4.4.6 Severe Winter Storms – Blizzards, Ice Storms

Blizzards are storms that contain heavy snowfall, strong winds, and cold temperatures. The combination of these elements creates blinding snow with near zero visibility, deep snowdrifts, and life-threatening wind chill temperatures. Blizzards are the most dramatic and destructive of all winter storms that occur within Steele County, and are generally characterized as storms bearing large amounts of snow accompanied by strong winds. They have the ability to completely immobilize travel in large areas and can be life-threatening to humans and animals in their path. According to the National Weather Service (NWS), there is no fixed temperature requirement for blizzard conditions, but the life-threatening nature of low temperatures in combination with blowing snow and poor visibility increases dramatically when temperatures fall below 20° F. Blizzards typically occur between October and April; however, they occur most frequently from early November to late March.

Figure 19. Armistice Day Blizzard, 1940

The greatest numbers of blizzards historically have occurred in the months of January, followed by March and November, respectively. Steele County, along with all areas of Minnesota, is susceptible to blizzards.

Damages from blizzards can range from human and livestock deaths to significant snow removal costs. Stranded drivers can make uninformed decisions, such as leaving the car to walk in conditions that put them at risk. Because of the blinding potential of heavy snowstorms, drivers are also at risk of collisions with snowplows or other road traffic. Drivers and homeowners without emergency plans and kits are vulnerable to the life-threatening effects of heavy snow storms such as power outages, cold weather, and inability to travel, communicate, obtain goods or reach their destinations. Heavy snow loads can cause structural damage, particularly in areas where there are no building codes or where residents live in manufactured home parks. The frequency of structural fires tends to increase during heavy snow events, primarily due to utility disruptions and the use of alternative heating methods by residents.

Between the years of 1975 and 1991, there were 49 deaths associated with blizzards statewide, or an average of 3 deaths per year. Deaths attributable to blizzards have dropped in recent years, primarily due to increased weather awareness and warning capabilities across the state. The economic costs of winter storms are generally not recorded by the NCEI; however, a winter storm in November 2001 resulted in property damage of $500,000.

Ice storms are described as occasions when damaging accumulations of ice occur due to freezing rain. The terms freezing rain and freezing drizzle warn the public that a coating of ice is expected on the ground and other exposed surfaces. Heavy accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers.

Communications and power can be disrupted for days while utility companies work to repair extensive damage. Ice forming on exposed objects generally ranges from a thin glaze to coatings more than 1 inch thick. Even small accumulations of ice on sidewalks, streets, and highways may cause extreme hazards to Steele County motorists and pedestrians. Sleet does not stick to trees and wires, but sleet of sufficient thickness does cause hazardous driving conditions. Heavy sleet is a relatively rare occurrence, defined as an accumulation of ice pellets covering the ground to a depth of ½-inch or more.

Ice and sleet storms typically occur from October through April. The NWS notes that over 85% of ice storm-related deaths are the result of traffic accidents. The NCEI has recorded 2 ice storms in Steele County: in November 1996 and January 1998, but no deaths or injuries were reported.

Observing winter storm watches and warnings and adequate preparation can lessen the impact of blizzards in Minnesota. Technical advances made in transportation, including safer vehicles and improved construction and maintenance of roads, have also contributed to the decline in deaths related to blizzards. Historical estimates of dollar losses associated with blizzards were not available for the purposes of this analysis. However, costs incurred by state and local government for snow removal associated with disaster declaration DR-1158 (January 1997) totaled over $27,300,000 dollars. Blizzards rank 9th out of the 10 natural hazards economically impacting Minnesota according to the statewide risk analysis. The chance that another winter storm affecting Steele County will occur is highly probable.

Severe Winter Storm History in Steele County

The total of notable events defined as heavy snows, blizzards, winter weather, ice storms and winter storms in Steele County recorded by the NCEI for the period from 1996 to March 2017 is 76. An overview of some of the recent notable winter storms can be found in Table 25 below.

Table 25. Notable Winter Weather Events in Steele County

Date	Type	Cost	Deaths	Injuries	Description
January 2015	Blizzard	0	0	0	Snowfall occurred on January 5th, 2015, and 50 mph winds created blizzard conditions. Blowing and drifting snow across roads caused multiple accidents.
December 2015	Winter Storm	0	0	0	Owatonna received 6 inches of snow, and the following morning 2-4 additional inches accumulated.
March 2014	Heavy Snow	0	0	0	Snow developed across the county on March 4th. The snow became heavier toward the evening, with heavier bands of snow within the Minnesota River valley. Totals ranged from 6-11 inches across the county.
January 1997	Severe Winter Storms, Blizzards	N/A	N/A	N/A	Severe winter storms and blizzards resulted in presidential disaster declaration DR-1158, which included Steele County.

Severe Winter Storms and Climate Change

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

According to the 2015 Minnesota Weather Almanac, a recent study of seasonal snowfall records across the state from 1890-2000 showed that 41 of 46 climate stations recorded an increase in average annual snowfall, by as much as 10 inches. Higher snowfall levels can result in greater runoff potential during spring snow melt, and many watersheds in Minnesota have shown more consistent measures of high-volume flows during spring, often at or above flood stage (Seeley M. , 2015).

Vulnerability

The number of heavy snowfall years for the Midwest has fluctuated between 1900 and 2006. The periods of 1900-1920 and 1960-1985 had numerous years with snowfall totals over the 90th percentile. In the past 3 decades, the number of heavy seasonal snowfall totals has been much lower. Despite these generally lower seasonal snowfall totals, some areas of the Midwest have still experienced significant snow totals in the most recent decade. The 100-year linear trends based on decadal values show that the upper Midwest had statistically significant (1% level) upward linear trends in snowstorm frequency from 1901 to 2000 (Kunkel, et al., 2013).

Winter storms affect Steele County each year, so there is a 100% probability that the county and its jurisdictions will be affected annually. The amount of snow and ice, number of blizzard conditions, and days of sub-zero temperatures each year are unpredictable and within Steele County the vulnerability of jurisdictions to winter storms does not vary geographically. Citizens living in climates such as these must always be prepared for situations that put their lives or property at risk. It is not always the size of the storm or the depth of the cold, but an unprepared individual with a vehicle breakdown or lack of a personal winter safety kit that are at risk. Rural citizens are more vulnerable to issues with deep snow. The vulnerability of each jurisdiction to severe winter storms has not changed due to any development in the last 5 years.

Severe Winter Storms and Electrical Outages

The leading cause of electric outages in Minnesota during 2008 to 2013 was Weather/Falling Trees. Between 2008 and 2013, the greatest number of electric outages in Minnesota occurred during the month of March (U.S. Department of Energy, 2015).

Plans and Programs in Place

Winter Weather Warnings – Winter weather warnings are issued by the National Weather Service. There is an I-35 closure plan for MN DOT and Steele County Emergency Management that addresses the closing plan, sheltering, parking and rescue of stranded motorists.

Winter Hazard Awareness Week – Steele County helps promote and participates in the National Weather Service's "Winter Hazard Awareness Week" held in November each year. The event seeks to educate residents on the dangers of winter weather and how to properly deal with it.

School Closings – All school districts within Steele County have a school closing policy and communications plan in place if inclement weather or temperatures create a hazardous situation for students or staff.

Program Gaps or Deficiencies

MN DOT I-35 Road Closure (Traffic Control & Sheltering) – During severe winter storms that require closure of I-35, better traffic control coordination and communication is needed between MN DOT, Steele County Emergency Management, and local law enforcement to direct all motorists to designated shelters and parking areas. Doing so will ensure the safety of stranded motorists until I-35 is re-opened.

Backup Power – Not all county & city facilities have backup power in the event of a severe winter storm that takes out power.

Power Lines – Above-ground power lines are susceptible to damage as a result of ice and windstorms. Locating lines underground where it is feasible and cost effective, as is occurring in some parts of Steele County, can reduce damage and potential power outages.

4.4.7 Extreme Cold

Winter in Steele County can be severe, and especially dangerous for disabled citizens and outdoor workers. Record temperature lows and arctic-like wind chills can cause cold-related illnesses such as frostbite and hypothermia, which can be deadly. Hypothermia is the greatest and most life-threatening cold weather danger.

In Steele County cold winter weather can have severe or fatal impacts. Hypothermia occurs when the core body temperature drops below 96° F. Anyone who is exposed to severe cold without enough protection can develop hypothermia. Frostbite occurs when skin tissue and blood vessels are damaged from exposure to temperatures below 32° F. It most commonly affects the toes, fingers, earlobes, chin, cheeks, nose, and other body parts that are often left uncovered in cold temperatures. The NWS issues "Extreme cold" warnings when it feels like -30° F or colder across a wide area for several hours. Extreme cold watches are issued a day or two before the conditions are expected.

Medical costs related to extreme heat and cold can be enormous: in 2005 the total was $1.5 billion nationwide, or more than $16,000 per patient (Union of Concerned Scientists, 2009).

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

Extreme cold temperatures affect the county nearly every year. Extremely cold air settled over Minnesota on January 31st of 1996, and remained entrenched through February 4th. A new record low temperature for Minnesota was set in the town of Tower on February 2, 1996, at -60° F. Numerous record low temperatures were set during the period at St. Cloud, Rochester and the Twin Cities. Minneapolis/St. Paul set 3 new record low temperatures as well as recording the 2nd coldest day on record on February 2, 1996. A mean temperature of -25° F was measured that day with a high of -17° F and a low of -32° F in the Twin Cities. This was within 2 degrees of tying the all-time record low

temperature set in the Twin Cities and the coldest temperature recorded this century. Many central and southern Minnesota locations set new record low temperatures the morning of the 2nd. The Governor closed all schools that day.

In February of 2014, nearly all of Minnesota was between 10-15° F colder than normal (1981-2010 period) (High Plains Regional Climate Center, 2014). The winter of 2013-2014 was the sixth coldest on record in Minnesota (The Weather Channel, 2014), with schools in the Twin Cities canceling 5 times in January due to dangerous wind chills. It was the coldest winter in the Twin Cities in 35 years, with an average temperature for December-February of 9.7° F (MN DNR, 2014). Many areas in the state also experienced higher than average precipitation through the winter and spring months.

Extreme Cold History in Steele County

January is the coldest month on average in Owatonna. The lowest temperature ever recorded there occurred in 1977, when it fell to -35° F. The average low temperature in Owatonna for the month of January is 2° F, with an average annual snowfall of 8.5" (Intellicast, 2017).

The National Centers for Environmental Information (NCEI) recorded 4 extreme cold/wind chill events during the winter of 2014-2016. No deaths or injuries were reported.

Extreme Cold and Climate Change

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

Vulnerability

Extreme cold temperatures affect the county nearly every year. The amount of snow and ice, number of blizzard conditions, and days of sub-zero temperatures each year are unpredictable.

Within Steele County the risk of extreme cold does not vary geographically. Citizens living in climates such as these must always be prepared for situations that put their lives or property at risk. It is not always the depth of the cold, but an unprepared individual with a vehicle breakdown or lack of a personal winter safety kit that are at risk. Rural citizens not connected to city gas lines are more vulnerable to issues with extreme cold. The vulnerability of each jurisdiction to extreme cold has not changed due to any development in the last 5 years.

Plans and Programs in Place

Emergency Temporary Shelter – If needed the Armory will be opened to people in need to provide emergency shelter from extreme cold.

School Closings – All school districts within Steele County have a school closing policy and communications plan in place if inclement weather or temperatures create a hazardous situation for students or staff.

Program Gaps or Deficiencies

No program gaps or deficiencies identified.

4.4.8 Extreme Heat

Humans need to maintain a constant body temperature if they are to stay healthy. Working in high temperatures induces heat stress when more heat is absorbed into the body than can be dissipated out. Heat illness such as prickly heat, fainting from heat exhaustion, or heat cramps are visible signs that people are working in unbearable heat. In the most severe cases, the body temperature control system breaks down altogether and body temperature rises rapidly. This is a heat stroke, which can be fatal. The NWS issues a heat advisory when, during a 24-hour period, the temperature ranges from 105° F to 114° F during the day, and remains at or above 80° F at night.

Extreme heat events are linked to a range of illnesses, even death, and can exacerbate pre-existing chronic conditions such as cardiovascular, respiratory, liver, and neurological diseases, endocrine disorders, and renal disease or failure. Populations who are most vulnerable to extreme heat include persons over 65 or under 5 years old; living alone, without air-conditioning, or residing on the topmost floor of a building; and with an income at or below the poverty line. People who are exposed to heat because of recreational activities or job-related activities also are more vulnerable, including athletes, construction workers, and landscape/agricultural workers (Adapting to Climate Change in Minnesota: 2013 Report of the Interagency Climate Adaptation Team, 2013).

Medical costs related to extreme heat and cold can be enormous: in 2005 the total was $1.5 billion nationwide, or more than $16,000 per patient (Union of Concerned Scientists, 2009).

Extreme Heat History in Steele County

July is the hottest month on average in Owatonna. The highest temperature ever recorded in Owatonna occurred in 1988, 1990, 1995, when it rose to 102° F (Intellicast, 2015). According to the High Plains Regional Climate Center, the average July maximum temperature (from 1961-February, 2017) in Owatonna was 97° F.

The National Centers for Environmental Information has recorded 3 instances of extreme heat in Steele County since 2011. They occurred in July of 2011, August of 2013 and July of 2016. No deaths or injuries were reported. This most recent heat event caused surface heat indices to be over 105° F on July 21, 2016. The following day a heat index of 111° F was recorded.

Extreme Heat and Climate Change

Minnesota's average temperature has increased more than 1.5°F since recordkeeping began in 1895, with increased warming happening in recent decades (International Climate Adaptation Team, 2013). Annual temperatures in the Midwest have generally been well above the 1901-1960 average since the late 1990s, with the decade of the 2000s being the warmest on record (Kunkel, et al., 2013). 7 of Minnesota's 10 warmest years occurred in the last 15 years. Projected increases are 2° F to 6° F more by 2050 and 5° F to 10° F by 2100 (MN Environmental Quality Board, 2014). The Midwest has experienced major heat waves and their frequency has increased over the last 6 decades (Perera, et al., 2012). For the U.S., mortality increases 4% during heat waves compared with non-heat wave days (Anderson & Bell, 2011). During July 2011, 132 million people across the U.S. were under a heat alert –

and on July 20 the majority of the Midwest experienced temperatures in excess of 100° F. Heat stress is projected to increase as a result of climbing summer temperatures and humidity (Schoof, 2012). On July 19, 2011, Moorhead Minnesota set a new state record for the hottest heat index ever, at 134° F. That same day, Moorhead also recorded a new state record for the highest dew point at 88. It was the hottest, most humid spot on the planet that day (Douglas, 2011).

Recent statistics from NOAA show that there are more human fatalities each year due to heat waves than from floods, lightning, tornadoes and winter storms. Many cities have responded by creating Heat Wave Response Plans to ensure that those in marginal health without air conditioning can obtain the relief and care they need, and the Minnesota Department of Health developed the Extreme Heat Toolkit to help educate at-risk populations on how to reduce risks associated with heat waves (Seeley M. , 2015).

Increasing temperatures impacts Minnesota's agricultural industry. Agriculture is highly dependent on specific climate conditions. As a result of increasing temperature, crop production areas may shift to new regions of the state where the temperature range for growth and yield of those crops is optimal. According to the National Climate Assessment, the Midwest growing season has lengthened by almost 2 weeks since 1950 due in large part to earlier timing of the last spring freeze. This trend is expected to continue. While a longer growing season may increase total crop production, other climate changes, such as increased crop losses and soil erosion from more frequent and intense storms, and increases in pests and invasive species, could outweigh this benefit. There may also be higher livestock losses during periods of extreme heat and humidity. Losses of livestock from extreme heat lead to a challenge in the disposal of animal carcasses. Currently there are only 2 rendering facilities in Minnesota available for livestock disposal. If a rendering facility is not available, lost livestock must be composted on an impervious surface. If losses are high, finding an impervious surface large enough is a challenge. In an attempt to adapt to increased temperatures, livestock areas in Minnesota may shift farther north. As a result of new livestock areas and the resulting manure production, farmers may transition to manure-based fertilizer applications in areas where traditionally only commercial fertilizers have been used, with accompanying environmental advantages and disadvantages (Adapting to Climate Change in Minnesota: 2013 Report of the Interagency Climate Adaptation Team, 2013). In order to minimize the detrimental effects of heat stress on animal metabolism and weight gain, Minnesota farmers have also begun redesigning and retrofitting dairy, hog, and poultry barns with better watering, feeding, and ventilation systems (Seeley M. , 2015).

Vulnerability

Within Steele County the risk of extreme heat does not vary geographically. The vulnerability of each jurisdiction to extreme heat has not changed due to any development in the last 5 years.

Plans and Programs in Place

Emergency Temporary Shelter – If needed the Armory will be opened to people in need to provide emergency shelter from extreme heat.

School Closings – All school districts within Steele County have a school closing policy and communications plan in place if inclement weather or temperatures create a hazardous situation for students or staff.

Program Gaps or Deficiencies

No program gaps or deficiencies identified.

4.4.9 Drought

A drought refers to an extended period of deficient rainfall relative to the statistical mean for a region. Drought can be defined according to meteorological, hydrological, socioeconomic, and agricultural criteria. Meteorological drought is qualified by any significant deficit of precipitation. Hydrological drought is manifest in noticeably reduced river and stream flow and critically low groundwater tables. The term agricultural drought indicates an extended dry period that results in crop stress and harvest reduction. Socioeconomic drought refers to the situation that occurs when water shortages begin to affect people and their lives. It associates economic goods with the elements of meteorological, agricultural, and hydrological drought. Many supplies of economic goods (e.g., water, food grains, hydroelectric power) are greatly dependent on the weather. Due to natural variations in climate, water supplies are high in some years but low in others. Fluctuating long-term climate variations make drought difficult to predict.

Drought History in Steele County

National Centers for Environmental Information records show no droughts in Steele County. However, in the fall of 2012 a dry period that crossed the Midwest had significant consequences in Ellendale. The southwest corner of Steele County recognized slightly more significant impacts from drought conditions, which were reflected in agricultural practices. On Oct. 17, 2012, Steele County was among 6 other counties that were declared as a primary natural disaster area and could receive assistance. This allowed farmers within Steele County to declare losses correlating to the drought. The USDA and FSA describe efforts derived from the USDA to supplement or limit agricultural losses through the purchase of up to $170 million of pork, lamb, chicken, and catfish; this came after Agriculture Secretary Tom Vilsack announced an extension for emergency grazing on Conservation Reserve Program (CRP). Additionally, the department transferred $14 million in unobligated program funds into the Emergency Conservation Program and lowered the penalty on CRP acres used for emergency haying or grazing, from 25% to 10%.

The hazard rank for drought in Steele County is medium. A drought may not have a severe impact on human life due to decreased water access; however, the economic impact on farmers would be significant. A drought would also have a detrimental impact on the local economy due to stunting growth of agriculture crops and negative impacts on livestock. Extended drought conditions may also make an area more prone to wildfire. Droughts can also be closely linked with insect infestation. Trees may be lost due to lack of moisture. In severe instances, a drought may cause wells to dry up entirely.

Drought and Climate Change

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

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

Across the nation, drought is affecting water supplies, as ground and surface water levels are increasingly reduced due to growing consumption and withdrawal. These trends are expected to continue, with a higher likelihood of water shortages (Georgakakos, et al., 2014).

In 2007, 24 Minnesota counties received drought designation, while 7 counties were declared flood disasters. In 2012, 55 Minnesota counties received federal drought designation at the same time 11 counties declared flood emergencies (MN Environmental Quality Board, 2014).

As of May 2015, over 90% of Minnesota was undergoing severe or moderate drought, due to low snow levels during the 2014-2015 winter and dry spring weather, with precipitation deficits totaling 3-6 inches below average across much of the state since October 2014. Water levels on streams, lakes, and wetlands were below average, and wildfires were common during April of 2015. Blowing soil was also reported due to high winds and the dried-out landscape (MN DNR, 2015).

Vulnerability

Jurisdictions in Steele County do not vary in their vulnerability to drought. The vulnerability of each jurisdiction to drought has not changed due to any development in the last 5 years.

Plans and Programs in Place

Steele County SWCD Precipitation Monitoring – The SWCD has a network of 12 volunteers that record any precipitation that falls at their location, including during wintertime.

Program Gaps or Deficiencies

No program gaps or deficiencies identified.

4.4.10 Wildfire

A wildfire is an uncontrolled fire spreading through vegetative fuels, posing danger and destruction to property. Wildfires can occur in undeveloped areas and spread to urban areas where structures and other human developments are more concentrated. While some wildfires start by natural causes like lightning, humans cause 4 out of every 5 wildfires. Debris burns, arson or carelessness are the leading causes of wildfires. As a natural hazard, a wildfire is often the direct result of a lightning strike that may destroy personal property and public land areas, especially on national and state forest lands. The dangers from wildfire include the destruction of timber, property and wildlife, and injury or loss of life to people living in the affected area or using the area for recreational facilities.

While wildfires are often viewed in a negative light, they are a naturally occurring part of the environment. Wildfires are an important component of healthy forest and prairie ecology, and can be beneficial by reducing dangerously high fuel levels and putting nutrients into the ground that spur new growth. In addition, many flora species require fire for seed germination. However, as people settled

this country and began clearing land and building homes, roads, railroads, and campgrounds, new artificial causes of wildfire emerged and their frequency and level of destruction increased.

Causes of wildfires vary from state to state. For example, in Florida, lightning ignites approximately half of all wildfires, while in Minnesota lightning causes less than 5% of all wildfires. These variations are due to climate, vegetation, topography, and weather. People burning debris cause most wildfires in Minnesota. However, wildfires are also caused by vehicle exhaust, sparks from trains and heavy equipment, camping, smoking, and lightning.

Topography affects the movement of air and fire over the ground surface. The slope and shape of terrain can change the rate of speed at which the fire travels. Weather affects the probability of wildfire and has a significant effect on its behavior. Temperature, humidity and wind affect the severity and duration of wildfires.

Homes threatened by wildfire are primarily those located in the "wildland-urban interface." This is the zone where homes and subdivisions have been located in wildland areas where natural wildfires can have an impact. While wildfires are necessary for healthy ecosystems, they burn whatever fuel is in their path, whether vegetation or buildings.

One of the most common causes of a home being damaged or destroyed is due to radiant heat. In a wildfire, radiant heat is the heat given off by burning vegetation. The high temperatures of some wildfires can cause the deck, siding, or roof of a home to ignite, because the fire was too near the home. Studies in western wildfires have shown that approximately 85% of homes surviving a major wildfire had 30-50 feet of defensible space around them, coupled with fire-resistant roofing.

Approximately 1,600 wildfires occurred each year in Minnesota on average from 1976-2011 (MN DNR, 2011). Wildfires occur throughout the spring, summer and fall, however, most wildfires in Minnesota take place in March, April, and May. During this period, much of the existing vegetation has been killed due to winter temperatures and is dead, brown and combustible. Also, there is little green vegetation to serve as a barrier for a moving wildfire.

Wildfire History in Steele County

Wildfire has been ranked as a low risk by Steele County. Only one wildfire has been recorded by the DNR in the county (Figure 20). It occurred on October, 8th 2012 and affected 27 acres in the southern part of the county.

According to MN DNR data, there are 308 acres of peat in Steele County. Peat is partially decayed plant matter found in ancient bogs and swamps. Minnesota has approximately 6 million acres of peatland, the highest total acreage in the contiguous United States. Peat fires are deep-rooted fires that burn underground, lasting for weeks, months, or even years. They can smolder during winter months beneath the snow, surfacing again in the spring to burn above ground. Peat ignites when its moisture content is low, and then it supports combustion rather than flame. Once started, combustion is persistent because peat contains oxygen and needs little or no outside oxygen to continue burning. Peat's insulating qualities mean the fire loses little heat. As the peat dries, it becomes water repellent. These factors result in long-lasting fires that require extensive operations to extinguish. However, peat fires have not been an issue in Steele County.

Wildfire and Climate Change

Temperatures are predicted to rise in the state, which could lead to more extreme heat events and associated wildfire risks. As Minnesota's climate changes, weather fluctuations between drought and extreme rain events and increasing temperatures will result in changes to forest composition and/or distribution. These fluctuations can lead to dry conditions that may cause increased fire risk in both grassland and forest environments.

Vulnerability

Jurisdictions in Steele County do not vary in their vulnerability to wildfires. The vulnerability of each jurisdiction to wildfire has not changed due to any development in the last 5 years.

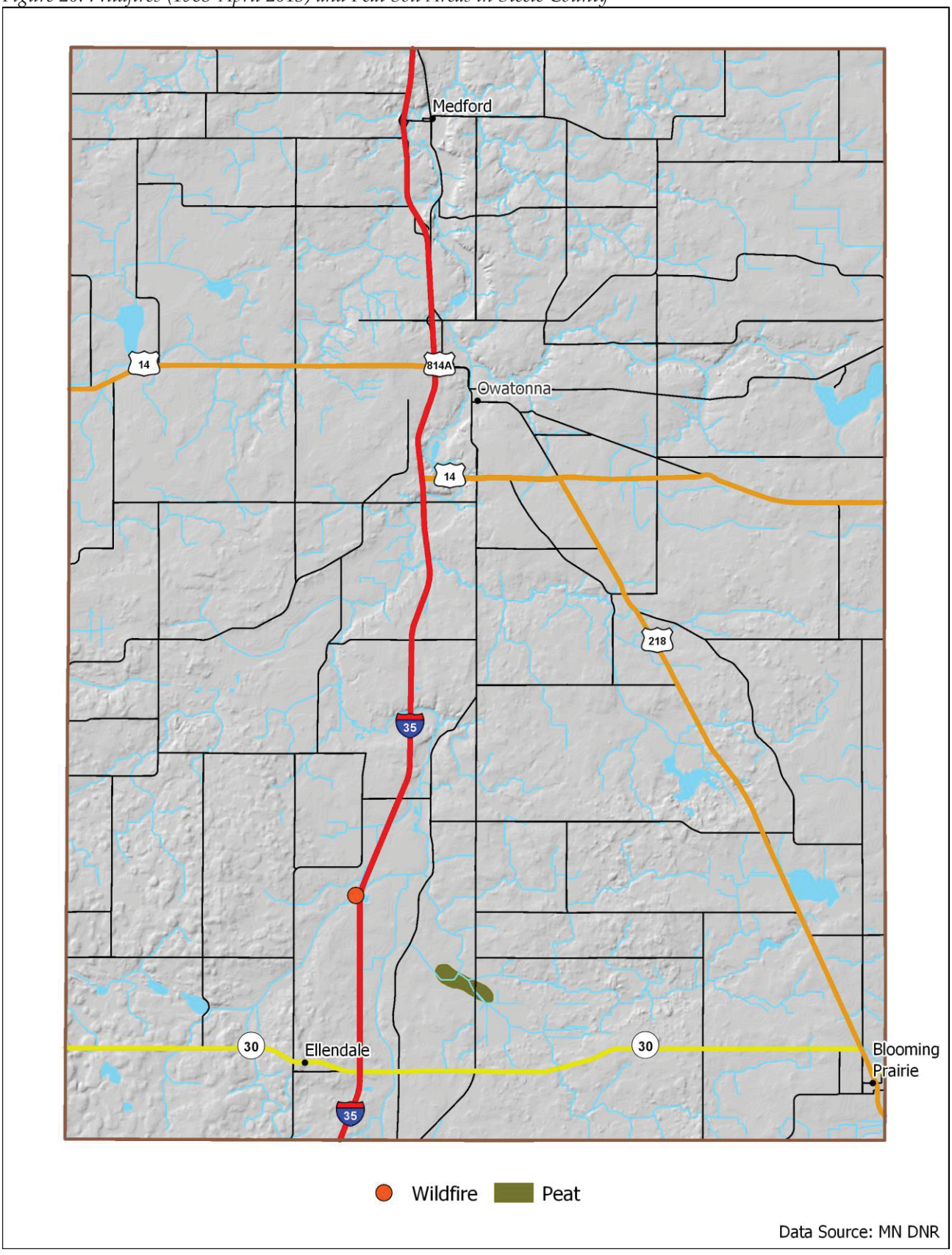
Plans and Programs in Place

Wildfire is not a significant problem in Steele County.

Program Gaps or Deficiencies

No program gaps or deficiencies were identified.

Figure 20. Wildfires (1985-April 2015) and Peat Soil Areas in Steele County



4.4.11 Landslides and Soil Erosion

Erosion is the wearing away of land, such as the loss of a riverbank, beach, shoreline, or dune material. It is measured as the rate of change in the position or displacement of a riverbank or shoreline over a period of time. Short-term erosion typically results from periodic natural events, such as flooding, hurricanes, storm surges, and windstorms, but may be intensified by human activities. Long-term erosion is a result of multi-year impacts such as repetitive flooding, wave action, sea level rise, sediment loss, subsidence, and climate change. Death and injury are not typically associated with erosion; however, it can destroy buildings and infrastructure (FEMA, 2013).

The movement of a mass of rock, debris, or earth down a slope by the force of gravity is considered a landslide. They occur when the slope or soil stability changes from stable to unstable, which may be caused by earthquakes, storms, volcanic eruptions, erosion, fire, or additional human-induced activities. Slopes greater than 10 degrees are more likely to slide, as are slopes where the height from the top of the slope to its toe is greater than 40 feet. Slopes are also more likely to fail if vegetative cover is low and/or soil water content is high. Potential impacts include environmental disturbance, property and infrastructure damage, and injuries or fatalities (FEMA, 2013).

Soil Erosion/Landslides History in Steele County

The Steele County Soil Survey indicates in the Steele County Local Water Management Plan that 79,000 acres in the county have a potential toward slight to moderate water erosion and that 32,000 acres have a potential of moderate to severe erosion by water. Wind erosion is most severe in the 26,000 acres of sandy and peat soils in the county.

To reduce soil loss from wind erosion the Steele County Soil and Water Conservation District (SWCD) has established the objective in their 2015 annual plan of work to reduce wind erosion to tolerable levels on all land. The SWCD sponsors a Tree and Shrub Program and installs 5 acres of farmstead and field windbreaks to prevent wind erosion. The SWCD is a resource to landowners residing on 'High Priority Erosion Problem' regions by accessing the State Cost-Share funds and implementing conservation practices.

According to the Steele County Emergency Manager, the city of Medford struggles with erosion issues. Some local residents have bank erosion on their properties abutting the Straight River. As of yet there has not been any property damage, but the erosion is a concern because their backyards are disappearing as the erosion encroaches on the structures on their property. These homeowners have received funding from the MN DNR to correct the erosion problem on the river. However, the residents have not started any work because they have not attained matching funds needed for the project.

Soil Erosion/Landslides and Climate Change

The increased magnitude and frequency of flooding events and storm activity that may result from climate change may in turn increase the risk of soil erosion and landslides. According to University of Washington geologist Dave Montgomery, "If the climate changes in a way that we get a lot more rainfall you would expect to see a lot more landslides" (Phillips, 2014).

In Minnesota, the wettest days are getting wetter. This can contribute to increased erosion in many locations due to flooding and saturation of soils. Reduced ice cover on lakes and shorelines (due to

warmer temperatures) could potentially expose shorelines to increased erosion or damage during weather events when they previously may have been covered with ice (National Climate Assessment Development Advisory Committee, 2013).

According to the 2014 National Climate Assessment, "Increased precipitation intensity also increases erosion, damaging ecosystems and increasing delivery of sediment and subsequent loss of reservoir storage capacity" (Pryor, et al., 2014).

Vulnerability

Figure A - 28 in Appendix A maps soil erodibility in Steele County using the Soil Erodibility Factor (K-Factor), which is a quantitative description of soil's inherent erodibility, by measuring the susceptibility of soil particles to shift due to rainfall and runoff. The Soil Erodibility Factor ranges in value from 0.02 to 0.69; however, all areas in Steele County are 0.37 or less. The highly erodible areas in Steele County are primarily due to the very steep slopes that bound the Straight River valley and the tributaries entering that valley.

Plans and Programs in Place

Steele County SWCD Education Programs and Resources – The Steele County Land Use Model shows a wide variety of conservation practices that take place in Steele County. The model is based on Steele County townships and the terrain in the area, and is available for educational purposes to any group wishing to use it. The SWCD also offers information to farmers on cover crops, and additional public education programs and assistance, such as helping schools with tree planting projects.

SWCD & NRCS Partnership – Through a Memorandum of Understanding the Steele County Soil and Water Conservation District works in conjunction with the Natural Resource Conservation Service to conserve the natural resources of Steele County. Example projects include providing assistance to farmers to implement erosion mitigation projects, such as reducing gully erosion through grassed waterways to safely transport stormwater in a non-erosive manner to a safe outlet, as well construction of water and sediment basins. Water and sediment basins are designed to reduce gully erosion, trap sediment and improve the farmability of sloping lands.

Program Gaps or Deficiencies

Erosion due to Flooding – Steele County and many communities experience high erosion due to flooding, including impacts to bridge areas and streambanks being severely cut away.

4.4.12 Dam Failure

Dams are structures that retain or detain water behind a large barrier. When full or partially full, the difference in elevation between the water above the dam and below create large amounts of potential energy, allowing the chance for failure. Dams can fail due to either 1) water heights or flows above the capacity for which the structure was designed; or 2) deficiencies in the structure such that it cannot hold back the potential energy of the water. If a dam fails, issues of primary concern include loss of human life/injury, downstream property damage, lifeline disruption (transportation routes and utility lines required to maintain or protect life), and environmental damage. Dams require constant monitoring and regular maintenance to insure their integrity.

Dam Failure History in Steele County

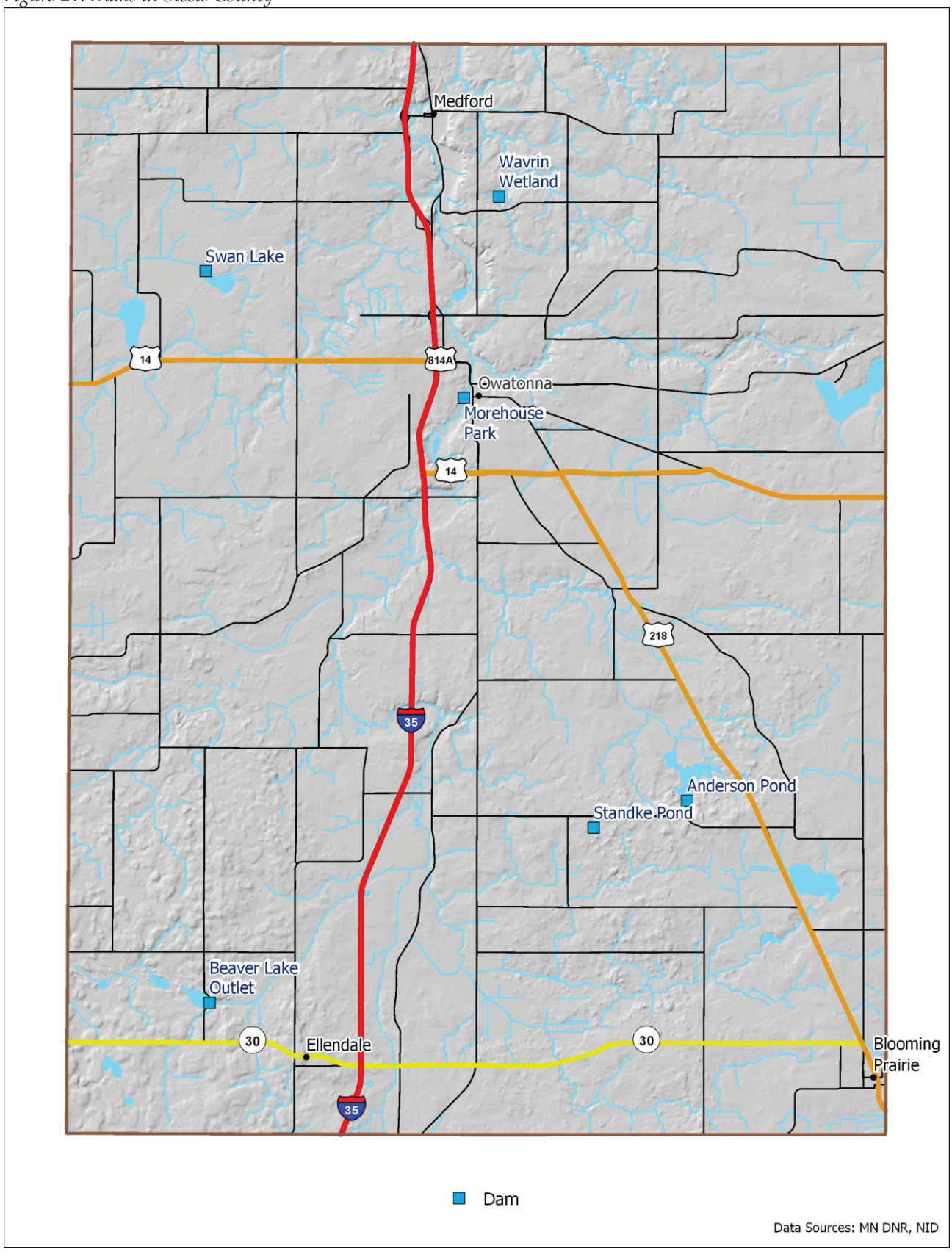
Table 26 below summarizes data on Steele County's dams based on data from the National Inventory of Dams. They are also mapped in Figure 21. None of Steele County's dams have Emergency Actions Plans.

There are no levees in Steele County.

Table 26. Dam Data for Steele County (National Inventory of Dams)

Name	Owner	River	Primary Purpose	Year Built	NID Height	Dam Type
Anderson Pond	Anderson, Donald	Turtle Creek - Off stream	Other	1972	0	Earth
Beaver Lake Outlet	MN DNR	Straight River - Tributary	Other	1939	0	Gravity and Earth
Morehouse Park	City of Owatonna	Straight River	Recreation	1930	0	Other
Standke Pond	Standke, Myron	Straight River - Off stream	Other	1968	0	Earth
Swan Lake	MN DNR	Straight River	Recreation, flood control and storm water management, and fishing	1970	7	Earth
Wavrin Wetland	Wavrin, Tom	Medford Creek - Tributary	Fishing	1999	6	Earth

Figure 21. Dams in Steele County



Dam Failure and Climate Change

Dams are designed based on assumptions about a river's annual flow behavior that will determine the volume of water behind the dam and flowing through the dam at any one time. Changes in weather patterns due to climate change may change the expected flow pattern. It is conceivable that bigger rainfalls at earlier times in the year could threaten a dam's designed margin of safety, causing dam operators to release greater volumes of water earlier in a storm cycle in order to maintain the required margins of safety. Such early releases of increased volumes can increase flood potential downstream.

While climate change will not increase the probability of catastrophic dam failure, it may increase the probability of design failures. Minnesota had a dam failure due to a large storm event in June 2012. The Forebay canal in Carlton County had operated as designed for nearly 100 years. The intensity of the 2012 rain event caused a failure of the canal wall which caused significant damage. Climate change is adding a new level of uncertainty that needs to be considered with respect to assumptions made during dam construction.

Vulnerability

Areas most susceptible to the effects of dam failure are the populated places downstream from a dam location. The vulnerability of each jurisdiction to dam failure has not changed due to any development in the last 5 years.

Plans and Programs in Place

Minnesota Department of Natural Resources, Division of Waters – Dam Safety Program – The MN DNR Dam Safety Program and current dam safety regulations require the safe design, construction, operation, and maintenance of dams in Minnesota. The state program includes review of design plans and plans for proposed dams, safety inspections of existing dams, and repair of dams. The Dam Safety Program keeps a file on all dams that are subject to state dam safety regulations or have had information or reports generated on them for another purpose. A typical file contains construction plans, photos, inspection reports, and correspondence.

Program Gaps or Deficiencies

No program gaps or deficiencies were identified.