	9.86	66	3.54
1913	2.28	47	-4.04
1914	3.29	51	-3.03
1915	18.21	84	11.89
1916	22.31	91	15.99
1917	14.17	73	7.85
1918	11.19	68	4.87
1919	35.67	111	29.35
1920	8.15	61	1.83
1921	-25.46	16	-31.78
1922	-38.7	5	-45.02
1923	-37.91	6	-44.23
1924	-9.15	28	-15.47
1925	4.24	55	-2.08
1926	2.73	49	-3.59
1927	15.27	77	8.95
1928	6.8	59	0.48
1929	7.55	60	1.23
1930	1.32	44	-5
1931	-20.1	21	-26.42
1932	-0.55	41	-6.87
1933	-27.82	13	-34.14
1934	-74.21	1	-80.53
1935	-22.15	20	-28.47
1936	-19.01	23	-25.33
1937	-32.32	11	-38.64
1938	-5.04	35	-11.36
1939	-15.97	25	-22.29
1940	-34.79	8	-41.11
1941	13.08	72	6.76
1942	14.75	76	8.43
1943	27.69	98	21.37
1944	29.98	102	23.66
1945	27.58	97	21.26
1946	21.71	90	15.39
1947	20.34	88	14.02
1948	-5.47	34	-11.79
1949	-17.04	24	-23.36
1950	-32.99	9	-39.31
1951	28.12	99	21.8
1952	14.44	75	8.12
1953	1.04	43	-5.28
1954	-0.68	40	-7
1955	-23.99	18	-30.31
1956	-25.71	15	-32.03
1957	1.03	42	-5.29
1958	-19.19	22	-25.51
1959	-24.18	17	-30.5
1960	17.27	81	10.95
1961	4.2	54	-2.12
1962	12.14	70	5.82

Annual Palmer Modified Drought Index in South Central Minnesota, 1895-2016 *(con't)*

Year	Average Temp.	Rank	Above/Below Average 6.32 PMDI
1963	-6.43	31	-12.75
1964	-6.87	29	-13.19
1965	34.94	110	28.62
1966	12.56	71	6.24
1967	4.13	53	-2.19
1968	10.9	67	4.58
1969	28.63	101	22.31
1970	3.82	52	-2.5
1971	15.72	79	9.4
1972	8.85	64	2.53
1973	15.51	78	9.19
1974	2.54	48	-3.78
1975	-1.85	38	-8.17
1976	-26.66	14	-32.98
1977	-28.86	12	-35.18
1978	8.51	63	2.19
1979	26.58	96	20.26
1980	9.39	65	3.07
1981	11.65	69	5.33
1982	25.49	93	19.17
1983	42.98	117	36.66
1984	31.77	104	25.45
1985	19.12	85	12.8
1986	37.78	114	31.46
1987	-13.68	26	-20
1988	-41.14	4	-47.46
1989	-53.79	3	-60.11
1990	-9.4	27	-15.72
1991	32.49	105	26.17
1992	45.79	118	39.47
1993	76.32	122	70
1994	49.62	119	43.3
1995	34.84	109	28.52
1996	25.56	94	19.24
1997	25.96	95	19.64
1998	19.57	87	13.25
1999	21.62	89	15.3
2000	1.91	46	-4.41
2001	23.82	92	17.5
2002	5.13	57	-1.19
2003	-3.48	36	-9.8
2004	14.28	74	7.96
2005	41.17	116	34.85
2006	17.95	83	11.63
2007	16.48	80	10.16
2008	17.88	82	11.56
2009	2.8	50	-3.52
2010	33.79	107	27.47
2011	28.36	100	22.04
2012	-36.21	7	-42.53
2013	-6.83	30	-13.15
2014	1.54	45	-4.78
2015	8.22	62	1.9
2016	59.94	121	53.62

Source: National Oceanic and Atmospheric Administration National Climatic Data Center, "Climate at a Glance" database: http://www.ncdc.noaa.gov/cag/time-series/us

Appendix IV - FEMA

FEMA Declarations

Year	County	Declaration Date	Disaster Type	Incident Type	Title
1965	Blue Earth	4/11/1965	DR	Flood	Flooding
2011	Blue Earth	5/10/2011	DR	Flood	Severe Storms And Flooding
1996	Blue Earth	6/1/1996	DR	Flood	Flooding And Severe Storms
1997	Blue Earth	1/16/1997	DR	Severe Storm	Severe Winter Storms
2010	Blue Earth	7/2/2010	DR	Tornado	Severe Storms, Tornadoes, And Flooding
1998	Blue Earth	6/23/1998	DR	Tornado	Severe Storms, Straight Line Winds, And Tornadoes
1998	Blue Earth	4/1/1998	DR	Tornado	Tornadoes And Severe Storms
1991	Blue Earth	12/26/1991	DR	Severe Ice Storm	Ice Storm
1976	Blue Earth	6/17/1976	EM	Drought	Drought
2010	Blue Earth	4/19/2010	DR	Flood	Flooding
2010	Blue Earth	3/19/2010	EM	Flood	Flooding
1968	Blue Earth	8/15/1968	DR	Flood	Heavy Rains & Flooding
1993	Blue Earth	6/11/1993	DR	Severe Storm	Severe Storms, Tornadoes & Flooding
2005	Blue Earth	9/13/2005	EM	Hurricane	Hurricane Katrina Evacuation
1969	Blue Earth	4/18/1969	DR	Flood	Flooding
2010	Blue Earth	10/13/2010	DR	Severe Storm	Severe Storms And Flooding
1997	Blue Earth	4/8/1997	DR	Flood	Severe Flooding, High Winds,Severe Storms
2014	Blue Earth	7/21/2014	DR	Flood	Severe Storms, Straight-Line Winds, Flooding, Landslides, And Mudslides
2014	Brown	7/21/2014	DR	Flood	Severe Storms, Straight-Line Winds, Flooding, Landslides, And Mudslides
2005	Brown	9/13/2005	EM	Hurricane	Hurricane Katrina Evacuation
2010	Brown	3/19/2010	EM	Flood	Flooding
2001	Brown	5/16/2001	DR	Flood	Severe Winter Storms, Flooding, And Tornadoes
2011	Brown	5/10/2011	DR	Flood	Severe Storms And Flooding
1993	Brown	6/11/1993	DR	Severe Storm	Severe Storms, Tornadoes & Flooding
1997	Brown	4/8/1997	DR	Flood	Severe Flooding, High Winds,Severe Storms
1997	Brown	1/16/1997	DR	Severe Storm	Severe Winter Storms
1998	Brown	4/1/1998	DR	Tornado	Tornadoes And Severe Storms
2010	Brown	7/2/2010	DR	Tornado	Severe Storms, Tornadoes, And Flooding
2010	Brown	10/13/2010	DR	Severe Storm	Severe Storms And Flooding
1976	Brown	6/17/1976	EM	Drought	Drought
1965	Brown	4/11/1965	DR	Flood	Flooding
2010	Brown	4/19/2010	DR	Flood	Flooding

FEMA Declarations *(con't)*

Year	County	Declaration Date	Disaster Type	Incident Type	Title
1969	Brown	4/18/1969	DR	Flood	Flooding
1993	Faribault	6/11/1993	DR	Severe Storm	Severe Storms, Tornadoes & Flooding
1968	Faribault	8/15/1968	DR	Flood	Heavy Rains & Flooding
1991	Faribault	12/26/1991	DR	Severe Ice Storm	Ice Storm
1997	Faribault	1/16/1997	DR	Severe Storm	Severe Winter Storms
1996	Faribault	6/1/1996	DR	Flood	Flooding And Severe Storms
2013	Faribault	7/25/2013	DR	Severe Storm	Severe Storms, Straight-Line Winds, And Flooding
2004	Faribault	10/7/2004	DR	Severe Storm	Severe Storms And Flooding
2010	Faribault	7/2/2010	DR	Tornado	Severe Storms, Tornadoes, And Flooding
1965	Faribault	4/11/1965	DR	Flood	Flooding
2014	Faribault	7/21/2014	DR	Flood	Severe Storms, Straight-Line Winds, Flooding, Landslides, And Mudslides
1969	Faribault	4/18/1969	DR	Flood	Flooding
2000	Faribault	6/27/2000	DR	Severe Storm	Severe Storms And Flooding
2010	Faribault	10/13/2010	DR	Severe Storm	Severe Storms And Flooding
1998	Faribault	6/23/1998	DR	Tornado	Severe Storms, Straight Line Winds, And Tornadoes
2001	Faribault	5/16/2001	DR	Flood	Severe Winter Storms, Flooding, And Tornadoes
2005	Faribault	9/13/2005	EM	Hurricane	Hurricane Katrina Evacuation
1997	Faribault	1/7/1997	DR	Severe Storm	Severe Ice Storm
1993	Le Sueur	6/11/1993	DR	Severe Storm	Severe Storms, Tornadoes & Flooding
2011	Le Sueur	5/10/2011	DR	Flood	Severe Storms And Flooding
1968	Le Sueur	8/15/1968	DR	Flood	Heavy Rains & Flooding
1976	Le Sueur	6/17/1976	EM	Drought	Drought
1969	Le Sueur	4/18/1969	DR	Flood	Flooding
2010	Le Sueur	3/19/2010	EM	Flood	Flooding
1998	Le Sueur	4/1/1998	DR	Tornado	Tornadoes And Severe Storms
2014	Le Sueur	7/21/2014	DR	Flood	Severe Storms, Straight-Line Winds, Flooding, Landslides, And Mudslides
2001	Le Sueur	5/16/2001	DR	Flood	Severe Winter Storms, Flooding, And Tornadoes
2010	Le Sueur	10/13/2010	DR	Severe Storm	Severe Storms And Flooding
1965	Le Sueur	4/11/1965	DR	Flood	Flooding
2005	Le Sueur	9/13/2005	EM	Hurricane	Hurricane Katrina Evacuation

FEMA Declarations *(con't)*

Year	County	Declaration Date	Disaster Type	Incident Type	Title
1997	Le Sueur	4/8/1997	DR	Flood	Severe Flooding, High Winds,Severe Storms
1997	Le Sueur	1/16/1997	DR	Severe Storm	Severe Winter Storms
2005	Martin	9/13/2005	EM	Hurricane	Hurricane Katrina Evacuation
1969	Martin	4/18/1969	DR	Flood	Flooding
1976	Martin	6/17/1976	EM	Drought	Drought
1965	Martin	4/11/1965	DR	Flood	Flooding
1993	Martin	6/11/1993	DR	Severe Storm	Severe Storms, Tornadoes & Flooding
2010	Martin	10/13/2010	DR	Severe Storm	Severe Storms And Flooding
1997	Martin	1/16/1997	DR	Severe Storm	Severe Winter Storms
2004	Martin	10/7/2004	DR	Severe Storm	Severe Storms And Flooding
2014	Martin	7/21/2014	DR	Flood	Severe Storms, Straight-Line Winds, Flooding, Landslides, And Mudslides
1991	Martin	12/26/1991	DR	Severe Ice Storm	Ice Storm
2011	Nicollet	5/10/2011	DR	Flood	Severe Storms And Flooding
1965	Nicollet	4/11/1965	DR	Flood	Flooding
1969	Nicollet	4/18/1969	DR	Flood	Flooding
2001	Nicollet	5/16/2001	DR	Flood	Severe Winter Storms, Flooding, And Tornadoes
2010	Nicollet	3/19/2010	EM	Flood	Flooding
1993	Nicollet	6/11/1993	DR	Severe Storm	Severe Storms, Tornadoes & Flooding
1976	Nicollet	6/17/1976	EM	Drought	Drought
1998	Nicollet	4/1/1998	DR	Tornado	Tornadoes And Severe Storms
2010	Nicollet	4/19/2010	DR	Flood	Flooding
1968	Nicollet	8/15/1968	DR	Flood	Heavy Rains & Flooding
2010	Nicollet	10/13/2010	DR	Severe Storm	Severe Storms And Flooding
1996	Nicollet	6/1/1996	DR	Flood	Flooding And Severe Storms
2010	Nicollet	7/2/2010	DR	Tornado	Severe Storms, Tornadoes, And Flooding
1997	Nicollet	4/8/1997	DR	Flood	Severe Flooding, High Winds,Severe Storms
2014	Nicollet	7/21/2014	DR	Flood	Severe Storms, Straight-Line Winds, Flooding, Landslides, And Mudslides
2005	Nicollet	9/13/2005	EM	Hurricane	Hurricane Katrina Evacuation
1997	Nicollet	1/16/1997	DR	Severe Storm	Severe Winter Storms
1993	Sibley	6/11/1993	DR	Severe Storm	Severe Storms, Tornadoes & Flooding
1997	Sibley	1/16/1997	DR	Severe Storm	Severe Winter Storms
1997	Sibley	4/8/1997	DR	Flood	Severe Flooding, High Winds,Severe Storms
2010	Sibley	7/2/2010	DR	Tornado	Severe Storms, Tornadoes, And Flooding

FEMA Declarations *(con't)*

Year	County	Declaration Date	Disaster Type	Incident Type	Title
1976	Sibley	6/17/1976	EM	Drought	Drought
2014	Sibley	7/21/2014	DR	Flood	Severe Storms, Straight-Line Winds, Flooding, Landslides, And Mudslides
2010	Sibley	10/13/2010	DR	Severe Storm	Severe Storms And Flooding
2010	Sibley	4/19/2010	DR	Flood	Flooding
2005	Sibley	9/13/2005	EM	Hurricane	Hurricane Katrina Evacuation
2013	Sibley	7/25/2013	DR	Severe Storm	Severe Storms, Straight-Line Winds, And Flooding
1965	Sibley	4/11/1965	DR	Flood	Flooding
2001	Sibley	5/16/2001	DR	Flood	Severe Winter Storms, Flooding, And Tornadoes
1969	Sibley	4/18/1969	DR	Flood	Flooding
2011	Sibley	5/10/2011	DR	Flood	Severe Storms And Flooding
2012	Sibley	7/6/2012	DR	Severe Storm	Severe Storms And Flooding
2010	Sibley	3/19/2010	EM	Flood	Flooding
1997	Waseca	1/7/1997	DR	Severe Storm	Severe Ice Storm
1965	Waseca	4/11/1965	DR	Flood	Flooding
1997	Waseca	1/16/1997	DR	Severe Storm	Severe Winter Storms
2010	Waseca	10/13/2010	DR	Severe Storm	Severe Storms And Flooding
1993	Waseca	6/11/1993	DR	Severe Storm	Severe Storms, Tornadoes & Flooding
1991	Waseca	12/26/1991	DR	Severe Ice Storm	Ice Storm
2005	Waseca	9/13/2005	EM	Hurricane	Hurricane Katrina Evacuation
2014	Waseca	7/21/2014	DR	Flood	Severe Storms, Straight-Line Winds, Flooding, Landslides, And Mudslides
1996	Waseca	6/1/1996	DR	Flood	Flooding And Severe Storms
1997	Watonwan	1/16/1997	DR	Severe Storm	Severe Winter Storms
1969	Watonwan	4/18/1969	DR	Flood	Flooding
1965	Watonwan	4/11/1965	DR	Flood	Flooding
1993	Watonwan	6/11/1993	DR	Severe Storm	Severe Storms, Tornadoes & Flooding
1976	Watonwan	6/17/1976	EM	Drought	Drought
2014	Watonwan	7/21/2014	DR	Flood	Severe Storms, Straight-Line Winds, Flooding, Landslides, And Mudslides
2010	Watonwan	10/13/2010	DR	Severe Storm	Severe Storms And Flooding
2005	Watonwan	9/13/2005	EM	Hurricane	Hurricane Katrina Evacuation

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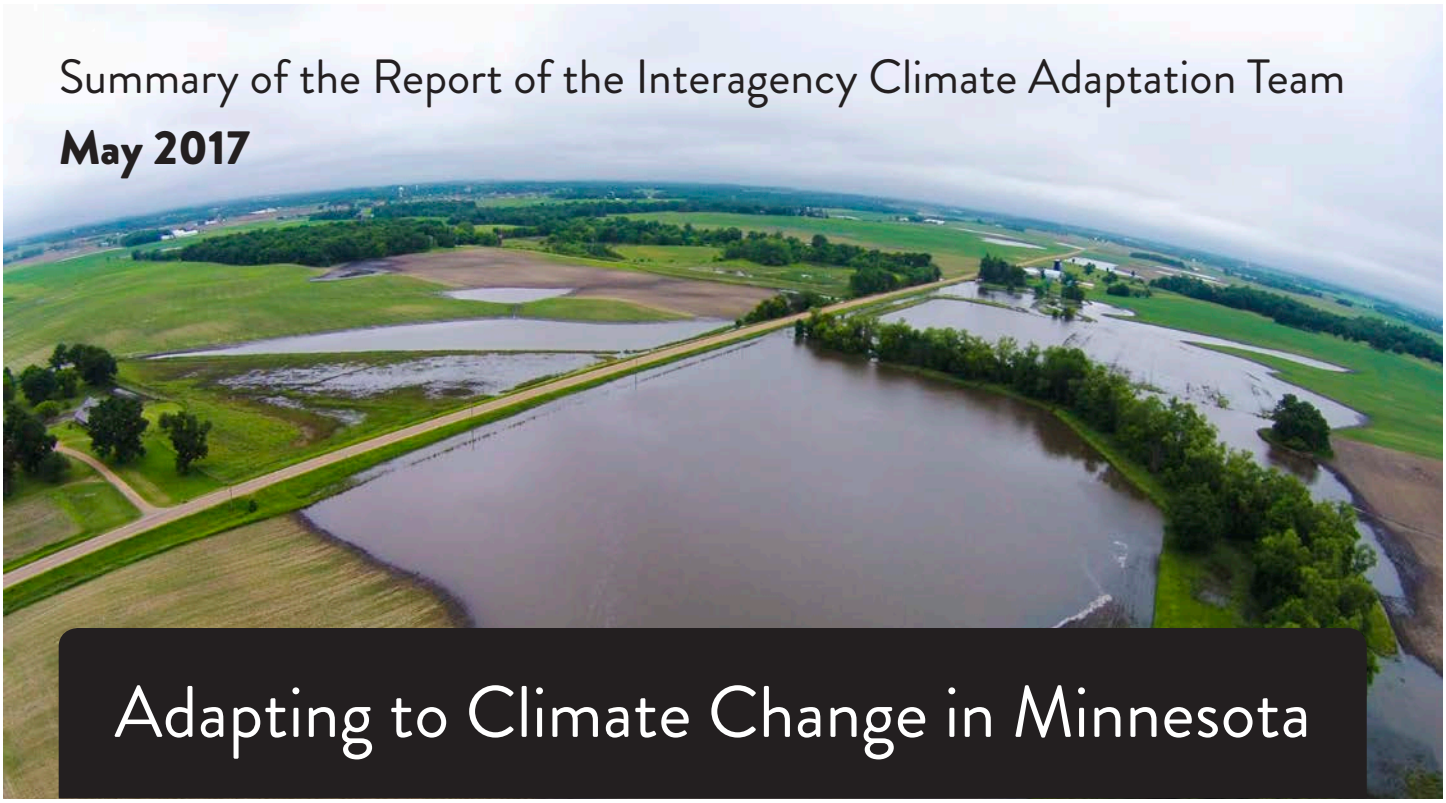
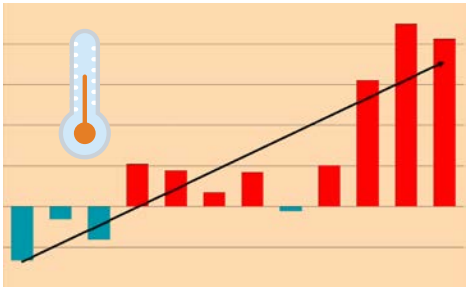
Summary of the Report of the Interagency Climate Adaptation Team

May 2017



Adapting to Climate Change in Minnesota



Our climate is changing

Climate change is already occuring in Minnesota and its impacts are affecting our state's environment, economy, and communities.

Over the last several decades, the state has experienced substantial warming during winter and at night, with increased precipitation throughout the year, often from larger and more frequent heavy rainfall events.

In the years and decades ahead, winter warming and increased extreme rainfall will continue to be Minnesota's two leading symptoms of climate change.

How we're adapting

Minnesota is taking many steps to increase climate adaptation in our state, including a wide range of planning, assessment, and implementation efforts.

This report summarizes ongoing adaptation activities in eleven Minnesota state agencies, including the Departments of Agriculture, Commerce, Health, Military Affairs, Natural Resources, Homeland Security and Emergency Management, and Transportation, as well as the Environmental Quality Board, Pollution Control Agency, Board of Water and Soil Resources, and Metropolitan Council.

Planning for the future

State agencies have developed five statewide climate adaptation indicators to help track Minnesota's progress in climate adaptation.

The Interagency Climate Adaptation Team has also identified six priority recommendations for needed action in climate adaptation by state government. These focus on resilience to extreme precipitation, health of vulnerable populations, preserving ecosystems, strengthening agricultural water management, managing climate impacts in population centers, and better using climate data.

Download full report at **www.pca.state.mn.us**

MINNESOTA

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Minnesota's climate is changing

Minnesota's position near the center of North America subjects us to an exceptional variety of weather. During the course of a single year, most Minnesotans will experience blinding snow, bitter wind chills, howling winds, pounding thunderstorms, torrential rains and heat waves, as well as dozens of bright and sunny days.

The conditions, however, have changed rapidly, and an overwhelming base of scientific evidence projects that Minnesota's climate will see additional significant changes through the end of the 21st century. Over the last several decades, the state has experienced substantial warming during winter and at night, with increased precipitation throughout the year, often from larger and more frequent heavy rainfall events. These changes alone have damaged buildings and infrastructure, limited recreational opportunities, altered our growing seasons, impacted natural resources, and affected the conditions of lakes, rivers, wetlands, and our groundwater aquifers that provide water for drinking and irrigation. The years and decades ahead in Minnesota will bring even warmer winters and nights, and even larger rainfalls, in addition to other climatic changes not yet experienced in the state.

In 2014, the U.S. Global Change Research Program completed its third National Climate Assessment. Both the science summarized in the National Climate Assessment and high-quality climatic data show that in Minnesota and the Midwest, rising temperatures have been driven by a dramatic warming of winter and also nights, with both the frequency and the severity of extreme cold conditions declining rapidly. Annual precipitation increases have been punctuated by more frequent and more intense heavy rainfall events. The heaviest snowstorms have also become larger, even as winter has warmed.

Several other changes noted elsewhere in the U.S. and world have not yet been observed in Minnesota. For instance, summer high temperatures have not increased in several decades, and heat waves have not worsened when compared to historical patterns. Droughts in Minnesota also have shown no long-term increase in magnitude, duration, or geographic coverage. Tornadoes, large hail, and damaging thunderstorm winds are difficult to compare historically but show a complex tendency towards more "outbreaks" consisting of multiple events at a time, though no increases in overall numbers or severity.

We're already seeing the impacts of climate change in Minnesota: **increased rain and higher temperatures**. Projections say these trends will continue in the decades ahead, accompanied by **other changes** we have yet to encounter.

In the years and decades ahead, winter warming and increased extreme rainfall will continue to be Minnesota's two leading symptoms of climate change. Climate models used in the 2014 National Climate Assessment also project that Minnesota will have a greater tendency toward extreme heat, especially by the middle of the 21st century. The future drought situation in Minnesota is less clear and appears to depend on how much greenhouse gas emissions increase by mid-century.

Hazard	Projections through century	Confidence in projected changes
Extreme cold	Continued loss of cold extremes and dramatic warming of coldest conditions	Highest
Extreme rainfall	Continued increase in frequency and magnitude; unprecedented flash-floods	
Heat waves	More hot days with increases in severity, coverage, and duration of heat waves	High
Drought	More days between precipitation events, leading to increased drought severity, coverage, and duration	Moderately High
Heavy snowfall	Large events less frequent as winter warms, but occasional very large snowfalls	Moderately low
Severe thunderstorms & tornadoes	More "super events" possible, even if frequency decreases	

Confidence scale: Lowest > Low > Moderately low > Moderately high > High > Highest

Snapshot of projected and expected trends among common weather hazards in Minnesota, and confidence that those hazards will change (further) through the year 2099 in response to climate change. Graphic based on information from the 2014 National Climate Assessment, and data analyzed by the Minnesota DNR State Climatology Office.

How we're adapting

Based on state agency understanding of climate trends, agencies participating in the Interagency Climate Adaptation Team (ICAT) are now implementing programs to address climate impacts. Here are some of the examples highlighted in the report.

The Minnesota Department of Commerce implements the **Weatherization Assistance Program** providing free home energy upgrades to income-eligible homeowners and renters to help save energy and ensure their homes are healthy and safe. Better insulation builds resilience to heat and cold while also lowering energy bills and greenhouse gas emissions.

The Minnesota Pollution Control Agency, in partnership with Conservation Corps Minnesota, supports **community resilience projects through Youth Outdoors and the Summer Youth Corps**. These projects focus on new green infrastructure in underserved urban neighborhoods and in cities throughout the state. The work helps to reduce stormwater runoff, improve air quality, add pollinator habitat, and increase shaded areas.

The Minnesota Department of Transportation conducted a **climate vulnerability assessment pilot project** as supported by the Federal Highway Administration to examine the effects of climate hazards on transportation systems. The project team scored and ranked 316 bridges, 521 large culverts, 920 pipes, and approximately 45 miles of road segments in MnDOT districts in southeast and northeast Minnesota.

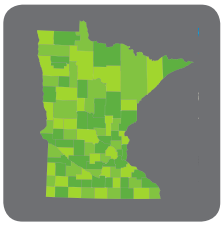
The Minnesota Board of Water and Soil Resources worked with **four landowners and state, federal and local agencies to restore wetlands**, an important approach for adapting to climate change by increasing the resiliency of watersheds. Hydrology restoration and planting diverse seed mixes decreases downstream flooding by retaining water from large storms while also increasing wildlife habitat.

Metropolitan Council **maintains and rehabs its wastewater infrastructure** to ensure the system has capacity to handle future demands and support communities' efforts to reduce excessive flows through inflow and infiltration (I/I) reduction strategies. Efforts by communities, property owners, and the Council have helped to reduce volumes even as precipitation, rainfall intensities, and populations have increased.

Planning for the future

► Statewide climate adaptation indicators

With the goal of better tracking and monitoring Minnesota's climate adaptation progress, ICAT developed five statewide indicators in late 2015 using the Results-Based Accountability process. ICAT established baselines and data sources for each of these indicators in fall 2016.



1. Climate adaptation planning by state agencies, local and tribal governments.

2. Disruptions to the power grid.

3. Emergency department data for heat-related health impacts.

4. Inflation adjusted damages from extreme weather.

5. Canopy cover of urban and community forests.

► Recommendations for action

ICAT's vision is of a resilient, economically thriving, and healthy Minnesota that is prepared for both short- and long-term climate changes and weather extremes. The team recognizes that building a resilient Minnesota in the face of a changing climate is a complex challenge.

While Minnesota state agencies are carrying out a wide range of activities related to adaptation as described in this report, additional opportunities also exist for agencies to increase collaborative efforts on this issue. ICAT has identified the following priority recommendations for needed action in climate adaptation by state government. ICAT will work in 2017 to further flesh out priority actions and work plans related to these recommendations.

Build greater resilience to extreme precipitation.

Identify ways to support health of vulnerable populations through state and local government cooperation.

Increase focus on preserving terrestrial and aquatic habitat to increase resilience of wildlife and native plants.

Strengthen agricultural water management efforts to increase resilience to climate change impacts.

Increase focus on managing climate impacts in cities, towns, and other population centers.

Strengthen our climate information infrastructure to support climate adaptation practices.

In addition to the specific recommendations above, ICAT also recommends that Minnesota state government accelerate the incorporation of climate adaptation into all aspects of state agency operations. This can be accomplished through a variety of methods, such as Governor's Executive Orders, Legislative directives, commissioner-led agency operational orders, agency strategic planning processes, program budgeting and development, and staff training.

ICAT also recognizes that state government will not be able to fully achieve the complex and evolving goal of climate adaptation on its own. It will be necessary and important to build and nurture partnerships on climate adaptation among state government and federal, tribal, and local governments, higher educational institutions, the private sector, nonprofit organizations, community members, and other collaborators. As a vehicle for focusing this collaboration, ICAT recommends that Minnesota state government engage in a comprehensive effort along with public and private partners to develop a multistakeholder statewide climate adaptation plan by 2020.