State of South Dakota

Hazard Mitigation Plan

April 2019

wood.

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Hazard Mitigation Plan

April 2019

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FEMA

TABLE OF CONTENTS

Section 1 Introduction 1-1
1.1 Mission Statement and Purpose 1-1
1.2 Background 1-1
1.3 Plan Organization 1-2
1.4 Executive Summary 1-2
1.5 Compliance with Federal and State Laws and Regulations 1-5
1.6 Adoption by the State 1-6

Section 2 Planning Process 2-1
2.1 2019 Planning Process Update 2-1
2.1.1 2016 Hazard Identification and Risk Assessment (HIRA) Update 2-1
2.1.2 South Dakota Drought Mitigation Plan 2-1
2.1.3 Enhanced Plan Process 2-1
2.2 Stakeholder Involvement 2-2
2.2.1 State Hazard Mitigation Team 2-2
2.2.2 Coordination with State and Regional Agencies 2-2
2.2.3 Coordination with Federal Agencies 2-4
2.3 Documentation of the Planning Process 2-5
2.3.1 Timeline of the 2019 Planning Process 2-5
2.3.2 Planning Meetings 2-6
2.3.3 Additional Coordination Between Planning Team & Stakeholders 2-8
2.4 Public Participation 2-9
2.4.1 Ongoing Public Outreach Since Last Update 2-9
2.5 Loss Avoidance Analysis Tool (LAAT) Development 2-11

Section 3 Hazard Identification and Risk Assessment 3-1
3.1 Identifying Hazards 3-1
3.1.1 Geography 3-2
3.1.2 Climate 3-2
3.1.3 Methodology 3-3
3.1.4 Non-Natural Hazards 3-4
3.1.5 Prioritizing Hazards 3-4
3.1.6 Presidential Declarations 3-8
3.1.7 Probability of Future Events 3-11
3.2 Profiling Hazards 3-12
3.2.1 Agricultural Pests and Diseases 3-14
3.2.2 Flood 3-32
3.2.3 Summer Storm 3-58
3.2.4 Winter Storm 3-68
3.2.5 Wildfire 3-79

3.2.6 Drought 3-94
3.2.7 Tornado 3-109
3.2.8 Windstorm 3-121
3.2.9 Hazardous Materials 3-127
3.2.10 Geologic Hazards 3-140
3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction 3-153
3.3.1 Growth and Development 3-155
3.3.2 Social Vulnerability 3-163
3.3.3 Federal Disaster Declaration History and Analysis 3-164
3.3.4 Building Exposure 3-167
3.3.5 Agricultural Pests and Diseases 3-168
3.3.6 Floods 3-171
3.3.7 Summer Storms 3-185
3.3.8 Winter Storms 3-188
3.3.9 Wildfire 3-194
3.3.10 Drought 3-202
3.3.11 Tornadoes 3-209
3.3.12 Windstorms 3-215
3.3.13 Hazardous Materials 3-219
3.3.14 Geologic Hazards 3-220
3.3.15 Rural Electric Cooperative Considerations 3-223
3.4 Assessing Vulnerability & Estimating Potential Losses of State Facilities 3-228
3.4.1 Floods 3-234
3.4.2 Wildfire 3-236
3.4.3 Tornadoes, Wind, and Winter Storms 3-236
3.4.4 Drought 3-237
3.4.5 Hazardous Materials 3-238
3.4.6 Geologic Hazards 3-241
3.5 Risk Assessment Summary and Conclusions 3-241

Section 4 State Capability Assessment 4-1
4.1 2019 Updates to the Capability Assessment 4-2
4.2 Integrated Hazard Mitigation Planning 4-3
4.2.1 South Dakota Hazard Mitigation Team (SHMT) 4-3
4.2.2 State Drought Task Force 4-4
4.2.3 State Laws, Regulations & Policies 4-5
4.2.4 State Hazard Mitigation Capabilities and Program Integration Summary 4-7
4.3 South Dakota Office of Emergency Management (OEM) 4-17
4.3.1 OEM Mitigation Section 4-17
4.3.2 Hazard Mitigation Grants and Program Management 4-18
4.3.3 National Flood Insurance Program 4-18
4.3.4 Risk Mapping, Assessment, and Planning (Risk MAP) 4-20
4.3.5 Hazard Mitigation Training Program 4-21

4.3.6 Other OEM Plans and Program Initiatives 4-21
4.4 Other State and Regional Agencies 4-23
4.4.1 South Dakota Department of Environment and Natural Resources 4-23
4.4.2 South Dakota Department of Agriculture 4-25
4.4.3 South Dakota Department of Transportation 4-27
4.4.4 South Dakota State Historic Preservation Office 4-28
4.4.5 South Dakota Department of Health – Office of Public Health Preparedness and Response 4-28
4.4.6 South Dakota Bureau of Information and Telecommunications 4-29
4.4.7 South Dakota Office of Risk Management 4-30
4.4.8 South Dakota Office of Homeland Security 4-31
4.4.9 South Dakota Game, Fish & Parks 4-32
4.4.10 South Dakota State University Extension 4-33
4.4.11 Rural Electric Cooperatives 4-34
4.4.12 Planning and Development Districts 4-35
4.4.13 Additional State Plans and Programs 4-40
4.4.14 Effective Use of State Capabilities for Mitigation 4-41
4.5 Integration with Federal/National Mitigation Programs and Initiatives 4-43
4.5.1 FEMA Region VIII 4-43
4.5.2 U.S. Army Corp of Engineers 4-44
4.5.3 Natural Resource Conservation Service 4-45
4.5.4 U.S. Geological Survey 4-45
4.5.5 National Weather Service 4-46
4.5.6 U.S. Bureau of Reclamation 4-47
4.5.7 Federal Highway Administration 4-47
4.5.8 Housing and Urban Development (HUD) Community Development Block Grant Disaster Recovery Grants (CDBG_DR) 4-47
4.6 Local Capability Assessment and Integration 4-48
4.6.1 Local Technical and Financial Assistance 4-48
4.6.2 Prioritizing Local Assistance 4-50
4.6.3 Local Plan Integration 4-51
4.6.4 Local Plan Review Process 4-51
4.6.5 Local Capabilities Overview 4-51
4.6.6 Local Mitigation Actions Overview 4-56
4.7 Tribal Capability Assessment and Integration 4-61
4.7.1 Prioritizing Assistance to Tribes 4-61
4.7.2 Tribal Plan Integration 4-61
4.7.3 Tribal Capabilities Overview 4-62
4.7.4 Tribal Integration in State Mitigation Strategy 4-63

Section 5 Mitigation Strategy and Progress 5-1
5.1 Hazard Mitigation Goals and Objectives 5-1
5.1.1 Updates to the Goals and Objectives 5-2
5.1.2 Related Plan Goals 5-3

5.2 Mitigation Actions 5-4
5.2.1 Process Used to Evaluate and Prioritize Mitigation Actions 5-4
5.2.2 2019 Revisions to the Mitigation Actions 5-6
5.2.3 Mitigation Actions Details 5-7
5.2.4 Progress on Mitigation Goals and Actions 5-22
5.2.5 Comprehensive Mitigation Strategy 5-30
5.3 Funding Sources 5-34
5.3.1 Hazard Mitigation Assistance (HMA) Program 5-43
5.3.2 Other FEMA Grants Programs 5-47
5.4 Effective Use of Available Mitigation Funding 5-48
5.4.1 Demonstrated Use of Mitigation Funding 5-48
5.4.2 Subgrant Application Review and Prioritizing 5-52
5.4.3 Mitigation Program Management Performance and Capability Enhancements 5-54
5.4.4 Integration of Mitigation into Post-Disaster Recovery Operations 5-56
5.4.5 Determining Cost-Effectiveness of Proposed Mitigation Measures 5-57
5.4.6 Post-Event Determination of Losses Avoided and Project Effectiveness 5-61
5.4.7 Loss Avoidance Analysis Tool (LAAT) 5-64
5.4.8 Loss Avoidance Case Studies 5-64

Section 6 Plan Implementation and Maintenance 6-1
6.1 Monitoring, Evaluating, and Updating the Plan 6-1
6.1.1 Annual Review 6-1
6.1.2 Post-Disaster Review 6-2
6.2 Monitoring Progress and Effectiveness of Mitigation Activities 6-2
6.2.1 Annual Progress Assessment 6-2
6.2.2 Monitoring Implementation of Mitigation Measures and Project Closeouts 6-2
6.2.3 Post-Disaster Review of Mitigation Measures 6-3
6.3 Integrating the SHMP Into Other Plans 6-3
6.3.1 Threat and Hazard Identification and Risk Assessment (THIRA) 6-3
6.3.2 State Emergency Operations Plan (SEOP) and Related Response Plans 6-4
6.3.3 Recovery Plan 6-4
6.3.4 Continuity of Operations Plans (COOP) 6-5

List of Appendices

Appendix 1 - Acronym Guide
Appendix 2 - Enhanced Plan Compliance
Appendix 3A - Population and Growth
Appendix 3B - Hazus-MH Flood Results
Appendix 3C - Flood Insurance Claims Detail
Appendix 3D - Vulnerability Methodology
Appendix 3E - Hazus Earthquake Scenario
Appendix 3F - Critical Facilities in Flood and Wildfire Zones
Appendix 4A - NFIP Participating Communities
Appendix 4B - FEMA Annual Consultation Visit Notes
Appendix 5 - Local and Tribal Plan Rollup (Electronic)
Appendix 6 - Loss Avoidance Analysis Tool (LAAT) User Guide

List of Attachments

Attachment A - South Dakota Drought Mitigation Plan
Attachment B - HMGP Administrative Plan

List of Tables

Table 1-1 Hazard Ranking and Planning Consideration 1-3
Table 2-1 Agency and Stakeholder Participation in the 2019 Planning Process 2-3
Table 2-2 Overview of 2019 Update Planning Process 2-5
Table 3-1 Hazard Rankings 3-5
Table 3-2 Hazard Ranking Worksheet – South Dakota 3-6
Table 3-3 Hazard Ranking Legend 3-7
Table 3-4 Presidential Declarations 3-8
Table 3-5 Summary of 2016 Hazard Identification and Risk Assessment Update 3-13
Table 3-6 Summary of 2019 Hazard Identification and Risk Assessment Update 3-14
Table 3-7 South Dakota Livestock Diseases 3-24
Table 3-8 Small Grains 3-28
Table 3-9 Sunflowers, Oilseeds, Dry Beans, Dry Peas and Soybeans, Corn, Alfalfa and Flax 3-28
Table 3-10 U.S. Army Corps of Engineers Owned Levees by County in South Dakota 3-41
Table 3-11 Significant South Dakota Flood Events 3-43
Table 3-12 Hail Size Description Chart 3-59
Table 3-13 Impacts by Incident-Hail 3-61
Table 3-14 Number of Hail Incidents by County (1996-2016) 3-61
Table 3-15 Selected South Dakota Hail Events 3-63
Table 3-16 South Dakota Lightning Events 1996-2016 3-65
Table 3-17 Impacts by Incident-Lightning 3-67
Table 3-18 South Dakota Winter Storm Events 3-71
Table 3-19 South Dakota Wildfire Events 3-87
Table 3-20 Duration and Magnitude Estimates of 15 Dry and 15 Wet Spells in South Dakota 3-101
Table 3-21 South Dakota Droughts: 1889-2017 3-104

Table 3-22 Original Fujita Scale 3-110
Table 3-23 Enhanced Fujita Scale 3-110
Table 3-24 Wind Zones 3-112
Table 3-25 South Dakota Tornadoes 3-114
Table 3-26 South Dakota Wind Events 3-122
Table 3-27 Gas Transmission Line and Hazardous Liquid Line Mileage by County 3-129
Table 3-28 Transportation Hazardous Materials Incidents, 1971-2016 3-134
Table 3-29 Details of South Dakota Pipeline Incidents, 1983 – 2012 3-135
Table 3-30 Chemical Releases by County, 2014 3-138
Table 3-31 Top 10 South Dakota Facilities with Greatest Total Releases, 2014 3-138
Table 3-32 Top 10 Chemicals Reported Released in South Dakota, 2014 3-139
Table 3-33 South Dakota Landslides and Mudflows 3-146
Table 3-34 South Dakota Earthquakes 3-149
Table 3-35 Growth and Development Trends Extracted from Local Plans 3-155
Table 3-36 South Dakota Decennial Census 1970-2010 3-159
Table 3-37 Ten Largest Counties Ranked by Population (Estimated), 2011 and 2014 3-160
Table 3-38 Top Ten Counties with Greatest Estimated Population Gains (Numerical), 2000-2011 and 2010-2014 3-160
Table 3-39 Top Ten Counties with Greatest Estimated Population Gains (Percent), 2000-2011 and 2010-2014 3-161
Table 3-40 Interim South Dakota Population Projections, 2010-2030 3-161
Table 3-41 Top Ten Counties Ranked by Population Density, 2011 and 2014 3-162
Table 3-42 Project Worksheets (PWs) Summary by FEMA Disaster Declaration 1990-2018 3-165
Table 3-43 PA Disaster Expenditures Summarized by Damage Categories, 1999-2018 3-166
Table 3-44 Consequence Summary for Agricultural Pest and Disease 3-170
Table 3-45 Hazus-MH Base Flood (1 Percent Chance) Loss Estimation Results: Impacts by County, Ranked by Highest Building Losses 3-174
Table 3-46 Digital Flood Insurance Rate Maps Base Flood (1 Percent Chance) Loss Estimations 3-178
Table 3-47 Top Ten Counties for Flood Insurance Dollars Paid (Historical), 1978 – 2016 3-181
Table 3-48 Repetitive Loss Properties by County 3-182
Table 3-49 Repetitive Loss Claims by County 3-183
Table 3-50 Flood Consequence Table 3-184
Table 3-51 Vulnerability of South Dakota Counties to Hail (ranked by vulnerability) 3-186
Table 3-52 Summer Storms Consequence Table 3-188
Table 3-53 Vulnerability of South Dakota Counties to Winter Storms 3-191
Table 3-54 Winter Storms Consequence Summary 3-194
Table 3-55 WUI Exposure 3-195
Table 3-56 State Fire Suppression Costs by Year, 1994-2014 3-199
Table 3-57 Wildfire Consequence Table 3-202
Table 3-58 South Dakota Crop Loss Due to Drought: 2002 and 2012 3-203
Table 3-59 Crop Vulnerability Analysis to Drought 3-205
Table 3-60 Drought Consequence Table 3-208
Table 3-61 Vulnerability of South Dakota Counties to Tornadoes 3-212

Table 3-62 Tornado Consequence Table 3-214
Table 3-63 Vulnerability of South Dakota Counties to Windstorm 3-217
Table 3-64 Windstorm Consequence Table 3-219
Table 3-65 Hazardous Materials Consequence Table 3-220
Table 3-66 Landslides, Expansive Soils, Subsidence Consequence Table 3-222
Table 3-67 Earthquakes Consequence Table 3-223
Table 3-68 Rural Electric Cooperative Hazard Vulnerabilities 3-225
Table 3-69 REC Mitigation Funding and Miles of Line Buried by County: 2005-2012 3-226
Table 3-70 FEMA Public Assistance Section 406 Project and Mitigation Funding: 2008-2016 3-227
Table 3-71 State Owned Building Replacement Value Estimates: 2011-2012 3-233
Table 3-72 State Facilities in Counties Vulnerable to Winter Storm, Wind, and Tornado Hazards 3-237
Table 3-73 State Facilities within a 0.5 mile buffer of Tier II Facilities 3-238
Table 3-74 State Facilities within a 0.5 mile buffer of Railroad Corridors 3-239
Table 3-75 State Facilities within a 0.5 mile buffer of Highway Corridors 3-240
Table 3-76 Hazard Risk Summary Table 3-242
Table 4-1 Summary of State Hazard Mitigation Capabilities by Agency 4-8
Table 4-2 Summary of Federal Partner Capabilities In South Dakota 4-11
Table 4-3 State/Regional Agency Hazard Expertise 4-14
Table 4-4 State/Regional Agency Integration by Sector 4-16
Table 4-5 References to Hazards in Regional CEDs 4-36
Table 4-6 Summary of Local Capabilities 4-52
Table 4-7 Comparison of Current Local Mitigation Actions, 2014 vs. 2019 4-56
Table 4-8 Comparison of Most Commonly Identified Local Mitigation Actions and Related State Mitigation Actions 4-58
Table 4-9 Summary of Completed Local Mitigation Actions, 2019 4-60
Table 4-10 South Dakota Tribal Mitigation Planning Status 4-62
Table 4-11 Summary of Tribal Capabilities 4-62
Table 4-12 State Mitigation Actions Specific to Tribes 4-64
Table 4-13 Tribal Mitigation Actions Identified and Completed in 2019 Plans 4-64
Table 5-1 Goals and Objectives 5-2
Table 5-2 STAPLE/E Criteria 5-5
Table 5-3 Revised Mitigation Actions 5-6
Table 5-4 South Dakota 2019 Mitigation Actions 5-8
Table 5-5 Progress on Mitigation Actions 5-22
Table 5-6 Mitigation Actions by Hazards Addressed 5-30
Table 5-7 Mitigation Actions by Sectors Addressed 5-32
Table 5-8 Mitigation Funding Sources in South Dakota 5-35
Table 5-9 Status of Recent HMGP Grants in South Dakota 5-48
Table 5-10 PDM Grants in South Dakota, 2010-2017 5-49
Table 5-11 Types of PDM-Funded Mitigation Projects, 2010-2017 5-49
Table 5-12 Summary of Mitigation Projects Conducted by Project Type,2015-2018 5-50
Table 5-13 Properties Acquired or Relocated Out of Hazard Areas 5-50
Table 5-14 HMA Grant Management Performance Requirements and Best Practices 5-54

Table 5-15 FEMA Public Assistance Section 406 Project & Mitigation Funding: 2010-2018..... 5-57
Table 5-16 Examples of Key Data Needed for Analyzing Project Applications..... 5-59

List of Figures

Figure 3-1 South Dakota's Average Annual Precipitation, 1981-2010 3-3
Figure 3-2 South Dakota National Agriculture Rankings by Commodity 3-15
Figure 3-3 Land Cover in South Dakota 3-19
Figure 3-4 2016 Adult Grasshopper Density for South Dakota..... 3-20
Figure 3-5 South Dakota Grasshopper Hazard..... 3-21
Figure 3-6 Drainage Basins of South Dakota 3-36
Figure 3-7 South Dakota High and Significant Hazard Dams..... 3-40
Figure 3-8 Levee Protection in South Dakota by County 3-42
Figure 3-9 Projected Change in Daily, 20-year Extreme Precipitation..... 3-57
Figure 3-10 Generalized Potential for Flash Flooding in the Black Hills Area..... 3-58
Figure 3-11 NOAA Hail Size Comparison Chart 3-59
Figure 3-12 Cloud to Ground Lightning..... 3-60
Figure 3-13 South Dakota Hail Events 1996 – May 2016..... 3-63
Figure 3-14 National Weather Service Wind Chill Chart 3-69
Figure 3-15 South Dakota Winter Storm Events 1993 – May 2016 3-71
Figure 3-16 Map of Black Hills National Forest with District Boundaries..... 3-82
Figure 3-17 South Dakota Communities at Risk to Wildfire..... 3-83
Figure 3-18 South Dakota's Wildland-Urban Interface 3-85
Figure 3-19 South Dakota Fire Occurrences 1,000 Acres or More: 1980-2016..... 3-86
Figure 3-20 South Dakota Fire Occurrence Causes (1000 Acres or more): 1980-2016..... 3-87
Figure 3-21 National Weather Service Heat Index..... 3-95
Figure 3-22 South Dakota Drought Status, July 24, 2007..... 3-98
Figure 3-23 South Dakota's Drought Status, July 27, 2010..... 3-99
Figure 3-24 South Dakota's Drought Status, February 12, 2013.....3-100
Figure 3-25 South Dakota's Drought Status, July 5, 2016 3-101
Figure 3-26 Drought Impact Distribution in South Dakota: 1980-2015 3-104
Figure 3-27 United States: Percent of Time in Drought, 1895-1995 3-108
Figure 3-28 Tornado Activity in the United States 3-111
Figure 3-29 Wind Zones in the United States 3-112
Figure 3-30 South Dakota Tornadoes by County, 1950-2016 3-113
Figure 3-31 Tornado Paths in South Dakota 1953-2016 3-114
Figure 3-32 Damaging Tornado Probability by County 3-121
Figure 3-33 South Dakota Wind Events by County, 1955 – 2016.....3-122
Figure 3-34 South Dakota Transportation Infrastructure 3-128
Figure 3-35 South Dakota Hazardous Materials Transmission Lines 3-130
Figure 3-36 South Dakota Tier II Facility Counts 2015.....3-131

Figure 3-37 South Dakota Oil and Gas, Well, Test Hole and Permit Locations 3-132
Figure 3-38 South Dakota Abandoned Hardrock Mines and Waters Polluted by Metals 3-133
Figure 3-39 South Dakota Landslide Incidence and Susceptibility 3-143
Figure 3-40 State of South Dakota Subsidence Risk 3-144
Figure 3-41 South Dakota Expansive Soils 3-145
Figure 3-42 Earthquakes in South Dakota 1872-2016 3-149
Figure 3-43 Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years 3-153
Figure 3-44 Estimated Percent Change in Population by County, 2000-2014 3-159
Figure 3-45 Social Vulnerability to Environmental Hazards, County Comparison within the State, 2006-2010 3-164
Figure 3-46 FEMA Individual Assistance Claims 1993-2009 3-165
Figure 3-47 FEMA Public Assistance Damage Sites by Damage Category 1993-2016 3-167
Figure 3-48 Building Exposure 2016 3-168
Figure 3-49 Total Market Value of Crops Sold by County 3-169
Figure 3-50 Total Market Value of Livestock Sold by County in 2012 3-170
Figure 3-51 South Dakota Digital Flood Insurance Rate Map Coverage 2016 3-173
Figure 3-52 South Dakotas 100-year Flood Zones based on Hazus 3-173
Figure 3-53 Hazus-MH Base Flood (1 Percent Chance) Building and Income Loss Estimation by County 3-176
Figure 3-54 Hazus-MH Base Flood (1 Percent Chance) Building Loss Ratio 3-177
Figure 3-55 Hazus-MH Base Flood (1 Percent Chance) Content Loss Ratio 3-177
Figure 3-56 Hazus-MH Base Flood (1 Percent Chance) Displaced Population Estimation by County 3-178
Figure 3-57 Hazus MH Flood Average Annualized Loss 3-180
Figure 3-58 Vulnerability of South Dakota Counties to Hail with State Facilities 3-185
Figure 3-59 Vulnerability of South Dakota Counties to Winter Storms with State Facilities 3-190
Figure 3-60 Vulnerability of South Dakota Counties to Winter Storms with Mitigation Projects 3-191
Figure 3-61 Aggregate Wildland Fire Vulnerability 3-201
Figure 3-62 Drought Impact Reporter for South Dakota (January 1980-May 2015) 3-203
Figure 3-63 Annualized Estimated Crop Economic Losses from Drought, by County 2000-2014 3-207
Figure 3-64 Crop Vulnerability Rank by County - 2000-2014 3-208
Figure 3-65 Tornado Damage 1950-2016 3-210
Figure 3-66 Tornado Vulnerability and State Facilities 3-211
Figure 3-67 Tornado Vulnerability and Mitigation Projects 3-212
Figure 3-68 Windstorm Vulnerability and State Facilities 3-216
Figure 3-69 Windstorm Vulnerability and Mitigation Projects 3-216
Figure 3-70 Hazus Probabilistic Earthquake: Direct Economic Losses For Buildings 3-222
Figure 3-71 South Dakota Rural Electric Cooperative Boundaries 3-224

Figure 3-72 South Dakota Total Building Exposure 3-230
Figure 3-73 South Dakota State Facilities 3-231
Figure 3-74 South Dakota Utilities 3-231
Figure 3-75 South Dakota Utility Infrastructure 3-232
Figure 3-76 South Dakota Transportation Infrastructure 3-232
Figure 3-77 South Dakota Critical Facilities and State Assets at Risk to Flooding 3-235
Figure 3-78 South Dakota State-Owned Bridges 3-236
Figure 4-1 Regional Planning Districts 4-36
Figure 5-1 Mitigation Projects by Federal Share Obligated in South Dakota, 2018 5-51
Figure 5-2 Mitigation Projects by Type of Project, 2018 5-52

SECTION 1 INTRODUCTION

1.1 Mission Statement and Purpose

The South Dakota hazard mitigation team (SHMT) reviewed and validated the following mission statement for the state's overall mitigation planning efforts at the August 16, 2018 planning meeting.

To reduce the impacts to life and property from hazards through a long term sustainable statewide mitigation strategy while maintaining economic vitality.

The purpose of the State of South Dakota Hazard Mitigation Plan is:

1. To guide South Dakota's mitigation program to reduce the impact of or eliminate destructive effects of significant hazards to the state e.g., threats to life and property.
2. To serve as a public and private sector reference document and management tool for mitigation activities throughout South Dakota.
3. To meet the state planning requirements of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended, and other federal and state requirements as detailed in Section 1.1.

1.2 Background

Hazard Mitigation is defined as *any action taken to reduce or eliminate the long-term risk to human life and property from hazards*. The term is sometimes used in a stricter sense to mean cost-effective measures to reduce the potential for damage to a facility or facilities from a disaster event (FEMA definition).

South Dakota's first recorded hazard mitigation efforts took place in the late 1800's. After the 1881 flood of the Vermillion and Missouri Rivers that destroyed the town of Vermillion, the town was relocated on the bluffs behind the former town to prevent another recurrence. This marks the first recorded hazard mitigation effort by a government entity in South Dakota. During the 1950's, the U.S. Army Corp of Engineers placed levees along the Belle Fourche River in Belle Fourche and also placed flash flood containment systems in Fall River County to protect the community of Hot Springs from flash flooding. Following the 1972 Black Hills/Rapid City flood, development was prohibited from the floodway.

Hazard mitigation efforts were also conducted after the Deadwood Fire in 1959. Homestake Mining Company implemented a large Wildfire Urban Interface tree thinning project on private lands around Lead, South Dakota to protect the community from another large forest fire.

South Dakota mitigation efforts have also involved mitigation of landslides. Since 1969, the South Dakota Department of Transportation (SDDOT) has created and implemented engineering and construction methods and procedures for mitigation of landslides. Over time, these measures were copied by other states and are still in use today. South Dakota has received national recognition for their mitigation leadership.

Currently, the South Dakota Office of Emergency Management (OEM) oversees hazard mitigation grant funding available through FEMA's Hazard Mitigation Assistance programs and supports local

implementation of various mitigation projects. Across the State of South Dakota mitigation progress has included multiple outreach and public education campaigns, acquisition and relocation projects to reduce flood damage, drainage improvement projects, road elevation projects, vegetation management to prevent wildfire, power line burials, and much more.

The first State of South Dakota Hazard Mitigation Plan was completed and approved in June 2004, and formally adopted by the State on February 28, 2005. The Plan was updated in 2008, 2011, and 2014; additionally, the HIRA section was updated in 2016. This current 2019 revision updates the Plan with new information and analyses, and also brings the Plan into compliance with the requirements for an Enhanced State Hazard Mitigation Plan, as set out in 44CFR§201. South Dakota remains committed to updating this plan every five years, or as new information requires it. The Plan will also be reviewed and evaluated regularly to monitor progress and assess the effectiveness of mitigation activities.

1.3 Plan Organization

This plan demonstrates the state's current and future mitigation actions in an organized fashion consistent with the guidance materials provided by FEMA. The reviewer will note that the section headings and subheadings follow the organization of the Standard and Enhanced State Hazard Mitigation Plan Review Tool. Several appendices accompany this plan. They contain technical data, meeting minutes, and other relevant information that complements the content of this plan.

Section 1 demonstrates the legal authority of this plan through the Governor's adoption and compliance with federal and state laws and regulations. Section 2 documents the planning process for developing this plan, including coordination with local mitigation planning efforts. Section 3 outlines the identified hazards South Dakota is vulnerable to and assesses the risk for each hazard on a per county basis. Section 4 details the statewide capability assessment, to include assessment of local capabilities, and demonstrates coordination/integration with other agencies and programs. Section 5 describes the State's mitigation strategy, along with how the state prioritizes and funds mitigation activities while ensuring funds are used effectively. Section 6 outlines the plan implementation and maintenance process. Each section includes details on how this 2019 plan was updated from the previous 2014 plan.

1.4 Executive Summary

Introduction

This plan is an update of the 2014 State Hazard Mitigation Plan pursuant to the Disaster Mitigation Act of 2000 as amended. This Plan is written in compliance with FEMA's most recent State Mitigation Plan Review Guide dated March 2016. This plan demonstrates the State's current and future mitigation actions in an organized fashion similar to the guidance materials provided by FEMA.

The South Dakota Hazard Mitigation Team (SHMT), led by the director of the South Dakota Office of Emergency Management and charged by the governor with the responsibility of implementing a statewide Hazard Mitigation Program based upon Section 409 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (P.L. 93-288, as amended), recommended that this 2019 revised and updated Hazard Mitigation Plan be adopted by the governor. Governor Kristi Noem adopted the revised Plan on April 8, 2019

Section 2 Planning Process

The 2019 Plan update process was conducted in full accordance with DMA2000 requirements and other FEMA guidance. As with previous SHMP updates, the SHMT served as the primary planning team during the 2019 update, with technical assistance from the consulting team of Wood Environment and

Infrastructure Solutions (Wood). The core leadership of the State Hazard Mitigation Team consists of one representative from each state and regional department or agency with mitigation responsibilities. The South Dakota Silver Jackets again functioned as a core coordination element for involving relevant federal stakeholders and conducted meetings jointly with the SHMT. Three face-to-face meetings were supplemented by numerous phone calls and email exchanges. A draft version of the plan was made available to the entire SHMT and Silver Jackets for comment and was also made available for public comment.

Section 3 Hazard Identification and Risk Assessment (HIRA)

The state HIRA was completely revised in 2016 and updated again in 2018 to add new hazard events or information. Past disaster history was reviewed, future trends were analyzed, and hazards were evaluated base on probability of occurrence, primary & secondary impacts, and the area affected. Input from local hazard mitigation plans as well as the results of the 2014 public survey were also incorporated. The following hazards were determined to be the greatest concern statewide and are profiled in detail in this plan.

Table 1-1 Hazard Ranking and Planning Consideration

Hazard Type and Ranking		Planning Consideration Based on Hazard Level
1	Flooding (flash, long-rain, snowmelt, and dam or levee failure)	Significant
2	Winter Storms	Significant
3	Wildfires	Significant
4	Drought	Significant
5	Tornadoes	Significant
6	Summer Storms	Moderate
7	Wind	Moderate
8	Agricultural Pests and Diseases	Moderate
9	Hazardous Materials	Moderate
10	Geological Hazards (Landslide, Mudflow, Expansive Soils, Earthquake)	Limited

The hazard rankings are based on the probability of occurrence, area affected, primary and secondary impacts, local plan rankings, and the survey score for each hazard. Overall significance is given for the state as a whole, although significance can vary greatly in different parts of the state. Section 3 details the process for developing the 2016 revised hazard prioritization, which is summarized in Section 3.5.

The vulnerability of each county & tribe was also evaluated based on population, growth and development patterns, social vulnerability, past disaster declarations, and building exposure. The vulnerability of state facilities was also assessed separately.

Section 4 State Capability Assessment

The state has established a comprehensive, multi-directional state hazard mitigation program. State mitigation initiatives are integrated with FEMA programs, and are designed to focus federal and state programs in support of local planning efforts. State mitigation planning is integrated with other state emergency management efforts as well as other state and regional planning initiatives.

True success in reducing the statewide risk to all hazards requires strong collaboration among state agencies, federal agencies, and local and tribal governments. Thus the SHMP is closely linked to a number of statewide and local planning initiatives. Throughout the 2019 Plan update process, other plans, programs, and initiatives were reviewed to ensure they were integrated into the Plan. Section 4 outlines

the capabilities and activities of state agencies that support hazard mitigation, and how those programs are integrated with the SHMP. The integration of the State Hazard Mitigation Plan with other state planning initiatives primarily occurs through, the assessment of state capabilities, data-sharing between different plans, and through participation on planning committees and policy commissions.

Supporting local mitigation efforts is a top priority for the state. In order to prioritize these needs, an assessment of local capabilities is included in Section 4.6. That section also summarizes local risk reduction capabilities, as well as completed and identified mitigation actions noted within the LHMPs.

Section 5 Mitigation Strategies

Since the development of the first State Hazard Mitigation Plan in 2004, South Dakota has achieved significant progress in reducing risk to natural hazards. Section 5.1 lists six goals of the state mitigation program, as revised during the 2019 update process:

Goals:

1. Reduce injuries and loss of life from natural hazards
2. Reduce damage to existing and future structures within hazard areas
3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards
4. Reduce impacts to the economy, the environment, and cultural resources from hazards
5. Support and assist local mitigation capabilities and efforts
6. Increase partnerships with tribal nations

The goals are purposefully applicable to all of the identified hazards and intended to encompass all mitigation needs identified by the state as well as local communities. One or more objectives were identified for each goal to provide more detailed direction.

Many of the mitigation actions identified in the 2014 Plan remain ongoing. Section 5.2 presents the current ongoing and new mitigation actions as confirmed by the SHMT during the 2019 update process. Progress made since the 2014 Plan update is noted for each action.

Funding sources used for mitigation projects are described in Section 5.3, along with other potential funding sources identified by the SHMT. Section 5.4 discusses the effective use of mitigation funding, to include determining loss avoidance, measuring effectiveness, and integrating mitigation into post-disaster recovery operations.

Section 6 Plan Maintenance Procedures

The SHMT meet regularly throughout the year and as needed following disaster events. They will review this Plan at least annually, to include a review of mitigation goals and objectives to ensure they remain relevant. The status of ongoing mitigation actions will also be reviewed, and implementation notes and/or progress notes added as available. The SHMT will also meet following every declared disaster to determine if any mitigation projects were impacted by the disaster, and whether or not it is possible to evaluate the effectiveness of those projects in reducing losses or damage. The state will participate in an annual consultation with FEMA that will include a review of the enhanced plan criteria to remain in good standing.

The South Dakota Office of Emergency Management (OEM) will continue to review applications for submittal for FEMA Pre Disaster Mitigation (PDM) grants. OEM may also maintain a list of proposed or

contemplated actions that could quickly be turned into applications for new projects when Hazard Mitigation Grant Program (HMGP) funds or other grant funds become available.

The state will submit an updated Hazard Mitigation Plan to FEMA for review and approval every five years, as required by DMA 2000.

1.5 Compliance with Federal and State Laws and Regulations

44 CFR Part 201 Requirement:
The plan must: Include assurances that the State will comply with all applicable Federal statutes and regulations in effect with respect to the periods for which it receives grant funding, including 2 CFR parts 200 and 3002. The State will amend its plan whenever necessary to reflect changes in State or Federal laws and statues).

This plan is prepared to comply with the requirements of:

- The Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 as amended by Public Law 106-390, October 30, 2000 United States Code Title 42. Public Health and Welfare Chapter 68. Disaster Relief [As amended by Pub. L. 103-181, Pub. L. 103-337, and Pub. L. 106-390] (Pub. L. 106-390, October 30, 2000, 114 Stat. 15521575) hereafter referred to as the Disaster Mitigation Act of 2000 (DMA 2000);
- All pertinent presidential directives associated with the U.S. Department of Homeland Security and FEMA;
- All aspects of 44 CFR pertaining to hazard mitigation planning and grants pertaining to the mitigation of adverse effects of disasters (natural, manmade, and other);
- All interim and final rules pertaining to hazard mitigation planning and grants, as described above;
- All planning criteria issued by FEMA, to include the most recent State Mitigation Plan Review Guide dated March 2016; and
- All Office of Management and Budget circulars and other federal government documents, guidelines, and rules.

The State of South Dakota complies with all federal statutes and regulations in effect with respect to mitigation grants it receives, in compliance with 2 CFR parts 200 and 3002. As stated in Section 1.2 Plan Adoption, the plan will be updated every five years or as required, and amendments will be made as necessary to address changes in federal or state statutes, regulations, and policies. Such amendments will be submitted to FEMA for approval. Additional information about how the plan will be reviewed and updated is in Section 6.

The state complies with all administrative requirements outlined in 2 CFR parts 200 and 3002 in their entirety and to monitor all Sub-recipients supported activities to ensure compliance with 2 CFR parts 200 and 3002 in their entirety. The state also requires all sub-recipients receiving $750,000 or more in federal assistance to have an audit conducted in accordance with the Single Audit Act under 44 CFR 14, Administration of Grants: Audits of State and Local Governments. Such reports by an independent certified public accountant will be maintained by OEM. All general audit requirements in 44 CFR 14 will be adhered to by OEM as well as sub-recipients receiving FEMA hazard mitigation grant awards.

This plan also complies with and implements all relevant State of South Dakota laws, regulations, and policies as detailed in Section 4.2.2.

1.6 Adoption by the State

44 CFR Part 201 Requirement:
The plan must: Be formally adopted by the State prior to submittal to [FEMA] for final review and approval.

Governor M. Michael Rounds adopted the original State of South Dakota Hazard Mitigation Plan by letter dated February 28, 2005, and also adopted the updated 2007 Plan by letter dated April 22, 2008. Governor Dennis Daugaard adopted the 2011 Plan on April 14, 2011 and adopted the revised and updated 2014 Plan on August 16, 2014. These letters are included on the following pages to demonstrate the legacy of the State of South Dakota's commitment to hazard mitigation.

The State Hazard Mitigation Team, led by the director of the South Dakota Office of Emergency Management and charged by the Governor with the responsibility of implementing a statewide Hazard Mitigation Program based upon Section 409 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (P.L. 93-288, as amended), directed this most recent Plan update, and presented it to the Governor and recommended it for adoption. Governor Noem adopted the 2019 Plan on April 8, 2019.

The state will continue to comply with all applicable federal statutes and regulations in effect with respect to the periods for which it receives grant funding, in compliance with § 13.11 (c). As reflected in Section 6 Plan Implementation and Maintenance, the state will amend its plan when necessary to reflect changes in state or federal laws and statues as required in §13.11 (d), or in the event of significant changes the state's hazards or capabilities.

STATE OF SOUTH DAKOTA

OFFICE OF THE GOVERNOR

KRISTI L. NOEM | GOVERNOR

April 8, 2019

Lee dePalo
FEMA Region VIII
Denver Federal Center, Building 710
PO Box 25267
Denver, CO 80225-0267

Dear Mr. dePalo:

On behalf of the State of South Dakota, I am proud to adopt the South Dakota Multi-Hazard Mitigation Plan. This plan clearly outlines the highest risk hazards along with the projects that will lessen the impacts of these hazards in future disasters within our state. This plan is a great tool for our state's entire emergency management community and will be an asset which can be utilized for years to come with noteworthy goals to accomplish.

The State is committed to fulfilling the mitigation goals outlined in the plan and authorizes the responsible agencies to execute their responsibilities toward mitigation actions. The State will comply with all applicable Federal statutes and regulations in effect with respect to the periods for which it receives grant funding, in compliance with 44 CFR 13.11(c). The State will amend its plan whenever necessary to reflect changes in State or Federal statutes and regulations as required in 44 CFR 13.11(d).

With this submission of the State of South Dakota Multi-Hazard Mitigation Plan, the plan is hereby adopted by the State of South Dakota.

Sincerely,

Kristi Noem
Governor

STATE CAPITOL | 500 EAST CAPITOL | PIERRE, SOUTH DAKOTA | 605.773.3212

STATE OF SOUTH DAKOTA
DENNIS DAUGAARD, GOVERNOR

April 16, 2014

Tony Russell
FEMA Region VIII
Denver Federal Center, Building 710
P.O. Box 25267
Denver, CO 80225-5267

Dear Mr. Russell,

On behalf of the state of South Dakota, I am proud to adopt the South Dakota Multi-Hazard Mitigation Plan. This plan clearly outlines the highest risk hazards along with the projects that will lessen the impacts of these hazards in future disasters within our state. This plan is a great tool for our state's entire emergency management community and will be an asset which can be utilized for years to come with noteworthy goals to accomplish.

The state is committed to fulfilling the mitigation goals outlined in the plan and authorizes the responsible agencies to execute their responsibilities toward mitigation actions. The state will comply with all applicable Federal statutes and regulations in effect with respect to the periods for which it receives grant funding, in compliance with 44 CFR 13.11(c). The state will amend its plan whenever necessary to reflect changes in state or federal statutes and regulations as required in 44 CFR 13.11(d).

With this submission of the state of South Dakota Multi-Hazard Mitigation Plan, the plan is hereby adopted by the state of South Dakota.

Sincerely,

Dennis Daugaard

Dennis Daugaard

DD:nn

STATE CAPITOL • 500 EAST CAPITOL • PIERRE, SOUTH DAKOTA • 57501-5070 • 605-773-3212

STATE OF SOUTH DAKOTA
DENNIS DAUGAARD, GOVERNOR

April 14, 2011

Robin Finegan
FEMA Region VIII
Denver Federal Center, Building 710
P.O. Box 25267
Denver, CO 80225-0267

Dear Ms. Finegan:

On behalf of the State of South Dakota, I am proud to adopt the South Dakota Multi-Hazard Mitigation Plan. This plan clearly outlines projects that will lessen the impacts of future disasters within our state. This plan is a great tool for our state's entire emergency management community and will be an asset which can be utilized for years to come with noteworthy goals to accomplish.

With this submission of the State of South Dakota Multi-Hazard Mitigation Plan, the plan is hereby approved and adopted.

Sincerely,

Dennis

Dennis Daugaard

Best regards!

DD:nn

STATE CAPITOL • 500 EAST CAPITOL • PIERRE, SOUTH DAKOTA 57501-5070 • 605.773.3212

STATE OF SOUTH DAKOTA
M. MICHAEL ROUNDS, GOVERNOR

April 22, 2008

Doug Gore
FEMA Region VIII
Denver Federal Center, Building 710
P.O. Box 25267
Denver, CO 80225-0267

Dear Doug,

On behalf of the state of South Dakota, I am proud to adopt the South Dakota Multi-Hazard Mitigation Plan. This plan clearly outlines projects that will lessen the impacts of future disasters within our state. This plan is a great planning tool for our state's entire emergency management community and will be an asset which can be utilized for years to come with noteworthy goals to accomplish.

With the submission of the state of South Dakota Multi-Hazard Mitigation Plan, the plan is hereby approved and adopted.

Sincerely,

M. Michael Rounds

MMR:ls

STATE CAPITOL • 500 EAST CAPITOL • PIERRE, SOUTH DAKOTA 57501-5070 • 605·773·3212

STATE OF SOUTH DAKOTA
M. MICHAEL ROUNDS, GOVERNOR

February 28, 2005

David Maurstad
FEMA Region VIII
Denver Federal Center, Building 710
P.O. Box 25267
Denver, CO 80225-0267

Dear David:

On behalf of the State of South Dakota, I am proud to adopt the South Dakota Multi-Hazard Mitigation Plan. This plan clearly outlines projects that will lessen the impacts of future disaster within our great state. This plan is a great planning tool for our state's entire emergency management community and will be an asset that can be utilized for years to come with noteworthy goals to accomplish.

With the submission of the 2004 State of South Dakota's Natural Hazards Mitigation Plan, the plan is hereby approved and adopted by the state of South Dakota, Office of the Governor.

Sincerely,

M. Michael Rounds

MMR:ls

STATE CAPITOL • 500 EAST CAPITOL • PIERRE, SOUTH DAKOTA 57501-5070 • 605-773-3212

SECTION 2 PLANNING PROCESS

44 CFR Part 201 Requirement:
[The State plan must include a] description of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how other agencies participated.

This section details the planning process conducted during 2017-2019 to revise and update the State of South Dakota Hazard Mitigation Plan (previously adopted on April 16, 2014).

2.1 2019 Plan Update Process

The planning process for this update formally began in December 2017 and continued through 2018 until the adoption of the plan in April of 2019. This process has provided and continues to provide all relevant stakeholders the opportunity to actively participate in the update of this plan. The 2019 planning process was conducted through several in-person meetings. These meetings are described further in Section 2.3. Related planning efforts with direct linkages to the 2019 process are noted below, which include activities that date back to 2014 and 2016.

2.1.1 2016 Hazard Identification and Risk Assessment (HIRA) Update

In 2016, SD OEM decided to use available Emergency Management Performance Grant (EMPG) funds to update the Hazard Identification and Risk Assessment (HIRA) section of the SHMP. Conducting a full HIRA update in 2016 allowed the 2018-2019 update process to focus more on the mitigation strategy and other sections of the Plan. During the 2018-2019 update, the HIRA was only revised to include hazard events that had occurred since 2016 or other areas where additional data was available and significant; new maps were created only when necessary to reflect significant changes since 2016. The planning process used during the 2016 HIRA update is described further in Section 2.3.

2.1.2 South Dakota Drought Mitigation Plan

In 2014-2015, the state went through a comprehensive, DMA-compliant planning process to develop the South Dakota Drought Mitigation Plan. to better analyze the hazards, vulnerabilities, and mitigation activities associated with drought. The Drought Plan was created to serve as a hazard-specific supplement to the SHMP and is included as an attachment to this Plan. The planning process for development of the Drought Plan is touched on in Section 2.3.3 below and is described in more detail in Section 2 of the Drought Plan.

2.1.3 Enhanced Plan Process

For the 2019 update, the State of South Dakota elected to pursue approval as an Enhanced State Hazard Mitigation Plan in accordance with 44CFR§201.5 and FEMA guidance. An enhanced state mitigation plan documents sustained, proven commitment to hazard mitigation. The enhanced status acknowledges the coordinated effort a state currently is taking to reduce losses, protect life and property, and create safer communities. Approval of an enhanced state mitigation plan by FEMA results in eligibility for increased HMGP funding.

Additional information and material to meet the requirements of an enhanced plan are incorporated throughout the Plan. The locations of specific enhanced plan elements are summarized in Appendix 2.

2.2 Stakeholder Involvement

44 CFR Part 201 Requirement:
The [state] mitigation planning process should include coordination with other State agencies, appropriate Federal agencies, interested groups, and be integrated to the extent possible with other ongoing State planning efforts as well as other FEMA mitigation programs and initiatives.

The State of South Dakota's mitigation planning process has included all relevant stakeholders at the state, regional, local, tribal, and federal level, as well as private sector entities and the public. The engagement of stakeholders is an ongoing and key aspect of the State's comprehensive mitigation strategy that goes beyond the update of this SHMP. Thus, additional details of the State's integrated hazard mitigation planning program are detailed in Section 4.2 Integrated Hazard Mitigation Planning. Integration with other Federal/National Mitigation Programs and Initiatives is covered in Section 4.5. The following section describes the coordination specific to the update of the 2019 SHMP.

2.2.1 State Hazard Mitigation Team

The South Dakota Hazard Mitigation Team (SHMT) is the principal body responsible for coordinating the state's comprehensive hazard mitigation program. The membership and responsibilities of the SHMT are established via a series of Executive Orders, the most recent being EO 2007-07 dated April 4, 2007, and updated by a Governor's letter dated October 23, 2014. The SHMT consists of one representative from each of the departments and offices listed in the executive order. More details on the SHMT, including membership and designated responsibilities, can be found in Section 4.2.1.

Participation of SHMT Members in the 2017-2019 planning process meetings is captured in Table 2-2 below. Early in the planning process the role of the SHMT was defined at the kickoff meeting in December 2017. The role and participation expectations included:

- Attending planning meetings
- Assisting with data collection
- Reporting on agency mitigation capabilities
- Leveraging funding/programs to maximize benefits
- Providing input to mitigation strategy/actions
- Reviewing the draft of the updated SHMP

2.2.2 Coordination with State and Regional Agencies

As noted above, the SHMT was the primary vehicle for coordinating the plan update with relevant state agencies throughout the planning process. The State Hazard Mitigation Officer (SHMO) communicated regularly via e-mail and follow-up phone calls with members of the SHMT and other stakeholders. He ensured that everyone on the SHMT was given multiple opportunities to provide input during the planning process.

As was done for the 2014 plan update, the SHMT identified a list of stakeholders from state, regional, local, tribal, and federal agencies to solicit input. Regional stakeholders include the participation and

representation from Rural Electric Cooperatives and related associations in SHMP update planning meetings. Involvement of local governments and the public are discussed in Section 2.4. To illustrate how the planning team encompassed all relevant hazards and areas of responsibilities, participating state and regional agencies were cross-walked against the list of identified hazards, and against different impacted sectors (see Section 4.2.4, tables 4-3 and 4-4).

Table 2-1 shows agency and stakeholder attendance during the planning process, including their participation in the three in-person planning meetings. A complete list of attendees are on file with the OEM SHMO.

Table 2-1 Agency and Stakeholder Participation in the 2019 Planning Process

Stakeholder Organization	Liaison Position	SHMT Member	12/14/17 Meeting	3/22/18 Meeting	8/16/18 Meeting
South Dakota Office of Emergency Management	State Hazard Mitigation Officer	Y	Y	Y	Y
South Dakota Office of Emergency Management	Deputy Director		Y	Y	Y
South Dakota Office of Emergency Management	Hazard Mitigation Specialist		Y	Y	Y
South Dakota Office of Emergency Management	Hazard Mitigation Specialist		Y	Y	Y
South Dakota Office of Emergency Management	Logistics and Admin Branch Team Leader		Y	Y	
South Dakota Office of Emergency Management	State NFIP Coordinator		Y	Y	Y
South Dakota Office of Emergency Management	Recovery and Mitigation Manager		Y	Y	Y
South Dakota Office of Emergency Management	Director		Y		Y
South Dakota Office of Emergency Management	State Planner HMEP Grant Administrator				Y
South Dakota Department of Environment & Natural Resources	Natural Resources Engineer III	Y	Y	Y	Y
South Dakota Department of Environment & Natural Resources	Engineer II		Y	Y	Y
South Dakota Department of Tribal Relations	Tribal Relations	Y		Y	
South Dakota Department of Agriculture	Special Projects Coordinator	Y			Y
South Dakota Game, Fish, and Parks	Grants Coordinator				Y
South Dakota Game, Fish, and Parks	Fisheries Program Administrator	Y		Y	Y
South Dakota Office of Risk Management	State Risk Manager	Y		Y	Y

Stakeholder Organization	Liaison Position	SHMT Member	12/14/17 Meeting	3/22/18 Meeting	8/16/18 Meeting
South Dakota Department of Transportation	Operations Maintenance Engineer	Y			Y
South Dakota Governor's Office of Economic Development	Program Accountant	Y		Y	Y
South Dakota State Historic Preservation Office	Review and Compliance Coordinator	Y		Y	Y
South Dakota State University	State Climatologist	Y	Y	Y	Y
United States Army Corps of Engineers	Engineer			Y	Y
United States Army Corps of Engineers	Engineer			Y	
United States Army Corps of Engineers	Engineer		Y		
United States Army Corps of Engineers	Engineer		Y		
Federal Highway Administration	Special Projects & ROW Engineer			Y	
Federal Highway Administration	Division Bridge Engineer		Y		
FEMA	Senior Community Planner			Y	
National Weather Service	Sr. Service Hydrologist			Y	
National Weather Service	Warning Coordinator Meteorologist				Y
United States Geological Survey	Hydrologist		Y		
West River Electric Association	CFO/Manager of Finance		Y	Y	Y
West Central Electric	Staff Engineer		Y		Y
Central Electric	Manager of Finance and Administration		Y	Y	
Wood Environment and Infrastructure	Hazard Mitigation Lead		Y	Y	Y

In November 2018 the SHMT reviewed a complete draft of this plan update. All SHMT members reviewed the draft plan and their comments were incorporated into the final Plan as appropriate.

2.2.3 Coordination with Federal Agencies

As with the 2014 update process, the South Dakota Silver Jackets was the primary mechanism for coordinating the Plan update with relevant federal stakeholders. The Silver Jackets program provides a formal and consistent strategy for an interagency approach to planning and implementing measures to

reduce risks associated with flooding and other natural hazards. In South Dakota, the Silver Jackets team consists of the US Army Corp of Engineers, FEMA Region VIII, USGS, National Weather Service, US Department of the Interior Bureau of Reclamation, South Dakota Office of Emergency Management, South Dakota Department of Environment and Natural Resources, South Dakota Department of Transportation, and South Dakota Bureau of Information and Telecommunications. All SHMT meetings were conducted jointly with Silver Jacket meetings to maximize participation while minimizing redundant meetings.

The primary federal agencies involved in the planning process are listed in Table 2-1 above and are described in more detail in Section 4.5. In particular, Section 4.5.1 discusses the Annual Mitigation Consultation Meetings conducted with FEMA Region VIII since 2014. The summaries of these meetings are included in Appendix 4B.

2.3 Documentation of the Planning Process

The South Dakota Office of Emergency Management (OEM) oversaw and directed the planning process required to update and revise the Plan in 2017-2019 for adoption in 2019. The staffing and organization of the OEM Hazard Mitigation Section is described in Section 4.3. OEM contracted with the consulting firm Wood Environment and Infrastructure Solutions (Wood) for technical assistance throughout the process including meeting facilitation, risk assessment expertise and plan updating and alignment with FEMA Enhanced Plan requirements.

2.3.1 Timeline of the 2019 Planning Process

The 2019 planning process involved three in-person meetings of the SHMT, Silver Jackets, and consulting team, in addition to meetings with an advisory committee that updated the HIRA in 2016. These in-person meetings were supplemented by many calls among team members and the contracted consulting staff, as well as general communication via e-mail and digital data sharing to facilitate draft reviews and collection of comments. An overview of those meetings and collaboration results is presented in Table 2-2, and elaborated on in the following sections.

Table 2-2 Overview of 2019 Update Planning Process

Timeframe	Activity
May-September 2016	HIRA update – including meetings with advisory committee
February 10, 2017	RFP issued to hire contractor to assist with Plan update
August 30, 2017	Contract awarded to Wood Environment and Infrastructure Solutions
October 10, 2017	Initial Coordination Conference Call
December 14, 2017	Kick Off Meeting (Meeting #1)
March 22, 2018	Mitigation Strategy Meeting and Workshop (Meeting #2)
August 16, 2018	Plan Update Meeting (Meeting #3)
November 2018	SHMT Review Period of Complete Draft
December 2018	SHMT review comments incorporated into Public Review Draft
January 2019	Public Review Period
February-March 2019	Submittal to FEMA for Review
April 2019	Adoption by the State of South Dakota

Meeting invitations, agendas, sign-in sheets, presentations, meeting summaries, and handouts used throughout the planning process are on file with the OEM SHMO.

2.3.2 Planning Meetings

2016 HIRA Update

The State of South Dakota Hazard Mitigation Plan update process began in 2016 with the HIRA update. Two in-person meetings were held as part of the 2016 HIRA Update process: a Kickoff Meeting on June 2, 2016, and a Results Overview Meeting on September 8, 2016. These in-person meetings were supplemented by calls among team members and the contracted consulting staff, as well as general communication via e-mail and digital data sharing to facilitate draft reviews and collection of comments. Details of those meetings are elaborated on below.

The 2016 HIRA update included significant new or updated GIS data for analysis of hazards such as flooding, summer and winter storms, wildfire, hazardous materials, and the inclusion of climate change considerations. More specific information on the HIRA update process can be found in Section 3.

HIRA Update Kickoff Meeting, June 2, 2016

This two-hour kickoff meeting was held in person in Pierre, SD with the SHMT and other key stakeholders. The meeting agenda was as follows:

- Introductions
- Discussion of objectives and schedule for the HIRA update
- Approach and Tasks
- HIRA update requirements
- New items: EMAP consequence analysis and climate change
- Review and discussion of Identified Hazards
- Data collection needs
- Next steps
- Questions and answers

One of the primary outcomes of this meeting was to update and revise hazard identification to include summer storms (hail and lightning) to make the plan's hazards more consistent with local mitigation plans.

HIRA Update Results Overview Meeting, September 8, 2016

The updated HIRA was presented to the SHMT during a two-hour meeting again held in person in Pierre, SD. The meeting agenda was as follows:

- Introductions
- Review of Objectives and Schedule for the HIRA Update
- Review and Discussion of Identified Hazards
- Risk Summary and Vulnerabilities by Hazard
- Climate Change considerations
- Consequence Analysis
- Outstanding Data Needs
- Next Steps/HIRA Review/Schedule
- Questions and Answers

The primary purpose of this meeting was to review the highlights of the updated HIRA and obtain input, so the HIRA could be finalized by September 30, 2016.

SHMP Update Initial Coordination Conference Call, October 10, 2017

The initial coordination meeting was conducted via conference call. Participants on the call included OEM staff (SHMO, Recovery and Mitigation Manager) and Wood staff. Discussion topics included SHMT membership and other stakeholders, coordination between agencies, public involvement, data collection, and significant changes since the 2014 Plan update.

Kick Off Meeting (Meeting #1), December 14, 2017

The kickoff meeting was held to orient the SHMP and Silver Jackets to the 2018-19 plan update process. Kickoff meeting participants are shown in Table 2-1. The meeting agenda was as follows:

- Overview of the Disaster Mitigation Act and Enhanced Plan Requirements
- Role of the State Hazard Mitigation Team
- 2018 Update Strategy—Overview of Main Tasks
- 2016 Risk Assessment Update and Recent Events
- Plan Update Timeline
- Initial Information Needs – Capability Assessment

A worksheet to gather input from the SHMT on state capability assessment changes and changes in funding sources was shared with the group. Loss avoidance tracking, and potential loss avoidance incidents were discussed at this meeting.

Mitigation Strategy Meeting and Workshop (Meeting #2), March 22, 2018

Meeting participants are shown in Table 2-1. This meeting focused on several key aspects of the planning process, utilizing the following agenda:

- Brief Review of Planning Process and Risk Assessment Key Issues
- Capability Assessment Update Highlights
- Review and Update of Plan Goals
- Mitigation Action Strategy Update
  - Review of Mitigation Action Categories
  - Progress on State Mitigation Actions
  - Work Session on Mitigation Action Revisions and Identification of New Mitigation Actions
  - Mitigation Action Prioritization Criteria
  - Prioritization of New Actions
- Plan Update Timeline
- Information Needs/Next Steps

The South Dakota capability assessment highlights were discussed, including those at the local level. Current mitigation goals and objectives were presented, followed by potential update strategies and actions. Identifying and prioritizing new mitigation actions was the focus on several discussion points as well, and suggestions were offered to the SHMT. A prioritization exercise was carried out so that meeting attendees could vote on mitigation activities following the STAPLEE criteria (see Section 5). The meeting was adjourned after reviewing the next steps for the plan, preliminary schedule, and addressing any attendee questions.

Plan Update Meeting (Meeting #3), August 16, 2018

The third in-person meeting of the SHMT focused on refinement of the mitigation action strategy, analysis of strengths and weaknesses of the state's mitigation capabilities, and coordination with other plans and programs. The following items were included on the agenda:

- Introductions
- Brief Review of Planning Process and Enhanced Plan Requirements
- Mitigation Action Strategy Update Recap
- Capability Assessment Update
  - State pre and post disaster mitigation capability evaluation
  - Local pre and post disaster mitigation capability evaluation
  - Available or potential funding sources
- Mitigation Coordination and Integration
  - Other state and regional planning initiatives
  - Drought Mitigation Plan
  - State agency alignment with FEMA sectors
- Enhanced Plan Future Compliance
  - Method and Schedule
- Tracking Mitigation Effectiveness
- Plan Update Timeline/Next Steps

Milestones and the project schedule were reviewed. The general progress made since the previous meeting in March of 2018 was covered, followed by the mitigation action strategy updates. Finalized goals and objectives were discussed, along with the revised and updated mitigation actions. The SHMT discussed final edits to the mitigation actions. The capability assessment update was presented next, with an explanation of the Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis. Coordination and integration of planning efforts was also a key topic of this meeting. The last few subjects discussed were the plan implementation and maintenance, ways to track mitigation effectiveness, and the next steps/project timeline.

2.3.3 Additional Coordination Between Planning Team & Stakeholders

As discussed in Section 2.2.3 above, all SHMT meetings were conducted jointly with the South Dakota Silver Jackets to maximize stakeholder participation. In addition to the specific joint meetings listed above, the Silver Jackets met quarterly throughout the update cycle to discuss risk reduction strategies and activities pertaining to floods and other hazards.

As mentioned in Section 2.1 previously, the state developed the South Dakota Drought Mitigation Plan as a hazard-specific supplement to the SHMP. As part of that planning process, the state's interdisciplinary Drought Task Force held three in-person meetings on September 3, 2014, December 11, 2014, and May 7, 2015. These in person meetings were supplemented with numerous phone calls, emails, and other communications among state, regional, and federal stakeholders. The Drought Task Force also conducted a public survey that received 1,450 responses and released the draft plan for public comment. See Section 2 of the Drought Plan for further details of that planning process.

Frequent email communications between SHMT members and other stakeholders kept the planning process moving between in-person meetings.

2.4 Public Participation

As noted earlier in Section 2.1, the SHMT reviewed the survey and public meeting conducted as part of the 2014 Plan Update; the SHMT determined that those results were still valid and concluded that repeating them for this update would not be necessary.

The State Hazard Mitigation Officer (SHMO) attended the local kick-off meetings for the counties that were awarded PDM 2017 funds to develop LHMPs. The SHMO discussed the SHMP update, the availability of HMA funding, and the opportunity they have to develop mitigation projects to reduce or eliminate the hazards identified in their plans. The SHMO also discussed the SHMP update at quarterly board meetings for the Planning and Development Districts (see Section 4.4.12), and various meetings with the South Dakota Rural Electric Association (see Section 4.4.11).

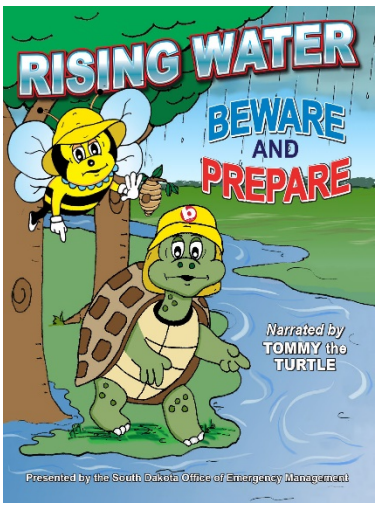
From January 4th to February 7th, 2019, OEM made the complete draft available for public review prior to plan adoption. The plan was made available through a variety of sources:

- The plan was posted on OEM's website.
- A press release was issued resulting announcing the availability of the plan for review: http://news.sd.gov/newsitem.aspx?id=24106
- Announcements regarding the public review draft were made on Facebook and Twitter by OEM (3,885 Facebook followers and 4,657 Twitter followers) and the South Dakota Department of Agriculture.
- A flyer was disseminated at the South Dakota Emergency Management Association's conference, as well as the County Commissioners' conference. https://twitter.com/SDPublicSafety/status/1082654030348894208 and https://www.facebook.com/SoDakResponds/posts/141421183871994.

No public comments were received by the end of the comment period.

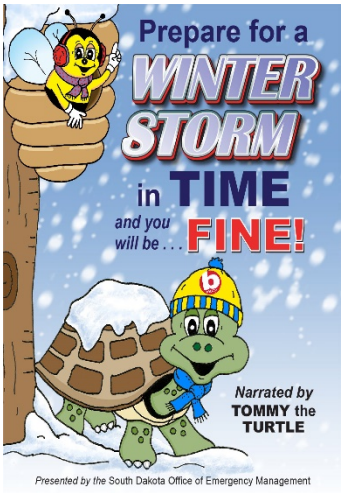
Additionally, in 2015 the state Drought Task Force conducted a public survey as part of the development of the Drought Plan, receiving 1,450 responses. They also released a draft of that plan for public comment, receiving 25 comments. See Section 2 of the Drought Plan for details of the public input on that plan.

2.4.1 Ongoing Public Outreach Since Last Update



During the preparation of the 2007 Plan update, OEM began several new methods of outreach to coordinate and integrate mitigation planning throughout the state. OEM (with assistance from FEMA) developed a mitigation brochure to advertise the idea of mitigation planning and encourage organizations of all types to partner with OEM in mitigating natural hazards. OEM has continued to use this brochure in ongoing outreach efforts through the 2019 update process.

Beginning in 2016, OEM wrote and distributed a series of four *Tommy the Turtle* children's books, created to educate children on the importance of being prepared for disasters. Each book focuses on one of the state's four top hazards as identified in the HIRA: flooding, severe



winter storms, tornadoes and fires. Copies have been distributed to all 2nd grade classrooms in the state, along with all dental offices, doctor's offices, and public libraries. The Fire Marshall's office is also distributing the fire books to kids visited by fire departments throughout the state.

In addition, OEM has continued to partner with the Department of Health on their "bReady" campaign to educate the public on preparedness measures. A guidebook, brochures, and information available to the public as part of this campaign can be found at http://www.bready.sd.gov/. The Department of Health advertises this website and publicizes the campaign to schools, daycares, nursing homes, and at every meeting and exercise they operate (e.g. training exercises for the pandemic flu).

Since the 2014 Plan update, OEM has continued to use outreach materials along with several additional outreach campaigns. Current and ongoing campaigns and efforts to improve public outreach include:

- South Dakota Disaster Kits
- Extension Disaster eNetwork (EDEN)
- Community Wildfire Protection Plans
- Rangeland Insurance (cropland insurance is strong)
- Winter weather and severe weather preparedness guides
- Twitter announcements for severe weather
- School safety sessions
- Safety classes through SDSU Extension
- Partnership with the Public Utility Commission One Call system
- Information on local warning sirens
- NFIP flood insurance promotion through meetings and ad campaigns. NFIP Coordinator provides information to communities that do not participate in the NFIP. For those that do participate, the NFIP Coordinator assists with the development of mitigation plans
- Encourages floodplain ordinances / policies for local governments

Other state agencies also conduct preparedness exercises and mitigation outreach. These agencies and some of their relevant public outreach campaigns are listed below.

- Department of Transportation: Buckle Up, Save it For Later, Give 'em a Brake, Don't Crowd the Plow, temperature warnings, highways construction and hazard notification press releases, safetravelusa.com, 511 Travel Information
- Department of Agriculture: Drought education, wildfire prevention
- Department of Public Health: Flu campaign
- National Weather Service: Flood safety
- Rural Electric Cooperatives: Electrical safety literature, outreach materials, and public service announcements
- State Historic Preservation Office: Public Education on historic property mitigation
- Drought Task Force: provides a forum for community members affected by drought in which they can ask questions and obtain information

In addition, OEM continues to provide mitigation materials at their State Fair booth annually. A severe weather preparedness week is funded through EMPG. This includes a package of information that goes to schools, local emergency managers, daycares, assisted living centers, and nursing homes. Safe room information is also disseminated from the hazard mitigation office to local emergency managers and floodplain administrators.

2.5 Loss Avoidance Analysis Tool (LAAT) Development

One significant enhancement to the 2019 Plan and the State's comprehensive mitigation program is the development of a Loss Avoidance Analysis Tool (LAAT) to assess the effectiveness of mitigation projects. With this tool, hazard events are evaluated against mitigation projects so that the potential reduction of losses can be evaluated and documented. The tool is available for use via a web-map interface and will assist OEM staff with tracking loss avoidance incidents and highlighting mitigation successes. The tool was developed by the planning consultant in during the same timeframe as the 2017-2019 update. More information on the tool is discussed in Chapter 5, Section 5.4.7. Loss avoidance incidents and mitigation successes are described in Section 5.4.8. User guidance is in included in Appendix 6.

SECTION 3 HAZARD IDENTIFICATION AND RISK ASSESSMENT

44 CFR Part 201 Requirement:
[The State plan must include] Risk assessments that provide the factual basis for activities proposed in the strategy portion of the mitigation plan. Statewide risk assessments must characterize and analyze natural hazards and risks to provide a statewide overview. This overview will allow the State to compare potential losses throughout the State and to determine their priorities for implementing mitigation measures under the strategy, and to prioritize jurisdictions for receiving technical and financial support in developing more detailed local risk and vulnerability assessments.

The Hazard Identification and Risk Assessment (HIRA) lays the foundation for the South Dakota Multi-Hazard Mitigation Plan. It sets the stage for identifying mitigation goals and activities to help the state become disaster resilient and keep South Dakota residents safe. The major components of this HIRA include a hazard identification/analysis and a vulnerability analysis that answer the following questions: What are the hazards that could affect South Dakota? What can happen as a result of those hazards? How likely is each of the possible outcomes? When the possible outcomes occur, what are the likely consequences and losses, and how does this vary across the state? This section attempts to answer these questions on a hazard by hazard basis, based on best available data.

The Federal Emergency Management Agency (FEMA) defines risk assessment terminology as follows:

- **Hazard** - A hazard is an act or phenomenon that has the potential to produce harm or other undesirable consequences to a person or thing.
- **Vulnerability -** Vulnerability is susceptibility to physical injury, harm, damage, or economic loss. It depends on an asset's construction, contents, and economic value of its functions.
- **Exposure -** Exposure describes the people, property, systems, or functions that could be lost to a hazard. Generally, exposure includes what lies in the area the hazard could affect.
- **Risk -** Risk depends on hazards, vulnerability, and exposure. It is the estimated impact that a hazard would have on people, services, facilities, and structures in a community. It refers to the likelihood of a hazard event resulting in an adverse condition that causes injury or damage.
- **Risk Assessment -** Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from hazards.

3.1 Identifying Hazards

44 CFR Part 201 Requirement:
[The State risk assessment shall include an] overview of the type…of all natural hazards that can affect the State…

The following resources were used to identify hazards that may affect the State of South Dakota:

- Federal disaster/emergency declarations (see Table 3-4)
- State South Dakota Hazard Mitigation Team (SHMT) and South Dakota Silver Jackets members
- Local hazard mitigation plans covering all 66 counties and 6 tribal governments
- Public input via an online survey (2013)
- Hazus-MH (see Sections 3.3 – 3.5)

The geography and climate of South Dakota are central to the hazards that affect the state. The following information is directly from NetState.com.

3.1.1 Geography

- **Longitude/Latitude** - Longitude: 97° 28′ 33"W to 104° 3′W/Latitude: 42° 29′ 30"N to 45° 56′N
- **Length x Width** - South Dakota is about 380 miles long and 210 miles wide.
- **Geographic Center** - The geographic center of South Dakota is located in Hughes County, 8 miles NE of Pierre (Longitude: 100° 28.7' W, Latitude: 44° 24.1' N).
- **Borders** - South Dakota is bordered by North Dakota on the north and by Nebraska on the south. On the east, South Dakota is bordered by Minnesota and Iowa. On the west, South Dakota is bordered by Montana and Wyoming.
- **Total Area** - South Dakota covers 77,121 square miles, making it the 17th largest of the 50 states.
- **Land Area** - 75,898 square miles of South Dakota are land areas.
- **Water Area** - 1,224 square miles of South Dakota is covered by water.
- **Highest Point** - The highest point in South Dakota is Black Elk Peak at 7,242 feet above sea level.
- **Lowest Point** - The lowest point in South Dakota is Big Stone Lake at 966 feet above sea level.
- **Mean Elevation** - The Mean Elevation of the state of South Dakota is 2,200 feet above sea level.
- **Major Rivers** - Cheyenne River, Missouri River, James River, White River, Big Sioux River
- **Major Lakes** - Lake Oahe, Lake Francis Case, Lewis and Clark Lake

The Missouri River runs through the central part of South Dakota. To the east of the river, low hills and lakes formed by glaciers are now fertile farms. To the west of the Missouri River, the land consists of deep canyons and rolling plains.

South Dakota is comprised of four major land regions; the Drift Prairie, the Dissected Till Plains, the Great Plains, and the Black Hills.

The **Drift Prairie** covers most of eastern South Dakota. This is the land of low hills and glacial lakes. This area was called Coteau des Prairies (Prairie Hills) by early French traders. In the north, the Coteau des Prairies is bordered on the east by the Minnesota River Valley and on the west by the James River Basin. The James River Basin is mostly flat, following the flow of the James River through South Dakota from north to south.

The **Dissected Till Plains** lie in the southeastern corner of South Dakota. This area of rolling hills is crisscrossed by many streams.

The **Great Plains** cover most of the western two thirds of South Dakota. The Coteau de Missouri hills and valleys lie between the James River Basin of the drift prairie and the Missouri River. West of the Missouri River the landscape becomes more rugged and consists of rolling hills, plains, canyons, and steep flat-topped hills called buttes. These buttes sometimes rise 400 to 600 feet above the plains. In the south, east of the Black Hills, lie the South Dakota Badlands. Badlands National Park is located here.

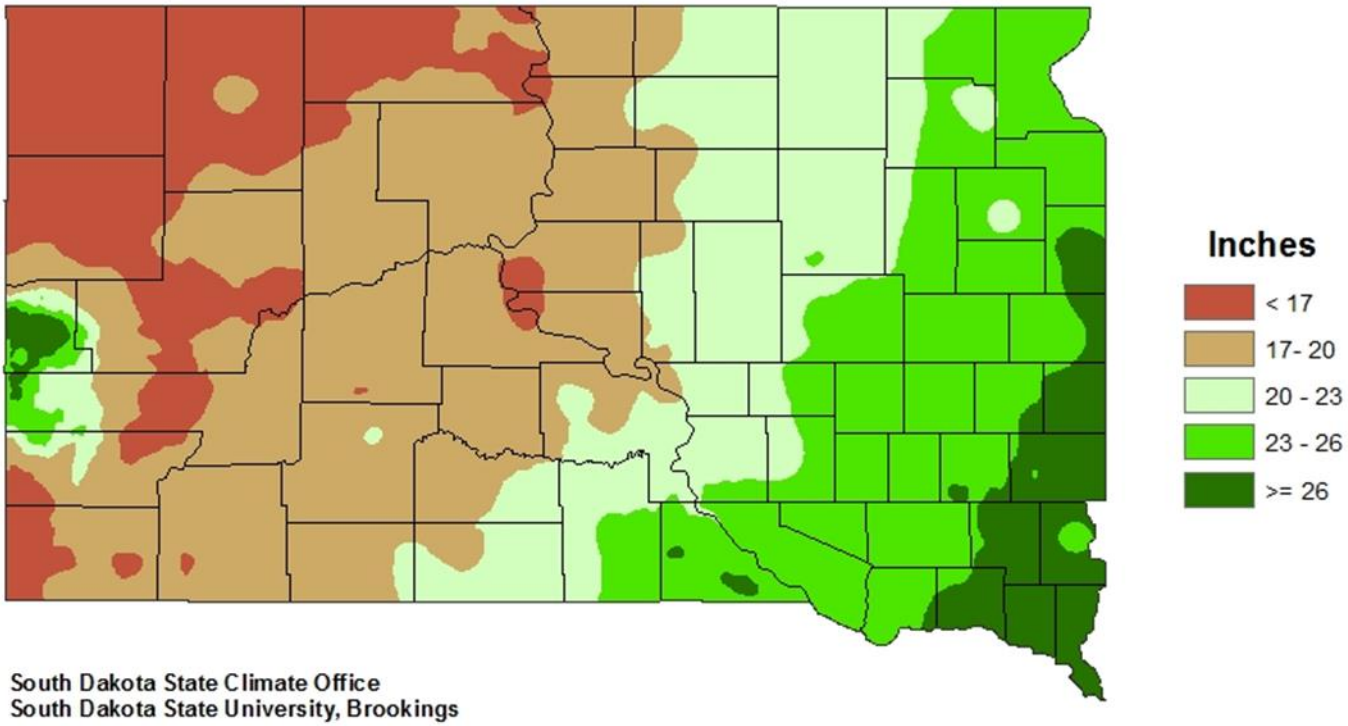
The **Black Hills** are in the southwestern part of South Dakota and extend into Wyoming. This range of low mountains covers 6,000 square miles with mountains that rise from 2,000 to 4,000 feet high. The highest point in South Dakota, Black Elk Peak (7,242 feet above sea level), is in the Black Hills. The Black Hills are rich in minerals such as gold, silver, copper, and lead.

3.1.2 Climate

- Highest Temperature - The highest temperature recorded in South Dakota is 120°F. This record high was recorded on July 5, 1936 at Gann Valley, and tied on July 16, 2006near Fort Pierre.
- Lowest Temperature - The lowest temperature in South Dakota, -58°F, was recorded on February 17, 1936 at McIntosh.
- Average Temperature - Monthly average temperatures range from a high of 86.5°F degrees to a low of 1.9°F degrees.

- Climate - Average yearly precipitation for South Dakota, from 1981 to 2010, is shown in Figure 3-1.

Figure 3-1 South Dakota's Average Annual Precipitation, 1981-2010



3.1.3 Methodology

Based on past disaster history and population and property potentially at risk (numbers and dollars), the following hazards have emerged as the greatest concern statewide and are profiled in detail in this plan:

- Agricultural Pests and Diseases
- Drought
- Floods (flash, long-rain, snowmelt, and dam failure or levee failure floods)
- Summer Storm (Hail and Lighting)
- Winter Storm
- Wildfire
- Tornado
- Windstorm
- Hazardous Materials
- Geological Hazards (Landslides, Mudflows, Expansive Soils, Subsidence, and Earthquakes)

During the 2014 hazard mitigation plan update, the South Dakota Hazard Mitigation Team (SHMT) reexamined those hazards that threaten the state. During the 2014 plan update process, the SHMT discussed adding a hazard profile for Summer Storms to align with local plans. While flooding from severe thunderstorms is addressed in the flood hazard profile, this hazard profile would include hail and lightning. Microburst wind associated with thunderstorm is already addressed in the wind profile. The SHMT recommended that Summer Storms should be added as a new hazard profile during the next plan update. In 2016 OEM updated the HIRA in anticipation of the 2017-19 Mitigation Plan (Plan) update process. The 2016 HIRA update includes this new hazard profile. The Summer Storms hazard profile includes hail and lightning. Extreme heat is addressed in the drought hazard profile, and extreme cold is part of the winter storm hazard. Future updates may consider profiling extreme temperature hazards

individually. During the 2019 Plan update, the 2016 HIRA was incorporated into the SHMP. The statistical analyses for weather-related hazards include NOAA storm database queries through June 2016. Significant hazard events that occurred between July 2016-August2018 are noted in the hazard profiles where applicable.

The following natural hazards are not included in this analysis because they do not threaten South Dakota: avalanches, coastal erosion, coastal storms, hurricanes, tsunamis, and volcanoes.

3.1.4 Non-Natural Hazards

The SHMT determined not to include human-caused and technological hazards in this plan. The state's Threat and Hazard Identification and Risk Analysis (THIRA), originally developed in 2012 and updated periodically, is an all hazards risk assessment that analyzes the state's capabilities toward addressing natural, human-caused, and technological hazards. The THIRA was developed in compliance with the U.S. Department of Homeland Security Comprehensive Preparedness Guide 201 by a committee led by the state's Office of Homeland Security. The THIRA includes hazard profiles for the most pertinent human-caused and technological hazards intended to supplement the natural hazards profiled within this Multi-Hazard Mitigation Plan. The THIRA is discussed further in Section 4.4.8.

3.1.5 Prioritizing Hazards

A similar hazard ranking exercise as used in the previous plan update was used by the SHMT to validate and rank the hazards during the 2016 HIRA update. The ranking methodology includes risk considerations from local plans and input from a 2013 public survey. The hazards of greatest significance were identified to be flooding, winter storms, wildfires, and drought. Tornadoes, wind, summer storms, and agricultural pests and diseases were ranked as moderate. Tornadoes, ranked as significant in the 2011 plan update, were determined to be moderate during this update. Geological hazards, including earthquake, were also downgraded from moderate in 2011 and ranked as a limited hazard in 2014. Significance rankings remained the same during the 2016 HIRA update.

Prioritization of the hazards that threaten the state was based on four factors: probability, potential impact, consideration in local hazard mitigation plans, and survey input. The likely geographical extent of the affected area, primary impacts of the event, and related secondary impacts all factor into the overall potential impact. While primary impacts are a direct result of the hazard, secondary impacts can only arise subsequent to a primary impact. For example, a primary impact of a flood event may be road damage due to submerged pavement or eroded surface. A possible secondary impact in these circumstances would be restricted access of emergency vehicles to citizens in a particular area due to the road closure.

A formula was developed to assign a value for probability and impact for each of the hazards considered. The probability of each hazard was determined by assigning a level, from 1 to 4, based on the likelihood of occurrence (which is based on historical data). Similarly, levels from 1 to 4 were assigned to each of the three impact factors mentioned above. Probability and impact factor levels assigned to each hazard were each then multiplied by an importance factor, with probability assigned the highest importance factor based on previous input from the SHMT from legacy versions of this plan.

To incorporate the consideration of these hazards in local plans, the number of local plans that included the hazard was divided by 68 (total local and tribal plans within the state) and multiplied by 10 to create a Local Plans Score on a scale of 0 -10.

Survey respondents rated the hazards on a scale of 1 – 3. The average rating was divided by 3 and multiplied by 10 to create a Survey Score on a scale of 1-10.

The total hazard ranking score was calculated as follows:

[(Probability x 2) x [(Affected Area x 0.8) + (Primary Impact x 0.7) + (Secondary Impacts x 0.5)]] + Local Plans Score + Survey Score

Based on the total calculated score, the hazards were separated into three categories that describe the relative risk level they pose to the state: high significance, moderate, and limited. The most significant hazards in South Dakota are Flooding, Winter Storms, Wildfire and Drought. The hazard ranking was based on the overall probability and impact on the state as a whole. When examining various regions of the state, the same ranking does not always apply. Table 3-1 summarizes the ranking established by the state using the method described above.

Table 3-1 Hazard Rankings

Hazard Type and Ranking		Risk Level
1	Flooding (flash, long-rain, snowmelt, and dam or levee failure)	Significant
2	Winter Storms	Significant
3	Wildfires	Significant
4	Drought	Significant
5	Tornadoes	Moderate
6	Summer Storms	Moderate
7	Wind	Moderate
8	Agricultural Pests and Diseases	Moderate
9	Hazardous Materials	Moderate
10	Geological Hazards (Landslide, Mudflow, Expansive Soils, Earthquake)	Limited

A Hazard Identification and Ranking Worksheet is included on the following page and contains the calculations and formulas utilized during the 2016 update.

Table 3-2 Hazard Ranking Worksheet – South Dakota

Hazard Type	Probability	Impact			Local Plans	Survey Rating	Local Plans Score	Survey Score	Total Score	Risk Level
		Affected Area	Primary Impact	Secondary Impacts						
Flooding	4	4	2	3	66	1.73	9.71	5.75	64.26	Significant
Winter Storms	4	4	2	3	67	2.49	9.85	8.30	66.95	Significant
Wildfires	4	2	4	3	59	1.94	8.68	6.47	62.34	Significant
Drought (Including Extreme Heat)	4	3	2	4	45	2.39	6.62	7.97	60.98	Significant
Tornadoes	4	1	4	4	43	2.12	6.32	7.07	58.19	Moderate
Summer Storms	4	2	2	2	31	1.94	4.70	6.47	43.16	Moderate
Wind	4	2	2	2	28	2.19	4.12	7.30	43.42	Moderate
Agricultural Pests/Diseases	3	3	1	4	3	1.85	0.44	6.17	37.21	Moderate
Hazardous Materials*	4	1	1	3	41	1.79	6.03	5.97	36.00	Moderate
Geological Hazards	3	2	1	2	15	1.18	2.21	3.92	25.92	Limited

Table 3-3 Hazard Ranking Legend

Probability	Importance	2.0
Based on estimated likelihood of occurrence from historical data		Score
Unlikely (Less than 1% probability in next 100 years or has a recurrence interval of greater than every 100 years.)		1
Somewhat Likely (Between 1 and 10% probability in next year or has a recurrence interval of 11 to 100 years.)		2
Likely (Between 10 and 100% probability in next year or has a recurrence interval of 10 years or less.)		3
Highly Likely (Near 100% probability in next year or happens every year.)		4

Affected Area	Importance	0.8
Based on size of geographical area of community affected by hazard		Score
Isolated		1
Small		2
Medium		3
Large		4

Primary Impact	Importance	0.7
Based on percentage of damage to typical facility in community		Score
Negligible - less than 10% damage		1
Limited - between 10% and 25% damage		2
Critical - between 25% and 50% damage		3
Catastrophic - more than 50% damage		4

Secondary Impacts	Importance	0.5
Based on estimated secondary impacts to community at large considering economic impacts, health impacts, and crop losses		Score
Negligible - no loss of function, downtime, and/or evacuations		1
Limited - minimal loss of function, downtime, and/or evacuations		2
Moderate - some loss of function, downtime, and/or evacuations		3
High - major loss of function, downtime, and/or evacuations		4

Local Plans Score	Importance	1.0
Local Plans Score = (# of plans / 68) x 10 where:		
# of plans includes local and tribal plans within South Dakota that identified the hazard		

Survey Score	Importance	1.0
Survey Score = (Survey Rating / 3) x 10 where:		
Survey Rating is the average rating of concern based on a scale of 1 (low concern) to 3 (high concern) compiled from the survey responses.		

Total Score = (Probability x Impact) + Local Plans Score +Survey Score, where:
Probability = (Probability Score x Importance)
Impact = (Affected Area + Primary Impact + Secondary Impacts), where:
Affected Area = Affected Area Score x Importance
Primary Impact = Primary Impact Score x Importance
Secondary Impacts = Secondary Impacts Score x Importance

Hazard Planning Consideration	Total Score Range
Limited	0 - 30
Moderate	30.1 - 60
Significant	60.1 - 90

As shown in Table 3-2 the Hazard Ranking Worksheet, the majority of the local plans identified hazards consistently with those prioritized by the SHMT. Several additional hazards were identified by the local plans. These hazards are listed below followed by the number of plans that identified each hazard. While these are not explicitly profiled in this plan, the SHMT and the State Hazard Mitigation Officer (SHMO) will use this information to continue working with the local communities to understand the concerns these hazards pose, how they are in part already addressed by the state plan, and ways they can be mitigated:

- Summer Storms (30)
- Hail (23)
- Civil Disturbances (22)
- Thunderstorms (20)
- Urban Fire (19)
- Mass Casualty Incident (18)
- Infectious Disease/Epidemic (17)
- Ice Storms (15) (see winter storms)
- Aviation Incident (15)
- Lightning Strike (13)

It must be noted that 37 of the 66 counties and 2 tribal governments identified terrorism as a significant risk. The SHMT recognizes this risk and feels that on a statewide level, terrorism is being mitigated to the best of their ability by the South Dakota Office of Homeland Security. As described above, the state's THIRA is the appropriate vehicle for addressing the measures being taken in South Dakota to fight terrorism and other human-caused and technological hazards, such as civil disturbances and mass casualty incidents.

3.1.6 Presidential Declarations

Table 3-4 summarizes presidential disaster declarations, fire management assistance declarations, and emergency declarations for South Dakota since 1954 through mid-2018. Forty-eight presidential declarations in this 64-year period indicate that a disaster is declared in the state roughly every two years. However, the frequency of disasters has increased in recent decades; since the early 1990's the state has had a presidential declaration on nearly an annual basis.

Table 3-4 Presidential Declarations

Declaration Number	Declaration Date	Counties (#)	Disaster Type	FEMA Disaster Relief Costs[1] (federal share)
FEMA-4298-DR	2/1/2017	24 counties	Severe Winter Storm	$9,632,647.63*
FEMA-4233-DR	7/30/2015	11 counties	Severe Storms, Tornadoes, Straight-line Winds, and Flooding	$3,039,800.56*
FEMA-4186-DR	7/28/2014	11 counties	Severe Storms, Tornadoes, and Flooding	$11,144,676.10*
FEMA-4155-DR	11/8/2013	11 counties	Severe Winter Storm, Snowstorm, and Flooding	$43,113,022.91*
FEMA-4137-DR	8/2/2013	8 counties	Severe Storms, Tornado, and Flooding	$1,159,221.44*
FEMA-4125-DR	6/28/2013	4 counties	Severe Storms, Tornado, and Flooding	$1,215,685.33*
FEMA-4115-DR	5/10/2013	7 counties	Severe Winter Storm and Snowstorm	$8,231,034.73
FEMA-1984-DR	5/13/2011	28 counties	Severe Storms and Flooding	$4,799,393.02

Declaration Number	Declaration Date	Counties (#)	Disaster Type	FEMA Disaster Relief Costs[1] (federal share)
FEMA-1947-DR	11/2/2010	4 counties (including 1 reservation within designated counties)	Severe Storms and Flooding	$1,079,972.79*
FEMA-1938-DR	9/23/2010	12 counties	Severe Storms and Flooding	$4,429,890.33*
FEMA-1929-DR	7/29/2010	3 counties (including 1 reservation within designated counties)	Severe Storms, Tornadoes, and Flooding	$666,648.61*
FEMA-1915-DR	5/13/2010	31 counties	Flooding	$21,498,619.82*
FEMA-1914-DR	5/13/2010	3 counties	Severe Winter Storm	$1,862,942.69*
FEMA-1887-DR	3/10/2010	29 counties (including 3 reservations within designated counties)	Severe Winter Storm	$49,059,867.72*
FEMA-1886-DR	3/9/2010	12 counties (including 2 reservations within designated counties)	Severe Winter Storm and Snowstorm	$874,502.99*
FEMA-1844-DR	06/16/2009	14 counties (including 2 reservations within designated counties and extending into North Dakota)	Severe Storms and Flooding	$301,081.25*
FEMA-1811-DR	12/12/2008	13 counties (including four reservations within designated counties)	Severe winter storm and record and near record snow	$5,825,275.23*
FEMA-1774-DR	07/02/2008	26 counties (including portions of 3 reservations within designated counties)	Severe storms and flooding	$4,716,310.17*
FEMA-1759-DR	05/22/2008	6 counties	Severe winter storm and record and near record snow	$7,826,995.83*
FEMA-1702-DR	5/22/2007	24 counties (including 3 reservations within designated counties)	Severe Storms, Tornadoes, and Flooding	$6,226,611.95
FEMA-1647-DR	6/5/2006	6 counties	Severe Winter Storm	$3,177,445.62
FEMA-1620-DR	12/20/2005	26 counties	Severe Winter Storm	$24,647,039.99
FEMA-1596-DR	7/22/2005	7 counties	Severe Storm (wind)	$688,994.86
FEMA-1531-DR	7/20/2004	9 counties, 1 reservation	Severe Storms and Flooding	$1,058,536.53
FEMA-1375-DR	5/17/2001	24 counties	Severe Storms (flooding)	$5,097,818.74
FEMA-1330-DR	5/19/2000	7 counties	Winter Storm	$1,779,885.95
FEMA-1280-DR	6/9/1999	2 counties	Severe Storms, Flooding, and Tornadoes	$801,099.77
FEMA-1218-DR	6/1/1998	9 counties	Flooding, Severe Storms, and Tornadoes	$15,953,312
FEMA-1173-DR	4/7/1997	66 counties	Severe Storms, Flooding (high winds)	$82,490,180
FEMA-1161-DR	2/28/1997	10 counties	Severe Winter Storms	$2,526,209
FEMA-1156-DR	1/10/1997	66 counties	Severe Winter Storms/Blizzards	$18,431,301
FEMA-1075-DR	1/5/1996	26 counties	Ice Storms	$12,431,366
FEMA-1052-DR	5/26/1995	52 counties	Severe Storms, Flooding	$33,866,882

Declaration Number	Declaration Date	Counties (#)	Disaster Type	FEMA Disaster Relief Costs[1] (federal share)
FEMA-1045-DR	3/14/1995	21 counties	Severe Winter Storms	$3,627,131
FEMA-1031-DR	6/21/1994	21 counties	Severe Storm, Flooding.	$7,789,915
FEMA-999-DR	7/19/1993	39 counties	Flooding, Severe Storms, Tornadoes	$50,202,256
FEMA-948-DR	7/2/1992	9 counties	Flooding, Severe Storms, Tornadoes (high winds)	$1,669,825
FEMA-764-DR	5/3/1986	25 counties	Severe Storms, Flooding	$4,893,611
FEMA-717-DR	7/19/1984	9 counties	Severe Storms, Flooding	$4,216,001
FEMA-511-DR	6/25/1976	4 counties	Flash Flooding, Mudslides	$4,439,769
FEMA-336-DR	6/10/1972	4 counties	Heavy Rains, Flooding	$111,907,010
FEMA-257-DR	4/18/1969	26 counties	Flooding	$4,369,737
FEMA-197-DR	5/26/1965	4 counties	Flooding	$3,771,780
FEMA-132-DR	7/27/1962	23 counties	Floods, Tornadoes	$3,652,937
FEMA-99-DR	4/8/1960	16 counties	Floods	$933,934
FEMA-20-DR	7/31/1954	2 counties	Floods	$252,255
FEMA-3234-EM	9/10/2005	All counties	Hurricane Katrina Evacuation	n/a
FEMA-3015-EM	6/17/1976	n/a	Drought	n/a
FEMA-5272-FM	8/11/2018	n/a	Vineyard Fire	$943,237
FEMA-5229-FM	12/12/2017	Custer	Legion Lake Fire	$3,055,336n/a
FEMA-5010-FM	9/1/2012	Oglala Lakota	Wellnitz Fire	$6,664.22
FEMA-2996-FM	7/20/2012	Custer	Myrtle Fire	Unknown
FEMA-2716-FSA	7/21/2007	Lawrence	Boxelder Fire	n/a
FEMA-2710-FSA	7/8/2007	Fall River	Alabaugh Canyon Fire	$2,659,373
FEMA-2658-FSA	7/27/2006	Meade	East Ridge Fire	$1,973,107
FEMA-2569-FSA	7/16/2005	Pennington	Skyline #2 Fire	$18,975
FEMA-2565-FSA	7/10/2005	Meade	Ricco Fire	$573,581
FEMA-2513-FSA	11/20/2003	Pennington	Mill Road Fire	$62,852
FEMA- 2458-FSA	8/18/2002	Pennington	Battle Creek Fire	$1,816,503
FEMA-2434-FSA	6/29/2002	Lawrence	Grizzly Gulch Fire	n/a
FEMA-2369-FSA	7/31/2001	Custer	Elk Mountain Fire	$293,000
FEMA-2324-FSA	8/25/2000	Custer	Jasper Fire	$2,500,000
FEMA-2319-FSA	8/13/2000	Fall River	Flagpole Fire	$1,750,000
FEMA-2109-FSA	8/16/1994	Meade	Stagebarn Canyon Fire	n/a
FEMA-2076-FSA	9/14/1990	Custer	Swedlund Fire	n/a
FEMA-2068-FSA	7/26/1988	Pennington	West Berry Trail Fire	n/a
FEMA-2061-FSA	7/22/1987	Fall River	Battle Mountain Fire	n/a
FEMA-2057-FSA	7/15/1985	Fall River	Flint Hill Fire	n/a
FEMA-2056-FSA	7/15/1985	Fall River	Seven Sisters Fire	n/a
FEMA-2017-FSA	7/29/1975	Custer	Custer State Park	n/a
FEMA-2016-FSA	7/8/1974	Custer	Argle & Booms Canyon	n/a

Sources: Federal Emergency Management Agency, South Dakota Office of Emergency Management, Public Entity Risk Institute
1Costs include Public Assistance, Individual Assistance, and mitigation and are in constant 2006 dollars (with the exception disasters post-2006, which are year of event dollars). Fire costs are from the state, represent total outlays, and are not adjusted for inflation (with the exception of FEMA-2710-FSA, which is from InciWeb).
2Projects are not closed; costs are estimates from the state (FEMA-1702-DR is public assistance only).
*Includes Public Assistance only

3.1.7 Probability of Future Events

The probability of future events is estimated by looking at the frequency of past damaging events, where good data is available, or else by using scientific estimates. Based on available information and the process discussed in this section, one can conclude that that severe winter storms, tornadoes, wildfires, landslides/mudflows, and earthquakes will continue to occur in the future much as they have in the past.

Climate Change Exacerbation

FEMA's 2015 State Mitigation Plan Review Guide emphasizes the need to discuss how future risk and vulnerability may be affected by changing climatic conditions. According to the guidance, probability must include considerations of changing future conditions, including the effects of long-term changes in weather patterns and climate on the identified hazards. While the intensity and frequency associated with the hazards profiled in this plan are largely based on historic events, climate change has the potential to alter the nature and frequency of hazard events in the future. In 2017 FEMA Region VIII developed the Assessing Future Conditions Report for the State of South Dakota which includes a summary table of projected changes related to future hazard events. The summary table was used in the 2019 update planning process to confirm the findings from the 2016 HIRA update. The Third National Climate Assessment (https://nca2014.globalchange.gov) was published in 2014 that addresses the impacts of climate change on the United States, now and in the future. A team of more than 300 experts guided by a 60-member Federal Advisory Committee produced the report, which was extensively reviewed by the public and experts, including federal agencies and a panel of the National Academy of Sciences.

The reports discuss climate-related impacts for various societal and environmental sectors and regions across the nation. The science summarized in the reports points to increasing mean temperatures in the northern Great Plains region where South Dakota is located. Winter season temperatures are warming faster than summer season temperatures. This may lead to increased evaporation and drought frequency, which will compound water scarcity problems. Across South Dakota, there is a long-term trend of increasing annual precipitation, among the highest in the country. The majority of this increase is occurring in spring and fall seasons. There is high confidence that precipitation extremes will increase in frequency and intensity that could exacerbate flooding. Increased demand for water and energy will constrain development, stress natural resources, and increase competition for water. New agricultural practices will be needed to cope with changing conditions.

Each of the hazard profiles now includes a 'Climate Change Considerations' subsection that notes where changes in temperature, intensity, hazard distribution, and/or frequency of weather events may increase the probability and vulnerability to hazards in the future, based on a literature review of best available science, e.g. 2014 National Climate Assessment, 2017 FEMA Region VIII Assessing Future Conditions Report, and other studies. Other studies include one from the U.S. Environmental Protection Agency which features a regional study on the effect climate change will have on the Great Plains. "Climate Impacts in the Great Plains" addresses precipitation increases, temperature variations, and impacts on vulnerable communities, impacts on water resources, impacts on agriculture, and impacts on ecosystems. Additional studies are noted within the hazard subsections. Future updates to this plan should continue to integrate the best available science on climate change and how it may alter hazard frequency and intensity. The Climate Science Special Report (https://science2017.globalchange.gov/) was released in 2017 that outlines climate trends and projections for the United States. The Fourth National Climate Assessment was released in November of 2018 as this plan was being finalized and largely re-affirms the findings within the 2014 Climate Assessment. The State Climatologist participated in the 2019 plan update as a SHMT member and reviewed the climate change related aspects of this HIRA.

3.2 Profiling Hazards

44 CFR Part 201 Requirement:
[The State risk assessment shall include an overview of the] location of all natural hazards that can affect the State, including information on previous occurrences of hazard events, as well as the probability of future hazard events, using maps where appropriate…

Hazard profiles include information on past events as well as the probability of future occurrences, expected magnitude and severity of impacts to determine relative levels of risk throughout the state. Information for the hazard profiles and at-risk facilities came from a variety of sources and organizations, including, but not limited to, the following:

- South Dakota Agencies and Departments
  - South Dakota Department of Public Safety
    - Office of Emergency Management
    - Office of Homeland Security
  - South Dakota Department of Environment and Natural Resources
  - South Dakota Department of Agriculture
    - Division of Wildland Fire
  - South Dakota Animal Industry Board
  - South Dakota Department of Health
  - Northern State University, Aberdeen, South Dakota
  - South Dakota State University, Brookings, South Dakota
- Federal Emergency Management Agency
  - FEMA Region VIII
  - Hazus-MH
- Public Entity Risk Institute
- University of South Carolina Hazards and Vulnerability Research Institute
  - Spatial Hazard Events and Losses Database for the United States (SHELDUS)
  - Social Vulnerability Index for the United States
- National Oceanic and Atmospheric Administration
  - National Climactic Data Center
  - National Weather Service
- U.S. Department of Agriculture Risk Management Agency
- Federal Wildland Fire Occurrence Database
- University of Wisconsin-Madison Spatial Analysis for conservation and Sustainability Lab
- U.S. Army Corps of Engineers
- U.S. Geological Survey
- Literature and written and oral communications from state and national hazard experts
- Input given at stakeholder meetings during the 2013 update process

2016 HIRA Update Highlights

The SHMT met twice between June and September 2016 during the course of the HIRA update to discuss the project. Amec Foster Wheeler (now Wood Environment & Infrastructure Solutions, Inc.) was the consultant utilized to prepare the update during May-September 2016.

During the 2016 update, all hazard profiles were updated with recent hazard events occurring since the last time the HIRA was updated during 2012-2013. The drought, winter storm, and agricultural disease chapters were enhanced with additional analysis on livestock and crop loss data. Tornado, wind, and

winter storm data was obtained and integrated from the National Centers for Environmental Information (NCEI) Storm Events database (formally known as the NCDC database) and year of damage dollar losses inflated to 2016 dollars and used to update the vulnerability assessment by county. Building Exposure data utilized in the vulnerability assessment was updated using Hazus 3.1, which includes inventory data based on 2010 Census data. Updated wildfire occurrence data was obtained from Division of Wildland Fire and the Federal Wildland Fire Occurrence database to update the wildland fire hazard profile. The state has been impacted by several disasters since 2013 including severe flooding, winter storm, and drought. The losses from these disasters have been summarized, including an analysis of the types and amounts of disaster expenditures where available. South Dakota has funded several mitigation projects with FEMA funds. Projects such as power line burial projects have been summarized and compared to high-risk counties for wind, winter storm, and tornado as an indication of progress towards reducing exposure to these hazards and further refinement of vulnerabilities related to Rural Electric Cooperatives. A consequence analysis was completed for each hazard in part to meet Emergency Management Accreditation Program (EMAP) requirements, and climate change considerations were added to floods, summer storms, drought, wildfire, windstorm, tornado, and winter storm hazards. Table 3-5 highlights some of the changes made to the HIRA.

Table 3-5 Summary of 2016 HIRA Update

2016 Hazard Name	Highlights of Changes from Previous HIRA
Floods	DFIRM analysis updated, hazard history updated.
Summer Storms	Added as new hazard with a profile on lightning and hail impacts and related vulnerability analysis.
Drought	Incorporated elements of 2015 South Dakota Drought Plan vulnerability assessment.
Wildfire	Incorporated vulnerability analysis from 2015 Drought Plan, new wildland fire occurrence data
Windstorm, Tornado, Winter Storm	Updated with NCEI data; inflated $ losses to 2016; updated tornado probability map. Changed classification scheme for Building Exposure and Population Density to further refine vulnerability by county. Included location of related hazard mitigation projects on maps to indicate loss reduction activities in relation to vulnerable counties. State facilities added to maps to graphically portray potential vulnerabilities.
Hazardous Materials	Added information related to oil and gas development and abandoned mines. Developed additional analysis of risk to state facilities from transportation and Tier II facilities.
Other	Climate change considerations added; EMAP consequence analysis tables added for all hazards; risk summary by hazard developed.

2019 SHMP Update

For the 2019 SHMP update, Wood Environment and Infrastructure Solutions, Inc. (formally Amec Foster Wheeler) was again the consultant assisting with the planning process. The 2016 Hazard Identification and Risk Assessment was updated to add significant events that have occurred between 2016 and August 2018. Additionally, the number of tribal plans reviewed increased from 3 in 2016 to 6 2019. Table 3-6 summarizes these updates.

Table 3-6 Summary of 2019 Hazard Identification and Risk Assessment Update

Location in Plan	Updates
3.1 Presidential Declarations	Updated to include a severe winter storm event and two Fire Management Assistance Declarations.
3.2.4 Winter Storms	Updated Past Events table to include description of significant winter storm event.
3.2.5 Wildfire	Updated Past Events section to include description of two significant wildfire events.
3.2.9 Hazardous Materials - Pipelines	Added mention of proposed Keystone and Dakota Access Pipeline to Future Development Vulnerability and updated Past Events section to include description of pipeline spill event that occurred in 2017.
Growth and Development	Table 3-3 updated to include new information from local plans that were updated after the 2016 HIRA Update

3.2.1 Agricultural Pests and Diseases

Description

Agriculture is South Dakota's prime industry, contributing $20.9 billion dollars to, or 20% of, the state's economy each year. In addition, agriculture and its associated industries employ over 80,000 South Dakotans. According to the most recent (2012) census conducted by the United States Department of Agriculture (USDA), the state had 31,989 farms, with over 43,257,079 acres of farmland, for an average farm size of 1,392 acres; the agriculture industry nets over $2 billion per year in farm income. The state boasts 46,000 producers on 31,700 farms, ninety-eight percent of which are family owned and operated, and over 2,500 farms have been in the same family for more than 100 years. South Dakota's agricultural history dates back to the nineteenth century, when homesteaders used a mule and moldboard plow to break the thick prairie sod. Currently, in the twenty-first century, crop production has increased as farmers embrace new technologies, better hybrids, and more efficient land-use practices. More than 19 million acres of the state is cropland and 23 million acres are devoted to pastureland.

Figure 3-2 South Dakota National Agriculture Rankings by Commodity

U.S. RANK	COMMODITY AND DATE	NUMBER	UNIT	PERCENT OF U.S. TOTAL
1	BISON, inventory, Census of Agriculture, 2012	33,637	head	20.7
	OATS, production, 2014	9,300,000	bushels	13.3
	SUNFLOWER, ALL, production, 2014	876,620,000	pounds	39.6
2	HAY, ALFALFA, inventory, 2014	4,370,000	tons	7.1
	HONEY, production, 2014	24,360,000	pounds	13.7
3	MILLET, PROSO, production, 2014	2,139,000	bushels	15.9
	FLAXSEED, production, 2014	90,000	bushels	1.4
	WHEAT, SPRING, production, 2014	71,680,000	bushels	12.0
4	BEANS, DRY EDIBLE, NAVY , production, 2014	99,000	cwt	2.2
	HAY, ALL, production, 2013	6,665,000	tons	4.8
	WHEAT, ALL, production, 2014	131,260,000	bushels	6.5
5	BEEF COWS, ALL, inventory, January 1, 2015	1,632,000	head	5.5
	CALF CROP, inventory, 2014	1,620,000	head	4.8
	LAMB CROP, inventory, 2014	215,000	head	6.3
	LAND IN FAMRS, 2014	43,300,000	acres	4.7
	POPCORN, production, Census of Agriculture,2012	27,686,379	pounds	3.5
6	BEANS, DRY EDIBLE, CHICKPEAS, production, 2014	37,000	cwt	1.3
	CORN FOR GRAIN, production, 2014	787,360,000	bushels	5.5
	SHEEP AND LAMBS, MARKET, inventory, January 1, 2015	55,000	head	4.1
	SORGHUM FOR GRAIN, production, 2014	9,450,000	bushels	2.2
	SORGHUM FOR SILAGE, production, 2014	220,000	tons	5.3
	WOOL, production, 2014	1,750,000	pounds	6.6
	WHEAT, DURUM, production, 2014	180,000	bushels	0.3
7	CATTLE ON FEED, inventory, January 1, 2015	385,000	head	3.0
	ON FARM GRAIN STORAGE CAPACITY, December 1, 2015	690,000,000	bushels	5.3
	SHEEP AND LAMBS, ALL, inventory, January 1, 2015	255,000	head	4.8
	WHEAT, WINTER, production, 2014	59,400,000	bushels	4.3
8	CATTLE AND CALVES, ALL, inventory, January 1, 2015	3,700,000	head	4.1
	CROPLAND, total, acres, Census of Agriculture, 2012	19,147,320	acres	4.9
	PRINCIPAL CROPS HARVESTED, 2014	17,335,000	acres	5.6
	PRINCIPAL CROPS PLANTED, 2014	17,816,000	acres	5.5
	SOYBEANS, production, 2014	229,950,000	bushels	5.8
	CORN FOR SILAGE, production, 2014	6,200,000	tons	4.8
9	PIG CROP, inventory, 2014	3,684,000	head	3.3
10	HAY, OTHER, production, 2014	2,295,000	tons	2.9
	OFF FARM GRAIN STORAGE CAPACITY, December 1, 2014	345,000,000	bushels	3.2
11	HOGS AND PIGS, ALL, inventory, December 1, 2014	1,250,000	head	1.9
12	CASH RECEIPTS FROM FARM MARKETINGS, 2013	10,352,529,000	dollars	2.6
	BEANS, DRY EDIBLE, ALL, production, 2014	243,000	cwt	0.8
	BEANS, DRY EDIBLE, PINTO, production, 2014	64,000	cwt	0.7

Source: 2015 USDA Agriculture Bulletin No. 75, August 2015

Agricultural hazards are divided into two categories: pests and diseases. For this plan, such events are defined as the naturally occurring infection of crops or livestock with insects, vermin, or diseases that render the crops or livestock unfit for consumption, sale, or other use. South Dakota has a substantial agricultural industry and a significant infrastructure composed of related facilities and locations, so the potential for infestation of crops or livestock pose a significant risk to the economy of the state. In order to profile each element adequately, this hazard profile focuses on events that primarily affect livestock (primarily disease) and crops (disease and pests). In some cases, pests may also serve as the vector of

disease for livestock. For clarity, the profile examines livestock and crop impacts separately, following the same evaluation criteria of location, past events, and probability demonstrated in other profiles.

Small losses caused by agricultural pests and diseases are normal for South Dakota farmers and ranchers. Concerns arise when the level of an infestation escalates suddenly and overwhelms normal control efforts, a new type of infestation occurs, diseases decimate animal populations, or when diseases pose a risk to humans. The levels and types of such events vary based on many factors, including cycles of heavy rains and drought, feeding practices, cross contamination or exposure, or inadequate infection control measures.

While zoonotic diseases (those transmissible to humans from animals or via an animal vector) are a concern, those events are best addressed in a pandemic or contagious disease plan, in order to address the variability and magnitude the events entail. The control of insects and rodents partially addresses the mitigation of Zoonotic disease, but for the purposes of this plan, that is an extra factor, rather than a primary focus. This hazard profile focuses on the diseases which impact the population of domesticated livestock or crops, which in turn damages the economic return on these valuable assets.

The following evaluation of crop hazards is reproduced from the South Dakota State University website:

> Farmers endure a number of problems during the growing season which can curtail yield. Some of these problems occur because best management practices are not applied. The lack of a good stand, crop-nutrient deficiencies, insect infestations, weed population increases, poor field drainage, and salinity problems can to some degree be managed. However, there are some weather related natural events that are beyond the farmer's control. High humidity and strong southerly breezes can carry windborne pathogens from Mexico and the southern states to infect crops. Violent storms from May to August can bring hail can reduce crop yield potential or damage crops beyond recovery. Lack of timely precipitation can wither crops and reduce yields. Late frost in the spring can kill crops and early frost in the fall can curtail the grain filling period of fall harvested crops.[1]

Weeds that infest fields may cause problems during harvest. The weeds may clog small to medium size combines, so alternative harvesting techniques are required. The cut-and-swathing technique is not preferable as it may encourage grain loss and requires a greater investment of time and/or manpower.[2]

Rodent infestations threaten crops, which is one of the primary industries in the planning area. Mice, rabbits, and other pests damage crops in all stages of the production process. Young plants are vulnerable to the rodents who feed on them. Harvested and stored crops may be contaminated by rodents burrowing into storage units, either to feed on the materials or create nests during winter months or become contaminated by fecal matter. The nature of such infestations makes tracking statistical data nearly impossible. Variables include the geographic distribution of the rodents and the crops, the number of rodents in the area, the presence and proliferation of natural predators, and the reproduction rates relative to the amount of natural food resources available. As such, while this is an acknowledged element of the agricultural hazards, it is not a primary focus in this profile.

Insect plagues also cause significant damage to crops in South Dakota. The last major grasshopper infestation in the United States occurred in the 1930s. Following this disaster, it was decided that local control of grasshopper outbreaks was insufficient, and that regional coordination was required. The 1934 Congress charged the U.S. Department of Agriculture (USDA) with controlling grasshoppers on federal rangeland. In 1987, the Animal and Plant Health Inspection Service (APHIS), which is part of the USDA,

1 http://plantsci.sdstate.edu/woodardh/Soils_and_Ag/Eastern/Crop_Production_Problems/crop_production_problems.htm
2 http://plantsci.sdstate.edu/woodardh/Soils_and_Ag/Eastern/Crop_Descriptions/crop_desciptions.htm

created the Grasshopper Integrated Pest Management (GHIPM) Project to develop new technologies for managing grasshopper populations. Grasshopper infestations in the 1950s, 1980s, and 2000s further underscore the importance of mitigating this insect-driven hazard.

Similar insect hazards include locusts, aphids, and bark beetle plagues. In 2012, Campbell, Corson, Harding, and Perkins counties all received USDA disaster designations involving insects and disease (S3467). In early March 2010, USDA designated Ziebach County as a primary natural disaster area due to weather and grasshopper problems in 2009.

Location

Since diseases and pests are profiled together, instead of examining each potential hazard individually, the geographic location of the hazards is somewhat general. It is recognized that the individual occurrences of the hazards contained in this profile will exert unequal pressures and impacts. In general, it is important to know where the hazards may occur in order to determine the severity of the hazard when compared to other hazards in this plan. Specific vulnerabilities may be best addressed in county or local mitigation plans.

Livestock diseases are possible anywhere that livestock are present. In addition, humans who come into contact with contaminated livestock or byproducts may also be exposed to livestock diseases. 23,025,294 acres in South Dakota are devoted to pastureland, which accounts for 47.4% of the total land area of the state. Pastureland is primarily located in bands that stretch from north to south in the eastern half of the state, and in the grasslands that dominate the western area of the state. In Figure 3-3, pastureland areas are indicated in yellow, while grasslands are indicated in beige.

Similarly, crop diseases are possible in any cultivated cropland environment. While some crop varieties are engineered for resistance to specific diseases or pests, the overall location of any pest or disease hazard corresponds to the cropland extent in the state. Specific variances to general distributions are noted in Table 3-9. 19,095,318 acres in South Dakota are designated as cropland, which accounts for 39.3% of the total land area of the state.

Cultivated crops are more prevalent in the eastern half of the state, though significant areas of cropland interspersed with grasslands also exist in the west. In Figure 3-3, these areas are indicated by brown shading.

Rodents such as mice, rats, and rabbits, are found across the entire planning region, as are insects. The presence of the rodents and insects is a consistent feature, with normal population density flows following the seasonal patterns. However, when density of these populations exceeds the capacity of the ecosystem, agricultural industries such as crops and the health of livestock are threatened. As discussed above, the ability to model these trends is difficult and inconsistent.

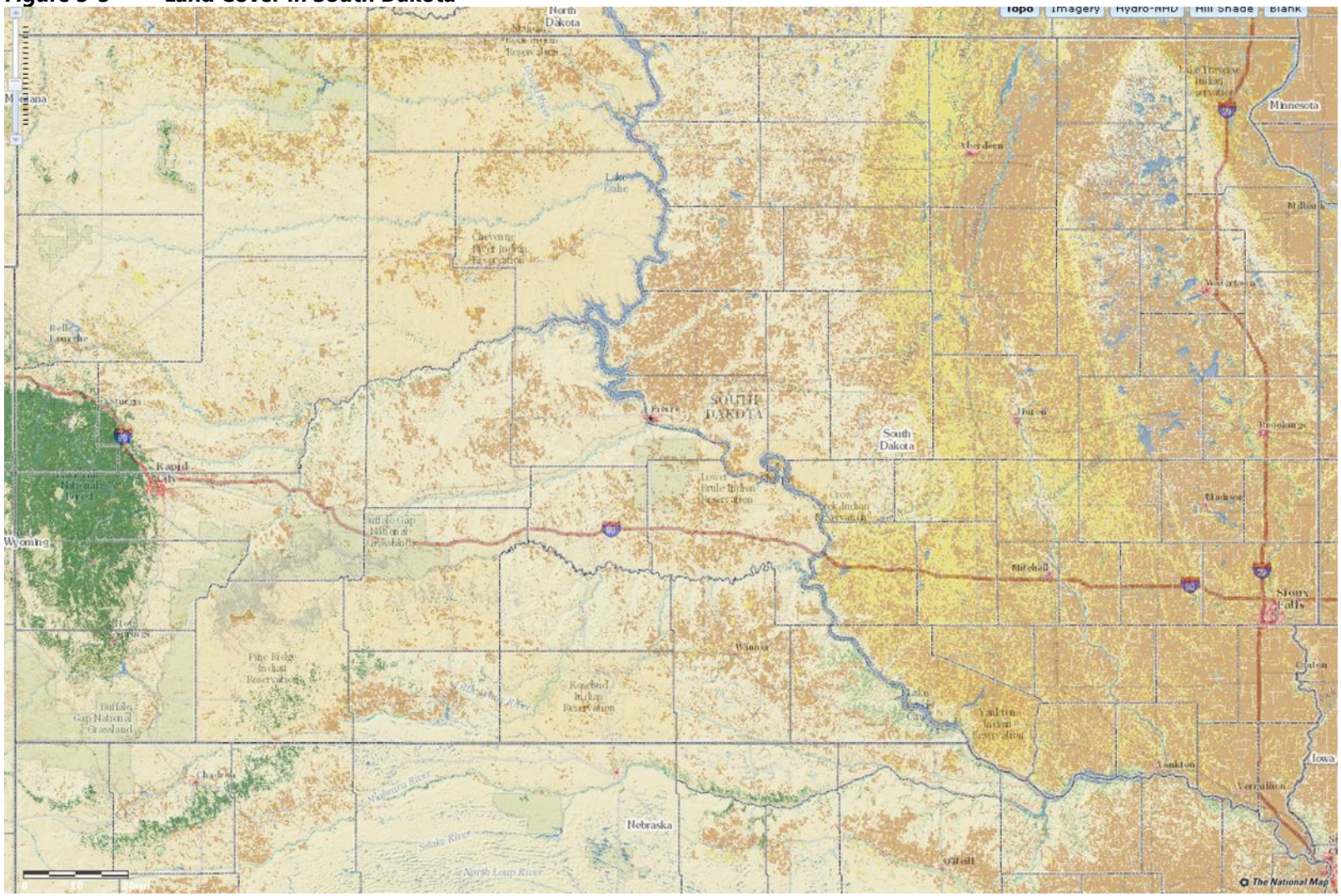
Grasshoppers are a historical insect hazard impacting agricultural production of crops. Figure 3-4 shows the adult grasshopper density for South Dakota measured in September 2012. While the map indicates that the majority of the density ratings are in western South Dakota, outside of the majority of cultivated cropland, this is due to the fact that the USDA does not survey in the eastern part of the state.

The impacts of grasshoppers on cattle have also been significant. Campbell, Corson, Harding, and Perkins counties received USDA disaster designations for losses related to insects and disease (S3467) in 2012. In that same year, 30 counties received a total of $702,633 in indemnities for crop loss related to insects. 22 counties received $184,810 in insect-related indemnities in 2011, and 27 counties received $927,938 in insect-related indemnities in 2010. The crop losses in all three years included forage used to feed livestock. The prediction for 2009, based on the density ratings, indicated that food supplies for cattle in the western portion of the state would be severely impacted by the grasshoppers. This proved accurate in

August of 2009, when the Associated Press reported that grasshopper infestations forced ranchers to sell livestock because food supplies were unavailable.[3] South Dakota, specifically Ziebach County, was named in USDA Secretarial Disaster Declaration S2916 for damages done by grasshoppers. Figure 3-5 predicts the grasshopper hazard for 2016 for the western United States (outbreaks have historically occurred in the 17 states that lie west of the 100th meridian[4]), including South Dakota.

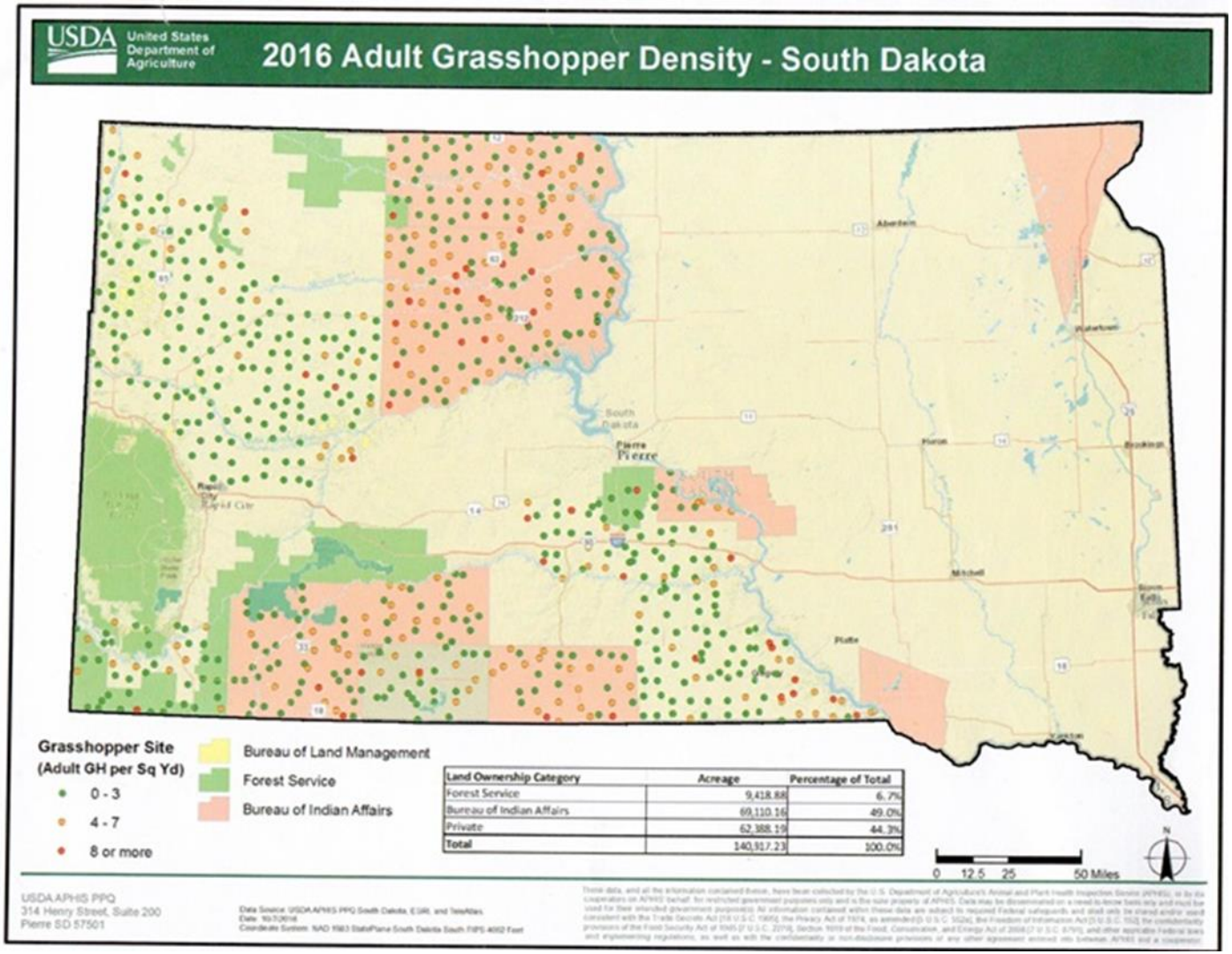
3 Carson Walker, Associated Press. "Grasshopper Infestation forces livestock sales in 15 states including Oklahoma"
4 USDA APHIS. http://www.aphis.usda.gov/plant_health/plant_pest_info/grasshopper/index.shtml

Figure 3-3 Land Cover in South Dakota



Source: The National Map Seamless Server hosted by the USGS, using NLCD 2006 Land Cover data.

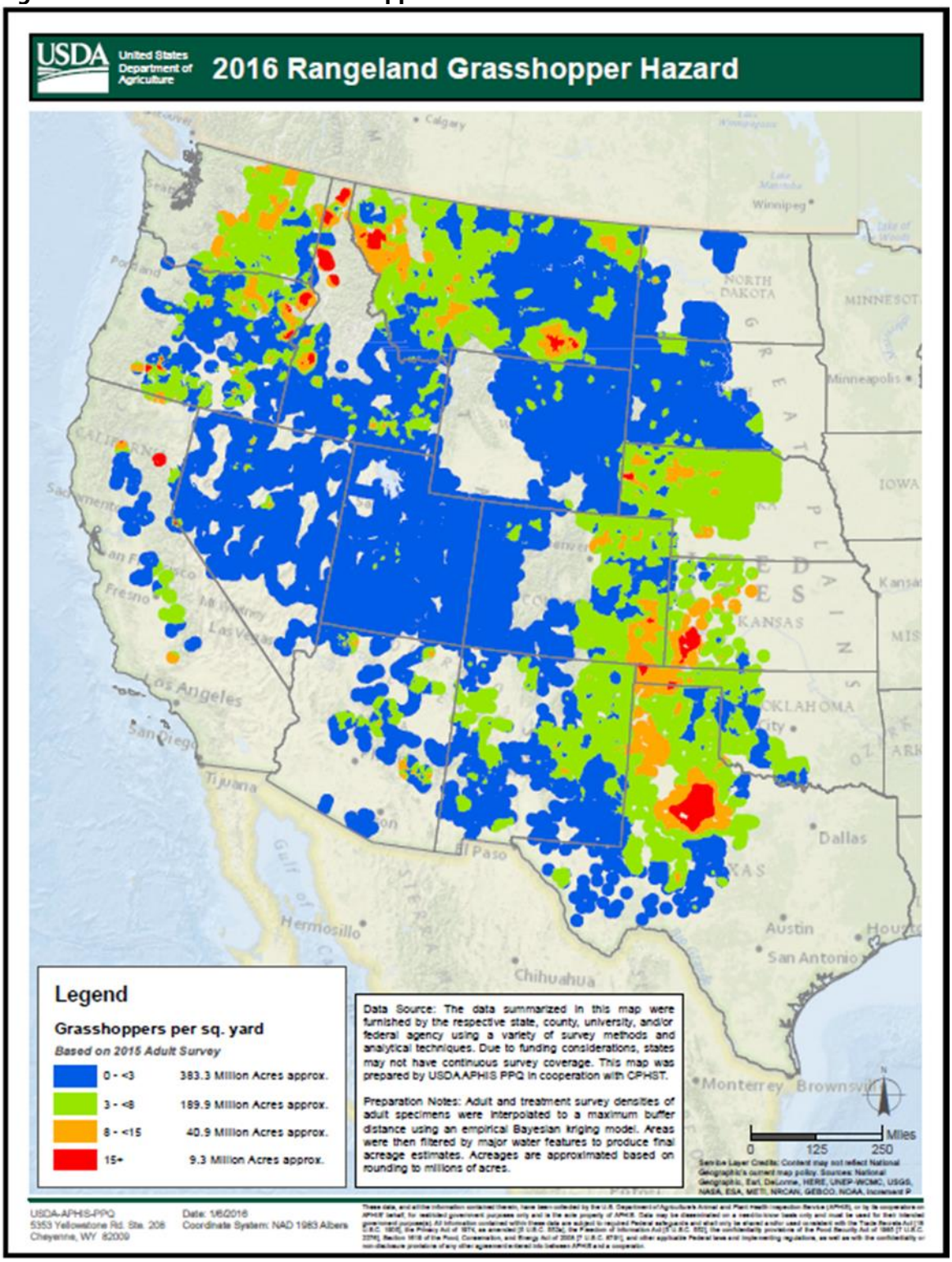
Figure 3-4 2016 Adult Grasshopper Density for South Dakota



Land Ownership Category	Acreage	Percentage of Total
Forest Service	9,418.88	6.7%
Bureau of Indian Affairs	69,110.16	49.0%
Private	62,388.19	44.3%
Total	140,917.23	100.0%

Source: USDA, South Dakota Department of Agriculture

Figure 3-5 South Dakota Grasshopper Hazard



Past Events

Past events are detailed differently in this section compared to other hazard profiles. While previous occurrences are listed, where applicable, it is also important to recognize the potential devastating diseases or pests for which the state constantly monitors. The use of vaccines in livestock and fungicides, pesticides or resistant seeds have mitigated some previously severe hazards. Other potentially devastating hazards have not yet appeared in South Dakota and appropriate preventative measures are in place to help inhibit their introduction. As such, monitored diseases or infestations are as equally important as known events.

Table 3-7 is a summary of the information presented on the South Dakota Animal Industry Board Disease Control Website with additional information provided from the USDA and other resources. Only diseases for cattle, pigs, poultry, and wildlife are profiled here due to their importance to South Dakota's economy. However, additional information on sheep and horses is also available on the website. In addition, diseases with minimal impact on humans and a low incidence rating in animals are not included in this profile.

There are many common crop diseases that impact the production, yield, and overall quality of harvests. Some crops are sold as a commodity, while others are used to support the livestock industry. As with livestock disease, tracking every occurrence is unwieldy because, to some level, crop disease is omnipresent. This section shows the occurrence rate of common crop hazards for the top commodities groups grown in South Dakota - that is, small grains, oilseeds, dry beans and dry peas (ranked 9th in the nation for value of sales), corn for grain (ranked 7th in the nation for production in 2010), soybeans (ranked 8th in the nation for production in 2010), sunflowers (ranked 2nd in the nation for production in 2010), and forage (ranked 3rd in the nation for production). Note that commodities are grouped by disease vulnerability, rather than by commodities group. The information is drawn from an issue of "Extension Extra" published by the College of Agricultural and Biological Sciences at the South Dakota State University, which discusses the recognition and management of common crop diseases in South Dakota.[5] Additional information was obtained from news sources and the USDA for events post-2009.

The 2016 HIRA update did not identify significant events post-2012. Some highlights of the events listed below, or events of particular significance, include:

- Campbell, Corson, Harding, and Perkins counties received USDA disaster designations for losses related to insects and disease (S3467) in 2012. In that same year, 30 counties received a total of $702,633 in indemnities for crop loss related to insects. 22 counties received $184,810 in insect-related indemnities in 2011, and 27 counties received $927,938 in insect-related indemnities in 2010. The crop losses in all three years included forage used to feed livestock.
- In 2013, the majority of counties in the state were declared by the USDA for drought (S3591; S3620; S3505; S3522; S3549); secondary impacts of this drought included insect infestation and disease spread.
- Several counties also received indemnities for crop losses related to plant disease between 2010 and 2012. 12 counties received $62,183 in 2012, 38 counties received $3,303,117 in 2011, and 16 counties received $572,831 in 2010. Impacted crops included wheat, corn, soybeans, oats, dry peas, sunflowers, forage, and "other" not specified. The specific plant diseases that caused these losses were not identified in the Risk Management Agency data.
- The USDA produced a "Cattle Death Loss" report in 2011 which detailed the number of cattle and calves lost to various causes (predator and non-predator) in each state in 2010. A total of 68,000 head of cattle and 90,000 calves died in South Dakota in 2010. 12.6% (8,568 head) of cattle losses were

5 https://openprairie.sdstate.edu/extension_extra/

attributed to digestive problems, 31.1% (21,148 head) to respiratory problems, and 5.2% (3,536 head) to other unspecified diseases. 12.8% (11,520 head) of calf losses were related to digestive problems, 29.2% (26,280 head) to respiratory problems, and 0.9% (810) to other unspecified diseases. Additional details were not available on the specific nature of the digestive and respiratory problems. At a value of $1,133 per head for cattle and $381 per head for calves, South Dakota's cattle industry losses in 2010 totaled $52,384,926 due to respiratory, digestive, and other diseases. (Weather-related cattle and calf losses are discussed in the *Winter Storm* hazard profile.)

- The USDA "Cattle Death Loss" report comes out approximately every five years, but previous reports for 2005 and 2000 organized data by region rather than state. The 1995 and 1991 reports are organized by state and can be compared to the 2011 report. The 1995 report indicates that a total of 59,600 cattle and 162,600 calves were lost in 1995. Of the 59,600 total cattle deaths, 6,800 were lost to digestive problems and 14,300 to respiratory problems. Of the 162,600 total calf deaths, 37,000 died from digestive problems and 30,000 were lost to respiratory problems. In 1991, cattle and calf losses totaled 55,000 head and 110,000 head respectively. Digestive problems killed 8,100 cattle and 33,400 calves. Respiratory problems killed 16,500 cattle and 31,300 calves. "Other diseases" was not listed as a category in 1995 or 1991. Total dollar value per head was not provided in the 1995 and 1991 reports.
- In January 2011, the USDA designated Jackson and Todd counties as natural disaster areas due to the ongoing grasshopper infestation that began in June 2010. Designated contiguous counties included Bennett, Jones, Pennington, Tripp, Haakon, Mellette, and Oglala Lakota (previously Shannon County).
- In April 2010, the state was approved for pasture grazing loss assistance under the Emergency Livestock Assistance Program (ELAP) due to the 2009 grasshopper infestation.
- In 2009, the state experienced combined effects of severe storms with hail, high wind, flooding, and grasshopper infestation in 35 counties. This led to the release of USDA Secretarial Disaster S2916.
- In 2005, the state experienced an unusually high outbreak of anthrax, with 56 positively confirmed cases in 18 counties.
- Trichomoniasis (trich) cases have been steadily increasing in recent years. The highest number of cases also occurred in FY 2005, with 45 positive cases in 11 counties.
- Asian soybean rust is still not documented and confirmed in the state, but extensive scouting efforts are underway, particularly in the southeast counties.
- The 2016 HIRA update did not note any significant agricultural pest and/or disease events past 2009.
- Palmer amaranth, a vigorous weed that has developed herbicide resistance in other states, was confirmed in central South Dakota in 2014. It has since been found in other locations in the state and in North Dakota, but it is not widespread and is currently being monitored.

Table 3-7 South Dakota Livestock Diseases

Disease Name	Incidents, history, and other reporting measures	Human Vulnerability
Cattle		
Brucellosis, also known as Bangs Disease or Bangs	U.S. states are free from Brucellosis in domestic cattle herds due to extensive vaccination and testing requirements. Buffalo and Elk in the Greater Yellowstone Area remain natural carriers of the disease and present the largest risk to domestic cattle herds. Documented cases include far-reaching impacts and tremendous costs for movement restrictions, testing requirements, indemnities, and epidemiology.	Yes, if ingested or directly exposed to the bacteria. Human-to-human transmission is possible, but rare.
Tuberculosis, also known as TB.	South Dakota has maintained a "TB Free" status by the USDA since 1982; however, all intact dairy cattle imported to the state must reflect a 'negative' result in official TB testing within 60 days prior to entering South Dakota. The bovine strain of bacteria is distinct from the most common forms that impact humans. However, the strain may be passed between cattle, from humans to cattle, and from cattle to humans. In both human and cattle patients, TB may be fatal if untreated or neglected.	Yes, if ingested (particularly from untreated milk). Sustained animal-to-human transmission is possible but rare.
Bovine Spongiform Encephalopathy (BSE), also called 'Mad Cow Disease'	First surfacing in Great Britain in 1986, BSE is a chronic degenerative disease of the central nervous system. There is no method for testing for the disease in live cattle, so suspected cases pose an extreme cost impact on ranchers. There have been sporadic cases in Canada and the United States. Strict regulations prohibit the feeding of ruminant derived proteins to ruminants. The disease is not passed between cows except via consumption. According to the Center for Disease Control, the first confirmed domestic case of BSE disease was reported in Washington state in 2003. Two subsequent diagnoses were confirmed for a 2004 case in Texas (confirmed in 2005) and in 2006 in Alabama. Luckily, these cases have resulted in minimal impact on domestic cattle herds, but monitoring remains a key component.	Suspected yes, if ingested. The link is suspected between VSE and certain cases of CJD, which is a chronic degenerative central nervous disease in humans.
Anthrax	Anthrax is a spore-forming bacterium that causes acute infections. In 2005, South Dakota experienced a serious anthrax outbreak, with 55 herds with confirmed losses to the disease in the space of four months. Mitigation and response measures helped contain the outbreak, with efforts to vaccinate over 1 million cattle during the summer months. The State Veterinarian reported that the effects of drought, contributed to the severity of the 2005 outbreak. Since South Dakota is located in the 'anthrax belt', potential losses and vulnerability remain high and vigilance remains critical. Previous cases include 1infected herd in 2009, 3 in 2008, 2 in 2007, and 2 in 2006.	Yes, if spores are inhaled, ingested, or infected materials are improperly handled. The disease is not known to be peer-to-peer transmissible.

Disease Name	Incidents, history, and other reporting measures	Human Vulnerability
Johne's Disease (pronounced Yo-nees), also called Paratuberculosis	Johne's disease is a chronic infection that causes diarrhea and wasting, which primarily impacts cattle over the age of 2 years and is also found in other ruminant animals such as goats and sheep. The disease is closely related to tuberculosis but grows very slowly. The disease causes wasting of the inflicted animals and may be spread via fecal matter, nursing from infected dams or contamination of the udder with manure, or en vitro. The disease may cause early death or culling losses, decreased milk production, decreased slaughter weights, loss of show, sale and breeding animals, and incurred veterinary costs. There is no effective vaccine. Johne's disease cases are reported at a rate of approximately 4.4% and appear to be increasing. Dairy cows seem to demonstrate a higher occurrence rate than beef cows.	There does not appear to be a transmission of this disease to people. Crohn's disease is a similar infliction in human populations.
Foot and Mouth Disease (FMD)	FMD is a fast-spreading virus which impacts all cloven-footed animals and causes blisters on feet, in mouths, and on mammary glands, resulting in lameness, the inability to eat or drink, and mastitis in dairy animals. In all cases, animals rapidly lose weight and may die. Transmission rates are nearly 100% of exposure, and young animals may die. FMD poses huge economic risks to livestock owners and consumers. In February 2001, the UK was forced to destroy over 9% of the national food animal production industry, and over 11 months to eradicate the disease.	FMD is distinct from Hand, foot, and mouth disease that impacts humans though the symptoms are similar. People cannot contract FMD.
Vesicular Stomatitis (VS)	VS is a virus that causes similar symptoms as FMD and is highly contagious, though it demonstrates a lower mortality rate. The disease may lead to serious restrictions on the movement, marketing, and exportation of animals from affected areas, which has a significant economic impact on livestock-driven economies. While no cases have been diagnosed recently in South Dakota, cases in nearby states underscore the need for vigilance and close reporting requirements.	Humans may contract the disease from sand flies or improper handling of infected animals and animal byproducts. Symptoms are flulike.
Trichomoniasis, also called 'trich'	Trich is a venereal disease that causes infertility and occasional abortions in cows. Bulls, once infected, carry the disease for life but cows seem to spontaneously recover after a period of infection, in some cases. During the FY 2005 breeding season, South Dakota experienced an unexpected resurgence of the disease in 45 confirmed cases, all west of the Missouri river. The known endemic qualities of the disease and the presence of the disease in states west and south of South Dakota, increased cases and magnified losses. Regulations for controlling and reporting Trichomoniasis were affected on June 1, 2005. Additional cases include 13 in FY 2009, 7 in FY 2008, 10 in FY 2007, and 9 in FY 2006.	Humans may contract the disease and spread it from person to person via sexual contact. The disease may be contracted from livestock through improper hygiene when handling infected animals.

Disease Name	Incidents, history, and other reporting measures	Human Vulnerability
Swine		
Pseudorabies (PRV), also known as Aujesky's Disease or mad itch in cattle	PRV is a viral disease that causes abortion, high mortality of piglets, and may cause other symptoms in adult pigs. In addition, cattle, dogs, bears, cats, sheep, rabbits, and raccoons may contract the disease, which often proves fatal in these secondary hosts. The disease is spread via nasal secretions and saliva. On April 16, 2003, South Dakota was granted Stage V-Free status. Though domestic swine herds have been PRV-free since 2003, the disease remains in feral herds, which pose the greatest risk to domesticated animals. Positive animals must be destroyed to limit the spread, and, in some cases, the entire herd must be destroyed. The disease is considered one of the most economically devastating diseases of swine herds and the potential for a reintroduction of the virus from feral pig exposures remains a concern.	Humans are not potential hosts.
Porcine Reproductive and Respiratory Syndrome (PRRS)	PRRS is a virus that attacks the respiratory system and leads to an overall weakened immune system. The disease is highly contagious and spreads rapidly but seems to impact different herds with varying degrees of severity for unknown reasons. First identified in the U.S. in North Carolina in the 1980s, the disease spread rapidly across the continent. All breeds and ages of pigs are susceptible, though there is some indication that some breeds demonstrate less vulnerability than others. The impacts of this disease are still under evaluation, but losses to pig herds have economic ramifications for sale for slaughter and breeding.	There is no known human susceptibility to the disease. Humans may serve as mechanical vectors of the disease without proper infection control practices.
Poultry		
Avian Influenza	While Avian Influenza is not currently documented in the state, the concern remains that exposure could result in the infection of domestic avian flocks, including turkeys, geese, chicken, and other fowls, that may contribute to the crossover between birds and people. A detailed response and containment plan has been developed and is a factor in mitigation should quarantine and/or subsequent destruction of flocks be required. A surveillance project went into effect in FY 2007.	Currently humans may contract the disease through extensive exposure to avian carriers. The concern is that the influenza serotype could genetically alter to sustain peer-to-peer transmission.
West Nile Virus	The first identified domesticated cases of WNV occurred in FY 2006, identified in geese at a production site in northeastern South Dakota.	Though mosquitoes remain the primary vector for human transmission, close contact with birds also increases the risk of exposure and may contribute to an alteration of the virus for sustained peer-to-peer transmission.

Disease Name	Incidents, history, and other reporting measures	Human Vulnerability
Wildlife		
Chronic Wasting Disease	The first case of CWD in farmed elk or deer in the U.S. was identified in a private South Dakota herd in late 1997. On February 5, 1998, a mandatory Cervid Chronic Wasting Disease Surveillance Identification (CCWDSI) Program was enacted. This monitoring program has become the model program for numerous other state CWD monitoring programs as well as the federal interim CWD monitoring plan.	No known human transmissions exist at this time. The disease is a variant of the same family that houses BSE, however, so appropriate precautions are appropriate.
Rabies	Rabies in the wildlife population remains at a high level. Skunks are the reservoir of the disease and they represent the largest number of positive diagnoses at the laboratory. Bats have also been recognized as a significant reservoir of rabies. For FY 2009, thirty-two (32) animals were reported infected with rabies, compared to twenty-nine (29) in FY 2008, twenty-five (25) in FY 2007; fifty-three (53) in FY 2006; eighty (80) in FY 2005; one hundred five (105) in FY 2004.	Yes, if exposed through bites or handling of infected animals.

Sources: South Dakota Animal Industry Board Disease Control Website, Centers for Disease Control, U.S. APHIS

Table 3-8 Small Grains

Disease	Winter Wheat	Spring Wheat	Barley	Oats	Rye	Occurrence
Barley Yellow Dwarf (Red Leaf of Oats)	X	X	X	X		Common
Common Root Rot	X	X	X	X	X	Widespread
Covered Smut & Common Bunt	X	X	X	X	X	Fairly Common
Dryland Root & Crown Rot	X	X	X	X	X	Widespread, most serious on winter wheat
Leaf Rust	X	X	X	X		Widespread
Loose Smut	X	X	X	X		Common (>2% In Given Field)
Scab (Fusarium Head Blight)	X	X	X	X	X	East River Counties: Common West River Counties: Rare
Stem Rust	X	X	X	X	X	Rare
Stripe Rust	X	X				Frequent, Severity Varies by Year
Take All	X					Rare
Tan Spot, Septoria Leaf Blotch & Other Leaf Spot Diseases	X	X	X	X		Widespread
Vomitoxin	X	X	X	X	X	Fairly Common
Wheat Streak Mosaic	X	X				Frequent

Table 3-9 Sunflowers, Oilseeds, Dry Beans, Dry Peas and Soybeans, Corn, Alfalfa and Flax

Disease	Sun-flowers	Canola	Safflower	Field Pea	Chick-pea	Lentil	Dry Bean	Soy-beans	Corn	Alfalfa	Flax	Occurrence
Alternaria Leaf &Stem Spot, Leaf Blight	X		X*									Annually in late summer *common
Anthracnose						X	X		X*	X	X*	Rare *Occasional
Apical Chlorosis	X											Infrequent
Ascochyta Blight					X	X						Common
Asian Soybean Rust								X				Not yet reported in the state

Disease	Sun-flowers	Canola	Safflower	Field Pea	Chick-pea	Lentil	Dry Bean	Soy-beans	Corn	Alfalfa	Flax	Occurrence
Aster Yellows		X									X	Infrequent, no control
Bacterial Blight & Wilt$				X			X*	X		X$		Widespread, *Occasional $Rare
Bean Pod Mottle								X				Widespread
Black Leg		X										Common
Blackspot		X										Common, no control
Brown Spot								X				Widespread
Brown Stem Rot (BSR)								X				Occasional
Charcoal Rot								X				Occasional, extreme southeast counties
Common Leaf Spot										X		Common
Damping-Off			X						X	X		Common
Downy Mildew	X							X				Common
Eyespot									X			Occasional
Frogeye Leaf Spot								X				Rare in state, observed in extreme southeast counties
Fusarium Root Rot and Wilt$				X	X	X	X	X		X$*	X$*	Occasional *Common
Goss's Bacterial Wilt & Blight									X			Rare
Gray Leaf Spot									X			Fairly common
Holcus Spot									X			Annual in early summer
Maize Dwarf Mosaic									X			Common, typically low incidence
Northern Stem Canker								X				Frequent
Northern Corn Leaf Blight									X			Occasional
Pasmo											X	Occasional
Phoma Black Stem	X											Annually in late summer

Disease	Sun-flowers	Canola	Safflower	Field Pea	Chick-pea	Lentil	Dry Bean	Soy-beans	Corn	Alfalfa	Flax	Occurrence
Phomopsis Stem Canker	X											Annually in late summer
Pod & Stem Blight								X				Widespread
Pythium Damping Off & Seed Decay				X	X	X	X	X		X		Widespread
Pytophthora Root & Stem Rot								X		X*		Widespread *Fairly Common
Rhizoctonia Seedling Blight$ & Root Rot								X			X$*	Widespread *Common
Root & Crown Rot Complex										X		Common
Sclerotinia Wilt, Stalk Rot & Head Rot	X											Annually in late summer
Soybean Cyst Nematode								X				Widespread in south-eastern counties, scattered in other areas
Soybean Mosaic								X				Rare
Spring Black Stem & Leaf Spot										X		Widespread
Stalk Rot Complex									X			Annual in fall
Stem Nematode										X		Rare, restricted to western counties
Sudden death syndrome (SDS)								X				Rare: only in Clay County
Summer Black Stem & Leaf Spot										X		Common
Verticillium Wilt										X		Common
White Mold		X	X	X	X	X	X					Common

Probability

To some extent, these events are guaranteed to occur on an annual basis, particularly when evaluated on a statewide scale. The determination of probability becomes most valuable when areas of particular occurrence rates, or when events of unusual severity, are recorded. Many times, extreme events are documented concurrently with other hazard event occurrences, such as the outbreak of high anthrax levels in 2005, which was attributed to drought; the grasshopper plagues of the 1930s, also attributed to drought; or the recurrence of certain crop molds, which correspond to unusually wet growing periods.

Overall, if the general annual probability of occurrence statewide is near 100%, some general probabilities for regions or specific counties may also be drawn.

In general, the western portion of the state (counties lying to the west of the Missouri River) have a higher documented occurrence rate of trich and stem nematode afflictions of alfalfa crops. Counties along the river basins bore the brunt of the anthrax outbreaks in 2005. Eastern counties have higher documented rates of the soybean cyst nematode, frogeye leaf spot, scab, and West Nile Virus in domestic fowl flocks. Areas with a primarily cultivated crop land use are more susceptible to crop diseases, and thus have a predicted higher probability rating than areas devoted to rangeland. Areas where wildlife interaction is more common among livestock have higher exposure probabilities to diseases like rabies and brucellosis.

A South Dakota State University Extension entomologist said that "based on the high grasshopper count late last summer (2009), there is potential for another year of grasshopper infestation in counties in western South Dakota". This prediction was accurate; grasshopper infestations continued to plague South Dakota in 2010. Dangerously high levels of grasshopper populations seem to follow a cycle of 7 to 10 years, meaning the state can reasonably expect another between 2017 and 2020. Drought or periods of higher-than-average temperatures, particularly in the winter, increase the severity of grasshopper population numbers, because more eggs survive to hatch. Based on historical data, South Dakota has experienced four grasshopper plagues in 123 years (1887 to 2010) for an annual chance of 3.2%. Smaller infestations, which still exert significant economic impact, may be predicted at the cycle of ten years, or a 10% annual chance.

Climate Change Consideration

With agriculture as South Dakota's primary industry, climate change has the potential to have a direct impact on the economy. UC Davis published research on the effects climate change has on agricultural pests, crop diseases and weed species. Climate change can alter and increase the range or "damage niche" of many weed species. With these geographic range shifts, new weed species can enter communities further north than in the past. The effects of climate change on vary by region and crop type, so it is important to understand the different environmental factors and the underlying physiological mechanisms' responses. If the invasion of new species can be detected in advance, efforts can be made to control the growth.

Crop diseases can be animal, fungal, bacterial or viral. An increase in severe weather events such as tornadoes, high wind, or storms may increase crop damage, crop losses and/or catalyze the spread of crop disease such as soybean rust. Local increases in precipitation also have the potential to aid in the dispersal of plant and crop disease.

Various frost-sensitive insects have been shown to increase in population with the rise of milder winters. Warmer winters may foster an environment that allow for pests and invasive weeds to survive through the cold season. Increasing annual average temperatures also aid in the growth and reproduction in certain insects. Studies on aphids and moths have shown that increasing temperatures can allow insects to reach their minimum flight temperature sooner, aiding in increased dispersal capabilities. Multiple studies have

shown the northward expansion or shift of insect ranges, such as Edith's checkerspot butterfly or the mountain pine beetle, to be correlated with increasing temperatures.

The Third National Climate Assessment explains that climate change has both positive and negative consequences to agricultural productivity. Winter and spring precipitation is expected to increase, which may increase soil moisture reserves during the early season but may also be offset by fields too wet to plant and increased flooding due to spring snowmelt. Summer season precipitation is projected to decrease slightly, which will increase the risk of drought. Drought will reduce cropland productivity by limiting water for crops, but also by increased pest pressure from spider mites, grasshoppers and other insects. The growing season is lengthening as well, providing a longer frost-free season that could enable higher crop yields, but also more opportunity for weed, insect and diseases to grow.

The rising minimum (overnight) temperatures and relative humidity, particularly in the summer season, also have impacts on livestock health. Warm, humid nights can prevent proper body cooling and reduce cattle comfort and performance.

3.2.2 Flood

Description

Throughout the United States, flooding is recognized as the most prominent disaster-producing phenomenon, generating annual losses in the billions of dollars. Floods are among the most serious, devastating, and costly natural hazards that affect South Dakota. The greatest impact of these phenomena has been to the eastern half of the state, principally, the Big Sioux, Vermillion, and James River basins, which have recurring problems and are unregulated (no dams) within South Dakota.

The following is extracted from "Flooding in South Dakota," a fact sheet written by Stan F. Pence from the South Dakota Department of Environment and Natural Resources.

> ***What Is a Flood?***
>
> A flood occurs when water rises to flow over land that is normally dry. Floods happen in low-lying areas, such as valley bottoms, lake basins, and coastal areas. In South Dakota, flooding occurs mainly in valley bottoms, deep canyons, and lake basins when the amount of water moving through a river, or entering a lake, is so great that the natural or artificial banks can no longer contain all of the water. Therefore, the water overflows the banks of the river or lake and spreads out onto low-lying areas that are not normally covered with water.
>
> ***What Causes A Flood?***
>
> In South Dakota, there are two main climatological causes of flooding: runoff from rainfall and runoff from melting snow. The water from rainfall or melting snow flows overland until it reaches a nearby river or lake. If the river or lake cannot hold all the water that is entering it, some of the water will begin to overflow the banks of the river or lake, causing flooding. The size of the flood is commonly influenced by such factors as the intensity of the rainfall, length of the rainfall, melting rate of the snow, and the infiltration rate of the water into the ground.
>
> In addition to climatological reasons for flooding in South Dakota, floods can also result from the failure of dams. Dam failure can result from defective construction, poor maintenance or a poor foundation. Many small dams in South Dakota fail because their spillway is not big enough. Often, failure occurs as a result of extremely heavy rainfall that

causes a large increase in the amount of water held by the dam. This increase in water behind the dam could place more stress (pressure) on the dam than it was designed to handle, causing the dam to fail.

What Types of Floods Occur in South Dakota?

Four types of floods can occur in South Dakota. The first type is commonly called a flash flood. A flash flood is the result of several inches or more of rain falling in a very short period of time, often tens of minutes. This high intensity rainfall is commonly caused by powerful thunderstorms that cover a small geographic area. Because so much water is falling onto the ground very rapidly, there is little time for the water to soak in, and most of the water runs off into nearby rivers or lakes. The flood that occurs as a result of this runoff happens very rapidly, hence the term “flash.” This type of flood is generally very destructive, affecting a fairly small, localized area, commonly several tens of square miles or less. The flash flood often ends almost as quickly as it started. Probably the best-known flash flood in South Dakota occurred when Rapid Creek left its banks on June 9, 1972, in Rapid City. Fifteen inches of rain that fell in less than 6 hours caused the flooding. This flood was devastating both in terms of loss of human life and property damage. Two hundred thirty-eight people lost their lives in this flood and about $150 million (in 1972 dollars) of property damage occurred.

The second type of flooding is sometimes termed the long-rain flood and is the most common cause of major flooding. This type of flood results after several days or even weeks of fairly low-intensity rainfall over a widespread area, often hundreds of square miles. As a result, the ground becomes "water logged," and the water can no longer infiltrate into the ground; therefore, the water begins to flow toward rivers or lakes. The flooding that can result is often widespread, covering hundreds of square miles, and can last for several days or many weeks. Much of the flooding that occurred in eastern South Dakota during the summer of 1993 was this type of flooding.

The third type of flood in South Dakota is the result of melting snow in the spring. This type has characteristics that are almost a combination of the flash flood and long-rain flood. The area covered by this type of flood is generally not as large as that covered by the long-rain flood but is typically larger than that covered by the flash flood. Generally, the flood lasts for several days, occurring when large amounts of snow melt rapidly due to warm temperatures. The flooding can be made worse if the ground remains frozen while the snow is melting; this causes all of the melt water to run off to nearby rivers and lakes rather than infiltrate into the ground.

Some of the largest floods that have occurred in South Dakota were the result of melting snow and ice. These large floods have occurred along the entire length of the Missouri River. The Great Flood of 1881 is probably the most well-known of all the floods to take place in South Dakota. Ice jams on the river caused the flooding to become extremely devastating, destroying large amounts of property and causing many lives to be lost. Towns such as Yankton, Vermillion, Burbank, Meckling, and Pierre were all severely damaged by the flooding.

The fourth type of flood results from the failure of dams or levees. The four largest dams in South Dakota - Oahe at Pierre, Big Bend at Fort Thompson, Fort Randall at Pickstown, and Gavins Point at Yankton - are all located on the Missouri River. Large dams in the Black Hills are the Deerfield, Pactola, Sheridan, Angostura and Orman dams. If any of

these large dams were to fail, flood damage could be very great. Fortunately, all of these dams are considered to be properly constructed and have been designed to hold back very large amounts of water; therefore, they are considered to be very safe, and the likelihood of failure is extremely small. Except for these Missouri and Black Hills dams, the majority of the dams in South Dakota are very small, and if they were to fail, flooding would likely be minimal. Levees protect many areas in South Dakota; however, many of these levees protect small areas from flooding (see Figure 3-8).

Further information regarding dam and levee failure and other flooding risk in South Dakota follows.

Dam Failure

South Dakota has approximately 2,500 dams in the National Inventory of Dams (see Figure 3-7 in Location section below). The state defines a dam as follows: "a structure is a dam if the height to the dam crest is greater than or equal to 25 feet and the storage at the dam crest (not at the spillway elevation) is greater than 15 acre feet or if the height to the dam crest is greater than 6 feet and the storage at the dam crest (not at the spillway elevation) is greater than or equal to 50 acre feet. The height of the dam is the difference in elevation between the natural bed of the watercourse or the lowest point on the toe of the dam, whichever is lower, and the crest elevation of the dam."

Of the roughly 2,500 dams, 89 are high hazard dams. Eighty-five of these high hazard dams, of which 73 are state regulated, have emergency action plans. This is an improvement since 2007, when 21 dams had no emergency action plan and in 2012, 15 had no emergency action plans. All high hazard dams are required to have emergency action plans. Of the total dams, approximately 155 are significant hazard dams. Because of South Dakota's low population and low density, most of the state's dams are low hazard dams. In *Federal Guidelines for Dam Safety: Hazard Potential Classification Systems for Dams* (FEMA 2004), dams are classified as follows:

- **Low Hazard Potential** - Dams assigned the low hazard potential classification are those where failure or mis-operation result in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.
- **Significant Hazard Potential** - Dams assigned the significant hazard potential classification are those dams where failure or mis-operation result in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
- **High Hazard Potential** - Dams assigned the high hazard potential classification are those where failure or mis-operation will probably cause loss of human life as well as economic, environmental, and lifeline losses.

Levee Failure

In addition to these dams, South Dakota also has levees that pose flood risks. Levees are earth embankments constructed along rivers and coastlines to protect adjacent lands from flooding. Floodwalls are concrete structures, often components of levee systems, designed for urban areas where there is insufficient room for earthen levees. When levees and floodwalls and their appurtenant structures are stressed beyond their capabilities to withstand floods, levee failure can result in loss of life and injuries as well as damages to property, the environment, and the economy. In South Dakota, there are numerous levees ranging from small agricultural levees that protect farmland from high-frequency flooding to large urban levees that protect people and property from larger-less frequent flooding events such as the 100-year and 500-year flood levels. For purposes of this discussion, levee failure will refer to both overtopping

and breach of a levee as defined in the U.S. Army Corp of Engineers' Publication - S*o You Live Behind a Levee!* (https://mrcc.illinois.edu/1913Flood/awareness/materials/SoYouLiveBehindLevee.pdf).

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

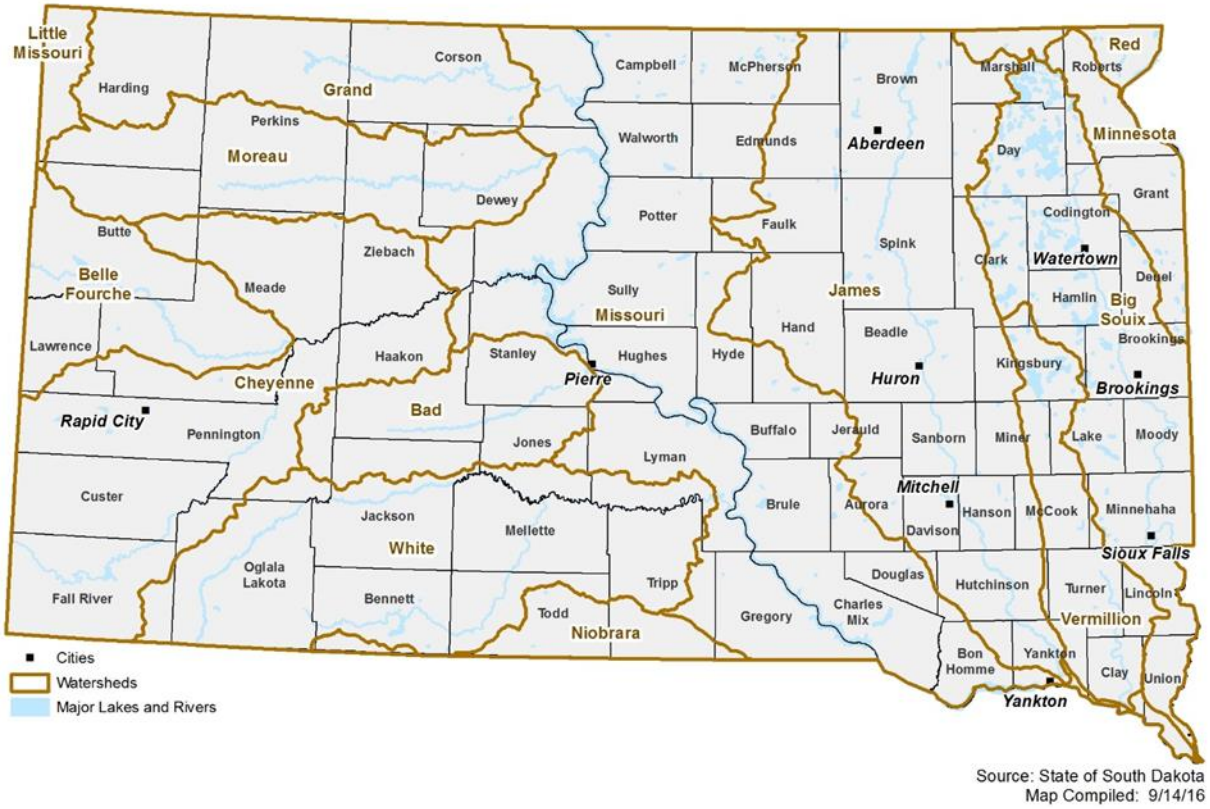
Location

According to the National Weather Service, flash floods are the deadliest natural disaster in South Dakota. They are caused by stationary or slow-moving thunderstorms that produce heavy rain over a small area. The Black Hills are especially vulnerable to flash floods, where steep terrain and narrow canyons can funnel heavy rain into small creeks and dry ravines, turning them into raging walls of water. Even on the prairie, normally dry draws and low spots can fill with rushing water during very heavy rain.

Critical to the mission of disaster identification and risk assessment is the ability to statistically log and compare various types of flood and demographic data. Through the use of modern GIS technologies, multiple analyses of structures, historical sites, city boundaries, airports, and schools can be performed and then compared to the floodplains in which they are located. Based on numbers of people and property at risk, i.e., the vulnerability of people and property at risk, the South Dakota Office of Emergency Management has determined that the cities of Aberdeen, Pierre, Rapid City, Sioux Falls, and Watertown are at the greatest risk from flood events.

South Dakota is divided into 14 river drainage basins (See Figure 3-6). These basins extend beyond the political boundary of the state. Although not discussed or included in this plan, an interstate understanding of water policy is required to fully analyze and comprehend South Dakota water systems.

Figure 3-6 Drainage Basins of South Dakota



Source: USDA Natural Conservation Resources Service South Dakota

Missouri River Basin

The following description of the Missouri River Basin is from Microsoft Encarta Online Encyclopedia:

> Considered as a separate river, the Missouri is the longest in the United States. In combination with the Mississippi River into which it flows at St. Louis, it is the longest river system in the United States. The river begins where the Gallatin River, Jefferson River, and Madison River come together in the foothills of the Rockies in Montana. It flows through Montana, North Dakota, and South Dakota before forming the boundary between Iowa and Nebraska. It forms the extreme northeast border of Kansas before turning almost due east through the state of Missouri.
>
> South Dakota is drained almost entirely by the Missouri River and its tributaries. The only sections that are not lie in the extreme northeast and northwest. The Missouri flows southward and then southeastward across the state, in a deep, wide channel. It forms part of the South Dakota–Nebraska state line. Much of the South Dakota section of the river is now made up of a chain of four reservoirs impounded by large dams. These dams include Fort Randall, Gavins Point, Big Bend, and Oahe dams which were built for flood control and to provide water for irrigation and the generation of hydroelectricity. Lake Oahe is formed by Oahe Dam at Pierre. The James River, the Vermillion River, and the Big Sioux River, all in the eastern half of the state, flow southward in roughly parallel courses to join the Missouri. In the western part of the state the Grand, Moreau, Cheyenne, Bad, and White rivers flow generally eastward to join the Missouri.

South Dakota cities on the river include Pierre, Mobridge, Oacoma, Chamberlain, Pickstown, Fort Thompson, Ft. Pierre, Springfield, Yankton, and Lower Brule. The interstate effects of water policy are evident in the capital city of Pierre, where national policy objectives produce an ever-rising Missouri River to offset flooding in downriver states.

The largest natural lake in South Dakota is Lake Thompson in the east-central part of the state. Other natural lakes of significant size in South Dakota are lakes Traverse and Big Stone, both in the northeastern corner of the state. Lake Traverse is a reservoir created by damming up the Boise Des Sioux Rivers near Rosholt. Big Stone Lake is a reservoir created by damming the Little Minnesota River near Big Stone City. In addition, there is the Waubay Lakes Chain and adjoining closed basins (discussed further in this section) located in the northeastern part of the state, which have continuous ongoing flooding issues. Numerous small lakes and sloughs dot the landscape of northeastern South Dakota, as well. The largest lakes are the reservoirs behind dams on the Missouri River, all of which were constructed as part of the Missouri River Basin Project.

Big Sioux River Basin

The Big Sioux River Basin is the eastern most major river pattern in South Dakota. It is formed within a topographic feature known as the Coteau de Prairie Highlands. This glacial formed feature rises about 800 feet above the bordering Red River lowlands of Minnesota. It is also bordered on the west by the James River lowland. The Coteau has what is known as a flatiron shape lying in a general northwest to southeast direction. It is about 200 miles long and 80 miles wide at the widest point. It has a variation in elevation from 2,050 feet at the highest point to 1,090 feet at the lowest point.

The northern part of the Coteau has geologically developed features of potholes, sloughs, and lakes. During periods of low precipitation, these features tend to hold backwater and do not contribute to the drainage of the Big Sioux River. Conversely, during wet years, this area can accumulate enough moisture to greatly increase the water supply to the drainage basin. There are about 1,970 square miles of land within the basin that is designated as noncontributing to the drainage system. The portion of the basin that does contribute to the Big Sioux River is about 7,280 square miles. A total of 4,280 square miles of the figure is located in South Dakota

The headwaters for the Big Sioux River are found in the Coteau Lake Region of Roberts and Day counties. The river flows in a southerly direction to its junction with the Missouri River near Sioux City, Iowa. The variation in elevation from the headwaters to the mouth greatly influences the movement of water through the basin. The elevation decreases from 1,826 feet near Waubay to 1,281 at Sioux Falls. The Granite Falls formation of Sioux Falls has a 100-foot drop in elevation. Below the falls, the elevation varies from 1,281 feet to 1,098 feet at the river's mouth near Sioux City, Iowa.

Associated with the elevation is the slope profile of the river. The slope varies from 1.83 feet per mile near Watertown, 1.50 feet per mile at Sioux Falls, and 0.5 feet per mile at the junction with the Missouri River. The Big Sioux River has a steeper gradient than the James or Vermillion rivers. This steep slope causes water to move quickly down the drainage system and thus shortens the time of peak flooding in any given portion of the basin.

James River Basin

The James River Basin is the largest of the East River Basin Systems. It is bordered on the east by highlands of the Coteau de Prairie and on the west by the high ground of the Coteau de Missouri. The valley is a nearly flat stretch of land about 216 miles long and averaging 60 miles wide. It is only in the southern portion that the topography becomes steeper. There is little variance in the elevation of the

basin. At Columbia, where the river basin forms in South Dakota, the elevation is 1,290 feet. At the southern terminus of the basin near Yankton, the elevation is 1,162 feet.

The James River drainage area encompasses all or part of 23 counties. It drains 12,609 square miles or over eight million acres of land in South Dakota. This represents 16.3 percent of the total land in the state. The river valley is about 400 miles long, 25 to 75 feet deep, and varies in width from a few hundred feet to three miles. The slope of the valley is .493 feet per mile and the average slope of the river is .280 feet per mile.

There are seventeen contributing streams within the James River Valley. These streams drain 10,606 square miles. The majority of the basin lacks good drainage features. This is due to the slight variance in elevation and limited slope of the river. Much of its drainage is noncontributing and remains in small swales and basins.

Vermillion River Basin

The Vermillion River Basin is the smallest of the East River systems. It has its headwaters in the lake country of Kingsbury County. The river flows through McCook, Turner, and Clay counties to join with the Missouri River near Burbank, South Dakota. The west branch originates in Miner County and connects with the main stem near Parker in Turner County.

The Vermillion River Basin is formed in the Dakota Valley or what is more commonly called the James River Lowland. This area is more than 200 miles long and about 60 miles wide and occupies a portion of the lower half of the basin. The gradient of this river system is approximately 400 feet throughout the length of the river. The east branch elevation is 1,518 feet and the elevation near Vermillion is 1,119 feet. The slope profile is approximately four feet per mile.

The drainage system is supplied with water from both the east and west portion of the basin. The major tributaries are the Little Vermillion River, Turkey Ridge Creek, and Saddle Creek. There are also a number of very small tributaries contributing to its drainage pattern.

Black Hills Region

The western most drainage system is found in the Black Hills region. The Black Hills lie within the states of Wyoming and South Dakota with the majority in western South Dakota. The region is 125 miles long and 60 miles wide. The general shape of the Black Hills is elliptical. This formation presents a startling contrast to the surrounding topography. Its eastern side rises from the prairie to a height from 2,600 to 3,500 feet. The western part of the Black Hills varies in elevation from 3,500 to 7,200 feet at Black Elk Peak.

The major drainage creeks of Alkali, Battle, Bear Butte, Beaver, Box Elder, Elk, French, Rapid, Spearfish, Spring, and Whitewood are all capable of causing heavy flooding and flood-related damage. These eleven creeks drain about 7,500 square miles of land.

Waubay Lakes Chain and Adjoining Closed Basins

The Waubay Lakes Chain is part of a 409 square mile closed basin area in the Big Sioux River Basin in northeastern South Dakota (mostly in Day County). The 10 major lakes in this chain are glacial in origin and include Bitter Lake, Blue Dog Lake, Enemy Swim Lake, Hillebrands Lake, Minnewasta Lake, Pickerel Lake, Rush Lake, Spring Lake, Swan Pond, and Waubay Lake. In closed basins, under most circumstances, water does not have a direct drainage path to a river outside the closed basin and the water would have to evaporate into the atmosphere for lake levels to recede. The northeastern area of South Dakota is much like a giant bathtub. Water fills the basin until it overflows the sides. Because the area is atop a flat

area of high ground, the sides of the tub are higher than the normal drainage routes (e.g., the Big Sioux and the James Rivers), leaving the accumulated runoff without a natural outlet.

Rising waters have inundated portions of Day County and the surrounding areas in the past, in particular during the 1990s. Significant increases in lake levels within the Waubay Lakes Chain have occurred mainly due to greater-than-normal precipitation along with less-than-normal evaporation. In September 1998, FEMA issued a mission assignment to the U.S. Geological Survey to provide oversight, coordination, and hydrologic expertise for a study of the Waubay Lakes Chain and the adjoining closed basins. This study, including pertinent maps, is on file with the OEM and FEMA Region VIII. The U.S. Army Corps of Engineers also provided technical expertise and analysis for the study as well as possible structural mitigation solutions. The Natural Resource Conservation Service provided soils data. This study found that from 1991 until the report was published in 1999, the Waubay Lakes Chain experienced a wet climatic period that can be expected to occur less than once every 100 years, on average. Due to periods of above normal precipitation and below normal evaporation, significant increases in lake levels and inundation areas within closed basins in northeastern South Dakota have been observed.

Based on the study of the Waubay Lakes Chain the lake levels for Bitter, Hillebrands, Minnewasta, Rush, Spring, and Waubay lakes and Swan Pond have significantly increased. The total surface area of the ten major lakes increased by 74 percent between 1991 and 1998. The water levels for Bitter, Hillebrands, Spring, and Waubay lakes and Swan Pond increased between 15 and 18 feet from 1991 to 1998. Blue Dog, Enemy Swim, and Pickerel lakes have concrete weir outlet structures and experienced lake level increases of 2.7, 1.8, and 0.1 feet respectively between fall 1991 and fall 1998. Minnewasta and Rush lakes experienced lake level increases of 9.2 feet and 3.9 feet respectively.

At the time the study was published, the U.S. Army Corps of Engineers' hydrologic model simulation suggested that flooding problems would persist in the region for the next few years, regardless of whether the climate was wet or dry. It would take at least a decade of drought similar to that experienced in the 1930s to return the lakes to pre-1992 conditions. If relatively wet climate conditions persist, the lakes would continue to climb until Bitter, Blue Dog, Rush, and Waubay lakes form a single lake that will inundate over 60,000 acres and the natural drainage divide south of Bitter Lake could overflow and spill to the Big Sioux River. This scenario, however, would require nearly 15 years of wet conditions.

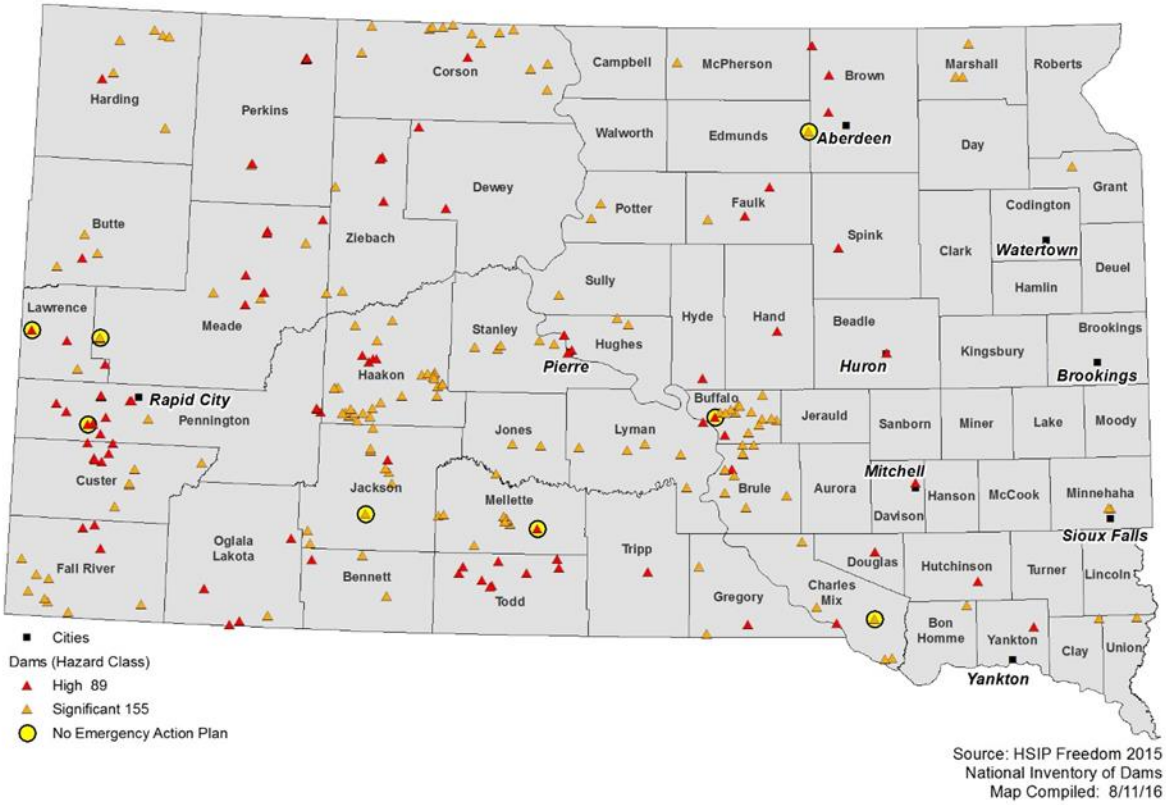
Rising water levels in the Waubay Lakes Chain have resulted in substantial damage to public and private properties in the basin. Several presidential declarations in the 1990s allowed for funding to be used to address the immediate problems of inundated roads and structures for emergency access purposes. Numerous public roads and highways have been damaged or closed because of high water, and some have been raised at great cost. Many parks and recreational facilities have been adversely affected as well. The available data show that the greatest impacts from flooding have been to agriculture and transportation. The federal government had spent over $71 million in northeastern South Dakota for response and recovery efforts and emergency measures during the 1990s. However, because a major storm event or flash flood did not cause the damage (it was caused by an accumulation of annual runoff and a lack of evaporation), established FEMA disaster programs could not adequately address the situation. Since that time 29 homes have been acquired in Waubay with FEMA HMA funding in 2012, which should mitigate some of the losses to residential structures in this area in the future.

South Dakota Dams

As mentioned previously, the four largest dams in South Dakota are Oahe at Pierre, Big Bend at Fort Thompson, Fort Randall at Pickstown, and Gavins Point at Yankton. These are U.S. Army Corps of Engineers Dams on the Missouri River. Large dams in the Black Hills are the U.S. Department of the Interior Bureau of Reclamation's (BOR) Deerfield, Pactola, and Angostura dams, the U.S. Forest Service's

Sheridan Lake dam and the Orman dam which is associated with the Belle Fourche Irrigation District. Shadehill Reservoir, while not in the Black Hills, is a significant BOR dam which stores water for irrigation (6,700 acres) and flood control purposes. Figure 3-7 shows the locations of the high and significant hazard dams in South Dakota.

Figure 3-7 South Dakota High and Significant Hazard Dams



More specific location information is in the following section on past events and Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction.

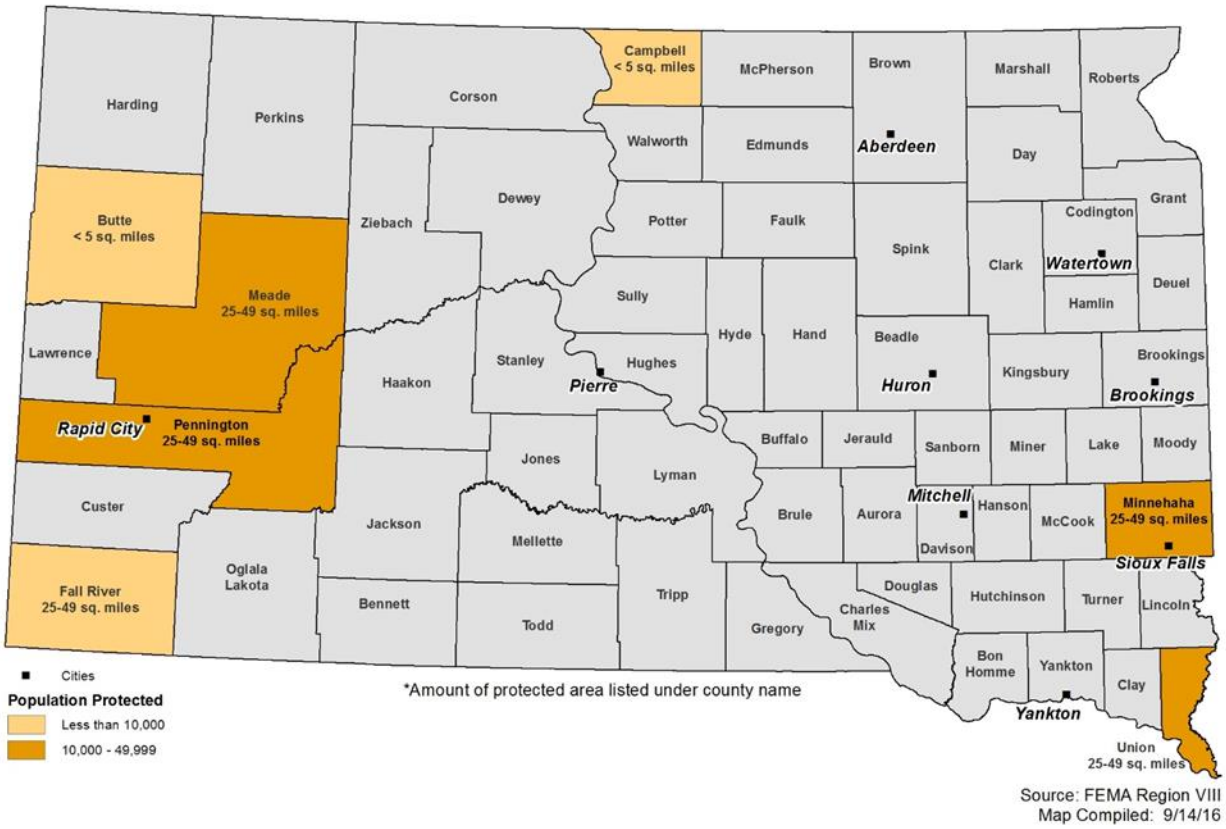
South Dakota Levees

As mentioned previously, South Dakota contains numerous levees ranging from small agricultural levees that protect farmland from high-frequency flooding, to urban levees protecting large urban populations and property from larger less-frequent flooding events such as 100-year and 500-year floods. Table 3-10 shows the location of the U.S. Army Corp of Engineers Levees, as well as detail about each levee. These are also graphically depicted on Figure 3-8. The following table is not a comprehensive inventory of levees in the state. The SHMT noted that there are several levees along the James River in Spink and Brown counties that are not certified and frequently overtopped. Although these are not represented in the FEMA database of levees, the James River Water Development District (JRWDD) commissioned a LiDAR survey of the floodplain and now maintains GIS data of all of the levee locations along the James River. This information is being used by the JRWDD to identify specific mitigation actions within the watershed. JRWDD and Brown County are exploring opportunities to commission LiDAR for the entire county.

Table 3-10 U.S. Army Corps of Engineers Owned Levees by County in South Dakota

County	City	System Name	Construction Completion Date	Inspection Rating	Last Routine Inspection Date
Brown	City of Aberdeen	Aberdeen - Moccasin Creek RB	-	Unacceptable	7/20/2017
Butte	City of Belle Fourche	Belle Fourche RB	6/1/1938	Unacceptable	9/13/2016
Campbell	Town of Herrid	Herrid - Spring Creek RB	10/19/1953	Unacceptable	8/28/2017
Fall River	City of Hot Springs	Hot Springs - Fall River Channel West System	7/25/1949	Minimally Acceptable	7/28/2016
Fall River	City of Hot Springs	Hot Springs - Fall River Channel East System	7/25/1949	Minimally Acceptable	7/28/2016
Lincoln, Minnehaha	City of Sioux Falls	Sioux Falls - Big Sioux RB and Skunk Creek RB	1/1/1961	Minimally Acceptable	8/18/2017
Meade	City of Sturgis	Sturgis - Deadman Gulch RB	6/26/1980	Minimally Acceptable	8/29/2017
Minnehaha	City of Sioux Falls	Sioux Falls - Diversion Channel LB - South	1/1/1961	Unacceptable	8/18/2017
Minnehaha	City of Sioux Falls	Sioux Falls - Diversion Channel LB - North	1/1/1961	Minimally Acceptable	8/18/2017
Minnehaha	City of Sioux Falls	Sioux Falls - Big Sioux RB and Skunk Creek LB	1/1/1961	Unacceptable	8/18/2017
Minnehaha	City of Sioux Falls	Sioux Falls - Big Sioux RB	1/1/1961	Unacceptable	8/18/2017
Minnehaha	City of Sioux Falls	Sioux Falls - Big Sioux LB North and Diversion Channel RB	1/1/1961	Minimally Acceptable	8/18/2017
Minnehaha	City of Sioux Falls	Sioux Falls – Big Sioux LB Downtown		Unacceptable	8/18/2017
Minnehaha	City of Sioux Falls	Sioux Falls – Big Sioux River LB South		Minimally Acceptable	8/15/2017
Pennington	City of Rapid City	Rapid City - Rapid Creek RB	11/26/1978	Minimally Acceptable	8/28/2017
Union	City of North Sioux City	North Sioux City - Union County - Big Sioux River RB	10/20/1981	Unacceptable	9/21/2016

Figure 3-8 Levee Protection in South Dakota by County



Past Events

According to the National Centers for Environmental Information (NCEI) Storm Events database, there were 1,302 floods in South Dakota between 1993 and August 2015. Total property and crop damage for these events is estimated at $310.6 million in 2016 dollars. This suggests that South Dakota experiences an average of 62.3 floods and $14.1 million in flood losses (property and crop) annually. There were also five deaths and five injuries during this time period. Table 3-11 describes some of the floods that have occurred in South Dakota. See Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction for more information about how floods affect individual counties.

South Dakota is remarkable in that as early as the late 1800s, flood mitigation efforts were pursued and implemented. The first effort was after the 1881 flood of the Vermillion and Missouri rivers that wiped out the town of Vermillion. The town was relocated on the bluffs behind the former town to prevent another recurrence. This was the first recorded hazard mitigation effort by a government entity in South Dakota and possibly in the nation.

The second effort followed the 1972 Black Hills/Rapid City flood. This flood stands out in South Dakota history as the deadliest and most expensive in terms of damage. Following the flood, Rapid City refused to allow rebuilding in the floodway, effectively launching federal government efforts to create a hazard mitigation program.

While there have been failures of low hazard dams in recent years, no deaths or injuries were reported, and property damage was minimal. The only significant failures of high hazard dams are the breach of Canyon Lake Dam in 1972 (Rapid City flood) and the failure of Menno Dam in 1984 (see event

descriptions below). Rose Hill Dam in Hand county failed in 2010 due to heavy rains. Two people were stranded, hanging from a tree as floodwaters rushed passed, until first responders were able to rescue them.

Table 3-11 Significant South Dakota Flood Events

Date	Comments
June 24, 2015	Strong thunderstorms over western and central Pennington County dumped three to four inches of rain during the evening and overnight hours of June 23-24. Runoff from the heavy rain caused areas of flooding along streams. Runoff from heavy rain caused flooding in Rapid Valley. Green Valley Drive was flooded for a quarter of a mile and Anderson Road was impassable. Flooding was also observed at two gauging stations along Rapid Creek. The river gauge near Rapid Valley crested 2.1 feet over flood stage and the river gauge at Farmingdale crested 0.9 feet over flood stage. Total property damage in those counties is estimated to be more than $20,000.
June 4, 2015	Heavy rain over Fall River County and adjacent areas of Nebraska and Wyoming caused widespread flooding across most of southern Fall River County. Hat Creek, Horsehead Creek, and the Cheyenne River downstream of Angostura Reservoir and their tributaries flooded. Flooding in Oral occurred after runoff backed up at a plugged culvert along Sand Creek. East Oral Road was underwater, with several homes and businesses in Oral and north of East Oral Road inundated. Total property damage in those counties is estimated to be more than $105,000.
June 1, 2015	Additional runoff from several heavy rainstorms continued to cause minor to moderate flooding along Spring Creek upstream of and downstream from Sheridan Lake. Releases from Pactola Reservoir reached 500 cubic feet per second, which combined with the heavy rain, caused minor to moderate flooding along Rapid Creek from Pactola Dam to the Cheyenne River. Many roads were flooded by heavy rain and high stream levels. On the north side of Rapid City, 143rd Avenue was underwater near Neva Way. In Rapid Valley; Reservoir Road, Green Valley Drive between Reservoir Road and Greenfield Road, South Valley Drive, the east end of Dunn Road, Anderson Road, South Radar Hill Road, and Antelope Creek Road were flooded. Around Box Elder; Elk Vale Road just north of Interstate 90, 155th Street south of Highway 14-16, and the South Ellsworth Road bridge were flooded. Hammerquist Road and 157th Street in the Caputa area were closed. Palmer Gulch Road east of Hill City was underwater. Old Hill City Road and the Needles Highway (SD Highway 87) from Playhouse Road to Sylvan Campground were flooded in various areas. At Hart Ranch, the golf course sustained flooding and debris damaged foot bridges. Spring Creek reached the bottom of the bridge at Mulligan Mile Crossing. High water damaged private bridges in Magic Canyon west of Rapid City. Total property damage in those counties is estimated to be more than $700,000.
May 19, 2015	Record flooding occurred along the White River from the Nebraska state line to Badlands National Park. The White River was over 200 yards wide and at least two feet deep on BIA Highway 41 north of Oglala, where a vehicle was swept off the highway and the passengers had to be rescued. BIA Highway 32 near Slim Butte was washed out and a culvert on BIA Highway 27 washed out and the road was damaged north of Rockyford. Total property damage in those counties is estimated to be more than $20,000.
June 14-18, 2014	Repeating heavy rain caused record flooding of the lower Big Sioux River from June 15th through June 26th. Considerable flooding of farmland and other lowlands included numerous roads, with some roads damaged and a few washed out. A few farm homes and other buildings were damaged by floodwaters. There was considerable damage to counties

Date	Comments
	including Union, Minnehaha, Lincoln, Turner, Jackson, Lake, Yankton, Clay, Hutchinson, McCook, Moody, Butte, Harding, Meade, Perkins, and Ziebach. Repeated heavy rains caused record flooding of the Big Sioux River. Farmland and other lowlands including numerous roads were flooded. Some roads were damaged, and some secondary roads were washed out. A few farm homes, other farm buildings, and some fences were damaged by floodwaters. The river crested at a record 12.92 feet above flood stage at Hawarden, Iowa on June 17th. Interstate 29 was temporarily closed along a 22 mile stretch to facilitate levee building to divert some Big Sioux River water to McCook Lake, but the Interstate was re-opened when the river crested at a lower level than was feared. A levee breach across the river from Akron, Iowa, briefly aggravated lowland flooding before it was repaired. Total property damage in those counties is estimated to be more than $1 million.
October 11, 2013	Heavy rain falling on snow remaining from the October 3-5 blizzard caused flooding over portions of western South Dakota. One to three inches of rain fell on October 10 and 11. The runoff and melted snow caused flash flooding in Keystone and flooding along creeks and streams on the plains of western South Dakota. Water covered Elk Creek Road and Antelope Creek Road north of Box Elder, Curlew Road and Pioneer Road north of New Underwood, and Coyote Lane and Golden Valley Drive north of Rapid City. Some fields and pastures in southern Meade County also flooded. The river gauge on Elk Creek at Elk Vale Road north of Rapid City reached a height of 12.6 feet, which is 3.6 feet over flood stage. Total property damage is estimated to be more than $50,000.
June 1, 2013	A large upper level low pressure system pushed across the Northern Plains, bringing heavy rain to the northern Black Hills. Embedded thunderstorms produced additional heavy rain, with four to six inches of rain falling over a 24 hour period. Runoff caused minor flooding along the Belle Fourche River and its tributaries. Several county roads were closed or washed out and culverts were damaged. Redwater River, Crow Creek, and several small creeks and streams experienced flooding. Water reached the edge of a house along the Redwater River and some low water crossings were flooded. Total property damage in those counties is estimated to be more than $200,000.
May 29, 2013	Thunderstorms developed along the eastern slopes of the Black Hills and adjacent plains from Nisland to Sturgis to the Rapid City area. As these storms moved toward the northwest, they redeveloped and became stationary over the eastern foothills. As much as six inches of rain fell in a few hours. Flash flooding was reported in Rapid City; Sturgis; and rural areas of Butte, Meade, and Pennington Counties. Runoff from the rainfall quickly inundated city streets, overflowed small creeks, and breached a few private stock dams. After heavy during the early evening caused flash flooding in south central Butte County, additional rain overnight exacerbated the flooding. High water from several tributaries caused minor flooding along the Belle Fourche River, which was two feet deep over the Bismark Bridge east of Vale. Total property damage is estimated to be more than $25,000.
May 5, 2012	Thunderstorms produced large hail, damaging winds, and flash flooding in southeast South Dakota, near and north of Interstate 90, during the evening of May 5th. The flash flooding continued past midnight on May 6th. Heavy rainfall of up to 6 inches caused flash flooding of numerous roads, parks, fields, other low areas, and buildings including homes. At least 90 homes were heavily damaged in Madison by the flooding, including at least two with basement walls washed out. A basement wall of a dentist's business was also washed out, and the basement flooded with 9 feet of water. Numerous personal possessions in flooded homes and businesses were destroyed. The flash flooding included Memorial Creek, and

Date	Comments
	there was a fatality when an out of state visitor drowned attempting to cross the flooded creek. While this fatality and most of the damage was in Madison, many rural roads and fields were flooded in the area, and east to near the town of Wentworth.
March 11 – July 22, 2011	**Severe Storms and Flooding (FEMA-1984-DR)** A deep and expansive snow pack across the area began to melt bringing many areas of flooding to central and northeast South Dakota beginning in mid-March and continuing into early April. Many roads along with countless acres of crop and pastureland remained flooded. Roads, culverts, and bridges were damaged across the region. Several roads were washed out with many closed. Many homes were threatened with some surrounded by water. Rising lake levels in northeast South Dakota also threatened and flooded many homes. Many people had to use four-wheelers to get to their homes. A Presidential Disaster was declared for all of the counties due to the flooding damage. The total damage estimates, including March, were from 4.5 to 5 million dollars for the area. High water and groundwater levels resulting from record precipitation in the previous year contributed to the slowness of any improvement in the flooding situation until the spring. The flooding diminished across much of the area into May. Flash flooding events began in May and continued through July. Heavy rains and thunderstorms produced flash floods around the state. Storms dropped several inches of rain over the already saturated soils in a matter of hours.
September 22-23, 2010	Persistent thunderstorms developed in the late morning over southeast South Dakota and continued through the afternoon and evening. All of the storms through early afternoon produced large hail, with one report of damaging wind gusts. Large hail, heavy rain, and flash flooding were noted during the evening. Some of the flash flooding continued through the night and next day as flooding.
July 21-30, 2010	**Flooding (FEMA-1938-DR)** A powerful storm dumped heavy rain causing flash flooding in South Dakota. As much as nine inches of rain fell in the southeastern part of the state, flooding homes and neighborhoods. The heavy rain also forced Sioux Falls officials to discharge untreated wastewater into the Big Sioux River. The storms in late-July affected counties where soils already were saturated, and roads, bridges and culverts had been damaged from the earlier flooding and storms. Rain gauge readings ranged from 3.69 inches to 4.15 inches. The NWS says the previous July 21 record at Mitchell was 2.32 inches in 1907. Total damage to public infrastructure in those counties is estimated to be more than $4 million from heavy rains and severe storms during the period between July 21 and July 30, 2010.
March 10, 2010	**Flooding (FEMA-1915-DR)** Floodwaters closed roads, filled basements, and soaked agricultural fields in southeastern South Dakota in late March 2010. A combination of snowmelt, ice jams, and heavy rains drove the Vermillion, Big Sioux, and James Rivers over their banks. Some residents described the flooding as the worst in living memory, according to the Associated Press. This event also resulted in a presidential disaster declaration.
April 2009 through June 2009	March flooding of the James River continued throughout April. The James River went above flood stage at Redfield on April 18th and continued through the end of the month. The James River at Redfield rose to 25.7 feet on April 30th, almost 6 feet above the flood stage of 20 feet. The James River from Columbia to Ashton was from 6 to as much as 10 feet above flood stage throughout the month. The James River continued to cause major issues throughout Brown and Spink counties for roads, fields, cropland, along with some homes. State Highway 34 was closed for about two weeks at the state border near Hecla. The

Date	Comments
	flooding washed away the highway base. The James River west of Hecla became a 3 mile wide lake. Some people near Hecla said this was the highest the James River had been near Hecla in several decades. The high water forced the evacuation of people from two homes near Hecla. Many roads along the James River throughout Brown and Spink counties were closed. Also, several bridges along the river were overtopped. Many outbuildings along the river were flooded and damaged with over 100 livestock deaths attributed to the flooding. At the Sand Lake National Wildlife Refuge, both the Sand and Mud Lakes hit record levels on the morning of April 17th. Sand Lake's elevation was 1,292.58 feet, breaking the previous record of 1,292.39 feet in 1997. Mud Lake's elevation was 1,293.36 feet, breaking the previous record of 1,293.29 feet. The elevation of the river remained above flood levels through June though waters began receding in early June. This event also resulted in a presidential disaster declaration.
March 20, 2009	Rapid snowmelt and ice jamming caused the Elm River near Westport to rise above flood stage on March 20th. The Elm River reached an all-time record level of 22.69 feet on March 25th almost 9 feet above flood stage. The previous record was 22.11 feet set on Apri1 10th, 1969. The flood stage for the Elm River at Westport is 14 feet. The city of Westport was evacuated with the flood waters causing damage to many homes and roads in and around Westport. Also, many other roads and agricultural and pastureland along the river were flooded. The Elm River slowly receded and fell below flood stage on March 30th. The flood waters from the Elm River flowed south and into the northern portion of Moccasin Creek. Subsequently, the Moccasin Creek rose as the water flowed south into the city of Aberdeen. Flooding became a concern for Aberdeen and for areas along the creek north of Aberdeen. The Governor signed an emergency declaration which allowed the state to help with flood response efforts, including sending 50,000 sandbags to the area. Also, the National Guard was activated to move a variety of heavy equipment. Some sandbagging and a falling Elm River kept the Moccasin Creek from causing any significant flooding in and north of Aberdeen. Although, some township and county roads were flooded from the creek.
June 1 – June 6, 2008	A series of intense storms impacted more than twenty counties across the state over a period of five days, incurring several million dollars' worth of damage and causing flash flooding, hail and wind damages to livestock, wildlife, property and cropland, and resulting in a presidential disaster declaration. Periodic flash flooding continued for another four days, incurring several hundred thousand dollars more of damage.
August 17, 2007	An intense summer thunderstorm dropped rainfall in the foothills of the Black Hills ranging from four to seven inches that caused flash flooding in and around Hermosa. The flash flooding resulted in widespread catastrophic damage to homes and businesses. Some houses were moved off their foundations and destroyed; other homes and businesses received significant flood damage. Critical utilities were also nonfunctional.
May–June 2007	**Severe Storms, Tornadoes, and Flooding (FEMA-1702-DR)** Flooding brought on by record-setting rainfall on May 4 and 5 caused widespread damage to homes, businesses, farmland, infrastructure, and utilities across eastern South Dakota. Houses were destroyed; with basement walls collapsing, and critical utilities were nonfunctional. Thousands of acres of farmland were flooded that could not be planted, resulting in financial impacts to the individual operations as well as businesses dependent on the farming community. State and local governments also sustained damage to infrastructure. Flooding along the James River in Yankton County exposed URD cable. The Bon Homme Yankton Electric Association was forced to relocate the cable. Additionally, the flooding shut down one irrigation system for the entire summer. The Association's emergency repair and restoration costs were estimated at $20,023.

Date	Comments
May–June 2004	**Severe Storms and Flooding (FEMA-1531-DR)** Thunderstorms developed from northern Turner County to western Yankton County on May 29. These storms produced large hail and strong winds across the area and saw very little movement over an eight-hour period. As a result, three to six inches of rain fell in portions of Yankton, Turner, and Minnehaha counties, including Sioux Falls and the towns of Parker, Hartford, Crooks, and Marion. Urban flooding resulted with rapid runoff from streets across Sioux Falls. Willow Creek in Crooks and Skunk Creek in Hartford rose several feet in only a couple of hours. In western Sioux Falls, Skunk Creek reached its highest level in 20 years. River flooding continued the following two days. On June 16, strong thunderstorms developed in western Sioux Falls and moved east. As the storms moved east, new storms developed just west of Sioux Falls, resulting in repeated episodes of heavy rain in the Sioux Falls metropolitan area. Rainfall amounts were similar to May 29, but the rate of rainfall was much higher. Over two inches of rain fell in one hour at the Sioux Falls airport, and multiple locations around the city received more than three inches of rain in two hours. The highest amount of rainfall reported in Sioux Falls was 7.79 inches. There were numerous reports of three to six inches across the city. The large amount of rainfall in a short period of time produced excessive runoff across the city and Skunk Creek and the Big Sioux River rose rapidly as a result. At the time, the 31 days up to and including June 16 marked the wettest 31 day period on record for Sioux Falls (12.74 inches at Joe Foss Field). Source: NWS Sioux Falls
April 2001	**Severe Storms (Flooding) (FEMA-1375-DR)** This presidentially declared disaster was precipitated by an onset of flooding that began during a spring thaw in early March 2001. On April 6, a series of rainstorms that dropped from two to six inches of rain resulted in flooding of the James, Vermillion, and Big Sioux rivers. According to the National Weather Service, the James River, at Huron, reached its highest crest of 18.1 feet (flood stage of 11 feet) on April 10, the second highest crest on record. On April 11, a second similar weather system produced more heavy rains in the Aberdeen, Huron, Watertown, and Brookings areas. Flooding of the James River occurred in and around Huron and Mitchell. The west fork of the Vermillion River caused flooding around Parker and Centerville. The Big Sioux River flooded in and around Watertown, Dells Falls, and Sioux Falls. At Mitchell, the James River reached its highest crest of 21 feet (flood stage of 14 feet) on April 11, the second highest crest on record according to the National Weather Service. Peak crests on the Vermillion and West Vermillion rivers were two to four feet above flood stage. The Big Sioux River in Sioux Falls crested at 22 feet (flood stage of 16 feet) on April 24. A third major system passed through South Dakota on April 21-22. The Black Hills, in the western part of the state, received up to 22 inches of heavy wet snow and the eastern portion of the state received 4-8 inches. Beadle, Brookings, Brown, Buffalo, Clark, Codington, Day, Deuel, Edmunds, Grant, Gregory, Hamlin, Hanson, Jerauld, Kingsbury, Marshall, Mellette, Moody, Roberts, Sanborn, Spink, Todd, Turner, and Tripp counties were included in the disaster declaration. The major impact was to public infrastructure. Due to ice and wind damage to utility poles and lines, electrical services to some areas were interrupted. Numerous bridges and roads were impacted as well. There was damage to county and township roads in the eastern and northeastern portion of the state that had previously not been affected by floodwater. Some of the damaged roads included school bus, mail, and farm-to-market routes. Travel on these roadways involved

Date	Comments
	significant risk. Several roads were temporarily impassable, requiring residents to travel greater distances because of detours. Many farmers were unable to access their fields to begin spring planting. In Mellette County, ice jam fluctuations substantially damaged a bridge, which caused the county to close the bridge to through traffic, resulting in a 40-mile detour for residents needing to cross the White River. This disaster also heavily impacted South Dakota's agricultural and livestock community.
February–May 1997	**Severe Storms/Flooding (FEMA-1173-DR)** This disaster had its roots in past flooding events. Beginning in 1992, the state had a series of weather-related events of sufficient magnitude and impact to warrant eight presidential disaster declarations prior to this event; five for flooding, four for ice/snow; and one for just snow. These events kept the water table saturated, which prevented much of the winter snow melt and the spring/summer rains from soaking into the ground, thus contributing to flooding. The first significant winter storm of 1996 hit the eastern part of the state in mid-November, dumping up to 10 inches of snow across the northeast and producing a major ice storm with widespread damage across the southeast (see Winter Storms). In 1997, major winter storms were fairly frequent throughout January with several blizzards, mostly in the northeast part of the state (see Winter Storms). From mid-November to mid-February, the general weather across the eastern part of the state was cold and wet with below normal temperatures (in excess of 30°F below zero) and record-setting above normal snowfall. The persistent cold greatly limited snowmelt between storms, allowing up to 48 inches of snow to accumulate across much of the northeastern part of the state. Mid-February snow depths elsewhere across eastern South Dakota ranged from 10 to 24 inches. The NWS snow water equivalent measurements of February 12 ranged from approximately two inches near the Missouri River to over six inches in Marshall County. Snow water equivalent values from 4 to 5 ½ inches were common over the central and northern portions of the James and Big Sioux river basins. Seasonably cool and relatively dry weather prevailed across the eastern part of the state from mid-February to early April. An early April blizzard added to the remaining snow pack, which gradually melted south to north by the end of April. Heavy rain and snowstorms in April, compounded by severe winter blizzards and existing saturated soil conditions, resulted in persistent flooding throughout the state. Many people were evacuated from their homes and farms, while others had limited or no access or escape. Heavy snowmelt and pounding rains turned prairie potholes into lakes, pushed people from their homes, and prevented farmers from planting thousands of acres of land. The James River Water Development District estimated that five years of flooding destroyed or severely damaged approximately 75 percent of the forested areas in the James River Valley. Riverine flooding destroyed or damaged many homes and businesses, impacted water and sewage treatment plants, and damaged or destroyed many roads and bridges. All counties were included in the presidential disaster declaration. This flood caused approximately $82.5 million in damage (2006 dollars) and two deaths.
March–May 1995	**Severe Storms, Flooding (FEMA-1052-DR)** The entire state had above normal precipitation between January and May, ranging from about one to two inches above normal in the southwest to five to nine inches above normal in the east. This is up to 200 percent of normal. Many official reporting stations, including Huron, Mitchell, and Sioux Falls, experienced their all-time wettest springs on record. Most damage to public facilities was caused by ground saturation and flooding due to very high residual groundwater tables from 1994, heavy winter snow and spring rain, and rapid snowmelt. Many roads were under water or unusable due to high groundwater saturation of

Date	Comments
	the subgrade, causing interruption of emergency services. Damage to power transmission and distribution facilities owned by rural electric cooperatives was also reported. Preliminary damage surveys identified over 3,000 homes with some type of damage. The vast majority of damage was from one to three inches of groundwater seepage into basements. In many areas, the water table rose to near land surface levels, saturating septic drain fields and preventing proper treatment of residential sewage. Preliminary damage surveys estimated $9.3 million in damage to infrastructure of public facilities. Roads and Bridges and Utilities incurred the most damage with almost $5.7 million and $2.6 million in estimated damages, respectively. Federal aid system roads received $7.1 million in damage.
March–July 1994	**Severe Storm/Flooding (FEMA-1031-DR)** Flooding in northeastern South Dakota began in mid-February 1994, as a result of very high residual groundwater tables from 1993's extremely high levels of precipitation (snow and rain) and rapid melting of the snowpack. Flooding continued into late March 1994 and then subsided. Rain continued throughout the spring and summer months, but the remainder of the snowmelt was gradual and did not significantly contribute to flooding. On July 6, a significant storm system passed through central and northeastern South Dakota. Severe winds caused damage in the Pierre area, and the town of Milbank in Grant County received approximately six inches of rain in two to three hours. The thunderstorm in Milbank caused the town's storm and sanitary sewer systems to overload and water backed into basements of several homes. Damage was estimated at approximately $4 million. The vast majority of damage was to county and township roads (which had significantly deteriorated because of saturation from near ground-level water tables), culverts, and bridges. Many roads remain under water, as once-small (or dry) glacial lakes with no drainage outlets, grow in size and encroach upon nearby roadways. In 1995, total damages were estimated to be $36.5 million.
March–September 1993	**Flooding, Severe Storms, Tornadoes (FEMA-999-DR)** Early and rapid snowmelt resulted in localized flooding along portions of the three eastern river basins. Major problems began in May when severe weather spawned tornadoes and floods in five eastern counties, injuring 12 and killing 1. Heavy rains continued throughout May, June, and July, which included a 6.5 inch deluge in Sioux Falls on May 23 that backed up sewage into 190 basements and damaged city streets. By the end of June, the Big Sioux River was over a mile wide in places, flooding many communities along its banks. During early July, the swollen Vermillion and James rivers inundated thousands of acres of farmland and surrounding communities. Heavy July rains developed flash flood torrents on small drainages in Madison and Yankton, while rising lake levels flooded numerous communities on lake shores. Overall, the disaster heavily impacted 39 counties in South Dakota, over half the state, and contributed to four deaths, approximately $2 million damage to business, $12 million damage to public facilities, $10 million to private residences, and $204 million to agriculture. Federal aid system roads received $3 million.
June 1992	**Flooding, Severe Storm, Tornadoes (FEMA-948-DR)** On June 13 and 14, a major spring storm resulted in severe weather in Harding County. Golf ball size hail and 10 ½ inches of rain occurred in a three-hour time span. Crops were destroyed and over 500 sheep were killed. On the afternoon and evening of the June 16, several violent thunderstorms (super cells) produced large amounts of rain and several large, damaging tornadoes. Heavy rain was experienced in the Davison, Miner, Kingsbury, Lyman, Buffalo, Moody, Brookings, Deuel, Minnehaha, and Hamlin counties. The heavy rains occurred in an area already saturated by previous rains. Over a two to three day period, 15 to 20 inches of rain fell in the Clear Lake/Watertown area resulting in widespread flooding of the Big Sioux

Date	Comments
	River. The rains subsided late in the week. Some flooding was experienced by South Dakotans as far south as Sioux Falls.
May 1986	**Severe Storms, Flooding (FEMA-764-DR)** The above average fall rains and heavy winter storms during 1985-86 created a condition of supersaturated ground and record water levels in the lakes and Big Sioux River Basin in the northeast part of the state. The snowmelt run-off into the numerous lakes forced the already full lakes to overflow and seriously impact residences, cottages, resort business, and agribusiness. A severe winter storm covered the entire state the week of April 14, adding one to three inches of precipitation to the area. Flood damage was estimated at approximately $25.9 million, $20.6 million of which was to agriculture.
Spring 1984	**Severe Storms, Flooding (FEMA-717-DR)** The winter of 1983-84 was the third snowiest on record (75 inches of snow at Sioux Falls). The heaviest snows occurred in November 1983 and in March 1984. Severe snowmelt flooding began March 20 and after the fourth wettest April on record, caused near record flooding on the Big Sioux, Vermillion, and lower James rivers in April. These rivers did not go below flood stage until the end of April. Numerous reports of water damage were recorded in the communities of Mt. Vernon, Parkston, Tabor, and Volin. June was the wettest June on record in southeast South Dakota and was the sixth wettest month on record at Sioux Falls. Between June 4 and June 22, many large storms crossed the region and dumped approximately 30 inches of rain, which caused repeated flash floods. Numerous roads and bridges were heavily damaged. Many areas had severe urban flooding, because sewers and storm drains were unable to handle the load. As a result, many basement walls collapsed. The Lake Menno Dam (Hutchinson County) collapsed on June 12, killing 450 hogs, destroying one car and damaging two, moving a farmhouse 75 feet off its foundation, scattering and destroying farm machinery, and completely sweeping away grain bins. On June 16, three feet of water was flowing through downtown Davis (Turner County). Vermillion Lake Dam (McCook County) and many smaller dams sustained severe erosion. The Fulton Lake Dam (Hanson County) was severely weakened and in imminent danger of failing but held. On June 18, a train was derailed at Parker (Turner County) due to washed out tracks. On June 20, Lake Dimock Dam (Hutchinson County) gave way, destroying the dam and causing flooding in Milltown. A 400-yard sandbag dike saved the Lake Carthage Dam (Miner County) from destruction. Widespread flash flooding caused severe erosion; washed out or weakened many roads, bridges, and culverts; and washed away crops in low lying areas. Many small stock dams collapsed, washing out roads, bridges, and culverts beneath them. In Mt. Vernon (Davison County), there was three to four feet of water in homes. Twenty homes were evacuated along Dry Run Creek in Mitchell (Davison County). Sewage was five to six feet deep in parts of Mitchell. Estimates by the U.S. Geological Survey place the flooding on the Big Sioux River drainage at about a 10 to 30 year recurrence interval, the Vermillion River at about a 100–500 year recurrence interval, and the lower James River at about a 100–300 year recurrence interval. By June 22, over one million acres of cropland in the region were under water. Total damage was estimated at $289 million.
Spring 1983	The winter of 1982–83 was the fourth snowiest on record and led to severe snowmelt flooding on the lower Big Sioux and Vermillion rivers from late February to mid-March

Date	Comments
	(March '83 was the fifth wettest on record). Heavy rains through April and into early May prolonged flooding and high stages on these rivers through the middle of May. Very heavy rains again in mid and late June caused flash flooding in the area and again caused severe flooding on the lower Big Sioux River and near record flooding on the lower Vermillion River. The flash flooding in June caused widespread erosion and crop damage and there was severe agricultural land flooding on the mainstreams of the lower Big Sioux and Vermillion rivers.
Spring 1979	Big Sioux River - A minor flood in North Sioux City was caused by an ice jam. Lake Kampeska - A minor flood affected property on the lake shore.
June 1976	**Flash Flooding, Mudslides (FEMA-511-DR)** In a 24-hour period on June 13-14, 3 to 10 inches of rain fell in the northern Black Hills. And additional two to three inches of rain plus heavy snow was recorded over this area on the June 15 and 16. The run-off from this precipitation did considerable damage in the counties of Lawrence, Meade, Butte, and Harding. Physical structures, streets, roads, sewers, and water systems sustained about $1.5 million in damage. Deadwood, Spearfish, Belle Fourche, Sturgis, and Galena received most of this damage. Throughout the region, a number of bridges and culverts were washed out and many of the roads suffered water erosion. Debris damage was not as great as in 1972, however, there was considerable movement of rocks and gravel. There was also a problem with mudslides and landslides. One death resulted from this flood.
June 1972	**Heavy Rains, Flooding (FEMA-336-DR)** On June 9-10, 1972, extremely heavy rains over the eastern Black Hills of South Dakota produced record floods on Rapid Creek and other streams in the area. Scattered showers had occurred throughout the Black Hills area on several days prior to the heavy rains that began on June 9. Near Pactola Dam, these earlier showers left the soil saturated, which increased the amount of runoff for the flood of June 9-10. Rainfall began in the Black Hills area on the afternoon of June 9, when a group of almost-stationary thunderstorms formed over the eastern Black Hills. Precipitation totals for June 9-10 ranged from 4 inches to more than 12 inches in the Rapid Creek watershed between Pactola Dam and Rapid City. In the Boxelder Creek watershed, 15 inches of rain during a six-hour period was measured at Nemo. The heaviest rainfall averaged about four times the six-hour amounts that are to be expected once every 100 years in the area. The resulting runoff produced record floods (highest peak flows recorded) along Battle, Spring, Rapid, and Boxelder creeks. Smaller floods also occurred along Elk Creek and Bear Butte Creek. The floods struck quickly and forcefully, but they did not last long, nor did they make much impact farther downstream in the basins. Nonetheless, the Black Hills region sustained millions of dollars of damage to roads, streets, and bridges (very few bridges were left standing). Rapid City - Evacuation of residents along Rapid Creek was ordered by 10:15 p.m. Flood and debris-laden water flowed into Canyon Lake and clogged the dam's chute spillway. This caused a 300-foot breach in the dam and sent a wall of water and debris pouring down on residents below the dam. The effect of this dam failure on the subsequent flood wave into urban Rapid City has been difficult to assess because the amount of water coming down Rapid Creek and several tributaries (accounting for 86 percent of the peak flow) far overshadowed the amount of water in the small lake. The peak flow was carried through Rapid City via Rapid Creek at about midnight on June 9, while many people were asleep and unaware of the impending flood. The stage of Rapid Creek (measured above Canyon Lake) rose more than 13 feet in five hours during the flood.

Date	Comments
	The toll of the flood-produced carnage was staggering. At least 238 people died (including 5 listed as missing and presumed dead). Thousands of people barely escaped death and hundreds of people were forced to climb, stand, or cling to objects which saved them from being swept away. Property damage exceeded $79 million. 436 houses were destroyed, and 930 houses damaged. 710 mobile homes were either damaged or destroyed. 36 businesses were wiped out and 236 more sustained damage. About 5,000 cars were reported lost to the flood. Keystone - Motels, shops, bars, and restaurants, which cater to tourists were either damaged or destroyed. Many campgrounds located along the creeks were washed away. At least 10 campers died. Total damage was set at $1.4 million. Black Hawk and Box Elder - These cities incurred $2 million in damage as the flood destroyed or damaged 75 homes and 180 mobile homes along Box Elder Creek. Sturgis - Sturgis sustained over half a million dollars in damage; 275 houses and 25 businesses were affected.
Spring 1969	**Flooding (FEMA-257-DR)** Big Sioux River - This flood surpassed the flood of 1881 in magnitude with water discharge rates more than twice those of 1962. It resulted from a large buildup of snow. Snow fell in December (1968) in normal amounts, but the accumulations for January and February set a record. The temperatures during March were below the seasonal average, so little run-off occurred. The entire basin was ice free by April 6. The upper part of the basin received an inch of rain on April 7 and compounded the flood. One-eighth of Watertown was under water. Dempster, Estelline, and Castlewood had flood damage as did the lower portion of Dell Rapids. Fifty families were evacuated from Moody County, and fifty people had to be removed from Renner. Sioux Falls was more fortunate as they had developed a flood control system, which was credited with preventing more than $12 million in flood damage. Vermillion River - This flood was greater than the 1962 flood. The town of Centerville was surrounded by water. Within the town, the sewers backed up and the disposal plant was flooded. In the surrounding country, the damage was about the same as in the previous floods. Three bridges were washed out and numerous roads damaged. 450 feet of one highway was completely washed away. The dike system did not contain the water and the lowlands flooded. The U.S. Geological Survey placed the damage to the basin at $1 million. James River - The river was in flood during all of April. The creeks in the lower portion of the basin started flooding early in the month. Their discharge of water started breaking up ice on the main stem of the James. The massive flow of the smaller tributaries caused a backing up of water along the James and increased the problem of flooding. Huron recorded a flood crest of 16.7 feet, almost one foot higher than registered in the previous 30 years. In that area, damage was estimated at $750,000. In the northern part of the state, Moccasin Creek flooded from water coming out of Richmond Lake. This caused some flooding in Aberdeen, as well as extensive flooding in the surrounding countryside. Total damage to the basin was over $16 million. Most of the damage was incurred by farm land, bridges, and roads.
May 18, 1965	Flooding (FEMA-197-DR) Black Hills - Flash flooding brought widespread damage to Deadwood, Spearfish, and Sturgis. Heavy snows in excess of 30 inches and 7 inches of rain triggered an avalanche of water shooting down the creeks and gullies. Some houses were swept away in the Spearfish-Sturgis area while others sustained major damage. One resident whose home was near a creek lost everything. He reportedly had a 70 ton concrete retaining wall between the house and the

Date	Comments
	creek - this was completely washed away. Flood damage to the Black Hills area was estimated at over $2 million.
Summer 1962	**Flooding**, Tornadoes (FEMA-132-DR) Black Hills - A summer storm dumped more than three inches of rain on Rapid City. The resulting damage: 120 mobile homes, 2 motels, and over 400 homes had water damage. Bridges, roads, sewer systems, streets, and recreation areas along Rapid Creek were also damaged. Total damage to Rapid City alone was over $800,000. Sturgis, Deadwood, and Whitewood received extensive damage to roads and bridges. Road equipment lost during this flood was estimated at $200,000.
Spring 1962	Big Sioux River - Snow and ice were the cause of the devastation. Ice jams were a serious problem as they held back the run-off. From Brookings to Sioux Falls, ice caused problems. Flandreau and Renner also had flooding because of the ice. Farther north, flooding also occurred. Watertown received flooding from Willow Creek, Lake Kampeska, and the Big Sioux River. The U.S. Army Corps of Engineers estimated damage by the Big Sioux River to be $2.5 million. The interstate bridge near Sioux City collapsed - replacement cost was $600,000. Vermillion River - One of the worst for the southern segment of the basin. This flood resulted from snow melt and ice buildup. The towns of Centerville and Davis reported minor flooding. The majority of the flooding impacted the farm country. Thousands of acres of land were submerged. The highway system received heavy damage. Five bridges in Turner County were washed out and many roads were closed. The damage to the roads and bridges was estimated at $60,000.
April 1960	**Floods (FEMA-99-DR)** Vermillion River - Between 10 and 15 thousand acres were flooded when the dikes were unable to retain the rapid run-off. Many fences were destroyed due to ice and debris pile up. Also, county road systems were damaged due to erosion. The town of Davis received about one foot of water.
March 1960	Big Sioux River - Flooding occurred from the Brookings area south to the junction with the Missouri. Deer Creek and Medary Creek caused flooding in Aurora. Bruce and Sioux Falls also experienced flooding. Damage was heavy and estimated at $2.3 million. Approximately half of this was incurred in the lower basin. About 86,000 acres of land were flooded, and 41,000 of these were between Sioux Falls and Sioux City. James River - The U.S. Geological Survey reported that severe flooding occurred north of Huron with flood water lingering in the area. Tributaries in the Mitchell area also presented flood problems. Pony Creek, which flows through Parkston, rose to flood stage in three hours. People living along its banks had to be evacuated. A number of culverts and bridges in the town were jammed with debris. North of Mitchell, Dry Run Creek flooded, causing at least five families to be evacuated.
June 17, 1957	General Comments: Rated as a 10 to greater than a 100-year event. Five deaths. Attributed solely to rain. Big Sioux River - An estimated seven inches of rain fell in the Flandreau and Sioux Falls area. The Skunk and Marne creeks as well as the Big Sioux River were in flood stage. The towns of Flandreau, Egan, Baltic, Trent, Sioux Falls, and Canton were all impacted by the flood. Sioux Falls had flood damage to the north and southern parts of town as well as heavy flooding in

Date	Comments
	the business district along the river. Damage was estimated to be over $1 million in the city and $4 million over all. Of this amount, $980,000 was sustained in the southern half of the Big Sioux River Basin - over 62,000 acres of land were flooded. Families were forced from their homes, and many of the houses were flooded. Most of the crops in the area were destroyed by the water and there was little or no chance to replant because of the short growing season. Vermillion River - The sudden rain that fell during the middle of June dropped between three and eight inches of precipitation throughout Turkey Ridge Creek and the Vermillion River north of Centerville. The citizens and National Guard filled sandbags to be used in and around Centerville. An estimated 50,000 sandbags were placed on the lowland dike system south of the town to help contain the water. An estimated 80 square miles were flooded. James River - The southern portion of the basin was also affected. The tributary of Marne Creek erupted with a flash flood which brought considerable water and debris to Yankton. Several homes and businesses adjacent to the creek received water and mud damage.
May 1952	Rapid City - Heavy flooding through the Canyon Lake area of west Rapid City. Damage was very much like that sustained in the 1972 flood. Sturgis/Deadwood - Heavy rains brought flash flooding that tore up streets and gas pipelines in Sturgis. Bridges were washed out and water erosion caused rock slides. Water damage and landslides also occurred in Deadwood.
April 8, 1952	Big Sioux River - Warm weather brought on another rapid snow melt and flooding conditions. Watertown had flooding starting at Lake Kampeska. There was also heavy flooding in the southern part of the town. Farther downstream at Estelline, the river was about one mile wide. Flooding occurred in the towns of Flandreau, Trent, and Dell Rapids. There was also heavy flooding around the Sioux Falls Air Base (Joe Foss Field). Pictures of the locality gave it the appearance of a large lake. From Watertown to Sioux Falls, about 99,000 acres were flooded and $4.5 million of damage sustained. Below the falls to the mouth of the river, an additional 30,000 acres of land were covered, and about $1 million damage done to the area. James River Basin - The tributaries of the Elm and Maple rivers delivered snowmelt run-off over thousands of acres of farmland. Ice jams on the Elm and Maple rivers forced the water over land. Hundreds of farm families were isolated by the water, while other families in the area were still snowbound. The end result was an enormous amount of water standing on frozen ground, causing the Elm River to spread to one mile in width. This water washed out a number of culverts and roads and isolated farms.
Spring 1951	Big Sioux River - Heavy flooding originated in the Brookings area. An accumulation of snow throughout February and an additional six to fourteen inches during March served as the flood source. High temperatures in late March brought about rapid melting and the flood condition. The Big Sioux was ½ mile wide in Moody County, 1 ½ miles wide around Baltic and Sioux Falls, and 2 miles wide below the Rock River. The area from Brookings to below the falls of Sioux Falls had about 73,400 acres of land flooded and damage of nearly $2.25 million. The area from Sioux Falls to Sioux City, Iowa, had an estimated 29,000 acres flooded and $600,000 in damage. Vermillion River - The combination of snow melt run-off and ice dams brought extensive water to the town of Davis. The entire main street of the town had water damage. One portion of town had three inches of water, which caused a number of families to evacuate.

Date	Comments
	Elsewhere, the towns of Centerville and Montrose received some water. At least three bridges were washed away, lowlands were flooded, and some stored grain destroyed.
Apr/May 1950	Grand, Moreau, and James rivers - 10- to 25-year flood event. Much of the damage was the result of water lingering over the fields. Parts of Brown County and adjacent counties had flood conditions for more than a month. More than 40,000 acres of cropland were submerged, and damage was greater than $900,000. Flooding also created heavy damage to road surfaces and caused the loss of some grain and livestock. Total damage was estimated at $5 million.
May 1922	Cheyenne and James river basins - 25-50-year flood event: Caused by snowmelt and rain.
May 1920	Rapid City - Homes were flooded, bridges were washed out, and utility systems disrupted. Hat Creek and James River - 25-50-year flood event: Caused by snowmelt and rain. Deaths: 7.
Jun 12, 1907	Rapid City - Caused by more than five inches of rain throughout the Black Hills in one six-hour period. The flood destroyed five bridges, damaged roads and power lines, and washed out about ½ of Canyon Lake Dam. The entire downtown area along Rapid Creek was under water. Four people died, and the railroad system sustained heavy damage.
May 1883	Rapid City - Similar flood to 1878: bridges, buildings, and homes received heavy water damage.
Spring 1881	Big Sioux River - Winter began in mid-October 1880. The total winter was very cold and an accumulation of two to four feet of snow covered the state. When the ice broke up in March, the Big Sioux River Basin was flooded. Sioux Falls was especially hit hard. The river was recorded as rising 16 feet in 24 hours on March 20, 1881. The rapid rise brought widespread destruction throughout the Sioux Falls area. Approximately 100 buildings in north Sioux Falls were washed away. Three major bridges were also washed out in a 15-minute period. Estimated damage was $150,000 to the Sioux Falls area. Below the falls, farms along the river suffered heavy flood damage. Large amounts of grain, livestock, and personal possessions were lost to the flood. Many of the railroad bridges and wagon bridges were washed away. The only means of travel was by foot or horseback. No lives were lost. Vermillion River - The town of Vermillion was located on the banks of the Missouri and Vermillion Rivers. Almost all the homes and stores were located along or near the shoreline. The heavy accumulation of winter snow started melting, which caused the Missouri River to flood. Associated with the flood was ice blockage, which not only backed up the water into the Vermillion River but also formed an ice dam that prevented normal run-off. The tributary run-off added to the back water until the river became one to two miles wide in places. Mills, houses, and stables were washed away. When the Vermillion River finally broke through the ice blockage, the impact was devastating. A wall of water entered the town of Vermillion and covered it in depths ranging from 3 to 10 feet of water. The combined forces of the Missouri and Vermillion rivers resulted in the town literally floating away. An estimated 132 buildings were destroyed, and many others were damaged by the ice and water. The end result was ¾ of the town was totally destroyed and about $142,000 in damage was sustained. This destruction was so total and severe that the town was relocated on the bluffs behind the former town to prevent another recurrence.
1878	Rapid City - Rapid Creek rose 20 feet in one hour. Streets were under water, buildings flooded, and bridges washed out.

Source: If not otherwise sourced in the table, the NCEI is the information source.

Probability

FEMA flood studies provide mapping and detailed flood information for floodplains where the water body has a one percent chance of occurrence in any given year in identified special flood hazard areas. Smaller and more frequent damaging events occur in the state on an annual basis. Floods result in $14.1 million per year in average annualized losses to the state.

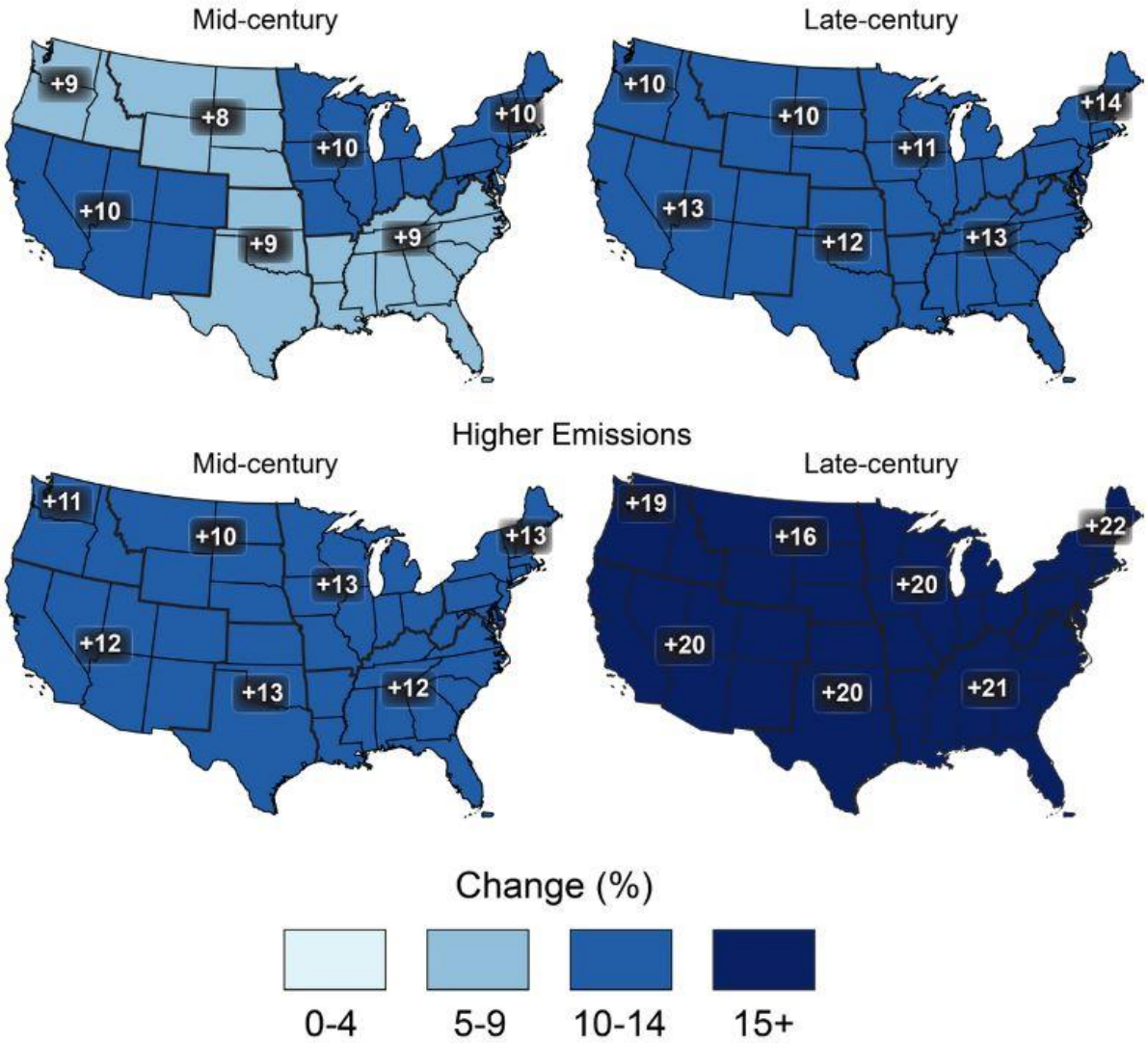
USGS, South Dakota Department of Transportation, and other state and federal agencies published a study in June 2012 titled "Extreme Floods in the Black Hills Area: New Insights from Recent Research." One of the most significant findings of the study is that massive floods as large as or larger than the 1972 flood have occurred multiple times over the past millennium in many drainage basins of the eastern Black Hills. According to the study, geologic evidence indicates that 12 floods exceeding 66,000 cfs occurred in the past 2,000 years, with the largest one occurring 440 years ago. The study found that "the steep terrain and narrow canyons along the eastern periphery of the Black Hills are most susceptible to flash flooding. Here the thin rocky soils absorb little rainfall, and the steep slopes cause rapid runoff into the stream channels. The steep and narrow canyons further amplify ferociously fast and deep floods." Figure 3-10 depicts the areas of the Black Hills with the highest and lowest potential for flash flooding based on the USGS/SDDOT study.

Climate Change Considerations

The nature and frequency of flooding could be altered by climate change. Globally, higher temperatures will result in increased atmospheric water vapor available to form precipitation. Precipitation extremes and their hydrological impacts (e.g. floods) are expected to become larger because in most places.

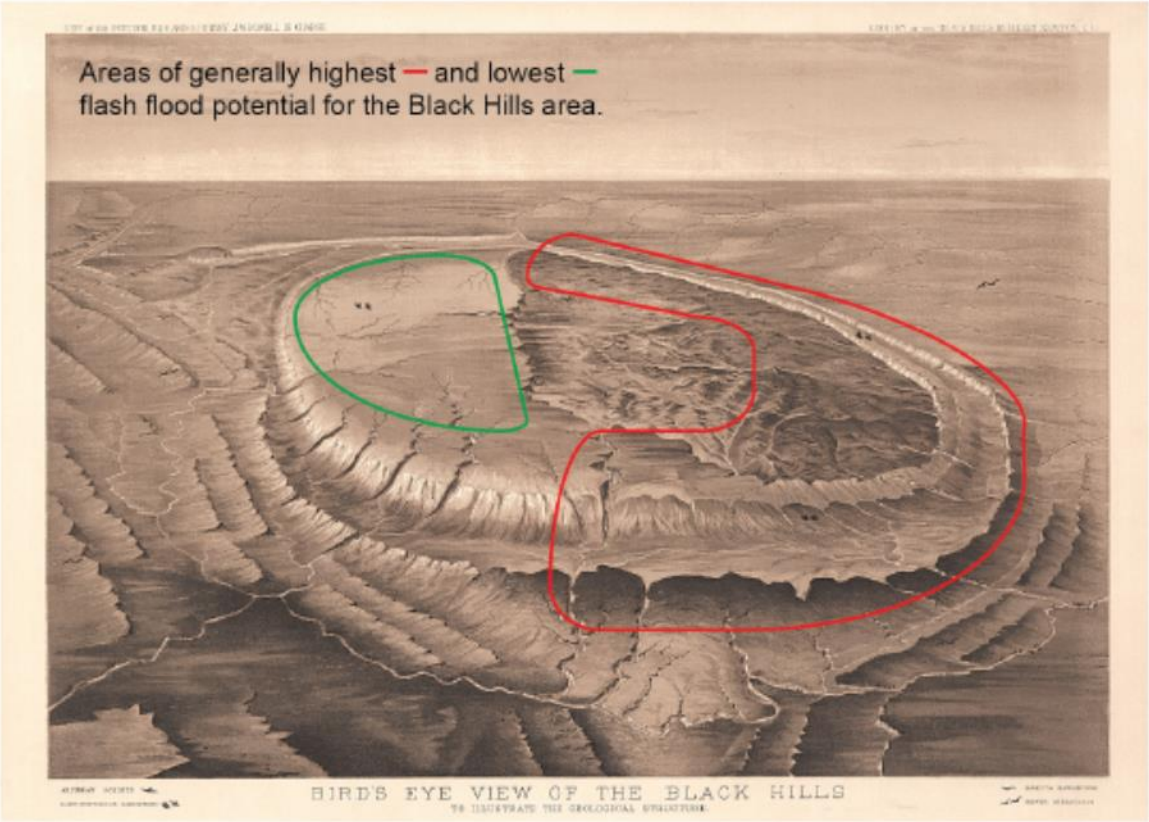
There is no comprehensive assessment of how climate change might affect flooding in the state, but regional trends for the northern Great Plains based on the Third National Climate Assessment and the Climate Science Special Report demonstrate a trend toward less frequent, but more intense rain events. In this scenario rainy days would become less frequent, but if conditions are right for an extreme event, and more moisture is available in the atmosphere, then larger, extreme events are possible. For the years 1948 to 2015, there was an increasing trend in 1-day, 20-year return period events. These single day events are trending larger, with more rain per event, as much as 0.27" per 1-day, 20-year event in the fall season. Climate projections indicate that 1-day, 20-year return events will increase in frequency by 8% to 16% in the coming decades (refer to Figure 3-9). In the northern Great Plains region, this is compounded by an overall wetter trend of about 15% increase when comparing the years 1986-2015 to 1901-1960. The additional moisture overall can add to the increase in precipitation per extreme event. A 2013 report 'The Impact of Climate Change and Population Growth on the National Flood Insurance Program Through 2100' (AECOM 2013) suggests that special flood hazard areas will increase nationally, on average, by 40%-50% by 2100 as a result of climate change and in some areas, increased urbanization.

Figure 3-9 Projected Change in Daily, 20-year Extreme Precipitation



Source: Climate Science Special Report (CSSR) https://science2017.globalchange.gov/chapter/7/#fig-7-7

Figure 3-10 Generalized Potential for Flash Flooding in the Black Hills Area (modified from Driscoll and others, 2010)



Source: Driscoll, Huft, and O'Connor, Extreme Floods in the Black Hills Area: New Insights from Recent Research, 2012

3.2.3 Summer Storm

Description

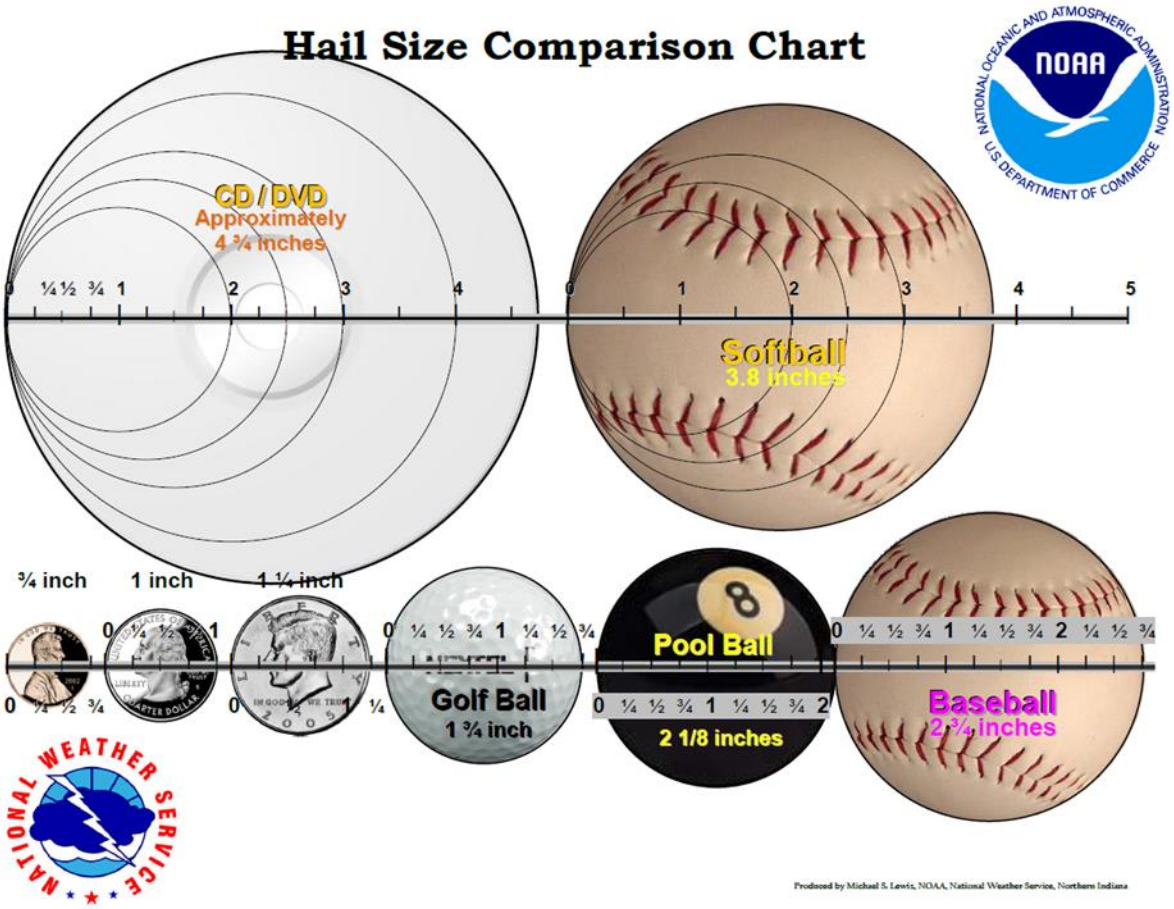
Summer storms are not limited to one area of the state, and historically occur from early spring to early fall. Summer storms can include high winds, heavy rains and flooding, lightning and hail; they can also spur the development of funnel clouds and tornadoes. They can vary in intensity from mild to severe, and can cause injury or death, destroy property and kill livestock. Winds, flooding and tornadoes are discussed further in other chapters. This chapter covers two types of hazards caused by summer storms: hail and lightning.

Hail

Hail is formed when water droplets freeze and thaw as they are circulated high into the upper atmosphere by the violent internal forces of thunderstorms. Hail is sometimes associated with severe storms within the State of South Dakota Planning Area. Hailstones are usually less than two inches in diameter and can fall at speeds of 120 miles per hour (mph). Severe hailstorms can be quite destructive, causing damage to roofs, buildings, automobiles, vegetation, and crops.

Hail diameter is usually referenced in accordance with everyday objects; a hail size comparison chart is presented below in both visual and table form.

Figure 3-11 NOAA Hail Size Comparison Chart



Source: National Weather Service

Table 3-12 Hail Size Description Chart

Hailstone Size	Measurement	
	Inches	Centimeters
BB	< 0.25	<0.64
Pea	0.25	0.64
Dime	0.70	1.8
Penny	0.75	1.9
Nickel	0.88	2.2
Quarter	1	2.5
Half Dollar	1.25	3.2
Golf Ball	1.75	4.4
Billiard Ball	2.13	5.4
Tennis Ball	2.5	6.4
Baseball	2.75	7
Softball	3.8	9.7
Compact Disc	4.75	12.1

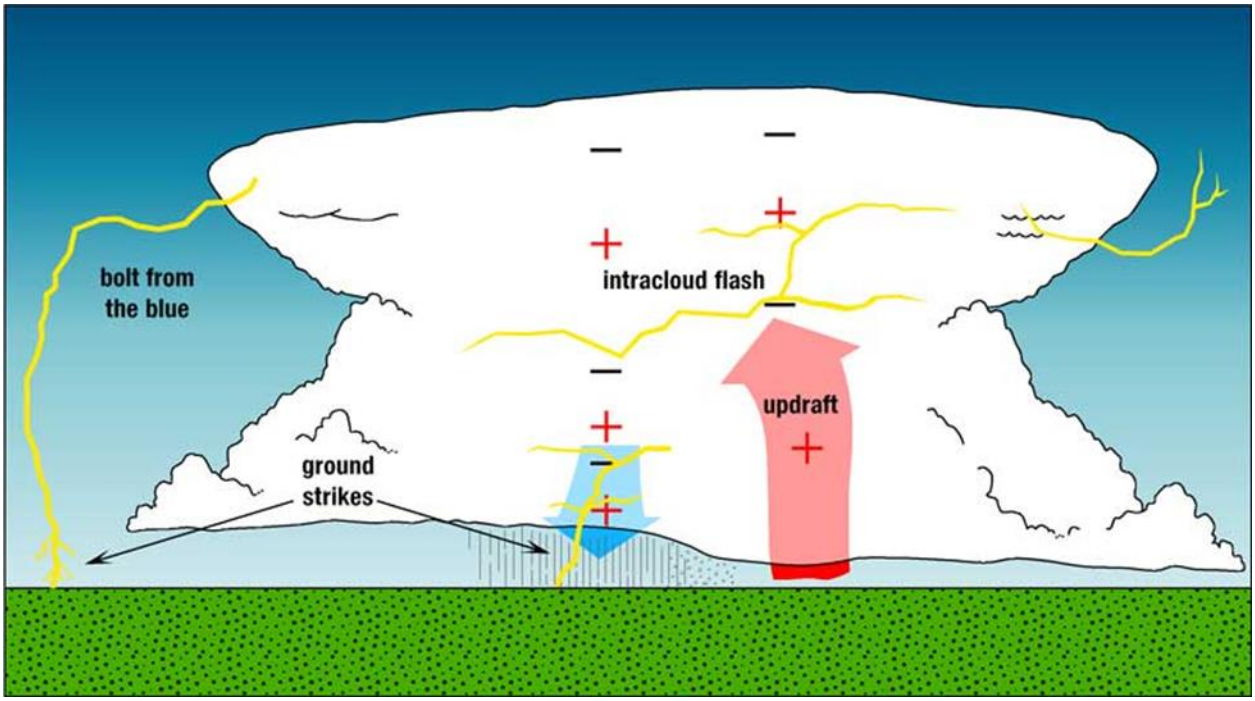
Lightning

Lightning is defined as any and all of the various forms of visible electrical discharge caused by thunderstorms. Cloud-to-ground lightning can kill or injure people by direct or indirect means. Objects

can be struck directly, which may result in an explosion, burn, or total destruction. Damage may also be indirect, when the current passes through or near an object, which generally results in less damage. Refer to 3.2.5 Wildfire for more information on the related to the risk associated with lighting in igniting wildland fires in the Blacks Hills and prairie ecosystems.

Cloud-to-ground lightning is the most damaging and dangerous type of lightning. Most flashes originate near the lower-negative charge center and deliver negative charge to earth. However, a large minority of flashes carry positive charge to earth. These positive flashes often occur during the dissipating stage of a thunderstorm's life. Positive flashes are also more common as a percentage of total ground strikes during the winter months. This type of lightning is particularly dangerous for several reasons. It frequently strikes away from the rain core, either ahead or behind the thunderstorm. It can strike as far as 5 or 10 miles from the storm in areas that most people do not consider to be a threat. Positive lightning also has a longer duration, so fires are more easily ignited. And, when positive lightning strikes, it usually carries a high peak electrical current, potentially resulting in greater damage.

Figure 3-12 Cloud to Ground Lightning



Source: National Weather Service

Location

Summer storms can occur anywhere across the state, though the higher elevations of the Black Hills have more potential for lightning strikes. More location information is in the following section on past events and Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction.

Past Events

According to the NCEI South Dakota has experienced 10,502 separate hail incidents between 1996 and May 2016. It is important to note that these incidents may be separate impact areas caused by the same storm; it is also important to note that while NCEI is the best available free source for data on hazard impacts, the data can sometimes be imperfect.

NCEI data shows that the hail caused $160,637,750 in property damage and $42,775,000 in crop damage over this time period. Data on indemnity payouts for crop loss was obtained from the Risk Management Agency in 2016, refer to section 3.2.6 Drought for more information.

The NCEI records include 38 injuries and no fatalities caused by hail over this same timeframe. During the 2019 planning process a query of all hail events from June 2016 to mid-2018 took place and found one event of significance taking place in Lawrence County and amounted to $2 million in property damages. This event is not included in the tables below nor the probability calculations or vulnerability assessment. The following table analyzes the percentage of these incidents that caused recorded impacts.

Table 3-13 Impacts by Incident-Hail

Impact	Total	Number of Incidents w/ Impact	Percentage of Incidents with Recorded Impacts
Property Damage	$160,637,750	500	4.7%
Crop Damage	$42,775,000	70	.67%
Injuries	38	12	.11%
Fatalities	0	N/A	N/A

The following table lists recorded hail incidents by county between 1996 and 2016. The top five counties for recorded hail incidents are Pennington (807), Meade (510), Custer (411), Lawrence (307), and Minnehaha (299).

Table 3-14 Number of Hail Incidents by County (1996-2016)

County	Total Listed Events	Total Cumulative Damage
Aurora	111	$465,000
Beadle	170	$125,000
Bennett	144	$2,087,000
Bon Homme	149	$425,000
Brookings	107	$9,430,000
Brown	241	$0
Brule	117	$7,140,000
Buffalo	62	$0
Butte	173	$4,532,000
Campbell	95	$0
Charles Mix	179	$4,721,000
Clark	156	$0
Clay	116	250,000
Codington	145	$0
Corson	220	$0
Custer	411	$4,556,000
Davison	128	$5,050,000
Day	127	$0
Deuel	60	$0
Dewey	157	$0
Douglas	56	$1,275,000

County	Total Listed Events	Total Cumulative Damage
Edmunds	194	$0
Fall River	210	$2,713,250
Faulk	119	$0
Grant	87	$0
Gregory	169	$4,960,000
Haakon	142	$160,500
Hamlin	121	$0
Hand	226	$0
Hanson	74	$65,000
Harding	226	$250,500
Hughes	114	$0
Hutchinson	105	$7,391,000
Hyde	94	$0
Jackson	201	$1,127,500
Jerauld	80	$2,285,000
Jones	78	$0
Kingsbury	118	$3,506,000
Lake	104	$1,560,000
Lawrence	307	$5,763,000
Lincoln	127	$4,200,000
Lyman	145	$0
Marshall	121	$0
McCook	118	$135,000
McPherson	129	$0
Meade	510	$3,664,500
Mellette	104	$170,500
Miner	78	$110,000
Minnehaha	299	$28,361,000
Moody	92	$1,675,000
Oglala Lakota	216	$611,000
Pennington	807	$67,584,000
Perkins	203	$2,051,000
Potter	79	$0
Roberts	79	$0
Sanborn	83	$2,747,000
Spink	152	$0
Stanley	119	$0
Sully	106	$0
Todd	171	$573,000
Tripp	180	$740,000

County	Total Listed Events	Total Cumulative Damage
Turner	132	$2,351,000
Union	112	$581,000
Walworth	107	$0
Yankton	177	$17,270,000
Ziebach	162	$751,000

Source: NCEI

Figure 3-13 South Dakota Hail Events 1996 – May 2016

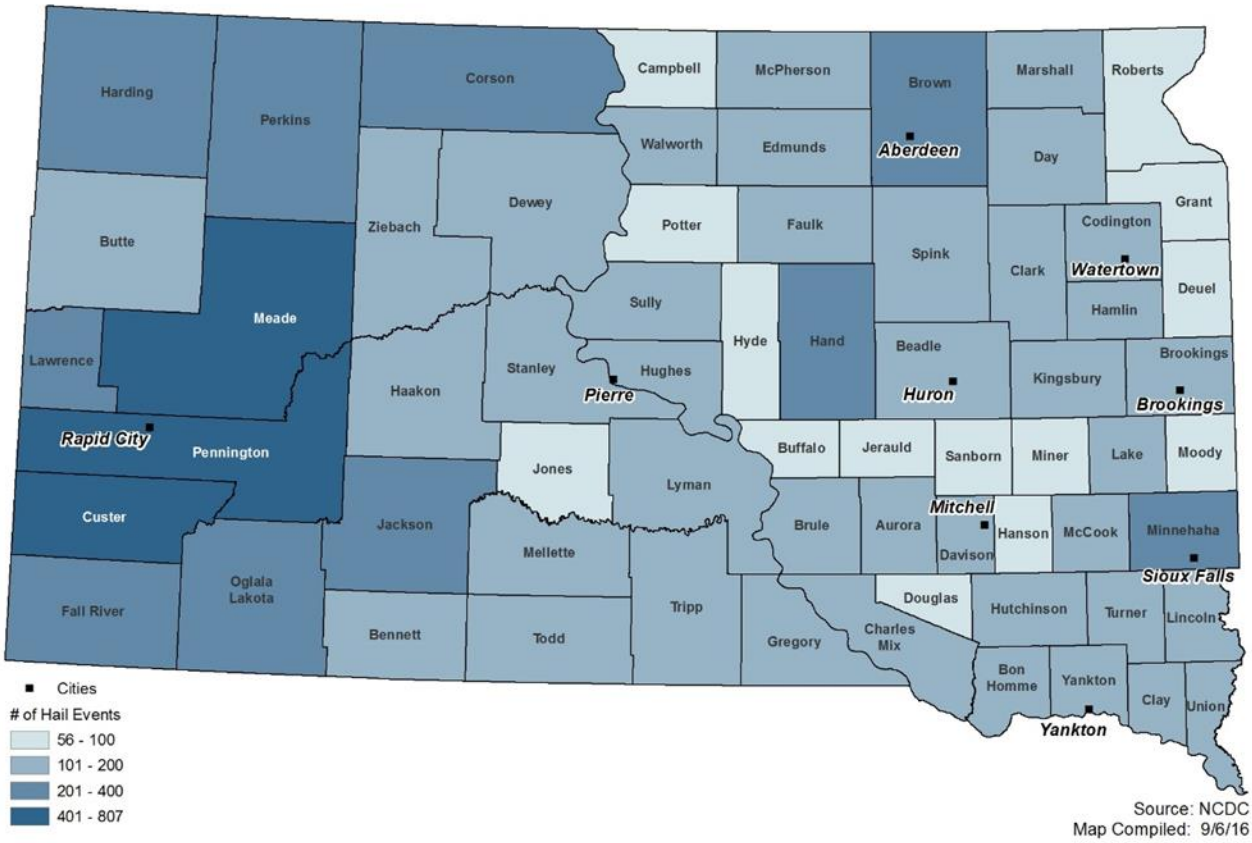


Table 3-15 shows selected hail incidents by hail size. It is noteworthy that the hailstone from Vivian on July 23, 2010 currently holds the record as the largest hailstone by diameter, circumference and weight in the United States. It measured 8 inches in diameter, 18.75 inches circumference, and 1.938 pounds.

Table 3-15 Selected South Dakota Hail Events

County	Area	Date	Hail Size in Inches	Deaths	Injuries	Property Damage	Crop Damage
Lyman	Vivian	7/23/2010	8	0	5	$0	$0
Charles Mix	Dante	8/21/2007	6.88	0	0	$0	$0
Charles Mix	Wagner	8/21/2007	6.13	0	0	$0	$0
Butte	Nisland	6/19/2015	6	0	0	$25000	$0

County	Area	Date	Hail Size in Inches	Deaths	Injuries	Property Damage	Crop Damage
Minnehaha	Hartford	7/13/1997	4.5	0	0	$20,00,000	$2,000,000
Meade	Piedmont	6/1/2015	4.5	0	0	$500,000	$0
Kingsbury	Lake Preston	7/28/2002	4.5	0	0	$100,000	$0
Lawrence	St. Onge	6/19/2015	4.5	0	0	$10,000	$0
Meade	Howes	6/26/1998	4.5	0	1	$0	$0
Faulk	Faulkton	8/4/2000	4.5	0	0	$0	$0
Fall River	Oelrichs	6/12/2001	4.5	0	0	$0	$0
Brown	Barnard	6/23/2002	4.5	0	0	$0	$0
McPherson	Leola	7/9/2002	4.5	0	0	$0	$0
Meade	Elm Springs	8/26/2002	4.5	0	0	$0	$0
Lyman	Presho	6/11/2003	4.5	0	0	$0	$0
Butte	Newell	6/19/2015	4.5	0	0	$0	$0
Pennington	Rapid City	8/3/2007	4.25	0	0	$500,000	$0
Pennington	Johnson Siding	8/30/2013	4.25	0	0	$500,000	$0
Todd	Rosebud	7/13/2009	4.25	0	0	$200,000	$0
Todd	St Francis	3/18/2012	4.25	0	0	$100,000	$0
Fall River	Edgemont	6/22/2012	4.25	0	0	$100,000	$0
Oglala Lakota	Oglala	8/17/2014	4.25	0	0	$100,000	$0
Fall River	Angostura Reservoir	5/24/2010	4.25	0	0	$40,000	$0
Custer	Fairburn	6/21/2013	4.25	0	0	$25,000	$0
Todd	Lakeview	7/20/2005	4.25	0	0	$20,000	$0
Harding	Camp Crook	7/22/2011	4.25	0	0	$10,000	$0
Meade	Faith	6/7/2005	4.25	0	0	$5,000	$0
Sully	Agar	8/24/2006	4.25	0	0	$0	$0
Douglas	Delmont	9/16/2006	4.25	0	0	$0	$0
Aurora	White Lake	6/21/2007	4.25	0	0	$0	$0
Aurora	White Lake	6/21/2007	4.25	0	0	$0	$0
Sully	Clifton	6/21/2007	4.25	0	0	$0	$0
Sully	Clifton	6/21/2007	4.25	0	0	$0	$0
Turner	Center Pt	5/1/2008	4.25	0	0	$0	$0
Custer	Hermosa	6/1/2008	4.25	0	0	$0	$0
Brown	Westport	7/17/2010	4.25	0	0	$0	$0
Lyman	Vivian	7/23/2010	4.25	0	0	$0	$0
Butte	Belle Fourche	7/5/1998	4	0	3	$3,000,000	$0
Lake	Countywide	7/11/2000	4	0	0	$500,000	$1,000,000
Custer	Buffalo Gap	5/24/2010	4	0	0	$75,000	$0
Meade	Piedmont	6/14/1997	4	0	0	$0	$0
Hughes	Pierre	6/30/1997	4	0	0	$0	$0

County	Area	Date	Hail Size in Inches	Deaths	Injuries	Property Damage	Crop Damage
Roberts	Wilmot	7/19/1997	4	0	0	$0	$0
Pennington	Wall	8/2/1997	4	0	0	$0	$0
Oglala Lakota	Oglala	6/4/1999	4	0	0	$0	$0
Butte	Belle Fourche	6/25/2007	4	0	0	$0	$0
Bon Homme	Avon	8/8/2009	4	0	0	$0	$0
Davison	Betts	8/8/2009	4	0	0	$0	$0
Spink	Spink Colony	6/21/2013	4	0	0	$0	$0

While not as prominent as hail, NCEI records include 113 lightning incidents between 1996 and 2016. (Note that NCEI only counts lightning strikes that were significant enough in some way to be reported; the actual number of lightning strikes is undoubtedly far higher.) The recorded lightning strikes caused $2,171,200 in property damage and no recorded crop damage; 5 fatalities and 17 injuries were attributed to these events. The following table presents lightning incidents in the state that caused damages, injuries or fatalities. During the 2019 planning process a query of lighting events from 2016 to mid-2018 took place and no damaging events were found to have taken place in that timeframe.

Table 3-16 South Dakota Damaging Lightning Events 1996-2016

County	Area	Date	Deaths	Injuries	Property Damage	Crop Damage
Lake	Chester	5/7/1996	0	0	$1,000	$0
Kingsbury	Lake Preston	5/18/1996	0	0	$2,000	$0
Douglas	Armour	7/6/1996	0	0	$10,000	$0
Bon Homme	Springfield	8/6/1996	0	0	$10,000	$0
Lincoln	Sioux Falls	10/16/1996	0	0	$20,000	$0
Davison	Mitchell	7/16/1997	0	0	$1,000	$0
Fall River	Edgemont	7/23/1997	0	0	$5,000	$0
Davison	Mitchell	7/24/1997	0	0	$4,000	$0
Clay	Vermillion	7/27/1997	0	0	$20,000	$0
Minnehaha	Brandon	9/8/1997	0	0	$20,000	$0
Lincoln	Beresford	5/15/1998	0	0	$40,000	$0
Bon Homme	Running Water	6/17/1998	0	0	$20,000	$0
Pennington	Rochford	7/8/1998	0	1	$0	$0
Beadle	Huron	7/18/1998	0	0	$10,000	$0
Moody	Flandreau	7/18/1998	0	0	$5,000	$0
Brookings	Volga	7/20/1998	0	0	$5,000	$0
Hutchinson	Parkston	8/5/1998	0	1	$0	$0
McCook	Bridgewater	8/23/1998	0	0	$10,000	$0
Kingsbury	De Smet	6/4/1999	0	0	$2,000	$0
Todd	Parmelee	8/11/1999	0	1	$0	$0
Marshall	Langford	8/12/1999	0	0	$50,000	$0

County	Area	Date	Deaths	Injuries	Property Damage	Crop Damage
Lake	Madison	5/17/2000	0	0	$1,000	$0
Moody	Colman	6/3/2000	0	0	$70,000	$0
Minnehaha	Sioux Falls	6/25/2000	0	0	$100,000	$0
Brookings	Bruce	7/9/2000	0	0	$5,000	$0
Lawrence	Lead	7/27/2000	0	0	$5,000	$0
Brookings	Elkton	4/22/2001	0	0	$80,000	$0
Minnehaha	Sioux Falls	4/22/2001	0	0	$20,000	$0
Minnehaha	Sioux Falls	4/22/2001	0	1	$5,000	$0
Oglala Lakota	Pine Ridge	6/9/2001	1	1	$1,000	$0
Pennington	Sheridan Lake	6/24/2001	1	2	$0	$0
Yankton	Yankton	7/7/2001	0	0	$10,000	$0
Charles Mix	Lake Andes	7/7/2001	0	0	$1,000	$0
Brookings	Brookings	7/22/2001	0	0	$3,000	$0
Brookings	Brookings	7/22/2001	0	0	$3,000	$0
Bon Homme	Avon	7/30/2001	0	0	$5,000	$0
Aurora	Plankinton	7/30/2001	0	0	$1,000	$0
Custer	Custer	8/1/2001	0	0	$500,000	$0
Brookings	Brookings	5/7/2002	0	0	$5,000	$0
Moody	Flandreau	6/10/2002	0	0	$5,000	$0
Kingsbury	De Smet	7/28/2002	0	0	$10,000	$0
Brule	Kimball	8/8/2002	0	0	$20,000	$0
Kingsbury	Arlington	8/12/2002	0	0	$2,000	$0
Minnehaha	Sioux Falls	9/19/2002	0	0	$20,000	$0
Beadle	Huron	5/29/2003	0	0	$5,000	$0
Beadle	Huron	5/29/2003	0	0	$5,000	$0
Lincoln	Hudson	7/3/2003	0	0	$5,000	$0
Pennington	Rapid City	7/8/2003	0	1	$0	$0
Yankton	Midway	7/20/2003	1	1	$0	$0
Union	Elk Pt	4/21/2004	0	1	$2,000	$0
Miner	Howard	5/21/2004	0	0	$20,000	$0
Todd	Okreek	6/8/2004	0	0	$500,000	$0
Beadle	Hitchcock	8/1/2004	0	0	$5,000	$0
Hanson	Alexandria	8/3/2004	0	0	$50,000	$0
Yankton	Yankton	8/22/2004	0	0	$2,000	$0
Brule	Bijou Hills	8/23/2004	0	0	$20,000	$0
Davison	Mitchell	8/31/2004	0	0	$10,000	$0
Davison	Mitchell	9/4/2004	0	0	$2,000	$0
Kingsbury	De Smet	5/7/2005	0	0	$200,000	$0
Lake	Madison	6/29/2005	0	0	$200	$0

County	Area	Date	Deaths	Injuries	Property Damage	Crop Damage
Minnehaha	Sioux Falls	7/7/2005	0	0	$10,000	$0
Grant	Milbank	8/10/2007	0	0	$2,000	$0
Hughes	Pierre	6/5/2008	0	0	$50,000	$0
Minnehaha	East Sioux Falls	7/31/2008	0	2	$0	$0
Meade	Sturgis	8/5/2008	0	3	$0	$0
Brookings	Brookings	5/4/2009	0	0	$5,000	$0
Lincoln	Tea	6/23/2009	0	0	$30,000	$0
Moody	Colman	9/30/2009	0	0	$1,000	$0
Yankton	Yankton	7/11/2010	0	0	$5,000	$0
Moody	Flandreau	5/10/2011	0	0	$20,000	$0
Pennington	Rapid City	6/24/2011	0	0	$6,000	$0
Pennington	Wasta	8/3/2011	1	0	$0	$0
Custer	Buffalo Gap	5/27/2014	0	1	$0	$0
Brown	Aberdeen	6/5/2014	0	0	$2,000	$0
Pennington	Rockerville	6/4/2015	0	0	$2,000	$0
Pennington	Rapid City	6/20/2015	0	0	$50,000	$0
Lawrence	Spearfish	7/12/2015	1	1	$0	$0
Lincoln	South Sioux Falls	8/27/2015	0	0	$5,000	$0
Lincoln	Tea	8/27/2015	0	0	$5,000	$0
McCook	Salem	5/25/2016	0	0	$45,000	$0

Source: NCEI

The following table analyzes the percentage of these incidents that caused impacts.

Table 3-17 Impacts by Incident-Lightning

Impact	Total	Number of Incidents w/ Impact	Percentage of Incidents with Impact
Property Damage	$2,171,200	69	61%
Crop Damage	0	N/A	N/A
Injuries	17	13	11%
Fatalities	5	5	4.3%

Source: NCEI

See Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction for more information about how lightning and hail affect individual counties.

Probability

According to the NCEI, there were 10,501 hail incidents in South Dakota between January 1996 and May 2016. The average hail stone size for these incidents was a little over 1 inch in diameter, though hail up to eight inches in diameter was recorded in Vivian in Lyman County in July 2010. This suggests that South Dakota averages 525 separate hail incidents annually. Zero deaths and 38 injuries were attributed to these events. Based on past history, South Dakota can expect few if any deaths, and almost 1-2 injuries each year caused by hail.

Based on this information, the probability that multiple hail storms will occur in South Dakota in any given year is 100 percent.

Lightning is a common event that occurs in almost every thunderstorm in the state. Most lightning is harmless to those on the ground, bouncing from cloud to cloud. However, when lightning does strike a target on the ground, it can do tremendous damage to people and property. Between May 1996 and August 2016 (Note, a query was run during the 2019 planning process and no new damaging lighting events were found to have occurred between July 2016 and mid-2018), NCEI recorded 114 separate lightning strikes, or almost six per year. Cumulatively, these storms caused five deaths and seventeen injuries. Extrapolated into the future, the State of South Dakota can expect damaging lightning strikes annually; based on NCEI-recorded data, these strikes will cause one recorded injury every other year, and a lightning-caused fatality every four years.

Climate Change Considerations

The Climate Science Special Report (2017) states that damages from convective weather hazards (such as severe thunderstorms and tornadoes) have undergone the largest increase in damages, relative to other extreme weather, since 1980. In the last 40 years, the number of days with weather conditions favorable for tornado development has reduced, but the number of tornadoes per day with favorable conditions has increased. This is to say that the frequency of days with large numbers of tornadoes is increasing because there are fewer days with low numbers of tornadoes. Additionally, the tornado season itself is getting longer.

Some studies have considered the number of days that will be favorable for severe thunderstorms as well. There is projected to be an increase in potential days for severe thunderstorms in the mid- to late 21st century. The largest increases, however, are in neighboring regions of the Midwest and Southern Plains. Also, storm intensity is projected to increase. There is some uncertainty in these projections, but severe thunderstorms and tornadoes will remain a hazard in South Dakota every year.

3.2.4 Winter Storm

Description

Winter storms are not limited to one area of the state and historically occur from late fall to the middle of spring. They vary in intensity from mild to severe. Winter storms regularly destroy property and kill livestock. They can immobilize a region, blocking roads and railways and closing airports, which can disrupt emergency and medical services, hamper the flow of supplies, and isolate homes and farms, possibly for days. Heavy snow can collapse roofs and knock down trees and power lines. Unprotected livestock may be lost. Economic impacts include cost of snow removal, damage repair, and business losses.

The NWS describes different types of snow events as follows:

- **Blizzard** - Winds of 35 mph or more with snow and blowing snow reducing visibility to less than ¼ mile for at least 3 hours.
- **Blowing Snow** - Wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground picked up by the wind.
- **Snow Squalls** - Brief, intense snow showers accompanied by strong, gusty winds. Accumulation may be significant.
- **Snow Showers** - Snow falling at varying intensities for brief periods of time. Some accumulation is possible.
- **Snow Flurries** - Light snow falling for short durations with little or no accumulation.

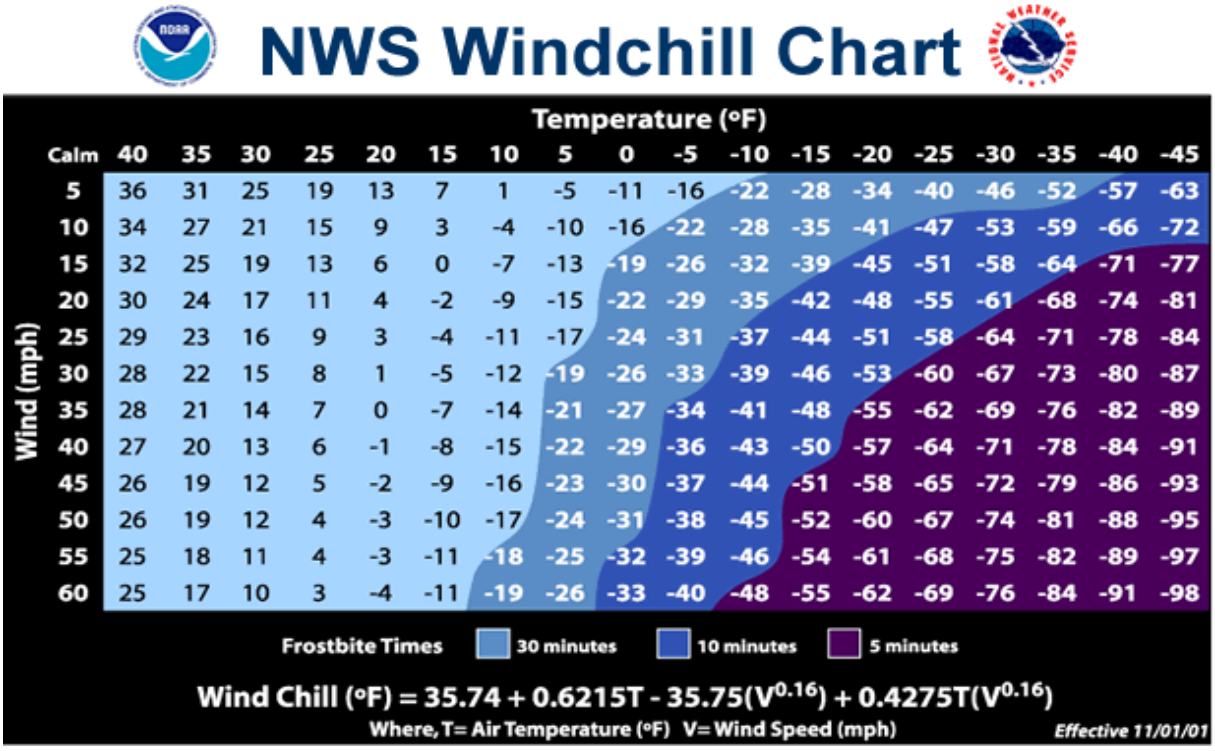
Also associated with winter storms are ice, freezing rain, and sleet. Freezing rain coats objects with ice. This ice coating on sidewalks, roads, etc., creates dangerous conditions. Sleet does not generally cling to objects like freezing rain, but it does make the ground very slippery. Heavy accumulations of ice can bring down trees and topple utility poles and communication towers. Ice can disrupt communications and power for days while utility companies repair extensive damage; even small accumulations of ice can be extremely dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

Winter storms can also generate flooding, usually as a result of ice jams or snowmelt, which can cause significant damage and loss of life. Ice jams form when long cold spells cause rivers and lakes to freeze and a rise in water level or a thaw breaks the ice into large chunks that become jammed at obstructions (e.g., a bridge). Water backs up at the jam, which is acting as a dam, and flooding results. The snowmelt hazard is defined as a sudden thaw of a heavy snow pack that often leads to flooding. Both snowmelt and ice jam floods are common in South Dakota.

Extreme cold often accompanies a winter storm or is left in its wake. It is most likely to occur in the winter months of December, January, and February. Prolonged exposure to the cold can cause frostbite or hypothermia and can become life-threatening. Infants and the elderly are most susceptible. Pipes may freeze and burst in homes or buildings that are poorly insulated or without heat. Extreme cold can disrupt or impair communications facilities.

In 2001, the NWS implemented an updated Wind Chill Temperature index (see Figure 3-14). This index was developed to describe the relative discomfort/danger resulting from the combination of wind and temperature. Wind chill is based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Figure 3-14 National Weather Service Wind Chill Chart



Source: National Weather Service

Location

Winter storm has an even probability across the state due to its topography. The inherent nature of temperature hazards makes them a regional threat, impacting most or all the planning area simultaneously as well as extending the effects into the surrounding jurisdictions. Prairie lands, which cover most of the state, offer little resistance to high winds and drifting snow. Even the Black Hills region, which presents some resistance to wind conditions, is not excluded from blizzard conditions. Blizzards in this region are often less severe than elsewhere in the state, but they can still produce heavy drifting snows. Early blizzards were so devastating that South Dakota had the dubious distinction of being called the Blizzard State.

According to the National Weather Service, most of South Dakota has an annual mean snowfall of 24.1 to 36 inches. Some areas in the northeast, northwest, and southwest have an annual mean snowfall of 36.1 to 48.0 inches, and a small area in the southwest has an annual mean snowfall greater than 72 inches.

More location information is in the following section on past events and Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction.

Past Events

According to the NCEI, there were 1,971 winter storms (snow and ice events) recorded in South Dakota between January 1993 and March 2016, and 477 extreme cold events from January 1994 to March 2016. Total property damage for these events is estimated at $91 million dollars. This suggests that South Dakota averages 85 winter storms and $4 million in winter storm losses annually, as well as 20 extreme cold events each year. 12 deaths and 127 injuries were attributed to these events. This suggests that South Dakota can expect approximately 1 death every other year and 6 injuries each year. South Dakota's agricultural industry is also very susceptible to losses from winter weather and extreme cold. During the 2019 planning process a query of winter storm events from 2016 to mid-2018 took place and only one significant event was found to have taken place in that timeframe. The event which took place in December 25, 2016 also resulted in a Presidential Declaration for 24 counties. The table below provides more details on the event. Note, this event is not reflected in Figure 3-15or in Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction.

See Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction for more information about how winter storms affect individual counties.

Figure 3-15 South Dakota Winter Storm Events 1993 – May 2016

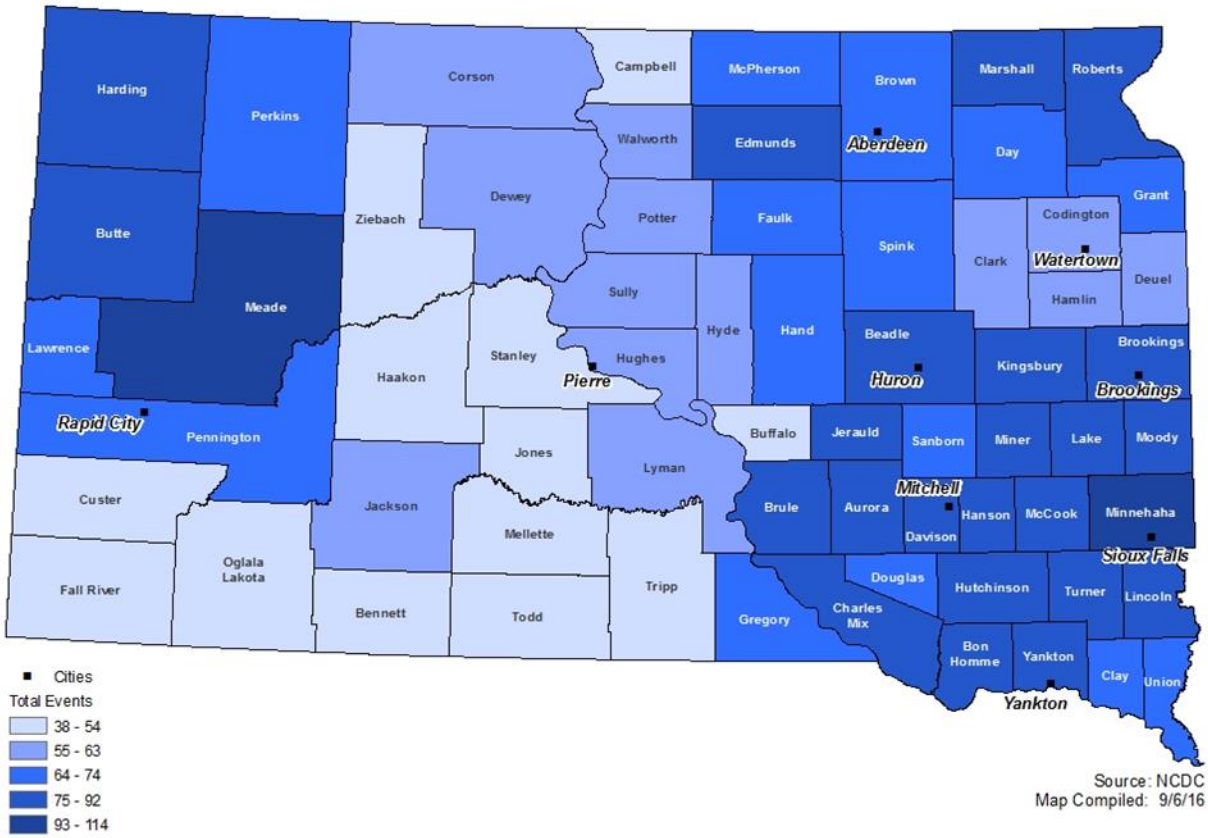


Table 3-18 South Dakota Winter Storm Events

Date	Comments
December 25, 2016	**Severe Winter Storm and Snowstorm (FEMA-4298-DR)** An intense storm system moved across the Northern Plains, producing snow and strong winds across much of western South Dakota. Areas of freezing rain, freezing drizzle, sleet, and snow developed over the area in the morning, before changing to snow. Snowfall was heaviest during the late afternoon and nighttime hours. Four to eight inches of snow were reported across much of western South Dakota, with local amounts as much as a foot. Embedded thunder was also noted with the precipitation. Strong winds developed late in the day and continued into the next morning, with blizzard conditions across much of the western South Dakota plains. Interstate 90 was closed for a prolonged period from the Wyoming border to Chamberlain. Rural electric systems sustained significant damage to poles and wires due the snow, ice, and wind. A man died as he tried to walk home after his pickup truck went into a ditch. This storm resulted in a major disaster declaration for 24 counties. NCEI identifies $1,553,000 in combined property damage. FEMA Public Assistance totaled $9,632,647 for the event (Federal share).
April 8-10, 2013	**Severe Winter Storm and Snowstorm (FEMA-4115-DR)** A large spring snowstorm dumped heavy snow over most of western South Dakota April 8-10, 2013. The final NWS storm report showed that Deadwood received 30 inches of snow during the storm and Rapid City received 28.2 inches for some of the highest snowfalls in the state. April 2013 ended up being the snowiest month on record for South Dakota with 39.5

Date	Comments
	inches total, beating the previous record of 38.5 inches set in April 1927. This storm resulted in a major disaster declaration for seven counties.
January 17, 2011	Northwest winds caused blowing and drifting snow over an area which extended from Brookings County into southwest Minnesota. Cold temperatures and wind chills approaching 20 degrees below zero developed during the event and continued through the night as the winds and blowing snow slowly decreased. There was a fatality from exposure in Brookings County during the event. A 65 year old woman died of exposure after she left her vehicle which had become stuck in drifts on a township road near Elkton.
January 9, 2011	Snow produced heavy accumulations of 8 to 10 inches in an area near the Missouri River in southeast South Dakota during a 24 hour period beginning in the late afternoon of January 9th. Lesser accumulations of 4 to 8 inches were reported further north and west in southeast South Dakota. An exposure fatality was reported in Sioux Falls during the snowfall. A 70 year old woman died after wandering away from her assisted living facility at night. Wind chills at the time varied from zero to 5 above.
December 23, 2010	An upper level disturbance passed over the region during the night and early morning, bringing milder air over cold air at the surface. Light freezing rain developed over western South Dakota, mixing with snow and sleet at times. The heaviest freezing rain fell across southwestern South Dakota, including the Black Hills, where as much as a quarter inch of ice accumulated. Roads became ice covered and caused many accidents during the morning. A total of $475,000 in damages (2010$) resulted from this event. NCEI did not record any injuries or fatalities.
December 10, 2010	Snowfall ranging from 2 to 8 inches was accompanied by sustained northwest winds which reached 40 mph at times, with gusts as high as 55 mph. The snowfall, strong winds, and existing snow cover resulted in widespread blizzard conditions. Travel was made impossible in much of the area. There were several accidents and vehicles going into ditches, attributed to slick roads and low visibilities. Several motorists were stranded. Businesses were forced to close, and several school and other weekend activities were canceled or postponed.
April 2, 2010	**Severe Winter Storm (FEMA-1914-DR)** The April 2, 2010, blizzard caused an estimated $1.6 million in damage in the three-county area. A band of heavy snow set up across Corson and Dewey counties during the early morning hours of April 2nd. Along with heavy wet snow, northwest winds gusting up to 40 mph developed. By the time the snow ended in the late morning hours, 6 to 8 inches of snow had fallen. The heavy snow, combined with the strong winds, downed many power poles across the region along with making travel treacherous. Some snowfall amounts included; 4 inches at Eagle Butte; 6 inches at Timber Lake, McLaughlin, and 14 miles north of Isabel; 7 inches at Isabel and 6 miles southeast of McIntosh; 8 inches southwest of Keldron. Heavy snow and strong winds knocked down power lines and poles, cutting off electricity to more than 1,500 rural electric customers. More than 400 poles were lost to the heavy snow leaving approximately 800 people without power. Eighty linemen worked through the Easter weekend in the snow and mud. McLaughlin and Keldron were the hardest hit. Several hundred people were still without power on April 5th. Corson, Perkins, and Ziebach Counties were also among those struck by a late-January ice storm that qualified them for an earlier Presidential Disaster Declaration. Some of the power lines damaged by the April storm had just been repaired from damage caused by the January ice storm.
January 20-26, 2010	**Severe Winter Storm (FEMA-1887-DR)** A powerful storm struck the northeast half of the state. The storm began with rain, turning to sleet, followed by heavy snow. Winds of up to 60 mph accompanied the storm. Power lines

Date	Comments
	burdened by ice after several days of heavy fog began snapping and falling. FEM Electric lost over 4,300 utility poles in Edmunds, Faulk, McPherson, and Potter counties. Customers of 1,600 meters were without power for 13 days. One customer was poisoned from inhaling generator exhaust. FEM Electric's business and economic impacts were estimated at $40,000,000, while emergency repair and restoration costs were estimated at $10,000,000. High winds and blizzard conditions across the eastern and north central regions of the state stalled traffic and further complicated relief efforts. Interstate 90 was closed from Chamberlain to the Minnesota border. Interstate 29 was closed from Sioux Falls to the North Dakota border. An estimated 7,600 customers across South Dakota were without power. Some phone systems also experienced outages. At least 31 emergency shelters were open across the hard-hit regions. Indian reservations were hit especially hard. The Cheyenne River Sioux Tribe had a breakdown at the water treatment plant as a result of the storm that left many residents without potable water.
December 23-27, 2009	**Severe Winter Storm (FEMA-1886-DR)** A powerful winter storm blanketed the entire state. The entire Interstate highway systems were shut down for an extended period across South Dakota. Winds gusted as high as 76 mph in western South Dakota Preliminary storm totals from the State Climatologist across the state from the Christmas blizzard indicated that the large majority of the state received over 10" of snow in the storm with 20" or greater amounts in the southeast (Marion-Vermillion-Yankton), northeast (Sisseton and Clear Lake), central (Kennebec and Murdo) and northwest (Perkins County). The northern Black Hills recorded 40-50". The statewide average was 15.4". This would place it as one of the top few storms for snowfall totals statewide.
March 23-34, 2009	A powerful spring storm brought rain, snow, and very strong winds to western South Dakota. Precipitation started as rain, then changed to snow, and blizzard conditions developed. The heaviest snow fell over the northern Black Hills, where 18 to 48 inches of snow was measured. Ten to 20 inches of snow fell across far northwestern South Dakota, with drifts as high as ten feet. Most other locations received at least six inches of snow. Sustained winds of 30 to 55 mph, with gusts over 80 mph, were reported. Interstate 90 and other highways were closed for more than 24 hours. Some power outages were reported, mainly across the northern Black Hills and northwestern South Dakota. Tens of thousands of livestock perished. Damage estimates were slated in the millions.
November 5-7, 2008	An intense fall storm brought heavy snow and gusty winds to much of the Black Hills. The heaviest snow fell across the northern Black Hills as upslope-enhanced snow fell for many hours. Snowfall amounts ranged from only a few inches across the southeastern slopes of the Black Hills to near five feet from Cheyenne Crossing to Lead and Deadwood in the northern Black Hills. The next day, a strong area of low pressure moving across South Dakota and into Minnesota brought widespread rain, freezing rain, and snow to central, north central, and northeast South Dakota. Much of the freezing rain fell across central and north central South Dakota west of the Missouri River. As the freezing rain changed over to snow and the winds increased, the ice and snow buildup on the power lines and poles caused hundreds of power poles to break across Jones, Stanley, Dewey, and Corson counties. East of the Missouri River, the colder air and stronger winds moved in changing the rain over to snow. Strong winds of 30 to 45 mph with gusts near 60 mph brought widespread blizzard conditions to all the area. Ice buildup from the freezing rain ranged from a tenth to as much as an inch for counties west of the Missouri River. Snowfall amounts across the entire area generally ranged from 2 to 8 inches with a 15 inch amount recorded in southwest Corson County. Some of the snowfall amounts included: 3 inches at Eagle Butte, Blunt, Kennebec, Mission Ridge, and Onida; 4 inches at Pollock,

Date	Comments
	Gettysburg, and Bowdle; 5 inches south of Harrold, Iona, and near McIntosh; 6 inches at Mobridge; 7 inches at Murdo; 8 inches at McLaughlin, and 15 inches southwest of Keldron. All 4,600 customers of the Moreau-Grand Electric company lost power due to the storm. The last time this occurred was during the winter of 1967-68. The monetary loss to this cooperative and other electric cooperatives for Jones, Stanley, Corson, and Dewey counties was in the hundreds of thousands of dollars. There were over 100 line workers working countless hours with crews coming from as far away as Nebraska and Iowa to assist in the power recovery. Over 1,000 customers were without power for an extended period of time. Cell phone coverage was also knocked out for parts of the West River area due to downed towers. The blizzard resulted in numerous school, business, and road closures along with flight cancellations. Interstate-90 was shut down from Mitchell, South Dakota to the Wyoming border from Thursday the 6th until Friday evening of the 7th. Many semi-trucks and cars were stranded along the Interstate with many people being rescued. Many travelers took shelter in Murdo, Chamberlain, and Pierre until the Interstate reopened Friday evening. There were also several accidents across the area with a serious accident in Walworth county on Highway 83 near the Potter county line. In the early afternoon hours of Friday, the 7th, slippery roads, high winds, and low visibilities contributed to the rollover of a passenger van carrying seven students. The passenger van rolled several times causing serious injuries to three of the students. Also, a semi-truck rolled over on an icy and snowy Highway 45 south of Miller in the late afternoon hours of the 6th. The driver received minor injuries. The Governor declared a state of emergency on the 7th, and President Bush declared South Dakota a disaster area.
April 25-26, 2008	A strong low-pressure area brought widespread heavy snow of 6 to 20 inches to most of northeast South Dakota for much of the 25th and into the early morning hours of the 26th. The precipitation began as light freezing rain in the early morning across parts of the area before changing to all snow by mid-morning. As the low-pressure area intensified, snowfall rates and the north winds also increased. The heavy snow combined with the strong winds created widespread visibility problems along with large snowdrifts. Snowfall amounts included, 6 inches at Andover, Britton, Gann Valley, and 15 miles south of Miller, 8 inches at Roy Lake, 9 inches at Clark, Big Stone City, Hillside Colony, and Sisseton, 10 inches 7 miles south of Bristol, and 11 inches at Hayti. Locations with a foot or more of snowfall included, 12 inches at Wilmot, Webster, and Waubay, 13 inches at Milbank, 15 inches at Castlewood, 16 inches near Victor, and near Summit, 17 inches at Clear Lake, 19 inches at Watertown, and 20 inches at Bryant. There were a number of automobiles that went into the ditch along with many other automobiles damaged in accidents. Many stranded motorists had to abandon their vehicles in the hardest hit areas. Travel was not advised across the entire area. A school bus slid into a ditch east of Castlewood with no injuries occurring. Interstate-29 was closed from 3 pm the 25th until 3 pm on the 26th from Brookings north to the North Dakota border. In addition, South Dakota State Highway 12 was closed from Webster to the Minnesota line from the afternoon of the 25th until the late morning of the 26th. Most counties affected by the storm opened emergency shelters when Interstate 29 was closed to house stranded motorists. Also, many schools were closed across the area. The very heavy snow set several records across the area. The 19 inches at Watertown broke its all-time 24 hour snowfall record of 16 inches. Both Victor and Clear Lake had their second highest snowfall ever recorded in a 24 hour period. Watertown, along with several other locations in northeast South Dakota, received near record or record snowfall for the month of April. In fact, Watertown's 29.5 inches of snow for the month of April was almost their seasonal normal snowfall. This event was also declared a disaster by the President.

Date	Comments
March 1, 2007	In southeast South Dakota, four to eight inches of snow was accompanied by sustained winds of over 30 mph at times with gusts over 40 mph. The combination of new snow, wind, and existing fresh snow cover resulted in a blizzard with widespread near zero visibilities. Drifting snow made travel extremely difficult to impossible. As a result, some who did attempt to travel became stuck or slid off roads. Schools and school activities were cancelled, and numerous businesses closed. Source: National Climatic Data Center
April 18-20, 2006	**Severe Winter Storm (FEMA-1647-DR)** The strongest storm of the 2005-2006 winter brought heavy, wet snow to northwestern South Dakota and the Black Hills and heavy rain across southwestern and south central South Dakota. Reported snow totals included 10 to 24 inches in northwestern South Dakota, 16 to 30 inches in the Bear Lodge Mountains, 40 to 70 inches in the northern Black Hills, 74 inches in Lead, and 55 inches in Deadwood. Fifteen-foot drifts were reported on the plains of northwestern South Dakota. Source: NWS Rapid City
November 27-29, 2005	**Severe Winter Storm (FEMA-1620-DR)** This storm brought snow and ice to the state. It was one of the worst ice storms in the state's history. Snowfall accumulations in central South Dakota ranged from 2 to 20 inches. Strong northwest winds of 30 to 50 mph with gusts to 70 mph caused widespread blizzard conditions. Visibilities were reduced to zero across the area with snowdrifts of 5 to 10 feet high in some places. Freezing rain occurred before the snow in some areas coating objects with up to three inches of ice and causing power outages. Some power lines were also brought down by snow and ice accumulation and high winds. Tens of thousands of households and businesses lost power from one day to up to two to three weeks in some rural areas. One electric cooperative said it was the worst damage they had in their 65 years of existence. Bon Homme Yankton Electric Association had 455 broken poles, 82 cross arms, and numerous line breaks. 509 customers were affected. The last line was turned on 8 days after the start of the storm. Consumers experienced roughly 118.1 hours or 4.9 days without power. Emergency repair and restoration costs were estimated at $352,323 with $282,538 in federal and state disaster relief funding. Many roads, including Interstates 90 and 29 were closed due to the treacherous travel conditions. Several accidents occurred during the storm, killing two and injuring others. Many motorists were stranded. Several people had to be rescued. Air traffic was also brought to a halt across much of the area. Schools, businesses, government offices, and many other organizations were closed. Minor damage was caused to homes and vehicles by the strong winds and by windblown debris, mainly from trees. A 79-year old man died from exposure in Douglas County. Source: NCEI and SHMT
April 2000	**Winter Storm (FEMA-1330-DR)** From April 19-20, a severe spring storm consisting of rain, heavy snow, and very high winds struck seven western counties of South Dakota. The storm's greatest impact was on the electrical power system. One to three feet of heavy, wet snow coupled with ice and high winds caused significant damage to three rural electric cooperatives, resulting in widespread power outages to homes and businesses. The power providers reported that over 1,500 power poles were damaged or destroyed. Eligible damage to public infrastructure was estimated at approximately $2,500,000.

Date	Comments
April 1997	An ice storm that affected Edmunds and McPherson counties damaged 400 utility poles and caused 1,500 wire breaks. FEM Electric customers on 600 meters were without power for seven days. Business and economic impacts of this storm were estimated at $3,000,000 and emergency repair and restoration costs were estimated at $1,000,000.
January 1997	**Severe Winter Storms/Blizzards (FEMA-1156-DR)** All counties were declared disaster areas. Twice in a seven-day period in early January, cold Arctic air swept down and "froze" the state. The governor closed the interstates for public safety. More than 36,000 head of cattle perished. Roads were blocked or covered by 20-foot drifts of snow. Fifteen days after the storm ended, some roads were still blocked by snow. The Day County highway superintendent reported 20- and 40-foot vertical drifts blocking the highway. Livestock losses, damaged buildings, and feed shortages occurred in an area called the "red zone." This is an area of 4,722 cattle operations, 1,200 sheep operations, 1,000 hog farms, and 515 dairies along the northern third of the state west to east. The storm caused more than $30 million in damage/cleanup efforts. Three people died while trapped in vehicles along the highways. The snowmelt from this record-breaking storm was a major contributor to the flood disaster a few months later.
December, 1996	Extreme cold struck portions of South Dakota. A Summit man died from exposure to the extreme cold after his vehicle became stuck in the snow. The man attempted to walk for help and was found about one mile from his car in the driveway of a home about a mile and a half west and one mile south of Summit.
November 13-26, 1996	A slow-moving winter storm with severe snow and freezing rain entrenched itself over much of the state. The effects of the storm were felt primarily in the Black Hills and southeastern portions of the state. The storm was a result of a strong system of cold air, hovering close to the ground, with a system of warm air above. This combination made for rain, fog, and snow that quickly turned to damaging ice. The snow and ice formed and amassed on roadways, trees, electric transmission lines, and power poles. Some power lines were swollen by ice to five inches in diameter. The excessive weight and severe wind conditions snapped lines and flattened poles. Thousands of polebraces, crossarms, and anchors cracked under the heavy stress. Six rural electric cooperatives, affecting approximately 10,700 customers, experienced serious outages due to the loss of poles, braces, lines, crossarms, anchors, and substation failures. Customers were without power in subfreezing temperatures for several hours to several days. The force of the storm caused major delays on Interstates 90 and 29. Portions of state and county highways and roads were closed for an extended period of time due to heavy ice and snow accumulation and extremely poor visibility.
October 22-24, 1995	**Ice Storms (FEMA-1075-DR-SD)** Between October 22 and 24, 1995, a severe autumn snow and ice storm caused widespread damage in South Dakota. Effects of this storm were felt first in the Black Hills. Portions of the hills received up to 22 inches of snow. As the storm moved across South Dakota, ice and 5 to 15 inches of wet snow-covered trees and electric lines and poles. Winds associated with the storm caused lines to slap together and poles to fail, producing widespread power outages to large portions of rural South Dakota. Tree damage also led to significant damage to electrical utilities. Thirteen rural electric cooperatives reported damage from this storm. The cooperatives lost nearly 9,500 poles and 170 transmission lines. Damage was estimated at $10 to $10.3 million to rural electric infrastructure only. Approximately 30,290 households were affected by the power outages. Crews from electric cooperatives in South and North Dakota, Minnesota, Iowa, and Nebraska assisted local cooperatives with line repairs.

Date	Comments
	The power outages also caused several rural water system pumping stations to go off-line, causing a loss of water utilities to members of rural water systems. The National Guard provided generators to power these pumping stations to restore water service. This storm also forced major transportation delays as portions of Interstates 90 and 29 had to be closed because of the snow accumulation on the roadway and poor visibility. One of these interstate closings led Davison and Codington counties to initiate their sheltering plans for travelers who could not find rooms at local motels. The storm also caused numerous cancellations and delays in school openings because of travel conditions or the lack of power. Interstate traffic was restored by early October 24. Twenty-eight counties were included in the disaster declaration: Aurora, Beadle, Bon Homme, Brookings, Brule, Buffalo, Charles Mix, Clark, Codington, Davison, Day, Deuel, Douglas, Grant, Gregory, Hamlin, Hanson, Hutchinson, Jerauld, Kingsbury, Lake, McCook, Marshall, Miner, Roberts, Sanborn, Spink, and Tripp Counties.
January–February 1995	**Severe Winter Storms (FEMA-1045-DR)** Damage to electric power lines in 21 counties was caused by an unusually foggy January weather. Continuous fog in many areas resulted in a heavy crust of ice forming on many of the power lines in central South Dakota. The fog-crust was reported to be three to five inches in diameter. The addition of high winds caused power poles to snap. Deep drifts of snow made it difficult for power company linemen to gain access to the damaged power lines, and in many areas, county snow removal equipment was required to provide access. According to reports, 13,435 households were without power for varying periods of time. The maximum time without power was 12 days. Early damage was estimated at more than $3.2 million. More than 1,700 power poles had to be replaced.
November–December 1983	Weeks of subzero temperatures preceded the actual blizzard and set the stage for the deadly combination of cold, blizzard conditions, and loss of electrical power. A series of winter storms struck South Dakota in late November and throughout December. The impact was felt statewide, but it was particularly heavy on the Rosebud and Pine Ridge reservations. Cheyenne River, Lower Brule, and Crow Creek reservations were also affected, but to a lesser degree. Many of the Rosebud and Pine Ridge communities had propane fueled/heated homes. At the height of the storms, reservation roads were drifted closed and became impassible. A fuel shortage occurred when the weeks of subzero temperatures drained propane tanks faster than normal. Tribal governments opened community shelters for those who could make it to the shelters. As conditions worsened, fuel contractors could not start their delivery vehicles and roads were increasingly impassible. County and tribal government snowplows were overwhelmed by the enormity of the task. One death resulted from these storms.
October 9, 1981	The entire Black Hills area was virtually paralyzed by three to six feet of heavy snow and 40 to 70 mph winds. Roads were totally blocked, trees and power lines broken, and some homes sustained heavy damage. Not only were the northern hills residents isolated, but some were also without water and power for at least three days, causing food spoilage.
March 29, 1981	A winter storm front created a tornado near Martin, which destroyed a mobile home and injured one occupant. By 3:00 a.m. on March 30, the storm was generating 50 to 80 mph winds and dumping up to 10 inches of heavy, wet snow in the northwest. Power lines and at least 1,500 poles in the northwest were snapped after being coated with one to six inches of ice. Strong winds also snapped power lines and poles in south central South Dakota. These winds overturned trucks and cars along Interstate 29. The winds also overturned a railroad tank car, spilling phosphoric acid. This accident forced the evacuation of part of Garretson.

Date	Comments
January 1981	A series of storms blocked the majority of roads in eastern South Dakota, overturned vehicles, and stranded hundreds of motorists. The severity of these storms caused four deaths in vehicles stalled in the deep snow.
1977	February, March, and November were especially active months for winter storms. Many rural roads were blocked with snow drifts six to eight feet high. Interstate 90 was often blocked and up to 100 cars were stranded. Six people died as a result of these storms. In addition to power outages reported in various part of the state, the March storm dropped over an inch of rain in the eastern part of the state and generated walnut size hail in Grant County. In November, a winter storm toppled a 1,400 foot television tower and derailed six freight cars.
January 1975	Of the two blizzards in 1975, the one on January 11 and 12 was the worst. High winds exceeding 60 mph, subzero temperatures, and heavy snow combined to produce killer conditions. Several people died, and thousands of head of livestock perished in eastern South Dakota.
March 1969	Heavy snowfall and high winds knocked out power in the Aberdeen area. Rural residents were hard hit as blocked roads prevented early power line repair. The Belle Fourche area also sustained loss of power and phone service as hundreds of poles were knocked down.
March 1966	This storm moved into eastern South Dakota and remained stationary for 12 hours. Winds of 60 to 70 mph were common. Gettysburg had gusts up to 100 mph. The driving wet snow clung to the mouths of livestock and they suffocated. Cattle and sheep loss approached 100,000 animals with a value of nearly $20 million. Many towns suffered physical damage from the storm. A total of 380 people in Pierre had to be evacuated as the result of a power failure. Many towns lost phone service, and some communities had windows shattered by high winds, allowing snow to drift into buildings. A 121-car train was completely stopped by snow drifts. This storm killed 10 people.
December 1965	An ice storm destroyed an estimated 3,500 telephone poles in the Aberdeen area. Damage was nearly $650,000. Total damage to light and power systems approached $1 million. At the time, this was the worst ice storm experienced in 40 years.
January 1952	The temperature dropped from 40°F to -8°F in a short period of time. The wet, driving snow clung to everything. Cattle were blinded and suffocated as snow covered their mouths and noses. Young country school children lost their way home and died of hypothermia. A few ranchers died when they tried to gather their livestock. Snow piled up to a point that people could walk along tops of power lines. In some isolated areas, people were snowed in for four months off and on throughout the winter. Planes were used to deliver mail, groceries, fuel, and feed for livestock. Snow track vehicles were used to transport doctors to isolated farm areas.
January 1949	A blizzard affected the entire state. Blizzard conditions existed for weeks rather than days. The general weather conditions were low temperatures (-2°F to -8°F), heavy snows (24 inches for the month), and winds from 40 to 73 mph. Towns and rural areas were completely isolated as the snow blocked up everything. Roads, railroad tracks, and buildings were buried under tons of snow. People were lost in the storm and many cattle were frozen. Airplanes were used to deliver food, fuel, and medicine to stranded people. Snow was very deep in western South Dakota. Pictures of the area showed drifts 35 feet high and several thousand feet long.
1943	A blizzard killed a large number of cattle.
1927	A blizzard killed a large number of cattle.

Date	Comments
May 1905	A blizzard hit western South Dakota counties in May. Cattle wandering around in the blizzard walked off the bluffs in the Badlands area and fell to their death. Estimated cattle loss exceeded 16,000.
January 12, 1888	A blizzard was preceded by 10 days of cold, snowy weather, 8 to 10 inches of new snow, and a low temperature of -28°F. The weather warmed on January 11 and 12; it was foggy and about 32°F. The temperature dropped on the afternoon of January 12 to -20°F in five minutes. The wind blew so strongly that it knocked people off their feet. Many children, sent home from school, did not make it home. The blizzard was so withering that people lost their sense of direction and wandered about until they died of hypothermia (exposure). Thousands of head of livestock and wild animals perished. Many buildings were covered with snow or destroyed, and all transportation stopped. Although the storm lasted less than one day, an estimated 400 people died throughout the Dakotas, 174 of which were in South Dakota.

Probability

According to the NCEI, there were 1,462 winter storms (snow and ice events) recorded in South Dakota between January 1993 and March 2016, and 295 extreme cold events from January 1994 to October 2012. This suggests that South Dakota averages 63 winter storms and 12.8 extreme cold events each year. During the same time period, 12 deaths and 127 injuries were attributed to these events. This suggests that South Dakota can expect approximately 1 death every other year and 6 injuries each year. Based on this information, the probability that at least one winter storm will occur in South Dakota in any given year is 100 percent. (Note, the significant winter storm that took place December 25, 2016 in not included in this calculation. More information on the event can be found in Table 3-17).

Climate Change Considerations

The winter season is warming at a faster rate than any other season in the Northern Plains region, and this is also true for South Dakota. Winter storms and blizzards, however, will continue to be a severe weather hazard in the state. Warmer winter temperatures could mean more ice and freezing rain events, which often impact electrical utilities and communication systems, but can also affect agricultural livestock and roads and transportation. A warmer winter climate could reduce energy consumption for heating in the long run, but there will still be some periods of exceptional cold temperatures.

The northern U.S. has experienced an increase in the frequency of large snowfall events, where other places in the country have been decreasing. Some analyses have shown an increase in winter storm frequency and intensity, with storm tracks moving northward since 1950. There remains some uncertainty in projections for the coming decades, but the rising trend of extreme precipitation events in general (including winter season) will continue to be a hazard.

3.2.5 Wildfire

Description

Wildfires are uncontrolled conflagrations that spread freely through the environment. Wildfires near populated areas pose threats, not only to natural resources, but also to human life and personal property. Natural causes, such as lightning, or human acts may ignite wildfires. Lightning remains a fixed element of the ecosystem, and human-caused fire risks continue to increase as more and more people move to and recreate in fire-prone wildland areas.

South Dakota has a history of damaging wildfires. The state's susceptibility to wildfire was recognized nationally in 1897 when, prompted by a series of large forest fires in 1893, President Grover Cleveland

established the Black Hills Forest Reserve to protect the forests from fires (as well as wasteful lumbering practices).

Prior to 2010, years of drought along with extremely low percentages of normal snowpack in the Black Hills created the potential for catastrophic wildfires in South Dakota. 2015 was a dry year, thus wildfire risk returned. Compounding this situation is the impact of the mountain pine beetle on pine trees in South Dakota. The most common host is the ponderosa pine. This tree occurs on more than 1 million acres of forestland in South Dakota. When the beetle population is very low, only stressed or weakened trees, such as those struck by lightning or stressed by drought, are colonized. However, approximately every ten years the beetle population increases, and the beetles begin colonizing healthy as well as stressed trees. The South Dakota Department of Agriculture (SDDA) reported in 2012 that the mountain pine beetle population had reached epidemic proportions. SDDA published a Black Hills Regional Mountain Pine Beetle Strategy (2012) which proposed mitigation strategies for reducing the population to endemic levels over the course of several years. Between mountain pine beetles and dry conditions, there is great concern for wildfires in the wildland-urban interface and also for agricultural and rural wildfires. Fires involving grass, prairie, or timber can cause mass destruction of property and vegetation.

South Dakota's semi-arid climate, highly flammable native vegetation, rugged terrain, and populated wildland-urban interface up its wildfire make hazard.

Topography - The Black Hills are an outcropping of the Rocky Mountains, lying in an ellipse 100 miles long and 50 miles wide along the state's western edge. In the Black Hills, terrain varies from broad, open valleys; rolling topography; mountainous terrain up to 7,242 feet in elevation; and steep, narrow canyons.

Fuels - Fuels are generally conducive to high rates of spread, represented by National Fire Danger Rating System fuel models "G", "L," "K," and "C." Grass predominates in the broad valley bottoms. Ponderosa Pine grows on all aspects, and extensive pure forests of Ponderosa grow in the Black Hills. Mixed grass and timber stands occur in many areas depending on aspect. Fuel loading is lightest in the southern Black Hills and heaviest in the northern Black Hills.

Weather - During the summer months, temperatures are often in the 90s and low 100s with relative humidity in the teens. The average annual precipitation is approximately 17.5 inches. Some of this precipitation comes in association with thunderstorms that bring lightning during the fire season.

Lightning fires tend to burn more acreage than human-caused fires, in part, because 1) multiple lightning fire ignitions often occur at the same time; 2) lightning fires can occur throughout the protection area, while most human-caused fires occur in accessible areas; 3) people often detect and report human-caused fires quickly due to their proximity to inhabited areas; and 4) lightning producing thunderstorms typically occur during the hottest portion of the fire season, while many human-caused fires start during spring or fall.

Conditions - The Black Hills ecosystem is fire adapted, having evolved with fire and fire dependent plant species. The forests of the Black Hills are very different from pre-settlement times when frequent, low-intensity fires maintained a healthy forest structure. Ponderosa Pine is adapted to benefit from frequent, low-intensity fires started in summer by lightning. Historically, these fires killed smaller plants that competed with the pines for moisture and released nutrients from litter on the forest floor. These fires also prevented accumulation of fuels that feed severe fires, which can destroy the thick-bark defense of the trees.

Today, the forest contains many more trees per acre and much more undergrowth, needle litter and deadwood than it did historically. Under these circumstances, when wildfires occur under dry, warm, and windy conditions, they will frequently develop into uncontrollable crown fires that destroy the forest and any homes within it.

Mountain pine beetle attacks in Ponderosa Pine often coincide with abundant weak trees resulting from drought and overgrown conditions. These circumstances have been common throughout the Black Hills and have allowed a mountain pine beetle infestation to become epidemic. The Custer State Park area around Harney Peak, and the Norbeck Wildlife Preserve adjacent to Mount Rushmore has extremely high fuel loading due to Mountain Pine Beetle outbreaks.

Wildland-Urban Interface - Wildfires destroy hundreds of structures throughout the western United States every year. These fires can and will occur anywhere that humans and their development meet or intermix with wildland fuels. This wildland-urban interface fire problem exists in every state, including South Dakota, and worsens each year. People continue to develop residential properties in fire-prone environments, increasingly exposing themselves and their personal property to the risks of wildfire. Fire and resource management professionals know that wildland-urban interface development can draw the efforts of firefighters away from protecting the natural resources, whose stewardship they are charged with.

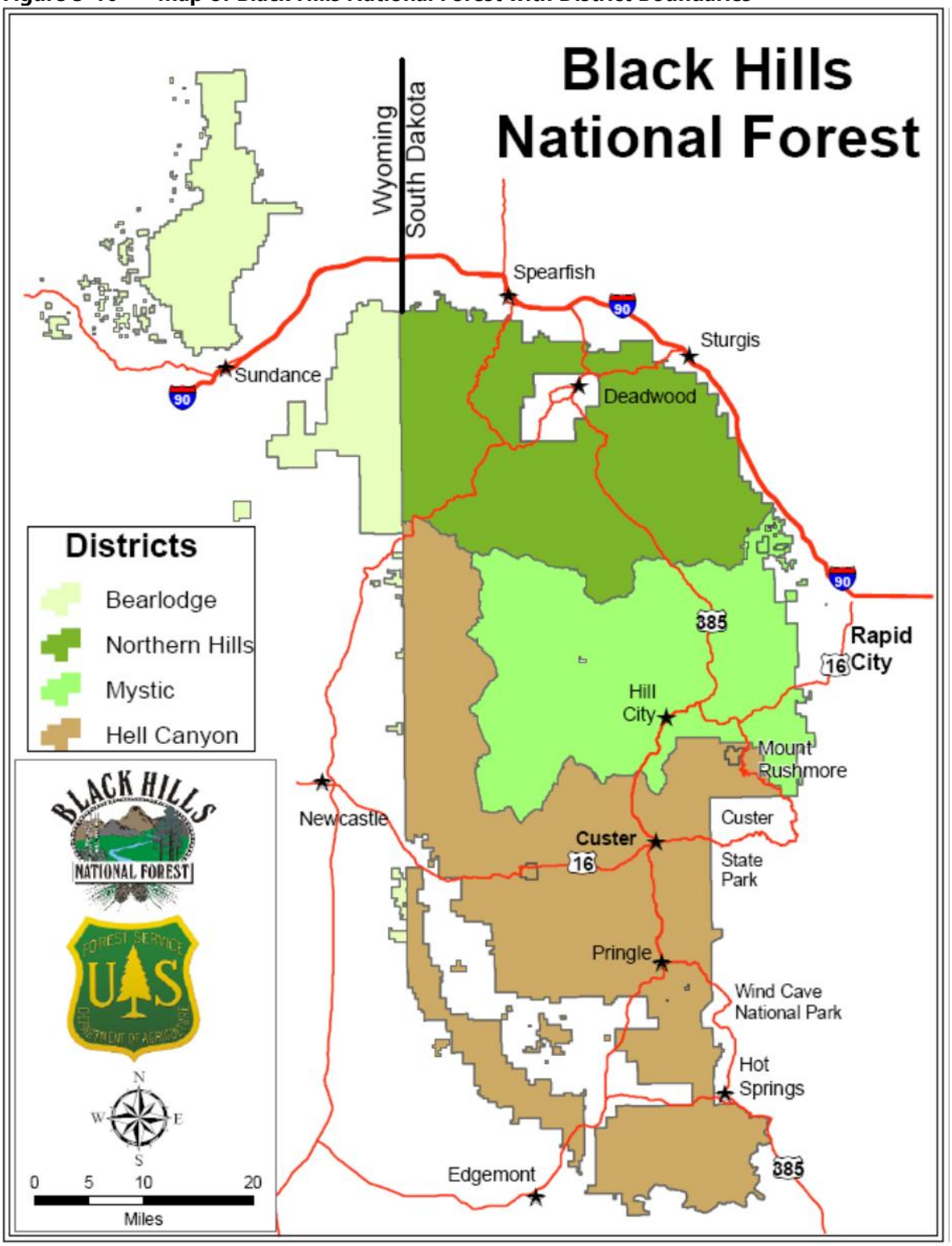
Location

Early writings by explorers, trappers, and settlers often describe South Dakota as a sea of waving grass. The descriptions would not be valid today for the eastern half of the state. The more fertile and climatically desirable prairie of the eastern portion is now used for crop production. But the wild prairie still exists in the western part of the state. South Dakota's portion of the Great Plains now exists from the foothills of the Black Hills to the western boundary of the Missouri River. This amounts to nearly 35,000 square miles of land, which is used primarily for livestock grazing and some wheat and small grain cultivation. For most of the year, this area is at risk to wildfires because of the nature of the ground cover and the limited precipitation.

Although wildfires occur throughout the state, the grass and forestland areas west of the Missouri River represent the area most prone to large wildfires. This area remains vulnerable due to the large areas of continuous fuels and the extreme burning conditions that occur in the area. The area of the state known as the Black Hills has the highest potential for loss of lives and personal property from wildfire. After years of fire suppression, the landscape of the Black Hills has become a dense forest. High fuel loads, years of drought, and mountain pine beetle infestation have combined to make the area particularly susceptible to wildfire. Between 2000 and 2002, 10 percent of the Black Hills National Forest burned (see Past Events) (U.S. Forest Service, Spearfish, South Dakota, and the Northern Black Hills: Steps to Improve Community Preparedness for Wildfire).

The Black Hills National Forest encompasses 1,534,471 acres of land in South Dakota and Wyoming (see Figure 3-16). Over one million acres of the forest are exclusively in South Dakota (Custer, Fall River, Lawrence, Meade, and Pennington counties). Of the one million acres, about 80 percent is federally controlled. The remaining 20 percent is controlled by the state and private citizens.

Figure 3-16 Map of Black Hills National Forest with District Boundaries



Source: U.S. Forest Service, http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5228288.pdf

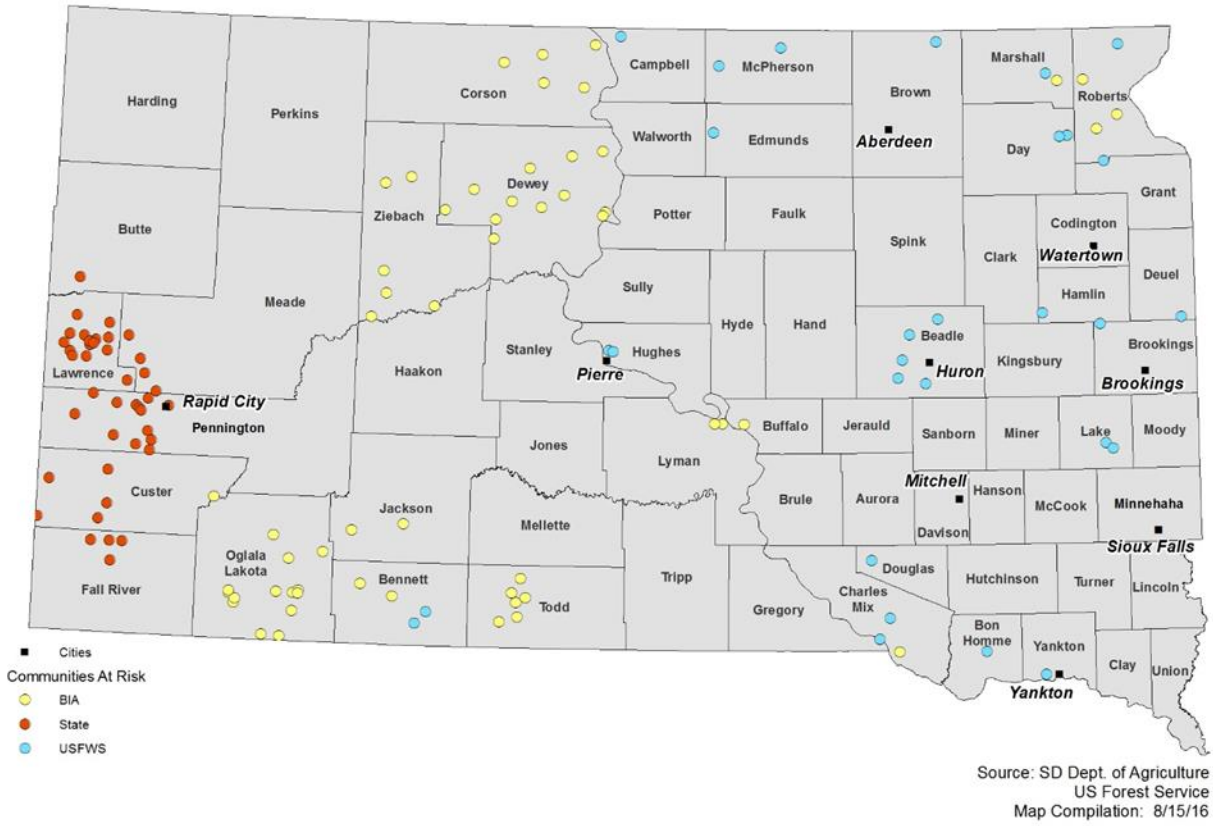
The land ownership pattern in the Black Hills includes a mix of private, Black Hills National Forest, State of South Dakota, Bureau of Land Management, and National Park Service lands. A "checkerboard" ownership

pattern in the Black Hills National Forest produces a condition where private, residential structures are scattered throughout much of the National Forest. The U.S. Forest Service has reduced, through land exchanges, the number of individual property inholdings and the land area they cover within the Black Hills National Forest. However, the number of occupied developments on the remaining inholdings increases constantly. This rural residential growth continually and dramatically increases private property exposure within U.S. Forest Service's fire jurisdiction.

The state primarily maintains fire protection responsibility on private and state lands but protects a relatively large amount of Federal land as well. The State of South Dakota Department of Agriculture Wildland Fire (SDWF) division is the protecting agency (under contract) for all BLM lands in SD, approximately 250,000 acres. In addition, we provide mutual aid assistance to our federal wildland firefighting agencies throughout the state. Since a large portion of the state's fire protection area is private land, single-family dwellings exist throughout the state's protection area. However, there are existing pockets with no dwellings due to the roughness of the terrain in some areas.

The greatest concentration of structures is located in and around the towns and cities in the Black Hills, including subdivisions within a few miles of the town and city limits. Rapid City and bedroom communities within a five-mile radius of the city represent the greatest concentration of structures located in the forested areas of the Black Hills. The population of new residents is growing, especially in Custer, Pennington, and Meade Counties, and there are far more individual property owners to deal with than in the past. Figure 3-17displays growing communities at risk to wildfires.

Figure 3-17 South Dakota Communities at Risk to Wildfire

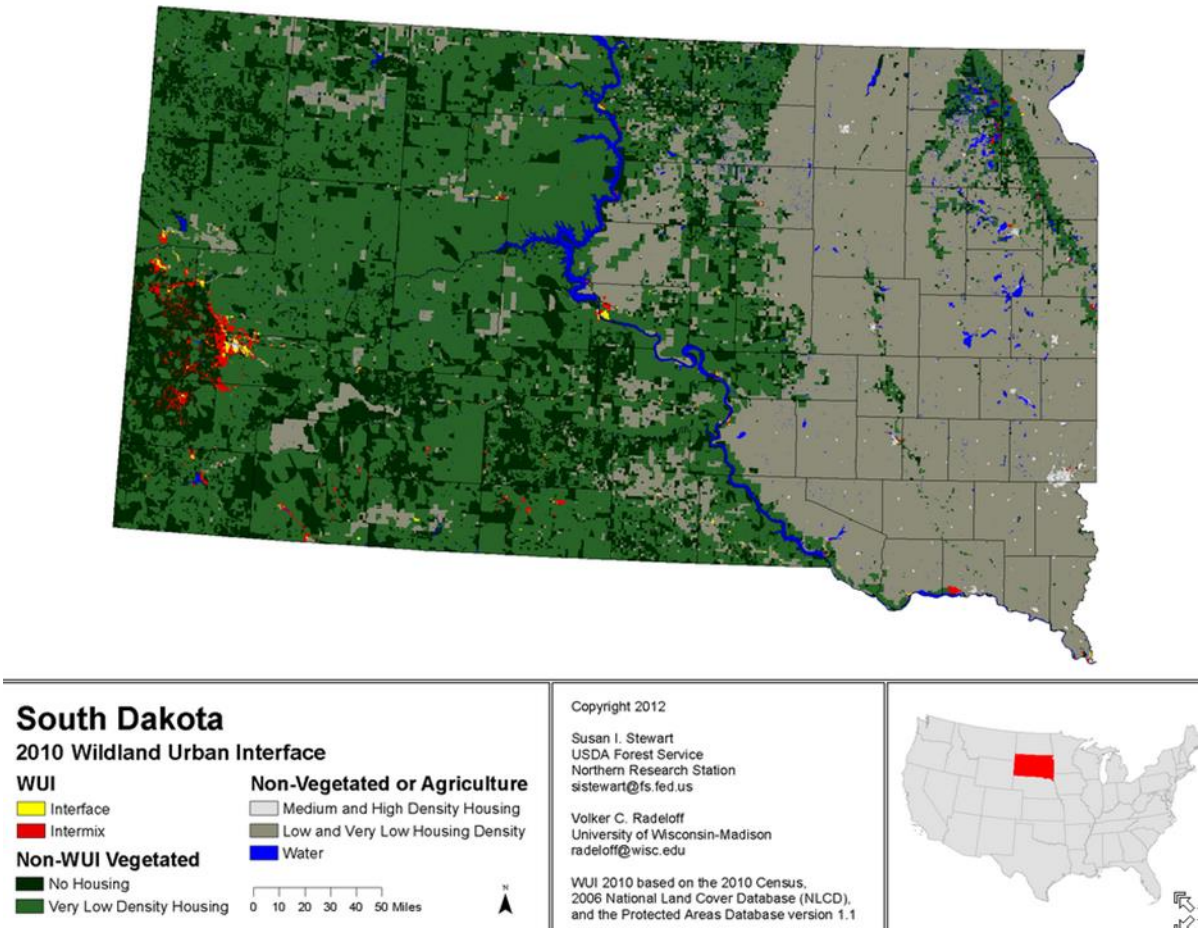


Many new residents are unfamiliar with the realities and responsibilities of living in a fire dependent ecosystem such as the Black Hills, are unaware of the natural role of fire, the concept of defensible space, and the capabilities of local government services. Many homeowners seem to value aesthetics more than safety and resist the concept of defensible space, believing that they will spoil the environment for which they came.

In addition to the Black Hills National Forest, there are fire-prone smaller forested areas on the Custer National Forest in Harding County, and BIA Trust and tribal lands on the Pine Ridge Reservation of Oglala Lakota County (unorganized), and the Rosebud reservation of Todd County (also unorganized). These three counties are in western South Dakota.

South Dakota codified law (SDCL 41-20-5) was amended in 2008 and now contains language that expands the use of the Fire Suppression Special Revenue Fund to include rangeland fires outside the Black Hills Forest Fire Protection District. The Governor has to declare an emergency for the area affected by the rangeland fire and the SDWF must assist with the fire suppression and extinguishment. Figure 3-18 illustrates South Dakota's wildland-urban interface using 2010 U.S. Census data. Wildland-urban interface, as illustrated in this figure from the SILVIS Lab at the University of Wisconsin–Madison, is composed of both interface and intermix communities. In both interface and intermix communities, housing must meet or exceed a minimum density of one structure per 40 acres. Intermix communities are places where housing and vegetation intermingle. In intermix, wildland vegetation is continuous, more than 50 percent vegetation, in areas with more than 1 house per 40 acres. Interface communities are areas with housing in the vicinity of contiguous vegetation. Interface areas have more than 1 house per 40 acres, have less than 50 percent vegetation, and are within 1.5 miles of an area (made up of one or more contiguous Census blocks) over 1,325 acres that is more than 75 percent vegetated. The minimum size limit ensures that areas surrounding small urban parks are not classified as interface WUI.

Figure 3-18 South Dakota's Wildland-Urban Interface



Source: SILVIS Lab, Forest Ecology and Management, University of Wisconsin–Madison, 2012

Past Events

The South Dakota Department of Agriculture's Division of Wildland Fire Suppression database indicates that lightning represents the single largest ignition source in its jurisdiction, causing 35 percent of fires and burning 41 percent of the acreage lost between 1996 and 2000. While debris burning caused slightly more fires, these fires burned only about one third of the acreage lost to lightning-caused fires. Figure 3-19 contains information about wildfires in the Black Hills between 1977 and 2000. Most of the fire occurrence and corresponding acres burned in the Black Hills occur in Custer and Fall River Counties.

Since 2012, the State of South Dakota has received four Fire Management Assistance Declarations. These four events are described in further details below. The NCEI recorded seven wildfire events in South Dakota since 2010. These events are summarized in Table 3-18.

The Vineyard Fire (FEMA-5272-FM) began on August 11, 2018 in Fall River County. Evacuations were put in place for areas of the City of Hot Springs and lifted on August 12, 2018 although pre-evacuations continued to be in place until August 13. The fire is estimated to have burned over 550 acres and came in close proximity to dense residential areas in Hot Springs. No injuries or structural damage had been recorded at the time of this plan update. The cause of the fire is still under investigation while the State Plan was being updated.

The Legion Lake Fire (FEMA-5229-FM) which began on December 12, 2017 in Custer State Park is the third-largest wildfire in the region's history burning 54,000 acres. It was fully contained by December 19, 2018. The fire was caused by a tree falling on a power line that caused sparks which ignited dormant vegetation that had been left from previous logging operations. The fire eventually moved out of the State Park, into Wind Cave National Park and onto private property, in total burning 10,000 acres of private ranches.

Two Fire Management Assistance Declarations were received in 2012. The Myrtle Fire (FEMA-2996-FM) began on July 19th, 2012 in Custer County due to human causes. The fire burned 10,080 acres and was 100% contained by July 24th, 2012. The Wellnitz Fire (FEMA-5010-FM) began on August 29th due to lightning. The fire burned 77,159 acres across Oglala Lakota County (previously Shannon County), South Dakota and into Nebraska. Burned acreage in South Dakota alone was estimated at 28,478. The fire was 100% contained by September 7, 2012.

Additional data on wildfire occurrences was obtained from the Federal Wildland Fire Occurrence website (http://wildfire.cr.usgs.gov/firehistory/data.html). The Federal Wildland Fire Occurrence data had records for 26,808 fires between 1980 and 2015 of varying sizes between 0 and 84,782 acres. These fires burned an estimated total of 1,340,965 acres. The largest of these was the Jasper Fire complex in August 2000, which is profiled in Table 3-19. Of these fire between 0.1 and 84,782 acres, 88% were human-caused, 10% resulted from natural causes, and the causes of the remaining 2% were unknown. Between 1980 and 2015 191 fires burned 1,000 acres or more. Collectively these 191 fires burned a total of 1,058,056 acres. 121 (63%) of these fires occurred due to human causes, and the remaining 70 (37%) occurred due to natural causes. The location and cause distribution of the 191 events are depicted in Figure 3-19 and Figure 3-20, respectively.

Figure 3-19 South Dakota Fire Occurrences 1,000 Acres or More: 1980-2016

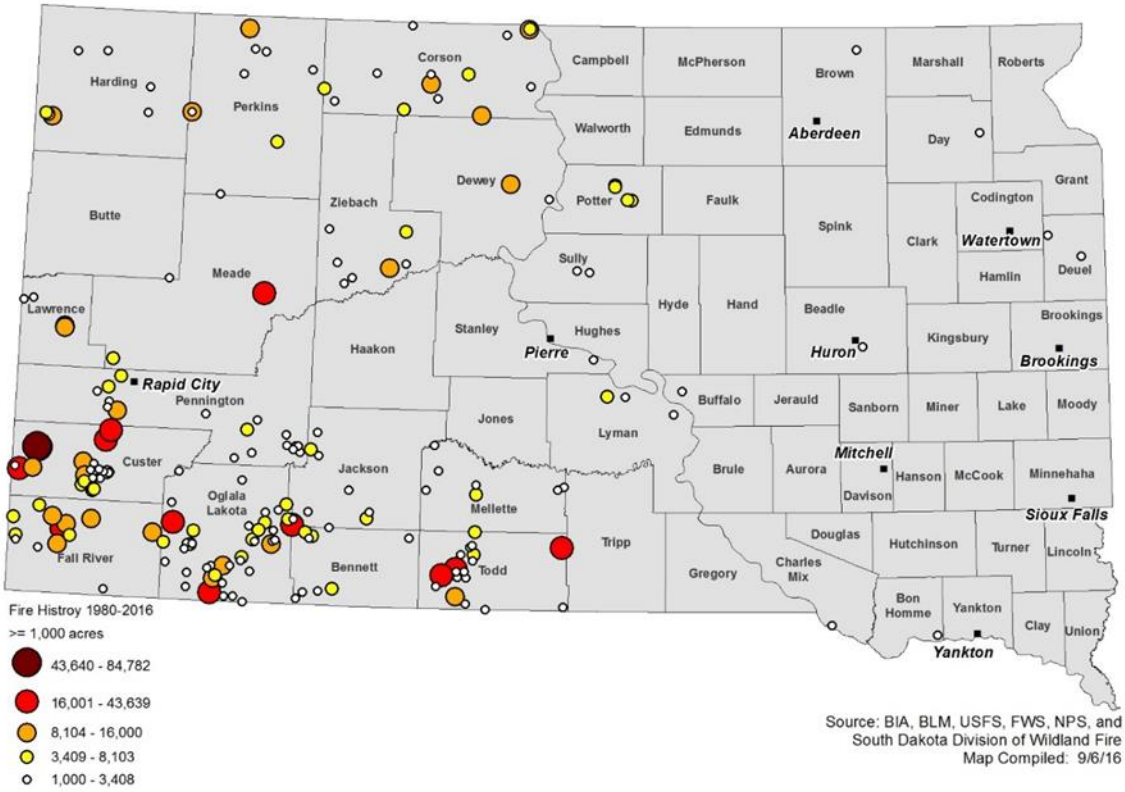


Figure 3-20 South Dakota Fire Occurrence Causes (1000 Acres or more): 1980-2016

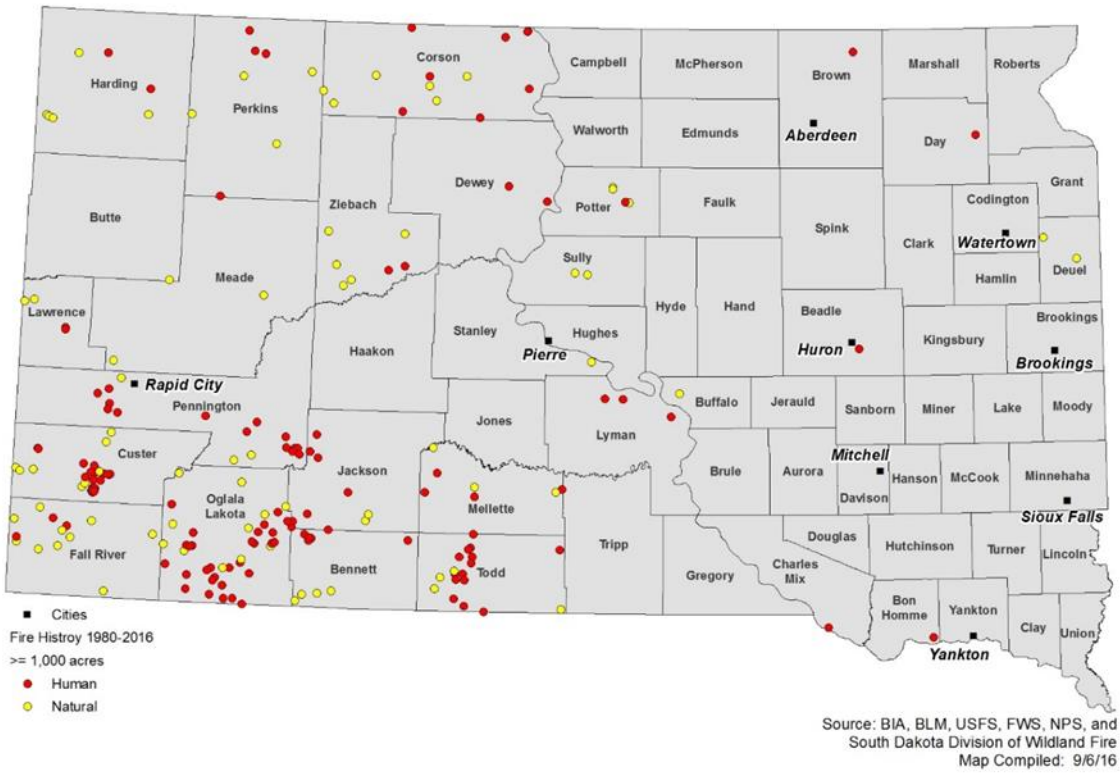


Table 3-19 South Dakota Wildfire Events

Date	Comments
August 11, 2018	**The Vineyard Fire (FEMA-5272-FM)** The fire began on August 11, 2018 east of the City of Hot Springs. The fire is estimated to have burned over 550 acres and came in close proximity to dense residential areas in Hot Springs. No injuries or structural damage had been recorded at the time of this plan update. The cause of the fire is still under investigation while the State Plan was being updated.
December 12, 2017	**The Legion Lake Fire (FEMA-5229-FM)** The Legion Lake Fire began on December 12, 2017 in Custer State Park and was fully contained by December 19, 2018. The fire was caused by a tree falling on a power line that caused sparks which ignited dormant vegetation that had been left from previous logging operations. The fire eventually moved out of the State Park, into Wind Cave National Park and onto private property burning 10,000 acres of private ranches. The Legion Lake Fire is the third-largest wildfire in the region's history burning 54,000 acres.
2015	**Sheep Draw Fire** The Sheep Draw Fire in northwest South Dakota was estimated at 13,949 acres. One non-commercial structure was burned. No injuries reported.
2013	**Pautre Fire** Planned to be a prescribed fire up to 210 acres on the Dakota Prairie National Grasslands, strong winds pushed the fire across a mowed fire line into tall grass and ultimately burned 10,679 acres.

Date	Comments
2012	**Crookston Fire** Driven by strong winds, the blaze started northeast of Kilgore and burned its way down to Crookston, Nebraska. The smoke was so thick firefighters closed the highway west of Valentine, Nebraska.
August 29, 2012	**Wellnitz Fire (FEMA-5010-FM)** The Wellnitz Fire began on August 29th due to lightning. The fire burned 77,159 acres across Oglala Lakota County (previously Shannon County), South Dakota and into Nebraska. Burned acreage in South Dakota alone was estimated at 28,478. The fire was 100% contained by September 7, 2012.
August 16, 2012	A wildfire burned grassland in and near the Karl E. Mundt National Wildfire Refuge in southeastern Gregory County South Dakota on August 16th. No structures were burned. The fire burned 146 acres, including 112 acres on the refuge and 34 acres of private land.
July 19, 2012	**Myrtle Fire (FEMA-2996-FM)** South Dakota received two Fire Management Assistance Declarations in 2012. The Myrtle Fire began on July 19th, 2012 in Custer County due to human causes. The fire burned 10,080 acres and was 100% contained by July 24th, 2012.
January 9, 2012	Unseasonably warm and dry weather, along with dry and dormant vegetation, provided a setting in which several fires that were started to burn trash and vegetation went out of control in Moody County. The largest was several miles northeast of Flandreau, where the burning of a tree pile spread to grassland. This fire burned about 120 acres, reaching to the eastern border of the county and state. Another fire just northwest of Flandreau, started to burn garbage, burned 4 acres of grassland. No indications of damage amounts were received, but no structures were reported to have burned.
October 4, 2011	Several wildfires broke out in Gregory and Charles Mix counties during the four day period. Warm and dry weather, strong winds, and dry vegetation due to extended dry weather preceding this time contributed to the fires starting and spreading. The fires affected grassland and cropland, including baled hay.
2011	740 fires burned 38,684.62 acres
2010	609 fires burned 13,448.181 acres
August 27, 2010	**Flynn Creek Fire** - Human caused fire that burned 65 acres of U.S. Forest Service Southeast of Custer, SD
2009	495 fires burned 11,372.499 acres
July 24, 2009	**Duck Creek Fire** - Railroad caused fire that burned 342.95 acres on U.S. Forest Service Southwest of Hot Springs, SD
2008	476 fires burned 7,088.953 acres
May 18, 2008	**Freeland Well Fire** - Human caused fire that burned 168 acres on U.S. Forest Service South of Custer, SD
2007	808 fires burned 160,851.23 acres
July 2007	**Boxelder Fire (FEMA-2716-FSA)** At the time of the state's request, the fire had burned approximately 700 acres and had resulted in the evacuation of 100 residents from the town of Nemo in Lawrence County.

Date	Comments
July 2007	**Alabaugh Fire (FEMA-2710-FSA)** This fire near Hot Springs in Fall River County was started by lightning on July 7 and was contained on July 12. It burned 10,324 acres. The fire killed one man and destroyed 33 homes. It also forced the evacuation of about 600 residents in about 300 homes. Fire suppression costs were estimated at $2.7 million. A state official said the blaze was the most intense wildfire ever recorded in the Black Hills. Sources: InciWeb, Rapid City Journal, National Public Radio
2006	1,388 fires burned 371,226.31 acres Source: Steve Hasenohrl, South Dakota Chief Fire Management Officer
July 2006	**East Ridge Fire (FEMA-2658-FSA)** 3,204 acres burned, $1,973,107 total outlay
2005	781 fires burned 45,323.641 acres
July 2005	**Skyline #2 Fire (FEMA-2569-FSA)** 42 acres burned, total outlay: $18,975 (FEMA share: $14,231)
July 2005	**Ricco Fire (FEMA-2565-FSA)** 3,939 acres burned in Meade County, started by lightning, total outlay: $573,581 (FEMA share: $428,064)
April 2005	**Camp Five Fire (FEMA-2557-FSA)** 775 acres burned. Request for assistance withdrawn because event did not meet fire cost thresholds.
2004	437 fires burned 15,517.87 acres
2003	710 fires burned 111,999.37 acres
November 2003	**Mill Road Fire (FEMA-2513-FSA)** Total outlay: $62,852 (FEMA share: $45,685)
2002	846 fires burned 179,287.9 acres
August 2002	**Battle Creek Fire (FEMA-2458-FSA)** On August 16, 2002, the Battle Creek Fire ignited on private land near Keystone. High temperatures, low relative humidity, and strong winds created conditions that led to intense fire behavior with long-range spotting. The fire burned actively for four days and burned 12,450 acres (9,120 acres of national forest system lands, 3,330 acres of private lands) before it was fully contained on August 25. Over 600 structures and the town of Keystone were threatened, but thanks to firefighters, losses were limited to three residences near Hayward. Source: U.S. Forest Service, Battle Creek Fire Rapid Assessment (www.fs.fed.us/r2/blackhills/fire/history/battlecreek/index.shtml) Total outlay: $1.8 million
June–July 2002	**Grizzly Gulch Fire (FEMA-2434-FSA)** This fire near Deadwood and Lead burned 10,801 acres and destroyed 7 homes and 20 other structures. Source: Jerome Harvey, "Historic Wildfire in the Black Hills"

Date	Comments
	(www.nfpa.org/assets/files/PDF/blackhills.pdf)
2001	611 fires burned 124,401.74 acres
July–August 2001	**Elk Mountain #2 Fire (FEMA-2369-FSA)** This fire burned mostly in Wyoming but was complexed with the Roger's Shack fire which burned 11,896 acres in South Dakota in western Custer County. Two single family residential homes were lost. Total outlay: $293,000
August–September 2000	**Flagpole Fire Complex (FEMA-2319-FSA) and Jasper Fire (FEMA-2324-FSA)** The Flagpole fire complex started on August 11, 2000, in Fall River County in southwestern South Dakota. The wildfire was actually three different starts, the Flagpole Mountain, Green Canyon, and Chilson II fires in the southern hills area. The fires were attributed to lightning. The Flagpole Mountain fire burned in ponderosa pine; the Green Canyon fire burned in grass, scrub, and juniper. The terrain was extremely rocky and steep, making access and fire-fighting difficult. Pushed by shifting winds, the Flagpole fire immediately threatened structures, including two homes, and destroyed one outbuilding. The Flagpole and Chilson II fires burned more than 6,000 acres by the evening of August 12. The Flagpole fire threatened 30 homes on the north, south, and east sides of the fire and prompted officials to call for voluntary evacuations in the Shep's Canyon area, where there was only one access road. One residence was lost on the north side of the fire. The fires eventually burned 7,386 acres. The Jasper Fire was located in Custer County in the Southwest Black Hills. It was the largest fire to occur in the Black Hills in at least a century. The fire started at about 2:30 p.m. on August 24, 2000 and was contained on September 8, 2000. The cause of the fire was arson. The weather was very hot and dry, vegetation moisture was at record low levels, and atmospheric conditions were very unstable. The conditions caused extreme fire behavior and the fire spread rapidly, doubling in size every hour on the day it started. Almost immediately after ignition, the fire spread into the tops of the trees and blowing embers began causing spot fires ahead of the main fire. The fire created its own weather pattern as it burned. Lightning from the storm created by the fire was a big concern. The fire completely blackened some areas, leaving scorched, dead trees and ash-covered ground in its wake. Other areas experienced only a light ground burn. Large areas within the fire perimeter remained green, either lightly burned or completely undamaged. Firefighting efforts continued for a month, and firefighters declared the fire controlled on the evening of September 25, 2000. The Jasper fire burned 83,500 acres and was the largest fire in Black Hills history. It destroyed one summer cabin and three outbuildings, burned acreage at the Jewel Cave National Monument, and threatened more than 100 other structures and the communities of Custer and Hill City. Fire losses included approximately 244 million board feet of timber, 150 miles of range fence, 65 livestock water tanks, 20 miles of range water lines, 17 wildlife water developments, 59 wooden power line structures, and 2,738 feet of above ground telephone line. Total outlay for both fires: $4.25 million
2000	1,348 fires burned 354,357.13 acres
1999	879 fires burned 161,972.42 acres
1998	208 fires burned 6,843.96 acres

Date	Comments
1997	69 fires burned 1,353.65 acres.
March 28, 1997	**Burdock Fire** - burned 350 acres on Private
1996	69 fires burned 3,484.57 acres
February 10, 1996	**East Gate Fire** - Powerline fire that burned 996 acres on Private
1995	56 fires burned 1,588.97 acres
September 5, 1995	**Indian Canyon Fire** - Lightning caused fire on Private burned 1,504 acres
1994	201 fires burned 2,663 acres [includes Stagebarn Canyon].
August 15, 1994	**Stagebarn Canyon Fire (FEMA-2109-FSA)** Stagebarn Canyon near Indian Hills subdivision northwest of Rapid City. Fire started by lightning. 112 acres burned; cost in excess of $159,000.
1993	44 fires burned 678 acres.
1992	958 fires burned 20,367 acres.
1991	815 fires burned 43,782 acres.
September 1990	**Swedlund Fire (Cicero Peak fire) (FEMA-2076-FSA)** Burned 14,518 acres, approximately 5,000 acres in Custer State Park. Caused by logging equipment.
1990	860 fires burned 11,725 acres.
1989	911 fires burned 14,779 acres.
1988	1,171 fires burned 69,512 acres.
July 5, 1988	**Galena Fire** – 16,788 acres burned in Custer State Park. Started by lightning and required the evacuation of the City of Keystone during the height of tourist season.
Jul 25, 1988	**Westberry Trail Fire (FEMA-2068-FSA)** Suspected arson fire and was located in a subdivision on the western edge of Rapid City. Burned 14 homes and 3,980 acres.
June 20, 1988	**The Short Pines Fire** in Harding County started by lightning burned over 5,274 acres of School and Public state land and one 105 acre fire started by a powerline in Rapid City on Skyline Drive destroyed one single family residence.
Jul 20, 1987	**Battle Mountain Fire (FEMA-2061-FSA)** Started by lightning in the game production area, two miles from Hot Springs. Burned 2,200 acres.
1987	1,638 fires burned 52,277 acres.
1986	478 fires burned 3,572 acres.
July 12, 1985	**Flint Hill Fire (FEMA-2057-FSA)** Lightning caused fire that burned 23,000 acres west of Edgemont.
July 12, 1985	**Seven Sisters Fire (FEMA-2056-FSA)**

Date	Comments
	Lightning cause fire that burned 9,300 acres south of Hot Springs.
1985	1,229 fires burned 110,669 acres.
1984	651 fires burned 28,230 acres.
1983	950 fires burned 18,613 acres.
1982	403 fires burned 6,886 acres.
1981	1,556 fires burned 24,537 acres.
1980	1,349 fires burned 42,077 acres.
1979	485 fires burned 14,214 acres.
1978	479 fires burned 48,290 acres.
1977	535 fires burned 6,952 acres.
1976	582 fires burned 9,130 acres.
July 1975	**Custer State Park (FEMA-2017-FSA)**
1975	851 fires burned 30,671 acres
July 1974	**Argle & Booms Canyon (FEMA-2016-FSA)** Lightning caused fire that burned 4,356 acres north of Hot Springs.
1974	1,022 fires burned 38,864 acres.
1973	704 fires burned 36,252 acres.
1972	452 fires burned 13,638 acres.
1971	815 fires burned 20,890 acres.
1970	477 fires burned 6196 acres.
1969	211 fires burned 3254 acres.
November 21, 1962	Burned an area that stretched from Harrold to Highmore (20 miles long) and consumed 30,000 acres of hay and cropland. No loss of life.
August 30, 1960	Two simultaneous lightning strikes south of Hot Springs started the Green Canyon fire (6,389 acres) and the Wildcat fire (10, 454 acres).
September 8, 1959	This human-caused fire nearly destroyed the town of Deadwood. The fire burned 4,500 acres (1,971 federal, 2,560 private) around the town and did more than $1 million (1959 dollars) in damage. More than 60 structures (businesses, residences, utilities, etc.) were destroyed and damage to infrastructure was severe. Nearly 4,000 people were evacuated from the town in less than 30 minutes. Source: Jerome Harvey, "Historic Wildfire in the Black Hills" (www.nfpa.org/assets/files/PDF/blackhills.pdf)
August 23, 1949	Human-caused forest fire started by Nemo. Burned out to the hogback area by Tilford. Burned 6,630 acres and required both the SDNG and Rapid City Air Base to provide over a 1000 personnel to the Black Hills NF to suppress the fire. (Source: Big Elk fire file, SDWF agency historical archives)

Date	Comments
September 5, 1947	Three human-caused fires burned into one conflagration that burned an estimated 320,000 acres in Hyde, Sully, Potter, Faulk and Hughes Counties in one day. Estimated $2,000,000 damage to improvements (1947 dollars). Considerable damage to range and farm land, (Source: SDWF agency historical archives and *"75 Years of Sully County History*" published by the *Onida Watchman.*
July 10, 1939	**McVey Fire by Hill City South Dakota** - Cause is still unclear. Burned 21, 857 acres. Almost burned over the town of Hill City. One firefighter was killed by a lightning strike during mop-up. 45 miles of fireline was constructed by over 1775 men at the height of the blaze. (Source*: Sawmills of the Black Hills*, by M. Linde and SDWF agency archives.
1931	**Rochford Burn** - Arson set forest fire. Burned approximately 20,900 acres in western Pennington County in the high elevation limestone country of the Black Hills National Forest, 12 structures were lost. (Source: SDWF Agency historical archives)
1899	**The Iron Creek fire** - Burned for most of August south of Spearfish. By the time winter snows arrived, it had burned 38,400 acres of timber on the Black Hills National Forest and numerous mining claims.
March 1879	This fire burned for at least one week in an area from Brookings County to Union County. The path was over 100 miles long and 20 miles wide.
October 1871	During the week of the Great Chicago fire, a large wildland fire occurred along the Missouri River burning from Springfield to Yankton, burning many structures and farms.

Probability

As shown in the differences in fires reported in Figure 3-20 wildfire reporting in the state varies regionally. Using the data in Table 3-19 (excluding the outlier of the 1879 fire), there were 87 wildfire events in South Dakota between 1871 and 2016 (48 years). Given both sets of data, wildfires, including those of a significant size, have a 100% chance of occurrence somewhere in the state from early spring to late fall every year. (Note, the two significant wildfire events that took place in 2017 and 2018 are not included in this calculation. More information on these events can be found in the Past Events section above).

According to the Federal Wildland Fire Occurrence data, 163 significant fires (1,000 acres or more in size) occurred between 1980 and 2011. Based on this data there is a 100% chance that a large fire of 1,000 acres or more will occur in South Dakota in any given year. Smaller fires also have a 100% annual occurrence probability.

Climate Change Considerations

Wildfire conditions across South Dakota and the western United States in general are likely to worsen in the future due to climate change. This is due to increasing temperatures, an increase in annual precipitation, and drought as a regular occurrence. The increase in temperatures can dry out fuels more rapidly. The increase in moisture can provide favorable conditions for fuel (vegetation) growth. The trend towards larger precipitation events with drought as a common occurrence provides multiple windows of opportunity for the fuels to dry out and burn, particularly fine fuels like grasses. South Dakota has already had large fires in every month of the year, and so it is possible that the state will have a true 12-month fire season. As a case in point the Legion Lake Fire on December 12-19 was the third-largest wildfire in the Black Hills region's history, burning 54,000 acres.

The U.S. Forest Service released a study titled "Wildland Fire and Climate Change" detailing the effect climate change will likely have on atmospheric patterns that affect fire weather. These changes could result in fire patterns that will in turn impact carbon cycling, forest structure, and species composition. The

study explains that with a doubled CO2 environment, there is potential for an increase in lightning activity, a higher frequency of surface pressure and associated circulation patterns conducive to surface drying, and fire-weather conditions in general. These findings suggest that these factors and higher summer temperatures will likely increase the annual window of high fire risk by 10-30%. Predictions past 2040 are largely speculative given the current rate of increase in fossil fuel emissions, but there will certainly be in increase in the potential for drought and the number of days in a year with flammable fuels. The above variables will extend fire seasons and area burned in ecoregions where fire extent is linked to fuel conditions. More intense wildfires can produce highly erodible soils that can lead to increased sediment loading in reservoirs and streams, damaging water infrastructure and degrading water quality. This can also result in increased flood and debris flow risk in affected watersheds for many years following a destructive fire.

3.2.6 Drought

Description

According to the National Weather Service, "Drought is a deficiency in precipitation over an extended period, usually a season or more, resulting in a water shortage causing adverse impacts on vegetation, animals, and/or people. It is a normal, recurrent feature of climate that occurs in virtually all climate zones, from very wet to very dry. Human factors, such as water demand and water management, can exacerbate the impact that drought has on a region." Four common types of drought are defined below.

- **Meteorological** drought is most often described in terms of dryness and the duration of the dry period. Other types of drought typically begin with a meteorological drought.
- **Hydrological** drought usually occurs as a result of precipitation shortfalls that negatively impact water supply.
- **Agricultural** drought links impacts on agriculture to meteorological or hydrological drought with a focus on precipitation shortages, soil water deficits, reduced water levels needed for irrigation, etc.
- **Socioeconomic** drought refers to the situation that occurs when physical water shortages begin to affect people.
- **Flash** drought refers to relatively short period of warm surface temperature and anomalously low and rapid decreasing soil moisture. It is related to the rate of rapid drought intensification rather than duration of drought conditions.

South Dakota is vulnerable to the social, economic, and environmental impacts of drought. Specifically, drought in South Dakota means limited water availability for people, agriculture, and recreation. The demand for water for multiple uses also impacts water availability. Rural water systems designed largely to supply water for people are now also being used for cattle and to fight wildfires, taxing the limits of the systems. These problems are only expected to get worse in the years to come as populations grow.

Drought in South Dakota is often accompanied by periods of extreme heat. According to information provided by FEMA, extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Heat kills by taxing the human body beyond its abilities. In a normal year, about 175 Americans succumb to the demands of summer heat. According to the NWS, among natural hazards, only the cold of winter - not lightning, hurricanes, tornadoes, floods, or earthquakes - takes a greater toll. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the heat wave of 1980, more than 1,250 people died.

Heat disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When heat

gain exceeds the level the body can remove, or when the body cannot compensate for fluids and salt lost through perspiration, the temperature of the body's inner core begins to rise, and heat-related illness may develop. Elderly persons, small children, those with chronic illnesses, those on certain medications or drugs, and persons with weight and alcohol problems are particularly susceptible to heat reactions, especially during heat waves in areas where moderate climate usually prevails. The chart below illustrates the relationship of temperature and humidity to heat disorders.

Figure 3-21 National Weather Service Heat Index

NOAA's National Weather Service

Heat Index

Temperature (°F)

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

Likelihood of Heat Disorders with Prolonged Exposure or Streuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Source: National Weather Service

Note: Heat Index (HI) values were devised for shady, light wind conditions. Exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

The NWS has in place a system to initiate alert procedures (advisories or warnings) when the Heat Index is expected to have a significant impact on public safety. The expected severity of the heat determines whether advisories or warnings are issued. A common guideline for the issuance of excessive heat alerts is when the maximum daytime high is expected to equal or exceed 105°F and a nighttime minimum high of 80°F or above is expected for two or more consecutive days. Heat alerts are issued by a county when any locations within the county is expected to reach these criteria.

Location

No portion of the State of South Dakota is immune to drought conditions. The effects of drought vary based on where in the state it occurs, when it happens, and how long the drought persists. For example, a drought in East River (defined as the eastern half of the state east of the Missouri River) can greatly affect agricultural crops. A long-term drought is not needed to affect agricultural yields. Droughts of just a few

weeks, also known as "flash drought", during critical periods of plant development can have disastrous effects on agriculture production. Droughts that occur in the Black Hills during winter months may affects winter sports related tourism and recreation. Droughts that occur in in the western part of the state may increase the threat of wildfire. In summary, drought is one of the few hazards with the potential to directly or indirectly impact the entire population of the state, be it from water restrictions, higher water and food prices, reduced air or water quality, or restricted access to recreational areas (McKee and Doesken, 1999).

Past Events

A comprehensive compendium of historical drought information for South Dakota is difficult to find. The following is a summary of information on major droughts that have affected South Dakota, much of it based on data compiled from the NCEI and from earlier versions of the SHMP.

1889–1905 – This multi-year, statewide drought was most severe between 1894 - 1896 and 1898 - 1901.

1910-1914 – This drought was worse in the western half of the state, but regional impacts varied. It was most severe in 1911.

The 1930's Drought – The Dust Bowl drought severely affected much of the United States during the 1930s. The drought came in three waves, 1934, 1936, and 1939-1940, but some regions of the High Plains experienced drought conditions for as many as eight consecutive years. The soil, depleted of moisture, was lifted by the wind into great clouds of dust and sand which were so thick they concealed the sun for several days at a time. They were referred to as "black blizzards." The period itself is known as the dust bowl. The "black blizzards" were caused by sustained drought conditions compounded by years of land management practices that left topsoil susceptible to the forces of the wind.

The agricultural and economic damage devastated residents of the Great Plains. The Dust Bowl drought worsened the already severe economic crises that many Great Plains farmers faced. In the early 1930s, many farmers were trying to recover from economic losses suffered during the Great Depression. To compensate for these losses, they began to increase their crop yields. High production drove prices down, forcing farmers to keep increasing their production to pay for both their equipment and their land. When the drought hit, farmers could no longer produce enough crops to pay off loans or even pay for essential needs. Even with federal emergency aid, many Great Plains farmers could not withstand the economic impacts of the drought. Many farmers were forced off their land. One in ten farms changed possession at the peak of the drought. The agricultural and economic damage devastated residents of the Great Plains.

Many factors contributed to the severe impact of this drought and in its aftermath a better understanding of the interactions between the natural elements (e.g., climate, plants, and soil) and human-related elements (e.g., agricultural practices, economics, and social conditions) of the Great Plains developed. As a result, farmers adopted new cultivation methods to help control soil erosion in dry land ecosystems; consequently, subsequent droughts in the region have not had the same impact.

The 1950s Drought – Fueled by post-war economic stability and technological advancement, the 1950s represented a time of growth and prosperity for some Americans. But while much of the country celebrated a resurgence of well-being, many residents of the Great Plains and southwestern United States were suffering. During the 1950s, the Great Plains and the southwestern U.S. withstood a five-year drought, and in three of these years, drought conditions stretched coast to coast. The 1950s drought was characterized by both decreased rainfall and excessively high temperatures. The first effects of the drought were felt in the southwestern U.S. in 1950 and by 1953 conditions had spread to Oklahoma, Kansas, and Nebraska. By 1954, the drought encompassed a ten-state area reaching from the mid-west to the Great Plains, and southward into New Mexico. The area from the Texas panhandle to central and eastern South Dakota, western Kansas, and central Nebraska experienced severe drought conditions. The

drought maintained a stronghold in the Great Plains, reaching a peak in 1956. The drought subsided in most areas with the spring rains of 1957. A disaster of this magnitude can create severe social and economic repercussions, as was the case in the southern Great Plains region. The drought devastated the region's agriculture, with crop yields in some areas decreased as much as 50%. Excessive temperatures and minimal rainfall scorched grasslands typically used for grazing. With grass scarce, hay prices rose, forcing some ranchers to feed their cattle a mixture of prickly pear cactus and molasses. By the time the drought subsided in 1957, many counties across the region were declared federal drought disaster areas (NCEI, 2003).

The 1975-1976 Drought – This drought was short but severe, and similar to the 2012-2013 drought in agricultural impacts. This drought resulted in the state's only drought emergency declaration (FEMA-3015-EM in 1976) to date.

The 1980-1982 Drought – This was a statewide drought that was most severe in 1981 and rated as a 10-25 year event.

The 1988-1992 Drought – This drought contributed to large wildland fires in the Black Hills. Conditions became so severe that the state considered using cloud seeding, despite the bad press associated with cloud seeding in the aftermath of the 1972 Rapid City flood.

The 2002-2007 Drought – The state also experienced significant droughts in 2002-2007. South Dakota dealt with impacts such as switching some reservoir intakes to river intakes in 2002-2003 because the reservoir levels receded below the intake. Water recreation declined in 2006. The 2002-2007 drought also exacerbated wildland fire risk, leading to a particularly bad fire season during 2006. The impacts of this drought are discussed in greater detail by sector in Chapter 3 Vulnerability Assessment.

The 2012-2013 Drought – The 2012-2013 drought wasn't as lengthy as other droughts but did have significant agricultural impacts. Shutoff orders were issued to water rights holders in the spring of 2012. The 2012-2013 drought actually created some positive aspects by offsetting the impacts of the floods during 2010-2011. The impacts of this drought are discussed in greater detail by sector in Section 3.3.10 Vulnerability Assessment.

Winter-Spring 2015 Drought - South Dakota experienced its driest January-April of any year on record since the late 1800s. Dry conditions continued across much of the state until mid-May when unusually copious rainfall continued into June and virtually eliminated drought conditions and caused flooding issues instead.

Figure 3-22 South Dakota Drought Status, July 24, 2007

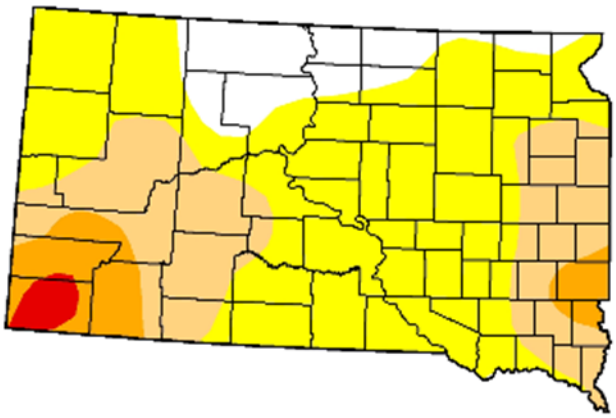
U.S. Drought Monitor

South Dakota

July 24, 2007
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	11.3	88.7	33.8	9.0	1.5	0.0
Last Week (07/17/2007 map)	45.8	54.2	16.8	6.6	1.5	0.0
3 Months Ago (05/01/2007 map)	49.0	51.0	32.4	13.7	1.1	0.0
Start of Calendar Year (01/02/2007 map)	11.9	88.1	56.5	52.2	10.9	0.0
Start of Water Year (10/03/2006 map)	30.1	69.9	57.9	52.1	13.4	0.0
One Year Ago (07/25/2006 map)	0.0	100.0	100.0	81.0	54.6	18.9



Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements

http://drought.unl.edu/dm

Released Thursday, July 26, 2007
Author: Richard Heim/Liz Love-Brotak, NOAA/NESDIS/NCDC

Source: University of Nebraska–Lincoln National Drought Mitigation Center
http://drought.unl.edu/dm/DM_state.htm?SD,HP

The Drought Monitor graphic in Figure 3-22 illustrates South Dakota's drought status as of July 24, 2007. Following Figure 3-21, a drought monitor graphic is shown for 2010, 2013, and 2016. Together the graphics show how intensity and coverage varies over time., and how drought conditions changed since 2007 from drought free in 2010 to intense drought in 2013.

Figure 3-23 South Dakota's Drought Status, July 27, 2010

U.S. Drought Monitor

South Dakota

July 27, 2010
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	100.0	0.0	0.0	0.0	0.0	0.0
Last Week (07/20/2010 map)	100.0	0.0	0.0	0.0	0.0	0.0
3 Months Ago (05/04/2010 map)	100.0	0.0	0.0	0.0	0.0	0.0
Start of Calendar Year (01/05/2010 map)	100.0	0.0	0.0	0.0	0.0	0.0
Start of Water Year (10/06/2009 map)	97.0	3.0	0.0	0.0	0.0	0.0
One Year Ago (07/28/2009 map)	95.7	4.3	0.0	0.0	0.0	0.0

Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements

http://drought.unl.edu/dm

Released Thursday, July 29, 2010
Author: D. Miskus, CPC/NOAA

Source: University of Nebraska–Lincoln National Drought Mitigation Center
http://drought.unl.edu/dm/DM_state.htm?SD,HP

U.S. Drought Monitor archives indicate that most of 2011 was also a wet year for South Dakota. However, dry conditions returned that winter.

Figure 3-24 South Dakota's Drought Status, February 12, 2013

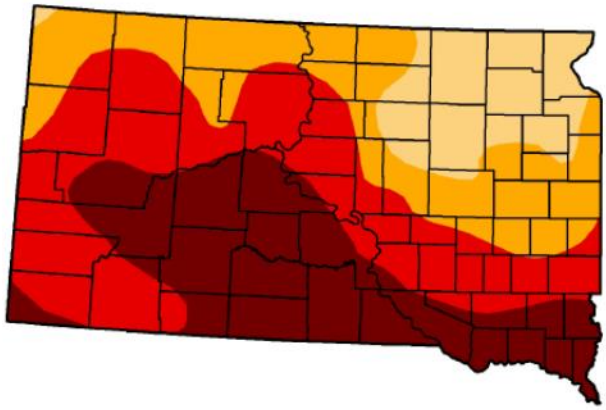
U.S. Drought Monitor

February 12, 2013
Valid 7 a.m. EST

South Dakota

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	86.77	63.21	29.58
Last Week (02/05/2013 map)	0.00	100.00	100.00	96.93	64.29	29.57
3 Months Ago (11/13/2012 map)	0.00	100.00	100.00	93.09	54.71	32.57
Start of Calendar Year (01/01/2013 map)	0.00	100.00	100.00	96.95	63.17	30.68
Start of Water Year (09/25/2012 map)	0.00	100.00	100.00	74.69	50.53	6.72
One Year Ago (02/07/2012 map)	30.59	69.41	20.25	1.65	0.00	0.00



Intensity:

- *D0 Abnormally Dry*
- *D1 Drought - Moderate*
- *D2 Drought - Severe*
- *D3 Drought - Extreme*
- *D4 Drought - Exceptional*

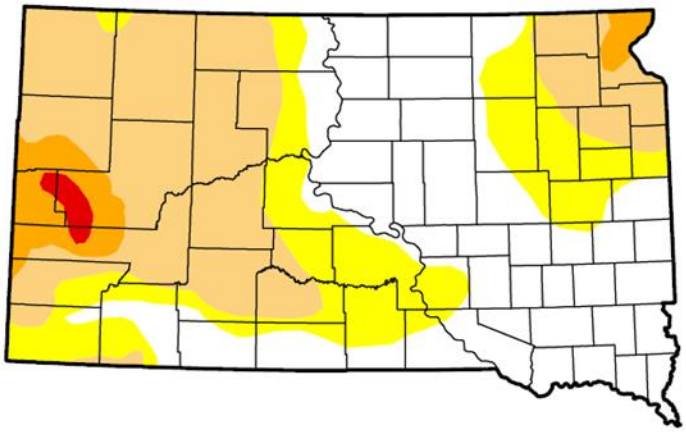
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu

Released Thursday, February 14, 2013
Michael Brewer, National Climatic Data Center, NOAA

Source: University of Nebraska–Lincoln National Drought Mitigation Center
http://drought.unl.edu/dm/DM_state.htm?SD,HP

Figure 3-25 South Dakota's Drought Status, July 5, 2016



U.S. Drought Monitor
South Dakota

July 5, 2016
(Released Thursday, Jul. 7, 2016)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	40.45	59.55	38.36	5.62	0.81	0.00
Last Week 6/28/2016	38.52	61.48	38.91	5.81	0.81	0.00
3 Months Ago 4/5/2016	74.27	25.73	0.00	0.00	0.00	0.00
Start of Calendar Year 12/29/2015	89.43	10.57	0.00	0.00	0.00	0.00
Start of Water Year 9/29/2015	94.77	5.23	0.00	0.00	0.00	0.00
One Year Ago 7/7/2015	95.43	4.57	0.00	0.00	0.00	0.00

Intensity:
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
David Miskus
NOAA/NWS/NCEP/CPC

http://droughtmonitor.unl.edu/

Historical drought information for South Dakota is difficult to find. An article in the Proceedings of the South Dakota Academy of Science suggests that South Dakota has seen droughts worse than the 1930's Dust Bowl. The article is based on a study of tree core data conducted to learn more about historical drought in South Dakota. The results of the study are illustrated in Table 3-20. According to the U.S. Drought Monitor, South Dakota remains in a moderate drought as of July 2016.

Table 3-20 Duration and Magnitude Estimates of 15 Dry and 15 Wet Spells in South Dakota

	Dry Periods			Wet Periods		
Rank	Years	No. Years	% of Max	Years	No. Years	% of Max
1	1531-1551*	21	100.0	1429-1448*	20	100.0
2	1325-1344*	20	90.8	1284-1297*	14	80.3
3	1859-1873	15	82.5	1559-1574*	16	66.0
4	1397-1411*	15	73.0	1609-1617	9	53.6
5	1710-1725	16	65.8	1762-1769	8	35.7
6	1780-1791	12	51.3	1882-1892	11	31.5
7	1933-1942	10	50.0	1683-1695	12	30.0
8	1753-1761	9	43.5	1792-1806	15	28.1
9	1660-1668	9	44.7	1903-1910	8	27.2
10	1580-1598*	9	32.2	1962-1969	8	26.1
11	1852-1857	6	29.7	1773-1779	7	24.4

	Dry Periods			Wet Periods		
Rank	Years	No. Years	% of Max	Years	No. Years	% of Max
12	1956-1961	6	29.6	1832-1842	11	21.1
13	1467-1472*	6	27.0	1726-1733	8	21.0
14	1377-1388*	12	26.3	1943-1947	5	20.6
15	1637-1640	4	24.8	1641-1645	5	19.5

Source: Bunkers, M.J., L.R. Johnson, J.R. Miller, and C.H. Sieg. 1999. Old Black Hills Ponderosa Pines Tell a Story. *Proceedings of the South Dakota Academy of Science*, Vol. 78.

Note: *Sample size <5 trees and is likely not adequate to reliably infer precipitation patterns.

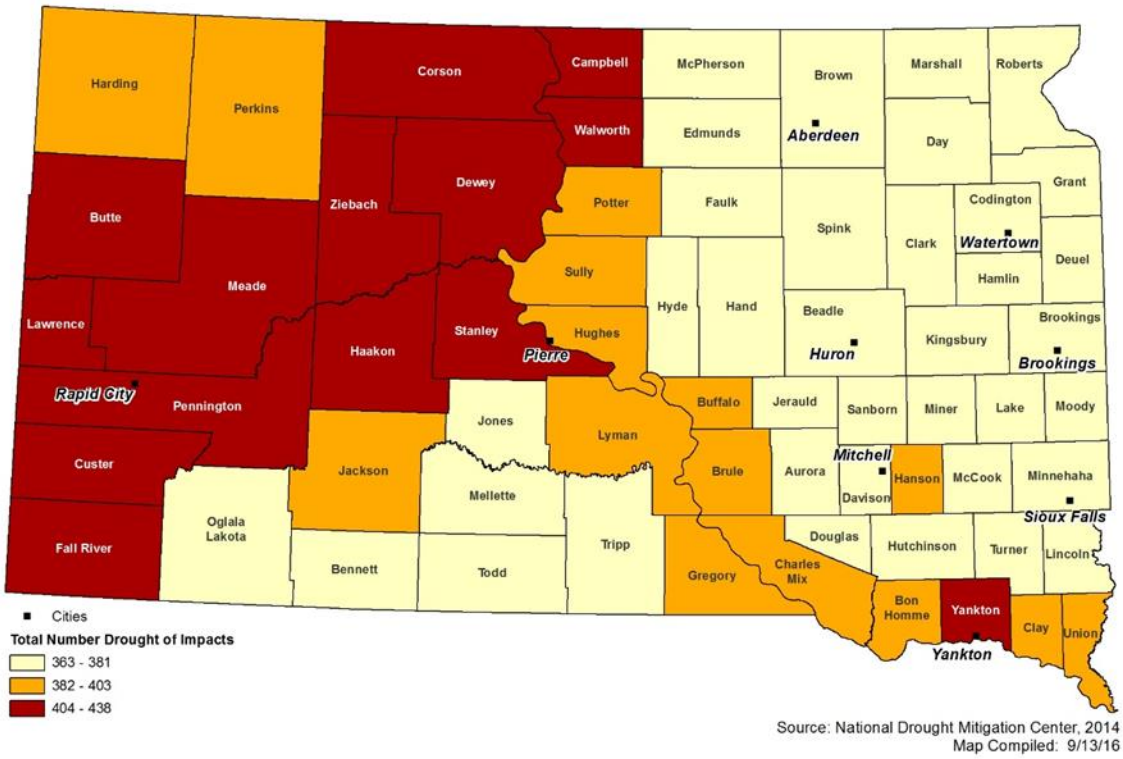
The National Drought Mitigation Center's Drought Impact Reporter contains information on 380 drought impacts from droughts that affected South Dakota between January 1, 1980 and July 2016. Figure 3-26 shows the distribution of drought impacts among South Dakota's counties. Corson, Campbell, Dewey, Walworth, and Pennington counties have experienced the most drought impacts according to the map. Most of the impacts, 172, were classified as "agriculture." Other impacts include "energy" (5), "plants and wildlife" (36), "society and public health" (44), "water supply and quality" (60), "business and industry" (17), "fire" (48), "relief, response, and restrictions" (103), and "tourism and recreation" (4). These categories are described as follows:

- **Agriculture** - Drought effects associated with agriculture, farming, aquaculture, horticulture, forestry, or ranching. Examples of drought-induced agricultural impacts include damage to crop quality; income loss for farmers due to reduced crop yields; reduced productivity of cropland; insect infestation; plant disease; increased irrigation costs; cost of new or supplemental water resource development (wells, dams, pipelines) for agriculture; reduced productivity of rangeland; forced reduction of foundation stock; closure/limitation of public lands to grazing; high cost or unavailability of water for livestock, Christmas tree farms, forestry, raising domesticated horses, bees, fish, shellfish or horticulture.
- **Business & Industry** - This category tracks drought's effects on non-agriculture and non-tourism businesses, such as lawn care, recreational vehicles or gear dealers, and plant nurseries. Typical impacts include reduction or loss of demand for goods or services, reduction in employment, variation in number of calls for service, late opening or early closure for the season, bankruptcy, permanent store closure, and other economic impacts.
- **Energy** - This category concerns drought's effects on power production, rates, and revenue. Examples include production changes for both hydropower and non-hydropower providers, changes in electricity rates, revenue shortfalls and/or windfall profits, and purchase of electricity when hydropower generation is down.
- **Fire** - Drought often contributes to forest, range, rural, or urban fires, fire danger, and burning restrictions. Specific impacts include enacting or easing burning restrictions, fireworks bans, increased fire risk, occurrence of fire (number of acres burned, number of wildland fires compared to average, people displaced, etc.), state of emergency during periods of high fire danger, closure of roads or land due to fire occurrence or risk, and expenses to state and county governments of paying firefighters overtime and paying equipment (helicopter) costs.
- **Plants & Wildlife** - Drought effects associated with unmanaged plants and wildlife, both aquatic and terrestrial, include loss of biodiversity of plants or wildlife; loss of trees from rural or urban landscapes, shelterbelts, or wooded conservation areas; reduction and degradation of fish and wildlife habitat; lack of feed and drinking water; greater mortality due to increased contact with agricultural producers, as animals seek food from farms and producers are less tolerant of the intrusion; disease; increased vulnerability to predation (from species concentrated near water); migration and concentration (loss of wildlife in some areas and too much wildlife in others); increased stress on

endangered species; salinity levels affecting wildlife; wildlife encroaching into urban areas; and loss of wetlands.

- **Society & Public Health** - Drought effects associated with human, public and social health include health-related problems related to reduced water quantity and/or quality, such as increased concentration of contaminants; loss of human life (e.g. from heat stress, suicide); increased respiratory ailments; increased disease caused by wildland fire concentrations; increased human disease caused by changes in insect carrier populations; population migration (rural to urban areas, migrants into the United States); loss of aesthetic values; change in daily activities (non-recreational, like putting a bucket in the shower to catch water); elevated stress levels; meetings to discuss drought; communities creating drought plans; lawmakers altering penalties for violation of water restrictions; demand for higher water rates; cultural/historical discoveries form low water levels; prayer meetings; cancellations of fundraising events; cancellation/alteration of festivals or holiday traditions; stockpiling water; public service announcements and drought information websites; protests; and conflicts within the community due to competition for water.
- **Tourism & Recreation** - Drought effects associated with recreational activities and tourism include closure of state hiking trails and hunting areas due to fire danger; water access or navigation problems for recreation; bans on recreational activities; reduced license, permit, or ticket sales (e.g. hunting, fishing, ski lifts, etc.); losses related to curtailed activities (e.g. bird watching, hunting and fishing, boating, etc.); reduced park visitation; and cancellation or postponement of sporting events.
- **Water Supply & Quality** - Drought effects associated with water supply and water quality include dry wells, voluntary and mandatory water restrictions, changes in water rates, easing of water restrictions, increases in requests for new well permits, changes in water use due to water restrictions, greater water demand, decreases in water allocation or allotments, installation or alteration of water pumps or water intakes, changes to allowable water contaminants, water line damage or repairs due to drought stress, drinking water turbidity, change in water color or odor, declaration of drought watches or warnings, and mitigation activities.

Figure 3-26 Drought Impact Distribution in South Dakota: 1980-2015



Source: National Drought Mitigation Center Drought Impact Reporter

NCEI reported 297 drought events affecting 46 counties and/or zones in South Dakota since 2012. No damages or casualties were recorded for these events. Table 3-21 summarizes some of the most severe droughts in the state since 1889.

Table 3-21 South Dakota Droughts: 1889-2017

Date	Comments
June 2017	Governor Daugaard activates the Drought Task Force and on June 8, 2017 declares a drought emergency for the state. The 2017 drought is reported to have led to diminished crop production in the state and to have lasted into January 2018.
July 2016	Governor Daugaard activated the Drought Task Force due to the moderate and severe drought conditions in western portions of the state and extreme conditions in northeastern South Dakota. By August 2016 over 50% of the state was in moderate drought.
January-June 2013	Drought conditions continued over all southeast South Dakota in January. Precipitation was below to well below normal, although with the low midwinter normals, even greater precipitation would have been unlikely to change the dry soil conditions. There was little noted in the way of new effects of the drought, with the dry conditions giving a poor outlook for the Spring and Summer, including poor germination of the winter wheat crop during the dry fall. Water restrictions continued to be few during the winter because of the low water usage, but the area was becoming more vulnerable to even marginally weather if it developed in the spring and summer. Drought was generally listed as continued severe to extreme for the area.
October 2012	Drought conditions continued over all southeast South Dakota in October with well below normal rainfall keeping soil and vegetation dry. Rainfall for the month was below normal

Date	Comments
	everywhere, and less than half of normal in much of the area. Harvest of drought affected crops was completed, but there was no estimation available on how much yields were reduced. Winter wheat was planted on time, but the lack of moisture greatly hampered germination. Water restrictions were generally eased, with water use dropping off with the fall season. Drought was generally listed as continued severe to extreme for the area.
September 2012	Drought conditions continued over all southeast South Dakota with well below normal rainfall keeping soil and vegetation dry. Rainfall for the month varied from around half to less than a quarter of normal. Stress on crops that prevailed over the growing season became more evident with the start of harvest, although the amount of the reduced yields was still uncertain. Local governments continued to use water use restrictions in an effort to prevent serious water supply problems. Drought was generally listed as continued severe to extreme for the area.
August 2012	Drought conditions continued over all the area with below normal rainfall keeping soil conditions dry. Stress on crops continued even though August was less hot than July, with temperatures averaging only a little above normal. Crop damage was quite evident, though the amount of reduced yields and other damage which might become evident at harvest was uncertain. While reported water supply problems were not extreme, many local governments had water use restrictions in place. Drought was generally listed as severe to extreme for the area and was being compared to the worst of the dust bowl years, though not yet over as long a time period.
July – August 2012	Drought conditions became established over much of the state with long term dry climate and soil conditions combining with much below normal rainfall during the month. Stress on crops increased and was continuous with no significant relief during the dry month. Hot weather added to the stress as it contributed to high evaporation. Crop damage in the form of reduced yields became certain, but the long remaining time to harvest and the unknown rainfall before that time made even rough damage estimates impossible. Severe general long term non-agricultural water supply problems were not observed, but the continued long term dry conditions raised fears of this for the future. Cattle sell-offs were also occurring across the region. Range and pasture conditions were poor to very poor with fire danger remaining a big issue. The severe drought continued into August.
June 2012	Long term dry climate and soil conditions combined with well below normal rainfall to make the dry conditions more acute and short term. This resulted in stress on crops developing during the month, mainly south of Interstate 90. After an abnormally dry fall and winter, short term drought fears had been temporarily forestalled by spring rains. The rains had fallen shortly after an unusually early planning brought on by very warm late winter and early spring weather. However, the return to dry weather in June compounded the effects of the long term dry conditions.
January –March 2012	The severe drought conditions from December continued across part of northeast South Dakota including the counties of Deuel, Codington, and Hamlin throughout March. The severe drought conditions would continue into February.
2007	Drought continued in some areas of South Dakota. The July 24, 2007, Drought Monitor for South Dakota (Figure 3-23) showed that drought encompassed most of the state. Most of Fall River County was experiencing severe drought conditions that also reached north into southern Custer County.
2006	Fifty-six counties designated primary natural disaster areas by the USDA. The other 10 were contiguous to primary natural disaster areas and thus also eligible for assistance. For many areas, this was their seventh consecutive year of drought. The NWS cooperative observer 8 miles north-northwest of Usta in Perkins County recorded a maximum temperature of 120

Date	Comments
	degrees on July 15th, which tied the previous all-time record high in South Dakota, first set on July 5th, 1936 in Gann Valley. A woman died of heat exhaustion while hiking in the Badlands National Park on July 16th.
2005	Fifteen counties designated primary natural disaster areas by the USDA. Twenty-nine were contiguous to primary natural disaster areas and thus also eligible for assistance. In 2005, the Missouri River basin had experienced five consecutive years of below normal runoff. System storage was at a record low due to the combined impact of the drought and water allocation decisions made during the drought. Impacts included reduced hydropower production, loss of fish production, unusable boat ramps, and irrigation water supply problems. Source: South Dakota Engineer Society
2004	Thirty-four counties designated primary natural disaster areas by the USDA. Eighteen were contiguous to primary natural disaster areas and thus also eligible for assistance.
2003	Forty-three counties designated primary natural disaster areas by the USDA. Twenty were contiguous to primary natural disaster areas (in South Dakota or neighboring states) and thus also eligible for assistance.
2002	Many areas in South Dakota were devastated by drought in 2002. After a dry winter and spring, below normal rainfall for June brought severe drought conditions to the area. Much of the rainfall for June was below 50 percent of normal with much of the area receiving 20 to 40 percent of the normal rainfall. Some locations were at 10 to 15 percent of normal rainfall. Central and north central South Dakota were the hardest hit with the drought conditions. As a result of the severe dryness, a lot of grazing land and stock ponds dried up, and ranchers had to buy additional feed for their animals, transport them to healthier pastureland for grazing, or sell their herds prematurely. Crops suffered with much having to be cut up for hay or replanted. Water levels on lakes and rivers were also way down. Burn bans and voluntary or mandatory water restrictions were implemented across much of the area. All counties were declared drought disasters.
May/July 1992	Twenty-eight counties declared by governor as drought disaster areas: Aurora, Bon Homme, Buffalo, Butte, Campbell, Charles Mix, Corson, Dewey, Douglas, Edmunds, Haakon, Hand, Harding, Hughes, Hyde, Jackson, Jerauld, Jones, Lawrence, Lyman, Meade, Perkins, Stanley, Sully, Todd, Tripp, Walworth, and Ziebach.
1988	Statewide. Regional impact varied.
1985–1987	Western half of state during 1985; continued in Black Hills during 1986 and 1987. Rated as a 10- to 25-year event.
1980–1982	Statewide. Rated as a 10- to 25-year event. Most severe in 1981.
1973–1977	Statewide, except Black Hills. Rated as a 10- to 25-year event. Most severe in 1976. Includes drought emergency declaration (FEMA-3015-EM) in 1976.
1954–1962	Statewide. Rated as a 25-year event. Regional variations. Most severe in 1956 and 1959, except in the Black Hills where it was most severe in 1961.
1929–1942	Statewide. Rated as greater than a 25-year event. Dust Bowl years. Regional impact varied a little. Most severe in 1931, 1933, 1934, and 1936. Included in this period was a “plague” of grasshoppers.

Date	Comments
1910–1914	Western half of state. Regional impact varied. Most severe in 1911.
1889–1905	Statewide. Regional impact varied. Most severe between 1894 and 1896 and 1898 and 1901.

Source: NCEI

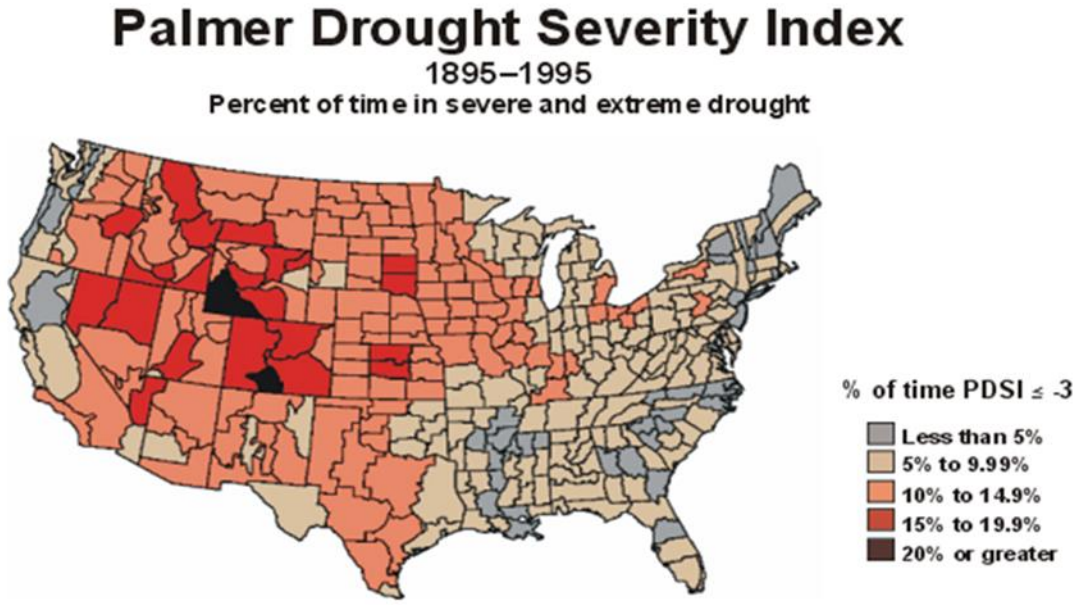
Data on indemnity payouts for crop loss due to drought and high heat between 2010 and 2012 was obtained from the Risk Management Agency. In 2012, the state received $838,876,036 for crop loss due to drought and $47,640,782 due to heat, for a total of $886,516,818. This contrasts sharply with the indemnity payments in 2011 and 2010, both of which were wet years. In 2011, the state received $9,879,016 for crop losses from heat and $4,766,416 for drought for a total of $14,555,432. In 2010, the state received $4,985,132 for crop losses from drought and $2,110,751 for heat, for a total of $7,095,883. Clearly, severe drought years can have a devastating financial impact on South Dakota's agricultural industry.

Probability

Figure 3-26 from the NDMC website, illustrates that most of South Dakota has experienced severe or extreme drought between 15 and 19.9% of the time over a 100-year period. Based on the tree ring research noted previously, which spans a period of roughly 400 years, multi-year droughts as significant as the 1930's drought or worse occur on average every 57 years. Based on historical records (10 in the past 118 years, counting the 2002-2007 dry spell and other multi- year events as one event) notable droughts have occurred somewhere in the state on average about every 12 years, which is equivalent of an 8% chance any given year. Climate change could increase the frequency of drought in South Dakota in the future. The next section discusses climate change as it relates to the probability of future droughts and its general implications for the state.

Note, the drought experienced in 2016 and 2017 took place after the 2016 HIRA was completed and are not reflected in these probability calculations or reflected in Section 3.3.10 Assessing Drought Vulnerability.

Figure 3-27 United States: Percent of Time in Drought, 1895-1995



SOURCE: McKee et al. (1993); NOAA (1990); High Plains Regional Climate Center (1996)
Albers Equal Area Projection; Map prepared at the National Drought Mitigation Center

Climate Change Considerations

The Third National Climate Assessment provides an in-depth look at climate change impacts on the U.S on a regional basis (http://nca2014.globalchange.gov/report). The 2017 Climate Science Special Report provided updates to this information, in preparation for the Fourth National Climate Assessment which was released in November 2018. South Dakota is part of the Great Plains region which includes the states of Kansas, Montana, Nebraska, North Dakota, Oklahoma, Texas, and Wyoming. The science summarized in the report points to increasing mean temperatures in the Great Plains. This will lead to increased evaporation and drought frequency, which will compound water scarcity problems. In parts of the region, this will constrain development, stress natural resources, and increase competition for water among communities, agriculture, energy production, and ecological needs. Changing extremes in precipitation are projected across all seasons, including higher likelihoods of both increasing heavy rain and snow events and more intense droughts.

South Dakota will remain vulnerable to periodic drought, due to at least two primary factors. First, much of the agricultural area in South Dakota relies on rain (in other words, is not irrigated). Dry periods during the warm season can have devastating effects on crops grown in the state and on grass, hay and pastures. This critical sector of the state economy is very susceptible to drought impacts. Second, for water supply systems that rely on the Missouri River, such as many rural water systems both east and west of the river, changes in high elevation snowpack accumulation and earlier runoff in the northern Rockies may alter water availability and flow through the Missouri River system. because much of the projected increase in precipitation is expected to occur in the cooler months while increasing temperatures will result in additional evapotranspiration.

In regard to temperatures and extreme heat, warmer and more extreme temperatures can exacerbate drought impacts and result in consequences regardless of drought. According to the National Climate Assessment, for an average of seven days per year, maximum temperatures reach about 95ºF in the Northern Plains. These high temperatures are projected to occur much more frequently, even under a scenario of substantial reductions in heat-trapping gas (also called greenhouse gas) emissions, with days

over 100ºF projected to double in number in the Northern Great Plains region by mid-century. These increases in extreme heat will have many negative consequences, including increases in surface water losses, heat stress, and demand for air conditioning. Additionally, summertime increases in humidity and a rising trend in minimum (overnight) temperatures are increasing heat stress risk to humans and animals. The animal agriculture (livestock) sector of South Dakota can be very susceptible to warm, humid nights and create stress on the physical health of animals.

3.2.7 Tornado

Description

The NWS defines a tornado as a violently rotating column of air extending from a thunderstorm to the ground. The most violent tornadoes are capable of tremendous destruction with wind speeds of 250 mph or more. Damage paths can be in excess of one-mile wide and 50 miles long. In an average year, about 1,000 tornadoes are reported across the United States, resulting in approximately 80 deaths and more than 1,500 injuries.

Though climate data is available to explain a predisposition to tornadoes, there is no accurate way of predicting when or where a tornado may occur. Tornado systems have been linked to the development of temperature and wind flow patterns in the atmosphere, which can cause moisture, instability, lift, and wind shear. Expert predictions of these conditions begin first by modeling in the long term and relying on critical analysis of satellite data, weather stations, balloon packages, airplanes, wind profilers, and radar-derived winds to pinpoint storm activity for the short term.

Tornadoes typically occur in South Dakota in May, June, and July, but they can occur in any month. The greatest period of tornado activity (about 82 percent of occurrence) is from 11 a.m. to midnight. Within this time frame, most tornadoes occur between 4 pm and 6 pm.

Prior to February 1, 2007, tornado intensity was measured by the Fujita (F) scale. This scale was revised and is now the Enhanced Fujita scale. Both scales are sets of wind estimates (not measurements) based on damage. The new scale provides more damage indicators (28) and associated degrees of damage, allowing for more detailed analysis, better correlation between damage and wind speed. It is also more precise because it takes into account the materials affected and the construction of structures damaged by a tornado. Table 3-22 shows the wind speeds associated with the original Fujita scale ratings and the damage that could result at different levels of intensity. Table 3-23 shows the wind speeds associated with the Enhanced Fujita Scale ratings. The Enhanced Fujita Scale's damage indicators and degrees of damage can be found online at www.spc.noaa.gov/efscale/ef-scale.html.

Table 3-22 Original Fujita Scale

Fujita (F) Scale	Fujita Scale Wind Estimate (mph)
F0	< 73
F1	73-112
F2	113-157
F3	158-206
F4	207-260
F5	261-318

Source: NOAA Storm Prediction Center, www.spc.noaa.gov/faq/tornado/f-scale.html

Table 3-23 Enhanced Fujita Scale

Enhanced Fujita (EF) Scale	Enhanced Fujita Scale Wind Estimate (mph)	Potential Damage
EF0	65-85	Minor damage. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e., those that remain in open fields) are always rated EF0.
EF1	86-110	Moderate damage. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	Considerable damage. Roofs torn off from well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	Severe damage. Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations are badly damaged.
EF4	166-200	Devastating damage. Well-constructed and whole frame houses completely leveled; cars and other large objects thrown, and small missiles generated.
EF5	Over 200	Incredible damage. Strong-framed, well-built houses leveled off foundations are swept away; steel-reinforced concrete structures are critically damaged; tall buildings collapse or have severe structural deformations; some cars, trucks, and train cars can be thrown approximately 1 mile (1.6 km).

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

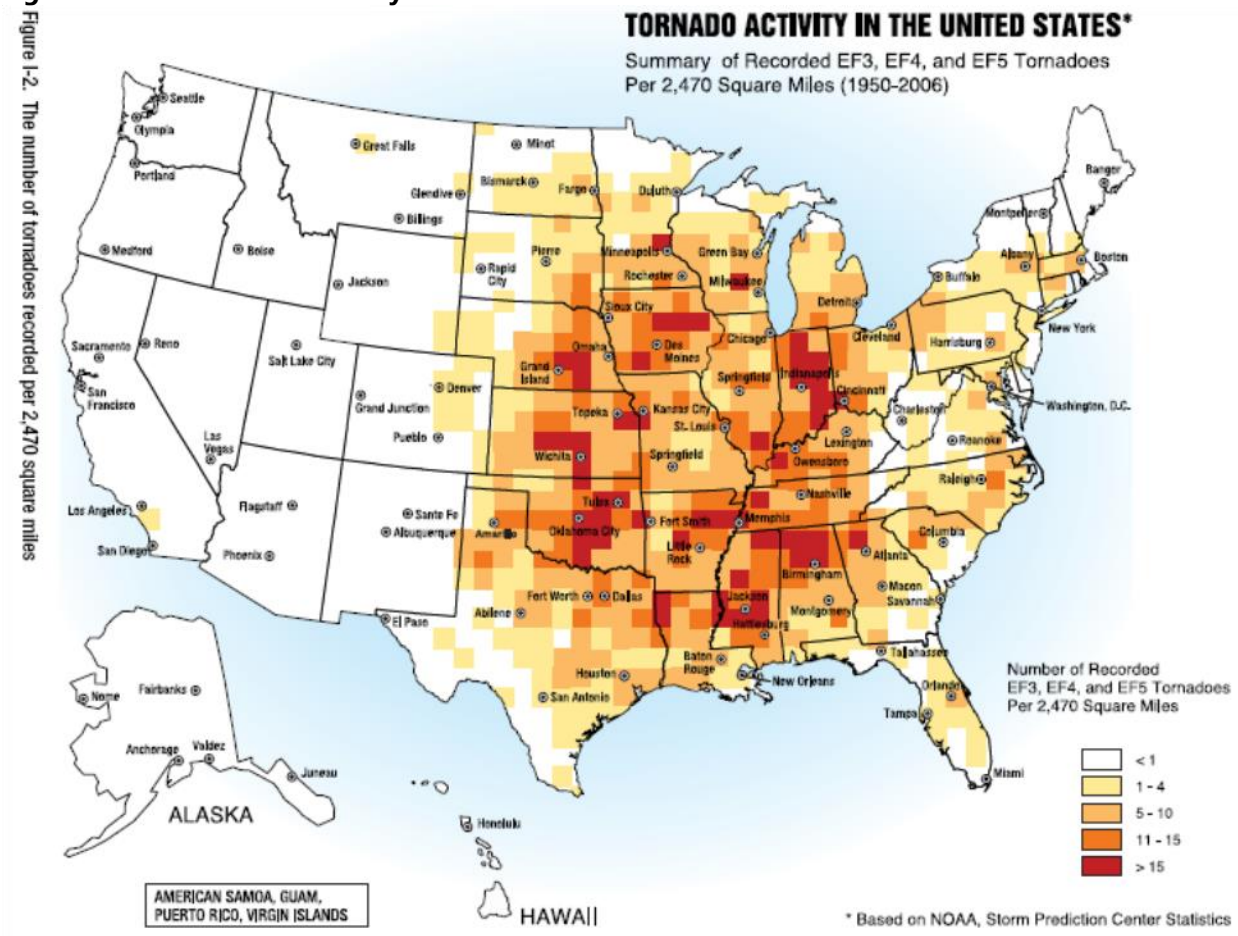
Location

Tornado disasters are often associated with Tornado Alley (the area from the Gulf to the Northern Great Plains that has high tornado incidence). South Dakota sits in the northern region of Tornado Alley and is susceptible to the specific conditions to which the formation of tornadoes has been attributed: warm Gulf air coming in contact with cool Canadian air fronts and dry air systems from the Rocky Mountains. The intersection of these three systems produces thunderstorm conditions that can spawn tornadoes. According to NOAA, tornadoes can occur at any location and from a wide variety of conditions. Western South Dakota, though not in the Tornado Alley, is still vulnerable to tornadoes of different strengths.

Figure 3-28 illustrates the number of F3, F4, and F5 tornadoes recorded in the United States per 2,470 square miles between 1950 and 2006. Figure 3-29 illustrates the wind zones in the United States. By

noting the South Dakota data from these two maps and matching them up in Table 3-24, it appears that approximately 90 percent of South Dakota has a high tornado risk and 10 percent has a moderate tornado risk. A very small area in the northwest corner of the state has a low tornado risk.

Figure 3-28 Tornado Activity in the United States



Source: Taking Shelter from the Storm (FEMA 2008)

Figure 3-29 Wind Zones in the United States

Source: Taking Shelter from the Storm (FEMA 2008)

Table 3-24 Wind Zones

Number of Tornadoes Per 2,470 square miles (See Figure 3-28)	Wind Zone (See Figure 3-29)			
	I	II	III	IV
<1	Low Risk	Low Risk	Low Risk	Moderate Risk
1-4	Low Risk	Moderate Risk	High Risk	High Risk
5-10	Low Risk	Moderate Risk	High Risk	High Risk
11-15	High Risk	High Risk	High Risk	High Risk
>15	High Risk	High Risk	High Risk	High Risk

Source: Taking Shelter from the Storm (FEMA 2008)

Past Events

According to the NCEI, there were 636 tornadoes in South Dakota between 1950 and July 2016 rated as an F1 or higher. Tornadoes reported in the database are in segments. One tornado can have multiple segments as the NCEI counts a new segment when county boundaries are crossed. So, the number of past occurrences is really a reflection of the number of past tornado segments. Total property damage for these events is estimated at $688 million. There were 17 deaths and 456 injuries in this time period. This number increases to 18 deaths and 465 injuries if all tornado events, including those smaller than an F1,

are recorded. This suggests that South Dakota averages 10 tornadoes of F1 intensity or greater, $10,967,741 in damages, and seven injuries each year. See Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction for more information about how tornadoes affect individual counties. Figure 3-30 shows the number of tornadoes by county between 1950 and 2016. Figure 3-31 shows tornado paths of individual tornadoes where data was available.

During the 2019 planning process a query of tornado events from July 2016 to mid-2018 took place and found one event of significance taking place in Lawrence County and amounted to $2 million in property damages. These events are not included in the following figures (Figure 3-30, Figure 3-31) nor the probability calculations or vulnerability assessment. Details for each event are included in Table 3-25 South Dakota Tornadoes below.

Figure 3-30 South Dakota Tornadoes by County, 1950-2016

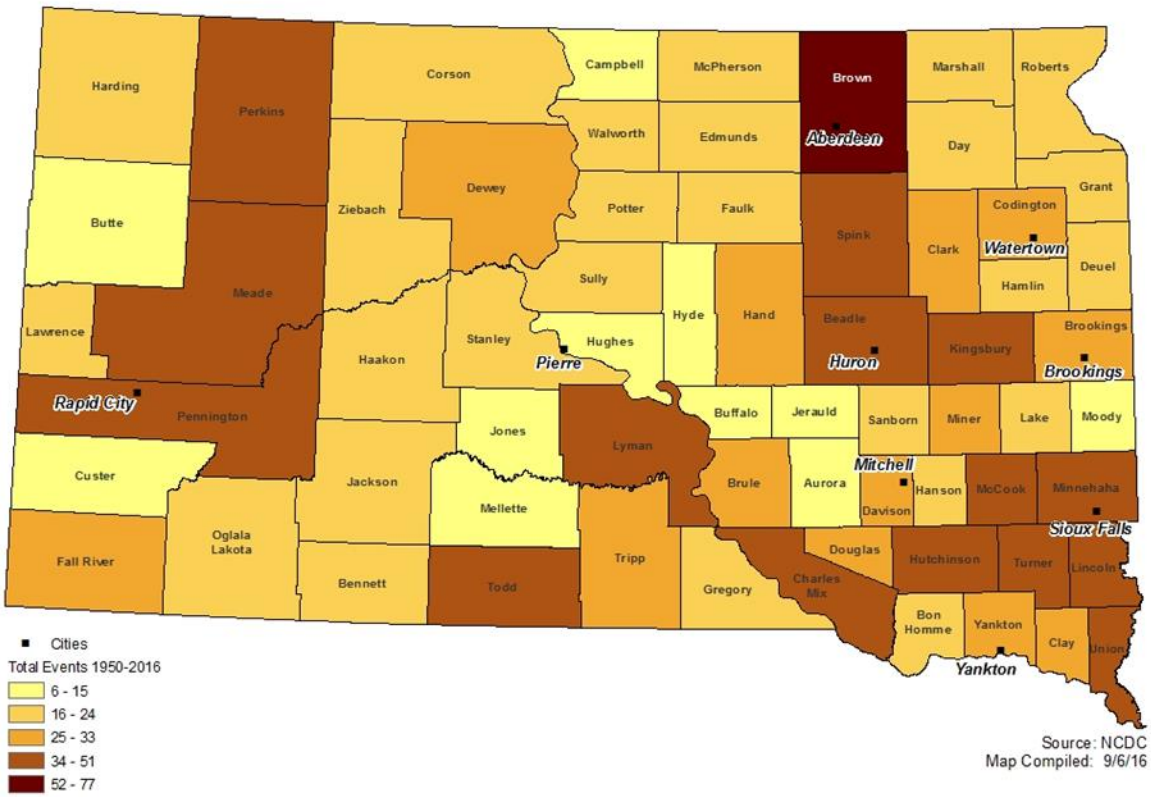


Figure 3-31 Tornado Paths in South Dakota 1953-2016

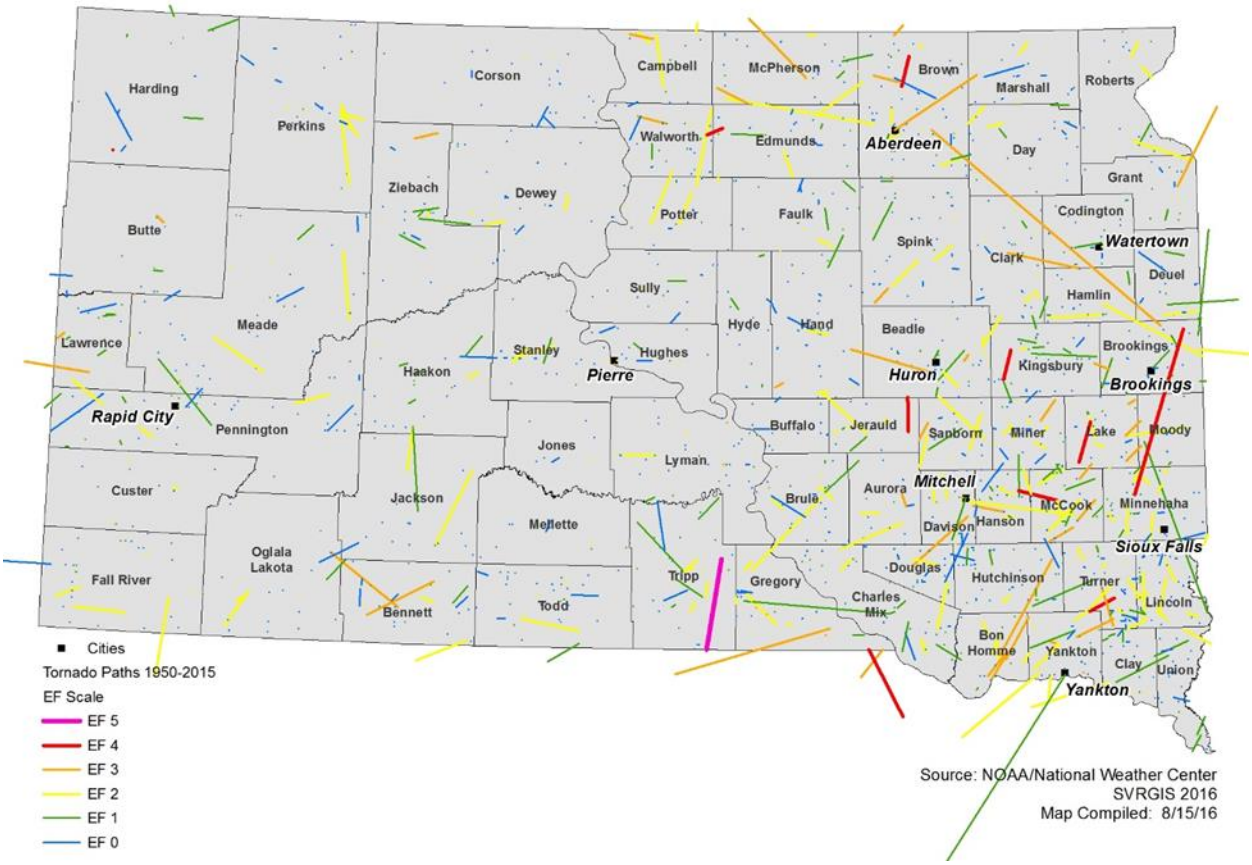


Table 3-25 South Dakota Tornadoes

Date	Comments
June 28, 2018	A tornadic thunderstorm tracked east-northeast from Montana across Harding County during the evening. The storm produced several tornadoes, including four in Harding County. The largest of the tornadoes was rated EF-3 and caused significant damage at a couple of ranches. Each event is described below: The tornado started south of Capitol, Montana and crossed the state line into South Dakota approximately ten miles south-southwest of Camp Crook. The tornado produced considerable tree and structural damage west of South Camp Crook Road. It also lifted and destroyed some farm machinery, including a five-ton tractor that was found a few miles northwest in Montana. East of Camp Crook Road, a large farm outbuilding was destroyed, and its foundation was extracted from the ground and broken apart. The tornado was rated an EF-3 with peak wind speeds estimated around 136 mph. The tornado developed just south of SD Highway 20 near mile marker 17, where it snapped power poles and trees near a house. A farm outbuilding was also severely damaged, with most of its exterior walls collapsed. Based on video evidence, the tornado then continued northward across rural areas northwest of Buffalo and crossed Clanton Road before dissipating. The tornado was rated an EF-2 with peak wind speeds estimated near 115 mph. Based on eyewitness reports and video evidence, the tornado developed east of the first tornado near Johnson Draw and continued northeastward to near Waterhole Creek before

Date	Comments
	dissipating. A home on Holcomb Place was damaged. The tornado was rated an EF2 with peak wind speeds were estimated near 120 mph.
June 13, 2016	A severe thunderstorm developed over the eastern slopes of the central Black Hills and tracked northeastward onto the plains. The storm produced large hail and eventually formed into a line of storms with strong wind gusts as it moved across the plains. An EF2 tornado developed as the storm moved north of Hermosa; Numerous pine trees were snapped along Murphy Road where the tornado initially formed. Several power poles were snapped where it crossed Highway 79. Several homes were badly damaged, and many outbuildings were destroyed as the tornado passed through the Spring Creek Acres subdivision. The property damage is estimated at $100,000
May 22, 2016	An EF2 tornado developed over southeastern Todd County and moved northeastward for about ten minutes. The tornado did not damage any structures as it tracked across fields for almost five miles. However, it did snap eight to ten power poles at the ground at the intersection of Littleburg Road and Hidden Timber Road. Several large trees in a shelter belt were snapped off and uprooted. Property damages are estimated at $10,000. The same storm produced an EF1 tornado in Tripp county and resulted in $25,000 in property damages.
August 6, 2015	Thunderstorms produced damaging winds in southeast South Dakota during the afternoon and early evening of August 6th. The storms affected mostly Brookings County, but the first report was some distance away in Gregory County, and there were reports in Moody County also. There were also two tornadoes and one report of large hail. A tornado damaged the roof, gutters, and siding of three houses, damaged the roof, patio deck, chimney, and garage of another house, and damaged a fence. Damages estimated at $80,000.
June 19, 2015	A long-lived complex of severe thunderstorms tracked from southeastern Montana across northwestern South Dakota. The strongest storms produced hail to six inches in diameter, wind gusts over 80 mph, and a tornado in southern Meade County. Significant structure, property, and crop damage was reported in Butte and Meade Counties. Livestock were killed by the large hail in the Nisland area, with one rancher losing 35 sheep. The storms continued into south central South Dakota, but no reports were received due to a widespread power outage. A tornado touched down in rural southern Meade County, damaging buildings and tossing equipment at two ranches. Damage estimated at $100,000.
May 10, 2015	Thunderstorms over southeast South Dakota from late morning to the start of the evening on May 10th produced several tornadoes, including one that caused injuries and severe damage in Delmont in Douglas County. The thunderstorms also produced large hail, damaging winds, and flash flooding in locations extending to the eastern border of the state. A tornado, crossing into Douglas County from Charles Mix County, destroyed or damaged 84 structures in and near Delmont, and injured 9 people in Delmont. About 50 of the homes and other structures were destroyed or severely damaged. The damage included numerous small farm buildings totally destroyed, most at four farms south of Delmont, several houses severely damaged, a large 100-year-old church severely damaged, and a newly constructed fire hall destroyed. Power lines and poles were down, and the town was without power and water for two days. 100 residents were displaced. Damages estimated at $1.5 million.
June 18, 2014	Thunderstorms during the evening of June 18th produced tornadoes in Jerauld County, with one tornado crossing briefly into Beadle County. The tornadoes included one that caused severe damage to Wessington Springs. There was also a report of large hail. A tornado severely damaged two family farms, including destroying a farmhouse as the family took shelter in their basement. A couple in the house suffered minor injuries. The tornado also

Date	Comments
	damaged trees, power poles, and power lines; and caused an unknown amount of crop damage. The tornado crossed briefly into Beadle County before lifting. Damage estimated at $325,000.
June 17, 2014	Thunderstorms during the late evening of June 17th produced a tornado near Humboldt South Dakota in Minnehaha County and large hail near Dolton in McCook County. The tornado blew down the exterior walls of a house, in which a family escaped injury by taking shelter in the basement. The tornado also tore the roof off a farm storage building, tore the metal roof off a metal building, blew down electrical poles, and caused tree damage, including several trees snapped off at the trunks. Damage estimated at $100,000.
October 4, 2013	A tornado crossed the Missouri River from Dakota County in Nebraska and entered Union County. The tornado severely damaged the roof of a house, and collapsed a chimney, carport and porch roof, and the walls of a garage in the same house. The tornado also caused tree damage, including trunks snapped, overturned an irrigation system, and damaged the roof, siding, and/or gutters of at least four other houses. Damage estimated at $450,000.
May 28, 2013	A tornado touched down on the west side of Allen Road south of Allen and rolled a mobile home down a hill. It tore off the roof and collapsed several walls of a small stick-built house on the east side of the road before dissipating. Damage was estimated at $100,000.
June 22, 2012	A severe thunderstorm tracked eastward from Wyoming across southern Fall River County. The storm produced enormous hail near Edgemont and a tornado between Edgemont and Ardmore. The tornado damaged buildings on a ranch north of Ardmore and blew down power poles and trees. A large wooden barn was completely destroyed; its walls and roof were blown more than 100 yards away. Two large sheds lost roofs and walls, and smaller sheds were blown apart. A modular house sustained minor damage. Damage was estimated at $500,000.
June 12, 2011	A cluster of severe thunderstorms moved east from northeastern Wyoming and southeastern Montana across Harding and Butte counties. The storms produced hail, wind gusts near 80 mph, and a small tornado west of Redig. The tornado destroyed part of a barn, rolled large steel calf shelters, blew down steel stockade walls, and lifted a calf shelter over a nine-foot fence.
May 9, 2011	A severe thunderstorm produced a tornado northeast of Wall and wind gusts to 60 mph over far eastern Meade County. A large electric transmission tower was crumpled, seven wooden power poles were snapped, and trees were snapped.
June 16, 2010	FEMA-1929-DR An intense low-pressure system developed across the northern Plains states and impacted the region on June 17. At least 61 tornadoes were reported that afternoon and evening across North Dakota, South Dakota, and Minnesota. A supercell around Dupree and Faith spawned 16 or more tornadoes, with 4 and possibly 5 on the ground at the same time.
May 22, 2010	Severe weather shifted north as a low-pressure system tracked across the northern Plains states on May 22. Isolated tornadoes were reported across portions of central South Dakota that afternoon. The most intense supercell produced a long-lived wedge tornado in and around Bowdle, South Dakota where numerous houses and farm buildings were destroyed, and cars were thrown into the air. It was rated as an EF4, but fortunately remained in rural areas and no injuries were reported. Tornadoes in Edmunds and McPherson counties damaged 60 utility poles. FEM Electric customers on 40 meters were without power for 48 hours. Emergency repair and restoration costs for FEM Electric were estimated at $210,000.
July 9, 2009	Severe storms developed over Fall River County and moved eastward across southwestern and south central South Dakota. The storms produced large hail and strong wind gusts. Two tornadoes were observed in Todd County and two tornadoes touched down in southern Tripp County. A small tornado touched down on a farm west of the intersection of 286th Street and

Date	Comments
	313th Avenue. The tornado blew a garage off its foundation, tipped over a combine, and snapped large cottonwood trees.
May 12, 2009	An F1 tornado travelled for eight miles with a width of 200 yards. The tornado touched down west of Dupree and tracked eastward before dissipating northeast of Dupree. It dented several grain bins, blew over a small mobile home and semi-trailer truck, tore sheet metal off sheds, and toppled a large communications tower.
June 5, 2008	An F1 tornado 100 yards wide damaged a path ten miles long. The tornado severely damaged a home, destroyed outbuildings, and damaged storage bins at a farm near Ravinia. The tornado also caused tree damage along its path. An F2 tornado caused damage to silos, farm buildings, power lines, and numerous trees southeast of Baltic.
May 29, 2008	An F-1 Tornado two miles long and 100 yards wide destroyed a barn, damaged or destroyed several outbuildings, scattered lumber across a field, and damaged trees and power lines. Damages were estimated at $100, 000.
May 5, 2007	Severe Storms, Tornadoes, and Flooding (FEMA-1702-DR) Twenty-five tornadoes were recorded in southeast South Dakota. It was the most significant tornado outbreak in southeast South Dakota since June 24, 2003. The strongest tornado, an EF-3, occurred in Aurora County. On the ground for five miles, it did its most significant damage to a pheasant hunting lodge/preserve, where numerous buildings and trees were severely damaged and numerous adult and chick pheasants were lost. Winds were estimated at around 140 mph. In Bon Homme County, an EF-2 tornado was on the ground for six miles, severely damaging many homes, barns, out-buildings, and trees. An EF-2 tornado traveled through both McCook and Hanson Counties and was observed to be very large before it dissipated. Most of the damage was to trees and a junk yard. In western Hanson County, an EF-1 tornado damaged trees and took a roof off a building. In Yankton County, a tornado began at the Lewis and Clark Recreation Area and resulted in considerable tree damage and damage to homes. It was on the ground for approximately four miles. For a while, it was joined by a second tornado. These tornadoes were determined to be EF-1s based on the damage homes. High winds related to these storms damaged power distribution lines and poles in Bon Homme and Yankton counties. Seven poles were damaged in Bon Homme County for a total of $13,014 in damages. Twenty-five poles were damaged in Yankton County for $34,809 in damages. 20 outages affected 214 customers, leaving them without power for roughly 9 hours. Source: NWS Sioux Falls and SHMT
September 16, 2006	Seven tornadoes touched down over southeast South Dakota. The strongest, an F2, was in McCook County and damaged several buildings and killed several cattle. An F1 tornado in Minnehaha County damaged some buildings and downed power lines. There was no damage reported from the other storms (F0s). Source: NWS Sioux Falls
August 26, 2006	Severe weather in east central South Dakota produced at least three tornadoes. In Beadle County, two tornadoes did considerable damage to farmsteads, power lines, and crops. One was a 24.5 mile long-track F2/F3 tornado with winds up to 200 mph that measured between 400 and

Date	Comments
	500 yards at its widest. Another tornado touched down in Kingsbury County, but did little to no damage. Source: NWS Sioux Falls
May 2, 2006	An F1 tornado touched down in Kingsbury County. While the tornado was generally F0, there were a couple of periods where it approached F1 intensity. It hit a hog operation, destroying a barn and two other outbuildings, downing several trees, and killing numerous hogs. Source: NWS Sioux Falls
June 24, 2003	Sixty-seven tornadoes touched down in South Dakota on this day. This rare occurrence tied the U.S. record at the time for the most tornadoes within a state in a 24-hour time period. However, the 67 tornado touchdowns recorded that day occurred in a period of less than eight hours. The strongest of the 67 tornadoes was an F4, which destroyed the town of Manchester and injured five people. Winds were estimated to be between 207 and 260 mph. The tornado warning issued by the NWS in Sioux Falls provided the residents of Manchester with 28 minutes of advance warning. The NWS offices in Aberdeen and Sioux Falls issued more than 350 warnings, statements, and storm reports on the evening of June 24. The 67 tornado touchdowns recorded that day represented a significant portion of the 85 total tornado touchdowns recorded for all of 2003. Despite the historic events of this day and the destruction of the town of Manchester, no presidential disaster declarations were issued.
June 23, 2002	Four separate tornado tracks and two satellite tornadoes were confirmed across McPherson and Brown counties. The first was an F0, the second an F1, the third and F3, and the fourth an F4. This was the first F4 tornado recorded in Brown County. Source: NWS Aberdeen
July 27, 2001	In Lincoln County, an F1 tornado downed numerous trees and damaged storage sheds and buildings along Main Street in Lennox, including the VFW (Veterans of Foreign Wars). Source: NWS Sioux Falls
July 11, 2000	An F2 tornado hit Lake County and damaged the Lake County Speedway. Source: NWS Sioux Falls
June 4, 1999	Severe Storms, Flooding, and Tornadoes (FEMA-1280-DR) A deadly tornadic storm moved across southwest South Dakota during the late afternoon and evening of June 4. Multiple tornadoes (F1 and F2) were observed from several supercells that moved toward the northeast from west of Chadron, Nebraska, to near Kyle, South Dakota, between 5:30 and 8:00 p.m. The most severe damage occurred where the paths of these storms passed near the community of Oglala in Oglala Lakota County (previously Shannon County), South Dakota. Oglala was heavily impacted by the tornadoes as were other smaller communities on the Pine Ridge Indian Reservation. The Red Cross estimated that 123 homes sustained major damage and an additional 139 sustained minimal damage. FEMA deemed 49 homes beyond repair and demolished them. In one area, all the telephone poles were snapped and tossed, mobile homes were thrown over 100 yards with debris strewn over a quarter of a mile, and a newly framed house was leveled with wood projectiles in the ground 100 yards downwind. The total Public Assistance damage for the disaster was $1,029,000. One person was killed and over 40 were injured; 22 required medical attention at area hospitals. The fatality was the first from a tornado in western South Dakota since 1939 and only the third ever recorded in western South Dakota.

Date	Comments
	Very large hail was also reported in the area. Grapefruit-sized hail was observed two miles west of Oglala with golf ball and baseball-sized stones reported in Oglala itself.
May–June 1998	Flooding, Severe Storms, and Tornadoes (FEMA-1218-DR) By late afternoon of May 30, 1998, the atmosphere over the north central United States had become favorable to a significant outbreak of severe weather. At approximately 8:40 p.m., following a series of thunderstorm warnings and numerous funnel sightings in the area, a violent tornado struck the town of Spencer, South Dakota, approximately 45 miles west northwest of Sioux Falls in extreme western McCook County. Deemed the deadliest tornado in recorded South Dakota history, the F4 tornado killed 6 people, injured more than one-third of the town's 320 residents, and destroyed most of the town's 190 buildings, including all public and numerous private facilities. Only 12 structures were left standing in the entire town of Spencer. An assisted living center was destroyed, and since it had no basement, there was no protection from the tornado. Most of the fatalities were residents of the center. In addition to the town of Spencer, some farms in Hanson and McCook Counties were heavily damaged. Total damage was estimated at $18 million. During the storm, electrical service was out. Survivors reported that the warning siren system lost power prior to the touchdown of the tornado.
June 14, 1993	Pierre - Three homes damaged. No deaths. Arlington - Minor damage.
March 29, 1981	A winter storm front created a tornado near Martin, which destroyed a mobile home and injured one occupant.
May 12, 1984	Clark and Codington counties - 18 to 20 farmsteads and homes were directly affected and ten homes severely damaged.
June 19, 1979	Watertown - Damage to trees, roofs, and power lines. Bon Homme, Turner, Yankton, Hanson, Sanborn counties - Tornado damage. Letcher - Tornado caused minor injuries with numerous reports of tree and building damage. Springfield - Tree damage.
June 1978	Aberdeen - On June 15 and 16, Aberdeen and Marshall County experienced tornadoes, hail, and some flooding. Five trailers were damaged by tornadoes. Marshall County had crop and building damage from hail and tornado winds.
Summer 1977	Arlington - Minor damage.
July 23, 1973	Ft. Pierre/Pierre - The tornado began in Ft. Pierre where it did minor damage; one grain elevator and a few mobile homes were affected. It jumped the Missouri River and then "skipped" through Pierre. Houses and businesses were damaged, and a few homes were completely destroyed. Many mobile homes were either scattered about or piled upon one another. No deaths. Ten people were injured. Damage amounted to over half a million dollars.
June 18, 1967	Rapid City - One motel suffered heavy structural damage along with several other buildings in the city. No deaths. Three people were injured. Over $2 million in damage was done.
May 21, 1962	Gregory County - Several homes were destroyed as was farm equipment, automobiles, and livestock. Many miles of power poles and lines were also knocked down. Damage exceeded $500,000. Mitchell - Damage was estimated at about $2 million to Mitchell and the surrounding countryside.

Date	Comments
July 31, 1949	Beresford and Elk Point - A series of tornadoes struck the countryside between Beresford and Elk Point in the southeast corner of the state. Property damage exceeded $1 million.
June 29, 1947	Howard and Carthage - Occurred in the rural area of Howard and Carthage. Damage was light. A barn and airplane hangar were damaged. One death resulted.
June 12, 1947	Turner/Yankton counties - The rural area of Turner/Yankton counties was struck by a tornado that did hundreds of thousands of dollars in damage. Barns, houses, and sheds were destroyed, and crop damage was listed as heavy. There were no recorded deaths or injuries.
July 9, 1932	South of Sioux Falls (Minnehaha County) - One person died, 11 were people injured, and damage was estimated at $150,000. A number of horses and cattle were killed or injured, buildings were knocked down, and telephone and power lines were destroyed. This tornado was from a storm that also dropped baseball-sized hail throughout the area.

Source: NCEI, unless otherwise noted.

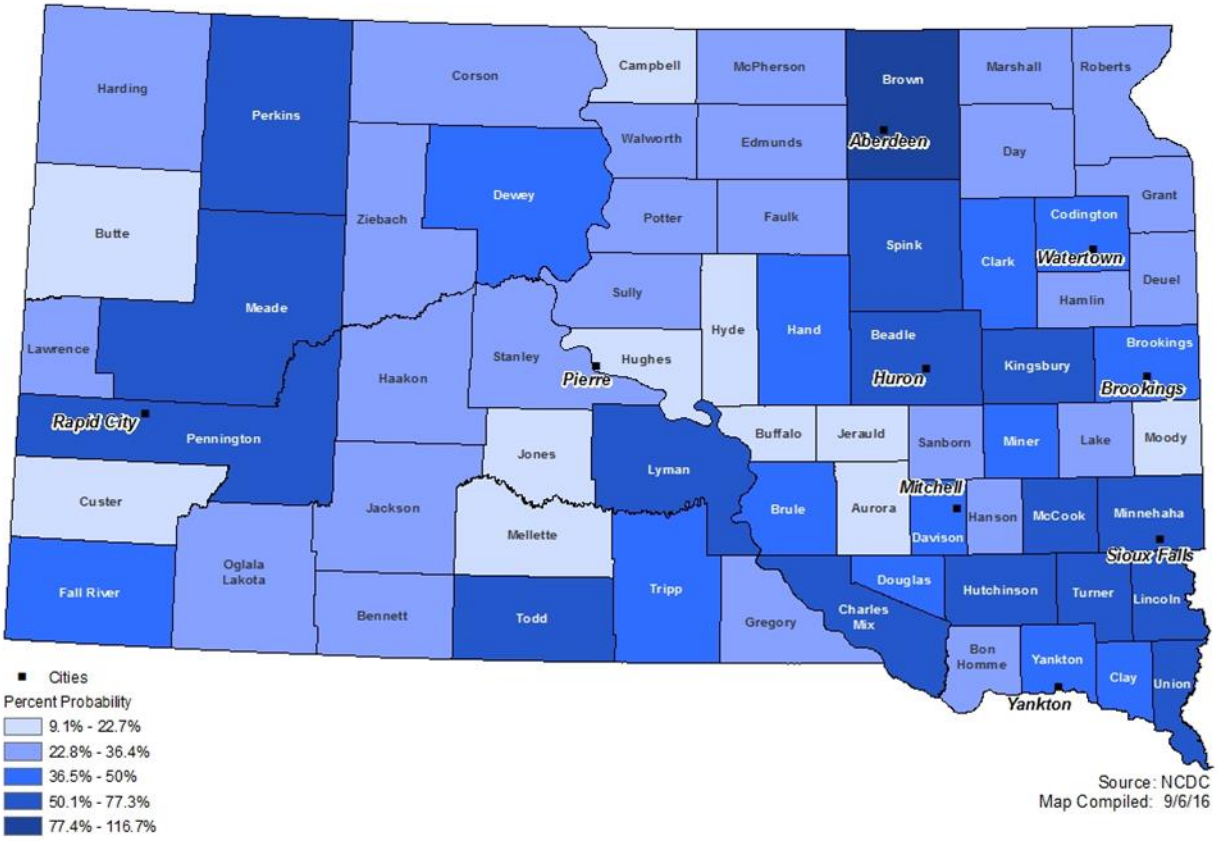
Probability

According to the National Climatic Data Center, there were 1,711 tornadoes, of which 636 were F1 or higher, in South Dakota between 1950 and 2016 (66 years). Based on this information, the probability that at least one tornado will occur in South Dakota is 100%. Annualized losses are estimated at nearly $11 million. Figure 3-32 depicts the probability of a damaging tornado occurring in each county based on the historical data.

Climate Change Considerations

There presently is not enough data or research to quantify the magnitude of change that climate change may have related to tornado frequency and intensity. NASA's Earth Observatory has conducted studies which aim to understand the interaction between climate change and tornados. Based on these studies meteorologists are unsure why some thunderstorms generate tornadoes and others don't, beyond knowing that they require a certain type of wind shear. Tornadoes come from about 1 percent of thunderstorms, usually supercell thunderstorms that are in a wind shear environment that promotes rotation. As noted in the summer storm profile there are some studies that show a potential for a decrease in wind shear in mid-latitude areas. As there is a lot of uncertainty with the influence of climate change on tornadoes future updates to the mitigation plan should include the latest research on how the tornado hazard frequency and severity could change. The level of significance of this hazard should be revisited over time.

Figure 3-32 Damaging Tornado Probability by County



3.2.8 Windstorm

Description

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

Thunderstorms over the Northern Plains typically happen between late April and early September, but, given the right conditions, they can develop as early as March. They are usually produced by supercell thunderstorms or a line of thunderstorms that typically develop on hot and humid days.

Location

The entire state is susceptible to high wind events. Figure 3-29 in the tornado section above illustrates the wind zones in the United States. Most of South Dakota is in Zone III, which is vulnerable to winds up to 200 mph. The westernmost part of the state is in Zone II, which is susceptible to winds up to 160 mph.

Past Events

According to the NCEI, there were 7,971 windstorm events (6,901 thunderstorm wind, 1,070 high wind, and 6 strong wind events) in South Dakota between 1955 and July 2016. There were 11 deaths and 136 injuries in this time period. Total property and crop damage for events between 1993 (when damage figures began being kept) and 2016 is estimated at $151,296,500 in 2016 dollars. This suggests that South Dakota averages 272 wind events, $2,605,982 in wind losses, and approximately five injuries each year. See Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction for more information about how wind affects individual counties. The map below shows the number of wind events by county between 1955 and 2016. Note, during the 2019 planning process a query of wind events from mid-2016 to mid-2018 yielded no significant events in that timeframe.

Figure 3-33 South Dakota Wind Events by County, 1955 – 2016

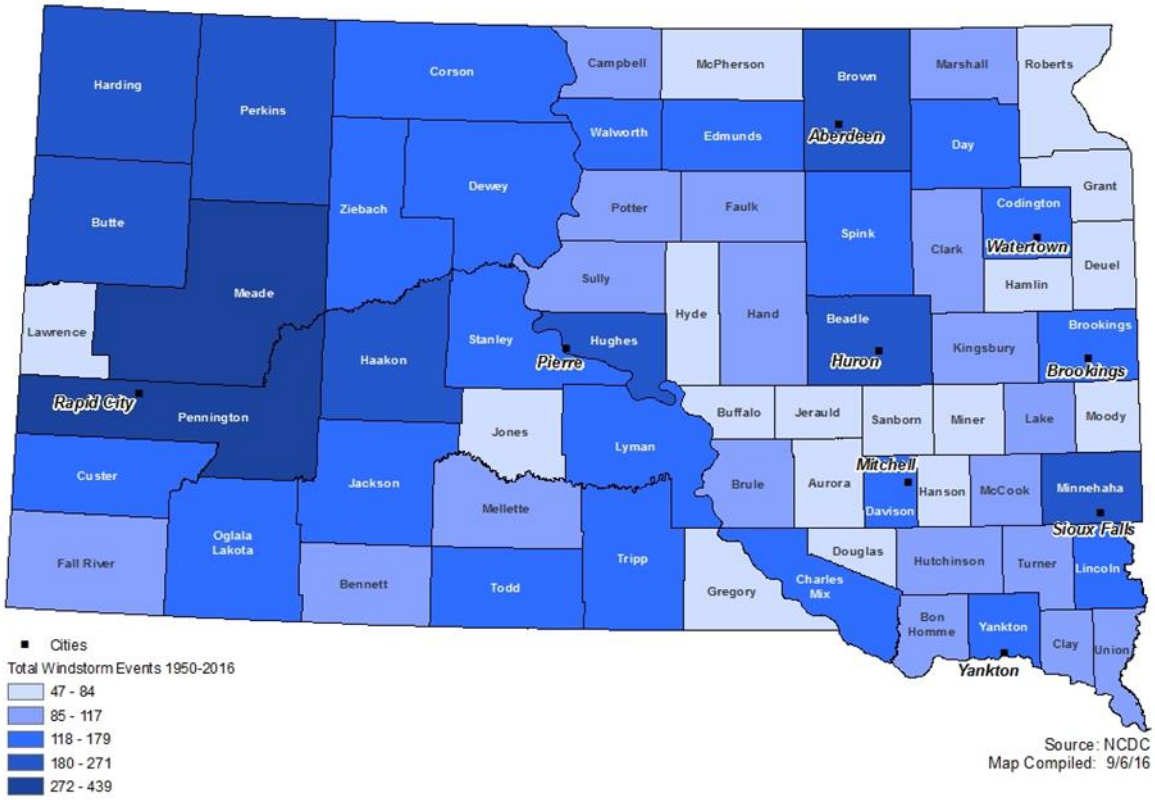


Table 3-26 South Dakota Wind Events

Date	Comments
September 4, 2016	Thunderstorms with damaging winds affected parts of southeast South Dakota from the Missouri River to Sioux Falls. The winds caused substantial damage to the City of Springfield in Bon Homme County. Damages included the destruction of 6 houses as well as damaging houses, damaging businesses, several unattached garages and destroying farm outbuildings and other farm structures. As well as causing widespread tree damage including knocking trees down. It is also reported that the wind moved a large boat 25 yards from a parked position. Property damage is reported to be $1 million.
February 18, 2016	A strong cold front crossed the region, bringing gusty northwest winds to much of western and south-central South Dakota. Wind gusts from 60 to 80 mph accompanied the front late on the 18th into the nighttime hours. Wind gusts around 65 mph redeveloped on the 19th

Date	Comments
	across portions of northwestern South Dakota and the Black Hills as a tight pressure gradient remained in place over the Northern Plains.
July 30, 2013	A long-lived supercell thunderstorm developed over western Haakon County and moved south-southeast across south central South Dakota. Very large hail was reported in some areas, along with strong wind gusts, and a small tornado near Philip. The wind-driven hail caused extensive damage to houses from Corn Creek to Parmelee. The combination of large hail and wind caused extensive damage to buildings and vehicles around town.
June 21, 2013	A strong warm front along with very unstable air and strong deep layer winds brought several supercell thunderstorms along with a damaging line of thunderstorms/bow echo to parts of central and northeast South Dakota during the afternoon hours. Damaging winds up to 90 mph uprooted large trees and caused considerable structural and crop damage and loss of power to those in its path. The worst wind damage was located at Lake Poinsett, Watertown, and Milbank. A woman was killed, and her husband was seriously injured on Lake Poinsett when their lake house was destroyed. Numerous trees were downed along with many structures damaged or destroyed. Many trees had fallen onto homes, cabins, and trailers. The bowling alley in Clear Lake lost its roof along with numerous pole barns being destroyed along the storm's path. Thousands of people were also left without power. Four tornado touchdowns occurred along with hail up to the size of softballs. Isolated flash flooding also occurred. Codington, Hamlin, Grant, and Deuel counties were all declared in a Federal Disaster Declaration. Total damage estimates were around 1,100,000 dollars.
May 28, 2013	A line of thunderstorms produced a small tornado that touched down briefly and strong straight line winds south of Allen. Straight-line wind damage was observed along BIA Road 22 southeast of Allen. The winds tore part of the roof off a small building and ripped shingles and metal roofing off two houses. A mobile home was rolled and completely smashed. A large cottonwood tree was snapped.
April 15, 2012	Very strong northerly winds affected southeast South Dakota during the evening of April 15th. Winds gusted to over 60 mph in parts of the area. A large outbuilding was destroyed near the western edge of Hitchcock, and a power pole standing in water was snapped off 4.5 miles east of Hitchcock.
April 2, 2012	A strong cold front passed through the region during the night. Strong north to northwest winds developed behind the front for several hours. The strongest winds occurred in the Rapid City area, where wind gusts to 65 mph were recorded. A semi-trailer was blown over on Interstate 90 six miles east of New Underwood.
April 30, 2011	A tight pressure gradient over the region resulted in strong northwesterly winds across western and central South Dakota. Sustained winds of 35 to 55 mph with gusts near 80 mph caused minor damage around Newell and Sturgis. The strongest winds were over the northwestern South Dakota plains. A large metal sign at a campground east of Sturgis was blown over. A pickup truck and travel trailer were flipped over south of Bear Butte.
June 10, 2010	Damaging winds, not directly from thunderstorms, affected the Madison to Brookings South Dakota area during the morning of June 10th. High winds severely damaged a barn. The winds also caused tree damage, with a playhouse damaged by tree debris. Vehicles were damaged by flying tree debris.
May 24, 2010	An intense low-pressure system and cold front produced strong winds across southwestern South Dakota. Ahead of the low, strong south the southwest winds developed across south central South Dakota during the early afternoon. Behind the front, winds switched to the west across southwestern South Dakota in late afternoon. Sustained winds of 30 to 45 mph, with

Date	Comments
	gusts to 70 mph, were recorded over much of the area. Some trees were downed by the wind. Minor damage occurred around the Hot Springs area.
August 7, 2009	A super cell thunderstorm developed across the northern Black Hills and moved eastward across the Sturgis area, southern Meade County, northeastern Pennington County, Haakon County, and northeastern Jackson County. The storm produced baseball sized near Sturgis, then strong winds of 61 knots and hail larger than baseball sized developed as the storm moved across the plains. The storm hit Sturgis during the annual motorcycle rally and caused extensive damage to motorcycles, vehicles, and property. Minor injuries from the hail were also reported.
July 13, 2009	High winds developed behind an existing area of thunderstorms causing damage along with some injuries. Wind gusts to 50 to 70 mph were estimated or measured across parts of north central and northeast South Dakota. As a result, A mobile home was rolled twenty feet and destroyed by gradient winds associated with a wake low pressure area. The mobile home was not tied down and caught fire as it rolled into a propane tank. The three people inside the mobile home at the time all escaped with minor injuries.
October 26, 2008	Strong northwest winds reached sustained speeds of 40 mph or more with gusts to around 60 mph over all of southeast South Dakota during the morning and afternoon of October 26th.High winds sustained at 40 to 45 mph and gusting to over 60 mph caused damage to trees, shingles, and road signs. The tree damage included one very large weeping willow tree blown down in De Smet.
July 31, 2008	In the early morning hours of July 31st, a line of storms originating in North Dakota began to expand and surge southeast into northeast South Dakota. As the storms moved southeast, they began to tap into warmer, more humid air and rapidly evolve into a line of severe thunderstorms. Widespread damage occurred in a wide swath extending from Long Lake in McPherson County all the way into eastern Grant County and southern Big Stone County in Minnesota. The most extensive damage was generally found along and near U.S. Highway 12 from Aberdeen to Milbank. Several observing stations in the path of this system measured wind speeds ranging from 70 mph to over 115 mph. Estimated wind speeds from damage surveys indicated even stronger winds with peak speeds of 120 mph. Over fifty communities in northeast South Dakota and the surrounding rural areas received minor to major tree and structural damage as straight line winds from 70 to 120 mph raced across the area. Webster and Waubay received the most extensive damage from the storms. Thousands of trees were snapped or uprooted, hundreds of grain bins were damaged or destroyed, hundreds of homes, businesses, and outbuildings were damaged or destroyed along with many power poles and miles of power lines downed. Many mobile homes, campers, and boats were damaged or destroyed along with many road and business signs. Countless homes, vehicles, and campers were also damaged by fallen trees. Thousands of acres of crops were also damaged or completely destroyed by the winds and hail. The greatest crop damage occurred in the Roslyn, Grenville, Eden, and Pickerel Lake areas in Marshall and Day counties. Many acres of corn were blown down and not able to come back. The large hail combined with the strong winds also broke out countless windows in homes and vehicles along with damaging the siding on homes. Thousands of people were left without power for up to several days. Large hay bales were moved up to 700 yards by the high winds. A semi was overturned on Highway 12 near Webster, injuring the driver. Near Milbank on Highway 12, two other semis were blown off the road resulting in injuries to both drivers. A State Forestry Specialist said it was one of the worst tree damage events he has ever seen in the Webster area. A fifty-eight-year-old man died two miles north of Waubay during the cleanup after the storms when he was pinned between a backhoe and a tree.

Date	Comments
June 26, 2008	On the evening of 26 June 2008, a compact upper level low pressure system tracking through the Northern Plains interacted with a very moist and unstable air mass over western and central South Dakota resulting in a widespread severe weather outbreak. Three confirmed tornadoes occurred briefly in western Dewey County. Little or no damage was reported, and all three tornadoes were rated EF-0. In addition to the tornadoes, multiple reports of large hail were received over Corson and Dewey Counties, including some to the size of baseballs near the communities of McLaughlin and Isabel. The large hail broke out many home and vehicle windows and damaged many roofs in Dewey, Corson, and Sully Counties. Significant wind damage occurred over sections of Sully County. There were multiple reports of wind gusts in excess of 70 mph, with the most concentrated swath of damaging winds extending from near Sutton Bay, eastward to the city of Onida, then southeast to the community of Harrold. The storm survey began near Sutton Bay on Lake Oahe, where a wind gust of 92 mph was recorded. The most significant property damage was found further east near the community of Agar where multiple grain bins were either damaged or destroyed. Nine miles west of Agar, a barn was destroyed, and a large pine tree was snapped in half. Winds in this area were estimated to range from 80 to 100 mph. Near the intersection of Highways 1804 and 175th Street, several Western Area Power Administration (WAPA) electrical transmission towers were completely collapsed. This is consistent with wind speeds ranging from 130-140 mph. In the city of Onida a bank roof was damaged, and the city was without power until the next day. Four miles north of Onida, a feed wagon was tossed nearly 40 feet. In Harrold, several railroad cars were tipped over. Also, of great significance during the event was the peak wind speed of 124 mph recorded at the Onida airport. This wind speed is the strongest wind gust ever measured in the Aberdeen County Warning Area (CWA) and the 4th strongest wind speed ever reported in South Dakota
January 27, 2008	Strong southwesterly winds developed across the Black Hills during the afternoon and persisted through much of the night. Wind gusts of 60 to 70 mph were common across the higher terrain of the Black Hills and the northern and eastern foothills. The strongest winds were noted in the Spearfish and Hermosa areas, where a few gusts exceeded 90 mph. The strong winds caused a semi-trailer to jack knife on interstate 90 in Spearfish. Downed tree branches, signs, and damage to roofs were also reported around Spearfish.
July 9, 2007	Severe storms produced wind gusts to 80 mph across south central South Dakota. Roofs were torn off two houses and a trailer house was rolled three times. No injuries were reported. Damage estimates were reported at $75,000.
November 19, 2006	Strong southwest winds developed during the evening across parts of the northern Foothills. Winds gusted near 80 mph just west of Spearfish, while gusts over 50 mph were recorded in the Sturgis area. Several power poles and lines were downed in the Spearfish area, with minor damage around Sturgis.
August 18, 2006	Damaging winds associated with a line of thunderstorms moved through Lincoln County and were estimated between 50 and 80 mph. A downburst caused significant damage, especially to crops, which were shredded by wind-blown hail. Source: NWS Sioux Falls
May 23, 2006	Eighty mph straight-line winds damaged a Union County farm. Two outbuildings were destroyed, and a third building lost its roof. A fourth building was also damaged, and debris was strewn along a ¼ mile stretch. Tree damage was also documented in the area. Source: NWS Sioux Falls

Date	Comments
April 17, 2006	Severe thunderstorms. The earliest reports of large hail and strong winds on record for northwestern South Dakota. Source: NWS Rapid City
June 7-8, 2005	This was one of the most damaging severe thunderstorm events of the past several years for central and northeast South Dakota. In the late afternoon of June 7, a line of thunderstorms developed across western South Dakota and moved east across the state and into west central Minnesota. Widespread damage was reported. Hundreds of grain bins and countless buildings were damaged or destroyed and numerous trees, power lines, and poles were downed. Winds of 60 to over 100 mph were reported. It illustrated the fact that extreme straight-line winds can do as much damage as tornadoes. Source: NWS Aberdeen
March 10, 2005	Sustained winds of 40 to 45 mph with gusts above 60 mph persisted from mid-morning until late afternoon. The winds caused widespread tree damage with branches and smaller tree debris broken off. Several power lines were knocked down by the wind or by windblown debris. This resulted in several power outages, especially between the Missouri and James Rivers. Damages to buildings were mostly to shingles and gutters. However, a metal storage building was blown over at Mitchell. Also, at Mitchell, construction barriers were blown over, and windows were broken in two vehicles by blowing rocks. An aluminum recycling cage was blown away at Woonsocket. A window was blown out at a school in Freeman. In Sioux Falls, there was damage to the airport tower.
July 3-4, 2003	A line of severe thunderstorms developed in Montana and moved into and across North Dakota, South Dakota, and Minnesota. It brought large hail and winds over 80 mph at times to Brown, Marshall, and Roberts counties, which resulted in widespread property and crop damage. Approximately 30 percent of Marshall County's 227,000 acres of crops were damaged or destroyed. Trees, branches, and power lines and poles were downed; roofs and siding were damaged from hail and fallen trees; farm outbuildings were damaged or destroyed; and many windows were broken out of homes and vehicles. A crop spraying plane at the Sisseton airport was thrown 450 feet and a 55,000 bushel grain bin in Claire City was blown off its foundation and flattened. On the opposite side of the state, a supercell thunderstorm developed over Lawrence County and moved into Meade County. It moved through Rapid City with 60 to 70 mph winds and moved quickly east-southeast across southwestern and south central South Dakota producing 60 to 80 mph winds. The strong winds downed many trees and power lines from Rapid City to the Winner area. Source: NCEI, NWS Aberdeen
June 9, 2001	A severe windstorm struck portions of western South Dakota with gusts estimated to 80 mph. The greatest damage occurred in Philip and Wanblee. The damage was consistent with strong straight-line winds. Source: NWS Rapid City
August 1, 2000	A powerful thunderstorm moved into western South Dakota from northeast Wyoming. Winds in the Spearfish area, estimated at 90-110+ mph, were particularly devastating, causing a considerable amount of damage and several injuries. Strong downburst winds were responsible for most of the observed damage. As the storm approached Sturgis, it evolved into a bow echo with winds estimated at 65-80 mph that toppled and blew away merchandise tents that had been set up for the Sturgis Rally. Strong winds in excess of 70 mph were also noted in the Black Hawk, Piedmont, Rapid City, and Ellsworth AFB areas. Source: NWS Rapid City

Date	Comments
June 3-4, 2000	Two severe thunderstorms brought strong straight-line winds to Clay and Union counties. The first storm had wind gusts of 70-75 mph. The second storm had 60-65 mph wind gusts. Trees were damaged, and a picnic shelter was destroyed Source: NWS Sioux Falls
August 6, 1999	Downburst wind event in Meade County. Winds were estimated up to 70 mph at 8:05 p.m. as the front passed through the area. Numerous trees were damaged, and a few were blown down. The worst of the storm hit Ellsworth Air Force Base at 8:18 p.m. where they gusted to 89 mph. Between that time and 8:30 p.m., the wind speed did not drop below 50 mph at the base. Sensors measured gusts of 129 mph and 165 mph. Damage was minimal due the rural location. Source: NWS Rapid City
June 20, 1997	These severe thunderstorms brought strong straight-line winds, estimated at 80-90 mph, which caused widespread tree, crop, power line, and building damage and destruction in Davison County and injured eight people. The damage path was at least 15 miles wide by 50 miles long. Many people believed the damage was caused by a tornado, but the damage assessment proved otherwise. Source: NWS Sioux Falls

Source: NCEI, if not otherwise sourced

Probability

According to the National Climatic Data Center, there were 7,971 wind events (excluding events from associated with snow, see event description above) in South Dakota between 1955 and July 2016 (61 years). Based on this information, the probability that at least one wind event will occur in South Dakota in any given year is 100 percent. Annualized losses are estimated at $2,605,982, with two injuries per year on average.

Climate Change Considerations

There presently is not enough data or research to quantify the magnitude of potential change that climate change may have on windstorms. Future updates to the mitigation plan should include the latest research on how the windstorm hazard frequency and severity could change. The level of significance of this hazard should be revisited over time.

3.2.9 Hazardous Materials

Description

South Dakota's Codified Law Chapter 33-15 Emergency Management defines a hazardous material as "any material, including but not limited to, explosives, flammable liquids, flammable compressed gas, flammable solids, oxidizing materials, poisons, corrosive materials, and radiological materials, the loss of control or mishandling of which could cause personal injury or death to humans or damage to property or the environment." A hazardous materials incident can occur during production, storage, transportation, use, or disposal of said materials. These substances are most often released as a result of transportation accidents or chemical accidents in plants and can be caused and complicated by a different type of hazard event (e.g., flood, earthquake). They affect humans through inhalation, ingestion, and direct contact with skin. South Dakota is concerned about transportation, fixed facility, and pipeline hazardous materials incidents.

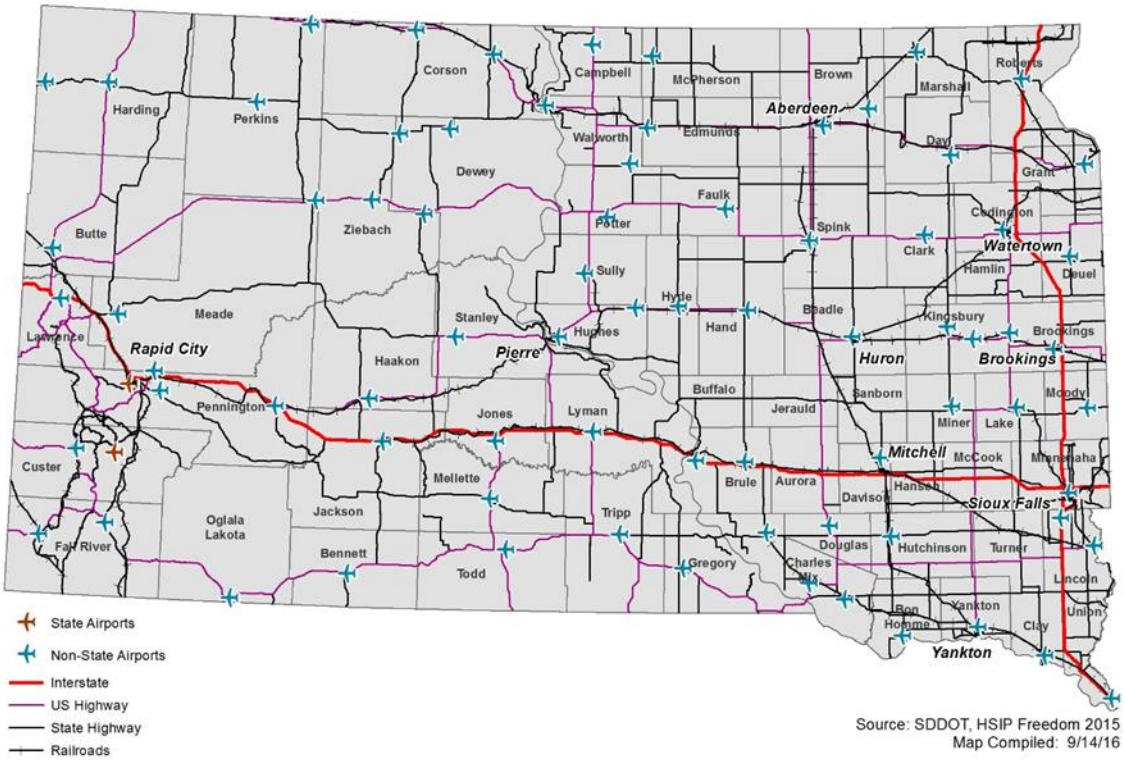
Location

Hazardous materials incidents can happen throughout the state. Localities where hazardous materials are fabricated, processed, and stored as well as those where hazardous waste is treated, stored, and disposed of are most at risk for hazardous materials incidents. Additionally, localities along transportation corridors that carry these materials to their final destinations are also at risk. More than half of the transportation incidents between 1971 and 2016 occurred in Minnehaha and Pennington counties, where the state's largest cities, Sioux Falls and Rapid City, are located (see the discussion on past events in the following section).

Transportation

Figure 3-34 illustrates South Dakota's transportation infrastructure. There is not a designated hazardous materials route map, but the interstates and other highways and railroads are the typical corridors that have hazardous materials being transported on them.

Figure 3-34 South Dakota Transportation Infrastructure



Pipelines

According to the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA), South Dakota's pipeline system is as follows:

- Hazardous liquid line mileage: 803
- Gas transmission line mileage: 1,661
- Gas gathering line mileage: 0
- Gas distribution mileage: 4,570*
- Total pipeline mileage: 7,034

All mileages are for 2011 and are approximate as some data sources may not have contained a complete record of state pipeline mileage.

*Gas distribution service lines (the connection between the distribution line and the end user) are not included in the gas distribution mileage. The total number of such services is 193,628.

Table 3-27 Gas Transmission Line and Hazardous Liquid Line Mileage by County (ranked by percent of total) shows the breakdown of gas transmission line and hazardous liquid line mileage by county. Note that some counties are not listed on the table. Figure 3-35 shows the location of these lines, the majority of which are located in the eastern half of the state.

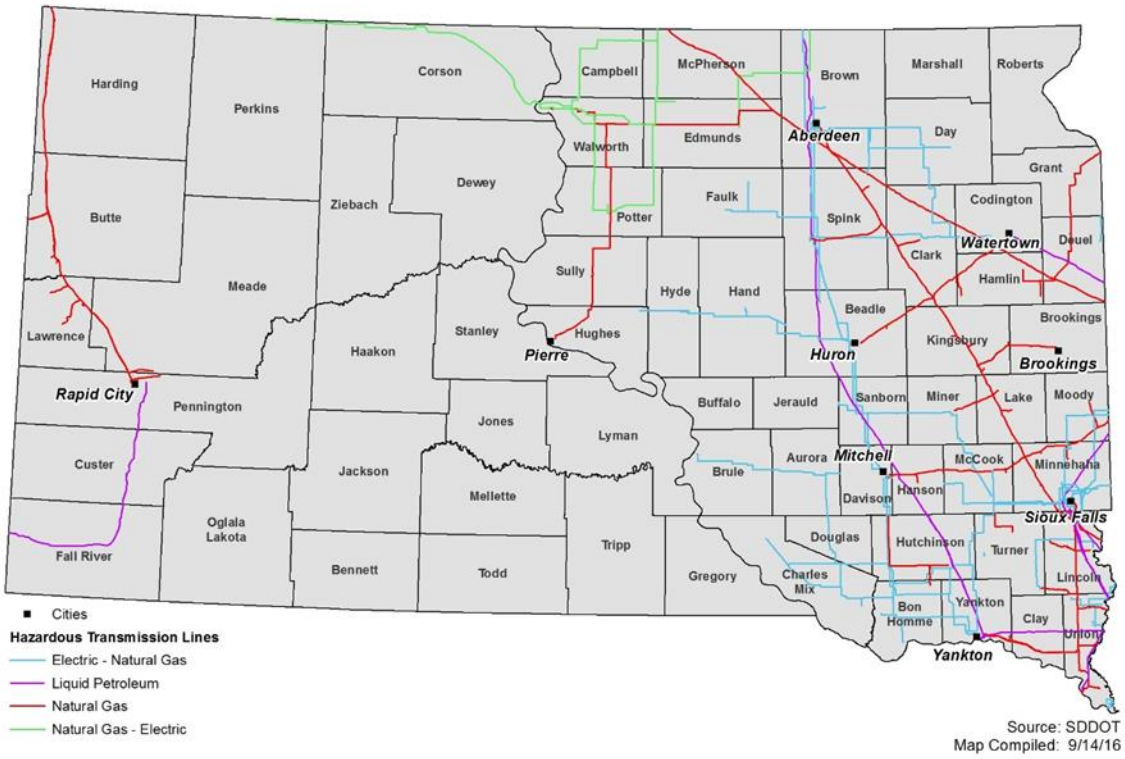
Table 3-27 Gas Transmission Line and Hazardous Liquid Line Mileage by County (ranked by percent of total)

County	Gas Miles	Liquid Miles	Percent of Total
Lincoln	85	106	7.70%
Minnehaha	126	37	6.60%
Brown	83	53	5.50%
Clark	87	39	5.10%
Spink	71	46	4.70%
Butte	99	0	4.00%
Hutchinson	43	52	3.80%
Union	74	19	3.70%
Harding	84	0	3.40%
Kingsbury	67	16	3.30%
Yankton	22	60	3.30%
Deuel	53	24	3.10%
Beadle	19	51	2.80%
Meade	60	0	2.40%
Edmunds	56	0	2.30%
Hanson	20	37	2.30%
Clay	36	17	2.10%
Day	20	33	2.10%
McCook	40	12	2.10%
Walworth	54	0	2.10%
Fall River	0	50	2.00%
Hamlin	50	0	2.00%
Sully	50	0	2.00%
Lawrence	46	0	1.90%
Codington	28	12	1.60%
Lake	39	0	1.60%
McPherson	40	0	1.60%
Pennington	22	18	1.60%
Miner	8	26	1.30%
Grant	30	0	1.20%

County	Gas Miles	Liquid Miles	Percent of Total
Custer	0	29	1.10%
Sanborn	0	29	1.10%
Davison	16	8	1.00%
Marshall	0	26	1.00%
Moody	22	3	1.00%
Potter	26	0	1.00%
Turner	24	0	0.90%
Hughes	19	0	0.70%
Brookings	15	0	0.60%
Roberts	11	0	0.40%
Totals	**1,660**	**803**	**100%**

Source: Pipeline and Hazardous Materials Safety Administration, http://primis.phmsa.dot.gov/comm/reports/safety/SD_detail1.html

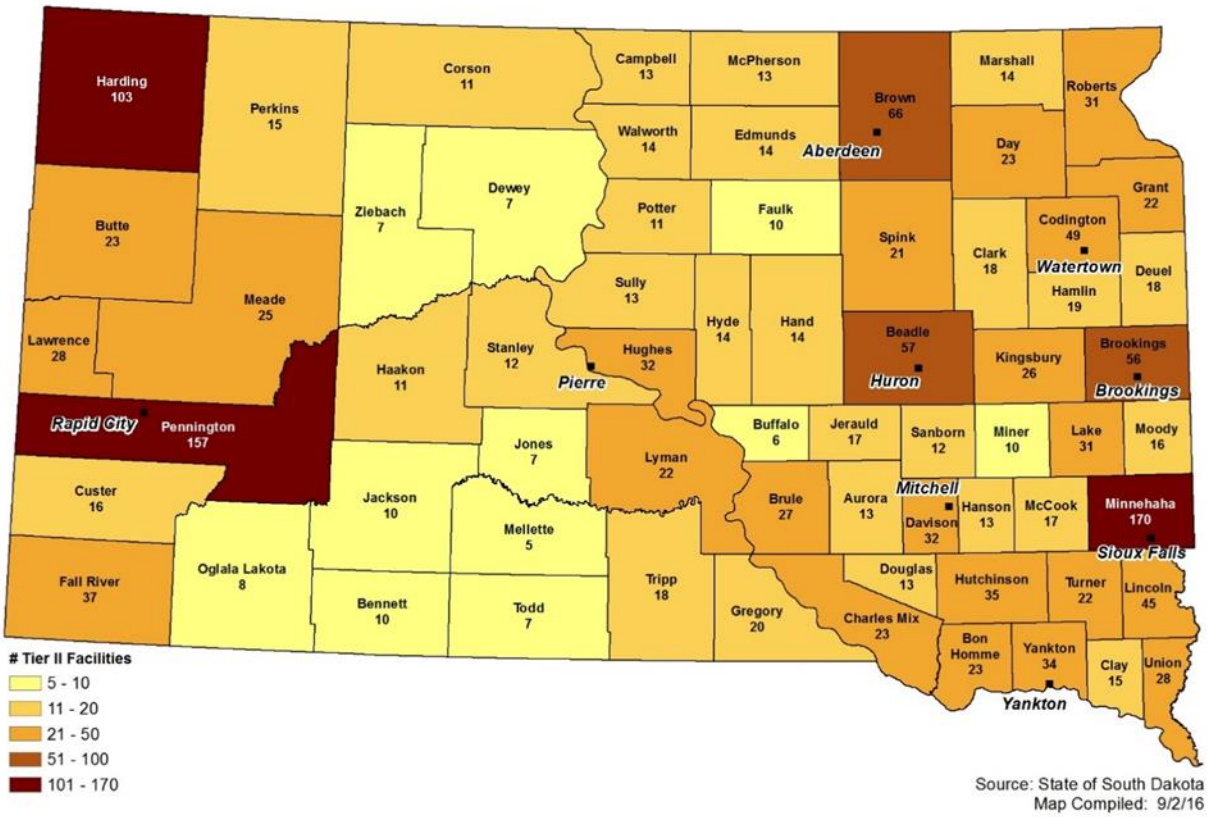
Figure 3-35 South Dakota Hazardous Materials Transmission Lines



Fixed Facility

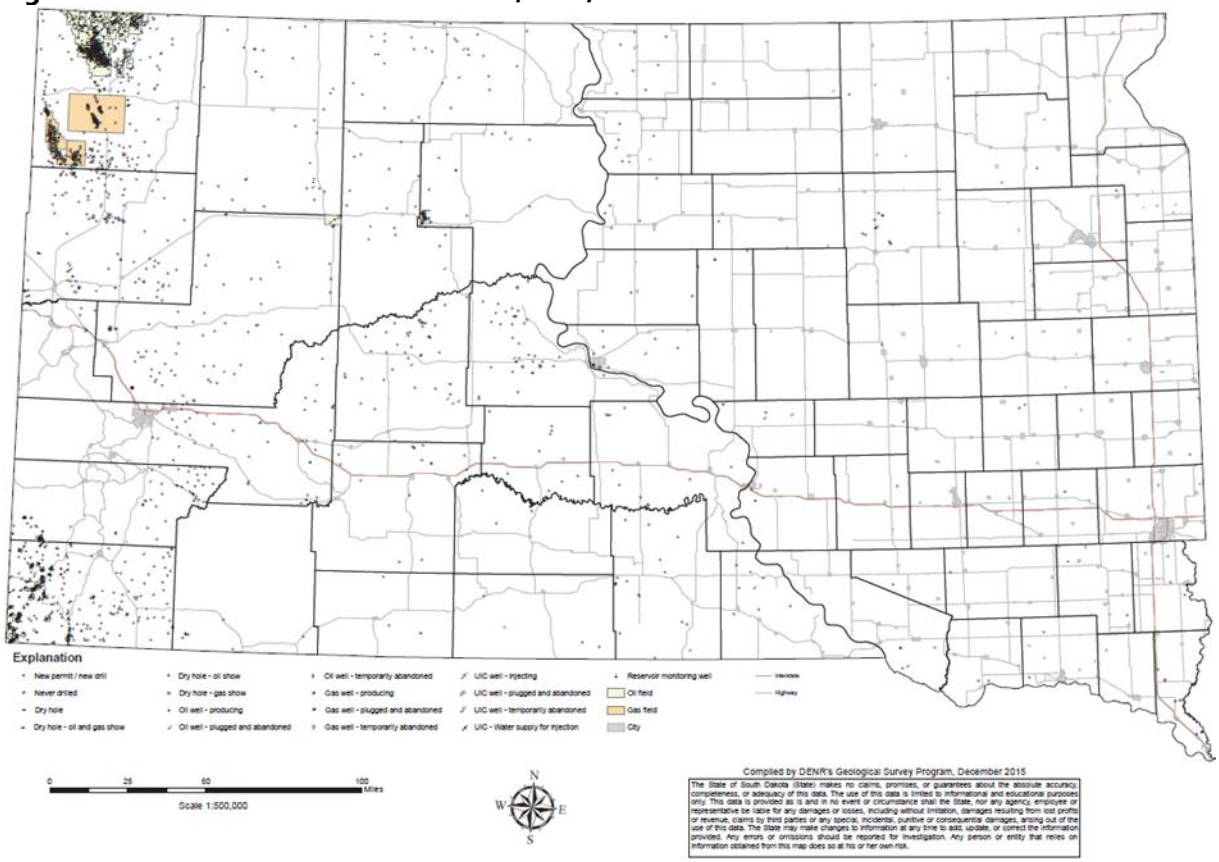
Figure 3-36 shows the number of Tier II facilities in each county. Tier II refers to facilities that are covered by the Emergency Planning and Community Right-to-Know Act (EPCRA). These facilities are required to submit an Emergency and Hazardous Chemical Inventory Form to their LEPC, the State Emergency Response Commission, and local fire departments each year. South Dakota requires that these facilities use the Tier II reporting form.

Figure 3-36 South Dakota Tier II Facility Counts 2015



With the boom in the oil, gas and mining industries seen in the northern great plains, the risk of hazardous materials from mining for resources has increased as new sites are developed. The following figure shows oil and gas resources across the State of South Dakota; these facilities carry inherent risk for hazardous materials spills or accidents related to transportation of oil and gas extracted from these sites. The majority of these sites are west of the Missouri River and in the northwest and southwest corners of the state.

Figure 3-37 South Dakota Oil and Gas, Well, Test Hole and Permit Locations

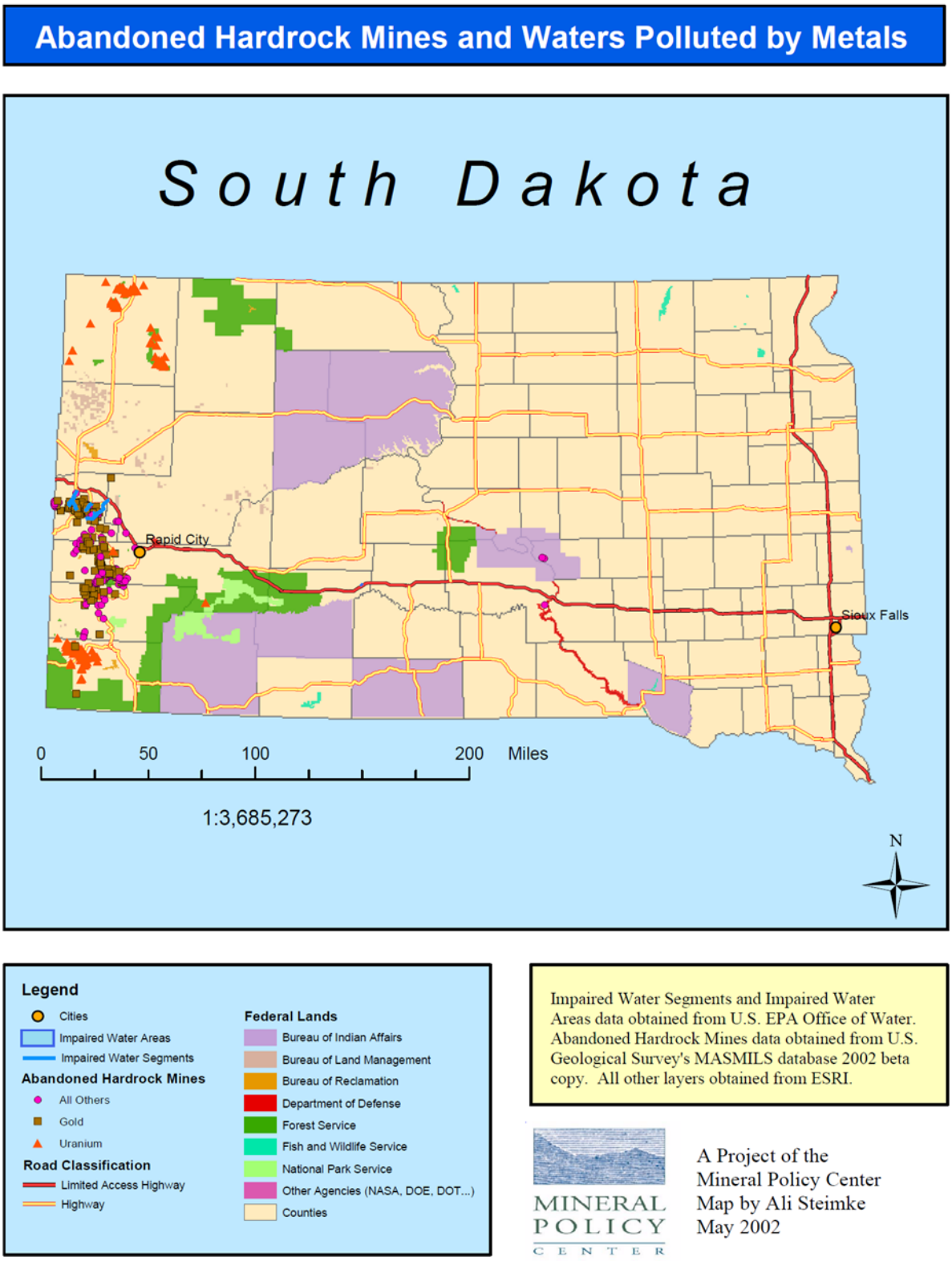


Source: South Dakota DENR – Geological Survey Program

Abandoned mines can sometimes contain hazardous materials and release toxic materials into the surrounding watersheds. The following map shows abandoned mines located in South Dakota.

New mining activity may also pose a concern in the future, such as uranium mining permitting in process in Fall River County (source SHMT 2016). A nuclear waste test project in Spink County was also noted as a potential concern by the SHMT.

Figure 3-38 South Dakota Abandoned Hardrock Mines and Waters Polluted by Metals



Past Events

Transportation

The Hazardous Materials Incident Report Subsystem (HMIRS) of the PHMSA Hazardous Materials Information System was established in 1971 to fulfill the requirements of the federal hazardous materials transportation law. Unintentional releases of hazardous materials or the discharge of any quantity of hazardous waste must be reported. The federal law defines hazardous material as "a substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and has designated as hazardous materials. The term includes hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, materials designated as hazardous in the Hazardous Materials Table (see 49 CFR 172.101)."

According to the U.S. Department of Transportation's (DOT) Hazardous Materials Information System, South Dakota experienced 823 transportation incidents involving hazardous materials between 1971 and 2016. The total cost of damage associated with these incidents was $15,033,401. This suggests that South Dakota averages 18 transportation incidents involving hazardous materials and $334,076 in related damage each year. Among these incidents there were 6 deaths and 33 injuries. The majority of incidents occurred on the highway.

Table 3-28 Transportation Hazardous Materials Incidents, 1971-2016

County	# of Events	Fatalities	Total Injuries	Damages ($)	Evacuations
Minnehaha	434	0	5	536,396	213
Pennington	111	1	2	88,836	0
Brown	34	0	2	286,470	0
Codington	35	0	0	81,146	0
Brookings	18	0	0	207,419	1
Davison	18	0	0	57,948	5
Lawrence	15	0	0	3,366	0
Beadle	14	0	3	10,742	40
Hughes	13	0	0	1,150	0
Meade	12	0	0	84,915	0
Fall River	10	0	0	0	0
Grant	11	0	0	377,456	75
Butte	9	0	1	100	0
Tripp	9	0	0	0	0
Clay	7	0	0	135,500	0
Haakon	7	0	0	575	0
Hand	7	0	0	165,665	0
Custer	6	0	1	0	0
Lake	5	0	0	44,887	0
Oglala Lakota	5	0	0	12,347	0
Yankton	5	0	0	2,500	2
Hutchinson	4	0	0	0	0
Perkins	4	0	0	0	0
Union	4	0	0	134,786	0
Brule	3	0	2	0	0
Potter	3	0	0	133031	0

County	# of Events	Fatalities	Total Injuries	Damages ($)	Evacuations
Walworth	3	0	0	1,200	0
Aurora	2	2	1	4,000,000	0
Corson	2	0	0	1,230	0
Day	3	0	0	0	0
Jackson	2	0	0	83,000	0
Kingsbury	2	0	0	0	0
Lincoln	2	0	0	55,837	21
McCook	2	0	0	0	0
Spink	3	0	0	165,038	0
Ziebach	2	0	0	0	0
Bon Homme	4	0	0	1,622,498	0
Buffalo	1	0	0	100	0
Clark	1	0	0	0	0
Deuel	1	0	0	8,000	0
Edmunds	1	0	0	0	0
Hamlin	1	0	0	26,000	0
Hyde	1	0	0	600	0
Marshall	1	0	0	5,000	0
McPherson	1	0	0	0	0
Moody	1	0	0	89,387	0
Stanley	1	0	0	64,840	0
Sully	1	0	0	8,380	0
Todd	1	0	0	0	0
Turner	1	0	0	0	0
Total	760*	3	16	6,537,056	357

Source: DOT's Office of Hazardous Materials Safety Incident Reports Database, https://hazmatonline.phmsa.dot.gov/IncidentReportsSearch/search.aspx
*Although this column totals up to 761, one event occurred in both Meade and Pennington counties and thus is only counted once.

Reports from PHMSA provide detail and significant incident history for the pipeline systems in the State of South Dakota between 1983 and 2012. Table 3-29 lists these incidents. Similar data was not available during the 2016 update. Significant incidents are those incidents reported by pipeline operators with any of the following conditions met: 1) fatality or injury requiring in-patient hospitalization; 2) $50,000 or more in total costs, measured in 1984 dollars; 3) highly volatile liquid releases of 5 barrels or more or other liquid releases of 50 barrels or more; 4) liquid releases resulting in an unintentional fire or explosion.

Table 3-29 Details of South Dakota Pipeline Incidents, 1983 – 2012

County	Date	Fatalities	Injuries	Damage ($)	Gross Barrels Lost	Barrels Recovered	Type of Incident
Beadle	2/20/2012	0	0	266,340	500	450	Hazardous Liquid
Lawrence	2/10/2012	0	0	108,650	n/a	n/a	Natural Gas Distribution
Clark	5/21/2010	0	0	207,508	0	0	Hazardous Liquid
Hughes	04/02/2009	0	0	150,000	0	0	Natural Gas Transmission
Hughes	02/20/2008	0	0	152,979	0	0	Natural Gas Distribution

County	Date	Fatalities	Injuries	Damage ($)	Gross Barrels Lost	Barrels Recovered	Type of Incident
Lincoln	03/29/2007	0	0	499,705	0	0	Natural Gas Distribution
Davison	03/08/2007	0	0	505,216	0	0	Natural Gas Transmission
Minnehaha	10/14/2006	0	0	25,100	n/a	n/a	Natural Gas Distribution
Minnehaha	6/16/2006	0	0	14,400	n/a	n/a	Natural Gas Transmission
Sanborn	12/28/2004	0	0	192,102	193	154	Hazardous Liquid
Pennington	10/11/2004	0	0	107,577	n/a	n/a	Natural Gas Distribution
Clark	4/28/2003	0	0	75,027	n/a	n/a	Natural Gas Distribution
Beadle	2/26/2001	0	0	62,642	n/a	n/a	Natural Gas Distribution
Lincoln	10/4/2000	0	0	0	n/a	n/a	Natural Gas Distribution
Custer	8/10/1998	0	0	37,083	123	0	Hazardous Liquid
McCook	5/30/1998	0	0	92,707	n/a	n/a	Natural Gas Distribution
Union	4/4/1998	0	0	49,444	195	0	Hazardous Liquid
Lawrence	3/19/1997	0	0	0	n/a	n/a	Natural Gas Transmission
Pennington	9/12/1994	0	0	68,027	147	30	Hazardous Liquid
Walworth	10/22/1993	0	1	69,735	n/a	n/a	Natural Gas Distribution
Pennington	4/9/1993	0	0	7,601	300	250	Hazardous Liquid
Pennington	3/2/1993	0	0	174,338	n/a	n/a	Natural Gas Distribution
Minnehaha	1/13/1992	0	0	0	7,200	1,849	Hazardous Liquid
Brown	5/14/1991	0	1	0	n/a	n/a	Natural Gas Distribution
Union	4/8/1991	0	0	184,911	2,881	0	Hazardous Liquid
Codington	2/18/1990	0	0	10,802	332	101	Hazardous Liquid
Minnehaha	12/25/1989	0	0	40,650	1	1	Hazardous Liquid
Minnehaha	12/24/1989	0	0	40,650	6	6	Hazardous Liquid
Yankton	7/5/1989	0	0	0	n/a	n/a	Natural Gas Distribution
McCook	3/21/1989	0	1	0	n/a	n/a	Natural Gas Transmission
Pennington	1/9/1989	0	0	0	0	0	Hazardous Liquid
Pennington	1/9/1988	0	0	0	n/a	n/a	Natural Gas Distribution
Lincoln	12/10/1987	0	0	0	100	0	Hazardous Liquid

County	Date	Fatalities	Injuries	Damage ($)	Gross Barrels Lost	Barrels Recovered	Type of Incident
Pennington	4/9/1987	0	1	13,321	n/a	n/a	Natural Gas Distribution
Minnehaha	4/8/1987	0	0	444,050	25	0	Hazardous Liquid
Minnehaha	3/11/1987	0	0	888,099	200	5	Hazardous Liquid
Minnehaha	2/16/1987	0	0	7,104,796	715	19	Hazardous Liquid
Brown	9/25/1986	2	0	551,471	n/a	n/a	Natural Gas Distribution
Pennington	12/20/1985	0	0	93,633	n/a	n/a	Natural Gas Distribution
Kingsbury	6/17/1985	0	0	0	n/a	n/a	Natural Gas Transmission
Decatur	5/7/1984	0	0	6,796	n/a	n/a	Natural Gas Distribution
Beadle	2/13/1983	0	0	n/a	n/a	n/a	Natural Gas Transmission

Source: DOT's PHMSA Significant Incident Listings and Incident Report Files, http://primis.phmsa.dot.gov/comm/reports/safety/IncDetSt_st_SD_flt_sig.html?nocache=9577
Notes: The costs in the years prior to 2012 are in 2012 dollars.

For years 2002 and later, property damage is estimated as the sum of all public and private costs reported in the 30-day incident report. For years prior to 2002, accident report forms did not include a breakdown of public and private costs, so property damage for these years is the reported total property damage field in the report.

During the 2019 planning process, one event of significance was found to have occurred on November 16, 2017 in Marshall County. The spill occurred along the Keystone Pipeline on farmland in the Town of Amherst. Initial reports from the U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) estimated the spill released 210,000 gallons and was likely caused by mechanical damage during the construction of the pipeline in 2008. In April 2018, the local news source Aberdeen American News reported that a spokeswoman for the pipeline owner, TansCanada Corporation, estimated the spill to be 407,400 gallons, twice as much as was first reported in 2017. According to the PHMSA, this pipeline spill is now considered to the seventh largest onshore oil or petroleum product spill in the U.S. since 2010. Note, this event is not included in the probability calculations below or Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdictions.

Fixed Facility

The U.S. Environmental Protection Agency maintains a database on toxic chemical releases and other waste management activities, which are reported annually by certain covered industry groups as well as federal facilities: The Toxics Release Inventory. In 2014, the most recent data available, 6.2 million pounds of hazardous materials were disposed of or released in South Dakota. Table 3-30 ranks chemical releases by county for 2014. Table 3-31 and Table 3-32 show the top 10 releasing facilities and the top 10 chemicals released in 2014.

Table 3-30 Chemical Releases* by County, 2014 (all figures are in pounds)

County	Total On-site Disposal or Other Releases	Total Off-site Disposal or Other Releases	Total On- and Off-site Disposal or Other Releases
Minnehaha	2,940,292	17,834	2,958,128
Lawrence	1,383,945		1,383,945
Grant	602,028	238,523	840,551
Brookings	504,877	3,587	508,514
Pennington	114,582	16	114,599
Codington	67,742	1,470	69,229
Roberts	59,856		59,856
Lincoln	53,168		53,168
Brown	41,378	126	41,504
Turner	38,051		38,051
Edmunds	31,532		31,532
Lake	23,029	770	23,799
Yankton	21,203	1,477	22,940
Spink	18,456		18,456
Day	12,861	0	12,861
Beadle	8,379		8,379
Davison	6,362	317	6,684
Bon Homme	5,850		5,850
Campbell		1,936	3,872
Hamlin	887		887
Deuel	0	389	389
Hutchinson	7	0	7
Total	**5,934,483**	**266,445**	**6,203,200**

Source: U.S. Environmental Protection Agency, Toxics Release Inventory Explorer, www.epa.gov/triexplorer/
*Includes releases to land, air, and water

Table 3-31 Top 10 South Dakota Facilities with Greatest Total Releases,* 2014 (all figures are in pounds)

Facility	County or Parish or County Equivalent	Total On-site Disposal or Other Releases	Total Off-site Disposal or Other Releases	Total On- and Off-site Disposal or Other Releases
John Morrell & Co.	Minnehaha	2,759,044	16,682	2,775,726
Wharf Resources	Lawrence	1,365,327	0	1,365,327
Otter Tail Corp (DBA Otter Tail Power Co)	Grant	484,478	209,726	694,206
South Dakota Soybean Processors LLC	Brookings	413,013	0	413,013
Starmark Cabinetry	Minnehaha	73,727	0	73,727
U.S. DOD USAF	Pennington	52,791	14	52,805
Pete Lien & Sons Inc.	Pennington	48,202	0	48,202
Valley Queen Cheese Factory Inc.	Grant	39,300	750	40,050
Woodland Cabinetry Inc.	Roberts	38,176	0	38,176

Facility	County or Parish or County Equivalent	Total On-site Disposal or Other Releases	Total Off-site Disposal or Other Releases	Total On- and Off-site Disposal or Other Releases
Glacial Lakes Energy LLC	Codington	37,840	0	37,840

Source: U.S. Environmental Protection Agency, Toxic Resources Inventory, www.epa.gov/tri/
*Includes releases to land, air, and water

Table 3-32 Top 10 Chemicals Reported Released* in South Dakota, 2014 (all figures are in pounds)

Chemical	Total On-site Disposal or Other Releases	Total Off-site Disposal or Other Releases	Total On- and Off-site Disposal or Other Releases
Nitrate Compounds	2,991,027.00	11,362.00	3,002,389.00
Lead Compounds	1,064,981.10	3,987.37	1,068,968.47
Barium Compounds	431,494.00	209,726.00	641,220.00
N-Hexane	456,874.56	.	456,874.56
Xylene (Mixed Isomers)	168,483.59	9	168,492.59
Acetaldehyde	132,017.26	.	132,017.26
Hydrochloric Acid (1995 and after Acid Aerosols only)	101,402.00	.	101,402.00
Chromium	81,333.27	816.56	82,149.83
Ammonia	70,936.00	6,334.00	77,270.00
N-Butyl Alcohol	61,508.09	.	61,508.09

Source: U.S. Environmental Protection Agency, Toxic Resources Inventory, www.epa.gov/tri/; *Includes releases to land, air, and water

Probability

Transportation

According to the U.S. Department of Transportation's Hazardous Materials Information System, there were 831 transportation incidents involving hazardous materials in South Dakota between 1971 and 2016 (45 years). Based on this information, the probability that at least one transportation incident involving hazardous materials will occur in South Dakota annually is 100%.

Pipeline

According to the U.S. Department of Transportation's Office of Pipeline Safety, there were 42 pipeline incidents in South Dakota between 1983 and 2012 (29 years). Based on this information, the probability that at least one pipeline incident will occur in South Dakota annually is 100%.

Fixed Facility

According to the U.S. Environmental Protection Agency's Toxic Resource Inventory, 6.1 million pounds of hazardous materials were disposed of or released in South Dakota in 2014. Based on this information, there is a 100 percent probability that a fixed facility will dispose of or release a hazardous material in South Dakota each year.

3.2.10 Geologic Hazards

A multitude of geologic hazards affect the State of South Dakota. For purposes of this plan, the geologic hazards profiled consists of landslides, mudflows, expansive soils, subsidence, and earthquakes

Description

What Is a Landslide?

Landslides are a serious geologic hazard common to almost every state in the United States. It is estimated that nationally they cause up to $2 billion in damage and 25 to 50 deaths annually. Globally, landslides cause billions of dollars in damage and thousands of deaths and injuries each year.

Some landslides move slowly and cause damage gradually, whereas others move so rapidly that they can destroy property and take lives suddenly and unexpectedly. Gravity is the force driving landslide movement. Factors that allow the force of gravity to overcome the resistance of earth material to landslide movement include saturation by water, steepening of slopes by erosion or construction, alternate freezing or thawing, earthquake shaking, and volcanic eruptions.

Landslides are typically associated with periods of heavy rainfall or rapid snow melt and tend to worsen the effects of flooding that often accompanies these events. In areas burned by forest and brush fires, a lower threshold of precipitation may initiate landslides.

Landslides are defined as a rapid slipping of a mass of earth or rock from a higher elevation to a lower level under the influence of gravity and water lubrication. More specifically, rockslides are the rapid downhill movement of large masses of rock with little or no hydraulic flow, similar to an avalanche. Water-saturated soil or clay on a slope may slide downhill over a period of several hours. Earthflows of this type are usually not serious threats to life because of their slow movement, yet they can cause blockage of roads and do extensive damage to property.

Earthquakes also may cause landslides by shaking unconsolidated or weathered material from slopes. Rockslides triggered by an earthquake in Montana in 1959 caused an entire mountainside to slide into the Madison River Gorge, killing 27 people in its path, damming the gorge, and forming a new lake. Humans have triggered a number of tragic landslides that have caused great damage and loss of life. In the Los Angeles area of California, extensive real estate development carried out on hillsides has resulted in widespread mudflows after winter rains have saturated the over-steepened embankments of soil. In some areas, slow-moving earthflows have been initiated by the lubrication of certain types of underlying clays by septic tank effluent. Submarine slides, or a sliding mix of seawater and mud, are called turbidity currents. Undersea landslides can travel several hundred miles across very gradual slopes, riding on a thin film of water that reduces friction.

What Is a Mudflow?

Mudflows (or debris flows) are rivers of rock, earth, and other debris saturated with water. They develop when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt, changing the earth into a flowing river of mud or "slurry." A slurry can flow rapidly down slopes or through channels and can strike with little or no warning at avalanche speeds. A slurry can travel several miles from its source, growing in size as it picks up trees, cars, and other materials along the way. In hilly or mountainous areas for years after a wildfire, heavy rainfall creates mudflow and landslide risks to people, structures, and infrastructure located below such areas.

Damages from mudflows are covered under the National Flood Insurance Program; landslides are not.

What is Expansive Soil?

Expansive soils are referred to by many names, such as. "Expandable soils," "expansive clays," "shrink-swell soils," and 'heavable soils." are some of the many names used for these materials. Expansive soils contain minerals such as smectite clays that are capable of absorbing water. When expansive soils are present, they will generally not cause a problem if their water content remains constant. The situation where greatest damage occurs is when there are significant or repeated moisture content changes. When they absorb water, they increase in volume. The more water they absorb the more their volume increases. Expansions of ten percent or more are not uncommon. This change in volume can exert enough force on a building or other structure to cause damage. The force of expansion is capable of exerting pressures of 15,000 pounds per square foot or greater on foundations, slabs, and other confining structures. Cracked foundations, floors and basement walls are typical types of damage done by swelling soils. Damage to the upper floors of the building can occur when motion in the structure is significant. Expansive soils will also shrink when they dry out. This shrinkage can remove support from buildings or other structures and result in damaging subsidence. Fissures in the soil can also develop. These fissures can facilitate the deep penetration of water when moist conditions or runoff occurs. This produces a cycle of shrinkage and swelling that places repetitive stress on structures.

Expansive soils are present throughout the world and are found in each American state. Every year they cause billions of dollars in damage. The American Society of Civil Engineers estimates that 1/4 of all homes in the United States have some damage caused by expansive soils. In a typical year in the United States they cause a greater financial loss to property owners than earthquakes, floods, hurricanes and tornadoes combined. Even though expansive soils cause enormous amounts of damage most people have never heard of them. This is because their damage is done slowly and cannot be attributed to a specific event. The damage done by expansive soils is then attributed to poor construction practices or a misconception that all buildings experience this type of damage as they age.

What is Subsidence?

Land subsidence is the sinking of the land over manmade or natural underground voids. Subsidence occurs naturally and also through man-driven or technologically exacerbated circumstances. Natural causes of subsidence occur when water in the ground dissolves minerals and other materials in the earth, creating pockets or voids. When the void can no longer support the weight of the earth above it, it collapses, causing a sinkhole depression in the landscape. Often, natural subsidence is associated with limestone erosion, but may also occur with other water-soluble minerals. Man-driven or technology-exacerbated subsidence conditions are associated with the lowering of water tables, extraction of natural gas, or subsurface mining activities. As the underground voids caused by these activities settle or collapse, subsidence occurs on the surface.

Location

Landslides

Areas that are generally prone to landslide hazards include existing old landslides, the bases of steep slopes, the bases of drainage channels, and developed hillsides where leach-field septic systems are used.

Areas that are typically considered safe from landslides include areas that have not moved in the past, relatively flat-lying areas away from sudden changes in slope, and areas at the top or along ridges, set back from the tops of slopes.

In certain areas of South Dakota landslides do occur. Over the years, many landslides have been dealt with by the State of South Dakota and in particular the South Dakota Department of Transportation (SDDOT).

SDDOT has spent a lot of time stabilizing landslides throughout the state. Two of the larger slides were the US U.S. 12 Missouri River Crossing at Mobridge and the US U.S. 212 Missouri River crossing at Forest City. At Mobridge, stone columns were used for the first time in the United States to stabilize a clay-shale landslide. Forest City also used stone columns and also incorporated the use of massive concrete shear pins installed by slurry wall process to stabilize the approach berm. This was the first time in the United States that this technique was used to mitigate a landslide of this magnitude. A civil engineer, who was head of the SDDOT Geotechnical Activity Section from 1969 to 2001, achieved national recognition for his innovative work with these two landslides. A slide area also exists near Cheyenne Crossing along U.S. Highway 14A in Lawrence County. Road crews were engaged in landslide repair efforts at the site in 2012 and continuing into 2013. A potential landslide area existed near Yates Pond in Lawrence County along U.S. Highway 14A, but SDDOT mitigated this area in 2010.

Subsidence

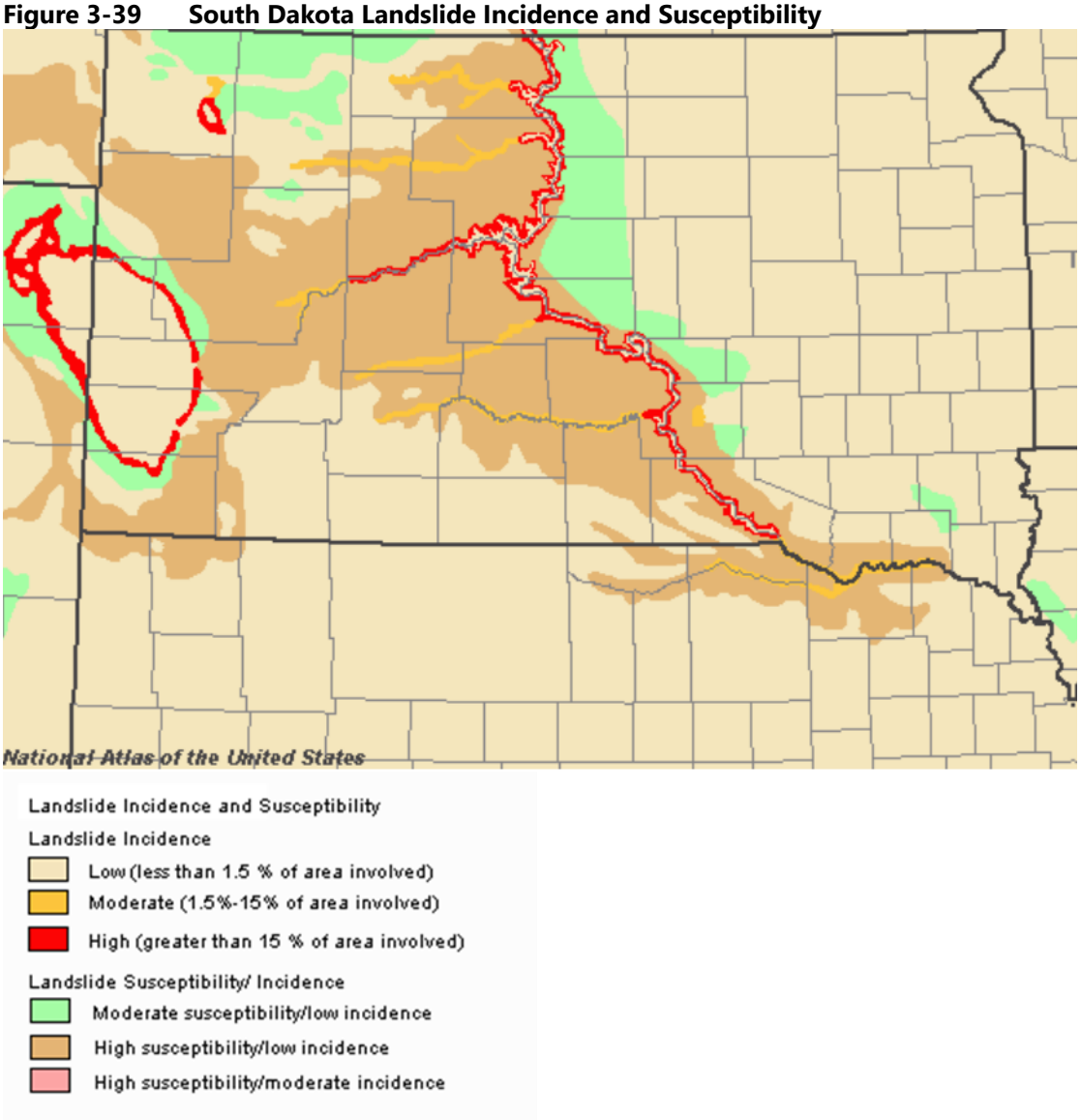
There are certain areas in South Dakota at risk to subsidence (see Figure 3-39). The Niobrara Formation (Upper Cretaceous) and its equivalents are the most widespread carbonate rocks in western Kansas, eastern Nebraska, and southeastern South Dakota. The Niobrara is generally covered by more than 50 ft. (15 m) of younger sediments. Small fissures, less than 1,000 ft. (300 m) long and up to 100 ft. (30 m) deep, are present, but they are not common and are generally irregularly spaced with 1,000 ft. (300 m) or more of solid rock between fissures.

In western South Dakota and adjacent parts of Wyoming and Montana, Paleozoic and Cretaceous carbonate rocks, arched steeply upwards, encircle the structural dome that forms the Black Hills. Caves and open fissures are common in the Paleozoic carbonate rocks. A few caves contain many miles of passages but most of the cave passages and fissures in the Black Hills area only extend up to 3,000 ft. (900 m) in length and are generally less than 150 ft. (45 m) in depth. Closely spaced solution joints also are prevalent.

Expansive Soils

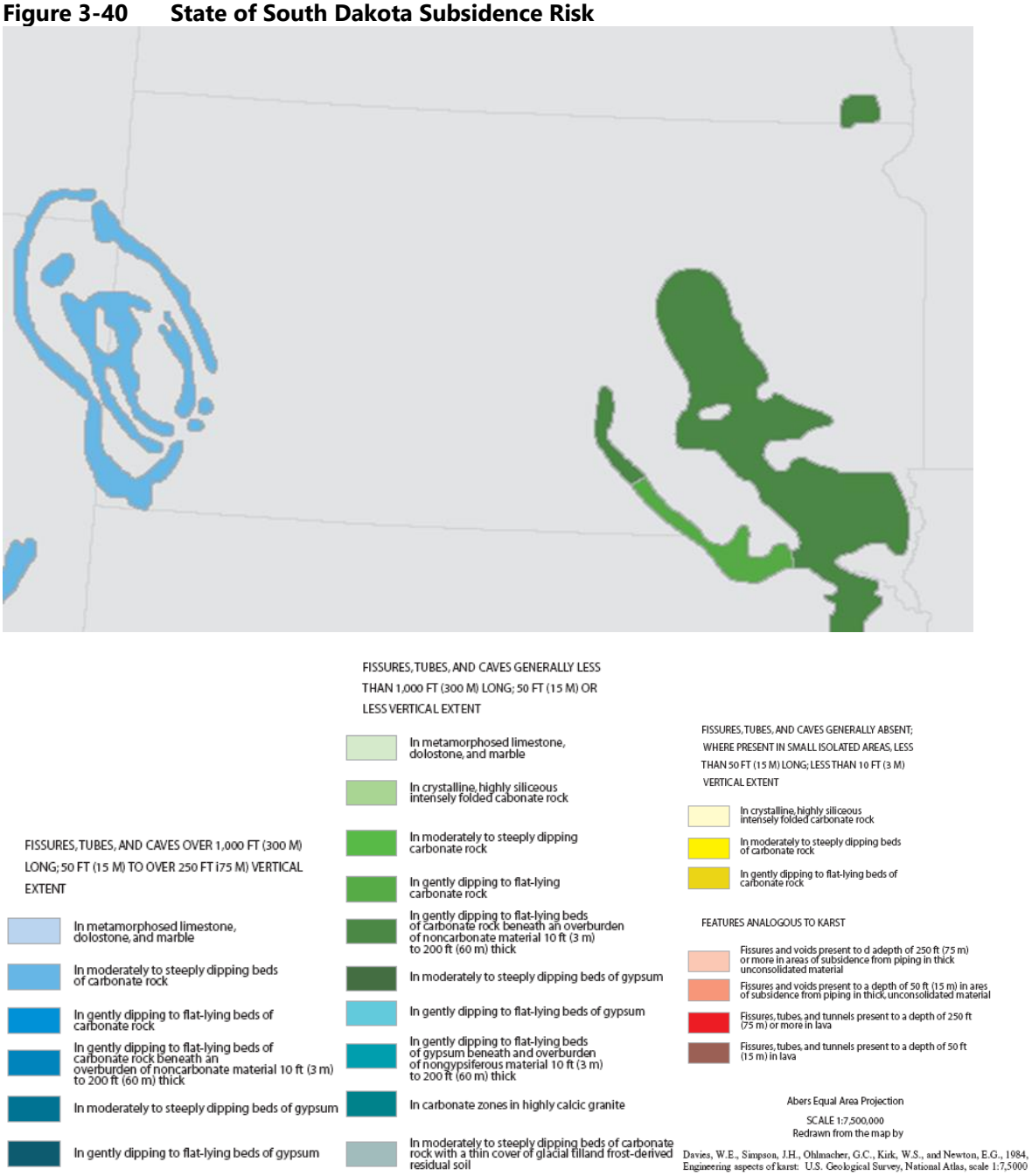
There are certain areas of South Dakota at risk to expansive soils. The map below shows the geographic distribution of soils which are known to have expandable clay minerals which can cause damage to foundations and structures. It also includes soils that have a clay mineral composition which can potentially cause damage. The map is meant to show general trends in the geographic distribution of expansive soils. It is not meant to be used as a property evaluation tool. It is useful for learning areas where expansive soils underlie a significant portion of the land and where expansive soils might be a localized problem. According to this map, the majority of the State has the potential for expansive soils.

Figure 3-39 South Dakota Landslide Incidence and Susceptibility



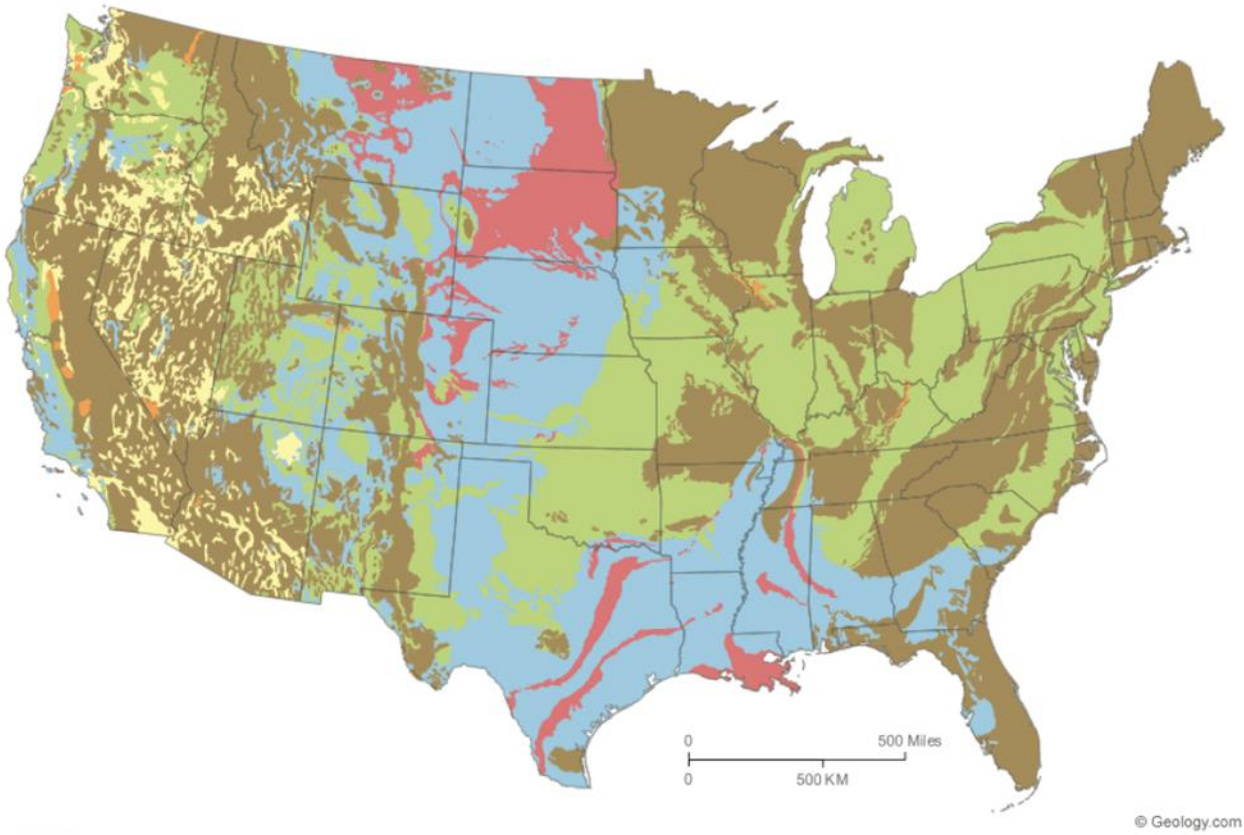
Source: U.S. Geological Survey, map generated by https://nationalmap.gov/ www.nationalatlas.gov

Figure 3-40 State of South Dakota Subsidence Risk



Source: The National Karst Map http://www.nckri.org/map/maps/engineering_aspects/davies_map_PDF.pdf

Figure 3-41 South Dakota Expansive Soils



Over 50 percent of these areas are underlain by soils with abundant clays of high swelling potential.

Less than 50 percent of these areas are underlain by soils with clays of high swelling potential.

Over 50 percent of these areas are underlain by soils with abundant clays of slight to moderate swelling potential.

Less than 50 percent of these areas are underlain by soils with abundant clays of slight to moderate swelling potential.

These areas are underlain by soils with little to no clays with swelling potential.

Data insufficient to indicate the clay content or the swelling potential of soils.

Source: The map above is based upon "Swelling Clays Map of the Conterminous United States" by W. Olive, A. Chleborad, C. Frahme, J. Shlocker, R. Schneider and R. Schuster. It was published in 1989 as Map I-1940 in the USGS Miscellaneous Investigations Series. Land areas were assigned to map soil categories based upon the type of bedrock that exists beneath them as shown on a geologic map. In most areas, where soils are produced "in situ", this method of assignment was reasonable. However, some areas are underlain by soils which have been transported by wind, water or ice. The map soil categories would not apply for these locations.

Past Events

Table 3-33 provides information regarding past landslides, mudflows, subsidence, and expansive soils.

Table 3-33 South Dakota Landslides and Mudflows

Date	Comments
2012-2013	Road crews worked to repair a slide area near Cheyenne Crossing along U.S. Highway 14A in Lawrence County. Repair efforts included excavating landslide debris and constructing a new back slope.
2006	A landslide near Wasta in Pennington County took the water system out for a week.
August 8, 2004	A heavy rain at the rate of about one inch per hour fell over the area burned by the Grizzly Gulch fire in Lawrence County just six weeks before. The result was that the steep hillsides lost most of their topsoil, which flowed down into Deadwood. Hardest hit was the area of the Northern Hills General Hospital where a retaining wall was damaged, Whistler's Gulch Campground and Mile High Mobile Home Park, and properties along Sherman Street in Deadwood. Cleanup would have been well over one million dollars, but the use of a state prison work crew and volunteers reduced the out of pocket expense to property owners.
2001	A mudflow caused by heavy rain occurred after the Black Hills Grizzly Gulch Fire in 2001. The mudflow caused damage to many homes in the burn area or below.
June 1976	Flash Flooding, Mudslides (FEMA-511-DR) In a 24-hour period on June 13-14, 3 to 10 inches of rain fell in the northern Black Hills. And additional two to three inches of rain plus heavy snow was recorded over this area on the June 15 and 16. The run-off from this precipitation did considerable damage in the counties of Lawrence, Meade, Butte, and Harding. There was also a problem with mudslides and landslides.
May 1952	Sturgis/Deadwood - Heavy rains brought flash flooding that tore up streets and gas pipelines in Sturgis. Bridges were washed out and water erosion caused rock slides. Water damage and landslides also occurred in Deadwood.

Limited information was available regarding past impacts from swelling soils. Modern building practices often take this hazard into account and incorporate mitigation. The SDDOT does normal maintenance and accounts for this hazard in their construction practices, which does result in additional costs for mitigation and road maintenance. Research yielded little information regarding past impacts from subsidence.

Probability

Although historical landslide/mudflow/subsidence/expansive soil occurrence data is limited it can be assumed that landslides will occur occasionally in the future, typically during wet climate cycles or following heavy rains, but in limited areas of the state.

Earthquake Description

Earthquakes east of the Rocky Mountains are less frequent than in the western United States and are typically felt over a much broader region. Most of North America east of the Rocky Mountains has infrequent earthquakes. Most of the enormous region from the Rockies to the Atlantic can go years without an earthquake large enough to be felt, and several U.S. states have never reported a damaging earthquake. The earthquakes that do occur are typically small and occur at irregular intervals.

East of the Rockies it is difficult to determine the specific fault that is responsible for an earthquake since this vast region is far from plate boundaries, which are in the Atlantic Ocean, the Caribbean Sea, and in California and offshore from Washington and Oregon. Known faults do exist in this "stable continental region," but numerous smaller or deeply buried faults remain undetected, even most of the known faults

are poorly located at depths typically associated with earthquakes. Thus, few earthquakes east of the Rockies can be linked to named faults. Also, it is difficult to determine if a fault is still active and capable of generating an earthquake. Consequently, in most areas east of the Rockies, the best guide to earthquake hazards is the earthquakes themselves.

South Dakota is somewhat more seismically active than other areas in the Northern Great Plains, although the earthquake magnitudes have been relatively minor to date. At least two mechanisms may be important in generation of the earthquakes. These include initiation of movement along preexisting fractures due to crustal plate movements or movements due to glacial rebound. Ground motion accelerations can be calculated based upon historical seismic records, but the poor quality of the database does not allow great confidence to be placed in those calculations. These calculations show highs in ground motion acceleration that correspond reasonably closely with areas of greater earthquake frequency.

Location

A zone of higher earthquake frequency extends from the northeastern corner of the state and a generally higher frequency of earthquakes is recorded along the eastern flank of the Black Hills and in the southwestern corner of the state. The earthquakes occurring in South Dakota appear to be concentrated along the Great Lakes Tectonic Zone and possibly along the boundaries of the structural provinces in the Precambrian, crystalline basement.

The Black Hills, being a structural dome, is full of faults and joints dating to the uplift some 50 million years ago. Very little strain now accumulates along them, so only small, rare earthquakes have occurred in the region during historic times. Work by several geologists during the last decade or so have shown that much of the region has widely spaced joints and faults breaking the Earth's crust into blocks, each a township size in area. Fortunately, there is very little strain to release as earthquakes in South Dakota. In the south central part of the state, the South Dakota Geologic Survey have mapped some of these blocks and have identified individual block-bounding faults that have moved 40 feet or more vertically and a few hundreds of feet horizontally in very small increments during the last 50 million years.

Past Events

According to the USGS, no major earthquakes have been reported in South Dakota since 1967. However, earthquakes have historically caused relatively minor damage in South Dakota. Documented damages include cattle stampedes, shaking buildings, falling or rattling dishes and pictures, stuck doors and windows, cracked window glass, foundations heaving or cracking, wall and ceiling plaster cracks, furniture moving, etc.

The following is excerpted directly from an abridged version of Carl A. von Hake's "South Dakota History" in Earthquake Information Bulletin, Volume 9, Number 1, January-February 1977:

The first earthquake reported in the region occurred on October 9, 1872, 17 years before South Dakota was admitted to the Union. This shock was apparently centered near Sioux City, Iowa. Severe effects were noted at Sioux City, at Yankton and White Swan, South Dakota, and elsewhere in the Dakota Territory. Two strong tremors 45 minutes apart caused some damage in eastern Nebraska on November 15, 1877. The large felt area (over 350,000 square kilometers) included all or most of South Dakota.

On December 29, 1879, a mild earthquake produced rumbling noises at Yankton (V). Two shocks, estimated at intensity IV-V, occurred in the Black Hills region on October 11, 1895. The first was reported strongest at Rochford; the latter was strongest at Keystone and Hill City.

The earthquake of June 2, 1911, was reported from Huron (V) and other places in South Dakota, Iowa, and Nebraska, an area covering approximately 100,000 square kilometers. It was apparently centered in the James River valley. A shock on October 23, 1915, near Kadoka, was accompanied by loud noises. Some cracks in the ground were reported (V). The Black Hills region experienced another earthquake on November 16, 1928. At Custer and Rochford there was a deep rumbling sound (V).

Buildings were jarred, dishes rattled, and loose object swayed (V) at Sioux Falls from an October 11, 1938, tremor. Police stations received more than 50 calls from alarmed residents. The total felt area affected was about 7,500 square kilometers in South Dakota and one town in Minnesota. A strong, localized shock on July 23, 1946, caused several cracks in water mains (VI) at Wessington. The earthquake, which occurred about 12:45 a.m., also awakened sleepers at Huron. The small felt area extended from Pierre to De Smet and from Wessington to Redfield. A similar disturbance occurred on December 31, 1961, causing slight damage at Pierre. Reports of cracked plaster and a cracked cement floor were received. Also, buildings shook and loose objects rattled. Newspaper and police switchboards were swamped with calls from alarmed residents (VI). Fisherman along the Missouri River reported that many fish leaped into the air at the time the earthquake occurred. The felt area extended from Midland on the west to Huron on the east.

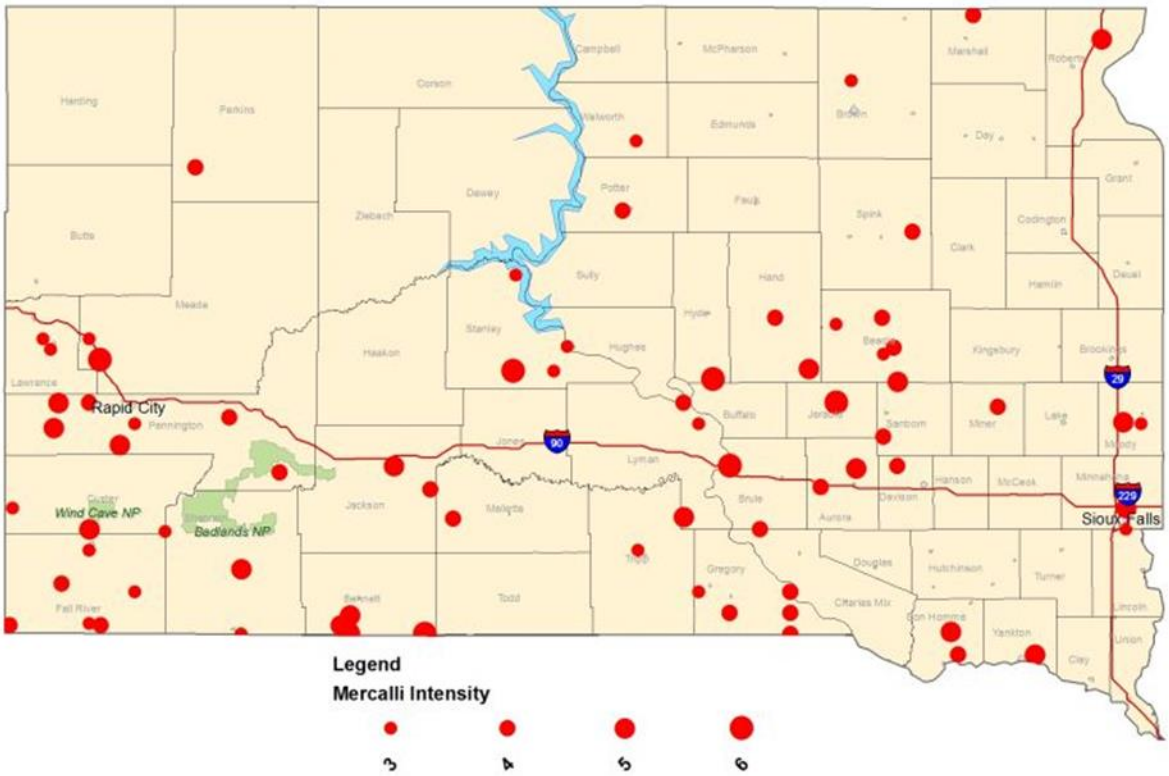
An earthquake with an abrupt onset and a short duration (3-5 seconds) was felt by all at Wind Cave National Park. The March 24, 1964, tremor caused small rocks to fall in the cave. Buildings creaked, and a slight trembling motion was noticed at Hot Springs (V). Three days later (March 27), another shock was reported from the same area. The epicenter was apparently located near Van Tassell, Wyoming, although no instrumental records were available for this event owing to the proximity in time of its occurrence to the occurrence of the great Alaska earthquake. There was no connection between the shocks, although many persons within the felt area thought effects from the Alaskan earthquake had been observed. Maximum intensity (V) was noted at Van Tassell; felt reports were received from Harrison and Hyannis, Nebraska, and Edgemont, Hot Springs, Keystone, Pine Ridge, and Provo, South Dakota.

The strongest tremor in this series (measured at magnitude 5.1) occurred at 3:08 a.m. CST, March 28, 1964. The instrumental epicenter was near Merriman, Nebraska, where broken goods were reported in stores; also, dishes were broken in homes, and stucco under windows cracked. Sixteen kilometers south, 75 cracks were noted in the highway, and some steep banks tumbled along the river (VII). Plaster fell at Rushville, and part of a chimney toppled at Alliance, Nebraska. Slight damage also occurred in southwestern South Dakota - a retaining wall was damaged at Deadwood, there were a few slight cracks in ceiling plaster at Interior, a glass container broke in a market at Martin, and wall and ceiling plaster cracked at Pine Ridge. Several farms near Martin also reported broken glass. The total felt area, including several places in Wyoming, covered approximately 230,000 square kilometers. One town in Montana (Alzada) reported this tremor.

An earthquake on June 26, 1966, near Rapid City, caused slight damage over a small area. A patio and concrete steps were cracked at Rapid City; well water was muddied and could not be used for several hours at Keystone (VI). The magnitude 4.1 shock produced intensity V effects at Deadwood and Silver City. It was also felt at Black Hawk, Hill City, Lead, Piedmont, Pine Ridge, and Oglala Lakota County (previously Shannon County).

A magnitude 4.4 shock on November 23, 1967, was felt over a small area of southern South Dakota and northern Nebraska. Press reports indicated that houses shook, and dishes fell from shelves in the Winner - Rosebud - White River areas (V). Many residents were frightened at Gregory, where furniture was shifted, and some windows were cracked. Livestock stampeded through fences on some farms. Felt reports were also received from Carter, Chamberlain, Colome, Martin, Mission, and Stephan, South Dakota, and Ainsworth and Dunning Nebraska. One isolated report stated the shock was felt by a few people at Douglas, Wyoming.

Figure 3-42 Earthquakes in South Dakota 1872-2016



Source: South Dakota Geological Survey

Table 3-34 South Dakota Earthquakes

Date	Comments
February 7, 2014	Magnitude 3.0, Northwest of Platte
December 12, 2013	Magnitude 3.5, South of Colonial Pine Hills
January 16, 2012	Magnitude 3.0 near Custer/Fall River/ Oglala Lakota County (previously Shannon County) borders
November 15, 2011	Magnitude 3.3 in Fall River County
November 14, 2011	Magnitude 4.0 in Fall River County
August 9, 2011	Magnitude 3.4 near Hughes/Stanley County border
September 25, 2009	Magnitude 3.8 at 10:11 am. 30 miles northwest of Belle Fourche
February 7, 2007	Maximum Intensity III - Magnitude 3.1, 4:35 a.m. 7 miles west southwest of Wasta, 17 miles west northwest of Wall.
October 19, 2005	Magnitude 3.1
January 24, 2004	Magnitude 2.5
January 5, 2004	Magnitude 2.8
November 21, 2003	Magnitude 3.5
May 25, 2003	Intensity IV at Kyle and Gordon, III at Pine Ridge and Chadron - Magnitude 4.0, 1:32 a.m. 35 miles east of Pine Ridge, 115 miles southwest of Pierre.
July 26, 2002	Magnitude 3.1
July 12, 1998	Magnitude 3.1
May 3, 1996	Magnitude 3.1

Date	Comments
February 6, 1996	Intensity V - 9:10 a.m. 24 miles south southwest of Yankton (Magnitude 3.6). Felt by many people. The quake caused Gavins Point Dam personnel to conduct dam safety checks. Intensity V - 9:08 a.m. Northwest of Mt. Rushmore (3.7 Richter). Felt by many people who noticed typical earthquake ground movement. Both quakes were centered about 5 km below the surface. Neither quake can be definitely associated with any mapped fault, but both are near known or postulated faults.
July 3, 1995	Intensity III - Southwest of Ft. Thompson (2.8 Richter)
March 18, 1994	Intensity III - Hot Springs (2.8 Richter)
September 5, 1993	Intensity III - Deadwood (2.7 Richter)
October 25, 1990	Intensity V - Aurora County north of Plankinton and west southwest of Storla.
March 2, 1990	Intensity IV - Oglala Lakota County (previously Shannon County) north of Manderson.
January 28, 1990	Intensity V - Oglala Lakota County (previously Shannon County) north of Manderson.
November 26, 1989	Intensity III - Walworth County near Lowery.
October 15, 1987	Intensity III - Beadle County northeast of Wessington.
July 9, 1987	Intensity III - Beadle County near Virgil.
May 25, 1986	Intensity IV - Sanborn County slightly northeast of Storla.
March 4, 1983	Intensity VI - On Hyde–Buffalo County border south of Mac's Corner.
November 15, 1982	Intensity V - Bon Homme County near Avon.
July 11, 1982	Intensity V - Moody County near Egan.
September 13, 1981	Intensity V - Bennett County southeast of Batesland on the Nebraska border.
May 16, 1975	Intensity IV - Fall River County near Edgemont.
October 19, 1971	Intensity IV - 3:15 p.m. Jackson County half way between Kadoka and Norris. Glass rattled.
November 23, 1967	Intensity V - Lyman County east of Hamill near Tripp-Lyman County border. Magnitude 4.4, felt in Winner, Rosebud, White River areas. Many residents were frightened in Gregory, where furniture shifted, and windows cracked. Livestock stampeded through fences on some farms.
Jun 26, 1966	Intensity VI - 5:59 a.m. Meade County between Bethlehem and Tilford. Magnitude 4.1, slight damage at Rapid City. At Keystone, well water was muddied for several hours. At Rapid City, concrete steps cracked away from a house and a patio cracked. At Deadwood, there was a fallen tree due to the shock. At Keystone, one observer reported he could see the ground moving. Pictures on walls bounced, buildings creaked, and dishes rattled. There was a gradual on-set with a bumping swaying motion. In Rapid City, buildings creaked, and loose objects rattled. There was a rapid on-set with a bumping motion, and moderately loud earth sounds were also heard.
August 26, 1964	Intensity IV - Pennington County south of Wall in Badlands National Park.
March 28, 1964	Intensity VII - Epicenter in western Nebraska. Magnitude 5.1. Duration: 10 seconds. Depth: 65.98 miles. (This quake was not actually in South Dakota but caused damage anyway. It is listed here to represent the danger from earthquakes that originate outside the state's borders.)
March 27, 1964	Unknown strength due to proximity of the Great Alaska Quake - 9:00 p.m. Near Van Taussell, Wyoming. Felt throughout Black Hills with an apparent intensity of IV. (This quake was not actually in South Dakota but caused damage anyway. It is listed here to represent the danger from earthquakes that originate outside the state's borders.)
March 24, 1964	Intensity V - 12:12 a.m. Custer County north northeast of Hot Springs near Fall River-Custer County border. Felt by all at Wind Cave National Park. Small rocks fell in cave, buildings creaked, and loose objects rattled. Moderately loud, rumbling noise heard. Abrupt on-set, trembling motion. Duration: 3–5 seconds.

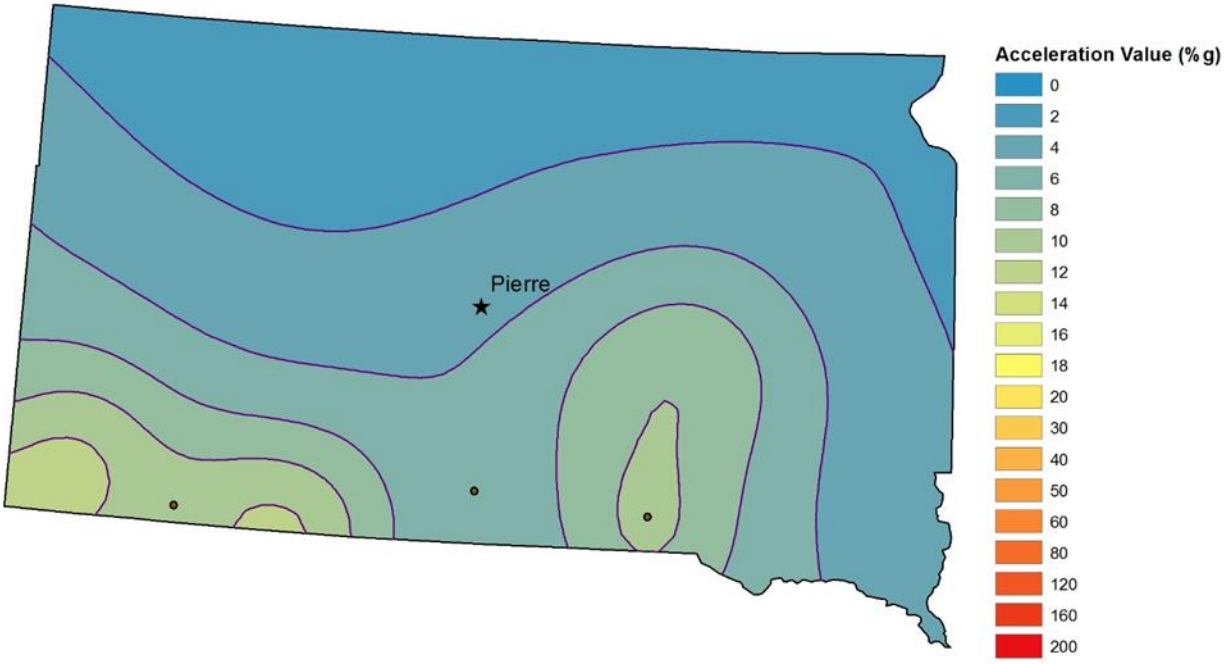
Date	Comments
December 31, 1961	Intensity VI - 10:35 a.m. Stanley County near Wendte. Felt by many in Pierre. Slight damage. Plaster cracked, cement floors cracked, refrigerator doors shaken open, clothes dryer moved several inches. Fishermen along the Missouri River reported that the moment the quake struck, hundreds of fish jumped into the air. Buildings shook and loose objects rattled. Intensity V - Murdo - felt by many. Plaster on walls cracked, venetian blinds swayed, dishes rattled, faint earth sounds heard, trembling motion with abrupt onset. Intensity IV - Presho and Winner. Intensity I-III - Draper, Hayes, Huron, Midland, Onida, Philip, and White River.
January 12, 1959	Intensity IV - 7:15 a.m. Spink County near Doland. Felt by many; rumbling sound followed by what sounded like a boiler explosion. Dishes and windows rattled.
December 3, 1957	Intensity IV - 1:30 a.m. Davison County near Loomis. Awakened several people in Mount Vernon, where buildings creaked and loose objects rattled. At Mitchell, houses shook and windows and doors rattled. Livestock was "alarmed and all bunched up."
December 31, 1953	Intensity IV - Gregory County south of Burke.
December 21, 1953	Intensity IV - Perkins County near Zeona
November 14, 1952	Intensity IV - Pennington County near Silver City
December 14, 1949	Intensity III - Gregory County near Dallas.
Jun 3, 1949	Intensity IV - Potter County near Gettysburg.
March7, 1949	Intensity III - Hand County near Miller.
August 25, 1947	Intensity IV - Gregory County near Bonesteel.
July 23, 1946	Intensity VI - Jerauld County near Wessington Springs. In Wessington water mains cracked at two points.
November 10, 1945	Intensity IV - 3:00 a.m. Bon Homme County east of Kingsbury and southeast of Tyndall. Rattled dishes.
May 16, 1943	Intensity IV - 12:40 p.m. Custer County north northeast of Hot Springs near Fall River-Custer County border. Felt by many "like heavy trucks rumbling down the street." Dishes rattled.
March 11, 1942	Intensity III - 11:55 a.m. Meade County near Sturgis. Light shock felt in Deadwood, Fort Meade, Lead, Piedmont, Sturgis, Terraville, Trojan, Whitewood, and Black Hawk.
May 25, 1941	Intensity V - 12:25 a.m. Custer County north northeast of Hot Springs near Fall River-Custer County border. In Hot Springs, one wall reported cracked. Pictures and light fixtures swayed in Hot Springs, Rapid City, and Martin. Not felt in Longvalley, Belvidere, Oelrichs, or Cottonwood.
Jun 10, 1939	Intensity IV - 12:30 p.m. Gregory County on Nebraska border south of Fairfax. There was one shock of about 15 seconds duration. It was of a gradual bumping nature, direction northwest to southeast, with a rumbling sound.
November 4, 1938	Intensity IV - 10:10 and 10:15 p.m. Gregory County near Whetstone Bay. Felt in Academy, Lake Andes, Burke, Colome, Dallas, Gregory, and Platte.
October 11, 1938	Intensity V - 3:37 a.m. Minnehaha County between Renner and Sioux Falls. In Sioux Falls, buildings jarred, beds shook, dishes rattled, and pictures and other loose objects swayed. A rumbling subterranean noise came as a climax of the earthquake. The recording pens on water and electric meters at the municipal water works were jarred. Sioux Falls police received more than 50 calls from citizens. Intensity IV - Humboldt, Madison, Parker, Spencer, and Yankton. Intensity III and under - Canton, Centerville, Egan, Hudson, Lennox, Salem, Sherman, and Vermillion. Not felt in Beresford, Brookings, Howard, Mitchell, or Olivet.
October 1, 1938	Intensity V - 4:15 p.m. Brule County near Chamberlain.
January 2, 1938	Intensity IV - 11:05 a.m. Beadle County near Broadland.
October 30, 1936	Intensity IV - Custer County north northeast of Hot Springs near Fall River. Not felt elsewhere.

Date	Comments
November 1, 1935	Intensity III - Moody County between Egan and the Minnesota border on Highway 34.
August 30, 1934	Intensity IV - On the Brule and Charles Mix County border between Bijou Hills and Academy: Abrupt trembling motion accompanied by a rumbling sound, felt by many, small objects moved. Also felt in Pukwana.
January 29, 1934	Intensity IV - 6:30 a.m. Marshall County north northwest of Kidder near Newark. Awakened several, dishes rattled, rumbling sound.
January 17, 1931	Intensity IV - Aurora County east of Platte Lake and south of White Lake. Felt by many. Trembling motion with loud sounds.
October 6, 1929	Strong Shock - 6:30 a.m. City of Yankton. Deep rumbling resembling distant thunder set windows rattling. Some dishes thrown from shelves. Felt around Yankton and at Gayville and Volin about 15 miles to the east.
November 16, 1928	Intensity V - Pennington County near Mystic City. Felt at Custer and Rochford.
December 30, 1924	Intensity IV - 10:10, 10:15, 10:20, and 10:30 p.m. - Custer County north northeast of Hot Springs near Fall River-Custer County border.
January 2, 1922	Intensity VI - Brule County near Chamberlain.
September 24, 1921	Intensity IV - Aurora County east of Platte Lake and south of White Lake.
March 16, 1921	Intensity III - Minnehaha County near Sioux Falls at Lincoln County border.
July 14, 1920	Intensity III - Fall River County near Oelrichs.
June 29, 1916	Intensity III - Tripp County near Winner.
February 24, 1916	Intensity III - Oglala Lakota County (previously Shannon County) -near Pine Ridge.
October 23, 1915	Intensity V - Jackson County near Kadoka. Loud noises and some cracks in the ground.
Jun 2, 1911	Intensity V - Beadle County near James River crossing into Sanborn County. Felt in the James River Valley.
May 10, 1906	Intensity VI - Bennett County near southeast corner and on the Nebraska border. Felt from Rushville to Valentine, Nebraska.
March 14, 1900	Intensity III - 5:00a.m. Brown County near northeast corner of Richmond Lake. Intensity III - 3:00a.m. Brown County near northeast corner of Richmond Lake.
December 6, 1899	Intensity IV - Hand County near Miller.
October 12, 1895	Intensity V - Pennington County near Hayward.
October 11, 1895	Intensity IV–V - Pennington County near Hayward. Felt at Rochford, Keystone, and Hill City.
December 29, 1879	Intensity V - Yankton County near Yankton.
August 17, 1876	Intensity IV - Lyman County near Lower Brule.
October 9, 1872	Intensity V - At Sioux City, Iowa. Severe effects at Yankton and White Swan. Felt in all or most of South Dakota.
February 9, 1872	Intensity III - Stanley County near Mission Ridge.

Probability

South Dakota is relatively geologically stable based upon the sparse data available. However, there is potential for larger earthquakes than the magnitude 4.4 earthquake that struck the Black Hills in 1964. The U.S. Geological Survey estimates this risk as only a 10 percent chance of exceeding a 5.1 magnitude in any one 50-year period. The map in Figure 3-43 shows ground motions that have a 2 percent chance of being equaled or exceeded in a 50-year period.

Figure 3-43 Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years



Source: U.S. Geological Survey, National Earthquake Information Center

3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction

44 CFR Part 201 Requirement:
[The State risk assessment shall include an] overview and analysis of the State's vulnerability to the hazards described in paragraph (c)(2), based on estimates provided in local risk assessments as well as the State risk assessment. The State shall describe vulnerability in terms of the jurisdictions most threatened by the identified hazards and most vulnerable to damage and loss associated with hazard events…. *Plan must be reviewed and revised to reflect changes in development….*
44 CFR Part 201 Requirement:
[The State risk assessment shall include an] overview and analysis of potential losses to identified vulnerable structures, based on estimates provided in local risk assessments….

The following section assesses the vulnerability of South Dakota by county to the hazards previously identified and profiled. For purposes of this plan, county boundaries are the smallest jurisdictions considered and include information pertinent to all smaller jurisdictions located within the county. Other geographical, political and jurisdictional boundaries such as cities, towns, municipalities, and townships are better evaluated in specific hazard mitigation plans, which allow for the collection and analysis of more detailed information at the specific jurisdictional level.

Vulnerability is defined as the extent to which people and property are exposed to harm or damages created by a hazard. The quantification of vulnerability is based on best available data on the hazard and

exposed populations and buildings. The method of determining vulnerability varies by hazard and data availability, and these methods are discussed in detail in each hazard profile. Where the data permits, loss estimations to people and property are provided. It was noted at stakeholder meetings during the 2007 plan update that the state may want to consider impacts to South Dakota's agricultural economy as a vulnerability factor in future plan updates. As such, the hazard profile "Agricultural Diseases and Pestilence" was added during the 2009 update. Additional data on crop and livestock loss due to natural hazards was added to the 2013 plan update. For the 2016 HIRA update, the hazard profile and vulnerability analysis for Summer Storms was added. Also added in 2016 was a consequence analysis for each hazard. The consequence analysis considers the impact on the hazards on the public; responders; continuity of operations including continued delivery of services; property, facilities, and, infrastructure; the environment; the economic condition of the state and public confidence in the state's governance.

The 2007 update to this plan synthesized and analyzed data that was previously included in several attachments and annexes. In 2009, the plan expanded on those data resources and attempted to fill previous data gaps. In 2013, additional data was obtained to fill in data gaps identified in the 2010 plan. This new data utilized the methods established in 2010 and 2007 and allowed for a comparative perspective on vulnerability to the hazards which impact the state. The results of this analysis are presented in this section. In addition, and in response to the FEMA evaluation of 2007, the growth and development trends were developed further in this update. The social vulnerability section, which was added in 2007, was also re-evaluated in the 2009 update and again in the 2013 update. Counties and other local jurisdictions can follow this same process to assist in developing or updating their local mitigation plans in a manner that consistently reflects vulnerability evaluations.

New vulnerability assessment methodologies were conducted during the 2007 update to refine vulnerability and loss estimates for flood, tornadoes, severe wind, winter storm, wildfire, and earthquake. These assessments were updated in 2009-2010, 2013-2014, and again in 2016. A significant change to the 2009-2010 plan was the incorporation of a statewide flood loss estimation based on FEMA's Hazus-MH computer model. Additional information was added in 2009-2010 and 2016 to improve the drought vulnerability section. A limited vulnerability analysis was added for hazardous materials. Vulnerability and loss assessments were not conducted for geologic hazards due to their ranking as limited for planning significance. New vulnerability assessment methodologies and data were introduced in 2013 and continued in 2016. Data on crop loss and livestock death was added to the profiles and vulnerability assessments for agricultural pests and disease, drought, and winter storm. Vulnerability assessments for tornado, wind, and winter storm were enhanced with more detailed analysis on events with higher magnitudes (e.g. tornadoes of F1 or greater), damages, and casualties. The 2016 vulnerability assessments also used new classification schemes to refine the vulnerability ranking system. Damage estimates were inflated to 2016 dollars. Vulnerability for the Rural Electric Cooperatives was further analyzed with new data on hazards and completed or planned mitigation projects. The 2016 update also includes new data on Individual Assistance and Public Assistance claims for major disasters that have occurred in South Dakota. With each successive update the vulnerability and loss estimates improve, though some information gaps remain.

Each update process includes a review of current and approved local hazard mitigation plans covering 66 counties and 6 tribal plans for vulnerability and loss information. While some plans used a standard format for identifying potential loss, most of the plans contained limited vulnerability information and utilized different methodologies for determining the vulnerability. Therefore, it is currently not possible to consolidate the vulnerability and loss information from the local plans for a complete statewide comparison. Relevant information on vulnerability and potential losses was captured for the purposes of reference for the HMPC, this information can be found in Appendix 5 (electronic).

3.3.1 Growth and Development

As part of the plan update process, the state looked at changes in growth and development at the county level and examined these changes in the context of the state's hazard-prone areas and how the changes in growth and development affect loss estimates and vulnerability. Increases in population growth and development can result in greater exposure to hazards, particularly atmospheric hazards such as tornadoes windstorms, and winter storms.

General Land Use in South Dakota

Land use and development trends exert a significant impact on the vulnerability assessments for South Dakota relative to specific hazards. In some cases, a dominant land use may increase the vulnerability to a specific hazard, such as agricultural diseases or wildfire. Land use trends may also indicate areas where vulnerability and risk may be more sustained than in other areas of the state and help identify areas where vulnerability and risk levels vary. This is particularly important to examine in a statewide hazard mitigation plan, to ensure the document reflects accurate variability of these elements.

One characteristic of local land use in South Dakota that must be considered in both state and local hazard mitigation planning is how the land use patterns are changing at the community level. Identifying both the type and rate of change from existing land uses to future land uses, whether they are planned or unplanned, can help to identify the local jurisdictions most subject to development pressures and consequently help to focus the mitigation planning to minimize the vulnerability to future disasters of the newly constructed neighborhoods, facilities, and infrastructure. Data from local plans can be used to identify the jurisdictions where planned land uses are significantly different from existing land uses.

Land cover in South Dakota is predominantly cropland and rangeland. The significant forested areas in the state are concentrated in the Black Hills region, located in the south west corner of the state. Large bands of cultivated cropland and pastureland or haymaking areas run from north to south across eastern South Dakota. Areas in the western half of the state are marked with cropland and pastureland and pockets of barren land but are primarily characterized by grasslands. Highly concentrated areas of development, including residential and commercial/industrial/transportation classifications of land, are limited geographically and centralized around the major population centers of Rapid City, Pierre, and Sioux Falls. Other areas of concentrated urbanization include Aberdeen, Watertown, and Huron, which correspond to the population and demographic information outlined in the next section.

County Land Use in South Dakota

Notable and important growth and development trends were identified in the review of county hazard mitigation plans. Considerations of county growth and development trends is important in that increased growth exposes more citizens and building to hazards such as tornadoes, winter storms, wildfires, and floods. Table 3-35 summarizes the trends identified in the local and tribal hazard mitigation plans.

Table 3-35 Growth and Development Trends Extracted from Local Plans

County	Growth and Development Trend
Aurora	Population in the county has been declining but is projected to show stability in the future. The only significant development that has occurred since the County's 2011 update is the reopening of the MRC rail line and a new grain elevator complex. The plan notes this development is not expected to increase the vulnerability to any particular hazard.
Beadle	The only community in Beadle County that is experiencing any growth and/or development is Huron. The rest of the jurisdictions have experienced declining populations over the past

County	Growth and Development Trend
	10 years. Due to the declining population, these jurisdictions do not maintain plans for growth or development.
Bennett	It took into consideration present and projected land use and development trends within the communities and the unincorporated portions of Bennett County. The planning team evaluated county and community demographic data to get a picture of the changes that have taken place during the past 60 years.
Bon Homme	Little development is expected anywhere in the county. The population is expected to continue decreasing. However, one place where growth was identified to likely occur is the southern edge of Tyndall, which is covered in part by a flood prone area identified by Hazus. The conversion of wetlands and other marginal land in the county to agricultural land due to the ethanol boom is of some concern because it may increase the probability and severity of flooding as the land's natural capacity to absorb excess surface water is decreased. This development could also have a negative impact on rural roads and structures. Conditions for growth were also identified along the Missouri River. Since this area is fairly rugged with a considerable amount of cedar trees and brushy vegetation, new housing constructed in this area would be somewhat vulnerable to wildfire.
Brookings	There was a 12 percent population increase 1990 and 2000. Mitigation activities are needed at the business level to ensure the safety and welfare of workers and limit damage to industrial infrastructure. Transportation systems in Brookings County have expanded and evolved
Brown	The only communities experiencing growth and/or development at this time are Aberdeen, Groton, areas around Elm Lake and Richmond Lake. The remaining jurisdictions have experienced declining populations over the past 10 years. The smaller jurisdictions do not maintain plans for growth and/or development.
Brule	No development in this county is expected to increase severity of identified hazards.
Buffalo/Crow Creek	The population in the county is expected to slightly increase with an almost all growth expected to occur on the Crow Creek Reservation. The local vulnerability to wildfire was increase with continued growth, particularly in areas around Fort Thompson which is already identified as being high risk of fire.
Charles Mix	There is no significant development occurring in Charles Mix, nor is any activity foreseen. However, the conversion of wetlands and other marginal land in the county could have an adverse impact on flooding. Much of the county's soil is fertile and suitable for growing crops, such as corn and wheat. Cattle production is also important. The economy is dependent upon agriculture. The County experienced a population decline during the last half of the twentieth century but did register a slight increase from 1990 to 2000. The City of Wagner has decided to participate in NFIP to ensure that future development does not occur in the City's flood zone. Some development has been occurring in the hilly terrain west of Wagner. It is possible that area will experience increased damage from fires because the hilly terrain and thick vegetation makes firefighting difficult.
Codington	The County is projecting 1,386 acres of future residential development. The County identified 103 acres of future residential development with a potential of 47 lots for future development that could take place in the flood hazard area zone. 30 undeveloped lots are identified as being located in the flood hazard area and have already appropriately zoned for residential development.
Custer	The County and jurisdictions have experienced an influx of individuals from more urban and popular areas of the U.S. Larger tracts of land vital to the ranching economy are being subdivided for residential and recreational development and there is a concern of displacing

County	Growth and Development Trend
	agriculture and ranching traditions. Town of Hermosa on the eastern side of the county, has been planning for major growth in its residential population. It is estimated the area surrounding Hermosa could triple in size in the next 3-5 years. The development is likely to increase with the completion of the north-south 4-lane Heartland Express Highway. Numerous developments have been built around the boundaries of Custer State Park, Wind and Jewel Cave National Parks and throughout private lands intermixed with Black Hills National Forest. The county has seen the greatest increase in development within subdivisions that surround communities. Custer and Hermosa have experienced the greatest number of development 3-5 miles outside of jurisdictional boundaries.
Day	Steadily losing population since 1930. No future buildings, infrastructure, or critical facilities proposed that would be located in identified hazard areas. Mitigation options will be considered in future land use decisions.
Douglas	No development in this county is expected to increase severity of identified hazards.
Edmunds	No future development is identified to be within hazard areas.
Gregory	No development in this county is expected to increase severity of identified hazards.
Haakon	Declining number of farms, rural population steadily decreased and now leveling off, and some rural subdivision development. No future development is identified in a hazard area. The County does not have plans for growth or development.
Hamlin	Slow and steady growth due to its proximity to larger communities such as Watertown and Codington County. No future buildings, infrastructure, or critical facilities are planned within hazard areas and mitigation options will be considered in future land use decisions. Small businesses and industries that are agricultural related are also increasing employment in the area. Agriculture is the basis of the economy.
Hand	In 2006, the County had a population of 3,323, a decline of 11.2% from the 2000 Census, which translates to around 2.3 persons per square mile, classifying the County as mostly rural. One major city, Miller, has a population of 1,530. The population has been decreasing over the years. The declining population offers limited potential for growth in the county and communities. As a result, there are currently no planned or potential buildings.
Hughes/Stanley	Both counties are experiencing population increases, reductions in household size, a trend toward rural living without farming, size of farms increasing. No future development in either county was identified in a hazard area.
Hutchinson	No development in this county is expected to increase severity of identified hazards.
Hyde	Declining population. Small, rural county. Growth will likely be limited to the expansion of existing agriculture storage facilities. Future development will be within or near the city. No future development is identified within hazard areas.
Jerauld	No development in this county is expected to increase severity of identified hazards.
Jones	Declining number of farms, rural population steadily decreased and now leveling off, and some rural subdivision development. No future development is identified in a hazard area. Future development will focus on the traveling public.
Lincoln	Reduction in farmland, replaced by housing.
McCook	Since 1930, the population of McCook County has experienced a rise and then a decline of population growth. This trend is expected to continue.
Meade	Growth and development along I-90, Sturgis, and also in the southwest corner of the County near Piedmont and Summerset. The Sturgis Motorcycle Rally increases population

County	Growth and Development Trend
	and chances for hazards for a short period during the Rally in August of each year. County has planning mechanisms in place to regulate development.
Mellette	Residential growth is not expected to be significant but needs to be controlled through planning and development guidelines. No development is expected to increase the severity of identified hazards.
Moody	Steadily losing population since 1930. Agriculture is the basis of the economy. No future buildings, infrastructure, or critical facilities are planned to be located in hazard areas. Mitigation options will be considered in future land use decisions.
Oglala Lakota	The county Hazard Mitigation Plan indicates that there is minimal population growth.
Pennington	Population growth, most in established towns and communities, mining is focus of industrial land use; however, residential development southwest of Rapid City in the county is greatly increasing the risk and exposure to catastrophic wildland fire.
Potter	Steadily losing population since 1930. Agriculture is the basis of the economy. No future buildings, infrastructure, or critical facilities proposed to be located in identified hazard areas. Mitigation options will be considered in future land use decisions.
Roberts	Steadily losing population since 1930. Agriculture is the basis of the economy. No future buildings, infrastructure, or critical facilities proposed to be located in identified hazard areas. Mitigation options will be considered in future land use decisions.
Spink	Decreasing population and limited potential for growth. There are no planned or potential buildings.
Sully	Declining number of farms, rural population steadily decreased and now leveling off, and some rural subdivision development, but the overall population trend is decidedly downward. No future development identified in a hazard area.
Tripp	No development in this county is expected to increase severity of identified hazards.
Turner	Steady decline in population since 1930, increase shown in 2000 census.
Union	Steady decline in population since 1930, large increase in population since 1990.
Yankton	Intensively farmed. Developed land makes up a small fraction of land area in the county. Many of the poorly drained areas have been left as wetlands. There is no significant development in areas that are prone to flooding. In general, increased population in and around the City of Yankton leads to increased risk to the hazards identified in the plan.
Rosebud Sioux Tribe	Rural housing may increase vulnerability to winter storms and tornadoes. Increasing number of methamphetamine labs.
Sisseton-Wahpeton Oyate Tribe	The Districts within the Oyate are experiencing growth and have comprehensive land use plans which identified future areas for development. Specifically, available undeveloped areas projected for residential, commercial, and industrial use were reviewed. Based upon their own projected density of development for each land use, the Oyate then identified the potential number of lots which could be created within flood hazard areas given current land use regulations and controls.
Oglala Sioux Tribe	The Oglala Sioux Tribe Hazard Mitigation Plan does not provide information on growth and development.

Source: Local hazard mitigation plans

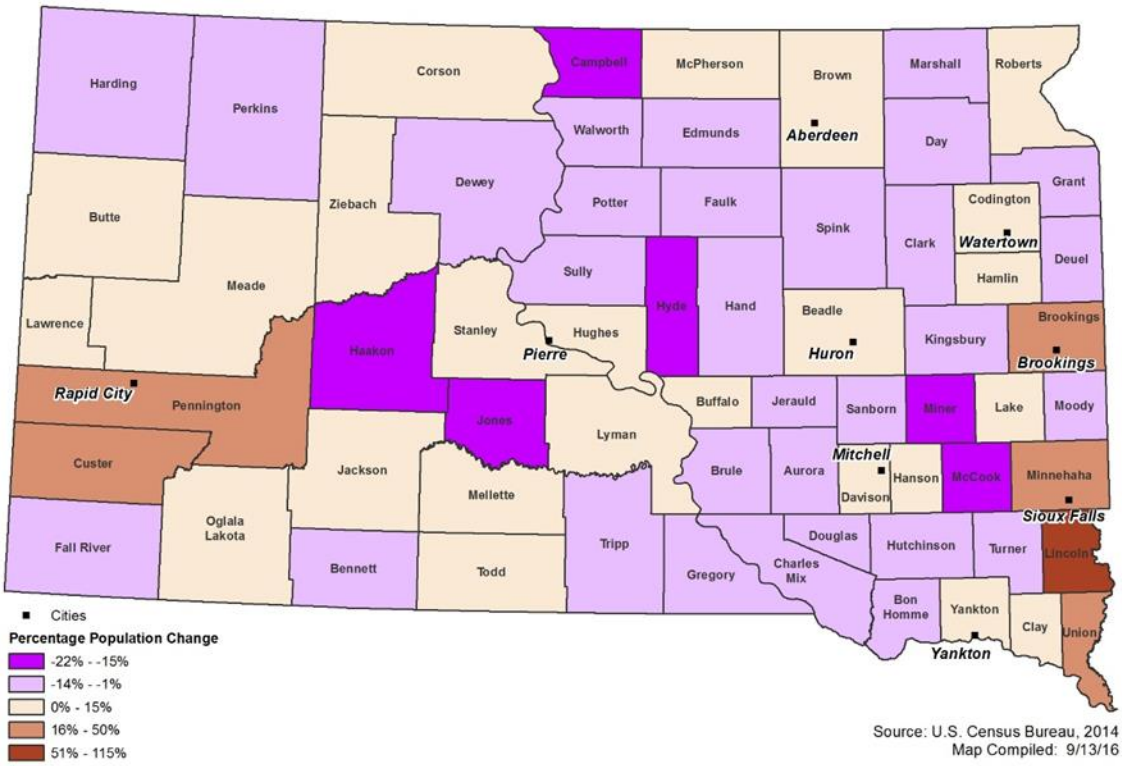
In addition to the trends noted in the hazard mitigation plans, plan reviewers commented on the following: Butte County is developing an ethanol plant and as a result experiencing a population increase.

Lawrence County is noticing growth in the Spearfish area. The discussion that follows focuses on population growth and housing unit trends and density by county, based on the most recent U.S. Census Bureau data.

Population

U.S. Census Bureau American Community Survey (ACS) estimates South Dakota's 2014 population at 853,175. This reflects an increase of 13% between 2000 and 2014. South Dakota ranked 46th among the 50 states in population in 2010, 25th in rate of growth from 2000 to 2010, 16th in land area, and 46th in population density in 2010. Figure 3-44 illustrates the estimated population changes (by percent) for the counties in the state between 2000-2014.

Figure 3-44 Estimated Percent Change in Population by County, 2000-2014



Decennial Census findings from the last few decades illustrate South Dakota's growth (see Table 3-36).

Table 3-36 South Dakota Decennial Census 1970-2010

Year	Population	% Change
1970	665,507	-2.2
1980	690,768	+3.8
1990	696,004	+.8
2000	754,844	+8.5
2010	814,180	+7.9

Between 2000 and 2011, 26 South Dakota counties gained population. With an estimated population gain of 85.8%, Lincoln County was the 4th fastest growing county in the United States (of counties with 10,000 or more in population) between 2000 and 2011 at 93.9% change in population. No counties in South

Dakota were ranked among the top 100 largest (by population) in the U.S. The three largest counties in the state (Minnehaha, Pennington, and Lincoln) were in the Top 10 Counties that experienced the largest population growth by number and by percent gained. Table 3-37, Table 3-38, and Table 3-39 show the Top 10 South Dakota counties ranked by estimated population and those with the greatest

Table 3-37 Ten Largest Counties Ranked by Population (Estimated), 2011 and 2014

County	2011 Population	2014 Population
Minnehaha	171,752	182,882
Pennington	102,815	108,242
Lincoln	46,793	51,548
Brown	36,822	38,408
Brookings	32,226	33,314
Codington	27,442	27,938
Meade	25,546	26,951
Lawrence	24,312	24,657
Yankton	22,612	22,684
Davison	19,651	19,885

Table 3-38 Top Ten Counties with Greatest Estimated Population Gains (Numerical), 2000-2011 and 2010-2014

County	Population Gain 2000-2011	Population Gain 2000-2014
Minnehaha	23,471	34,601
Lincoln	22,662	27,417
Pennington	14,250	19,677
Brookings	4,006	5,094
Lawrence	2,510	2,855
Union	2,067	2,445
Codington	1,545	2,041
Oglala Lakota	1,462	1,752
Brown	1,362	2,948
Meade	1,293	2,698

Source: U.S. Census Bureau American Community Survey 2011 and 2014 Estimates

Table 3-39 Top Ten Counties with Greatest Estimated Population Gains (Percent), 2000-2011 and 2010-2014

County	Population Gain (%) 2000-2011	Population Gain (%) 2000-2014
Lincoln	93.9%	114%
Union	16.4%	19.4%
Pennington	16.1%	22.2%
Minnehaha	15.8%	23.3%
Custer	14.6%	16.1%
Brookings	14.2%	18.1%
Ziebach	13.2%	12.2%
Butte	12.8%	13.2%
Oglala Lakota	11.7%	14.1%
Lawrence	11.5%	13.1%

Source: U.S. Census Bureau American Community Survey 2011 and 2014 Estimates

Between 2000 and 2011, 40 South Dakota counties lost population. Of the counties with the most rapid losses, five of them (Campbell, Jones, Miner, Hyde, and Haakon) also rank among South Dakota's 10 least populous counties. Four counties reported rapid population loss in 2007. In the 2010 plan update, only two counties reported rapid population loss. This seemed to indicate that the state's population was stabilizing. Data from the 2011 American Community Survey Estimates suggests that several counties are experiencing rapid population decline again. Between 2010 and 2014, only 23 counties are estimated to be experiencing population loss. The analysis for 2010 to 2014 also shows that some counties like Pennington are predicted to have grown almost as much in four years as they had in 10 years.

Interim population projections issued by the U.S. Census Bureau in 2009 suggests that South Dakota's population will continue to grow but percentages will drop through 2020 (see Table 3-40). After 2020, population growth is projected to level off and begin to decline slightly after 2025. Population projections are only available at the state level. The U.S. Census Bureau has not updated this information and currently has no plans to produce a new set of state population projections.

Table 3-40 Interim South Dakota Population Projections, 2010-2030

Year	Projected Population	% Change
2010	786,399	+1.9
2015	796,954	+1.3
2020	801,939	+.6
2025	801,845	0
2030	800,462	-.2

Source: U.S. Census Bureau

Appendix 3A Population and Growth contains more population and growth information for all South Dakota counties.

Table 3-41 Top Ten Counties Ranked by Population Density, 2011 and 2014

County	2011 Estimated Population Density*	Population Density Change (%) 2000-2011	2014 Estimated Population Density	Population Density Change (%) 2000-2014	2011 Estimated Housing Density	Housing Density Change (%) 2000-2011
Minnehaha	212.8	15.6%	224.8	22.8%	90.2	20.8%
Lincoln	81.1	91.0%	89.1	113.7%	32.3	104.4%
Davison	45.1	4.9%	45.5	5.81%	20.4	9.8%
Yankton	43.4	4.7%	42.6	2.65%	18.6	9.6%
Brookings	40.7	14.2%	41.4	16.62%	17.0	16.4%
Codington	39.9	5.8%	39	3.45%	18.1	10.2%
Pennington	37.0	15.8%	38.9	21.94%	16.4	21.9%
Clay	34.1	4.0%	33.4	1.52%	13.7	3.6%
Union	31.8	16.3%	32.2	17.95%	13.8	19.0%
Lawrence	30.4	11.7%	30.8	12.82%	16.2	24.3%

Source: U.S. Census Bureau 2000 Census and American Community Survey 2011 Estimate
*Note: Density is reported as people/housing units per square mile and is based on the square mileage of each county's land area.

The percent change in population density tracks with the percent change in population growth. The fastest growing counties are also experiencing a more rapid increase in population density than the other counties. Determining areas of significant population density growth helps establish areas that may be more vulnerable to hazards due to the increased number of people living in a potentially impacted area.

Summary of Impact of Growth and Development Trends on Vulnerability and Loss Estimates

In general, counties with growing populations and number of housing units have an increased exposure to hazards not defined by specific geographic areas. These hazards may include winter storms, summer storms, tornadoes, wind, drought, wildfire, and earthquake. The counties experiencing the most development pressures all participate in the National Flood Insurance Program. Rapid City, in Pennington County, is in the Community Rating System at Class 7. This suggests that flood risk should not be increasing, assuming that county floodplain ordinances are being effectively implemented and wise use of floodplains encouraged. Three other cities in South Dakota were added to the Community Rating System Eligibility list in 2014. The city of Madison was added in May 2014 with a current rating of Class 8. The cities of Parkston and Spearfish were also added in May 2014 with Class 9 ratings. New data in Table 3-48 suggests that repetitive loss is increasing in the state. This may be mostly attributed to second homes. Union County is one of the fastest growing counties and has potential for high flood losses as described in the flood vulnerability section. Growth and development trends and their impact on vulnerability were noted during stakeholder meetings held in conjunction with the 2007 update to the plan. Growth trends noted at that time included in Charles Mix County, where lodges were being built with potential risk to wildfire. New development in forested areas in Minnehaha County east of Sioux Falls are demanding city services for fire protection. New housing being built near Mitchell Lake and in North Lincoln County could also be at risk to wildfire. Values of homes in forested areas in the Black Hills are rising, thus the exposure analysis conducted for this plan is likely to underestimate the property values exposed to wildfire risk. New homes being built in Meade and other Counties increase the exposure to damage from tornadoes.

3.3.2 Social Vulnerability

A Social Vulnerability Index (SoVI) compiled by the Hazards and Vulnerability Research Institute in the Department of Geography at the University of South Carolina measures the social vulnerability of U.S. counties to environmental hazards. The comparison of SoVI values between counties within the state allows for a more detailed depiction of variances in risk and vulnerability. The Index is based on national data sources, primarily the 2010 census, and synthesizes 30 socioeconomic variables that research literature suggests contribute to reduction in a community's ability to prepare for, respond to, and recover from hazards. Seven components differentiate counties according to their relative level of social vulnerability. The components include race and class, wealth, elderly residents, Hispanic ethnicity, special needs individuals, Native American ethnicity, and service industry employment.

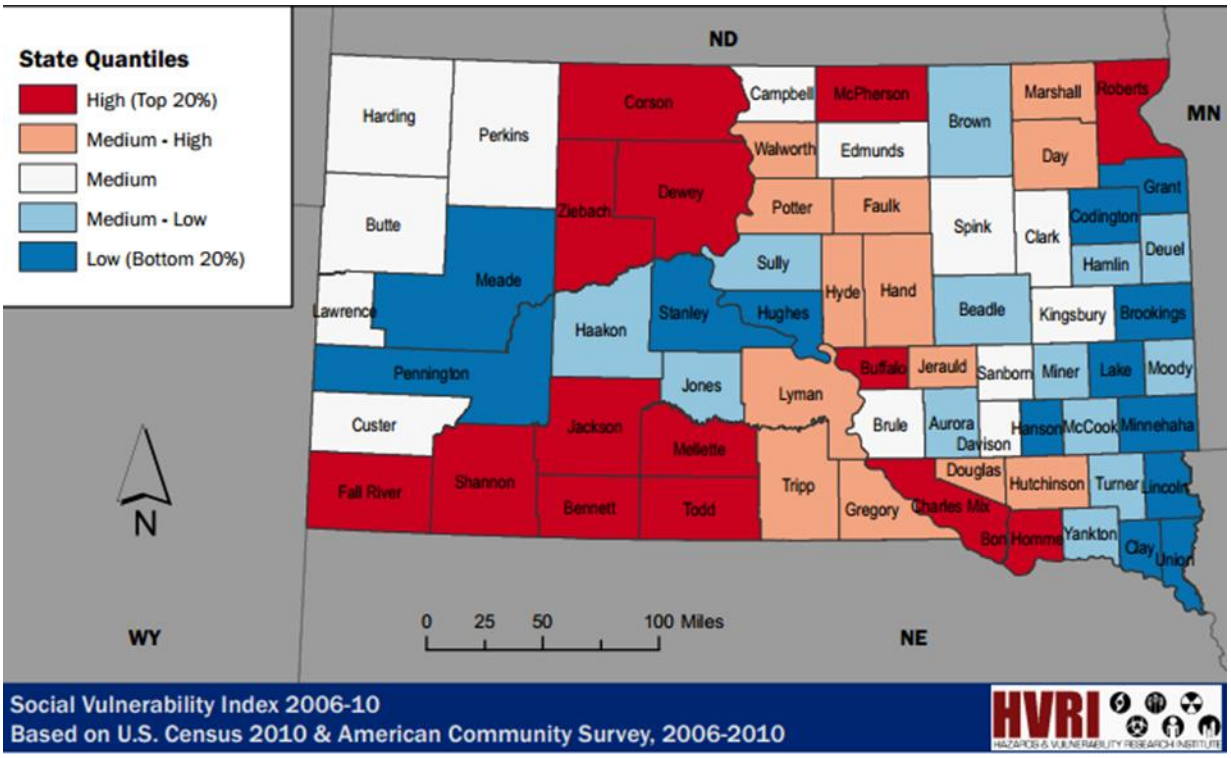
The index can be used by the state to help determine where social vulnerability and exposure to hazards overlaps and how and where mitigation resources might best be used. See Figure 3-45 for a map that illustrates South Dakota's geographic variation in social vulnerability. According to the index, the following, listed in order, are South Dakota's most socially vulnerable counties:

1. Buffalo
2. Todd
3. Oglala Lakota*
4. Jackson
5. Mellette
6. McPherson
7. Bennett
8. Ziebach*
9. Corson
10. Fall River
11. Dewey
12. Charles Mix
13. Bon Homme
14. Roberts

*Note: An asterisk (*) denotes counties that are among the 10 fastest growing counties in the state.

In addition to the fourteen counties listed above, Potter, Faulk, Lyman, Gregory, Jerauld, Walworth, Douglas, Day, Hyde, Hand, Hutchinson, Tripp, Marshall, Perkins, Spink, and Edmunds County all rank in the top 20 percent in the nation in terms of social vulnerability.

Figure 3-45 Social Vulnerability to Environmental Hazards, County Comparison within the State, 2006-2010

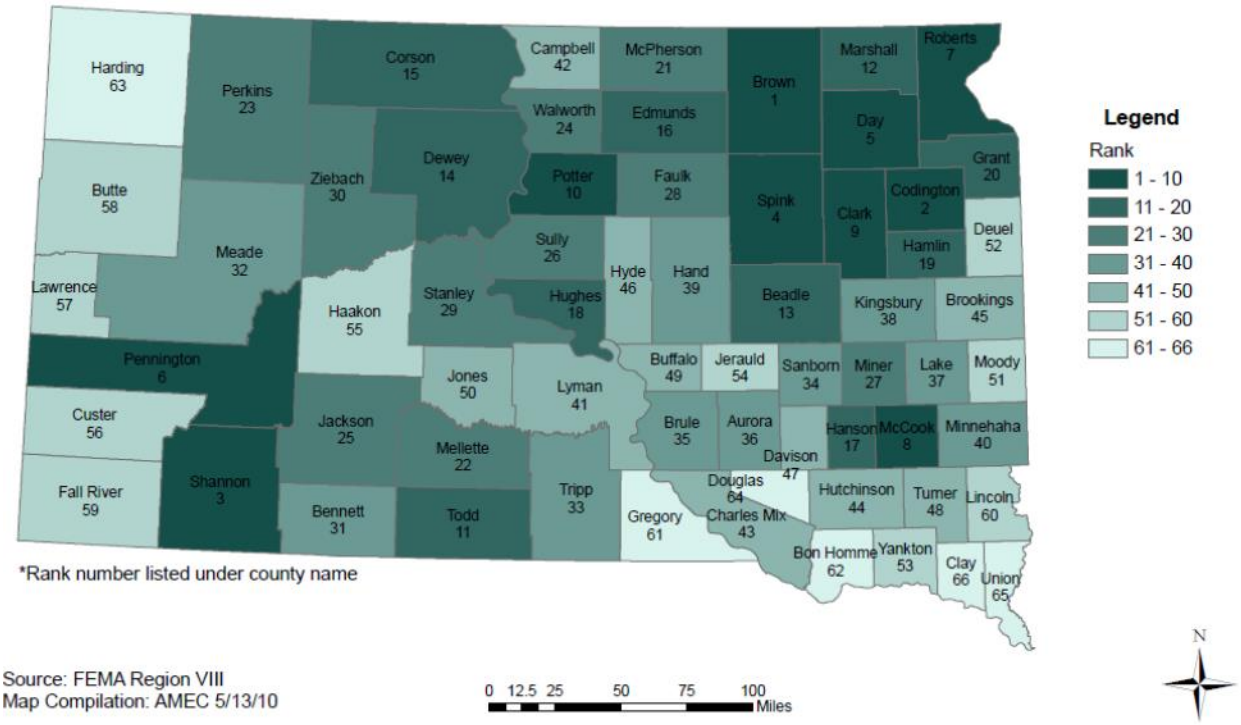


3.3.3 Federal Disaster Declaration History and Analysis

Another indicator of vulnerability by jurisdiction is looking at the pattern of past disaster declarations by county across the state. FEMA Region VIII made available summary counts of the number of Individual Assistance (IA) claims and Public Assistance Project Worksheets (PWs). These summaries are presented on the maps in for the time period of July 1993 to May 2009 for the IA claims and 1993 to 2016for the PA claims. The 2009 IA claims still represent the last major disaster with IA at the time the 2019 SHMP update.

The tables below summarize PWs data for major disaster declarations in South Dakota since 1990 by disaster declaration and by category of assistance. Based on this data the majority of PW funding is for public utilities damage, roads and bridges and emergency protective measures. The public utilities damage is largely damage from winter storms or wind storms that result in downed power lines, broken power poles, or disrupted electrical distribution/transmission lines. The state is actively investing hazard mitigation funding (both under PA and HMGP) into electric utilities, which appears to be a worthwhile investment given patterns of past damages and claims. See the discussion on Rural Electric Cooperatives later in this section for more on the use of PA Section 406 funding and Hazard Mitigation Grant Program funding used to assist with mitigation and retrofitting of power infrastructure. The roads and bridges infrastructure damage largely represents flood related damages, including washed out gravel roads and culverts, and only represents a portion of the true disaster losses. There is another federal program under the Federal Highways Administration that also has been used for emergency repairs. This data could be obtained to further enhance this analysis in future updates.

Figure 3-46 FEMA Individual Assistance Claims 1993-2009



Source: FEMA Region VIII

Table 3-42 Project Worksheets (PWs) Summary by FEMA Disaster Declaration 1990-2018

DR #	Declaration Date	# of PWs	Federal Share Obligate
2076	9/14/1990	2	$715,276
999	7/19/1993	2,990	$10,175,366
1031	6/21/1994	742	$4,827,885
2109	8/16/1994	2	$49,833
1045	3/14/1995	35	$2,048,897
1052	5/26/1995	2,593	$12,503,592
1075	1/5/1996	51	$7,771,260
1156	1/10/1997	1,151	$13,086,329
1161	2/28/1997	15	$1,628,069
1173	4/7/1997	3,175	$35,271,441
1218	6/1/1998	415	$4,282,197
1280	6/9/1999	38	$760,273
1330	5/19/2000	41	$1,705,192
2319	8/13/2000	1	$1,050,618
2324	8/25/2000	1	$2,496,379
1375	5/17/2001	1,121	$4,853,342
2369	8/1/2001	1	$293,179
2434	6/29/2002	4	$759,650
2458	8/18/2002	3	$1,313,879
2513	11/20/2003	1	$45,685
1531	7/20/2004	123	$1,001,758
2565	7/10/2005	2	$428,064
2569	7/16/2005	4	$14,231

DR #	Declaration Date	# of PWs	Federal Share Obligate
1596	7/22/2005	44	$640,944
3234	9/10/2005	6	$208,997
1620	12/20/2005	299	$24,018,919
1647	6/5/2006	25	$3,061,273
2658	7/27/2006	3	$1,543,489
1702	5/22/2007	1,257	$5,939,128
2710	7/8/2007	7	$1,953,897
2716	7/21/2007	1	$387,967
1759	5/22/2008	37	$7,826,996
1774	7/9/2008	736	$4,716,310
1811	12/12/2008	55	$5,825,275
1844	6/16/2009	834	$5,301,081
1886	3/9/2010	95	$874,503
1887	3/10/2010	514	$49,059,868
1914	5/13/2010	12	$1,862,943
1915	5/13/2010	2,465	$21,498,620
1929	7/29/2010	85	$666,649
1938	9/23/2010	300	$4,429,890
1947	11/2/2010	173	$1,079,973
1984	5/13/2011	2,475	$52,090,678
2996	7/20/2012	3	$622,321
5010	9/1/2012	1	$6,664
4115	5/10/2013	53	$8,231,035
4125	6/28/2013	71	$1,215,685
4137	8/2/2013	89	$1,159,221
4155	11/8/2013	229	$43,113,023
4186	7/28/2014	157	$11,144,676
4233	7/30/2015	68	$3,039,801
4298	2/1/2017	100	$9,632,648
	Total	**22,705**	**$378,234,869**

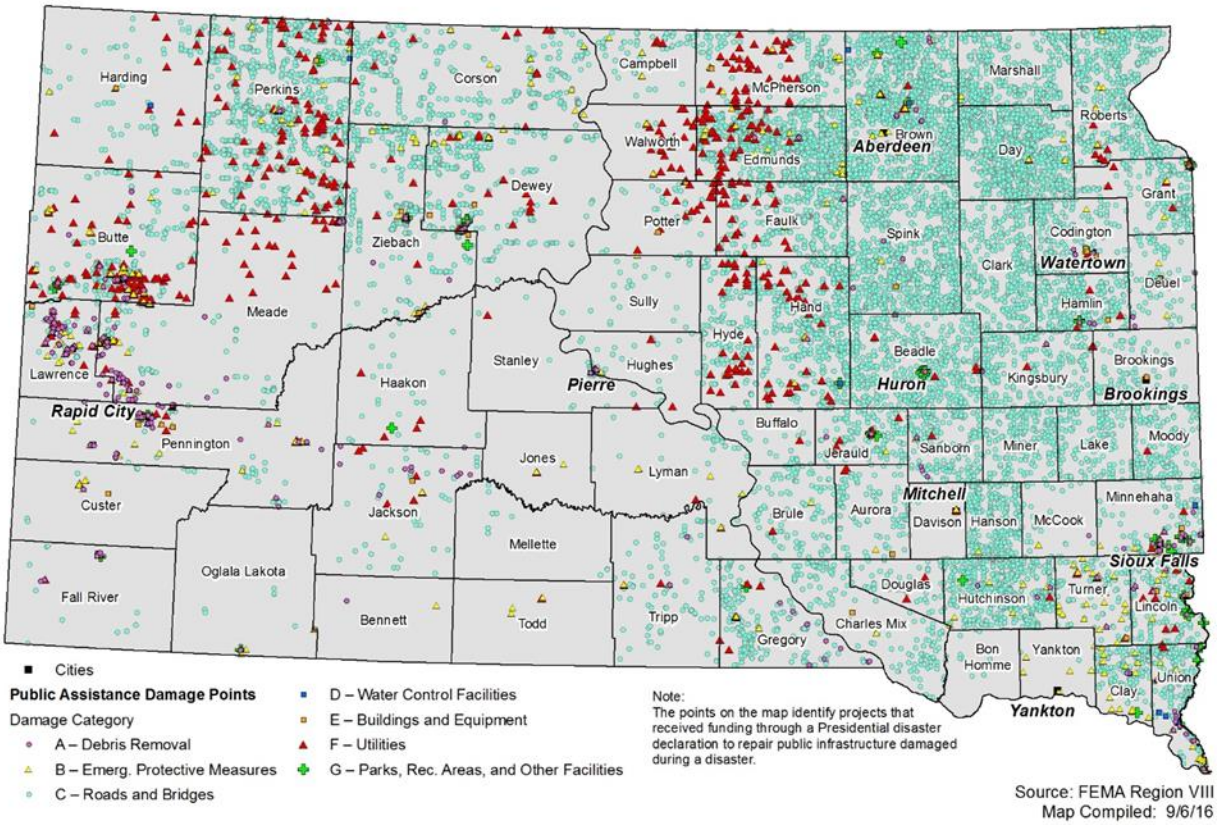
Source: OEM *FEMA-1984-DR was not included as it was IA only

Table 3-43 PA Disaster Expenditures Summarized by Damage Categories: 1999-2018

Damage Category	Total Requested (100% PWs)	Amount Obligated Federal Share
A – Debris Removal	$23,077,412	$17,756,434
B – Emerg. Protective Measures	$74,890,352	$56,171,442
C – Roads and Bridges	$80,492,673	$60,369,514
D – Water Control Facilities	$6,860,467	$5,145,350
E – Public Buildings	$3,028,521	$2,271,391
F – Public Utilities	$167,255,945	$125,441,959
G – Parks, Rec. Areas, and Other Facilities	$4,454,852	$3,341,139
Total	**$360,060,221**	**$270,497,229**

Source: OEM

Figure 3-47 FEMA Public Assistance Damage Sites by Damage Category 1993-2016



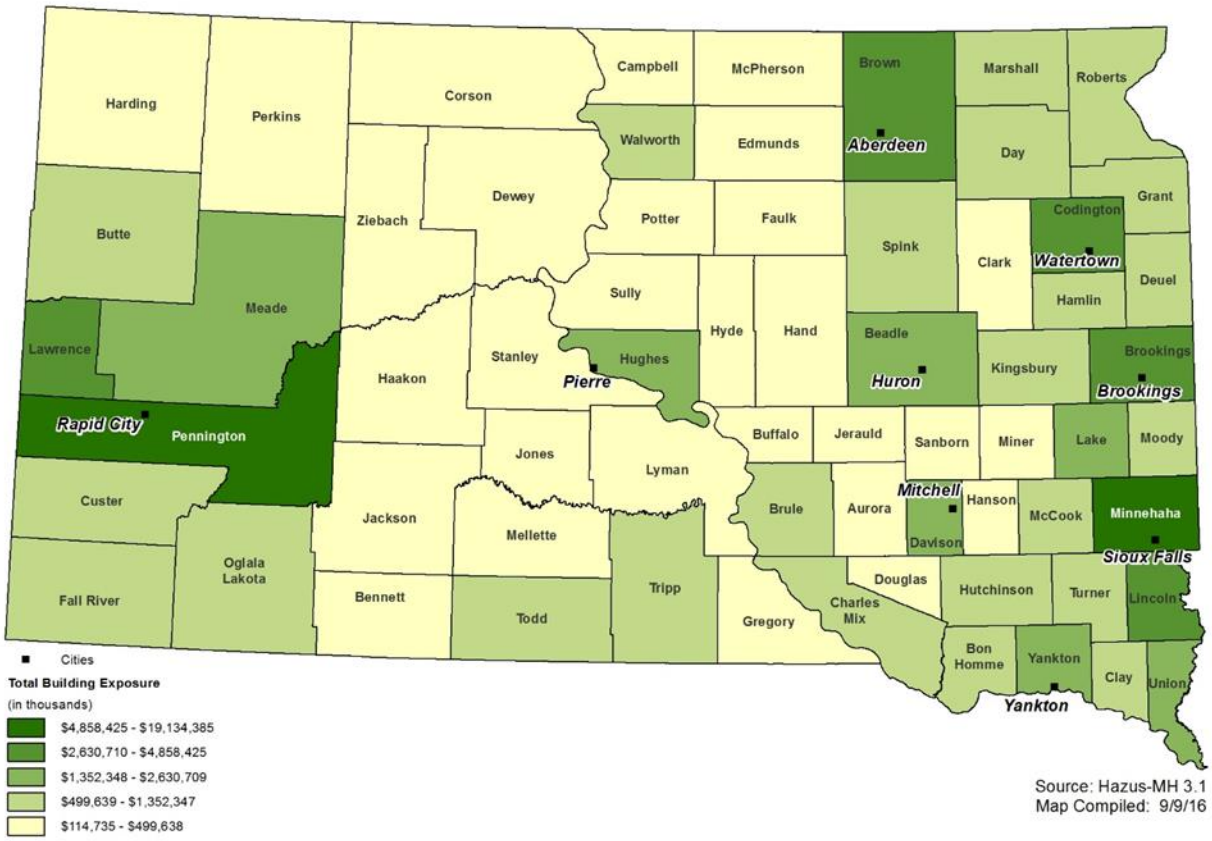
Source FEMA Region VIII/OEM

3.3.4 Building Exposure

Exposure is a term borrowed from the insurance industry as a measure of property "exposed" to a particular hazard. Hazus-MH Ver. 3.1 building inventory data provided the basis for measuring the number and value of buildings vulnerable to hazards. There are an estimated 343,736 buildings in South Dakota with a total building replacement value (excluding contents) of $89,567,051,000. Approximately 92 percent of the buildings (and 70 percent of the building value) are associated with residential housing. Figure 3-48 shows a thematic map at how building exposure varies by county across the state.

In terms of a catastrophic event, the entire building inventory could be at risk to a hazard. An event that would destroy or damage the entire inventory in a given county is unlikely, but it is possible that a tornado impacting the heart of a rural community could result in considerable building losses.

Figure 3-48 Building Exposure 2016



3.3.5 Agricultural Pest and Diseases

This hazard was added to the plan in 2010 and retained for the 2013 and 2016 HIRA updates. This hazard includes a number of different pests and diseases that could affect the agricultural industry in South Dakota. The types of impacts will vary from year to year and county to county, but it is anticipated that the agricultural industry will continue to suffer losses from the various pests and diseases. Economically, these impacts can total up to a billion dollars in the state. Outside of the economic impacts, some of these have the potential to affect human health as well, as noted in in the Agricultural Pest and Diseases hazard profile. Average annual crop loss can be estimated based on indemnity data from the RMA. Between 2003 and 2015, there was a total of $9,626,082 in indemnity payments in insect infestation with an annual loss of $740,468. There was a total of $6,713,015 in indemnity payments between 2003 and 2015 in plant disease with an annual loss of $516,386.

Annual cattle death loss is more difficult to estimate accurately given the report increments and absence of state level data in 2005 and 2000. Averages of the data from 2011, 1995, and 1991 indicate that South Dakota could expect to lose 60,866 cattle and 120,866 calves to combined predator and non-predator causes in any given year. This includes 7,822 cattle and 27,306 calves lost to digestive problems in any given year, and 17,316 cattle and 29,193 calves lost to respiratory problems in any given year. At a value of $1,133 per head for cattle and $381 per head for calves, South Dakota's cattle industry losses in 2010 totaled $52,384,926 due to respiratory, digestive, and other diseases. Total dollar value per head was not provided in the 1995 and 1991 reports. Additional outreach to the South Dakota Animal Industry Board during 2013 did not yield updated or more specific impact data. Further analysis of the risk and potential loss from these hazards should be considered in future updates to this plan.

The following figures show the total market value of crops sold in 2012 and cattle inventories by county as an indicator of exposure to agricultural pest and diseases. The counties with higher values rely more heavily and directly on crops and cattle economically. Crop producers and ranchers can see increased damages and therefore significantly diminished profits caused by agricultural pests and diseases. The counties with the highest crop exposure values include Roberts, Spink and Brown. These counties have a crop exposure value between $200 million and $460 million. Edmunds, Day, Faulk, Clark, Sully, Hand, Beadle, Kingsbury, Brookings, and Minnehaha all have a crop exposure value between $1.5 million and $2 million. The counties with the highest market value of livestock include Marshall, Spink, Beadles, Kingsbury, Grant, Brookings, Minnehaha, Hutchinson, Charles Mix, Tripp, and Fall River. Counties with a total market value of livestock between $75 million and $100 million include Meade, Perkins, Edmunds, Hand, Clark, Deuel, Moody, Douglas, and Turner.

Figure 3-49 Total Market Value of Crops Sold by County

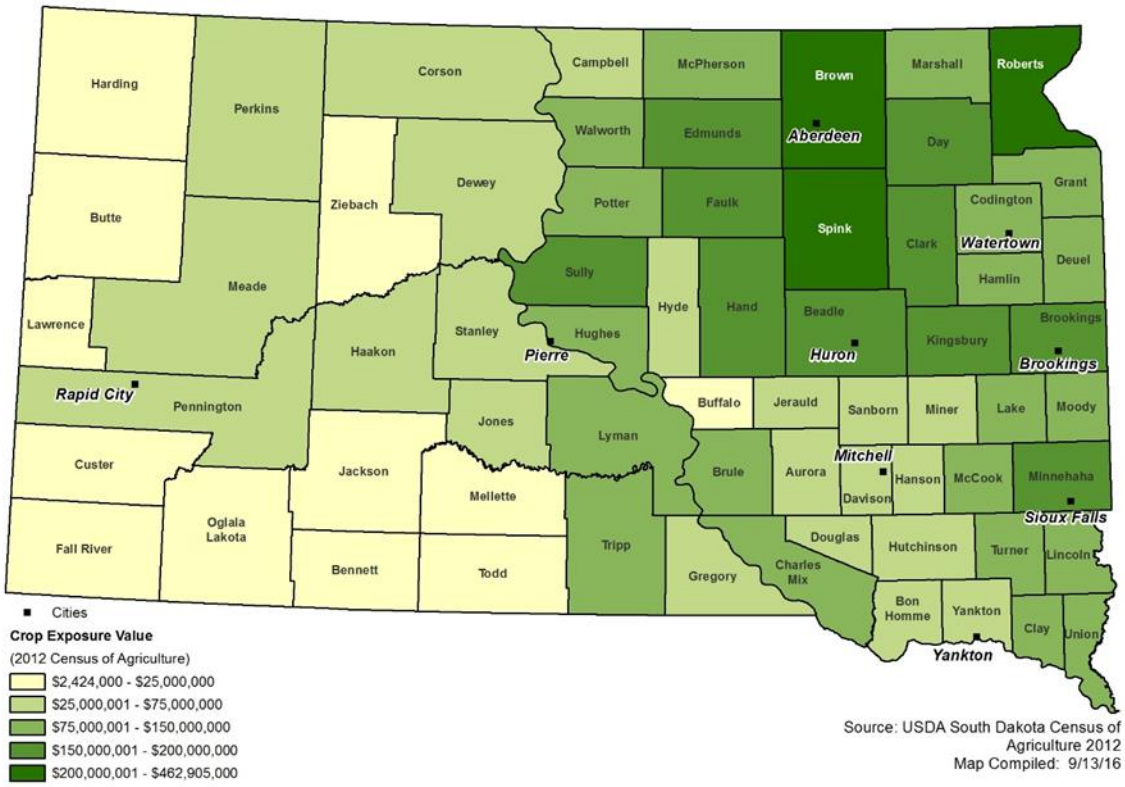
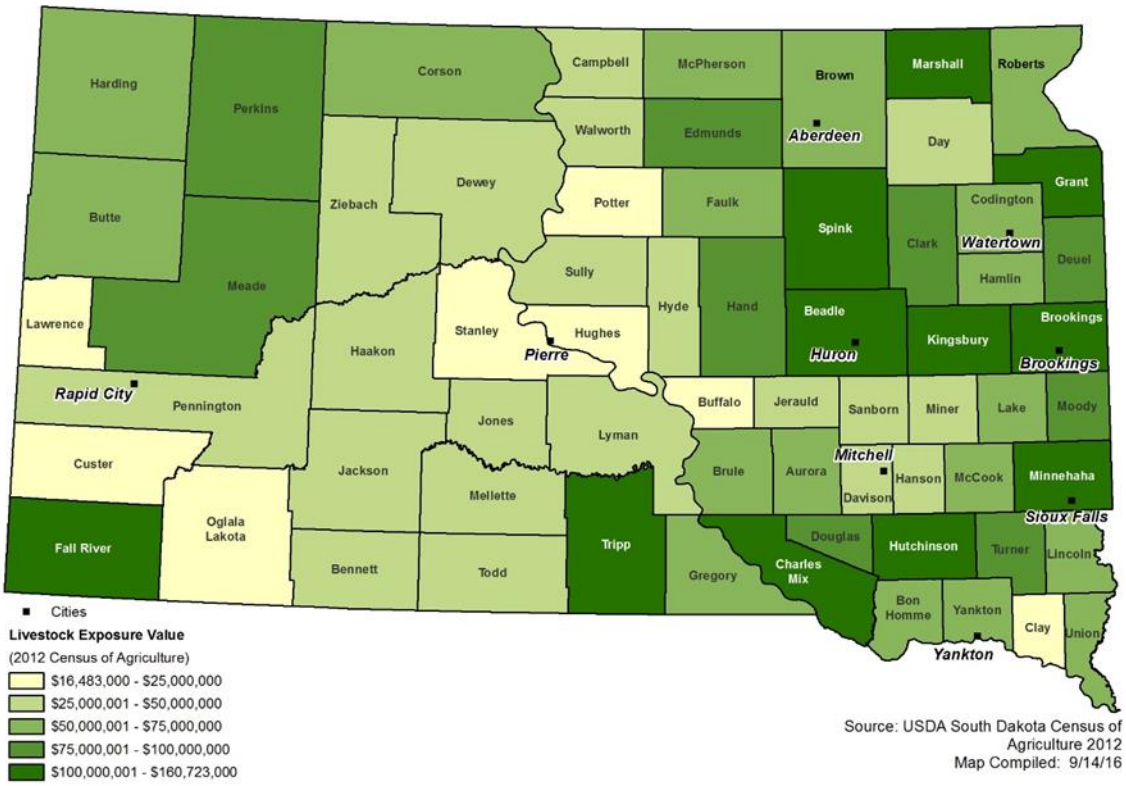


Figure 3-50 Total Market Value of Livestock Sold by County in 2012



Future Vulnerability

Agriculture has a long history in South Dakota and continues to be the state's primary industry, contributing 20% of the state's economy or $20.9 billion and employing 80,000 individuals statewide. An agriculture pest or disease event can have devasting impacts on both the state's economy as well as the livelihood and mental health of individuals in the industry. With an annual probability of occurrence of 100% that an agriculture pest or disease event will occur in any given year, the state's vulnerability to this type of hazard event is not expected to decrease in the future. As shown in the figures above, counties with the highest crop exposure values (Roberts, Spink and Brown) and the highest livestock exposure values (Marshall, Spink, Beadles, Kingsbury, Grant, Brookings, Minnehaha, Hutchinson, Charles Mix, Tripp, and Fall River) will continue to be the counties most vulnerable to future agricultural pests and disease events. As noted within the Climate Change Consideration subsection of Section 3.2.1., climate change is expected to increase winter and spring precipitation which may lead to disruptions in planting seasons. While summer season precipitation is projected to decrease, this may lead to an increase in drought events which in turn will continue to leave the state vulnerable to agricultural pests and diseases.

Table 3-44 Consequence Summary for Agricultural Pest and Disease

Category	Narrative
Impact on the Public	Potential for animal to human transfer of disease; potential for loss of livelihoods; potential for mental health issues due to severe economic hardship
Impact on the Economic Condition of the State	Potentially devastating depending on the pest or disease and its impacts; disease can wipe out whole herds; pests or disease can wipe out crops; incident may disrupt business operations of farms statewide; impacts could come from an incident in the state, or an incident in a nearby state; agriculture economy can be affected by something as simple as an unchecked rumor

Category	Narrative
Impact on the Environment	Zoonotic animal diseases may spread between livestock and wildlife; crop diseases or pests may spread between crops and surrounding flora; potential for widespread impacts depending on parameters of incident
Impact on Property, Facilities, and Infrastructure	No physical impacts to property; infected crops or livestock may be barred from slaughterhouses, co-ops, markets and other agriculture sites
Impact on the Public Confidence in Government	Ability to respond and recover may be questioned and challenged if planning, response, and recovery is not timely and effective.
Impact on Responders	Isolation or quarantine can stress first responders needed to close roads or provide security
Impact on Continuity of Operations	Need for personnel may stress limited resources
Cascading Hazards	N/A

3.3.6 Floods

Nearly every county in South Dakota is vulnerable to floods. South Dakota's January 2004 Map Modernization Plan divides the state into five regions based on population and flooding hazards. The priority regions and the jurisdictions associated with those regions are:

- **Priority 1: Big Sioux Region** - Brookings, Clark, Clay, Codington, Day, Deuel, Grant, Hamlin, Hutchinson, Kingsbury, Lake, Lincoln, Marshall, McCook, Miner, Minnehaha, Moody, Roberts, Turner, Union, and Yankton.
- **Priority 2: James Region** - Aurora, Beadle, Bon Homme, Brown, Brule, Buffalo, Campbell, Charles Mix, Davison, Douglas, Edmunds, Faulk, Hand, Hanson, Hughes, Hyde, Jerauld, McPherson, Potter, Sanborn, Spink, Sully, and Walworth.
- **Priority 3: Grand/Moreau Region** - Butte, Corson, Dewey, Harding, Meade, Perkins, and Ziebach.
- **Priority 4: Cheyenne Region** - Custer, Fall River, Haakon, Lawrence, Pennington, Oglala Lakota, and Stanley.
- **Priority 5: White/Bad Region** - Bennett, Gregory, Jackson, Jones, Lyman, Mellette, Todd, and Tripp.

The following section describes progress the state has made developing vulnerability and loss estimates for the highlighted counties. Future updates to this plan will include additional vulnerability analyses as more DFIRMs become available and as more resources for Hazus-MH studies are obtained.

Methodology

Planning level flood loss estimates were made available for every county in South Dakota with the 2010 update to the South Dakota Hazard Mitigation Plan. These estimates were still relevant for the 2016 update. FEMA used Hazus-MH MR2 to model the 100-year floodplain and perform associated building and population risk assessments. Hazus-MH is FEMA's GIS-based natural hazard loss estimation software. The Hazus-MH flood model results included analysis for each of the 66 counties modeling streams draining a 10 square mile minimum drainage area, using 30 meter (1 arc second) Digital Elevation Models (DEM). Hydrology and hydraulic processes utilize the DEMs, along with flows from USGS regressions and gauge data, to determine reach discharges and to model the floodplain. Losses are then calculated using Hazus-MH national baseline inventories (buildings and population) at the census block level.

Hazus-MH produces a flood polygon and flood-depth grid that represents the 100-year floodplain. The 100-year floodplain represents a flood that has a 1% chance of being equaled or exceeded in any single year. While not as accurate as official flood maps, these floodplain boundaries are available for use in GIS and could be valuable to communities that have not been mapped by the National Flood Insurance Program. Hazus-MH generated damage estimates are directly related to depth of flooding and are based

on FEMA's depth-damage functions. For example, a two-foot flood generally results in about 25 percent damage to the structure (which is based on 25 percent of the structure's replacement value). The Hazus-MH flood analysis results provide number of buildings impacted, estimates of the building repair costs, and the associated loss of building contents and business inventory. Building damage can cause additional losses to a community as a whole by restricting the building's ability to function properly. Income loss data accounts for losses such as business interruption and rental income losses as well as the resources associated with damage repair and job and housing losses.

Data Limitations: Potential losses derived from Hazus-MH used default national databases and may contain inaccuracies; loss estimates should be used for planning level applications only. There could also be errors and inadequacies associated with the hydrologic and hydraulic modeling of the Hazus-MH model. In rural South Dakota, census blocks are large and often sparsely populated or developed; this may create inaccurate loss estimates. Hazus-MH assumes population and building inventory to be evenly distributed over a census block; flooding may occur in a small section of the census block where there are not actually any buildings or people, but the model assumes that there is damage to that block. In addition, excessive flood depths may occur due to problems with a DEM or with modeling lake flooding. Errors in the extent and depth of the floodplain may also be present from the use of 30 meter digital elevation models. Hazus-MH Level II analyses based on local building inventory, higher resolution terrain models, and DFIRMs could be used in the future to refine and improve the accuracy of the results. Another limitation is that Hazus does not model lake shore flooding and may not represent the closed basin flooding scenarios common in South Dakota, as in Brown County. Hazus level 1 modeling does not account for levee protection.

Hazus-MH building data is based on average housing costs and 2000 census counts. There may be errors within the Hazus-MH data itself. The size and shape of the census block affects the accuracy of this model. The larger and more irregular the census block, typically found in rural areas, the less accurate this method becomes. There could be spatial inaccuracies with DFIRM data, or the data may not include all the possible flood hazards within a particular county. This model may include structures within the 100-year floodplain (A Zone) that may be elevated above the level of the base flood elevation, according to local floodplain development requirements. This model may not fully reflect real world conditions, but it does serve as a basis to quantify the possible risk from floods, using the best available data.

Hazus-MH produces a flood polygon and flood-depth grid that represents the base flood. While not as accurate as official flood maps, such as digital flood insurance rate maps, these floodplain boundaries are available for use in GIS and could be valuable to communities that have not been mapped by the National Flood Insurance Program. A statewide digital flood hazard layer was created by appending floodplain boundaries created in each county run and is displayed in Figure 3-52. Figure 3-51 shows the current extent of effective DFIRMs in the state.

Risk MAP

As a participant in FEMA's Risk MAP program, South Dakota has increased the availability of flood risk assessment data to the public. The state has encouraged local communities to access the Risk MAP data and use it in future planning processes. More information on South Dakota's Risk MAP efforts and accomplishments can be found in Section 4.3.4.

Figure 3-51 South Dakota Digital Flood Insurance Rate Map Coverage 2016

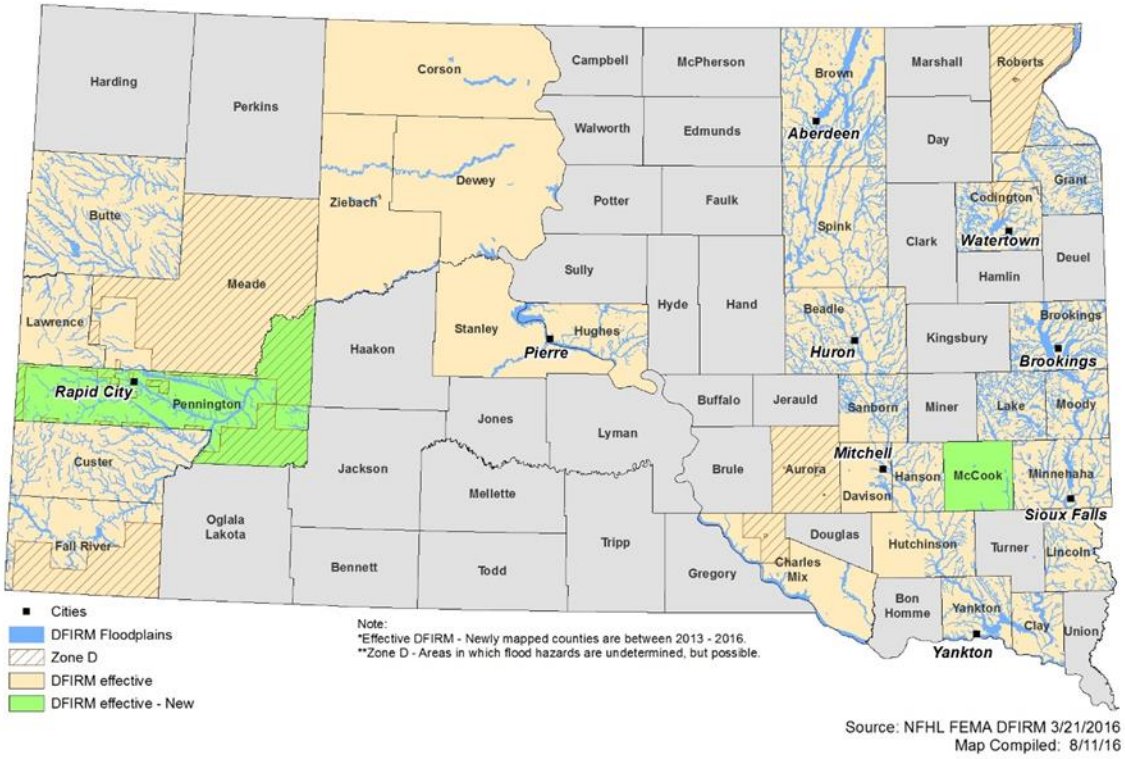
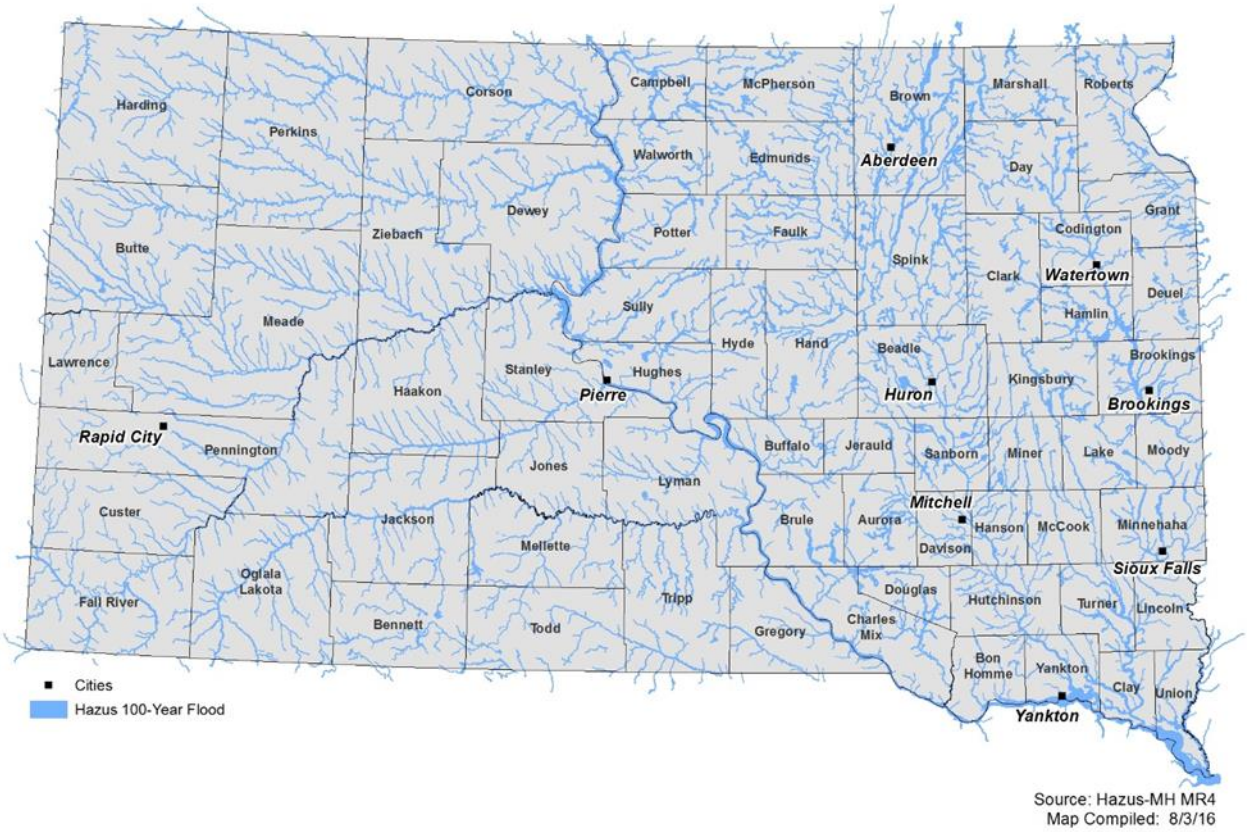


Figure 3-52 South Dakotas 100-year Flood Zones based on Hazus



Vulnerable Jurisdictions and Potential Losses

The intent of this analysis was to enable the state to estimate where flood losses could occur and quantify the degree of severity using a consistent methodology. The computer modeling helps quantify risk along known flood hazard corridors such as along the James, Big Sioux, and Vermillion rivers. In addition, flood losses are estimated for certain lesser streams and rivers where the flood hazard may not have been previously studied.

Hazus-MH impact analyses were run for direct economic losses for buildings and societal impacts (displaced people and shelter needs) to display the relative ranking of counties based on these risk indicators (these losses and impacts are illustrated in the tables that follow). The primary indicators used to assess flood losses were:

- Direct building losses combined with income losses,
- Loss ratio of the direct building losses compared to overall building inventory,
- Loss ratio of building contents compared to overall building inventory, and
- Population displaced by the flood and shelter needs.

The results, shown in Table 3-45, Figure 3-53, Figure 3-54, Figure 3-55, and Figure 3-56, display the potential base flood losses to all counties. More detailed results are in Appendix 3B. The results show potential losses as highest in Minnehaha, Union, Yankton, Pennington, Codington, Lawrence and Brown counties. Floods in these counties have the potential to displace at least a thousand persons in each county. Statewide there is the potential for $1.7 Billion in flood losses from the 1% annual chance flood.

Based on the loss ratio, which is the percent of the total building inventory value that could be damaged from flooding in any given year, Union, Yankton, Fall River and Campbell Counties are most at risk and may have difficulty recovering from a flood event. Note that Union County does contain levees (see the flood hazard profile section), which is likely being ignored by Hazus. The results presented for Union County may be more representative of a levee failure scenario.

Table 3-45 Hazus-MH Base Flood (1 Percent Chance) Loss Estimation Results: Impacts by County, Ranked by Highest Building Losses

County Name	Building Damage Count	Building Damage Loss ($K)	Building Damage Loss Ratio*	Contents Damage Loss ($K)	Contents Loss Ratio	Total Direct Econ Bldg Loss **($K)	Short Term Shelter Needs	Displaced Population
Minnehaha	719	162,527	1.6%	252,358	3.6%	432,484	6,159	7,482
Union	867	119,836	11.6%	203,473	25.4%	349,991	3,451	4,428
Yankton	713	81,492	5.6%	105,103	9.7%	193,250	2,614	3,328
Pennington***	88	15,085	0.32%	33,970	0.4%	113,162	888	1,301
Codington	221	28,917	1.7%	48,403	3.9%	81,843	2,301	3,027
Lawrence	72	20,631	1.5%	28,237	3.0%	50,103	504	979
Brown	71	16,502	0.7%	22,083	1.4%	40,502	854	1,785
Stanley	131	14,974	9.2%	11,356	10.9%	26,644	340	666
Fall River	92	14,007	3.2%	20,735	7.5%	36,379	250	525
Butte	24	9,890	2.3%	10,891	4.0%	21,428	271	892
Lake	72	8,740	1.1%	11,306	2.1%	20,840	664	1,128
Oglala Lakota	34	8,180	2.5%	11,173	5.1%	20,430	492	1,214
Lincoln	26	7,275	0.5%	6,826	0.7%	14,514	210	524
Spink	15	6,474	1.3%	7,554	2.4%	14,644	217	572
Davison	24	6,417	0.6%	6,297	0.8%	13,185	216	530
Hutchinson	29	5,799	1.2%	9,436	2.6%	16,001	646	957

County Name	Building Damage Count	Building Damage Loss ($K)	Building Damage Loss Ratio*	Contents Damage Loss ($K)	Contents Loss Ratio	Total Direct Econ Bldg Loss **($K)	Short Term Shelter Needs	Displaced Population
Turner	12	5,659	0.9%	7,748	1.9%	14,191	39	391
Hamlin	18	5,398	1.4%	9,963	4.0%	16,441	31	387
Custer	6	5,092	1.1%	10,476	3.7%	16,746	44	257
Meade	8	4,808	0.4%	6,458	0.8%	11,765	106	469
Brookings	7	4,563	0.3%	9,953	0.8%	15,476	383	943
Grant	22	4,422	0.9%	4,652	1.4%	9,592	97	415
Charles Mix	4	4,020	0.7%	5,337	1.4%	9,842	46	232
Aurora	17	3,914	2.0%	5,561	4.5%	10,125	101	481
Haakon	13	3,761	2.6%	5,756	5.3%	10,151	78	303
Beadle	6	3,673	0.3%	6,000	0.8%	10,393	64	387
Tripp	31	3,470	0.9%	3,446	1.3%	7,248	86	265
Campbell	37	3,393	3.2%	5,017	7.1%	8,813	124	383
Lyman	13	3,267	1.5%	3,329	2.3%	6,876	38	145
McCook	18	3,257	0.9%	2,680	1.1%	6,096	65	252
Hughes	7	3,195	0.3%	5,319	0.7%	8,871	297	611
Clay	18	2,952	0.4%	2,268	0.5%	5,327	88	248
Roberts	8	2,903	0.5%	3,991	1.0%	7,273	36	320
Edmunds	30	2,718	1.0%	2,526	1.4%	5,461	156	293
Todd	9	2,227	0.8%	3,458	1.9%	5,723	105	314
Corson	16	2,089	1.5%	1,711	1.9%	3,894	285	446
Hand	9	2,083	0.7%	1,931	1.0%	4,161	39	197
Moody	2	2,072	0.5%	1,949	0.8%	4,220	9	216
Bon Homme	7	1,815	0.4%	1,870	48.9%	3,828	37	117
Day	5	1,649	0.3%	1,386	0.5%	3,187	10	157
Dewey	3	1,532	0.8%	981	0.9%	2,557	31	166
Miner	9	1,527	0.8%	1,685	1.4%	3,363	66	159
Mellette	14	1,501	1.9%	817	1.6%	2,331	109	223
Brule	1	1,423	0.4%	1,813	0.7%	3,498	19	151
Ziebach	8	1,403	2.1%	749	1.9%	2,158	75	191
Deuel	2	1,386	0.5%	2,256	1.2%	3,922	34	154
Hanson	0	1,368	0.8%	1,029	0.9%	2,473	3	94
Kingsbury	0	1,366	0.3%	2,080	0.8%	3,672	48	281
Perkins	0	1,293	0.6%	982	0.7%	2,339	-	76
Faulk	4	1,275	0.8%	1,592	1.4%	3,056	94	179
Clark	2	1,208	0.5%	1,880	1.1%	3,328	45	159
Bennett	0	1,165	1.0%	1,808	2.3%	3,145	2	71
Sanborn	0	1,121	0.7%	1,121	1.0%	2,400	3	142
Marshall	0	1,062	0.3%	1,052	0.5%	2,223	7	143
Douglas	5	984	0.5%	1,163	0.9%	2,342	14	152
Walworth	0	780	0.2%	786	0.3%	1,632	-	63
Jackson	0	702	0.6%	723	1.0%	1,445	3	69
Buffalo	1	645	1.1%	631	1.5%	1,347	30	79
McPherson	0	628	0.3%	815	0.6%	1,545	4	95
Jerauld	0	591	0.3%	833	0.7%	1,534	8	77
Potter	0	537	0.2%	781	0.4%	1,416	1	44
Harding	0	504	0.6%	516	1.0%	1,045	2	43
Sully	0	502	0.4%	456	0.6%	1,016	1	42

County Name	Building Damage Count	Building Damage Loss ($K)	Building Damage Loss Ratio*	Contents Damage Loss ($K)	Contents Loss Ratio	Total Direct Econ Bldg Loss **($K)	Short Term Shelter Needs	Displaced Population
Gregory	0	474	0.2%	254	0.1%	731	-	44
Hyde	0	292	0.3%	370	0.5%	709	-	39
Jones	1	288	0.4%	243	0.5%	551	-	17
	3,571	634,703	1.3%	929,402	3%	1,706,878	22,876	40,598

Source: FEMA Region VIII Hazus-MH MR2 Notes:
*Loss ratio is the percent of the total building inventory value that could be damaged from flooding in any given year.
**Total Direct Economic loss includes relocation loss, capital-related loss, wages loss, rental income loss and building loss.
***Added from South Dakota Emergency Management Hazus run to account for problem reach in FEMA analysis

Figure 3-53 Hazus-MH Base Flood (1 Percent Chance) Building and Income Loss Estimation by County

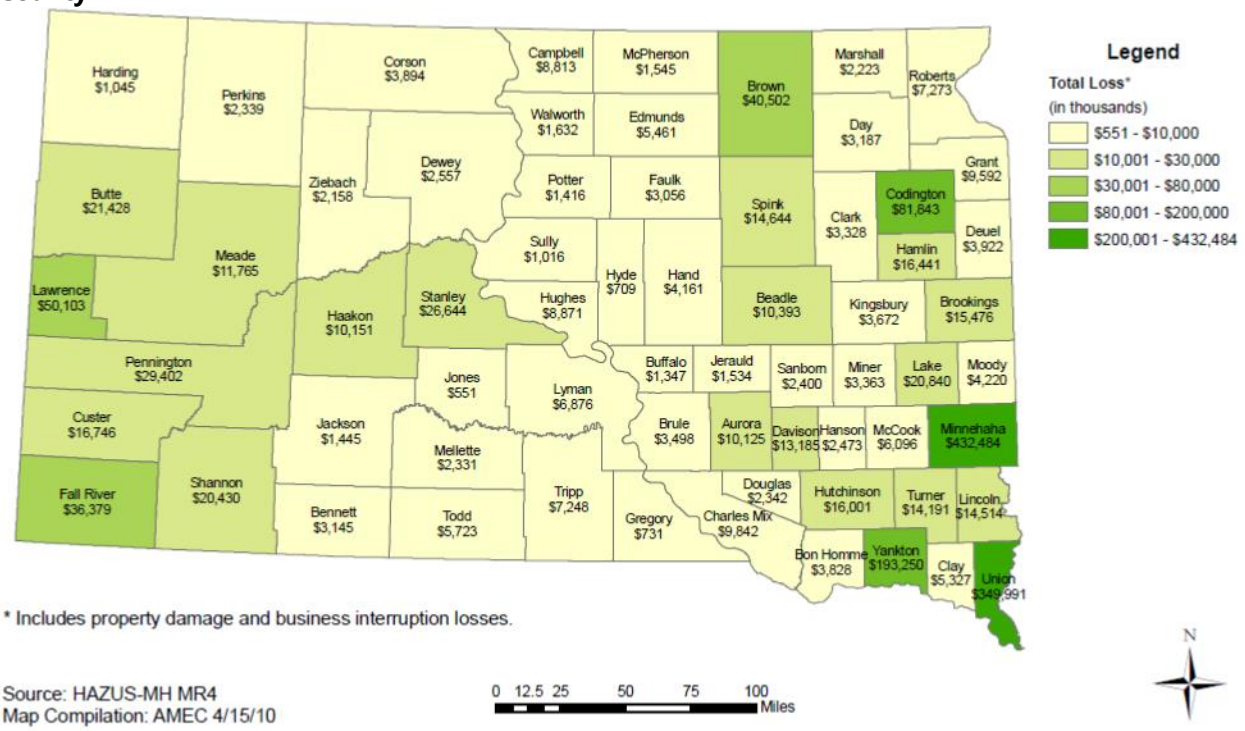
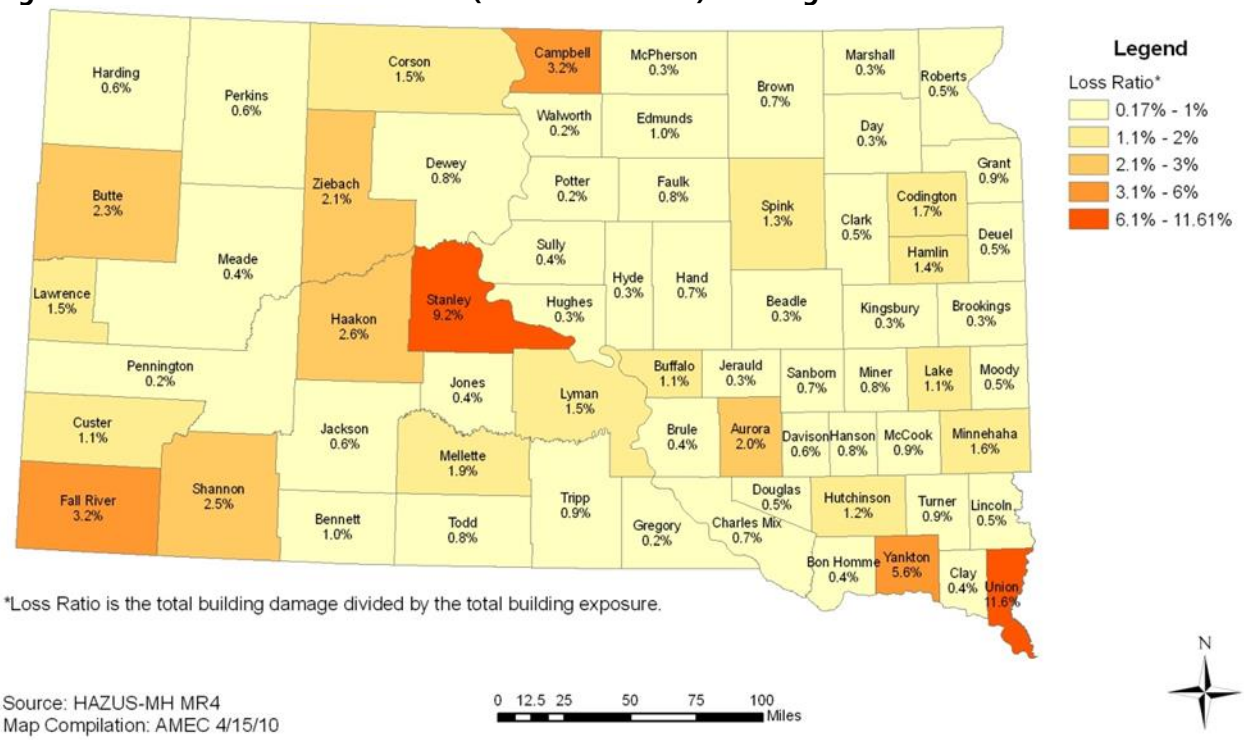
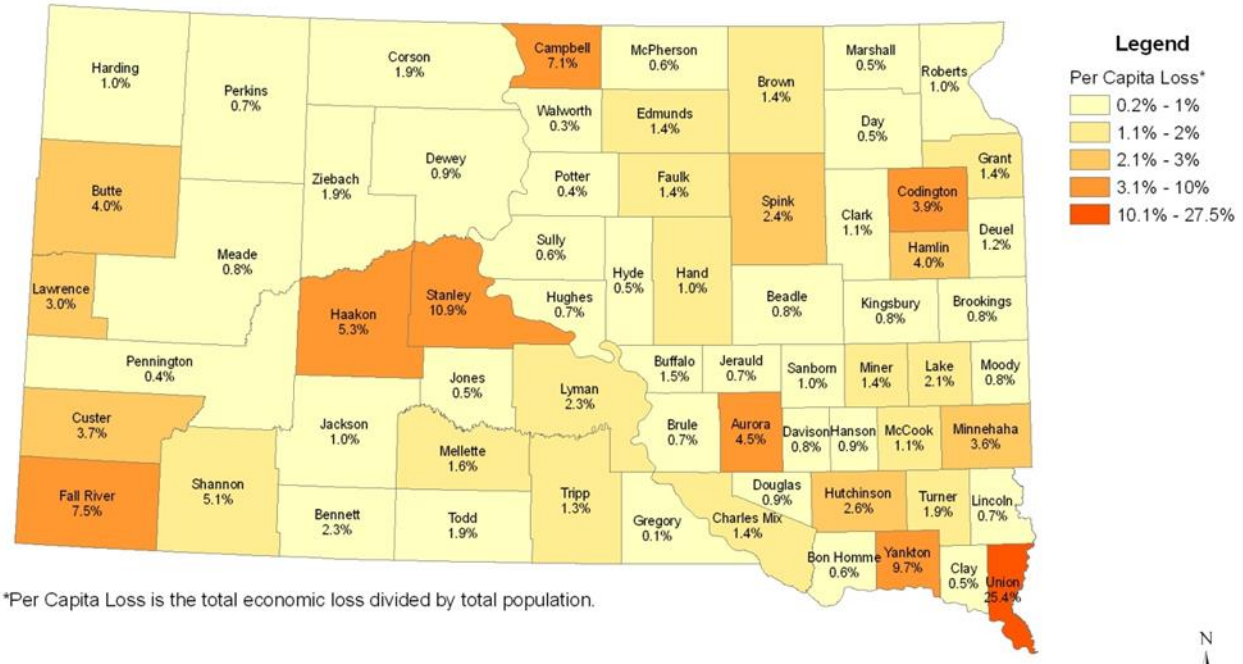


Figure 3-54 Hazus-MH Base Flood (1 Percent Chance) Building Loss Ratio



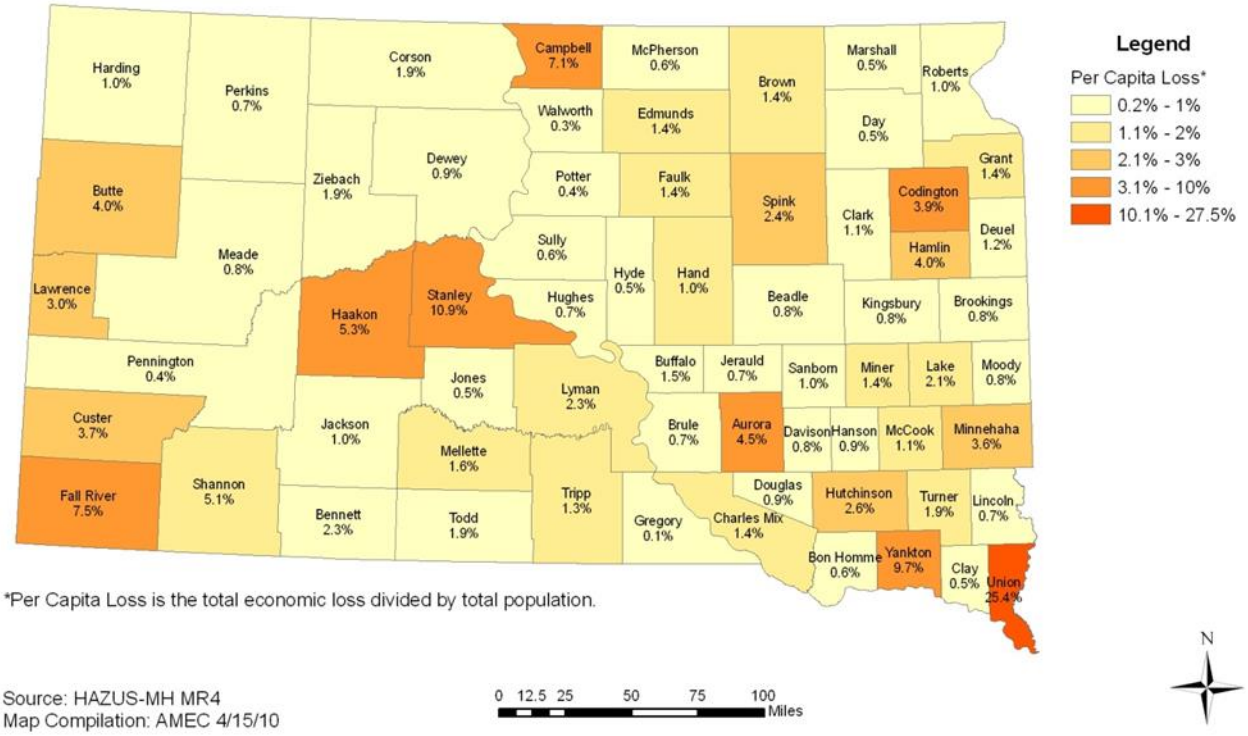
Source: HAZUS-MH MR4
Map Compilation: AMEC 4/15/10

Figure 3-55 Hazus-MH Base Flood (1 Percent Chance) Content Loss Ratio



Source: HAZUS-MH MR4
Map Compilation: AMEC 4/15/10

Figure 3-56 Hazus-MH Base Flood (1 Percent Chance) Displaced Population Estimation by County



A separate methodology was used in 2007 and updated in 2013 to analyze those counties with existing DFIRMs. Using GIS, the DFIRM special flood hazard area boundaries were overlaid on Hazus-MH building inventory, which is linked to census block geography. A proportional division was performed to account for blocks that were split by flood boundaries, and to better model values in the floodplain. For example, a census block that was split in two by a floodplain (50 percent in, 50 percent out) had its building count and valuation attributes multiplied by 0.50. From this method, information on the number of buildings and building replacement value at risk could be estimated by county and by flood zone.

The DFIRM loss estimation results are presented separately in Table 3-46. The DFIRM floodplains should be more accurate, but in some cases not as extensive, as the Hazus-MH generated floodplains. Some DFIRMs are community-based only and do not cover the entire county. McCook County was the only county with new DFIRM in 2016. The county's DFIRM was imported into Hazus 3.1 Enhanced Quick Look to generate the loss estimate.

Table 3-46 Digital Flood Insurance Rate Maps Base Flood (1 Percent Chance) Loss Estimations

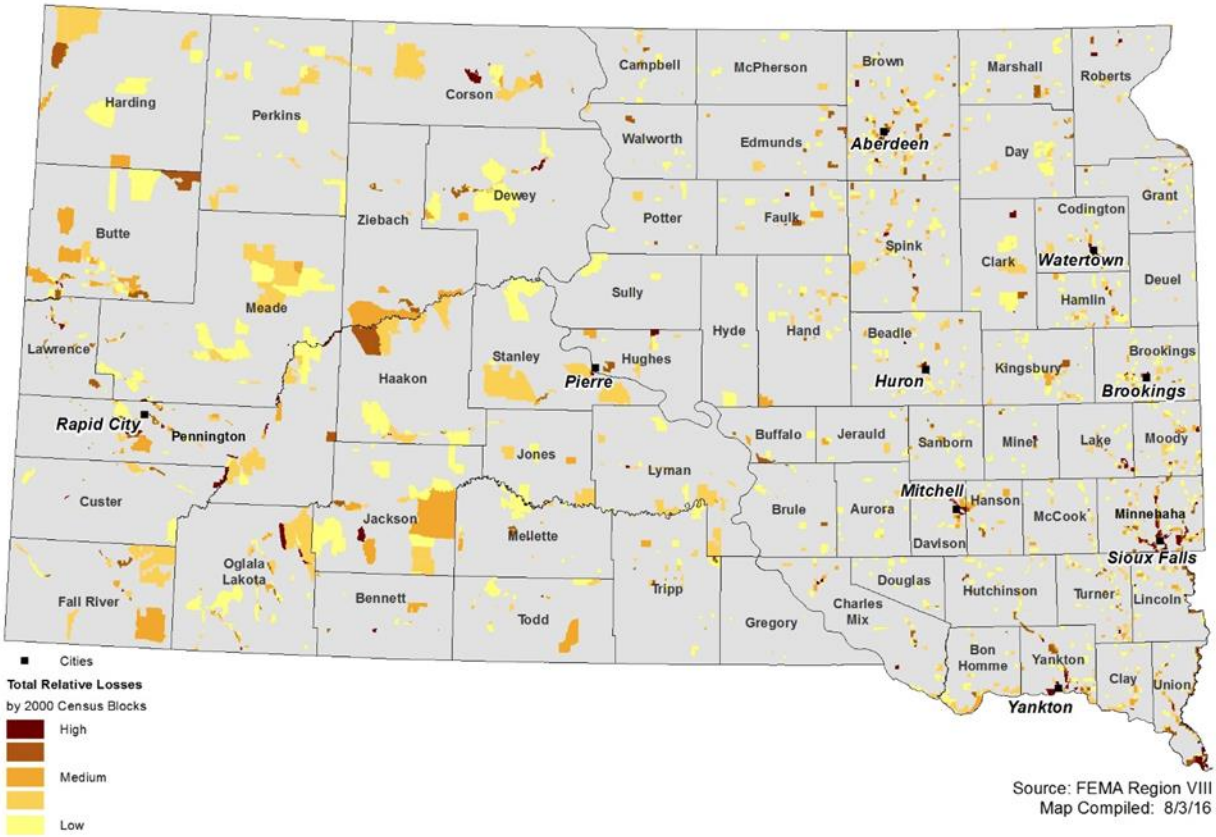
County	Percent of County in Floodplain	Building Count	Total Exposure	Estimated Flood Loss
Minnehaha	12.86%	4,508	$1,700,878,282	$425,219,570
Pennington	2.26%	2,627	$554,516,791	$138,629,198
Codington	3.70%	1,961	$387,336,901	$96,834,225
Brown	13.56%	1,534	$278,794,681	$69,698,670
Brookings	8.99%	1,088	$202,465,157	$50,616,289
Yankton	11.93%	824	$192,415,451	$48,103,863
Lawrence	1.22%	903	$162,485,138	$40,621,284
Meade	1.63%	709	$148,200,897	$37,050,224

County	Percent of County in Floodplain	Building Count	Total Exposure	Estimated Flood Loss
Lake	3.88%	747	$121,188,376	$30,297,094
Hughes	2.67%	354	$95,424,076	$23,856,019
Lincoln	5.23%	444	$88,456,803	$22,114,201
Custer	1.71%	449	$88,280,833	$22,070,208
Stanley	1.82%	558	$73,146,476	$18,286,619
Roberts	10.08%	464	$69,161,018	$17,290,255
Moody	8.70%	445	$59,291,843	$14,822,961
Spink	7.22%	414	$55,893,903	$13,973,476
Butte	1.44%	408	$55,729,397	$13,932,349
Fall River	2.02%	238	$55,237,998	$13,809,500
Beadle	6.56%	394	$51,825,695	$12,956,424
Davison	11.42%	297	$50,427,520	$12,606,880
Grant	2.05%	313	$49,909,217	$12,477,304
Hutchinson	8.46%	198	$29,063,726	$7,265,932
Sanborn	3.28%	168	$23,740,640	$5,935,160
Charles Mix	12.22%	164	$21,228,852	$5,307,213
Clay	21.00%	137	$18,929,360	$4,732,340
McCook*	0.01%	16	$613,226,000	$2,198,000
Aurora	11.17%	66	$9,353,611	$2,338,403
Hanson	7.93%	91	$8,802,869	$2,200,717
Corson	3.67%	70	$7,451,377	$1,862,844
Ziebach	4.33%	71	$5,565,882	$1,391,471
Dewey	4.50%	49	$4,629,792	$1,157,448

Source: Building value is from Hazus-MH. Estimated flood loss is 25 percent of total value.
* Added in 2016, analysis based on import of DFIRM into Hazus 3.1 Enhanced Quick Look.

In 2009-2010 FEMA conducted a Hazus Flood Average Annualized Loss (AAL) study which was performed for the entire continental United States using the MR4 release of Hazus-MH (Figure 3-57). The analysis was performed at the county level using Level 1 methodology with national datasets. FEMA subsequently revised the study as the initial AAL costs appeared to over-estimate the average annual loss potential in most areas. The revised results were obtained from FEMA Region VIII during the 2013 update to the HIRA and compared with the previous 1% annual chance Hazus analysis included from the 2010 update. As of mid-2016 an updated study was not available. AAL total losses for the state are estimated to be $45,996,000 based on this study. FEMA staff indicated that this loss estimate could be high. Based on updated NCEI data (see the flood hazard profile) alone AAL is $15.5 M, and about $1M based on NFIP claims data. The 1% annual chance total losses associated with the AAL study are $817,993,000. Based on the previous Hazus Level 1 studies done in the 2010 plan (including buildings, contents and economic loss) the 1% annual chance $1.7 billion in flood losses for the state. It was determined that the existing level 1 Hazus for the 1% annual chance flood (100-year) was still valid. Based on FEMA staff recommendations the AAL loss data is being used for relative risk comparisons only and is illustrated on a loss by census block basis in the following figure.

Figure 3-57 Hazus MH Flood Average Annualized Loss



Flood Insurance Claims Analysis

In addition to the Hazus-MH flood runs and local plans, the state analyzed National Flood Insurance Program (NFIP) flood-loss data to determine areas of South Dakota with the greatest flood risk. South Dakota flood-loss information was obtained from FEMA's "NFIP Policy and Claims Report" for South Dakota, which documents losses from 1978. This section was updated based on information obtained from FEMA through OEM in mid-2016.

There are several limitations to analyzing flood risk entirely on this data, including:

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

Despite these limitations, the data depict a pattern of historical flood losses in the state. The greatest losses have been in Codington, Lincoln, and Union counties. Table 3-47 shows the details of the 10 South Dakota counties with the greatest historical dollar losses. Union County was not within the top ten list in the 2010 plan update but is now number three behind Codington and Lincoln Counties. Codington remains the leader in terms of overall dollars paid. Codington's polices, however, decreased from 835 in 2010 to 704 in 2012 to 524 in 2016. Since 2012, Lincoln County has increased dollars paid about $4 million, but decreased current policies by 35. Other notable changes include Minnehaha's decrease in dollars paid by about $2.5 million and over 1,000 less policies than it had in 2012. South Dakota's State

NFIP coordinator explained the policy count decrease as partly related to the historic Missouri River flood of 2011, which caused a spike in policies. Union County, for example, went from 570 to almost 1,300 policies in 2011. Since then, people have opted to cancel their policies. Another large decrease could occur in 2018; the City of Sioux Falls had their levee system certified by the Corps of Engineers which will result in 1,600 structures no longer being required to have flood insurance when mapping becomes effective in 2017. NFIP policy summary statistics from FEMA for Region VIII states show a consistent trend towards a decrease in policies in each state.

Table 3-47 Top Ten Counties for Flood Insurance Dollars Paid (Historical), 1978 - 2016

County	Dollars Paid ($ Historical)	Flood Claims	Current Policies	Coverage ($)
Codington	$5,749,018	425	524	$97,426,900
Lincoln	$5,233,428	177	1,336	$389,092,500
Union	$5,076,498	420	403	$119,134,300
Hamlin	$4,201,281	347	57	$12,326,900
Day	$4,011,874	252	31	$4,943,600
Brown	$3,283,454	483	277	$51,238,300
Stanley	$2,555,204	113	125	$31,329,800
Lake	$1,419,607	152	169	$30,609,500
Spink	$921,480	69	36	$6,109,500
Minnehaha	$906,393	132	132	$24,017,700

Source: FEMA, NFIP Insurance Report, 2016

Information about flood insurance losses and policies for all South Dakota counties is in Appendix 3C. Based on this data the average annual insured losses are about $1 million.

Repetitive Loss Analysis

A high priority in South Dakota and nationwide is the reduction of losses to repetitive loss structures. These structures strain the National Flood Insurance Fund. They increase the NFIP's annual losses and the need for borrowing and, more importantly, they drain resources needed to prepare for catastrophic events. The NFIP defines a repetitive loss property as "any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. At least two of the claims must be more than 10-days apart."

Table 3-48 lists the number of South Dakota's 193 repetitive loss properties by county, to include historical numbers from 2007, 2010, 2012, and 2016. Overall the number of repetitive loss properties in the state continues to increase. Hamlin and Codington Counties have the most repetitive loss properties, followed by Day, Minnehaha, and Brown Counties. Two new counties were added to this list since 2012: Lincoln and Union. Multiple buyouts in Day County are in process as of January 2019.

Table 3-49 shows repetitive loss claims by county. Lincoln, Codington, and Day counties are the top three by repetitive loss dollars paid. The numbers from the 2007, 2010, and 2012 plans, as well as the 2016 HIRA Update have been preserved to show changes in the past 11 years. Repetitive loss claims have increased through the state, mainly due to the 2011 floods. An increased number of second homes being flooded may also be a contributing factor, since the state does not buyout second homes.

Table 3-48 Repetitive Loss Properties by County

County*	2007	2010	2012	2016	2018	Difference 2012-2018
Beadle	0	1	2	1	2	0
Brookings	0	0	3	4	4	+1
Brown	7	10	14	13	14	0
Butte	0	0	1	1	1	0
Charles Mix	0	1	1	1	1	0
Clark	1	2	2	2	2	0
Clay	0	0	1	1	1	0
Codington	33	33	39	32	38	-1
Davison	1	1	1	1	1	0
Day	8	9	21	19	20	-1
Grant	2	2	2	4	4	+2
Hamlin	4	4	41	38	39	-2
Hanson	0	0	1	1	1	0
Hughes	2	2	4	4	4	0
Lake	3	3	3	2	3	0
Lincoln	0	0	0	6	6	+6
Marshall	0	0	2	2	2	0
McCook	0	0	1	1	1	0
Meade	0	0	1	2	2	+1
Minnehaha	10	10	17	17	19	+2
Moody	3	3	7	7	7	0
Pennington	0	0	2	1	3	+1
Roberts	0	0	4	5	5	+1
Spink	0	0	8	8	8	0
Turner	0	0	1	1	1	0
Union	0	0	0	1	2	+2
Yankton	0	0	2	2	2	0
Total	**74**	**81**	**181**	**177**	**193**	**+12**

Source: South Dakota Emergency Management, FEMA's "NFIP Insurance Report," 2016
* County includes policy and loss information for both incorporated and unincorporated areas
** Includes insured and uninsured properties

Table 3-49 Repetitive Loss Claims by County

	Number of RL Claims					RL Dollars Paid ($ Historical)			
County*	2007	2010	2012	2016	2018	2010	2012	2016	2018
Beadle	0	3	6	3	6	$43,389	$116,289	$72,899	$116,289
Brookings	0	0	7	9	9		$96,691	$103,500	$103,500
Brown	14	21	29	27	29	$162,871	$206,324	$198,798	$206,324
Butte	0	0	2	2	2		$6,593	$6,593	$6,593
Charles Mix	0	2	3	3	3	$156,344	$181,763	$227,915	$227,915
Clark	2	4	5	5	5	$78,954	$117,455	$117,454	$117,455
Clay	0	0	2	2	2		$4,881	$4,880	$4,880
Codington	74	72	95	80	97	$1,427,850	$1,872,695	$1,552,284	$1,971,014
Davison	2	2	2	2	2	$17,207	$17,207	$17,206	$17,207
Day	16	18	43	41	43	$359,057	$1,186,524	$1,125,151	$1,186,524
Grant	4	5	5	10	10	$44,453	$30,943	$107,408	$107,408
Hamlin	9	9	90	86	88	$185,508	$1,599,878	$1,474,551	$1,498,552
Hanson	0	0	2	2	2		$5,771	$5,770	$5,770
Hughes	4	4	8	8	8	$36,385	$75,263	$75,262	$75,263
Lake	6	6	6	4	6	$81,511	$81,511	$61,511	$81,511
Lincoln	0	0	0	13	13			$2,690,957	$2,690,957
Marshall	0	0	6	6	6		$23,766	$23,765	$23,766
McCook	0	0	2	2	2		$4,431	$4,431	$4,431
Meade	0	0	2	5	5		$15,788	$28,626	$28,627
Minnehaha	21	21	41	42	46	$94,423	$266,517	$300,464	$422,858
Moody	7	8	19	19	19	$81,815	$180,728	$180,727	$180,728
Pennington	0	0	4	2	6		$17,331	$5,261	$48,068
Roberts	5	0	8	10	10		$99,611	$142,522	$142,522
Spink	0	0	19	19	19		$446,931	$446,931	$446,931
Turner	0	0	2	2	2		$28,259	$28,259	$28,259
Union	0	0	0	2	4			$70,098	$126,216
Yankton	0	0	4	4	4		$17,331	$15,052	$15,052
Total	**164**	**175**	**412**	**410**	**448**	**$2,769,767**	**$6,700,481**	**$9,088,275**	**$9,884,620**

Source: South Dakota Emergency Management, FEMA's "NFIP Insurance Report," 2016
* County includes policy and loss information for both incorporated and unincorporated areas

Severe Repetitive Loss Analysis

The Flood Insurance Reform Act of 2004 identified another category of repetitive loss, severe repetitive loss, and defined it as "a single family property (consisting of one-to-four residences) that is covered under flood insurance by the NFIP and has incurred flood-related damage for which four or more separate claims payments have been paid under flood insurance coverage with the amount of each claim payment exceeding $5,000 and with cumulative amount of such claims payments exceeding $20,000; or

for which at least two separate claims payments have been made with the cumulative amount of such claims exceeding the reported value of the property." In South Dakota, as of 2019, there are 10 properties that potentially meet this definition (6 of these were pending). Counties with these properties include Beadle, Clark, Coding, Day, and Hughes. In Codington County, one property experienced 9 losses and more than $566,000 in claims, and in Day County there are two properties that have over $100,000 in total claims each. According to the NFIP data none of these had been mitigated.

Future Vulnerability

The counties experiencing the most development pressures in the state all participate in the NFIP and many communities have taken steps to also participate in CRS. Despite the pressures from population growth and increased development being felt in some counties, the overall flood risk should be not increasing assuming county floodplain regulations and standards are being effectively implemented and local mitigation measures are taking place. The risk of flooding is not expected to change, and future vulnerability to flooding for the state as a whole is not expected to increase.

Table 3-50 Flood Consequence Table

Category	Narrative
Impact on the Public	Impacts on people will change with characteristics of event (e.g., flash flood in a canyon, river flood on the plains, etc.); residents/ property owners without flood insurance may be impacted greater than those with coverage; residents may be displaced due to evacuation, damage, or inaccessibility to homes; persons within flood areas have the potential for direct contact with hazardous materials; potential for drowning or personal injury; increased potential for exposure to disease
Impact on the Economic Condition of the State	Local economy and finances adversely affected, possibly for an extended period of time depending on damage and length of investigation; potential for businesses to permanently close; localized disruption of roads, facilities, and/or utilities caused by incident may postpone delivery of some services
Impact on the Environment	Localized impact expected to be severe for incident areas and moderate to light for other areas affected by flood; wetland impacts due to flooding can result in water quality impacts and wildlife habitat impacts; potential for hazardous materials impacts if a release occurs
Impact on Property, Facilities, and Infrastructure	Vulnerabilities to critical infrastructure, facilities and property in floodplain areas; High potential for flooded basements; foundation damage; transportation corridor (road, bridge, rail line) washouts; culvert damage
Impact on the Public Confidence in Government	Ability to respond and recover may be questioned and challenged if planning, response, and recovery are not timely and effective.
Impact on Responders	Need for evacuation support such as door-to-door notification and traffic management may increase responder risk; widespread flooding could stretch first responder personnel thin some areas; potential impacts to transportation corridors and communications lines may affect ability to effectively respond; possibility of responder injury or death; higher risk to responders in flash flood
Impact on Continuity of Operations	Damage to facilities/personnel in incident area may require temporary or permanent relocation of some operations
Cascading Hazards	Hazardous Materials Incidents, Dam Failure, Levee Failure

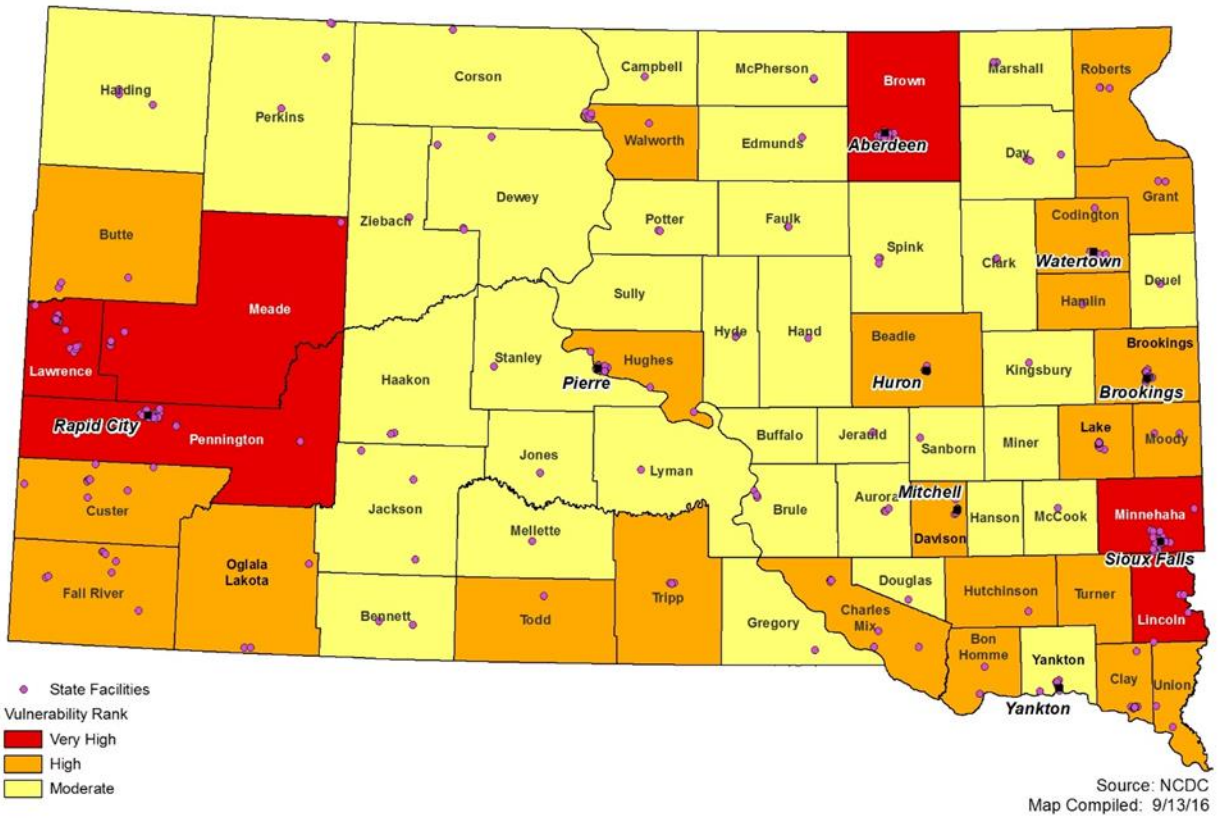
3.3.7 Summer Storms

Methodology

All counties in South Dakota are vulnerable to summer storms. To assess the relative vulnerability of each of South Dakota's counties to summer storms three factors were examined at the county level: prior events, building exposure, and population density. NCEI hail occurrence data was used for the prior events factor. The following table (Table 3-51) and map (Figure 3-58) refer directly to hail vulnerability since lightning data is not as abundant or quantifiable. Ratings were applied to each factor and summed to obtain overall vulnerability scores for each county to allow comparison for greatest relative vulnerability.

This methodology assumes that the more developed areas, represented by greater building values and higher population densities, will generally have greater costs due to hail impacts. The more developed areas may have the capacity to absorb those costs more than the rural areas, so in terms of loss ratio (ratio of the losses to the total inventory in the county) the rural areas are potentially more vulnerable.

Figure 3-58 Vulnerability of South Dakota Counties to Hail with State Facilities



Total Summer Storm Vulnerability and Estimate of Potential Loss

According to this methodology, while every county in South Dakota is vulnerable to hail; Brown, Lawrence, Lincoln, Meade, Minnehaha, and Oglala Lakota were rated as having a very high vulnerability.

The NCEI data did not lend itself to county by county loss summaries, only a statewide summary. According to the NCEI, there were 11,781hail events in South Dakota between January 1996 and August

2018. Total property damage for these events is estimated at $162 million dollars. This suggests that South Dakota averages $8 million in hail losses annually.

Between 1996 and 2016, NCEI recorded 114 separate lightning strikes, or almost six per year. Cumulatively, these storms caused five deaths, seventeen injuries, $2,171,200 in property damage and no in crop damage. Extrapolated into the future, the State of South Dakota can expect damaging lightning strikes annually; based on NCEI-recorded data, these strikes will cause one recorded injury every other year, and a lightning-caused fatality every four years. The average lightning strike in South Dakota causes $31,466 in property damage and no crop damage.

Table 3-51 Vulnerability of South Dakota Counties to Hail (ranked by vulnerability)

County	Prior Event Rating	Total Cumulative Damage ($)	Building Exposure Rating	Population Density Rating	Vulnerability Rating
Pennington	10	$67,584,000	10	8	Very High
Minnehaha	4	$28,361,000	10	10	Very High
Lawrence	4	$5,763,000	8	8	Very High
Meade	7	$3,664,500	7	5	Very High
Brown	3	$0	8	8	Very High
Lincoln	1	$4,200,000	9	9	Very High
Codington	2	$0	8	8	High
Turner	2	$2,351,000	7	8	High
Davison	1	$5,050,000	7	9	High
Brookings	1	$9,430,000	8	8	High
Walworth	1	$0	8	8	High
Beadle	2	$125,000	7	7	High
Custer	5	$4,556,000	6	4	High
Clay	1	$250,000	6	8	High
Hughes	1	$0	7	7	High
Lake	1	$1,560,000	7	7	High
Tripp	2	$740,000	6	6	High
Oglala Lakota	3	$611,000	5	5	High
Charles Mix	2	$4,721,000	6	5	High
Bon Homme	2	$425,000	5	6	High
Roberts	1	$0	6	6	High
Hamlin	1	$0	5	6	High
Hutchinson	1	$7,391,000	6	5	High
Moody	1	$1,675,000	5	6	High
Grant	1	$0	5	6	High
Fall River	3	$2,713,250	5	3	High
Butte	2	$4,532,000	5	4	High
Todd	2	$573,000	4	5	High
Union	1	$581,000	5	5	High
Spink	2	$0	5	3	Moderate

County	Prior Event Rating	Total Cumulative Damage ($)	Building Exposure Rating	Population Density Rating	Vulnerability Rating
Day	1	$0	5	4	Moderate
Marshall	1	$0	4	5	Moderate
Kingsbury	1	$3,506,000	5	4	Moderate
Deuel	1	$0	4	5	Moderate
Hand	3	$0	4	2	Moderate
Edmunds	2	$0	4	3	Moderate
Gregory	2	$4,960,000	4	3	Moderate
Clark	2	$0	4	3	Moderate
Brule	1	$7,140,000	4	4	Moderate
Hanson	1	$65,000	3	5	Moderate
Douglas	1	$1,275,000	3	5	Moderate
McPherson	1	$0	4	3	Moderate
Dewey	2	$0	3	2	Moderate
Lyman	2	$0	3	2	Moderate
Bennett	2	$2,087,000	2	3	Moderate
McCook	1	$135,000	3	3	Moderate
Aurora	1	$366,000	3	3	Moderate
Sanborn	1	$2,747,000	3	3	Moderate
Corson	3	$0	2	1	Moderate
Perkins	2	$2,051,000	3	1	Moderate
Haakon	2	$1,605,000	3	1	Moderate
Faulk	1	$0	3	2	Moderate
Stanley	1	$0	3	2	Moderate
Jerauld	1	$2,285,000	2	3	Moderate
Potter	1	$0	3	2	Moderate
Miner	1	$110,000	2	3	Moderate
Harding	3	$250,500	1	1	Moderate
Jackson	2	$1,127,500	2	1	Moderate
Campbell	1	$0	2	2	Moderate
Buffalo	1	$0	1	3	Moderate
Yankton	2	$17,270,000	1	1	Moderate
Sully	1	$0	2	1	Moderate
Hyde	1	$0	2	1	Moderate
Mellette	1	$170,500	1	1	Moderate
Jones	1	$0	1	1	Moderate
Ziebach	2	$751,000	1	1	Moderate

South Dakota's data was obtained from the Risk Management Agency's indemnity reports for 2003 through 2016. The average annual crop damage statewide was $2,138,750 between January 1, 1996 and May 30, 2016 for Hail; total crop damage $42,775,000.

Future vulnerability

Many counties in South Dakota have seen an increase in population growth and development pressures. Pennington and Codington counties identified population growth and construction of new homes in their local plans. Lincoln experienced the greatest population gain from 2000 – 2014 of all the counties in South Dakota. Campbell experienced the greatest population loss from 2000 – 2014. Minnehaha, Pennington, Union, Brookings, and Custer counties have increased their population and development by more than 15% since 2000. Climate change is predicted to increase both the occurrence and intensity of summer storms. As these counties continue to grow, the increase in population and development exposed to these summer storm events will likely increase their vulnerability to the hazard. The agricultural industry, which is one of the state's primary industries will continue to be vulnerable to hail events. Counties that are particularly dependent economically on crops or livestock will have high vulnerability to this type of hazard event. (See agricultural pests and diseases vulnerability discussion).

Table 3-52 Summer Storms Consequence Table

Category	Narrative
Impact on the Public	Exposure risks to motorists, outdoor workers, homeless persons, general public; risk to persons with energy dependent medical needs and pre-existing medical conditions.
Impact on the Economic Condition of the State	Potential loss of facilities or infrastructure function or accessibility and uninsured.
Impact on the Environment	Tree and vegetation damage, crop damage; animal impacts.
Impact on Property, Facilities, and Infrastructure	Buildings, equipment, and utility infrastructure are exposed to heavy hail, sometimes complicated by strong winds; transportation system impacts; possibility of roof damage; potential power loss and strain on energy systems.
Impact on the Public Confidence in Government	High expectations of government capabilities for reducing impact of hail events related to transportation.
Impact on Responders	Exposure risks; adverse working conditions.
Impact on Continuity of Operations	Potential loss of facilities or infrastructure function; potential loss of ability or accessibility to provide services; possible power interruption; transportation system impacts.
Cascading Hazards	Floods

3.3.8 Winter Storms

Methodology

All counties in South Dakota are vulnerable to winter storms. To assess the relative vulnerability of each of South Dakota's counties to winter storms, the state assigned ratings to three factors that were examined at the county level: prior events, building exposure, and population density. Ratings were applied to each factor and summed to obtain overall vulnerability scores for each county to allow comparison for greatest relative vulnerability. The methodology is further detailed in Appendix 3D Vulnerability Methodology.

This methodology assumes that the more developed areas, represented by greater building values and higher population densities, will generally have greater costs for snow removal and functional downtime as a result of loss of utility services. The more developed areas may have the capacity to absorb those costs more than the rural areas, so in terms of loss ratio (ratio of the losses to the total inventory in the

county) the rural areas are potentially more vulnerable. This is difficult to measure without good historical damage data and is a limitation of this vulnerability assessment.

Total Winter Storm Vulnerability and Estimate of Potential Loss

According to this methodology, while every county in South Dakota is vulnerable to winter storms, Brookings, Brown, Davison, Lake, Lincoln, Meade, Minnehaha, and Pennington were rated with a "Very High" Vulnerability Ranking. Figure 3-59 illustrates the vulnerability of South Dakota counties to winter storms, and Table 3-53 lists all the South Dakota counties ranked by total winter storm vulnerability along with their three vulnerability factor ratings.

Figure 3-59 illustrates the vulnerability of South Dakota counties to winter storms, and Table 3-53 lists all the South Dakota counties ranked by total winter storm vulnerability along with their three vulnerability factor ratings. Figure 3-60 illustrates each county's vulnerability to winter storm and where various mitigation projects have been implemented.

To estimate potential losses to winter storms, historic loss data was analyzed. The NCEI data did not lend itself to county by county loss summaries, only a statewide summary. According to the NCEI, there were 1,943 winter storms (snow and ice events) in South Dakota between January 1993 and August 2016, and 82 extreme cold events from January 1994 to October 2016. Total property damage for these events is estimated at $210.5 million dollars. This suggests that South Dakota averages 59 winter storms and $6.4 million in winter storm losses annually, as well as 4.3 extreme cold events each year. 12 deaths and 127 injuries were attributed to these events. This suggests that South Dakota can expect approximately 1 death every other year and 6 injuries each year. Of these storms, 11 resulted in major disaster declarations. Based on the frequency of events, South Dakota averages one major disaster-level winter storm every year and a half.

If areas with the highest number of winter storm events are plotted on a map, it becomes immediately clear that some areas of the state have a higher occurrence rate than others. If counties with at least 50 events are plotted, the concentration of winter storms occurs primarily in the southeast corner of the state and in the Black Hills region, with a smaller occurrence in the far northeast corner. When these counties are narrowed to those with at least 60 events, the groupings of events is even clearer. This distribution corresponds to the areas of highest elevation (the Black Hills region) and the areas with the greatest moisture content (the southeast corner of the state, where terrain is peppered with lakes and streams.

Figure 3-59 Vulnerability of South Dakota Counties to Winter Storms with State Facilities

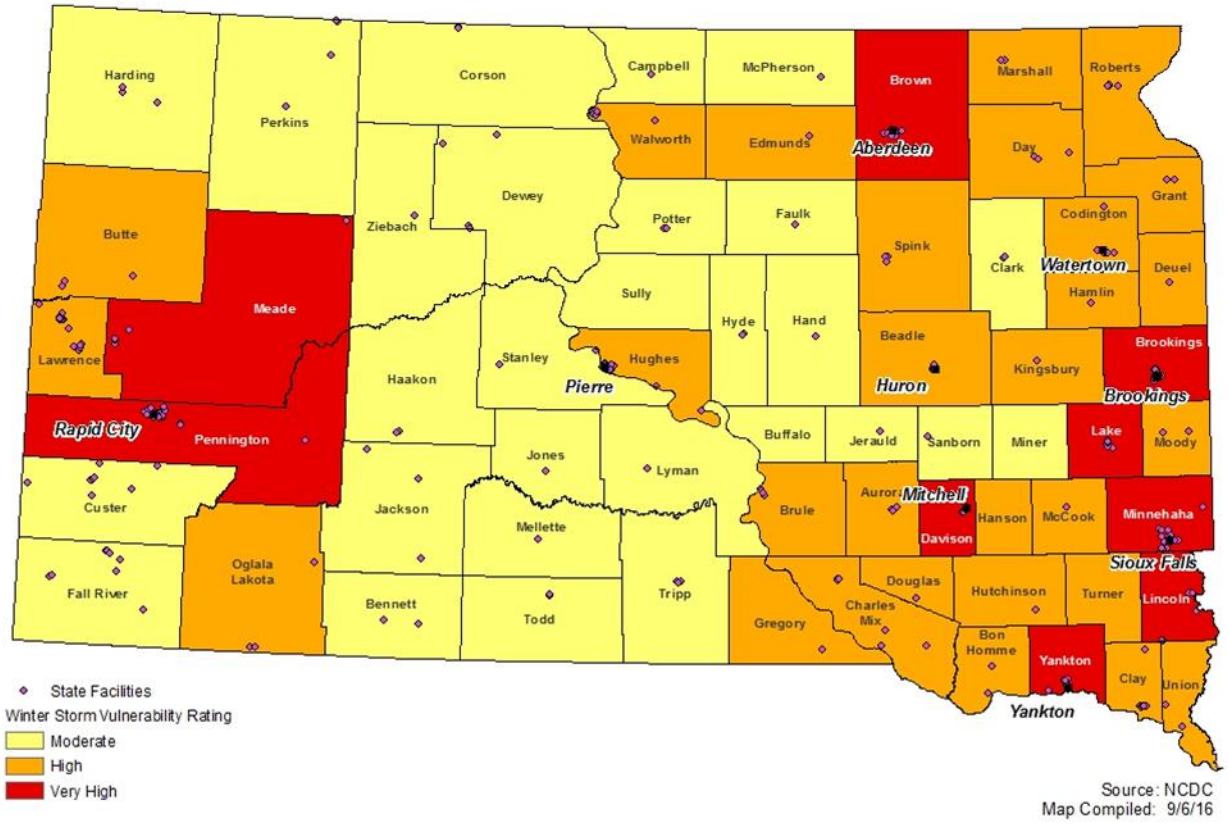


Figure 3-60 Vulnerability of South Dakota Counties to Winter Storms with Mitigation Projects

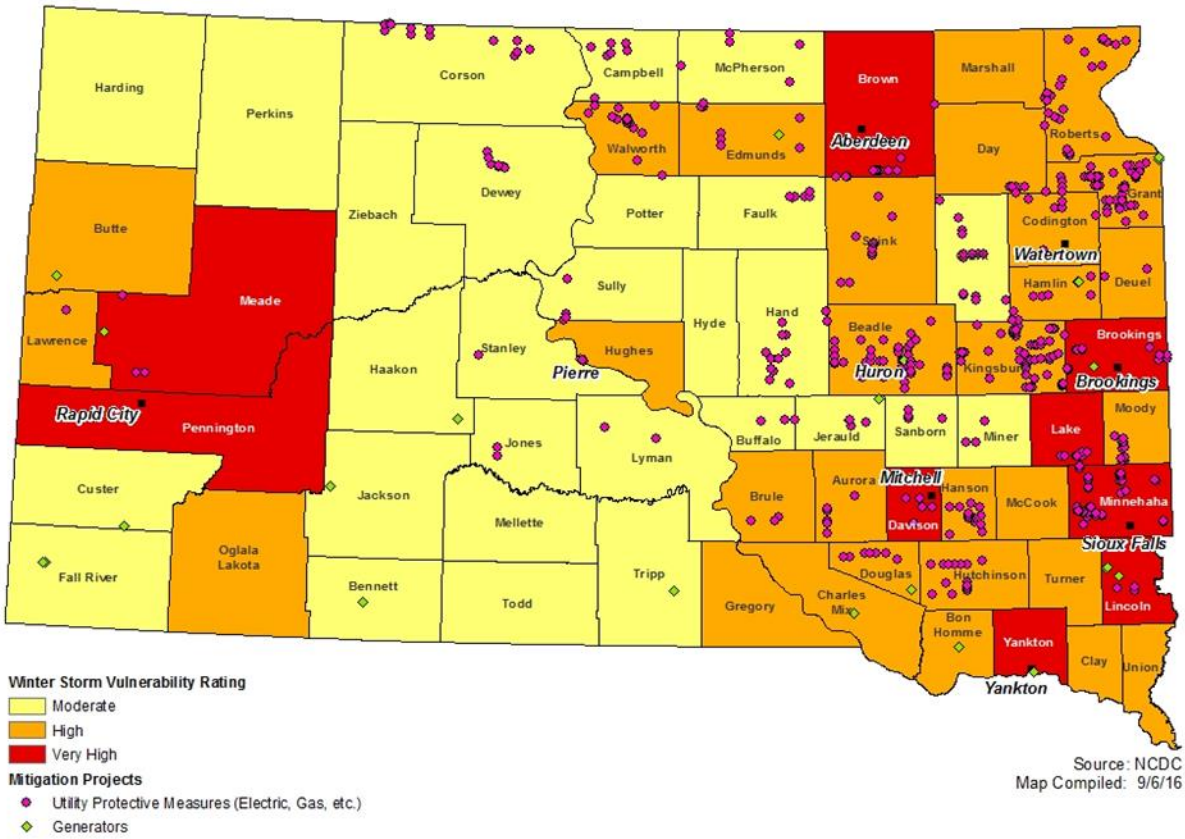


Table 3-53 Vulnerability of South Dakota Counties to Winter Storms (ranked by total vulnerability)

County	2016 Prior Event Rating	2016 Building Exposure Rating	2016 Pop Density Rating	Total Rating	New Rating
Brookings	7	8	8	23	Very High
Brown	5	8	8	21	Very High
Davison	6	7	9	22	Very High
Lake	7	7	7	21	Very High
Lincoln	6	9	9	24	Very High
Meade	10	7	5	22	Very High
Minnehaha	8	10	10	28	Very High
Pennington	4	10	8	22	Very High
Yankton	5	8	8	21	Very High
Aurora	6	3	3	12	High
Beadle	6	7	7	20	High
Bon Homme	6	5	6	17	High
Brule	6	4	4	14	High
Butte	6	5	4	15	High

County	2016 Prior Event Rating	2016 Building Exposure Rating	2016 Pop Density Rating	Total Rating	New Rating
Charles Mix	6	6	5	17	High
Clay	4	6	8	18	High
Codington	3	8	8	19	High
Day	5	5	4	14	High
Deuel	4	4	5	13	High
Douglas	5	3	5	13	High
Edmunds	5	4	3	12	High
Grant	5	5	6	16	High
Gregory	5	4	3	12	High
Hamlin	3	5	6	14	High
Hanson	6	3	5	14	High
Hughes	3	7	7	17	High
Hutchinson	7	6	5	18	High
Kingsbury	6	5	4	15	High
Lawrence	4	8	8	20	High
Marshall	6	4	5	15	High
McCook	7	3	3	13	High
Moody	6	5	6	17	High
Roberts	6	6	6	18	High
Oglala Lakota	3	5	5	13	High
Spink	5	5	3	13	High
Turner	7	6	6	19	High
Union	4	7	8	19	High
Walworth	3	5	5	13	High
Bennett	3	2	3	8	Moderate
Buffalo	2	1	3	6	Moderate
Campbell	2	2	2	6	Moderate
Clark	4	4	3	11	Moderate
Corson	3	2	1	6	Moderate
Custer	1	6	4	11	Moderate
Dewey	3	3	2	8	Moderate
Fall River	2	5	3	10	Moderate
Faulk	4	3	2	9	Moderate
Haakon	2	3	1	6	Moderate
Hand	4	4	2	10	Moderate
Harding	5	1	1	7	Moderate
Hyde	3	2	1	6	Moderate
Jackson	3	2	1	6	Moderate

County	2016 Prior Event Rating	2016 Building Exposure Rating	2016 Pop Density Rating	Total Rating	New Rating
Jerauld	6	2	3	11	Moderate
Jones	2	1	1	4	Moderate
Lyman	3	3	2	8	Moderate
McPherson	4	4	3	11	Moderate
Mellette	2	1	1	4	Moderate
Miner	6	2	3	11	Moderate
Perkins	4	3	1	8	Moderate
Potter	4	3	2	9	Moderate
Sanborn	4	3	3	10	Moderate
Stanley	2	3	2	7	Moderate
Sully	3	2	1	6	Moderate
Todd	2	4	5	11	Moderate
Tripp	3	5	3	11	Moderate
Ziebach	3	1	1	5	Moderate

South Dakota's data was obtained from the Risk Management Agency's indemnity reports for 2003 through 2016. The Risk Management Agency identifies several causes of loss related to extreme cold and winter weather, including cold winter, freeze, and frost. The Risk Management Agency has an "other" category that includes snow-lightning, etc., but it is not possible to determine which losses in this category resulted specifically from snow. South Dakota received $29,613,025 in indemnities from winter weather-related in 2015, $16,074,436 in 2014, $17,021,180 hazards in 2013, $4,304,101 in 2012, $4,521,931 in 2011, and $1,050,838 in 2010. This averages out to $12,097,585 in winter weather-related indemnities each year.

The USDA produced a "Cattle Death Loss" report in 2011 which detailed the number of cattle and calves lost to various causes (predator and non-predator) in each state in 2010. A total of 68,000 head of cattle and 90,000 calves died in South Dakota in 2010. 13.1% (890 head) of cattle losses and 36.8% (33,120 head) of calf losses were attributed to weather. The total value of the animals in South Dakota in 2010 was $1,133 per head for cattle and $381 per head for calves. Thus, the state's cattle industry suffered $13,627,090 in weather-related losses that year.

Future Vulnerability

Every county in the state is at moderate to high risk of winter storms. Despite this risk and high probability of future occurrences of a winter storm, the vulnerability to future winter storms is not likely to increase. Every county at high risk of exposure to winter storm events has implemented mitigation projects (Refer to Figure 3-60) to address their risk and decrease their vulnerability winter storms. The agricultural industry will also continue to be vulnerable to winter storms. Counties that are particularly dependent economically on crops or livestock will have a higher vulnerability to the effects of a winter storm event.

Table 3-54 Winter Storms Consequence Summary

Category	Narrative
Impact on the Public	Exposure risks to motorists, outdoor workers, homeless persons, general public; risk to persons with energy dependent medical needs and pre-existing medical conditions.
Impact on the Economic Condition of the State	Potential loss of facilities or infrastructure function or accessibility and uninsured; impact to transportation sector and movement of goods, even if closures aren't in the state itself; lost revenue to decreased business patronage or inability of workers to reach employment locations.
Impact on the Environment	Tree and vegetation damage, crop damage; animal impacts.
Impact on Property, Facilities, and Infrastructure	Buildings, equipment, and utility infrastructure are exposed to heavy snow and ice, sometimes complicated by strong winds; transportation system impacts; possibility of roof collapse; potential power loss and strain on energy systems; frozen pipes; limited access to or ability to maintain operations of public transportation or access to transportation hubs.
Impact on the Public Confidence in Government	High expectations of government capabilities for reducing impact of snow and ice events related to transportation (roads, bridges, airports, rail); expectations for rapid power restoration.
Impact on Responders	Exposure risks; adverse working conditions; buried fire hydrants.
Impact on Continuity of Operations	Potential loss of facilities or infrastructure function; potential loss of ability or accessibility to provide services; possible power interruption; transportation system impacts.
Cascading Hazards	Floods

3.3.9 Wildfire

Methodology

The vulnerability analysis involved the use of GIS to quantify the population and buildings at risk within wildfire risk zones. The best available data for wildfire risk was the wildland- urban interface/intermix data from the SILVIS Lab at the University of Wisconsin–Madison mentioned previously in the wildfire hazard profile. The SILVIS data is classified into 13 categories, based on 2010 Census housing unit density and percent of vegetation in the area. In both interface and intermix communities, housing must meet or exceed a minimum density of one structure per 40 acres. Intermix communities are areas where housing and vegetation intermingle, and vegetation exceeds 50 percent. Interface communities are areas with housing in the vicinity of contiguous vegetation, have less than 50 percent vegetation, and are within 1.5 miles of an area that exceeds 1,325 acres and are more than 75 percent vegetated. For the purposes of this plan these areas were further classified into High, Moderate, and Low risk threat zones as follows:

High Risk Threat Zone (areas of various housing unit density within areas of high vegetation)

- High Density Intermix
- Medium Density Intermix
- High Density Interface

Moderate Risk Threat Zone (areas of lower housing unit density within areas of high vegetation)

- Medium Density Interface
- Low Density Intermix

Low Risk Threat Zone (either no vegetation, or no housing density)

- Low Density Interface
- High Density No Vegetation

- Medium Density No Vegetation
- Wildland Intermix
- Uninhabited Vegetation
- Uninhabited No Vegetation
- Low Density No Vegetation
- Wildland No Vegetation

The SILVIS Census Blocks that met the High or Moderate Risk Threat Zone definitions above were selected within GIS and are represented on Figure 3-61. The total population and number of housing units within each zone was summarized by county, based on 2010 Census Block data included in the SILVIS data set. The results are shown in Table 3-55. The analysis shows 212,659 persons and 98,378 housing units exposed in the high and moderate threat zones. Pennington County has the highest building and population exposure by far compared to the other counties, followed by Lawrence, Meade, Hughes, Custer and Butte. To estimate losses an exposure analysis was used based on applying an average home value for each county (based on 2010 Census median home value) multiplied by the number of housing units at risk. For the purposes of estimating potential loss, the total replacement value is used as well as an estimate of contents (based on Hazus occupancy class content estimate standards), as catastrophic fires tend to result in total loss of the structure. The total property exposed based on this methodology is $6 Billion in structures and $18 Billion including structure and contents. It is very unlikely that a wildfire would result in loss of all the structures potentially at risk within a given county, but the results provide an indication of where the highest losses from a fire in the Interface or Intermix areas could occur.

Table 3-55 WUI Exposure

County	Total Population	Total Housing Units	2010 Census Median Home Value ($)	2010 Medium Home Value*Housing Units ($)	Contents Replacement Value ($)	Total Replacement Value ($)
Aurora	-	-	-	-	-	-
Beadle	138	82	83,400	$6,838,800	$3,419,400	$10,258,200
Bennett	1,669	597	60,200	$35,929,818	$17,964,909	$53,894,727
Bon Homme	851	506	67,700	$34,256,200	$17,128,100	$51,384,300
Brookings	494	282	$138,300	$39,000,600	$19,500,300	$58,500,900
Brown	125	71	$115,700	$8,214,700	$4,107,350	$12,322,050
Brule	2,262	1,091	$87,300	$95,221,556	$47,610,778	$142,832,335
Buffalo	1,071	299	$67,500	$20,182,500	$10,091,250	$30,273,750
Butte	7,335	3,333	$114,300	$380,927,373	$190,463,687	$571,391,060
Campbell	748	554	$40,600	$22,492,400	$11,246,200	$33,738,600
Charles Mix	376	199	$67,700	$13,472,300	$6,736,150	$20,208,450
Clark	197	104	$64,500	$6,708,000	$3,354,000	$10,062,000
Clay	100	54	$116,900	$6,312,600	$3,156,300	$9,468,900
Codington	828	361	$131,000	$47,291,000	$23,645,500	$70,936,500
Corson	2,054	741	$45,900	$34,011,900	$17,005,950	$51,017,850
Custer	6,340	3,578	$160,700	$574,984,600	$287,492,300	$862,476,900
Davison	661	277	$108,800	$30,137,600	$15,068,800	$45,206,400
Day	742	894	$64,800	$57,919,128	$28,959,564	$86,878,692

County	Total Population	Total Housing Units	2010 Census Median Home Value ($)	2010 Medium Home Value*Housing Units ($)	Contents Replacement Value ($)	Total Replacement Value ($)
Deuel	444	193	$87,200	$16,812,339	$8,406,170	$25,218,509
Dewey	3,284	1,187	$56,900	$67,540,300	$33,770,150	$101,310,450
Douglas	10	4	$58,300	$233,200	$116,600	$349,800
Edmunds	618	324	$70,300	$22,777,200	$11,388,600	$34,165,800
Fall River	5,264	3,174	$86,800	$275,503,200	$137,751,600	$413,254,800
Faulk	788	485	$51,300	$24,880,500	$12,440,250	$37,320,750
Grant	233	121	$99,800	$12,123,280	$6,061,640	$18,184,920
Gregory	2,278	1,407	$56,100	$78,921,613	$39,460,807	$118,382,420
Haakon	1,013	558	$74,800	$41,738,400	$20,869,200	$62,607,600
Hamlin	173	76	$83,700	$6,361,200	$3,180,600	$9,541,800
Hand	98	72	$74,900	$5,392,800	$2,696,400	$8,089,200
Hanson	77	24	$87,300	$2,095,200	$1,047,600	$3,142,800
Harding	385	261	$67,000	$17,487,000	$8,743,500	$26,230,500
Hughes	14,059	6,485	$133,200	$863,839,923	$431,919,962	$1,295,759,885
Hutchinson	22	14	$68,700	$961,800	$480,900	$1,442,700
Hyde	776	385	$66,600	$25,641,000	$12,820,500	$38,461,500
Jackson	1,791	660	$54,600	$36,036,000	$18,018,000	$54,054,000
Jerauld	71	43	$62,200	$2,674,600	$1,337,300	$4,011,900
Jones	629	373	$75,000	$27,975,000	$13,987,500	$41,962,500
Kingsbury	82	59	$70,300	$4,147,700	$2,073,850	$6,221,550
Lake	203	80	$108,800	$8,704,000	$4,352,000	$13,056,000
Lawrence	20,958	11,355	$155,100	$1,761,160,500	$880,580,250	$2,641,740,750
Lincoln	101	53	$169,700	$8,994,100	$4,497,050	$13,491,150
Lyman	2,280	1,034	$64,900	$67,106,600	$33,553,300	$100,659,900
Marshall	205	472	$81,700	$38,562,400	$19,281,200	$57,843,600
McCook	50	19	$91,900	$1,746,100	$873,050	$2,619,150
McPherson	824	653	$45,100	$29,450,300	$14,725,150	$44,175,450
Meade	20,512	9,013	$145,800	$1,314,095,400	$657,047,700	$1,971,143,100
Mellette	1,200	465	$49,800	$23,157,000	$11,578,500	$34,735,500
Miner	-	-	-	-	-	-
Minnehaha	899	329	$144,900	$47,672,100	$23,836,050	$71,508,150
Moody	66	26	$102,800	$2,672,800	$1,336,400	$4,009,200
Oglala Lakota	8,334	2,054	$18,600	$38,204,400	$19,102,200	$57,306,600
Pennington	78,815	34,905	$149,700	$5,225,253,054	$2,612,626,527	$7,837,879,581
Perkins	19	11	$50,800	$558,800	$279,400	$838,200
Potter	502	516	$55,600	$28,681,869	$14,340,935	$43,022,804

County	Total Population	Total Housing Units	2010 Census Median Home Value ($)	2010 Medium Home Value*Housing Units ($)	Contents Replacement Value ($)	Total Replacement Value ($)
Roberts	964	415	$73,200	$30,378,000	$15,189,000	$45,567,000
Sanborn	104	52	$62,700	$3,260,400	$1,630,200	$4,890,600
Spink	119	53	$62,700	$3,323,100	$1,661,550	$4,984,650
Stanley	2,161	995	$113,700	$113,131,500	$56,565,750	$169,697,250
Sully	153	88	$72,200	$6,353,600	$3,176,800	$9,530,400
Todd	5,898	1,862	$53,800	$100,175,600	$50,087,800	$150,263,400
Tripp	1,313	707	$69,400	$49,093,265	$24,546,633	$73,639,898
Turner	47	18	$85,600	$1,540,800	$770,400	$2,311,200
Union	2,392	1,059	$132,200	$140,049,081	$70,024,541	$210,073,622
Walworth	4,528	2,525	$62,500	$157,791,465	$78,895,732	$236,687,197
Yankton	752	388	$115,500	$44,814,000	$22,407,000	$67,221,000
Ziebach	1,176	304	$62,200	$18,903,145	$9,451,573	$28,354,718
Totals	212,659	98,378	$5,337,800	$12,205,037,912	$6,105,938,356	$18,317,815,068

Forest fires are of longer duration due to the heavy fuels and resistance to control efforts. Fires in forested areas have the potential to do significant damage to homes and property. These fires generally cost more to suppress than prairie fires. Prairie fires tend to stress local response resources and can quickly damage livestock grazing areas. Damage to agricultural resources is very dependent on when the fire occurs, with the early season March and April fires easier to recover from. Research yielded little information on agricultural losses due to wildfire. RMA indemnities data for 2010, 2011, and 2012 only showed fire-related losses in 2011. Total fire-related indemnities for that year were $126,230. While historic loss data was limited on agricultural losses from fires this information may be collected in future updates from sources that might include the Farm Services Agency, Risk Management Agency, State Department of Agriculture, or South Dakota State University.

Additional vulnerability data was obtained from individual county Community Wildfire Protection Plans (CWPPs) where possible. A digital copy of Fall River County's CWPP was reviewed for the 2013 plan update. The Fall River County CWPP identified 3,918 structures in the County with an assessed value of roughly $388 million as of 2008. 523 structures with an assessed value of $6.8 million were located in the Black Hills Forest Fire Protection District. Lawrence, Meade, Pennington, and Perkins counties also provided digital CWPPs but did not provide estimates of assessed property values at risk to wildfire. Other jurisdictions that have completed CWPPs in the state include Butte, Custer, and Stanley counties and Rapid City. South Dakota's numerous recreational, historical, archaeological, and paleontological sites are also vulnerable to wildfire events.

Factors That Affect Vulnerability to Wildfires

South Dakota's vulnerability to wildfires is influenced by several factors. These factors may not affect all counties in the same way.

Fuels

Fuels in South Dakota are generally conducive to high rates of spread, represented by National Fire Danger Rating System fuel models "G", "L," "K," and "C." Grass predominates in the broad valley bottoms. Ponderosa Pine grows on all aspects, and extensive pure forests of Ponderosa grow in the Black Hills. Mixed grass and timber stands occur in many areas depending on aspect.

Fuel density in the Black Hills is greater today than in the past. When wildfires occur in high density fuel loads under dry, warm, and windy conditions, they will frequently develop into uncontrollable crown fires that destroy the forest and any homes within it. Fuel loading is lightest in the southern Black Hills and heaviest in the northern Black Hills.

Topography

The Black Hills are an outcropping of the Rocky Mountains, lying in an ellipse 100 miles long and 50 miles wide along the state's western edge. In the Black Hills, terrain varies from broad, open valleys; rolling topography; mountainous terrain up to 7,242 feet in elevation; and steep, narrow canyons. The topography in the Black Hills is conducive to rapid wildfire spread. Fires spread faster on steep slopes as the heat from the flames is closer to the next fuel source.

Beetle and Insect Infestation

Mountain pine beetle infestations often coincide with drought, which weakens trees. When the beetle population is very low only stressed or weakened trees, such as those struck by lightning, are colonized. However, approximately every ten years the beetle population increases, and the beetles begin colonizing healthy trees as well. These circumstances have been common throughout the Black Hills and have allowed a mountain pine beetle infestation to become epidemic. The Custer State Park area around Harney Peak, and the Norbeck Wildlife Preserve adjacent to Mount Rushmore has extremely high fuel loading due to Mountain Pine Beetle outbreaks. The South Dakota Department of Agriculture (SDDA) reported in 2012 that the mountain pine beetle population had reached epidemic proportions. SDDA published a Black Hills Regional Mountain Pine Beetle Strategy (2012) which proposed mitigation strategies for reducing the population to endemic levels over the course of several years.

Climate and Weather

During the summer months, temperatures are often in the 90s with relative humidity in the teens. Temperatures may climb into the low 100s, though this is rare in South Dakota. The average annual precipitation is approximately 17.5 inches, with the East River generally receiving more precipitation than West River. Some of this precipitation is associated with thunderstorms that bring lightning during the fire season.

Lightning fires burn more acreage than human-caused fires, in part, because 1) multiple lightning fire ignitions often occur at the same time; 2) lightning fires can occur throughout the protection area, while most human-caused fires occur in accessible areas; 3) people often detect and report human-caused fires quickly due to their proximity to inhabited areas; and 4) lightning producing thunderstorms typically occur during the hottest portion of the fire season, while many human-caused fires start during spring or fall. When combined with drought, these conditions can create devastating wildfires.

Climate change may also affect wildfire risk and magnitude in the future. Longer, hotter summers deplete moisture in soils and vegetation. Beetles and other insects favor drier conditions that weaken trees and make them more vulnerable to infestation. Water supply for vegetation and fire suppression may also decrease as snowpack melts earlier and precipitation declines and evaporates more rapidly. Climate

change is also believed to increase the severity of thunderstorms, leading to more lightning strikes that can ignite fires.

Growth and Development Trends

Wildfires destroy hundreds of structures throughout the western United States every year. These fires can and will occur anywhere that humans and their development meet or intermix with wildland fuels. This wildland-urban interface fire problem exists in every state, including South Dakota, and worsens each year. People continue to develop residential properties in fire-prone environments, increasingly exposing themselves and their personal property to the risks of wildfire. An increase in population in the WUI also means more potential ignition sources. People may accidentally start forest or rangeland fires when using farming equipment, camping, or burning trash on their properties.

Estimating Potential Losses

Fire Response Expenditures

Drought can create conditions for more numerous and intense fires that quickly overwhelm local and state capacities for fire suppression. Generally, large wildfires make up a small portion of total fire occurrences in any given year but account for the greatest portion of suppression costs. Expenses can also be driven up by atypically large numbers of moderate or small fires that drain resources. Table 3-56 summarizes South Dakota's fire suppression costs from 1994 to 2018. State fire suppression costs have totaled $54,956,928 in the past 24 years. This averages as $2,289,872 annually per year and does not include losses to structures, forests, utilities, etc. Note that the amount of financial support was not known for every event. Within that 24-year time period, the highest suppression costs occurred in 2002, 2006, 2007, and 2012; each of these years coincided with a drought. The fire suppression costs for these years was orders of magnitude greater than that of wet years, such as 2010. In addition, in response to the drought year 2006, the South Dakota Legislature passed a law that was enacted to allow the use of the state Fire Suppression Fund to pay for responding and managing large wildfire activity in the prairie regions of the state. This can drive up fire fund expenditures in future years. (Source, SDCL 41-20A-8.)

Table 3-56 State Fire Suppression Costs by Year, 1994-2018

Year	State Fire Suppression Costs
2018	$943,237
2017	$3,055,336
2016	$3,004,592
2015	$1,196,440
2014	$454,641
2013	$893,262
2012*	$8,493,171
2011	$1,789,511
2010	$801,405
2009	$525,343
2008	$938,134
2007*	$7,686,640
2006*	$6,026,422

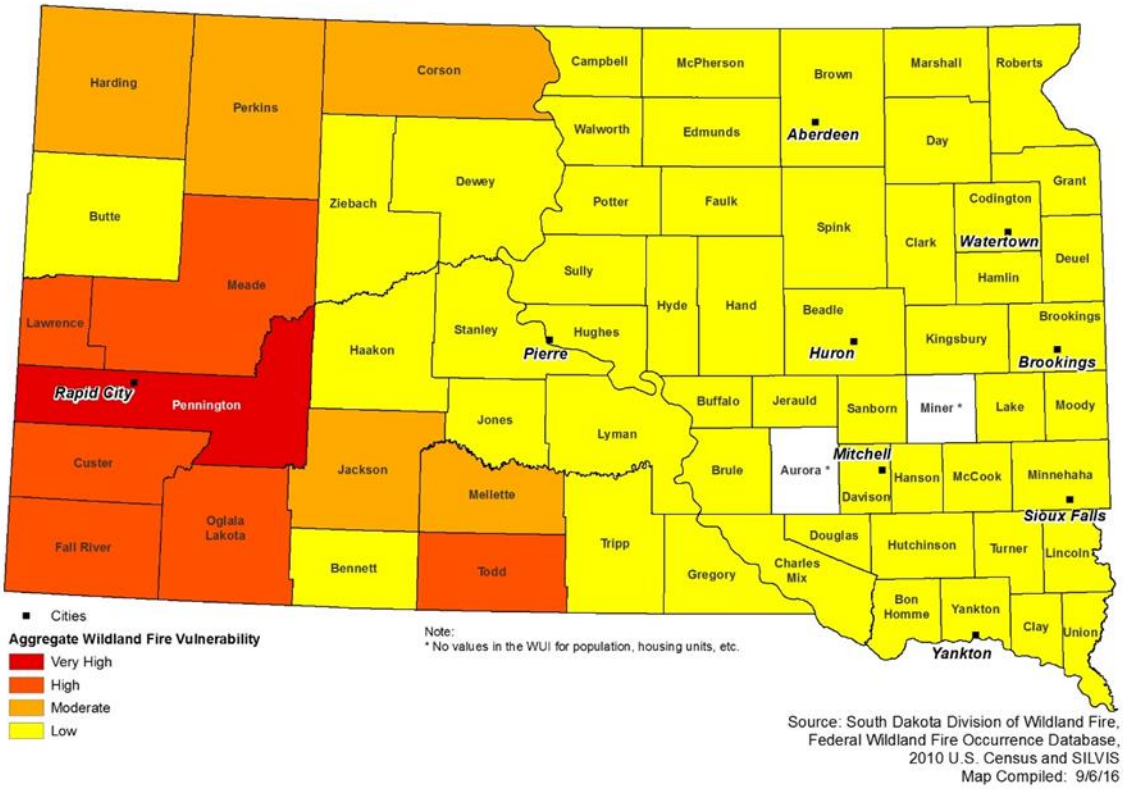
Year	State Fire Suppression Costs
2005	$2,127,925
2004	$1,009,829
2003	$1,599,697
2002*	$9,444,193
2001	$2,025,028
2000	$1,510,648
1999	$191,441
1998	$135,301
1997	$149,239
1996	$307,694
1995	$258,766
1994	$389,033
Total	$54,956,928

Source: South Dakota Department of Agriculture, 2018;
*Drought year

Exposure, Values at Risk, and Number and Magnitude of Reported Fires by County

An analysis of areas of the state that are most vulnerable to the impacts wildfire was conducted as an estimate of where wildfire would have the highest consequences. This analysis was completed based on several factors including the total replacement value of homes in the WUI, the total population in the WUI, the number of housing units, average annual number of historical fires at least 1,000 acres in size, and average annual burned acreage. The fire occurrence data used in the analysis ranges over a 56-year time span between 1959 and 2015. Each of these factors was assigned a numerical value between 1 and 4, with 1 representing low values and 4 representing high values. The score for each factor was added to obtain a total numerical value for each county. The highest scores indicated the highest vulnerability to wildfire. Pennington County has the highest overall vulnerability to wildfire. Lawrence, Meade, Custer, Fall River, Oglala Lakota, and Todd counties were ranked in the second highest vulnerability. Harding, Perkins, Corson, Jackson, and Mellette counties were ranked at moderate vulnerability. The data indicated that Aurora and Miner counties did not have any population or structures at risk in the WUI, nor did they have any previous fire occurrences.

Figure 3-61 Aggregate Wildland Fire Vulnerability



Summary of Economic Impacts

Based on the previous analysis over the past 21 years, fire suppression costs in South Dakota have averaged $2,226,539 million annually. Drought has undoubtedly exacerbated the magnitude and frequency of fires in the state, leading to higher fire suppression costs. Wildfire also impacts tourism revenue and can have a more direct impact on visitation than drought alone. This is discussed in more detail in the Tourism Sector vulnerability assessment of the South Dakota Drought Mitigation Plan.

Future Vulnerability

Many counties have experienced an increase in population and resulting development pressures. Counties in the Black Hills region that are at a higher risk of wildfire exposure than counties east of the Missouri River have felt these development pressures. Pennington, Custer, and Meade counties have seen an increase in the development of subdivisions and residential properties within the WUI in their jurisdictional boundaries as well as surrounding communities. In addition to the increased growth in the WUI, climate change is expected to increase the fire risk for the state by 10-30%, because of increased temperatures, increased likelihood of drought events, as well as the increased risk to beetle and insect infestations. Due to these factors, future vulnerability to wildfire events is likely to increase. The implementation of mitigation projects such as educating homeowners on how to protect their property, or the implementation of development standards and regulations related to wildfire mitigation, will help the state's population and infrastructure be better protected when a wildfire event does occur.

Table 3-57 Wildfire Consequence Table

Category	Narrative
Impact on the Public	Staff, recreationists, campers, property owners in remote areas or the wildland urban interface areas, and persons with breathing difficulties may at risk to injury or death; secondary impacts may negatively affect water quality and downstream water users.
Impact on the Economic Condition of the State	Potential loss of facilities or infrastructure; potential impact to tourism and land development activities depending on severity of the fire season and location of fire events. Depending on nature of area where fire occurs, many home based businesses will be impacted due to evacuation, lack of utility service, or through destruction of property. State fire suppression and management costs average $2M annually.
Impact on the Environment	Significant impact related to loss of forest or grasslands, impacts to water quality; erosion and sedimentation may affect critical infrastructure and natural waterways. Loss of ground vegetation may encourage landslides, mudslides, or other geologic movement of land. Dead or damaged trees are at risk of falling.
Impact on Property, Facilities, and Infrastructure	Vulnerabilities in wildland urban interface areas include critical infrastructure, facilities, properties, equipment, vehicles, and communications and utility infrastructure.
Impact on the Public Confidence in Government	Ability to respond and recover may be questioned and challenged if planning, response, and recovery is not timely and effective. Coordinated warning and evacuation is essential.
Impact on Responders	Exposure exists to response personnel performing routine duties when event occurs; fire event - related duties may cause significant danger to response personnel including evacuation, suppression, law enforcement, and damage assessment. Local, state and federal fire management personnel involved in firefighting at risk to injury and death.
Impact on Continuity of Operations	Potential loss of facilities or infrastructure function or accessibility or ability to provide services. Power interruption is likely if not adequately equipped with backup generation.
Cascading Hazards	Landslides, Floods

3.3.10 Drought

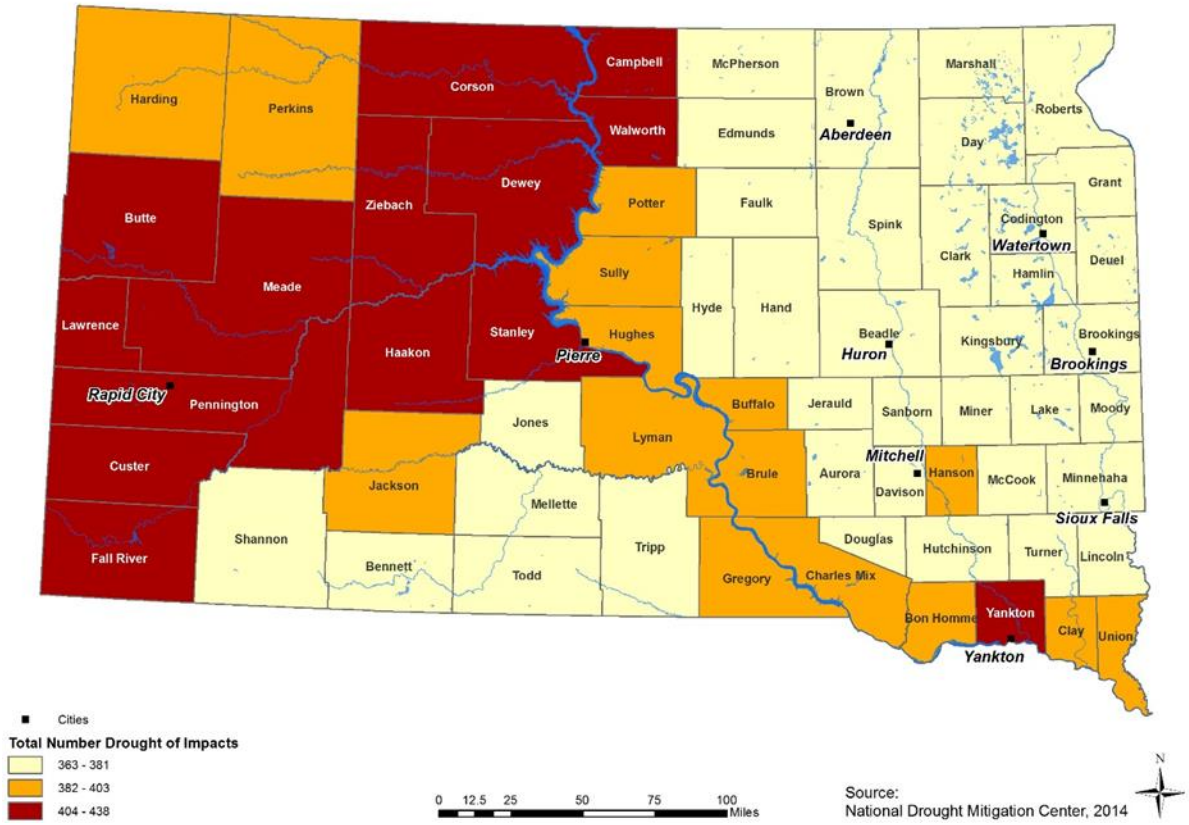
As discussed in the profile, the entire State of South Dakota is vulnerable to drought, but in different ways. A summary of impacts from the Drought Impact Reporter completed during the development of the South Dakota Drought Mitigation Plan indicates that all counties are vulnerable.

Figure 3-62 shows reported total drought impacts for all South Dakota counties from 1980 to May 2015 in the following impact categories:

- Agriculture
- Business & Industry
- Energy
- Fire
- Plants & Wildlife
- Relief, Response & Restrictions
- Society & Public Health
- Tourism & Recreation
- Water Supply & Quality

Those counties shown with a higher number of impacts include recreational areas such as the "Great Lakes" Missouri River corridor and Black Hills Regions. In addition to agriculture impacts these areas could suffer from lowered lakes levels impacting boating and fishing activities and associated revenue.

Figure 3-62 Drought Impact Reporter for South Dakota (January 1980-May 2015)



Source: South Dakota Drought Mitigation Plan 2015

Drought takes a particularly heavy toll on agriculture due to crop losses from lack of moisture. Farmers often protect themselves from the effects of drought by insuring all or a portion of their crop against drought losses. This is done through multi-peril crop insurance, which is underwritten by The Risk Management Agency. The Risk Management Agency, part of the USDA, maintains a database of crop insurance claims. Table 3-58 shows the crop losses due to drought in one of the most recent and severe periods of statewide drought, which occurred in 2002. Drought-related crop losses that year totaled $294,625,661. Data for 2002 is compared to that of 2012, both significantly dry years in South Dakota. In 2012 drought-related crop losses totaled $838,876,036, nearly three times as much as the losses in 2002. The drought in 2012 was particularly worse for some counties, notably Hutchinson, Bon Homme, Charles Mix, Lincoln, and McCook. In 2013, the drought-related crop losses totaled $232,648,444. In 2014, the losses totaled $20,902,831 and in 2015, the losses totaled $48,005,987.

Table 3-58 South Dakota Crop Loss Due to Drought: 2002 and 2012

County	2002 Indemnities ($)	2012 Indemnities ($)
Aurora	$9,981,468	$20,312,297
Beadle	$16,888,079	$15,920,978
Bennett	$3,031,438	$2,547,781

County	2002 Indemnities ($)	2012 Indemnities ($)
Bon Homme	$6,868,510	$53,074,783
Brookings	$387,848	$4,652,860
Brown	$3,492,269	$3,867,983
Brule	$10,078,871	$11,189,445
Buffalo	$3,093,701	$5,442,786
Butte	$570,113	$568,080
Campbell	$3,352,881	$1,639,784
Charles Mix	$14,953,511	$52,741,118
Clark	$4,452,317	$6,613,557
Clay	$1,250,351	$37,583,767
Codington	$1,394,286	$6,544,813
Corson	$4,422,324	$3,837,987
Custer	$309,970	$617,713
Davison	$7,885,578	$25,309,304
Day	$979,621	$2,046,009
Deuel	$371,275	$3,268,970
Dewey	$2,612,684	$1,718,676
Douglas	$5,463,319	$32,805,118
Edmunds	$5,121,562	$3,333,600
Fall River	$319,562	$1,659,373
Faulk	$3,245,911	$3,244,005
Grant	$218,744	$3,096,120
Gregory	$4,700,874	$13,427,341
Haakon	$4,439,525	$5,317,145
Hamlin	$347,794	$5,296,778
Hand	$12,896,771	$7,447,056
Hanson	$3,298,202	$26,245,752
Harding	$3,402,141	$1,841,929
Hughes	$9,941,061	$5,915,209
Hutchinson	$9,758,512	$94,572,548
Hyde	$8,411,019	$4,555,116
Jackson	$2,546,546	$1,749,899
Jerauld	$5,164,721	$3,543,515
Jones	$2,182,334	$2,660,595
Kingsbury	$4,896,508	$4,912,931
Lake	$1,167,346	$3,646,413
Lawrence	$19,545	$83,794
Lincoln	$139,801	$55,931,547
Lyman	$9,304,102	$9,970,739
McCook	$624,002	$45,295,473
McPherson	$4,624,314	$4,338,115
Marshall	$476,464	$1,021,099
Meade	$4,288,087	$4,512,961
Mellette	$1,187,891	$1,459,244
Miner	$3,799,930	$6,899,052
Minnehaha	$576,527	$29,759,062
Moody	$311,254	$2,742,224
Oglala Lakota	$1,188,991	$1,157,968
Pennington	$3,261,621	$3,339,429
Perkins	$8,077,696	$3,292,653

County	2002 Indemnities ($)	2012 Indemnities ($)
Potter	$13,821,626	$3,994,871
Roberts	$80,479	$880,552
Sanborn	$3,651,509	$5,650,254
Spink	$10,169,572	$8,827,121
Stanley	$4,749,540	$1,951,946
Sully	$18,609,676	$8,206,428
Todd	$978,776	$1,580,025
Tripp	$7,241,518	$15,736,702
Turner	$1,379,258	$56,652,120
Union	$131,241	$28,868,718
Walworth	$5,895,543	$781,254
Yankton	$3,498,560	$49,536,920
Ziebach	$2,638,591	$1,636,631
Total	$$294,625,661.00	$838,876,036

Source: Risk Management Agency Cause of Loss Historical Data Files

The South Dakota Drought Mitigation Plan analyzed agricultural areas of the state that are most vulnerable to the impacts of drought. The analysis was completed based on crop exposure as well as the crop loss data based on crop insurance payments. The drought-related crop insurance payments have been extrapolated to estimate damages to insurable crops that are not insured. This is based on the percent of insurable crops that are covered by crop insurance. Ninety-one percent of South Dakota's crops were insured in 2014. The crop exposure value from the 2012 Census of Agriculture is provided as the basis for the development of a loss ratio by county. The loss ratio is the average annualized losses divided by overall crop exposure. The higher the ratio the higher the vulnerability. Average annualized losses were obtained from Risk Management Agency historical crop indemnity data. The 2000-2014 indemnities related to drought were added together and then divided by 15 (for the 15-year time period from 2000 to 2014). Over the past 15 years, insured crop losses in South Dakota due to drought have averaged $189 million annually.[6]

Table 3-59 provides the annualized estimated crop losses by county due to drought. Figure 3-63 displays this data in a statewide thematic map. The vulnerability rank is based on the calculated crop damage ratio. Figure 3-64 displays this information in a color-coded statewide map. The map indicates a trend of higher vulnerability in the southeastern counties as well as most counties located west of the Missouri River.

Table 3-59 Crop Vulnerability Analysis to Drought

County Name	Crop Exposure Value (2012 Census of Agriculture)	Drought-Related Crop Insurance Paid (2000-2014)	Crop Damages (extrapolated based on 91% insured in 2014)	Annualized Crop Damages	Crop Damage Ratio (%)	Vulnerability Rank*
Aurora	$68,196,000	$60,107,074	$66,051,730	$4,403,449	6%	Moderate
Beadle	$190,063,000	$92,111,439	$101,221,362	$6,748,091	4%	Moderate
Bennett	$22,270,000	$17,758,157	$19,514,458	$1,300,964	6%	Moderate
Bon Homme	$41,325,000	$73,489,666	$80,757,875	$5,383,858	13%	Very High
Brookings	$162,340,000	$14,051,951	$15,441,704	$1,029,447	1%	Low
Brown	$462,905,000	$68,329,209	$75,087,042	$5,005,803	1%	Low
Brule	$76,953,000	$59,487,913	$65,371,333	$4,358,089	6%	Moderate

6 2015 Risk Management Agency data

County Name	Crop Exposure Value (2012 Census of Agriculture)	Drought-Related Crop Insurance Paid (2000-2014)	Crop Damages (extrapolated based on 91% insured in 2014)	Annualized Crop Damages	Crop Damage Ratio (%)	Vulnerability Rank*
Buffalo	$22,972,000	$20,227,215	$22,227,709	$1,481,847	6%	Moderate
Butte	$17,320,000	$3,737,033	$4,106,630	$273,775	2%	Low
Campbell	$62,126,000	$28,953,764	$31,817,323	$2,121,155	3%	Low
Charles Mix	$102,917,000	$111,016,981	$121,996,682	$8,133,112	8%	High
Clark	$159,568,000	$30,126,654	$33,106,213	$2,207,081	1%	Low
Clay	$79,678,000	$58,576,644	$64,369,939	$4,291,329	5%	Moderate
Codington	$108,293,000	$23,376,681	$25,688,661	$1,712,577	2%	Low
Corson	$59,621,000	$27,898,868	$30,658,096	$2,043,873	3%	Low
Custer	$2,871,000	$3,257,277	$3,579,425	$238,628	8%	High
Davison	$50,170,000	$57,768,651	$63,482,034	$4,232,136	8%	High
Day	$158,390,000	$18,397,556	$20,217,095	$1,347,806	1%	Low
Deuel	$93,232,000	$10,278,900	$11,295,495	$753,033	1%	Low
Dewey	$29,240,000	$18,302,602	$20,112,749	$1,340,850	5%	Moderate
Douglas	$41,558,000	$57,730,389	$63,439,988	$4,229,333	10%	Very High
Edmunds	$186,317,000	$66,231,491	$72,781,859	$4,852,124	3%	Low
Fall River	$6,474,000	$8,444,878	$9,280,086	$618,672	10%	Very High
Faulk	$156,409,000	$48,886,691	$53,721,639	$3,581,443	2%	Low
Grant	$135,881,000	$18,178,471	$19,976,341	$1,331,756	1%	Low
Gregory	$39,961,000	$34,859,827	$38,307,502	$2,553,833	6%	Moderate
Haakon	$33,129,000	$38,890,487	$42,736,799	$2,849,120	9%	High
Hamlin	$124,886,000	$12,122,384	$13,321,302	$888,087	1%	Low
Hand	$197,905,000	$60,871,887	$66,892,183	$4,459,479	2%	Low
Hanson	$67,135,000	$50,813,618	$55,839,141	$3,722,609	6%	Moderate
Harding	$17,114,000	$12,352,443	$13,574,113	$904,941	5%	Moderate
Hughes	$87,163,000	$51,862,163	$56,991,388	$3,799,426	4%	Moderate
Hutchinson	$71,342,000	$147,360,051	$161,934,122	$10,795,608	15%	Very High
Hyde	$63,078,000	$41,078,904	$45,141,652	$3,009,443	5%	Moderate
Jackson	$17,969,000	$16,808,952	$18,471,376	$1,231,425	7%	High
Jerauld	$62,010,000	$25,495,565	$28,017,104	$1,867,807	3%	Low
Jones	$40,121,000	$20,801,602	$22,858,903	$1,523,927	4%	Moderate
Kingsbury	$175,284,000	$36,624,897	$40,247,140	$2,683,143	2%	Low
Lake	$112,379,000	$10,578,149	$11,624,340	$774,956	1%	Low
Lawrence	$2,424,000	$279,496	$307,138	$20,476	1%	Low
Lincoln	$103,441,000	$79,528,376	$87,393,820	$5,826,255	6%	Moderate
Lyman	$95,031,000	$59,056,885	$64,897,676	$4,326,512	5%	Moderate
Marshall	$146,118,000	$14,962,187	$16,441,964	$1,096,131	1%	Low
McCook	$96,689,000	$65,847,210	$72,359,572	$4,823,971	5%	Moderate
McPherson	$84,627,000	$38,911,478	$42,759,866	$2,850,658	3%	Low
Meade	$25,425,000	$26,702,248	$29,343,130	$1,956,209	8%	High
Mellette	$13,929,000	$7,893,801	$8,674,507	$578,300	4%	Moderate
Miner	$74,947,000	$27,165,658	$29,852,371	$1,990,158	3%	Low
Minnehaha	$164,228,000	$39,826,268	$43,765,130	$2,917,675	2%	Low
Moody	$131,252,000	$8,304,554	$9,125,884	$608,392	0%	Low
Oglala Lakota	$8,720,000	$7,474,476	$8,213,710	$547,581	6%	Moderate
Pennington	$29,599,000	$19,390,759	$21,308,526	$1,420,568	5%	Moderate
Perkins	$43,281,000	$31,657,712	$34,788,695	$2,319,246	5%	Moderate

County Name	Crop Exposure Value (2012 Census of Agriculture)	Drought-Related Crop Insurance Paid (2000-2014)	Crop Damages (extrapolated based on 91% insured in 2014)	Annualized Crop Damages	Crop Damage Ratio (%)	Vulnerability Rank*
Potter	$140,531,000	$57,310,814	$62,978,916	$4,198,594	3%	Low
Roberts	$200,141,000	$16,253,489	$17,860,977	$1,190,732	1%	Low
Sanborn	$69,389,000	$25,796,275	$28,347,555	$1,889,837	3%	Low
Spink	$334,151,000	$59,735,881	$65,643,825	$4,376,255	1%	Low
Stanley	$40,815,000	$42,644,551	$46,862,143	$3,124,143	8%	High
Sully	$186,494,000	$100,036,938	$109,930,701	$7,328,713	4%	Moderate
Todd	$15,910,000	$6,432,324	$7,068,487	$471,232	3%	Low
Tripp	$86,671,000	$46,512,542	$51,112,684	$3,407,512	4%	Moderate
Turner	$100,867,000	$77,854,625	$85,554,533	$5,703,636	6%	Moderate
Union	$106,501,000	$46,118,750	$50,679,945	$3,378,663	3%	Low
Walworth	$89,049,000	$29,051,962	$31,925,233	$2,128,349	2%	Low
Yankton	$56,866,000	$66,978,827	$73,603,107	$4,906,874	9%	High
Ziebach	$19,261,000	$20,593,934	$22,630,696	$1,508,713	8%	High
Totals	$6,072,922,000	$2,579,569,105	$2,834,691,324	$188,979,422		

Source: Amec Foster Wheeler based on analysis of data from USDA Risk Management Agency; 2012 USDA Census of Agriculture
* Vulnerability ranking classification based on the following loss ratios: Low (0-3%), Moderate (4-6%), High (7-9%), Very High (10-15%)

Figure 3-63 Annualized Estimated Crop Economic Losses from Drought, by County 2000-2014

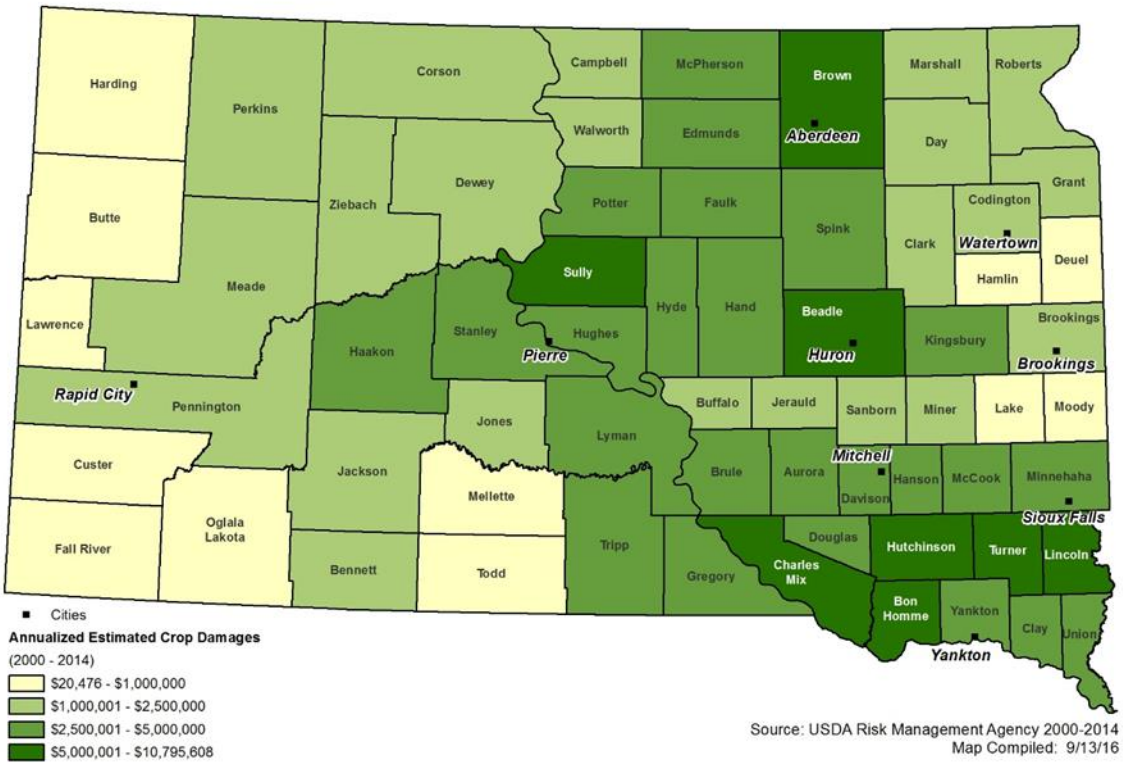
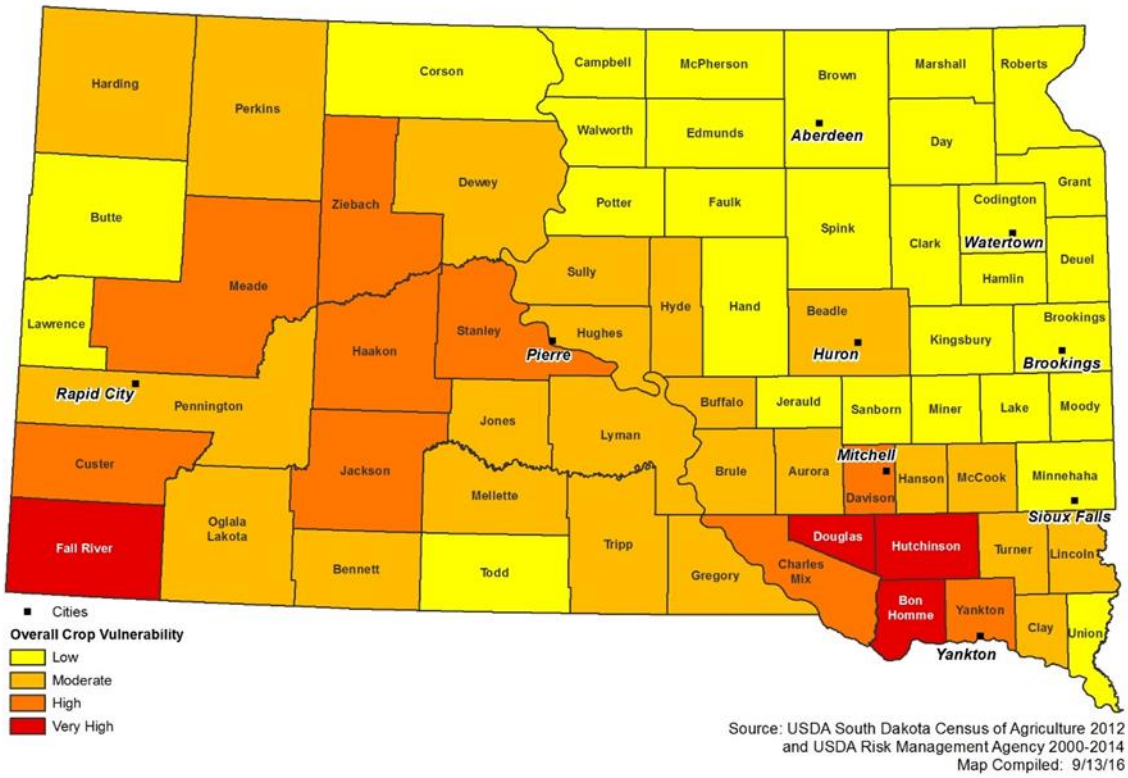


Figure 3-64 Crop Vulnerability Rank by County - 2000-2014



Future Vulnerability

Based on the state Drought Mitigation Plan the availability of water supplies in some of these areas is becoming an issue as the population increases, particularly in Sioux Falls and other areas that depend on the Big Sioux River. Rapid City, in the Black Hills is also experiencing water availability challenges related to population growth that can be exacerbated during dry periods. In the western portion of the state, there is concern regarding the need of water for people and rangeland. Areas can best reduce their drought vulnerability by effectively planning for reliable future water supplies.

Table 3-60 Drought Consequence Table

Category	Narrative
Impact on the Public	Health impacts from low water quality; reduced air quality; increased risk of infectious diseases/contamination; water supply disruptions and reduced water quality could impact service delivery; air quality from blowing dust could have detrimental heath impacts.
Impact on the Economic Condition of the State	Agricultural economies are adversely affected if drought results in widespread loss of crop or yield reductions or livestock impacts. Agricultural supply and support industries can also be affected. Food costs increase due to higher costs or lack of production; reduced tourism and recreation revenue for activities reliant on precipitation (i.e. ski industry; summer water sport industries, fishing, hunting). Local economy and finances dependent on consistent water supply or precipitation (i.e. snow at ski areas) may be adversely affected for duration of drought.
Impact on the Environment	Disruptions in wildlife and habitat, including increased animal mortality; decreased land quality; low stream flows; increased water contamination. May

Category	Narrative
	cause disruptions in wildlife habitat, resulting in an increasing interface with people, or reducing numbers of animals if forage becomes too sparse. Land quality can be negatively impacted by overgrazing during drought. Water quality can become degraded to the point of causing localized fish kills. Low stream flows and higher water temperatures will have negative impacts on riparian habitats and aquatic species.
Impact on Property, Facilities, and Infrastructure	Infrastructure can be damaged by excessively dry expansive soil as it contracts; dams and ditches can experience structural damage due to decreased pore water pressure, damage caused by high sediment loads when pulling water from the bottom of reservoirs, and damage caused by debris flows and flooding following wildfires. Water treatment facilities may be stressed. Reduced hydroelectric power generation.
Impact on the Public Confidence in Government	Ability to respond and recover may be impaired if planning, response, and recovery is not timely and effective.
Impact on Responders	Strain on water supply for responders; minor impacts; dust storms might require special equipment.
Impact on Continuity of Operations	Strain on water supply for operations and municipal services reliant on water. Slow onset and nature of drought makes it unlikely to have an impact on continuity of operations. Nature of hazard not expected to impact delivery of government services, except for moderate impact on water utilities. In extreme cases municipal water delivery may be interrupted. Ability to deliver recreational services may be impacted at the local level. Food supply and delivery could be disrupted, with an associated increase in food prices.
Cascading Hazards	Wildfire, Flood, expansive soil issues

3.3.11 Tornadoes

Methodology

All 66 counties in the state of South Dakota are vulnerable to tornado hazards. To refine and assess the relative vulnerability of each of South Dakota's counties to tornadoes, the state assigned ratings to four factors that were examined at the county level: prior events, building exposure, population density, and past tornado damage. Ratings were applied to each factor and summed to obtain overall vulnerability scores for each county to allow comparison for greatest relative vulnerability. The methodology is further detailed in Appendix 3D Vulnerability Methodology.

Figure 3-65 Tornado Damage 1950-2016

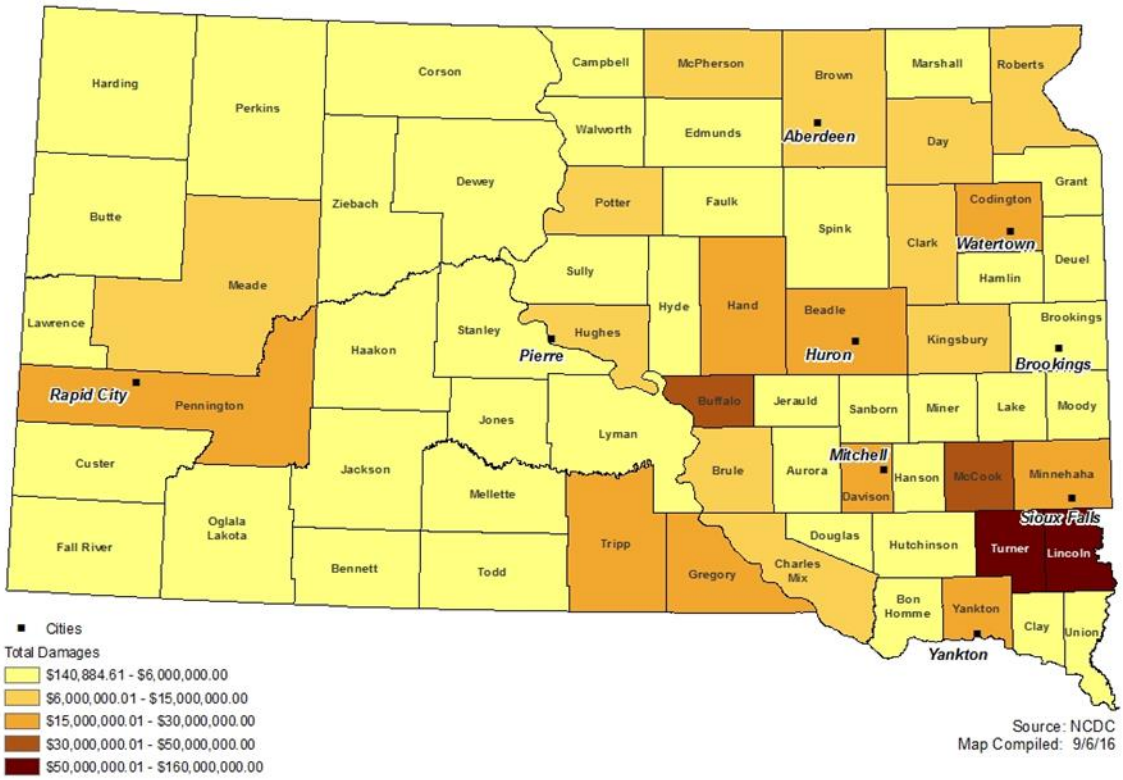


Figure 3-65 shows past tornado damage ratings for all South Dakota counties. A table that includes the corresponding values can be found in Appendix 3D Vulnerability Methodology.

Total Tornado Vulnerability and Estimate of Potential Loss

According to this methodology, while every South Dakota county is vulnerable to tornadoes, only Minnehaha and Lincoln Counties have a very high vulnerability for tornadoes with a Fujita rank of F1 or greater, or that caused damage or casualties. Lincoln is the only county with Very High rank for all tornadoes. Figure 3-66 illustrates the vulnerability of South Dakota counties to tornadoes, and Table 3-61 shows all the South Dakota counties ranked by total tornado vulnerability along with their four vulnerability factor ratings.

To provide additional insight into potential losses caused by tornadoes, historic loss data were also analyzed on a statewide scale. According to the NCEI, there were 1,773 tornadoes in South Dakota between January 1950 and August 2018. Of those, 795 were rated as greater than F1. Total property damage for these events is estimated at $713 million in 2016 dollars. This suggests that South Dakota averages 26 tornadoes and $10million in losses each year. There were 18 deaths and 452 injuries in this time period, which averages out to approximately seven injuries each year. Of these storms, five resulted in major disaster declarations, with a total relief cost estimated at $160 million in 2016 dollars. This averages out to $31.711 million per major disaster. Based on the frequency of events, South Dakota averages one major disaster-level tornado every 328 events or approximately every 12.4 years.

Based on Figure 3-66, tornadoes do not seem to concentrate in one particular area of the state. If the counties with at least 15 F1 or greater events are plotted on the map, the concentration remains in the

southeast corner. The only outliers are Pennington, Meade, and Brown. As such, it is expected that the counties of Minnehaha, Lincoln, Turner, McCook, Yankton, Charles Mix, and Davison have higher vulnerabilities to tornados and associated losses than the other counties in the state, although Pennington, Beadle, and Brown Counties should all also be considered at high risk. Figure 3-67 illustrates each county's vulnerability to tornado events, and where mitigation projects have been implemented.

Figure 3-66 Tornado Vulnerability and State Facilities

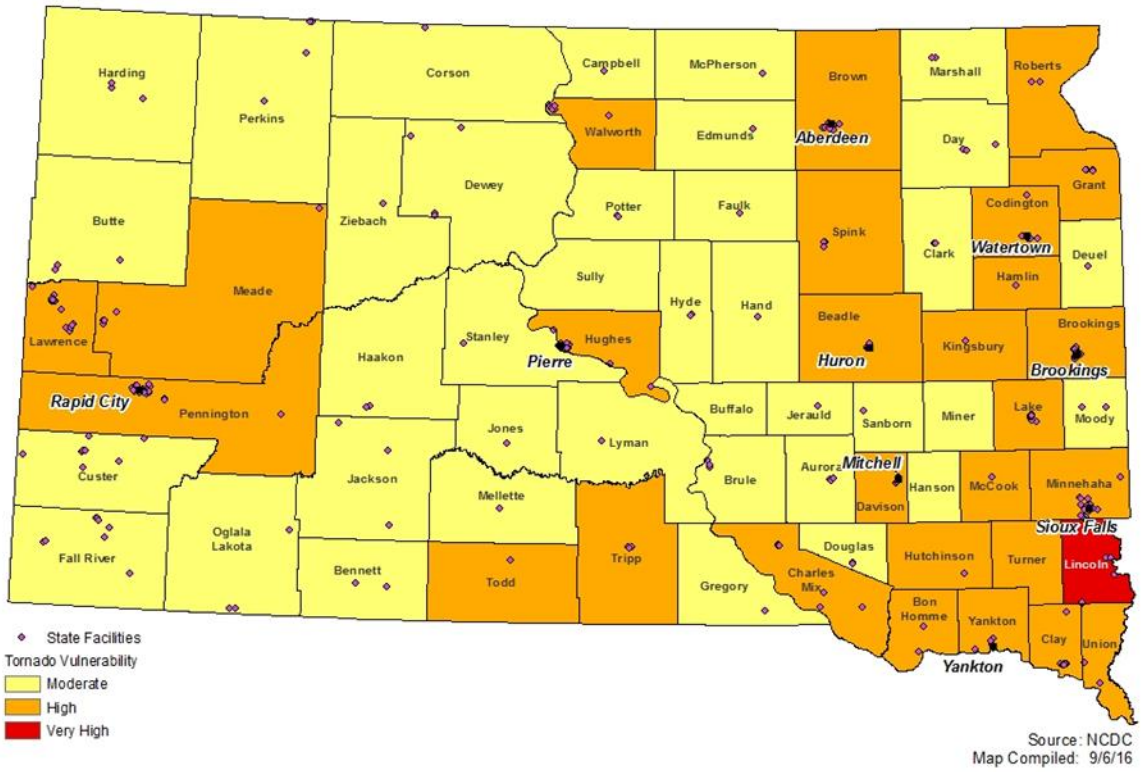


Figure 3-67 Tornado Vulnerability and Mitigation Projects

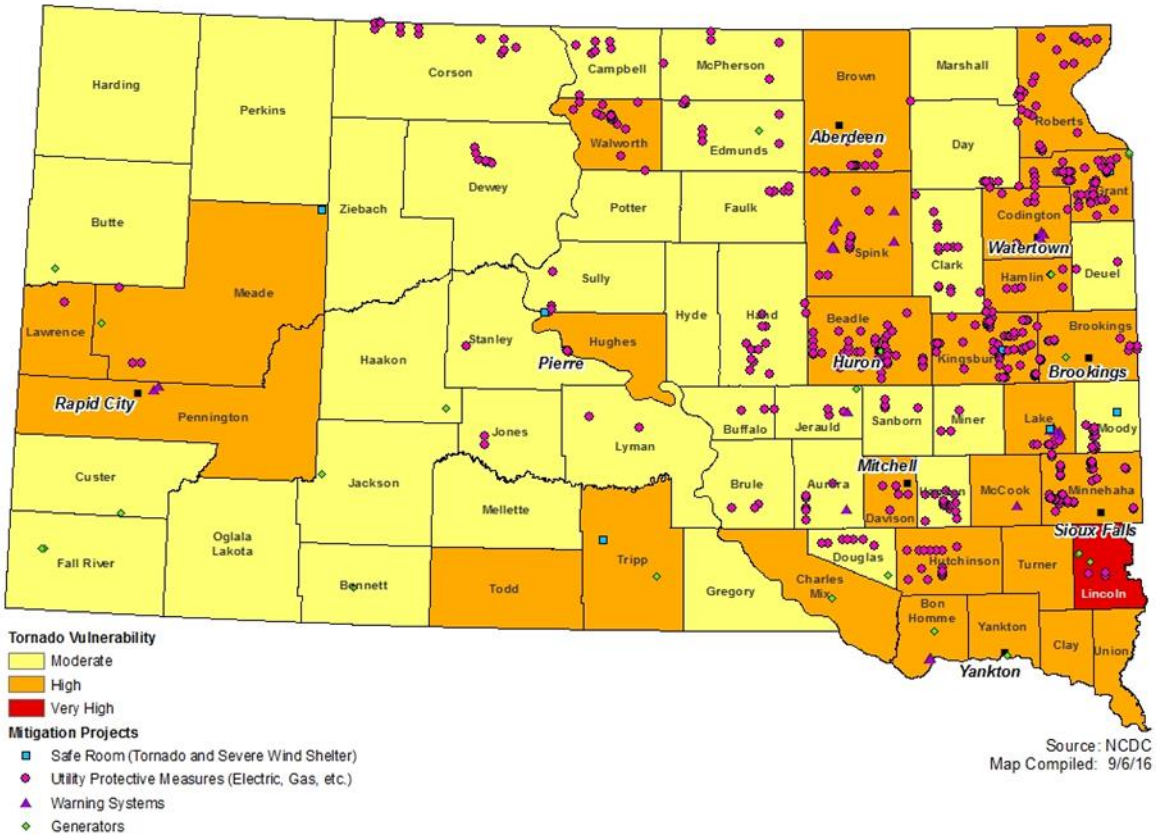


Table 3-61 Vulnerability of South Dakota Counties to Tornadoes

County	2016 Prior Event Rating	2016 Prior Event Rating ≥F1	Building Exposure Valuation Rating	Pop. Density Rating	Tornado Vulnerability	Tornado Vulnerability ≥F1
Lincoln	6	8	9	9	Very High	Very High
Brown	10	10	8	8	High	High
Minnehaha	5	8	10	10	High	Very High
Pennington	5	7	10	8	High	High
Union	6	6	7	8	High	High
Codington	4	4	8	8	High	High
Yankton	4	6	8	8	High	High
Davison	3	5	7	9	High	High
Turner	5	8	6	6	High	High
Brookings	3	4	8	8	High	High
Beadle	4	6	7	7	High	High
Lawrence	2	4	8	8	High	High
Clay	4	5	6	8	High	High
Meade	5	8	7	5	High	High
Hutchinson	5	7	6	5	High	High
Lake	2	5	7	7	High	High
Charles Mix	5	9	6	5	High	High
Roberts	3	6	6	6	High	High

County	2016 Prior Event Rating	2016 Prior Event Rating ≥F1	Building Exposure Valuation Rating	Pop. Density Rating	Tornado Vulnerability	Tornado Vulnerability ≥F1
Hughes	1	3	7	7	High	High
Bon Homme	3	6	5	6	High	High
Kingsbury	5	6	5	4	High	High
Hamlin	2	3	5	6	High	High
Grant	2	3	5	6	High	High
Spink	5	5	5	3	High	High
Todd	4	4	4	5	High	High
Walworth	3	5	5	5	High	High
Tripp	4	6	5	3	High	High
McCook	5	8	3	3	High	High
Moody	1	3	5	6	Moderate	High
Fall River	4	6	5	3	Moderate	High
Oglala Lakota	2	4	5	5	Moderate	High
Day	3	3	5	4	Moderate	Moderate
Deuel	2	3	4	5	Moderate	Moderate
Custer	1	4	6	4	Moderate	High
Butte	2	4	5	4	Moderate	High
Douglas	3	4	3	5	Moderate	Moderate
Marshall	2	4	4	5	Moderate	High
Brule	3	5	4	4	Moderate	High
Hand	4	5	4	2	Moderate	Moderate
Gregory	3	4	4	3	Moderate	Moderate
Hanson	2	4	3	5	Moderate	Moderate
Clark	3	6	4	3	Moderate	High
McPherson	3	4	4	3	Moderate	Moderate
Edmunds	2	3	4	3	Moderate	Moderate
Lyman	4	6	3	2	Moderate	Moderate
Sanborn	3	4	3	3	Moderate	Moderate
Perkins	5	6	3	1	Moderate	Moderate
Miner	4	6	2	3	Moderate	Moderate
Stanley	3	4	3	2	Moderate	Moderate
Aurora	2	2	3	3	Moderate	Moderate
Dewey	3	3	3	2	Moderate	Moderate
Bennett	3	4	2	3	Moderate	Moderate
Buffalo	2	2	1	3	Moderate	Moderate
Faulk	2	3	3	2	Moderate	Moderate
Haakon	3	5	3	1	Moderate	Moderate
Jerauld	2	3	2	3	Moderate	Moderate
Potter	2	5	3	2	Moderate	Moderate
Corson	3	2	2	1	Moderate	Moderate
Campbell	2	3	2	2	Moderate	Moderate
Sully	2	3	2	1	Moderate	Moderate
Jackson	2	4	2	1	Moderate	Moderate
Ziebach	3	3	1	1	Moderate	Moderate
Harding	2	3	1	1	Moderate	Moderate
Hyde	1	2	2	1	Moderate	Moderate

County	2016 Prior Event Rating	2016 Prior Event Rating ≥F1	Building Exposure Valuation Rating	Pop. Density Rating	Tornado Vulnerability	Tornado Vulnerability ≥F1
Jones	1	2	1	1	Moderate	Moderate
Mellette	1	2	1	1	Moderate	Moderate

Future vulnerability

Based on Figure 3-67, which illustrates the location of mitigation projects associated with tornadoes (safe rooms, warning systems, utility line burials and generators), the future vulnerability of many of the high and very high ranked counties will be lessened to a degree by these projects. Pennington and Codington counties identified population growth and construction of new homes in their local plans. Lincoln experienced the greatest population gain from 2000 – 2014 of all the counties in South Dakota. Campbell experienced the greatest population loss from 2000 – 2014. Growth and development trends such as these must be taken into consideration when reviewing the vulnerability results. Minnehaha, Pennington, Union, Brookings, and Custer counties continue to increase their vulnerability as population and development increases by more than 15%. However, future growth in any county may alter the increased future vulnerability to tornado events, as density increases (which increases the potential for catastrophic damages) or as more population becomes exposed. This should be carefully monitored in the southeast corner of the state.

Table 3-62 Tornado Consequence Table

Category	Narrative
Impact on the Public	Anyone without adequate shelter during an event at high risk of injury and death; impacts will be localized to the immediate area around the tornado path.
Impact on the Economic Condition of the State	Potential loss of facilities or infrastructure function or accessibility and uninsured damages; impact to transportation sector and movement of goods.
Impact on the Environment	Significant impact related to tree damage; possible cascading water quality issues from damaged water treatment facilities. Debris issues.
Impact on Property, Facilities, and Infrastructure	Buildings, vehicles, signage and/or any exposed or unsecured property may be affected during a tornado; property may be destroyed or have significant damage.
Impact on the Public Confidence in Government	Public holds high expectations of government capabilities for warning, public information, and response and recovery activities related to a tornado; high expectations for rapid restoration of critical facilities. Ability to respond and recover may be impaired if planning, response, and recovery is not timely and effective.
Impact on Responders	Exposure exists to personnel performing routine duties when event occurs; storm-related duties are primarily post-event; however unsafe structural or environmental conditions may persist during the response period.
Impact on Continuity of Operations	Loss of facilities or infrastructure function or accessibility or ability to provide services; power interruption is likely if not adequately equipped with backup generation.
Cascading Hazards	

3.3.12 Windstorms

Methodology

To assess the vulnerability of each of South Dakota's counties to windstorm events, the state assigned ratings to three factors that were examined at the county level: prior events, building exposure, and population density. The state then summed the ratings to obtain overall vulnerability scores for each county so that they could be compared and greatest vulnerability determined. Ratings were applied to each factor and summed to obtain overall vulnerability scores for each county to allow comparison for greatest relative vulnerability. The methodology is further detailed in Appendix 3D Vulnerability Methodology.

Total Windstorm Vulnerability and Estimate of Potential Loss

According to this methodology, every South Dakota county is vulnerable to windstorm, but some counties have a higher risk than others. In addition, the vulnerability can vary slightly based on the severity of windstorm events. In both scenarios, Pennington, Minnehaha, Meade, and Brown had very high vulnerability. This is largely due to the counties' high ratings for building exposure and population density. When windstorm events of at least 70 knots or that caused damage, injuries, or fatalities are considered, Minnehaha, Pennington, Lincoln, Brookings, Yankton, and Meade have high vulnerability. Figure 3-68 illustrates the vulnerability of South Dakota counties to windstorm, and Table 3-63 shows all the South Dakota counties ranked by total windstorm vulnerability along with their three vulnerability factor ratings. In general, the counties with the greatest vulnerability to windstorm events are those in the Black Hills region and those with major cities. Figure 3-68 illustrates each county's vulnerability to windstorm events and where mitigation projects have been implemented.

It is difficult to pick an area of higher vulnerability to windstorms in the state if all windstorm events are examined. Counties where at least 100 events have been recorded are fairly evenly distributed across the state. Counties with at least 150 reported events are centralized in the Black Hills region, and then include the counties of Hughes, Brown, Beadle, Davison and Minnehaha. When counties receiving a past events rating higher than 5 for events of at least 70 knots are plotted, they are distributed in the southeast corner of the state and in the Black Hills region.

Figure 3-68 Windstorm Vulnerability and State Facilities

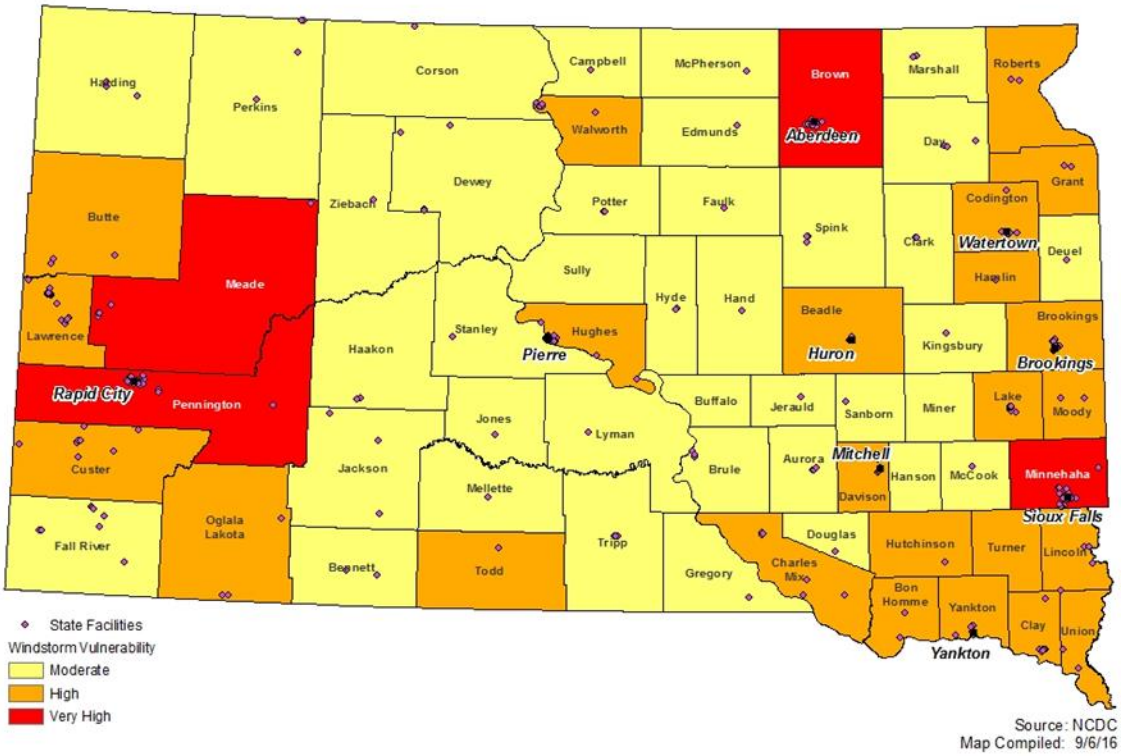


Figure 3-69 Windstorm Vulnerability and Mitigation Projects

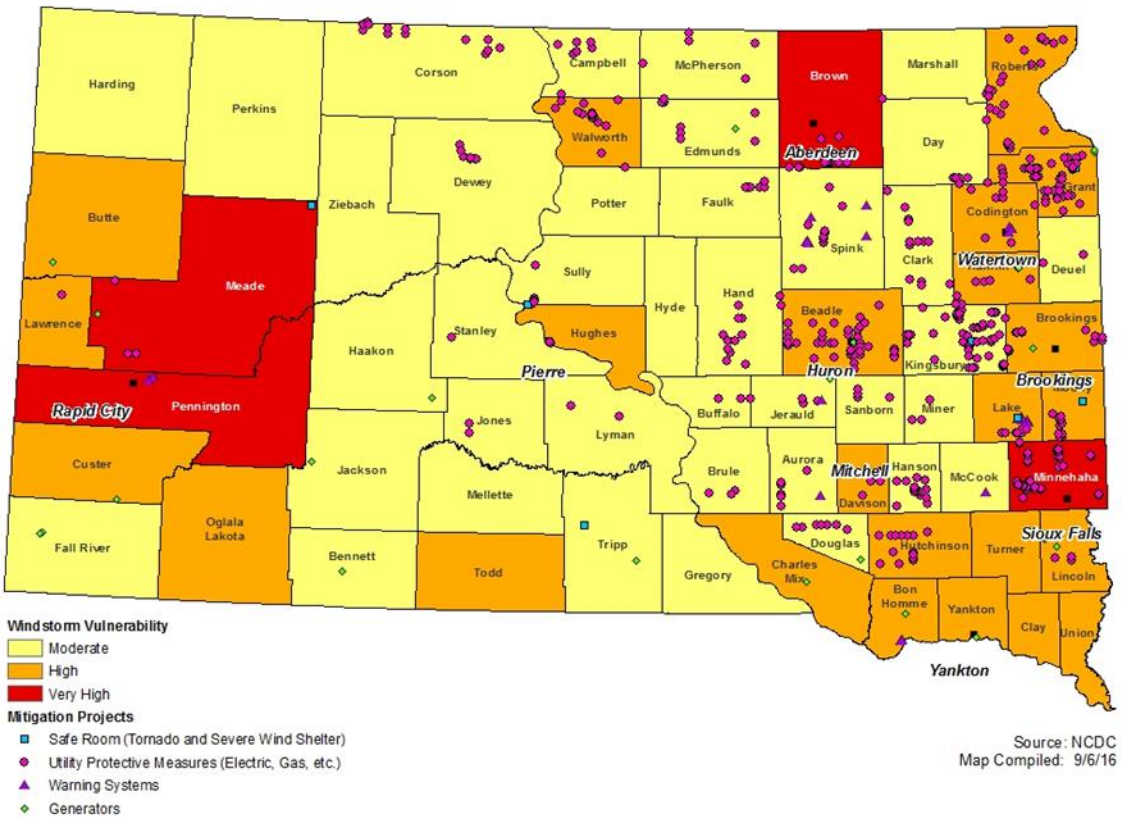


Table 3-63 Vulnerability of South Dakota Counties to Windstorm

County	Prior Event Rating	Building Exposure Valuation Rating	Pop. Density Rating	Windstorm Vulnerability
Brown	6	8	8	Very High
Meade	10	7	5	Very High
Minnehaha	6	10	10	Very High
Pennington	9	10	8	Very High
Beadle	5	7	7	High
Bon Homme	2	5	6	High
Brookings	3	8	8	High
Butte	5	5	4	High
Charles Mix	3	6	5	High
Clay	2	6	8	High
Codington	3	8	8	High
Custer	4	6	4	High
Davison	3	7	9	High
Grant	1	5	6	High
Hamlin	1	5	6	High
Hughes	4	7	7	High
Hutchinson	2	6	5	High
Lake	2	7	7	High
Lawrence	1	8	8	High
Lincoln	3	9	9	High
Moody	1	5	6	High
Roberts	1	6	6	High
Oglala Lakota	3	5	5	High
Todd	3	4	5	High
Turner	2	6	6	High
Union	2	7	8	High
Walworth	3	5	5	High
Yankton	2	8	8	High
Aurora	1	3	3	Moderate
Bennett	2	2	3	Moderate
Brule	2	4	4	Moderate
Buffalo	1	1	3	Moderate
Campbell	2	2	2	Moderate
Clark	2	4	3	Moderate
Corson	4	2	1	Moderate
Day	2	5	4	Moderate
Deuel	1	4	5	Moderate
Dewey	2	3	2	Moderate
Douglas	1	3	5	Moderate
Edmunds	3	4	3	Moderate
Fall River	2	5	3	Moderate
Faulk	2	3	2	Moderate
Gregory	1	4	3	Moderate
Haakon	4	3	1	Moderate
Hand	2	4	2	Moderate

County	Prior Event Rating	Building Exposure Valuation Rating	Pop. Density Rating	Windstorm Vulnerability
Hanson	1	3	5	Moderate
Harding	6	1	1	Moderate
Hyde	1	2	1	Moderate
Jackson	3	2	1	Moderate
Jerauld	1	2	3	Moderate
Jones	1	1	1	Moderate
Kingsbury	2	5	4	Moderate
Lyman	3	3	2	Moderate
Marshall	2	4	5	Moderate
McCook	2	3	3	Moderate
McPherson	1	4	3	Moderate
Mellette	1	1	1	Moderate
Miner	1	2	3	Moderate
Perkins	5	3	1	Moderate
Potter	2	3	2	Moderate
Sanborn	1	3	3	Moderate
Spink	3	5	3	Moderate
Stanley	3	3	2	Moderate
Sully	2	2	1	Moderate
Tripp	3	5	3	Moderate
Ziebach	3	1	1	Moderate

To estimate potential losses to wind, historic loss data was analyzed. The NCEI data did not lend itself to county by county loss summaries, only a statewide summary. Based on historic loss information presented in the wind hazard profile, South Dakota averages 123.3 windstorms, $2.605 million in wind losses, and roughly two injuries each year. The average cost of a windstorm in South Dakota is $21,137. The state has also experienced 1,841 events since 1955 with a wind speed of at least 70 knots, which accounted for three deaths and 67 injuries. This averages out to 27 particularly severe storms per year with an average yearly cost of $1.385 million. In addition, South Dakota has experienced three windstorms that resulted in a disaster declaration. Of these three events, the event on July 22, 2005 was credited entirely to wind, while the other two events also included damages from flooding and/or tornadoes. The total FEMA disaster relief costs for these three events are estimated at over $121.6 million in 2012 dollars, with an average cost of $40.5 million (also in 2012 dollars.) Based on past events, South Dakota can expect a disaster declaration-level windstorm event every 2,342 events or once approximately every 21 years.

Future vulnerability

Based on the map (Figure 3-69) showing the location of mitigation projects associated with windstorms (safe rooms, warning systems, utility line burials and generators) the future vulnerability of many of the high and very high ranked counties will be lessened to a degree by these projects as there is a lot of corresponding overlap. Population increases, and the associated growth of development, may increase a county's risk to damages and losses from windstorms. In general, livestock are not severely impacted by windstorms although particularly severe events or events that cause a drastic change in the environment (such as wind chill) may incur disproportionate losses in livestock relative to the rest of the hazard events, therefore agricultural counties may also have periodic increases of vulnerability to events.

Table 3-64 Windstorm Consequence Table

Category	Narrative
Impact on the Public	Anyone without adequate shelter during an event at high risk of injury; impacts will be localized to the immediate area around the windstorm; air quality from blowing dust could have detrimental heath impacts.
Impact on the Economic Condition of the State	Potential damage to facilities or infrastructure; economic impacts from prolonged power outages.
Impact on the Environment	Significant impact related to tree damage. May contribute to soil erosion and dust storms.
Impact on Property, Facilities, and Infrastructure	Buildings, vehicles, signage and/or any exposed or unsecured property may be affected during a tornado; property may be destroyed or have significant damage. Older buildings more susceptible to damage.
Impact on the Public Confidence in Government	Ability to respond and recover may be impaired if planning, response, and recovery is not timely and effective.
Impact on Responders	Unsafe structural or environmental conditions may persist during the response period.
Impact on Continuity of Operations	Loss of facilities or infrastructure function or accessibility or ability to provide services; power interruption is likely if not adequately equipped with backup generation.
Cascading Hazards	Exacerbates wildfire, drought and winter storm hazards.

3.3.13 Hazardous Materials

It is difficult to quantify trends in hazardous materials transportation incidents due to their somewhat random nature but based on historic incidents more than half of the transportation incidents between 1971 and 2012 occurred in Minnehaha and Pennington counties, where the state's largest cities, Sioux Falls and Rapid City, are located. These counties are trailed by Brown, Codington, and Brookings in terms of numbers of incidents. Based on the information in the hazard profile section, South Dakota experienced 760 transportation incidents involving hazardous materials between 1971 and 2012, an increase of 51 events since the 2010 plan. The total cost of damage associated with these incidents was approximately $6,537,056. This suggests that South Dakota averages 18 transportation incidents involving hazardous materials and $159,440 in related damage each year. Among these incidents there were 3 deaths and 16 injuries. In total, 357 people were evacuated. 16 of the incidents were rail related, 28 were air, and the remaining 716 were highway. Other concerns noted in the planning process are the transport of nuclear materials, which often occurs without the knowledge of local governments or tribal organizations.

Vulnerability to pipeline incidents was determined solely on the total number of miles of gas or hazardous liquid transmission lines, as detailed in the hazard profile section. Based on this table the top ten counties with the most transmission lines are Lincoln, Minnehaha, Brown, Clark, Spink, Butte, Hutchinson, Union, Harding, and Kingsbury, most of which are located in southeastern/eastern South Dakota. According to the U.S. Department of Transportation's PHMSA, there were 42 pipeline incidents in South Dakota between 1983 and 2012 (29 years), totaling $12,245,360, which equates to $422,254 in average annual loss. Pennington and Minnehaha each had 8 incidents in this time period, Beadle had 3, and Brown, Clark, Codington, Custer, Decatur, Kingsbury, Lawrence, Lincoln, McCook, Sanborn, Union, Walworth, and Yankton each had 2 or fewer.

Note during the 2019 planning process one event of significance was found to have occurred in 2017. This event is not included in these vulnerability calculations but is included in the 3.2.9 Hazardous Material, Past Events section.

Future vulnerability

Pennington and Codington counties identified population growth and construction of new homes in their local plans. Lincoln experienced the greatest population gain from 2000 – 2014 of all the counties in South Dakota. Campbell experienced the greatest population loss from 2000 – 2014. Minnehaha, Pennington, Union, Brookings, and Custer counties continue to increase their vulnerability as population and development increases by more than 15%. Growth and development trends such as these must be taken into consideration when assessing vulnerability of jurisdictions to hazardous materials incidents. Although a high vulnerability for Brookings County did not arise in this plan, they may become more vulnerable to hazardous materials as the population increases and the transportation systems expand throughout the county. Southeastern counties are more vulnerable to fixed facility incidents in general due to the number of facilities there. The counties with these facilities are listed in the hazard profile section. Available data does not support further refinement of vulnerability to fixed facility incidents based on historic losses.

There are two future pipelines that are planned to traverse through South Dakota in the future. The Keystone XL, currently under construction, is planned to cross through nine (9) counties in the western portion of the state. The Dakota Access Pipeline is also proposed to go through the state, along the eastern portion, crossing twelve (12) counties. Thus, the miles of pipeline are expected to increase in the state. The vulnerability to pipeline incidents, which for the purposes on this HIRA were determined solely on the total number of miles of gas or hazardous liquid transmission lines, will increase for the counties that will have these new pipelines traversing them.

Table 3-65 Hazardous Materials Consequence Table

Category	Narrative
Impact on the Public	Impact is dependent upon characteristics of the chemicals associated with the incident. Health impacts from contamination in water or air; anyone without adequate shelter or appropriate protection during an event at high risk of injury and death.
Impact on the Economic Condition of the State	Potential loss of facilities or infrastructure; potential impact to tourism depending on severity and location of the event.
Impact on the Environment	Significant impact related to water quality and air quality; significant impact to animal habitats depending on location and severity.
Impact on Property, Facilities, and Infrastructure	Vulnerabilities to critical infrastructure, facilities, properties, equipment, vehicles, and communications and utility infrastructure.
Impact on the Public Confidence in Government	Ability to respond and recover may be questioned and challenged if planning, response, and recovery is not timely and effective.
Impact on Responders	Exposure exists to response personnel performing routine duties when event occurs; appropriate protection required.
Impact on Continuity of Operations	Potential loss of facilities or infrastructure function or accessibility or ability to provide services.
Cascading Hazards	

3.3.14 Geologic Hazards

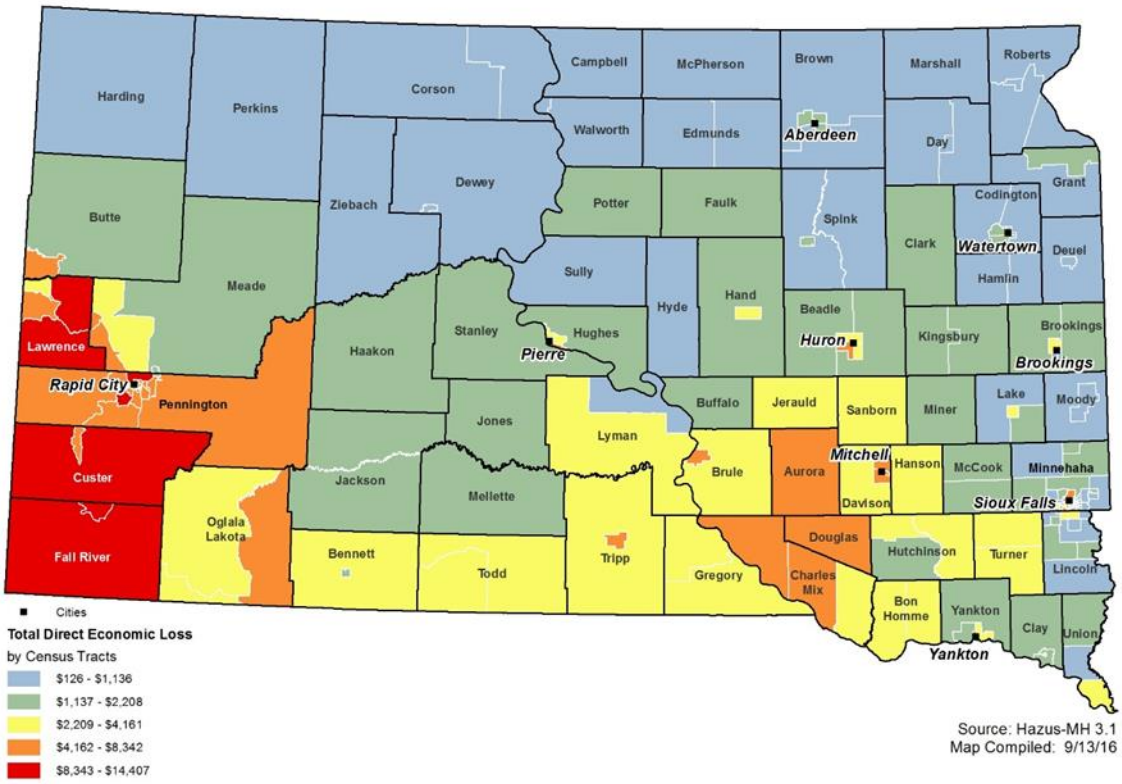
Information regarding previous landslides, mudflows, and subsidence throughout the State of South Dakota was too limited, at the time of this plan update, to assess the vulnerability and potential losses by jurisdiction. Limited areas throughout the state are vulnerable to landslides and mudflows as depicted in the hazard profile. Available data does not support further refinement of vulnerability to landslides and mudflows based on historic losses. South Dakota Geological Survey has been updating county studies on swelling soils. Completed studies should be referenced during the next plan update.

A Hazus-MH annualized earthquake loss scenario was run for the entire state in the 2007 and again in 2016 to update this plan. This enabled a consistent comparison of earthquake risk across the state. Version 3.1 of Hazus was used in 2016, which has inventory data based on 2010 Census data. The annualized expected loss (AEL) addresses key components of risk: the probability of hazard occurring in the study area, the consequences of the hazard (largely a function of building construction type and quality), and the intensity of the hazard event. By annualizing estimated losses, the AEL factors in historical patterns of frequent small events with infrequent larger events to provide a balanced presentation of the risk. In Hazus-MH, losses are annualized over eight earthquake return periods (100, 200, 500, 750, 1,000, 1,500, 2,000, and 2,500 years).

The results of the annualized scenario indicate total economic loss estimated at $371.25 million. The building losses (includes building structure, content and income losses) totaled $0.6 million. 29% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 53% of the total loss.

A Hazus-MH Probabilistic Scenario for a 2,500-year return period earthquake was run as well (Figure 3-70). This represents a worst-case scenario. The results of this scenario indicate total economic loss estimated at $949.15 million. The building losses (includes building structure, content and income losses) totaled $578.51 million. 25% of the estimated losses were related to the business interruption of the region. The largest loss was sustained by the residential occupancies which made up over 55% of the total loss. 6,930 buildings would be at least moderately damaged with an estimated 62 buildings that will be damaged beyond repair. The counties with the highest building losses are Pennington ($148,000), Minnehaha ($71,000), and Lawrence ($34,000), Davison ($20,000), Fall River ($22,000), and Meade ($21,000) with the remaining counties having $20,000 or less in loss. Three casualties were generated by the scenario. The map below displays the probabilistic economic losses for a 2500-year earthquake in South Dakota. The Hazus global summary reports for both scenarios are included in Appendix 3E.

Figure 3-70 Hazus 2500 Year Probabilistic Earthquake Scenario: Direct Economic Losses for Buildings



Future vulnerability

Areas with high development will continue to be the most vulnerable to structural damage from earthquakes. Site specific investigations and mitigation measures should help to limit future damages from expansive soils and landslides. SDDOT has plans to inventory the known active and/or previously addressed slide locations as part of the Department's overall asset management program. This initiative may not be completed for some time but should be revisited during the next plan update if the data is available.

Table 3-66 Landslides, Expansive Soils, Subsidence Consequence Table

Category	Narrative
Impact on the Public	Staff, recreationists, campers, property owners in remote areas may be at risk to injury or death from debris flows.
Impact on the Economic Condition of the State	Potential loss of facilities or infrastructure; potential impact to tourism and land development activities depending on severity; depending on nature of area where landslide occurs, many home based businesses will be impacted due to destruction of property.
Impact on the Environment	Impacts to water quality; erosion and sedimentation may affect critical infrastructure and natural waterways.
Impact on Property, Facilities, and Infrastructure	Vulnerabilities to critical infrastructure, facilities, properties, equipment, vehicles, and communications and utility infrastructure within landslide extent.
Impact on the Public Confidence in Government	Ability to respond and recover may be questioned and challenged if planning, response, and recovery is not timely and effective.

Category	Narrative
Impact on Responders	Exposure exists to response personnel performing routine duties when event occurs.
Impact on Continuity of Operations	Potential loss of facilities or infrastructure function or accessibility or ability to provide services. Power interruption is likely if near power lines.
Cascading Hazards	

Table 3-67 Earthquakes Consequence Table

Category	Narrative
Impact on the Public	Increase in sheltering and evacuation demands; vulnerable populations along fault lines will be severely impacted; while likelihood of a damaging event is rare there is potential for mass for injury or death from structural and non-structural building elements.
Impact on the Economic Condition of the State	Potential business impacts from facility damage, road closures and other transportation issues; potential loss of facilities or infrastructure function or accessibility and uninsured damages; debris management demands (costs/location).
Impact on the Environment	Environmental damage variable due to location and magnitude; possible cascading water quality issues from damaged water treatment facilities or impacts to ground and air quality from hazardous material leaks
Impact on Property, Facilities, and Infrastructure	Buildings, vehicles, signage, and/or any unsecured property may be damaged or destroyed during a significant event; Older and historic structures more vulnerable. Possible impacts to communications; expected damage to water treatment facilities, government buildings, public safety facilities, power generation and distribution, and healthcare facilities expected to be minor based on Hazus modeling. Potential for breaks and leaks in gas, water and waste water utility lines and associated disruption.
Impact on the Public Confidence in Government	Public holds high expectations of government capabilities for public information and response and recovery activities related to large scale disaster events such as earthquake; high expectations for rapid restoration of critical lifelines
Impact on Responders	Unsafe structural or environmental conditions may persist during the response period putting search and rescue personnel and other responders at risk; structural damage to hospitals, fire stations, police stations; scale of event will likely overwhelm local resources and require mutual aid assistance from outside the area of impact
Impact on Continuity of Operations	Loss of facilities or infrastructure function or accessibility or ability to provide services; power interruption is likely if not adequately equipped with backup generation; large scale of event will typically overwhelm emergency response and coordination services and may require mutual aid assistance from outside the impacted area
Cascading Hazards	Energy Disruption; Urban Fire; Dam/Levee Failure, Hazardous Materials

3.3.15 Rural Electric Cooperative Considerations

During the 2013-2014 update the Rural Electric Cooperatives (REC) were engaged as participants in the state planning effort. This discussion focuses on the potential hazard risks to REC's. During the 2013 update a REC data collection guide was developed to guide RECs on the information needed for refining vulnerability and loss estimates in future updates. This includes a hazard identification and vulnerability assessment that can be used to help a REC identify its primary risks. The goal of this process is to produce information that may inform the state's hazard mitigation plan in future updates. This process may also

help RECs identify possible projects that may be eligible for federal mitigation funding pre or post disaster. These guides were distributed to the RECs and should provide more data collection for integration and analysis in the HMP's next update cycle. In 2013 two of these were filled out by RECs and used to enhance the hazard profiles for winter storm, tornado, and wind, which are also the hazards noted as most significant from the RECs' perspective. Winter storms, wind and tornadoes pose the greatest risk to power lines and facilities operated by the REC's. These hazards can knock down power lines, which tend to be the most vulnerable elements of the electrical grid. To determine how this risk may vary across the various REC's an overlay analysis of REC was done to determine their intersection with and very high vulnerable counties for Winter Storms, Wind, and Tornadoes identified through the previous methods described. In 2016, the ranking scheme was changed from equal interval to natural breaks to refine the ranking system. This change allowed for the analysis to be done with all counties with "Very High" vulnerability to these hazards. The boundaries of the RECs are displayed in Figure 3-71. The results of the analysis are summarized in Table 3-68.

Figure 3-71 South Dakota Rural Electric Cooperative Boundaries

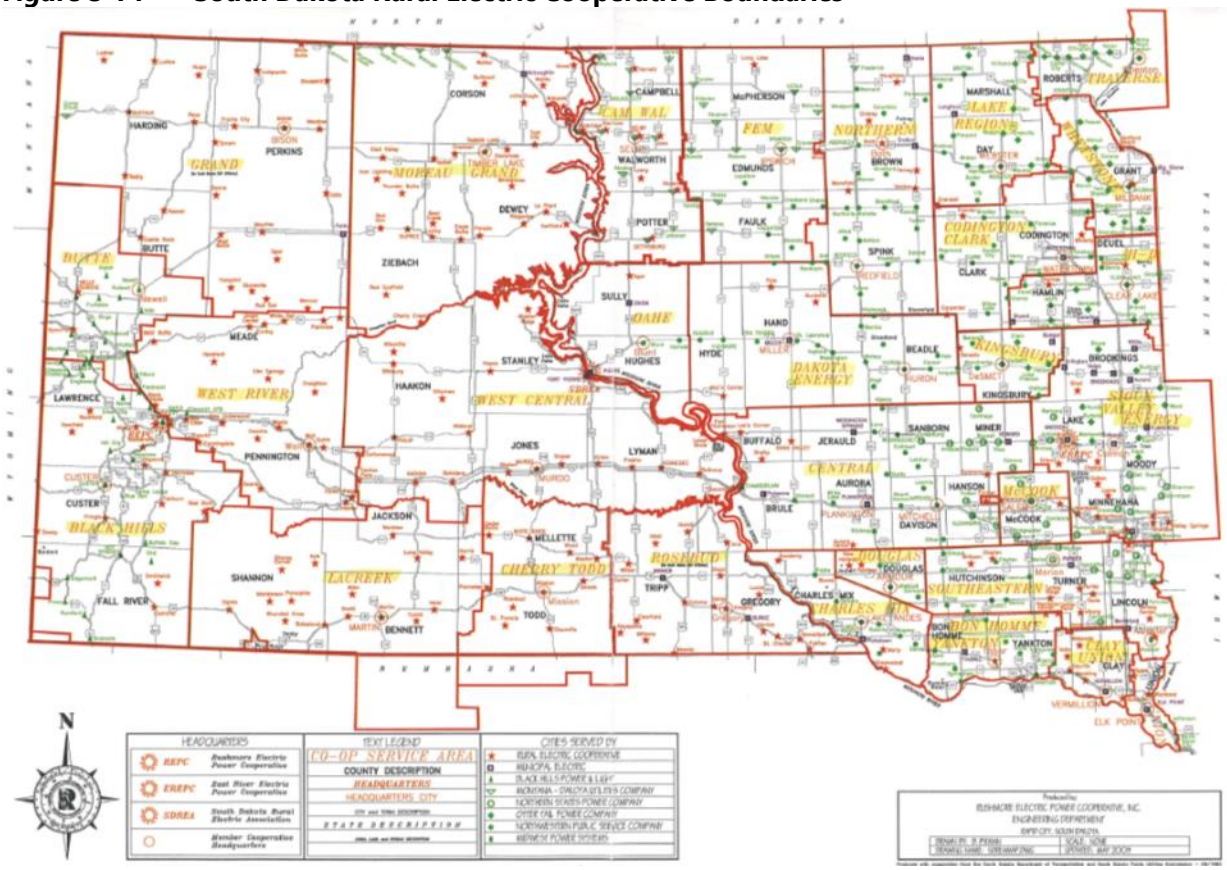


Table 3-68 Rural Electric Cooperative Hazard Vulnerabilities

Rural Electric Cooperative	County	Winter Storm Vulnerability	Wind Storm Vulnerability for events 70 kts or greater*	Tornado Vulnerability for events F1 or greater*
Black Hills Electric Cooperative, Inc.	Pennington	Very High	Very High	High
Black Hills Power & Light Co	Meade	Very High	Very High	High
Black Hills Power & Light Co	Pennington	Very High	Very High	High
Butte Electric Cooperative, Inc.	Meade	Very High	Very High	High
Central Electric Cooperative Inc.	Davison	Very High	High	High
Clay-Union Electric Corporation	Lincoln	Very High	Very High	Very High
Grand Electric Cooperative, Inc.	Meade	Very High	Very High	High
H-D Electric Cooperative, Inc.	Brookings	Very High	Very High	High
Kingsbury Electric Cooperative, Inc.	Brookings	Very High	Very High	High
Lake Region Electric Association, Inc.	Brown	Very High	High	High
MidAmerican Energy	Lincoln	Very High	High	Very High
Montana-Dakota Utilities Co	Brown	Very High	High	High
Northern Electric Cooperative Inc.	Brown	Very High	High	High
Northwestern Energy	Brown	Very High	High	High
Northwestern Energy	Davison	Very High	High	High
Otter Tail Power Co	Brookings	Very High	Very High	High
Sioux Falls Municipal Electric and Xcel Energy	Minnehaha	Very High	Very High	Very High
Sioux Valley Energy	Brookings	Very High	Very High	High
Sioux Valley Energy	Minnehaha	Very High	Very High	Very High
Southeastern Electric Cooperative, Inc.	Lincoln	Very High	High	Very High
Southeastern Electric Cooperative, Inc.	Minnehaha	Very High	Very High	Very High
Southeastern Electric Cooperative, Inc.	Turner	Moderate	High	High
West River Electric Association, Inc.	Meade	Very High	Very High	High
West River Electric Association, Inc.	Pennington	Very High	Very High	High
XCEL Energy	Lincoln	Very High	High	High
XCEL Energy	Minnehaha	Very High	Very High	Very High

*Also includes events that caused death or injury, or resulted in recorded financial damage

Based on this analysis notable REC's subject to risk from winter storm, wind, and tornadoes include:

- Black Hills Electric Coop
- Black Hills Power & Light Co.
- Clay-Union Electric Corporation
- MidAmerican Energy
- Sioux Falls Municipal Electric/Xcel Energy
- Sioux Valley Energy
- Southeastern Electric
- West River Electric

In addition, wildfire can impact power lines in the Black Hills and parts of southeastern South Dakota (e.g. Lincoln County). The Black Hills, Butte, West River, and Southeastern REC's are more vulnerable to wildfires.

An overlay of power facilities on flood and wildfire hazard areas to identify specific facilities potentially at risk is discussed in the next section and captured in the tables in Appendix 3F.

South Dakota has funded several power line burial projects with HMGP funds in an effort to reduce future disaster losses. Since 2005 the state has spent $19 million of HMA grant funding (primarily HMGP) in helping to bury over 700 miles of power lines. These projects are summarized in Table 3-69. Refer to Section 4.4.11 Rural Electric Cooperatives for additional information on power line burial efforts by the RECs.

When comparing the data to Rural Electric Cooperative Hazard Vulnerabilities (Table 3-68), it does not appear that funding for REC mitigation projects is necessarily being spent in the areas with the highest vulnerability to windstorm, winter storm, or tornado. For example, Minnehaha, McCook, and Pennington counties each ranked high or very high in vulnerability to at least one of the hazards, but the mitigation project data does not indicate investments in these counties. However, investments have been made in Lincoln, Brookings, Brown, and Davison counties which all had high or very high ranking in at least one of the three hazards. Additional data collection and analysis will be needed to estimate potential dollar losses to the REC's.

Table 3-69 REC Mitigation Funding and Miles of Line Buried by County: 2013-2018

Rural Electric Cooperative	County	Miles	Total Obligated
Central	Aurora	14.5	$468,393
Dakota Energy	Beadle	49.25	$1,449,253
Kingsbury	Brookings	5.5	$106,291
Northern	Brown	29.25	$654,434
Central	Brule	9	$200,520
Central	Buffalo	3	$115,500
Butte	Butte	14.4	$913,085
Cam-Wal	Campbell	19.9	$382,086
Codington-Clark	Clark	16.5	$496,235
Codington-Clark	Codington	18	$642,412
Town of Colman	Colman	0.6	$125,500
Moreau-Grand	Corson	37	$1,028,140
Central	Davison	17.5	$451,742
Codington-Clark	Day	4	$107,516
H-D	Deuel	4	$127,200
Moreau-Grand	Dewey	6.3	$396,739
Douglas	Douglas	4.5	$332,085
FEM	Edmunds	28.95	$409,799
FEM	Faulk	24.2	$572,943
Whetstone	Grant	75.9	$1,746,322
City of Bryant	Hamlin	6.5	$401,344

Rural Electric Cooperative	County	Miles	Total Obligated
H-D	Hamlin	8	$323,543
Dakota Energy	Hand	28.5	$711,750
Central	Hanson	19.75	$610,097
City of Pierre	Hughes	0.5	$140,902
Southeastern	Hutchinson	25	$948,546
City of Wessington Springs	Jerald	0.2	$29,682
West Central	Jones	4	$75,137
Kingsbury	Kingsbury	63.6	$1,137,801
West Central	Lyman	2.2	$104,820
FEM	McPherson	15.5	$385,359
Central	Miner	9.5	$193,278
Traverse and Whetstone	Roberts	53.7	$1,160,323
Central	Sanborn	12	$541,479
Northern	Spink	18.5	$690,244
West Central	Stanley	5	$133,721
Oahe	Sully	2.45	$139,189
Cam-Wal	Walworth	34.95	$1,106,504
	Total	**692.1**	**$19,559,914**

Source: OEM

South Dakota has also used FEMA Public Assistance Section 406 mitigation to fund power line strengthening, burial, and retrofitting as part of project worksheets (PW) during post-disaster reconstruction. The table below (Table 3-70) summarizes the number of projects and mitigation funding associated with Section 406 from disasters in 2008-2016 based on information provided by OEM. The damage category F mitigation dollars shown for DR1759 and DR1887 in the table below are primarily associated with power line burials or upgrades for REC's. DR1759 included funding for Grand Electric Coop and Butte Electric. DR 1887 included funding for Cam-Wal, Central, Dakota Energy, FEM, Grand, Moreau-Grand, and Whetstone Valley Electric cooperatives. Total mitigation funding from these two disasters is over $11M. Combined with the HMGP funding in the previous table the total includes over $41.7M in mitigation funds for the RECs since 2008.

Table 3-70 FEMA Public Assistance Section 406 Project and Mitigation Funding: 2008-2016

DR#	Type	Year	Damage Category	# of PW's	Total
4298	Winter Storm	2016	F	15	$2,268,759
4233	Flooding	2015	C	14	$117,882
4186	Tornado/Flooding	2014	C	48	$340,282
4155	Winter Storm	2013	F	24	$5,784,998
4137	Flood	2013	C	7	$30,141
4125	Flood	2013	C	19	$31,164
4115	Winter Storm	2013	F	1	$245,759

DR#	Type	Year	Damage Category	# of PW's	Total
1984	Flood	2011	C	98	$745,578
1947	Flood	2010	D+E	8	$86,870
1938	Flood	2010	C	14	$712,318
1929	Tornados/Flooding	2010	C	4	$71,426
1915	Flood	2010	C	102	$294,124
1914	Winter Storm	2010	F	4	$381,044
1887	Winter Storm	2010	F	297	$9,596,751
1759	Winter Storm	2008	F	3	$1,458,213
				Total	**$22,165,309**

Source: OEM

3.4 Assessing Vulnerability and Estimating Potential Losses of State Facilities

44 CFR Part 201 Requirement:

[The State risk assessment shall include an] overview and analysis of the State's vulnerability to the hazards described in paragraph (c)(2), based on estimates provided in local risk assessments as well as the State risk assessment. …State owned or operated critical facilities located in the identified hazard areas shall also be addressed….

The State shall update the overview and analysis of vulnerable State owned or operated buildings, critical facilities, and infrastructure, based on available data. The update should reflect acquisition or development of new properties and infrastructure.

44 CFR Part 201 Requirement:

[The State risk assessment shall include an] overview and analysis of potential losses to identified vulnerable structures, based on estimates provided in local risk assessments as well as the State risk assessment. The State shall estimate the potential dollar losses to State-owned or operated buildings, infrastructure, and critical facilities located in the identified hazard areas.

44 CFR Part 201 Enhanced Plan Requirement:

Enhanced State Mitigation Plans must include…

A comprehensive, multi-year plan to mitigate the risks posed to existing buildings that have been identified as necessary for post-disaster response and recovery operations.

South Dakota uses the following definitions from the National Infrastructure Protection Plan to define its infrastructure, critical infrastructure, and key resources:

Infrastructure: The framework of interdependent networks and systems comprising identifiable industries, institutions (including people and procedures), and distribution capabilities that provide a reliable flow of products and services essential to the defense and economic security of the United States, the smooth functioning of government at all levels, and society as a whole. Consistent with the definition in the Homeland Security Act, infrastructure includes physical, cyber, and/or human elements.

Critical Infrastructure: Assets, systems, and networks, whether physical or virtual, so vital to the United States that the incapacity or destruction of such assets, systems, or networks would have a debilitating impact on security, national economic security, public health or safety, or any combination.

Key Resources: As defined in the Homeland Security Act, key resources are publicly or privately controlled resources essential to the minimum operations of the economy and the government.

OEM has developed a database of Key Resources and Critical Infrastructure that combines state and local facility information. State owned or operated facilities are included in this database, based on input from state agencies. Using a geocoded database of government office buildings in the state from FEMA, OEM staff worked through a Technical Advisory Group (TAG), whose membership represents: Department of Tourism and State Development; Game, Fish and Parks; Bureau of Information and Telecommunication; Department of Public Safety; Department of Revenue and Regulation; Department of Environmental and National Resources; and Department of Transportation, to obtain available information regarding state owned or operated facilities.

Some local facilities are included in this database as well. The county emergency managers have contributed information on the facilities they feel align with the National Infrastructure Protection Plan definitions. Some of this information is sensitive and has restricted public access. A non-restricted version of the GIS database was made available for analysis during this plan's update in 2007, 2010, 2013 and 2016. Improvements to the database could include the addition of a building valuation field and a standardized classification of facility type. These improvements are still recommended in 2016. The database included the following types of facilities:

- Educational/School
- Electric power
- Emergency services
- Energy
- Hydro Electric
- Hospitals
- Law Enforcement
- Natural Gas
- Communication
- Airports
- Water Facilities
- Waste Water Facilities
- Processing
- Storage stockpiles
- Local health department offices
- State penitentiary
- State office buildings\facilities

Five other GIS layers available from SDDOT contain additional information on utility-specific facilities, including:

- Water
- Communication
- Power
- Natural Gas
- Fuel

The state also provided a state buildings layer in GIS with state owned or leased facilities. The state did not have a complete utility/infrastructure layer, but several GIS layers were available from the South Dakota Department of Transportation. These layers included fuel, power, and natural gas utilities (point locations), and road and railroad networks (Figure 3-76). Utility networks included fiber optic, electric, natural gas, liquid petroleum, telecommunications, television and other networks (Figure 3-75). These

layers were supplemented with national infrastructure data such as the National Inventory of Bridges and National Inventory of Dams and the Homeland Security Infrastructure Program (HSIP 2015) for the infrastructure vulnerability analysis.

Maps showing the general locations of the state buildings, critical facilities and utility infrastructure are included in Figure 3-72, Figure 3-73 and Figure 3-74. The scale of these maps is limited by the size constraints of this document. Images can be made available for large scale printing if desired or re-created from GIS.

Figure 3-72 South Dakota Total Building Exposure

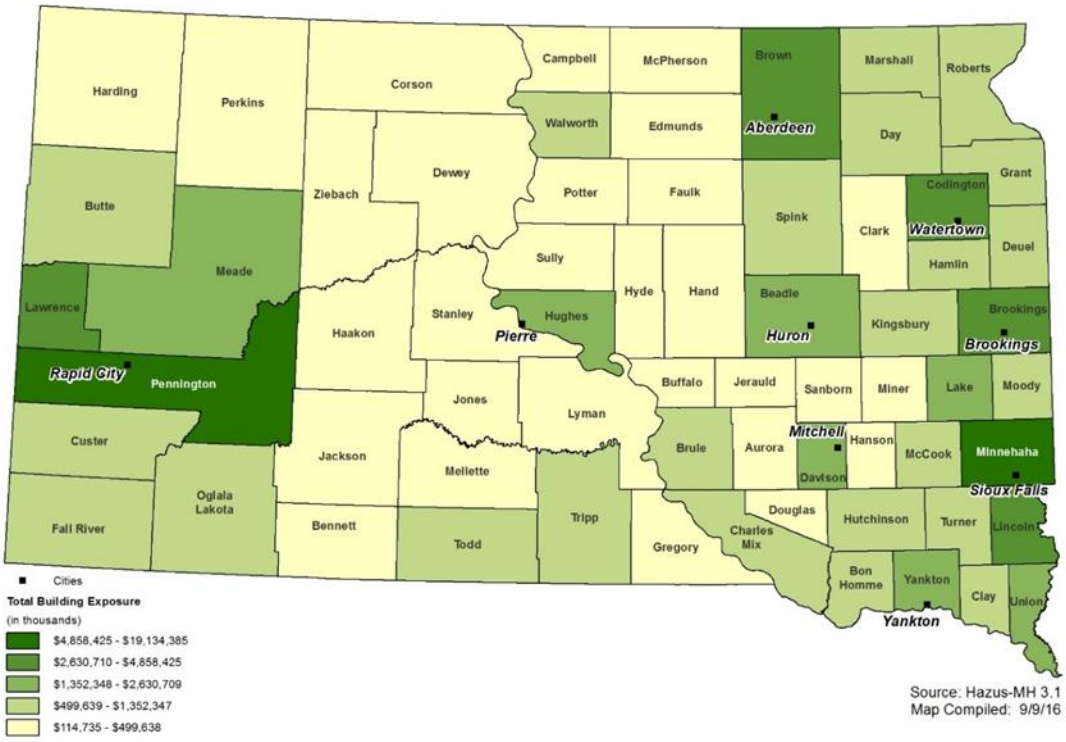


Figure 3-73 South Dakota State Facilities

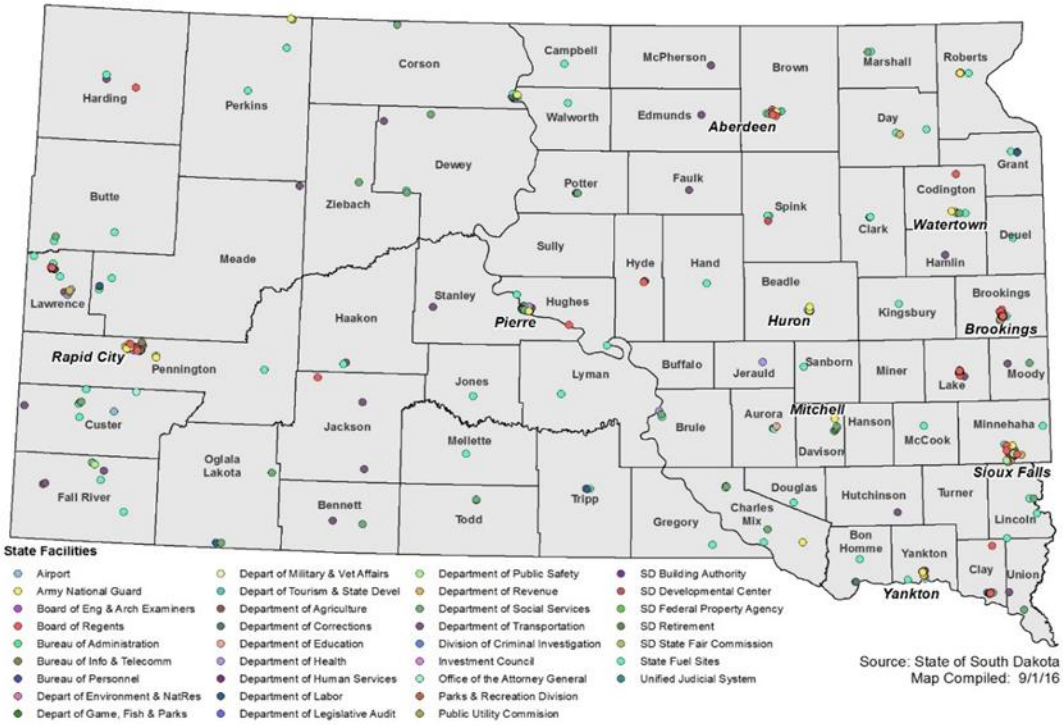


Figure 3-74 South Dakota Utilities

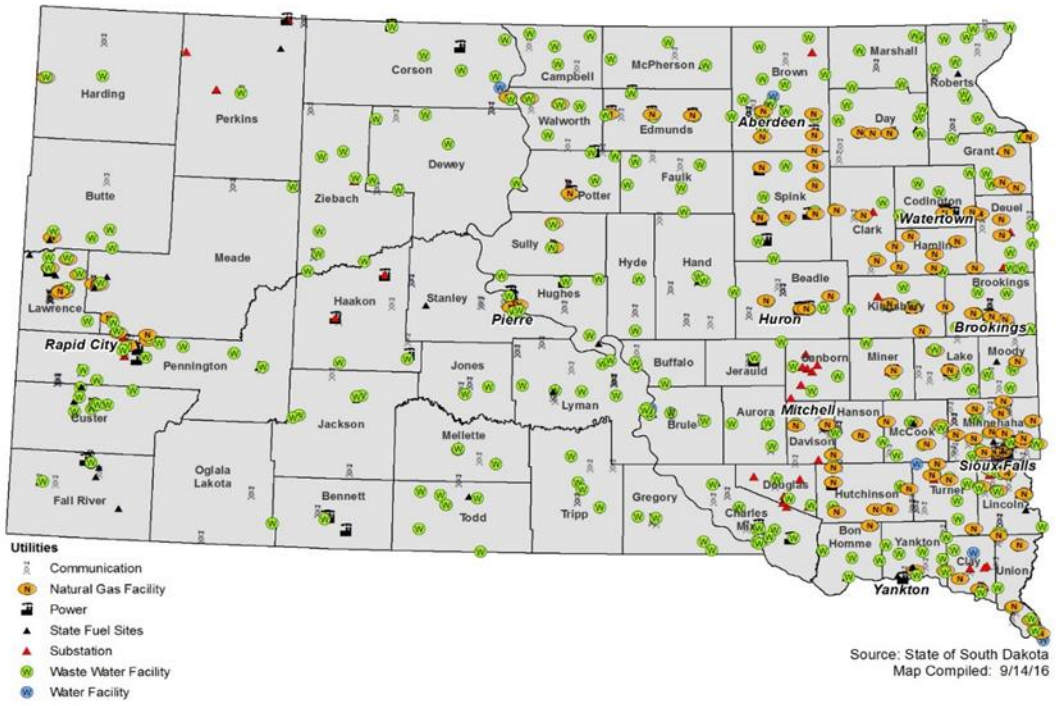


Figure 3-75 South Dakota Utility Infrastructure

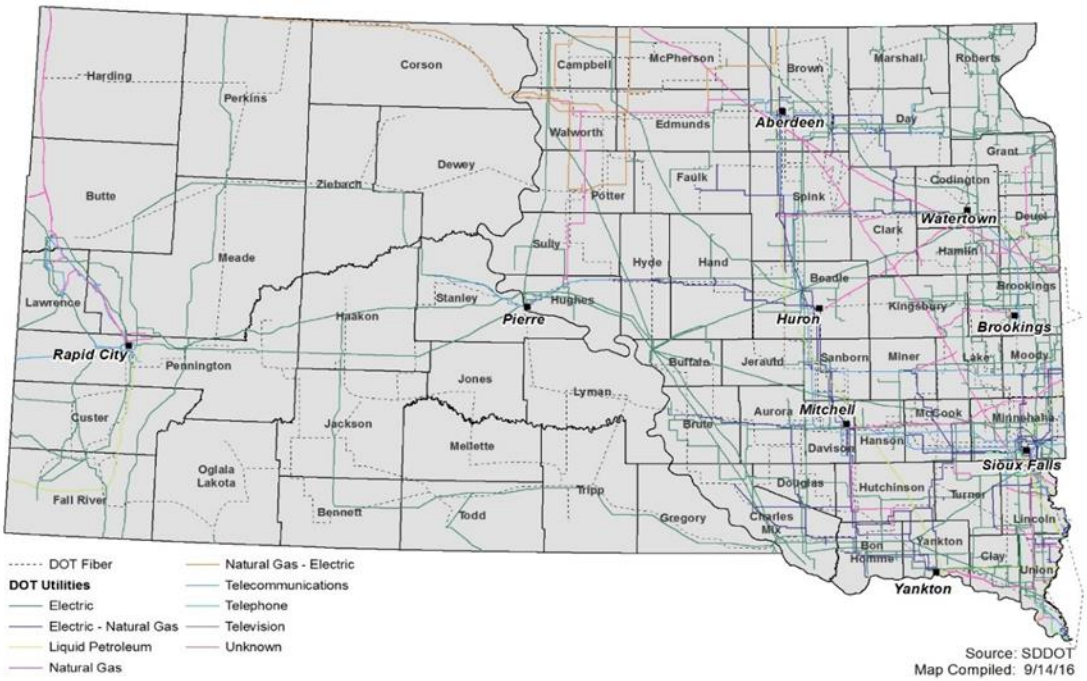
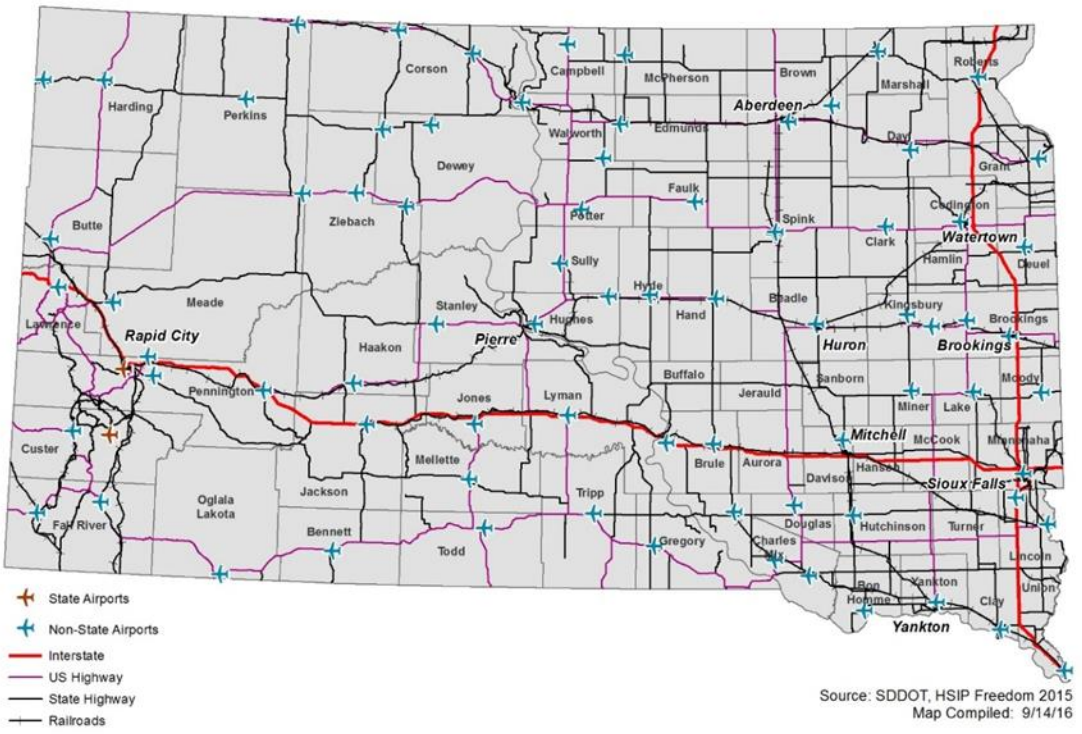


Figure 3-76 South Dakota Transportation Infrastructure



Methodology

The method used to determine vulnerability to state facilities was to overlay facilities data on digital hazard maps, where available, and identify those facilities potentially at risk. This method was used to determine vulnerability to floods and wildfire. For severe weather hazards including winter weather, tornadoes, wind, and drought it is generally accepted that these hazards could strike anywhere in the state at various levels of severity. Instead, an exposure analysis was used for these hazards. Exposure analyses are different from loss estimates in that they present facilities that may be exposed to these hazards, but do not attempt to estimate the amount of damages to be incurred during an event. Using the previous county by county risk assessments the state facilities have been shown on the summary vulnerability maps to show exposure in general terms. Available data does not support a detailed vulnerability and loss estimation for impacts on critical facilities from the following identified hazards: hazardous materials, landslides and mudflows, and earthquakes.

Building valuations are not included in the state's GIS-based facility data, thus an estimate of potential losses to state facilities is difficult to quantify. The state's facility data was used for location information to overlay the facilities with the hazard maps. During the 2013 update the following data on state buildings was provided as an estimate of the replacement values of facilities in the state. The state was in the process of updating replacement values of state facilities during the 2016 update and more current information was not available.

Table 3-71 State Owned Building Replacement Value Estimates: 2011-2012

Campus Name	Gross Sq. Ft.	Replacement Value		Average Cost per Sq. Ft.
		Low	High	
Capitol Complex, Pierre	585,818	$174,713,480	$277,461,225	$386
Other buildings, Pierre	369,741	$65,041,873	$90,336,174	$210
HSC, Yankton	377,048	$43,371,028	$60,237,540	$137
MDSP, Springfield	375,365	$42,561,669	$59,113,414	$135
State Training School, Plankinton	154,831	$24,399,209	$33,887,510	$188
SD Penitentiary, Sioux Falls	806,481	$154,706,515	$208,215,388	$225
SDSVI, Aberdeen	65,000	$8,512,593	$11,823,047	$156
SD Developmental Center, Redfield	530,683	$55,699,349	$75,565,475	$124
Star Academy, Custer	169,911	$23,300,353	$32,361,908	$164
SDSD, Sioux Falls	97,955	$11,647,572	$16,177,184	$142
Veteran's Home, Hot Springs	163,141	$18,432,548	$25,600,845	$135
State Fair, Huron	832,742	$27,334,020	$44,190,939	$43
Total	4,528,716	$649,720,209	$934,970,649	$175

In order to further quantify the value of critical facilities and infrastructure in the state the best available data remains data extracted from Hazus-MH data sets. Hazus-MH breaks critical facilities into two groups: essential facilities and high potential loss (HPL) facilities. Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

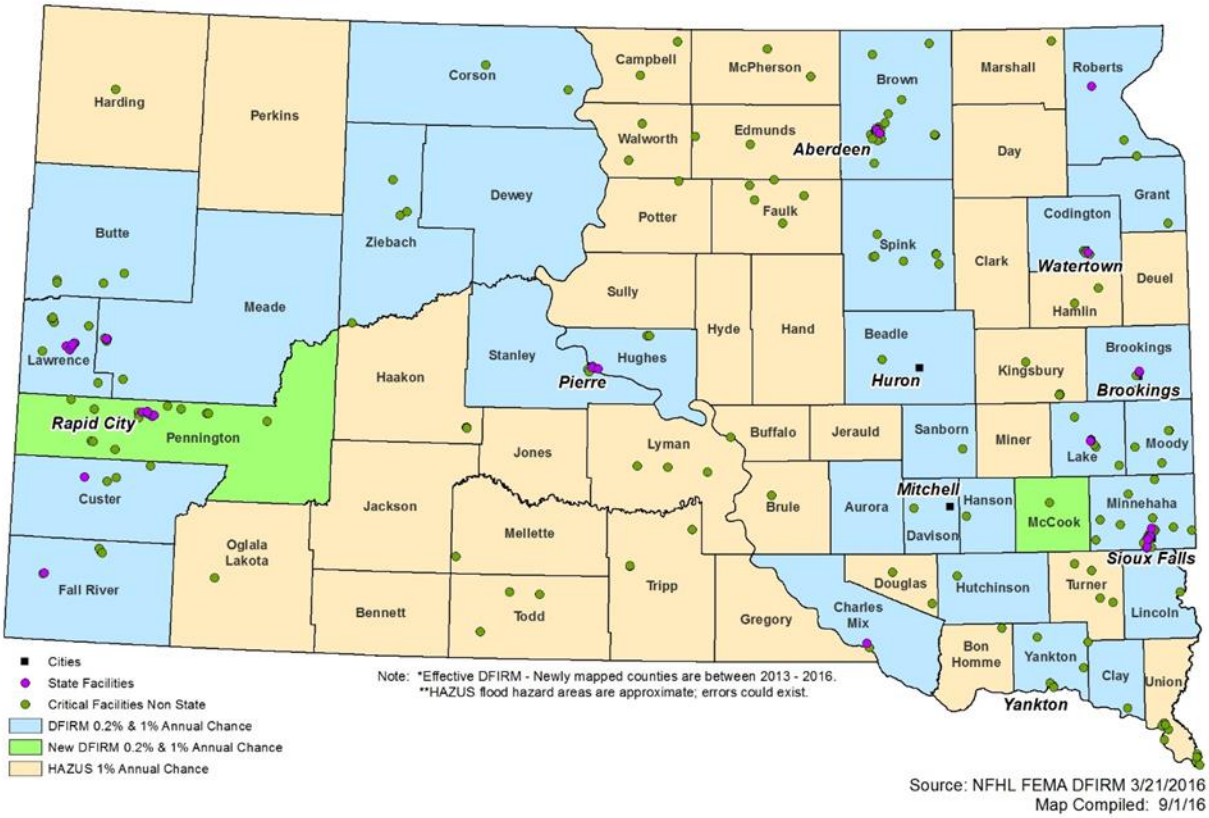
Hazus-MH data includes all state owned and operated facilities as part of the total numbers of buildings, square feet, dollars and other pertinent information for each county. This data includes local and private assets such as electrical utility infrastructure maintained by the Rural Electric Cooperatives. The Government category in the building stock inventory includes all facilities owned and operated by the State of South Dakota as well as Schools, Police Departments, Fire Departments and Emergency Operations Centers. Using the exposure analysis approach, the total value of buildings included in these

categories total approximately $837 million. Other essential facilities in Hazus include 832 schools representing $374 million in potential losses, 54 hospitals with 4,538 beds representing $290 million in potential losses, 157 police stations, 278 fire stations and 24 emergency operations facilities representing $196 million, $65 million and $20 million in potential losses respectively. These numbers represent collectively state property at risk statewide from any disaster event. In Hazus-MH there are utility and infrastructure data sets that are considered 'lifeline' inventory. There are seven transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The total value of the lifeline inventory is over $80,019 Million. This inventory includes over 11,937 kilometers of highways, 5,122 bridges, and 68,980 kilometers of pipes.

3.4.1 Floods

A GIS overlay analysis was performed to determine vulnerability of critical facilities to flooding. Both the latest available DFIRM (1% and 0.2% annual chance flood zones) and Hazus-MH modeled base flood extents (in areas where DFIRM was not available) were used. Areas protected by levee were extracted from DFIRM data and also analyzed. Figure 3-77 illustrates critical facilities and their relationship to floodplains. Tables 3Ha-3He in Appendix 3F provides details on the numbers of facilities in the floodplain. The results of the analysis found 29 state facilities potentially at risk to flooding, based on both Hazus and DFIRM mapping. Notable critical facilities and state assets at risk include 12 Board of Regents facilities and 3 Army National Guard. All state buildings are self-insured but do not carry flood insurance policies. There were 23 state facilities located within DFIRM 0.2% Annual Chance flood hazard zones, and four with areas protected by levees. Non-state critical facilities included 171 facilities, including 60 Tier II facilities. Limitations to this analysis include the number of counties with digital floodplains available, and the accuracy of the digital floodplains themselves, with the Hazus-MH derived floodplains considered the less accurate of the two sources. This analysis does not consider if the building is elevated on fill or by other means, or floodproofed.

Figure 3-77 South Dakota Critical Facilities and State Assets at Risk to Flooding



Analysis of Dams

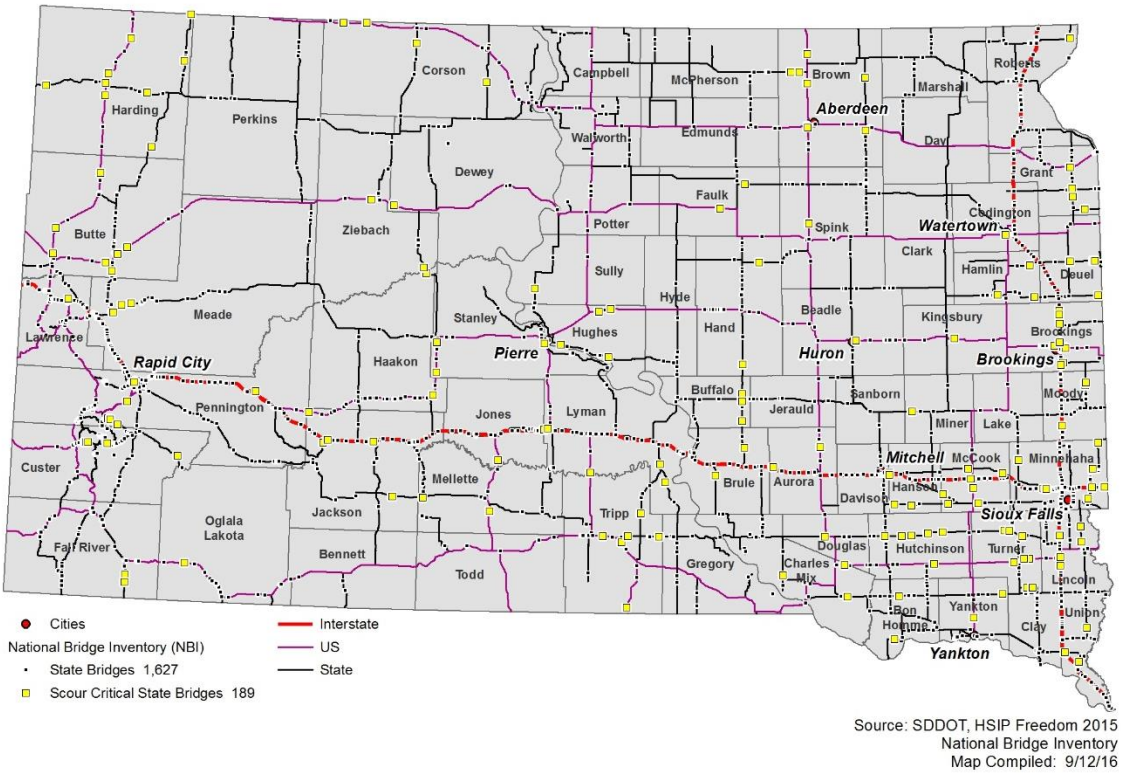
According to information from the South Dakota Department of Natural Resources and the National Inventory of Dams, there are four high hazard dams in South Dakota that do not have emergency action plans, two of which are state regulated: Rank Dam in Buffalo County and Bruning No. 1 in Mellette County. Bruning No. 1 is the only state owned high hazard dam without an emergency action plan. The state DNR has made a concerted effort to improve the number of dams with emergency action plans. For example, Kroetch dam in Haakon County is a state-owned dam that did not have an EAP in 2007 but now does. The other two high hazard dams that do not have plans are Major Lake Dam and Iron Creek Dam. The largest (based on normal storage volume) of the high hazard dams without emergency action plans is the privately-owned Rank Dam in Buffalo County. Figure 3-7 illustrates the high and significant hazard dams in South Dakota. The state owns 180 of the 2,511 dams in the state; 90% of these dams (2,267) are low hazard dams.

Analysis of Scour Critical Bridges

Included with Hazus-MH is a database of bridges called the National Bridge Inventory (NBI), which was developed by the Federal Highway Administration. One of the database items includes a "scour index" that is used to quantify the vulnerability of bridges to scour during a flood. Bridges with a scour index between one and three are considered "scour critical," or a bridge with a foundation element determined to be unstable for the observed or evaluated scour condition. Based on the NBI information submitted to the Federal Highway Administration in March 2016, there are 189 state-owned bridges identified as scour

critical and nine local government bridges. Additionally, there are 1,627 state owned bridges in the inventory with unknown foundations.

Figure 3-78 South Dakota State-Owned Bridges



During the 2007 update stakeholder meetings it was noted that railroads are vital to the rural farming economy in South Dakota, and that floods have impacted railroad bridges, delaying rail shipments of agricultural supplies for days or weeks. The NBI bridge database does not contain railroad bridges so further analysis of vulnerability could not be determined. Also noted during the planning process were the number of repeated culvert washouts and replacements on gravel roads from multiple flood disasters. Location and loss information from the FEMA Public Assistance program has been incorporated in updates to this HIRA.

According to the 2016 NBI report for South Dakota, the state has 1,193 structurally deficient bridges (85 of which are state-owned) and 217 functionally obsolete bridges (92 of which are state-owned). Refer to Figure 3-78 above.

3.4.2 Wildfire

Analysis of wildfire impacts to critical facilities was done using a wildfire risk layer from SILVIS. GIS was used to identify the critical facilities that lie within a high or moderate wildfire risk zone. A total of 481 facilities were identified statewide. Descriptions of the facilities potentially at risk are listed in Table 3Hf-3Hg in Appendix 3F.

3.4.3 Tornadoes, Wind, and Winter Storms

An exposure analysis was used to identify the number of critical facilities in the counties most susceptible to tornadoes, wind, and winter storm hazards, based on the assessment of vulnerability by jurisdiction

section. Fifteen counties were identified to have either 'very high' vulnerability to one or more of these hazards. The number of state facilities and other critical facility GIS layers (state Layer, Power, Natural Gas, and Fuel) was quantified in each of these counties. The results are displayed in Table 3-72. Due to the general nature of this exposure analysis individual facilities are not identified, but more detail can be reference in the state's GIS layers. The table also displays overlap in vulnerability to the three hazards, particularly in Brown, Meade, Lincoln, Minnehaha and Pennington counties. The mitigation strategies for these hazards often overlap as well, and this table indicates where multi-hazard critical facility protection opportunities may lie. See also the maps in Section 3.3 that show the spatial distribution of the state facilities on the counties vulnerable to windstorms, winter storms and tornadoes.

Table 3-72 State Facilities in Counties Vulnerable to Winter Storm, Wind, and Tornado Hazards

County	Winter Storm Vulnerability	Wind Vulnerability for events 70 kts or greater*	Tornado Vulnerability for events F1 or greater*	State Layer Facility Count	Power Facility Count	Natural Gas Facility Count	Fuel Facility Count
Brookings	Very High	High	High	9	1	1	-
Brown	Very High	Very High	High	14	2	1	1
Davison	Very High	High	High	10	-	1	1
Lake	Very High	High	High	5	1	1	1
Lincoln	Very High	Very High	Very High	4	1	1	1
Meade	Very High	Very High	High	5	-	1	1
Minnehaha	Very High	Very High	Very High	24	2	1	1
Pennington	Very High	Very High	High	28	2	1	1
Yankton	Very High	Very High	High	7	1	1	1

*Also includes events that caused death or injury, or resulted in recorded financial damage

While these counties are considered more vulnerable, tornadoes, wind and winter storms can happen anywhere in the state with considerable impacts. It is noted that Hughes County includes Pierre, the state capital, and has the highest concentration of state owned buildings, facilities and employees. While rated 'moderate' in terms of vulnerability to the three hazards it does lie within Wind Zone III (200 mph design wind speed).

During the 2013 October blizzard, record amounts of snow developed on the SD Game Fish and Parks McNenny Fish Hatchery west of Spearfish. The excessive amounts caused the roof to fail and collapse in on itself. FEMA Public Assistance funding was used for the repairs.

3.4.4 Drought

In terms of state assets, state parks in South Dakota are likely to suffer the greatest impacts from drought, particularly those that provide water-based recreational activities. Direct losses to the state can include lost revenue from park access fees. Other sources of state revenue that can be impacted by drought include hunting and fishing license sales. The SD Game Fish and Parks annual budget is reduced due to a decrease in hunting, fishing, and boating license sales. This is discussed further in the South Dakota Drought Mitigation Plan, though currently the GFP does not track license sales in a way that makes the sales data easy to access or analyze patterns in drought years vs non-drought years. Tracking these data would allow for an economic analysis of drought impacts to the GFP. Based on an account in the Drought Impact Reporter the South Dakota Game, Fish, and Parks Department noted that the state lost approximately $1 million in pheasant hunter license fees during the 2005 drought. The drought conditions reduced pheasant populations and, corresponding, pheasant hunter numbers across the state Available data does not support a more detailed vulnerability and loss estimation for drought impacts on non-state

critical facilities. One example is power plants that generate hydroelectric power from dams on the Missouri River could be vulnerable to drought-reduced reservoir levels.

3.4.5 Hazardous Materials

Data available in 2016 allowed for a refined loss analysis of state facilities to both transportation and fixed facility incidents. To assess the vulnerability of state facilities to hazardous materials incidents, a GIS analysis was performed to detect state facilities within a 0.5-mile buffer of Tier II Facilities. The table below displays state facilities within this buffer. Based on this analysis, Hughes (67 state facilities), Pennington (55), Brookings (37) and Brown (34) counties have the higher potential for hazardous materials incidents. More details can be found in Appendix 3F.

Table 3-73 displays state facility counts within the 0.5-mile buffer of a tier II facility. Based on this analysis the Board of Regents, state fuel sites, SDDOT and the Department of Social Services have the greatest exposure to a fixed facility hazardous materials incident.

Table 3-73 State Facilities within a 0.5-mile buffer of Tier II Facilities

State Facilities	Count
Airport	1
Army National Guard	21
Board of Eng & Arch Examiners	1
Board of Regents	137
Bureau of Administration	9
Bureau of Info & Telecomm	7
Bureau of Personnel	1
Depart of Environment & NatRes	4
Depart of Game, Fish & Parks	6
Depart of Military & Vet Affairs	2
Depart of Tourism & State Devel.	5
Department of Agriculture	7
Department of Corrections	17
Department of Education	3
Department of Health	13
Department of Human Services	7
Department of Labor	24
Department of Legislative Audit	2
Department of Public Safety	14
Department of Revenue	13
Department of Social Services	30
Department of Transportation	49
Division of Criminal Investigation	1
Investment Council	1
Office of the Attorney General	5
Parks & Recreation Division	1
Public Utility Commission	1

State Facilities	Count
SD Building Authority	1
SD Federal Property Agency	1
SD Retirement	1
SD State Fair Commission	1
State Fuel Sites	53
Unified Judicial System	1
Total	440

Table 3-74 displays state facility counts within the 0.5-mile buffer of railroad corridors within South Dakota. Based on this analysis the Board of Regents, Department of Transportation, state fuel sites, and the Department of Labor have the most risk for hazardous materials incidents.

Table 3-74 State Facilities within a 0.5 mile buffer of Railroad Corridors

State Facilities	Count
Army National Guard	12
Board of Eng. & Arch Examiners	1
Board of Regents	51
Bureau of Administration	8
Bureau of Info & Telecomm	4
Bureau of Personnel	1
Depart of Environment & NatRes	3
Depart of Game, Fish & Parks	5
Depart of Military & Vet Affairs	2
Depart of Tourism & State Devel.	4
Department of Agriculture	4
Department of Corrections	11
Department of Education	2
Department of Health	6
Department of Human Services	6
Department of Labor	19
Department of Legislative Audit	2
Department of Public Safety	7
Department of Revenue	9
Department of Social Services	14
Department of Transportation	22
Office of the Attorney General	3
Parks & Recreation Division	1
Public Utility Commission	1
SD Building Authority	1
SD Federal Property Agency	1
SD Retirement	1
SD State Fair Commission	1

State Facilities	Count
State Fuel Sites	21
Unified Judicial System	1
Total	224

Table 3-75 displays state facility counts within the 0.5 mile buffer of highways corridors within South Dakota. Based on this analysis the Board of Regents has the most at risk with 308 facilities. Other facilities at risk for hazardous materials incidents are state fuel sites, Department of Transportation, and the Department of Social Services.

Table 3-75 State Facilities within a 0.5-mile buffer of Highway Corridors

State Facilities	Count
Airport	1
Army National Guard	14
Board of Eng. & Arch Examiners	1
Board of Regents	308
Bureau of Administration	9
Bureau of Info & Telecomm	6
Bureau of Personnel	1
Depart of Environment & NatRes	3
Depart of Game, Fish & Parks	6
Depart of Military & Vet Affairs	3
Depart of Tourism & State Devel.	4
Department of Agriculture	7
Department of Corrections	13
Department of Education	4
Department of Health	13
Department of Human Services	6
Department of Labor	22
Department of Legislative Audit	2
Department of Public Safety	13
Department of Revenue	9
Department of Social Services	29
Department of Transportation	74
Division of Criminal Investigation	1
Investment Council	1
Office of the Attorney General	5
Parks & Recreation Division	1
Public Utility Commission	1
SD Building Authority	1
SD Developmental Center	1
SD Federal Property Agency	1
SD Retirement	1

State Facilities	Count
SD State Fair Commission	1
State Fuel Sites	82
Unified Judicial System	1
Total	645

3.4.6 Geologic Hazards

Resources and data did not support a detailed vulnerability and loss estimation for landslides, mudflow, expansive soil, and subsidence impacts on state facilities during the 2007, 2010, 2013, and 2016 updates to this plan. History has proven that earthquakes have not caused significant damage in the State of South Dakota. A 2,500-year probabilistic earthquake scenario was run in Hazus-MH. The results showed no damage to critical facilities. While not specified in Hazus, it is assumed that state facilities would have light to minimal impacts from earthquakes. The detailed results of this scenario are included as Appendix 3E.

Future Vulnerability of State Facilities

At the time this plan was prepared, limited information regarding development of new state facilities was available. Significant population increases and decreases are outlined per county in Section 3.3.1 Growth and Development. These trends should be considered as existing facilities are maintained, improved, and or enhanced. The hazard areas identified in this plan are being considered when new state facilities are constructed. For example, a new prison in Rapid City was originally planned to be built within a floodplain. OEM has coordinated a new site for the prison outside of the floodplain.

An oil refinery is planned for development in Union County between state highways 48 and 50. This refinery may increase economic development in the county leading to an increase in population and therefore an overall increase in vulnerability to natural hazards. The oil refinery may also cause vulnerability to man-made hazards generated by mishaps at the refinery. Operation of this facility began in 2014.

The former Home Stake Gold Mine in Lead has been chosen by the National Science Foundation as a site for a multipurpose deep underground science and engineering laboratory. The underground laboratory and proposed Sanford Science Education Center will provide education and outreach opportunities.

Collecting better data on existing and future state facilities to allow for more detailed analysis is an improvement identified for the next SHMP update, and is addressed in Mitigation Action 2-2 (p5-24).

3.5 Risk Assessment Summary and Conclusions

Although the majority of the state is vulnerable to all the hazards identified and discussed previously, impacts may vary widely in different areas of the state and at different times of year. The hazards as identified in Table 3-1 have impacted or have the potential to impact the citizens and governments of the state to one degree or another at any given time. However, based upon the research and analyses conducted for the HIRA over the years, it is evident that drought, floods, winter storms, wildfires, and tornadoes continue to require the most effort and expense in terms of response and recovery activities and their associated costs.

The following is a summary of the key vulnerabilities, losses and consequences associated with each hazard, based on the HIRA. This summary was added to the HIRA in 2016 to provide a quick reference for planners in the development of mitigation strategies.

Table 3-76 Hazard Risk Summary Table

Hazard	Vulnerability Summary/Problem Statements	State Facility and Critical Infrastructure Impacts	Climate Change Impacts	Overall Planning Significance
Agricultural Pests and Diseases	• Significant pests and diseases include Foot and Mouth Disease, Trichomoniasis, Avian Influenza, West Nile Virus, Rabies, Asian Soybean Rust, Blight, Soybean Cyst Nematode. • Diseases tracked for plants include sunflowers, canola, safflower, field pea, chickpea, lentil, dry bean, soybeans, corn, alfalfa, flax, winter wheat, spring wheat, barley, oats, rye. • Diseases tracked for animals include cattle, swine, poultry, wildlife. • Cattle losses $52 M in 2010 due to respiratory, digestive and other diseases. • $9,626,082 in total indemnity payments between 2003 and 2015 in insect infestation; annual loss of $740,468. • $6,713,015 in total indemnity payments between 2003 and 2015 in plan disease; annual loss of $516,386. • $1,256,854 average annual losses statewide between 2003 and 2015. • Can have devastating impacts on agricultural economy statewide and beyond. • Ag sector impacts can be both direct (impacts to crops in the state) and indirect (impacts to the market from infestations elsewhere). • Livestock exposure is greatest west of the Missouri River. • Crop exposure is greatest east of the Missouri River. • Some outbreaks are associated with drought or warmer than typical winters (grasshoppers, anthrax).	• Risk to state owned/leased buildings and infrastructure is expected to be minimal. • Other critical infrastructure impacts are minimal.	• Climate change can alter and increase the range of many invasive weed species; increasingly powerful storms can exacerbate the spread of diseases; warmer temperatures can aid the spread of warm-weather pests into traditionally colder climates.	Moderate
Summer Storms (Hail and Lighting)	• Added as new hazard profile in 2016 to align state HIRA with hazards identified in local Hazard Mitigation Plans. <u>Hail</u> • Hail impacts vary based on hail diameter, duration, location and exposure. • Over 10,200 separate records of hail incidents between 1996 and 2016.	• Risk to state owned/leased buildings and infrastructure is expected to be minimal; the potential exists for hail damage to state-owned vehicles and	• As climate change warms the earth and affects weather patterns, science shows that storms have generally become more intense, however	Moderate

Hazard	Vulnerability Summary/Problem Statements	State Facility and Critical Infrastructure Impacts	Climate Change Impacts	Overall Planning Significance
	• $8,031,888 average annual property damage statewide between January 1, 1996 and May 30, 2016 for hail; total property damage of $160,637,750. • $2,138,750 average annual crop damage statewide between January 1, 1996 and May 30, 2016 for Hail; total crop damage of $42,775,000. • Average hailstone size in the state is 1.15"; largest recorded is 8" (Vivian, Lyman County, 7/23/2010). • NCEI records 38 hail-related injuries; no hail related deaths between 1996 and 2018. • 95% of recorded incidents did not cause property damage, crop damage, injuries or fatalities. <u>Lightning</u> • Over 100 separate records of lightning incidents recorded between 1996 and 2016. • $108,560 average annual property damage statewide between January 1, 1996 and May 30, 2016 for Lightning; total property damage $2,171,200; no recorded crop damage during this timeframe. • NCEI records 17 lightning-related injuries; five lightning-related deaths between 1996 and 2016.	roofs/windows of state facilities. • Other critical infrastructure impacts minimal; potential for limited energy disruption caused by lightning; critical points should be protected from exposure to hail and lightning	research specific to hail and lighting is sparse.	
Flood (Including Dam and Levee Failure)	• The greatest impacts have been to the eastern half of the state, principally, the Big Sioux, Vermillion, and James River Basins, which have recurring problems. • Flood Insurance policy analysis in 2016 yielded: – The number of policies statewide has fluctuated from 5,406 in 2010, 6,914 in 2012, to 4,684 in 2016. The higher policy count in 2012 is likely a carryover from flooding on the Missouri River in 2011 that generated a lot of interest in flood insurance. – Statewide there has been $40,055,373 in flood loss claims since 1978, an increase of $3,037,150 from the $37,018,223 sum noted previously in the HIRA from November 2012. – Flood loss claims increased from 3,316 in 2010 to 3,344 as of mid-2016.	• Risk to state owned/leased buildings and infrastructure includes the following based on GIS analysis: – There are state facilities potentially at risk to flooding in the following counties: Lawrence, Meade, Pennington, Custer, Fall River, Hughes, Brown, Codington,	• Climate change science indicates potential for increased potential for extreme rainfall events which could indicate increasing flood losses.	High

Hazard	Vulnerability Summary/Problem Statements	State Facility and Critical Infrastructure Impacts	Climate Change Impacts	Overall Planning Significance
	– Flood loss claims result in an average annual loss of $1,054,088 • Repetitive loss properties (2 or more claims in a ten-year period) continue to be an issue. The 2018 repetitive loss statistics indicate: – In 2012, the total amount in repetitive loss claims was $6,700,481. As of 2018, the total had increased to $9,884,620. – The number of repetitive loss properties has increased by 12 since 2012; 28 counties now have repetitive loss properties, an increase of 2 since 2012 (Lincoln and Union added to list). – The counties of Lincoln, Codington, Hamlin, Day, Minnehaha and Brown have the most repetitive loss properties. • Based on numbers of people and property at risk, i.e., the vulnerability of people and property at risk, the cities of Aberdeen, Pierre, Rapid City, Sioux Falls, and Watertown are at the greatest risk from flood events. • Dam failure flooding is included in the flood hazard profile. Of the roughly 2,500 dams, 155 are significant hazard and 89 are high hazard. The Majority of these dams are west of the Missouri River including concentrations in the Black Hills and along the Missouri River corridor.	Roberts, Brookings, Lake, Minnehaha, and Charles Mix. – Of the critical facilities at risk, 392 are non-state critical facilities and 56 are state – Within the DFIRM 1% Annual Chance category, 29 state facilities and 171 Non-state Facilities are at risk. – Within the DFIRM 0.2% Annual Chance category, 23 state facilities and 81 Non-state Facilities are at risk. – Within the category "Area Protected by Levee," 4 state facilities are at risk and 65 non-state facilities are at risk. – Facility valuation data was not available but could be used to refine exposure and loss estimates. • Roads and bridges impacts have resulted in numerous and costly disaster assistance claims. Analysis of FEMA		

Hazard	Vulnerability Summary/Problem Statements	State Facility and Critical Infrastructure Impacts	Climate Change Impacts	Overall Planning Significance
		PA funding from disasters between 1993 and 2014 indicates $203,909,385 have been spent on Category C (Roads and Bridges) and is assumed to represent flood-related public infrastructure damage. The majority of these claims are in the northeast corner of the state.		
Winter Storm	• According to the NCEI, there were 1,971 winter storms (snow and ice events) in South Dakota between January 1993 and March 2016, and 477 extreme cold events from January 1994 to March 2016. • Total property damage for these events is estimated at $91 million dollars. • South Dakota averages 85 winter storms and $4 million in winter storm losses annually, as well as 20 extreme cold events each year. 12 deaths and 127 injuries were attributed to these events. • Approximately 1 death every other year and 6 injuries each year. • $3.3 million in winter-related crop loss indemnities each year. • Cattle impacts have been significant. • An updated statistical analysis resulted in 27 of the 66 counties with a moderate vulnerability ranking, 29 with a high ranking, and 8 with a very high ranking. Pennington and Minnehaha have the greatest amount of critical facilities at risk and very high vulnerability rankings.	• Winter storms have been particularly damaging to electric utilities. Analysis of FEMA PA funding from disasters between 1993 and 2014 indicates $466,422,028 spent on Category F-Utilities, which is assumed to largely represent winter storm losses. This equates to an average annual loss of $21,201,001. • Direct impacts to state owned facilities are not likely to result in losses, but winter storms can temporarily disrupt travel on local, state and federal highways and	• EPA research indicates that the amount of winter precipitation and the number of days with heavy snowfall are projected to increase in northern states. A warming climate may also result in warmer winters.	High

Hazard	Vulnerability Summary/Problem Statements	State Facility and Critical Infrastructure Impacts	Climate Change Impacts	Overall Planning Significance
		result in significant expenses associated with snow removal and first responders assisting stranded travelers.		
Wildfire	• Forests in the Black Hills of western South Dakota have many more trees per acre and much more undergrowth, needle litter and deadwood than it did historically. • Mountain pine beetle attacks in Ponderosa Pine often coincide with abundant weak trees resulting from drought and overgrown conditions, resulting in higher fuel loads. • The greatest concentration of Wildland Urban Interface (WUI) structures is located in and around the communities in the Black Hills. Rapid City and bedroom communities within a five-mile radius of the city represent the greatest concentration of structures located in the forested areas of the Black Hills. The population of new residents is growing, especially in Custer, Pennington, and Meade Counties. • In addition to the Black Hills National Forest, there are fire-prone smaller forested areas on the Custer National Forest in Harding County, and BIA Trust and tribal lands on the Pine Ridge Reservation of Oglala Lakota County, and the Rosebud reservation of Todd County. • The wildfire vulnerability analysis associated with the drought vulnerability assessment noted that the counties of Pennington (Very High), Meade, Lawrence, Custer, Fall River, Oglala Lakota, and Todd have the greatest wildfire exposure based on an analysis of historic fire occurrence, WUI housing units, and population.	• State fire suppression costs have been $2,226,539 annually between 1994-2014. • An analysis conducted as part of the 2015 Drought Mitigation Plan noted a significant increase in fires, acres burned, and suppression costs in drought years. • Risk to state owned/leased buildings and infrastructure includes a number of facilities located in the very high and high vulnerable counties; a more refined vulnerability analysis would be needed to determine site-specific risks. • Other critical infrastructure impacts include impacts to rural electric infrastructure.	• Wildfire conditions across South Dakota are likely to worsen in the future due to climate change given that climate projections indicate continued increasing summer temperatures and milder temperatures overall, thus an extended fire season.	High

Hazard	Vulnerability Summary/Problem Statements	State Facility and Critical Infrastructure Impacts	Climate Change Impacts	Overall Planning Significance
Drought (including Extreme Heat)	• Notable droughts have occurred somewhere in the state on average about every 12 years, which is equivalent of an 8% chance any given year. • The state returned to severe but short-lived drought conditions in 2012-2013 after several wet years. • 13 separate days with a heat-related incident were noted in NCEI 2006-2016; incidents recorded in 2006, 2011, 2012. • These incidents included 1 fatality, ten injuries, $30,000 in property damage (all caused by cattle deaths) and no crop damage. • Sector based analysis for 2015 Drought Mitigation Plan included: – Agriculture – Wildland Fire – Water Resources – Wildlife – Tourism – Health and Indirect Societal Effects • According to the USDA Risk Management Agency, insured crop losses to farmers in the State of South Dakota from 2000 to 2014 as a result of drought conditions totaled $2,579,569,105 which equates to an average annual loss of $189M. • Livestock impacts were estimated at $162 million for the 2012 drought and $92 million in the 2013 drought. • Water supply and water quality impacts have been greatest along the Missouri River corridor counties. • Quantifying losses to other sectors is challenging due to data limitations.	• Direct losses to state owned/leased buildings and infrastructure is expected to be minimal. • State parks in South Dakota are likely to suffer the greatest impacts from drought, particularly those that provide water-based recreational activities. Direct losses to the state can include lost revenue from park access fees and loss in hunting and fishing license revenue. In 2013, there were 20% fewer small game hunting licenses purchased than in 2012 which resulted in a $2 million decrease in revenue. • Other critical infrastructure impacts include impacts to water facilities, reduced hydroelectric power generation during low flows.	• Climate change science indicates changing extremes in precipitation are projected across all seasons, including higher likelihoods of both increasing heavy rain and snow events and more intense droughts. The Northern Plains will remain vulnerable to periodic drought because much of the projected increase in precipitation is expected to occur in the cooler months while increasing temperatures will result in additional evapotranspiration. In regard to temperatures and extreme heat, warmer and more extreme temperatures can exacerbate drought impacts and result in consequences regardless of drought.	High
Tornado	• South Dakota's location in the northern region of Tornado Alley makes it susceptible to the formation of tornadoes due to warm Gulf air coming in contact with cool Canadian air fronts and dry air systems from the Rocky Mountains. The intersection of these	• Risk to state owned/leased buildings and infrastructure is expected to be limited	• There presently is not enough data or research to quantify the magnitude of	High

Hazard	Vulnerability Summary/Problem Statements	State Facility and Critical Infrastructure Impacts	Climate Change Impacts	Overall Planning Significance
	three systems produces thunderstorm conditions that can spawn tornadoes. • According to the National Climatic Data Center, there were 1,711 tornadoes, of which 636 were F1 or higher, in South Dakota between 1950 and 2016 (66 years). Based on this information, the probability that at least one tornado will occur in South Dakota in any given year is 100%. • Annualized losses are estimated at nearly $11 million. • Maps of tornado paths indicate a higher likelihood east of the Missouri River and in the southeastern part of the state. • Based on an updated statistical analysis, the vulnerability rankings yield 37 of the 66 counties with a moderate vulnerability ranking, 27 with a high ranking, and 1 with a very high ranking: Lincoln County. • High ranked counties include: Pennington, Lawrence, Meade, Walworth, Hughes, Brown, Spink, Beadle, Tripp, Todd, Charles Mix, Bon Homme, Hutchinson, McCook, Davison, Yankton, Turner, Clay, Union, Minnehaha, Lake, Kingsbury, Brookings, Hamlin, Codington, Grant, and Roberts.	due to the low likelihood of direct impacts. There are four state owned facilities located in Lincoln County, which has the highest vulnerability to tornadoes. • Other critical infrastructure impacts include impacts to rural electric infrastructure and the potential for direct impacts to local critical facilities.	change that climate change may have related to tornado frequency and intensity.	
Windstorm	• According to the NCEI, there were 7,971 windstorm events (6,901 thunderstorm wind, 1,070 high wind, and 6 strong wind events) in South Dakota between 1955 and July 2016. There were 11 deaths and 136 injuries in this time period. • Total property and crop damage for events between 1993 (when damage figures began being kept) and 2016 is estimated at $151,296,500. • This suggests that South Dakota could experience 272 wind events, $2,605,982 in wind losses, and approximately five injuries each year. • After GIS analysis, the vulnerability rankings concluded that 37 of the 66 counties have a moderate vulnerability ranking, 24 have a high ranking, and 4 have a very high ranking. • Pennington, Meade, Brown, and Minnehaha Counties are all rated very high vulnerability to wind storms.	• Each very highly ranked county has multiple state-owned critical facilities at risk however direct damages are expected to be minimal if buildings are built to modern codes and standards. • Windstorms can create power outages and exacerbate winter storms.	• There presently is not enough data or research to quantify the magnitude of potential change that climate change may have on windstorms.	Moderate

Hazard	Vulnerability Summary/Problem Statements	State Facility and Critical Infrastructure Impacts	Climate Change Impacts	Overall Planning Significance
	• Highly ranked counties include: Butte, Lawrence, Custer, Oglala Lakota, Todd, Hughes, Walworth, Charles Mix, Davison, Beadle, Bon Homme, Hutchinson, Yankton, turner, Clay, Union, Lincoln, Lake, Moody, Brookings, Hamlin, Codington, Grant, and Roberts Counties.			
Hazardous Materials	• Includes both fixed facility and transportation/mobile (air, road, pipeline, rail). • Impacts dependent on type of chemical, type of release, mode, area of release, environmental factors. • U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) statistics indicate 228 reported hazmat incidents (air, highway, water, railway) between 2007 and 2016 that include: – Rail – 7 incidents - $1,790,208 damages – Air – 20 incidents - $0 – Highway – 201 incidents - $1,037,522 – Water – 0 incidents - $0 – 1 incident with a hospitalized injury – 1 incident with a non-hospitalized injury – No recorded fatalities – $2,827,730 in recorded damages – Average 25 hazmat incidents/year – Average $34,910 in annual damage • 2012 Commodity Flow study in western South Dakota showed that the majority of hazardous materials transported on roadways were flammable liquids. • Top ten counties with the most pipelines and potentially higher exposure to an incident are Lincoln, Minnehaha, Brown, Clark, Spink, Butte, Hutchinson, Union, Harding, and Kingsbury; most of these are in the eastern third of the state. • An analysis of Tier II facilities by county yielded that Minnehaha, Pennington, and Harding counties have over 100 facilities.	• Risk to state owned/leased buildings and infrastructure is expected to be minimal; higher risk to facilities that store hazardous materials, or those facilities close to designated transportation routes.	• None expected.	Moderate
Geologic Hazards –	• Includes expansive soils, subsidence, landslide, mudflow, and earthquake.	• Risk to state owned/leased buildings and infrastructure thus	• None expected.	Limited

Hazard	Vulnerability Summary/Problem Statements	State Facility and Critical Infrastructure Impacts	Climate Change Impacts	Overall Planning Significance
Includes Expansive soils, **Subsidence** **Earthquake** **Landslide**	• Extensive expansive soils distribution across state based on US-wide mapping. • Subsidence (sinkhole) potential with Karst terrain in Black Hills, southeast. • Landslides in Black Hills and Missouri River Bluff counties. • Lawrence County landslide along Highway 14A near Cheyenne Crossing in 2012-2013. • Recent earthquakes: – January 16, 2012, magnitude 3.0 near Custer/Fall River/Oglala Lakota border – December 12, 2013, magnitude 3.5, south of Colonial Pine Hills – February 7, 2014, magnitude 3.0, Northwest of Platte • Earthquake loss by county using Hazus resulted in $918M in losses for the 2,500-year probabilistic earthquake.	far has been limited to state highways. • Other critical infrastructure impacts likely to be limited but could include impacts to bridges, pipelines, water distribution systems, and roads. Hazus loss modeling did not result in any damage to critical facilities for the 2,500-year event.		

SECTION 4 STATE CAPABILITY ASSESSMENT

44 CFR Part 201 Requirement:
The mitigation planning process should include coordination with other State agencies, appropriate Federal agencies, interested groups, and be integrated to the extent possible with other ongoing State planning efforts as well as other FEMA mitigation programs and initiatives. *[The State mitigation strategy shall include a] discussion of the State's pre- and post-disaster hazard management policies, programs, and capabilities to mitigate the hazards in the area, including:* *An evaluation of State laws, regulations, policies, and programs related to hazard mitigation as well as to development in hazard-prone areas [and]* *A discussion of State funding capabilities for hazard mitigation projects[.]* *[In order to be eligible for the reduced cost share authorized for the FMA and SRL programs, the State plan must identify] specific actions the State has taken to reduce the number of repetitive loss properties (which must include severe repetitive loss properties) and specifies how the State intends to reduce the number of such repetitive loss properties. In addition, the plan must describe the strategy the State has to ensure that local jurisdictions with severe repetitive loss properties take actions to reduce the number of these properties, including the development of local mitigation plans.*
44 CFR Part 201 Enhanced Plan Requirement:
Enhanced State Mitigation Plans must include… *Demonstration that the plan is integrated to the extent practicable with other State and/or regional planning initiatives (comprehensive, growth management, economic development, capital improvement, land development, and/or emergency management plans) and FEMA mitigation programs and initiatives that provide guidance to State and regional agencies.* *Demonstration that the State is committed to a comprehensive state mitigation program, which might include any of the following:* *A commitment to support local mitigation planning by providing workshops and training, State planning grants, or coordinated capability development of local officials, including Emergency Management and Floodplain Management certifications.* *A statewide program of hazard mitigation through the development of legislative initiatives, mitigation councils, formation of public/private partnerships, and/or other executive actions that promote hazard mitigation.* *A comprehensive, multi-year plan to mitigate the risks posed to existing buildings that have been identified as necessary for post-disaster response and recovery operations.* *A comprehensive description of how the State integrates mitigation into its post-disaster recovery operations.*

The State of South Dakota has established a comprehensive, multi-faceted state hazard mitigation program. State mitigation initiatives are integrated with Federal Emergency Management Agency (FEMA) programs and are designed to focus federal and state programs in support of local planning efforts. State mitigation planning is integrated with other state emergency management efforts as well as other state and regional planning initiatives.

True success in reducing the statewide risk to all hazards requires strong collaboration among state agencies, federal agencies, and local and tribal governments. Thus, while the SHMP is written to be a stand-alone document, it is closely linked to other state plans and program initiatives. Throughout the 2019 Plan update process, other plans, programs, and initiatives were reviewed to ensure they were integrated into the Plan. This section outlines the capabilities and activities of state agencies that support hazard mitigation, and how those programs are integrated with the SHMP. The integration of the SHMP with other state planning initiatives primarily occurs through the assessment of state capabilities, cross-referencing between different plans, and through participation on planning committees and policy commissions.

Supporting local mitigation efforts is a top priority for the state. In order to prioritize these needs, an assessment of local capabilities is included in Section 4.6. That section also summarizes local risk reduction capabilities, as well as completed and identified mitigation actions noted within the LHMPs.

4.1 2019 Updates to the Capability Assessment

The state's capability assessment has been updated to reflect changes to risk reduction policies, programs, and funding opportunities that are managed by the various state agencies and cooperating federal agencies. At the December 14, 2017 SHMT kickoff meeting agencies were asked to review their respective capabilities within the previous SHMP and complete a questionnaire answering the following three questions:

1. What programs does your agency provide that support risk reduction activities?
2. What policies does your agency enforce that encourage mitigation measures?
3. What funding opportunities does your agency offer for risk reduction, community resiliency, and mitigation activities?

The results of this input were summarized and reviewed at the March 22, 2018 workshop and used to inform the update of this plan.

During the 2019 plan update, the SHMT reviewed the mitigation-related plans and programs of other state and regional agencies. Since response and recovery plans and programs also typically have a mitigation component, the SHMT also incorporated those plans in this review. The purpose of this review was to identify changes, updates, and/or additions since the 2014 Mitigation Plan update to incorporate relevant data and capabilities into the mitigation plan and to better understand areas where mutual responsibilities and policies could be leveraged. This review culminated in an analysis of strengths, weaknesses, opportunities, and threats (SWOT) conducted at the August 16, 2018 meeting.

The local capability assessment section was also updated based on a review of local hazard mitigation plans (LHMPs) conducted in 2018, and documents local capabilities self-identified in those plans.

Finally, the capability assessment was expanded to better describe coordination and integration efforts between agencies and stakeholders, to ensure the SHMP is part of a comprehensive statewide program of hazard mitigation, risk reduction, and increased resiliency, in accordance with the Enhanced Plan requirements of 44 CFR §201.5.

4.2 Integrated Hazard Mitigation Planning

44 CFR Part 201 Requirement:
The mitigation planning process should…be integrated to the extent possible with other ongoing State planning efforts as well as other FEMA mitigation programs and initiatives. *[The State mitigation strategy shall include an] evaluation of State laws, regulations, policies, and programs related to hazard mitigation as well as to development in hazard-prone areas.*
44 CFR Part 201 Enhanced Plan Requirement:
Enhanced State Mitigation Plans must include… *Demonstration that the plan is integrated to the extent practicable with other State and/or regional planning initiatives (comprehensive, growth management, economic development, capital improvement, land development, and/or emergency management plans) and FEMA mitigation programs and initiatives that provide guidance to State and regional agencies.* *Demonstration that the State is committed to a comprehensive state mitigation program, which might include… the development of legislative initiatives, mitigation councils, formation of public/private partnerships, and/or other executive actions that promote hazard mitigation.*

4.2.1 South Dakota Hazard Mitigation Team (SHMT)

The South Dakota Hazard Mitigation Team (SHMT) is the principal body responsible for coordinating the state's comprehensive hazard mitigation program. The SHMT coordinates the integration of all state hazard mitigation and risk reduction efforts with the SHMP by ensuring that all member agencies are aware of the data, programs, and priorities of other state agencies, and how they can be integrated into their own plans. Through the SHMT, OEM planners are made aware of the data, programs, and priorities of other state agencies. Conversely, other agencies become more knowledgeable about mitigation policies and programs and how they can be integrated into their own plans.

The SHMT was established via a series of Executive Orders, the most recent being EO 2007-07 dated April 4, 2007, and updated by a Governor's letter dated October 23, 2014 which remained effective for the 2018-2019 Plan update. The Governor charged the SHMT with "eliminating or reducing the physical and financial impacts of natural disasters upon the governments and citizens of South Dakota by implementing a statewide Hazard Mitigation Program based upon Section 409 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act." Duties and responsibilities of the team are identified as:

- Meet periodically to review and update the State Multi-Hazard Mitigation plan as needed or at least every five years.
- Establish statewide hazard mitigation goals and objectives.
- Establish priorities for categories of hazard mitigation projects.
- Review and evaluate hazard mitigation grant applications for funding approval within the guidelines of the State Multi-Hazard Mitigation plan.
- Assist in the writing, preparation, and coordination of the State Multi-Hazard plan.

The SHMT consists of individuals from the following agencies, as designated by the Governor:

- South Dakota Office of Emergency Management – Chair
- Office of the Governor

- Governor's Office of Economic Development
- Department of Tourism
- Department of Agriculture
- Department of Game Fish and Parks
- Department of Health
- Department of Transportation
- Bureau of Administration, Office of Risk Management
- Department of Environmental and Natural Resources
- South Dakota State University, State Climatologist
- Department of Tribal Relations

(The original 2007 Executive Order did not formally include the Department of Environmental and Natural Resources or the State Climatologist; they were added via the Governor's October 23, 2014 letter. Conversely, the 2007 Executive Order did include the State Historic Preservation Office (SHPO), which was not formally listed in the 2014 letter, although the SHPO continues to participate in the SHMT when needed.)

In situations where expertise is required beyond that available within the SHMT, the SHMO will identify those needs and make a request through the GAR for additional assistance. The GAR will contact the recommended agencies for such supplemental assistance.

The SHMT has met 10 times since 2014, on the following dates:

- April 8, 2014 (project review)
- September 26, 2015 (project review)
- May 13, 2015 (project review)
- May 23, 2016 (project review)
- June 2, 2016 (planning)
- September 9, 2016 (planning)
- November 7, 2016 (project review)
- December 14, 2017 (planning)
- March 22, 2018 (planning)
- August 16, 2018 (planning)

As indicated above, half of these meetings focused on reviewing and approving mitigation projects, while the other half were primarily planning meetings for this Plan update. Many SHMT meetings are held in conjunction with meetings of the USACE Silver Jackets program, which helps improve participation and coordination with federal agencies and other stakeholders.

4.2.2 State Drought Task Force

Another critical interagency coordinating structure is the State Drought Task Force (DTF), which was created by Governor Daugaard in July of 2012, and has been active since particularly during times of drought. The task force is co-chaired by the Department of Agriculture and the Office of Emergency Management and consists of various state agencies to include the Governor's Office, Department of Environment and Natural Resources, Department of Game, Fish and Parks, South Dakota National Guard, and Bureau of Information and Telecommunications. The goal of this task force is to monitor drought conditions by gathering the best, most current data available and to make sure that South Dakotans have access to that information as quickly as possible. The group coordinates the exchange of drought information among government agencies and agriculture groups, fire managers, and water-supply organizations. The task force also monitors the impact of drought on economic sectors of the state.

Citizens affected by drought are provided with a forum in which they can ask questions about drought conditions and obtain information on help available to them. (http://drought.sd.gov/)

The Task Force oversaw the development of the South Dakota Drought Mitigation Plan, which provides a strategy for the state to reduce the impacts of drought-related water shortages over the short and long term. The Drought Plan was completed in November 2015 as a hazard-specific supplement to the SHMP. For the Drought Plan's next update, the task force is considering whether to keep it as a separate plan, or fully incorporate it into the SHMP. There are two major components of the plan: the mitigation strategy and vulnerability assessment. Mitigation actions from the Drought Plan that were ranked as having a High priority are included in the Mitigation Strategy section of this Plan.

Other drought-related initiatives included attending the Western Governors' Drought Forum and a series of five regional workshops and webinars. Each regional Drought Forum workshop featured a case study on drought management. South Dakota OEM participated as a partner in the forum, which included attendance at a forum on drought impacts and solutions for various sectors in Tempe, Arizona (October 2014), Sacramento, California (November 2014), and Las Vegas, Nevada (December 2014).

DTF members also joined SDSU representatives at the NIDIS Missouri River Basin Regional Drought Early Warning System development in 2014. The purpose of this effort was to bring together a diverse group of federal, state, tribal, local partners and stakeholders from the water- and land-management communities, to discuss and understand decision-makers' needs for drought, climate, weather, and water-related information and improving our capacity to meet those needs across the Missouri Basin. This included engagement with participants from several South Dakota tribes at a workshop in Rapid City in September 2014.

The Drought Task Force was reactivated by the Governor on June 8, 2017 to monitor drought conditions across the state and remains active as of October 2018. During that period, it has met three times: January 25, March 22, and September 26, 2018. Topics discussed included:

- Current and forecasted drought conditions
- Agricultural and water supply impacts
- Wildfire outlook
- A review of agency capabilities as per the Drought Plan
- Coordination with USACE

4.2.3 State Laws, Regulations & Policies

The South Dakota State Hazard Mitigation Plan is an important component of state-level programs for management of disasters and their impacts. The plan is written to comply with all relevant federal laws and regulations, as described in Section 1.1, and to be consistent with and supportive of all state policies, plans, and implementation procedures that govern mitigation-related programs. The South Dakota laws, regulations, and policies that are most relevant to the hazard mitigation program are described below.

SD Codified Law § 34-48A: Emergency Management

The primary state law regulating hazard mitigation in South Dakota is South Dakota Codified Laws Title 34 - Public Health and Safety, Chapter 48A - Emergency Management § 34-48A.

The purpose of this section is "to ensure that preparation of this state will be adequate to deal with an emergency or disaster, and to provide for the common defense and to protect the public peace, health,

and safety and to preserve the lives and property of the people of the state." §34-48A forms the legal basis for OEM's activities, to include hazard mitigation.

SD Codified Law § 41-20A: Fire Prevention and Suppression

This law establishes the Division of Wildland Fire within the Department of Agriculture, charging them with "prevention, fire suppression, fuels mitigation and reduction, education, and training of homeowners, the public, and firefighters, along with other duties or responsibilities as may be necessary to fulfill the purpose of this chapter." [Emphasis added.] This section also establishes the state fire suppression special revenue fund, which is used primarily to pay for firefighting costs but can also fund fire prevention measures.

SD Codified Law § 10-10: Building Codes and Standards

SD Codified Law § 10-10 adopts the current (2018) edition of the International Building Code (IBC) as the state standard for new construction anyplace that has not adopted other local standards. The section exempts "any one or two family dwelling, mobile or manufactured home, townhouse, or farmstead and any accessory structure or building thereto" from these standards. While South Dakota law does not mandate that local governments must adopt building codes, §10-10 states that if any local government does adopt any construction code or standards, they must comply with the IBC. However, the section does allow local jurisdictions to "amend, modify, or delete any portion of the International Building Code" before adoption.

Efforts by the state to coordinate and encourage local adoption of building codes are described below in Section 4.6.5. See also Section 5.2.3, Item 2-1 for a mitigation action pertaining to the integration of floodplain management ordinances into local building codes.

SD Codified Law § 31-14: Maintenance and Inspection of Bridges and Culverts

SD Codified Law § 31-14 specifies inspection requirements for bridges and culverts on non-state highways. The law requires that culverts be inspected annually by the township board of supervisors or the county highway superintendent. County highway superintendents are also responsible for inspecting all bridges in their county "at reasonable intervals." The chapter further specifies that all such bridges and culverts "shall be maintained and kept clean at the expense of the township."

Executive Orders: SHMT Agency Designation

As noted above in Section 4.1, the South Dakota Hazard Mitigation Team (SHMT) has been established through a series of Executive Orders and Governor's letters. In FEMA's comments on the 2014 SHMP, the Executive Order designating the SHMT duties and membership was highlighted as "a best practice and example for other states in how to increase commitment and engagement across state agencies." The following is a list of the executive orders that designate SHMT membership and collaboration:

- Executive Order 93-12, dated October 19, 1993
- Executive Order 97-14, dated October 21, 1997
- Executive Order 2003-12, dated December 8, 2003
- Executive Order 2007-07, dated April 4, 2007
- Governor's Letter to SHMT Members, dated October 23, 2014

SHMT Policies

HMGP State Match Policy: In some cases, the state may cover a portion of the required 25% local match on FEMA HMGP grants to provide further incentives to utilize the funding and provide additional financial assistance to communities with a demonstrated need. The policy is discussed in detail in Section 4.6.1.

Home Mitigation Project Policy: This policy, originally adopted by the SHMT in August 2011, established that acquisition projects are the only mitigation projects related to private residences that will be funded with HMGP funds. The SHMT later amended this policy to also allow relocation projects.

Pre-Disaster Mitigation Plan Policy: In order to foster LHMP updates with limited planning funds, the SHMT decided in April 2012 that all applications for mitigation plan funding going forward must have a minimum of two bids and a brief explanation on the selection process. If at least two bids are not submitted with the application, no funding will be considered for the applicant until they can successfully fulfill the requirement.

Other Regulations

While state law or regulations do not include any restrictions on development in floodplains or other hazard areas, local flood damage prevention ordinances regulate building and development in Special Flood Hazard Areas. OEM also works with NFIP communities to promote participation in the CRS program, which strengthens local floodplain management practices; see Section 4.3.3 below.

4.2.4 State Hazard Mitigation Capabilities and Program Integration Summary

South Dakota' integrated hazard mitigation program leverages the respective hazard mitigation capabilities of the agencies represented on the SHMT. Table 4-1 summarizes all capabilities identified by participating state agencies in terms of programs, policies, and funding sources. Those capabilities that are **bolded** in the table are discussed in the following sections (Sections 4.3 and 4.4) that provide more details in relation to the specific agencies. Funding sources are discussed in more detail in Section 5.3. Federal partners also play an important role in hazard mitigation in South Dakota. These are summarized in Table 4-2.

Table 4-1 Summary of State Hazard Mitigation Capabilities by Agency

Plan Section	Agency	Programs	Policies	Funding
4.3	SD Office of Emergency Management	• **SHMT Lead** • **Drought Task Force co-chair** • **NFIP** • **Risk Map** • **Repetitive Flood Loss Properties** • **State Emergency Operations Plan** • **State Recovery Plan** • State Hazard Mitigation Plan • Public Outreach and Education • Severe weather awareness campaign • PA reservists to help during and after a disaster	• **Home Mitigation Project Policy** • **Pre-Disaster Mitigation Plan Policy** • **HMGP State Match Policy** • Local floodplain ordinances	• **Hazard Mitigation Grant Program** • **Pre-Disaster Mitigation Grant Program** • **Flood Mitigation Assistance** • Public Assistance Section 406 • Increased Cost of Compliance Coverage • Emergency Management Performance Grant • General funds
4.4.6	SD Bureau of Information and Telecommunications	• **GIS Data and Training** • **State Radio System** • **SD Public Broadcasting** • **Business Continuity** • LiDAR data		• BIT is an unfunded agency. Tasks must be funded by the requesting agency.
4.4.9	SD Game, Fish, and Parks	• **SHMT member** • **Statewide Comprehensive Outdoor Recreation Plan** • Private Lands Habitat and Access Strategic Plan • Habitat and Access Programs for Landowners • Wildlife Damage Management	• GF&P Commission	• State funds for dam maintenance • General funds
4.4.2	SD Department of Agriculture (SDDA)	• **SHMT member** • **Drought Task Force co-chair**		• State fire suppression special revenue fund • General funds

Plan Section	Agency	Programs	Policies	Funding
		• **Wildland Fire Suppression (Black Hills Protection District and Community Wildfire Protection Plans)** • **Conservation (Forest Action Plan)** • **Beat the Beetles MPB Black Hills** • **Firewise** • Grasshopper Management • Pest and Disease Control • Soil, wind, water		
4.4.3	SD Department of Transportation	• **SHMT member** • **Emergency Relief Program** • SD Strategic Highway Safety Plan • SD DOT Annual Report • SD Statewide Long Range Transportation Plan • DOT Strategic Plan • Safetravelusa.com • 511 Travel Information • Public Outreach and Education • SDDOT Bridge Inspection Program		• **Emergency Relief Funding** • General funds
4.4.1	SD Department of Environment and Natural Resources	• **SHMT member** • **Dam Safety** • Oil and Gas Initiative • Geologic Information and Maps • Hazardous Waste and Hazardous Waste Manage Firms List	• Flood Control Project Permitting Requirements • Dam Permitting Requirements •	• **Water and Waste Funding** • General funds

Plan Section	Agency	Programs	Policies	Funding
		• Mineral and Mining • Spills and Spills Database • Watershed Protection • Wellhead Protection • Drinking Water • Ground Water Quality • Flood Drainage Technical Assistance • Stormwater		
4.4.4	State Historic Preservation Office	• **SHMT member** • Public education on historic property mitigation • National Historic Preservation Act review and mitigation recommendations	• National Historic Preservation Act – Section 106	• **Deadwood Grant** • General funds
4.4.7	SD Office of Risk Management	• **SHMT member** • Property Insurance • Boiler Insurance • Aviation Insurance • Fidelity Bond • Risk audits of state government buildings • Public entity pool for liability	• Loss Control Committees	• Extraordinary Training Fund • General funds
4.4.8	SD Office of Homeland Security	• **THIRA** • **Homeland Security & Emergency Management Senior Advisory Committee** • ACAMS assessments for government buildings, hospitals, and schools • Regional Response Teams		• State Homeland Security Grant for funding of radios, communication towers, generators, shelters, warning sirens, regional response teams • General funds

Plan Section	Agency	Programs	Policies	Funding
4.4.5	SD Department of Health – Office of Public Health Preparedness and Response	• **SHMT member** • **Hospital Preparedness Program (HPP)** • **Public Health Emergency Preparedness Program (PHEP)** • SD Department of Health 2020 Plan	• Preparedness Activities – planning, training, and exercises across 15 capabilities for public health and hospital preparedness	• Office of the Assistant Secretary for Preparedness and Response (ASPR) Funding • Center for Disease Control Funding (PHEP) • General funds
4.4.10	South Dakota State University (SDSU) Extension	• **State Climatologist** • **SHMT member**		

Table 4-2 Summary of Federal Partner Capabilities In South Dakota

Section	Agency	Programs	Policies	Funding
4.5.1	US Army Corp of Engineers (Omaha and St. Paul Districts)	• **Silver Jackets** • **Floodplain Management Service Program** • Continuing Authorities Program • General Investigations • Construction General • Planning Assistance to States and Tribes • Tribal Partnership Program • Operation and Maintenance • Drought Assistance	• Executive Order 1198 to avoid spending federal dollars in the floodplain • PL84-99 Emergency Preparedness, Response, and Recovery	• General Investigations • **Floodplain Management Service Program** • Technical Assistance for Drought, Landslides, Mudslides • Planning Assistance • Section 22 Assistance • Section 203 Tribal Partnerships
4.5.7	Federal Highway Administration	• FHWA National Bridge Inspection Program	• Emergency Relief Manual	• SD DOT Emergency Relief (ER) Program
4.5.3	Natural Resource Conservation Service	• Drought Assistance		• Environmental Quality Incentives Program Initiatives
4.5.4	US Geological Survey	• Flood Inundation Mapping Program		• National Earthquake Hazards Reduction Program (NEHRP)

Section	Agency	Programs	Policies	Funding
		• National Earthquake Information Center (NEIC) • "Did You Feel It?" program • Cooperative Water Program • National Streamflow Information Program • WaterUse Program • WaterAlert & WaterNow applications • Hydrologic Investigation Program • WaterWatch Program • Groundwater Level Monitoring Programs		• USGS receives only a portion of the budget from federal funding, the balance of activities is funded from full or matching dollars from other federal, state, and local partners.
4.5.8	Housing and Urban Development (HUD)			• **Community Development Block Grant - Disaster Recovery Grants (CDBG_DR)**
4.5.5	National Weather Service	• **StormReady** • **Weather-Ready Nation Ambassadors** • Severe weather and flood warnings • Weather and flooding safety guides • NOAA radio broadcasts • Storm Spotter training		
4.5.6	US Bureau of Land Reclamation	• WaterSMART Program • Water Conservation Field Services Program • Rural Water Supply Program • Resource Management and Planning		

Section	Agency	Programs	Policies	Funding
		• National Irrigation Water Quality Program • Flood Hydrology and Consequences Group • Drought Program • Dam Safety • Building Seismic Safety Program • Snowpack and Reservoir Levels		

Table 4-3 below identifies which departments/agencies have subject matter expertise in each of the hazards identified in Section 3 Hazard Identification and Risk Assessment (HIRA). This was created to demonstrate how the SHMP planning process and the statewide mitigation program includes state agencies with expertise across all identified hazards. The table also serves as an easy reference for which agencies can be consulted when discussing mitigation options for different hazards and highlights the comprehensive all-hazards nature of South Dakota's hazard mitigation program.

Table 4-3 State/Regional Agency Hazard Expertise

State Agency (SHMT Members are bolded)	Agricultural Pests & Disease	Flood	Summer Storm	Winter Storm	Wildfire	Drought	Tornado	Windstorm	Hazardous Materials	Geologic Hazards
Bureau of Administration – Office of Risk Management										
Bureau of Information and Telecommunications										
Department of Agriculture	X				X	X				X
Department of Environment and Natural Resources (DENR)		X				X			X	X
DENR - Division of Environmental Services		X				X			X	
DENR – Division of Financial and Technical Services – Geological Survey		X				X				X
DENR – Division of Financial and Technical Services – Watershed Protection		X				X				
Dept. of Health – Office of Public Health Preparedness & Response	X	X							X	
Department of Public Safety – Office of Emergency Management	X	X	X	X	X	X	X	X	X	X
Department of Public Safety – Office of Homeland Security									X	
Department of Tourism					X	X				
Department of Transportation		X		X					X	X
Game, Fish & Parks	X	X				X				X
Governor's Office of Economic Development										
State Emergency Response Committee									X	

State Agency (SHMT Members are bolded)	Agricultural Pests & Disease	Flood	Summer Storm	Winter Storm	Wildfire	Drought	Tornado	Windstorm	Hazardous Materials	Geologic Hazards
State Historic Preservation Office										
SDSU Extension – State Climatologist		X	X	X	X		X	X		
Regional Planning Districts										
Rural Electric Cooperatives			X	X	X			X		
Silver Jackets		X								

Table 4-4 shows which SHMT members and other state agencies relate to each of seven sectors defined in the 2015 FEMA State Mitigation Plan Review Guide. This helps demonstrate cross-sector coordination and integration by ensuring state government is adequately addressing all sectors during the SHMP planning process, and as part of the broader statewide hazard mitigation program. The table helps identify which agencies have expertise in and the responsibility or authority to implement mitigation actions with other planning initiatives and mitigation programs into ongoing state activities that achieve risk reduction and resilience.

Table 4-4 State/Regional Agency Integration by Sector

Agency/Organization (SHMT Members are bolded)	Emergency Management	Economic Development	Land Use Development	Housing	Health & Social Services	Infrastructure	Natural & Cultural Resources
Bureau of Administration – Office of Risk Management	X					X	
Bureau of Information and Telecommunications		X				X	
Department of Agriculture	X	X	X				X
Department of Environment and Natural Resources (DENR)	X	X	X		X	X	X
DENR - Division of Environmental Services		X	X				X
DENR – Division of Financial and Technical Services – Geological Survey		X	X			X	X
DENR – Division of Financial and Technical Services – Watershed Protection			X			X	X
Dept. of Health – Office of Public Health Preparedness & Response	X				X		
Department of Public Safety – Office of Emergency Management	X	X	X	X	X	X	X
Department of Public Safety – Office of Homeland Security	X				X	X	
Department of Tourism		X					
Department of Transportation	X		X			X	X
Game, Fish & Parks			X				X
Governor's Office of Economic Development		X	X	X			
State Emergency Response Committee	X					X	
State Historic Preservation Office			X				X
SDSU Extension – State Climatologist		X	X				X
Regional Planning Districts	X	X	X				
Rural Electric Cooperatives						X	
Silver Jackets	X					X	

4.3 South Dakota Office of Emergency Management (OEM)

44 CFR Part 201 Requirement:
The mitigation planning process should include coordination with other State agencies, appropriate Federal agencies, interested groups, and be integrated to the extent possible with other ongoing State planning efforts as well as other FEMA mitigation programs and initiatives. *[The State mitigation strategy shall include a] discussion of the State's pre- and post-disaster hazard management policies, programs, and capabilities to mitigate the hazards in the area.* *[In order to be eligible for the reduced cost share authorized for the FMA and SRL programs, the State plan must identify] specific actions the State has taken to reduce the number of repetitive loss properties (which must include severe repetitive loss properties) and specifies how the State intends to reduce the number of such repetitive loss properties. In addition, the plan must describe the strategy the State has to ensure that local jurisdictions with severe repetitive loss properties take actions to reduce the number of these properties, including the development of local mitigation plans.*
44 CFR Part 201 Enhanced Plan Requirement:
Enhanced State Mitigation Plans must include… *Demonstration that the plan is integrated to the extent practicable with other State and/or regional planning initiatives (comprehensive, growth management, economic development, capital improvement, land development, and/or emergency management plans) and FEMA mitigation programs and initiatives that provide guidance to State and regional agencies.* *Demonstration that the State is committed to a comprehensive state mitigation program, which might include any of the following:* *A commitment to support local mitigation planning by providing workshops and training, State planning grants, or coordinated capability development of local officials, including Emergency Management and Floodplain Management certifications.* *A statewide program of hazard mitigation through the development of legislative initiatives, mitigation councils, formation of public/private partnerships, and/or other executive actions that promote hazard mitigation.*

An office within the state Department of Public Safety, the South Dakota Office of Emergency Management (OEM) provides leadership for the overall state mitigation strategy and works in collaboration with other state agencies to ensure that the various mitigation programs complement each other and work toward achieving the state's overall mitigation strategy.

There are several programs administered by OEM related to development and implementation of the state mitigation strategy. These programs include:

4.3.1 OEM Mitigation Section

The OEM Mitigation Section is the primary state entity responsible for coordinating and facilitating technical assistance for local hazard mitigation planning. The Mitigation Section is comprised of the State Hazard Mitigation Officer (SHMO), a Mitigation Specialist, and a Mitigation Disaster Reservist.

The SHMO and the rest of the Mitigation Section are responsible for coordinating and supporting the SHMT, as detailed in Section 4.2.1 above. The Mitigation Section maintains the State Hazard Mitigation Plan and assists local jurisdictions with development and updates of local hazard mitigation plans.

Mitigation Section staff work to promote mitigation activities, works with jurisdictions and agencies to identify potential projects, maintains a strong public outreach effort on the mitigation grant processes and requirements, and maintains a database of all the projects for programmatic and finance performance. Staff assists sub-applicants with submitting complete applications, provides technical assistance to all sub-applicants in all aspects of the grants process, and serves as a liaison between sub-applicants and FEMA Region VIII. Staff completes the state quarterly report, based on reporting from sub-applicants, and submits the report to FEMA. Staff ensures projects follow the approved scope of work, conducts final project inspections, reviews all requests for close-out, and submits final project and disaster close-out requests to FEMA. The Mitigation Section also maintains the state HGMP Administrative Plan and develops a Hazard Mitigation Program Strategy for each federally-declared disaster, which lays out disaster-specific mitigation objectives, identifies mitigation actions, and provides a framework for implementing long-term cost, effective measures to minimize future disaster damages statewide.

4.3.2 Hazard Mitigation Grants and Program Management

OEM funds mitigation activities in the state primarily through federal grant programs, supplemented by state, federal, and private/NGO programs. These grants are described in detail in Section 5.3.2. The demonstrated effective use and management of hazard mitigation grant funding are discussed in Section 5.4.

4.3.3 National Flood Insurance Program (NFIP)

The state promotes overall flood risk reduction and sound floodplain management practices through its support of FEMA's National Flood Insurance Program (NFIP).

The state has designated a state NFIP Coordinator who administers, promotes, and provides training on all aspects of the NFIP, including providing technical assistance to local communities on floodplain management, flood insurance, and map related issues. The NFIP Coordinator provides information at commission meetings to communities that currently do not participate in the NFIP and meets with county and city commissioners to maintain awareness, create a desire to learn more about the programs, and assist in resolving issues relating to program compliance and floodplain management. The NFIP Coordinator conducts approximately 10-12 Community Assistance Visits each year. Pamphlets and/or manuals are distributed to local officials outlining the NFIP. A Floodplain Administrators Directory and information bulletin are prepared and distributed biannually to local floodplain administrators and FEMA.

Figure 3-50 in Section 3 portrays South Dakota's Digital Flood Insurance Rate Map (DFIRM) coverage as of 2016. Thirty-one counties currently have effective DFIRMS; this is an increase of one since the 2014 Plan update. South Dakota has made significant progress in this area since 2011, when only seventeen counties had effective DFIRMs.

As of July 2018, there are a total of 229 communities throughout the State of South Dakota participating in the NFIP, according to NFIP Community Status Book at www.fema.gov/fema/csb.shtm. This is one more community than was participating at the time of the 2014 plan update. The list of participating communities is included as Appendix 4A.

The state has a recommended flood ordinance, but no statewide rules or regulations related to floodplain development. At present, OEM encourages floodplain legislation at the local level.

Repetitive Flood Loss Strategy

FEMA defines a Repetitive Loss (RL) property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling ten-year period. Since 1978, 191 properties in 27 South Dakota counties have suffered repetitive losses, submitting a total of 440 claims worth nearly $9.6 million. Fourteen of those properties have been successfully mitigated, leaving 177 Repetitive Loss properties in the state, see Section 3.3, Table 3-47 for more information.

FEMA further defines Severe Repetitive Loss properties as any single-family property for which the NFIP has paid four or more claims exceeding $5,000 and with the cumulative amount of such claims payments exceeding $20,000. Fortunately, there is only one property in South Dakota that meets the definition of a Severe Repetitive Loss property: a property in Beadle County with three losses totaling $72,899.50.

The SHMP has a legacy objective under goal two related to "reducing the number of repetitive flood loss structures." During the 2019 update a more specific mitigation action was developed titled "Map repetitive flood loss properties to identify concentrations of properties or high losses and identify potential mitigation options." This more specific repetitive flood loss strategy will be done in cooperation with the USACE Silver Jackets and will result in mitigation of more properties in the future. See the mitigation strategy in Section 5.2 for more information.

Community Assistance Program – State Support Services Element (CAP-SSSE)

The Community Assistance Program – State Support Services Element (CAP-SSSE) program provides funding to states for technical assistance to communities in the NFIP, and for evaluating community performance in implementing NFIP floodplain management activities. In this way, CAP-SSSE helps to:

- Ensure that the flood loss reduction goals of the NFIP are met,
- Build state and community floodplain management expertise and capability, and
- Leverage state knowledge and expertise in working with their communities.

As the State Coordinating Agency for CAP-SSSE, OEM has the responsibility to direct activities related to proper floodplain management and implementation of the goals of flood loss reduction and education within the state. The NFIP Coordinator works closely with local floodplain managers across South Dakota by providing assistance on FEMA map revision applications, floodplain development permitting and other technical floodplain issues. In many instances, the managers may be city or county finance officers or planning officials, depending on staffing levels within the participating NFIP community.

The NFIP verifies compliance with the CAP by conducting Community Assistance Visits (CAVs). These visits assess "the community's floodplain management program; assist the community and its staff in understanding the NFIP and its requirements; and assist the community in implementing effective flood loss reduction measures when program deficiencies or violations are discovered." These CAV meetings often identify, prevent and resolve floodplain management issues before they develop into problems that require enforcement actions and monetary penalties. The NFIP Coordinator conducts typically 10-12 CAVs per year. Communities that participate in the NFIP are generally visited every three to five years.

Community Rating System (CRS)

OEM encourages communities to join the Community Rating System (CRS), which provides discounts on flood insurance premiums for communities that go above and beyond the minimum requirements of the NFIP. The NFIP Coordinator assists local NFIP participating communities in joining the CRS Program by

providing general technical assistance, conducting entry CAVs, and offering state support for activities credited for points by CRS. State support may include:

- obtaining copies of surface water discharge permits issued by DENR for industrial operations within the particular community (5 CRS points),
- obtaining the emergency preparedness plans for any hydraulic dams within the community and state dam safety program (45 CRS points),
- providing NFIP informational handouts and pamphlets to be displayed in the building permit kiosk area of the local government administration building (2 CRS points per handout).

Interested communities are required to have a successful CAV meeting six months prior to their CRS application submittal.

As of November 2018, seven South Dakota communities (one county and six cities) participate in the CRS, and 29.5% of flood insurance policies in the state receive some level of CRS discount. OEM's goal is to add two new CRS communities each year.

4.3.4 Risk Mapping, Assessment, and Planning (Risk MAP)

FEMA's Risk MAP is an action-driven program that emphasizes community participation, adopting mitigation plans, communicating risk to citizens, implementing mitigation actions to reduce risk, and utilizing mitigation plans to secure grant funding. Through Risk MAP, FEMA provides information to enhance local mitigation plans, improve community risk awareness outreach, and increase local resilience to flooding. Through collaboration with state, tribal, and local entities, Risk MAP delivers quality data that increases public awareness and leads to action that reduces risk to life and property.

As participant in FEMA's Risk MAP Program South Dakota is currently analyzing the flood risk for 27 counties in the eastern part of the state using the two-dimensional HEC-RAS 5.0.1. Not only is the project identifying the boundary limits of the 100-year and 500-year floodplains, but also producing water surface elevations for multiple lower return periods, model - backed flood depth information for these identified floodplains, the corresponding water surface elevations, and velocity grids of potential floodwaters. The floodplains were derived from new state-collected LiDAR, which is a much more accurate terrain source than the older USGS topographic maps used during initial flood mapping in the past. For counties west of the existing FEMA Risk Map project area, there are efforts to collect LiDAR for the rest of the State. The long term goal is to hopefully have a base level engineering flood risk assessment run for the entire state of South Dakota.

State OEM staff attended 54 local government meetings with FEMA to discuss the mapping project and attempted to gather structure information needed for the new hydraulic models. The State is actively promoting the availability of this newly produced flood risk assessment data – which can be downloaded at http://bit.ly/SDakotaMapJournal - to local officials through newsletters, emails and conversations, so individuals are truly aware of their potential flood risk. The State is urging communities to utilize this data for future planning purposes and to develop potential flood mitigation projects in elevated risk areas; and is currently coordinating with FEMA on local meetings starting in 2019 to begin sharing the latest version of the flood risk maps before going preliminary and eventually effective.

4.3.5 Hazard Mitigation Training Program

The OEM Mitigation Section develops and promotes mitigation training to meet the needs of sub-applicants and other stakeholders. Starting with Fiscal Year 2013, OEM adopted a comprehensive training program for emergency management stakeholders. These requirements were adopted in response to changes in grant guidance from the U.S. Department of Homeland Security. The guidance calls for an increased number of trainings and exercises with a strong all-hazards focus. The program also lists recommended courses, course scheduling, and instructor qualifications/requirements.

The 2016-2018 SD training plan includes several recommended courses focusing on mitigation, to include G-318 Local Mitigation Planning, and G-393 Mitigation for Emergency Managers. The state has supported local Certified Floodplain Manager (CFM) exam refresher/study courses as a commitment to enhance local floodplain manager knowledge and expertise. Mitigation-related training courses and workshops conducted since the 2014 Plan update include:

- Feb 12, 2013, Chamberlain: CFM Refresher Course
- Nov 18, 2013, Rapid City: E0172 Hazus for Floods
- March 5, 2014, Huron: G393 Mitigation for Emergency Managers
- Nov 18, 2014, Chamberlain: Floodplain Management 101
- March 10, 2015, Pierre: G318 Local Mitigation Planning Workshop
- Dec 14, 2015, Rapid City: G393 Mitigation for Emergency Managers
- March 7, 2016, Pierre: Hazard Mitigation Application Development and Benefit Cost Analysis Workshop
- May 10, 2016, Pierre: G318 Local Mitigation Planning Workshop
- June 15, 2016, Rapid City: G361 Flood Fight Operations
- Dec 8, 2016, Pierre: G393 Mitigation for Emergency Managers
- Nov 1, 2017, Pierre: G361 Flood Fight Operations
- Jan 8, 2018, Pierre: G393 Mitigation for Emergency Managers
- July 17, 2018, Aberdeen: FEMA MT-1 and MT-2 Application Workshop
- July 19, 2018, Sioux Falls: FEMA MT-1 and MT-2 Application Workshop
- Sep 12, 2018, Rapid City: CFM Exam Study Session

4.3.6 Other OEM Plans and Program Initiatives

Other mitigation activities OEM is involved in include:

- The **South Dakota State Emergency Operations Plan (SEOP)** establishes policy for state government agencies in their response to the threat of natural, technological or national security emergency/disaster situations. It documents the policies, concept of operations, organizational structures and specific responsibilities of state agencies in their response to provide for the safety and welfare of citizens. It also addresses the need for preparedness, response, recovery and mitigation activities to enhance the state's overall capability to cope with potential hazards.
  The SEOP is organized around Emergency Support Functions (ESFs). ESF #14, Long-Term Recovery and Mitigation, specifically addresses the integration of mitigation activities into post-disaster recovery "to reduce or eliminate risk." This includes the effective management of HMA grants, PA Section 406 grants, and other grant programs. The ESF #14 section states
  - "Long-term community recovery and mitigation efforts are forward-looking, [and] market-based…with attention to mitigation of risk in future incidents," and

- "The state uses the post-Incident environment as an opportunity to measure the effectiveness of previous community recovery and mitigation efforts."

Primary and supporting agencies are tasked to:

- "Establish procedures to integrate pre-incident planning and risk assessment with post-incident recovery and mitigation efforts."
- "Produce digital mapping that guides recovery and mitigation efforts."

See also Section 6.3.2 for discussion of how the SHMP informs and is integrated into the SEOP.

- The **State Disaster Recovery Plan** builds on the policies and procedures in the ESF 14 section of the SEOP described above, to ensure the most efficient and effective state coordination to assist local jurisdictions in the recovery phase of any disaster. The Recovery Plan is structured similarly to the SEOP but is organized around Recovery Support Functions (RSFs). Mitigation is primarily addressed under the Community Planning and Capacity Building RSF, which places "an emphasis on integration of hazard mitigation throughout the continuum of pre- and post-disaster recovery planning and implementation." As the Primary Entity, OEM is tasked to:
  - "Aid communities in identifying mitigation opportunities through hazard risk assessments"
  - "Support development of local and tribal mitigation plans.

  See Section 5.4.4 Integration of Mitigation into Post-Disaster Recovery Operations for more information. See also Section 6.3.3 for discussion of how the SHMP informs and is integrated into the Recovery Plan.

- **bReadySD** is a statewide emergency preparedness program with tips, events, and tools you can use to talk with your family about having a plan in the event of a disaster. http://www.bready.sd.gov/
- The **OEM website** includes mitigation-related material, including answers to questions such as "Are counties required to complete a Pre-Disaster Mitigation plan?", "What are a community's responsibilities to participate in NFIP?", and "How do I know if I should have flood insurance?"
- OEM co-chairs the **State Drought Task Force** as discussed in Section 4.2.2.

4.4 Other State and Regional Agencies

44 CFR Part 201 Requirement:
The mitigation planning process should include coordination with other State agencies…and be integrated to the extent possible with other ongoing State planning efforts. *[The State mitigation strategy shall include a] discussion of the State's pre- and post-disaster hazard management policies, programs, and capabilities to mitigate the hazards in the area.*
44 CFR Part 201 Enhanced Plan Requirement:
Enhanced State Mitigation Plans must include… *Demonstration that the plan is integrated to the extent practicable with other State and/or regional planning initiatives (comprehensive, growth management, economic development, capital improvement, land development, and/or emergency management plans).*

4.4.1 South Dakota Department of Environment and Natural Resources (DENR)

The mission of DENR is to protect public health and the environment by providing environmental monitoring and natural resource assessment, technical and financial assistance for environmental projects, and environmental regulatory services. Several mitigation related programs, policies, and funding opportunities exist within DENR. These are outlined in the Capabilities Matrix, with the most significant described in the following sections.

South Dakota Dam Safety Program

The National Dam Safety Program (NDSP) is a partnership of state agencies, federal agencies, and other stakeholders that encourages and promotes the establishment and maintenance of effective Federal and state dam safety programs to reduce the risks to human life, property, and the environment from dam related hazards.

The NDSP is implemented through the DENR as the South Dakota Dam Safety Program. Requirements for dam building, including permitting and the Safety of Dams rules, are administered through DENR. Details on the status of the dams in South Dakota (high hazard, significant hazard, low hazard) are included in Section 3. DENR receives FEMA State Assistance Grant funding to reduce risks to life and property associated with dams, increase awareness of the benefits and risks related to dams, and advance the state practice of dam risk management. DENR Water Rights Program section is the lead agency for implementing this program.

For more information on the Dam Safety Program, visit http://denr.sd.gov/des/wr/dam.aspx.

Geological Survey Program

The Geological Survey Program performs scientific investigations designed to generate information on South Dakota's geologic and hydrologic resources. Recently efforts have concentrated on to completing countywide assessments of geologic and hydrologic resources in the eastern half of the state. With the completion of the countywide studies, the focus is now centered on the protecting the state's natural resources. The Survey has begun long term efforts to monitor the water quality of the state's shallow aquifers as well as produce more detailed mapping of the shallow aquifers in the state.

Water and Wastewater Funding

DENR's Division of Financial and Technical Assistance is responsible for evaluating the natural resources of the state and providing technical and financial assistance for the protection, restoration, and development of those resources. One program found under this division is Water and Wastewater Funding. Reviews of projects seeking funding through the Board of Water and Natural Resources are conducted through this program. Projects requesting funding must be on the State Water Facilities Plan (http://denr.sd.gov/dfta/wwf/statewaterplan/statewaterplan.aspx). Other funding found through this board includes:

- Small Community Planning Grant Program – Provides small communities with 2,500 people or less with funds to hire a consultant to develop a preliminary engineering study, a rate analysis, or a project specific engineering report.
- Consolidated Water Facilities Construction Program – Provides grants and loans for small water, wastewater, and watershed projects.
- Clean Water State Revolving Fund Program – Provides low interest loans for wastewater, storm sewer, and nonpoint source projects.
- Drinking Water State Revolving Fund Program – Provides low interest loans for drinking water projects.
- Solid Waste Management Program – Provides grants and loans for solid waste and recycling projects.
- State Water Resources Management System – Provides grants and loans for projects that have been established by the Legislature as a priority objective for water resources management in South Dakota.

Water and Waste Funding also works with staff from the Rural Development to coordinate state and federal financial assistance when applicants request financial assistance from both agencies. Program staff work with the SD DOT concerning water/wastewater projects that are concurrent with a road project and with the State Revolving Fund concerning water/wastewater projects that are deemed to be green infrastructure type projects. For more information on funding sought through SD DENR's Water and Waste Funding Program, visit http://denr.sd.gov/dfta/wwf/wwf.aspx.

State Emergency Response Commission (SERC)

The South Dakota State Emergency Response Commission (SERC) was created to implement the state elements of the Emergency Planning and Community Right-To-Know Act (EPCRA). The SERC assists with local emergency planning committee plan development and reviews local plans for completeness; reviews local plans to determine the level of threat from an accidental release of dangerous chemicals and the local capability to adequately respond to those releases; prepares recommendations for action to be taken to develop and coordinate emergency response capabilities, including the feasibility of regional emergency response; evaluates various options and prepares a recommendation concerning funding based on user fees to support on-going emergency planning activities and incident response preparedness; develops recommendations for future state emergency response commission structure; designates local emergency planning districts and supervises and coordinate the activities of the local emergency planning committees; and coordinates and implements federal grants for training of local emergency planning committees and public sector employees.

The SERC meets quarterly and is coordinated and supported by DENR. The Commission is composed of ten individuals, including the Secretaries of the Departments of Environment and Natural Resources,

Transportation, and Public Safety or their designees, as well as the Director of the Division of Emergency and Disaster Services. The remaining six members are appointed by the Governor, to include: an elected or appointed member of a political subdivision, a member of the chemical industry, a person actively engaged in an agricultural business, a health care professional, a member of a fire department, and a member of a local emergency planning committee.

Integration Activities

Additional examples of recent integration activities involving DENR programs and staff include:

- The DENR Big Sioux Flood Information System, which came online in 2018, has the ability predict the severity of flood events under a range of climatic events and is intended to support the implementation appropriate countermeasures to mitigate the impacts to life and property in extreme events. The project was a collaborative effort of State and local government and utilized a consultant team.
- Staff from DENR served a term in 2017-2018 on the National Integrated Drought Information System (NIDIS) Executive Council. The NIDIS program was authorized by Congress in 2006 (Public Law 109-430) with an interagency mandate to coordinate and integrate drought research, building upon existing federal, tribal, state, and local partnerships in support of creating a national drought early warning information system.
- Staff from DENR participates on a team comprised of staff members from several other state and federal agencies to develop and implement an Upper Missouri River – Plains Snow and Soil Moisture Monitoring Network as authorized by Congress in the Water Resources Development Act of 2014, the Water Resources Reform and Development Act of 2016 and the America's Water Infrastructure Act of 2018.
- From 2016 through 2018, DENR worked with SD DOT, DPS, BIT, local governments, and the private sector to create the Big Sioux River Flood Information System, a web-based tool that can be used by government officials and the general public to predict the impact of flood events in the Big Sioux River Basin.
- DENR leverages the existing USGS stream gauges in the state by adding their own stream sensors. The USGS stream gages provide real-time streamflow monitoring and long term historical record and are used by the NWS and others in making flood forecasts and flood monitoring. The new DENR stream sensors are in place to provide water flow information at water quality monitoring sites DENR maintains for regulating water quality on public waters. NWS also leverages this information in order to have additional locations to make flood forecasts and provide better flood monitoring. The Big Sioux River Flood Information System discussed above uses real-time river stage information from both the USGS sites and the DENR sites in the hydrologic and hydraulic modeling for predictive purposes.

4.4.2 South Dakota Department of Agriculture (SDDA)

SDDA is comprised of seven divisions pertaining to agriculture, conservation and forestry, and wildland fire. Several mitigation related programs exist within the SDDA. These are outlined in the Capabilities Matrix, with the most applicable described below. In addition to encouraging mitigation through programs and policies, the SDDA promotes resiliency amongst ranchers and farmers through public outreach campaigns. As discussed in Section 4.2.2, SDDA co-chairs the State Drought Task Force and regularly coordinates with OEM through participation on the Task Force and SHMT.

Black Hills Forest Fire Protection District

The Black Hills Forest Fire Protection District was created in state law in 1941 as a community risk reduction strategy to protect the Black Hills area from "unusual fire dangers". All open burning is banned in the District unless a permit is first obtained from either the State of South Dakota or the Black Hills National Forest. The permit process reduces the chances of escaped open fires burning structures and other man-made improvements.

Community Wildfire Protection Plans

The enactment of the Healthy Forests Restoration Act (HFRA) in 2003 provided incentive to communities to develop Community Wildfire Protection Plans (CWPPs). These plans are used by the SD Wildland Fire Suppression Division (SDWFS) and US Fish & Wildlife Service (USF&WS) to give consideration and priorities to local communities regarding their forest management and hazardous fuel reduction projects. CWPPs typically address issues such as wildfire response, hazard mitigation, community preparedness, and/or structure protection. Currently Butte, Custer, Perkins, Stanley, Pennington, Meade, Fall River, and Lawrence counties as well as Rapid City have effective CWPPs. Under these plans, National Fire Plan fuel mitigation grants are administered by the South Dakota Division of Wildland Fire to meet hazardous fuel reduction projects around "communities at risk" identified in the CWPP's.

South Dakota Forest Action Plans – Assessment and Strategy

South Dakota's forest action plan provides a comprehensive summary of the five forest types that occur in the state and establishes priority landscapes for targeting management resources. These forests are examined in terms of extent, condition, values, threats, ownership, needs, problems, and opportunities. The Statewide Strategy provides direction for addressing the issues and threats facing these forests and details strategies, existing resources, needs, partners, and monitoring (http://www.forestactionplans.org/states/south-dakota).

Hazard Mitigation Grant Program Post Fire

Beginning with federal Fiscal Year 2017, FEMA began providing HMGP funds for mitigation following Fire Management Assistance declarations. SDDA's Division of Wildland Fire has worked closely with OEM to develop and implement guidance for HMGP Post Fire grant funding. The state prioritizes funding for the area of the burn scar, the watershed, and the county included in the declaration; remaining funds may be awarded to other mitigation action across the state.

This is a new program, and OEM continues to work with SDDA on developing immediate actions and tasks that need to be accomplished after the fire, and other mitigation actions to assist in the restoration of the burn scar area. OEM and SDDA are coordinating to develop shovel-ready projects that can be submitted quickly following the next FMAG award. SDDA and OEM are also developing an Environmental Planning and Historic Preservation Programmatic Agreement to facilitate a quicker approval of pre-selection mitigation actions for future funding opportunities. Mitigation Action 4-3 (page 5-15) will further enhance coordination for this program.

Beat the Beetles Mountain Pine Beetle Control Plan

The infestation of pine beetles in the Black Hills has led to dead and dying pine trees, which increase the chances of wildfire. In 2013, State legislature appropriated $2 million for mountain pine beetle suppression. This project allowed the Black Hills National Forest to implement effective pine beetle mitigation tactics on up to 248,000 acres in critical areas. This included large-scale thinning and timber

harvest on up to 122,000 acres. Due largely to these efforts, the mountain pine beetle population in the Black Hills has dropped to acceptable levels. Forest Health personnel from SDDA and USFS continue to monitor this situation and all potential forest health threats.

Firewise Program

Firewise is a program run by the National Fire Protection Association (NFPA) that teaches people how to adapt to living with wildfire and encourages neighbors to work together and take action to prevent losses. Communities develop an action plan that steers their residential risk reduction activities, while engaging and encouraging their neighbors to become active participants in building a safer place to live.

A total of seven South Dakota communities are currently Firewise participants. Mountain Plains I and II, subdivisions located on the west side of Spearfish, became the first Firewise Community in South Dakota in 2003 and was one of the original pilot program sites; they have worked hard over the years to maintain that status, and are one of the few communities to reach 10 years of recognition. The Department of Agriculture, Wildland Fire Division is the lead agency for administering the Firewise program.

4.4.3 South Dakota Department of Transportation (SDDOT)

The mission of the SDDOT is to provide a safe, efficient, and effective transportation system. Programs administered under this department include transportation inventory management; road and bridge design, construction, maintenance, and inspection; and public safety outreach campaigns.

Emergency Relief (ER) Program

The Emergency Relief (ER) program is administered by the SDDOT in conjunction with the FHWA. Roads and bridges on Federal-aid highways that are damaged as a direct result of a natural disaster or catastrophic failure from an external cause are eligible for ER funds. Federal-aid highways are public roads that are classified as arterial, urban collectors and major rural collectors. Highways that are classified as minor rural collectors or local roads are not eligible for ER funding even if other federal-aid funds have been used on those roads. For example, "off system" bridges that were replaced with federal-aid funds or non-highway projects that were constructed with enhancement funds are not eligible for ER funding. State roadway classification maps identify these routes and their designations. The FHWA publication "Guidance for the Functional Classification of Highways" has descriptions of the functional classifications. It is available at http://www.fhwa.dot.gov/policy/ohpi/hpms/fchguidance.cfm.

Title 23 Code of Federal Regulations (23 CFR) Part 668, Subpart A provides that an event generally must have caused at least $700,000 (federal share) in eligible damage for the event to be eligible for ER funding. Disaster damage less than $700,000 (federal share) is generally considered to be heavy maintenance or routine emergency repair. For exceptions to this damage threshold, see 23 CFR 668.105(j). By policy, a minimum $5,000 in repair costs per site is used to determine if sites are eligible for ER funds. Sites that have sustained less than $5,000 in damage are generally considered to be heavy maintenance. Chapter II, Section C-3, "Damage Estimate under $5,000 per Site" provides further guidance on the definition of a site.

The ER program generally provides funding to repair and restore highway facilities to pre-disaster conditions. ER funds are not intended to replace other federal-aid, state, or local funds for new construction, to correct non-disaster related deficiencies, or to otherwise improve highway facilities." (FHWA Emergency Relief Manual, May 2013 – https://www.fhwa.dot.gov/reports/erm/er.pdf)

Integration Activities

Additional examples of recent integration activities involving SDDOT programs and staff include:

- SDDOT runs the state Bridge Inspection Program, as part of the Federal Highway Administration's (FHWA's) National Bridge Inspection Program. All structures that are defined as highway bridges located on all public roads are inspected on an interval of 12, 24, or 48 months, depending on the category of bridge. Public safety is first and foremost. FHWA conducts an annual review of the SDDOT bridge inspection program to enhance an already robust bridge inspection program.
- SDDOT collaborates with the FHWA on an interdisciplinary scour team that convenes on an as needed basis to review scour critical bridges and mitigation measures.

4.4.4 South Dakota State Historic Preservation Office

The State Historic Preservation Office (SHPO) manages the National Register of Historic Places program of the National Park Service in South Dakota. An office within the Department of Education, the program surveys, inventories, and registers historic properties; monitors state, federal, and local government activities which affect cultural and historic resources; provides advice on preservation methods; promotes public education on historical properties; and supports municipal and county historic preservation commissions to advance the state's economic, social, and education objectives. The State Historic Preservation Officer reviews state and local project submittals for FEMA grant funding. The SHPO is on the SHMT and conducts National Historic Preservation Act (NHPA) reviews for mitigation projects. One grant program, described below, could be used toward mitigation projects in the State.

Deadwood Grant

This grant is funded by a portion of the gambling revenue generated in Deadwood, South Dakota. Grants range from $1,000 to $25,000 and are given toward projects that retain, restore, or rehabilitate historic buildings, structures, and archaeology sites for commercial, residential, or public purposes. Rehabilitation projects can include improvements to historical structures that have been damaged by a disaster.

Integration Activities

Additional examples of recent integration activities involving SHPO programs and staff include:

- OEM coordinates with SHPO closely on all mitigation projects. During a home buy-out project in Waubay, special reports and pictures had to be taken of historic homes and reviewed with SHPO before the homes could be approved for demolition.
- SHPO coordinated with OEM and FEMA on the rehab of Garrison Dam, which is listed in the National Register of Historic Places.
- OEM staff reviews all project files before they are destroyed to share any significant historical data/pictures for SHPO archives.

4.4.5 South Dakota Department of Health (DOH) – Office of Public Health Preparedness and Response

The mission of the Office of Public Health Preparedness and Response is to develop and maintain the relationships, infrastructure, and expertise necessary to prepare for and respond to public health emergencies. A wide range of public health services to prevent disease, promote health, and ensure access to needed, high-quality health care is supported through this office. Two programs are described in detail below.

Hospital Preparedness Program

The primary focus of this program is to provide leadership and funding to enhance the infrastructure of hospitals to plan for, respond to, and recover from mass casualty events. Funding is used to improve surge capacity and enhance community and hospital preparedness for public health emergencies.

Public Health Emergency Preparedness Program (PHEP)

PHEP funding provides approximately $700 million annually to 50 states, four localities, and eight US territories for building and strengthening their abilities to respond to public health incidents. To be eligible for this federal funding, the State has identified 15 public health preparedness capabilities under the following categories that are defined by the Center for Disease Control to help assist state and local planners in identifying gaps in preparedness, determining specific priorities, and developing plans for building and sustaining capabilities:

- Biosurveillance
- Community Resilience
- Countermeasures and Mitigation
- Incident Management
- Information Management
- Surge Management

SD DOH maintains the state Pandemic Influenza plan, which was originally published in 2016 and is scheduled to be updated in 2019. Additional DOH plans include a Points of Dispensing plan and a Strategic National Stockpile plan, which while response-oriented also incorporate some mitigation.

Integration Activities

Additional examples of recent integration activities involving DOH programs and staff include:

- DOH was a major collaborator on the Drought Task Force during development of the 2015 South Dakota Drought Mitigation Plan. DOH directed a vulnerability assessment of the Health and Socioeconomic Sector, focusing on both Physical/Public Health and Behavioral Health. The assessment used the Social Vulnerability Index (SOVI) developed by the University of South Carolina's Hazards and Vulnerability Research Institute to measure the social vulnerability of South Dakota counties to environmental hazards. The analysis identified adaptive capabilities that could address the vulnerabilities and made recommendations for future actions and further studies, several of which fed directly into Mitigation Actions. (See Table 5-4, Actions DMP 1.4, DMP 1.5, and DMP 5.3).

4.4.6 South Dakota Bureau of Information and Telecommunications (BIT)

The SD BIT is an unfunded agency. Tasks taken on by this agency must be funded by the requesting agency. BIT works closely with OEM on flood inundation mapping, and BIT houses the IT infrastructure OEM uses to map mitigation projects and post them on their website.

The following programs that support mitigation are administered by the SD BIT.

Geographic Information Systems

State agencies utilize the GIS infrastructure to take advantage of the centrally located data by creating web applications to publish their data to the Internet. GIS is used for many applications from flood prediction and management to tax rate evaluation. Online maps and GIS data are available via the SD GIS website (http://arcgis.sd.gov/server/sdGIS/Data.aspx). GIS informal training is offered to GIS users within

the state government. SD BIT has been involved in creating statewide LiDAR data that is used by localities for planning and zoning purposes.

State Radio System

This system includes over 18,000 registered radios that provide public safety communication to South Dakota law enforcement, first responders, public safety and supporting agencies at the local, state, federal, and tribal level.

South Dakota Public Broadcasting (SDPB)

SDPB is a statewide TV and radio broadcaster. It is the statewide point of contact for the Emergency Alert System and Amber Alert system.

Business Continuity

Data storage is provided through a secure and reliable environment by using technologies that provide redundancies and the ability to restore lost or damaged data. Business continuity refers to activities performed daily to maintain service, consistency and recovery for applications defined as critical business functions. Client service includes the executive, legislative and judicial branches as well as constitutional and elected offices.

Integration Activities

Additional examples of recent integration activities involving BIT programs and staff include:

- BIT coordinates with many state, regional, local, and tribal agencies on development and implementation of FirstNet.
- BIT works with OEM at Technical Advisory Group meetings to ensure all state agencies have the data they need to support each other during a disaster.

4.4.7 South Dakota Office of Risk Management

The mission of the SD Office of Risk Management is to efficiently and effectively protect the assets of the state of South Dakota in the conduct of governmental activity. This mission is accomplished through the use of risk management and insurance programs as well as safety and loss techniques. Programs to reduce risk include property, boiler, and aviation insurance; fidelity bonds; risk audits of state government buildings; and a public entity pool for liability. Loss Control Committees are strongly encouraged to be implemented in all areas of state government. The committees are comprised of employees within their agencies. These committees are responsible for reviewing loss history and safety and health concerns in their respected arena. They are also responsible to conduct a walk-through of their buildings and grounds to identify and correct any hazards. The committees normally meet on a quarterly basis. In addition, the Extraordinary Training Fund provides funding toward training programs that can help reduce risk to the state government.

Integration Activities

Additional examples of recent integration activities involving Office of Risk Management programs and staff include:

- The Office of Risk Management worked with OEM to improve insurance coverage for state government buildings. In the past, the state would take out policies on individual buildings only after a building was impacted by a disaster. Now all state government buildings are covered under an

insurance policy; thus, only the deductible needs to be funded when a Presidential disaster is declared.

4.4.8 South Dakota Office of Homeland Security

The South Dakota Office of Homeland Security (SDOHS) works to prevent terrorism, enhance security and support response for all-hazards incidents. SDOHS was established in 2003 to address terrorism-related threats in South Dakota. Since its creation, SDOHS has broadened its scope to focus on an inclusive, all-hazards approach to homeland security as well as expanded partnerships in the state at all levels of government and in the private sector.

SDOHS develops and maintains the State Homeland Security Strategic Plan, which identifies the state's capabilities in preparing for human-caused hazards. The Office administers Homeland Security grants to assist city, county, state, and tribal governments secure the resources needed to prevent, respond to, and recover from hazards. These grants have been used to purchase radios, communication towers, generators, shelters, warning sirens, and to support regional response teams. SDOHS also manages the state's Critical Infrastructure Protection Program (CIPP), and conducts CIPP assessments of government buildings, hospitals and schools to help state, local and tribal governments build critical infrastructure protection programs.

Threat and Hazard Identification and Risk Assessment (THIRA)

The Threat and Hazard Identification and Risk Assessment (THIRA) is used by South Dakota to better understand its threats and hazards, and how the impacts may vary according to time of occurrence, season, location, and other community factors. This knowledge helps the state establish informed and defensible capability targets, and commit appropriate resources drawn from the whole community to close the gap between a target and a current capability, or for sustaining existing capabilities. As noted in Section 3.1.4, South Dakota's THIRA, originally developed in 2012 and updated periodically, is an all hazards risk assessment that analyzes the State's capabilities toward addressing natural, human-caused, and technological hazards.

Development of the South Dakota THIRA follows the process outlined in CPG 201 "Threat and Hazard Identification and Risk Assessment (THIRA) and Stakeholder Preparedness Review (SPR) Guide." The THIRA is primarily a capability assessment process, but it uses an all-hazards risk assessment as its foundation. The THIRA adds context to the hazard information and risk assessment provided by the SHMP and identifies desired outcomes and target capabilities based on the core capabilities established by the National Preparedness Goal. The HIRA (Section 3) of the SHMP is utilized as a key input in the ongoing development of the THIRA. In turn, information from the THIRA, particularly in the planning scenarios, are integrated into the HIRA section of this SHMP. See Section 6.3.1 for more details on how these plans interact.

Homeland Security and Emergency Management Senior Advisory Committee

The Homeland Security and Emergency Management Senior Advisory Committee (HSEMSAC) provides recommendations for the administration of Homeland Security and Emergency Management programs throughout the state. Committee representatives include:

- Animal Industry Board
- Attorney General's Office
- Bureau of Information and Telecommunications

- Chiefs of Police Association
- Department of Tribal Relations
- Native American Tribes
- SD Department of Agriculture
- SD Department of Environment and Natural Resources
- SD Department of Game, Fish and Parks
- SD Department of Health
- SD Department of the Military
- SD Department of Public Safety
- OEM Regional Coordinators
- SD Fusion Center
- SD National Guard
- SD Office of Homeland Security
- SD Highway Patrol
- Sheriffs Association
- State Radio Communications
- Taskforce 1
- U.S. Department of Homeland Security

Integration Activities

Additional examples of recent integration activities involving SDOHS programs and staff include:

- SDOHS works closely with OEM and other agencies on equipment purchases and other grant projects. A good example is the purchase of generators for critical facilities. Some communities may apply for both mitigation funds and homeland security funds for these projects or may be ineligible for one program but eligible for another. Close coordination between SDOHS and OEM helps reduce duplication, verifies prioritization, and helps ensure grant funds are used efficiently.

4.4.9 South Dakota Game, Fish & Parks

Game, Fish & Parks serves the public in the management and enjoyment of South Dakota's outdoor resources. The Game, Fish & Parks Commission, by legislative mandate, serves as the advocate and liaison between Game, Fish & Parks and its stakeholders – the people of South Dakota. The law enforcement team protects outdoor resources by responding to violations. Game, Fish & Parks actively seeks partnerships for wildlife habitat management and hunting access as well as supporting cooperative research opportunities. Game, Fish & Parks also offers services such as wildlife damage control. A variety of technical resources for managing habitat and maintaining South Dakota's natural resources are available on the South Dakota Game, Fish & Parks website (http://gfp.sd.gov/wildlife/private-land/technical.aspx).

Statewide Comprehensive Outdoor Recreation Plan

The South Dakota Department of Game, Fish and Parks – Division of Parks and Recreation maintains and promulgates the South Dakota Statewide Comprehensive Outdoor Recreation Plan, last updated in 2018. This plan analyses and lays out a plan for "how to best meet the needs of our citizens to provide quality, accessible outdoor recreational facilities in our state." This includes strategies and measures related to hazard mitigation, such as:

(Under Strategy #2) Be vigilant against potential threats, including fires, floods, pollution, infestations, overuse and abuse of outdoor recreation lands.

- Continue to train staff in controlled burning and firefighting methods and coordinate with appropriate agencies, as needed.
- Research common and alternative methods for land management and protection.
- Continue to monitor small head dams.
- Collaborate amongst agencies to fight insect infestations, including the pine beetle, Emerald Ash Borer and others.
- Monitor and take action in areas where there is over-use and/or abuse of the land, such as compaction on trails, erosion and other negative impacts to park lands and waters.

Chapter 4, Wetlands Component, also describes how wetlands can provide natural mitigation against hazards, through actions such as flood attenuation and reduction, water quality enhancement, erosion control, and sediment retention.

Integration Activities

Additional examples of recent integration activities involving GF&P programs and staff include:

- Game, Fish & Parks worked closely with multiple state, local and federal agencies on a shoreline stabilization project in Oacoma, which successfully mitigated the sliding issue of the hillside. The complexity of this project and the number of agencies involved highlights the successful partnerships built over many years.

4.4.10 South Dakota State University (SDSU) Extension

The South Dakota State University (SDSU) Extension is the state's leading source of un-biased, vetted, and relevant new knowledge generated from research. As a cornerstone of SDSU's land-grant university mission, SDSU Extension empowers citizens to be more competitive in a growing global economy through education and technical training or assistance.

SDSU Extension's purpose is to foster a learning community environment that empowers citizens to advocate for sustainable change that will strengthen agriculture, natural resources, youth, families, and the communities of South Dakota. In pursuit of this purpose, several core values support the mission of SDSU Extension and provide the foundation for the organization. They include:

- A defined public value
- A learning community focus
- Prioritized effort
- Access for all citizens
- A setting that is inclusive, collaborative, and sustainable
- A culture that embraces change

State Climatologist

The South Dakota State Climate Office is the recognized climate office for South Dakota supplying climate and drought information, data, tools, outlooks and a variety of other climate-related information to serve the state of South Dakota. Information is available to people involved in agriculture, industry, public safety and the general public through web sites, social media and print and electronic media.

Integration Activities

Additional examples of recent integration activities involving SDSU programs and staff include:

- The State Climatologist has partnered with OEM during local mitigation planning classes (G318) to present to students on climate change, the studies that SDSU are completing, and how to address climate change in local mitigation plans.

4.4.11 Rural Electric Cooperatives

The state continues to work with the Rural Electric Cooperatives (RECs) to improve the integration of mitigation practices throughout the state's electrical system. OEM meets and coordinates with the RECs on a recurring basis through interaction with the Rural Electric Association and individual RECs. The Rural Electric Association was represented as a stakeholder and participated in SHMT meetings during the update of the 2019 HMP. The HMP has covered the RECs since 2011, making all the private-nonprofit RECs eligible for mitigation funding through the HMGP.

Of particular note, the RECs have been working proactively to harden their systems by burying power lines. The 2014 SHMP noted that 348 miles of power lines had been buried, with 167 miles pending; as of 2018 that figure stands at over 700 miles. Much of this has been accomplished using state & federal mitigation funding, but the RECs also bury lines with their own funding. In a survey on South Dakota mitigation spending conducted in early 2018, the 38 RECs reported receiving $19,559,914 in mitigation grant funds over the last five years, an average of $3,911,983 per year; during that same five-year period, they reported spending approximately $226,415,575 of their own funds on line hardening.

The RECs have also been very active in gathering and quantifying data on losses avoided due to mitigation efforts; see Section 5.4.6 for details.

Integration Activities

Additional examples of recent integration activities involving the RECs include:

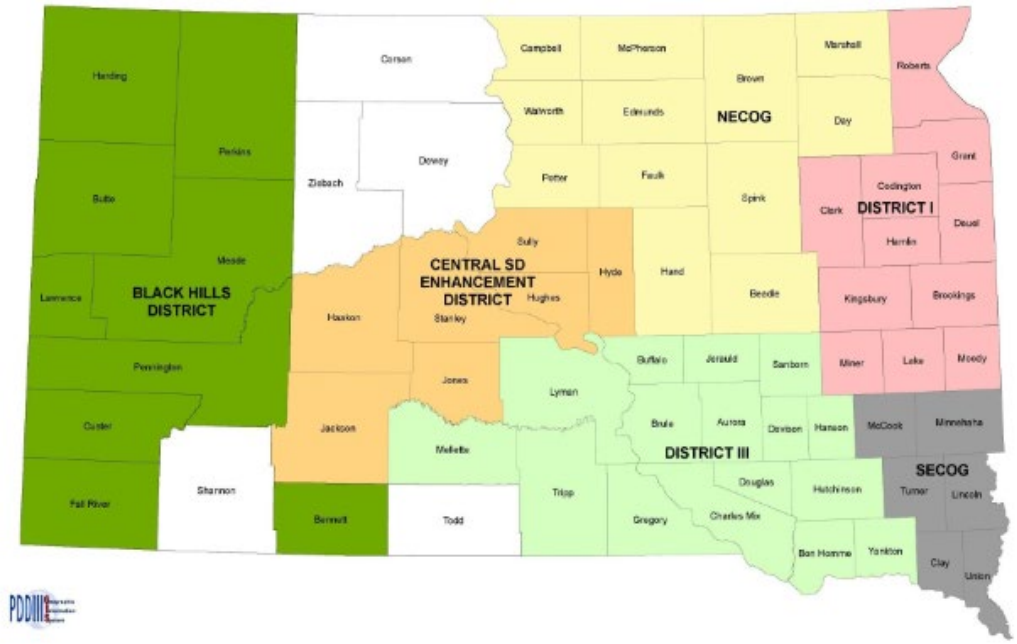
- OEM coordinates with the RECs to maintain a list of shelf-ready line-hardening projects, to ensure that funding opportunities are not missed. The OEM mitigation team further coordinates with the individual RECs on priority of projects, application status, and completion of projects using REC funds.
- The RECs work with linemen and tree trimming contractors to ensure trees are within a safe distance to power lines. They also conduct extensive public outreach and education, through electrical safety literature, outreach materials, and public service announcements.
- OEM attends SDREA meetings of General Managers, Operation Managers and Office Managers at least annually, to present any changes to the Public Assistance and Hazard Mitigation Assistance programs and provide updates to funding opportunities and programmatic changes.
- OEM workings diligently when impending weather threatens REC infrastructure. Staff work seamlessly to share weather and damage information such as EOC forecast packages and the REC Sperry-Piltz Ice Accumulation (SPIA) Index. The SPIA Index is a scale for rating ice storm intensity, based on the expected ice accumulation as a result of a storm and the expected damaged a storm inflicts on human-built structures, especially exposed to overhead utility systems. Additionally, while monitoring the SDREA outage map, OEM can begin to assess which REC's in the state have been affected and to confirm with SDREA if outages are a result of significant pole damage or substation outages.

4.4.12 Planning and Development Districts

South Dakota's Planning and Development Districts were established with the purpose of improving and enhancing local communities and their economies. On December 4th, 1970 Governor Frank Farrar issued an executive order to establish the boundaries of six multi-county Planning and Development Districts, through the use of the South Dakota Codified Law (Joint Powers Statutes) which allows local governments to cooperate in undertaking planning and development activities. The districts were grouped by populations of counties in order to make districts of larger populations to pool money, provide more resources, and help manage and integrate federal grants into local programs. The six Planning and Development Districts were structured to satisfy the requirements of multiple federal agencies such as the U.S. Department of Housing and Urban Development (HUD) and the U.S. Department of Commerce's Economic Development Administration (EDA). The First District, which was the pilot district organized before the other five districts, become an Economic Development District (EDD) in 1973. All other Districts have followed suit to also become EDDs (White and Watrel, 2013). The Planning Districts are quasi-governmental and have no legal, regulatory, or taxing authorities. There is no requirement for local governments to implement or comply with policies of the district and as shown in Figure 4-1, not every county is associated with a district as it is voluntary to participate.

Each district is unique in terms of the services they provide and how they are structured. Services related to emergency management including recovery and mitigation are key services that many of the Planning Districts offer. State policy is that if a county chooses to use a Planning District to write their Local Hazard Mitigation Plans (LHMP), then no bidding is required as the Planning Districts are considered an extension of state government. As of 2018, the Districts were responsible for writing and/or providing technical assistance for the majority of Local Hazard Mitigation Plans in the state, including 42 of the 66 counties and 2 of 9 tribal governments. With the Districts' 48-year history of serving communities through local plan development, South Dakota's Planning and Development Districts have the knowledge of local communities that allows them to be more cognizant of mitigation and how to incorporate basic principles of mitigation into other planning efforts, including economic development and comprehensive planning.

Figure 4-1 Regional Planning Districts



Source: Planning & Development District III https://denr.sd.gov/des/gw/Sourcewater/SWAP%204%20Folder/Planning_Districts_2006.pdf

Comprehensive Economic Development Strategy

The origins of South Dakota's Planning and Development Districts stem from state encouragement to support regional opportunities for economic development. As mentioned above, every Planning and Development District has also been designated by the U.S. Economic Development Administration (EDA) as an Economic Development District (EDD). One requirement of becoming an EDD is the implementation of a Comprehensive Economic Development Strategy (CEDS). A CEDS is a plan that focuses on strategies for regional economic development. The planning process for a CEDS is designed to increase a region's capacity by building a foundation in which the public sector can work with the private sector to create economic prosperity and resiliency for the region. There are four required sections of a CEDS: Background Summary, SWOT Analysis (which is required to consider natural hazard and climate change risk), Strategic Direction/Action Plan, and an Evaluation Framework. CEDS in South Dakota acknowledge the risk natural hazards pose to their regions through the SWOT analysis, specific goals and objectives and within the specific chapter *Disaster and Economic Recovery and Resiliency*. Table 4-5 below summarizes where hazards are mentioned and have been incorporated within the South Dakota Regional Comprehensive Economic Development Strategy plans.

Table 4-5 References to Hazards in Regional CEDS

Planning Development District	Location in CEDS
South Eastern Council of Governments (2014 -2019)	**Chapter II – Background** – references the region's struggle with detrimental weather patterns including storms, tornadoes, flooding and drought. **Environment** (pg. 34) – *Wetlands and Flood Plains*- references the region is prone to flooding and speaks to National Flood Insurance Program and working with communities to stay compliant with the program and assist with drafting floodplain ordinances. ***Natural Disasters*** *(pg. 37)* - Table on Federal Disaster Declarations in region

Planning Development District	Location in CEDS
	Hazardous Waste and Toxic Contamination (pg. 39) – Notes EPA Superfund site in region, speak to LEPCs in region. **Goals and Objectives (**pg. 50) – *Goal 8:* "Increase the region's resiliency to disasters" *Objectives:* "Provide technical assistance to communities to assess vulnerability to disasters; Assist communities with pre-disaster planning activities; Assist communities with pre-disaster mitigation and disaster recovery activities" **Table 21: Partnership Relationships** (pg. 61) – Lists specific relationships/agencies the Planning District works with regularly "to facilitate greater community and economic development in region" **Chapter VI – Strategic Projects, Programs, and Activities** – Table 22: Development Projects – Several projects are related to Goal 8 "increase regions resiliency to disasters" including: Property acquisition projects, generator upgrades, safe rooms, and municipal ordinances updates **Chapter IX** – Disaster and Economic Recovery and Resiliency – broken up by *Pre-Disaster Preparedness, Post-Disaster Planning* and *Implementation, and Economic Redevelopment*
Black Hills Council of Local Governments (2014-2019)	**Chapter I – Overview** – Regional Partners (pg. 7) – Reference South Dakota OEM and FEMA as partners **Chapter II – Region** – Resources and the Environment (pg. 26-27) – Note EPA Superfund Sites in region; Summary of significant 100-year floodplains in region; **Chapter III- Action Plan** (pg. 31) – Objective # 3: *Provide assistance to local governments in developing community plans, ordinances, and regulations.* Strategy: "work with communities on developing transportation, recreation, hazard mitigation plans, and other community facility plans" Goal #4: *Provide information, data, and technical assistance to local governments concerning items related to their community development needs* Strategies: "provide information on programs impacting emergency responders", and "provide information on programs that mitigate impacts from natural and manmade disasters" Goal #5: *Collaborate on regional projects that will have long-term impact in the district as a whole*. Strategy: "Promote sustainable development of the region's natural resources with an emphasis on water management" **Chapter V – Disaster and Economic Recovery and Resiliency** (pg. 36 - 39) – Phase I: Pre-Disaster Preparedness, Phase II: Post-Disaster Planning and Implementation, Ongoing Mitigation Efforts
Central South Dakota Enhancement District (2018-2022)	**Chapter I – Introduction & Organization** (pg. 15) – Identifies existing relationship and notes FEMA, SD OEM. **Chapter II – The Region and Its Economy** (pg. 19) – "All development needs to account for the location's prevailing winds, flood potential drainage, and soil conditions, as well as potential natural disasters" referenced again under *Labor Force Characteristics/Business & Industry* section (pg. 51-52) *Natural Disasters* (pg. 20) – describes Presidentially Declared Disasters in the region with an analysis on the frequency of declarations. Highlights 2017 drought. Summarizes connection of natural disaster and impacts on agricultural

Planning Development District	Location in CEDS
	economy. *Environment and Natural Resource Profile* - Hazardous Materials; Flood Plains (pg. 28) **Chapter IV: Regional Goals/Implementation Plan** – *Goals, Objectives, and Strategies* – **Disaster Preparedness and Community Resiliency Goal** (pg. 73): *Increase a community's resiliency to disasters.* Objective 1: "to reduce or eliminate long-term risk to people and property from natural hazards and their effects" Strategy: Work with state and federal agencies to assist local units of governments in securing funding to undertake drainage improvement infrastructure, permanent flood control structures, safe room, etc. Strategy: Work with local units of government to incorporate local mitigation plans and projects into the comprehensive planning process and capital improvement programs Strategy: Encourage educational programs on flood proofing techniques for private property. Encourage education programs on protecting private property against wildfires and high winds. Strategy: Encourage local units of government to adopt and enforce building codes Objective 2: To restore services and economic vitality Strategy: Work with emergency managers and units of government to secure financing for repair of critical infrastructure Strategy: Encourage property owners to work with SBDC and local financial institutions to secure financing for reopening and /or facility improvements as a deterrent to natural disasters. Strategy: Encourage county emergency managers to have a plan for activating a long-term recovery committee should a disaster occur **Natural Resources Development Goal** (pg. 75) Objective: Participate in Missouri River Preservation, Flood Protection, and Development Projects Strategy: Assist governments with flood and siltation issues **CEDS Strategy Implementation Summary Table** (Pg. 84-87) Lists strategy and activities related to the goals noted above. **Chapter IV: Economic Resiliency** (Pg. 91-98) – *Disaster and Economic Recovery and Resiliency Strategy* **Appendix C: Environmental Restraints & Relationship to Economic Conditions Restraints/NEPA Environmental Checklist** (pg. 134)
Planning & Development District III (2014-2019)	**Section I: Background Information – Environment** (pg.43-44) – Notes Superfund sites, Hazardous Waste Sites, and 100-year floodplains **Section V: Strategic Projects, Programs, and Activities** – Describes how the previous CEDS planning period was impacted by specific events including "Unprecedented Missouri River Flooding" and "Major Drought" **Section VIII: Disaster and Economic Recovery and Resiliency** (pg. 108)
First District Association of Local Governments (2017- 2022)	**Strategic Direction and Action Plan** (pg. 30) – Community Development Objective #2: Provide assistance to local governments and economic development groups in developing strategic community/economic development plans, ordinances, and regulations.

Planning Development District	Location in CEDS
	Strategy – Assist local units of government on developing transportation, recreation, hazard mitigation plans, and other community facility plans. Community Development Objective #3: Provide information, data and technical assistance to local governments concerning items related to their community development needs Strategy – Provide information on programs impacting emergency responders **Economic Resiliency** (pg. 46-48) – Pre-Disaster Preparedness, Post-Disaster Planning and Implementation, Economic Redevelopment **Appendix B - Region's Geography** - (pg. 59) Table 11 Federal Disaster Declarations **Appendix D- Environmental Baseline** – (pg. 76) Regional Floodplains
Northeast Council of Governments (2014-2018)	**Section 3 – Region and Its Economy – Climate** (pg. 21) Table 2 Federal Disaster Declarations; (pg. 25) Superfund Sites, and Hazardous Chemical Manufactures/Storage of Hazardous Chemicals; (pg. 26) Floodplains **Section 5 – Goals and Objectives** (pg. 73) Goal 9: Increase the regions resiliency to disasters. Objectives: Assist in updating hazard mitigation, disaster mitigation and/or emergency planning documents; Work with state and federal agencies to assist local units of government in securing funding to mitigate hazards in the region **Section 6 – Strategic Project and Activities** – (pg. 81- 82) Lists several mitigation projects related to Goal 9 **Section 7 – Strategic Partners** – (pg. 85) Table 38: Partnership Relationships – Lists OEM as existing partner **Section 9 – Disaster & Economic Recovery & Resiliency Strategy** (pg. 90-99)

Comprehensive Economic Development Plans and Hazard Mitigation Plans both have the goal of increasing a community's capability to withstand or avoid the shock of a disaster. During the planning process for a CEDS, it is encouraged to consider other regional planning efforts and integrate or leverage federal funds and private resources, to advance regional goals and objectives. As shown in Table 4-4, South Dakota Planning and Development Districts have already made an effort to incorporate hazards and their risks into the regional CEDS. Similar to hazard mitigation plans, which are required to be updated every five years to qualify for federal funding, CEDS are also required to be updated every five years in order for a region to qualify for EDS assistance.

Integration Activities

Additional examples of recent integration activities involving the Planning Districts include:

- OEM stays in regular contact with each planning district regarding the development of mitigation project applications, even when there is not an open funding opportunity. OEM has encouraged submission of project applications at any time to allow sub-recipients to have shelf ready projects ready when a funding opportunity arises. OEM staff has presented mitigation program updates at all the planning district board meetings and SECOG Resource Fair. At these presentations, staff are available afterwards to discuss the independent community projects that often lead to a site visit.

Without these presentations, the mitigation program would not reach as many communities to assist in funding their mitigation projects.

- Beginning in 2016, OEM has coordinated with the planning districts to increase the mitigation section of the districts' CEDS; this coordination will continue in the future to provide guidance and funding opportunities to the local communities. There may be future opportunities to update the CEDS and local hazard mitigation plans simultaneously, or at a minimum developing guidance on how each planning process can benefit from integrating specific information found within each plan.

4.4.13 Additional State Plans and Programs

Continuity of Operations Plans (COOPs)

Continuity of Operations Plans (COOPs) prepare stakeholders to continue completing their essential functions during any incident or emergency that may disrupt normal operations. In South Dakota, all state agencies are required to create and maintain a COOP for their agency. Planners with OEM coordinate planning efforts, host continuity training opportunities and manage the state continuity planning software tool to ensure all state agencies and several other entities are able to continue completing their essential functions when any array of circumstances might otherwise interfere with normal operations.

COOPs detail the mission essential functions that are critical to that agency's overall operation, the resources (including personnel and equipment) needed to perform those functions, and what actions are being taken or need to be taken to secure those resources against loss. Agencies are encouraged to coordinate with OEM on any needed actions that may be eligible for mitigation funding.

SD Emergency Management Association (SDEMA)

OEM promotes mitigation efforts through the SD Emergency Management Association (SDEMA) at the association's quarterly meetings by providing updates to funding opportunities that the regional representatives distribute to their membership. The SDEMA's annual conference provides another opportunity for local and tribal emergency managers to engage with the state OEM mitigation team.

Volunteer Organizations Active in Disasters (VOAD)

South Dakota has a state VOAD group that meets periodically utilizing the partnerships that have been developed through the National VOAD, along with some additional partnerships.

Several VOAD organizations have been working with the Oglala Sioux Tribe since a 2016 wind storm damaged and destroyed many homes. The VOADs are helping construct new buildings that are more wind-resistant, building strong stick structures instead of unsecured trailers, not using vinyl siding, and other measures. The reservation did not have access to homes like this until VOAD partners started building them.

Great Plains Fire Safe Council

The Great Plains Fire Safe Council, which is a separate non-state volunteer organization, holds public outreach meetings to talk about fire prevention subjects such as burning brush piles appropriately, vegetation clearance around structures to meet Firewise recommendations, fire resistive plants, etc. There are monthly meetings where a number of subjects are discussed, such as which large public events (home shows, sport shows, etc.) are coming up to potentially have a booth at, Wildfire Awareness Month activities to host/participate in, etc. The goal of this organization is to be citizen driven and supported by the state/federal land management agencies. The Council also supports fire service agencies with various fire prevention messages across the state.

Growth Management, Capital Improvement, and/or Land Development Plans

Regarding capital improvement planning the South Dakota Department of Environment and Natural Resources does not have any specific requirements for design or mitigation. Typically, DENR leaves the design sizing of the storm sewers up to the engineers and the communities to work out what is the best and most practical for them, or what is in accordance with local codes and standards. Designing for even a 25-year storm can be expensive and may provide a limited benefit for the cost. Most of DENR projects design for the more frequent 5-year storm; this helps keep costs reasonable and improves the system, and while it will not fully handle the larger storms it still helps to convey the flows. South Dakota Governor's Office of Economic Development also allows the community/engineer to design the project and then requests DENR to review the plans.

4.4.14 Effective Use of State Capabilities for Mitigation

The State of South Dakota remains committed to using all available mitigation capabilities as effectively and efficiently as possible, in order to maximize risk reduction while working with limited funding. At the August 16, 2018 HMP planning meeting, the SHMT conducted an analysis of strengths, weaknesses, opportunities, and threats (SWOT) pertaining to the statewide hazard mitigation program. The results of that analysis have been combined with other SHMT comments and stakeholder feedback to produce the following discussion of the effective use of mitigation capabilities by the State of South Dakota.

In general, the SHMT noted that local communities across the state have shown a strong commitment to mitigation through the increase in both the number and quality of local mitigation plans since the previous Plan update. The state has been very efficient in its use of available mitigation grant funding, as discussed in detail in Section 5.4.1. The fact that small, rural jurisdictions are often unable to afford the local match requirement for mitigation projects has been a major obstacle to furthering local mitigation in the past; however, the state's policy for providing a portion of the 25% local match when local governments are unable to afford it, as discussed in Section 4.6.1, has been successful in overcoming this limitation.

As discussed in Section 4.4.11, the Rural Electric Cooperatives (RECs) have a successful working relationship with OEM and have leverage HMGP funding to supplement the considerable mitigation work being on their own, burying and hardening power lines. The result is a more resilient power grid in many areas of the state and reduced public expenditures in the future from winter storms and other hazards that affect power lines.

Despite the state's excellent track record of effectiveness, the SHMT identified several opportunities for improvement. Some of these improvements are addressed in the Plan's mitigation strategy in Section 5. Because others are mostly process improvements internal to OEM, and some of them are contingent upon anticipated FEMA policy changes, the planning team did not feel they warranted specific mitigation actions. OEM will be working on addressing all of them in the coming years.

- Local awareness of mitigation programs and roles often suffers due to frequent turnover in local government administrations. Therefore, it is important for OEM to continue to provide mitigation training for local officials (see Section 4.3.5).
- The length of time the grant process takes is another barrier to entry for some potential applicants. OEM will continue to do what it can to expedite the process on their end and provide technical assistance to applicants that require help.

- PA 406 and Resilient Infrastructure funding provide opportunities to fund a broader array of mitigation projects.
- Potential changes to FEMA's acquisition program to more of a post-disaster recovery program could result in more interest in home buyouts following a disaster.
- Another improvement could be the development of a resource list for matching funds for local and tribal government reference.
- As mentioned in Section 4.4.2, SDDA and OEM have started conservations about developing an Environmental Planning and Historic Preservation Programmatic Agreement to facilitate a quicker approval of pre-selection mitigation actions for future funding opportunities. This issue is addressed by mitigation action 4-3 (p5-15).
- Considering the new HGMP Post Fire funding opportunity, OEM is working to develop a list of shovel-ready projects in fire prone areas that can easily be updated and submitted when funding becomes available. This idea builds on the notable success the state has had maintaining a similar list of shovel-ready power line hardening projects, as discussed in Section 4.4.11.
- As noted in Section 3.4.6, limited information was available for this update regarding development of future state facilities. Collecting better data on existing and future state facilities to allow for more detailed analysis is a improvement identified for the next SHMP update, and is addressed in Mitigation Action 2-2 (p5-24).

4.5 Integration with Federal/National Mitigation Programs and Initiatives

44 CFR Part 201 Requirement:
The mitigation planning process should include coordination with…appropriate Federal agencies [and] interested groups and be integrated to the extent possible with…other FEMA mitigation programs and initiatives.
44 CFR Part 201 Enhanced Plan Requirement:
Enhanced State Mitigation Plans must include… *Demonstration that the plan is integrated to the extent practicable with…FEMA mitigation programs and initiatives that provide guidance to State and regional agencies.*

For the 2014 plan update, the SHMT teamed with the Silver Jackets to form an interagency committee. This process proved to be very effective, and so it was used again for the 2019 update. In addition to the state agencies described above, the Silver Jackets is comprised of several federal agencies working to reducing risk in South Dakota. Those federal agencies are outlined in the following subsections.

4.5.1 FEMA Region VIII

OEM works in close partnership with FEMA Region VIII to prepare for, respond to, and recover from disasters. Many federal mitigation funding opportunities, policies, and programs are administered by FEMA and carried out at the state level by OEM; more information on these programs can be found in Sections 4.3 and 5.3.

Annual Mitigation Consultation Meetings

The OEM Mitigation Section meets with FEMA mitigation staff at least annually to "to have an open and honest dialogue about what FEMA is doing well, as well as what we could improve upon to provide better service to South Dakota. The intended outcome is to continue to provide support to South Dakota's entire mitigation program and enhance the State's capabilities to advance mitigation action." Topics discussed at recent consultation meetings include:

- SHMP update and enhanced plan process
- State mitigation planning meetings
- FEMA technical assistance & training
- Local mitigation planning & planning district support
- Tribal mitigation planning & technical assistance to tribes
- HMA grant programs & state cost-sharing
- Risk MAP
- NFIP & floodplain management
- Climate change: impacts and adaptation
- Building sciences & building codes
- Environmental planning and historic preservation
- Rural Electric Cooperatives (RECs) mitigation, and participation in the SHMP update
- Environmental planning and historic preservation programmatic agreements

The notes from these consultation meetings for 2015, 2016, 2017, and 2018 are included in Appendix 4B.

Future consultation meetings will include a review of the state's Enhanced status, including what the state is working on and how they have improved their mitigation capabilities.

FEMA Grant Outcomes (FEMA GO)

OEM staff have been active participants in the FEMA Grant Outcomes (FEMA GO) initiative, formerly known as Grants Management Modernization (GMM). FEMA GO brings together a group of stakeholders via calls and workshops to develop the new FEMA Grant Platform that will replace ten legacy systems with one cloud-based platform for all FEMA grants. Membership includes state and tribal representatives, as well as the FEMA Regions, and field representatives in business process, governance, policy, and technology domains.

Hazard Mitigation Assistance External Stakeholder Working Group

The SD SHMO is a member of FEMA's Hazard Mitigation Assistance External Stakeholder Working Group working to develop new Grant Outcomes and is one of three SHMOs in the country on the Working Group. This working group is integral to the process of moving the HMA grants away from eGrants and NEMIS to the new grants platform. The intent of the ESWG is to:

- Open channels of communication between federal and state, territory, federally recognize tribe, local, and regional mitigation staff
- Gather insight into mitigation and/or HMA program issues from the state, territory, tribal, local, or regional perspective
- Provide feedback from non-federal stakeholders on gaps, needs, and methods to make program improvements
- Provide ideas for how to meet the FEMA Strategic Goal of increasing investment in mitigation by 2022 and participate in the implementation and execution of these goals
- Increase transparency in HMA goals, program priorities, and policy development
- Help HMA provide a consistent, predictable experience for external stakeholders

4.5.2 U.S. Army Corps of Engineers (USACE)

The U.S. Army Corp of Engineers (USACE), Omaha and St. Paul Districts, supports engineering and construction services in the areas of water resources, design, construction, and environmental restoration. They are involved in flood management projects, wetlands restoration, dam and lake projects, drought and flood relief, and disaster preparedness. The capabilities described below showcase the USACE's ability in flood hazard mitigation.

Silver Jackets

The Silver Jackets program provides a formal and consistent strategy for an interagency approach to planning and implementing measures to reduce risks associated with flooding and other natural hazards. The teams are developed and led at the state level with the support of federal partners. In South Dakota, the Silver Jackets team consists of the USACE, FEMA Region VIII, USGS, National Weather Service, US Department of the Interior Bureau of Reclamation, South Dakota Office of Emergency Management, South Dakota Department of Environment and Natural Resources, South Dakota Department of Transportation, and South Dakota Bureau of Information and Telecommunications.

The Silver Jackets team meets quarterly. The program's desired outcomes are:

- Reduce flood risk
- Agencies better understand and leverage each other's programs
- Collaboration between various agencies, coordinated programs, cohesive solutions

- Multi-agency technical resource for state and local agencies
- Mechanism for establishing relationships to facilitate integrated solutions post-disaster
- Work with OEM to improve levee inventory databases

As noted above and throughout Section 2 Planning Process, South Dakota has leveraged the Silver Jackets program by holding joint meetings with the SHMT to improve stakeholder participation in the SHMP update process.

Floodplain Management Service Program

This program enables the USACE to provide technical services, planning assistance, and guides and pamphlets for floodplain management to help prevent or reduce flood damage by using structural and/or nonstructural mitigation measures. All activities under this program are 100 percent federally funded.

Other USACE programs that enhance mitigation include:

- Risk Assessments
- Risk Communication
- Dam Safety Program
- Levee Safety Program
- Flood Risk Management Program
- Civil Works Emergency Management Program
- Specific SD Projects?

4.5.3 Natural Resource Conservation Service

The NRCS provides information and assistance to farmers who are affected by the drought in South Dakota. They administer the Environmental Quality Incentives Program Initiatives, as well as numerous Farm Bill programs that provide technical and financial assistance to farmer and ranchers to install conservation practices.

The state has leveraged NRCS Emergency Watershed Protection funding when available, although that program is usually underfunded and seldom has funding available when needed following a disaster. Each drought year this program is discussed, and NRCS offers what they can to the declared drought counties.

4.5.4 U.S. Geological Survey

The USGS provides information on South Dakota's rivers, streams, ground water, and water quality. The organization operates an extensive network of stream-gaging stations in the state, many of which form the backbone of flood-warning systems. StreamStats for South Dakota is a web-based GIS program that provides users with access to analytical tools that are useful for water-resources planning and management, and for engineering design applications, such as the design of bridges. This program allows users to obtain streamflow statistics, drainage basin characteristics, and other information on streams. The Flood Inundation Mapping Program is designed to help state and local communities understand flood risks and make cost-effective mitigation decisions. The USGS also heads flood studies and reports on areas of South Dakota that are prone to flooding.

South Dakota's mitigation efforts align with a variety of USGS programs, to include:

- National Earthquake Information Center (NEIC)
- National Earthquake Hazards Reduction Program (NEHRP)

- "Did You Feel It?" program
- Geologic hazard mapping

Section 4.4.1 discusses how DENR works with USGS to coordinate information from USGS stream gauges and DENR stream sensors.

4.5.5 National Weather Service (NWS)

Part of the National Oceanic and Atmospheric Administration (NOAA), the National Weather Service (NWS) has 3 offices in South Dakota, in Sioux Falls, Aberdeen, and Rapid City. They provide severe weather and flood warnings, and NOAA All-Hazards Weather Radio broadcasts. They also offer storm spotter training, training hundreds of South Dakotans each year in how to recognize and protect themselves from severe storms. NWS also provides weather and flooding safety guides, in addition to cooperating with OEM in the development of the *Tommy the Turtle* children's books discussed in Section 2.4.1.

Section 4.4.1 discusses how NWS uses information from both USGS stream gauges and DENR stream sensors for flood prediction and monitoring.

StormReady

StormReady is a nationwide program that helps communities better protect citizens during severe weather, encourages communities to take a proactive approach to improving local hazardous weather operations, and provides guidance to emergency managers on how to improve hazardous weather operations. There are 32 StormReady entities in South Dakota as of August 8, 2018, including 15 counties, 10 communities, 1 tribe, 2 hospitals, 1 university, and 2 federal government facilities, and South Dakota OEM.

Weather-Ready Nation Ambassadors

The Weather-Ready Nation (WRN) Ambassador initiative is a NOAA-NWS effort to formally recognize NOAA partners who are improving the nation's readiness, responsiveness, and overall resilience against extreme weather, water, and climate events. As a WRN Ambassador, partners commit to working with NOAA and other Ambassadors to strengthen national resilience against extreme weather. In effect, the WRN Ambassador initiative helps unify the efforts across government, non-profits, academia, and private industry toward making the nation more ready, responsive, and resilient against extreme environmental hazards. WRN is a strategic outcome where society's response should be equal to the risk from all extreme weather, water, and climate hazards.

To be officially recognized as a WRN Ambassador, an organization must commit to:

- Promoting Weather-Ready Nation messages and themes to their stakeholders;
- Engaging with NOAA personnel on potential collaboration opportunities;
- Sharing their success stories of preparedness and resiliency; and
- Serving as an example by educating employees on workplace preparedness.

As of July 17, 2018, six South Dakota organizations have been recognized as WRN Ambassadors:

- South Dakota Department of Health
- South Dakota Highway Patrol
- South Dakota Office of Emergency Management
- South Dakota Science and Technology Authority

- South Dakota State University
- South Dakota State University (SDSU) Extension

4.5.6 U.S. Bureau of Reclamation

The Bureau is the largest wholesaler of water in the country, bringing water to more than 31 million people and providing one out of five Western farmers with irrigation water for 10 million acres of farmland that produce 60% of the nation's vegetables and 25% of its fruits and nuts. The Bureau is also the second largest producer of hydroelectric power in the western US.

The Bureau is a water management agency with a Strategic Plan outlining numerous programs, initiatives and activities that will help the Western states, Native American tribes, and others meet new water needs and balance the multitude of competing uses of water in the West. Their mission is to assist in meeting the increasing water demands of the West while protecting the environment and the public's investment in these structures. Programs, initiatives and activities include:

- WaterSMART Program
- Water Conservation Field Services Program
- Rural Water Supply Program
- Resource Management and Planning
- National Irrigation Water Quality Program
- Flood Hydrology and Consequences Group
- Drought Program
- Dam Safety
- Building Seismic Safety Program
- Snowpack and Reservoir Levels

4.5.7 Federal Highway Administration

The South Dakota FHWA division office provides leadership and guidance to the SDDOT in planning, construction, and maintenance of transportation projects. They help to ensure that roads, bridges, and tunnels are safe and continue to support economic growth and environmental sustainability.

As discussed in Section 4.3.3, FHWA and SDDOT coordinate closely on the National Bridge Inspection Program and interdisciplinary scour team. The SDDOT Emergency Relief (ER) program, also detailed in Section 4.3.3, is funded through the FHWA.

4.5.8 Housing and Urban Development (HUD) Community Development Block Grant Disaster Recovery Grants (CDBG_DR)

HUD provides flexible grants to help cities, counties, and states recover from Presidentially declared disasters, especially in low-income areas, subject to availability of supplemental appropriations. In response to Presidentially declared disasters, Congress may appropriate additional funding for the Community Development Block Grant (CDBG) Program as Disaster Recovery grants to rebuild the affected areas and provide crucial seed money to start the recovery process. Since CDBG Disaster Recovery (CDBG-DR) assistance may fund a broad range of recovery activities, HUD can help communities and neighborhoods that otherwise might

not recover due to limited resources. The Governor's Office of Economic Development administers CDBG-DR funding for the State of South Dakota.

HUD works with OEM and the Governor's Office of Economic Development when CDBG-DR funds are made available after a disaster. HUD has very specific guidelines for providing the money to low to moderate income counties in the disaster declared counties, and they rely on the state's expertise to help seek out projects in these areas. Several powerline burial projects have been done with CDBG-DR funds.

4.6 Local Capability Assessment and Integration

44 CFR Part 201 Requirement:
[The State mitigation strategy shall include] a general description and analysis of the effectiveness of local mitigation policies, programs, and capabilities.
44 CFR Part 201 Enhanced Plan Requirement:
Enhanced State Mitigation Plans must include…Demonstration that the State is committed to a comprehensive state mitigation program, which might include any of the following: *A commitment to support local mitigation planning by providing workshops and training, State planning grants, or coordinated capability development of local officials, including Emergency Management and Floodplain Management certifications.* *The State provides a portion of the non-Federal match for HMGP and/or other mitigation projects.* *To the extent allowed by State law, the State requires or encourages local governments to use a current version of a nationally applicable model building code or standard that addresses natural hazards as a basis for design and construction of State sponsored mitigation projects.*

The State of South Dakota has a strong history of working with local governments to reduce their risk from hazards. Maintaining this relationship is a top priority for OEM and the SHMT. This section describes the state's policies and processes for assisting local governments with hazard mitigation planning and projects.

Section 4.7 breaks out tribal information separately to highlight the unique nature of the state's relationship with the tribes.

4.6.1 Local Technical and Financial Assistance

44 CFR Part 201 Requirement:
[The section on the Coordination of Local Mitigation Planning must include a] description of the State process to support, through funding and technical assistance, the development of local mitigation plans.
44 CFR Part 201 Enhanced Plan Requirement:
Demonstration that the State is committed to a comprehensive state mitigation program [might include]: *A commitment to support local mitigation planning by providing workshops and training, State planning grants, or coordinated capability development of local officials.* *The State provides a portion of the non-Federal match for HMGP and/or other mitigation projects.*

OEM provides funding and technical assistance to local governments, to include provision of funds, plan development assistance, technical assistance for developing risk assessments, G318 trainings for hazard mitigation planning, benefit cost analysis (BCA) training, and tribal planning assistance.

The SHMO works with each county in the state to support the development of local mitigation plans. The SHMO performs a preliminary review of each plan prior to submitting it to FEMA. It is the goal of the SHMO to support plan development for every county in the state, to ensure it meets FEMA's requirements, as well as supporting the maintenance and updates of these plans. During the planning process for the 2019 State Plan, 60 counties and 6 tribal governments had FEMA approved hazard mitigation plans or plans in the process of being updated. In total, 79% of the counties in the state are covered by an approved local mitigation plan. The SHMO will continue regular meetings with each county to ensure maintenance and required updates for all local plans are performed. To further incentive the development of local hazard mitigation plans, OEM is requiring plans as a condition of receiving FEMA Emergency Management Performance Grant funding.

Technical assistance is a cradle to grave program for the mitigation staff. The OEM mitigation staff provides technical assistance to any potential applicant upon inquiry. Staff conducts site inspections, discusses grant opportunities, and provides guidance on application development. This assistance continues upon application submission to ensure that the application is complete as strong as possible prior to submission to FEMA. At and after grant award, mitigation staff conducts periodic project inspections and visits to ensure that the sub-recipient is successful while meeting all the grant requirements.

As documented in the Hazard Mitigation Grant Program Administrative Plan dated August 7, 2018, the SHMO coordinates review of each project application for funding eligibility in FEMA's Hazard Mitigation Assistance programs. The State Hazard Mitigation Team (SHMT) serves as a review and prioritization panel for the Hazard Mitigation Grant Program (HMGP).

OEM in collaboration with the SHMT awards mitigation grant funds and completes the required paperwork and monitoring process for those funds. In addition, the State Hazard Mitigation Officer has coordinated multiple technical assistance activities. These include trainings for flood planning assistance and awareness, BCAs, and tribal planning assistance. See Section 4.3.5 for a discussion of mitigation training opportunities provided by OEM. OEM also provides technical assistance in the completion of BCAs for applicants that have little-to-no experience conducting BCAs.

State Assistance with Local Matching Funds

Many small towns and townships in South Dakota want to build resiliency but cannot afford the 25% local matching funds required by many hazard mitigation grants. To better assist local governments, the SHMT has adopted a policy that authorizes the state to provide a portion of the matching funds when it is deemed necessary and appropriate. The SHMT uses the following criteria to determine which projects should receive a state funding match:

- No state match will be provided towards the completion of local hazard mitigation plans.
- The sub-recipient must prove they are under financial stress and demonstrate that their project cannot be funded without the help of a state share. Sub-recipients can prove financial stress by submitting documents illustrating their financial situation and the hardship they would encounter if they were required to fund the entire 25% share.

- A sub-recipient who applies for hazard mitigation projects in a county that has been included in a Presidential disaster declaration and has received Public Assistance (PA) funds within the last five years is eligible for a 20% state funding match.

Applicants who submit projects located outside of a disaster county are eligible to receive a 10% state funding match.

This policy has been very successful in stimulating local mitigation projects, and the state has provided as much as a 20% funding match for several local projects, such as for completion of tornado shelters in Pierre and Pukwana. Projects that have received a 10% match are: City of Groton Generator, City of DeSmet Generator, Town of Delmont Tornado Safe Rooms, Town of Lesterville Generator, and Yankton County/Boy Scouts of America Tornado Safe Rooms.

4.6.2 Prioritizing Local Assistance

44 CFR Part 201 Requirement:
[The section on the Coordination of Local Mitigation Planning must include] criteria for prioritizing communities and local jurisdictions that would receive planning and project grants under available funding programs which should include: *Consideration for communities with the highest risks,* *Repetitive loss properties, and* *Most intense development pressures.* *Further that for non-planning grants, a principal criterion for prioritizing grants shall be the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.* *[The] plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities.*

As noted previously, providing assistance to local governments is a top priority for the state hazard mitigation program. The following section discusses how the SHMT screens and prioritizes project applications. In particular, the SHMT and OEM help local jurisdictions develop and maintain current local hazard mitigation plans in compliance with the Disaster Mitigation Act of 2000. OEM encourages jurisdictions that have an LHMT due to expire within 3 years to apply for PDM funding to assist with the update, or to the 7% set aside for planning under HMPG (when available). Plans that have expired or are close to expiring receive a higher priority. The information gathered in this Plan is available to the local communities for use when developing their own plans.

The State Hazard Mitigation Team recognizes that some counties are more vulnerable to certain hazards than others. Section 3.5 Risk Assessment Summary and Conclusions summarizes the key vulnerabilities, losses and consequences associated with each hazard identified in the HIRA and highlights how those impacts vary from county to county. The SHMT and OEM use that information to help prioritize funding and assistance between different jurisdictions.

See also Section 5.4.2 on eligibility criteria that is used to screen proposed mitigation projects.

4.6.3 Local Plan Integration

44 CFR Part 201 Requirement:
[The section on the Coordination of Local Mitigation Planning must include a] description of the State process and timeframe by which the local plans will be reviewed, coordinated, and linked to the State Mitigation Plan. *[The] plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities*

Between the approval of the 2014 State Plan and the planning process for the 2019 plan update, 49 local hazard mitigation plans were approved by FEMA. In total 68 local plans, covering all 66 counties and 6 tribal governments (five plans were joint plans with neighboring counties or Tribes), were reviewed and integrated into this plan. Of these plans 60 were approved and 8 had expired in 2017 or will expire in 2018. Each local plan was reviewed for the following components:

- Hazards
- Local Capabilities
- Mitigation Actions (completed and identified)
- Estimated Losses
- Growth and Development Trends

Information from the local plans is integrated throughout the HIRA. Section 3.1 discusses how hazards affecting local jurisdictions were identified and prioritized using information from local plans. Information from local plans was used through the hazard profiles (Section 3.2) and vulnerability Sections (3.3 and 3.4). Table 3-35 in Section 3.3 summarizes the growth and development trends identified in the local plans. A spreadsheet that is included as Appendix 5 (electronic) summarizes the hazard rankings and vulnerability data from local plans. Funding sources identified in the local plans are included in Section 5.3.

4.6.4 Local Plan Review Process

Local hazard mitigation plans are submitted to OEM either electronically or by hard copy. If there are any findings for corrections, OEM either calls or sends an email to the submitting jurisdiction. Staff keep track of where each plan is within the review process. They are typically reviewed in the order they are received, and within 30 days of receipt, unless there or circumstances requiring an expedited review. The number of plans submitted each quarter varies based on the update schedule for each plan.

Once OEM finds a plan to be complete and compliant with the requirements, they submit it to FEMA Region VIII for their review. FEMA has 45 days to provide comments back to the state or send up an approvable pending adoption letter. If revisions are required by FEMA, OEM notifies the submitting jurisdiction via email and offers to host a conference call to discuss the necessary revisions. All correspondence and notifications from OEM are distributed electronically.

4.6.5 Local Capabilities Overview

44 CFR Part 201 Enhanced Plan Requirement:
To the extent allowed by State law, the State requires or encourages local governments to use a current version of a nationally applicable model building code or standard that addresses natural hazards as a basis for design and construction of State sponsored mitigation projects.

Mitigation capabilities vary greatly between South Dakota's 66 counties and 9 Tribes. Variation in capabilities may result from many factors, including where the jurisdiction is located in relation to the hazard extent, regional economies impacting local tax base, political support, full-time or part-time personnel, regular maintenance of and adherence to community and operational plans, and the strength of regulation enforcement.

At the time of the 2019 Plan update, 60 of the state's 66 counties and six of the nine tribes were covered by FEMA-approved mitigation plans. Because some counties and tribes wrote joint plans, a total of 68 hazard mitigation plans were reviewed for this update. These plans were reviewed to compile information on local mitigation programs and capabilities. Data on each capability was collected from available local hazard mitigation plans and was then compiled into a master spreadsheet (Appendix 5 - electronic) to facilitate the detailed review and comparison between jurisdictions. Table 4-6 presents a summary of the policies, programs, administrative, and technical capabilities identified in local mitigation plans during the 2019 planning process, along with a comparison to those identified in the 2014 plan.

Table 4-6 Summary of Local Capabilities

Capability	# Identified in 2014 Plan	# Identified in 2019 Plan	% Identified in 2019 Plan	% Increase 2014 - 2019
Local Emergency Operations Plan	27	61	88%	126%
State Hazard Mitigation Plan Review/Incorporation	1	59	86%	5800%
Emergency Operations Center/Incident Command System Interface	6	58	84%	867%
Hazard Mitigation Interagency Team/Local Emergency Planning Committee	18	57	83%	217%
Designated Storm Shelters	24	56	81%	133%
Zoning/Planning Commission	21	54	78%	157%
Emergency Power	18	54	78%	200%
NFIP/Strict Development Regulations in Flood Hazard Zones/Floodplain Management Program	43	53	80%	23%
Outdoor/Indoor Warning System/Proactive Weather Program	43	51	74%	19%
Public Awareness Campaigns/CERT/Citizen Corp	24	48	70%	100%
HAZUS Incorporation or Ability to Access	1	48	70%	4700%
Comprehensive Plan	17	47	68%	176%
Fire Bans and Public Water Restrictions During Dry Periods	27	45	65%	67%
Regular Training for Emergency Responders	40	44	64%	10%
Equipment to Handle Fire/Wildfire	24	43	62%	79%
Pre-Planning for Winter Operations	16	41	59%	156%
Equipment for Winter Storm Response	21	39	57%	86%
Drainage Ordinance	4	37	54%	825%
Mutual Aid Agreements with other fire departments	21	36	52%	71%
GIS Data and Mapping	5	35	51%	600%
Building Code	28	34	49%	21%
Weather Spotters	22	33	48%	50%
Public Safety Programs for Public and Children	19	32	46%	68%
Flood Damage Prevention Ordinance	5	32	46%	540%

Capability	# Identified in 2014 Plan	# Identified in 2019 Plan	% Identified in 2019 Plan	% Increase 2014 - 2019
Continual Maintenance of Infrastructure (Electrical, Lift Stations, Sewer, Drain)	15	29	42%	93%
Regular Dam and Culvert Inspections and Maintenance	24	29	43%	21%
Radio Station Weather Announcements	1	26	38%	2500%
NOAA Weather Radio	8	23	33%	188%
Regular Road Maintenance and Repair	2	23	33%	1050%
Elevation Certificate/Ordinance	3	23	33%	667%
Response Plan in Case of Dam Failure	11	19	28%	73%
SD Electric Cooperatives Mutual Aid Plan	13	18	26%	38%
Emergency Exercises to Test Emergency Plans	3	18	26%	500%
Digital Infrastructure Mapping	2	17	25%	750%
Equipment to Respond to Hazardous Materials Incidents	14	16	23%	14%
Storm Ready	4	16	26%	300%
Monitor Drought Situation	2	15	22%	650%
Catalogue and Track Hazardous Materials	12	11	16%	-8%
CWPP	5	11	16%	120%
Stormwater Master Plan/Ordinance	1	10	14%	900%
911 Addressing	2	10	14%	400%
Capital Improvement Plan	3	9	13%	200%
Stored Sandbags for Flood Fighting Operations	10	9	13%	-10%
Tree Trimming near Power Lines	1	8	12%	700%
Increased Security, Communication, and Educational Outreach to Prevent Terrorism	7	7	10%	0%
NIMS Compliant	2	7	10%	250%
Fire Mitigation Plan	3	6	9%	100%
Contingency Plans	2	6	9%	200%
Regional Terrorism Response Plan	1	1	1%	0%

Several capabilities identified in the county and tribal plans can assist with the implementation of local and state mitigation actions. Planning and regulatory capabilities (e.g. plans, codes, ordinances, planning mechanisms) have the highest percentage of identification in local plans. Most local plans, 80%, identified participating in the National Flood Insurance Program or having a floodplain management program. Overall, ordinances related to developing in floodplains, fire bans, water use restrictions and drainage were most commonly identified in the local plans. Over half of the local plans (68%) identified having a comprehensive plan, a tool that communities can use to determine where future development can and should be directed. Each local jurisdiction is unique and may have additional regulatory or planning capabilities that are not listed in the table above.

In addition to planning and regulatory capabilities, administrative capabilities such as having the staff to implement plans and enforce regulations was also captured in the local capability assessment. A majority of local plans noted having a zoning and/or planning commission that are charged with making land use decisions. Of the local jurisdictions whose capabilities were evaluated, 83% identified having a Hazard Mitigation Interagency Team or Local Emergency Planning Committee (LEPC). This team or committee is

often charged with ensuring hazardous materials emergency response plans are up to date as well as contributing to the Local Emergency Operations Plan, which a majority of local mitigation plans (88%) identified as having in place. The LEPC is often responsible for conducting public awareness campaigns, which may be one reason why 70% of local plans identified having conducted a public awareness campaign since 2014. In smaller communities the ability to have full-time staff is often financially challenging. The counties that participate in one of the six Planning and Development Districts discussed in Section 4.4.12 can supplement local staff with the District by providing planning and technical assistance including GIS support.

A high percentage of local plans (86%) identified reviewing and/or incorporating information from the 2014 State Hazard Mitigation Plan, including the risk information that informed the local risk analysis using the software Hazus and GIS. In addition to the use of Hazus and GIS, other technical capabilities such as designated storm shelters, emergency power, outdoor/indoor warning system and hazard specific equipment (fire/wildfire and winter storm response) were also common capabilities identified in local plans.

The 2014 Plan noted that local mitigation planning had increased tremendously since the previous Plan update. As Table 4-6 makes clear, this momentum has continued and accelerated into 2018. Most of the capabilities shown in Table 4-6 saw an increase in identification in local plans between 2014 and 2019. The capabilities that saw the greatest increase include: Radio Station Weather Announcements, Regular Road Maintenance and Repair, Stormwater Master Plan/Ordinance, Emergency Operations Center and Drainage Ordinance. Capabilities related to the hazards of greatest significance to the state (flooding, winter storms, wildfire and drought), are among the capabilities that saw the greatest increase in identification between 2014 and 2019. These capabilities include flood damage prevention ordinances, tree-trimming from power lines, monitoring drought situation, and having a Community Wildfire Protection Plan (CWPP).

Other capabilities also saw an increase in identification in local plans. Weather spotters saw a 50% increase in identification and participation in StormReady also saw a significant increase. The increase in capabilities that could be used to address severe weather hazards may be related to the State's outreach efforts including participation in the National Weather Service's (NWS') Severe Weather Awareness Week, an awareness campaign conducted in partnership between the OEM and the NWS; several local plans mentioned taking part in awareness activities during this week. This may also explain why there was an increase in local plans identifying having a public awareness campaign, while several plans also noted ongoing public awareness as a shortcoming. This shows there is an opportunity for the state to continue to provide resources to conduct these types of awareness campaigns in the future.

Another opportunity for the State to increase local capabilities is in monitoring drought. While this capability did see an increase between 2014 and 2019, only 22% of local plans identified monitoring drought, often including receiving information from the State Drought Task Force. Several others did not profile drought at all, stating challenges in mitigating the hazard. The 2015 South Dakota Drought Mitigation Plan contains a detailed drought vulnerability assessment and strategies to mitigate drought. Moving forward the Drought Mitigation Plan could be used to inform local plans in future updates.

Few capabilities saw a decrease in identification in local plans since 2014. The capabilities related to hazardous materials were among those that did see a decrease or only a minor increase in identification in the local plans. This may be due to some counties, about 30%, having separate Hazardous Materials Plans where capabilities related to hazardous materials are likely to be stated. This presents an

opportunity for incorporation and integration of information between local plans including the hazardous materials and local hazard mitigation plans.

A complete inventory of the capabilities identified in the local plans is included in Appendix 5. OEM recognizes that many of the listed capabilities are more effective for disaster response than hazard mitigation. The State Hazard Mitigation Officer continues to work with the local communities on improving the local hazard mitigation plans.

Local Adoption of Building Codes

Building codes are among the most important and effective mitigation capabilities a state and local government can have. The State of South Dakota has adopted building codes but does not mandate city or counties to adopt codes. If a city or county chooses to adopt building codes, they must at minimum follow the state code. Of the local plans reviewed for this update, 49% have adopted building codes, which represents a 21% increase from the 2014 update.

In 2014, the SHMT identified a mitigation action to "Coordinate with South Dakota Building Officials' Association to integrate floodplain management ordinances into local building codes" (See Section 5.2.3, Action 2-1.) This action was retained for the 2019 Plan update.

OEM has been working with the South Dakota Building Officials' Association to verify if floodplain management ordinance regulations are integrated and correspond to the adopted building code provisions at the local government level. The South Dakota State government has adopted the 2018 Edition of the International Building Code (IBC 2018), as published by the International Code Council. However, local government enforcement of IBC 2018 is not mandated at the state level. Thus, there are various towns and counties across South Dakota that have a building official and an office that issues building permits, and other communities that do not. When a community has not adopted IBC 2018, South Dakota Codified Law 11-10-6 Standards for New Construction Where Building Code Ordinance Has Not Been Adopted is triggered. SDCL 11-10-6 requires any new construction that commenced after 7/1/2018, within a community that has not adopted an ordinance prescribing standards for new construction, must have the design standard based on IBC 2018.

When IBC 2018 is properly followed and enforced, the communities can rely on the flood provisions of the IBC to fulfill their responsibilities for participation in the NFIP, provided development other than buildings are also regulated. Because requirements for utilities and equipment are specified in the IBC (by reference to ASCE 24), there are no gaps or conflicts if one or more of the codes that govern mechanical, plumbing and fuel gas installations is not adopted.

The South Dakota Building Officials' Association will be reaching out to officials from South Dakota's seven CRS communities (Aberdeen, Rapid City, Madison, Meade County, Parkston, Spearfish and Watertown) during their upcoming 2018 and 2019 meetings to ensure the communities' adopted higher floodplain standards or revisions have been reflected within their adopted building code. The State of South Dakota has inserted into their building code regulations (SDCL 11-10-5) that more restrictive building code requirements or revised requirements can be put in place, as long as the higher standards are legally made effective upon their adoption and subsequently filed with the local auditor's office.

Community Comprehensive Plans

A comprehensive plan is an official document adopted by cities and counties that states a community's overarching vision, goals, policies and strategies to help guide future land use decisions and preserve and

protect community assets. The plan is not a regulatory document but is often tied to the approval criteria for development applications. Comprehensive plans cover all aspects of a community including land use, transportation, housing, the economy and the environment.

South Dakota regulations state the purpose of a county comprehensive plan is to protect and guide "the physical, social, economic, and environmental development of the county; to protect the tax base…" (SL 1941, ch 216, § 3; SDC Supp 1960, § 12.20A03; SL 1967, ch 20, § 2; SL 1975, ch 113, § 6). Similarly, state regulations for municipalities' comprehensive plans emphasize the protection of a community's health and general welfare by "encouraging the most appropriate use of land." However, South Dakota does not require either county or municipality comprehensive plans to address natural or man-made hazards. There continues to be an opportunity for communities to incorporate information from risk and vulnerability analysis of local hazard mitigation plans into local comprehensive plans to ensure future development is directed away from areas at risk of certain hazards. OEM has had preliminary discussions with one of the Planning and Development Districts (See Section 4.4.12) about improving the integration of mitigation planning into comprehensive plans; this possibility will be explored further in the coming months.

Comprehensive planning is a service that all six Planning and Development Districts in the state offer. (See Section 4.4.12.) Many of the districts have written the comprehensive plans, comprehensive economic development plans, and the local hazard mitigation plans for communities. The districts will continue to be a resource for communities to help protect people and property by guiding future land use decisions away from known hazard areas.

4.6.6 Local Mitigation Actions Overview

As part of the 2019 planning process, completed and identified mitigation actions from a total of 68 local and tribal plans were captured and summarized. The database is included as an electronic Appendix (Appendix 5). Capturing available local information on mitigation actions allows the State and local jurisdictions to see what progress in implementing mitigation projects has taken place and what gaps may still exist. The following tables show how localities in South Dakota plan to mitigate risk in the future and what types of actions local jurisdictions have already taken to decrease their risk to the hazards that pose a risk to their community.

Identified Local Mitigation Actions

Table 4-7 Comparison of Current Local Mitigation Actions, 2014 v. 2019

Identified Actions	2014	2019
Stormwater Improvement/Drainage and Culvert Improvement	38	44
Powerline Burial/Improvement	34	31
Generator/Power Backup	32	37
Flood Control/Management	32	16
Firefighter/Flood Manager/Volunteer/GIS Training/Exercises/Certification	31	31
Public Awareness and Education Campaigns	31	54
Storm Shelter/Tornado Safe Room	29	45

Identified Actions	2014	2019
New Warning System/Warning System Improvement	28	34
Continued NFIP Compliance/Encourage NFIP Participation/CRS	27	38
Land Use Policies/Zoning Enforcement/Building Code/Drainage Ordinance/Wildfire Policy	24	31
Improve/Create Mapping and/or Facility and Data Inventory (Infrastructure, Critical Facilities, Flood, Vulnerable Populations)	24	33
Controlled Burns/Burn Bans/Vegetation Management/Firebreaks/Defensible Space	22	34
Improvement to Emergency Communication System	21	20
Purchase/Improvement of EMS Equipment (Fire, Ambulance, Police)	20	19
StormReady®	14	15
Software/Technology Improvements for Data Analysis	12	17
Debris Removal	12	11
Tree Removal	9	16
Implement/Improve 911 Emergency/First Responder System	9	7
Promote NFIP/Flood Insurance to nonparticipating communities	8	8
Create/Continue partnerships with non-profits, private organizations/citizens, neighboring emergency managers, and transportation agencies	8	33
Elevation/Acquisition/Relocation/Floodproofing	8	15
Develop Severe Weather Preparedness Plans (mass sheltering, business continuation, debris removal)/Conservation Plans/HazMat Plans	7	30
Improve traffic safety/road improvements	6	36
Install Stream Gauges	2	4
Install Snow fence/Plant Living Wind/Snow breaks	2	21
TOTAL	**490**	**680**

Between 2014 and 2019 there was about a 40% increase in the number of proposed mitigation actions and projects identified in local plans. This is primarily due to the 50% increase in the number of approved plans reviewed in 2019 compared to 2014. The four mitigation actions that saw the greatest increase in identification in local plans were: creating and continuing partnerships, developing severe weather

preparedness plans, improve traffic safety/road improvements and install snow fence/plant living wind/snow breaks.

Many of the actions identified in the local plans are supported by actions in the state's mitigation strategy. As shown in Table 4-8 below, many of the state's mitigation actions will support the most commonly identified actions in local plans. For example, the lack of storm shelters in local communities was often listed in local plans as a shortcoming and was identified as a mitigation action in 45 of the 68 plans reviewed in 2019, a 55% increase from the previous Plan update. The state has long-recognized the importance of local communities having storm shelters and has completed a considerable amount of work related to funding local shelters and safe rooms. Public awareness was also noted in many local plans as a shortcoming. Of the plans reviewed in 2019, 54 of the 68 local plans identified actions related to awareness and education campaigns, more than any other mitigation action identified in the local plans reviewed. The state's 2019 mitigation strategy, as well the mitigation actions identified in the State Drought Mitigation Plan, will help to support the implementation of local awareness and education campaigns. Continuing to provide resources to complete and fund local mitigation projects will be crucial for the state to keep local communities engaged and focused on mitigation.

Table 4-8 Comparison of Most Commonly Identified Local Mitigation Actions and Related State Mitigation Actions

Local Mitigation Action	Related State Mitigation Actions
Public awareness and education campaigns (54 Plans)	1-3: Coordinate public outreach/ education regarding shelter locations and warning systems. Develop brochures, websites, news briefs, and other media to notify the public of shelter locations and what sounds to expect from the warning systems. 1-4: Support and encourage public education/outreach efforts for all hazards awareness and safety. 4-4: Develop and deploy targeted messaging aimed at educating and informing travelers during drought, fire and flood events. 5-1: Support and continue public outreach efforts regarding methods to reduce losses due to natural hazards. DMP 2.5: Coordinate communication for in-state and out-of-state tourists, including social media, email databases and tourism industry partners. DMP 2.8: Create public awareness campaigns that various agencies can use for water conservation, fire prevention, etc. DMP 2.10: Educate producers on production modifications available to lessen drought impacts DMP 2.11: Disseminate public outreach, awareness, and education on fire mitigation

Local Mitigation Action	Related State Mitigation Actions
	DMP 2.12: Increase awareness and education for drought planning ranchers DMP 2.13: Disseminate public awareness and information (e.g. fliers, brochures, PSAs, social media)
Storm shelter/tornado safe room (45 Plans)	1-1: Support the construction and operation of hardened shelters/safe rooms through local project application
Stormwater improvements/drainage and culvert (44 Plans) improvements	2-4: Support and encourage flood control projects through state & local project applications. 3-3: Encourage removal of debris in waterways (i.e. near bridges, culverts, within stream channels). 3-4: Support and encourage drainage improvement projects through local applications (i.e. proper sizing). 3-5: Support and encourage routine inspections of existing utilities and infrastructure for damage and weaknesses.
Continued NFIP compliance/encourage participation in NFIP (38 Plans)	2-1: Coordinate with South Dakota Building Code Officials Association to integrate floodplain management ordinances into local building codes 4-2: Promote insurance – Many different forms of insurance are available to cover damages incurred by the various natural hazards. The State will encourage residents, farmers, and business owners to purchase insurance appropriate for their risk.
Generator/Power backup Acquisition (37 Plans)	3-2: Encourage the purchase of generators for backup power to critical infrastructure / storm shelters and conduct regular testing for preparedness.

*Note: DMP label represents actions identified in the State Drought Mitigation Plan

Completed Local Mitigation Actions

The process of capturing completed local mitigation actions started with the 2014 Plan Update, although at that time only 44 local plans were available to review. Additionally, it should be noted that during the 2019 review of plans there were instances of completed actions being removed from plan updates, or no identified completed actions referenced, making it difficult to compare progress the completion of mitigation actions between 2014 and 2019. Nevertheless, capturing available local information on completed actions informs the State and local jurisdictions on the progress in implementation of mitigation projects and what gaps may still exist.

Table 4-9 Summary of Completed Local Mitigation Actions, 2019

Completed Actions	2019
Stormwater Improvement/Drainage and Culvert Improvement	10
Powerline Burial/Improvement	16
Generator/Power Backup	7
Flood Control/Management	10
New Warning System/Warning System Improvement	13
Tree Removal/Trimming	1
Improve Data/Mapping Capabilities	5
Improve Emergency Communication Capabilities	6
New Storm Shelter	4
Purchase of Winter Storm/Firefighting/EMS Equipment	1
Completion of Hazard Specific Mitigation Plan (i.e. CWPP, HazMat, Dam)	5
Road Infrastructure Improvement	12
Firefighter/Flood Manager/Volunteer Training/Exercises/Certification	6
Passage of Hazard Specific Mitigation Policy	9
Elevation/Acquisition/Relocation	1
TOTAL	106

The mitigation actions that have had the greatest increase in completed projects since the 2014 Plan Update (Refer to Table 4-5 in the 2014 Plan Update) include powerline burial/improvement, new warning system/warning system improvement, and road infrastructure improvement. As described in Sections 4.3.16 and 5.4.3, powerline burial or hardening has been an extremely successful initiative; between 2005 and 2014, the state alone has spent $19.4 million and buried 7,000 miles of power lines. Sixteen counties identified completing powerline burial or improvement projects, an increase from 2014 when only 11 counties identified completing this type of project. Trees falling on powerlines pose a risk of starting wildfires, as was seen during the 2017 Legion Lake Fire. The State's initiative for powerline burial along

with the recent wildfires related to powerline failures has continued the momentum for this mitigation action. As shown in Table 4-7 *Comparison of Current Local Mitigation Actions, 2014 vs 2019* above, 31 counties have identified powerline burial and improvement projects as a mitigation action. Overall, local communities have kept the momentum of completing mitigation projects that was seen in the previous Plan update.

4.7 Tribal Capability Assessment and Integration

Much of the material presented in the previous section on Local Government Capabilities and Integration also applies to South Dakota's Native American tribes. However, the unique nature, challenges, and legal status of the tribes makes it worthwhile to discuss several issues separately.

4.7.1 Prioritizing Assistance to Tribes

The state has made significant effort into increasing tribal engagement in hazard mitigation planning, particularly since 2014. The state Department of Tribal Relations was involved throughout the SHMP planning process. The State wants all the Tribes to have an approved plan and has invited all tribes to join with their overlapping Counties in multi-jurisdictional planning as an alternative to completing their own plans. This approach has yielded cost efficiencies and improved interagency coordination at the local, tribal and state level.

Notes from the state's annual coordination meetings with FEMA (discussed in Section 4.5.1 above) reflect frequent discussion of tribal concerns, to include:

- Improved coordination
- Status of tribal hazard mitigation plans
- Technical Assistance and training to tribes
- Tribal project applications
- Tribal Direct Grantee status
- Disaster requests from tribal governments
- Difficulties meeting match requirements

4.7.2 Tribal Plan Integration

Of the nine recognized tribes in South Dakota, six (66%) are currently covered under approved hazard mitigation plans. The number of tribal plans has tripled since 2014, when only two tribes (23%) had hazard mitigation plans. Additionally, the Lower Brule Sioux Tribe has an application in to develop their first mitigation plan. These plans were reviewed and included along with the local plans, as discussed in Section 4.6 above.

Table 4-10 South Dakota Tribal Mitigation Planning Status

Tribe	Current HMP?	Notes
Cheyenne River Sioux Tribe	Yes	
Crow Creek Sioux Tribe	Yes	Joint plan with Buffalo County
Flandreau Santee Sioux Tribe	No	
Lower Brule Sioux Tribe	No	Direct PDM grant received to develop HMP
Oglala Sioux Tribe	Yes	Joint plan with Oglala Lakota County
Rosebud Sioux Tribe	Yes	Update in process
Sisseton Wahpeton Oyate	Yes	Update in process with a direct PDM Grant
Standing Rock Sioux Tribe	Yes	
Yankton Sioux Tribe	No	

4.7.3 Tribal Capabilities Overview

Table 4-11 presents a summary of the policies, programs, administrative, and technical capabilities identified in the six tribal mitigation plans reviewed during the 2019 planning process. (Data extracted from Table 4-6 above.) Because two of those plans were joint tribal-county plans, some of these may not in fact be tribal capabilities, but still represent capabilities available to those tribes through partnership with the respective counties.

Table 4-11 Summary of Tribal Capabilities

Capability	# Identified in 2019 Plan	% Identified in 2019 Plan
Local Emergency Operations Plans	6	100%
Mutual Aid Agreements with other fire departments	6	100%
Designated Storm Shelters	5	83%
Emergency Power	5	83%
Fire bans and public water restrictions during dry periods	5	83%
Hazard Mitigation Interagency Team / Local Emergency Planning Committee	5	83%
HAZUS	5	83%
State Hazard Mitigation Plan Review/Incorporation	5	83%
Comprehensive Plan	4	67%
Continual maintenance of infrastructure (electrical, lift stations, sewer, drain)	4	67%
Emergency Operations Center / Incident Command System Interface	4	67%
GIS Data and Mapping	4	67%
Outdoor / Indoor Warning System / Proactive Weather Program	4	67%
Pre-Planning for Winter Operations	4	67%
Radio Station Weather Announcements	4	67%
Regular dam and culvert inspections and maintenance	4	67%
Regular road maintenance and repair	4	67%
Building Code	3	50%
Equipment to handle fire/wildfire	3	50%
NFIP / Strict development regulation in flood hazard zones/ Floodplain Management Program	3	50%

Capability	# Identified in 2019 Plan	% Identified in 2019 Plan
Public Awareness Campaigns / CERT / Citizen Corp	3	50%
Regular training for Emergency Responders	3	50%
Weather Spotters	3	50%
Zoning / Planning Commission	3	50%
Drainage Ordinance	2	33%
Emergency exercises to test emergency response plans	2	33%
Equipment for winter storm response	2	33%
NOAA Weather Radio	2	33%
Response plan in case of dam failure	2	33%
Stormwater master plan	2	33%
911 Addressing	1	17%
Capital Improvement Plans	1	17%
Contingency Plans	1	17%
CWPP	1	17%
Digital Infrastructure Mapping	1	17%
Elevation Certificates/Ordinance	1	17%
Equipment to respond to Hazardous Materials Incidents	1	17%
Fire Mitigation Plan	1	17%
Flood Damage Prevention Ordinance	1	17%
Increased security, communication, and educational outreach to prevent terrorism	1	17%
Monitor Drought Situation	1	17%
NIMS Compliant	1	17%
Public safety programs for public and children	1	17%
SD Electric Cooperatives Mutual Aid Plan	1	17%
Storm Ready	1	17%
Tree-trimming from power lines	1	17%
Catalogue and Track Hazardous Materials	0	0%
Regional Terrorism Response Plan	0	0%
Stored sandbags for flood fighting operations	0	0%

4.7.4 Tribal Integration in State Mitigation Strategy

Section 5 details the state's Mitigation Strategy. As discussed in Section 5.1.1, the 2014 SHMP included Goal #5 that addressed improving local and tribal partnerships. During the 2018-2019 planning process the SHMT decided to highlight progress the state has made in improving relations with tribal governments, particularly with hazard mitigation planning, as well as increase focus on improvements that remain. Thus, the SHMP added a new Goal and corresponding Objective specifically focused on working with tribal governments:

- Goal 6 – Increase partnerships with tribal nations

- Objective 6.1 – Support cooperation with tribes on mitigation and recovery efforts

A number of state mitigation actions detailed in Table 5-4 include the tribes as partners listed in Responsible Departments. There are also six mitigation actions specifically focusing on the tribes, as shown in the following table. (See Table 5-4 for more details on these actions.)

Table 4-12 State Mitigation Actions Specific to Tribes

Goal	Action #	Mitigation Action	Priority
4	4-3	Enhance and streamline coordination with the State Historic Preservation Officer, Tribal Historic Preservation Officer (as applicable), and other agencies on all projects.	High
6	6-1	Inform tribes of mitigation, public assistance, individual assistance, and SBA funding opportunities to help reduce risks and recover from disasters.	High
6	6-2	Continue working with tribal governments to develop approvable hazard mitigation plans and eligible mitigation project grant applications.	High
DMP 6	DMP 6.1	Increase outreach and interaction with local, tribal, and federal agencies	High
DMP 6	DMP 6.3	Engage tribal entities more closely in the drought planning and mitigation process	High
DMP 6	DMP 6.9	Encourage tribal representatives to coordinate with local planning personnel for joint initiative development and increase data sharing	High

Table 4-13 below shows mitigation actions listed in the six tribal hazard mitigation plans. As above, because two of the plans are joint tribal-county plans, some of these actions may not be specific to the tribes.

Table 4-13 Tribal Mitigation Actions Identified and Completed in 2019 Plans

Mitigation Actions	Identified	Completed
Storm Shelter/Tornado Safe Room - identification or obtaining resources needed for facilities	6	1
Public Awareness and Education Campaigns/local outreach	5	0
Generator/Power Backup Acquisition	4	1
New Warning System/Warning System Improvement	4	1
Develop Severe Weather Preparedness Plans (mass sheltering, business continuation, debris removal)/Conservation Plans/HazMat Plans/debris management	4	0
Firefighter/Flood Manager/Volunteer/GIS Training/Exercises/Certification	4	0
Land Use Policies/Zoning Enforcement/Building Code/Drainage Ordinance/Wildfire Policy	4	0
Improve/Create Mapping and/or Facility and Data Inventory (Infrastructure, Critical Facilities, Flood, Vulnerable Populations)	3	1
Implement/Improve 911 Emergency/First Responder System	3	0
Improve traffic safety/road improvements	3	0

Mitigation Actions	Identified	Completed
Stormwater Improvement/Drainage and Culvert Improvement	3	0
Flood Control and Management Projects	2	1
Powerline Burial/Improvement	2	1
Continued NFIP Compliance/Encourage NFIP Participation/CRS	2	0
Create/Continue partnerships with non-profits, private organizations/citizens; Create/Review Mutual aid agreements with neighboring emergency managers, and transportation agencies	2	0
Elevation/Acquisition/Relocation/Floodproofing/Retrofitting	2	0
Improvement to Emergency Communication System	2	0
Install Snow fence/Plant Living Wind/Snow breaks	2	0
Purchase/Improvement of EMS Equipment (Fire, Ambulance, Police)	2	0
StormReady Participate/Renew Status	2	0
Controlled Burns/Burn Bans/Vegetation Management/Firebreaks/Defensible Space	2	0
Software/Technology Improvements for Data Analysis	1	0
Tree Removal /hazardous fuel reduction	1	0
Passage/Enforcement of Hazard Specific Mitigation Policy	0	1

As of late 2018 four tribes were working on drought vulnerability assessments that will eventual lead to the development of drought plans. Additionally, the Oglala Sioux Tribe has completed a regional sustainable development plan, called Oyate Omniciye, that incorporates climate change adaptation and mitigation planning into long-term sustainable development planning. The plan is available at http://www.oglalalakotaplan.org/.

SECTION 5 MITIGATION STRATEGY AND PROGRESS

44 CFR Part 201 Requirement:
[The State plan must include a] Mitigation Strategy that provides the State's blueprint for reducing the losses identified in the risk assessment.
[The mitigation strategy shall include a] description of State goals to guide the selection of activities to mitigate and reduce potential losses.
[The] plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts and changes in priorities…

This chapter describes the state's strategy for reducing losses from the hazards identified in Section 3 Hazard Identification and Risk Assessment (HIRA). It includes the goals and objectives that frame the mitigation strategy, specific mitigation action undertaken or proposed by the state, available sources of mitigation funding, and how the state ensures those funds are used effectively and efficiently.

South Dakota's mitigation strategy emphasizes the need to ensure communities become better able to withstand hazards in the long term, while at the same time improving their residents' overall quality of life. By avoiding unnecessary exposure to hazard risks, communities will save lives, reduce property damages and minimize the social, economic and environmental disruptions that commonly follow hazard events. This SHMP addresses the needs of current residents and also considers the needs of future generations. The focus on an integrated, future-oriented approach will result in more disaster-resilient communities.

5.1 Hazard Mitigation Goals and Objectives

This section describes the goals and objectives that guide South Dakota's mitigation program. The goals are general guidelines articulating what the state wants to achieve. The objectives are more specific, measurable, and achievable descriptions of how the state will implement each goal. These objectives are then used to develop specific mitigation actions (see Section 5.2) taken to achieve loss reduction.

The goals and objectives listed below were developed by the SHMT to encompass all mitigation needs identified by stakeholders, including local and tribal communities. The goals and objectives are not prioritized and are written to be applicable to all hazards identified in the HIRA.

Reflecting the mature nature of South Dakota's statewide hazard mitigation program, these goals and objectives have evolved since the development of the first State Hazard Mitigation Plan in 2004. During the March 22, 2018 planning meeting, the group reviewed the preliminary results of the local and state vulnerability assessments and validated that the goals and objectives from the 2014 Plan remain relevant for the 2019 Plan. See Section 4.4.6 for further discussion of how local mitigation plans informed the state mitigation strategy. The group also identified a new sixth goal and corresponding objective pertaining to improving coordination with tribal nations. As part of the 2016 HIRA update, the state developed a summary of the key vulnerabilities, problem statements, and losses and consequences associated with each hazard. This information, as summarized in Table 3-75 Hazard Risk Summary Table, was provided as a handout during the March 22 planning meeting. SHMT members used this updated vulnerability information when reviewing the goals and objectives, as well as in developing mitigation actions.

The goals and objectives approved by the SHMT for 2019 are listed below in Table 5-1. The state encourages local and tribal governments, and other mitigation partners to consider the state's goals and objectives when developing their own mitigation strategies.

Table 5-1 Goals and Objectives

Goal 1	Reduce injuries and loss of life from hazards
Objective 1.1	Reduce the number of injuries/fatalities due to all hazards
Objective 1.2	Maintain and improve public health and safety outreach activities/programs

Goal 2	Reduce damage to existing and future structures within hazard areas
Objective 2.1	Reduce the number of repetitive flood loss structures
Objective 2.2	Reduce the number of structures lost by wildfires
Objective 2.3	Reduce the number of structures within the Special Flood Hazard Area and other identified local flood risk areas
Objective 2.4	Reduce the number of structures/infrastructure at risk to geologic hazards

Goal 3	Reduce the losses to critical facilities, utilities, and infrastructure from hazards
Objective 3.1	Reduce the number of power outages
Objective 3.2	Reduce negative impacts to water supply and sewage treatment systems
Objective 3.3	Improve reliability of communications during/following hazard events

Goal 4	Reduce impacts to the economy, the environment, and cultural resources from hazards
Objective 4.1	Reduce loss to natural resources (i.e. forest and watershed health)
Objective 4.2	Reduce impacts to cultural resources (i.e. historical/tribal)
Objective 4.3	Reduce agricultural losses
Objective 4.4	Reduce economic losses to recreation and tourism

Goal 5	Support and assist local mitigation capabilities and efforts
Objective 5.1	Encourage locals to participate in risk reduction measures

Goal 6	Increase partnerships with tribal nations
Objective 6.1	Support cooperation with tribes on mitigation and recovery efforts

5.1.1 Updates to the Goals and Objectives

During the March 22, 2018 planning meeting, the group reviewed the goals and objectives from the 2014 Plan. The group concluded that the existing goals and objectives from the 2014 Plan remain relevant, and identified a sixth goal and corresponding objective as noted below, which resulted in a slight modification to goal 5:

- **Goal 1** – Reduce injuries and loss of life from hazards – no changes
- **Goal 2** – Reduce damage to existing and future structures within hazard areas – no changes
- **Goal 3** – Reduce the losses to critical facilities, utilities, and infrastructure from hazards – no changes
- **Goal 4** – Reduce impacts to the economy, the environment, and cultural resources from hazards – no changes
- **Goal 5** – ***Support and assist local/tribal mitigation capabilities and efforts*** – The reference to tribal programs was dropped from this goal due to the creation of Goal 6.

- **Goal 6** – ***Increase partnerships with tribal nations*** – This new goal was adopted by the planning team, along with a new objective 6.1.

5.1.2 Related Plan Goals

As previously discussed in Section 4.2.2, the South Dakota Drought Mitigation Plan was developed in 2015 as a hazard-specific supplement to the SHMP. As part of that planning process, the Drought Task Force developed goals describing the overall direction that the state will take to reduce drought impacts and objectives to implement some of those goals.

The seven goals and related objectives developed for the South Dakota Drought Mitigation Plan are:

1. Improve water availability monitoring and drought impact/vulnerability assessment
2. Increase public awareness and education
3. Enhance mechanisms to provide water supplies to areas of shortage during droughts
4. Reduce water demand and encourage water conservation
5. Reduce drought impacts to South Dakota's economy, people, state assets, cultural resources, and environment
   - Reduce losses to natural resources (i.e., forest and watershed health)
   - Reduce impacts to cultural resources (i.e., historical/tribal)
   - Reduce agricultural losses
   - Reduce losses to critical facilities, utilities, and infrastructure
   - Reduce economic losses to recreation and tourism
6. Continue to maintain and enhance intergovernmental and interagency stakeholder coordination
   - Coordinate and provide technical assistance for state, local, tribal, federal, and watershed planning efforts
7. Evaluate changes in drought frequency and severity related to climate change as a planning issue, and incorporate into the South Dakota Hazard Mitigation Plan and other relevant plans

5.2 Mitigation Actions

44 CFR Part 201 Requirement:
[The State plan shall include an] identification, evaluation, and prioritization of cost-effective, environmentally sound, and technically feasible mitigation actions and activities the State is considering and an explanation of how each activity contributes to the overall mitigation strategy. This section should be linked to local plans, where specific local actions and projects are identified. *[The] plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts and changes in priorities….*
44 CFR Part 201 Enhanced Plan Requirement:
Enhanced State Mitigation Plans must include… *Established eligibility criteria for multi-hazard mitigation measures.* *A system and strategy by which the State will conduct an assessment of the completed mitigation actions and include a record of the effectiveness (actual cost avoidance) of each mitigation action.* *Demonstration that the State is committed to a comprehensive state mitigation program, which might include…A comprehensive, multi-year plan to mitigate the risks posed to existing buildings that have been identified as necessary for post-disaster response and recovery operations.*

This section presents the identification, evaluation, and prioritization of cost-effective, environmentally sound, and technically feasible mitigation actions and activities as confirmed by the SHMT during the 2019 update process. Mitigation actions have been developed to address the goals and objectives defined earlier. Many of the actions were developed during legacy planning meetings as the SHMP has been updated over the years. Each update cycle presents an opportunity to review and revise the mitigation actions to reflect changes in development, progress in statewide mitigation efforts and changes in priorities. Key vulnerabilities and problem statements from the updated HIRA were also considered in the update of mitigation actions. The actions in the 2015 State Drought Mitigation Plan were also formally linked and included with the update of the SHMP. Coordinated and integrated mitigation efforts were stressed whenever possible, as is evidenced by the number of multi-agency projects listed in the Mitigation Actions Table.

Many of the mitigation actions identified in the 2014 Plan remain ongoing. Several new mitigation actions were developed during the 2019 update process and are included in Table 5-4. The progress of the ongoing mitigation actions is documented in Table 5-5, which highlights progress towards meeting the plan's goals. A few ongoing mitigation actions were revised and updated for 2019; these are presented along with the reason for their revision in Table 5-3.

The SHMT has confirmed these actions with the understanding that approval of this plan does not obligate the state to complete each project before the next required update in 2024. The SHMT understands that the 2024 plan update must demonstrate progress in statewide mitigation efforts. This progress may be in the form of the actions listed below or additional actions that assist in reaching the goals and objectives outlined in this plan. The South Dakota Office of Emergency Management (OEM) will coordinate an annual joint meeting of the SHMT and Silver Jackets to review the matrix of mitigation actions and discuss progress made or opportunities to pursue progress of each action, as described further in Section 6.2.

5.2.1 Process Used to Evaluate and Prioritize Mitigation Actions

During the 2019 update, the SHMT and Silver Jackets members reviewed the STAPLE E criteria shown below to evaluate and identify priority levels for the hazard mitigation actions. The SHMT will continue to

support a diverse range of mitigation actions to ensure a comprehensive approach to reducing risk to all hazards across the entire state. A top priority of the SHMT for the 2014–2019 period was to improve the quality of hazard mitigation planning efforts for local and tribal governments; as described in Section 4.6.1 there has been much progress made, but this remains a high priority for the 2020-2024 period.

The state uses the following guiding principles to evaluate and prioritize proposed mitigation actions so that limited grant funds are used most effectively. These guiding principles are intended to be flexible and adaptable across state agencies and funding sources. During the 2019 Plan update cycle action priorities were revisited, and new actions were prioritized according to the process noted below.

In evaluating proposed mitigation actions, the SHMT used the STAPLE/E criteria: Social, Technical, Administrative, Political, Legal, Economic, and Environmental. The STAPLE/E criteria are commonly used in mitigation planning and are summarized in Table 5-2. Based on SHMT consensus, each action was then assigned one of the following priorities:

- **High** priority actions strongly support reduction of high risk hazards, achieve hazard mitigation goals as outlined in this plan, and eliminate or greatly lessen the impact of future incidents. These may also include actions that have a higher possibility for implementation in the near term (i.e. funding is available or current political feasibility supports the action).
- **Medium** priority actions may be educational, outreach, or maintenance actions. They may include small mitigation projects that would minimize severity but not mitigate hazards completely. Medium priority actions are less urgent but still significant towards improving the state's resiliency.
- **Low** priority actions are generally the responsibility of the local community. The state supports these projects but is often unable to provide the authority to implement them, does not have sufficient resources to do so, or else has judged the benefits/impact of the action to be a low priority.

Table 5-2 STAPLE/E Criteria

STAPLE/E Review and Selection Criteria
Social
Is the proposed action socially acceptable to the state or jurisdiction and surrounding community? Are there equity issues involved that would mean one segment of the state and/or community is treated unfairly? Will the action cause social disruption?
Technical
Will the proposed action work? Will it create more problems than it solves? Does it solve a problem or only a symptom? Is it the most useful action in light of other state or jurisdiction goals?
Administrative
Can the state or jurisdiction implement the action? Is there someone to coordinate and lead the effort? Is there sufficient funding, staff, and technical support available? Are there ongoing administrative requirements that need to be met?
Political
Is the action politically acceptable? Is there public support both to implement and to maintain the project?
Legal

STAPLE/E Review and Selection Criteria
Is the state or jurisdiction authorized to implement the proposed action? Are there legal side effects? Could the activity be construed as a taking? Will the state or jurisdiction be liable for action or lack of action? Will the activity be challenged?
Economic
What are the costs and benefits of this action? Do the benefits exceed the costs? Are initial, maintenance, and administrative costs taken into account? Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private)? How will this action affect the fiscal capability of the state or jurisdiction? What burden will this action place on the tax base or local economy? What are the budget and revenue effects of this activity? Does the action contribute to other state or jurisdiction goals? What benefits will the action provide?
Environmental
How will the action affect the environment? Will the action need environmental regulatory approvals? Will it meet local and state regulatory requirements? Are endangered or threatened species likely to be affected?

5.2.2 2019 Revisions to the Mitigation Actions

Many of the mitigation actions identified in the 2014 Plan remain ongoing. A few of the mitigation actions were revised for reasons noted in Table 5-3 below. In some cases action priorities were revised; these are noted where applicable in Table 5-3. No actions were deleted or marked as completed during this update, but much progress has been made. Progress notes for ongoing actions carried forward from the 2014 Plan and the 2015 Drought Mitigation Plan are detailed in Section 5.2.4 and Table 5-5 Progress on Mitigation Actions.

Table 5-3 Revised Mitigation Actions

2014 Mitigation Action	2019 Revision
"Coordinate with the State Historic Preservation Officer and Tribal Historic Preservation Officer (as applicable) on all projects."	"Enhance and streamline coordination with the State Historic Preservation Officer, Tribal Historic Preservation Officer (as applicable), and other agencies on all projects." Reason for change: reworded to reflect that since 2014 this coordination is ongoing, and to add the reference to other agencies.
"Release statewide campaigns to promote tourism and recreation."	Release statewide campaigns to promote tourism and recreation during drought, fire & flood events. Reason for change: added specific hazards that have the most impact on tourism and recreation.
"Continue working with local/tribal governments to develop approvable hazard mitigation plans and eligible mitigation project grant applications."	Reference to tribal governments removed. Reason for change: the creation of new Goal 6 and Action 6-2 made that wording redundant.

5.2.3 Mitigation Actions Details

The updated mitigation actions are listed in the matrix below in Table 5-4, organized by goal, to demonstrate how each activity contributes to the overall mitigation strategy. The matrix includes an action number, the action priority, status, potential funding sources, the responsible department and implementation steps. Ongoing and new mitigation actions are detailed in Table 5-4; under Responsible Department(s), the primary agency's name is bolded. Actions identified as "New" were developed in the Mitigation Strategy Meeting and Workshop (Meeting #2); ongoing actions were carried over from the 2014 SHMP. Mitigation actions from the South Dakota Drought Mitigation Plan that were ranked as having a High priority are also included in the Table, labeled as "DMP" under Goal and Action Number. The 'Implementation Notes' column provides more specifics on how the actions are being implemented, an improvement made to the action table for the 2019 update.

The State of South Dakota recognizes that local governments are key partners in the identification and implementation of hazard mitigation projects. As such many of the actions are related to supporting local project applications and linked to local plans, where specific local actions and projects are identified. See Section 4.6.6 Local Mitigation Actions Overview and Table 4-8 Comparison of Most Commonly Identified Local Mitigation Actions and Related State Mitigation Actions for more information and discussion on this topic. As part of the 2019 planning process, completed and identified mitigation actions from a total of 68 local and tribal plans were captured and summarized in a spreadsheet/database. The database is included as an electronic Appendix (Appendix 5).

Table 5-4 South Dakota 2019 Mitigation Actions

Goal	Action #	Mitigation Action	Priority	Mitigation Type	Potential Funding Source(s)	Responsible Department(s)*	Implementation Notes
1	1-1	Support the construction and operation of hardened shelters / safe rooms through local project applications.	High	Structure & Infrastructure Projects	HMGP, CDBG, PDM Local, Private	**OEM**, GF&P, HUD, FEMA, Local/Tribal Gov. Private Citizens	OEM provides technical assistance with grant applications to ensure they are compliant with FEMA standards GF&P implementation of shelters in state park facilities
1	1-2	Support the installation of outdoor warning sirens and NOAA weather radios through local project applications.	High	Structure & Infrastructure Projects	HMGP CDBG EMPG Local SHSGP GF&P	**OEM** GF&P, SDOHS, FEMA, NWS, Local/Tribal Gov. Private Businesses/ Citizens	OEM provides technical assistance with project applications
1	1-3	Coordinate public outreach/ education regarding shelter locations and warning systems. Develop brochures, websites, news briefs, and other media to notify the public of shelter locations and what sounds to expect from the warning systems.	Medium	Education, Awareness, & Outreach	EMPG PDM HMGP Local Gov. Private Businesses	**OEM** SD Public Safety – Fire Marshal's Office, NWS, Local/Tribal Gov.	Implemented as part of OEM severe weather awareness campaign and broader public outreach program www.bReadySD.sd.gov
1	1-4	Support and encourage public education/outreach efforts for all hazards awareness and safety.	High	Education, Awareness, & Outreach	EMPG PDM HMGP Homeland Security Grants	**OEM** Local/Tribal Gov.	Updated to include all hazards in 2014 OEM provides technical assistance to other state, regional, and local agencies, in addition to their own outreach & education efforts www.bReadySD.sd.gov

Goal	Action #	Mitigation Action	Priority	Mitigation Type	Potential Funding Source(s)	Responsible Department(s)*	Implementation Notes
1	1-5	Further analyze climate change effects in South Dakota to include frequency of flood events and other hazards.	Medium	Data & Studies	Staff time, Silver Jackets	**SDSU - State Climatologist** OEM, Silver Jackets, NWS	New for 2019. Additional analysis is needed for Summer storms and certain areas that are more affected by climate change and storms. Analyze 100-year flood event frequencies across the state to determine trends or higher risk areas. Also consider frequency analysis for drought and winter storms (including ice storms). Action will help the state identify where to concentrate mitigation projects on, as well as who to target for mitigation projects.
2	2-1	Coordinate with South Dakota Building Code Officials Association to integrate floodplain management ordinances into local building codes.	Medium	Planning & Regulations	No funding needed	**OEM** Local/Tribal Gov. FEMA	When IBC 2018 is properly followed and enforced in South Dakota, the communities can rely on the flood provisions of the IBC to fulfill their responsibilities for participation in the National Flood Insurance Program, provided development other than building is also regulated. Because requirements for utilities and equipment are specified in the IBC (by reference to ASCE 24), there are no gaps or conflicts if one or more of the codes that govern mechanical, plumbing and fuel gas installations is not adopted.
2	2-2	Improve the state facilities database by capturing classification and valuation information.	Low	Data & Studies	Internal staff time	**SD Bureau of Administration - Risk Management** **SD BIT**	Utilized for update of 2016 HIRA for State Plan. Additional effort to classify facilities data needed

Goal	Action #	Mitigation Action	Priority	Mitigation Type	Potential Funding Source(s)	Responsible Department(s)*	Implementation Notes
2	2-3	Support the purchase and relocation of structures within floodplains and other hazard prone areas through local project applications.	High	Structure & Infrastructure Projects	HMGP, PDM, FMA, Local, USACE, NRCS-EWPP	**OEM** Local/Tribal Gov. USACE, FEMA, NRCS	OEM provides technical assistance with project applications See Section 5.3.1 regarding Home Mitigation Project Policy
2	2-4	Support and encourage flood control projects through state & local project applications.	High	Structure & Infrastructure Projects	HMGP, PDM FMA, CDBG SD DENR, Rural Development, Local, USACE NRCS-ACEP	**SD DENR** **OEM** SD GOED USACE FEMA NRCS Local/Tribal Gov.	Related applications have been light to date, partly due to technical requirements for BCA and application, as well as uncertain funding. New flood hazard maps completed under Risk MAP may help generate more interest, particularly in areas where the floodplain has expanded from previous FIRMs.
2	2-5	Support and encourage elevation of structures in flood prone areas through local project applications.	Low	Structure & Infrastructure Projects	HMGP PDM FMA DENR Local USACE CDBG	**OEM** Local/Tribal Gov. USACE FEMA	Priority of action changed from high to low in 2019. Priority is to relocate or acquire properties, which is a more effective solution in most cases. Some interest in elevation of properties located in closed basins. OEM provides technical assistance with project applications.
2	2-6	Coordinate with all state departments and agencies through surveys and other mechanisms to identify structures in hazard areas and their replacement values.	Medium	Data & Studies	Risk MAP/ FEMA, Silver Jackets	**OEM** **SD Bureau of Administration - Risk Management** SHMT members Local/Tribal Gov. FEMA Silver Jackets	2016 HIRA update includes revised vulnerability assessment for state facilities. See Section 3.4 Vulnerable Jurisdictions and Potential Losses section for each hazard. This action should be revisited and updated when new flood mapping in the eastern third of the state becomes final.

Goal	Action #	Mitigation Action	Priority	Mitigation Type	Potential Funding Source(s)	Responsible Department(s)*	Implementation Notes
2	2-7	Support and encourage fire risk reduction projects such as the installation of fire breaks / fuel breaks and the creation of defensible space between structures and forested areas through local project applications.	Medium	Natural Systems Protection	SDDA HMGP PDM USFS SD GF&P BLM Private Citizens	**SDDA** **OEM** Local/Tribal Gov. USFS SD GF&P Private Citizens	South Dakota Department of Agriculture (SDDA) works with local landowners to create a safe zone around property to prevent damage from wildfire. SDDA creates fire breaks by cleaning wooded areas. SDDA administers the Beat the Beetle campaign.
2	2-8	Support and encourage communities to participate in Firewise, develop CWPPs, and participate in other fire protection programs to minimize risk to wildfire.	Medium	Technical Assistance	SDDA USFS BLM Private Citizens	**SDDA** USFS SD GF&P Private Citizens OEM Local/Tribal Gov. FEMA	The SDDA Wildland Fire division (SDWF) conducts outreach efforts to minimize fire. For example, SDWF hosts a variety of activities in the Black Hills area during Wild Fire Prevention Month (May). OEM is also conducting outreach on new HMGP-Post Fire funding opportunities.
2	2-9	Support bank stabilization and other geohazard risk reduction through local project applications.	Medium	Natural Systems Protection	Various Depts, EDA, Coast Guard, Local, HMGP, FHWA, NRCS: EQIP, ACEP, EWPP	**(Lead varies by project & funding)** SD DENR SD GF&P OEM SDDOT Local/Tribal Gov. FEMA, Coast Guard, USACE, NRCS, USGS	Action priority revised from High to Medium in 2019. OEM provides technical assistance with project applications.

Goal	Action #	Mitigation Action	Priority	Mitigation Type	Potential Funding Source(s)	Responsible Department(s)*	Implementation Notes
2	2-10	Map repetitive flood loss properties to identify concentrations of properties or high losses and identify potential mitigation options.	Medium	Data & Studies	No funding needed	**OEM** Silver Jackets Local/Tribal Gov.	New for 2019. Initial steps include mapping locations of repetitive loss structures statewide to verify their information and status Analyze data to identify concentrations of properties or high loss properties (multiple losses or significant claims paid) as targets for mitigation Work with Silver Jackets to identify potential mitigation solutions
3	3-1	Support the improvement to existing power lines through local project applications. (i.e. power line burial, spoiler installation, pole strengthening & heavier wires).	High	Structure & Infrastructure Projects	HMGP PDM Local PA-406 Utilities REC's RUS loans	**OEM** PUC SD Rural Electric Association RECs, Local/Tribal Gov. FEMA	Loss avoidance studies by the RECs have documented mitigation effectiveness. See 4.4.12 for details
3	3-2	Encourage the purchase of generators for backup power to critical infrastructure / storm shelters and conduct regular testing for preparedness.	High	Structure & Infrastructure Projects	Local & Municipal Utilities, HMGP, PDM, EMPG SHSGP	**OEM** PUC SD DOH Local/Tribal Gov. SD OHS FEMA	Limited by 5% initiative funding on HMGP post-disaster. BCA process on lift stations and wells has enabled more projects.
3	3-3	Encourage removal of debris in waterways (i.e. near bridges, culverts, within stream channels).	High	Natural Systems Protection	SD DOT Local Tribal Water development districts	**(Lead varies by project & funding)** SD DOT, DENR GF&P Local/Tribal Gov. Water Districts, Watershed Districts, NRCS, USACE, BOR	Primarily a local government issue. State law requires counties and townships to do annual inspections of their culverts to ensure they are functioning properly. A log must be maintained. Considering this law, counties and townships are more aware of problems with culverts, initiating more removal of debris that can cause flooding.

Goal	Action #	Mitigation Action	Priority	Mitigation Type	Potential Funding Source(s)	Responsible Department(s)*	Implementation Notes
3	3-4	Support and encourage drainage improvement projects through local applications (i.e. proper sizing).	High	Structure & Infrastructure Projects	HMA Local	**OEM** Local Gov. Tribal Gov. (apply separately) SD DENR SD GOED Local Watershed Districts Water Districts	OEM & DENR provide technical assistance with project applications. Risk MAP and related new flood hazard mapping may stimulate more projects at the local level.
3	3-5	Support and encourage routine inspections of existing utilities and infrastructure for damage and weaknesses.	High	Technical Assistance	Local Utilities REC Local	**SD Rural Electric Association** PUC, RECs Local/Tribal Gov.	SD DOT performs bridge inspections every two years and culvert inspections every five years. SD DENR's Dam Safety Inspection Program requires all high hazard and significant hazard dams to be inspected every three years. See progress notes in table 5-5
3	3-6	Maintain the state digital radio system through regular training and exercises.	Medium	Training & Exercises	No funding needed/ staff time	**OEM** SD BIT SD National Guard Local/Tribal Gov.	Quarterly drills are held in addition to trainings and exercises See progress notes in table 5-5
3	3-7	Reduce the number of susceptible dams to high flow/flood events through re-evaluation of design capacity and development of updated emergency preparedness plans.	Medium	Structure & Infrastructure Projects	USACE FEMA Dam Safety, BOH	**SD DENR** SD GF&P SD School & Public Lands Local Government USACE Silver Jackets Reclamation	New for 2019. Initial steps include evaluation of outlet flow vs downstream channel capacity to identify dams with a higher potential for controlled release flooding.

Goal	Action #	Mitigation Action	Priority	Mitigation Type	Potential Funding Source(s)	Responsible Department(s)*	Implementation Notes
4	4-1	Encourage agricultural modifications to lessen the impacts of drought such as crop rotation, drought resistant crops, no till, etc.	Medium	Education, Awareness, & Outreach	SDDA NRCS: EQIP, CSP, ACEP Private Citizens	**SDDA** Extension Service Private Citizens Local/Tribal Gov. USDA, NRCS	Initial steps include providing crop rotation information to agricultural producers, highlighting drought mitigation tools and via social media, and hosting a Climate Outlook Forum in May 2018. The SDDA administers campaigns on drought through the Drought Task Force, Extension Service, and Producer Groups. The NRCS and Conservation Districts support SDDA with drought.
4	4-2	Promote insurance – Many different forms of insurance are available to cover damages incurred by the various natural hazards. The state will encourage residents, farmers, and business owners to purchase insurance appropriate for their risk.	Medium	Education, Awareness, & Outreach	No Funding needed	**OEM** **SDDA** SDSU Extension DORR - Insurance Local/Tribal Gov. FEMA, USDA	OEM promotes NFIP flood insurance through meetings and ad campaigns. During spring, the state will coordinate flood outreach presentations with FEMA Region 8, National Weather Service, US Army Corps of Engineers, US Geological Survey and local officials as part of the National Flood Safety Awareness platform. FEMA RiskMAP Journal promotion, where individuals can view information and download the new flood maps and GIS data to better understand their risk.

Goal	Action #	Mitigation Action	Priority	Mitigation Type	Potential Funding Source(s)	Responsible Department(s)*	Implementation Notes
4	4-3	Enhance and streamline coordination with the State Historic Preservation Officer, Tribal Historic Preservation Officer (as applicable), and other agencies on all projects.	High	Planning & Regulations	No Funding needed	**OEM** SHPO, DENR, GF&P, THPO, FEMA, USFWS, USACE, etc.	The State Historic Preservation Officer coordinates with the OEM on mitigation projects when applicable. The South Dakota State Historical Society reviews mitigation activities funded by FEMA, Farm Service Agency – Emergency Conservation Program (ECP), and Natural Resource Conservation Service - Environmental Quality Incentives Program Initiatives (EQIP). SDDA and OEM are developing an Environmental Planning and Historic Preservation Programmatic Agreement to facilitate a quicker approval of pre-selection mitigation actions for future funding opportunities.
4	4-4	Develop and deploy targeted messaging aimed at educating and informing travelers during drought, fire and flood events.	Low	Education, Awareness, & Outreach	SD Dept of Tourism and State Development Chambers of Commerce	**SD Dept of Tourism and State Development** SD GF&P SD GOED	Department of Tourism has messages from past events that can be quickly customized for new or upcoming events Action text modified to slightly during 2019 to include the development of messaging. There has not been hazard events in recent years that warranted targeted messaging outside of usual marketing campaigns.
5	5-1	Support and continue public outreach efforts regarding methods to reduce losses due to natural hazards.	Medium	Education, Awareness, & Outreach	EMPG PDM HMGP	**OEM** Local Gov. Tribal Gov. SD OHS, SD DOH NWS, SDDA, USDA, FEMA, NRCS	OEM provides technical assistance to other state, regional, and local agencies, in addition to their own outreach & education efforts bReadySD

Goal	Action #	Mitigation Action	Priority	Mitigation Type	Potential Funding Source(s)	Responsible Department(s)*	Implementation Notes
5	5-2	Continue working with local governments to develop approvable hazard mitigation plans and eligible mitigation project grant applications.	High	Technical Assistance	PDM HMGP	**OEM** FEMA	Technical assistance on project grant applications includes guidance on eligibility, project scoping, and EHP considerations.
5	5-3	Support and encourage safer building practices in local communities to reduce risk from all hazards.	Medium	Education, Awareness, & Outreach	Staff time	**OEM** DORR Local/Tribal Gov.	OEM encourages and provides technical assistance on related practices.
5	5-4	Maintain and expand weather and climate monitoring/ observations through SD Mesonet, DOT, and other similar statewide networks.	High	Data & Studies	EPA, DENR-Water & Enviro Fund, Develop. Districts,	**SDSU** **DENR** SDDOT Local/Tribal Gov. NWS, NRCS, USGS	New for 2019. DENR stream sensors work with and compliment USGS stream gauges, as discussed in Section 4.4.1. SDSU conducts climate research. NRCS has been working with tribes on this issue.
6	6-1	Inform tribes of mitigation, public assistance, individual assistance, and SBA funding opportunities to help reduce risks and recover from disasters.	High	Technical Assistance	Staff time, FEMA SBA	**OEM** SD Tribal Relations, FEMA Tribal Relations, Tribal Gov.	New for 2019. Tribes are more often going directly to FEMA (Nation to Nation) for disaster declarations, rather than going through the state. FEMA RVIII Tribal Relations, SD Tribal Relations, and OEM have been meeting with tribes pre and post disaster to inform tribes of the recovery programs and how to access them.

Goal	Action #	Mitigation Action	Priority	Mitigation Type	Potential Funding Source(s)	Responsible Department(s)*	Implementation Notes
6	6-2	Continue working with tribal governments to develop approvable hazard mitigation plans and eligible mitigation project grant applications.	High	Technical Assistance	Staff time, FEMA - HMGP and PDM	**OEM** SD Tribal Relations, FEMA Tribal Relations, Tribal Gov.	New for 2019. Action reflects recent progress in improving and expanding tribal mitigation planning. OEM has been working with all tribes to develop HMPs, either on their own or in cooperation with the counties. OEM actively solicits mitigation projects from tribes.
DMP 1	DMP 1.2	Update and refine aquifer mapping to better quantify volume and location of water resources	High	Data & Studies	Staff time	**DENR Geological Survey**	The DENR Geological Survey has an ongoing effort to update county studies and as part of this effort, aquifer mapping is being updated where needed.
DMP 1	DMP 1.4	Increase or maintain surveillance and monitoring activities for drought-specific public health issues (e.g. West Nile surveillance, private well testing for water quality)	High	Data & Studies	Staff time	**Division of Behavioral Health**	Provide input at DTF meetings and coordinate with other agencies on this topic. Monitor related impacts noted in the online Drought Impact Reporter
DMP 1	DMP 1.5	Provide guidance to state agencies on data collection in order to track drought impacts from year to year	High	Data & Studies	Staff time,	**Drought Task Force**	The vulnerability assessment in the Drought Mitigation Plan has recommendations for data collection needed to improved drought impact assessment
DMP 1	DMP 1.6	Convene the Drought Task Force annually to discuss data collection per each sector to enhance future versions of the drought plan	High	Planning & Regulations	Staff time	**Drought Task Force**	DTF continues to meet at least annually to discuss the actions and ensure they are not shelved without being looked at from year to year.
DMP 1	DMP 1.8	Increase weather and climate monitoring and expand manual/automated data network on precipitation, hydrology, soil moisture/ infiltration to support drought assessment	High	Data & Studies	NWS; USGS; NRCS; DENR;	**SDSU Extension**; NWS; USGS; NRCS; DENR; FSA; SDDA	SDSU extension has increased the number of weather monitoring locations in western SD.

Goal	Action #	Mitigation Action	Priority	Mitigation Type	Potential Funding Source(s)	Responsible Department(s)*	Implementation Notes
DMP 1	DMP 1.9	Increase monitoring and assessment of impacts related to economics, losses, and human factors	High	Data & Studies	Staff time	**State Climate Office**, other SDSU departments	The vulnerability assessment in the Drought Mitigation Plan has recommendations for data collection needed to improved drought impact assessment The iGrow Drought Center is a service of the South Dakota State University (SDSU) Extension providing reports, alerts and more.
DMP 2	DMP 2.2	Create and keep current a web-based state burn ban map	High	Education, Awareness, & Outreach	Wildland Fire, Staff time	**SDDA Wildland Fire Division**	This is maintained at www.sdresponse.gov as burn bans are put in place at the County level.
DMP 2	DMP 2.3	Create "Drought Tools" website for South Dakota	High	Education, Awareness, & Outreach	Staff time, BIT	**BIT**, DTF	DTF & BIT created an all-encompassing website, sdresponse.gov where citizens can view information related to any disaster in SD to include the drought monitor and fire danger.
DMP 2	DMP 2.5	Coordinate communication for in-state and out-of-state tourists, including social media, email databases and tourism industry partners	High	Education, Awareness, & Outreach	SD Dept of Tourism and State Development Chambers of Commerce	**Department of Tourism**	Dept. of Tourism has messages from past events that can be quickly customized for drought events.
DMP 2	DMP 2.6	Continue to use marketing and messaging during droughts	High	Education, Awareness, & Outreach	SD Dept of Tourism and State Development Chambers of Commerce	**Department of Tourism**	Dept. of Tourism has the ability to market tourism in a way that continues to promote tourism, even during times of drought. They would tailor their press releases if needed to ensure people know about recreation and tourism opportunities even if a large fire is burning in one part of the state or if there is a major drought.

Goal	Action #	Mitigation Action	Priority	Mitigation Type	Potential Funding Source(s)	Responsible Department(s)*	Implementation Notes
DMP 2	DMP 2.8	Create public awareness campaigns that various agencies can use for water conservation, fire prevention, etc.	High	Education, Awareness, & Outreach	Staff time	**Drought Task Force**	Leverage www.sdresponse.gov and www.bReadySD.sd.gov including social media
DMP 2	DMP 2.10	Educate producers on production modifications available to lessen drought impacts	High	Education, Awareness, & Outreach	Staff time	**SDDA**, SDSU Extension	SDSU extension hosts meetings to discuss with producers on what they can do to mitigate crop losses in drought years.
DMP 2	DMP 2.11	Disseminate public outreach, awareness, and education on fire mitigation	High	Education, Awareness, & Outreach	Staff time	**SDDA Wildland Fire**	Wildland Fire has a Firewise program they work with citizens to mitigate their homes from forest fires.
DMP 2	DMP 2.12	Increase awareness and education for drought planning ranchers	High	Education, Awareness, & Outreach	Staff time	**SDSU Extension**, SDDA, Farm Credit Services, NIDIS	SDSU extension hosts meetings to discuss with producers on what they can do to mitigate crop losses in drought years.
DMP 2	DMP 2.13	Disseminate public awareness and information (e.g. fliers, brochures, PSAs, social media)	High	Education, Awareness, & Outreach	Staff time	**SDSU Extension**, State OEM, NIDIS	SDSU Extension ensures the media outlets are aware of the meetings and when they are taking place.
DMP 3	DMP 3.1	Encourage development of drought-resistant rural water systems	High	Technical Assistance	Staff time	**SDDA**	Communicate this at SDSU extension meetings with producers
DMP 3	DMP 3.2	Develop instream flow protections	High	Technical Assistance	Staff time	**DENR Water Rights Program**, SD Water Management Board	The South Dakota Water Management Board has issued water right permits to entities to protect in-stream flow in the state's river and streams.
DMP 4	DMP 4.2	Create tax credit incentives for efficient water use	High	Planning & Regulations	Staff time	**SD Legislature**	No bills have been discussed to date related to this action.
DMP 4	DMP 4.3	Develop more efficient irrigation systems	High	Technical Assistance	Staff time Private sector	**SDDA**, SDSU Extension	Discuss at SDSU extension meetings with producers Monitor private sector and technological advances in irrigation systems

Goal	Action #	Mitigation Action	Priority	Mitigation Type	Potential Funding Source(s)	Responsible Department(s)*	Implementation Notes
DMP 5	DMP 5.3	Develop strategies to assist behavioral health providers if they become overwhelmed or need assistance from other providers of the Division of Behavioral Health	High	Technical Assistance	Staff time	**Division of Behavioral Health**	Increase outreach and communication to behavioral health providers during drought to assess needs
DMP 6	DMP 6.1	Increase outreach and interaction with local, tribal, and federal agencies	High	Planning & Regulations	Staff time	**Drought Task Force**	SDSU extension holds public forums to educate the public on measures they can do to reduce the effects of droughts. This is typically done in years when drought is prevalent and prior to summer.
DMP 6	DMP 6.3	Engage tribal entities more closely in the drought planning and mitigation process	High	Planning & Regulations	Staff time, NIDIS	**NIDIS**, State Climate Office, Tribal Relations	Continue efforts in coordination with NIDIS and the National Drought Mitigation Center (NDMC)
DMP 6	DMP 6.6	Encourage counties to increase support of local volunteer fire departments to prepare/fund suppression activities	High	Planning & Regulations	Staff time, county funds	**SDDA Wildland Fire**	Increase outreach and communication to local volunteer fire departments in advance of and during drought conditions.
DMP 6	DMP 6.7	Encourage local level drought planning and increase community/local level drought planning assistance and identify leaders at local level (i.e. create Drought Ready Communities)	High	Planning & Regulations	Staff time, Bureau of Reclamation WaterSmart grants	**SDSU Extension**, State OEM, NIDIS	OEM encourages counties to develop drought annexes to their LEOP.
DMP 6	DMP 6.8	Increase NIDIS interactions and planning efforts	High	Planning & Regulations	Staff time, NIDIS	**State Climate Office**	Continue efforts to coordinate with NIDIS and participate in NIDIS Missouri River Basin Drought Early Warning System (DEWS)

Goal	Action #	Mitigation Action	Priority	Mitigation Type	Potential Funding Source(s)	Responsible Department(s)*	Implementation Notes
DMP 6	DMP 6.9	Encourage tribal representatives to coordinate with local planning personnel for joint initiative development and increase data sharing	High	Planning & Regulations	Staff time	**Tribal Relations**, OEM	OEM continues to encourage this. Two tribes have developed joint HMPs with counties.

*The current representative on the State Hazard Mitigation Team for the noted Responsible Departments will be contacted for updates and progress reports on the mitigation actions.

5.2.4 Progress on Mitigation Goals and Actions

Since the development of its initial State Hazard Mitigation Plan in 2004, South Dakota has achieved significant progress in reducing risk to natural hazards. The following table shows progress that has been accomplished on all the mitigation actions listed previously in Table 5-4 South Dakota 2019 Mitigation Strategy, with the exception of new actions identified in 2019. This demonstrates progress towards meeting the Plan's identified goals, as mitigation actions associated with each goal have been implemented. Table 5-5 represents an improvement on the previous SHMP by linking the progress to specific actions; the 2014 plan had listed bullets on general progress.

A FEMA comment on the 2014 SHMP stated "The Risk Assessment includes a number of good descriptions of data limitations that can be improved as part of the next plan update, including mapping location and loss information from PA grant projects and improving data related to planning state owned and operated facilities to ensure they are not developed in known hazard areas." The mapping of PA project data was accomplished during the 2014 and 2016 updates and can be found in Section 3.3.3 Federal Disaster Declaration History and Analysis. Improving data on state facilities is the focus of Action #2-2.

Table 5-5 Progress on Mitigation Actions

Goal	Action #	Mitigation Action	2018 Progress Notes
1	1-1	Support the construction and operation of hardened shelters / safe rooms through local project applications.	Considerable work has been completed on this action since 2014. Numerous local shelter and safe room projects have been funded. Funding for Disaster 1984 provided 4 storm shelters, totaling $4,688. Funding for Disaster 1887 offered $615,000 to build a municipal safe room, while Disaster 1984 offered $683,820 to build two municipal safe rooms. GF&P has integrated shelters into new rest areas and bathrooms at campgrounds at a rate of about 4 per year. The August 30, 2018 issue of the Capital Journal carried a feature article on plans to build the Griffin Park shelter.
1	1-2	Support the installation of outdoor warning sirens and NOAA weather radios through local project applications.	OEM has been providing ongoing support for several applications. Numerous warning siren and weather radios have been funded. Since 2013, $646,651 of grant funds have gone to purchase sirens and generators in 20 different communities. Watertown has placed new sirens in growth areas, as well as maintaining old sirens. Sirens around Lake Madison have been added. GF&P has used HMGP funds in the past for sirens. SD Office of Homeland Security has purchased warning systems and generators. State NOAA all-hazards radio coverage is good.

Goal	Action #	Mitigation Action	2018 Progress Notes
1	1-3	Coordinate public outreach/ education regarding shelter locations and warning systems. Develop brochures, websites, news briefs, and other media to notify the public of shelter locations and what sounds to expect from the warning systems.	OEM has sent out 1,000's of copies of children's books on weather awareness, aimed at 2nd graders. Three different books developed for flood, tornado, and winter storm, and a fourth book on fire safety is in development. Local warning sirens tests are conducted regularly, and information is distributed to the public. The August 30, 2018 issue of the Capital Journal carried a feature article on plans to build the Griffin Park shelter.
1	1-4	Support and encourage public education/outreach efforts for all hazards awareness and safety.	OEM has conducted several preparedness fairs and received good feedback from participating schools. Created four *Tommy The Turtle* children's' books on disaster preparedness, distributed to 2nd grade classrooms, dental offices, doctor's offices, and public libraries. OEM and ORM encourage tornado drills in state buildings. Department of Public Safety: Winter weather and severe weather preparedness guides, Twitter announcements for severe weather, distributing information at the State Fair, school safety sessions, safety classes through Extension, work with the Public Utility Commission One Call system, B Ready. Department of Transportation: Buckle Up, Save it For Later, Give 'em a Brake, Don't Crowd the Plow, temperature warnings, highway construction and hazard notification press releases, safetravelusa.com, 511 Travel Information. Department of Agriculture: Drought education. Department of Public Health: Flu Awareness Campaign. National Weather Service: Flood Safety Awareness Campaign. Rural Electric Cooperatives: Electrical safety literature, outreach materials, and public service announcements. Severe weather preparedness week funded through EMPG. This includes a package of information that goes to schools, local emergency managers, daycares, assisted living centers, and nursing homes. Safe room information is also disseminated from the hazard mitigation office to local emergency managers and floodplain administrators.
1	1-5	Further analyze climate change effects in South Dakota to include frequency of flood events and other hazards.	New for 2019.

Goal	Action #	Mitigation Action	2018 Progress Notes
2	2-1	Coordinate with South Dakota Building Code Officials Association to integrate floodplain management ordinances into local building codes.	OEM is researching other states for possible floodplain legislation in South Dakota. The South Dakota Office of Emergency Management has been working with the South Dakota Building Officials' Association to verify if floodplain management ordinance regulations are integrated and correspond to the adopted building code provisions at the local government level. In South Dakota, state government has adopted the 2018 Edition of the International Building Code (IBC 2018), as published by the International Code Council. However, local government enforcement of IBC 2018 is not mandated at the state level. Thus, there are various towns and counties across South Dakota that have a building official and an office that issues building permits, and other communities that do not. When a community has not adopted IBC 2018, South Dakota Codified Law11-10-6 Standards for New Construction Where Building Code Ordinance Has Not Been Adopted is triggered. SDCL 11-10-6 requires any new construction that commenced after 7/1/2018, within a community that has not adopted an ordinance prescribing standards for new construction, have the design standard based on IBC 2018. The South Dakota Building Officials' Association will be reaching out to officials from South Dakota's seven CRS communities (Aberdeen, Rapid City, Madison, Meade County, Parkston, Spearfish and Watertown) during their upcoming 2018 and 2019 meetings to ensure the communities' adopted higher floodplain standards or revisions have been reflected within their adopted building code. The State of South Dakota has inserted into their building code regulations (SDCL 11-10-5) that more restrictive building code requirements or revised requirements can be put in place, as long as the higher standards are legally made effective upon their adoption and subsequently filed with the local auditor's office.
2	2-2	Improve the state facilities database by capturing classification and valuation information.	Risk Management has added all buildings valued at $100K or more. Still some improvements that can be made to refine vulnerability assessments to state facilities.
2	2-3	Support the purchase and relocation of structures within floodplains and other hazard prone areas through local project applications.	A voluntary program has purchased or relocated structures in the Waubay area of Day County. Other areas of progress include Hermosa, Madison, Parkston, and Davis (4 properties). Numerous acquisition and relocation projects have been funded. Various disasters, including 1984, 1915, 1887, and 1886, have allowed for over $4,262,615.25 worth of acquisition and relocation projects to be conducted throughout the state.
2	2-4	Support and encourage flood control projects through state & local project applications.	Numerous drainage improvement projects have been funded. Over $10,151,721 of flood mitigation and drainage improvement projects have been funded through disaster 1984, 1887, and 1915 funding. GF&P encourages wetlands projects which have flood reduction benefits.

Goal	Action #	Mitigation Action	2018 Progress Notes
2	2-5	Support and encourage elevation of structures in flood prone areas through local project applications.	Several road elevation projects have been funded. $165,938 from disaster 1887 was used to elevate a road in McCook County. In addition, public assistance funds from disaster 1984 attributed to road elevation projects as part of emergency protective measures.
2	2-6	Coordinate with all state departments and agencies through surveys and other mechanisms to identify structures in hazard areas and their replacement values.	City of Madison multi-agency project with Silver Jackets was funded. This Plan's HIRA in Chapter 3 has identified risk to state owned or leased facilities. Digital Flood Insurance Rate maps, and HAZUS -generated floodplains, have been used in GIS to identify state owned buildings within flood areas. All agencies through the Technical Advisory Group gathered data in preparation for flooding to update critical facilities information.
2	2-7	Support and encourage fire risk reduction projects such as the installation of fire breaks / fuel breaks and the creation of defensible space between structures and forested areas through local project applications.	OEM has conducted/funded: 1 Rapid City fuel reduction, defensible space program with HOA. Roof replacement on 17 homes (FY17 PDM). The Wildland Fire Division has an ongoing fuels mitigation program utilizing federal funds to treat approximately 1,500-2,000 acres per year on state and private lands. 2017, SDDA through the Wildland Fire division: Two state handcrews accomplished 105 acres of Wildland Urban Interface treatments. State handcrews burned 229 acres. Hired contractors thinned 147 acres; Hired contractors chipped 102 acres and burned 45 acres in 2017.
2	2-8	Support and encourage communities to participate in Firewise, develop CWPPs, and participate in other fire protection programs to minimize risk to wildfire.	Several communities, including the following counties: Butte, Custer, Perkins, Stanley, Pennington, Meade, Fall River, and Lawrence, as well as Rapid City have Community Wildfire Protection Plans.
2	2-9	Support bank stabilization and other geohazard risk reduction through local project applications.	A bank stabilization project at Cedar Shores completed 1-2 miles on the Lyman County side of the river. A project was attempted at Big Stone Lake, but few applications were received.
2	2-10	Map repetitive flood loss properties to identify concentrations of properties or high losses and identify potential mitigation options.	New for 2019.

Goal	Action #	Mitigation Action	2018 Progress Notes
3	3-1	Support the improvement to existing power lines through local project applications. (i.e. power line burial, spoiler installation, pole strengthening & heavier wires).	Projects totaling $19M have been completed since 2005. This includes: GPS mapping of poles, analysis of storm events, weak poles, and the age of lines. 348 miles of power lines have been buried, with 167 miles pending since last plan update using disaster assistance funding. In addition, rural electric cooperatives (co-ops) also bury lines with their own funding. HMGP funds have been used for spoilers to protect power line infrastructure. Public Assistance funds in disaster 1887 allowed for hundreds of miles to be upgraded with new conductor as well as being buried. Electrical co-ops have adopted new standards that if a line goes down from a storm, they will look into burying the line or putting up #2ACSR line which is lighter and stronger than copper line.
3	3-2	Encourage the purchase of generators for backup power to critical infrastructure / storm shelters and conduct regular testing for preparedness.	SD Office of Homeland Security has purchased warning systems and generators. Numerous generators have been purchased by OEM, SDOHS, and SD DENR (for water/wastewater facilities). Since 2013, $646,651 of grant funds have gone to purchase sirens and generators in 20 different communities. Recipients have included community well sites and rural water systems. In addition, EMGP and SHSGP funds have purchased numerous generators within counties to enhance local capabilities when there are power outages. Telephone cooperatives and rural water systems have used their own funds to purchase generators.
3	3-3	Encourage removal of debris in waterways (i.e. near bridges, culverts, within stream channels).	SD DOT conducts debris removal on state highways and drainage structures. NRCS funding is available for debris removal.
3	3-4	Support and encourage drainage improvement projects through local applications (i.e. proper sizing).	Numerous drainage improvement projects have been funded. Over $10,151,721 of flood mitigation and drainage improvement projects have been funded through disaster 1984, 1887, and 1915 funding.
3	3-5	Support and encourage routine inspections of existing utilities and infrastructure for damage and weaknesses.	Line patrols & pole testing are conducted annually and thoroughly by local utilities and RECs. Areas of weakness are mapped. Local utilities perform yearly inspections and replace problem areas using their existing budget. Rural Electric co-ops work with linemen and tree trimming contractors to ensure trees are within a safe distance to power lines. Rural Utilities Service's (RUS) requires inspection of all electrical lines once per year. SD DOT performs bridge inspections every two years and culvert inspections every five years. SD DENR's Dam Safety Inspection Program requires all high hazard and significant hazard dams to be inspected every three years.

Goal	Action #	Mitigation Action	2018 Progress Notes
3	3-6	Maintain the state digital radio system through regular training and exercises.	A radio drill is conducted quarterly with local EMS, NWS, Red Cross. SD National Guard uses the system in their annual exercise. Training is available to learn how to operate the state's digital radio system. Exercises using the radio are conducted quarterly.
3	3-7	Reduce the number of susceptible dams to high flow/flood events through re-evaluation of design capacity and development of updated emergency preparedness plans.	New for 2019.
4	4-1	Encourage agricultural modifications to lessen the impacts of drought such as crop rotation, drought resistant crops, no till, etc.	SDDA with SDSU-Extension hosted a Climate Outlook Forum in May to discuss climate conditions. SDDA also highlights various tools and production methods producers can consider for drought mitigation. This is largely done via social media. South Dakota is considering development of a comprehensive Drought Plan to identify specific measures for reducing the impacts of drought across the state. The Drought Task Force provides information to agricultural producers in order for them to make sound crop rotation decisions.
4	4-2	Promote insurance – Many different forms of insurance are available to cover damages incurred by the various natural hazards. The state will encourage residents, farmers, and business owners to purchase insurance appropriate for their risk.	South Dakota has the highest adoption of crop insurance in the country. The state often inspires residents and business owners to purchase insurance if they have a risk. During spring, the state will coordinate flood outreach presentations with FEMA Region 8, National Weather Service, US Army Corps of Engineers, US Geological Survey and local officials as part of the National Flood Safety Awareness platform. The town-hall meetings are designed to help citizens learn more about the annual flood outlook for their area, as well as the National Flood Insurance Program and general flood preparations. The state has worked closely with FEMA during their 27-county flood risk mapping effort started in 2016, where many communities were getting their flood risk mapped for the first time. The state has been actively promoting the FEMA RiskMAP Journal, where individuals can view information and download the new flood maps and GIS data to better understand their risk. The state is encouraging participation in the Community Rating System program, where communities receive discounts on their flood insurance premiums through additional floodplain management practices and higher regulatory standards. The state is also meeting with FEMA Region VIII staff and State Insurance Commissioners in August 2018 to have an insurance roundtable focusing on growing insurance partnerships, policy counts and claims numbers, communicating risk to the public and increasing coverages.

Goal	Action #	Mitigation Action	2018 Progress Notes
4	4-3	Enhance and streamline coordination with the State Historic Preservation Officer, Tribal Historic Preservation Officer (as applicable), and other agencies on all projects.	In 2014, the state signed a Programmatic Agreement with FEMA that allows the state to streamline coordination between OEM, the SHPO, THPO, and SDDA as needed. The SHMT elected to maintain this as a current action to facilitate implementation of the Programmatic Agreement. Additionally, the Programmatic Agreement will expire in 2021 unless extended.
4	4-4	Develop and deploy targeted messaging aimed at educating and informing travelers during drought, fire and flood events.	The Governor has developed public service announcements to promote tourism and recreation.
5	5-1	Support and continue public outreach efforts regarding methods to reduce losses due to natural hazards.	Related technical assistance to local governments include: Presentations to communities and VOADs on preparedness. Outreach to faith-based organizations. Outreach to veteran's service organizations Outreach and education is conducted at County Commission meetings, Towns & Townships conferences, the Hydrology Conference, and to private businesses. Mitigation staff encourages planning and zoning during visits to localities. LiDAR data is available to help local officials with planning and zoning decisions/policy. The NFIP program reaches out to counties and communities to ensure local enforcement of floodplains is occurring.
5	5-2	Continue working with local governments to develop approvable hazard mitigation plans and eligible mitigation project grant applications.	Technical assistance includes SHMO attending local planning kickoff meetings, and stressing improvement of mitigation strategy during updates, including development of actions that can support project applications.
5	5-3	Support and encourage safer building practices in local communities to reduce risk from all hazards.	OEM has encouraged and provided technical assistance on related practices including: Tie-downs for manufactured homes. Freeboard. Floodplain management. Trainings for local officials.
5	5-4	Maintain and expand weather and climate monitoring/ observations through SD Mesonet, DOT, and other similar statewide networks.	DENR has installed 17 new stream sensors on the Big Sioux and its tributaries. NRCS has been working with tribes on this issue. Integrating public and private data systems such as CoCoRAHS.

Goal	Action #	Mitigation Action	2018 Progress Notes
6	6-1	Inform tribes of mitigation, public assistance, individual assistance, and SBA funding opportunities to help reduce risks and recover from disasters.	New for 2019. All local and tribal emergency managers are notified whenever a funding opportunity becomes available for South Dakota.
6	6-2	Continue working with tribal governments to develop approvable hazard mitigation plans and eligible mitigation project grant applications.	New for 2019. Tribal acquisition projects have been funded, as well as two tribal LHMPs.
Drought Mitigation Plan - Various		47 actions	The Drought Mitigation Plan was developed in 2015 and some progress has been accomplished, notably on implementation of actions: 1.6, 1.8, 2.2, 2.3, 2.6, 2.10, 2.11, 2.12 and 2.13. See also Implementation Notes in Table 5-4.

5.2.5 Comprehensive Mitigation Strategy

South Dakota's mitigation strategy is designed to target all hazards that significantly impact the state. During the 2018-2019 SHMP update process, the SHMT reviewed all current and proposed mitigation actions to ensure the mitigation strategy addresses all hazards identified in Section 3 Hazard Identification and Risk Assessment. Table 5-6 lists all the mitigation actions from Table 5-4 and notes which hazards they address. This analysis indicates that the 2019 SHMP includes mitigation actions that will reduce vulnerabilities to each hazard identified in Section 3. Many of the actions address multiple hazards.

Table 5-6 Mitigation Actions by Hazards Addressed

Action #	Mitigation Action	Agricultural Pests/Diseases	Flood	Summer Storm	Winter Storm	Wildfire	Drought	Tornado	Windstorm	Hazardous Materials	Geologic Hazards
1-1	Shelters/ Safe Rooms		X	X	X	X		X	X	X	
1-2	Sirens, weather radios		X	X	X	X		X	X	X	
1-3	Shelter outreach & education		X	X	X	X		X	X	X	
1-4	All-hazards education & outreach	X	X	X	X	X	X	X	X	X	X
1-5	Climate change analysis		X			X	X				
2-1	Building codes		X	X	X	X		X	X	X	X
2-2	State facilities database		X	X	X	X	X	X	X	X	X
2-3	Purchase & relocation of at-risk structures		X								X
2-4	Flood control projects		X								
2-5	Elevation of structures in floodplain		X								
2-6	Identify structures in hazard areas		X	X	X	X		X	X	X	X
2-7	Wildfire risk reduction: defensible space, breaks					X					
2-8	Wildfire risk reduction: Firewise, CWPPs, etc..					X					
2-9	Bank stabilization & geohazard risk reduction		X								X
2-10	Repetitive loss strategy		X								

Action #	Mitigation Action	Agricultural Pests/Diseases	Flood	Summer Storm	Winter Storm	Wildfire	Drought	Tornado	Windstorm	Hazardous Materials	Geologic Hazards
3-1	Power line hardening		X	X	X			X	X		
3-2	Backup generators		X	X	X	X		X	X	X	X
3-3	Debris removal in waterways		X	X							
3-4	Drainage improvements		X	X							
3-5	Routine inspections of utilities, infrastructure		X	X	X	X		X	X	X	X
3-6	Maintain state digital radio system		X	X	X	X		X	X	X	X
3-7	Reduce susceptibility of dams		X								X
4-1	Drought agricultural modifications	X					X				
4-2	Promote insurance	X	X	X	X	X	X	X	X	X	X
4-3	SHPO/THPO coordination		X	X	X	X		X	X	X	X
4-4	Tourism & recreation promotion		X			X	X				
4-5	SD Drought Mitigation Plan actions						X				
5-1	Public outreach to reduce natural hazards losses	X	X	X	X	X	X	X	X		X
5-2	Local HMPs and projects	X	X	X	X	X	X	X	X	X	X
5-3	Safer building practices		X	X	X	X		X	X	X	X
5-4	Weather & climate monitoring		X	X	X	X	X	X	X		
6-1	Technical & funding assistance to tribes	X	X	X	X	X	X	X	X	X	X
6-2	Tribal HMPs and projects	X	X	X	X	X	X	X	X	X	X
Var.	47 Actions from Drought Mitigation Plan						X				

A comprehensive hazard mitigation program needs to coordinate with multiple sectors, not just emergency management. Table 5-6 lists all the mitigation actions from Table 5-4, and illustrates how they address seven sectors defined in the 2015 FEMA State Mitigation Plan Review Guide. Every sector is addressed by at least ten mitigation actions, and most actions address more than one sector. This analysis, in conjunction with Section 4.2.4 Table 4-4 State/Regional Agency Integration by Sector, demonstrates that the state's hazard mitigation program is fully integrated across all sectors.

Table 5-7 Mitigation Actions by Sectors Addressed

Action #	Mitigation Action	Emergency Management	Economic Development	Land Use Development	Housing	Health & Social Services	Infrastructure	Natural/Cultural Resources
1-1	Shelters/ Safe Rooms	X		X	X		X	
1-2	Sirens, weather radios	X		X		X		X
1-3	Shelter outreach & education	X		X	X	X	X	
1-4	All-hazards education & outreach	X	X	X	X	X	X	X
1-5	Climate change analysis	X	X	X	X	X	X	X
2-1	Building codes		X	X	X		X	
2-2	State facilities database	X					X	
2-3	Purchase & relocation of at-risk structures	X	X	X	X			
2-4	Flood control projects	X		X			X	X
2-5	Elevation of structures in floodplain	X		X	X		X	
2-6	Identify structures in hazard areas	X		X	X		X	
2-7	Wildfire risk reduction: defensible space, breaks	X		X			X	X
2-8	Wildfire risk reduction: Firewise, CWPPs, etc..	X		X			X	X
2-9	Bank stabilization & geohazard risk reduction	X		X			X	X
2-10	Repetitive loss strategy	X		X	X		X	

Action #	Mitigation Action	Emergency Management	Economic Development	Land Use Development	Housing	Health & Social Services	Infrastructure	Natural/Cultural Resources
3-1	Power line hardening	X					X	
3-2	Backup generators	X					X	
3-3	Debris removal in waterways	X		X				X
3-4	Drainage improvements	X		X			X	X
3-5	Routine inspections of utilities, infrastructure	X					X	
3-6	Maintain state digital radio system	X						
3-7	Reduce susceptibility of dams	X		X			X	
4-1	Drought agricultural modifications	X	X					X
4-2	Promote insurance	X	X			X		
4-3	SHPO/THPO coordination	X	X					X
4-4	Tourism & recreation promotion	X	X					X
4-5	SD Drought Mitigation Plan actions	X	X	X		X	X	X
5-1	Public outreach to reduce natural hazards losses	X	X	X	X	X	X	X
5-2	Local HMPs and projects	X	X	X	X	X	X	X
5-3	Safer building practices	X		X	X		X	
5-4	Weather & climate monitoring	X						X
6-1	Technical & funding assistance to tribes	X	X	X	X	X	X	X
6-2	Tribal HMPs and projects	X	X	X	X	X	X	X
Var.	47 Actions from Drought Mitigation Plan	X	X	X		X	X	X

Further commitment to a comprehensive mitigation strategy is the emphasis that has been placed on mitigation of infrastructure vital to response and recovery operations. This is highlighted in Goal 3 and associated objectives, mitigation actions 3-1 and 3-2, and in the demonstrated effective use of mitigation funding to bury power line infrastructure as described further in Sections 5.4.1 and 5.4.8.

5.3 Funding Sources

44 CFR Part 201 Requirement:
[The State mitigation strategy shall include an] identification of current and potential sources of Federal, State, local, or private funding to implement mitigation activities.
44 CFR Part 201 Enhanced Plan Requirement:
Enhanced State Mitigation Plans must include…Demonstration that the State has the capability to effectively manage the HMGP as well as other mitigation grant programs, including a record of the following: *Meeting HMGP and other mitigation grant application timeframes and submitting complete, technically feasible, and eligible project applications with appropriate supporting documentation;* *Preparing and submitting accurate environmental reviews and benefit-cost analyses;* *Submitting complete and accurate quarterly progress and financial reports on time; and* *Completing HMGP and other mitigation grant projects within established performance periods, including financial reconciliation.*

South Dakota uses a variety of sources to fund state and local mitigation activities. While much of the funding comes from the federal government, additional funding comes from state and local governments as well as private organizations. The state, through OEM, has instituted an effective and comprehensive all-hazard mitigation program. Through a variety of programs, and the wise use of available federal and state funds, the state has been successful in mitigating areas against the devastating effects of disasters. South Dakota remains committed to a comprehensive state hazard mitigation strategy, including the effective state management of all FEMA Mitigation Division grant programs.

OEM is successful in administering federal mitigation programs. The Hazard Mitigation Assistance (HMA) program, administered in collaboration with FEMA, serves the needs of the state for implementing hazard mitigation projects. The state recognizes there is limited funding available for hazard mitigation projects. The State Hazard Mitigation Officer (SHMO) and the South Dakota Hazard Mitigation Team (SHMT) administer funds for local projects requiring the local communities to provide the 25% match required for receipt of federal funds. (In some cases, the state has provided a portion of the 25% match; see Section 4.6.1.)

Section 322 of the Disaster Mitigation Act of 2000 provides for a significant increase in HMGP funding available to states with an enhanced mitigation plan. It therefore requires South Dakota to demonstrate its ability and commitment to manage HMA grants effectively to ensure it advances the tenets and benefits of mitigation as comprehensively as possible. South Dakota is committed to a comprehensive state hazard mitigation strategy included the effective state management of all FEMA Mitigation Division grant programs. See Section 5.4 for details.

During the 2019 Plan update process, the SHMT identified many sources of federal, state, local, and private funding that have been used to implement risk reduction or mitigation activities or could potentially be used in the future. These sources of funding are summarized in Table 5-8. Many of these funding sources have been listed in prior iterations of this Plan, but several new sources have been added

in 2019 and are identified with an asterisk (*). Funding sources identified in the 2015 South Dakota Drought Mitigation Plan have also been incorporated here and are marked with a †.

Table 5-8 Mitigation Funding Sources in South Dakota

Name	Level	Source Agency	Managing State Agency	Purpose of Funding
AmeriCorps*	Federal	Corporation for National & Community Service		Provides funding for volunteers to serve communities, including disaster prevention. AmeriCorps/Vista has assisted local communities with wildfire mitigation projects.
Assistance to Firefighters program - Fire Prevention & Safety (FP&S) Grants	Federal	FEMA	State Fire Marshal	Fire Prevention & Safety (FP&S) Grants support projects that enhance the safety of the public and firefighters from fire and related hazards.
Highway Bridge Replacement and Rehabilitation Program	Federal	FHWA	SDDOT	Provides funding to enable states to improve the condition of highway bridges through replacement, rehabilitation and systematic preventive maintenance. Also includes the National Historic Covered Bridge Preservation Program.
Bureau of Indian Affairs (BIA)	Federal	BIA		BIA's Tribal Wildfire Prevention programs provide leadership, training and guidance to develop strategies to reduce the number of human caused fires on Indian Reservations. The Fuels Management Program provides funding to reduce hazardous vegetation both in and outside the WUI.
Clean Water Act Section 319 Grants*	Federal	EPA		Provides grants for a wide variety of activities related to non-point source pollution runoff mitigation.
Community Assistance Program (CAP)*	Federal	FEMA, NFIP	OEM	Product-oriented financial assistance program directly related to the flood loss reduction objectives of the NFIP.
Community Development Block Grant – Disaster Recovery (CDBG-DR)	Federal	HUD	GOED	Often following a disaster, the state may receive a CDBG-DR Supplement intended for mitigation and disaster recovery projects in the affected areas. Funding can be used to acquire properties in hazard prone areas. Since CDBG funds lose their federal identify they can also be used to supplement state or local match requirements on other funds such as FEMA HMA grants. Funding also

Name	Level	Source Agency	Managing State Agency	Purpose of Funding
				supports public facilities including water and wastewater.
Community Fire Protection Program*	Federal	USDA		Mitigation delivered via USDA Forest Service and Private Forestry Coop Fire Program.
Economic Development Administration Grants and Investments	Federal	U.S. DOC, EDA		Invests and provides grants for community construction projects, including mitigation activities.
Emergency Community Water Assistance Grants†	Federal	USDA		$150,000 to $500,000 available to rural communities with populations over 10,000 people with a median household income less than $65,900. Provides assistance to communities who have experienced a decline in quantity or quality of drinking water as a result of an emergency including drought.
Emergency Management Performance Grant (EMPG)	Federal	FEMA	OEM	The EMPG program provides a yearly allocation of funding to support state and local emergency management programs. This has included providing some funding for local mitigation plans, mitigation-oriented studies, and related activities.
Emergency Relief (ER) Program	Federal	US DOT - FHWA	SDDOT	Provides funds for roads and bridges on Federal-aid highways that are damaged as a direct result of a natural disaster or catastrophic failure from an external cause.
Emergency Watershed Protection (EWP)*	Federal	USDA, NRCS		Provides funding and technical assistance for emergency measures such as floodplain easements in impaired watersheds. Funding available through the Simplified Acquisition Procedures (SAP) ranges from $25K to $100K. Funded through contracts between project sponsors and the NRCS. There are no grants. The NRCS pays 75% of the costs.
Environmental Quality Incentives Program (EQUIP)*	Federal	USDA, NRCS		Provides funding and technical assistance to farmers and ranchers to promote agricultural production and environmental quality as compatible goals.

Name	Level	Source Agency	Managing State Agency	Purpose of Funding
Fire Management Assistance Grants (FMAG)*	Federal	FEMA	SDDA - SDWL	Provides fire suppression support to states when loss of life and property are imminent. Wildfire mitigation is also eligible under emergency protection if life is in imminent danger.
Flood Mitigation Assistance (FMA) Program	Federal	FEMA	OEM	Repetitive flood loss property reduction and projects that mitigate losses to NFIP insured properties.
Forest Land Enhancement Program*	Federal	USDA, DNRC		Provides educational, technical, and financial assistance to help landowners implement sustainable forestry management objectives
Forest Legacy Program*	Federal	USFS		Program providing funding to protect private forest lands that are environmentally, economically, and socially critical. This program reduces development in the wildland-urban interface.
Hazard Mitigation Grant Program (HMGP)	Federal	FEMA	OEM	Post-disaster multi-hazard mitigation funding. Starting in 2018, FEMA made HMGP Post Fire funds available for states, territories, and tribes with an FMAG declaration.
Homeland Security Grant Program (HSGP)	Federal	DOJ, DHS	SDOHS	Homeland security activities identified in the state and local strategic plans. Funding supports threat & hazard and risk identification for natural, technological, and human-caused hazards. Some prevention activities may be considered mitigation.
Housing and Urban Development (HUD) Grants*	Federal	HUD	GOED	Provides a number of grants related to safe housing initiatives.
Hydrologic Research Grants†	Federal	NOAA		Up to $125,000 to conduct joint research and development on pressing surface water hydrology issues common to national, regional, local operational offices. Eligible applicants are federally recognized agencies of state or local governments, quasi-public institutions such as water supply or power companies, hydrologic consultants and companies involved in using and developing hydrologic forecasts.

Name	Level	Source Agency	Managing State Agency	Purpose of Funding
Individual Assistance (IA)	Federal	FEMA/ State	OEM	Following a disaster, funds can be used to mitigate hazards when repairing individual and family homes.
In-Lieu Fee Program Mitigation Projects*	Federal	USACE		Restoration, establishment, enhancement, and/or preservation of aquatic resources through funds paid to a governmental or non-profit natural resources management entity to satisfy compensatory mitigation requirements for Department of the Army permits.
Mitigation Banks*	Federal	USACE		Mitigation Banks are sites approved by the Corps to sell compensatory mitigation credits for projects resulting in unavoidable impacts to waters of the U.S. When a permit is issued that requires compensatory mitigation, the permit will specify how many credits are required to be purchased at an approved mitigation bank.
National Dam Safety Program*	Federal	FEMA	DENR	Promotes dam safety through Emergency Action Plans (EAPs), risk assessment, and exercises
National Earthquake Hazards Reduction Program (NEHRP)*	Federal	FEMA		Provides money to support enhanced earthquake risk assessments in local hazard mitigation plans and other earthquake hazard mitigation and preparedness activities.
National Fire Plan*	Federal	USDA, DOI		Provides pre-disaster funding for primarily wildland fire mitigation, but also planning for all hazards.
National Weather Service (NWS)	Federal	NWS		NWS offers storm spotter training, along with weather and flooding safety guides. They can also sometimes provide funding to support severe weather signage in parks or other public places.
National Wildlife Wetland Refuge System*	Federal	USFWS		Provides funding for the acquisition of lands into the federal wildlife refuge system.
North American Wetland Conservation Fund*	Federal	USFWS		Provides funding for wetland conservation projects.
NRCS Conservation Programs*	Federal	USDA, NRCS		Provides funding through a number of programs for the conservation of natural resources.

Name	Level	Source Agency	Managing State Agency	Purpose of Funding
Partners for Fish and Wildlife*	Federal	USFWS		Provides financial and technical assistance to landowners for wetland restoration projects in "Focus Areas" of the state.
Planning Assistance to States	Federal	USACE		Provides assistance to states in planning for the development, utilization, and conservation of water and related land resources.
Pre-Disaster Mitigation (PDM) Program	Federal	FEMA	OEM	Grants for specific multi-hazard mitigation projects, including planning.
Public Assistance (PA) Section 406 funds	Federal	FEMA/ State	OEM	Following a disaster, funds can be used to mitigate hazards when repairing damages to a public structure or infrastructure. Wildfire mitigation is also eligible under emergency protection if life is in imminent danger.
Public Health Emergency Preparedness Program (PHEP)	Federal	CDC	SD DOH-OPHPR	
Risk MAP Program	Federal	FEMA, NFIP	OEM	Establishes or updates floodplain mapping and multi-hazard risk products.
Rural Development Grants	Federal	USDA-Rural Development		Provides grants and loans for infrastructure and public safety development and enhancement in rural areas. Provides $100,000 or 75% of the total project, whichever is less.
Rural Fire Assistance Grant*	Federal	NIFC		Funds fire mitigation activities in rural communities.
Rural Utilities Service (RUS)	Federal	USDA-Rural Development		RUS administers programs that provide much-needed infrastructure or infrastructure improvements to rural communities. These include water and waste treatment, electric power and telecommunications services.
Small Business Administration (SBA) Pre-Disaster Mitigation Loan Program	Federal	SBA		Provides low-interest loans to small businesses for mitigation projects.
Small Flood Control Projects (USACE Section 205)*	Federal	USACE		Authorizes use of USACE to do feasibility and construction of small flood control projects

Name	Level	Source Agency	Managing State Agency	Purpose of Funding
Silver Jackets	Federal	USACE		Can provide funding for flood related studies, public awareness, risk analysis, and flood response plans. Construction of small flood control projects.
State Water Resources Research Act Program*	Federal	USGS		USGS in cooperation with the National Institutes for Water Resources supports an annual call for proposals to focus on water problems and issues that are of a regional or interstate nature or relate to a specific program priority identified by the Secretary of the Interior and the Institutes.
Surface Transportation Block Grant (STBG) Program*	Federal	FHWA		This program replaces the former Transportation Enhancement (TE) and Transportation Alternatives Program (TAP) grants. STBG provides funding for transportation alternatives and environmental mitigation projects.
United States Coast Guard (USCG)	Federal	USCG		USCG administers two grant programs designed to promote boating safety.
US Department of Justice (DOJ) Office of Justice Programs (OJP)	Federal	DOJ-OJP	DPS	DOJ-ODP provides a number of grants and awards focused on crime prevention to state and local law enforcement agencies and other eligible recipients.
United States Geological Survey (USGS)*	Federal	USGS		USGS issues competitive grants and cooperative agreements to support research in earthquake hazards, the physics of earthquakes, earthquake occurrence, and earthquake safety policy.
Water2025 Challenge Grant Program for Western States†	Federal	Bureau of Reclamation		Up to $250,000 for projects that can be completed within 24 months and that reduce conflicts through water conservation, efficiency, and markets
Water Conservation Field Services Program†	Federal	Bureau of Reclamation		Up to $25,000 for projects that improve water use efficiency and improve water management practices
WaterSMART – Drought Response Program*	Federal	Bureau of Reclamation		Provides for contingency planning, resiliency projects, and emergency response actions.
Watershed Processes and Water Resources†	Federal	USDA		$100,000 available. Sponsors research that address two areas: (1) understanding fundamental watershed processes; and (2) developing appropriate technology and management practices for improving the effective use of water (consumptive

Name	Level	Source Agency	Managing State Agency	Purpose of Funding
				and nonconsumptive) and protecting or improving water quality for agriculture and forestry production
Watershed Processes and Water Resources – National Research Initiative Standard Research (Part T)†	Federal	USDA		$500,000 available. Innovative research in understanding fundamental processes that affect the quality and quantity of water resources at diverse spatial and temporal scales, ways on improving water resource management in agriculture, forested, and rangeland watersheds, and developing appropriate technology to reach those goals.
Deadwood Grant	State	SHPO	SHPO	Awarded to projects that retain, restore, or rehabilitate historic buildings, structures, and archaeology sites for commercial, residential, or public purposes.
Drinking Water State Revolving Fund†	State	DENR	DENR	Funds projects that improve water use efficiency and improve water management practices. Interest rates and terms are 2.25% for up to 10 years or 3.0% for 11-20 years.
Small Community Planning Grant Program	State	DENR	DENR	The Small Community Planning Grant Program was established to promote a proactive approach to water and wastewater infrastructure management. The grant is available to systems serving a population of 2,500 or fewer.
South Dakota Department of Agriculture (SDDA)	State	SDDA	SDDA	The state fire suppression special revenue fund primarily pays for firefighting activities, but can also fund fire prevention activities.
South Dakota Department of Game, Fish and Parks (GF&P)	State	GF&P	GF&P	GF&P implementation of shelters in state park facilities
South Dakota Office of Emergency Management (OEM) funding	State	FEMA, Others	OEM	Hazard Mitigation Grant Program Pre-Disaster Mitigation Grant Program Flood Mitigation Assistance Public Assistance Section 406 Increased Cost of Compliance Coverage Emergency Management Performance Grant
State Water Plan†	State	DENR	DENR	Large costly water projects that are seeking significant state cost share participation must be identified on the

Name	Level	Source Agency	Managing State Agency	Purpose of Funding
				State Water Resources Management System portion of the State Water Plan.
Water and Wastewater Funding	State	DENR	DENR	Projects requesting funding must be on the State Water Facilities Plan
James River Water Development District	Local	JRWDD		The James River Water Development District participates in the planning and implementation of programs and projects that support the restoration of the James River Watershed and ecosystem.
Local Government Funding	Local	Local Government		Local government funding could be leveraged as partial or complete funding for mitigation.
Resource Conservation and Development (RCD) Councils	Local	RCDs		RCDs provide leadership and assistance to communities, local units of government, and individuals to conserve the natural resources, improve the environment, and develop economic opportunities.
School Districts	Local	School Districts		District funding could be leveraged for tornado safe room projects.
Siouxland Interstate Metropolitan Planning Council (SIMPCO)	Local	SIMPCO		SIMPCO serves over 75 local governments, special districts, school districts and non-profit organizations in the Tri-State area. SIMPCO partner with local governments in long-range planning, community development activities, and professional regional program management, which foster intelligent growth, economic development, and safe, accessible transportation.
American Red Cross	Private	Red Cross		The Red Cross provides training and tools to assist local responders and citizens in the aftermath of a disaster. They provide information for homeowners on protecting their properties from future damage, and supply resources for mold remediation after a flood, which helps mitigate against future health problems. .
CoBank	Private	CoBank		CoBank is a national cooperative bank serving vital industries across rural America. The bank provides loans, leases, export financing and other financial services to agribusinesses and rural

Name	Level	Source Agency	Managing State Agency	Purpose of Funding
				power, water and communications providers.
National Rural Utilities Cooperative Finance Corporation (CFC)	Private	CFC		CFC is a nonprofit finance cooperative that provides industry expertise, flexibility and responsiveness to serve the needs of rural electrical utilities, to include long-term shelf financing for electric infrastructure, emergency lines of credit for power restoration after disasters, specialized financing including loan syndications and loan resales through Farmer Mac and other partners, strategic planning and financial analysis, and financial education and training.
Private Electric Companies	Private	Electric Companies		
Rural Electric Cooperatives (RECs)	Private	RECs		The RECs have invested significant funding into line hardening, to include meeting matching funds for HMA-funded projects.
South Dakota Electrical Council*	Private	Electrical Council		The South Dakota Electrical Council is a non-profit organization supporting the electrical industry in South Dakota. While not typically a source of direct funding, they are an important resource and a critical partner.
South Dakota Rural Electric Association (REA)	Private	REA		SD REA provides leadership, training, communication, legislative representation, and other services to member electric cooperatives. While not typically a source of direct funding, they are an important resource and a critical partner.
Rural Water Systems (RWS)	Private	RWSes		
Water Development Districts (WDDs)*	Private	WDDs		

5.3.1 Hazard Mitigation Assistance (HMA) Program

The primary source of funding for South Dakota's mitigation activities is FEMA's Hazard Mitigation Assistance (HMA) program. The HMA program consists of three grants: the Hazard Mitigation Grant

Program (HMGP), the Pre-Disaster Mitigation (PDM) Program, and the Flood Mitigation Assistance (FMA) Program. These three grants are described in detail in the following sections.

OEM recognizes their regulatory responsibilities for all HMA grants: The state, serving as recipient, has primary responsibility for project management and accountability of funds as indicated in 2 CFR Part 200. The state is responsible for ensuring that subrecipients meet all program and administrative requirements.

OEM is committed to monitoring and providing technical assistance to all eligible and funded subrecipients. The SHMO, project manager, and/or technical support staff attend subrecipient meetings to ensure the policies and procedures are explained correctly. OEM has developed numerous forms, worksheets that have proven very successful; these materials can be found in the HMGP Administrative Plan and are discussed in the following section on HMGP. The OEM Program Guide breaks out local emergency management programs, including mitigation and grants management, and identifies roles and responsibilities. OEM also directs local governments to FEMA's *Local Mitigation Planning Handbook and Review Guide* as well as multiple hazard data resource websites.

For specifics on HMA grant funds awarded and expended in South Dakota, see Section 5.4.1.

Hazard Mitigation Grant Program (HMGP)

The purpose of the Hazard Mitigation Grant Program (HMGP) is to help communities implement hazard mitigation measures following a Presidential Major Disaster Declaration to reduce the risk of loss of life and property from future disasters. HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act.

South Dakota's program for managing HMGP grants is described in detail in OEM's HMGP Administrative Plan, last updated August 7, 2018, which is incorporated here by reference. The HMGP Administrative Plan details procedures and forms for:

- Identification of and Notification to Potential Applicants
- Determination of Eligibility
- Application Procedures
- Submission of Projects and Appeal of Decisions
- Project Application Review
- Financial Management
- Project Administration
- Designation of Applicant's Agent
- State-Local Assistance Agreements
- Tracking All Federal and Recipient Funds Commitment to Each Program Group
- Payment Management System Drawdown Process
- Project Evaluation
- Project Closeout Procedures

In August 2011, the SHMT approved the Home Mitigation Project Policy, establishing that acquisition projects are the only home/residence specific mitigation projects that will be funded by HMGP. The only exception is if the home is deemed to be a historical property by the State Historical Preservation Office, in which case the home is eligible for either relocation or acquisition if the home cannot be relocated. This policy also states that if a homeowner accepts mitigation funds for acquisition or relocation then they are not eligible to receive funds for the same purpose in the future. The program remains a voluntary

program for each individual homeowner and each project must have a local government entity sponsoring their application. In Day County, specifically the City of Waubay and around Bitter and Blue Dog lakes, all homes must be below the elevation of 1,811 FMSL NGVD29 in order to be eligible for acquisition or relocation.

Pre-Disaster Mitigation Grant (PDM) Program

To encourage sub-applications to the annual Pre-Disaster Mitigation (PDM) grant program, local emergency managers throughout the state are encouraged to review their local hazard mitigation plans annually and submit applications for funding as applicable. These are competitive, non-disaster specific grants. Local project sub-applications are sent to the SHMO for initial review. In the case of multiple sub-applications, they are provided to the SHMT for ranking as part of the state's overall grant submittal. OEM uploads the information into eGrants and submits to FEMA. FEMA typically notifies if the sub-applicants are successful in the national competition within 6-12 months of grant submittal.

The SHMT requires that all applications for mitigation plan funding have a minimum of two bids from qualified consultants and a brief explanation on the selection process (or bid solicitation process?). If at least two bids are not submitted with the application, no funding will be considered for the applicant until they can successfully fulfill the requirement.

Similar to HMGP, projects funded through PDM are monitored quarterly through an online FEMA-sponsored database and SMARTLINK application.

Flood Mitigation Assistance Program (FMA)

Similar to PDM, FMA funding is typically made available on an annual basis. Funding can be used for flood mitigation projects that include mitigation of at least one NFIP-insured structure, preferably multiple structures. There is a portion that can be used to fund the flood-related elements of a multi-hazard mitigation plan. South Dakota has received very little FMA funding to date. If FMA funds become available, OEM sends out notifications about flood mitigation funding to the all participating NFIP communities and all the County Emergency Managers. Eligible communities are contacted and informed of the availability of FMA funding, and related technical assistance. The state NFIP Coordinator assists these communities with development of individualized mitigation plans and ensures that communities submit viable, complete FMA applications. These applications are forwarded to FEMA for review. FEMA approved projects are monitored to ensure completion in accordance with project scope and grant agreements. Award letters and funds are distributed by the state to approved communities on a reimbursement basis.

Advance Assistance (AA)

Section 1104 of the Sandy Recovery Improvement Act (SRIA) authorized the use of Advance Assistance (AA) to accelerate the implementation of HMGP in the disaster recovery environment.. Beginning with the FY2018 grant cycle, FEMA is also authorizing AA payments for PDM and FMA grants. In all cases, AA comes from a portion of the authorized funding amount, not in addition to the approved grant amount. Requesting AA is at the state's discretion.

The state may request AA to:

- Pursue hazard mitigation opportunities early in disaster recovery;

- Develop mitigation strategies and obtain data to prioritize, select, and develop complete HMGP applications in a timely manner;
- Expedite the development of eligible applications;
- Work with sub-applicants on alternative analysis for proposed activities initially determined ineligible;
- Submit complete project applications up to or over the HMGP ceiling by the application deadline.

The state may use AA for the following activities:

- Obtain staff or resources to develop a cost-share strategy and identify potential match funding;
- Evaluate facilities or areas to determine appropriate mitigation actions;
- Incorporate environmental considerations early into program decisions;
- Collect data for Benefit Cost Analysis (BCA), environmental compliance, and other program requirements;
- Scope and prioritize hazard mitigation projects (including state coordination of local projects) to incorporate sustainability, resilience, and renewable building concepts;
- Develop hazard mitigation projects, including cost effectiveness, engineering design, and feasibility actions;
- Incorporate strategic funds management principles into mitigation project work schedules and budgets that will facilitate compliance with the legislative requirement to expend obligated funds within 24 months;
- Conduct meetings, outreach, and coordination with potential sub-applicants and community residents to identify potential participants for property acquisition and demolition or relocation projects;
- Conduct engineering design and feasibility studies for larger or complex community drainage projects or critical facility retrofits (such as for phased projects);
- Conduct hydrologic and hydraulic studies for unmapped flood zones or Approximate A Zone areas where communities propose to submit hazard mitigation projects;
- Perform professional cost estimation services to aid consistency in project budgeting across sub-applications;
- Rectify data consistency needs for other project application categories, including Environmental and Historic Preservation (EHP), cost sharing mechanisms, and work schedules; and
- Complete necessary documents for deed restricted properties such as acknowledgement of voluntary participation and the Model Acknowledgement of Conditions for Mitigation of Property in a Special Flood Hazard Area with FEMA Grant Funds for property acquisition projects.

If the state chooses to utilize the AA grant, it understands:

- A grant application form (HMGP, PDM or FMA) must be submitted to the Regional Mitigation Division Director;
- The application must identify the proposed use of funds, including costs in sufficient detail for each proposed activity and milestones for submitting completed applications to FEMA;
- AA is subject to the same cost-share requirements and Strategic Funds Management requirements as the base grant funding;
- Requests for AA must not exceed 25% of approved grant funding, or $10 million (whichever is less);
- AA is part of the approved grant funding amount (no additional funds are available for AA);

- No benefit cost analysis is required for AA prior to the release of AA funds. However, AA may provide the critical avenue of producing benefit-cost ratios to determine project eligibility.

Requirements and deliverables associated with AA and resulting HMGP applications may include:

- Documentation of AA accomplishments: the state must submit documentation to FEMA to support the accomplishment of all activities listed in the AA application;
- Submission of projects up to the grant funding amount: FEMA expects the state to submit complete project applications up to or over the available grant funding amount by the final project application deadline;
- Accounting for use of AA funds: For accounting and audit purposes, the state must submit sufficient financial detail to demonstrate that no costs claimed under AA are duplicated in subsequent HMGP project applications or in State Management Cost budgets;
- Documentation of environmental considerations: The state must document that effects to the environment and historic resources were considered early in planning and project scoping processes. This requirement is in addition to ensuring environmental compliance.

Prior to 2018 South Dakota has not applied for AA funding. For the Pre-Disaster Mitigation 2018 grant cycle, the mitigation staff is working with engineering firms to provide guidance and assistance to have sub-applicants apply for AA funding to complete hydrologic and hydraulic studies to assist in their project scoping activities.

5.3.2 Other FEMA Grants Programs

Public Assistance Program Section 406 Funding

South Dakota also uses FEMA's Public Assistance (PA) Program Section 406 funding to implement mitigation activities following a declared disaster. See Section 5.4.6 below for details.

Emergency Management Performance Grant (EMPG)

Many mitigation activities are eligible expenses under the Emergency Management Performance Grant (EMPG) and are allowed by the state. A good example is OEM's use of EMPG funds to complete the 2016 HIRA Update, as described in Section 2.

State Homeland Security Grant Program (SHSGP)

The State Homeland Security Grant Program (SHSGP) is able to fund many mitigation activities as long as they have a viable nexus to terrorism. As examples, South Dakota has used $1,725,373 of SHSGP funds to purchase 54 generators, 28 transfer switches, and 62 outdoor early warning sirens since 2012.

5.4 Effective Use of Available Mitigation Funding

44 CFR Part 201 Enhanced Plan Requirement:

Enhanced State Mitigation Plans must include…Documentation of the State's project implementation capability, identifying and demonstrating the ability to implement the plan, including:

A system to determine the cost effectiveness of mitigation measures, consistent with OMB Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, and to rank the measures according to the State's eligibility criteria.

Demonstration that the State has the capability to effectively manage the HMGP as well as other mitigation grant programs, including a record of the following:

Meeting HMGP and other mitigation grant application timeframes and submitting complete, technically feasible, and eligible project applications with appropriate supporting documentation;

Preparing and submitting accurate environmental reviews and benefit-cost analyses;

Submitting complete and accurate quarterly progress and financial reports on time; and

Completing HMGP and other mitigation grant projects within established performance periods, including financial reconciliation.

A comprehensive description of how the State integrates mitigation into its post-disaster recovery operations.

The State of South Dakota is committed to making the most effective and efficient use of available FEMA mitigation funds. As discussed in Section 4.6.1 the state advertises when funds are available, solicits input from local governments and tribes regarding needed mitigation projects, actively encourages and assists with project applications, and helps cover a portion of the local matching funds when possible. The state has also made local and tribal hazard mitigation plans a priority so that communities are eligible to apply for FEMA mitigation funding.

5.4.1 Demonstrated Use of Mitigation Funding

The state has been very effective at using the maximum available mitigation funds following presidential disaster declarations. Table 5-9 summarizes the amount of HMGP grants awarded to the State of South Dakota and jurisdictions within for disasters from 2010-2017.

Table 5-9 Status of Recent HMGP Grants in South Dakota

Disaster #	Disaster Year	Total Federal Share	Obligated	% Spent
1887	2010	$10,373,424	$9,243,656	89%
1914	2010	$446,241	$418,576	94%
1915	2010	$3,504,883	$2,780,704	79%
1929	2010	$112,904	$112,780	100%
1938	2010	$730,065	$135,660	19%
1947	2010	$176,014	$173,937	99%
1984	2011	$8,215,282	$7,676,674	93%
4115	2013	$1,175,629	$1,175,629	100%
4125	2013	$179,300	$179,449	100%
4137	2013	$178,146	$175,481	99%
4233	2015	$472,182	$472,182	100%
4298	2017	$1,493,505	$1,489,851	100%
	Total	**$27,057,575**	**$24,034,579**	**89%**

Up through 2011, the state only spent an average of 87% of available mitigation funds. This was largely because mitigation staff would input enough applications to reach the HMGP ceiling; when projects were deemed ineligible, partially eligible, or came in under budget, the resulting remaining funds often had to be returned to FEMA. Starting with DR-1984, staff began submitting additional applications to account for potential project attrition; and beginning with DR-4115, OEM staff have submitted project applications worth twice the amount of available funding. Since this policy went fully into effect with DR-4115, the state has spent 99.8% of available HMGP funds. While this practice does create additional work for OEM staff and local governments, unfunded project applications are retained on file for future funding opportunities.

The amount of PDM funding the state has received since 2010, and the types of projects that have been funded by the PDM Program, are listed in Table 5-10 and Table 5-11.

Table 5-10 PDM Grants in South Dakota, 2010-2017

Grant #	Total Project Funding
PDM2010	$502,803
PDM2013	$88,679
PDM2014	$247,801
PDM2015	$148,936
PDM2016	$415,778
PDM2017	$806,416
Total	**$2,210,413**

Table 5-11 Types of PDM-Funded Mitigation Projects, 2010-2017

Grant #	Total Project Funding
Power Line Hardening	$466,383
Plan Updates	$440,286
Drainage Projects	$412,033
Shelters/Safe rooms	$335,689
Property Acquisition/ Relocation	$210,292
Management Costs	$204,841
Roofing Projects	$140,887
Total	**$2,210,413**

To ensure maximum use of available funds, the state maintains a backlog of "shovel-ready" projects it can fund if "new" project applications are not sufficient. Primarily among these are power line burial projects associated with the Rural Electric Cooperatives (RECs). As discussed in Section 4.4.11, the RECs have been very proactive about hardening their systems by burying power lines and similar tasks. While the bulk of this has been accomplished with the RECs' own funding, the state assists with grant funding whenever possible.

The state has completed a wide variety of mitigation projects over the years, as summarized in Table 5-12, and show in Figure 5-2. The SHMT ensured that all Goals and Objectives were addressed by at least one mitigation action, and that all hazards identified in the HIRA were addressed by at least one mitigation action. South Dakota has also been proactive about using mitigation funds to acquire properties located

in hazard areas and either relocating or converting them to different uses with reduced vulnerability, as shown in Table 5-13.

Table 5-12 Summary of Mitigation Projects Conducted by Project Type, 2015-2018

Project Type	#
Acquisition of Private Real Property (Structures and Land) -- Riverine	15
Relocation of Private Structures-Riverine	5
Retrofitting Private Structures - Wildfire	1
Safe Room (Tornado and Severe Wind Shelter) - Public Structures	25
Vegetation Management - Wildfire	6
Shoreline Stabilization (Riprap, Etc.)	13
Utility Protective Measures (Electric, Gas, Etc.)	756
Water and Sanitary Sewer System Protective Measures	23
Infrastructure Protective Measures (Roads and Bridges)	13
Infrastructure Protective Measures (Roads and Bridges); 403.1: Stormwater Management - Culverts	4
Infrastructure Protective Measures (Roads and Bridges); 403.1: Stormwater Management - Culverts; 403.4: Stormwater Management - Detention/Retention Basins	1
Stormwater Management - Culverts	29
Stormwater Management - Diversions	13
Stormwater Management - Flapgates/Floodgates	5
Stormwater Management - Detention/Retention Basins	8
Other Minor Flood Control	8
Flood Control - Dam	2
Warning Systems; 601.1: Generators	7
Warning	15
Generators; 602.1: Other Equipment Purchase and Installation	1
Generators	30
Generators - Regular	4
Other Equipment Purchase and Installation	8
N/A - No Name - No Info	6
TOTAL	**998**

Table 5-13 Properties Acquired or Relocated Out of Hazard Areas

Disaster/Grant	Properties Acquired	Properties Relocated
1886	0	1
1887	33	0
1915	25	2
1984	5	1
4186	0	1
4233	2	0
PDM 2016	1	0
PDM 2017	0	1
Total	**66**	**6**

OEM tracks the location and status of all FEMA-funded mitigation projects using a geo-located database that can be viewed and queried in an online map server. This database began in 2013 using Google Earth, and in 2015 was migrated to OEM's GIS layer and an online web-map. The database is updated following the award of mitigation projects through with the HMA program (PDM, FMA or HMGP) and is located at: http://sdemergencymgmt.maps.arcgis.com/apps/webappviewer/index.html?id=65b3fa57815f45b5ac828d371fc94f76. This database provides the foundation for tracking losses avoided and mitigation effectiveness, which is described further in Section 5.4.2. Sample maps from this database are below.

Figure 5-1 Mitigation Projects by Federal Share Obligated in South Dakota, 2018

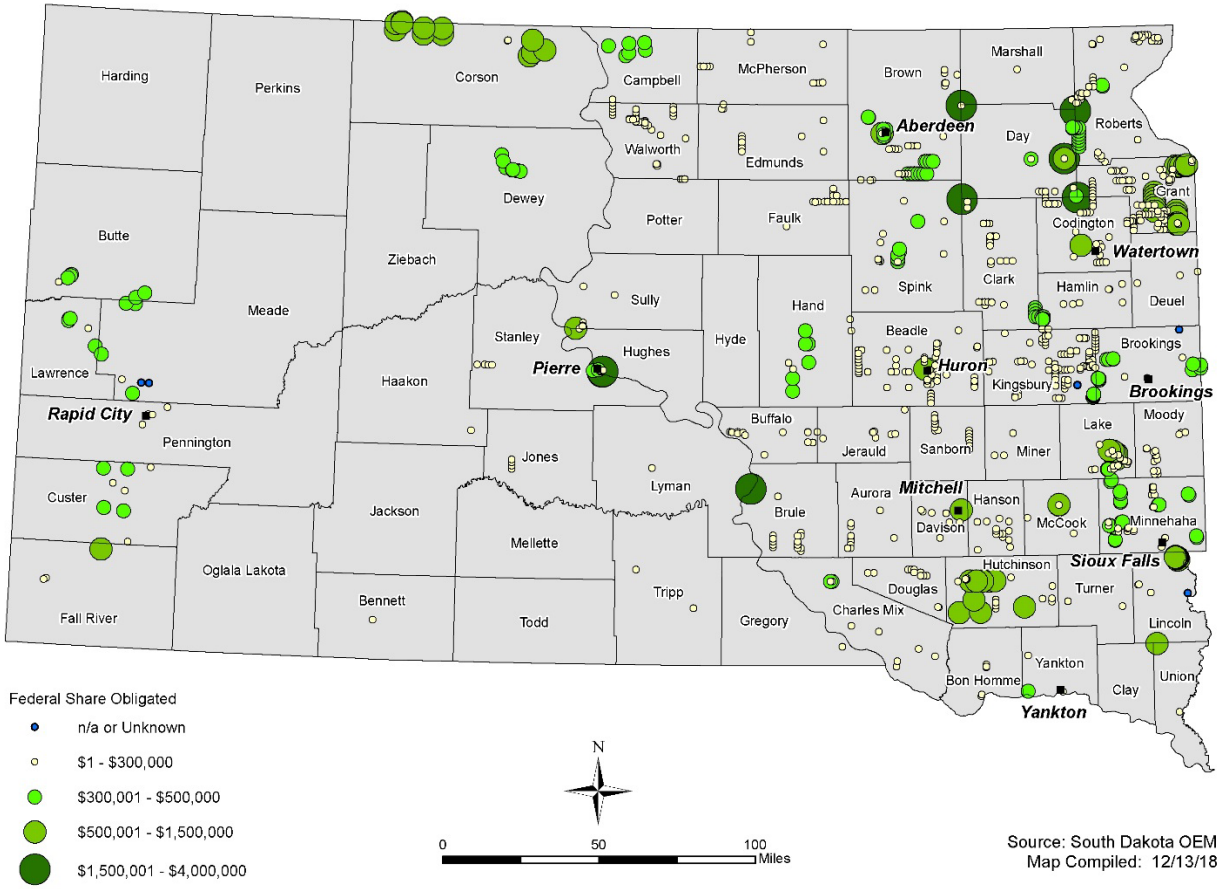
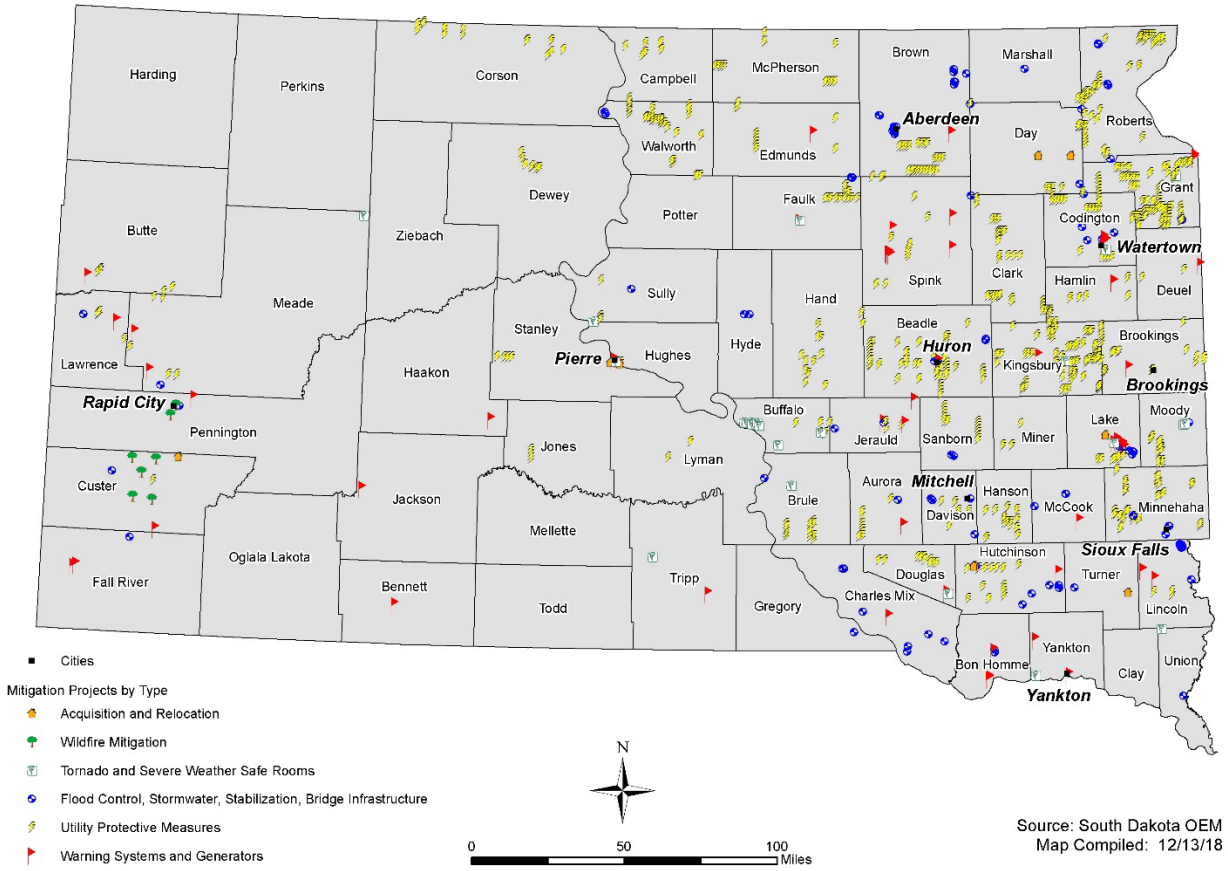


Figure 5-2 Mitigation Projects by Type of Project, 2018



5.4.2 Subgrant Application Review and Prioritizing

Following a disaster declaration, OEM provides a notice of funding availability in accordance with the procedures outlined in the state's HMGP Administrative Plan. PDM & FMA grants generally follow similar procedures as deemed appropriate by OEM and the SHMT. This includes requesting a notice of interest from potential sub-applicants that includes a brief project description, location, work schedule, cost estimate, and explanation of how the proposed project solves or mitigates a problem. Following receipt of notices of interest, initial eligibility is determined by OEM. Upon completion of initial eligibility review, full project applications are then requested from sub-applicants with eligible hazard mitigation projects.

Upon receipt of each completed sub-application, OEM reviews the submitted documents to ensure that adequate information has been provided and that the projects will meet the minimum criteria as defined by 44 CFR §206.434 and §206.436. Following the project's document review, and any site visits or meetings with sub-applicants deemed necessary; OEM conducts final preparation of the selected sub-applications for submittal to FEMA. OEM will prioritize sub-applications in a manner consistent with the guiding principles and project weighting described in the HMGP Administrative Plan. Unlike PDM and FMA prioritization, however, HMGP prioritization may happen multiple times during the 12 month application period due to the urgency of a post-disaster environment in affected communities.

The SHMT objectively reviews a project application in terms of federal criteria and the pre-determined state goals (such as the mitigation actions prioritized in Section 5.2). They look at the priority level of the

project type, review the benefit cost analysis, and determine whether the project will help achieve the state's identified goals and objectives. Much of the focus over the last several years had been on power line burials; however, the SHMT is working to encourage a more diverse range of project types.

As noted in Section 5.2.1, the SHMT used the STAPLE/E Selection Criteria to prioritize the state's mitigation actions. These criteria are also referred to during review of project applications.

Prior to a potential mitigation project advancing to the prioritization stage it must first meet the eligibility criteria of the funding source. This first requires determining if the project is being submitted by an eligible applicant. OEM's HMGP Administrative Plan, Section VIII, details applicant eligibility for HMGP projects; other grant streams may have different eligibility requirements.

Assuming the applicant is eligible to receive grant funds, the project itself must then be screened for eligibility, based on any of the following:

- The specific disaster situation
- The degree to which a project addresses known hazards
- Location of affected areas
- Availability of funds
- Unique program requirements of the funding source
- Current state and/or local hazard mitigation priorities
- Number/type of mitigation projects submitted by local governments

Eligibility criteria will vary depending on the source of federal or state funding. For example, all hazard mitigation projects submitted for HMGP funding consideration must meet the criteria outlined in 44 CFR §206.434, and reiterated in the HMGP Administrative Plan, Attachment B. To meet FEMA's minimum hazard mitigation project eligibility criteria, the project must:

- Have significant beneficial impact(s) on the declared disaster area (project may be located outside the disaster area)?
- Independently solve the problem are a functional part of a larger project where there is assurance that, as a whole, the larger project will be completed?
- Substantially reduce the risk of damage, hardship, loss, suffering, or death which would result from a future disaster?
- Apply to a repetitive problem, or one that poses a significant risk if left unresolved?
- Contribute to the long-term solution of the problem?
- Show affordable operation and maintenance costs which the local jurisdiction is committed to support?

The SHMT further screens all proposed projects to ensure they align with the goals and objectives of the mitigation program as described in Section 5.1. The SHMT reviews projects to determine if they:

- Fall within the goals and objectives of South Dakota's Hazard Mitigation Plan?
- Protect lives and reduce public risk?
- Reduce the level of damage vulnerability in existing structures and developed property?
- Avoid inappropriate future development in areas that are vulnerable to the hazard(s)?
- Show development and implementation of state or local comprehensive programs, standards, and regulations that reduce future damage?
- Provide a long-term mitigation solution in locations which experience repetitive damage?

- Reduce the number of vulnerable structures through acquisition, relocation, or retrofitting?
- Address secondary damage issues (such as landslides resulting from floods or wild fire)?
- Protect or restore wetlands and floodplains?
- Restore or protect natural resources, recreational areas, open space, or other environmental values?
- Improve the capability or effectiveness to: report time-sensitive information, relay information, or warn the public?
- Improve the capability of state agencies and county or local governments to exchange time-sensitive information during the disaster?
- Increase public awareness of the hazard(s), preventive measure(s), and emergency response(s) to the hazard(s)?

Further details regarding the State of South Dakota's policies on providing funding are explained in the Hazard Mitigation Grant Program Administrative Plan.

5.4.3 Mitigation Program Management Performance and Capability Enhancements

Table 5-14 lists the HMA Grants Management performance requirements and a summary of the general best practices implemented by OEM to meet program requirements.

Table 5-14 HMA Grant Management Performance Requirements and Best Practices

HMA Program Management Performance Requirements	Review Element	State of South Dakota Activities and Best Practices
All applications and amendments are submitted by the end of each program's respective application period.	E6.a	All HMGP sub-applications are submitted to FEMA through the National Emergency Management Information System (NEMIS) within 12 months from the date of the disaster declaration. All FMA and PDM applications are submitted to FEMA through the eGrants system within the application cycle.
All applications were entered into FEMA's electronic data systems (such as, NEMIS and/or eGrants).	E6.b	See above
Eligibility and completeness checklists are prepared for all applications.	E6.c	As a standard practice of OEM, all scoping letters and responses are submitted with each application.
All applications are determined to be complete by FEMA within 90 days of submittal or selection for further review.	E6.d	OEM Mitigation Section works closely with sub-applicants to completely respond to Requests for Information (RFIs) to ensure they are complete and no additional RFIs will be requested.
All applications and amendments … including all data requested by FEMA to support cost effectiveness determinations and environmental/historic preservation compliance reviews.	E7	FEMA's Environmental Review & Historic Preservation Compliance Checklist is submitted with each application. OEM Mitigation Section carefully reviews BCAs to ensure completeness and all supporting documentation is included
All progress reports were submitted complete and on time. Information in reports must accurately describe	E8.a	OEM Mitigation Section has consistently achieved a score of 95% and above in FEMA's Quarterly Progress Report Scorecard which

HMA Program Management Performance Requirements	Review Element	State of South Dakota Activities and Best Practices
grant activities, including data related to the completion of individual property acquisitions.		evaluates timeliness, completeness and reasonableness of submitted quarterly reports.
All federal financial reports (FFR), Standard Form (SF) SF-425 were submitted on time. Information in reports must accurately describe grant activities, as described in the HMA Guidance.	E8.b	As the Mitigation Section continues to consolidate request for reimbursement reviews across all programs (CDBG-DR, HMGP, PDM, FMA, PA) standard operating procedures will continue to be developed and implemented across these programs.
State consistently complied with the Financial Management Standard requirements described in 2 CFR §200.300 to §200.309.	E8.c	The OEM Mitigation Section requires subrecipients to follow state bid laws and procurement standards and encourages subrecipients to contact the Procurement Technical Assistance Center to assist in any procurement questions/concerns.
All work as part of HMA subawards was completed by the end of Period of Performance.	E9.a	OEM Mitigation Section works closely with subrecipients to ensure work will be completed within the allotted Period of Performance (POP) through proactive communication, monitoring of project milestones outlined in the project application, review of quarterly reports, and monitoring of project expenses submitted to date.
There were no major findings on single audits obtained by the state related to HMA programs.	E9.b	The State Department of Legislative Audit will perform regular auditing of the HMA Administered programs as programmatically required. Should any findings be identified as a result of this auditing those will be shared with FEMA Region VIII and a performance plan will be developed to address any concerns as needed.
All grant close-out activities, including financial reconciliation, were completed within 90 days from the end of the performance period.	E9.c	OEM has closed out all plans, projects and grants within 90 days of the end of the period of performance as required.
Actual expenditures have been documented and are consistent with SF-424A or SF-424C.	E9.d	During quarterly reporting and at grant closeout, subrecipients are required to submit invoices and copies of checks or other pay instruments to demonstrate proof of payment consistent with SF-424A/424C before any reimbursements are processed.

As part of this Enhanced Planning process, OEM evaluated their grants management performance to identify areas for improvement. Staff identified the most challenging management issues as being:

- Receiving complete applications from sub-recipients.
- Receiving complete and quantitative quarterly reports from sub-recipients.

OEM's goal is to submit complete sub-applications that do not require additional FEMA requests for information (RFIs).

- The most common RFIs have been for additional EHP clearances that usually result in a Class III archeological survey.
- RFIs are occasionally requested for additional documentation to support the BCA.

Therefore, OEM is implementing a number of improvements to grants management capabilities, including:

- Having an open application period all year long with established individual funding opportunities for each separate Notice of Funding Opportunity/HMGP disaster.
- Establishing an earlier application deadline to allow OEM staff to send RFIs for the sub-recipients to provide missing information.
- Continuing to foster enhanced technical assistance from project scoping/development, application, and grant award, through project oversight and closeout.

5.4.4 Integration of Mitigation into Post-Disaster Recovery Operations

FEMA's Section 404 hazard mitigation and Section 406 hazard mitigation grants both provide post-disaster mitigation assistance. However, they are distinct programs with key differences in their scope, purpose and funding.

Section 406 grants are attached to Public Assistance (PA) program projects. 406 funding is used to support mitigation measures in conjunction with repair of disaster-damaged facilities and is limited to declared counties and eligible damaged facilities. Section 406 is applied on parts of a facility that were damaged by the disaster, and the mitigation measures must directly reduce the potential of future, similar disaster damages to an eligible facility.

FEMA uses a Project Worksheet (PW) (FEMA Form 90-91) to document details of the project, including a detailed description of the disaster-related damage, dimensions, and the associated scope of work (SOW) and costs. For those projects with a total cost below the established minimum project threshold as established by FEMA each fiscal year ($125,500 for 2018), the project is termed "small" and may be developed by the individual applicant, subject to a validation process by FEMA. Once FEMA obligates a small project, FEMA does not adjust the approved amount of an individual small project. The federal cost share is also funded in full, based on the cost estimate, at time of obligation. For those projects with a total cost greater than the established minimum project threshold, the project is termed a "large" project and is funded based on documented actual costs for eligible work. Incorporation of mitigation measures into each of these PA projects is possible in many instances. Mitigation measures must be cost effective, which includes not exceeding 15% of the total eligible repair cost or not exceeding 100% of the total eligible repair cost of a pre-approved mitigation measure, as provided in FEMA Guidance document FP-104-009-2 Public Assistance Program and Policy Guide, Appendix J.

Section 404 grants are used to reduce future risk or reduce damages in facilities that were not damaged in the declared disaster. The entire state - not only presidentially declared counties - may qualify for 404 mitigation projects. The 404 grant is managed by the state under funding provided via HMGP. Section 404 grants may be used in conjunction with 406 mitigation funds to bring an entire facility to a higher level of disaster resistance, when only portions of the facility were damaged by a declared disaster event.

As discussed in Section 4.3.6, The State Disaster Recovery Plan addresses the importance of mitigation in post-disaster recovery. The Community Planning and Capacity Building function places "an emphasis on integration of hazard mitigation throughout the continuum of pre- and post-disaster recovery planning and implementation." As the Primary Entity, OEM is tasked to aid communities in identifying mitigation opportunities through hazard risk assessments within local hazard mitigation plans.

The underlying guiding principle of OEM's Public Assistance recovery delivery is that every project slated for repair under the PA program should be reviewed for potential inclusion of 406 mitigation. Lessons learned from recent disasters were leveraged in the development of these guidelines. Maximizing the use of 406 funds is also a standard objective included in all state Incident Action Plans.

OEM strongly encourages local communities to adopt codes and standards that reduce hazard exposure to infrastructure and development. This initiative has a twofold impact; first, new development and infrastructure will be less likely to be impacted by disasters when they occur. Additionally, in instances of federally declared disasters FEMA's Public Assistance program will cover the costs to repair the structure according to adopted codes and standards so long as those are uniformly applied by communities prior to a disaster.

Table 5-15 below summarizes the number of projects and amount of mitigation funding associated with Section 406 from disasters in 2010-2018.

Table 5-15 FEMA Public Assistance Section 406 Project & Mitigation Funding: 2010-2018

DR#	Type	Year	Damage Category	# of PW's	Total
4298	Winter Storm	2016	F	15	$2,268,759
4233	Flooding	2015	C	14	$117,882
4186	Tornado/Flooding	2014	C	48	$340,282
4155	Winter Storm	2013	F	24	$5,784,998
4137	Flood	2013	C	7	$30,141
4125	Flood	2013	C	19	$31,164
4115	Winter Storm	2013	F	1	$245,759
1984	Flood	2011	C	98	$745,578
1947	Flood	2010	D+E	8	$86,870
1938	Flood	2010	C	14	$712,318
1929	Tornados/Flooding	2010	C	4	$71,426
1915	Flood	2010	C	102	$294,124
1914	Winter Storm	2010	F	4	$381,044
1887	Winter Storm	2010	F	297	$9,596,751
				Total	**$20,707,096**

5.4.5 Determining Cost-Effectiveness of Proposed Mitigation Measures

A key criterion for mitigation projects to be eligible for funding is that they must be cost-effective. The primary method of estimating the cost-effectiveness of a proposed mitigation action is by conducting a Benefit Cost Analysis (BCA).

In order to ensure a consistent approach in determining the cost-effectiveness of all mitigation projects, South Dakota uses FEMA's BCA module and process, which is consistent with OMB Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs. A BCA assesses a mitigation

project based on the project, hazard, and benefit data provided in a grant application. OEM encourages applicants to pre-screen their proposed mitigation projects by using an upper-bound analysis, so an early determination of cost-effectiveness can be made. Upper-bound analyses are also used to identify projects that are not cost-effective.

As discussed in Section 4.3.5, Hazard Mitigation Training Program, OEM periodically conducts trainings and workshops for local and tribal governments on mitigation grants processes, to include how to conduct a BCA. OEM also provides technical assistance on BCAs to sub-applicants who may not be familiar with the process.

A positive benefit-cost ratio (greater than one) does not necessarily guarantee that a hazard mitigation project will be approved. However, by applying project specific information to the BCA module, it is possible to get a good look at the mitigation potential associated with a project. The results of this analysis can also help communities evaluate current and future mitigation projects and adjust their overall mitigation strategy accordingly.

The SHMT requires a BCA be completed for all mitigation projects seeking funding through from FEMA. All state agencies are further encouraged to complete BCAs for internally-funded projects to ensure consistency across the program. A completed BCA helps evaluate the effectiveness not just of the individual action, but of the overall mitigation program, and provides feedback to inform mitigation strategy updates.

The following section summarizes the three-step process used to determine a mitigation project's cost-effectiveness.

Step 1 - Screen Project Application Data

The first part of the process is screening the project application to gather data related to cost-effectiveness, to include economic, environmental, and engineering data. Because this data is often limited or unavailable, the amount of data available often determines the type of benefit-cost analysis used. The screening process involves three separate but related tasks. Each task is conducted simultaneously and is essential to developing an overall profile of the project before conducting the benefit-cost analysis.

- Engineering Review: This review, conducted by the applicant, establishes whether the project is feasible from an engineering standpoint and whether it will reduce damage as claimed. The reviewer may suggest changes to make the project more efficient in reducing damage and loss.
- Environmental Assessment: This part of the screening process alerts reviewers to any potential environmental concerns raised by the project.
- Project Application Data Review: This part of the screening process determines whether the application contains sufficient information and data for input into the benefit-cost model.

Table 5-16 shows the type of data that must be obtained from mitigation project applications in order to conduct a BCA. The examples below are key data used for analyzing flood, tornado, and wildfire hazard mitigation projects. Nevertheless, the same basic information and analysis is needed for mitigation projects related to any type of hazard.

Table 5-16 Examples of Key Data Needed for Analyzing Project Applications

Subject	Flood Project Data	Tornado Safe Room Project	Wildfire Project Data
Hazard Data (often not included in application)	Flood insurance study data or historical flood data from application	Windspeed Zone	Average Burn Recurrence Interval from state and local fire hazard maps or FEMA BCA tool
First Floor Elevation	Is this available from engineering surveys or can it be estimated from observed flood depths?	Not applicable	Not applicable
Scope	What problem does the project address? How vulnerable is the building, item, or area?	Same as flood	Same as flood
Cost	Is there a well-documented cost-estimate or only a rough estimate?	Same as flood	Same as flood
Useful Lifetime	How long will the project provide protection (mitigation) against damage and losses?	Same as flood	Same as flood
Economic Considerations	What is the square footage of the building? What are the replacement values of the building (or other facility) and contents?	Not applicable	Same as flood
Occupancy	Not usually applicable	Occupancy by hour	Not usually applicable
Function	What is the function of the facility and is it entirely or partially related to emergency response and recovery?	Same as flood	Same as flood
Damage Estimates - With Mitigation	What type of building is it? Why does damage occur? What is the historically-observed damage?	Not applicable (life safety mitigation)	Value of timber to be sold within proposed project area, and Fire suppression costs for one typical fire event within proposed project area
Damage Estimates - Without Mitigation	How effective will the mitigation project be in reducing future damage? (Reduced damage can be percent or dollar values)	Not applicable (life safety mitigation)	Same as flood

Step 2 - Conduct a Benefit-Cost Analysis

The second part of the process is determining which BCA tool to use based on the results of Step 1. If the data in the project application is more or less complete, then a more robust method of analysis can be used. For project applications with incomplete or limited data, FEMA has developed a streamlined process for determining project cost-effectiveness without all data included.

At its most basic level, a BCA determines whether the cost of investing in a mitigation project today (the "cost") will result in sufficiently reduced damage in the future (the "benefits") to justify spending money on the project. If the benefit is greater than the cost, then the project is cost-effective; if the benefit is less than the cost, then the project is not cost-effective. The Benefit-Cost Ratio (BCR) is a way of stating whether benefits exceed projects costs, and by how much. It is figured by dividing the benefits by the costs. If the result is 1.0 or greater, then the project is cost-effective.

Example 1: The project cost is $1,000, and the value of damage prevented after the mitigation measure is $2,000. The BCR ($2,000/$1,000) is 2.0. Because the dollar value of benefits exceeds the cost of funding the project, and the BCR is greater than 1.0, the project is cost-effective.

Example 2: The project cost is $2,000, and the value of damage prevented after the mitigation measure is $1,000. The BCR ($1,000/ $2,000) is of 0.50. Because the cost of funding the project exceeds the dollar value of the benefits, and the BCR does not meet the 1.0 required for cost-effectiveness, the project is not cost-effective.

While these examples are oversimplifications, the process and the associated benefit-cost analysis calculations are basically the same for all mitigation projects. It is important to understand that benefit-cost analysis is essentially the same for each type of hazard mitigation project. The only differences are the types of data that are used in the calculations. The types of data depend on whether the project is for floods, tornadoes, or earthquakes.

Three approaches are used to determine a project's benefit-cost ratio: lower-bound analysis, upper-bound analysis, and best estimate. The lower-bound and upper-bound methods are used in many cases to make final determinations of cost-effectiveness when there is limited data. In other cases, quick screening analysis with these approaches yields inconclusive results and additional data and screening may be required. Best estimate analysis produces the most accurate results.

Lower-Bound Analysis

Lower-bound analysis is a powerful tool that can demonstrate that projects are cost-effective even if the available data is not complete. A project's cost-effectiveness can sometimes be determined by using only one or two key pieces of data. The lower-bound analysis was developed with this in mind.

The lower-bound analysis considers only some of a project's benefits (those that are the most important or those for which data exist) and ignores other benefits that may be difficult to estimate or for which data may not be available. In other words, this analysis purposely uses only a few pieces of information, and undercounts or ignores other benefits that may be gained by implementing the project. If results indicate that a project is cost-effective, then no further analysis is needed, and no additional data has to be collected. Lower-bound analyses should not be used to rank or set priorities among projects, as they only determine broadly if a project is cost-effective.

Lower-bound analysis at a glance:

- It should be used when data is incomplete.
- It can determine that a project is cost-effective.
- It cannot determine that a project is not cost-effective.
- It uses data for one or two significant benefits.

Upper-Bound Analysis

If a lower-bound analysis shows that a project is not cost-effective, then the next step is an upper-bound analysis. Sometimes an upper-bound analysis is used if, at first glance, the project appears not to be cost-effective. Like lower-bound analysis, upper-bound analysis relies on limited project data. Upper-bound analysis, however, also uses professional judgment to estimate which input data will produce the highest reasonable benefits.

It is extremely important to note that upper-bound analysis cannot determine if a project is cost-effective because it relies on the highest reasonable estimate of benefits. An upper-bound analysis can only determine whether the project BCR is less than 1.0 and thus is not cost-effective. As with lower-bound analyses, upper-bound analyses should not be used to rank or set priorities among projects.

Upper-bound analysis at a glance:

- It can only determine that a project is not cost-effective.
- It is often used as the next step if the lower-bound analysis is negative (not cost-effective).
- It is used if a project initially appears unlikely to be cost-effective.
- It uses the highest reasonable estimate of benefits for a project.
- It analyzes as many inputs as possible, assigning the highest reasonable value to each.

Best Estimate Analysis

A best estimate analysis is used when the project application data is complete or nearly complete. This analysis provides a more accurate BCR because it considers more data in the analysis. Because this method of benefit-cost analysis provides the best estimate of cost-effectiveness, it can be used to rank or prioritize competing projects.

Best estimate analysis at a glance:

- It should be used when the project application data is complete, or almost complete.
- It produces a more accurate analysis than lower-bound and upper-bound analyses.
- It determines whether a project is cost-effective or not cost-effective.
- BCR can be used for ranking or setting priorities among projects.

Step 3 - Review the Results of the Analysis

There are three possible outcomes to a benefit-cost analysis: the project is deemed cost-effective (BCR > 1.0), the project is deemed not cost-effective (BCR < 1.0), or there is not sufficient data to make a determination.

Typically, if the project is cost-effective as determined by a lower-bound or best estimate analysis, then no further analysis or additional data collection is required, and the application moves to the next level in the funding process. If the project is not cost-effective as determined by an upper-bound or best estimate analysis, then no further analysis or additional data collection is required, and the project is rejected. If the cost-effectiveness of a project cannot be adequately determined, then additional data must be collected.

5.4.6 Post-Event Determination of Losses Avoided and Project Effectiveness

Assessing the performance of hazard mitigation measures is critical to substantiate the value of mitigation efforts, and loss avoidance assessment results help assure prudent use of limited public resources. A loss avoidance assessment is a method of measuring the effectiveness of hazard mitigation projects. Projects completed in the past provide a return on investment (ROI), which communicates the value of mitigation

measures and informs future allocation of resources for the highest and best use. Assessing the performance of hazard mitigation measures is critical to substantiate the value of mitigation efforts; evaluating effectiveness of mitigation efforts also helps assure prudent use of future resources.

OEM conducts a loss avoidance assessment after each Presidential Disaster Declaration and may do so after non-declared disasters where warranted. These post-event assessments use real event data to evaluate the impacts that were prevented by completed mitigation projects. Specifically, the assessment reports dollars saved due to mitigation measures (losses avoided) and calculates a ROI by comparing the cost of the project to actual losses avoided over time.

Loss avoidance assessments demonstrate the fiscal benefits associated with mitigation activities and support sound decision making related to public funding. Moreover, this assessment provides insight that the state and local communities can use to identify effective mitigation activities, improve mitigation strategies, and increase communities' resilience to natural hazards.

This assessment is limited to evaluating losses avoided in terms of direct physical damages and displacement costs. The impacts of fatalities and injuries can be included using FEMA's Value of a Statistical Life (VSL). However, the analysis does not typically include other, less-quantifiable impacts such as loss of critical services, roadway closures, and human impacts (mental stress or lost productivity).

The methodology noted below is used to assess effectiveness of FEMA-funded hazard mitigation projects in the State of South Dakota. The process can be used for state-funded mitigation projects as well, however most departments have their own procedures to follow.

This analysis follows a 4-phase process:

Phase 1: Project Identification and Selection

When a significant hazard event occurs anywhere in the state, OEM staff will compare the location of the event to a database of completed or ongoing mitigation projects. If there is a project or projects within the impacted area, the next step is to review what data is available for the project. Project data may come from the application scope of work, BCA, or other sources.

- Review data from hazard event.
- Compare area affected by the incident/disaster to database of mitigation projects. Are there any completed or ongoing mitigation projects in the impacted area?
  - [OR] Are there any mitigation projects in areas not impacted by the incident/disaster, which could be used to extrapolate losses that could have been reduced if the incident/disaster had happened in that area?
- Is the mitigation project of a type that could potentially reduce losses from the incident/disaster?
- Was a pre-event Benefit Cost Analysis (BCA) done for the project?
- Is there adequate data for the project to calculate effectiveness?
- What was the cost of the mitigation project?

Projects that have adequate data available are advanced to Phase 2.

Phase 2: Hazard Event Analysis

OEM then reviews data on the hazard event. This information may come from a variety of sources, such as local observation, local damage assessments, NOAA-NWS reports, and field investigation. First, it must be confirmed that the hazard did in fact affect the project area. Second, was the hazard event severe enough

to have caused damage if the project had not been in place. Technical resources may be needed to support analysis of the event; for example, determining the recurrence interval of a rain or flood event. Wherever possible, effectiveness should be measured in terms of interconnected hazards rather than simply looking at one event. For example, fire mitigation efforts may also be effective at decreasing flood losses.

- Was the hazard event severe enough to have caused damage if the project had not been in place?
- Has there been an estimation on the recurrence interval of the event? (i.e. – 100-year storm, 500-year flood, etc.)

If the hazard caused damage to the project, or would have in the absence of mitigation, the project is advanced to Phase 3.

Phase 3: Loss Avoidance Analysis

If sufficient quantitative data exists, an evaluation of the project is completed to compare the damage actually sustained with the damage that would likely have been sustained without mitigation.

- Is there enough information to make a quantitative evaluation?
  - [OR] Is there enough information to make a qualitative analysis and discussion summarizing the benefits (What would have been damaged if the project had not been in place?) and effectiveness (did the project perform as intended?) of the mitigation action?
- Calculate the damage that actually occurred with the mitigation action in place, referred to as Mitigation Project Complete (MPc).
- Calculate or estimate the damage that would likely have occurred if the mitigation action had not been taken, referred to as Mitigation Project Absent (MPa).
- MPa – MPc = Losses Avoided

Note: MPa is most often calculated based on past incidents that impacted this or similar areas.

Injuries and fatalities can be incorporated into damage estimates using the Value of a Statistical Life (VSL). FEMA currently uses the following VSLs:

- Deaths: $6.6M per individual
- Injuries: $2.2M per individual

Phase 4: Project Effectiveness and Documentation

The Loss Avoided is then compared to the project cost to determine the project's Return on Investment (ROI), similar to how the Benefit Cost Ratio (BCR) is calculated in a pre-event BCA (Section 5.4.1).

$$\text{Return on Investment (ROI)} = \frac{\text{MPa} - \text{MPc}}{\text{Cost of Project}}$$

The results of this assessment should then be documented in a memorandum or other report and provided to the SDOEM Mitigation Section.

If there is not enough information to make a quantitative evaluation, a qualitative analysis and discussion can be accomplished that summarizes the benefits (general losses avoided) and effectiveness (did the project perform as intended?) of the mitigation action. The results of the loss avoidance analysis will be

documented in a memorandum and shared with SHMT members. Wherever possible, effectiveness should be measured in terms of interconnected hazards rather than simply looking at one event. For example, fire mitigation efforts may also be effective at decreasing flood losses.

5.4.7 Loss Avoidance Analysis Tool (LAAT)

The web-based, Loss Avoidance Analysis Tool (LAAT) is a database of the mitigation project data necessary to complete Phase 1 of a loss avoidance study and is a data collection tool for the hazard event data necessary to complete Phase 2 of a loss avoidance study. A prototype tool was developed as part of the 2019 SD Hazard Mitigation Plan update. A User Guide has been prepared for the LAAT website and is included as Appendix 6.

The LAAT builds upon efforts of OEM staff to track mitigation projects in a GIS database since 2013, as previously noted in Section 5.4.1. The database is updated following the award of mitigation projects through with the HMA program (PDM, FMA or HMGP). Over time the database will be expanded to include all applicable mitigation projects led or funded by state agencies, beyond those funded by HMA. The LAAT database may be updated at any time to include additional project information. In addition, FEMA PA project locations are also able to be referenced in the web map application. This can be useful for identification of areas of repetitive damages such as gravel road or culvert repairs which might benefit from hazard mitigation.

Since a loss avoidance study measures benefits of a completed project based upon an actual event the LAAT has the ability for the user to locate a hazard event by uploading a shapefile of the affected area, or drawing an approximate area on the interactive map. A storm event data collection form allows the user to input details about the event. The user can spatially select those mitigation projects within the hazard event area and do a simple export to show the calculated loss avoidance.

This information and the results of completed loss avoidance studies will be incorporated into mitigation success stories, which can be included in the following section in future updates to this plan.

5.4.8 Loss Avoidance Case Studies

Power Line Burials

The state is proud of its success in burying power lines. Since 2005, the state has spent $19.4M of HMA grant funding (primarily HMGP) to help bury power lines, while the RECs are spending on average more than $45M each year of their own money on line hardening, to include burial. Overall more than 700 miles of power lines have been buried as of late 2018.

Data provided by the RECs show that line hardening prior to the 2016 Christmas storm prevented losses estimated at $407,500 compared to damage sustained from past storm from high wind and ice accumulation. The cost of hardening/burying the specific sections affected by the storm was $783,457. This means the project has recouped 52% of its costs after just one storm; the cost savings will only continue to grow after additional storms.

Spring Creek Culverts

Lincoln County spent $1.8M of HMGP funding and local matching funds to upsize box culverts and drainage channelization on Spring Creek. Shortly thereafter the creek flooded, and the culverts performed as designed, preventing flooding in many county/township roads and the Town of Schindler as had happened in previous floods. This project led Lincoln County to remap the area; post-project hazard mapping removed all structures from the Spring Creek floodplain.

USACE Dam/Levee Projects

Through the Silver Jacket's participation in the 2018-2019 SD HMP update process the Omaha District's Chief of Flood Risk and Floodplain Management was able to provide some insight on The U.S. Army Corps of Engineers (USACE) loss avoidance studies for dam and levees in South Dakota. In summary, since 1948 USACE dams and levees in South Dakota have prevented flood losses equal to almost $189M (in 2018 dollars). This corresponds to an average of $1.2M of losses avoided annually. Improvements to the Sioux Falls levee system, completed by the City of Sioux Falls in cooperation with the USACE, removed 1,600 structures from the floodplain.

USACE Property Acquisitions and Relocations

Since 2000, largely between 2000-2003, the USACE has relocated 81 properties out of the floodplain near Pierre, and has acquired and demolished an additional 47.

City of Mitchell/Avera Queen of Peace Storm Sewer Upgrade

This project included upgrades to the currently undersized and inadequate storm drainage system serving the east central region of the City of Mitchell as well as the Avera Queen Pease Medical Campus. During higher rain events this undersized storm sewer became overwhelmed, causing the Avera Queen of Peace Hospital to activate a flood gate at the entrance of their emergency room. This would result in non-ambulatory patients being brought through the hospital from the east entrance and wheeled through the hospital to the emergency room. This $1,504,663 project installed larger storm sewer catch basins and pipes to capture and transfer the storm water from the hospital to an above ground detention basin where discharge is metered into Firesteel Creek. Since the project completion, the new storm sewer system has resulted in no loss of service for the hospital or complicated emergency room access due to heavy rain events.

SECTION 6 PLAN IMPLEMENTATION AND MAINTENANCE

6.1 Monitoring, Evaluating, and Updating the Plan

44 CFR Part 201 Requirement:
[The Standard State Plan Maintenance Process must include an] established method and schedule for monitoring, evaluating and updating the plan.
44 CFR Part 201 Enhanced Plan Requirement:
[The Plan must] must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities and resubmitted for approval to the appropriate Regional Administrator every 5 years. *[The State is encouraged to] review its plan in the post-disaster timeframe to reflect changing priorities.*

Hazard mitigation planning is a continuous and ongoing process. South Dakota is committed to maintaining an ongoing effort to monitor and evaluate mitigation program implementation and to update the plan as progress, roadblocks, or changing circumstances are recognized. Policies and procedures established in this plan reflect the current emergency management and hazard mitigation philosophy at both the state and national level. Changes in hazard mitigation programs and/or priorities, including changes in legislation and available funding, may necessitate modifications to this plan. A major disaster could also prompt modifications to this plan. Finally, the state will submit an updated Hazard Mitigation Plan to FEMA for review and approval every five years as required by DMA 2000.

As described in Section 4.2.1, the South Dakota Hazard Mitigation Team (SHMT) is the principal body responsible for coordinating the state's comprehensive hazard mitigation program. Section 4.3.1 explains the South Dakota Office of Emergency Management (OEM) Mitigation Section's role in coordinating the SHMT, and its overall responsibility to maintain and implement the SHMP.

6.1.1 Annual Review

The SHMT will meet annually to review and evaluate the status of the SHMP and the mitigation program overall. This meeting will typically be held in conjunction with one of the quarterly Silver Jackets meeting, and will review:

- Mitigation goals & objectives
- Significant hazard incidents during past year
- Any needed updates to the HIRA
- Any outdated information
- Any identified gaps in the mitigation strategy
- Changes in state, federal, local, or tribal capabilities
- Standard and enhanced plan compliance
- Status of local and tribal mitigation plan adoption
- Results of the most recent FEMA consultation visit

Additionally, OEM will meet annually with FEMA Region VIII mitigation staff to review the state's enhanced plan status and associated requirements to validate that South Dakota remains in compliance.

6.1.2 Post-Disaster Review

The SHMT will also meet following every declared disaster, although this meeting may be deferred until their next regular meeting at the SHMT's discretion. Similarly, major changes in federal mitigation programs or legislation could necessitate a special meeting of the SHMT. The purpose of the post-disaster review is to assess opportunities for mitigation projects and mitigation funding.

Approximately 2 years before this Plan is due to expire (i.e. 3 years after date of approval), the SHMT will convene to lay out a road map for the next Plan update process. The SHMT will review the process used during the 2019 update process and decide on any changes that should be made to that process for the next update.

In addition to updating this hazard mitigation plan, following every declared disaster the SHMO will coordinate an update of the state's HMGP Administrative Plan if one is needed.

6.2 Monitoring Progress and Effectiveness of Mitigation Activities

44 CFR Part 201 Requirement:
[The Standard State Plan Maintenance Process must include] *A system for monitoring implementation of mitigation measures and project closeouts* *A system for reviewing progress on achieving goals as well as activities and projects in the Mitigation Strategy*

Just as reviewing the overall mitigation program is an ongoing process, so is reviewing and evaluating mitigation actions themselves.

6.2.1 Annual Progress Assessment

The SHMT will meet annually to review and evaluate ongoing mitigation actions. This may be a separate meeting held in conjunction with a quarterly Silver Jacket's meeting, or it may be combined with the mitigation program review meeting described in 6.1. This meeting will review the Mitigation Actions Table (Section 5.2.3), adding Implementation Notes and/or Progress Notes as available. By tracking the status of actions, the state can assess progress toward plan goals, as captured in Section 5.2.4, Table 5-5 Progress on Mitigation Actions.

6.2.2 Monitoring Implementation of Mitigation Measures and Project Closeouts

OEM will continue to annually review applications for submittal for PDM grants. OEM will also maintain a list of proposed or contemplated projects that could quickly be turned into applications for new projects when HMGP funds or other grant funds become available. These applications will be evaluated and prioritized using the same process and criteria as described in Section 5.2.1, unless the SHMT elects to use different criteria.

The progress of funded projects is tracked via a quarterly reporting system. In addition, they are physically inspected every two years while under construction. The state follows project closeout procedures as outlined in the HMGP Administrative Plan. These procedures require the sub-grantee to request closeout of the project by letter addressed to the SHMO. The SHMO coordinates via letters to and from FEMA for

preparation of final notice that the project was completed in accordance with FEMA approvals. Project closeout procedures are detailed in the HMGP Administrative Plan.

The process described above focuses primarily on FEMA-funded mitigation projects, as required by grant guidance. However, the same principles apply to all mitigation activities, the progress of which will be monitored in a similar manner.

6.2.3 Post-Disaster Review of Mitigation Measures

As noted in Section 6.1 above, the SHMT will also meet following every declared disaster, although this meeting may be deferred until their next regular meeting at the SHMT's discretion. An additional purpose of this post-event meeting is to determine if any mitigation projects were impacted by the disaster, and whether or not it is possible to evaluate the effectiveness of those projects in reducing losses or damage.

The process for post-event determination of project effectiveness is detailed in Section 5.4.2.

6.3 Integrating the SHMP Into Other Plans

Section 4 discussed in detail how the SHMP is integrated with other local, state, regional, and national/federal mitigation programs. But the Plan's utility is not limited to just mitigation programs. Properly implemented, the SHMP should serve as the foundational document of the state's emergency management program. The Hazard Identification and Risk Assessment (HIRA) Section in particular helps establish the scope of the emergency management program, since everything emergency management does should relate back in one way or another to the hazards the jurisdiction faces.

The following section provides some guidance on how the State of South Dakota will use the updated SHMP to inform and improve other state plans, procedures, and programs.

6.3.1 Threat and Hazard Identification and Risk Assessment (THIRA)

The State of South Dakota Threat and Hazard Identification and Risk Assessment (THIRA) is described in Section 4.4.8. CPG201 201 "Threat and Hazard Identification and Risk Assessment (THIRA) establishes Step 1 as "Identify the Threats and Hazards of Concern" and lists HIRAs and HMPs as possible sources of threat/hazard information. While the South Dakota SHMP does not address technological or manmade hazards, for natural hazards it contains all the information needed to complete Step 1.

The criteria for selecting which Threats/Hazards are "of concern" are defined as:

- Factor #1: Likelihood of a Threat or Hazard Affecting a Community
- Factor #2: The Impacts of a Threat or Hazard

Each natural hazard profiled in the HIRA (Section 3.2) contains a section analyzing the probability of future events, which provides a data-driven answer to Factor #1. Similarly, the vulnerability assessment sections of the HIRA (3.3 and 3.4) address what impacts can realistically be expected from both routine and extreme events of each hazard, which specifically addresses Factor #2.

Step 2 of CPG 201 is to "Give the Threats and Hazards Context" by creating a scenario for each hazard of concern, with specifics like time of day, area, and magnitude of the event, which are then used to establish capability targets for each of the 32 core capabilities. All the natural hazards profiled in the SHMP contain detailed information to ensure the hazard scenarios are plausible. For some hazards, such as flood or earthquake, detailed Hazus modeling runs have been done that can easily be incorporated as THIRA

scenarios. Other hazards include details on the most extreme historical events on record that can quickly be updated to modern scenarios.

Note that while FEMA requires the SHMP be updated every five years, the THIRA is required to be updated every three years. The SHMT in coordination with the Office of Homeland Security will determine whether or not to update the SHMP's HIRA section along with the 3-year THIRA update.

6.3.2 State Emergency Operations Plan (SEOP) and Related Response Plans

As noted in Section 4.3.5, the State Emergency Operations Plan (SEOP) is organized around Emergency Support Functions that are all-hazards in nature. But the plan also contains hazard-specific incident annexes containing information and concerns specific to each hazard type. These annexes were written based on the data and analysis in the HIRA, and in most cases quote directly from the SHMP to define the hazard and the risk to South Dakota. The current SEOP (dated 2015, but updated quarterly by section) contains incident annexes for hazards identified in the HIRA. (Because the SEOP is not a public document, this Plan will not list all hazards, annexes, etc. contained in the SEOP.)

Conversely, the section pertaining to Emergency Support Function #14, Long-Term Recovery and Mitigation, specifically addresses the integration of mitigation activities into post-disaster recovery "to reduce or eliminate risk." Section 5.4.4 Integration of Mitigation into Post-Disaster Recovery Operations addresses how post-disaster mitigation will continue to address the goals, objectives, and procedures of the overall SHMP.

Several other operational or functional response plans associated with the EOP are also influenced by information contained in the SHMP. These plans include but are not limited to:

- Damage Assessment Plan: A review of Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction can help identify what areas to initially prioritize following a hazard event. Similarly, a review of Section 3.4 Assessing Vulnerability and Estimating Potential Losses of State Facilities can help identify what state-owned facilities need to be assessed following a hazard event.
- Debris Management Plan: Hazus runs conducted for earthquake and flood scenarios include an estimate of how many tons of debris would likely be generated by those scenarios. These estimates can be used as bounding limits for how much and what type of debris generation is likely to be required, as well as what areas are most likely to see heavy debris generations.
- Evacuation & Sheltering Plan: A review of Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction can help identify what areas are more likely to need evacuation in different hazard scenarios. The sections on Growth and Development and Social Vulnerability (3.3.1 and 3.3.2) can help identify not only how many people would potentially be impacted by disasters, but how many are likely to need assistance with transportation, special medical or sheltering needs, etc. This review can also help evaluate the impacts of multiple or cascading hazards, so that evacuees are not relocated into an area that puts them at risk from other hazards.

6.3.3 Recovery Plan

As noted in Section 4.3.5, the State of South Dakota Disaster Recovery Plan builds on the policies and procedures in the ESF 14 section of the SEOP described above, to ensure the most efficient and effective state coordination to assist local jurisdictions in the recovery phase of any disaster. The Recovery Plan is organized around nine Recovery Support Functions (RSFs):

- Agriculture and the Environment
- Commodity PODs
- Community Planning & Capacity Building
- Disaster Recovery Centers
- Economic Recovery
- Health & Social Services
- Housing and Other Needs Assistance
- Infrastructure Systems
- Population Reception

The FEMA publication *Pre-Disaster Recovery Planning Guide for State Governments* notes:

> "…much of the research involved in the development of mitigation plans can be used to inform the pre-disaster recovery planning effort. The State mitigation plan is a very useful starting point for research for the pre-disaster recovery plan.
>
> "The pre-disaster recovery planning process will benefit from and build upon hazard mitigation as:
>
> - The mitigation planning process identifies local hazards, risks, exposures, and vulnerabilities;
> - Implementation of mitigation policies and strategies will reduce the likelihood or degree of disaster-related damage, decreasing demand on resources post-disaster;
> - The process will identify potential solutions to future anticipated community problems; and
> - Mitigation activities will increase public awareness of the need for disaster preparedness.
>
> "Pre-disaster recovery planning efforts also increase resilience by:
>
> - Establishing partnerships, organizational structures, communication resources, and access to resources that promote a more rapid and inclusive recovery process;
> - Describing how hazard mitigation will underlie all considerations for reinvestment;
> - Laying out a process for implementation of activities that will increase resilience; and
> - Increasing awareness of resilience as an important consideration in all community activities."

Similarly, the risk and vulnerability data in the SHMP should help inform the post-disaster recovery planning process, especially by ensuring that recovery plans fully take into account the dangers posed by other hazards, rather than focusing exclusively on the most recent hazard event. Section 3.4 Assessing Vulnerability & Estimating Potential Losses of State Facilities is also a useful resource to help identify critical resources that may have been impacted by the disaster, which can help target damage assessment efforts in the immediate aftermath of the disaster.

See also Section 5.4.4 Integration of Mitigation into Post-Disaster Recovery Operations for more information on this topic.

6.3.4 Continuity of Operations Plans (COOP)

All departments and agencies of South Dakota State government are required to maintain a Continuity Of Operations Plan (COOP) that details that agency's critical functions and how they will protect those functions in order to continue to provide services during a disaster or interruption. By defining and describing the hazards facing the state, including frequency and severity, the HIRA informs agency COOP plans by giving context to what types of disasters of interruptions are most likely to occur.

Appendix 1 - Acronym Guide

AA	Advance Assistance (HMA grants)
APHIS	Animal and Plant Health Inspection Service (USDA)
ASFPM	Association of State Floodplain Managers
ASCE	American Society of Civil Engineers
ASPR	Office of the Assistant Secretary for Preparedness and Response (HHS)
BCA	Benefit Cost Analysis
BCR	Benefit-Cost Ratio
BIA	U.S. Bureau of Indian Affairs
BIT	South Dakota Bureau of Information and Telecommunications
BLM	U.S. Bureau of Land Management
BOCA	Building Officials and Code Administrators
BOR	U.S. Bureau of Reclamation
CAP	Community Assistance Program
CDBG	Community Development Block Grant program
CDBG-DR	Community Development Block Grant – Disaster Recovery
CFM	Certified Floodplain Managers
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
COOP	Continuity Of Operations Plan
CRS	Community Rating System
CTP	Cooperating Technical Partner
CWPP	Community Wildfire Protection Plan
DEM	Digital Elevation Model
DENR	South Dakota Department of Environment and Natural Resources
DFIRM	Digital Flood Insurance Rate Map
DMA	Disaster Mitigation Act of 2000
DOJ	US Department of Justice
EDA	U.S. Economic Development Administration
EMAP	Emergency Management Accreditation Program

EMPG	Emergency Management Performance Grant (FEMA)
EQIP	Environmental Quality Incentives Program (NRCS)
EPCRA	Emergency Planning and Community Right-To-Know Act
ER	Emergency Relief program (SDDOT)
ESF	Emergency Support Function
EWPP	Emergency Watershed Protection Program
FEMA	Federal Emergency Management Agency
FFR	Federal Financial Reports
FHWA	Federal Highway Administration
FMA	Flood Mitigation Assistance program (FEMA)
FMAC	Flood Mitigation Advisory Committee
FMAG	Fire Management Assistance Grants (FEMA)
GAR	Governor's Authorized Representative
GF&P	South Dakota Game, Fish and Parks
GHIPM	Grasshopper Integrated Pest Management (USA)
GIS	Geographic Information System
GOED	South Dakota Governor’s Office of Economic Development
HFIA	Homeowner Flood Insurance Affordability Act
HHS	U.S. Department of Health & Human Services
HIRA	Hazard Identification and Risk Assessment
HMA	Hazard Mitigation Assistance Grants (FEMA)
HMGP	Hazard Mitigation Grant Program (FEMA)
HPP	Hospital Preparedness Program (HHS)
HSEMSAC	Homeland Security and Emergency Management Senior Advisory Committee
HSGP	Homeland Security Grant Program (FEMA)
HUD	U.S. Department of Housing and Urban Development
IA	Individual Assistance program (FEMA)
IBC	International Building Code
LEPC	Local Emergency Planning Committee

LiDAR	Light Detection And Ranging
LOMR	Letters of Map Revision
LOMR-F	Letter of Map Revision based on Fill
LHMP	Local Hazard Mitigation Plan
MOTF	Modeling Impact Task Force (FEMA)
MPa	Mitigation Project Absent
MPc	Mitigation Project Complete
MRP	Flood Risk Map
NED	National Elevation Dataset
NEHRP	National Earthquake Hazards Reduction Program (FEMA)
NEIC	National Earthquake Information Center (USGS)
NFHL	National Flood Hazard Layer
NFIP	National Flood Insurance Program (FEMA)
NLD	National Levee Database (USACE)
NLE	Non-Levee Embankments
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resource Conservation Service (USDA)
NWS	National Weather Service (NOAA)
OEM	South Dakota Office of Emergency Management
OJP	Office of Justice Programs (U.S. DOJ)
OPHPR	Office of Public Health Preparedness and Response (SD DOH)
ORM	Office of Risk Management
PA	Public Assistance program (FEMA)
PAR	Populations At Risk
PDM	Pre-Disaster Mitigation program (FEMA)
PHEP	Public Health Emergency Preparedness Program (HHS)
POA	Plan Of Action
PUC	Public Utilities Commission
PW	Project Worksheet

RCD	Resource Conservation and Development Councils
REA	Rural Electric Association
REC	Rural Electric Cooperatives
Risk MAP	Risk Mapping, Assessment and Planning Program
ROI	Return On Investment
RSF	Recovery Support Function
RUS	Rural Utilities Service (USDA)
RWS	Rural Water Systems
SBA	U.S. Small Business Administration
SDDA	South Dakota Department of Agriculture
SD DOH	South Dakota Department of Health
SDDOT	South Dakota Department of Transportation
SDOEM	South Dakota Office of Emergency Management
SDOHS	South Dakota Office of Homeland Security
SDSU	South Dakota State University
SDPB	South Dakota Public Broadcasting
SDWF	South Dakota Wildland Fire Division (SDDA)
SEOP	State Emergency Operations Plan
SERC	State Emergency Response Commission
SF	Standard Form
SHMO	State Hazard Mitigation Officer
SHMP	State Hazard Mitigation Plan
SHMT	South Dakota Hazard Mitigation Team
SHPO	State Historic Preservation Office
SSSE	State Support Services Element
STAPLE/E	Social, Technical, Administrative, Political, Legal, Economic, & Environmental
STBG	Surface Transportation Block Grant Program (DOT)
SVI	Social Vulnerability Index
SWA	State Wildlife Area

SWOT	Strengths, Weaknesses, Opportunities, and Challenges analysis
TAP	Technical Assistance Partnership
THIRA	Threat and Hazard Identification and Risk Assessment
THPO	Tribal Historic Preservation Office
UBC	Uniform Building Code
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
VOAD	Volunteer Organizations Active in Disasters
VSL	Value of a Statistical Life
WDD	Water Development District

Appendix 2 – Enhanced Plan Compliance

4.1 Meet Required Standard Plan Elements

Element	Requirement	Section(s)	Notes
E1	The Enhanced plan must meet all the required elements of the standard state mitigation plan.	All	See Standard Plan Review Tool

4.2 Integrated Planning

Element	Requirement		Section(s)	Notes
E2a	The Enhanced plan must demonstrate integration with other state and/or regional planning initiatives		4.2, 4.3, 4.4, 2.2, 2.3	Summarized in Table 4-1 (p4-8); and described in detail in sections 4.2, 4.3 and 4.4 (pages 4-3 to 4-42). See also 2.1, 2.2 & 2.3.3 (pages 2-1 to 2-5, 2-8) for coordination during the planning process.
E2a	The Enhanced plan must demonstrate integration with...at a minimum, the following sectors:			
	1	Emergency management;	4.2, 4.3, 4.4, 5.1, 5.2.5	Summarized in Table 4-4 (p4-16) and Table 4-1 (p4-8); described in sections 4.2, 4.3, 4.4.1, 4.4.2, 4.4.3, 4.4.5, 4.4.8, 4.4.12 (p 4-2 to 4-42). See also numerous Mitigation Objectives in Table 5-1 (p5-2) and Actions identified in Table 5-7 (p5-32).
	2	Economic development;	4.2, 4.3, 4.4, 5.1, 5.2.5	Summarized in Table 4-4 (p4-16) and Table 4-1 (p4-8); described in sections 4.2, 4.3, 4.4.1, 4.4.2, 4.4.6, 4.4.10, 4.4.12, 4.4.13 (p 4-2 to 4-42), and 4.6.5 (p4-56). See also Mitigation Objectives 3.1 & 4.4 in Table 5-1 (p5-2) and Actions identified in Table 5-7 (p5-32).
	3	Land use development;	4.2, 4.3, 4.4, 5.1, 5.2.5	Summarized in Table 4-4 (p4-16) and Table 4-1 (p4-8); described in sections 4.2, 4.3 and 4.4.1, 4.4.2, 4.4.3, 4.4.4, 4.4.9, 4.4.10, 4.4.12, 4.4.13 (p4-2 to 4-42), and 4.6.5 (p4-55 to 4-56). See also Mitigation Objectives 4.1, 4.2, 4.3, & 4.4 in Table 5-1 (p5-2) and Actions identified in Table 5-7 (p5-32).
	4	Housing;	4.2, 4.3, 4.4, 5.1, 5.2.5	Summarized in Table 4-4 (p4-16) and Table 4-1 (p4-8); described in sections 4.2, 4.3 and 4.4 (p 4-2 to 4-42). See also Mitigation Objectives 2.1, 2.2, 2.3, & 2.4 in Table 5-1 (p5-2) and Actions identified in Table 5-7 (p5-32).
	5	Health and social services;	4.2, 4.3, 4.4, 5.1, 5.2.5	Summarized in Table 4-4 (p4-16) and Table 4-1 (p4-8); described in sections 4.2, 4.3 and 4.4.1, 4.4.5, 4.4.8, 4.4.13 (p 4-2 to 4-42). See also Mitigation Objectives 1.1, 1.2, & 3.2 in Table 5-1 (p5-2) and Actions identified in Table 5-7 (p5-32).

	6	Infrastructure;	4.2, 4.3, 4.4, 5.1, 5.2.5	Summarized in Table 4-4 (p4-16) and Table 4-1 (p4-8); described in sections 4.2, 4.3 and 4.4.1, 4.4.3, 4.4.6, 4.4.7, 4.4.8, 4.4.11 (p 4-2 to 4-42). See also Mitigation Objectives 2.1, 2.2, 2.3, 2.4, 3.1, 3.2, & 3.3 in Table 5-1 (p5-2) and Actions identified in Table 5-7 (p5-32).
	7	Natural and cultural resources.	4.2, 4.3, 4.4, 5.1, 5.2.5	Summarized in Table 4-4 (p4-16) and Table 4-1 (p4-8); described in sections 4.2, 4.3 and 4.4.1, 4.4.2, 4.4.3, 4.4.4, 4.4.9, 4.4.10, 4.4.13 (p 4-2 to 4-42). See also Mitigation Objectives 4.1 & 4.2 in Table 5-1 (p5-2) and Actions identified in Table 5-7 (p5-32).
E2a	Where integration with other state and/or regional planning initiatives representing these sectors is not practicable, the plan must describe the limitations.		NA	The Plan integrates with all sectors, as referenced above.
E2b	The Enhanced plan must demonstrate integration of FEMA mitigation programs and initiatives, including, if applicable, but not limited to:		5.3, 5.4.1, 4.3, 4.5.1	
		HMGP	4.3.2, 4.5.1, 5.3.1, 5.4.1, 5.4.2, 5.4.3	page 4-18, 4-43 to 4-44, 5-43 to 5-47, page 5-48 to 5-56
		PDM	4.3.2, 4.5.1, 5.3.1, 5.4.1, 5.4.2, 5.4.3	page 4-18, 4-43 to 4-44, 5-43 to 5-47, page 5-48 to 5-56
		FMA	4.3.2, 4.5.1, 5.3.1, 5.4.1, 5.4.2, 5.4.3	page 4-18, 4-43 to 4-44, 5-43 to 5-47, page 5-48 to 5-56
		NFIP	4.3.3, 4.5.1	Page 4-18 to 4-20, 4-43 to 4-44.
		CRS	4.3.3, 4.5.1	Includes Repetitive Loss Strategy & CAP-SSSE Programs. Page 4-19 to 4-20, 4-43 to 4-44.
		Risk MAP	3.3.6, 4.3.4, 4.5.1	Page 3-172, 4-20, 4-43.
		National Dam Safety Program	4.4.1 4.5.1	Page 4-23, 4-43.
		[others]	5.3.2 5.4.4	Includes PA 406 and SHSGP programs. Page 5-47, 5-56 to 5-57.

E2b	The Enhanced plan must demonstrate integration of...FEMA programs that advance mitigation, such as:			See also sections listed above for E2b(1)
		Threat Hazard Identification and Risk Assessment,	4.4.8, 6.3.1	Page 4-31, 6-3 to 6-4.
		Emergency Management Performance Grant Program	5.3.2	Page 5-47.
		PA C-G.	5.3.2, 5.4.4	Page 5-47, 5-56 to 5-57.
E2b	Where integration with FEMA mitigation programs and initiatives is not practicable, the plan must describe the limitations.		NA	The Plan integrates with all relevant FEMA mitigation programs, as referenced above.

4.3 State Mitigation Capabilities

Element	Requirement		Section(s)	Notes
E3	The plan must describe an existing comprehensive state mitigation program that might include, but is not limited to, examples listed in the mitigation planning regulation at 44 CFR §201.5(b)(4).			
		(i) A commitment to support local mitigation planning by providing workshops and training, State planning grants, or coordinated capability development of local officials, including Emergency Management and Floodplain Management certifications.	4.3.5; 4.4.14, 4.6.1, 4.6.5, 5.1, 5.2.3	Workshops & training p4-21, 4-41 to 4-42, 4-48 to 4-50, 4-54 to 4-55. State planning grants p4-49 to 4-50. Development of local officials p4-21, 4-41, 4-54 to 4-55. See also Objectives 5.1 & 6.1; and Actions 5-2, 5-3, 6-2.
		(ii) A statewide program of hazard mitigation through the development of legislative initiatives, mitigation councils, formation of public/private partnerships, and/or other executive actions that promote hazard mitigation.	4.2, 4.3.6, 4.4.1, 4.4.2, 4.4.8, 4.4.11, 4.4.12, 4.5.1, 5.1, 5.2.3	SHMT p4-3; Drought Task Force p4-4; legislative & executive actions p4-5 to 4-7; bReadySD p4-22; SERC p4-24; Big Sioux Flood Information System p4-25; Black Hills Forest Fire Protection District p4-26; Beat the Beetles Mountain Pine Beetle Control Plan p4-26; HSEMSAC p4-31; RECs p4-34; RPDs p4-35; Silver Jackets 4-44. See also Table 4-1. See also Objectives 1.2, 5.1 & 6.1; and Actions 2-1, 2-8, 4-2, 4-3, 5-4.
		(iii) The State provides a portion of the non-Federal match for HMGP and/or other mitigation projects.	4.6.1	p4-49 to 4-50.

		(iv) To the extent allowed by State law, the State requires or encourages local governments to use a current version of a nationally applicable model building code or Standard that addresses natural hazards as a basis for design and construction of State sponsored mitigation projects.	4.6.5	p4-55.
		(v) A comprehensive, multi-year plan to mitigate the risks posed to existing buildings that have been identified as necessary for post-disaster response and recovery operations.	3.3, 3.4, 5.1, 5.2.3, Appendix 3F	Critical facilities are identified for each hazard in the vulnerability assessment and summarized in 3.4 (p3-228) & Appendix 3F. See also E2a6 above. See also Mitigation Objectives 3.1, 3.2 & 3.3; and Actions 2-2, 3-2, 3-5.
		(vi) A comprehensive description of how the State integrates mitigation into its post-disaster recovery operations.	5.4.4	p5-56 to 5-57.
E3	Comprehensive state mitigation program means a broad range of state-supported initiatives and activities that:			
	1	Targets risk reduction for each of the identified hazards in the state	5.2.5, 4.2.4	Table 5-6 (p5-30); see also Table 4-3 (p4-14).
	2	Is inclusive of various state agencies and sectors with mitigation capabilities and resources	4.2, 4.3, 4.4, 5.1, 5.2.3, 5.2.5	Summarized in Tables 4-1, 4-3, 4-4, 5-6, & 5-7. Described in detail in sections 4.2, 4.3 and 4.4 (p4-3 et. al.). See also Table 5-1 Goals & Objectives (p5-2), and Table 5-4 Mitigation Actions (p5-8, Responsible Department column).
	3	Is coordinated to increase statewide resilience from the adverse impacts of future hazard events	4.2, 4.3, 4.4.14, 4.6, 4.7, 5.1.1, 5.2.5, 5.4, 6.2	See Goals & Objectives (p5-2), Comprehensive Mitigation Strategy (5-30) and Effective Use of Available Mitigation Funding (p5-48+), and Monitoring Progress (p6-2 to 6-3). See also p3-11; Climate Change Considerations section for each hazard in Section 3.2 (p3-31, 3-56, 3-68, etc); Future Vulnerability section for each hazard in Section 3.3 (3-171, 3-184, 3-188, etc); and p3-241.
E3	Initiatives and activities that demonstrate commitment include, but are not limited to,			
		a combination of current training,	4.3.5	Page 4-20 to 4-21; 4-41 to 4-42; 4-50; 4-54 to 4-56.

		partnerships,	4.4.1, 4.4.2, 4.4.11, 4.4.12, 4.5.1	Black Hills Forest Fire Protection District p4-26; Beat the Beetles Mountain Pine Beetle Control Plan p4-26; RECs p4-34; RPDs p4-35; Silver Jackets 4-44. See also Table 5-4 (Actions 2-1, 4-3, 5-4, DMP2.10, DMP 3.1, DMP 6.6).
		leadership initiatives,	4.2.3	See SHMT Executive Order p4-6; SHMT Policies p4-7. See also Table 5-4 (Actions 1-5, 2-1, 2-8, 3-3, 3-5, 4-1, 4-2, DMP 4.2, DMP 5.3, DMP 6.6).
		funding,	4.2.4, 5.2, 5.3, 5.4, 4.6.1, 4.7.1	Table 4-1 (p4-8, Funding column), Table 5-4 (p5-8, Potential Funding Sources column), and Table 5-8 (p5-35). See also Table 5-4 (p5-8, Actions 1-1, 1-2, 2-3, 2-4, 2-5, 2-7, 3-1, 3-4, 5-2, 6-1).
		technical assistance,	4.2.4, 4.3, 4.4, 4.5, 4.6.1, 4.7.1.	Summarized in Table 4-1 (p4-8), addressed in agency sections (p4-23 to 4-42), and under Local Assistance (p4-49) and Tribal Assistance (p4-61). See also Table 5-4 (p5-8, Actions 2-8, 3-5, 5-2, 6-1, 6-2).
		codes and ordinances,	4.2.3	p4-5 to 4-7.
		other activities that reduce risks.	4.2.4, 4.4.14, 5.1, 5.2.3, 5.4.	Table 4-1 (p4-8 et. al.), Table 5-1 (p5-2), Table 5-4 (p5-8). See also p5-57 to 5-66 on evaluating effectiveness and loss avoidance.
E4a	The Enhanced plan must describe the system to rank the mitigation measures according to established eligibility criteria.		5.2.1, 5.4.5, 5.4.6, 4.4.14, 4.6.2, 4.7.1	p5-4 to 5-6 including Table 5-2; p5-57 to 5-64; p4-41 to 4-42; p4-51; p4-63.
E4a	The Enhanced plan must describe...a process to prioritize between funding programs, jurisdictions, and proposals that address different or multiple hazards.		5.2.1, 5.2.5, 5.4.5, 5.4.6, 4.4.14, 4.6.2, 4.7.1	p5-4 to 5-6 including Table 5-2; p5-30 to 5-34; p5-57 to 5-64; p4-41 to 4-42; p4-50; p4-61.
E4b	The Enhanced plan must describe how the state will assess the effectiveness of mitigation actions, including the agencies that are involved as well as the timeline, and use the results to inform the mitigation strategy. Effectiveness may be based on cost factors but may also include other beneficial functions.		5.4.5, 5.4.6, 5.4.7, 6.2, 4.4.14	Page 5-57 to 5-64; p6-2 to 6-3; p4-41 to 4-42.

E5a	The enhanced plan must document how the state has fully made use of the funding available through the FEMA assistance programs (for example, PA C-G, HMGP, PDM, and FMA).	5.4	Page 5-48 to 5-66, particularly p5-48 to 5-52.
E5a	If the state has not made full use of available funding, the enhanced plan must document the reasons why funding was not used and explain the process to improve this capability.	5.4.1	Page 5-48 to 5-49.
E5b	The enhanced plan must document how the state effectively uses existing state programs to achieve its mitigation goals.	4.2, 4.3, 4.4, 5.3, 5.4	Summarized in Table 4-1 (p4-8), Table 5-4 (p5-8, Goal column).

4.4 HMA Grants Management Performance

Element	Requirement	Section(s)	Notes
E6a	All applications and amendments are submitted by the end of each program's respective application period.	5.4.2, 5.4.3	See Table 5-14 (p5-54), See also HMGP Admin Plan (Attachment B)
E6b	All applications are entered into FEMA's electronic data systems (such as, NEMIS and/or eGrants).	5.4.3	See Table 5-14 (p5-54), See also HMGP Admin Plan (Attachment B)
E6c	Eligibility and Completeness Checklist is prepared for all applications.	5.4.3	See Table 5-14 (p5-54), See also HMGP Admin Plan (Attachment B)
E6d	All applications are determined to be complete by FEMA within 90 days of submittal or selection for further review. Required environmental and historic preservation reviews and consultations will not be included in the 90-day review timeframe calculation.	5.4.3	See Table 5-14 (p5-54), See also HMGP Admin Plan (Attachment B)
E7	All applications and amendments are determined to be complete by FEMA within 90 days of submittal or selection for further review, including all data requested by FEMA to support Cost Effectiveness determinations and environmental/historic preservation compliance reviews. Required environmental and historic preservation reviews and consultations will not be included in the 90-day review timeframe calculation.	5.4.3	See Table 5-14 (p5-54), See also HMGP Admin Plan (Attachment B)
E8a	All progress reports must be complete and submitted on time.	5.4.3	See Table 5-14 (p5-54), See also HMGP Admin Plan (Attachment B)
E8a	Information in reports must accurately describe grant activities, including data related to the completion of individual property acquisitions.	5.4.3	See Table 5-14 (p5-54), See also HMGP Admin Plan (Attachment B)

E8b	All Federal financial reports (FFR), Standard Form (SF) SF-425 are submitted on time.		5.4.3	See Table 5-14 (p5-54), See also HMGP Admin Plan (Attachment B)
E8b	Information in reports must accurately describe grant activities, as described in the HMA Guidance.		5.4.3	See Table 5-14 (p5-54), See also HMGP Admin Plan (Attachment B)
E8c	State consistently complies with the Financial Management Standard requirements described in 2 CFR §§200.300 to 200.309.		5.4.3	See Table 5-14 (p5-54), See also HMGP Admin Plan (Attachment B)
E9a	All work as part of HMA subawards must be completed by the end of Period of Performance as described in the HMA Guidance.		5.4.3	See Table 5-14 (p5-54), See also HMGP Admin Plan (Attachment B)
E9b	No major findings on last single audit obtained by the state related to HMA programs.		5.4.3	See Table 5-14 (p5-54), See also HMGP Admin Plan (Attachment B)
E9c	All grant close-out activities, including financial reconciliation, are completed within 90 days from the end of the performance period including:		5.4.3	See Table 5-14 (p5-54), See also HMGP Admin Plan (Attachment B)
E9c1		Final FFR SF-425 and Performance Reports were submitted within 90 days from the end of the performance period unless an extension is granted by FEMA.	5.4.3	See Table 5-14 (p5-54), See also HMGP Admin Plan (Attachment B)
E9c2		Statement submitted that approved Scope of Work and all environmental and historic preservation requirements have been satisfied.	5.4.3	See Table 5-14 (p5-54), See also HMGP Admin Plan (Attachment B)
E9c3		SF-270 Request for Advance or Reimbursement or request to de-obligate funds is completed, if applicable due to cost underruns.	5.4.3	See Table 5-14 (p5-54), See also HMGP Admin Plan (Attachment B)
E9c4		Other documentation as required in the HMA Guidance.	5.4.3	See Table 5-14 (p5-54), See also HMGP Admin Plan (Attachment B)
E9c5		No late drawdowns are requested or performed after the liquidation period has ended.	5.4.3	See Table 5-14 (p5-54), See also HMGP Admin Plan (Attachment B)
E9d	Actual expenditures have been documented and are consistent with SF-424A or SF-424C.		5.4.3	See Table 5-14 (p5-54), See also HMGP Admin Plan (Attachment B)

Appendix 3A – Population and Growth

County	2000 Population	2014 Population Estimate	# Change from 2000 to 2014	% Change from 2000 to 2014	2000 Pop Density	2014 Pop Density	Pop. Density Change from 2000-2014	Pop Density Change (%) 2000-2014
Aurora	3,058	2,745	-313	-10.24%	4.3	3.9	-0.4	-9.30%
Beadle	17,023	18,169	1,146	6.73%	13.5	14.4	0.9	6.67%
Bennett	3,574	3,430	-144	-4.03%	3	2.9	-0.1	-3.33%
Bon Homme	7,260	7,023	-237	-3.26%	12.9	12.1	-0.8	-6.20%
Brookings	28,220	33,314	5,094	18.05%	35.5	41.4	5.9	16.62%
Brown	35,460	38,408	2,948	8.31%	20.7	22.2	1.5	7.25%
Brule	5,364	5,309	-55	-1.03%	6.5	6.3	-0.2	-3.08%
Buffalo	2,032	2,077	45	2.21%	4.3	4.3	0	0.00%
Butte	9,094	10,298	1,204	13.24%	4	4.5	0.5	12.50%
Campbell	1,782	1,386	-396	-22.22%	2.4	1.8	-0.6	-25.00%
Charles Mix	9,350	9,287	-63	-0.67%	8.5	8.1	-0.4	-4.71%
Clark	4,143	3,645	-498	-12.02%	4.3	3.8	-0.5	-11.63%
Clay	13,537	13,932	395	2.92%	32.9	33.4	0.5	1.52%
Codington	25,897	27,938	2,041	7.88%	37.7	39	1.3	3.45%
Corson	4,181	4,182	1	0.02%	1.7	1.7	0	0.00%
Custer	7,275	8,445	1,170	16.08%	4.7	5.4	0.7	14.89%
Davison	18,741	19,885	1,144	6.10%	43	45.5	2.5	5.81%
Day	6,267	5,588	-679	-10.83%	6.1	5.1	-1	-16.39%
Deuel	4,498	4,312	-186	-4.14%	7.2	6.8	-0.4	-5.56%
Dewey	5,972	5,662	-310	-5.19%	2.6	2.3	-0.3	-11.54%
Douglas	3,458	2,973	-485	-14.03%	8	6.8	-1.2	-15.00%
Edmunds	4,367	3,983	-384	-8.79%	3.8	3.5	-0.3	-7.89%
Fall River	7,453	6,845	-608	-8.16%	4.3	3.9	-0.4	-9.30%
Faulk	2,640	2,357	-283	-10.72%	2.6	2.3	-0.3	-11.54%
Grant	7,847	7,241	-606	-7.72%	11.5	10.5	-1	-8.70%
Gregory	4,792	4,217	-575	-12.00%	4.7	4	-0.7	-14.89%

County	2000 Population	2014 Population Estimate	# Change from 2000 to 2014	% Change from 2000 to 2014	2000 Pop Density	2014 Pop Density	Pop. Density Change from 2000-2014	Pop Density Change (%) 2000-2014
Haakon	2,196	1,847	-349	-15.89%	1.2	1	-0.2	-16.67%
Hamlin	5,540	5,989	449	8.10%	10.9	11.1	0.2	1.83%
Hand	3,741	3,345	-396	-10.59%	2.6	2.3	-0.3	-11.54%
Hanson	3,139	3,419	280	8.92%	7.2	7.8	0.6	8.33%
Harding	1,353	1,250	-103	-7.61%	0.5	0.5	0	0.00%
Hughes	16,481	17,642	1,161	7.04%	22.2	22	-0.2	-0.90%
Hutchinson	8,075	7,200	-875	-10.84%	9.9	8.8	-1.1	-11.11%
Hyde	1,671	1,396	-275	-16.46%	1.9	1.6	-0.3	-15.79%
Jackson	2,930	3,274	344	11.74%	1.6	1.7	0.1	6.25%
Jerauld	2,295	2,007	-288	-12.55%	4.3	3.8	-0.5	-11.63%
Jones	1,193	975	-218	-18.27%	1.2	1	-0.2	-16.67%
Kingsbury	5,815	5,075	-740	-12.73%	6.9	5.9	-1	-14.49%
Lake	11,276	12,368	1,092	9.68%	20	21.5	1.5	7.50%
Lawrence	21,802	24,657	2,855	13.10%	27.3	30.8	3.5	12.82%
Lincoln	24,131	51,548	27,417	113.62%	41.7	89.1	47.4	113.67%
Lyman	3,895	3,877	-18	-0.46%	2.4	2.3	-0.1	-4.17%
Marshall	4,576	4,683	107	2.34%	5.5	4.1	-1.4	-25.45%
McCook	5,832	5,649	-183	-3.14%	10.2	6.4	-3.8	-37.25%
McPherson	2,904	2,429	-475	-16.36%	2.6	4.2	1.6	61.54%
Meade	24,253	26,951	2,698	11.12%	7	7.7	0.7	10.00%
Mellette	2,083	2,100	17	0.82%	1.6	1.6	0	0.00%
Miner	2,884	2,316	-568	-19.69%	5.1	4	-1.1	-21.57%
Minnehaha	148,281	182,882	34,601	23.33%	183.1	224.8	41.7	22.77%
Moody	6,595	6,367	-228	-3.46%	12.7	12.2	-0.5	-3.94%
Oglala Lakota*	12,466	14,218	1,752	14.05%	6	6.8	0.8	13.33%
Pennington	88,565	108,242	19,677	22.22%	31.9	38.9	7	21.94%

County	2000 Population	2014 Population Estimate	# Change from 2000 to 2014	% Change from 2000 to 2014	2000 Pop Density	2014 Pop Density	Pop. Density Change from 2000-2014	Pop Density Change (%) 2000-2014
Perkins	3,363	3,033	-330	-9.81%	1.2	1	-0.2	-16.67%
Potter	2,693	2,340	-353	-13.11%	3.1	2.6	-0.5	-16.13%
Roberts	10,016	10,374	358	3.57%	9.1	9.1	0	0.00%
Sanborn	2,675	2,336	-339	-12.67%	4.7	4.1	-0.6	-12.77%
Spink	7,454	6,598	-856	-11.48%	5	4.4	-0.6	-12.00%
Stanley	2,772	2,983	211	7.61%	1.9	2	0.1	5.26%
Sully	1,556	1,438	-118	-7.58%	1.5	1.3	-0.2	-13.33%
Todd	9,050	9,882	832	9.19%	6.5	7.1	0.6	9.23%
Tripp	6,430	5,512	-918	-14.28%	4	3.4	-0.6	-15.00%
Turner	8,849	8,272	-577	-6.52%	14.3	13.4	-0.9	-6.29%
Union	12,584	15,029	2,445	19.43%	27.3	32.2	4.9	17.95%
Walworth	5,974	5,511	-463	-7.75%	8.4	7.4	-1	-11.90%
Yankton	21,652	22,684	1,032	4.77%	41.5	42.6	1.1	2.65%
Ziebach	2,519	2,826	307	12.19%	1.3	1.4	0.1	7.69%

Source: Census Bureau; *Formerly Shannon County prior to March 2015

Appendix 3B - Hazus-MH Flood Results

County Name	Population	Building Damage Count	Building Damage Loss ($K)	Building Exposure ($K)	Percent Building Damage	Contents Damage Loss ($K)	Contents Exposure ($K)	Percent Contents Loss	Total Direct Econ Bldg Loss ($K)	Per Capita Loss ($)	Short Term Shelter Needs	Displaced Population
Aurora	2,867	17	3,914	192,008	2.0%	5,561	124,059	4.5%	10,125	3,532	101	481
Beadle	15,878	6	3,673	1,140,956	0.3%	6,000	785,184	0.8%	10,393	655	64	387
Bennett	3,393	0	1,165	121,952	1.0%	1,808	77,157	2.3%	3,145	927	2	71
Bon Homme	7,079	7	1,815	439,005	0.4%	1,870	289,434	48.9%	3,828	541	37	117
Brookings	29,668	7	4,563	1,762,160	0.3%	9,953	1,183,412	0.8%	15,476	522	383	943
Brown	35,154	71	16,502	2,361,052	0.7%	22,083	1,615,566	1.4%	40,502	1,152	854	1,785
Brule	5,205	1	1,423	359,042	0.4%	1,813	242,365	0.7%	3,498	672	19	151
Buffalo	2,142	1	645	59,844	1.1%	631	41,010	1.5%	1,347	629	30	79
Butte	9,593	24	9,890	424,525	2.3%	10,891	273,830	4.0%	21,428	2,234	271	892
Campbell	1,352	37	3,393	106,582	3.2%	5,017	71,024	7.1%	8,813	6,518	124	383
Charles Mix	8,906	4	4,020	542,879	0.7%	5,337	385,775	1.4%	9,842	1,105	46	232
Clark	3,436	2	1,208	253,750	0.5%	1,880	172,779	1.1%	3,328	969	45	159
Clay	13,605	18	2,952	787,934	0.4%	2,268	498,107	0.5%	5,327	392	88	248
Codington	26,317	221	28,917	1,684,272	1.7%	48,403	1,230,471	3.9%	81,843	3,110	2,301	3,027
Corson	4,136	16	2,089	137,273	1.5%	1,711	88,402	1.9%	3,894	941	285	446
Custer	7,811	6	5,092	462,408	1.1%	10,476	282,818	3.7%	16,746	2,144	44	257
Davison	18,931	24	6,417	1,159,549	0.6%	6,297	772,127	0.8%	13,185	696	216	530
Day	5,526	5	1,649	484,855	0.3%	1,386	307,022	0.5%	3,187	577	10	157

County Name	Population	Building Damage Count	Building Damage Loss ($K)	Building Exposure ($K)	Percent Building Damage	Contents Damage Loss ($K)	Contents Exposure ($K)	Percent Contents Loss	Total Direct Econ Bldg Loss ($K)	Per Capita Loss ($)	Short Term Shelter Needs	Displaced Population
Deuel	4,276	2	1,386	287,842	0.5%	2,256	184,891	1.2%	3,922	917	34	154
Dewey	5,931	3	1,532	185,425	0.8%	981	115,356	0.9%	2,557	431	31	166
Douglas	2,945	5	984	191,287	0.5%	1,163	136,333	0.9%	2,342	795	14	152
Edmunds	4,034	30	2,718	274,727	1.0%	2,526	177,453	1.4%	5,461	1,354	156	293
Fall River	7,145	92	14,007	434,042	3.2%	20,735	275,507	7.5%	36,379	5,092	250	525
Faulk	2,255	4	1,275	162,503	0.8%	1,592	111,483	1.4%	3,056	1,355	94	179
Grant	7,101	22	4,422	488,046	0.9%	4,652	322,886	1.4%	9,592	1,351	97	415
Gregory	4,084	0	474	277,213	0.2%	254	186,244	0.1%	731	179	-	44
Haakon	1,819	13	3,761	146,783	2.6%	5,756	109,343	5.3%	10,151	5,581	78	303
Hamlin	5,660	18	5,398	388,992	1.4%	9,963	250,564	4.0%	16,441	2,905	31	387
Hand	3,274	9	2,083	296,103	0.7%	1,931	202,183	1.0%	4,161	1,271	39	197
Hanson	3,609	0	1,368	175,231	0.8%	1,029	111,737	0.9%	2,473	685	3	94
Harding	1,145	0	504	82,331	0.6%	516	54,129	1.0%	1,045	913	2	43
Hughes	16,746	7	3,195	1,124,701	0.3%	5,319	780,813	0.7%	8,871	530	297	611
Hutchinson	7,250	29	5,799	503,541	1.2%	9,436	358,305	2.6%	16,001	2,207	646	957
Hyde	1,424	0	292	104,891	0.3%	370	71,114	0.5%	709	498	-	39
Jackson	2,711	0	702	117,513	0.6%	723	75,716	1.0%	1,445	533	3	69
Jerauld	1,982	0	591	173,814	0.3%	833	120,597	0.7%	1,534	774	8	77

County Name	Population	Building Damage Count	Building Damage Loss ($K)	Building Exposure ($K)	Percent Building Damage	Contents Damage Loss ($K)	Contents Exposure ($K)	Percent Contents Loss	Total Direct Econ Bldg Loss ($K)	Per Capita Loss ($)	Short Term Shelter Needs	Displaced Population
Jones	1,024	1	288	70,695	0.4%	243	48,339	0.5%	551	538	-	17
Kingsbury	5,394	0	1,366	397,000	0.3%	2,080	265,171	0.8%	3,672	681	48	281
Lake	11,693	72	8,740	802,854	1.1%	11,306	543,394	2.1%	20,840	1,782	664	1,128
Lawrence	23,524	72	20,631	1,420,311	1.5%	28,237	943,068	3.0%	50,103	2,130	504	979
Lincoln	39,713	26	7,275	1,526,898	0.5%	6,826	1,004,113	0.7%	14,514	365	210	524
Lyman	3,811	13	3,267	210,965	1.5%	3,329	142,040	2.3%	6,876	1,804	38	145
Marshall	4,320	0	1,062	345,298	0.3%	1,052	224,483	0.5%	2,223	515	7	143
McCook	5,671	18	3,257	374,493	0.9%	2,680	242,410	1.1%	6,096	1,075	65	252
McPherson	2,480	0	628	186,748	0.3%	815	131,351	0.6%	1,545	623	4	95
Meade	23,989	8	4,808	1,269,102	0.4%	6,458	789,678	0.8%	11,765	490	106	469
Mellette	1,982	14	1,501	79,167	1.9%	817	50,927	1.6%	2,331	1,176	109	223
Miner	2,435	9	1,527	180,686	0.8%	1,685	119,490	1.4%	3,363	1,381	66	159
Minnehaha	179,180	719	162,527	10,171,077	1.6%	252,358	7,016,387	3.6%	432,484	2,414	6,159	7,482
Moody	6,414	2	2,072	392,198	0.5%	1,949	248,960	0.8%	4,220	658	9	216
Pennington	98,533	88	13,624	5,606,639	0.2%	14,685	3,848,985	0.4%	29,402	298	724	1,379
Perkins	2,900	0	1,293	210,653	0.6%	982	145,019	0.7%	2,339	807	-	76
Potter	2,123	0	537	255,587	0.2%	781	204,883	0.4%	1,416	667	1	44
Roberts	9,851	8	2,903	612,941	0.5%	3,991	401,423	1.0%	7,273	738	36	320

County Name	Population	Building Damage Count	Building Damage Loss ($K)	Building Exposure ($K)	Percent Building Damage	Contents Damage Loss ($K)	Contents Exposure ($K)	Percent Contents Loss	Total Direct Econ Bldg Loss ($K)	Per Capita Loss ($)	Short Term Shelter Needs	Displaced Population
Sanborn	2,447	0	1,121	166,987	0.7%	1,121	107,751	1.0%	2,400	981	3	142
Shannon*	13,637	34	8,180	321,592	2.5%	11,173	218,211	5.1%	20,430	1,498	492	1,214
Spink	6,664	15	6,474	484,402	1.3%	7,554	312,052	2.4%	14,644	2,197	217	572
Stanley	2,703	131	14,974	162,796	9.2%	11,356	103,953	10.9%	26,644	9,857	340	666
Sully	1,356	0	502	114,641	0.4%	456	74,970	0.6%	1,016	749	1	42
Todd	10,167	9	2,227	277,272	0.8%	3,458	185,432	1.9%	5,723	563	105	314
Tripp	5,681	31	3,470	392,821	0.9%	3,446	274,410	1.3%	7,248	1,276	86	265
Turner	8,366	12	5,659	606,311	0.9%	7,748	409,118	1.9%	14,191	1,696	39	391
Union	14,131	867	119,836	1,031,826	11.6%	203,473	800,039	25.4%	349,991	24,768	3,451	4,428
Walworth	5,238	0	780	393,371	0.2%	786	263,677	0.3%	1,632	312	-	63
Yankton	21,835	713	81,492	1,464,392	5.6%	105,103	1,081,598	9.7%	193,250	8,850	2,614	3,328
Ziebach	2,542	8	1,403	66,932	2.1%	749	39,623	1.9%	2,158	849	75	191
TOTAL	**804,194**	**3,571**	**633,242**	**47,491,686**	**1.3%**	**910,117**	**32,326,151**	**3%**	**1,623,118**	**126,423**	**22,876**	**40,598**

Source: HAZUS-MH MR4; *County name changed to Oglala Lakota in 2015

Appendix 3C - Flood Insurance Claims Detail

County	# of Policies	Total Coverage	Total Premium	Total Claims Since 1978	Total Paid Since 1978
Aurora	7	$492,300	$4,059	0	$0
Beadle	15	$3,199,100	$7,045	21	$327,076
Bon Homme	3	$770,000	$1,110	0	$0
Brookings	151	$18,224,100	$127,778	83	$829,743
Brown	277	$51,238,300	$243,082	483	$3,283,454
Brule	0	$0	$0	2	$142,021
Butte	50	$6,336,300	$32,696	12	$11,834
Charles Mix	5	$494,300	$3,189	6	$326,230
Clark	12	$1,565,000	$6,919	11	$184,850
Clay	11	$3,330,000	$4,378	12	$50,954
Codington	524	$97,426,900	$403,212	425	$5,749,018
Corson	1	$200,000	$939	0	$0
Custer	85	$14,825,300	$58,898	42	$560,642
Davison	29	$5,664,500	$17,662	13	$85,072
Day	31	$4,943,600	$35,020	252	$4,011,874
Deuel	2	$288,000	$1,840	1	$3,758
Dewey	1	$250,000	$835	0	$0
Douglas	0	$0	$0	1	$520
Edmunds	2	$700,000	$827	4	$2,980
Fall River	22	$2,857,500	$23,593	1	$25
Faulk	0	$0	$0	2	$5,206
Grant	20	$4,546,100	$26,190	26	$226,226
Gregory	1	$350,000	$373	2	$161,998
Haakon	13	$1,195,000	$11,684	2	$0
Hamlin	57	$12,326,900	$35,550	347	$4,201,281
Hand	6	$1,429,300	$4,779	3	$76,119
Hanson	6	$846,600	$6,570	3	$30,480
Hughes	70	$15,088,500	$60,370	81	$693,587
Hutchinson	13	$1,576,300	$8,202	9	$95,129
Hyde	0	$0	$0	1	$0
Jerauld	1	$350,000	$412	0	$0
Kingsbury	2	$430,000	$1,275	33	$365,002

County	# of Policies	Total Coverage	Total Premium	Total Claims Since 1978	Total Paid Since 1978
Lake	169	$30,609,500	$121,452	152	$1,419,607
Lawrence	197	$40,278,900	$204,428	38	$267,432
Lincoln	1,336	$389,092,500	$1,337,679	177	$5,233,428
Lyman	8	$775,200	$14,217	3	$117,254
Marshall	3	$910,000	$1,133	12	$144,192
McCook	23	$3,568,600	$22,884	11	$41,756
Meade	121	$19,214,000	$122,272	20	$42,863
Miner	1	$350,000	$370	0	$0
Minnehaha	132	$24,017,700	$108,723	132	$906,393
Moody	24	$3,133,500	$30,940	58	$455,782
Pennington	540	$121,375,700	$500,596	116	$308,246
Potter	54	$10,584,900	$46,510	61	$634,544
Roberts	3	$1,420,000	$1,887	14	$46,953
Sanborn	36	$6,109,500	$27,847	69	$921,480
Spink	125	$31,329,800	$110,361	113	$2,555,204
Stanley	1	$350,000	$412	5	$22,793
Sully	6	$639,900	$5,997	2	$1,362
Todd	2	$450,000	$2,087	0	$0
Turner	13	$1,547,600	$9,063	12	$77,189
Union	403	$119,134,300	$275,463	420	$5,076,498
Yankton	69	$15,670,400	$54,482	48	$353,891
Ziebach	1	$210,000	$348	3	$3,427
State Total:	**4,684**	**$1,071,715,900**	**$4,127,638**	**3,344**	**$40,055,373**

Appendix 3D - Vulnerability Methodology

This appendix includes more details for the methodology for the vulnerability analysis of winter storms, windstorm and tornadoes.

Building Exposure— One aspect of vulnerability is considering assets exposed and potentially vulnerable to loss. A total building exposure by county was derived from HAZUS V3.1 (residential, commercial, industrial, agricultural, religion, government, and education) which is based on Census 2010 statistics. In the 2016 update the total exposure by county was extracted from HAZUS. For the 2016 HIRA update, the classification scheme changed for Building Exposure category to refine total rank by county (from equal interval to natural breaks). The total range of building exposure ($114,735-$19,134,394) was analyzed to find natural breaks in the data. The ranges were numbered 1 through 10 in ascending order as noted in the following table.

Table 1 Building Exposure Ratings

Building Exposure ($)	Rating
114,735-2,016,700	1
2,016,701-3,918,666	2
3,918,667-5,820,632	3
5,820,633-7,722,598	4
7,722,599-9,624,564	5
9,624,564-11,526,530	6
11,526,531-13,428,496	7
13,428,497-15,330,462	8
15,330,463-17,232,428	9
17,232,429-19,134,394	10

Population Density—Population density is determined by dividing a county's population by its land area. This section is based on the 2011 U.S. Census Bureau population estimates and the land area reported in the 2010 Census. For the 2016 update, the range of population densities (0.5 to 212.8) was divided into 10 roughly equal ranges as shown in Table 2. The ranges were numbered 1 through 10 in ascending order. For the 2016 update, the classification scheme changed for the Population Density category to refine total rank by county (from equal interval to natural breaks). The total range of population density (.5-203.7) was analyzed to find natural breaks in the data.

Table 2 Population Density Ratings

Population Density	Rating
Density	**Rating**
.5-23	1
23.1-45.5	2
45.6-68.1	3
68.2-90.7	4
90.8-113.3	5

Population Density	Rating
113.4-135.9	6
136-158.5	7
158.6-181.1	8
181.2-203.7	9

These building exposure and population density ratings were components of the vulnerability analyses for windstorm, tornado and winter storm. Windstorm, tornado, and winter storm vulnerability methodologies are described below and include the tables used to determine the summary vulnerability rankings.

Windstorm

Prior Events—This rating is based on the number of past windstorm events experienced by each county between January 1955 and August 2016 according to data from the National Climatic Data Center's Storm Events database (a compilation of storm data from the National Weather Service). For the purposes of this plan, a windstorm event is considered thunderstorm winds or high winds as identified in the National Climatic Data Center's database. In addition, particularly severe events (those with a speed of 70 knots or higher or that caused monetary damage, fatalities, or injuries) were also assessed. (see the description of the windstorm events that affect South Dakota in the Windstorm Hazard Profile).

To develop the prior event rating, the total range of past occurrences was divided into 10 roughly equal ranges as shown in Table 3 and Table 4. The ranges were numbered 1 through 10 in ascending order.

Table 3 Windstorm Prior Event Ratings

# of Past Occurrences	Rating
47-88	1
89-128	2
129-167	3
168-207	4
208-247	5
248-287	6
289-328	7
329-368	8
369-408	9
409-448	10

Table 4 Windstorm Prior Event Ratings (Wind speed ≥70 kts)

# of Past Occurrences	Rating
6-12	1
13-20	2
21-27	3
28-34	4

# of Past Occurrences	Rating
35-41	5
42-48	6
49-55	7
56-62	8
63-69	9
70-76	10

After rating each of the counties on the factors described above, each factor was separately added with building exposure ratings and population density ratings to produce a county-level vulnerability rating. The highest possible total vulnerability rating was 30. The total range of vulnerability was divided into three equal ranges as shown in Table 5. The ranges were assigned a corresponding level of windstorm vulnerability: moderate, high, and very high.

Table 5 Windstorm Vulnerability

Windstorm Vulnerability Range	Windstorm Vulnerability
3-11	Moderate
12-21	High
22-30	Very High

This vulnerability was assigned to each county considering both total windstorm events and those with a wind speed of 70 knots or greater, or that caused damage, injuries, or fatalities.

The table below provides details on each counties' individual ratings for each factor.

Table 6 Windstorm Vulnerability Calculations

County	Total Events	Event Rating	Total Events > 70 kts	Event Rating > 70 kts	Building Exposure	Building Exp. Rating (Natural	Population Density	Pop Density Rating (Natural	Vulnerability Rating	Vulnerability Category	Vuln. > 70 kts	Vuln>70kts Cateogry
Aurora	66	1	26	3	$343,330	3	3.9	3	7	Moderate	9	Moderate
Beadle	212	5	54	7	$1,950,510	7	14.4	7	19	High	21	High
Bennett	97	2	17	2	$247,449	2	2.9	3	7	Moderate	7	Moderate
Bon Homme	96	2	33	4	$684,668	5	12.1	6	13	High	15	High
Brookings	131	3	50	7	$3,232,047	8	41.4	8	19	High	23	Very High
Brown	249	6	30	4	$4,022,770	8	22.2	8	22	Very High	20	High
Brule	116	2	20	2	$598,841	4	6.3	4	10	Moderate	10	Moderate
Buffalo	69	1	7	1	$114,735	1	4.3	3	5	Moderate	5	Moderate

County	Total Events	Event Rating	Total Events > 70 kts	Event Rating > 70 kts	Building Exposure	Building Exp. Rating (Natural	Population Density	Pop Density Rating (Natural	Vulnerability Rating	Vulnerability Category	Vuln. > 70 kts	Vuln>70kts Cateogry
Butte	233	5	45	6	$859,242	5	4.5	4	14	High	15	High
Campbell	91	2	9	1	$211,527	2	1.8	2	6	Moderate	5	Moderate
Charles Mix	131	3	43	6	$979,078	6	8.1	5	14	High	17	High
Clark	90	2	17	2	$461,331	4	3.8	3	9	Moderate	9	Moderate
Clay	100	2	34	4	$1,352,347	6	33.4	8	16	High	18	High
Codington	131	3	18	2	$3,141,546	8	39.0	8	19	High	18	High
Corson	179	4	21	3	$261,189	2	1.7	1	7	Moderate	6	Moderate
Custer	175	4	24	3	$1,059,574	6	5.4	4	14	High	13	High
Davison	153	3	36	5	$2,033,945	7	45.5	9	19	High	21	High
Day	127	2	33	4	$739,380	5	5.1	4	11	Moderate	13	High
Deuel	84	1	11	1	$557,548	4	6.8	5	10	Moderate	10	Moderate
Dewey	127	2	24	3	$326,693	3	2.3	2	7	Moderate	8	Moderate
Douglas	57	1	19	2	$410,033	3	6.8	5	9	Moderate	10	Moderate
Edmunds	137	3	16	2	$428,157	4	3.5	3	10	Moderate	9	Moderate
Fall River	108	2	23	3	$772,078	5	3.9	3	10	Moderate	11	Moderate
Faulk	102	2	20	2	$319,966	3	2.3	2	7	Moderate	7	Moderate
Grant	70	1	15	2	$852,422	5	10.5	6	12	High	13	High
Gregory	71	1	22	3	$499,638	4	4.0	3	8	Moderate	10	Moderate
Haakon	192	4	33	4	$304,961	3	1.0	1	8	Moderate	8	Moderate
Hamlin	73	1	22	3	$657,563	5	11.1	6	12	High	14	High
Hand	109	2	10	1	$489,795	4	2.3	2	8	Moderate	7	Moderate
Hanson	76	1	27	3	$375,684	3	7.8	5	9	Moderate	11	Moderate
Harding	271	6	40	5	$134,729	1	0.5	1	8	Moderate	7	Moderate
Hughes	193	4	31	4	$2,011,351	7	22.0	7	18	High	18	High
Hutchinson	101	2	34	4	$921,743	6	8.8	5	13	High	15	High
Hyde	74	1	6	1	$174,088	2	1.6	1	4	Moderate	4	Moderate
Jackson	162	3	36	5	$279,813	2	1.7	1	6	Moderate	8	Moderate
Jerauld	65	1	23	3	$292,480	2	3.8	3	6	Moderate	8	Moderate
Jones	80	1	6	1	$154,067	1	1.0	1	3	Moderate	3	Moderate
Kingsbury	107	2	37	5	$718,391	5	5.9	4	11	Moderate	14	High
Lake	117	2	44	6	$1,464,020	7	21.5	7	16	High	20	High
Lawrence	47	1	7	1	$2,942,654	8	30.8	8	17	High	17	High
Lincoln	138	3	44	6	$4,858,425	9	89.1	9	21	High	24	Very High
Lyman	152	3	17	2	$387,530	3	2.3	2	8	Moderate	7	Moderate
Marshall	93	2	18	2	$613,226	4	6.4	5	11	Moderate	11	Moderate

County	Total Events	Event Rating	Total Events > 70 kts	Event Rating > 70 kts	Building Exposure	Building Exp. Rating (Natural	Population Density	Pop Density Rating (Natural	Vulnerability Rating	Vulnerability Category	Vuln. > 70 kts	Vuln>70kts Cateogry
McCook	97	2	37	5	$337,182	3	4.2	3	8	Moderate	11	Moderate
McPherson	80	1	9	1	$569,412	4	4.1	3	8	Moderate	8	Moderate
Meade	439	10	72	10	$2,374,927	7	7.7	5	22	Very High	22	Very High
Mellette	87	1	17	2	$145,156	1	1.6	1	3	Moderate	4	Moderate
Miner	76	1	26	3	$300,577	2	4.0	3	6	Moderate	8	Moderate
Minnehaha	257	6	68	9	$19,134,385	10	224.8	10	26	Very High	29	Very High
Moody	73	1	32	4	$752,929	5	12.2	6	12	High	15	High
Oglala Lakota	165	3	30	4	$623,369	5	6.8	5	13	High	14	High
Pennington	402	9	61	8	$11,128,870	10	38.9	8	27	Very High	26	Very High
Perkins	223	5	46	6	$349,270	3	1.0	1	9	Moderate	10	Moderate
Potter	95	2	10	1	$405,402	3	2.6	2	7	Moderate	6	Moderate
Roberts	83	1	14	2	$993,542	6	9.1	6	13	High	14	High
Sanborn	80	1	27	3	$331,251	3	4.1	3	7	Moderate	9	Moderate
Spink	130	3	34	4	$762,242	5	4.4	3	11	Moderate	12	High
Stanley	133	3	19	2	$316,125	3	2.0	2	8	Moderate	7	Moderate
Sully	103	2	13	2	$213,590	2	1.3	1	5	Moderate	5	Moderate
Todd	154	3	36	5	$584,882	4	7.1	5	12	High	14	High
Tripp	156	3	29	4	$660,351	5	3.4	3	11	Moderate	12	High
Turner	96	2	34	4	$1,047,334	6	13.4	6	14	High	16	High
Union	106	2	35	5	$1,866,198	7	32.2	8	17	High	20	High
Walworth	130	3	18	2	$664,408	5	7.4	5	13	High	12	High
Yankton	128	2	42	6	$2,630,709	8	42.6	8	18	High	22	Very High
Ziebach	158	3	30	4	$134,376	1	1.4	1	5	Moderate	6	Moderate

Tornado

Prior Events—This rating is based on the number of past tornadoes experienced by each county between January 1950 and August 2016 according to data from the National Climatic Data Center's Storm Events database (a compilation of storm data from the National Weather Service). Tornadoes reported in the database are in segments. So, the number of past occurrences is really a reflection of the number of past tornado segments. To develop the prior event rating, the total range of past occurrences was divided into 10 roughly equal ranges as shown in Table 7. The ranges were numbered 1 through 10 in ascending order.

Table 7 Tornadoes Prior Event Ratings

# of Past Occurrences	Rating
6-12	1
13-20	2
21-28	3
29-36	4
37-44	5
45-52	6
53-60	7
61-68	8
69-76	9
77-84	10

In addition to the total events tabulation, a prior event rating was established for each county based on the number of F1 or greater tornadoes in the county, the number of tornadoes that caused death or injury, or the number of tornadoes with recorded financial damage. This was used to help determine if there are areas of particular vulnerability to more severe tornado events. The increased the overall number of tornadoes analyzed, as well as total damages. Total damages were inflated to $2012 dollars instead of year-of-event dollars. The information was drawn from the NCDC database and may not account for new methodologies in assessing a tornado's rating. This information was also divided into ten roughly equal ranges and is displayed in the table below.

Table 8 Tornadoes of at least F1 Rating Prior Event Ratings

# of Past Occurrences	Rating
0-2	1
3-5	2
6-8	3
9-11	4
12-14	5
15-17	6
18-20	7
21-23	8
24-26	9
27-29	10

Past Tornado Damage— This rating is based on the property damage for the tornadoes that occurred in South Dakota between 1950 and 2016 as reported in the National Climatic Data Center's Storm Events database. This damage was presented in actual values for the year the events occurred. To more accurately compare the damage values, they were converted to 2016 dollars using Consumer Price Index conversion factors published by Oregon State University (this is similar to the methodology used in FEMA's inflation calculator in its Benefits Cost Analysis Toolkit). The inflated values suggest that the state had $713,216,263 (2016 dollars) in tornado damage between 1950 and 2016, which averages out to approximately $

10,806,307 per year. The total range of past tornado damage ($143,138-$160,034,605) was divided into 10 roughly equal ranges (16,000,000) as shown in Table 9. The ranges were numbered 1 through 10 in ascending order.

Table 9 Past Tornado Damage Ratings

Damages ($)	Rating
0-16,000,000	1
16,000,001-32,000,000	2
32,000,001-51,000,000	3
51,000,001-67,000,000	4
67,000,001-83,000,000	5
83,000,001-99,000,000	6
99,000,001-115,000,000	7
115,000,001-131,000,000	8
131,000,001-147,000,000	9
147,000,001-163,000,000	10

Table 10 Annualized Tornado Losses in South Dakota

County	Total Damages	Total Damages (2016 dollars)	Annualized Losses
Aurora	$513,026	$521,234	$7,897
Beadle	$21,896,842	$22,247,191	$337,079
Bennett	$3,331,730	$3,385,038	$51,288
Bon Homme	$4,922,708	$5,001,471	$75,780
Brookings	$5,021,762	$5,102,110	$77,305
Brown	$14,326,236	$14,555,455	$220,537
Brule	$12,031,035	$12,223,531	$185,205
Buffalo	$40,991,510	$41,647,374	$631,021
Butte	$2,083,622	$2,116,960	$32,075
Campbell	$3,142,331	$3,192,609	$48,373
Charles Mix	$8,485,126	$8,620,888	$130,620
Clark	$11,402,416	$11,584,854	$175,528
Clay	$5,032,445	$5,112,964	$77,469
Codington	$21,527,349	$21,871,786	$331,391
Corson	$2,178,746	$2,213,606	$33,539
Custer	$380,726	$386,818	$5,861
Davison	$20,572,249	$20,901,405	$316,688
Day	$8,213,528	$8,344,944	$126,439
Deuel	$189,694	$192,729	$2,920

County	Total Damages	Total Damages (2016 dollars)	Annualized Losses
Dewey	$561,240	$570,220	$8,640
Douglas	$3,320,104	$3,373,226	$51,109
Edmunds	$140,885	$143,139	$2,169
Fall River	$2,382,926	$2,421,053	$36,683
Faulk	$454,717	$461,992	$7,000
Grant	$867,345	$881,222	$13,352
Gregory	$22,208,895	$22,564,237	$341,882
Haakon	$931,208	$946,107	$14,335
Hamlin	$773,837	$786,218	$11,912
Hand	$19,966,516	$20,285,980	$307,363
Hanson	$2,019,246	$2,051,553	$31,084
Harding	$224,586	$228,179	$3,457
Hughes	$13,075,448	$13,284,655	$201,283
Hutchinson	$1,997,638	$2,029,601	$30,752
Hyde	$270,857	$275,190	$4,170
Jackson	$682,019	$692,932	$10,499
Jerauld	$5,728,852	$5,820,513	$88,190
Jones	$142,378	$144,656	$2,192
Kingsbury	$12,048,831	$12,241,613	$185,479
Lake	$5,907,212	$6,001,728	$90,935
Lawrence	$2,022,929	$2,055,296	$31,141
Lincoln	$157,514,376	$160,034,606	$2,424,767
Lyman	$728,615	$740,273	$11,216
Marshall	$4,530,233	$4,602,717	$69,738
McCook	$44,441,499	$45,152,563	$684,130
McPherson	$13,099,466	$13,309,058	$201,652
Meade	$6,865,296	$6,975,140	$105,684
Mellette	$1,343,958	$1,365,461	$20,689
Miner	$5,017,096	$5,097,369	$77,233
Minnehaha	$27,589,456	$28,030,888	$424,710
Moody	$827,037	$840,270	$12,731
Oglala Lakota	$4,926,733	$5,005,560	$75,842
Pennington	$18,114,266	$18,404,094	$278,850
Perkins	$2,530,977	$2,571,473	$38,962
Potter	$8,462,831	$8,598,236	$130,276
Roberts	$9,488,190	$9,640,001	$146,061

County	Total Damages	Total Damages (2016 dollars)	Annualized Losses
Sanborn	$1,049,842	$1,066,640	$16,161
Spink	$1,245,846	$1,265,780	$19,178
Stanley	$378,946	$385,009	$5,833
Sully	$320,096	$325,217	$4,928
Todd	$2,248,569	$2,284,546	$34,614
Tripp	$18,830,914	$19,132,208	$289,882
Turner	$51,471,078	$52,294,616	$792,343
Union	$5,030,606	$5,111,096	$77,441
Walworth	$3,350,528	$3,404,137	$51,578
Yankton	$28,935,743	$29,398,715	$445,435
Ziebach	$1,671,568	$1,698,313	$25,732

After rating each of the counties on the factors described above, each factor was separately added with damage ratings, building exposure ratings and population density ratings to produce a county-level vulnerability rating. The highest possible total vulnerability rating was 40. The total range of vulnerability was divided into three equal ranges as shown in Table 11. The ranges were assigned a corresponding level of tornado vulnerability: moderate, high, and very high. The vulnerability scale begins at moderate as every county has some degree of vulnerability.

Table 11 Tornado Vulnerability

Tornado Vulnerability Range	Tornado Vulnerability
1-13	Moderate
14-27	High
28-40	Very High

The table below provides details on each counties' individual ratings for each factor.

Table 12 Tornado Vulnerability Calculations

County	Total Events	Prior Event Rating	Damage Rating	Total events >F1	Prior Event Rating > F1	Building Exposure	Building Exposure Rating (Natural Breaks)	Population Density	Pop Density Rating (Natural Breaks)	Vuln. Rating	Vuln. Category	Vuln. ≥F1	Vuln. ≥F1 Category
Aurora	14	2	1	4	2	$343,330	3	3.9	3	9	Moderate	9	Moderate

County	Total Events	Prior Event Rating	Damage Rating	Total events > F1	Prior Event Rating > F1	Building Exposure	Building Exposure Rating (Natural Breaks)	Population Density	Pop Density Rating (Natural Breaks)	Vuln. Rating	Vuln. Category	Vuln. ≥F1	Vuln. ≥F1 Category
Beadle	35	4	2	17	6	$1,950,510	7	14.4	7	20	High	22	High
Bennett	24	3	1	11	4	$247,449	2	2.9	3	9	Moderate	10	Moderate
Bon Homme	23	3	1	15	6	$684,668	5	12.1	6	15	High	18	High
Brookings	26	3	1	10	4	$3,232,047	8	41.4	8	20	High	21	High
Brown	77	10	1	29	10	$4,022,770	8	22.2	8	27	High	27	High
Brule	27	3	1	12	5	$598,841	4	6.3	4	12	Moderate	14	High
Buffalo	15	2	3	3	2	$114,735	1	4.3	3	9	Moderate	9	Moderate
Butte	14	2	1	10	4	$859,242	5	4.5	4	12	Moderate	14	High
Campbell	13	2	1	8	3	$211,527	2	1.8	2	7	Moderate	8	Moderate
Charles Mix	43	5	1	25	9	$979,078	6	8.1	5	17	High	21	High
Clark	28	3	1	16	6	$461,331	4	3.8	3	11	Moderate	14	High
Clay	30	4	1	14	5	$1,352,347	6	33.4	8	19	High	20	High
Codington	29	4	2	10	4	$3,141,546	8	39	8	22	High	22	High
Corson	22	3	1	4	2	$261,189	2	1.7	1	7	Moderate	6	Moderate
Custer	11	1	1	9	4	$1,059,574	6	5.4	4	12	Moderate	15	High
Davison	25	3	2	13	5	$2,033,945	7	45.5	9	21	High	23	High
Day	23	3	1	7	3	$739,380	5	5.1	4	13	Moderate	13	Moderate
Deuel	19	2	1	7	3	$557,548	4	6.8	5	12	Moderate	13	Moderate
Dewey	27	3	1	8	3	$326,693	3	2.3	2	9	Moderate	9	Moderate
Douglas	25	3	1	9	4	$410,033	3	6.8	5	12	Moderate	13	Moderate
Edmunds	19	2	1	8	3	$428,157	4	3.5	3	10	Moderate	11	Moderate
Fall River	29	4	1	15	6	$772,078	5	3.9	3	13	Moderate	15	High
Faulk	18	2	1	8	3	$319,966	3	2.3	2	8	Moderate	9	Moderate
Grant	17	2	1	8	3	$852,422	5	10.5	6	14	High	15	High
Gregory	22	3	2	9	4	$499,638	4	4	3	12	Moderate	13	Moderate
Haakon	23	3	1	12	5	$304,961	3	1	1	8	Moderate	10	Moderate
Hamlin	18	2	1	7	3	$657,563	5	11.1	6	14	High	15	High
Hand	32	4	2	13	5	$489,795	4	2.3	2	12	Moderate	13	Moderate
Hanson	18	2	1	11	4	$375,684	3	7.8	5	11	Moderate	13	Moderate
Harding	18	2	1	6	3	$134,729	1	0.5	1	5	Moderate	6	Moderate
Hughes	12	1	1	6	3	$2,011,351	7	22	7	16	High	18	High

County	Total Events	Prior Event Rating	Damage Rating	Total events > F1	Prior Event Rating > F1	Building Exposure	Building Exposure Rating (Natural Breaks)	Population Density	Pop Density Rating (Natural Breaks)	Vuln. Rating	Vuln. Category	Vuln. ≥F1	Vuln. ≥F1 Category
Hutchinson	43	5	1	20	7	$921,743	6	8.8	5	17	High	19	High
Hyde	12	1	1	3	2	$174,088	2	1.6	1	5	Moderate	6	Moderate
Jackson	19	2	1	11	4	$279,813	2	1.7	1	6	Moderate	8	Moderate
Jerauld	14	2	1	8	3	$292,480	2	3.8	3	8	Moderate	9	Moderate
Jones	6	1	1	3	2	$154,067	1	1	1	4	Moderate	5	Moderate
Kingsbury	41	5	1	16	6	$718,391	5	5.9	4	15	High	16	High
Lake	20	2	1	13	5	$1,464,020	7	21.5	7	17	High	20	High
Lawrence	17	2	1	11	4	$2,942,654	8	30.8	8	19	High	21	High
Lincoln	51	6	10	21	8	$4,858,425	9	89.1	9	34	Very High	36	Very High
Lyman	36	4	1	16	6	$387,530	3	2.3	2	10	Moderate	12	Moderate
Marshall	18	2	1	10	4	$613,226	4	6.4	5	12	Moderate	14	High
McCook	39	5	3	23	8	$337,182	3	4.2	3	14	High	17	High
McPherson	24	3	1	11	4	$569,412	4	4.1	3	11	Moderate	12	Moderate
Meade	41	5	1	21	8	$2,374,927	7	7.7	5	18	High	21	High
Mellette	12	1	1	5	2	$145,156	1	1.6	1	4	Moderate	5	Moderate
Miner	33	4	1	16	6	$300,577	2	4	3	10	Moderate	12	Moderate
Minnehaha	40	5	2	21	8	$19,134,385	10	224.8	10	27	High	30	Very High
Moody	10	1	1	6	3	$752,929	5	12.2	6	13	Moderate	15	High
Oglala Lakota	20	2	1	10	4	$623,369	5	6.8	5	13	Moderate	15	High
Pennington	44	5	2	19	7	$11,128,870	10	38.9	8	25	High	27	High
Perkins	39	5	1	15	6	$349,270	3	1	1	10	Moderate	11	Moderate
Potter	20	2	1	12	5	$405,402	3	2.6	2	8	Moderate	11	Moderate
Roberts	23	3	1	15	6	$993,542	6	9.1	6	16	High	19	High
Sanborn	21	3	1	9	4	$331,251	3	4.1	3	10	Moderate	11	Moderate
Spink	37	5	1	13	5	$762,242	5	4.4	3	14	High	14	High
Stanley	21	3	1	11	4	$316,125	3	2	2	9	Moderate	10	Moderate
Sully	20	2	1	8	3	$213,590	2	1.3	1	6	Moderate	7	Moderate
Todd	36	4	1	11	4	$584,882	4	7.1	5	14	High	14	High
Tripp	30	4	2	15	6	$660,351	5	3.4	3	14	High	16	High

County	Total Events	Prior Event Rating	Damage Rating	Total events > F1	Prior Event Rating > F1	Building Exposure	Building Exposure Rating (Natural Breaks)	Population Density	Pop Density Rating (Natural Breaks)	Vuln. Rating	Vuln. Category	Vuln. ≥F1	Vuln. ≥F1 Category
Turner	43	5	4	22	8	$1,047,334	6	13.4	6	21	High	24	High
Union	45	6	1	16	6	$1,866,198	7	32.2	8	22	High	22	High
Walworth	23	3	1	12	5	$664,408	5	7.4	5	14	High	16	High
Yankton	29	4	2	15	6	$2,630,709	8	42.6	8	22	High	24	High
Ziebach	23	3	1	8	3	$134,376	1	1.4	1	6	Moderate	6	Moderate

Source: Amec Foster Wheeler analysis of NCDC data

Winter Storms

Vulnerability Factors

Prior Events—This rating is based on the number of past winter storms experienced by each county between January 1993 and August 2016 according to data from the National Climatic Data Center's Storm Events database (a compilation of storm data from the National Weather Service). The database does not have information for winter storms prior to 1993. Although the University of South Carolina Hazards and Vulnerability Research Institute's Spatial Hazard Events and Losses Database for the United States (SHELDUS) has events from 1963-2011, it only includes those events for which damage was reported, thus it is not as comprehensive as the National Climatic Data Center. The winter storm profile in Section 3.2.2 describes events that happened before 1993, but that data is not appropriate for this vulnerability assessment. This information was verified during the 2013 update, and the NCDC database remains the most comprehensive dataset for assessing vulnerability.

To develop the prior event rating, the total range of past occurrences (38 to 117) was divided into 10 roughly equal ranges as shown in Table 13. The ranges were numbered 1 through 10 in ascending order.

Table 13 Winter Storm Prior Event Ratings

# of Past Occurrences	Rating
38-45	1
46-53	2
54-61	3
62-69	4
70-77	5
78-85	6
86-93	7
94-101	8

102-109	9
110-117	10

A fourth factor, past winter storm damage, may be considered for the next plan update based on the availability of information. Currently, county-level damage information is not available for winter storms. The damage values captured in the National Climatic Data Center's Storm Event database are for an entire event and cannot be approximated for each individual county.

After rating each of the counties on the factors described above, each factor was separately added with building exposure ratings and population density ratings to produce a county-level vulnerability rating. The highest possible total vulnerability rating is 28. The range of vulnerability (3 to 28) was divided into three equal ranges as shown in Table 14. The ranges were assigned a corresponding level of winter storm vulnerability: moderate, high, and very high.

Table 14 Winter Storm Vulnerability

Winter Storm Vulnerability Range	Winter Storm Vulnerability
3-11	Moderate
12-20	High
21-28	Very High

The table below provides details on each counties' individual ratings for each factor.

Table 15 Winter Storm Vulnerability Calculations

County	Total Events	Prior Event Rating	Total Building Exposure	Building Exposure Rating (Natural	New Population Density	Pop Density Rating (Natural Breaks)	Vuln. Rating	Vuln. Rating Category
Aurora	84	6	$343,330	3	3.9	3	12	High
Beadle	83	6	$1,950,510	7	14.4	7	20	High
Bennett	54	3	$247,449	2	2.9	3	8	Moderate
Bon Homme	85	6	$684,668	5	12.1	6	17	High
Brookings	92	7	$3,232,047	8	41.4	8	23	Very High
Brown	71	5	$4,022,770	8	22.2	8	21	Very High
Brule	82	6	$598,841	4	6.3	4	14	High
Buffalo	49	2	$114,735	1	4.3	3	6	Moderate
Butte	79	6	$859,242	5	4.5	4	15	High
Campbell	53	2	$211,527	2	1.8	2	6	Moderate
Charles Mix	83	6	$979,078	6	8.1	5	17	High
Clark	62	4	$461,331	4	3.8	3	11	Moderate
Clay	64	4	$1,352,347	6	33.4	8	18	High

County	Total Events	Prior Event Rating	Total Building Exposure	Building Exposure Rating (Natural	New Population Density	Pop Density Rating (Natural Breaks)	Vuln. Rating	Vuln. Rating Category
Codington	59	3	$3,141,546	8	39.0	8	19	High
Corson	56	3	$261,189	2	1.7	1	6	Moderate
Custer	38	1	$1,059,574	6	5.4	4	11	Moderate
Davison	80	6	$2,033,945	7	45.5	9	22	Very High
Day	72	5	$739,380	5	5.1	4	14	High
Deuel	63	4	$557,548	4	6.8	5	13	High
Dewey	59	3	$326,693	3	2.3	2	8	Moderate
Douglas	70	5	$410,033	3	6.8	5	13	High
Edmunds	76	5	$428,157	4	3.5	3	12	High
Fall River	51	2	$772,078	5	3.9	3	10	Moderate
Faulk	69	4	$319,966	3	2.3	2	9	Moderate
Grant	71	5	$852,422	5	10.5	6	16	High
Gregory	74	5	$499,638	4	4.0	3	12	High
Haakon	53	2	$304,961	3	1.0	1	6	Moderate
Hamlin	58	3	$657,563	5	11.1	6	14	High
Hand	65	4	$489,795	4	2.3	2	10	Moderate
Hanson	83	6	$375,684	3	7.8	5	14	High
Harding	76	5	$134,729	1	0.5	1	7	Moderate
Hughes	57	3	$2,011,351	7	22.0	7	17	High
Hutchinson	88	7	$921,743	6	8.8	5	18	High
Hyde	57	3	$174,088	2	1.6	1	6	Moderate
Jackson	58	3	$279,813	2	1.7	1	6	Moderate
Jerauld	79	6	$292,480	2	3.8	3	11	Moderate
Jones	52	2	$154,067	1	1.0	1	4	Moderate
Kingsbury	79	6	$718,391	5	5.9	4	15	High
Lake	86	7	$1,464,020	7	21.5	7	21	Very High
Lawrence	69	4	$2,942,654	8	30.8	8	20	High
Lincoln	83	6	$4,858,425	9	89.1	9	24	Very High
Lyman	57	3	$387,530	3	2.3	2	8	Moderate
Marshall	78	6	$613,226	4	6.4	5	15	High
McCook	88	7	$337,182	3	4.2	3	13	High
McPherson	66	4	$569,412	4	4.1	3	11	Moderate
Meade	114	10	$2,374,927	7	7.7	5	22	Very High
Mellette	50	2	$145,156	1	1.6	1	4	Moderate

County	Total Events	Prior Event Rating	Total Building Exposure	Building Exposure Rating (Natural	New Population Density	Pop Density Rating (Natural Breaks)	Vuln. Rating	Vuln. Rating Category
Miner	79	6	$300,577	2	4.0	3	11	Moderate
Minnehaha	96	8	$19,134,385	10	224.8	10	28	Very High
Moody	78	6	$752,929	5	12.2	6	17	High
Oglala Lakota	54	3	$762,242	5	6.8	5	13	High
Pennington	66	4	$349,270	10	38.9	8	22	Very High
Perkins	68	4	$405,402	3	1.0	1	8	Moderate
Potter	62	4	$993,542	3	2.6	2	9	Moderate
Roberts	83	6	$331,251	6	9.1	6	18	High
Sanborn	66	4	$623,369	3	4.1	3	10	Moderate
Spink	71	5	$11,128,870	5	4.4	3	13	High
Stanley	48	2	$316,125	3	2.0	2	7	Moderate
Sully	58	3	$213,590	2	1.3	1	6	Moderate
Todd	50	2	$584,882	4	7.1	5	11	Moderate
Tripp	54	3	$660,351	5	3.4	3	11	Moderate
Turner	86	7	$1,047,334	6	13.4	6	19	High
Union	67	4	$1,866,198	7	32.2	8	19	High
Walworth	59	3	$664,408	5	7.4	5	13	High
Yankton	77	5	$2,630,709	8	42.6	8	21	Very High
Ziebach	54	3	$134,376	1	1.4	1	5	Moderate

Appendix 3E - Hazus Earthquake Scenario

Appendix 3E Hazus-MH: Earthquake Event Report

Region Name: SouthDakota

Earthquake Scenario: Annualized Loss

Print Date: September 08, 2016

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

Table of Contents

Section	Page #
General Description of the Region	3
Building and Lifeline Inventory	4
Building Inventory	
Critical Facility Inventory	
Transportation and Utility Lifeline Inventory	
Earthquake Scenario Parameters	6
Direct Earthquake Damage	7
Buildings Damage	
Critical Facilities Damage	
Transportation and Utility Lifeline Damage	
Induced Earthquake Damage	11
Debris Generation	
Social Impact	12
Shelter Requirements	
Casualties	
Economic Loss	13
Building Losses	
Transportation and Utility Lifeline Losses	
Long-term Indirect Economic Impacts	
Appendix A: County Listing for the Region	
Appendix B: Regional Population and Building Value Data	

General Description of the Region

Hazus is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 66 county(ies) from the following state(s):

South Dakota

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 77,095.39 square miles and contains 222 census tracts. There are over 322 thousand households in the region which has a total population of 814,180 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 343 thousand buildings in the region with a total building replacement value (excluding contents) of 89,645 (millions of dollars). Approximately 90.00 % of the buildings (and 77.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 58,412 and 21,607 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 343 thousand buildings in the region which have an aggregate total replacement value of 89,645 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 75% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 54 hospitals in the region with a total bed capacity of 4,538 beds. There are 832 schools, 278 fire stations, 157 police stations and 24 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 161 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 80,019.00 (millions of dollars). This inventory includes over 11,937 kilometers of highways, 5,122 bridges, 68,980 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	5,122	2,373.70
	Segments	1,628	48,254.10
	Tunnels	0	0.00
		Subtotal	**50,627.80**
Railways	Bridges	0	0.00
	Facilities	16	42.60
	Segments	1,103	2,936.00
	Tunnels	0	0.00
		Subtotal	**2,978.60**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	20	19.40
		Subtotal	**19.40**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	68	724.30
	Runways	107	4,062.10
		Subtotal	**4,786.40**
		Total	**58,412.10**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	689.80
	Facilities	7	207.50
	Pipelines	0	0.00
		Subtotal	**897.30**
Waste Water	Distribution Lines	NA	413.90
	Facilities	341	20,212.40
	Pipelines	0	0.00
		Subtotal	**20,626.30**
Natural Gas	Distribution Lines	NA	275.90
	Facilities	1	1.00
	Pipelines	0	0.00
		Subtotal	**276.90**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	12	1,174.80
		Subtotal	**1,174.80**
Communication	Facilities	134	11.90
		Subtotal	**11.90**
		Total	**22,987.20**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Annualized
Type of Earthquake	Probabilistic
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	Annualized
Longitude of Epicenter	NA
Latitude of Epicenter	NA
Earthquake Magnitude	NA
Depth (Km)	NA
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	NA

Building Damage

Hazus estimates that about 4,537 buildings will be at least moderately damaged. This is over 1.00 % of the buildings in the region. There are an estimated 1 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	5,005	1.67	158	1.05	15	0.35	0	0.00	0	0.00
Commercial	8,282	2.76	66	0.44	5	0.12	0	0.00	0	0.00
Education	90	0.03	0	0.00	0	0.00	0	0.00	0	0.00
Government	287	0.10	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	1,200	0.40	0	0.00	0	0.00	0	0.00	0	0.00
Other Residential	35,501	11.83	4,072	27.02	2,157	50.08	64	27.95	0	0.00
Religion	1,126	0.38	4	0.03	1	0.02	0	0.00	0	0.00
Single Family	248,577	82.84	10,768	71.46	2,129	49.43	165	72.05	1	100.00
Total	**300,068**		**15,068**		**4,307**		**229**		**1**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	243,418	81.12	8652	57.42	978	22.71	8	3.49	0	0.00
Steel	5,620	1.87	26	0.17	10	0.23	0	0.00	0	0.00
Concrete	68	0.02	0	0.00	0	0.00	0	0.00	0	0.00
Precast	300	0.10	0	0.00	0	0.00	0	0.00	0	0.00
RM	89	0.03	0	0.00	0	0.00	0	0.00	0	0.00
URM	23,465	7.82	2418	16.05	1,172	27.21	157	68.56	1	100.00
MH	27,108	9.03	3972	26.36	2,147	49.85	64	27.95	0	0.00
Total	**300,068**		**15,068**		**4,307**		**229**		**1**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 4,538 hospital beds available for use. On the day of the earthquake, the model estimates that only 3,552 hospital beds (78.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 89.00% of the beds will be back in service. By 30 days, 98.00% will be operational.

Table 5: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	54	0	0	54
Schools	832	0	0	832
EOCs	24	0	0	24
PoliceStations	157	0	0	157
FireStations	278	0	0	278

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: Expected Damage to the Transportation Systems

System	Component		Number of Locations			
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	1,628	0	0	1,628	1,628
	Bridges	5,122	0	0	5,122	5,122
	Tunnels	0	0	0	0	0
Railways	Segments	1,103	0	0	1,103	1,103
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	16	0	0	16	16
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	20	0	0	20	20
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	68	0	0	68	68
	Runways	107	0	0	107	107

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	7	0	0	7	7
Waste Water	341	0	0	340	341
Natural Gas	1	0	0	1	1
Oil Systems	0	0	0	0	0
Electrical Power	12	0	0	12	12
Communication	134	0	0	134	134

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	34,490	142	35
Waste Water	20,694	101	25
Natural Gas	13,796	29	7
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	322,282	0	0	0	0	0
Electric Power		0	0	0	0	0

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.18 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 67.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 7,160 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 336 households to be displaced due to the earthquake. Of these, 204 people (out of a total population of 814,180) will seek temporary shelter in public shelters.

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
2 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
5 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 371.25 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 0.60 (millions of dollars); 29 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 53 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.00	0.03	0.00	0.00	0.04
	Capital-Related	0.00	0.00	0.03	0.00	0.00	0.03
	Rental	0.01	0.01	0.02	0.00	0.00	0.03
	Relocation	0.02	0.01	0.02	0.00	0.01	0.07
	Subtotal	**0.03**	**0.03**	**0.10**	**0.00**	**0.01**	**0.18**
Capital Stock Losses							
	Structural	0.04	0.02	0.03	0.00	0.01	0.10
	Non_Structural	0.12	0.05	0.05	0.01	0.02	0.24
	Content	0.03	0.01	0.02	0.01	0.01	0.08
	Inventory	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.19**	**0.08**	**0.10**	**0.02**	**0.04**	**0.43**
	Total	**0.22**	**0.10**	**0.21**	**0.02**	**0.05**	**0.60**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

Table 12: Transportation System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	48,254.10	$0.00	0.00
	Bridges	2,373.66	$0.38	0.02
	Tunnels	0.00	$0.00	0.00
	Subtotal	**50627.80**	**0.40**	
Railways	Segments	2,935.95	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	42.61	$1.90	4.45
	Subtotal	**2978.60**	**1.90**	
Light Rail	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Bus	Facilities	19.40	$0.95	4.88
	Subtotal	**19.40**	**0.90**	
Ferry	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Port	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Airport	Facilities	724.27	$39.09	5.40
	Runways	4,062.15	$0.00	0.00
	Subtotal	**4786.40**	**39.10**	
	Total	**58412.10**	**42.30**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	$0.00	0.00
	Facilities	207.50	$2.16	1.04
	Distribution Lines	689.80	$0.64	0.09
	Subtotal	**897.26**	**$2.80**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	20,212.40	$308.52	1.53
	Distribution Lines	413.90	$0.46	0.11
	Subtotal	**20,626.31**	**$308.98**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	1.00	$0.00	0.47
	Distribution Lines	275.90	$0.13	0.05
	Subtotal	**276.89**	**$0.14**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	1,174.80	$16.24	1.38
	Subtotal	**1,174.80**	**$16.24**	
Communication	Facilities	11.90	$0.19	1.56
	Subtotal	**11.93**	**$0.19**	
	Total	**22,987.19**	**$328.33**	

Table 14. Indirect Economic Impact with outside aid

(Employment as # of people and Income in millions of $)

LOSS		Total	%

Appendix A: County Listing for the Region

Aurora,SD

Beadle,SD

Bennett,SD

Bon Homme,SD

Brookings,SD

Brown,SD

Brule,SD

Buffalo,SD

Butte,SD

Campbell,SD

Charles Mix,SD

Clark,SD

Clay,SD

Codington,SD

Corson,SD

Custer,SD

Davison,SD

Day,SD

Deuel,SD

Dewey,SD

Douglas,SD

Edmunds,SD

Fall River,SD

Faulk,SD

Grant,SD

Gregory,SD

Haakon,SD

Hamlin,SD

Hand,SD

Hanson,SD

Harding,SD

Hughes,SD

Hutchinson,SD

Hyde,SD

Jackson,SD

Jerauld,SD

Jones,SD

Kingsbury,SD

Lake,SD

Lawrence,SD

Lincoln,SD

Lyman,SD

McCook,SD

McPherson,SD

Marshall,SD

Meade,SD

Mellette,SD

Miner,SD

Minnehaha,SD

Moody,SD

Pennington,SD

Perkins,SD

Potter,SD

Roberts,SD

Sanborn,SD

Shannon,SD

Spink,SD

Stanley,SD

Sully,SD

Todd,SD

Tripp,SD

Turner,SD

Union,SD

Walworth,SD

Yankton,SD

Ziebach,SD

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
South Dakota					
	Aurora	2,710	270	72	343
	Beadle	17,398	1,448	502	1,950
	Bennett	3,431	201	46	247
	Bon Homme	7,070	510	173	684
	Brookings	31,965	2,548	683	3,232
	Brown	36,531	3,021	1,001	4,022
	Brule	5,255	440	157	598
	Buffalo	1,912	87	27	114
	Butte	10,110	703	155	859
	Campbell	1,466	169	42	211
	Charles Mix	9,129	692	286	979
	Clark	3,691	358	102	461
	Clay	13,864	1,087	264	1,352
	Codington	27,227	2,296	845	3,141
	Corson	4,050	212	49	261
	Custer	8,216	921	138	1,059
	Davison	19,504	1,560	473	2,033
	Day	5,710	585	153	739
	Deuel	4,364	458	99	557
	Dewey	5,301	273	53	326
	Douglas	3,002	308	101	410
	Edmunds	4,071	401	105	506
	Fall River	7,094	611	160	772
	Faulk	2,364	243	76	319
	Grant	7,356	645	207	852
	Gregory	4,271	369	130	499
	Haakon	1,937	218	86	304
	Hamlin	5,903	512	144	657
	Hand	3,431	361	128	489
	Hanson	3,331	314	61	375
	Harding	1,255	102	32	134
	Hughes	17,022	1,436	574	2,011
	Hutchinson	7,343	681	240	921
	Hyde	1,420	123	50	174
	Jackson	3,031	234	45	279
	Jerauld	2,071	216	76	292
	Jones	1,006	117	36	154
	Kingsbury	5,148	563	155	718
	Lake	11,200	1,146	317	1,464
	Lawrence	24,097	2,355	586	2,942
	Lincoln	44,828	4,270	587	4,858
	Lyman	3,755	287	100	387
	McCook	5,618	475	137	613
	McPherson	2,459	239	97	337

	Marshall	4,656	447	121	569
	Meade	25,434	1,946	428	2,374
	Mellette	2,048	116	28	145
	Miner	2,389	228	72	300
	Minnehaha	169,468	14,444	4,690	19,134
	Moody	6,486	619	133	752
	Pennington	100,948	8,463	2,665	11,128
	Perkins	2,982	245	103	349
	Potter	2,329	241	164	405
	Roberts	10,149	783	209	993
	Sanborn	2,355	265	65	331
	Shannon	13,586	447	176	623
	Spink	6,415	578	183	762
	Stanley	2,966	250	65	316
	Sully	1,373	164	49	213
	Todd	9,612	472	112	584
	Tripp	5,644	461	199	660
	Turner	8,347	787	259	1,047
	Union	14,399	1,333	532	1,866
	Walworth	5,438	495	169	664
	Yankton	22,438	1,881	748	2,630
	Ziebach	2,801	119	14	134
Total State		**814,180**	**68,849**	**20,734**	**89,614**
Total Region		**814,180**	**68,849**	**20,734**	**89,614**

Direct Economic Losses For Buildings

September 13, 2016

All values are in thousands of dollars

	Capital Stock Losses					Income Losses				
	Cost Structural Damage	Cost Non-struct. Damage	Cost Contents Damage	Inventory Loss	Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
South Dakota										
Dewey	0	0	0	0	0.00	0	0	0	0	1
Beadle	3	7	3	0	0.00	2	1	1	1	18
Corson	0	0	0	0	0.00	0	0	0	0	0
Harding	0	0	0	0	0.00	0	0	0	0	0
Deuel	0	0	0	0	0.00	0	0	0	0	1
Lake	1	2	1	0	0.00	1	0	0	0	6
Sanborn	1	1	1	0	0.00	0	0	0	0	3
Hanson	0	1	0	0	0.00	0	0	0	0	3
Ziebach	0	0	0	0	0.00	0	0	0	0	0
Perkins	0	0	0	0	0.00	0	0	0	0	1
Codington	2	4	1	0	0.00	1	1	1	1	10
Turner	1	2	1	0	0.00	1	0	0	0	5
Brule	1	4	1	0	0.00	1	0	1	0	9

Study Region : SouthDakota

Scenario : 2,500yr 5.5mag

	Capital Stock Losses					Income Losses				
	Cost Structural Damage	Cost Non-struct. Damage	Cost Contents Damage	Inventory Loss	Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
Hand	1	2	1	0	0.00	0	0	0	0	4
Hutchinson	1	3	1	0	0.00	1	0	0	0	7
Pennington	24	58	19	0	0.00	16	10	12	9	148
Bon Homme	1	2	1	0	0.00	1	0	0	0	6
McCook	1	1	0	0	0.00	0	0	0	0	3
Douglas	1	2	1	0	0.00	0	0	0	0	5
Bennett	1	2	1	0	0.00	0	0	0	0	5
Walworth	0	1	0	0	0.00	0	0	0	0	1
Campbell	0	0	0	0	0.00	0	0	0	0	0
Day	0	1	0	0	0.00	0	0	0	0	2
Jackson	0	1	0	0	0.00	0	0	0	0	3
Kingsbury	1	1	0	0	0.00	0	0	0	0	3
Roberts	0	1	0	0	0.00	0	0	0	0	2
Butte	1	3	1	0	0.00	1	0	0	0	7
Miner	0	1	0	0	0.00	0	0	0	0	2
Grant	0	1	0	0	0.00	0	0	0	0	2
Jerauld	1	2	1	0	0.00	0	0	0	0	4
Clay	1	3	1	0	0.00	1	0	0	0	6

Study Region : SouthDakota

Scenario : 2,500yr 5.5mag

	Capital Stock Losses					Income Losses				
	Cost Structural Damage	Cost Non-struct. Damage	Cost Contents Damage	Inventory Loss	Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
Potter	0	1	0	0	0.00	0	0	0	0	2
Yankton	3	7	2	0	0.00	2	1	1	1	17
Tripp	1	3	1	0	0.00	1	0	1	0	8
Buffalo	0	1	0	0	0.00	0	0	0	0	1
Oglala Lakota	2	6	2	0	0.00	2	0	0	0	13
Meade	4	9	3	0	0.00	2	1	1	1	21
Fall River	3	9	4	0	0.00	2	1	1	1	22
Lincoln	3	6	2	0	0.00	1	0	1	1	14
Lawrence	5	13	4	0	0.00	4	2	3	2	34
Edmunds	0	0	0	0	0.00	0	0	0	0	1
Davison	3	8	3	0	0.00	2	1	1	1	20
Minnehaha	13	28	8	0	0.00	8	4	5	5	71
Marshall	0	0	0	0	0.00	0	0	0	0	1
Gregory	1	3	1	0	0.00	1	0	0	0	7
Hughes	2	5	2	0	0.00	1	1	1	1	12
Spink	1	1	0	0	0.00	0	0	0	0	3
Brookings	2	4	1	0	0.00	1	1	1	1	10
Clark	0	1	0	0	0.00	0	0	0	0	2

Study Region : SouthDakota

Scenario : 2,500yr 5.5mag

	Capital Stock Losses					Income Losses				
	Cost Structural Damage	Cost Non-struct. Damage	Cost Contents Damage	Inventory Loss	Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
Todd	1	3	1	0	0.00	1	0	0	0	6
Mellette	0	1	0	0	0.00	0	0	0	0	1
Faulk	0	1	0	0	0.00	0	0	0	0	1
Custer	3	8	3	0	0.00	2	1	1	1	19
Aurora	1	2	1	0	0.00	0	0	0	0	5
Lyman	1	1	1	0	0.00	0	0	0	0	4
McPherson	0	0	0	0	0.00	0	0	0	0	1
Brown	2	4	1	0	0.00	1	1	1	1	11
Haakon	0	1	0	0	0.00	0	0	0	0	2
Jones	0	0	0	0	0.00	0	0	0	0	1
Moody	0	1	0	0	0.00	0	0	0	0	2
Sully	0	0	0	0	0.00	0	0	0	0	1
Stanley	0	1	0	0	0.00	0	0	0	0	2
Hamlin	0	1	0	0	0.00	0	0	0	0	2
Hyde	0	0	0	0	0.00	0	0	0	0	1
Union	1	3	1	0	0.00	1	0	0	0	6
Charles Mix	2	6	2	0	0.00	1	2	2	1	16

Study Region : SouthDakota

Scenario : 2,500yr 5.5mag

	Capital Stock Losses					Income Losses				
	Cost Structural Damage	Cost Non-struct. Damage	Cost Contents Damage	Inventory Loss	Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
Total	101	243	82	2	0.00	66	33	43	34	604
Region Total	101	243	82	2	0.00	66	33	43	34	604

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Hazus-MH: Earthquake Event Report

Region Name: SouthDakota

Earthquake Scenario: 2,500yr 5.5mag

Print Date: September 08, 2016

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

Table of Contents

Section	Page #
General Description of the Region	3
Building and Lifeline Inventory	4
Building Inventory	
Critical Facility Inventory	
Transportation and Utility Lifeline Inventory	
Earthquake Scenario Parameters	6
Direct Earthquake Damage	7
Buildings Damage	
Critical Facilities Damage	
Transportation and Utility Lifeline Damage	
Induced Earthquake Damage	11
Debris Generation	
Social Impact	12
Shelter Requirements	
Casualties	
Economic Loss	13
Building Losses	
Transportation and Utility Lifeline Losses	
Long-term Indirect Economic Impacts	
Appendix A: County Listing for the Region	
Appendix B: Regional Population and Building Value Data	

General Description of the Region

Hazus is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 66 county(ies) from the following state(s):

South Dakota

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 77,095.39 square miles and contains 222 census tracts. There are over 322 thousand households in the region which has a total population of 814,180 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 343 thousand buildings in the region with a total building replacement value (excluding contents) of 89,645 (millions of dollars). Approximately 90.00 % of the buildings (and 77.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 58,412 and 21,607 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 343 thousand buildings in the region which have an aggregate total replacement value of 89,645 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 75% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 54 hospitals in the region with a total bed capacity of 4,538 beds. There are 832 schools, 278 fire stations, 157 police stations and 24 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 161 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 80,019.00 (millions of dollars). This inventory includes over 11,937 kilometers of highways, 5,122 bridges, 68,980 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	5,122	2,373.70
	Segments	1,628	48,254.10
	Tunnels	0	0.00
		Subtotal	**50,627.80**
Railways	Bridges	0	0.00
	Facilities	16	42.60
	Segments	1,103	2,936.00
	Tunnels	0	0.00
		Subtotal	**2,978.60**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	20	19.40
		Subtotal	**19.40**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	68	724.30
	Runways	107	4,062.10
		Subtotal	**4,786.40**
		Total	**58,412.10**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	689.80
	Facilities	7	207.50
	Pipelines	0	0.00
		Subtotal	**897.30**
Waste Water	Distribution Lines	NA	413.90
	Facilities	341	20,212.40
	Pipelines	0	0.00
		Subtotal	**20,626.30**
Natural Gas	Distribution Lines	NA	275.90
	Facilities	1	1.00
	Pipelines	0	0.00
		Subtotal	**276.90**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	12	1,174.80
		Subtotal	**1,174.80**
Communication	Facilities	134	11.90
		Subtotal	**11.90**
		Total	**22,987.20**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	2,500yr 5.5mag
Type of Earthquake	Probabilistic
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	2,500.00
Longitude of Epicenter	NA
Latitude of Epicenter	NA
Earthquake Magnitude	5.50
Depth (Km)	NA
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	NA

Building Damage

Hazus estimates that about 6,930 buildings will be at least moderately damaged. This is over 2.00 % of the buildings in the region. There are an estimated 62 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	6,193	1.95	482	2.61	170	2.77	28	3.83	2	2.91
Commercial	16,980	5.33	1,520	8.23	710	11.58	130	17.73	9	14.29
Education	755	0.24	58	0.32	26	0.42	3	0.47	0	0.69
Government	1,076	0.34	76	0.41	34	0.55	4	0.55	1	0.82
Industrial	4,250	1.34	368	2.00	186	3.04	34	4.60	2	2.75
Other Residential	38,482	12.09	4,830	26.16	2,584	42.11	183	24.94	9	14.22
Religion	1,816	0.57	147	0.80	66	1.08	13	1.75	1	2.17
Single Family	248,792	78.15	10,981	59.48	2,360	38.46	338	46.13	39	62.14
Total	**318,344**		**18,461**		**6,136**		**732**		**63**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	246,131	77.32	9323	50.50	1,169	19.06	64	8.80	0	0.05
Steel	13,764	4.32	1106	5.99	590	9.62	98	13.33	2	3.35
Concrete	1,470	0.46	101	0.54	37	0.61	3	0.46	0	0.10
Precast	1,784	0.56	121	0.65	92	1.50	21	2.94	0	0.40
RM	859	0.27	49	0.26	32	0.52	6	0.76	0	0.02
URM	27,028	8.49	3594	19.47	1,877	30.60	401	54.80	56	89.10
MH	27,309	8.58	4169	22.58	2,337	38.10	138	18.91	4	6.97
Total	**318,344**		**18,461**		**6,136**		**732**		**63**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 4,538 hospital beds available for use. On the day of the earthquake, the model estimates that only 3,552 hospital beds (78.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 89.00% of the beds will be back in service. By 30 days, 98.00% will be operational.

Table 5: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	54	0	0	54
Schools	832	0	0	832
EOCs	24	0	0	24
PoliceStations	157	0	0	157
FireStations	278	0	0	278

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: Expected Damage to the Transportation Systems

System	Component		Number of Locations			
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	1,628	0	0	1,628	1,628
	Bridges	5,122	0	0	5,122	5,122
	Tunnels	0	0	0	0	0
Railways	Segments	1,103	0	0	1,103	1,103
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	16	0	0	16	16
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	20	0	0	20	20
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	68	0	0	68	68
	Runways	107	0	0	107	107

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	7	0	0	7	7
Waste Water	341	0	0	340	341
Natural Gas	1	0	0	1	1
Oil Systems	0	0	0	0	0
Electrical Power	12	0	0	12	12
Communication	134	0	0	134	134

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	34,490	142	35
Waste Water	20,694	101	25
Natural Gas	13,796	29	7
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	322,282	0	0	0	0	0
Electric Power		0	0	0	0	0

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.18 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 67.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 7,160 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 336 households to be displaced due to the earthquake. Of these, 204 people (out of a total population of 814,180) will seek temporary shelter in public shelters.

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	1	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	2	0	0	0
	Other-Residential	50	7	0	1
	Single Family	49	6	1	1
	Total	**102**	**13**	**1**	**2**
2 PM	Commercial	84	12	1	2
	Commuting	0	0	0	0
	Educational	30	5	0	1
	Hotels	0	0	0	0
	Industrial	13	2	0	0
	Other-Residential	10	1	0	0
	Single Family	9	1	0	0
	Total	**146**	**21**	**2**	**3**
5 PM	Commercial	61	9	1	1
	Commuting	0	0	0	0
	Educational	3	0	0	0
	Hotels	0	0	0	0
	Industrial	8	1	0	0
	Other-Residential	19	3	0	0
	Single Family	19	3	0	0
	Total	**110**	**15**	**1**	**3**

Economic Loss

The total economic loss estimated for the earthquake is 949.15 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 578.51 (millions of dollars); 25 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 55 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	4.02	27.54	0.73	2.57	34.86
	Capital-Related	0.00	1.72	23.48	0.44	0.50	26.13
	Rental	5.25	9.46	12.17	0.29	0.82	27.99
	Relocation	17.68	7.66	19.66	1.71	7.31	54.02
	Subtotal	**22.94**	**22.85**	**82.85**	**3.18**	**11.20**	**143.00**
Capital Stock Losses							
	Structural	33.06	14.16	22.67	3.83	9.37	83.10
	Non_Structural	126.04	46.61	48.99	9.83	19.05	250.51
	Content	43.27	10.95	26.94	6.35	11.64	99.15
	Inventory	0.00	0.00	0.81	1.39	0.55	2.75
	Subtotal	**202.37**	**71.73**	**99.40**	**21.40**	**40.61**	**435.51**
	Total	**225.31**	**94.57**	**182.25**	**24.58**	**51.80**	**578.51**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

Table 12: Transportation System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	48,254.10	$0.00	0.00
	Bridges	2,373.66	$0.38	0.02
	Tunnels	0.00	$0.00	0.00
	Subtotal	**50627.80**	**0.40**	
Railways	Segments	2,935.95	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	42.61	$1.90	4.45
	Subtotal	**2978.60**	**1.90**	
Light Rail	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Bus	Facilities	19.40	$0.95	4.88
	Subtotal	**19.40**	**0.90**	
Ferry	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Port	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Airport	Facilities	724.27	$39.09	5.40
	Runways	4,062.15	$0.00	0.00
	Subtotal	**4786.40**	**39.10**	
	Total	**58412.10**	**42.30**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	$0.00	0.00
	Facilities	207.50	$2.16	1.04
	Distribution Lines	689.80	$0.64	0.09
	Subtotal	**897.26**	**$2.80**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	20,212.40	$308.52	1.53
	Distribution Lines	413.90	$0.46	0.11
	Subtotal	**20,626.31**	**$308.98**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	1.00	$0.00	0.47
	Distribution Lines	275.90	$0.13	0.05
	Subtotal	**276.89**	**$0.14**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	1,174.80	$16.24	1.38
	Subtotal	**1,174.80**	**$16.24**	
Communication	Facilities	11.90	$0.19	1.56
	Subtotal	**11.93**	**$0.19**	
	Total	**22,987.19**	**$328.33**	

Table 14. Indirect Economic Impact with outside aid

(Employment as # of people and Income in millions of $)

LOSS	Total	%

Appendix A: County Listing for the Region

Aurora,SD

Beadle,SD

Bennett,SD

Bon Homme,SD

Brookings,SD

Brown,SD

Brule,SD

Buffalo,SD

Butte,SD

Campbell,SD

Charles Mix,SD

Clark,SD

Clay,SD

Codington,SD

Corson,SD

Custer,SD

Davison,SD

Day,SD

Deuel,SD

Dewey,SD

Douglas,SD

Edmunds,SD

Fall River,SD

Faulk,SD

Grant,SD

Gregory,SD

Haakon,SD

Hamlin,SD

Hand,SD

Hanson,SD

Harding,SD

Hughes,SD

Hutchinson,SD

Hyde,SD

Jackson,SD

Jerauld,SD

Jones,SD

Kingsbury,SD

Lake,SD

Lawrence,SD

Lincoln,SD

Lyman,SD

McCook,SD

McPherson,SD

Marshall,SD

Meade,SD

Mellette,SD

Miner,SD

Minnehaha,SD

Moody,SD

Pennington,SD

Perkins,SD

Potter,SD

Roberts,SD

Sanborn,SD

Shannon,SD

Spink,SD

Stanley,SD

Sully,SD

Todd,SD

Tripp,SD

Turner,SD

Union,SD

Walworth,SD

Yankton,SD

Ziebach,SD

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
South Dakota					
	Aurora	2,710	270	72	343
	Beadle	17,398	1,448	502	1,950
	Bennett	3,431	201	46	247
	Bon Homme	7,070	510	173	684
	Brookings	31,965	2,548	683	3,232
	Brown	36,531	3,021	1,001	4,022
	Brule	5,255	440	157	598
	Buffalo	1,912	87	27	114
	Butte	10,110	703	155	859
	Campbell	1,466	169	42	211
	Charles Mix	9,129	692	286	979
	Clark	3,691	358	102	461
	Clay	13,864	1,087	264	1,352
	Codington	27,227	2,296	845	3,141
	Corson	4,050	212	49	261
	Custer	8,216	921	138	1,059
	Davison	19,504	1,560	473	2,033
	Day	5,710	585	153	739
	Deuel	4,364	458	99	557
	Dewey	5,301	273	53	326
	Douglas	3,002	308	101	410
	Edmunds	4,071	401	105	506
	Fall River	7,094	611	160	772
	Faulk	2,364	243	76	319
	Grant	7,356	645	207	852
	Gregory	4,271	369	130	499
	Haakon	1,937	218	86	304
	Hamlin	5,903	512	144	657
	Hand	3,431	361	128	489
	Hanson	3,331	314	61	375
	Harding	1,255	102	32	134
	Hughes	17,022	1,436	574	2,011
	Hutchinson	7,343	681	240	921
	Hyde	1,420	123	50	174
	Jackson	3,031	234	45	279
	Jerauld	2,071	216	76	292
	Jones	1,006	117	36	154
	Kingsbury	5,148	563	155	718
	Lake	11,200	1,146	317	1,464
	Lawrence	24,097	2,355	586	2,942
	Lincoln	44,828	4,270	587	4,858
	Lyman	3,755	287	100	387
	McCook	5,618	475	137	613
	McPherson	2,459	239	97	337

	Marshall	4,656	447	121	569
	Meade	25,434	1,946	428	2,374
	Mellette	2,048	116	28	145
	Miner	2,389	228	72	300
	Minnehaha	169,468	14,444	4,690	19,134
	Moody	6,486	619	133	752
	Pennington	100,948	8,463	2,665	11,128
	Perkins	2,982	245	103	349
	Potter	2,329	241	164	405
	Roberts	10,149	783	209	993
	Sanborn	2,355	265	65	331
	Shannon	13,586	447	176	623
	Spink	6,415	578	183	762
	Stanley	2,966	250	65	316
	Sully	1,373	164	49	213
	Todd	9,612	472	112	584
	Tripp	5,644	461	199	660
	Turner	8,347	787	259	1,047
	Union	14,399	1,333	532	1,866
	Walworth	5,438	495	169	664
	Yankton	22,438	1,881	748	2,630
	Ziebach	2,801	119	14	134
Total State		**814,180**	**68,849**	**20,734**	**89,614**
Total Region		**814,180**	**68,849**	**20,734**	**89,614**

Appendix 3F - Critical Facilities in Flood and Wildfire Zones

Table 3Ha – Critical Facilities in the DFIRM 1% Annual Chance Floodplain

State Facilities	Count
Army National Guard	3
Board of Regents	12
Depart of Environment & NatRes	1
Department of Agriculture	2
Department of Health	1
Department of Human Services	2
Department of Labor	1
Department of Public Safety	1
Department of Revenue	1
Department of Social Services	1
Department of Transportation	1
Office of the Attorney General	1
State Fuel Sites	2
Total	**29**

Non State Facilities	Count
Airport	1
Communication	14
EMS	4
Fire	12
Natural Gas Facility	6
Police	3
Power	5
Private School	2
Public School	17
Tier II Facilities	60
Waste Water Facility	46
Water Facility	1
Total	**171**

Table 3Hb – Critical Facilities in the DFIRM 0.2% Annual Chance Floodplain

State Facilities	Count
Board of Eng & Arch Examiners	1
Board of Regents	9
Bureau of Info & Telecomm	2
Depart of Environment & NatRes	1
Department of Corrections	3
Department of Labor	1
Department of Public Safety	1
Department of Revenue	1
Department of Social Services	1
Department of Transportation	2
State Fuel Sites	1
Total	**23**

Non State Facilities	Count
Communication	4
EMS	3
Fire	8
Hospital	2
Natural Gas Facility	4
Police	4
Power	3
Public School	10
Substation	2
Tier II Facilities	34
Waste Water Facility	7
Total	**81**

Table 3Hc – Critical Facilities in Areas Protected by Levees

State Facilities	Count
Army National Guard	1
Depart of Military & Vet Affairs	1
Depart of Tourism & State Devel	1
Department of Health	1
Total	**4**

Non State Facilities	Count
Airport	1
Communication	2
EMS	2
Fire	4
Higher Education	1
Natural Gas Facility	1
Private School	4
Public School	7
Tier II Facilities	43
Total	**65**

Table 3Hd – Critical Facilities in the HAZUS 1% Annual Chance Floodplain

Non State Facilities	Count
Airport	1
Communication	4
Fire	4
Hospital	1
Natural Gas Facility	3
Police	2
Public School	13
Tier II Facilities	17
Waste Water Facility	29
Water Facility	1
Total	**75**

*No State Facilities Found

Table 3He – DFIRM and HAZUS Total Flooded Critical Facilities

State vs Non State	Flood	Type	Count
State	0.2% Chance	Board of Eng & Arch Examiners	1
State	0.2% Chance	Board of Regents	9
State	0.2% Chance	Bureau of Info & Telecomm	2
State	0.2% Chance	Depart of Environment & NatRes	1
State	0.2% Chance	Department of Corrections	3
State	0.2% Chance	Department of Labor	1
State	0.2% Chance	Department of Public Safety	1
State	0.2% Chance	Department of Revenue	1
State	0.2% Chance	Department of Social Services	1
State	0.2% Chance	Department of Transportation	2
State	0.2% Chance	State Fuel Sites	1
State	1% Chance	Army National Guard	3
State	1% Chance	Board of Regents	12
State	1% Chance	Depart of Environment & NatRes	1
State	1% Chance	Department of Agriculture	2
State	1% Chance	Department of Health	1
State	1% Chance	Department of Human Services	2
State	1% Chance	Department of Labor	1
State	1% Chance	Department of Public Safety	1
State	1% Chance	Department of Revenue	1
State	1% Chance	Department of Social Services	1
State	1% Chance	Department of Transportation	1
State	1% Chance	Office of the Attorney General	1
State	1% Chance	State Fuel Sites	2
State	Leveed Area	Army National Guard	1
State	Leveed Area	Depart of Military & Vet Affairs	1
State	Leveed Area	Depart of Tourism & State Devel	1
State	Leveed Area	Department of Health	1
Non-State	0.2% Chance	Communication	4
Non-State	0.2% Chance	EMS	3
Non-State	0.2% Chance	Fire	8
Non-State	0.2% Chance	Hospital	2
Non-State	0.2% Chance	Natural Gas Facility	4
Non-State	0.2% Chance	Police	4
Non-State	0.2% Chance	Power	3
Non-State	0.2% Chance	Public School	10
Non-State	0.2% Chance	Substation	2

State vs Non State	Flood	Type	Count
Non-State	0.2% Chance	Waste Water Facility	7
Non-State	1% Chance	Airport	1
Non-State	1% Chance	Communication	14
Non-State	1% Chance	EMS	4
Non-State	1% Chance	Fire	12
Non-State	1% Chance	Natural Gas Facility	6
Non-State	1% Chance	Police	3
Non-State	1% Chance	Power	5
Non-State	1% Chance	Private School	2
Non-State	1% Chance	Public School	17
Non-State	1% Chance	Waste Water Facility	46
Non-State	1% Chance	Water Facility	1
Non-State	Hazus 100yr	Airport	1
Non-State	Hazus 100yr	Communication	4
Non-State	Hazus 100yr	Fire	4
Non-State	Hazus 100yr	Hospital	1
Non-State	Hazus 100yr	Natural Gas Facility	3
Non-State	Hazus 100yr	Police	2
Non-State	Hazus 100yr	Public School	13
Non-State	Hazus 100yr	Waste Water Facility	29
Non-State	Hazus 100yr	Water Facility	1
Non-State	Leveed Area	Airport	1
Non-State	Leveed Area	Communication	2
Non-State	Leveed Area	EMS	2
Non-State	Leveed Area	Fire	4
Non-State	Leveed Area	Higher Education	1
Non-State	Leveed Area	Natural Gas Facility	1
Non-State	Leveed Area	Private School	4
Non-State	Leveed Area	Public School	7

Table 3Hf – Critical Facilities in the High & Moderate Fire Risk Zones

Critical Facilities	Count
Airport	2
Army National Guard	3
Board of Regents	3
Bureau of Administration	3
Bureau of Info & Telecomm	2
Communication	16
Department of Environment & Natural Resources	1
Depart of Game, Fish & Parks	3
Depart of Tourism & State Development	2
Department of Agriculture	1
Department of Corrections	4
Department of Education	2
Department of Health	5
Department of Labor	6
Department of Legislative Audit	1
Department of Public Safety	5
Department of Revenue	3
Department of Social Services	12
Department of Transportation	10
Division of Criminal Investigation	1
EMS	60
Fire	89
HAZMAT	16
Higher Education	1
Hospital	12
Natural Gas Facility	15
Office of the Attorney General	2
Police	40
Power	3
Private School	11
Public School	93
Public Utility Commission	1
SD Building Authority	1
SD Retirement	1
State Fuel Sites	15
Substation	10
Waste Water Facility	26
Total	**481**

Table 3Hg-State Facilities in Fire Zones by State Agency

Agency	Count
BOA	7
DDN	34
DOA	1
DOC	3
DOH	10
DPS	5
DRR	2
DSS	14
Educational Facility	6
Electric Power	1
GFP	11
Natural Gas Pipe	1
Office Building	1
TSD	3
Unknown	1
Total	**100**

Table 3Hh- State Facilities within a 0.5 mile buffer of Tier II Facilities by County

County	Count
Aurora	2
Beadle	15
Bon Homme	3
Brookings	37
Brown	34
Brule	5
Butte	5
Campbell	2
Charles Mix	6
Clark	1
Clay	29
Codington	7
Corson	3
Custer	6
Davison	8
Day	2
Deuel	2
Dewey	6
Douglas	2
Edmunds	2
Fall River	7

County	Count
Faulk	2
Grant	2
Gregory	2
Haakon	2
Hand	2
Harding	1
Hughes	67
Hutchinson	2
Hyde	2
Jackson	1
Jerauld	1
Kingsbury	2
Lake	10
Lawrence	26
Lincoln	5
Lyman	2
Marshall	1
McCook	2
McPherson	2
Meade	4
Minnehaha	24
Moody	1
Oglala Lakota	2
Pennington	55
Perkins	6
Potter	1
Roberts	6
Sanborn	2
Stanley	1
Todd	3
Tripp	4
Union	1
Walworth	2
Yankton	8
Ziebach	2
Total	**440**

Table 3Hi- State Facilities within a 0.5 mile buffer of Tier II Facilities

State Facilities	Count
Airport	1
Army National Guard	21
Board of Eng & Arch Examiners	1
Board of Regents	137
Bureau of Administration	9
Bureau of Info & Telecomm	7
Bureau of Personnel	1
Depart of Environment & NatRes	4
Depart of Game, Fish & Parks	6
Depart of Military & Vet Affairs	2
Depart of Tourism & State Devel	5
Department of Agriculture	7
Department of Corrections	17
Department of Education	3
Department of Health	13
Department of Human Services	7
Department of Labor	24
Department of Legislative Audit	2
Department of Public Safety	14
Department of Revenue	13
Department of Social Services	30
Department of Transportation	49
Division of Criminal Investigation	1
Investment Council	1
Office of the Attorney General	5
Parks & Recreation Division	1
Public Utility Commission	1
SD Building Authority	1
SD Federal Property Agency	1
SD Retirement	1
SD State Fair Commission	1
State Fuel Sites	53
Unified Judicial System	1
Total	**440**

Table 3Hj- State Facilities within a 0.5 mile buffer of Railroad Corridors

State Facilities	Count
Army National Guard	12
Board of Eng & Arch Examiners	1
Board of Regents	51
Bureau of Administration	8
Bureau of Info & Telecomm	4
Bureau of Personnel	1
Depart of Environment & NatRes	3
Depart of Game, Fish & Parks	5
Depart of Military & Vet Affairs	2
Depart of Tourism & State Devel	4
Department of Agriculture	4
Department of Corrections	11
Department of Education	2
Department of Health	6
Department of Human Services	6
Department of Labor	19
Department of Legislative Audit	2
Department of Public Safety	7
Department of Revenue	9
Department of Social Services	14
Department of Transportation	22
Office of the Attorney General	3
Parks & Recreation Division	1
Public Utility Commission	1
SD Building Authority	1
SD Federal Property Agency	1
SD Retirement	1
SD State Fair Commission	1
State Fuel Sites	21
Unified Judicial System	1
Total	**224**

Table 3Hk- State Facilities within a 0.5 mile buffer of Highway Corridors

State Facilities	Count
Airport	1
Army National Guard	14
Board of Eng & Arch Examiners	1
Board of Regents	308
Bureau of Administration	9
Bureau of Info & Telecomm	6
Bureau of Personnel	1
Depart of Environment & NatRes	3
Depart of Game, Fish & Parks	6
Depart of Military & Vet Affairs	3
Depart of Tourism & State Devel	4
Department of Agriculture	7
Department of Corrections	13
Department of Education	4
Department of Health	13
Department of Human Services	6
Department of Labor	22
Department of Legislative Audit	2
Department of Public Safety	13
Department of Revenue	9
Department of Social Services	29
Department of Transportation	74
Division of Criminal Investigation	1
Investment Council	1
Office of the Attorney General	5
Parks & Recreation Division	1
Public Utility Commission	1
SD Building Authority	1
SD Developmental Center	1
SD Federal Property Agency	1
SD Retirement	1
SD State Fair Commission	1
State Fuel Sites	82
Unified Judicial System	1
Total	**645**

Appendix 4A - NFIP Participating Communities

Federal Emergency Management Agency
Community Status Book Report
SOUTH DAKOTA
Communities Participating in the National Flood Program

CID	Community Name	County	Init FHBM Identified	Init FIRM Identified	Curr Eff Map Date	Reg-Emer Date	Tribal
460007#	ABERDEEN, CITY OF	BROWN COUNTY	10/05/73	06/01/78	09/29/10	06/01/78	No
460153#	ALEXANDRIA, CITY OF	HANSON COUNTY	06/27/75	09/02/09	09/02/09	01/19/10	No
460096	ALPENA, CITY OF	JERAULD COUNTY	09/26/75		(NSFHA)	06/08/98	No
460234	ARMOUR, CITY OF	DOUGLAS COUNTY	08/06/76	10/01/86	10/01/86(L)	10/01/86	No
461207	ARTAS, CITY OF	CAMPBELL COUNTY			(NSFHA)	06/08/98	No
460097#	ARTESIAN, TOWN OF	SANBORN COUNTY	08/08/75	07/22/10	(NSFHA)	02/11/85	No
460077#	ASHTON, CITY OF	SPINK COUNTY	12/06/74	10/19/10	(NSFHA)	12/12/12	No
460293#	AURORA COUNTY *	AURORA COUNTY		11/19/03	11/19/03	02/02/09	No
460051#	AURORA, CITY OF	BROOKINGS COUNTY		07/16/08	07/16/08	07/16/08	No
460154	AVON, CITY OF	BON HOMME COUNTY	10/29/76		(NSFHA)	06/08/98	No
460058#	BALTIC, TOWN OF	MINNEHAHA COUNTY	12/06/74	11/19/80	09/02/09	11/19/80	No
460251#	BEADLE COUNTY *	BEADLE COUNTY	01/10/78	10/01/97	06/02/09	10/01/97	No
460012#	BELLE FOURCHE, CITY OF	BUTTE COUNTY	11/02/73	06/01/77	01/06/12	06/01/77	No
460156#	BIG STONE CITY, CITY OF	GRANT COUNTY	11/12/76	07/01/98	11/04/09(M)	07/01/98	No
460039#	BLUNT, CITY OF	HUGHES COUNTY	10/10/75	05/15/80	05/17/04	05/15/80	No
460252	BON HOMME COUNTY *	BON HOMME COUNTY			(NSFHA)	06/08/98	No
460089#	BOX ELDER, CITY OF	PENNINGTON COUNTY	10/25/74	05/15/80	06/03/13	05/15/80	No
460296#	BRANDON,CITY OF	MINNEHAHA COUNTY	11/19/76	07/10/79	11/16/11	07/10/79	No
460158#	BRIDGEWATER, CITY OF	MCCOOK COUNTY	11/19/76	06/18/13	(NSFHA)	07/11/11	No
460101#	BRISTOL, CITY OF	DAY COUNTY	06/03/77	12/06/01	(NSFHA)	04/25/97	No
460159	BRITTON, CITY OF	MARSHALL COUNTY			(NSFHA)	06/08/98	No
460253#	BROOKINGS COUNTY*	BROOKINGS COUNTY	12/20/77	01/01/87	07/16/08(M)	01/01/87	No
460004#	BROOKINGS, CITY OF	BROOKINGS COUNTY	03/22/74	10/17/78	07/16/08	10/17/78	No
460006#	BROWN COUNTY *	BROWN COUNTY	12/20/74	09/30/88	09/29/10	09/30/88	No
460005#	BRUCE, TOWN OF	BROOKINGS COUNTY	09/13/74	02/05/80	07/16/08(M)	02/05/80	No
460284	BRULE COUNTY *	BRULE COUNTY			(NSFHA)	06/08/98	No
460255	BUFFALO COUNTY *	BUFFALO COUNTY			(NSFHA)	06/08/98	No
460161	BURKE, CITY OF	GREGORY COUNTY			(NSFHA)	06/08/98	No
460236#	BUTTE COUNTY*	BUTTE COUNTY	12/20/77	01/06/12	01/06/12	01/06/12	No
460256	CAMPBELL COUNTY *	CAMPBELL COUNTY			(NSFHA)	06/08/98	No
460162#	CANISTOTA,CITY OF	MCCOOK COUNTY	08/13/76	06/18/13	(NSFHA)	04/25/97	No
460102	CANOVA, CITY OF	MINER COUNTY	05/20/77		(NSFHA)	04/25/97	No
460047#	CANTON, CITY OF	LINCOLN COUNTY	08/16/74	09/04/85	04/02/08(M)	09/04/85	No
460035	CASTLEWOOD, CITY OF	HAMLIN COUNTY	05/17/74	04/15/86	04/15/86(M)	04/15/86	No
461212#	CAVOUR, TOWN OF	BEADLE COUNTY		06/02/09	06/02/09(M)	06/08/98	No
460163	CENTERVILLE, CITY OF	TURNER COUNTY	08/13/76		(NSFHA)	06/08/98	No
461200#	CENTRAL CITY, TOWN OF	LAWRENCE COUNTY		04/17/12	04/17/12(M)	09/24/12	No
460164	CHAMBERLAIN, CITY OF	BRULE COUNTY	06/25/76		(NSFHA)	07/15/85	No
460104	CHANCELLOR, TOWN OF	TURNER COUNTY			(NSFHA)	06/08/98	No
460257#	CHARLES MIX COUNTY *	CHARLES MIX COUNTY	01/10/78	07/01/98	06/02/04	07/01/98	No
461209	CHELSEA, TOWN OF	FAULK COUNTY			(NSFHA)	06/08/98	No
461203#	CHEYENNE RIVER INDIAN RESERVATION DEWEY	DEWEY COUNTY/ZIEBACH COUNTY		05/03/04	05/03/04	06/08/98	Yes
460105#	CLAREMONT, TOWN OF NSFHA COMMUNITY.	BROWN COUNTY	04/25/75	09/30/88	(NSFHA)	03/05/10	No
460258	CLARK COUNTY *	CLARK COUNTY			(NSFHA)	06/08/98	No
460013	CLARK, CITY OF	CLARK COUNTY	03/12/76	07/01/98	07/01/98(L)	07/01/98	No
460259#	CLAY COUNTY*	CLAY COUNTY	10/18/77	08/05/10	08/05/10(L)	04/01/87	No
460260#	CODINGTON COUNTY*	CODINGTON COUNTY	01/24/78	02/01/86	01/16/09	02/01/86	No
460106#	COLMAN, CITY OF	MOODY COUNTY	07/11/75	08/19/08	(NSFHA)	02/11/85	No
460084	COLOME, CITY OF	TRIPP COUNTY	05/10/74	05/01/86	05/01/86(L)	05/01/86	No
460166#	COLTON, CITY OF	MINNEHAHA COUNTY	08/13/76	09/02/09	(NSFHA)	06/08/98	No

Federal Emergency Management Agency
Community Status Book Report
SOUTH DAKOTA
Communities Participating in the National Flood Program

CID	Community Name	County	Init FHBM Identified	Init FIRM Identified	Curr Eff Map Date	Reg-Emer Date	Tribal
460008#	COLUMBIA, CITY OF	BROWN COUNTY	12/06/74	07/17/78	09/29/10	04/07/94	No
460078#	CONDE, CITY OF	SPINK COUNTY	12/20/74	10/19/10	10/19/10(M)	09/21/11	No
460071#	CORONA, TOWN OF	ROBERTS COUNTY	02/21/75	03/04/87	07/20/09(M)	03/04/87	No
460237#	CORSON COUNTY*	CORSON COUNTY		05/17/04	05/17/04	06/08/98	No
	There are no unincorporated areas in the County.						
460107	CRESBARD, TOWN OF	FAULK COUNTY	07/18/75	07/01/98	07/01/98(L)	07/01/98	No
460314D	CROOKS, CITY OF	MINNEHAHA COUNTY		09/02/09	(NSFHA)	12/07/15	No
460018#	CUSTER COUNTY*	CUSTER COUNTY	10/18/77	09/29/86	01/06/12	09/29/86	No
460019#	CUSTER, CITY OF	CUSTER COUNTY	05/24/74	01/02/81	01/06/12	01/02/81	No
460108	DALLAS, TOWN OF	GREGORY COUNTY	04/25/75		(NSFHA)	03/18/86	No
465466#	DANTE, TOWN OF	CHARLES MIX COUNTY		06/02/04	06/02/04	01/30/13	No
460086#	DAVIS, TOWN OF	TURNER COUNTY	05/02/75	03/18/86	07/02/08(M)	03/18/86	No
460020#	DAVISON COUNTY*	DAVISON COUNTY	05/20/77	04/01/87	09/29/10	04/01/87	No
460261#	DAY COUNTY *	DAY COUNTY		12/06/01	12/06/01	06/08/98	No
460168	DE SMET, CITY OF	KINGSBURY COUNTY	07/11/75		(NSFHA)	04/25/97	No
460045#	DEADWOOD, CITY OF	LAWRENCE COUNTY	07/11/75	04/16/90	04/17/12	02/03/82	No
460059#	DELL RAPIDS, CITY OF	MINNEHAHA COUNTY	05/02/75	08/15/80	09/02/09	08/15/80	No
460025	DELMONT, TOWN OF	DOUGLAS COUNTY	08/08/75	08/05/86	08/05/86(M)	08/05/86	No
460262	DEUEL COUNTY *	DEUEL COUNTY			(NSFHA)	06/08/98	No
460023	DEWEY COUNTY*	DEWEY COUNTY			(NSFHA)	06/08/98	No
460079#	DOLAND, TOWN OF	SPINK COUNTY	02/07/75	10/19/10	10/19/10(M)	11/12/85	No
460169	DUPREE, CITY OF	ZIEBACH COUNTY	04/25/75	07/01/98	07/01/98(L)	07/01/98	No
460170	EAGLE BUTTE, TOWN OF	DEWEY COUNTY	11/12/76	07/01/98	07/01/98(L)	07/01/98	No
460026#	EDGEMONT, CITY OF	FALL RIVER COUNTY	08/02/74	12/16/80	12/18/07	12/16/80	No
460264	EDMUNDS COUNTY *	EDMUNDS COUNTY			(NSFHA)	06/08/98	No
460061#	EGAN, TOWN OF	MOODY COUNTY	03/01/74	01/22/80	08/19/08(M)	01/22/80	No
460172#	ELKTON, CITY OF	BROOKINGS COUNTY	08/22/75	07/16/08	(NSFHA)	04/25/97	No
460036#	ESTELLINE, CITY OF	HAMLIN COUNTY	05/10/74	01/22/80	01/22/80(M)	01/22/80	No
460111#	ETHAN, CITY OF	DAVISON COUNTY		09/29/10	(NSFHA)	03/08/89	No
460173	EUREKA, CITY OF	MCPHERSON COUNTY	07/16/76	10/01/86	10/01/86(L)	10/01/86	No
460238#	FALL RIVER COUNTY*	FALL RIVER COUNTY	11/01/77	12/18/07	12/18/07	12/27/07	No
460265	FAULK COUNTY *	FAULK COUNTY			(NSFHA)	06/08/98	No
460175	FAULKTON, CITY OF	FAULK COUNTY	02/21/75	08/05/86	08/05/86(M)	08/05/86	No
460062#	FLANDREAU, CITY OF	MOODY COUNTY	09/26/75	01/16/81	08/19/08	01/16/81	No
460306#	FLORENCE, TOWN OF	CODINGTON COUNTY		01/16/09	01/16/09(M)	02/24/10	No
465419#	FORT PIERRE, CITY OF	STANLEY COUNTY		01/12/73	05/17/04	01/12/73	No
460009#	FREDERICK, TOWN OF	BROWN COUNTY	11/22/74	03/01/78	03/18/08	03/01/78	No
460177#	GARRETSON, CITY OF	MINNEHAHA COUNTY	09/26/75	09/02/09	(NSFHA)	01/30/84	No
460112	GARY, TOWN OF	DEUEL COUNTY	06/27/75	07/01/98	07/01/98(L)	07/01/98	No
460205#	GAYVILLE, TOWN OF	YANKTON COUNTY		07/06/10	(NSFHA)	04/13/10	No
	NON-FLOODPRONE COMMUNITY						
460299	GETTYSBURG, CITY OF	POTTER COUNTY			(NSFHA)	06/08/98	No
460266#	GRANT COUNTY*	GRANT COUNTY	12/20/77	02/01/87	11/04/09	02/01/87	No
460267	GREGORY COUNTY *	GREGORY COUNTY			(NSFHA)	06/08/98	No
460178	GREGORY, CITY OF	GREGORY COUNTY	08/22/75		(NSFHA)	12/09/85	No
461201#	GRENVILLE, TOWN OF	DAY COUNTY		12/06/01	12/06/01	06/08/98	No
460179#	GROTON, CITY OF	BROWN COUNTY	07/11/75	03/01/78	03/18/08	03/01/78	No
460268	HAAKON COUNTY *	HAAKON COUNTY			(NSFHA)	06/08/98	No
460034#	HAMLIN COUNTY*	HAMLIN COUNTY		05/15/86	05/15/86(M)	05/15/86	No
460269	HAND COUNTY *	HAND COUNTY			(NSFHA)	06/08/98	No
460270#	HANSON COUNTY *	HANSON COUNTY	08/16/77	07/01/98	09/02/09	07/01/98	No

Federal Emergency Management Agency
Community Status Book Report
SOUTH DAKOTA
Communities Participating in the National Flood Program

CID	Community Name	County	Init FHBM Identified	Init FIRM Identified	Curr Eff Map Date	Reg-Emer Date	Tribal
460114#	HARRISBURG, CITY OF	LINCOLN COUNTY		04/02/08	04/02/08	06/08/98	No
460180#	HARTFORD, CITY OF	MINNEHAHA COUNTY	07/16/76	09/05/79	09/02/09(M)	04/25/97	No
	The initial FIRM date for the City of Hartford is 09/05/1979. A request has been made to the MSC to update the initial FIRM date field. This note will remain in the CSB until that update occurs.						
460294#	HECLA, CITY OF	BROWN COUNTY		09/30/88	(NSFHA)	09/03/86	No
460230#	HERMOSA, TOWN OF	CUSTER COUNTY	01/21/77	09/29/86	01/06/12	08/01/06	No
	Annexed areas on Custer County FIRM panel 460018 0085 B dated 03/02/1998. Current flood zones for Hermosa are Zones A and C.						
460181	HERREID, CITY OF	CAMPBELL COUNTY	07/11/75	07/01/98	07/01/98(L)	07/01/98	No
460182	HIGHMORE, CITY OF	HYDE COUNTY	07/11/75		(NSFHA)	01/30/84	No
460116#	HILL CITY, CITY OF	PENNINGTON COUNTY	04/23/76	11/18/81	06/03/13	11/18/81	No
460117	HOSMER, CITY OF	EDMUNDS COUNTY	10/29/76		(NSFHA)	04/25/97	No
460027#	HOT SPRINGS, CITY OF	FALL RIVER COUNTY		03/17/02	12/18/07	06/30/76	No
460183#	HOWARD, CITY OF	MINER COUNTY	07/11/75	08/19/85	08/19/85(M)	08/19/85	No
460271#	HUGHES COUNTY *	HUGHES COUNTY	01/10/78	07/01/98	05/17/04	07/01/98	No
460118#	HUMBOLDT, TOWN OF	MINNEHAHA COUNTY	09/05/75	09/02/09	09/02/09(M)	06/08/98	No
460003#	HURON,CITY OF	BEADLE COUNTY	06/28/74	07/16/87	06/02/09	07/16/87	No
460041#	HUTCHINSON COUNTY*	HUTCHINSON COUNTY	06/03/77	04/01/87	09/02/09	04/01/87	No
460272	HYDE COUNTY *	HYDE COUNTY			(NSFHA)	06/08/98	No
460184#	IPSWICH, CITY OF	EDMUNDS COUNTY	11/05/76	12/18/85	12/18/85(M)	12/18/85	No
460120#	IRENE, TOWN OF	TURNER COUNTY/CLAY COUNTY/YANKTON COUNTY	07/11/75	07/06/10	07/06/10(M)	10/31/11	No
460121#	IROQUOIS, CITY OF	KINGSBURY COUNTY/BEADLE COUNTY	07/18/75	10/15/85	10/15/85(M)	10/15/85	No
460122	ISABEL, CITY OF	DEWEY COUNTY			(NSFHA)	06/08/98	No
460240	JACKSON COUNTY*	JACKSON COUNTY			(NSFHA)	06/08/98	No
460273	JERAULD COUNTY*	JERAULD COUNTY			(NSFHA)	06/08/98	No
460185	KADOKA, CITY OF	JACKSON COUNTY	07/16/76		07/16/76	10/09/07(E)	No
460050	KENNEBEC, TOWN OF	LYMAN COUNTY	01/17/75	08/05/86	08/05/86(M)	08/05/86	No
460231#	KEYSTONE, TOWN OF	PENNINGTON COUNTY	01/07/77	03/04/80	06/03/13	03/04/80	No
460275#	KINGSBURY COUNTY*	KINGSBURY COUNTY		09/18/87	(All Zone D)	09/18/87	No
460187#	LAKE ANDES, CITY OF	CHARLES MIX COUNTY	02/07/75	06/02/04	(NSFHA)	12/09/85	No
460276#	LAKE COUNTY *	LAKE COUNTY	06/07/77	08/05/86	09/02/09	08/05/86	No
460124	LAKE NORDEN, CITY OF	HAMLIN COUNTY	09/19/75		(NSFHA)	04/05/11	No
	This community is NSFHA.						
460189	LAKE PRESTON, CITY OF	KINGSBURY COUNTY	07/18/75		(NSFHA)	01/30/84	No
460125	LANGFORD, TOWN OF	MARSHALL COUNTY	06/27/75		(NSFHA)	04/25/97	No
460094#	LAWRENCE COUNTY *	LAWRENCE COUNTY	06/17/77	05/17/90	04/17/12	05/17/90	No
460190#	LEAD, CITY OF	LAWRENCE COUNTY	02/07/75	04/17/12	04/17/12(M)	04/17/12	No
460068	LEBANON, TOWN OF	POTTER COUNTY	01/03/75		(NSFHA)	07/15/85	No
460192#	LENNOX, CITY OF	LINCOLN COUNTY	09/26/75	04/02/08	(NSFHA)	06/08/98	No
460206#	LESTERVILLE, TOWN OF	YANKTON COUNTY		07/06/10	(NSFHA)	04/22/11	No
460277B	LINCOLN COUNTY*	LINCOLN COUNTY	10/25/77	10/01/86	10/05/17	10/01/86	No
460278	LYMAN COUNTY *	LYMAN COUNTY				06/08/98	No
460044#	MADISON, CITY OF	LAKE COUNTY	08/02/74	07/05/82	09/02/09	07/05/82	No
460197	MARION, CITY OF	TURNER COUNTY	07/02/76		(NSFHA)	06/08/98	No
460279	MARSHALL COUNTY *	MARSHALL COUNTY			(NSFHA)	06/08/98	No
460280#	MCCOOK COUNTY *	MCCOOK COUNTY		06/18/13	06/18/13	06/08/98	No
460195#	MCINTOSH, CITY OF	CORSON COUNTY	09/19/75	05/17/04	(NSFHA)	06/08/98	No

Federal Emergency Management Agency
Community Status Book Report
SOUTH DAKOTA
Communities Participating in the National Flood Program

CID	Community Name	County	Init FHBM Identified	Init FIRM Identified	Curr Eff Map Date	Reg-Emer Date	Tribal
460054#	MEADE COUNTY *	MEADE COUNTY		08/01/78	09/16/11	08/01/78	No
460199#	MENNO, CITY OF	HUTCHINSON COUNTY	09/19/75	11/15/85	09/02/09(M)	11/15/85	No
460032	MIDLAND, CITY OF	HAAKON COUNTY	09/13/74	08/05/86	08/05/86(M)	08/05/86	No
460200#	MILBANK, CITY OF	GRANT COUNTY	08/13/76	11/04/09	11/04/09	12/09/85	No
460201#	MILLER, CITY OF	HAND COUNTY	04/25/75	10/15/85	10/15/85(M)	10/15/85	No
460283	MINER COUNTY *	MINER COUNTY			(NSFHA)	06/08/98	No
460057D	MINNEHAHA COUNTY *	MINNEHAHA COUNTY	05/24/77	09/05/79	10/05/17	09/05/79	No
460091#	MISSION HILL, TOWN OF	YANKTON COUNTY	12/13/74	06/18/80	07/06/10	06/18/80	No
460202	MISSION, CITY OF	TODD COUNTY	06/27/75	08/05/86	08/05/86(M)	08/05/86	No
460021#	MITCHELL, CITY OF	DAVISON COUNTY	03/22/74	02/01/79	09/29/10	02/01/79	No
461210	MONROE, TOWN OF	TURNER COUNTY			(NSFHA)	06/08/98	No
460052#	MONTROSE, CITY OF	MCCOOK COUNTY	12/13/74	08/05/86	06/18/13	08/05/86	No
460235#	MOODY COUNTY *	MOODY COUNTY	04/15/77	09/04/85	08/19/08(M)	09/04/85	No
460022#	MOUNT VERNON, CITY OF	DAVISON COUNTY		09/20/06	09/29/10	06/11/76	No
460092#	NEW UNDERWOOD, CITY OF	PENNINGTON COUNTY	01/28/77	05/15/80	06/03/13	05/15/80	No
460087#	NORTH SIOUX CITY, CITY OF	UNION COUNTY	11/16/73	12/01/77	02/23/01	12/01/77	No
460129	OLDHAM, TOWN OF	KINGSBURY COUNTY	10/29/76		(NSFHA)	06/08/98	No
460210	ONIDA, CITY OF	SULLY COUNTY	07/11/75		(NSFHA)	12/23/85	No
461202	ORIENT, TOWN OF	FAULK COUNTY			(NSFHA)	06/08/98	No
460211	PARKER, CITY OF	TURNER COUNTY	06/27/75		(NSFHA)	06/08/98	No
460042#	PARKSTON, CITY OF	HUTCHINSON COUNTY	06/14/74	11/15/85	09/02/09	11/15/85	No
460064#	PENNINGTON COUNTY *	PENNINGTON COUNTY	12/27/74	12/01/81	06/03/13	12/01/81	No
460033	PHILIP, CITY OF	HAAKON COUNTY	06/07/74	03/01/87	03/01/87(L)	03/01/87	No
465468#	PICKSTOWN, TOWN OF	CHARLES MIX COUNTY		06/02/04	06/02/04	03/27/12	No
461198#	PIEDMONT, CITY OF	MEADE COUNTY		09/16/11	09/16/11	09/16/11	No
460040#	PIERRE, CITY OF	HUGHES COUNTY	06/07/74	06/04/80	05/17/04	06/04/80	No
460001#	PLANKINTON, CITY OF	AURORA COUNTY	06/07/74	08/05/86	11/19/03	08/05/86	No
460212#	PLATTE, CITY OF	CHARLES MIX COUNTY		06/02/04	(NSFHA)	06/08/98	No
460132	POLLOCK, CITY OF	CAMPBELL COUNTY	06/27/75		(NSFHA)	06/08/98	No
460285	POTTER COUNTY *	POTTER COUNTY				12/10/98(E)	No
460297	PRESHO, CITY OF	LYMAN COUNTY	07/19/77		(NSFHA)	04/25/97	No
465420#	RAPID CITY, CITY OF	PENNINGTON COUNTY		09/14/73	06/03/13	09/14/73	No
461205	RAYMOND, CITY OF	CLARK COUNTY			(NSFHA)	06/08/98	No
460081#	REDFIELD, CITY OF	SPINK COUNTY	08/02/74	11/15/85	10/19/10(M)	11/15/85	No
460031#	REVILLO, TOWN OF	GRANT COUNTY	09/19/75	10/01/86	11/04/09(M)	10/01/86	No
460286#	ROBERTS COUNTY*	ROBERTS COUNTY	09/12/78	10/01/86	07/20/09(M)	10/01/86	No
460136	ROSCOE, TOWN OF	EDMUNDS COUNTY	11/12/76		(NSFHA)	06/08/98	No
461211#	ROSHOLT, CITY OF	ROBERTS COUNTY			(NSFHA)	06/08/98	No
460053#	SALEM, CITY OF	MCCOOK COUNTY	08/13/76	05/01/86	06/18/13(M)	05/01/86	No
460074#	SANBORN COUNTY *	SANBORN COUNTY	10/18/77	11/15/85	01/06/12	11/15/85	No
460213	SCOTLAND, CITY OF	BON HOMME COUNTY	09/05/75		(NSFHA)	01/30/84	No
461206	SENECA, TOWN OF	FAULK COUNTY			(NSFHA)	06/08/98	No
460098#	SINAI, TOWN OF	BROOKINGS COUNTY	06/27/75	07/16/08	07/16/08	07/16/08	No
460060D	SIOUX FALLS, CITY OF	LINCOLN COUNTY/MINNEHAHA COUNTY	06/28/74	01/17/79	10/05/17	01/17/79	No
460072#	SISSETON, CITY OF	ROBERTS COUNTY	06/28/74	05/01/86	07/20/09(M)	05/01/86	No
460046#	SPEARFISH, CITY OF	LAWRENCE COUNTY	03/29/74	09/02/81	04/17/12	09/02/81	No
460140#	SPENCER, TOWN OF	MCCOOK COUNTY	11/12/76	06/18/13	(NSFHA)	06/08/98	No
460076#	SPINK COUNTY *	SPINK COUNTY	01/10/78	08/05/86	10/19/10	08/05/86	No
460216	SPRINGFIELD, CITY OF	BON HOMME COUNTY	08/06/76		(NSFHA)	06/08/98	No
461219#	STANDING ROCK INDIAN RESERVATION	CORSON COUNTY		05/17/04	05/17/04	05/04/98	Yes

Federal Emergency Management Agency
Community Status Book Report
SOUTH DAKOTA
Communities Participating in the National Flood Program

CID	Community Name	County	Init FHBM Identified	Init FIRM Identified	Curr Eff Map Date	Reg-Emer Date	Tribal
460287#	STANLEY COUNTY *	STANLEY COUNTY		05/17/04	05/17/04	06/08/98	No
460065#	STRATFORD, TOWN OF	BROWN COUNTY		03/18/08	(NSFHA)	03/08/10	No
460055#	STURGIS, CITY OF	MEADE COUNTY	11/16/73	06/01/77	09/16/11	06/01/77	No
460288	SULLY COUNTY *	SULLY COUNTY			(NSFHA)	06/08/98	No
460316#	SUMMERSET, CITY OF	MEADE COUNTY		09/16/11	(NSFHA)	10/12/10(E)	No
460141#	SUMMIT, TOWN OF	ROBERTS COUNTY	07/18/75	07/20/09	(NSFHA)	05/11/11	No
460142	TABOR, TOWN OF	BON HOMME COUNTY	06/25/76		(NSFHA)	04/25/97	No
460143B	TEA, CITY OF	LINCOLN COUNTY	09/19/75	04/02/08	10/05/17	04/25/97	No
460063#	TRENT, TOWN OF	MOODY COUNTY	12/06/74	06/04/80	08/19/08	06/04/80	No
460289	TRIPP COUNTY *	TRIPP COUNTY			(NSFHA)	04/25/97	No
460145#	TULARE, TOWN OF	SPINK COUNTY	07/25/75	10/19/10	10/19/10(M)	11/01/12	No
460290	TURNER COUNTY *	TURNER COUNTY			(NSFHA)	06/08/98	No
461208#	TWIN BROOKS, CITY OF	GRANT COUNTY		11/04/09	(NSFHA)	06/08/98	No
460220	TYNDALL, CITY OF	BON HOMME COUNTY	08/06/76		(NSFHA)	04/25/97	No
460242	UNION COUNTY*	UNION COUNTY	05/10/77	02/01/87	02/23/01	02/01/87	No
460244#	UTICA, TOWN OF	YANKTON COUNTY		07/06/10	07/06/10(M)	03/13/12	No
460221#	VALLEY SPRINGS, CITY OF	MINNEHAHA COUNTY	09/26/75	07/16/80	09/02/09	07/16/80	No
460146	VEBLEN, TOWN OF	MARSHALL COUNTY	04/25/75	05/01/86	05/01/86(L)	05/01/86	No
460015#	VERMILLION, CITY OF	CLAY COUNTY	03/22/74	08/05/10	08/05/10	01/30/84	No
460223#	VOLGA, CITY OF	BROOKINGS COUNTY	10/08/76	07/16/08	07/16/08	09/22/11	No
460224#	WAGNER, CITY OF	CHARLES MIX COUNTY	08/13/76	06/02/04	06/02/04	03/12/09	No
460232#	WAKONDA, TOWN OF	CLAY COUNTY	11/12/76	08/05/10	(NSFHA)	04/08/10	No
	NSFHA						
460291	WALWORTH COUNTY *	WALWORTH COUNTY			(NSFHA)	06/08/98	No
460298#	WARNER, CITY OF	BROWN COUNTY	04/22/80	03/18/08	09/29/10(M)	06/08/98	No
460016#	WATERTOWN, CITY OF	CODINGTON COUNTY	06/28/74	07/04/89	01/16/09	07/04/89	No
460226#	WAUBAY, CITY OF	DAY COUNTY	07/23/76	12/06/01	12/06/01	04/25/97	No
460227#	WEBSTER, CITY OF	DAY COUNTY	12/24/76	12/06/01	12/06/01	04/25/97	No
460043	WESSINGTON SPRINGS, CITY OF	JERAULD COUNTY	10/18/74		(NSFHA)	01/30/84	No
460011#	WESTPORT, TOWN OF	BROWN COUNTY	03/06/79	08/05/86	03/18/08	08/05/86	No
460228#	WHITEWOOD, CITY OF	LAWRENCE COUNTY	08/13/76	04/17/12	(NSFHA)	11/30/83	No
460014#	WILLOW LAKE, TOWN OF	CLARK COUNTY	05/20/77	07/01/98	07/01/98(L)	07/01/98	No
460303	WINNER, CITY OF	TRIPP COUNTY			(NSFHA)	06/08/98	No
460075#	WOONSOCKET, CITY OF	SANBORN COUNTY	06/14/74	11/15/85	01/06/12	11/15/85	No
460151#	WORTHING, CITY OF	LINCOLN COUNTY	08/22/75	04/02/08	(NSFHA)	04/25/97	No
460088#	YANKTON COUNTY*	YANKTON COUNTY	08/16/77	10/01/86	07/06/10	10/01/86	No
461204#	YANKTON SIOUX TRIBE	CHARLES MIX COUNTY		06/02/04	06/02/04	06/08/98	Yes
460093#	YANKTON, CITY OF	YANKTON COUNTY	03/22/74	08/15/80	07/06/10	08/15/80	No
460292	ZIEBACH COUNTY *	ZIEBACH COUNTY			(NSFHA)	06/08/98	No

Summary:

Total In Flood Program	229
Total In Emergency Program	3
Total In the Regular Program	226
Total In Regular Program with No Special Flood Hazard	87
Total In Regular Program But Minimally Flood Prone	51

Federal Emergency Management Agency
Community Status Book Report
SOUTH DAKOTA
Communities Not in the National Flood Program

CID	Community Name	County	Init FHBM Identified	Init FIRM Identified	Curr Eff Map Date	Sanction Date	Tribal
461214#	ANDOVER, TOWN OF	DAY COUNTY		12/06/01	12/06/01	12/06/02	No
460305#	BATESLAND, TOWN OF	SHANNON COUNTY	05/13/80		05/13/80	05/13/81	No
460099	BISON, TOWN OF	PERKINS COUNTY	11/05/76		11/05/76	11/05/77	No
460247#	BUFFALO GAP, TOWN OF	CUSTER COUNTY	11/05/76	01/06/12	01/06/12	11/05/77	No
460037	BUFFALO, TOWN OF	HARDING COUNTY	11/05/76		11/05/76	11/05/77	No
461215#	BUTLER, TOWN OF	DAY COUNTY		12/06/01	12/06/01	12/06/02	No
460248#	FAIRBURN, TOWN OF	CUSTER COUNTY		01/06/12	01/06/12	01/06/13	No
460048#	FAIRVIEW, TOWN OF	LINCOLN COUNTY		04/02/08	04/02/08	04/02/09	No
460174#	FAITH, CITY OF	MEADE COUNTY		09/16/11	09/16/11	09/16/12	No
460002#	FRANKFORT, CITY OF	SPINK COUNTY		10/19/10	10/19/10	10/19/11	No
460312#	FRUITDALE, TOWN OF	BUTTE COUNTY		01/06/12	01/06/12	01/06/13	No
460310#	FULTON, CITY OF	HANSON COUNTY		09/02/09	09/02/09	09/02/10	No
460049#	HUDSON, TOWN OF	LINCOLN COUNTY	11/22/74	12/18/85	04/02/08	04/03/08(S)	No
460010#	KRANZBURG, TOWN OF	CODINGTON COUNTY		01/16/09	01/16/09	01/16/10	No
461216#	LILY, TOWN OF	DAY COUNTY		12/06/01	12/06/01	12/06/02	No
460209#	NEWELL, CITY OF	BUTTE COUNTY	07/18/75	01/06/12	01/06/12	07/18/76	No
460245#	NISLAND, CITY OF	BUTTE COUNTY	02/04/77	01/06/12	01/06/12	02/04/78	No
460080#	NORTHVILLE, TOWN OF	SPINK COUNTY	12/13/74	10/19/10	10/19/10	12/13/75	No
460217#	OLIVET, TOWN OF	HUTCHINSON COUNTY		09/02/09	09/02/09	09/02/10	No
460131#	PIERPONT, TOWN OF	DAY COUNTY		12/06/01	12/06/01	12/06/02	No
460315#	QUINN, TOWN OF	PENNINGTON COUNTY		06/03/13	06/03/13	06/03/14	No
460137#	ROSLYN, TOWN OF	DAY COUNTY	04/25/75	12/06/01	12/06/01	04/25/76	No
460214	SELBY, CITY OF	WALWORTH COUNTY	07/25/75		11/07/78	07/25/76	No
460188#	SOUTH SHORE, TOWN OF	CODINGTON COUNTY		01/16/09	01/16/09	01/16/10	No
460138	ST. FRANCIS, TOWN OF	TODD COUNTY	09/19/75		09/19/75	09/19/76	No
460139	ST. LAWRENCE, TOWN OF	HAND COUNTY	07/18/75		07/18/75	07/18/76	No
461199#	VERDON, TOWN OF	BROWN COUNTY		09/30/88	03/18/08	09/30/89	No
460215#	VOLIN, TOWN OF	YANKTON COUNTY		07/06/10	07/06/10	07/06/11	No
460225#	WALL, TOWN OF	PENNINGTON COUNTY		06/03/13	06/03/13	06/03/14	No
460250#	WASTA, TOWN OF	PENNINGTON COUNTY	12/24/76	06/03/13	06/03/13	12/24/77	No
460147#	WESSINGTON, TOWN OF	BEADLE COUNTY	08/22/75	06/02/09	06/02/09	08/22/76	No
460073#	WHITE ROCK, TOWN OF	ROBERTS COUNTY		07/20/09	07/20/09	07/20/10	No
460148#	WHITE, TOWN OF	BROOKINGS COUNTY	04/30/76	07/16/08	07/16/08	04/30/77	No
460150#	WOLSEY, TOWN OF	BEADLE COUNTY	08/13/76	06/02/09	06/02/09	08/13/77	No

Summary:

Total Not in Flood Program	34
Total Suspended from Emergency Program	0
Total Suspended from Regular Program	1
Total Withdrawn Communities Not In Program	0
Total Not In Program With Hazard Area Identified	34
Total Not In Program With Hazard Area Identified < 1 Year	0

Federal Emergency Management Agency
Community Status Book Report
SOUTH DAKOTA
Communities Not in the National Flood Program

CID	Community Name	County	Init FHBM Identified	Init FIRM Identified	Curr Eff Map Date	Sanction Date	Tribal

Legend:

(E)	Indicates Entry In Emergency Program
NSFHA	No Special Flood Hazard Area - All Zone C
(>)	Date of Current Effective Map is after the Date of This Report
N/A	Not Applicable At This Time
(S)	Suspended Community
(W)	Withdrawn Community
(M)	No Elevation Determined - All Zone A, C and X
(L)	Original FIRM by Letter - All Zone A, C and X

Appendix 4B - FEMA Annual Consultation Visit Notes

State Mitigation Plan Consultation
March 10, 2015
NOTES

Attendance

South Dakota Department of Public Safety: Jack Dokken and Jim Poppen

FEMA: Ryan Pietramali, Scott Roscoe, Kevin Williams, Shelby Hudson, and Margaret Doherty

Purpose of the State Mitigation Plan Consultations – Margaret Doherty

To provide an opportunity to have an open and honest dialogue about what FEMA is doing well, as well as what we could improve upon to provide better service to South Dakota. The intended outcome is to continue to provide support to South Dakota's entire mitigation program and enhance the State's capabilities to advance mitigation action.

State Mitigation Planning – Jim Poppen

- The State has a quarterly meeting with the Silver Jackets, which includes members of the SHMT. The next meeting on March 25th will be in-person and they will start the process of updating the plan and continue the process over the summer. The Progress Notes mentioned above will be reviewed in anticipation of these meetings.

FEMA technical assistance and Training – Ryan Pietramali

- If there are trainings or technical assistance that the State needs, outside of our typical BCA, G318, etc., please let us know.

Local Mitigation Planning – Jim Poppen

- The $10,000 fee per plan update is determined by the Planning District, not the State. The SHMT has a policy that if a County chooses to use a Planning District then they don't have to compare bids. When we get ready to reimburse the County we get two checks one for the 7,500 and the other 2,500 to show that they paid 100%.

Tribal Mitigation Planning – Jim Poppen

- The State is in the process of inviting all the Tribes to join with their underlying Counties in a multi-jurisdictional planning effort, which was successful with Pine Ridge and Shannon County. The State wants all the Tribes to have an approved plan.
- The new Emergency Manager for Pine Ridge used to work with Tribal Housing and has very little experience with FEMA programs. They want to do mobile homes tie-downs but are concerned with the match requirements. Scott and Ricki are going to try to talk mitigation generally with them next week.

HMA Grant Programs:

Jim Poppen

- Finding viable mitigation projects is a big issue; just getting people to attend applicant briefings is difficult.

Ryan Pietramali

- State planning initiatives can kick out good ideas, for instance Colorado is applying for a resiliency grant that is creating a list of project grants and envision Utah is creating some big project ideas—like heat sinks (structures in the Wasatch Front that are vulnerable to earthquake).

Margaret Doherty

- Need to review the local mitigation plans and filter for projects that have a good shot of meeting the HMA and BCA requirements.

Jim Poppen

- We have Townships with culvert projects, etc., but they can't meet the match; they may have annual budgets of less than 5k.
- The BCA methodologies make it difficult. It is difficult to convince local Engineering firms that it's going to be worth it to get qualified in BCA. We can offer the trainings, but the firms need to see the benefit. If we could get a firm on a retainer contract through the State, especially on big events, when they know that the BCA load is going to be pretty big they may be more willing to invest the time and resources into learning the system. However, the model/approval process seems to be getting more difficult each year, so it would be a long term commitment on their part to stay trained on the latest formulas.

- Could we establish a list of projects or project characteristics that we know meet the BCA so they could be exempt from the process?

EHP Approvals – Jim Poppen

- The EHP approval process is very difficult and seems to be continually evolving, i.e. it appears that the agencies that we work with change their requirements with every project application.

Risk MAP – Ryan Pietramali

- Risk MAP is about reducing risk by modernizing our maps and informing elected officials how they can use the science to reduce their risk through building science, planning, HMA projects, etc. We want to provide our products and processes to bring the State planners and project folks into the process. We need to identify the Risk MAP meetings where it makes sense to have the SHMO attend and we need to coordinate with the flood insurance program coordinators at the State and FEMA as well.

State Mitigation Plan Consultation

State EOC, Pierre, SD

May 10, 2016, 4pm CST

NOTES

Attendees

State:

Jack Dokken

Jim Poppen

Kyle Kafka

Martin Christopherson

Dr. Dennis Todey

FEMA:

Mike Hillenburg

Nicole Aimone

Brooke Conner

Margaret Doherty

Kevin Williams

Climate Change

Jim Poppen

- Briefed the group on Dr. Dennis Todey's presentation on climate change impacts in SD as part of the G318

Nicole Aimone

- Explained that our CERC team is coming up with tools that would meet the minimum requirements for State Mitigation Plans

Dr. Dennis Todey

- Would like to do more regionally. The Missouri River region needs modeling. He's not comfortable with the models that show this region. We need a better understanding of the impacts to agriculture.

Margaret Doherty

- Described the new climate change requirements that may be approved for Tribal Mitigation Plans

Kevin Williams

- Described the new HMA Climate Resilient Mitigation Activities

Mike Hillenburg

- Spoke to the BCA challenges of the new activities. As we move forward, we'll need to see if there's additional benefits that we can count.

Dennis Todey

- Officially, we receive no state funding so always looking for funding for studies on climate change.

<u>Enhanced Mitigation Plan</u>

Jim Poppen

- May 23rd State Mitigation Planning Committee meeting agenda includes a bullet about Enhanced plans. We know that we need to find out what the other agencies are doing re mitigation. For instance, SDOT—we need to find out what they are doing.
- Feel like HMA performance measures are not an issue. Keep on keeping on.

Mike Hillenburg

- Region VIII expectations are that you need to meet the performance measures at 100%. SD has no issues so far. Regarding "complete applications" may be harder. We're looking into it and trying to determine what the RFI process looks like and the timelines.

Jim Poppen

- Concerned about meeting the BCA 100% of the time. The RECs have asked a lot of questions about the BCA.

Brooke Conner

- The process is getting better. There are always a few applications that require more work. If we can solve problems with a phone call, that's a good step in the right direction.

Mike

- If there's an issue then call us before you submit. Like to get the completeness issues are solved before they get to FEMA.

Jim

- There are sub-recipients that only have one application in their history, so they don't need to know all the BCA requirements—we do.

Mike

- There's an ability to request extensions, so those will still be allowed but need to be making progress.

Jim

- We monitor the Periods of Performance and Quarterly Reports. We had one extension request with a lot of issues.
- We're taking an approach of "we will accept an application at any time" and then we'll have an "always open application period."
- We get lots of calls with engineering firms with potential applications and they go to the BCA trainings and then we don't hear from them again. We don't know why. We're trying to do more than powerline burials but it's hard to get them to submit an application.
- We'll over-submit for every HMGP application period and if we don't have other projects, we'll use the $ for powerline burials. We want to show that we can spend the entire 15% to show that we can spend the 20%.

Mike

- We're not concerned with one-offs. We're more concerned with trends of ongoing issues
- Need to show consistency and work flow
- SD has a great team. As long as the team remains, you should be fine. Staff capability is key. Good team and good procedures.

- The question is how are you going to swell and take the additional resources available during a big disaster?
- If you lose anyone and then you have a Minot type disaster; can you spend the $ and meet the deadlines?

Jim

- We have a large cache of reservists in PA. They can come in and assist during a disaster.
- We're trying to be more efficient and have contingencies in place

Mike

- Consider an ability to contract out some of the work
- Explain the contingencies that you're putting in place in your State Plan and Admin Plan

Jim

- We need an engineering firm that can learn the BCA and be ready to go.

Risk MAP

Brooke

- We kicked off Strategic Advances project for SD. This is a mapping project for 27 counties on the east side of state.
- Numerous briefings with the State and locals. Good coordination with communities. Only a couple are not excited. All counties have agreed to dates/times for meetings.
- Multiple state partners, including Jim and Mark Macy
- June 13-24: Meet and Greet Meetings
- August 15-26: Discovery Meetings with 13 communities
- October 17-28: Discovery Meetings w/other 13 and Lake Traverse Reservation
- Will produce a Discovery Report for each County to use in their mitigation plans
- Will result in scoping of 'plus up' mapping projects.

Jim

- We've been spreading the word about the project

Other Topics

Mike

- Is the state still looking at EMAP accreditation?

Jim

- Our Preparedness Team is working on our HIRA for EMAP. They hired AMEC to develop the HIRA. Our Drought Plan is available as well.

Jack

- SD State Share Initiative: provide opportunity for HMGP sub-recipients to apply for up to 20% match from the State. If they're A) in a disaster declaration and B) they've had a PA in the last five years, and C) they are financially stressed, then they are eligible for up to a 20% match from the State.
- If they have just A and C, they are eligible for up to 15% match from the State.
- Asked if there are any new FEMA policies, procedures, and guidance.

Jim

- We've developed a new Mitigation Map Viewer and PA created a Project Worksheets Map Viewer as well. Thinking we can go back to a lot of those old projects and do 406 later.

Actions:

- **Margaret to follow-up with link to Dr. Todey regarding BIA climate funding opportunities for Tribes**
- **Kevin to follow-up with factsheets to Dr. Todey of new HMA Climate Resilient Mitigation Activities**
- **Kevin and Jim to send Jack new FEMA policies and guidance.**

State Mitigation Plan Consultation

March 10, 2017, 10-12pm CT
800-320-4330 PIN: 057354

NOTES

Attendees

State:

Tyler Steen

Jim Poppen

Mark Macy

Kyle Kafka

FEMA:

Jeff Herd

Nicole Aimone

Margaret Doherty

Kevin Williams

Scott Roscoe

Sean McGowan

Tom Birney

Brooke Connor

State Mitigation Plan Update

- HIRA was completed in September 2016; will not be updated further as part of this plan update.
- South Dakota has not secured a funding source. The initial estimates for Christmas Disaster HMGP may not cover a state plan update. Waiting for PDM NOFO announcement to decide how to fund the plan update. SD will not allow plan to expire.
- RFP is out. Will be reviewing responses March/April. The period for questions ended in February and there were no questions. It was posted on the procurement website and sent to four vendors that SD has worked with in the past.
- Concerning the Enhanced requirements, SD will likely develop a methodology for a losses avoidance regarding burying of power lines over the years.

- *Future Conditions Requirement.* FEMA provides the climate data (from NOAA) and background work, and SD assesses how it affects their state. FEMA will provides Climate Change Reports as PowerPoint presentations or 1-pagers with infographics and solicit feedback. South Dakota will reach out to include the weather service to make it more of a comprehensive team effort.
- FEMA Community Planners would like to attend state hazard mitigation team meetings during the planning process in the future. Will be attending CO and UT meetings.

Mitigation Planning Portal

- The MPP will soon show whether plans have grants. Explained the different mapping functions and the RA's reporting requirements.

G318 Trainings

- No G318 trainings in South Dakota are needed this year. At this time there are no new SD planners writing plans. South Dakota received the invitation for the North Dakota G318 training in June and will forward to those who still may be interested.

Hazard Mitigation Assistance

- 80 projects have been closed and two disasters which equals 53% of the metrics for Region VIII.
- Hopefully Risk MAP will initiate other drainage projects. State continues to conduct outreach regarding flood mitigation projects but hears from local representatives that they are weary to spend money to conduct H&H for the BCA with no guarantee that the project will be approved.
- SD SHMT will continue to recommend every action submitted to the Team. State is proud of their success burying power lines. Since 2005, the State has spent $19.4M and buried 7,000 miles of power lines. The Christmas storm caused $18.8M and 600 miles of powerline burials. There is a huge benefit to getting started early with this effort.
- A few years ago, Flanders was being considered "best practice" for about the tornado but there was no follow up from FEMA Headquarters and eventually considered a waste of the State and Region's time. Going forward, the Region will capture best practices informally, and showcasing it through the G318 training.
- Lincoln County had a great project on Spring Creek because of their local champion, John. The Spring tributaries cost $1.8M and included upsized structures and drainage channelization. Along Hwy 11 the road was torn up and box culverts were replaced. Shortly thereafter, the river flooded

and the culverts performed as designed. The powerline burials and drainage projects are great examples.

- South Dakota will send Margaret a photo of their drainage "champion" on top of the culverts and create a one-page write-up/slide to incorporate into the G318. Used foam blocks instead of dirt to build box culverts. Some photos are online.
- Regarding the HMA program, we don't have any issues and don't foresee any in the future. Jim Poppen communicates with Kevin regularly. We also want to talk about another project on 9 Mile Creek.

Tribal Technical Assistance

- SD Tribal Mitigation Plan status
- SD Tribal Direct Grantee status
  - Oglala Sioux project applications
  - Sisseton-Wahpeton Oyate disaster request
- SD is in good shape. The Cheyanne River Sioux talked with State last year and we expect a draft very soon (April) from the planning district. Crow Creek/Buffalo County is APA. The council didn't do right resolution at first, but we're expecting the right one this week.
- Each county in SD must contact the tribes in their jurisdiction to get clarification on updating their plan along with the county's. They all have the same hazards, risks, and concerns, so it makes sense. State is currently talking to two tribes who will do their plans together.
- The Lower Brule Sioux tribe indicated they want to do a standalone plan. FEMA spoke with a tribal member around Christmas about the process and about a PDM grant. Not sure yet if they'll come directly to FEMA. South Dakota visited them about a year ago, the tribe was excited about a plan, but progress was put on hold after the death of their president. They're back up and running now and should get something out soon.
- Moody County will be updating their plan soon and the county emergency manager talks with tribe and Brooke Connor during Discovery Meetings.
- Standing Rock was recently approved. Two tribes have come to FEMA directly. We got an RFI for one project, plan update applications, back-up generators for some schools, acquisition for trailer park in Pine Ridge (probably won't come to fruition). All of these are in the RFI process.
- State has serious concerns that FEMA is encouraging Tribes to have Tribal Mitigation Plans, lowering the 'threshold' for disaster declarations, but then not providing the appropriate amount

of technical assistance for Tribes to be successful. "Giving tribes the keys to the car, but there's no gas in the car." The Tribes need assistance to develop an admin plan and learn FEMA systems. "I don't think we're doing them justice by giving them a PDM and leaving."

- State is always looking for projects from tribes. Perhaps we can help relay to tribes that even if it's a small pot of funds the State would still like to help them.
- South Dakota was very disappointed with the recent HQ webinar regarding the new declaration policy, "one of the worst organized he's ever been on." The State was also concerned that Tribal Representatives' questions were not being answered. There was snickering in the background, and overall, the webinar was not professional.
- Standing Rock: South Dakota will send Margaret an email saying SD approves Standing Rock HMP.

National Flood Insurance Program

- Freeman will be ready soon. 15-20 communities expressed interest in joining NFIP through Risk MAP Strategic Advances.
- State was at their Silver Jackets meeting this past Monday, focus on green space and acquisitions. State had a meeting with the Mayor and Emergency Manager to look at removing structures. Working on developing a process/program for gauging interest and blending HMA and corporate programs. Follow up meeting with Sioux Falls on Tuesday.

Risk Map Strategic Advances

- FEMA is working with the Strategic Advances Team to release deliverables and to redo the story map site since users didn't know to scroll through the site.
- Casey, FEMA Risk Map Analyst, will assist in developing the data request form online for communities who want data. FEMA may need communities send a hard drive to the Region to get the data in-house.
- Currently trying to figure out what products will be purchased in the future. Focusing on communities that touch the James River (specifically Brown, Clay, and Union counties) because it's easier to do a study of the river and we don't want to step on anyone's toes.
- Working with the PTS to develop course content. We purchased four trainings to help better understand the information we're providing them for use in mitigation plans, projects applications, etc. and how to use GIS.

- The State made a note to keep the planning districts involved in that process/communications.

Building Sciences Update

- FEMA released a memo last year saying that if there's a declared disaster certain structures would be replaced with the latest building codes and a standard 75/25 match would apply. The state adopts building code but it's not mandated, and if a city/county adopts then it has to follow state code. Towns are adopting codes that are not favorable to development for their area. No residential code currently exists in the state. We're happy to do some research to help you out with this.
- FEMA is going to ask all enhanced states to report on building codes because it's the most important mitigation action a state can take.
- Jim Poppen: We're sorry that Mike and Ryan couldn't make the call. We wanted to tell them that we're very appreciative of the relationship we have with Regional staff. If they don't know the answer they get back to us. We greatly appreciate it when the Region says they'll do some research and gets back to us when we have questions/issues or need something.

Actions:

- **Jim Poppen will reach out to include weather service to include State Plan Update, future conditions requirement.**
- **Jim Poppen will send Margaret a photo of their drainage "champion" Jim, so that FEMA Mitigation Planning can work on a one-page write-up/slide to incorporate into the G318.**
- **Scott Roscoe to check with HQ about declarations guidance for tribes.**
- **Jim Poppen will send Margaret an email saying he approves Standing Rock HMP.**

State Mitigation Plan Consultation

March 22, 2018, 8:30AM-11AM CST
800-320-4330 PIN: 537-038

NOTES

Attendees

State:

Tyler Steen, Recovery and Mitigation Manager

Jim Poppen, State Hazard Mitigation Officer

Kyle Kafka, Mitigation Specialist

Martin Christopherson, Mitigation Specialist

Mark Macy, NFIP Coordinator

Jeff Brislawn, State Plan Consultant, AMEC Foster Wheeler

FEMA:

Mike Hillenburg, HMA Branch Chief Nicole Aimone, Senior Community Planner

Kevin Williams, HMA Specialist

Scott Roscoe, Hazard Mitigation Tribal Specialist

Brooke Connor, Senior Engineer

Tom Birney, NFIP Specialist

Kyle Flesness, EHP Specialist

Bryan Mentlik, Mitigation Champion, CERC

Enhanced State Plan Update

- South Dakota continues to make progress towards meeting enhanced plan requirements
- South Dakota Office Emergency Management (SDOEM) is coordinating with state district managers and state agencies to compile a complete list of mitigation work planned/underway/completed
- Unlike in past plan updates, the rural electric companies are heavily engaged this year
- These entities represent some of the state's largest mitigation grant applicants

- SDOEM is continuing outreach to relevant planning partners to explain the enhanced state plan requirements and what they require for its completion

Tribal and Local Mitigation Planning

- 7 of the 9 tribes in South Dakota have updated plans or applications in to update them
- The Rosebud Sioux Tribe will be updating their plan in a joint effort with Tripp County
- The Lower Brule Sioux Tribe has an application in to develop their first mitigation plan
- SDOEM noted that other tribes developing plans in-house that are not part of a joint effort may also need technical assistance
- Eight applications for PDM grants have been submitted by the tribes with projects focused on tornado shelters and generators
- FEMA is providing webinars to review December 2017 updated tribal planning guidance with the next tentatively scheduled for 5/8/2018 – SDOEM requested to be kept in the loop as these are scheduled as some tribal plans come through their office

Hazard Mitigation Assistance

- DR4155 is nearly closed out
- DR4186 has management costs and two projects still open
- Every available dollar of mitigation funding is being used
- Grant projects are on schedule and have not missed any quarterly progress reports
- FEMA expressed interest in having South Dakota give a presentation to other municipalities on their successful work burying power lines at next R8 meeting with SHMOs.
- Some towns have expressed interest in utilizing Advanced Assistance to conduct studies that will them exactly what they need for mitigation work
- SDOEM noted that they enjoyed the recent, new BCA training. They felt it was more user friendly and accessible
- SDOEM will participate in the grants management modernization working group.

Environmental Planning and Historic Preservation: Review of Programmatic Agreements and Expiration Dates

- The NHPA programmatic agreement with the South Dakota Historic Preservation Officer was highlighted
- A similar agreement on endangered species compliance was noted to be in development
- All attendees stressed how useful these agreements have been/will be for future mitigation work in the state

FEMA Risk Map Updates: South Dakota Strategic Advances

- First phase of enhanced studies is underway. Focus has been on counties that touch the James River
- FY18 enhanced studies contracts are underway – will focus on northeast corner of state
- FY19 enhanced budget is being developed – will focus on southeast corner of state
- Clay and Union counties are moving forward with updated flood maps – moving to preliminary in late fall/early winter

National Flood Insurance Program & Floodplain Management Updates

- South Dakota is working on training opportunities for communities to discuss how to use NFIP data not just for floodplain management
- Aberdeen & Sioux falls have trainings scheduled for July 2018
- CFM exam will be held in Rapid City on September 10
- South Dakota has seen a 25% decrease in NFIP policies in the last year in a half
- This is primarily due to the Sioux Falls levee system which removed 1600 structures from the floodplain
- The recent dry years have also impacted the number of active policies
- The private insurer, Lloyds of London, is also now providing flood insurance policies in direct competition to NFIP
- 29.5% of policies in South Dakota receive some CRS discount

Appendix 5 - Local and Tribal Plan Rollup (Electronic)

The electronic Excel spreadsheet contains the following information related to the Local and Tribal Rollup:

- Hazard Identification by County and Tribe (Tab 1)
  - The natural and manmade hazards that have been identified in each LHMP including the significance rating given to each hazard, if applicable.
- Potential Losses (Tab 2)
  - Contains information collected from each LHMP (county only) related to loss data both potential and annualized for specific hazards, as well as Presidential Declarations for each county, Presidential Declaration Total Damage, Presidential Declaration PA costs, Damage to Rural Electronics, Total Exposure Value, Total Exposure Value in Hazard Area, and Estimated Potential Losses to Vulnerable Structures (RECs)
  - Also contains a Comment column for additional related information gathered from the LHMPs
- Capabilities – All (Tab 3)
  - Contains capability information collected from each County and Tribal LHMP. The capabilities range from planning and regulatory capabilities, administrative and technical capabilities, financial and education and outreach capabilities.
- Capabilities-Tribes (Tab 4)
  - Contains the capabilities information collected only from the Tribal plans.
- Completed Actions – All (Tab 5)
  - Contains actions that have been completed since the 2014 Plan from both County and Tribal LHMPs. This tab is built off of the Completed Actions table from the 2014 Plan.
  - Completed Actions – Tribes (Tab 6)
  - Contains actions that have been completed since the 2014 Plan from only Tribal LHMPs.
- Identified Actions -All (Tab 7)
  - Contains the newly identified actions in all of the County and Tribal LHMPs. This tab is built off of the Identified Actions table from the 2014 Plan.
- Identified Actions -Tribes (Tab 8)
  - Contains the newly identified actions in all of the Tribal LHMPs.

Tribe	Stormwater Improvement/Drainage and Culvert Improvement	Powerline Burial/Improvement	Generator/Power Backup	Flood Control/Management	New Warning System/Warning System Improvement	Debris Clean Out	Tree Removal/Trimming	Improve Data/Mapping Capabilities	Improve Emergency Communication Capabilities	New Storm Shelter	Purchase of Winter Storm/Firefighting/EMS Equipment	Completion of Hazard Specific Mitigation Plan or Study (i.e. CWPP, HazMat, Commodity Flow Study, Dam)	Wastewater Infrastructure Improvement	Road Infrastructure Improvement	Firefighter/Flood Manager/Volunteer Training/Exercises/Certification	Passage/Enforcement of Hazard Specific Mitigation Policy	Elevation/Acquisition/Relocation	Wetland Preservation	Notes
Buffalo/Crow Creek Tribe		Y																	
Cheyenne River Sioux Tribe																			
Oglala Sioux Tribe																			no previous plan
Sisseton-Wahpeton Oyate																			2007 plan was not
Rosebud Sioux Tribe			Y		Y			Y		Y						Y			Establish hazmat response agreement with Rapid City; Secuirty fencing for tribal water resources building and security camera for tribal admin building;
Standing Rock Sioux Tribe				Y															Completed Range Survey - Wildfire hazard;
Total	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	

Appendix 6 - Loss Avoidance Analysis Tool (LAAT) User Guide

Introduction

Assessing the performance of hazard mitigation measures is critical to substantiate the value of mitigation efforts, and loss avoidance assessment results help assure prudent use of limited public resources. A loss avoidance assessment is a method of measuring the effectiveness of hazard mitigation projects. Projects completed in the past provide a return on investment (ROI), which communicates the value of mitigation measures and informs future allocation of resources for the highest and best use.

OEM conducts a loss avoidance assessment after each Presidential Disaster Declaration and may do so after non-declared disasters where warranted. These post-event assessments use real event data to evaluate the impacts that were prevented by completed mitigation projects. Specifically, the assessment reports dollars saved due to mitigation measures (losses avoided) and calculates a ROI by comparing the cost of the project to actual losses avoided over time.

There are four phases of the general methodology for loss avoidance studies:

Phase 1: Project Identification and Selection

Phase 2: Hazard Event Analysis

Phase 3: Loss Avoidance Analysis

Phase 4: Project Effectiveness and Documentation

Phase 1 focuses on the selection of the completed project area to be included in the loss avoidance study. Mitigation projects are screened based on the availability of data required for completion of the study. Project data may come from the application scope of work, BCA, or other sources. Projects that have adequate data available are advanced to Phase 2. Mitigation projects with adequate data advance to Phase 2.

Phase 2 includes a hazard event analysis, to determine whether a post-construction hazard event is severe enough to have caused damage if the project had not been completed (MP_A scenario), and a hazard analysis, to determine the impact of the hazard event (e.g., depth of flooding) at the mitigation project location. This information may come from a variety of sources, such as local observation, local damage assessments, NOAA-NWS reports, and field investigation. Wherever possible, effectiveness should be measured in terms of interconnected hazards rather than simply looking at one event. For example, fire mitigation efforts may also be effective at decreasing flood losses. If the hazard caused damage to the project, or would have in the absence of mitigation, the project is advanced to Phase 3.

Phase 3 is an evaluation of the project to compare the damage actually sustained with the damage that would likely have been sustained without mitigation.

- Is there enough information to make a quantitative evaluation? [OR] Is there enough information to make a qualitative analysis and discussion summarizing the benefits (What would have been damaged if the project had not been in place?) and effectiveness (did the project perform as intended?) of the mitigation action?
- Calculate the damage that actually occurred with the mitigation action in place, referred to as Mitigation Project Complete (MPc).
- Calculate or estimate the damage that would likely have occurred if the mitigation action had not been taken, referred to as Mitigation Project Absent (MPa).
- MPa – MPc = Losses Avoided

Phase 4 is a comparison of the project cost to the project's Return on Investment (ROI), similar to how the Benefit Cost Ration (BCR) is calculated.

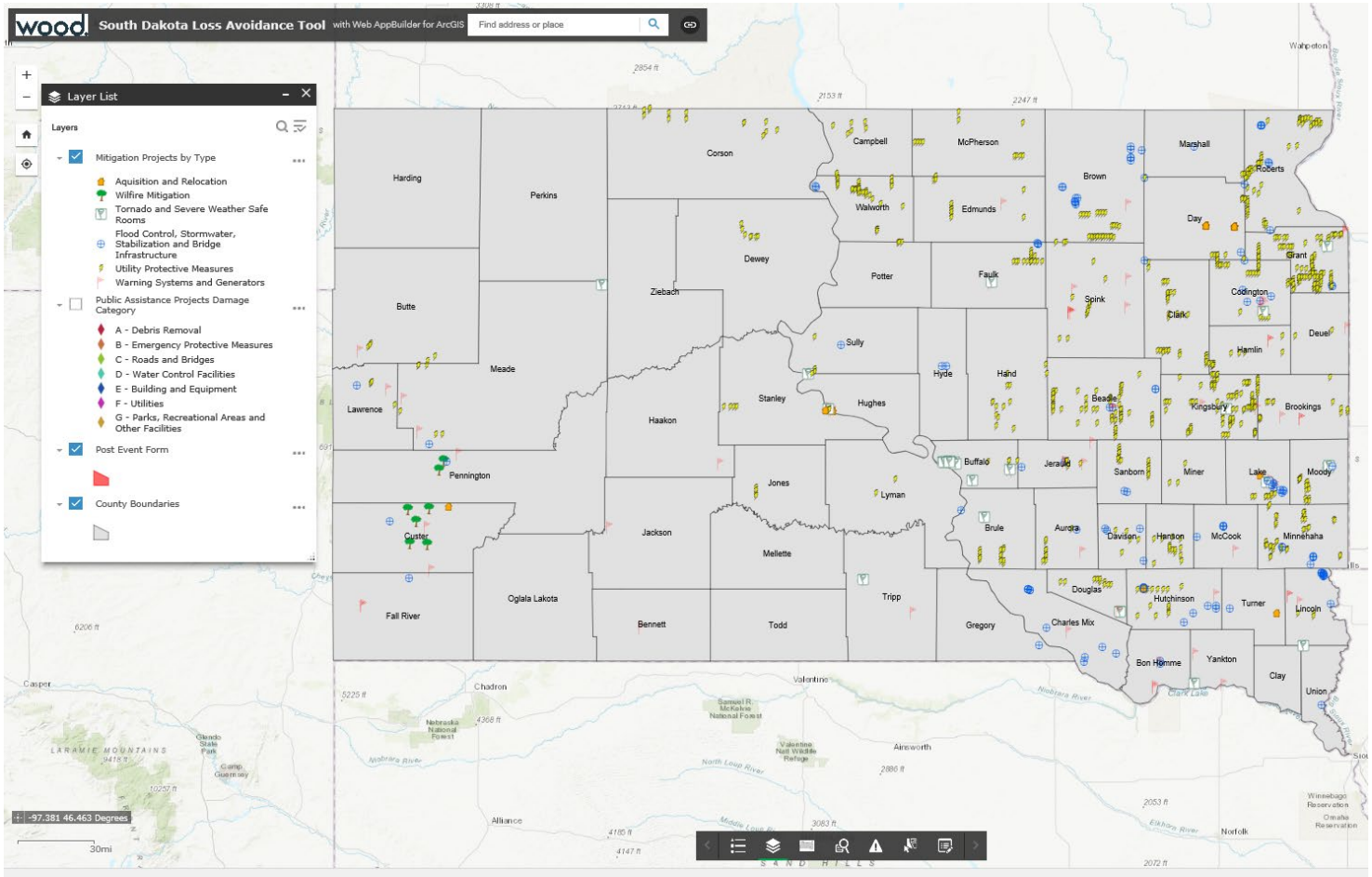
$$\text{Return on Investment (ROI)} = \frac{\text{MPa} - \text{MPc}}{\text{Cost of Project}}$$

Loss Avoidance Analysis Tool (LAAT) Overview

The web-based, loss avoidance analysis tool (LAAT) is a database of the structural data necessary to complete Phase 1 of a loss avoidance study and is a data collection tool for the hazard event data necessary to complete Phase 2 of a loss avoidance study. The LAAT website can be accessed here: http://bit.ly/SD_LossAvoidance

Step 1: Initial Project Selection – For all completed mitigation projects within the State, the LAAT database has been populated with project details. This includes structural information, and information about the disaster event and federal share used to complete the project, where it was available. Not all locations have all the information. **Figure 1** presents the LAAT website showing the completed mitigation projects by type.

Figure 1. Loss Avoidance Analysis Tool (LAAT) Website



Each mitigation project has also been spatially located based upon the street address or latitude/longitude, as either obtained from the project grant application or field located with GPS.

Those mitigation projects with limited structural or location data are included in the LAAT database, but should move forward to Phase 2 with an understanding of the known deficits before being utilized in a loss avoidance study.

The LAAT database may be updated at any time to include additional project information. For future mitigation projects, the structure data necessary to complete Phase 1 of a loss

avoidance study will be entered by SD OEM staff upon project completion and closeout.

Step 2: Project Effectiveness Analysis – Because a loss avoidance study measures benefits of a completed project based upon an actual event, the local official will be tasked with completing a hazard or storm event data collection form following a hazard event within their community or SD OEM staff can add this information easily to any reports resulting from disaster declarations. The user can spatially select those mitigation projects within the hazard event area and do a simple export to assist in determining loss avoidance. **Figure 2** displays the Operational Tools available on the website. **Figure 3** shows the Add Data Tool options. Users can either upload a project area shapefile or simple draw an area of interest to use for the analysis as shown in **Figure 7**, respectively. The user can also share the data from the analysis with others as shown in **Figure 5**.

Figure 2. LAAT Website – Operational Tools

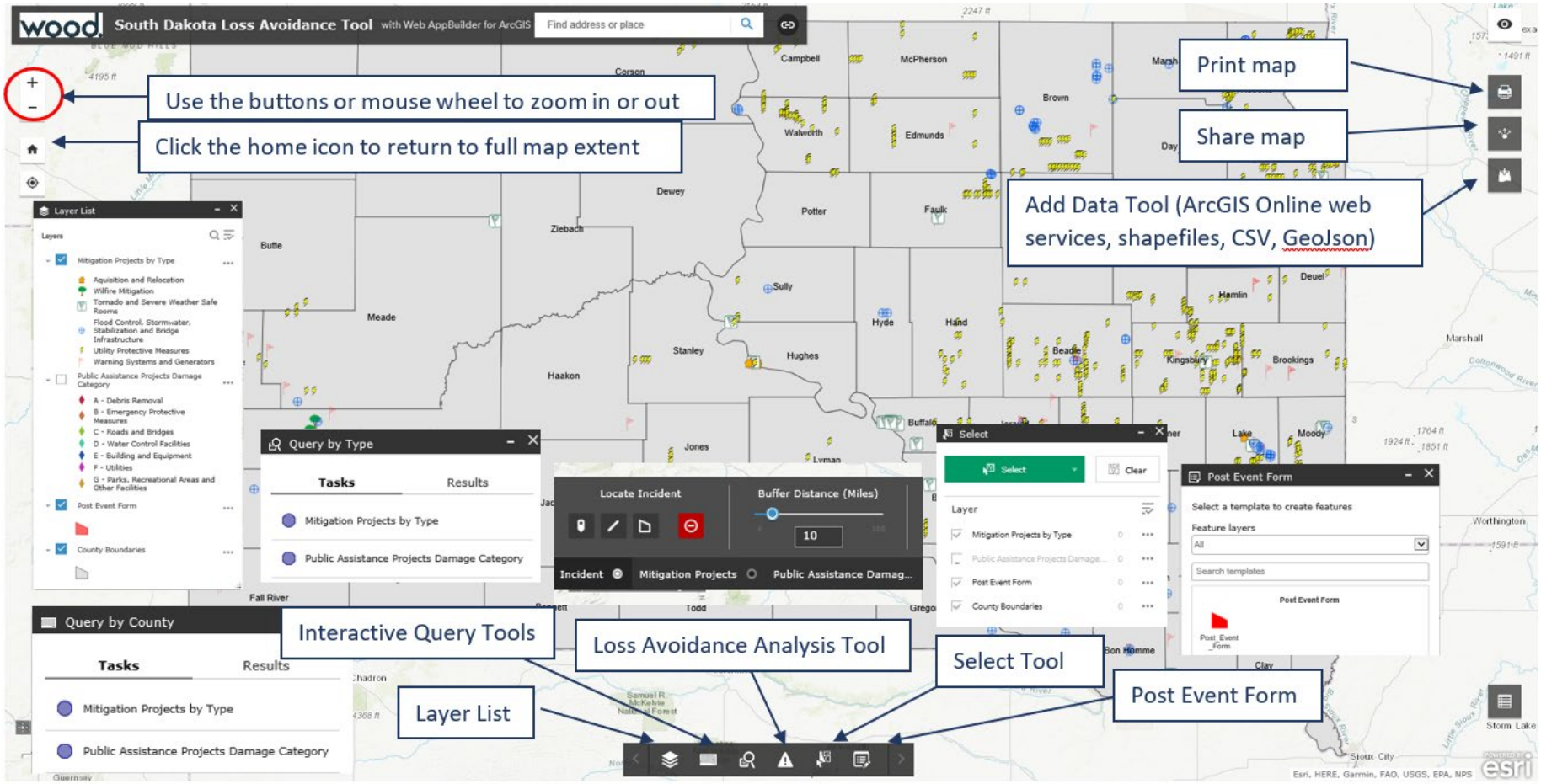
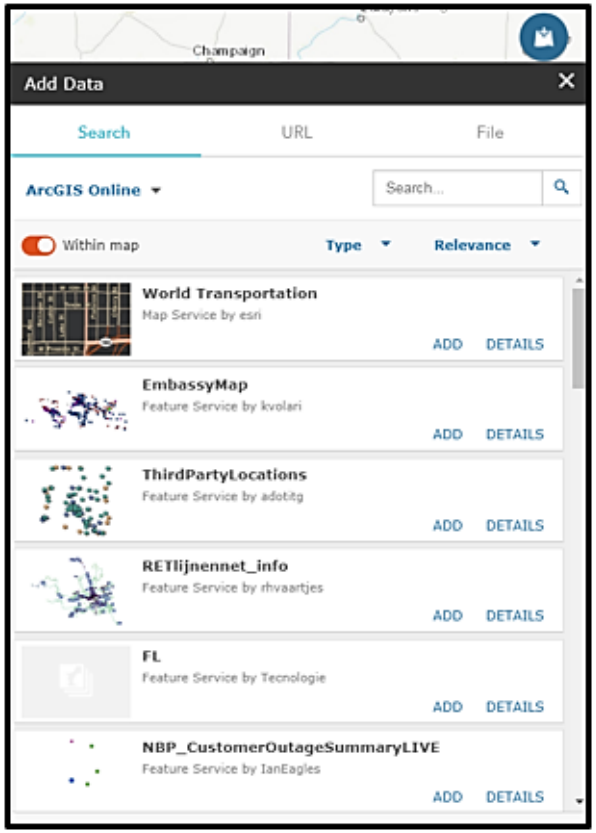
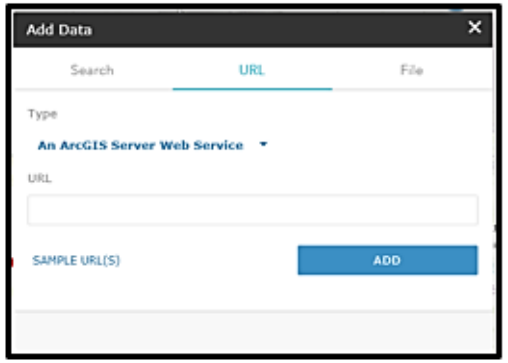


Figure 3. LAAT Website – "Add Data" Tool

1) From ArcGIS Online



2) From another Public Location/Agency



Add Data from following:

- ArcGIS Server Web Service
- WMS OGC Web Service
- KML
- GeoRSS File
- CSV File

3) Project and/or Personal Data

Add Data from Local Computer by Drag/Drop or Browse to Location.

Files Include:

- Shapefile
- CSV
- GPX
- GeoJson

Figure 4. LAAT Website – Print Tool

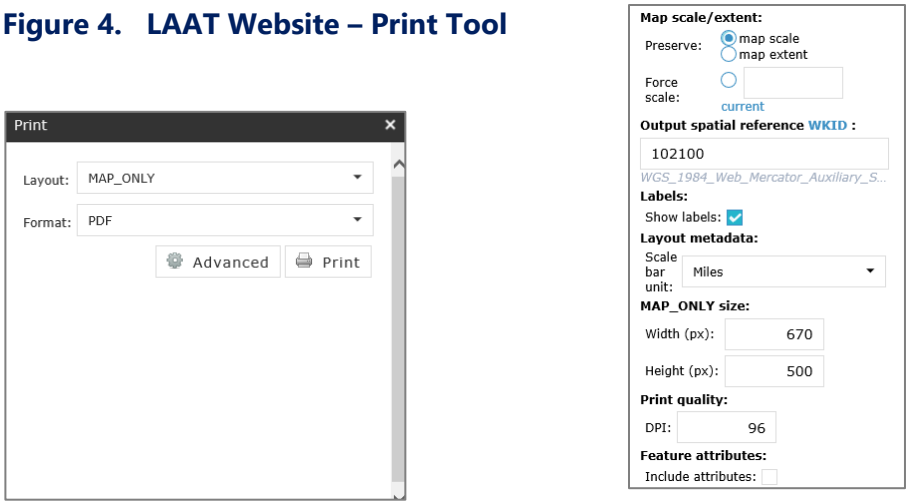
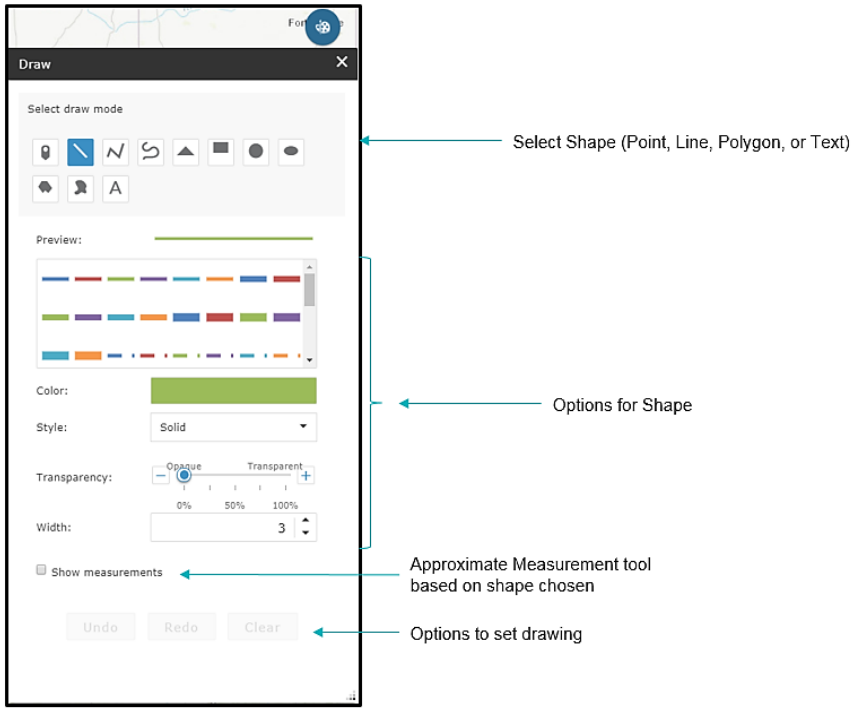


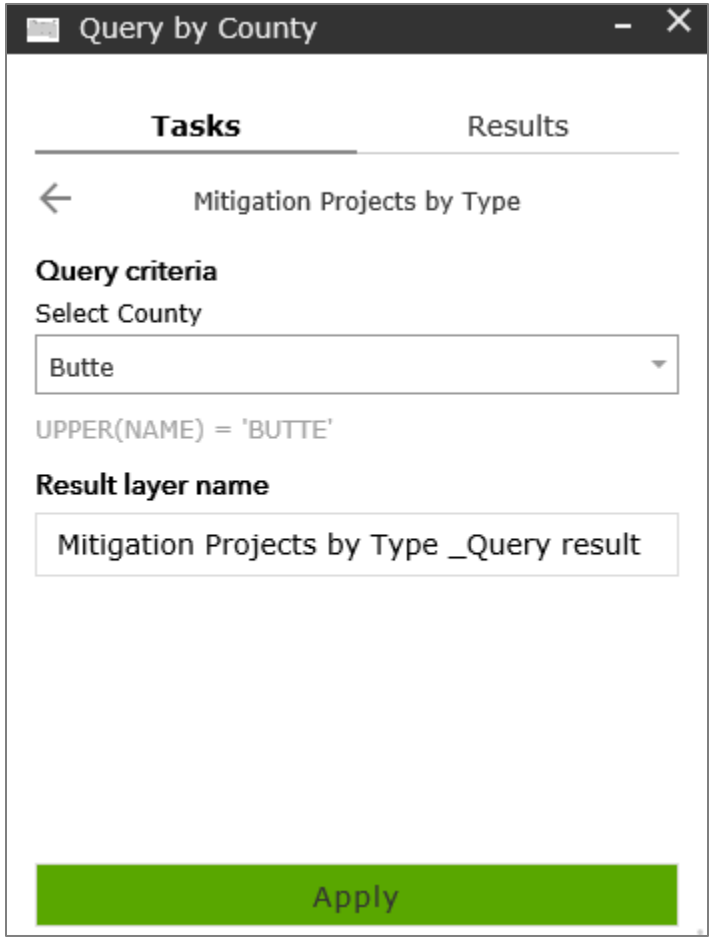
Figure 5. LAAT Website – "Share" Tool



Step 3: Loss Estimation Analysis - This final phase consists of estimating losses avoided based on the effectiveness of the mitigation project during the MP_C storm events. The two major tasks in Phase 3 are: (1) calculating losses avoided and (2) calculating the return on investment. This can now be done "on the fly" with the LAT by utilizing the Query Tool as shown in **Figure 6**.

The Incident Analysis Tool shown in **Figure 7** can be used to summarize the number projects and sum of federal share spent on mitigation projects. Users can draw an area on the map to represent the location of the area impacted by the hazard event. Once, the projects that have been completed are queried by the tool, the user can export them for use in further analysis.

Figure 6. LAAT Website – "Query" Tool



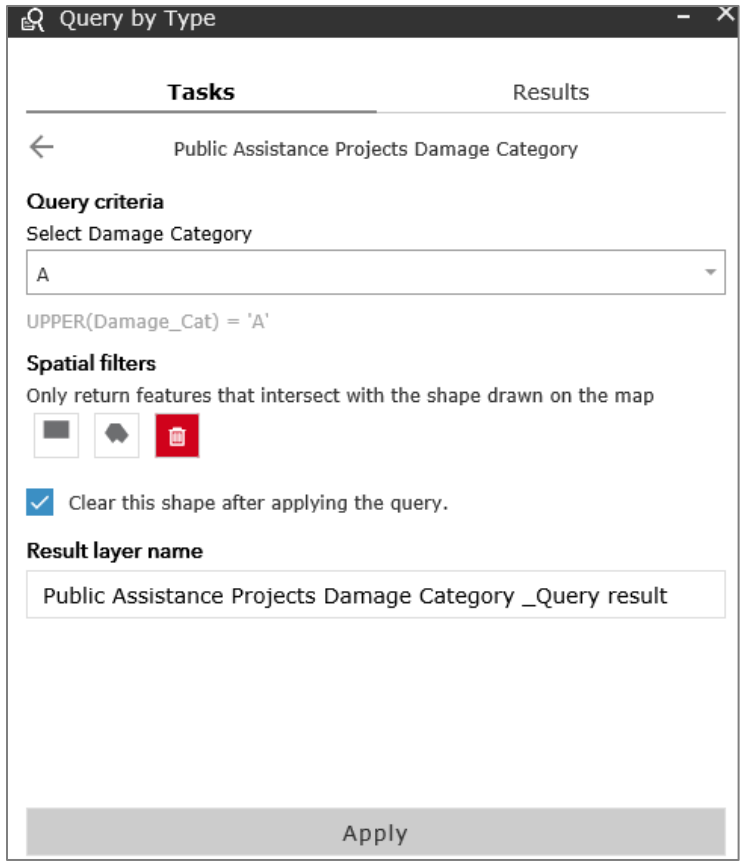
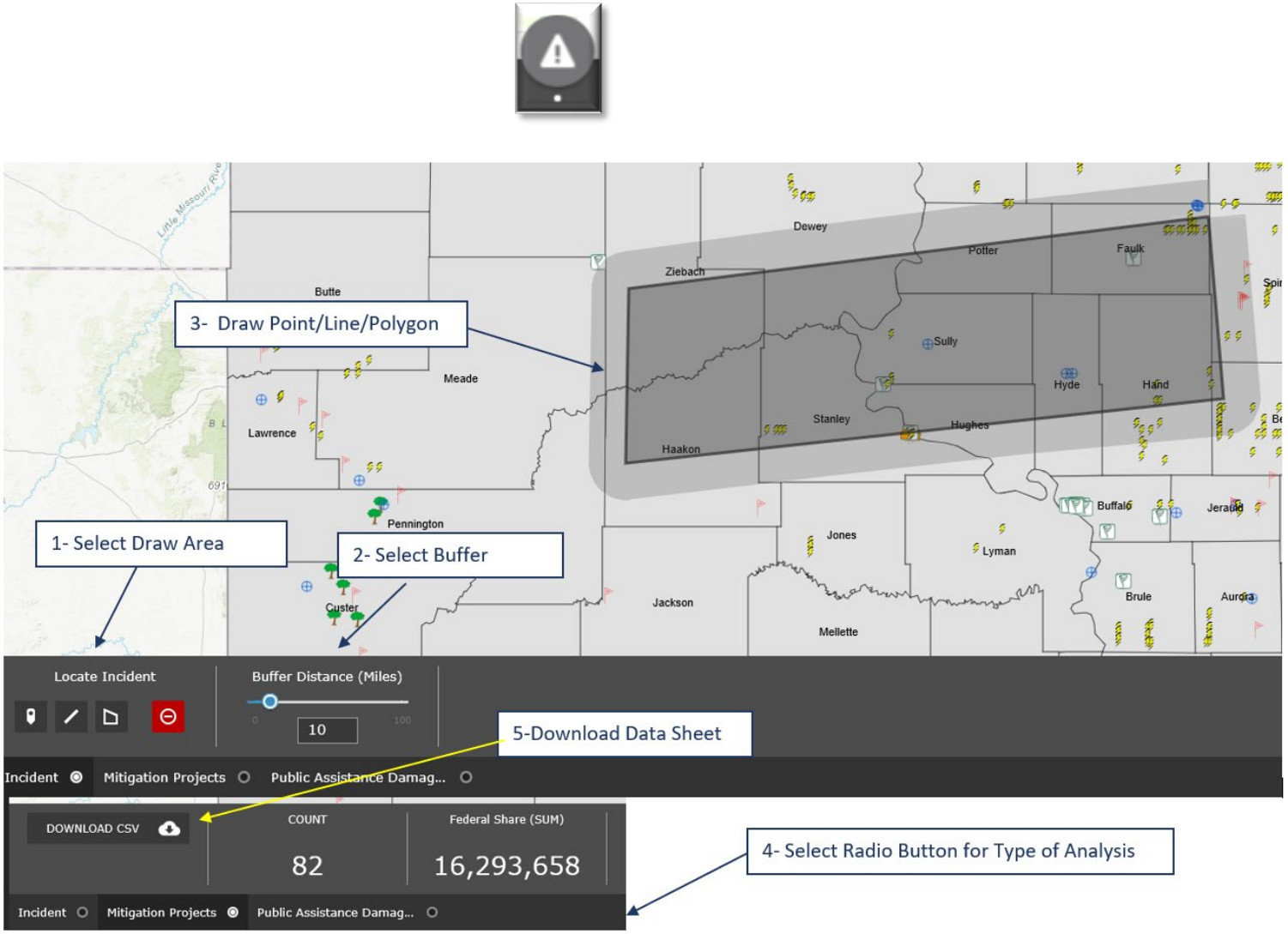
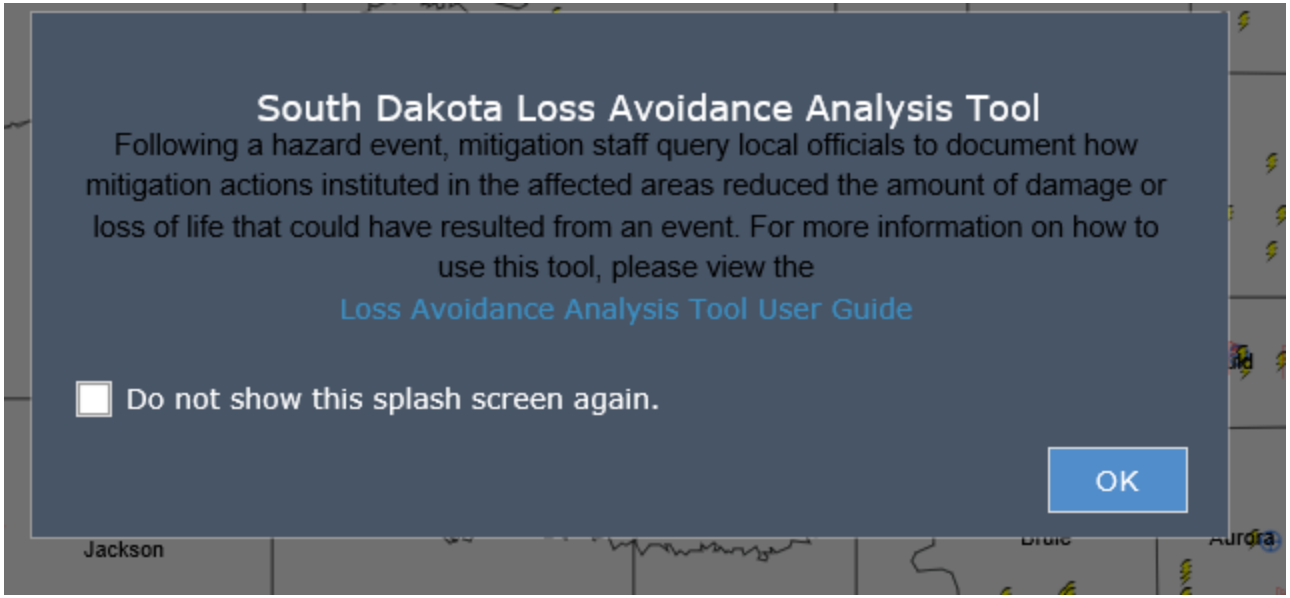


Figure 7. LAAT Website – "Incident Analysis" Tool



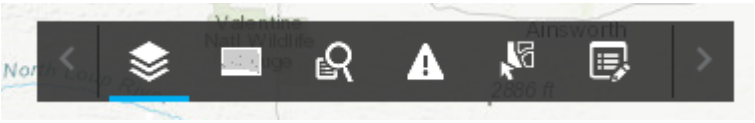


The web application opens with a splash screen that allows users to access this user guide. If the splash screen is not needed a user can check the box "Do not show this splash screen again" and it won't appear each time the application is used.

Use the + and – buttons in the upper left of the screen or the Mouse wheel to zoom in and out.

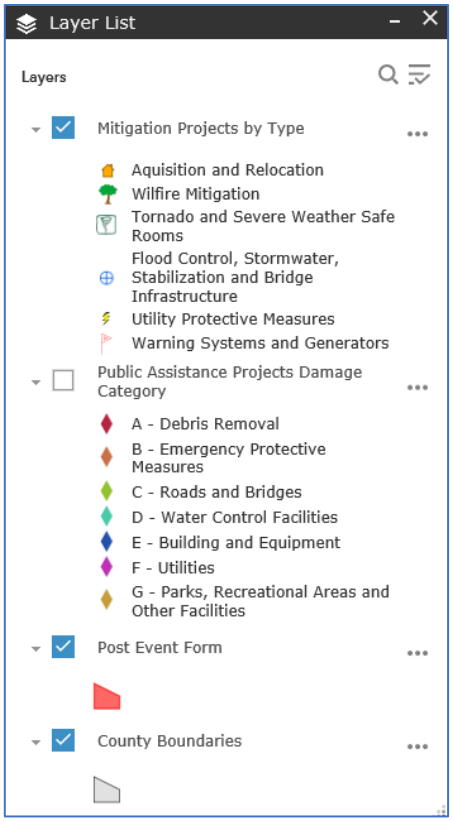
The Home or Full Scale button will zoom to the state and center it in the screen.

The Attribute button in the bottom right of the screen can be clicked to view the attributes associated with the layers in the map.

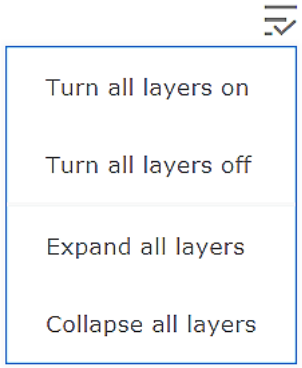


At the bottom of the page is a banner with six tool icons. From left to right they are the Layer List, the Query by County, Query by Type, the Incident Analysis and the Select tools. The following pages describes each icon.

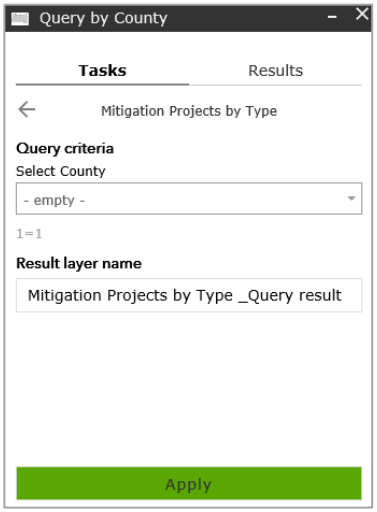
This icon is the Layers List. Clicking it will open a window indicating what Operational layers are in the map. The blue check marks indicate the layer is turned on, the empty checkbox indicates they are turned off. These are toggles and the layers can be easily activated/deactivated by clicking inside the checkboxes.



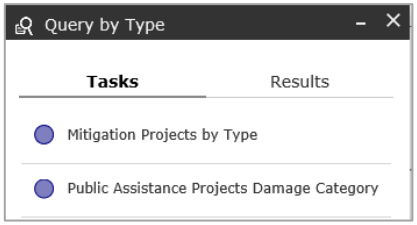
This icon in the upper right of the Layer List, when clicked will open to show options to turn on/off all layers and expand/collapse all layers.



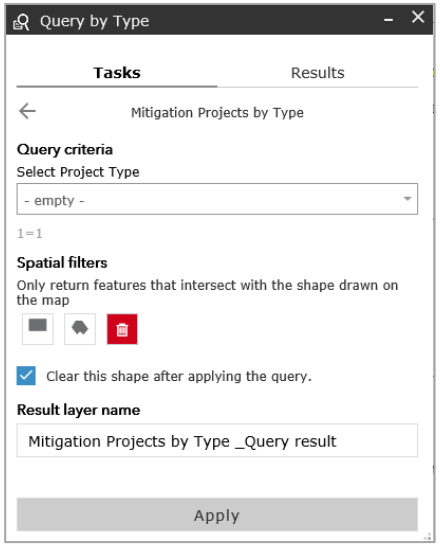
This icon is the Query by County Tool. Mitigation projects and public assistance projects can be queried by county. Select the type of query and then select a county from the drop-down menu.

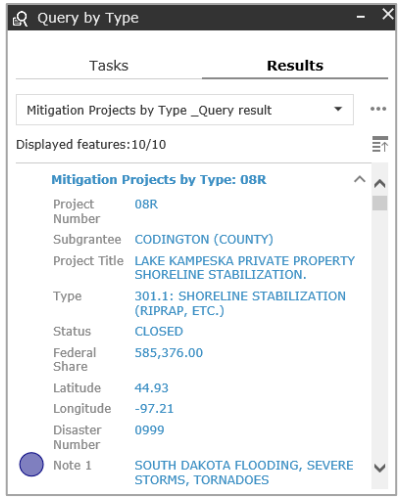


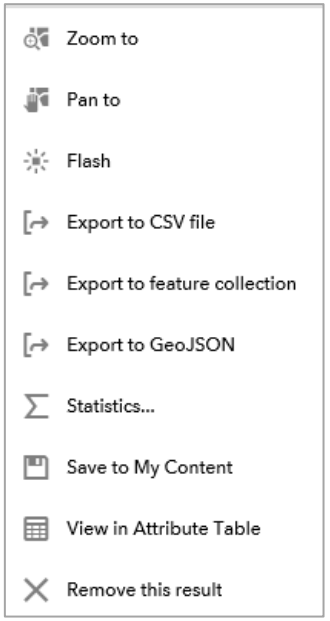
This icon is the Query by Type tool. Mitigation projects and public assistance projects can be queried by county. Select the type of query and then select project type from the drop-down menu. Select a drawing tool to draw an area to query.



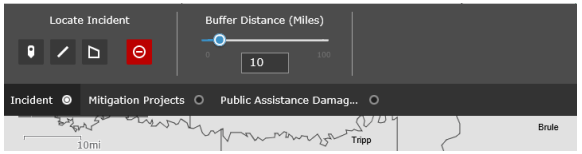
After the query selections are applied, the results can be viewed and exported by clicking the three dots in the upper right-hand corner of the query results box.



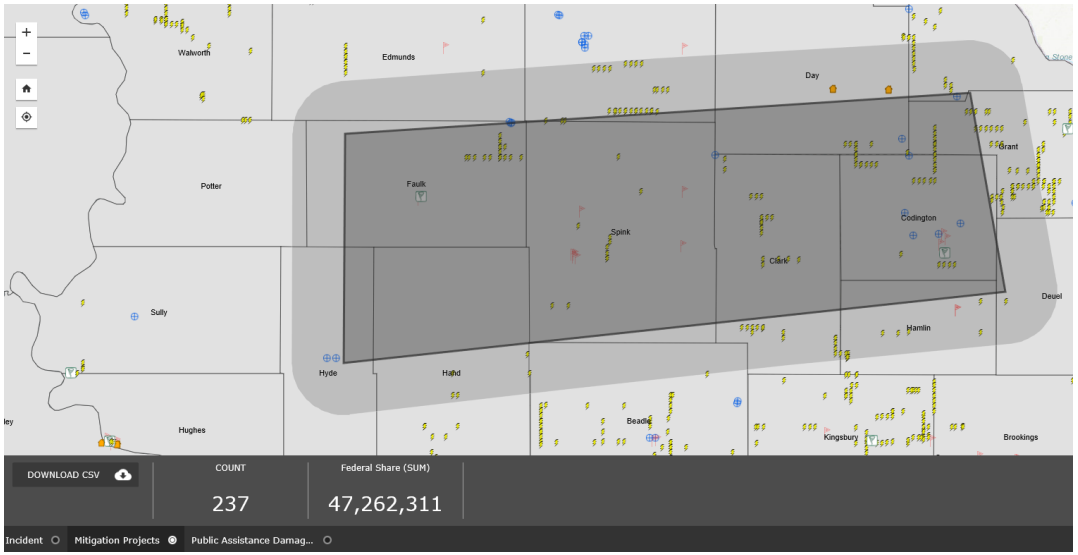




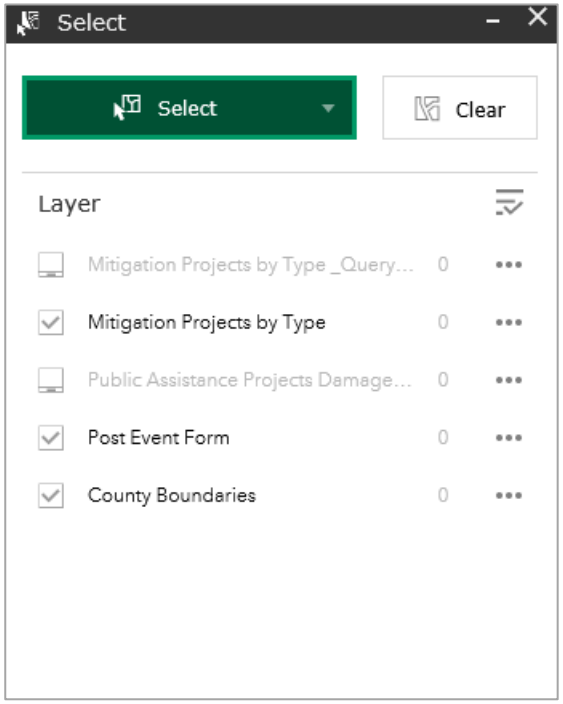
This icon is the Incident Analysis Tool. Clicking it will open a ribbon across the bottom of the screen.



A drawing tool is selected to draw the area of interest on the map. The buffer distance can be set. Choose the type of analysis using the radio buttons. The resulting analysis will sum up the number of projects and the total amount of the federal share spent to help with the calculation of losses avoided.

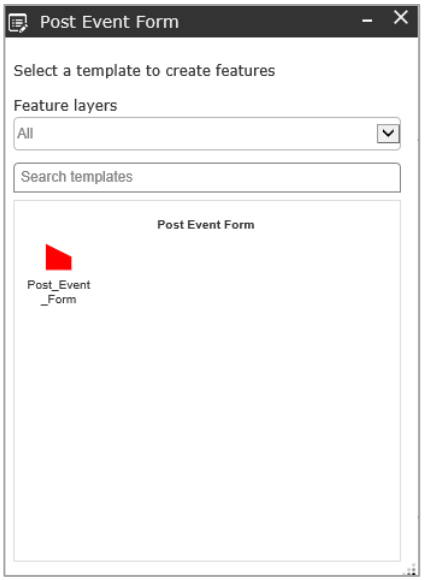


This icon is the Select Tool. Clicking it will open the Select window to allow the user to select certain points of interest in any of the layers in the list.

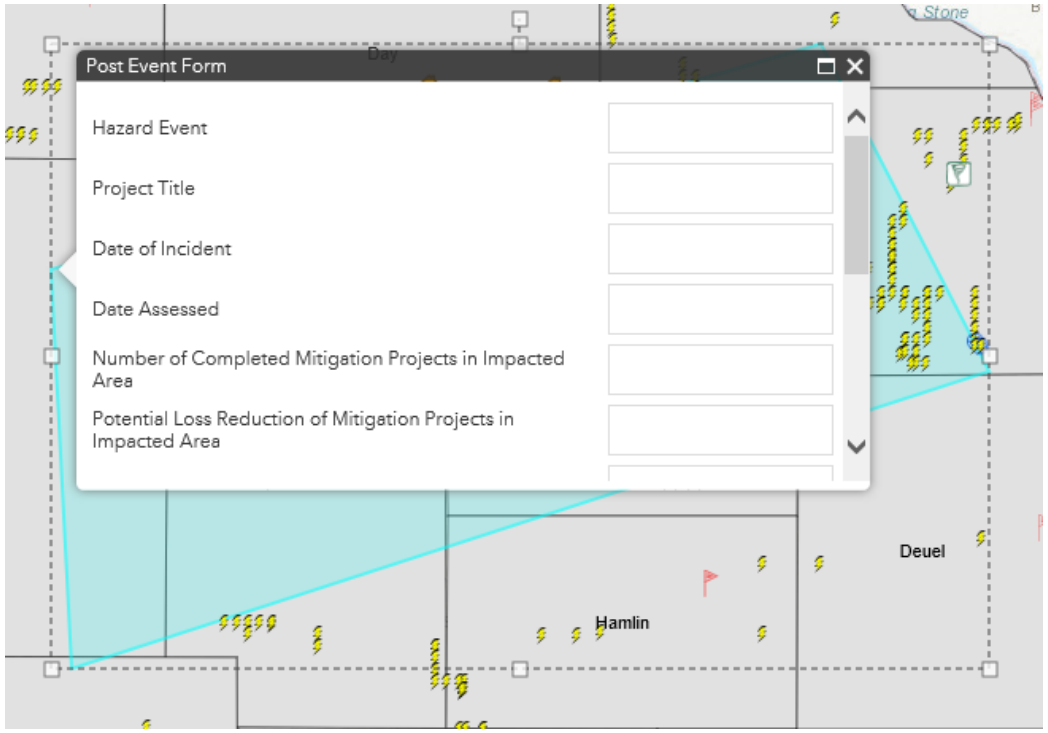


This icon opens the post-event form. The form can be used to collect data from local officials after a disaster event.

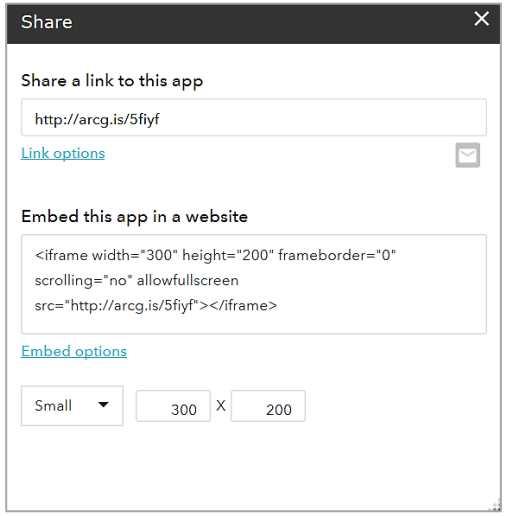
First select post-event form to draw the area of interest in the map.



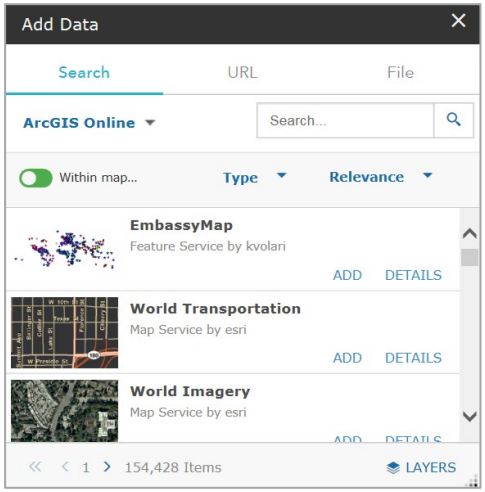
After area is drawn a form will pop-up and populated with information to help calculate losses avoided from the existing mitigation projects.



The "**Share**" button in the upper right of the screen opens the Share window giving the user the ability to share the map with others or embed the app in a website. Clicking the envelope button on the right of the window will open an email using your default email account with the link in it.



To **Add Data** for analysis, click this icon in the upper right of the screen and the Add Data window will open. Data from web services or user input can be added here.



Attachment A – South Dakota Drought Mitigation Plan

The November 2015 South Dakota Drought Mitigation Plan, developed as a stand-alone plan, is included as an attachment to this SHMP.

The Drought Plan was developed to provide a strategy for the State of South Dakota to reduce the impacts of drought-related water shortages over the short and long term. There are two major components of the plan: the mitigation strategy and vulnerability assessment. The Drought Plan was prepared in coordination with the State's Drought Task Force, which is comprised of various state agencies and co-chaired by the Departments of Agriculture and Department of Public Safety, Office of Emergency Management.

The Drought Plan includes a description of the process used to develop the Drought Plan and a profile of the drought hazard in South Dakota, including the nature of impacts and probability of occurrence. A drought vulnerability assessment discusses the past and potential impacts to six sectors that include agriculture, health and socioeconomic, tourism, water resources, wildland fire, and wildlife. A mitigation strategy outlines the goals of the Drought Plan and specific action items intended to meet those goals. Many of these mitigation actions can occur during drought and non-drought times. A capability assessment describes the State's pre- and post-disaster plans, policies, and procedures in place that already help manage and reduce drought impacts. The Drought Plan describes funding sources that can be used to implement local mitigation projects and plans and a description of the process for implementation, monitoring and evaluating the Plan.

Attachment B – HMGP Administrative Plan

The South Dakota Hazard Mitigation Grant Program (HMGP) Administrative Plan, last updated August 7, 2018 as a stand-alone plan, is included as an attachment to this SHMP.

The HMGP Administrative Plan documents the process for the administration of the Hazard Mitigation Grant Program and the management of the mitigation measures to be funded under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1989, as amended. Section 404 establishes an independent grant program and is closely tied to the post-disaster hazard mitigation plans defined under Section 322 of the Act.

The HMGP Administrative Plan is updated following major disasters that result in the award of HMGP funds, or whenever else SD OEM determines it needs revision.