

INTRODUCTION

Analyzing the hazards facing a community is an important and vital step in the mitigation planning process. Before mitigation strategies can be determined, a risk assessment must be made. Part III of this Lincoln County All-Hazards Mitigation Plan will focus on the following:

- Identification of all types of natural hazards that can affect Lincoln County
- An analysis of the hazards identified as pertinent to Lincoln County

The hazard analysis will consist of:

- Background information
- History of previous occurrences of hazard events
- An analysis of the County's vulnerability to future events
- An estimate of future probability and potential losses from the hazard

HAZARD IDENTIFICATION

The process of identifying those hazards that should be specifically addressed in the Lincoln County All Hazards Mitigation Plan was based on consideration of a number of factors. The process included a review of past hazard events to determine the probability of future occurrences and threat to human safety and property damage.

Worksheets from the Wisconsin Guide to All-Hazards Mitigation Planning were used by the Planning Taskforce to evaluate and rank the listing of possible hazards to help identify which hazards should be included in the Plan according to threat to human safety and possible damage to property. The Committee reviewed the composite results of this individual scoring exercise and concurred with the results with one exception, earthquake, which was dropped from the list as an anomaly in the scoring. Low magnitude earthquakes do occur in Wisconsin every few years, but none have exceeded a magnitude of 3.9, which would have vibrations similar to the passing of a semi-truck, therefore, earthquakes are not covered in this Plan.

The top hazards were selected and grouped by the Mitigation Planning Committee as follows, in priority order:

1. Tornado
2. Winter Storms/Extreme Cold
3. Thunderstorm/High Wind/Lightning/Hail
4. Drought/Extreme Heat
5. Cyber Attack
6. Flooding/Dam Failure
7. Forest/Wild Fires

This plan focuses on natural hazards that have or could cause disasters that can be mitigated on a local level. Technological or manmade hazards include things like transportation incidents, hazardous material incidents, structure fire, civil disturbances, mass casualty events, war, and terrorism. Lincoln County already has action plans for

these types of events as mandated by Homeland Security requirements, so they are not included in this planning process. Although fog can be an issue, it is not covered directly in this Plan due to a lack of ways to effectively mitigate against it. Lincoln County does not have avalanche, coastal hazard, hurricane, tsunami or volcano issues and conditions for landslide, subsidence or expansive soil problems are not significant in the County.

There was some discussion of the "agricultural" hazard due to the significance of agriculture in the Lincoln County economy. Many "agricultural" hazards are addressed through other hazard categories. Extreme cold, high winds or tornados, flooding, hail and drought can all decimate crops and threaten livestock. In addition, livestock disease outbreak (i.e.: "mad cow" and other diseases) are extensively planned and prepared for by the state's departments of Agriculture, Trade and Consumer Protection (DATCP) and Natural Resources (DNR), so they are not dealt with directly in this Plan to maintain manageability of the mitigation planning activity and also to reduce duplication.

Although a significant concern, human communicable diseases (including epidemic and pandemic situations) are not addressed in the Plan. The Lincoln County Health Department and area hospitals work with the Wisconsin Department of Health Services (WDHS) and the CDC to monitor and plan for these situations.

HAZARD ANALYSIS

The hazard analysis for each hazard included in this plan is broken down into four components, as follows:

1. Background on Hazard - The next step after identifying a hazard is to define the hazard and give some general background behind it. This can include occurrence of hazard within the County or State. This section may also give some indication of the risk to public health and safety and to personal and public property.

2. History of Hazards - Past experiences of disasters is an indication of the potential for future disasters for which Lincoln County would be vulnerable. A review of past occurrences for each identified hazard in Lincoln County was completed.

Some disasters have had damages that exceeded the capabilities of local communities and state agencies. Federal assistance is then requested. Federal assistance may be offered through a variety of programs. Assistance may be directed to agricultural producers, individuals and families, businesses, or local governments. There have been eight natural disasters in Lincoln County, where a Presidential Declaration was requested from 1971-2015. They include the following:

- 1971 Flooding
- 1973 Flooding – Presidential Disaster Declaration

- 1975 Army Worm Infestation
- 1976 Drought – Presidential Disaster Declaration
- 1977 High Winds/Hail – Presidential Disaster Declaration
- 1993 Flooding – Presidential Disaster Declaration
- 2002 Severe Storms/Flooding/Tornado – Presidential Disaster Declaration
- 2011 Tornado

It should be noted that this significantly underestimates the number of hazards that have occurred in Lincoln County. Almost every year there are significant weather events or disasters that cause millions of dollars in damage across the state for which no Federal disaster assistance is requested. Major indicators of hazard severity are the deaths, injuries, and economic losses resulting from natural hazards and disasters.

The National Oceanic and Atmospheric Administration (NOAA) and National Climatic Data Center (NCDC) publish the National Weather Service (NWS) data describing recorded weather events and resulting deaths, injuries, and damages. From January 1, 1950 to December 31, 2015, NCDC reported 349 weather events for Lincoln County.

Note that since the NCDC data is somewhat incomplete, this report focuses on the 10-year period from 2006 through 2015 (137 events). Other sources of data are used to supplement the NCDC data. These sources included other plans, reports, documents from Lincoln County Emergency Management, past local newspaper articles, the Wisconsin Department of Natural Resources, Wisconsin Emergency Management (WEM), and the National Weather Service.

3. Vulnerability Assessment For Hazards - For each hazard identified, a summary of the impact that may be caused to the community is given. When possible, existing buildings, infrastructures, and critical facilities located in the hazard areas are identified. Critical facilities are community buildings that are especially important to the health and welfare of the population following hazard events. Examples of such facilities include hospitals, police & fire stations, town halls, and shelters.

Because this is a multi-jurisdictional plan, FEMA requires that the plan assess each jurisdiction's risks where they vary from the risks facing the entire planning area. This section of the plan will identify variations in vulnerability for specific municipalities where they occur.

4. Future Probability and Potential Dollar Losses for Hazard - The historic data and vulnerability assessment for each hazard is used to project the potential future probability of that hazard occurring in the county and the potential damages in dollars that might be reasonably expected. This section sets the benchmark to mitigate for each hazard.

HAZARD ANALYSIS: TORNADOS**Background on Tornado Hazard:**

A tornado is a relatively short-lived storm composed of an intense rotating column of air, extending from a thunderstorm cloud system. It is nearly always visible as a funnel, although its lower end does not necessarily touch the ground. Average winds in a tornado, although never accurately measured, are between 100 and 200 miles per hour, but some tornados may have winds in excess of 300 miles per hour.

Table 10		
Tornado Wind and Damage Scale		
Tornado Scale	Wind Speeds	Damage
EF0	65 to 85 MPH	Some damage to chimneys, TV antennas, roof shingles, trees, and windows.
EF1	86 to 110 MPH	Automobiles overturned, carports destroyed, trees uprooted
EF2	111 to 135 MPH	Roofs blown off homes, sheds and outbuildings demolished, mobile homes overturned.
EF3	136 to 165 MPH	Exterior walls and roofs blown off homes. Metal buildings collapsed or are severely damaged. Forests and farmland flattened.
EF4	166 to 200 MPH	Few walls, if any, standing in well-built homes. Large steel and concrete missiles thrown far distances.
EF5	OVER 200 MPH	Homes leveled with all debris removed. Schools, motels, and other larger structures have considerable damage with exterior walls and roofs gone. Top stories demolished

Source: National Weather Service

A tornado path averages four miles, but may reach up to 300 miles in length. Widths average 300 to 400 yards, but severe tornados have cut swaths a mile or more in width, or have formed groups of two or three funnels traveling together. On average, tornados move between 25 and 45 miles per hour, but speeds over land of up to 70 miles per

hour have been recorded. Tornadoes rarely last more than a few minutes in one location or 15 to 20 minutes in a ten-mile area.

Tornadoes are classified into six intensity categories, EF0-EF5, see Table 10. This scale is an updated or "enhanced" version of the Fujita Tornado Scale (or "F Scale"). The scale estimates wind speeds within tornadoes based upon the damage done to buildings and structures. It is used by the National Weather Service in investigating tornadoes and by engineers in correlating building design standards against anticipated damage caused by different wind speeds.

Wisconsin lies along the northern edge of the nation's maximum frequency belt for tornadoes, known as "Tornado Alley". Tornado Alley extends northeast from Oklahoma into Iowa and then across to Michigan and Ohio. Winter, spring and fall tornadoes are more likely to occur in southern Wisconsin than in northern counties. Tornadoes have occurred in Wisconsin every month except February.

History of Tornadoes in Lincoln County:

The most recent (within the 2006 to 2015 study period) tornado event occurred on July 9, 2013. Thunderstorms formed along a weak boundary and produced several funnel clouds and four weak tornadoes. Damage by the tornadoes was minimal, affecting mainly wooded areas and open fields. One of the tornadoes touched down about six miles south of Irma and moved east for about 4 miles. A few trees and power lines were knocked down. Average path width was 75 yards.

Many in the Merrill area are still feeling the effects of the April 10, 2011 tornado. Wind speeds reached 140 mph, placing the tornado in the EF3 category. A number of people were injured and total damages were cited around \$11 million, however, it did not qualify for Federal disaster assistance. Several businesses in the Merrill Industrial Park were heavily damaged and numerous residences in the Town of Merrill were destroyed. Costs for debris removal, law enforcement and road repairs was approximately \$450,000 and was partly covered by the Wisconsin Disaster Fund.

Including these 2 events, Lincoln County has had 23 verified tornadoes from 1950 to 2015, with 2 since 2006 (Table 11). In addition, there have been five reported funnel clouds since 2005 which are not included in these statistics. The most recent of these funnel cloud reports came on September 19, 2012 when a funnel cloud was spotted over Tomahawk. Thunderstorms developed ahead of a cold front and a strong upper level system. Some of the storms produced large hail, damaging winds, and funnel clouds, including the one over Tomahawk. Another interesting report came on April 11, 2010 when a "dust devil" was reported to have caused about \$600 damage at a residence in Gilbert just south of Tomahawk.

On July 11, 2004. Clusters of thunderstorms moved across north-central Wisconsin during the late afternoon and early evening. A strong upper atmospheric disturbance enhanced rotation in the storms and several funnel clouds developed in Lincoln and surrounding areas. Some of the funnels touched down as tornadoes, including a pair of

tornadoes simultaneously west of the Tomahawk Airport. Two other tornadoes were spotted in Lincoln County; one near Irma and another west of Tomahawk.

A more severe event occurred on September 30, 2002, when a F2 tornado touched down for 3 miles uprooting and snapping off thousands of trees in its path. A house in the path also sustained major structural damage, all of the outbuildings on the property were demolished, and a camping trailer was crushed after being thrown 300 feet. A car was also thrown into a tree, resting 15 feet above the ground and two barns were also destroyed. The total estimated damage accounted for was roughly \$75,000. The storms also knocked out power to around 3,000 customers in the Tomahawk area and about 600 customers in the Rhinelander and Crandon areas. This tornado, combined with other tornados, storm damage and flooding across 19 counties, including Lincoln, resulted in a disaster declaration.

DATE	TIME	LOCATION	LENGTH (miles)	WIDTH (yards)	DEATHS	INJURIES	F-SCALE
7/9/2013	1359 CST	Irma	4.1	100	0	0	EF0
4/10/2011	1710 CST	T. Merrill	20	1,050	0	3	EF3
7/11/2004	1640 CST	T. Wilson	0.1	10	0	0	F0
7/11/2004	1613 CST	T. Wilson	0.1	10	0	0	F0
7/11/2004	1613 CST	T. Wilson	0.1	10	0	0	F0
7/11/2004	1545 CST	Irma	0.1	10	0	0	F0
9/30/2002	1830 CST	T. Tomahawk	3	250	0	0	F2
7/30/2002	1825 CST	T. Merrill	0.1	25	0	0	F0
7/30/2002	1808 CST	T. Merrill	9	200	0	0	F0
7/30/2002	1747 CST	T. Merrill	1	150	0	0	F0
4/18/2002	1549 CST	T. Bradley	0.1	25	0	0	F0
5/5/1999	1630 CST	T. Tomahawk	0.1	25	0	0	F0
3/29/1998	1928 CST	T. Tomahawk	5	75	0	0	F0
7/16/1997	1438 CST	T. Merrill	1	100	0	0	F2
7/18/1996	1620 CST	T. Tomahawk	3	100	0	0	F1
6/14/1991	1155 CDT	T. Harding	1	50	0	0	F1
6/16/1979	1540 CST	T. Skanawan	N/A	N/A	0	0	F1
6/16/1979	1530 CST	T. Skanawan	N/A	N/A	0	0	F1
6/13/1976	2045 CST	T. Pine River	6	50	0	0	F1
7/24/1962	1700 CST	T. Corning	1	50	0	0	F2
9/3/1961	1700 CST	T. Corning	1	33	0	0	F1
6/30/1958	1730 CST	T. Russell	2	50	0	0	F2
5/3/1955	1800 CST	T. Rock Falls	7	33	0	2	F1

Source: National Climatic Data Center

Insert Map 8 Tornado Vulnerability

To reduce file size for ease of emailing and downloading, the maps are omitted from this draft. To view the maps go to www.ncwrpc.org/lincoln/lincolnhazplan/index.html

On July 30, 2002, two months before the F2 tornado, three of four confirmed F0 tornados touched down in Lincoln County and the other touched down in Marathon County. The damage from these three tornados totaled \$105,000 destroying a barn and an outbuilding, tearing roofs off numerous buildings, and moving others off of their foundations. The tornados also demolished a mobile home and snapped many trees and tree limbs.

Out of the tornados reported in Lincoln County, none claimed a life and the May 3, 1955 tornado was the only one in addition to 2011 to have noted injuries, however several others have caused significant damages. The July 16, 1997, F2 tornado touched down in the Town of Pine River and damaged several homes, vehicles, and silos, and it destroyed several barns, sheds, and crops with total damage estimated at \$525,000.

Tornado Vulnerability Assessment:

Though Lincoln County is mostly a rural county, there are concentrations of population scattered throughout the County. Subdivisions, rural unincorporated communities, and the cities of Merrill and Tomahawk can be regarded as more vulnerable because tornados pose more of a threat to human safety and property damage in more concentrated areas, see Map 8.

Mobile homes are of significant concern in assessing the hazard risks from tornados, since they comprise about 7 percent of Lincoln County's housing units. In general, it is much easier for a tornado to damage and destroy a mobile home than a standard site-built home. Research by the NWS shows that 40 percent of all deaths in the nation from tornados were in mobile homes; compared to 29 percent in permanent homes, and 11 percent in vehicles.

While mobile homes are scattered throughout the County, many are concentrated in mobile home parks. Lincoln County has approximately 11 mobile home parks, see Map 8 for locations. Within these park sites, there are approximately 398 individual sites. The largest is located in the City of Merrill with about 140 sites (although it appears that 84 of the sites are empty at the time of this writing). The second largest is just north of the City in the Town of Merrill with about 77 sites. The total number of mobile homes reported in the 2012 American Community Survey (Census) reported for Lincoln County was 1,229.

Besides mobile homes, campground patrons are vulnerable to tornados because there usually is little shelter provided. Treehaven is the University of Wisconsin – Stevens Point field station where summer environmental classes are taught, and about 130 students and staff reside from May – August. Lincoln Hills School is a Type 1 Secured Juvenile Correctional Facility, where an average daily budgeted population of 345 are housed. Tornado shelters are provided onsite at both Treehaven and Lincoln Hills School.

The following is a list of things that may be affected by a tornado. Much of this list can be referenced in Part II.

- Community facilities – hospitals, schools, jails
- Public Service – police and fire departments
- Utilities – power lines, telephone lines, radio communication
- Transportation – debris clean-up, sign damage
- Residential – nursing homes, mobile homes/parks, garages, trees and limbs, roofing, siding, windows
- Businesses – signs, windows, siding, billboards
- Agricultural – buildings, crops, livestock

Based on review of the historic events of tornados, there are no specific areas in the county that have unusual risk of occurrence. The events are a countywide concern. General vulnerability by geographic area (local unit of government) is identified in Map 8. However, in their mitigation survey results, Town of Merrill identified tornado as a top vulnerability concern based on their past experience and having two LP suppliers and two mobile home parks in the Town. The City of Merrill, also heavily impacted by the 2011 tornado, echoed its neighboring towns concern regarding tornado vulnerability.

Future Probability and Potential Dollar Losses – Tornados:

Based on the historic data presented here (frequency of past events - 2006 to 2015), Lincoln County can expect a tornado about once every 5 years on average. This equates to a probability of 0.20 or about a 20 percent chance in a given year. Table 12 indicates the probability of tornados of a specific magnitude. However, these probabilities are slightly skewed by multiple tornado events, 3 on July 30, 2002 and 4 on July 11, 2004. The County did not experience a tornado between 2004 and 2011.

Tornado Scale	F0	F1	F2	F3	F4	F5
Number of Reported Tornados*	11	7	4	1	0	0
Probability of Occurrence	48%	30%	17%	4%	<1.0%	<1.0%

*Source: National Weather Service & NCWRPC – *Based on historical data from 1955 through 2015.*

Historic data is again used to estimate potential future dollar losses due to a tornado. Estimated damages resulting from various tornados in Lincoln County range from \$0 to \$11 million, including the 2011 event. On average, Lincoln County might expect damages of \$572,818 per tornado, however, only one of the 23 historic tornados, in addition to the 2011 event, resulted in damages exceeding \$500,000, four others had \$250,000, and the rest were \$100,000 or less. Over the next ten-year period, tornado losses in Lincoln County could approach \$1,145,636.

HAZARD ANALYSIS: WINTER STORMS / EXTREME COLD**Background on Winter Storms/Extreme Cold Hazard:**

A variety of weather phenomena and conditions can occur during winter storms. For clarification, the following are National Weather Service approved descriptions of winter storm elements:

Heavy snowfall – the accumulation of six or more inches of snow in a 12-hour period or eight or more inches in a 24-hour period.

Blizzard – the occurrence of sustained wind speeds in excess of 35 miles per hour accompanied by heavy snowfall or large amounts of blowing or drifting snow.

Ice Storm – an occurrence where rain falls from warmer upper layers of the atmosphere to the colder ground, freezing upon contact with the ground and exposed objects near the ground.

Freezing drizzle/freezing rain – the effect of drizzle or rain freezing upon impact on objects that have a temperature of 32 degrees Fahrenheit or below.

Sleet – solid grains or pellets of ice formed by the freezing of raindrops or the refreezing of largely melted snowflakes. This ice does not cling to surfaces.

Wind chill – an apparent temperature that describes the combined effect of wind and low air temperatures on exposed skin.

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

True blizzards are rare in Wisconsin. They are more likely to occur in the northwestern part of the state than in south-central Wisconsin, even though heavy snowfalls are more frequent in the southeast. However, blizzard-like conditions often exist during heavy snowstorms when gusty winds cause the severe blowing and drifting of snow. Heavy snow and ice have been part of nearly every winter in Lincoln County.

Dangerously cold conditions can be the result of the combination of cold temperatures and high winds. The combination of cold temperatures and high wind creates a perceived temperature known as "wind chill". Wind chill is the apparent temperature that describes the combined effect of wind and air temperatures on exposed skin. When wind blows across the skin, it removes the insulating layer of warm air adjacent to the skin. When all factors are the same, the faster the wind blows the greater the heat loss, which results in a colder feeling. As winds increase, heat is carried away from the body at a faster rate, driving down both the skin temperature and eventually the internal body temperature.

The National Weather Service issues wind chill advisories when wind chill readings of -20 to -34 degrees are expected. Wind chill warnings are issued when wind chill values are expected at or below -35 degrees. Extreme cold events are most likely during the months of January and February.

History of Winter Storms/Extreme Cold in Lincoln County:

The NCDC has reported 21 significant winter storm events for Lincoln County between 2006 and 2015. All of these storms contained some form of snow, sleet, freezing rain, or ice conditions.

The most recent (within the 2006 to 2015 study period) winter storm event occurred on November 10, 2014 when a complex storm system affected the region, bringing a swath of heavy snow to parts of northern Wisconsin. The main storm hit in two phases. The first phase was in the form of a long west to east band of snow which set up across Minnesota and northern Wisconsin early on November 10th. Low pressure then moved across far southern Wisconsin and produced another round of snow late on November 10th and into the 11th across central and northern Wisconsin. In addition to the long-duration storm, additional lake effect snow from Lake Superior pushed totals over 20 inches in some locations in the snowbelt. The highest reported snowfall total was 23.7 inches at Lac du Flambeau in Vilas County. Storm total snowfall of 10.9 inches was measured 8 miles west of Merrill, and at Rice Reservoir, near Bradley.

Noteable snowfall is attributed to the winter storm event on March 22, 2011. A low pressure system that moved across northern Illinois from Iowa received plenty of moisture from the Gulf of Mexico. This abundant moisture allowed the late-season storm to produce significant heavy, wet snow and some thundersnow across parts of central and northeast Wisconsin on March 22nd-23rd. During the two-day period, many locations received more than a foot of snow. Lightning from the storm destroyed a house in Marathon County. The high water content of the snow caused more problems than would normally be expected with storms having similar snowfall totals. Some of the highest snowfall totals from across the area included 18.8 inches in Shawano County and 18.0 inches at Irma. The 17.8 inches of snow that fell in Green Bay was the most from a single storm in more than 120 years. It was also the third highest storm total since Green Bay weather records began in 1886.

The National Weather Service has classified the December 11, 2010 snowstorm as a blizzard. In Merrill, 14.7 inches of snow fell with winds gusting up to 40 mph between December 11 and 12, causing numerous cancellations and rescheduling. The snow developed as low pressure moved from Wyoming to Lake Michigan. The pressure difference between an arctic high over southern Canada and the low pressure storm system generated strong winds resulting in severe blowing snow and blizzard conditions across the State. The Governor declared a state of emergency in all 72 counties and the state's Emergency Operations Center was activated. The State Patrol advised against traveling as it was difficult to keep the blowing and drifting snow off the highways. There were numerous slide-offs and accidents across the state including 9

slide-offs and 3 other crashes reported by the Lincoln County Sheriff's Office, although no injuries were noted. Frigid temperatures followed the storm with actual air temps dropping to -23 degrees.

On December 8, 2009 heavy snow developed as low pressure rapidly deepened as it moved into Lake Michigan. Strong winds generated by the deepening low created blowing snow and near blizzard conditions on the morning of the 9th across northeast Wisconsin. During the height of the snow, lightning and thunder were reported in central Wisconsin. Snow fall totals ranged from 8 to 16 inches across northern, central and east-central Wisconsin.

On December 23, 2007, a low pressure system over Missouri rapidly intensified as it moved into eastern Wisconsin during the early morning hours. Precipitation associated with the system began in the form of rain and then rapidly changed to snow as winds circulating around the low brought much colder air into the area. Heavy snow fell, and combined with west winds gusting over 40 mph to produce near blizzard conditions across much of the region. Six-foot high snow drifts made some roads impassible in central Wisconsin where over a foot of new snow fell. The highest reported snowfall total was 18.2 inches in Wood County while 14.3 inches was reported at Merrill.

On December 22, 2006, rain quickly turned to snow as an upper low pressure system moved across Wisconsin. The snow caused roads to become slippery and hundreds of vehicle accidents were reported. Heavy, wet snow stuck to power lines and tree branches causing them to snap under its weight. The downed tree limbs and power lines knocked out electricity to more than 30,000 customers, between Stevens Point and Rhinelander, including Merrill and parts of Lincoln County. About 11,000 customers were still without electricity on the morning of the 24th.

On November 10, 2006, 8 to 16 inches of snow fell from west-central into north-central Wisconsin as a low pressure system moved across the region. There were reports of more than 220 accidents on slick roads in Marathon and Lincoln counties. One of the accidents involved a logging truck that dumped part of its load onto U.S. Highway 51 in Lincoln County, snarling traffic for several hours. Two minor injuries were reported in Lincoln County accidents. Merrill recorded 12.0 inches of snowfall. The snow fell at a rate of 1 to 2 inches per hour at the height of the storm.

From the NCDC, 7 extreme cold temperature events have affected Lincoln County from 2006 to 2015. The most recent was on January 5, 2015. Temperatures in the 12 below to 22 below zero range combined with west winds of 10 to 20 mph to produce dangerous wind chills during the night of January 4th and the morning of the 5th. These dangerous wind chills were mainly across parts of central and north central Wisconsin. The wind chill dropped as low as 35 below zero at Merrill.

On January 27, 2014, high pressure over the Plains and upper level flow from the Canadian Plains brought extremely cold temperatures and wind chills to the area. Temperatures fell to lows in the 15 below to 28 below zero range. West winds of 10 to

20 mph combined with the frigid air to produce wind chills in the 35 below to 45 below zero range. The coldest temperature recorded in Lincoln County was 23 degrees below zero at Merrill with wind chills as low as 40 below zero.

On January 6, 2014, a bitterly cold arctic air mass, the coldest to impact the region in years, spread across the area following the passage of a cold front. Temperatures fell to lows in the 16 below to 32 below zero range. The cold temperatures, combined with west winds of 10 to 20 mph, produced wind chills in the 40 below to 55 below zero range. The coldest recorded temperature in Lincoln County was 30 degrees below zero at Tomahawk with wind chills as low as 51 below zero.

An extended cold streak occurred in February of 1996 when a frigid arctic air mass became entrenched across central and northeast Wisconsin. Actual temperatures remained below zero for more than 130 hours straight and dropped to 45 below at Harrison. The extreme cold temps combined with west winds of 10 to 15 mph produced wind chills from 50 to 70 below zero on February 2. The cold weather was responsible for many school closures, stalled vehicles, frozen pipes, and broken water lines, as well as, electrical and phone outages resulted from snapped lines. All outdoor events at the Badger State Games had to be canceled and ski hills were closed.

Winter Storms/Extreme Cold Vulnerability Assessment:

Winter storms and extreme cold present a serious threat to the health and safety of affected citizens and can result in significant damage to property. Heavy snow or accumulated ice can cause the structural collapse of buildings, down power lines, motor vehicle accidents, or isolate people from assistance or services. Extreme cold includes the risk of frostbite and hypothermia.

The following is a list of things that may be adversely affected by a winter storm or extreme cold. Much of these community assets can be referenced in Part II:

- Infrastructure – operation of emergency services, operation of public facilities and schools
- Utilities – down power and telephone lines
- LP Gas at residences freezing in temps below -40 degrees
- Septic systems - freezing
- Transportation – automobile accidents, roadway plowing, salting/sanding
- Residential – roofs
- Businesses –commerce
- Agricultural – livestock, frost or snow damage to crops

Based in review of the historic events of winter storms and extreme cold, there are no specific areas in the county that have an unusually high risk. The risk for winter storms and extreme cold is relatively uniform and a county-wide concern. However, in their mitigation survey results, the Towns of Birch and Corning identified winter storms as a top vulnerability concern, citing downed powerlines and blocked roads as problems in their heavily wooded areas.

Future Probability and Potential Dollar Losses – Winter Storms/Extreme Cold:

Based on historical frequency, Lincoln County can expect 2.1 major winter storm events per year on average. In other words the probability is 1.00 or a 100% chance in a given year.

For extreme cold temperatures, based on historical frequency, Lincoln County can expect an occurrence about every 1.4 years on average for a probability of 0.7 or a 70% chance in a given year. However, since extreme cold temperatures often accompany winter storms, a probability of 100% chance in a given year cannot be ruled out.

Estimating potential future losses for winter storms is difficult. Damages and losses are typically widespread. Auto accidents and additional snow removal time are typical impacts of winter storms, and such claims are not aggregated or tracked for monetary damage. Winter storms do have the potential to be extremely destructive, particularly in the case of ice storms. Potential future losses per incident might range from \$5,000 to \$2 million based on experiences from other counties.

HAZARD ANALYSIS: SEVERE THUNDERSTORM / HIGH WIND / HAIL / LIGHTNING**Background on Severe Thunderstorm Hazard:**

The National Weather Service definition of a *severe thunderstorm* is a thunderstorm event that produces any of the following: downbursts with winds of 58 miles per hour or greater (often with gusts of 74 miles per hour or greater), hail 1 inch in diameter or greater, or a tornado. Strong winds, hail, and lightning will be addressed in this section; however, tornadoes are referenced as a separate hazard due to their unique severity.

Lightning results from discharge of energy between positive and negative areas separated by rising and falling air within a thunderstorm. This discharge heats the surrounding air to 50,000 degrees. Hail results as the warm rising air cools, forming ice crystals which are held by the updrafts until accumulating enough weight to fall. The hail size depends on strength of the updrafts keeping it up.

Thunderstorm frequency is measured in terms of incidence of thunderstorm days or days on which thunderstorms are observed. Wisconsin averages between 30 and 50 thunderstorm days per year depending on location. A given county may experience ten or more thunderstorm days per year. The southwestern area of the state normally has more thunderstorms than the rest of the state.

History of Severe Thunderstorms in Lincoln County:

The NCDC has reported 35 severe thunderstorm events for Lincoln County between 2006 and 2015. These storms typically contain some form of heavy rain and strong winds. About 15 significant hail events, typically related to a severe thunderstorm were listed during this time period, however, there were no notable lightning incidents identified. In 1977, one of the five Presidential Disaster Declarations (since 1971) for

Lincoln County was associated with severe storms with high winds and hail being the primary cause of damages.

The most recent (within the 2006 to 2015 study period) thunderstorm event occurred on September 4, 2014. Thunderstorms formed north of a warm front and propagated east across northern Wisconsin. The storms produced wind gusts in excess of 60 mph, large hail, and heavy rainfall. The high winds caused scattered tree damage in Merrill. Quarter size hail fell in Harrison.

On June 26, 2013, an upper level disturbance triggered thunderstorms that moved across central and north central Wisconsin. The storms produced isolated severe weather across the area, including large hail, wind damage and heavy rainfall. The heavy rain in and around Merrill caused some street flooding with 1.77 inches of rain recorded with a 1-hour period at the Merrill Airport. High winds knocked trees onto power lines and a house. Reported hail ranged from nickel to quarter size at Merrill and Tomahawk.

On July 27, 2010, following an earlier strong thunderstorm on July 14. A cold front combined with a warm and humid air mass triggering thunderstorms that moved northeast Wisconsin. The storms produced hail to golf ball size, wind gusts to 95 mph, funnel clouds and heavy rainfall that led to flash flooding in some areas. Numerous trees and power lines were downed with power outages around Merrill. Winds were estimated at 60 mph at the intersection of County J and I-39.

One person was injured on April 23, 2001 when a mobile home was flipped on its side by thunderstorm winds 5 miles northeast of Tomahawk. This storm also downed more than 100 trees near Alice Lake. Two cottages were destroyed and six others were damaged when trees landed on them.

The most recent hail event noted by NCDC occurred on August 2, 2015. A thunderstorm that rapidly intensified over central Wisconsin dropped large hail, up to two inches in diameter, in and around Merrill as it moved across southern Lincoln County. Hail completely covered the ground in some locations. Penny size hail was reported southeast of Merrill, half dollar size hail was reported at the intersection of Highways 64 and 51, and golf ball size hail was reported west of Merrill.

Softball size hail fell near Highway 86 and County D near Tomahawk during a wide-spread hail event on April 25, 2008.

Lightning struck and burned a vacant house near Tomahawk on September 25, 1998. A lightning strike punched a hole in the roof and significantly damaged the electrical system of a home 3 miles northwest of Merrill on September 10, 1996. In May 1996, lightning started a fire that destroyed a home 3 miles southeast of Merrill. Damage was estimated at \$150,000.

Severe Thunderstorm Vulnerability Assessment:

The National Weather Service can forecast and track a line of thunderstorms that may be likely to produce severe high winds, hail, and lightening, but where these related hazards form or touch down and how powerful they might be remains unpredictable. The distribution of thunderstorms and related hazard events have been widely scattered throughout the County.

Many thunderstorm events (without tornadoes) have caused substantial property and infrastructure damage, and have the potential to cause future damage. In order to assess the vulnerability of the Lincoln County area to thunderstorms and related storm hazards, a review of the past events indicate significant impacts to:

- Infrastructure – hospitals, schools, street signs, police and fire departments
- Utilities – electric lines/poles/transformers, telephone lines, radio communication
- Transportation – debris clean-up
- Residential – mobile homes, garages, trees and limbs, siding, & windows
- Businesses – signs, windows, siding, & billboards
- Agricultural – buildings, crops, & livestock
- Vehicles – campers, boats, windshields, body, & paint

Based on review of the historic patterns of thunderstorms associated with high wind, hail, or lightening, there are no specific municipalities that have unusual risks. The events are relatively uniform and a countywide concern. However, in their mitigation survey results, the Towns of Birch and Skanawan identified high winds as a top vulnerability concern, citing downed powerlines and blocked roads as problems in their heavily wooded areas.

Future Probability and Potential Dollar Losses – Severe Thunderstorms:

Based on historical frequency, Lincoln County can expect 3.5 thunderstorm events per year on average. In other words, the probability is 1.0 or a 100% chance of multiple storms in a given year. The probability of a thunderstorm with damaging hail in Lincoln County is also at 1.0 or 100% chance with about 1.5 incidents in a given year. There was insufficient data to determine the probability of a significant lightning event in a given year.

According to the NCDRC, historic thunderstorm events with associated high wind averaged \$10,000 in damage per incident. There was insufficient data to calculate average hail or lightning damages. Losses in Lincoln County associated with severe thunderstorms could approach \$350,000 over the next ten-year period.

HAZARD ANALYSIS: DROUGHT / EXTREME HEAT**Background on Drought / Extreme Heat Hazard:**

A drought is an extended period of unusually dry weather, which may be accompanied by extreme heat (temperatures which are 10 or more degrees above the normal high

temperature for the period). There are basically two types of drought in Wisconsin: agricultural and hydrologic. Agricultural drought is a dry period of sufficient length and intensity that markedly reduces crop yields. Hydrologic drought is a dry period of sufficient length and intensity to affect lake and stream levels and the height of the groundwater table. These two types of drought may, but do not necessarily, occur at the same time.

Droughts, both agricultural and hydrologic, are relatively common in the state. Small droughts of shortened duration have occurred at an interval of about every ten years since the 1930's.

Extended periods of warm, humid weather can create significant risks for people, particularly the elderly who may lack air conditioning or proper insulation or ventilation in their homes. Animals are also at risk during extended periods of heat and humidity. The National Weather Service issues a Heat Advisory when the Heat Index ranges from 105 to 114 degrees daytime and remains at or above 80 degrees at night, during a 24-hour period. The heat index combines the effects of heat and humidity to better reflect the risk of warm weather to people and animals. When heat and humidity combine to reduce the amount of evaporation of sweat from the body, outdoor activity becomes dangerous even for those in good shape. The index measures the apparent temperature in the shade. People exposed to the sun would experience an even higher apparent temperature. A heat index of 105 is considered dangerous and prolonged exposure can result in heat stroke, exhaustion and cramps. People should be reminded to use extreme caution when the heat index is between 95 and 105. A heat index of 95 occurs when the temperature is 90 degrees and the relative humidity is 50 percent.

History of Drought / Extreme Heat in Lincoln County:

NCDC reports indicate that much of Wisconsin including Lincoln County was under drought conditions between 2004 and 2013. At one point, the Governor had declared a state of emergency to get assistance to the state's agricultural sectors. The extended dry conditions posed serious challenges for farmers from drought stressed crops to issues providing feed for livestock.

Beginning in 2013, improved rainfall across the Midwest gradually relieved the drought in Wisconsin. Nationally, however, what is being tagged as the 2012-2015 North American Drought has affected over 80% of the U.S. as well as parts of Canada and Mexico, and drought continues to affect parts of the country. This drought is on track to exceed the 1988-89 drought, which also affected Wisconsin (to a lesser extent in Lincoln), as the costliest natural disaster in U.S. history.

Lincoln County was one of 64 counties that were included in a Presidential Emergency Declaration for the drought of 1976-1977. Statewide agricultural losses during this drought were set at \$624 million. A number of wells in the County went dry and financial assistance was needed to drill new ones. Federal assistance totaled only 19% of losses attributed to the drought.

Despite all this drought, there are no incidences of extreme heat listed by the NCDC for Lincoln County between 2006 and 2015. The last excessive heat event reported by the NCDC was in 1999 when consecutive days of high temperature between July 23 and July 31 combined with high humidity levels resulted in numerous heat related illnesses. The heat caused some roads to buckle.

Drought / Extreme Heat Vulnerability Assessment:

Droughts can have a dramatic effect on the farms and other agricultural activities as well as forestry enterprises located throughout Lincoln County. With forestry and agriculture being important sectors of the County's economy, droughts can have disastrous effects. Even small droughts of limited duration can significantly reduce crop growth and yields, adversely affecting farm income. More substantial events can decimate croplands and result in total loss, hurting the local economy.

Irrigation can negatively impact the environment by drawing water that naturally goes to aquifers and surface water. Drought can exacerbate the problem when high withdrawal rates versus little precipitation deplete waterbodies and aquifer supplies, therefore decreasing drinking water supplies, drying streams, and hindering aquatic and terrestrial wildlife. During severe droughts, some wells - mainly private wells - will go dry.

Another significant area of impact from drought includes the tourism sector of the economy. As water levels go down, there is less tourism seen in the County. The past drought conditions reduced water levels on many lakes and streams across the County.

Droughts can trigger other natural and man-made hazards as well. They greatly increase the risk of forest fires and wildfires because of extreme dryness. In addition, the loss of vegetation in the absence of sufficient water can result in flooding, even from average rainfall, following drought conditions.

The following is a list of things that may be adversely affected by a drought. Much of these community assets can be referenced in Part II.

- Infrastructure – municipal water supplies
- Surface water – groundwater reserves, recreation, and wildlife
- Forests - forest products
- Agricultural - crops, livestock

The areas most susceptible to drought conditions would be agricultural towns. Agricultural land is scattered throughout the County but is more concentrated in the southern and eastern parts of the County, see Map 2. In their mitigation survey results the Towns of Tomahawk and Skanawan identified drought as a top vulnerability concern primarily due to the increased risk of wildfire in their heavily wooded areas.

According to the Wisconsin Emergency Management, excessive heat has become the most deadly hazard in Wisconsin in recent times. Extreme heat can happen anywhere within Lincoln County affecting everyone, however the elderly and young are the ones

with the highest risk of getting heat related injuries, which can lead to death. Ways to prevent injuries include wearing light-colored clothing, drink plenty of water, slow down, and do not stay in the sun for too long.

Future Probability and Potential Dollar Losses – Drought/Extreme Heat:

Based on the historic data presented here (frequency of past events), Lincoln County can expect a drought every ten years on average, which is a probability of 0.10 or a 10 percent chance in a given year. Significant severe drought is somewhat less common, affecting Wisconsin once about every 15 years.

Drought is another hazard lacking good loss figures at the county level. However, a look at aggregate data from two previous major droughts for which figures are available can give some indication of potential impact. Those droughts resulted in losses of \$9.6 million (1976-77) to \$18 million (1987-88) per affected county in Wisconsin on average.

Normally, central Wisconsin is known for its cold winters, however, extreme heat waves will affect Lincoln County in the future. There was insufficient data available to determine the probability of a significant extreme heat event in a given year.

HAZARD ANALYSIS: CYBER ATTACK

Background on Cyber Attack Hazard:

A vast array of networks form the foundation of our means to communicate and travel, power our homes, run our economy, and provide government services. Yet, cyber-attacks have increased dramatically in the United States over the last decade, exposing sensitive personal and business information, disrupting critical operations, and imposing high costs on the economy.

A cyber-attack is the actual or potential disruption of government information systems. Information technology systems are connected in networks or through the Internet, and thus are at risk of cyber-attack. An attack may be a deliberate effort to gain access to the system or processes; or it may be the result of a randomly initiated threat, such as a worm or virus. Unlike physical threats that prompt immediate action, cyber threats are often difficult to identify and comprehend. Among these dangers are viruses erasing entire systems, intruders breaking into systems and altering files, or intruders stealing confidential information.

Cyber-attack may result in the loss of confidence in the government's ability to protect citizens. However, the support services performed in the aftermath of an event can rebuild the reputation of the government's ability to provide services to the people in time of need.

With the extensiveness of information technology (IT) and cyber networks in nearly all parts of society, effectively securing critical infrastructure requires investments in network resiliency as well as cyber infrastructure protection. As all levels of government

now rely on cyber networks and assets to provide public safety and economic prosperity, their operations depend on information systems that are maintained, protected, and secured from exploitation and attack.

History of Cyber Attack in Lincoln County:

Cyber-attacks have increased throughout the world and are a major issue due to the increasing reliance on computers and networked technology. The probability of Lincoln County experiencing cyber-attacks is based on the increase of cyber-attacks throughout the country.

In Lincoln County's experience with firewalls and network security appliances, they are under continuous hacking attacks. So far, however, they have had viruses but not any hacking breaches. Lincoln County conforms as best it can to industry standards, utilizing products and vendors who specialize in these areas.

Other counties in the area have experienced viruses that resulted in loss of data from Department file servers including documents, pictures, pdf files, etc. Databases have had to be rebuilt. Denial of service issues have occasionally been a problem in the past. Denial of Service attacks are designed to overload a network with useless traffic preventing legitimate users access and crashing the system.

Cyber Attack Vulnerability Assessment:

The impact of a cyber-attack on property, facilities, and infrastructure is dependent on the type of event and the location in which it occurs. Cyber-attacks, in all probability, will have limited effect on buildings, properties, or infrastructure, but may severely affect the transportation of goods and services to and from critical facilities. Infrastructure damage or interruption of power to communication services could have a substantial impact; but effects are minimized through thorough planning on the part of the utility and its determination to resume critical services. Economic and financial systems could potentially be significantly impacted, depending on the scope, breadth, and success of the cyber-attack.

All government and personal computers and networks within Lincoln County are susceptible to cyber-attack. The County has 840 computers and 70 servers comprising its network. Attention must be given to security education and awareness, so we do not place too much faith in technology's ability to protect data. Inadequate security awareness can facilitate access to critical computer systems, making them vulnerable to attacks. Secure off-site back up is critical for reestablishing operations if a serious cyber-attack does occur. The County does maintain off-site back up of its computer data, and is looking at updating the back-up system. The City of Merrill also maintains off-site back-up of critical data and has set up the ability to continue government operations from the Fire Department in the event something happens to City Hall.

Cyber-attacks may last from minutes to days depending upon the type of intrusion, disruption, or infection. Generally, no direct effects are felt by the built environment, but secondary effects may occur depending upon the system being attacked. Denial of

service attacks can cripple all or part of a county computer system and are hard to protect against. The County is planning fail safes against denial of service type attacks.

The spectrum of cyber risks is limitless, and serious threats can have wide-ranging effects. Transportation, power, and other services may be disrupted by large scale cyber-attacks. The extent of the disruption is highly uncertain, as it will be determined by many unknown factors such as the target and size of the incident. Vulnerability to data breach and loss increases if a network is compromised. Information about citizens and employees can be at risk.

Future Probability and Potential Dollar Losses – Cyber Attack:

Although there is currently insufficient data to determine an accurate probability, the data suggests that the percentage chance of a serious cyber-attack on Lincoln County in any given year is estimated to be 20 percent.

The threat of cyber-attack has been identified as a significant and growing threat to Lincoln County. The level of success or damage will vary greatly. Intrusion detection systems log attack attempts almost every day. There are constant probes by individuals and groups with intent to cause anything from total system shutdown to simply “seeing if they can do it.”

No accurate method of estimating potential losses related to cyber-attack is available at this time for Lincoln County; however this will be monitored and reviewed for the next plan update.

HAZARD ANALYSIS: FLOODING/DAM FAILURE

Background on Flood/Dam Failure Hazard:

There are a variety of classifications for flooding including coastal, dam failure, flash, lake, riverine, stormwater and urban/small stream. Lincoln County has the potential for all these types except coastal. The following descriptions of the types of flooding are compiled from various FEMA and other notable hazard planning sources:

Coastal – Different from other types of flooding which relate to movement of water through a watershed, coastal flooding is due to the effect of severe storm systems on tides resulting in a storm surge. Primarily known as an ocean-based event, the Great Lakes coastal areas can also be affected.

Dam Failure – More of a technology related hazard than a natural hazard, various factors can result in the failure of the structural technology that is a dam, thus causing flooding of areas downstream of the dam often similar in effect to flash flooding.

Flash – Involves a rapid rise in water level moving at high velocity with large amounts of debris which can lead to damage including tearing out of trees, undermining buildings and bridges, and scouring new channels. Dam failure, ice jams and obstruction of the

waterway can also lead to flash flooding. Urban /built-up areas are increasingly subject to flash flooding due to removal of vegetation, covering of ground with impermeable surfaces and construction of drainage systems.

Lake – Prolonged wet weather patterns can induce water-level rises that threaten lakeshore areas.

Riverine – Also known as overbank flooding, this is the most common type of flooding event. The amount of flooding is a function of the size and topography of the watershed, the regional climate, soil and land use characteristics. In steep valleys, flooding is usually rapid and deep, but of short duration, while flooding in flat areas is typically slow, relatively shallow, and may last for long periods.

The cause of flooding in rivers is typically prolonged periods of rainfall from weather systems covering large areas. These systems may saturate the ground and overload the streams and reservoirs in the smaller sub-basins that drain into larger rivers. Annual spring floods are typically due to the melting of snowpack.

Stormwater – Water from a storm event that exceeds the capacity of local drainage systems, either man-made or natural, can result in flooding. Inadequate storm sewers and drainage systems are often the primary factor resulting in this type of flooding.

Urban and Small Stream – Locally heavy rainfall can lead to flooding in smaller rivers and streams. Streams through urban or built-up areas are more susceptible due to increased surface runoff and constricted stream channels.

Flooding in Lincoln County tends to occur in the spring when melting snow over frozen soil adds to normal runoff and in summer or early fall after intense rainfalls. This runoff builds up until the river or stream overflows its banks, for as long as a week or two and then slowly recedes inch by inch. The timing and location of this type of flooding is fairly predictable and allows ample time for evacuation of people and protection of property.

Flooding is a notable hazard in Lincoln County, particularly because the Wisconsin River runs right through the middle of the county and the two major cities. As described in Part II, there are approximately 668 miles of rivers and streams in Lincoln County within 13 watersheds. All but a small portion of the County is within the Upper Wisconsin River (Headwaters) Basin.

Floodplains exist along the Wisconsin River and the tributaries that feed into it. These floodplains are narrow along tributaries and lakes but extensive throughout the County. Floodplains are described in Part II and shown on Map 4. The Federal Emergency Management Agency (FEMA) identifies these floodplains on Digital Flood Insurance Rate Maps (DFIRMs), which the NCWRPC obtained from Lincoln County. While not officially certified, this digital floodplain data is a useful planning tool.

DAM NAME	MILES FROM NEXT CITY	HAZARD RATING	NAME OF NEXT CITY	OWNER	UPDATED EAP YEAR
ALEXANDER	1	HIGH	MERRILL	WI PUBLIC SERVICE CORP.	2015
CARL	0	LOW		CHUCK BYE	2015
DOERING	0	LOW		DOERING ENTERPRISES	
GRANDMOTHER FALLS	16	HIGH	MERRILL	PACKAGING CORP. OF AMER.	2015
HARRISON	0	LOW		LINCOLN COUNTY FOREST	2007
JERSEY	0	HIGH	TOMAHAWK	WI PUBLIC SERVICE CORP.	2014
JUNE LAKE	0	LOW		HANSON BROS LLC	2010
KINGS	1	HIGH	TOMAHAWK	TOMAHAWK POWER & PULP	1996
MERRILL	0	LOW	MERRILL	WI PUBLIC SERVICE CORP.	2014
NEW WOOD	0	LOW		WI DNR -WILDLIFE BIOLOGIST	2016
OLIVOTTI LAKE		LOW		GIRL SCOUTS	2013
PINTEN	0	LOW		PINTEN TRUST	
RICE	2	HIGH	TOMAHAWK	WI VALLEY IMPROVEMENT CO.	2015
SPIRIT RIVER RESERVOIR	1	SIGNIFICANT	RIVER OAKS SUB.	WI VALLEY IMPROVEMENT CO.	2015
TOMAHAWK (Pride's)	2	HIGH	RIVER OAKS...	WI PUBLIC SERVICE CORP.	2015
UPPER GRANDFATHER FALLS	10	HIGH	MERRILL	WI PUBLIC SERVICE CORP.	2015

Source: *WDNR Statewide Dams Database, 6/20/2016.*
<http://dnr.wi.gov/topic/Dams/data.html>

There are 48 dams in Lincoln County according to the DNR, but most do not pose a significant hazard if they would fail. These dams serve many useful purposes including agricultural uses, providing recreational areas, electrical power generation, erosion control, water level control, and flood control. According to the DNR, Lincoln County has 16 large dams (see Map 4), 24 small dams and the others were not classified. The Wisconsin DNR regulates all dams on waterways to some degree; however the small dams are not stringently regulated for safety purposes. The Federal Energy Regulatory Commission has jurisdiction over large dams that produce hydroelectricity. Jersey, King, Spirit River Reservoir, Tomahawk (Pride's) and Upper Grandfather Falls all have current FERC licenses. Licenses for Alexander and Grandmother Falls appear to have expired, and Merrill's FERC status is unknown.

A dam can fail for a number of reasons such as excessive rainfall or melting snow. It can also be the result of poor construction or maintenance, flood damage, weakening caused by burrowing animals or vegetation, surface erosion, vandalism or a combination of these factors. Dam failures can happen with little warning resulting in the loss of life and significant property damage in an extensive area downstream of the dam.

The WDNR assigns hazard ratings to large dams within the state, see Table 13 for Lincoln County. When assigning hazard ratings, two factors are considered: existing land use and land use controls (zoning) downstream of the dam. Dams are classified

into three categories that identify the potential hazard to life and property downstream should the dam fail. A high hazard indicates that a failure would most probably result in the loss of life. A significant hazard indicates a failure could result in significant property damage. A low hazard exists where failure would result in only minimal property damage and loss of life is unlikely. For Lincoln County, there are seven dams that have a high hazard rating: Alexander, Grandmother Falls, Jersey, Kings, Rice, Tomahawk, and Upper Grandfather Falls. Spirit River Reservoir is the only one having a significant rating, while the rest are rated low.

All dams perceived as posing a threat to downstream development have a dam failure analysis performed in order to identify the hydraulic shadow (that area of land downstream from a dam that would be inundated by water upon failure of the dam during a regional flood). This information is used to develop an Emergency Action Plan (EAP) for the dam, which includes provisions for notifying emergency personnel and warning affected downstream residents of a failure.

History of Flooding/Dam Failure in Lincoln County:

Flooding is significant hazard of concern in Lincoln County, being the principal cause of damage in three of five Presidential Disaster Declarations in Lincoln County (1973, 1993, 2002) since 1971. Disaster declaration was requested for flooding in 1971 but not awarded. NCDRC has reported only 1 flooding event in Lincoln County for the study period between 2006 and 2015.

The flood event noted by NCDRC occurred in September of 2010. Heavy rain fell across the County between September 22 and 23, causing streams to overflow their banks and resulting in the closure of 21 roads, mainly in the southern part of the County. A number of other roads were passable but had water near or over the roadway. Many basements had water in them and Merrill area schools were closed due to flooding and high water. Rainfall totals across exceeded 2.5 inches. The highest recorded total was 4.38 inches at Spirit Falls where the NCDRC reported flash flooding. Flooding continued across the southern part of the County for several days after the rainfall ended. Minor flooding continued along the Wisconsin River into the morning of the 26th.

Warm temperatures during the second week in April 2002 led to significant runoff from snow melt across much of northern Wisconsin. Additional rainfall then resulted in minor flooding in the Wisconsin River basin. A boat landing and some low areas on a County highway become covered by water. The flooding primarily affected agricultural lands and parks. The flooding combined with other storm damage across the area including tornadoes led to a disaster declaration.

In September of 2000, the Tomahawk area experienced urban and small stream flooding resulting from severe storms with heavy rain. The storms caused widespread problems including minor street flooding in Tomahawk.

Heavy runoff from spring snow melt compounded by rain in April 1996 resulted in widespread minor flooding across northern Wisconsin. With numerous roads and

culverts washed out in several counties including Lincoln. The Wisconsin River in Merrill rose to 2 feet above flood stage on April 21. Street flooding was reported in the Merrill area. A faulty gate on the Prairie River Dam was blamed for a water back up that resulted in the flooding of the 1200 block of 14th Street and a park. Area basements were filled with 3 feet of water and eight homes suffered damage.

One of the worst flood events experienced by Lincoln County, the state, and entire Midwest was the Flood of 1993. The flooding in Lincoln County was a result of several compounding factors including heavy rains and flooding in the fall of 1992, above average amounts of precipitation in the spring of 1993, and unusually heavy amounts of rain onto already saturated ground from early June throughout July.

Lincoln County was one of the 47 counties that were included under the disaster declaration; however their eligibility was only for individual assistance. Public facilities suffered minor impact compared to other counties. One highway built through a swamp had some damage, along with minor flooding problems reported at the City of Merrill Library and High School. Individual assistance disaster aid paid out \$41,540 to private citizens. The majority of these funds were used for basement damage (furnace or water heater and personal property), damage to septic systems, or contaminated wells.

The local businesses and economy were also impacted from the flood. Some stores suffered basement flooding, which resulted in merchandise damage. Tourism levels measured slightly lower than normal, and the logging industry reported inventories to be very low, resulting in increased prices. The farmers in Lincoln County received the greatest impact. While some fields were flooded by riverside overflows, the excessive moisture and saturated soils were the greater problem. Emergency financial assistance was provided to over 52 farmers encompassing 78 farms. Agricultural disaster assistance funds paid out over \$120,000, but the estimated crop losses countywide were over \$4 million.

Another flood event of note where Lincoln County received public assistance was in 1973. The 1973 flood affected a total of thirty-five counties, which were along the Mississippi and Wisconsin Rivers and bordering the Great Lakes. Total private and public damage losses were set at \$24 million.

Lincoln County has not experienced a dam break with any loss of life or substantial property damage. However, during the last mitigation plan process there was some concern about the aging of the dam structures within the County.

Flood/Dam Failure Vulnerability Assessment:

Flood events in the County have caused substantial property and infrastructure damage in the past and have the potential to cause future damage, since a significant number of structures still exist in the floodplain. Looking at past events, the following have been significantly impacted by flooding:

- Infrastructure – flooded public facilities, and schools

- Utilities - down electric lines/poles/transformers, telephone lines, and radio communication
- Roadways – washouts, inundated roadways, debris clean-up
- Residential structures – flooded basements, damaged septic systems
- Businesses – loss of commerce
- Agriculture - inundated cropland

To assess the vulnerability of Lincoln County to flooding hazards, basic inventory data in Part II must be analyzed. For this purpose, consideration should be given to structures (specifically critical facilities), infrastructure, and cropland.

One of the first reports to reference in assessing vulnerability to structures during flooding is the State of Wisconsin Repetitive Loss Report. This Report provides the status of repetitive loss structures by community. FEMA, through the Federal Insurance Administration, classifies a repetitive loss structure “when more than one flood insurance claim of at least \$1,000 is made within a ten-year period.” The information is used as a floodplain management tool and to supplement information provided by communities for flood mitigation grants administered WEM. According to the report, there are no repetitive loss structures in Lincoln County. Since no structures are listed in the Repetitive Loss Report, structures within floodplains were analyzed. The floodplain boundaries (as well as the watershed boundaries) within Lincoln County are shown on Map 4. These areas are generally located along the Wisconsin River and its major tributaries.

Table 14 shows the number of structures in each municipality identified as “vulnerable to flooding” according to proximity to floodplains. There were a total of 268 structures identified as within the designated floodplain boundaries (see Map 9). by the NCWRPC following the methodology below.

Methodology – Structures within Floodplains:

1. NCWRPC imported the County's DFIRM digital floodplain maps from into a GIS coverage for the County.

Municipality	Number	Total Value	Average Value
Birch town	0	\$-	\$126,100
Bradley town	16	\$2,768,000	\$173,000
Corning town	2	\$270,000	\$135,000
Harding town	3	\$480,000	\$160,000
Harrison town	1	\$183,600	\$183,600
King town	7	\$1,388,800	\$198,400
Merrill town	63	\$9,481,500	\$150,500
Pine River town	3	\$457,500	\$152,500
Rock Falls town	45	\$7,456,500	\$165,700
Russell town	15	\$1,650,000	\$110,000
Schley town	2	\$261,200	\$130,600
Scott town	1	\$152,400	\$152,400
Skawanaw town	0	\$ -	\$195,000
Somo town	1	\$100,000	\$100,000
Tomahawk town	4	\$477,200	\$119,300
Wilson town	7	\$1,026,900	\$146,700
Merrill city	97	\$8,603,900	\$88,700
Tomahawk city	1	\$140,800	\$140,800
Lincoln County	268	\$34,898,300	\$130,217

Source: U.S. Census and NCWRPC

2. A building point cover was digitized from county lidar data along the floodplain areas.
3. The floodplain coverage was then combined with the building point coverage to identify those structures within the floodplain boundary.
4. Total structures within the floodplain were then tabulated by municipality.
5. Average values from U.S. Census data were used to determine the total value for the identified vulnerable structures.

Lincoln County has seven dams within its boundaries that have a high hazard rating, and one that has a significant hazard rating. The Willow Reservoir dam, upstream from Lincoln County, is large with a high hazard rating that would affect Lincoln County if it failed. All nine of these major dam complexes, located on the Wisconsin River and its tributaries, have Emergency Action Plans.

Included in the plans are the warning procedures, identified areas that could be expected to flood during a dam break, and water flow coordination procedures among all the dams on the Wisconsin River.

To understand the potential risk from dam failure, a similar methodology was followed, starting with NCWRPC digitization of the inundation maps from the EAPs (Map 10). Average values for structures within the inundation areas are tabulated.

Dam	# Structures (Lincoln Co.)	Total Improvement Value	Average Value Per Structure
Willow River Reservoir	225	\$29,320,875	\$130,315
Rice	26	\$2,666,768	\$102,568
Jersey	10	\$1,069,650	\$106,965
Kings	140	\$13,574,120	\$96,958
Tomahawk	24	\$2,771,256	\$115,469
Spirit River Reservoir	2	\$260,630	\$130,315
Grandmother Falls	10	\$1,125,000	\$112,500
Upper Grandfather Falls	0		
Alexander	213	\$17,894,982	\$84,014

Source: US CENSUS and NCWRPC

In addition to structural damage from flooding, there would be significant damage to public roadways, particularly to roadway surfaces, culverts, and bridges. Flooding would inundate or close roadways due to washouts from a period of a few days up to as much as several months. Such interruptions in the County transportation network would cause travel delays through detours.

Insert Map 9 Flood Vulnerability

To reduce file size for ease of emailing and downloading, the maps are omitted from this draft. To view the maps go to www.ncwrpc.org/lincoln/lincolnhazplan/index.html

The agriculture industry is a sector that faces substantial losses, during floods, cool, rainy/wet, sunshine deficient climatic conditions of the spring and summer create a general condition of high water and saturated soils throughout the County.

Flood conditions can leave farmers with the following economic setbacks:

- Delayed planting (reduced growing season)
- Seed and agricultural chemicals washing out of fields
- Rotting of plants due to excess moisture
- Areas where planted crops are left in the fields due to excessive moisture
- Crops not reaching full maturity or stunted growth
- Requirements by farmers to expend higher amounts of money on additional soil amendments
- Lower quality (nutritional value) of harvestable crops as a feed source.

Reductions in quantity can result in loss of revenues from cash crops and increased expenses for purchasing the needed livestock feed from outside sources. Additionally, reductions in crop quality result in lower prices received for cash crops and increased amounts spent for nutritional supplements to animal feed, which need to be added even in much of the purchased feed.

The saturated soil conditions responsible for these woes can occur anywhere throughout the County. Agricultural land in Lincoln County is primarily located in the south and eastern portions of the County. These farming areas were previously forested tracts that were cleared by early settlers, which are composed of hard pan soils with poor drainage qualities.

Economic losses to farmers can generate a ripple affect to the local community as well. Reduction in farm income will curtail the farmers' ability to purchase new equipment and make other improvements. Farmers will have less money to spend at farm dealers, farm supplies, building/hardware suppliers, fertilizer, feed and seed dealers, and other agribusiness and retail establishments. The State itself will have reduced tax revenues. Farmers will have less money to save and invest, and suffer still more increases in debt load.

The forest products industry is affected similarly to agriculture. Forestlands become too wet for logging operations and many water logged tree plantations suffer high mortality rates. Mill inventories become very low, resulting in increased prices for consumers.

The areas considered to have a higher risk for impact from flooding include those communities with structures in floodplains as shown in Map 9 or those with structures in dam break inundation areas as shown in Map 10. Both cities, Merrill and Tomahawk, indicated in their planning meetings that flooding, particularly related to dam failure, is one of their top hazard concerns.

Insert Map 10 Dam Inundation Areas

To reduce file size for ease of emailing and downloading, the maps are omitted from this draft. To view the maps go to www.ncwrpc.org/lincoln/lincolnhazplan/index.html

Future Probability and Potential Dollar Losses – Flood/Dam Failure:

Based on the historic data presented here (frequency of past events - 2006 to 2015), Lincoln County can expect a flood event about every 10 years on average. This equates to a probability of 0.1 or about a 10 percent chance in a given year. However, localized heavy rainfall will continue to cause spot flooding from time to time. With 3 disaster declarations related to flooding, should anticipate and prepare for another major flood event in the future.

To estimate potential future dollar losses due to flood, historic data from past flood events for which we have loss figures is used. Lincoln County can anticipate property and crop losses of approximately \$508,128, on average, between the public and private sector for each significant flood occurrence. Over the next ten-year period, flood losses in Lincoln County could approach \$508,000.

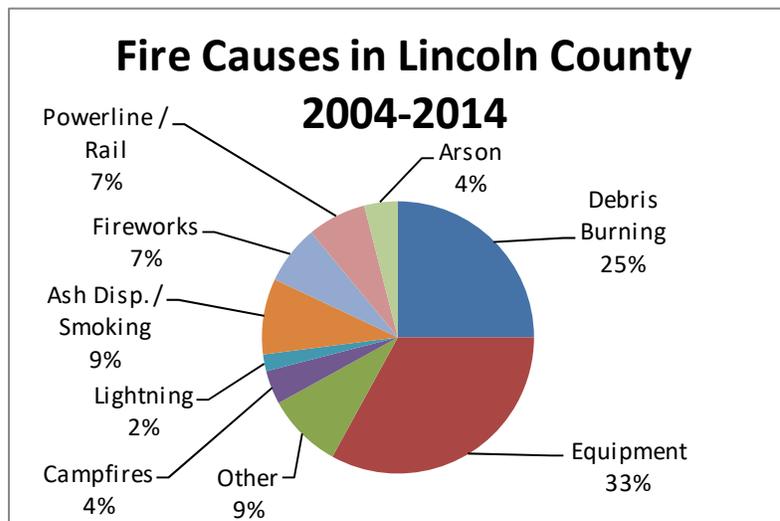
Potential flood losses for structures by jurisdiction are reflected in Table 13. While structures outside mapped floodplains may also be lost or damaged in a flood, structures within flood plains represent the greatest risk for flood damages.

As indicated earlier, no dam breaks have been identified within Lincoln County. Therefore, there is no historic frequency upon which to base a future probability, other than to say that the probability of a dam failure is very low. However, the number of significant dams and the risk illustrated in their EAPs make dam failure an important hazard to plan for. Table 14 shows potential structural losses from failure of each significant dam that would affect Lincoln County.

HAZARD ANALYSIS: FOREST FIRES/WILDFIRES

Background on Forest Fires/ Wildfires Hazard:

A forest fire is an uncontrolled fire occurring in a forest or in woodlands outside the limits of incorporated villages or cities. A wildfire is any instance of uncontrolled burning in brush, marshes, grasslands or field lands. For the purpose of this analysis, both of these kinds of fires are being considered together.



Forest fires and wildfires can occur at any time whenever the ground is not completely snow covered. The season length and peak months may vary appreciably from year to year. Land use, vegetation,

amount of combustible materials present and weather conditions such as wind, low humidity and lack of precipitation are the chief factors for fire season length.

History of Forest Fires/Wildfires in Lincoln County:

The Wisconsin DNR maintains a database of wildfire data. This data represents the most comprehensive source of information for analyzing fire trends in an area such as Lincoln County. However, the data is only current through 2014, so the ten year period from 2005 through 2014 is used for analysis. Between 2005 and 2014, there was an average of 27 fires that have burned 33 acres, annually. The typical fire in Lincoln County burns about 1.2 acres.

May is the leading month for wildfire in Lincoln with 32% of the total number of fires between 2005 and 2014. Wildfires have occurred each month of the year except January, February and December in Lincoln.

The Town of Merrill experienced the most wildfires between 2005 and 2014 with 47, and also leads the County in total acres burned with 147. The Town of Tomahawk had the fewest fires with 2 over that period. Town of Harding had the least area burned, among non-urban areas, with just 0.66 acres affected.

The chart above breaks down the causes of wildfire within Lincoln County between 2005 and 2014 as classified by the WDNR. The principle cause of wildfire with 33% in Lincoln County over this period is equipment which includes vehicle, motor and other machinery related causes except railroad. Debris burning, typically number one in Wisconsin, is the next leading category at 25% of wildfires within the County. Arson resulted in about 4% of wildfires, and lightning, the only natural cause of fire, was responsible for around 2%.

There has been some correlation between drought or heat waves and increased risk of wildfire in Lincoln County. The drought conditions from 2004 to 2010 shows a significant spike in the number and size of fires (with the exception of 2008 where the numbers are way down). Fire numbers also spike in the heatwave years of 1994 and 1995, however the numbers are comparably down a bit in the 1999 dry spell year.

Forest Fires/Wildfires Vulnerability Assessment:

Lincoln County has approximately 469,417 acres of forestland, or 81 percent of the area, scattered throughout the County. The potential for property damage from fire increases each year as more dwellings are developed on wooded land.

Rural buildings may be more vulnerable because of lack of access. Access to buildings off main roads is sometimes long, narrow driveways with minimal vertical clearance and no turn around areas large enough for emergency vehicles making it hard for emergency vehicles to combat fires. These buildings also may not have much of a defensible space because of little area between the structures themselves and highly flammable vegetation.

Campgrounds are also a concern because campfires cause about 4 percent of fires in Lincoln County as indicated by the Wisconsin Department of Natural Wildfire Database described above, see pie chart. Lincoln County has a number of campgrounds such as those shown on Map 8.

The trend toward introducing more human development into fire prone areas has brought about the term wildland urban interface or WUI. The WUI identifies areas where structures and human development meet or intermingle with undeveloped wildlands. It is within these areas where wildfire poses the greatest risk to human lives and property.

The WDNR has completed a statewide evaluation of fire risk, referred to as the CAR or Communities At Risk assessment. This assessment uses extensive DNR geodatabases to analyze and map hazardous woodland fuel types and the degree of the intermixing of development with wildlands. The maps identify the level of risk for each community on a scale of very high, high, moderate, or low, and also have a community of concern designation. The Towns of Bradley, King, Merrill and the City of Tomahawk are rated high. Birch, Harding, Harrison, Russell, Skanawan, Tomahawk and Wilson are designated as communities of concern. The Towns of Corning, Pine River, Rock Falls, Schley, Scott, Somo, and the City of Merrill are rated low risk for wildfire. See Map 11

Future Probability and Potential Dollar Losses – Forest Fires/Wildfires:

Forest and wild fires are relatively common occurrences in Lincoln County. Over the 10 year analysis, there has been an average of 27 fires per year in the County. In other words, the probability is 1.0 or 100% chance of wildfire each year.

Because of the relatively small impact of typical individual fires in the County, loss data is not tracked. This makes it difficult to develop an estimate of potential future dollar losses. However, with 27 fires per year, the County should expect some fires to "get out of hand" with the potential to easily exceed the \$1.4 million in damages of the 2005 Cottonville Fire that occurred in Adams County, for example.

Insert Map 11 Wildfire Risk

To reduce file size for ease of emailing and downloading, the maps are omitted from this draft. To view the maps go to www.ncwrpc.org/lincoln/lincolnhazplan/indez.html