Section Four: Risk Assessment

Regional Risk Assessment

Weather itself is not a hazard. However, one weather event often creates multiple hazards. For example, a single severe thunderstorm event may cause flooding, tornados, or wildfires from lightning. Man-made hazards, such as prolonged power outages, can also be linked to the incidence of weather events, but they may also occur under normal daily conditions.

The methodology utilized for the regional risk assessment varies by hazard, depending upon the information available. It consists of the following components: historical occurrences; estimated probability of future occurrences; the calculation of Average Annual Damages for those hazards where sufficient data was available; the identification of assets located within high risk areas such as the floodplain, for those hazards which can be spatially defined; and, measures of extent. The specific methodology utilized for each hazard is defined in the specific hazard sections.

The data source utilized for individual hazards varies based on the best and most appropriate source of information. The NCDC and RMA was utilized for many of the natural hazards, but it should be noted that these sources are not an all-inclusive, or exhaustive, source for historical hazard data. Often data records for short-term local hazard events are more detailed and readily accessible than data for long-term regional events.

The following table provides an overview of the data contained in the hazard profiles. This table is intended to be a quick reference for people using the plan and does not contain source information; source information and full discussion of individual hazards are included in this section. Hazards within Table 18 are listed in the order they are addressed in this plan.

- *Historical Occurrence*
  - This is reported as the number of events recorded during a defined time period. A variety of sources were utilized for this measure. A variety of sources were utilized for this measure, however, for any one hazard, a single "best" source is identified and used as a basis for analysis.
- *Probability*
  - For this plan, probability is established based on the historic record for each event. The number of reported events divided by the number of years of record yields a probability of annual occurrence. It should be

***Requirement §201.6(c)(2)**: Risk assessment. The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.*

***Requirement §201.6(c)(2)(i)**: [The risk assessment shall include a] description of the type … of all natural hazards that can affect the jurisdiction.*

***Requirement §201.6(c)(2)(i)**: [The risk assessment shall include a] description of the … location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*

***Requirement §201.6(c)(2)(ii)**: [The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.*

***Requirement §201.6(c)(2)(ii)**: [The risk assessment] must also address NFIP insured structures that have been repetitively damaged floods.*

***Requirement §201.6(c)(2)(ii)(A)**: The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and CF located in the identified hazard area.*

***Requirement §201.6(c)(2)(iii)**: For multi-jurisdictional plans, the risk assessment must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

noted that this predictive method is limited in that it does not consider changes in environment, changes in climate, or efforts undertake to reduce the potential of future occurrence. When changes related to occurrence have the potential to effect deviation from the historic record, those changes will be discussed as part of the hazard profile.

- *Extent*
  - Extent is a measure of strength or magnitude of the hazard. Extent can be described in a combination of ways depending on the hazard. Standard measures for extent will be utilized when possible.
  - A variety of sources were utilized for this measure. The individual data sources utilized will be identified in the hazard profile.

Table 18: Regional Risk Assessment Summary

Regional Risk Assessment			
Hazard	**Previous Occurrence Events/Years**	**Annual Probability**	**Likely Extent**
Severe Winter Storms	87/17	100%	.25 - .5” ice 20 - 40°F below zero (wind chills) 4 – 8” snow 25 – 40 mph winds
Tornados	35/17	100%	EF0
High Winds	35/17	100%	9-10 BWF
Severe Thunderstorms	180/17	100%	≥1” rainfall
Hail	340/17	100%	H4 – H9
Flooding	59/17	100%	Minor flooding**
Extreme Heat	41/1	100%	>90°
Drought	31/216*	14%	D3
Earthquakes	0/29	1%	<4.0
Grass/Wildfires	931/12	100%	<100 acres
Levee Failure	1/13	7%	No federal levees in the planning area
Dam Failure	0	1%	<5% of population in breach inundation area
Agricultural Diseases	20/1	100%	Data not available
Fixed Sites (Chemical, Radiological)	160/23	100%	Data not available
Transportation Incidents (Chemical, Radiological)	385/34	100%	9000 LGA
Terrorism	5/9	55%	Undefined
Civil Disorder	1/20	5%	Undefined
Urban Fire	1,124/1	100%	Limited (single structure fires)

*Due to the nature of drought, probability will be calculated as number of total months in drought divided by number of total month during the period of record.
**Flooding extents are defined in Table 26.

The hazards of most significant concern include tornados and high winds, severe thunderstorms, severe winter storms, flooding, and hail. These hazards were identified based upon having the highest probability of future

occurrence, impacts on population, and impacts on property. The results in Table 18 were calculated by utilizing data and historic records when possible. Each hazard addressed will cite the data source utilized and identify the timeframe examined. Information presented by the regional and local planning teams will provide the basis for the portions of the risk assessment discussing historic impacts to critical facilities and specific concerns related to future critical facility vulnerability.

Community Based Risk Assessment

Participating jurisdictions completed a risk assessment for their community/jurisdiction. The local planning teams were asked to prioritize hazards based on local occurrences and impacts. Participants were encouraged to consider: historic events; probability of future events; specific vulnerable populations; properties that may be at higher levels of risk related to hazards; potential impacts to critical facilities and critical services; and potential economic losses. The information developed during the community based risk assessment is presented in *Section Seven: Participant Sections.*

Average Annual Damages and Frequency

FEMA ***Requirement §201.6(c)(2)(ii) (B)*** suggests that when the appropriate data is available, HMPs should also provide an estimate of potential dollar losses for structures in vulnerable areas. This risk assessment methodology provides potential dollar losses for all hazards for which historic event data is available. Additional loss estimates are provided separately for those hazards for which sufficient data is available. These estimates can be found within the relevant hazard profiles.

Average annual losses from historical occurrences can be calculated for those hazards for which there is a robust historic record and for which monetary damages are recorded. There are three main pieces of data that are used throughout this formula. Each set of data has limitations that are explained as follows:

- **Total Damages in Dollars:** This is the total dollar amount of all property damages as recorded in federal, state, and local data sources. The limitation to these data sources is that dollar figures usually are estimates and often do not include all damages from every event, but rather only officially recorded damages from reported events.
- **Total Years of Record:** This is the span of years where data is available for recorded events. Vetted and cleaned up NCDC data is available for 1996 to 2013. Nebraska Forest Service has data available for wildfires from 2000 – 2012. RMA data was available from 2000 – 2013. Although some data is available back to 1950, this plan update utilizes only the more current and more accurate data available.
- **Number of Hazard Events:** This shows how often an event occurs. The frequency of a hazard event will affect how a city responds. A thunderstorm may not cause much damage each time, but multiple storms can have an incremental effort on housing and utilities. In contrast, a rare tornado can have a widespread effect on a city.

An example of the Annual Damage Estimate is as follows:

$$\textbf{Average Annual Damages } (\$) = \frac{Total\ Damages\ in\ Dollars\ (\$)}{Total\ Years\ of\ Record\ (17)}$$

$$\textbf{Annual Frequency } (\$) = \frac{Total\ Events\ Recorded (\#)}{Total\ Years\ Recorded\ (17)}$$

The hazard types identified are those found within the State of Nebraska HMP. Each hazard will be included, while those which have caused significant damages or in significant numbers are discussed in detail. It should be noted that the table below is calculated for the entire LPSNRD planning area that features all the NCDC

data including county-based and zonal. It should be noted NCDC data is not inclusive and it provides very limited information on crop losses. In order to provide a better picture of the crop losses associated with all the hazards within the planning area, crop loss information provided by RMA of the USDA was also utilized for this update of the plan. The collected data was from 2000 to 2013 and please refer to the table below for detailed information. Data for all the hazards' is not always available so that only those with available datasets are included in the following loss estimation table.

Table 19: Hazard Loss Estimation

Hazard Type	Total Property Loss[1]	Annual Property Loss [1]	Total Crop Loss[2]	Annual Crop Loss [2]
Severe Winter Storms	$19,175,000	$1,127,941	$400,000	$30,769
Tornados	$101,309,000	$5,961,000	$0	$0
High Winds	$32,000	$1882	$47,966	$2,822
Severe Thunderstorms	$3,285,400	$193,259	$0	$0
Hail Events	$3,000,000	$176,471	$1,250,000	$73,529
Flooding	$5,177,000	$304,529	$55,000	$4,230
Grass/Wildfires	$469,534[3]	$36,118	$39,535	$3041
Agricultural Diseases	N/A	N/A	$126,220	$9,709
Transportation Incidents Chemical/Radiological	$1,161,676	$35,202	$0	$0

1 Indicates the data is from NCDC (January 1996 to December 2013); 2 Indicates data is from USDA RMA (2000 to 2013); 3 Indicates Data is from NFS (2000 to 2012)

Severe Winter Storms (Severe Winter Storms and Extreme Cold)

HAZARD PROFILE

Winter storms can bring extreme cold, freezing rain, and heavy or drifting snow creating blizzards. These storms are capable of extending over large areas, potentially impacting a broad range of populations, properties, CFs, and infrastructures. Although these storm events can reach large distances, there is generally significant warning time before a severe winter storm occurs.

Extreme Cold

Along with snow and ice storm events, extreme cold can be dangerous to the well-being of people and animals. What constitutes extreme cold varies from region to region, but is generally accepted as being temperatures that are significantly lower than the average low temperature. For LPSNRD, the coldest months of the year are January, February, March, November and December. The average low for these months are all below freezing (average low for the five months 19.2°F). The average high temperatures for the months of January, February, and December are near 32°F. Record lows for the region range from -26°F in February and December, -23°F in January, and -20°F in March.

Freezing Rain

Along with snow events, winter storms also have the potential to deposit significant amounts of ice. Ice buildup on tree limbs and power lines can cause them to collapse. This is most likely to occur when ice falls in the form of rain that freezes upon contact, especially in the presence of wind. Freezing rain is the name given to rain that falls when surface temperatures are below freezing. Unlike a mixture of rain and snow, ice pellets or hail, freezing rail is made entirely of liquid droplets. Freezing rain can also lead to many problems on the roads, as it makes them slick, causing automobile accidents, and making vehicle travel difficult.

Blizzards

Blizzards are particularly dangerous due to drifting snow and the potential for rapidly occurring whiteout conditions which greatly inhibits vehicular traffic. Heavy snow is usually the most defining element of a winter storm. Large snow events can cripple an entire jurisdiction by hindering transportation, knocking down tree limbs and utility lines, and causing structural damage to buildings.

Generally, winter storms occur between the months of November and March, but may occur as early as October and as late as April. Heavy snow is usually the most defining element of a winter storm. Large snow events can cripple an entire jurisdiction by hindering transportation, knocking down tree limbs and utility lines, and causing structural damage to buildings.

EXTENT

The Sperry-Piltz Ice Accumulation Index (SPIA) was developed by the National Weather Service (NWS) to predict the accumulation of ice and resulting damages. The SPIA looks at total precipitation, wind, and temperatures to predict the intensity of ice storms. Figure 11 shows the SPIA index.

Figure 11: SPIA Index

The Sperry-Piltz Ice Accumulation Index, or "SPIA Index" – Copyright, February, 2009

ICE DAMAGE INDEX	* AVERAGE NWS ICE AMOUNT (in inches) *Revised-October, 2011	WIND (mph)	DAMAGE AND IMPACT DESCRIPTIONS
0	< 0.25	< 15	Minimal risk of damage to exposed utility systems; no alerts or advisories needed for crews, few outages.
1	0.10 – 0.25	15 - 25	Some isolated or localized utility interruptions are possible, typically lasting only a few hours. Roads and bridges may become slick and hazardous.
	0.25 – 0.50	> 15	
2	0.10 – 0.25	25 - 35	Scattered utility interruptions expected, typically lasting 12 to 24 hours. Roads and travel conditions may be extremely hazardous due to ice accumulation.
	0.25 – 0.50	15 - 25	
	0.50 – 0.75	< 15	
3	0.10 – 0.25	> = 35	Numerous utility interruptions with some damage to main feeder lines and equipment expected. Tree limb damage is excessive. Outages lasting 1 – 5 days.
	0.25 – 0.50	25 - 35	
	0.50 – 0.75	15 - 25	
	0.75 – 1.00	< 15	
4	0.25 – 0.50	> = 35	Prolonged & widespread utility interruptions with extensive damage to main distribution feeder lines & some high voltage transmission lines/structures. Outages lasting 5 – 10 days.
	0.50 – 0.75	25 - 35	
	0.75 – 1.00	15 - 25	
	1.00 – 1.50	< 15	
5	0.50 – 0.75	> = 35	Catastrophic damage to entire exposed utility systems, including both distribution and transmission networks. Outages could last several weeks in some areas. Shelters needed.
	0.75 – 1.00	> = 25	
	1.00 – 1.50	> = 15	
	> 1.50	Any	

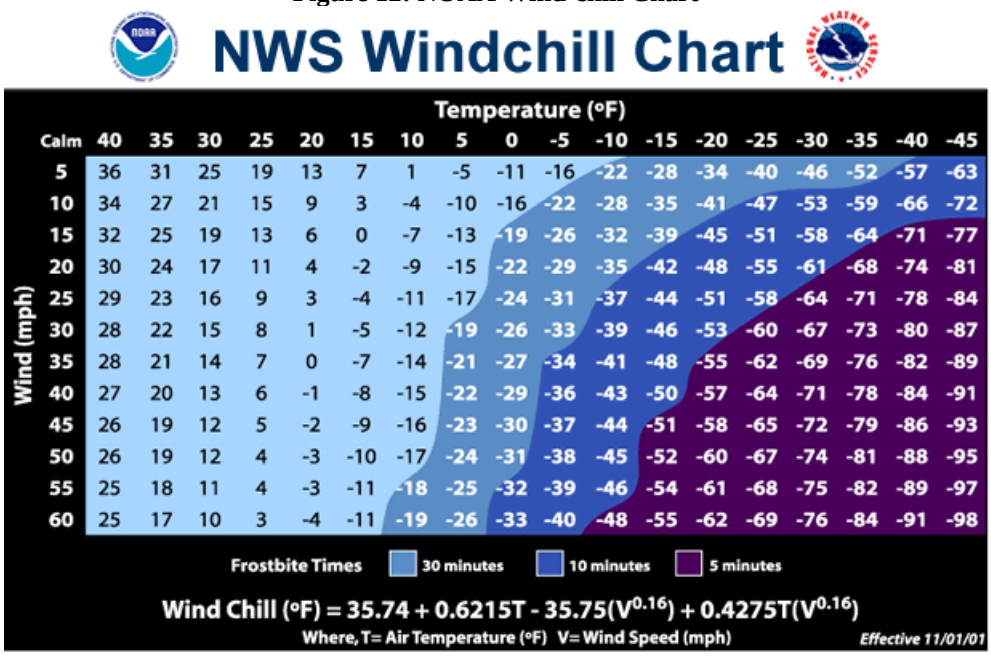
(Categories of damage are based upon combinations of precipitation totals, temperatures and wind speeds/directions.)

Source: http://www.spia-index.com/index.php

Reviews of historical severe winter storms across the planning area show that there is a range of events that can occur. Common component of winter storms in the planning area include extreme cold, ice, snow and high winds. Typical ice events correlate with Level 2 occurrences according to the SPIA Index. Ice accumulations range from a quarter of an inch to three quarters of an inch. The most common accumulation was one quarter of an inch to half an inch occurring in both ice events.

The Wind-chill Index was developed by the NWS to determine the decrease in air temperature felt by the body on exposed skin due to wind. The wind-chill is always lower than the air temperature and can quicken the effects of hypothermia or frost bite as it gets lower. Figure 12 shows the wind chill index used by the NWS.

Figure 12: NOAA Wind-chill Chart



NWS Windchill Chart

Wind (mph) \ Temperature (°F)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5		36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10		34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15		32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20		30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25		29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30		28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35		28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40		27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45		26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50		26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55		25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60		25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

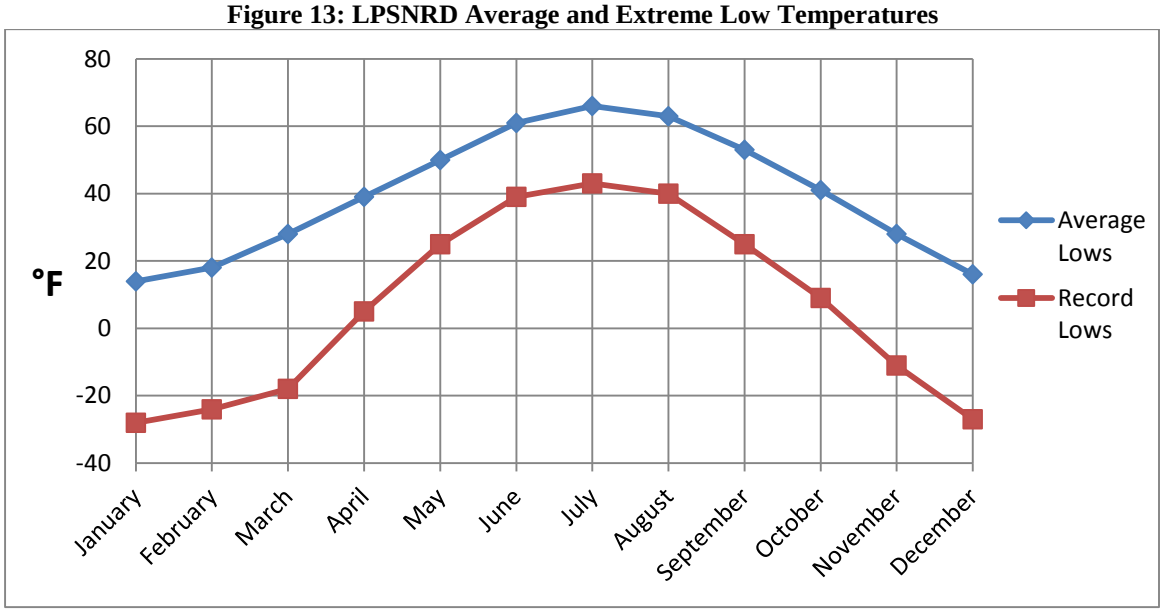
$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

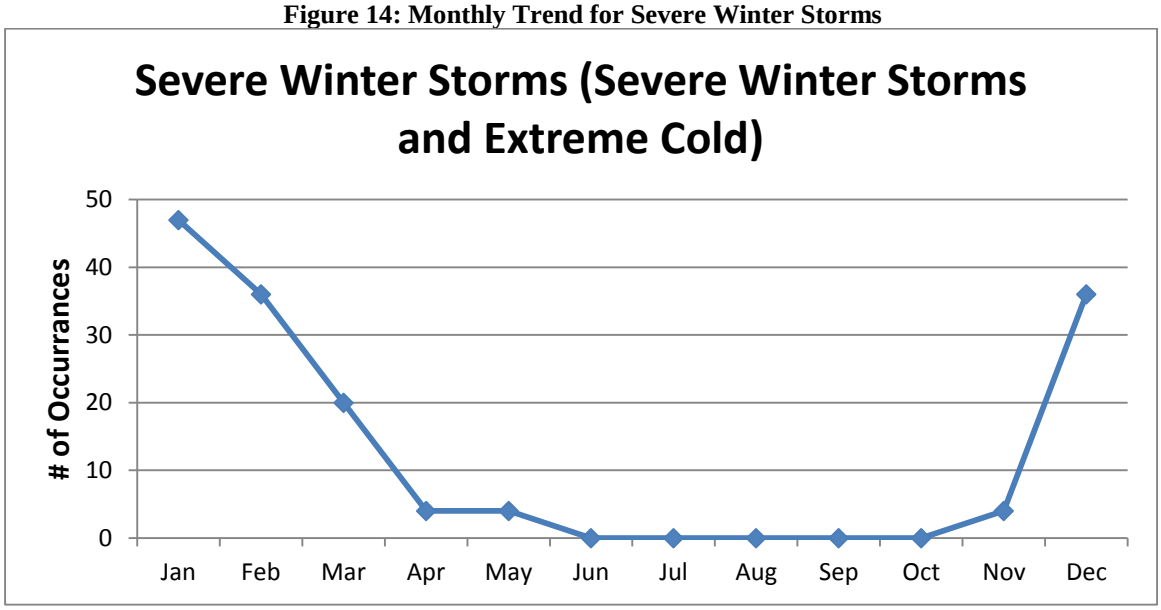
The coldest months of the year are January, February, March, November, and December and average lows for these months are generally around 20 degrees (refer to Figure 13 for regional low temperatures).

Figure 13: LPSNRD Average and Extreme Low Temperatures



Source: The Weather Channel (weather.com)

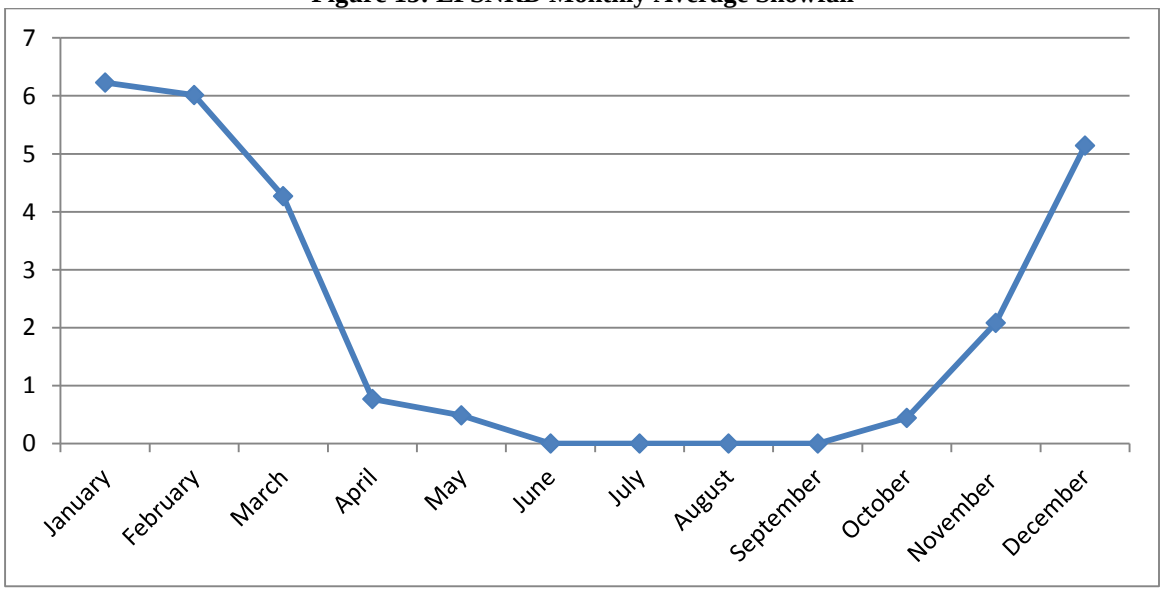
Figure 14: Monthly Trend for Severe Winter Storms



Source: NCDC

Historic snow events report accumulation between two inches and 14 inches during a twelve hour period [refer to Figure 15 for regional snow accumulation statistics reported by the weather stations located in Lincoln (254815), Lincoln Airport (254795), Raymond 2 NE (257055), Weeping Water (259090), Ashland (250375), Syracuse (258395), and Plattsmouth (256795)]. A common snow event (likely to occur annually) will result in accumulation totals between four and eight inches. Often these snow events are accompanied by high winds. It is reasonable to expect wind speeds of 25 to 40 mph with gusts reaching 60 mph or higher. Strong winds and low temperatures can combine to produce extreme wind chills of 45°F to 60°F below zero.

Figure 15: LPSNRD Monthly Average Snowfall



Source: NCDC, High Plains Regional Climate Center

HISTORICAL OCCURRENCES

Due to the regional scale of severe winter storms, the NCDC reports events as they occur in each county. While a single event can affect two or more counties at a time, the NCDC reports them as separate events.

NCDC cites 87 separate events, but many have to be the same event from different locations (given the fact that there are several on the same day) within LPSNRD from January 1996 to May 2013. No injuries or deaths were reported. However, these recorded events caused a total of $19,175,000 in property damages and $400,000 in crop damages. These events from NCDC and reported by participating communities were listed in each participant section in *Section Seven: Participant Sections*.

The following severe winter storm events were reported by participants through MindMixer:

- January 26, 1994: Freezing rain and sleet caused icing of trees and power lines. Some electrical outages also occurred. $50,000 worth of property damages was incurred.
- September 22, 1995: Record low temperatures from the lower 20s to the lower 30s put an end to an already stunted growing season across the midlands. Nearly the entire state of Nebraska fell below 28 degrees. Hardest hit were the milo, soybean, and corn crops. $262 million was reported in crop damages.
- January 19, 1996: Extreme cold temperatures were reported in the city of Lincoln resulting in $100,000 in property damages from frozen and ruptured pipes in the historic Haymarket area of Lincoln.
- March 24, 1996: Blizzard conditions in much of southeast Nebraska brought sustained winds of 30 to 50 mph with gust up to 60 mph and wind chill temperatures from 30 to 40 degrees below zero. Hundreds of motorists were stranded and several accidents occurred due to near zero visibility for more than ten hours.
- October 25, 1997: A major early season snowstorm struck much of the planning area, snow fall amounts ranged between 6 to 14 inches. More than 200,000 residents in the area were left without power, some power outages lasted for several days. In addition to the power outages, the city of Lincoln sustained damage to more than 25% of the tress in the city. This storm resulted in $56,500,000 in property damages across the state and $1,600,000 in crop and agricultural losses.
- March 7, 1998: A major winter storm moved through the central plains and created near blizzard conditions over portions of eastern Nebraska. Heavy snow combined with strong northerly winds of 40-45 mph created considerable blowing snow with 6-15 foot snow drifts throughout the planning area. Schools and businesses were closed for a few days as the strong winds continued to cause blowing snow, making clean up challenging. Throughout the affected area, there was $26,000 in reported property damages.
- September, 2007: A severe winter storm caused power interruptions and tree damages in the City of Ashland.
- December 24, 2009: Ice and later blizzard conditions produced heavy snow which made road conditions very dangerous, and in many cases, impassable in the villages of Brainard, Hallam, and Murdock. Areas in the villages of Brainard and Hallam were out of electricity due to the severe winter storm and the excessive drifts blocked all the streets, residences, and CFs in Murdock requiring extra labor and machines to remove snow and make streets drivable.

AVERAGE ANNUAL DAMAGES AND FREQUENCY

The 'event damage estimate formula' estimates potential losses for the planning area per event based upon historical data:

$$\textbf{Average Annual Damages } (\$\mathbf{1,127,941}) = \frac{Total\ Damages\ in\ Dollars\ (\$19{,}175{,}000)}{Total\ Years\ of\ Record\ (17)}$$

$$\textbf{Annual Frequency of Hazard Event } (\mathbf{5.12}\ \boldsymbol{per\ year}) = \frac{Total\ Events\ Recorded\ (87)}{Total\ Years\ of\ Record\ (17)}$$

The average annual damages estimate was determined based upon the average damage per year since 1996 and number of historical occurrences. The primary risks for severe winter storms are exposure, driving, and post-event behaviors. The most common types of private damages occur from downed trees falling on private property and from power outages causing frozen food to thaw. This does not include loss from displacement, functional downtime, economic loss, injury, or loss of life.

VULNERABILITY ASSESSMENT

Power outages, which occur almost on an annual basis with severe winter storms in Nebraska, in combination with cold temperatures and below zero wind-chill, can pose a significant threat to human life. Highly vulnerable populations, which are defined as the people who are at the most risk in regards to this hazard, include residents of nursing homes, young children, the elderly, and those living in less than adequate environments. CFs and infrastructure including emergency response and recovery operations, warning and communication systems, wells and water treatment, and many other services vital for returning the jurisdiction's functions to normal, are at risk during severe winter storm events due to potential power outages and other damages.

Severe winter storms occur on a regional scale, and can equally affect the entire planning area. All building stock and infrastructure, including CFs, are at risk of being damaged or affected by a severe winter storm.

The collection of snow and ice on power lines and electrical equipment can cause equipment damage, downed power lines, and a loss of electricity. Snow and ice accumulations on transportation routes can lead to obstruction of traffic flow and hinder emergency response. Severe winter storms can also cause significant damage to trees, with branches downing electrical lines, blocking roadways, or causing building and property damage.

Severe winter storms regularly result in damages to power lines and telephone lines, as well as other infrastructure related to threat communication (i.e. radio and television antennas). This potential for decreased message dissemination combined with potential power outages results in higher levels of vulnerability for a number of groups within the community including: the elderly, individuals and families living below the poverty line, those isolated from social interactions, groups with limited mobility, and residents that are new to the area/region. Elderly citizens are at higher risk of being isolated during severe winter storms as a result of decreased mobility, as well as a diminished ability to remove accumulations of snow and ice from vehicles and driveways. A 2011 study conducted by the Center for Injury Research and Policy found that on average there are 11,500 injuries and 100 deaths annually related to snow removal. People, especially males over the age of 55, are 4.25 times more likely to experience cardiac symptoms during snow removal.

Individuals and families below the poverty line and those isolated from social interactions may lack resources or access to resources that could mitigate the impacts of severe winter storms, such as sufficient food supplies when snowed in or even alternative heating sources during prolonged power outages. Severe winter storms often result in closed or impassable roadways. This increases the vulnerability among segments of the population that already have decreased mobility, making it important that they have a social network that can check on them and ensure that they have access to heat and food. Finally, people who are new to the area may not know what to expect from a severe winter storm and what actions are appropriate in preparing for the event. Threat communication is imperative for informing and educating this portion of the population.

FUTURE DEVELOPMENT AND VULNERABILITY

Overall, the planning area is experiencing slight growth. However, there is a wide range of growth and decline among the individual participating jurisdictions. There are many strategies that can be undertaken to protect both existing and future assets. Communities can incorporate "living snow fences" into community designs. "Living snow fences" are strategically placed trees and shrubs that act as a wind and snow block, reducing snow drifts and decreasing amounts of snow that would otherwise blow across flat areas. Communities can also bury power lines to reduce the chance of power outages resulting from severe winter storms and ice storms. New public buildings can be designed with redundant power supplies to ensure continuity of government services.

Building codes can be enhanced to prohibit flat roofs and to increase facility strengths to withstand greater snow loads. Stakeholder groups in the area play a significant role in assisting and protecting vulnerable populations during and following severe winter storms. *Section Seven* will identify specific strategies for each participating jurisdiction. These actions were identified by local planning teams and ranked for effectiveness and potential for implementation as a part of the planning process.

RISK ASSESSMENT SUMMARY

Overall, the risk and vulnerability assessment shows that Severe Winter Storms are likely to occur annually and often cause significant property damage across the planning area.

MITIGATION ALTERNATIVES

The following bullet points identify some general mitigation strategies that can be used to reduce a community's vulnerability to the threat of severe winter storms. Some of these strategies may already be in progress within the participating jurisdictions, refer to *Section 7: Participant Section* to find details on the status of these items for a specific jurisdiction. Many of these strategies are identified and discussed in greater detail in the FEMA document, *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards*.

- Improve buildings codes to eliminate flat roofs in areas that expect heavy snow loads
    - Current codes do not eliminate flat roofs but they do regulate design and construction to ensure they are appropriate for local conditions
- Retrofit buildings and infrastructure to withstand snow loads
- Increase weather monitoring procedures
- Incorporate text messaging into severe weather messaging programs
    - Both County EMAs utilize text alerts
- Incorporate cable TV interruption warning systems
    - Utilized throughout the planning area
- Establish road closure policies and procedures necessary to protect the public
    - Included in the Local Emergency Operations Plans (LEOP)
- Develop continuity plans for critical community services (public and private)
    - Identified as a mitigation strategy to be implemented by multiple communities
- Establish a Tree Board to assist in the development of a tree management program
    - Required for communities participating in Tree City USA
- Participate or continue participating in Tree City USA; establish a tree maintenance ordinance
    - Refer to *Section 7* for individual communities participation
- Establish redundancies for necessary municipal services (i.e. water, gas, electric, transportation)
- Develop a database of "vulnerable populations"
- Work with community groups serving "vulnerable populations" such as Meals on Wheels programs to help monitor vulnerable groups
- Establish public education programs to increase awareness of the dangers posed by severe winter storms and ways the public can mitigation the potential impacts
    - County EMAs offer materials related to regional hazards
- Educate property owners about freezing pipes (i.e., educating homeowners and builders on how to protect their pipes)

Tornados

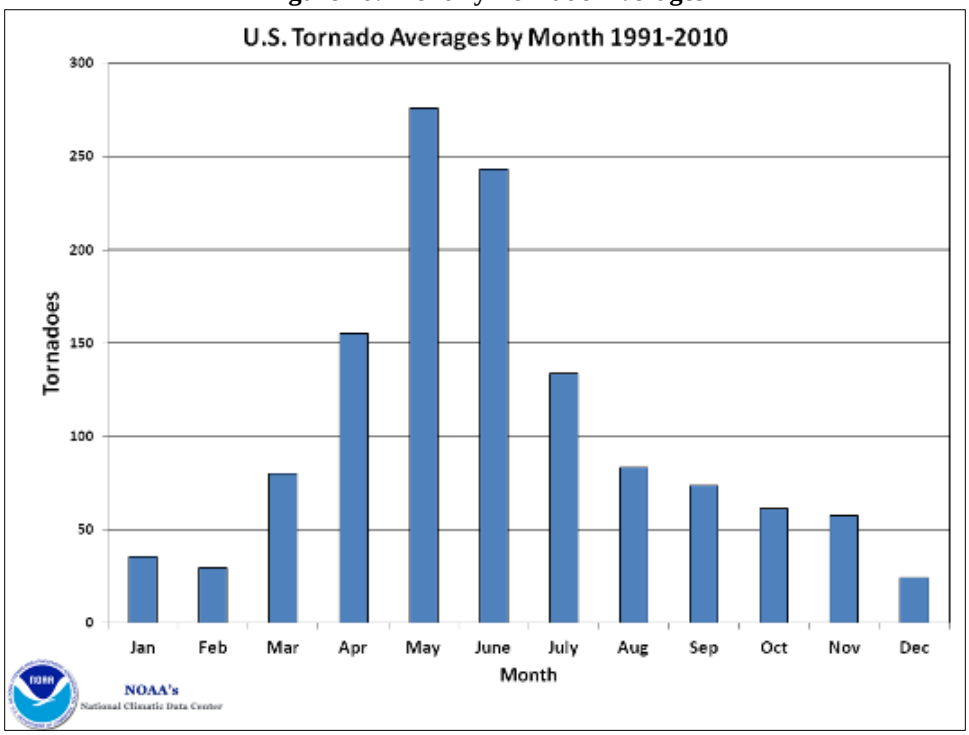
HAZARD PROFILE

A tornado is typically associated with a supercell thunderstorm. In order for rotations to be classified as tornados, three characteristics must be met:

- There must be a microscale rotating area of wind, ranging in size from a few feet to a few miles wide;
- The rotating wind, or vortex, must be attached to a convective cloud base and must be in contact with the ground; and,
- The spinning vortex of air must have caused enough damage to be classified by the Fujita Scale as a tornado.

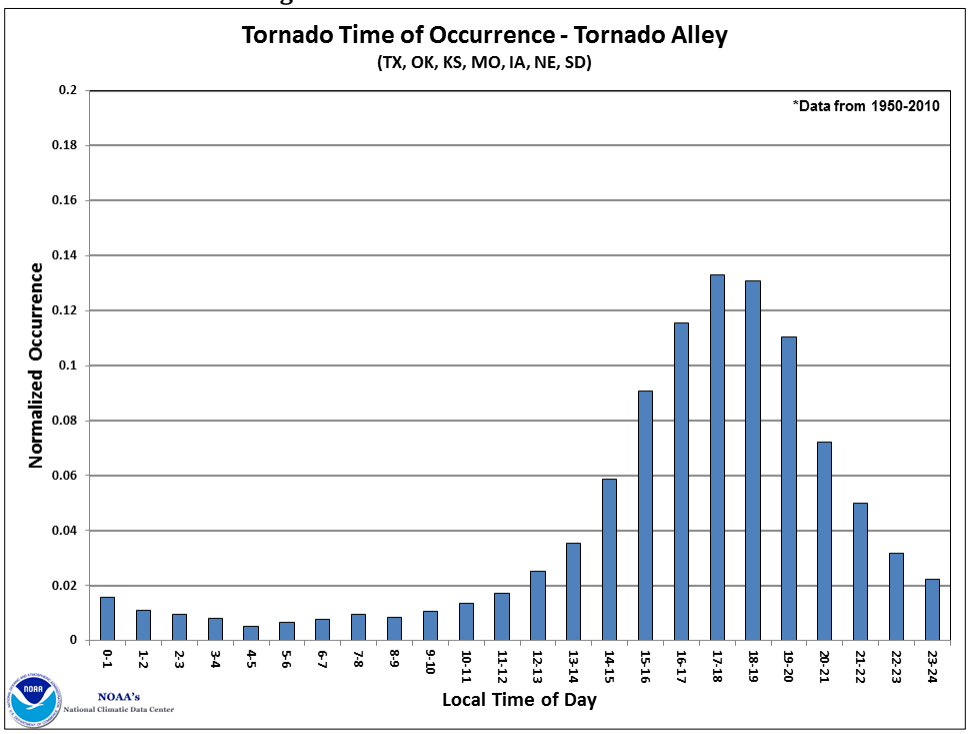
Once tornados are formed, they can be extremely violent and destructive. They have been recorded all over the world, but are most prevalent in the American Midwest and South, in an area known as "Tornado Alley." Approximately 1,000 tornados are reported annually in the contiguous United States (NOAA 2012). Tornados can travel distances over 100 miles and reach over 11 miles above ground. Tornados usually stay on the ground no more than 20 minutes. Nationally, the tornado season typically occurs between March and April. On average, 80% of tornados occur between noon and midnight. In Nebraska 77% of all tornados occur in the months of May, June, and July.

Figure 16: Monthly Tornado Averages



Source: NOAA

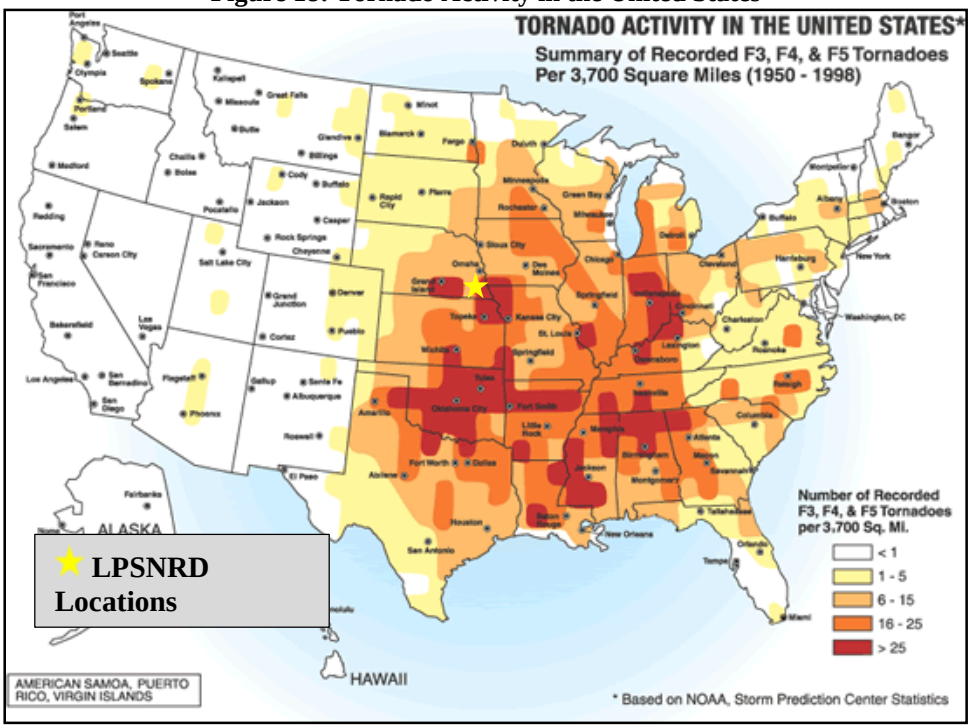
Figure 17: Tornado Time of Occurrence



Source: NOAA

Nebraska is ranked fifth in the nation for tornado frequency with an annual average of 45 tornados between 1953 and 2004 (NOAA 2011). The annual average number of tornados for Nebraska from 1991 to 2011 has increased slightly to 57 (NOAA 2013). Figure 18 shows the tornado activity in the United States as a summary of recorded F3, F4, and F5 tornados per 3,700 square miles form 1950-1998.

Figure 18: Tornado Activity in the United States



Source: United States Department of Commerce, NOAA, Storm Prediction Center Statistics

EXTENT

Tornados

After a tornado passes through an area, an official rating category is determined, which provides a common benchmark that allows comparisons to be made between different tornados. The magnitude of a tornado is measured by the Enhanced Fujita Scale. The Enhanced Fujita Scale does not measure tornados by their size or width, but rather the amount of damage caused to human-built structures and trees. The Enhanced Fujita Scale replaced the Fujita Scale in 2007. The enhanced scale classifies EF0-EF5 damage as determined by engineers and meteorologists across 28 different types of damage indicators, including different types of building and tree damage. In order to establish a rating, engineers and meteorologists examine the damage, analyze the ground-swirl patterns, review damage imagery, collect media reports, and sometimes utilize photogrammetry and videogrammetry. Based on the most severe damage to any well-built frame house, or any comparable damage as determined by an engineer, an EF-Scale number is assigned to the tornado. Tables 20 and 21 summarize the Enhanced Fujita Scale and damage indicators. According to a recent report from the National Institute of Science and Technology on the Joplin Tornado, tornados rated EF3 or lower account for around 96% of all tornado damages.

Table 20: Enhanced Fujita Scale

Storm Category	3 Second Gust (mph)	Damage Level	Damage Description
EF0	65-85 mph	Gale	Some damages to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages to sign boards.
EF1	86-110 mph	Weak	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages might be destroyed.
EF2	111-135 mph	Strong	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
EF3	136-165 mph	Severe	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
EF4	166-200 mph	Devastating	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
EF5	200+ mph	Incredible	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel re-enforced concrete structures badly damaged.
EF No rating	--	Inconceivable	Should a tornado with the maximum wind speed in excess of F5 occur, the extent and types of damage may not be conceived. A number of missiles such as iceboxes, water heaters, storage tanks, automobiles, etc. will create serious secondary damage on structures.

Source: NOAA; FEMA

Table 21: Enhanced F Scale Damage Indicators

Number	Damage Indicator
1	Small barns, farm outbuildings
2	One- or two-family residences
3	Single-wide mobile home (MHSW)
4	Double-wide mobile home
5	Apt, condo, townhouse (3 stories or less)
6	Motel
7	Masonry apt. or motel
8	Small retail bldg. (fast food)
9	Small professional (doctor office, branch bank)
10	Strip mall
11	Large shopping mall
12	Large, isolated ("big box") retail bldg.

Number	Damage Indicator
13	Automobile showroom
14	Automotive service building
15	School - 1-story elementary (interior or exterior halls)
16	School - jr. or sr. high school
17	Low-rise (1-4 story) bldg.
18	Mid-rise (5-20 story) bldg.
19	High-rise (over 20 stories)
20	Institutional bldg. (hospital, govt. or university)
21	Metal building system
22	Service station canopy
23	Warehouse (tilt-up walls or heavy timber)
24	Transmission line tower
25	Free-standing tower
26	Free standing pole (light, flag, luminary)
27	Tree - hardwood
28	Tree - softwood

Source: NOAA; FEMA

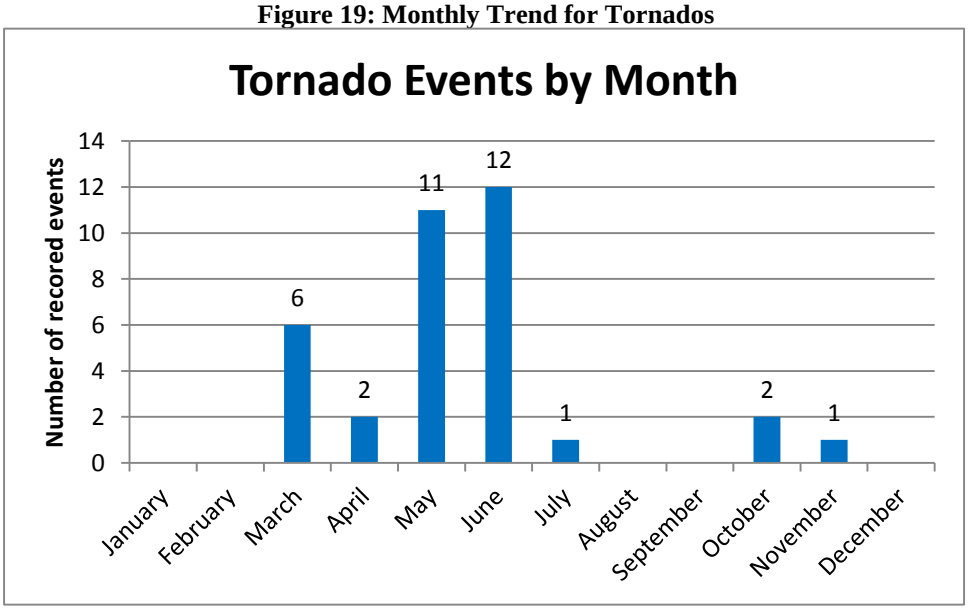
Based on the historic record it is most likely that tornados that do occur within the planning area will be of EF0 strength. Of the 35 reported events, one event was an F4 tornado in 2004, two events were EF2 tornados in 2009 and 2013, 11 events were F/EF1 tornados, all other events were F/EF 0.

Historical Occurrences

Due to the local scale of tornado events, the NCDC reports events as they occur in each city or town. While a single event can affect multiple towns or cities, the NCDC reports them as separate events.

The NCDC reported a total of 35 tornado events for the planning area from 1996 to 2013. It was reported to result in $101,309,000 in total property damages and no crop damages. There was one major event in 2004 in the area causing one death and 30 injuries. There were a total of one death and 38 injuries from 1996 to 2013.

Figure 19: Monthly Trend for Tornados



Source: NCDC

The following events listed below recorded fatalities, injuries, or significant monetary damages for the planning area.

The following tornados were reported by the NCDC for Cass or Lancaster Counties:

- August 13: 1952: An F4 tornado in Cass County resulted in twenty reported injuries, zero deaths and $250,000 in property damages.
- June 6, 1956: An F2 tornado in Lancaster County resulted in one reported injury, zero deaths and $3,000 in property damages.
- April 25, 1957: An F4 tornado in Lancaster County resulted in eight reported injuries, one death and $2.5 million in property damages.
- August 30, 1959: An F2 tornado in Lancaster County resulted in zero reported injuries or deaths and $25,000 in property damages.
- May 10, 1967: An unrated tornado in Lancaster County resulted in zero reported injuries or deaths and $250,000 in property damages
- April 3, 1981: An F2 tornado in Lancaster County resulted in zero reported injuries or deaths and $250,000 in property damages.
- May 1, 1983: An F1 tornado in Cass County resulted in three reported injuries, zero deaths and $250,000 in property damages
- June 12, 1984: An F2 tornado in Lancaster County resulted in zero reported injuries or deaths and $2.5 million in property damages
- May 22, 2004: An F4 tornado in Lancaster County resulted in 38 reported injuries, one reported death and more than $100 million in property damage. This tornado was the previous national record holder for peak width at nearly 2.5 miles wide.
- March 23, 2009: Multiple F1 tornados in Cass County resulted in 8 reported injuries and no deaths with $1,000,000 in monetary damages reported.
- June 1, 2010: An F1 tornado in Cass County resulted in zero injuries or deaths with $4,000 reported in property damages.

The following tornados were reported by participants at the public meetings:

- June 1, 1912: A tornado hit village of Hallam and caused substantial damages to nearby homes, barns, and machinery as well as one death.
- May 22, 2004: An F4 tornado hit the village of Hallam and resulted in one death and many injuries. It was reported that most of the town was destroyed and needed to be rebuilt. This severe event also caused the town to be out of adequate of utilities, water and sewer system, and gas and electricity system for an extended period of time.
- June 4, 2008: An F1 tornado totally destroyed two residential properties and caused substantial damage to at least three more in the village of Ceresco. Almost all structures in the village sustained damages as well as a lot of trees were lost. This tornado also resulted in electricity breakdown that lasted five days.

AVERAGE ANNUAL DAMAGES AND FREQUENCY

The average annual damage estimate was determined based upon the average damage per year between 1996 and 2013 and number of historical occurrences. This does not include loss from displacement, functional downtime, economic loss, injury, or loss of life. It should be noted that the total crop damages were included in the event details to express the magnitude of the event, but were not calculated into the average damage per event estimate.

TORNADO:

$$\textbf{Average Annual Damages } (\$\mathbf{5,961,000}) = \frac{Total\ Damages\ in\ Dollars\ (\$101{,}337{,}000)}{Total\ Years\ of\ Record\ (17)}$$

$$\textbf{Average Annual Frequency } (\mathbf{2.06}\ \boldsymbol{per\ year}) = \frac{Total\ Events\ Recorded\ (35)}{Total\ Years\ of\ Record\ (17)}$$

The average damage per event estimate was determined based upon the total damages in dollars since 1996 and the number of historical occurrences. This does not include loss of displacement, functional downtime, economic loss, injury, or loss of life. It should be noted that the total crop damages were included in the event details to express the magnitude of the event, but were not calculated into the average damage per event estimate, as crop damages would likely not affect the area.

VULNERABILITY ASSESSMENT

Tornados occur throughout the planning area. All building stock and above ground infrastructure, including CFs, are at risk of being damaged or affected by tornados and high winds. Tornados and high winds can cause structure losses, downed power lines, loss of electricity, obstruction to traffic flow, and significant damage to trees and center-pivot irrigation systems. A catastrophic event could lead to major economic loss for the jurisdiction. High wind speeds and flying debris can pose a significant threat to human life.

Tornados can impact a wide range of people and properties. People living in mobile homes are even more susceptible to the effects of tornados (6.3% of housing units in Cass County and 2% of housing units in Lancaster County). Mobile homes which are not anchored or are not anchored properly can be blown over by winds as small as 60 – 70 mph. A 2007 study conducted by Dr. W. Ashley at Northern Illinois University found that between 1985 and 2005, 44% of all tornado related fatalities occurred in mobile homes, while between 20 and 30% occurred in permanent homes. Tornado related deaths in mobile homes have increased over the timeframe investigated from 37% of all fatalities from 1986 to 1990 to nearly 57% of all fatalities from 2001 to 2005. The timing of tornados also impacts the vulnerability of people living in mobile homes. The 2007 study found that while only 25.8% of tornados occur between sunset and sunrise they account for 42.5% of tornado fatalities. This is a result of a number of factors including: decreased ability to identify tornados in the dark,

decreased ability to communicate tornado threats due to a high rate of people sleeping during the night, and a higher number of people in the housing units (i.e. mobile home) during the nighttime.

Other factors that may increase vulnerability to the threat posed by tornados include age, poverty levels, and home rentals. The 2007 study found that the middle aged (those over 40 years of age) and the elderly are more vulnerable to tornados. This may be a result of decreased mobility, higher rate of auditory complications, or lack of resources needed to mitigate potential tornado related impacts.

FUTURE DEVELOPMENT AND VULNERABILITY

There are some changes that communities can make to partially mitigate the impacts resulting from tornados and strong winds. Building codes for new structures can be strengthened, requiring increased rebar in foundations, enhanced nailing patterns for wall sheathing, and the use of Simpson Strong Ties and Straps. Building codes can also be strengthened to require the use of anchors and tie-downs of mobile homes. Additionally, individuals can choose to build to an optional Code Plus Standard, such as Fortified for Safer Living. Saferooms can be installed in new structures as well as made to adapt to existing structures. In-ground saferooms can be installed in existing structures for as little as $4,000. The installation of public saferooms in areas around vulnerable populations, such as mobile home parks, can increase safety of residents in those areas.

Considerations for future development should include developing tornado saferooms in/near mobile home parks. The 2003 Tornado Shelters Act authorizes communities to use Community Development Block Grant (CDBG) funds for construction of tornado-safe shelters in manufactured home parks with 20 or more housing units consisting predominately of low- and moderate-income residents.

RISK ASSESSMENT SUMMARY

Overall, the risk and vulnerability assessment shows that tornados do not occur as frequently as some of the other hazards, but can have significant impacts when they do occur. Historically, there have been high property damages and injuries.

MITIGATION ALTERNATIVES

The following bullet points identify some general mitigation strategies that can be used to reduce a community's vulnerability to the threat of tornados and high winds. Some of these strategies may already be in progress within the participating jurisdictions, please see *Section 7: Participant Section* to find details on the status of these items for a specific jurisdiction. Many of these strategies are identified and discussed in greater detail in the FEMA document, *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards*

- Enhance building codes to incorporate wind –resistant building techniques
    - Most communities with building codes have wind load requirements
- Bury overhead power lines
    - Many communities have a portion of powerlines buried but there is still a great need across the planning area
- Establish redundancies for necessary municipal services (i.e. water, gas, electric, transportation)
    - This varies from jurisdiction to jurisdiction
- Establish data recovery program and backup program for municipal employees
- Establish a Tree Board to assist in the development of a tree management program
- Participate in Tree City USA; establish a tree maintenance ordinance
    - Refer to Section 7 for individual communities participation
- Encourage the construction of safe rooms
    - This is a need for many communities in the planning area
- Require tornado saferooms in newly constructed municipal buildings
    - Not in place within the planning area
- Work with trailer and mobile home parks to develop tornado safe rooms

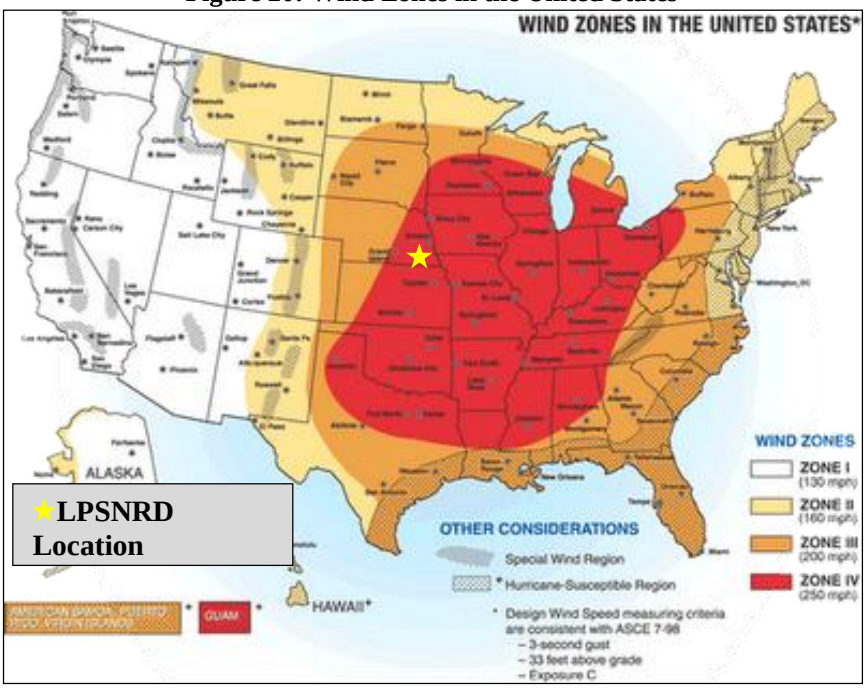
    - The City of Lincoln is working towards saferooms near vulnerable populations
- Ensure schools are equipped with sufficient safe space for their maximum student capacity
- Develop maps of "vulnerable populations" and saferooms located near those groups
    - Most communities in the planning area have not attempted this
- Ensure outdoor warning sirens are functional and located adequately to warn the public of potential tornado events
    - County EMAs perform regular test to ensure function of sirens
- Incorporate text messaging into severe weather messaging programs
    - Text alerts occur within the planning area
- Incorporate cable TV interruption warning systems
    - Text alerts occur within the planning area
- Establish mutual aide agreements with neighboring communities and privately owned businesses
- Develop business continuity plans for critical community services (public and private)
    - Identified as a mitigation strategy to be implemented by multiple communities
- Establish public education programs to increase awareness of the dangers posed by severe tornados and strong winds and ways the public can mitigate the potential impacts
    - County EMAs offer materials related to regional hazards

High Winds

HAZARD PROFILE

High winds typically accompany severe thunderstorms and severe winter storms and can cause significant property and crop damage, downed power lines, loss of electricity, obstruction to traffic flow, and significant damage to trees and center-pivot irrigation systems. All building stock and above ground infrastructure, including CFs, are at risk of being damaged or affected by high winds. High wind speeds and flying debris can pose a significant threat to human life. Figure 22 shows the wind zones in the United States.

Figure 20: Wind Zones in the United States



Source: FEMA

EXTENT

The NWS defines High Winds as sustained wind speeds of 40 mph or greater lasting for 1 hour or longer, or winds of 58 mph or greater for any duration. The NWS issues High Wind Advisories when there are sustained winds of 25 to 39 miles per hour and/or gusts to 57 mph. The Beaufort Wind Scale can be used to classify wind strength. Table 22 outlines the scale, providing wind speed ranking, range of wind speeds per ranking, and a brief description of conditions for each ranking.

Table 22: Beaufort Wind Force Rankings

Beaufort Wind Force Ranking	Range of Wind Speeds	Conditions
0	<1 mph	Smoke rises vertically
1	1 – 3 mph	Direction shown by smoke but not wind vanes
2	4 – 7 mph	Wind felt on face; leaves rustle; wind vanes move
3	8 – 12 mph	Leaves and small twigs in constant motion
4	13 – 18 mph	Raises dust and loose paper; small branches move
5	19 – 24 mph	Small trees in leaf begin to move
6	25 – 31 mph	Large branches in motion; umbrellas used with difficulty
7	32 – 38 mph	Whole trees in motion; inconvenience felt when walking against the wind
8	39 – 46 mph	Breaks twigs off tree; generally impedes progress
9	47 – 54 mph	Slight structural damage; chimneypots and slates removed
10	55 – 63 mph	Trees uprooted; considerable structural damages; improperly or mobiles homes with no anchors turned over
11	64 – 72 mph	Widespread damages; very rarely experienced
12 – 17	72 - >200 mph	Hurricane; devastation

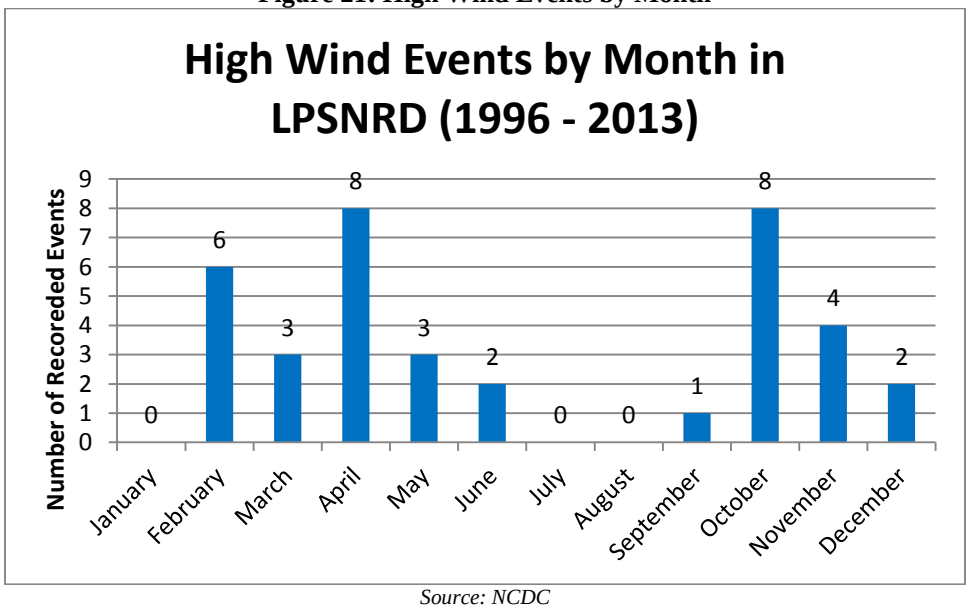
Source: NWS

Using the NCDC reported events the most common high wind event is a level 8/9. The reported high wind events produced an average event with 47 mph wind and gusts over 60 mph.

HISTORICAL OCCURRENCES

Due to the regional scale of high winds, the NCDC reports events as they occur in each county. While a single event can affect two or more counties at a time, the NCDC reports them as separate events. NCDC cites 37 separate events, but many have to be the same event from different locations (given the fact that there are several on the same day) within LPSNRD from January 1996 to May 2013. These recorded events also caused $32,000 property damages and one injury. The jurisdiction specific events from NCDC and reported by each community were listed in each participant section in *Section Seven: Participant Sections*.

Figure 21: High Wind Events by Month



Source: NCDC

The following high wind event was reported by participants at the public meetings:

- May 22, 2004: A high wind event took place in the village of Avoca that caused tree damage in all areas, broke limbs, and ruined electric lines.

AVERAGE ANNUAL DAMAGES AND FREQUENCY

The average annual damage was determined based upon the total damages between 1996 and 2013 and number of historical occurrences. This does not include loss from displacement, functional downtime, economic loss, injury, or loss of life. It should be noted that the total crop damages were included in the event details to express the magnitude of the event, but were not calculated into the average annual damage estimate.

HIGH WINDS:

$$\textbf{Average Annual Damage } (\$\mathbf{1882}) = \frac{Total\ Damages\ in\ Dollars\ (\$32{,}000)}{Total\ Years\ of\ Record\ (17)}$$

$$\textbf{Annual Frequency of Hazard Event } (\mathbf{2.17}\ \boldsymbol{per\ year}) = \frac{Total\ Events\ Recorded\ (37)}{Total\ Years\ of\ Record\ (17)}$$

The average damage per event estimate was determined based upon the average damage per event since 1996 and the number of historical occurrences. This does not include loss of displacement, functional downtime, economic loss, injury, or loss of life. It should be noted that the total crop damages were included in the event

details to express the magnitude of the event, but were not calculated into the average damage per event estimate, as crop damages would likely not affect the area.

VULNERABILITY ASSESSMENT

High winds occur with regularity throughout the planning area. All building stock and above ground infrastructure, including CFs, are at risk of being damaged or affected by high winds. High winds can cause structure loss, downed power lines, loss of electricity, obstruction to traffic flow, and significant damage to trees and center-pivot irrigation systems. A catastrophic event could lead to major economic loss for the jurisdiction. High wind speeds and flying debris can pose a significant threat to human life.

Other factors that may increase vulnerability to the threat posed by tornados include age, poverty levels, and home rentals. The 2007 study found that the middle aged (those over 40 years of age) and the elderly are more vulnerable to tornados. This may be a result of decreased mobility, higher rate of auditory complications, or lack of resources needed to mitigate potential tornado related impacts.

FUTURE DEVELOPMENT AND VULNERABILITY

There are some changes that communities can make to partially mitigate the impacts resulting from strong winds. Building codes for new structures can be strengthened, requiring increased rebar in foundations, enhanced nailing patterns for wall sheathing, and the use of Simpson Strong Ties and Straps. Building codes can also be strengthened to require the use of anchors and tie-downs of mobile homes. Additionally, individuals can choose to build to an optional Code Plus Standard, such as Fortified for Safer Living. Saferooms can be installed in new structures as well as made to adapt to existing structures. In-ground saferooms can be installed in existing structures for as little as $4,000. The installation of public saferooms in areas around vulnerable populations, such as mobile home parks, can increase safety of residents in those areas.

RISK ASSESSMENT SUMMARY

Overall, the risk and vulnerability assessment shows that high winds do not occur as frequently as some of the other hazards, but can have significant impacts when they do occur. Historically, there have been some property damages but no injuries.

MITIGATION ALTERNATIVES

The following bullet points identify some general mitigation strategies that can be used to reduce a community's vulnerability to the threat of tornado and strong winds. Some of these strategies, such as the use of warning systems, are already in place in the planning area. Many of these strategies are identified and discussed in greater detail in the FEMA document *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards*.

- Enhance building codes to incorporate wind –resistant building techniques
- Bury overhead power lines
- Establish redundancies for necessary municipal services (i.e. water, gas, electric, transportation)
- Establish data recovery program and backup program for municipal employees
- Establish a Tree Board to assist in the development of a tree management program
- Participate, or continue participating, in Tree City USA; establish a tree maintenance ordinance
- Encourage the construction of safe rooms
- Require tornado saferooms in newly constructed municipal buildings
- Work with trailer and mobile home parks to develop tornado safe rooms
- Ensure schools are equipped with sufficient safe space for their maximum student capacity
- Develop maps of "vulnerable populations" and saferooms located near those groups
- Ensure outdoor warning sirens are functional and located adequately to warn the public of potential tornadic events
- Incorporate text messaging into severe weather messaging programs
- Incorporate cable TV interruption warning systems

- Establish mutual aide agreements with neighboring communities and privately owned businesses
- Develop business continuity plans for critical community services (public and private)
- Establish public education programs to increase awareness of the dangers posed by severe tornados and strong winds and ways the public can mitigation the potential impacts

Severe Thunderstorms (Thunderstorm and Lightning)

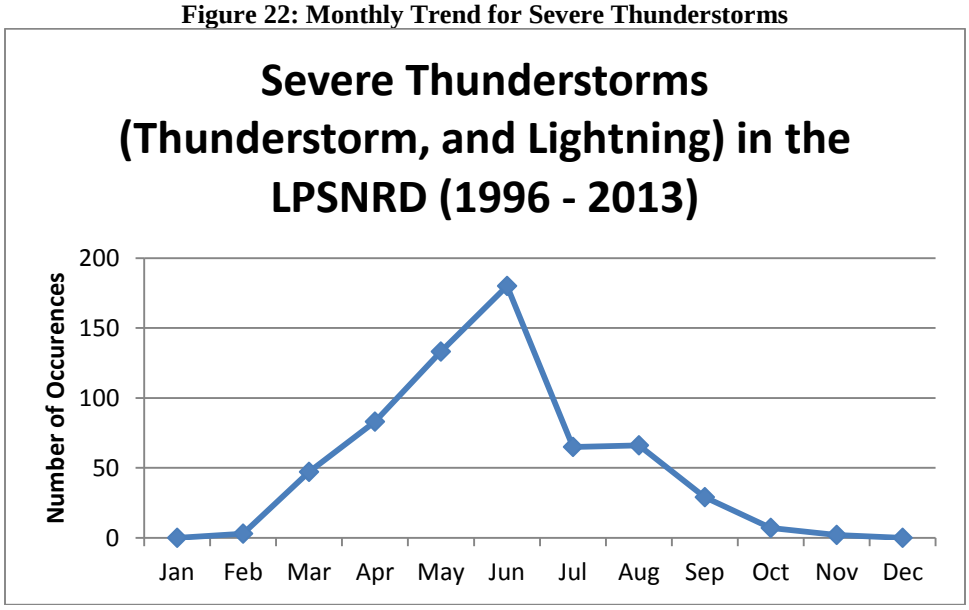
HAZARD PROFILE

Severe thunderstorms are common and unpredictable annual events throughout the central and southern United States. Thunderstorms differ from many other hazards in that they are generally large in magnitude, have a long duration, and travel across large areas and through multiple jurisdictions within a single region. Additionally, thunderstorms often occur in series, with one jurisdiction having the potential to be hit multiple times in one day.

A severe thunderstorm is defined by winds measuring 58 miles per hour or greater, hail one inch or larger, or the presence of tornado activity.

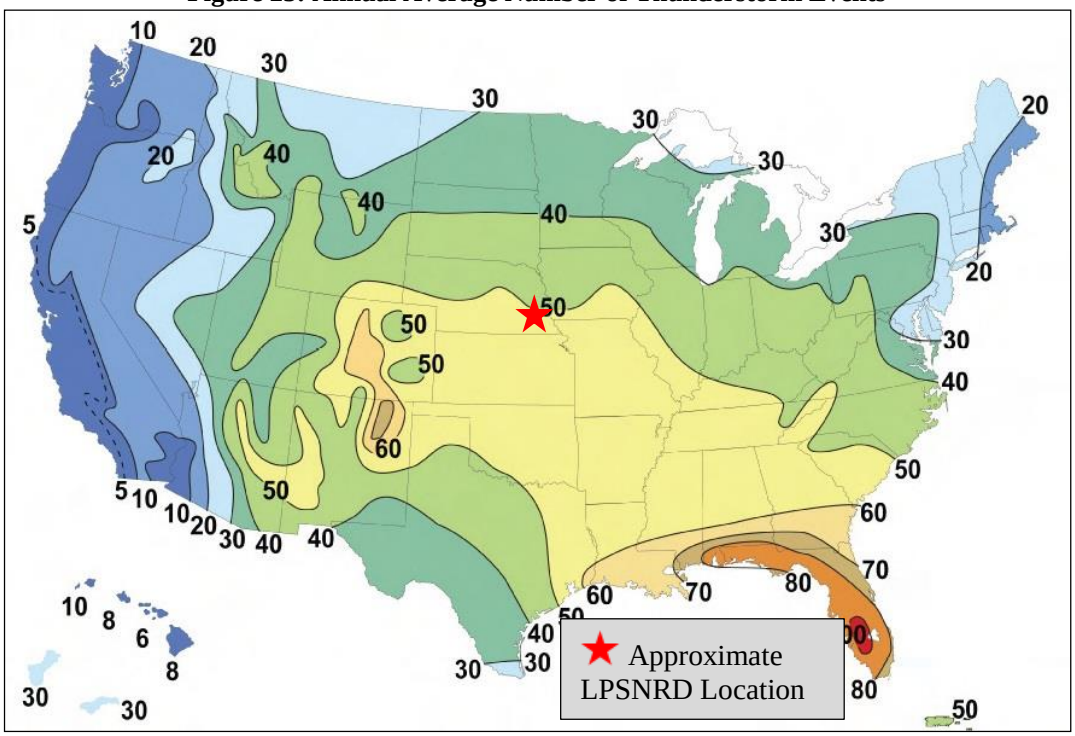
Severe thunderstorms in LPSNRD usually occur in the evening during the spring and summer months, see Figure 22 These often massive storms can include heavy rain, hail, lightning, high wind, and can produce tornados with little or no advanced warning. Furthermore, heavy rains can cause flooding, lightning can cause wildfires, and high winds can down trees, cause power outages, and destroy property with their shear force.

Figure 22: Monthly Trend for Severe Thunderstorms



Economically, thunderstorms are generally beneficial in that they provide moisture necessary to support Nebraska's largest industry, agriculture. The majority of thunderstorms do not cause damage, but when they escalate to the point of becoming severe, the potential for damages include crop losses from wind and hail, property losses due to buildings and automobiles damaged by hail, wind, or flash flooding, and death or injury to humans and animals from lightning, drowning, or being struck by falling or flying debris. Figure 23 displays the average number of days of thunder events across the country each year, with Nebraska experiencing between 40 to 50 days from north to south across the state.

Figure 23: Annual Average Number of Thunderstorm Events



Source: http://www.nws.noaa.gov/om/severeweather/index.shtml

Thunderstorms can develop in less than 30 minutes, and can grow to an elevation of eight miles into the atmosphere. There are an estimated 100,000 thunderstorms in the United States each year, of which 10% are severe. Lightning, by definition, is present in all thunderstorms and can be harmful to humans and animals, cause fires to buildings and agricultural lands, and cause electrical outages in municipal electrical systems. Between 1977 and 2006, averages of 62 people were killed each year by lightning in the United States. In Nebraska, eight fatalities were attributed to lightning between 1990 and 2003. Lightning can strike up to 10 miles from the portion of the storm depositing precipitation. There are three primary types of lightning: intra-cloud, inter-cloud, and cloud to ground. While intra and inter-cloud lightning are more common, it is when lightning comes in contact with the ground that society is potentially impacted. Lightning generally occurs when warm air is mixed with colder air masses resulting in atmospheric disturbances necessary for polarizing the atmosphere. There is no scale for measuring lightning. Damaging hailstorms are also common in severe thunderstorms. Hail measuring just three-quarters of an inch can approach speeds of 100 mph. Hail causes nearly $1 billion in damage to property and crops annually.

EXTENT

A major component of severe thunderstorms is rainfall accumulations. For the planning area it is reasonable to expect spring (March, April and May) and summer (June, July and August) to have the highest rainfall totals. Using data provided by the High Plains Regional Climate Center the spring months should have an average of 24 days with at least trace amounts of precipitation. 16 of those 24 days will receive precipitation totals greater than one tenth of an inch; approximately 5 of the 24 days will have more than one half an inch of precipitation; and approximately 2 of the 24 days will report rainfall totals equal to or greater than one inch. During the summer months the planning area can expect to receive at least trace amounts of precipitation on 25 days. More than 17 of those 25 days will report totals greater than or equal to one tenth of an inch; 7 of the 25 days will report rainfall totals of at least one half an inch; and 3 of the 25 days will report precipitation totals of at least one inch.

HISTORICAL OCCURRENCES

The NCDC reports events as they occur in *each* community. A single severe thunderstorm event can affect multiple communities at a time; the NCDC reports these large scale, multi-community events as separate events. The result is a single thunderstorm event covering the entire region could be reported by the NCDC as several events. NCDC cites 180 separate events, but many have to be the same event from different locations (given the fact that there are several on the same day) within LPSNRD from January 1996 to August 2013. No injuries or deaths were reported. These recorded events caused a total of $3,285,400 in property damages, 3 injuries, no deaths, and no crop damages. The jurisdiction specific events from NCDC and reported by each community were listed in each participant section in *Section Seven: Participant Sections*.

The following severe thunderstorm events were reported by the NCDC as causing injuries or death in Cass County:

- July 18, 1985: Severe thunderstorm winds injured five people. No property damage was reported.
- June 2, 1989: A severe thunderstorm with winds exceeding 59 mph injured one person. No property damage was reported.
- July 4, 1994: Strong winds blew down a 100-foot tall cottonwood tree. The upper limbs, which were between two and three feet in diameter, hit a tent that two people were camping in. A 58 year old male was killed and a 31 year old female was injured.

The following severe thunderstorm events were reported by the NCDC as causing injuries, death, or property damage in Lancaster County:

- May 7, 1993: In the city of Lincoln lighting striking a radio station resulted in $50,000 in property damages to the computer, telephone, and satellite equipment.
- May 22, 1996: In the city of Lincoln a severe thunderstorm with winds up to 83 mph damaged the roof of the Duncan Aviation facility and overturned multiple aircraft. The storm also damaged the roof at the State Fair Park's grandstand. The city of Lincoln sustained damages in the form of downed power lines and trees. The reported property damage for this event was $1.4 million.
- July 10, 1997: In the city of Lincoln lightning striking the roof of a home resulted in $25,000 in property damages.
- July 11, 2000: In the village of Bennet a severe thunderstorm with wind gust estimated at 70 mph resulted in $20,000 in property damages.
- July 20, 2000: In the town of Firth a severe thunderstorm with 50 mph winds and 2¾ inch hailstones resulted in damages to 148 of the 200 homes and business in the town. The total damages were $1 million in property damages and $2 million in crop damages.
- April 14, 2001: In the village of Bennet a severe thunderstorm with wind up to 70 mph damaged a garage, farm building, and power lines. The reported property damage for this event was $25,000.
- April 20, 2001: In the village of Raymond a severe thunderstorm with winds estimated at 80 mph knocked over a utility pole and damaged a house outside the village limits. The reported property damage for this event was $20,000.
- August 19, 2003: In the city of Lincoln lightning striking three businesses was responsible for $90,000 in property damages.
- August 8, 2006: In the city of Lincoln lightning striking a laundry facility was responsible for $225,000 in property damages.

The following thunderstorm events were reported by participants at the public meetings:

- Jun 21, 1996: In the city of Ashland lightning striking a barn was responsible for $3,000 worth of damage.
- June 20, 1997: In the city of Ashland a severe thunderstorm with high wind occurred that knocked down trees and was reported to cause $50,000 total property damage.
- July 5, 2003: In the city of Ashland a severe thunderstorm with high wind occurred that caused one injury.

- June, 2010: In the city of Weeping Water lightning damaged the water well control.
- September 13, 2010: In the village of Murdock a severe thunderstorm occurred with high winds that broke tree limbs, took power lines down, and caused damage to a few homes and roof of the village hall. As a result, extra labor and machines were needed to haul and grind tress.
- May, 2012: In the village of Union a severe thunderstorm with golf-ball size hail occurred that caused damage to a substantial number of residential roofs and commercial properties.

AVERAGE ANNUAL DAMAGES AND FREQUENCY

Severe thunderstorms occur on an irregular basis with varying magnitudes and can cause a wide range of damage. The damage can range from a few downed tree limbs to wide spread tree loss, hail damage, and significant property damage. The 'damage estimate formula' estimates potential losses for the planning area per year based upon historical data:

SEVERE THUNDERSTORM

$$\textbf{Average Annual Damages } (\$\mathbf{193,258}) = \frac{Total\ Damages\ in\ Dollars\ (\$3{,}285{,}400)}{Total\ Years\ Recorded\ (17)}$$

$$\textbf{Annual Frequency of Hazard Event } (\mathbf{11}\ \boldsymbol{per\ year}) = \frac{Total\ Events\ Recorded\ (179)}{Total\ Years\ of\ Record\ (17)}$$

This does not include loss of displacement, functional downtime, economic loss, injury, or loss of life. It should be noted that the total crop damages were included in the event details to express the magnitude of the event, but were not calculated into the average damage per event estimate, as crop damages would likely not affect the area.

VULNERABILITY ASSESSMENT

Severe thunderstorms and hail occur on an annual basis, and can equally affect the entire planning area. Severe thunderstorms can produce heavy rain, flooding, damaging hail, lightning, and high winds during and after the event. All building stock and infrastructure including CFs, vehicles, power lines, trees, and utilities are at risk of being damaged or affected by severe thunderstorms. According to climate data, May and June have the greatest amounts of rainfall. This coincides with severe thunderstorms and increased tornado activity during these months.

Severe thunderstorms can cause property damage or loss, downed power lines, loss of electricity, obstruction to traffic flow, significant damage to trees, and pose a threat to human life. The electrical infrastructure is highly vulnerable to damages from lightning strikes and downed tree branches, roadways are vulnerable to wash outs and surface damages from flash floods, and building stock and personal property are vulnerable to damages from large hail stones. Severe thunderstorms can also cause significant damage to crops, levees, and dams throughout the rural areas of the planning area.

Vulnerable populations related to severe thunderstorms include the elderly, those living in mobile homes, and those caught outside during storm events. During severe thunderstorms, it is not uncommon for residents/towns to lose power for a temporary or prolonged period of time. These power outages may prove deadly for elderly citizens that are reliant upon machines to remain alive. The elderly are generally less mobile than many other members or the community, making them more vulnerable to a wide range of threats. Mobile homes that are not anchored or are improperly anchored are also at high risk during thunderstorms because they can be turned over by a wind of 60 to 70 mph. Severe thunderstorms are defined by winds in excess of 58 mph.

Lightning is commonly considered the most dangerous and most frequently encountered weather hazard. The most vulnerable groups related to lightning strikes are people located outside during storm events. Vulnerable areas to consider include public parks, campgrounds, swimming pools, and schools with playgrounds.

Future Development and Vulnerability

Building codes can be enhanced so that they require or recommend the use of hail resistant material, tie-downs and ground anchors for mobile homes, and architectural designs that reduce or limit potential for wind-born debris. Existing structures can also incorporate hail resistant products such as concrete roof tiles and siding. CFs should install and utilize surge protectors to ensure continuity of vital services. Power lines can be buried to decrease the chance of prolonged power outage and saferooms can be constructed near vulnerable populations (schools, daycares, mobile home parks, etc.) to increase safety for residents in those areas. Communities can also establish Tree Boards and tree ordinances to ensure urban canopies are safe and healthy, reducing the potential impacts of severe thunderstorms.

Risk Assessment Summary

Overall, the risk and vulnerability assessment shows that thunderstorms are likely to occur several times every year, but do not cause as much property damage as severe winter weather. While NCDC does collect damages from thunderstorms it is likely that some damages may be missed or minor damages go unreported. This hazard can adversely impact various segments of the population.

Mitigation Alternatives

The following bullet points identify some general mitigation strategies that can be used to reduce a community's vulnerability to the threat of severe thunderstorms. Many of these strategies are identified and discussed in greater detail in the FEMA document, *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards*

- Install and maintain surge protection for CFs
- Incentive programs to encourage the use of hail resistant roofing materials for new and existing structures
    - Identified as a mitigation strategy to be implemented by multiple communities
- Bury overhead power lines
    - Many communities have a portion of powerlines buried but there is still a great need across the planning area
- Establish a Tree Board to assist in the development of a tree management program
- Participate in Tree City USA; establish a tree maintenance ordinance
    - Refer to Section 7 for individual communities participation
- Establish redundancies for necessary municipal services (i.e. water, gas, electric, transportation)
    - This varies from jurisdiction to jurisdiction
- Establish data recovery program and backup program for municipal employees
- Establish community severe weather warning protocols
    - Included in the Local Emergency Operations Plans (LEOP)
- Incorporate text messaging into severe weather messaging programs
    - Both County EMAs utilize text alerts
- Incorporate cable TV interruption warning systems
    - Utilized within the communities
- Purchase and issue weather radios to CFs and vulnerable populations
    - This is an ongoing project for many communities
- Establish mutual aide agreements with neighboring communities and privately owned businesses
    - In place for a majority of participants
- Develop business continuity plans for critical community services (public and private)
- Establish public education programs to increase awareness of the dangers posed by severe thunderstorms and ways the public can mitigation the potential impacts
    - County EMAs offer materials related to regional hazards

Hail (Hailstorm)

HAZARD PROFILE

Hail is usually associated with severe thunderstorms. This association makes hail just as unpredictable as a severe thunderstorm. Hail events in thunderstorms differ from many other hazards in that they are generally large in magnitude, have a long duration, and travel large areas and through multiple jurisdictions within a single region. Additionally, hail events in thunderstorms often occur in series, with one area having the potential to be hit multiple times in one day.

Severe thunderstorms in the planning area usually occur in the evening during the spring and summer months. These often massive storms can include heavy rain, hail, lightning, high wind, and can produce tornados with little or no advanced warning. Furthermore, hail can destroy property and crops with their shear force as some hail stones can fall at 100 mph.

While the moisture from the thunderstorms that are associated with hail events can be beneficial. When thunderstorms do produce hail the potential for crop losses, property losses due to building and automobile damages, and personal injury from people not seeking shelter during these events. The potential for damages increases as the size of the hail increases.

EXTENT

The TORRO scale is used throughout the United Kingdom to classify hailstones and provides some detail related to the potential impacts from hail. Table 23 outlines the TORRO Hailstone Scale.

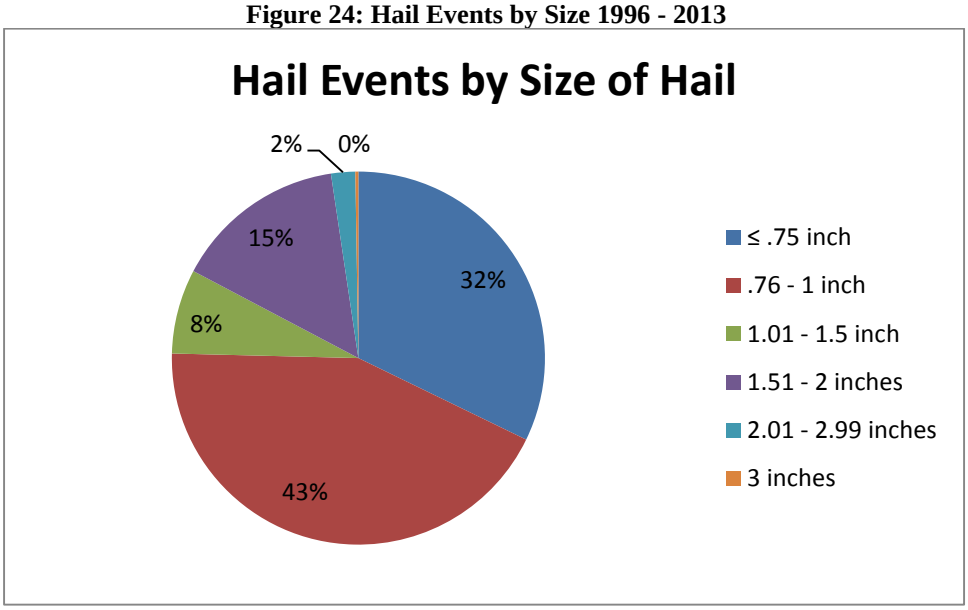
Table 23: TORRO Hailstone Scale

TORRO Classification/Intensity	Typical Hail Diameter	Typical Damage Impacts
H0: Hard Hail	5 mm; Pea size	No damage
H1: Potentially Damaging	5 -15 mm (marble)	Slight general damage to plants and crops
H2: Significant	10 -20 mm (grape)	Significant damage to fruit, crops, and vegetation
H3: Severe	20 -30 mm (Walnut)	Severe damage to fruit and crops, damage to glass and plastic structures
H4: Severe	30 -40 mm (Squash Ball)	Widespread damage to glass, vehicle bodywork damaged
H5: Destructive	40 – 50 mm (Golf ball)	Wholesale destruction of glass, damage to tiled roofs; significant risk or injury
H6: Destructive	50 – 60 mm (chicken egg)	Grounded aircrafts damaged, brick walls pitted; significant risk of injury
H7: Destructive	60 – 75 mm (Tennis ball)	Severe roof damage; risk of serious injuries
H8: Destructive	75 – 90 mm (Large orange)	Severe damage to structures, vehicles, airplanes; risk of serious injuries
H9: Super Hail	90 – 100 mm (Grapefruit)	Extensive structural damage; risk of severe or even fatal injuries to persons outdoors
H10: Super Hail	>100 mm (Melon)	Extensive structural damage; risk or severe or even fatal injuries to persons outdoors

25.4 mm = 1 inch

Hail is another component of severe thunderstorms in Nebraska and the planning area. Of the 340 hail events reported for the planning area the average hailstone size is 1.10 inches. Events of this magnitude correlate to an H3 classification. It is reasonable to expect H3 classified events to occur more than one time per year in the planning area. It is realistic to expect an H7 event to occur approximately one time per year in the planning area. Figure 24 shows the hail events based on the size of the hail.

Figure 24: Hail Events by Size 1996 - 2013



Historical Occurrences

The NCDC reports events as they occur in *each* community. A single hail event can affect multiple communities at a time; the NCDC reports these large scale, multi-community events as separate events. The result is a single hail event covering the entire region could be reported by the NCDC as several events. NCDC cites 340 separate events, but many have to be the same event from different locations (given the fact that there are several on the same day) within LPSNRD from January 1996 to May 2013. No injuries, deaths or damages were reported. This source did not record specific damages for countywide events. The jurisdiction specific events from NCDC and reported by each community were listed in each participant section in *Section Seven: Participant Sections*.

The following hail events were reported as causing injuries, death, or property damage in Cass County:

- July 28, 1996: Thunderstorms producing hail resulted in over 1,000 claims of damages to vehicles and homes in the Plattsmouth area. This event was responsible for $1,000,000 in property damages and $250,000 in crop damages.

The following hail events were reported as causing injuries, death, or property damage in Lancaster County:

- September 2, 1995: In the city of Lincoln hail stones up to 4.5 inches in diameter caused $20,000 in property damage. This same storm resulted in $20,000 in crop damages around the town of Malcolm.
- July 20, 2000: In the village of Firth and the surrounding area a storm producing hail as large as baseballs damaged 148 of 200 houses and business within the town, nearly every north facing window was broken out. This storm was responsible for $2,000,000 in property damages and $1,000,000 in crop damages.

Average Annual Damages and Frequency

Severe thunderstorms occur on an irregular basis with varying magnitudes and can cause a wide range of damage. The damage can range from a few downed tree limbs to wide spread tree loss, hail damage, and significant property damage.

The 'damage estimate formula' estimates potential losses for the planning area per year based upon historical data:

$$\textbf{Average Annual Damages } (\$\mathbf{176,471}) = \frac{Total\ Damages\ in\ Dollars\ (\$3{,}000{,}000)}{Total\ Years\ of\ Record\ (17)}$$

$$\textbf{Annual Frequency of Hazard Event } (\mathbf{22}\ \boldsymbol{per\ year}) = \frac{Total\ Events\ Recorded\ (382)}{Total\ Years\ of\ Record\ (17)}$$

The average damage per event estimate was determined based upon the average damage per event since 1996 and the number of historical occurrences. This does not include loss of displacement, functional downtime, economic loss, injury, or loss of life. It should be noted that the total crop damages were included in the event details to express the magnitude of the event, but were not calculated into the average damage per event estimate, as crop damages would likely not affect the area.

VULNERABILITY ASSESSMENT

Severe thunderstorms and hail occur on an annual basis, and can equally affect the entire planning area. Severe thunderstorms can produce heavy rain, flooding, damaging hail, lightning, and high winds during and after the event. All building stock and infrastructure including critical facilities, vehicles, power lines, trees, and utilities are at risk of being damaged or affected by severe thunderstorms. According to climate data, May and June have the greatest amounts of rainfall. This coincides with severe thunderstorms and increased tornado activity during these months.

Hail is another component of severe thunderstorms that can seriously impact residents of mobile homes. Nebraska is one of the three states that receive the highest number of hail events annually. Hail can damage vehicles, roofs, and landscaping, as well as cause injury and occasionally death.

FUTURE DEVELOPMENT AND VULNERABILITY

Building codes can be enhanced so that they require or recommend the use of hail resistant material. Existing structures can also incorporate hail resistant products such as concrete roof tiles and siding. CFs should install and utilize surge protectors to ensure continuity of vital services. Power lines can be buried to decrease the chance of prolonged power outage and saferooms can be constructed near vulnerable populations (schools, daycares, mobile home parks, etc.) to increase safety for residents in those areas. Communities can also establish Tree Boards and tree ordinances to ensure urban canopies are safe and healthy, reducing the potential impacts of severe thunderstorms.

RISK ASSESSMENT SUMMARY

Overall, the risk and vulnerability assessment shows that H3 hail events are likely annually, but do not cause as much property damage as severe winter weather. While NCDC does collect damages from hail events it is likely that some damages may be missed or minor damages go unreported.

MITIGATION ALTERNATIVES

The following bullet points identify some general mitigation strategies that can be used to reduce a community's vulnerability to the threat of severe thunderstorms. Many of these strategies are identified and discussed in greater detail in the FEMA document, *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards*

- Install and maintain surge protection for CFs
- Incentive programs to encourage the use of hail resistant roofing materials for new and existing structures
    - Identified as a mitigation strategy to be implemented by multiple communities
- Bury overhead power lines
    - Many communities have a portion of powerlines buried but there is still a great need across the planning area
- Establish a Tree Board to assist in the development of a tree management program
- Participate in Tree City USA; establish a tree maintenance ordinance
    - Refer to Section 7 for individual communities participation
- Establish redundancies for necessary municipal services (i.e. water, gas, electric, transportation)
    - This varies from jurisdiction to jurisdiction

- Establish data recovery program and backup program for municipal employees
- Establish community severe weather warning protocols
    - Included in the Local Emergency Operations Plans (LEOP)
- Incorporate text messaging into severe weather messaging programs
    - Both County EMAs utilize text alerts
- Incorporate cable TV interruption warning systems
    - Utilized within the communities
- Purchase and issue weather radios to CFs and vulnerable populations
    - This is an ongoing project for many communities
- Establish mutual aide agreements with neighboring communities and privately owned businesses
    - In place for a majority of participants
- Develop business continuity plans for critical community services (public and private)
- Establish public education programs to increase awareness of the dangers posed by severe thunderstorms and ways the public can mitigation the potential impacts
    - County EMAs offer materials related to regional hazards

Flooding (Riverine and Flash)

HAZARD PROFILE

Flood events are the most damaging and costly hazards in the United States, and account for 90% of all presidential disaster declarations. Flooding can occur on a local level, sometimes affecting only a few streets, but can also extend throughout an entire district, affecting whole drainage basins and impacting property in multiple states. The principal type of flood most common to Nebraska, due to geographic location and topography, is riverine floods.

Riverine floods, slower in nature, occur when water from sustained rainfall or rapid snow melt overflows a waterway once the volume of water exceeds the capacity of the waterway. Flash floods, faster in nature, result from convective precipitation usually due to intense thunderstorms or sudden release from an upstream impoundment created behind a dam, landslide, or levee. Flash floods are distinguished from a regular flood by a timescale less than six hours. Flooding from excessive rainfall in Nebraska usually occurs between late spring and early fall.

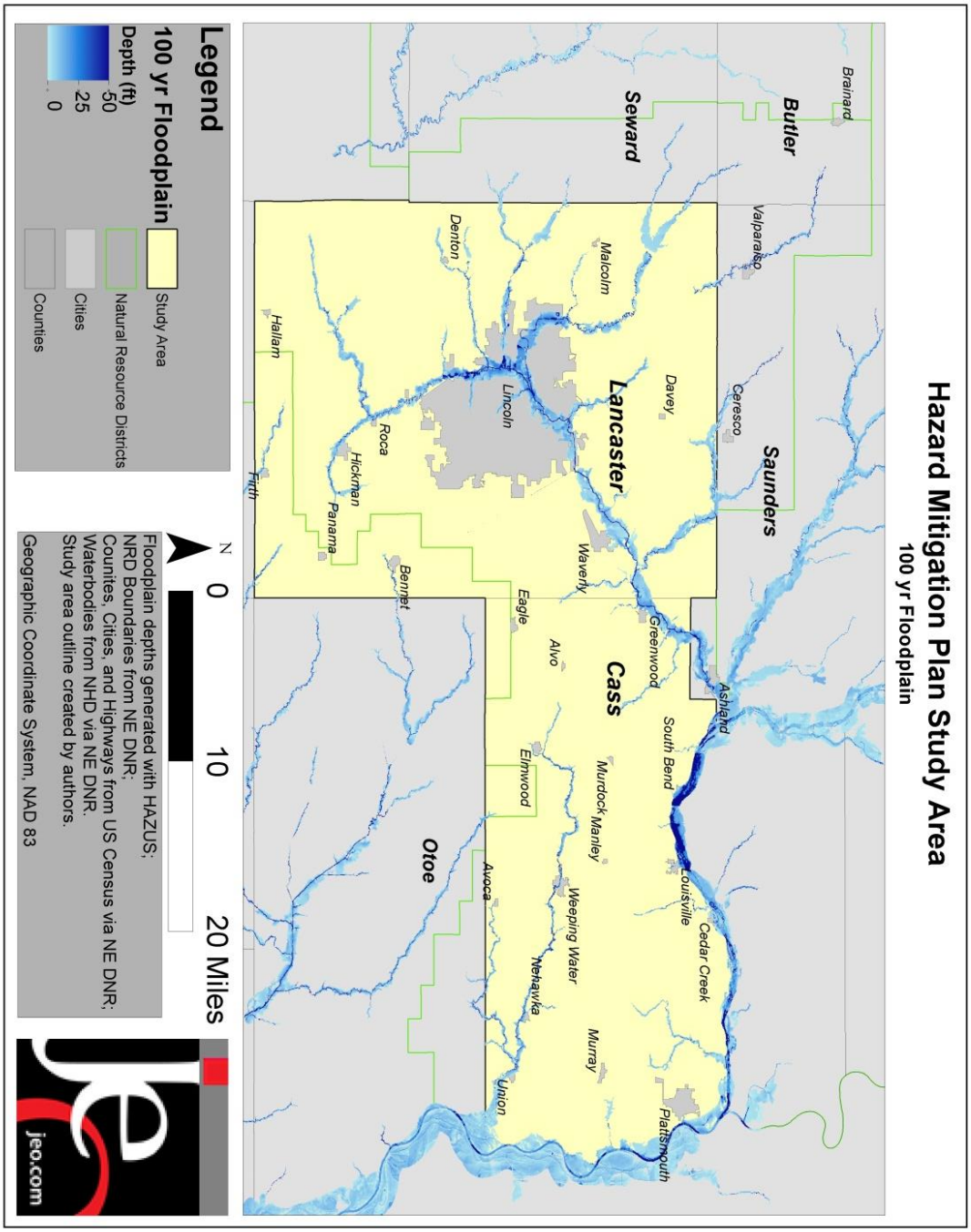
Flooding is most commonly caused by excessive rainfall or snowmelt, but unexpected drainage obstructions such as landslides, ice, or debris can cause slow flooding upstream of the obstruction. Ice jams can cause flooding when a warm snap breaks up river ice, which flows downstream, and piles up against bridges or other waterway obstructions, causing a temporary dam in the waterway with water backing up behind it. When an ice jam breaks, all of the backed-up water is suddenly released, causing a rush of water downstream which can rapidly exceed the capacity of waterways and cause severe flash flooding. Ice jams are common throughout Nebraska during the transition between winter and spring.

Flash floods are rapid flooding of geomorphic low-lying areas, when the ground becomes saturated with water that has fallen too quickly to be absorbed. They are usually caused by heavy rains associated with a severe thunderstorm. Flash floods can also occur after the collapse of an ice jam, or a man-made structure, such as a dam or levee. Flash floods most often occur in normally dry areas that have recently received precipitation. Flash floods are extremely dangerous because of their sudden nature.

At the time of the plan, all incorporated jurisdictions had a delineated 1% annual floodplain.

Jurisdictions with a delineated 1% annual floodplain, generally due to the presence and close proximity of a significant floodway, are more vulnerable to riverine and flash flooding. The potential for localized low-land flooding, especially flash floods with heavy rains, for properties in or near low-lying areas as well as areas where drainage is inadequate is still present for rural areas of the County without a delineated 1%-annual floodplain.

Figure 25: LPSNRD 1% Annual Floodplain Coverage



EXTENT

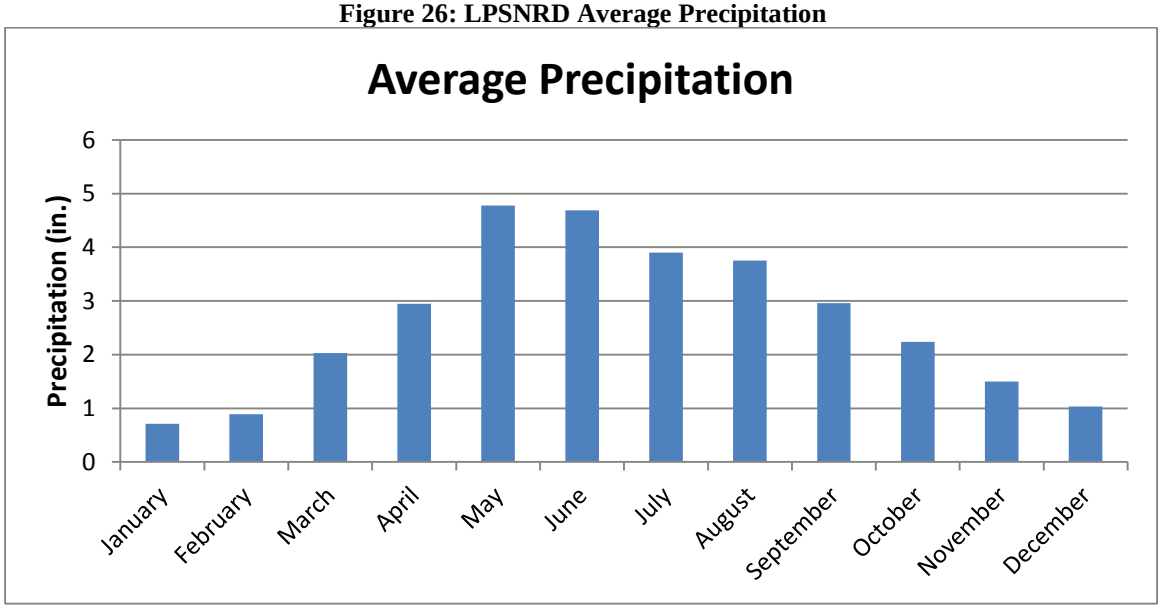
The NWS has three categories to define the severity of a flood once a river reaches flood stage.

Table 24: Flood Definitions

Minor Flooding	Minimal or no property damage, but possible some public threat or inconvenience
Moderate Flooding	Some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary
Major Flooding	Extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations

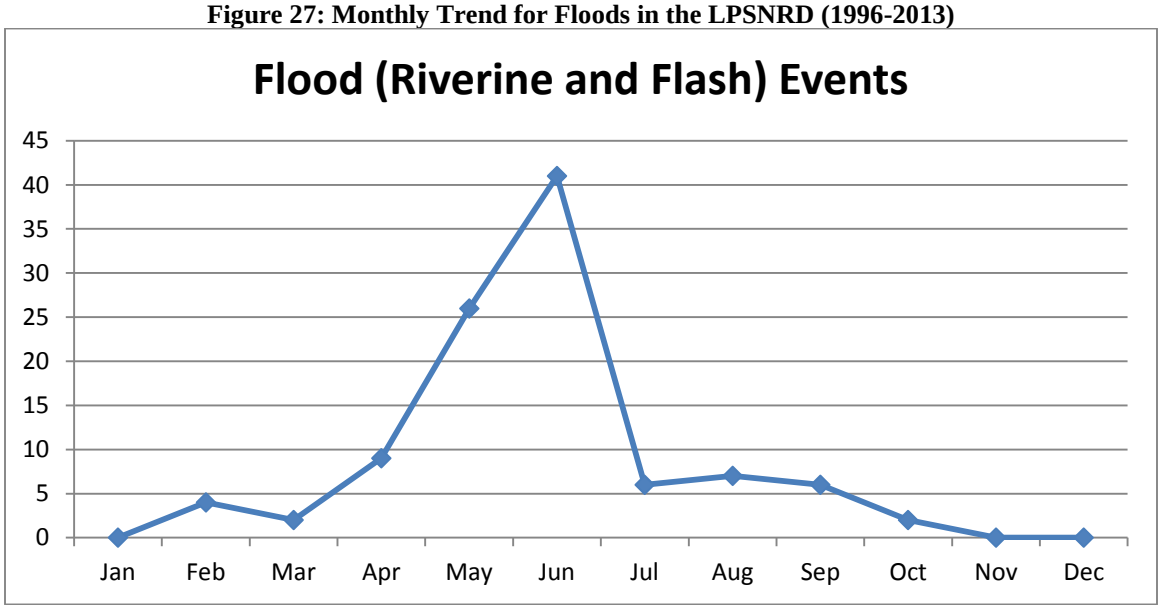
Source: NWS

Figure 26: LPSNRD Average Precipitation



Source: The Weather Channel (weather.com)

Figure 27: Monthly Trend for Floods in the LPSNRD (1996-2013)



Source: NOAA

Based on the historic record it is likely that any flooding that does occur will be minor. The most common months for flooding within the planning area are May and June. These months also happen to be when the planning area gets most of its precipitation.

NFIP

The NFIP was established in 1968 to reduce flood losses and disaster relief costs by guiding future development away from flood hazard areas where feasible by requiring flood resistant design and construction practices and by transferring the costs of flood losses to the residents of floodplains through flood insurance premiums.

In return for availability of federally backed flood insurance, jurisdictions applying to join the NFIP must agree to adopt and enforce minimum flood loss reduction standards to regulate proposed development in SFHA as defined by the FEMA flood maps. One of the strengths of the program has been keeping people away from

flooding rather than keeping the flooding away from people - through historically expensive flood control projects.

The NFIP has approximately 4.4 million policies in force, representing over $370 billion worth of coverage, in 19,884 participating jurisdictions nationwide. Ninety-five percent of flood insurance policies are written by private companies and sold by more than 110,000 insurance agents and brokers participating in the NFIP's Write Your Own (WYO) program. Since 1969, over $12.1 billion in claims have been paid.

Currently, Nebraska has 13,300 policies in force representing $1.3 billion worth of coverage. The planning area has 2,817 policies in force totaling $529,917,700 worth of coverage. Tables 25 and 26 summarize NFIP participation and active policies within the planning area.

Table 25: NFIP Status - December 2012

Jurisdiction	Eligible-Regular Program	Date Current Map	CRS	Sanction	Suspension	Rescinded	Participation in NFIP
Alvo		11/26/2010					No
Ashland	11/03/1982	04/05/2010					Yes
Avoca	08/03/1979	11/26/2010					Yes
Bennet	03/02/1981	04/16/2013					Yes
Brainard		08/16/2011					No
Cass County RWD #1	NA	(see Cass County)					
Cass County RWD #2	NA	(see Cass County)					
Cass County SID #6 (Lake WaConDa)	NA	(see Cass County)					
Cedar Creek	09/15/1978	11/26/2010	In Progress				Yes
Ceresco	07/03/1986	04/05/2010 04/16/2013					Yes
Davey		04/16/2013					No
Denton	09/21/2001	04/16/2013					Yes
Eagle	8/26/1977	11/26/2010				8/26/1977	Yes
Elmwood		11/26/2010					No
Firth	04/15/1981	04/16/2013					Yes
Greenwood	06/03/1980	11/26/2010					Yes
Hallam		04/16/2013					No
Hickman	02/03/1982	04/16/2013					Yes
Lancaster County SID #6 (Emerald)	NA	(see Lancaster County)					
Lancaster County RWD #1	NA	(see Lancaster County)					
Lincoln	04/23/1971	04/16/2013	Yes				Yes
Louisville	03/04/1980	11/26/2010	In Progress				Yes

Jurisdiction	Eligible-Regular Program	Date Current Map	CRS	Sanction	Suspension	Rescinded	Participation in NFIP
LPSNRD	NA	(See Counties)					
Malcolm	03/30/2009	04/16/2013					Yes
Manley		11/26/2010					No
Murdock		11/26/2010					Yes
Murray	01/05/1978	11/26/2010					Yes
Nehawka	02/15/1978	11/26/2010					Yes
Panama		04/16/2013					No
Plattsmouth	03/01/1978	11/26/2010					Yes
Raymond	04/18/1985	04/16/2013					Yes
Roca		04/16/2013				09/30/1998	No
South Bend	07/20/1984	11/26/2010					Yes
Sprague	09/21/2001	04/16/2013					Yes
Union	04/03/1978	11/26/2010					Yes
Valparaiso	06/03/1986	04/05/2010					Yes
Waverly	04/15/1982	04/16/2013					Yes
Weeping Water	12/01/1977	11/26/2010					Yes
Cass County	09/02/1982	11/26/2010	In Progress				Yes
Lancaster County	02/03/1982	02/18/2011					Yes

Source: NDNR, *NFIP*

Table 26: NFIP Policies - December 2012

Jurisdiction	Policies In-Force	Insurance In-Force Whole	Written Premium In-Force
Alvo	N/P	N/P	N/P
Ashland	15	$3,313,300	$10,617
Avoca	0	0	0
Bennet	4	$933,300	$3,762
Brainard	N/P	N/P	N/P
Cass County RWD #1	N/A	N/A	N/A
Cass County RWD #2	N/A	N/A	N/A
Cass County SID #6 (Lake WaConDa)	N/A	N/A	N/A
Cedar Creek	143	$20,065,300	$141,341
Ceresco	0	0	0
Davey	N/P	N/P	N/P
Denton	0	0	0
Eagle	0	0	0

Jurisdiction	Policies In-Force	Insurance In-Force Whole	Written Premium In-Force
Elmwood	N/P	N/P	N/P
Firth	3	$237,700	$623
Greenwood	0	0	0
Hallam	N/P	N/P	N/P
Hickman	30	$3,402,800	$28,402
Lancaster County SID #6 (Emerald)	N/A	N/A	N/A
Lancaster County RWD #1	N/A	N/A	N/A
Lincoln	1,931	$353,281,300	$1,778,987
Louisville	43	$6,103,900	$30,275
Malcolm	3	$577,000	$1,741
Manley	N/P	N/P	N/P
Murdock	N/P	N/P	N/P
Murray	0	0	0
Nehawka	13	$1,249,200	$11,172
Panama	N/P	N/P	N/P
Plattsmouth	63	$10,818,900	$56,793
Raymond	2	$73,000	$431
Roca	N/P	N/P	N/P
South Bend	23	$3,774,500	$12,412
Sprague	3	$212,000	$2,130
Union	1	$280,000	$343
Valparaiso	1	$140,000	$1,331
Waverly	110	$29,796,100	$85,111
Weeping Water	13	$2,255,500	$11,686
Cass County	374	$81,724,600	$219,341
Lancaster County	42	$6,676,300	$33,555
LPSNRD	2,817	$529,917,700	$2,430,194

N/P: Non-Participant; N/A: Not Applicable.
Source: NDNR, NFIP

This plan highly recommends and strongly encourages each plan participant to remain in good standing and continue involvement with the NFIP. Compliance with the NFIP should remain a top priority for each participant. Jurisdictions are encouraged to initiate activities above the minimum participation requirements, which are described in the CRS Coordinator's Manual (FIA-15/2013).

Another innovative program is FEMA's Cooperating Technical Partners Program (CTP). The main objective of CTP is to increase local involvement in the flood mapping process. With over 20,000 jurisdictions in the NFIP, the CTP encourages collaboration with NFIP jurisdictions and regional and state agencies who wish to become more active participants in the FEMA flood hazard mapping program.

In order to qualify for HMA, plan participants must have a good standing in NFIP if the project is located in a Flood Hazard Risk Area. Contact the NDNR for any questions regarding NFIP.

NFIP Repetitive Loss Structures

The NDNR was contacted to determine if any existing buildings, infrastructure, or CFs are classified as NFIP Repetitive Loss Structures. According to the NDNR, the planning area has 39 Single Family and 5 Non-residential NFIP Repetitive Loss Structures (as of January 2014).

Table 27: Repetitive Loss Properties

Community	Single Family	Non-residential
Ashland	2	1
Cass County	21	2
Cedar Creek	6	0
Lancaster County	1	0
Lincoln	1	1
Louisville	2	0
Nehawka	4	1
Weeping Water	2	0
Total	**39**	**5**

Average Annual Damages and Frequency

Flooding can occur on an irregular basis with varying magnitudes and can cause a wide range of damage. However, based on the historic record it is likely that any flooding that does occur will be minor.

The 'damage estimate formula' estimates potential losses for the planning area per year based upon historical data:

$$\textbf{Average Annual Damages } (\$\mathbf{196,882}) = \frac{Total\ Damages\ in\ Dollars\ (\$3{,}347{,}000)}{Total\ Years\ of\ Record\ (17)}$$

$$\textbf{Annual Frequency of Hazard Event } (\mathbf{3}\ \boldsymbol{per\ year}) = \frac{Total\ Events\ Recorded\ (59)}{Total\ Years\ of\ Record\ (17)}$$

Historical Occurrences

The NCDC reports 59 flooding events from 1996 to 2013. Of these 59 events 38 are flash flooding and 21 are riverine flooding. According to the NCDC flash flooding resulted in $3,347,000 in property damages and $55,000 in crop damage. Riverine flooding caused $1,830,000 in property damages and no crop damages.

No additional historical occurrences or records of damages from flooding were discovered after discussion with the planning team, and residents. The events below were significant in loss of life, injuries, or the amount of damages.

- June 21, 2010: In the village of Avoca the creek flooded and water was standing on the streets. The flooding caused damage to the Village Wastewater Plant, bridges, parks, and some residential buildings.
- September, 2010: In the city of Weeping Water the campgrounds and its amenities and park facilities flooded.
- 2011: Missouri river flooding.
- June/July, 2011: Flooding along the Missouri and Platte Rivers caused property damage to residents on lots in Buccaneer Bay along the Platte River and Four Mile Creek. No damage was caused to the water and wastewater infrastructure, though a number of preventative steps were required, such as plugs in manhole covers.

- June 4, 2013: In the city of Hickman large flood that filled basements and impacted the first floor of structures in the floodplain. It also largely impacted the city of Hickman Main Park.
- May 29, 2013: In the village of Ceresco a flooding event occurred that flooded the bridges and highways and disturbed traffic for several hours.

HAZUS 1% FLOOD ANALYSIS

A HAZUS-MH 1% flood scenario was created for the planning area. This scenario was run utilizing the data included within the HAZUS software, much of which is from the 2000 Census. This data also includes buildings, but that data is not as current or complete as local assessor data. It should be noted that the scenario below is limited by the quality of the base data utilized. The information from the HAZUS-MH assessment for the area is summarized below.

Table 28: Building Damage by Percent Damages in Thousands of Square Feet

County	Degree of Damage							Total Damaged
	None	1-10%	11-20%	21-30%	31-40%	41-50%	Substantial	
Cass	524.06	12.05	90.11	82.96	124.55	184.68	394.28	888.63
Lancaster	2848.71	690.51	2527.34	1631.71	1669.75	1511.75	1589.07	9620.13

Table 29: Building Damage by Occupancy in Thousands of Square Feet

County	Agricultural		Commercial		Government		Industrial		Residential		All		Percent Substantial	Percent of Total
	Sub.	Total	Sub.	Total	Sub.	Total	Sub.	Total	Sub.	Total	Sub.	Total		
Cass	1.2	11.1	18.4	117.2	0.2	4.4	6.5	29.7	367.6	713.6	394.3	888.7	27.9%	62.9%
Lancaster	9.9	67.0	233.3	3176.3	7.7	147.4	308.5	1848.3	1019.6	6636.4	1589.1	12468.8	12.7%	77.2%

Table 30: Building Damage by Percent Damages in Numbers of Buildings

County	Degree of Damage							Total Damaged
	None	1-10%	11-20%	21-30%	31-40%	41-50%	Substantial	
Cass	254	0	3	10	18	54	150	235
Lancaster	814	4	50	87	238	388	470	1237

Table 31: Building Damage by Occupancy Category in Numbers of Buildings

County	Residential		All		% Substantial	% of Total
	Substantial	Total	Substantial	Total		
Cass	150	235	150	235	30.6	47.9
Lancaster	471	1206	473	1264	23.3	60.1

Table 32: Direct Economic Losses from Buildings in Thousands of Dollars

County	Capital Stock Losses			Income Loss				Total Loss	% of Total
	Cost Structural Damage	Cost Contents Damage	Inventory Loss	Relocation Loss	Capital Related Loss	Wages Loss	Rental Income Loss		
Cass	37,714	28,268	700	52	21	39	11	66,805	9.9
Lancaster	260,583	406,914	29288	439	917	2220	229	700,590	10.3

Table 33: Shelter Requirements

County	Number of Displaced People	Number of People Needing Short Term Shelter
Cass	1,291	611
Lancaster	14,763	12,514

SUPPLEMENTAL ANALYSIS

As the tables above illustrate, a 1% annual flood has the potential to cause significant amounts of damage within the planning area. These damages include: economic impacts of around 10% of capital stock and income; the need to shelter almost 17,000 individuals; substantial damage to just below 1/3 of all buildings; and minor damages to many more buildings.

VULNERABILITY ASSESSMENT

A 2008 study examining social vulnerability as it relates to flood events found that low-income and minority populations are disproportionately vulnerable to flood events. These groups may lack resources that are needed to mitigate potential flood events as well as resources that are necessary for evacuation and response. In addition, low income residents are more likely to live in areas vulnerable to the threat of flooding, but lack the resources necessary to purchase flood insurance. The study did find that flash floods are more often responsible for injuries and fatalities than prolonged flood events. Other groups that may be more vulnerable to floods, specifically flash floods, include the elderly, those outdoors during rain events, and those in low-lying areas. Elderly residents may suffer from a decrease or complete lack of mobility and as a result, be caught in flood-prone areas. Residents in campgrounds or public parks may be more vulnerable to flooding events as many of these areas exist in natural floodplains and can experience rapid rise in water levels resulting in injury or death.

FUTURE DEVELOPMENT AND VULNERABILITY

Land-use regulations should be used to limit development in floodplains and other flood prone areas as well as protecting natural flood mitigation features. Buyout programs can be used to eliminate properties located in floodplains, especially properties that have experienced repetitive losses. Communities may also consider incorporating "Green Infrastructure" to address flooding concerns, examples of this would include using permeable surfaces for parking areas, using rainwater retention swales, developing rain gardens, developing green roofs, and establishing greenways. The city of Lincoln has four buildings that have installed green roofs. Three of the buildings are located in the downtown part of the city and help to reduce the runoff, while the fourth building is located at Pioneers Park in the southwest part of the city. The city, University of Nebraska-Lincoln, and LPSNRD completed the Antelope Valley project to remove 1,000 structures from the 1% annual floodplain and add green space. Building codes can be enhanced to require tie-down straps for propane tanks while existing structures can be retrofitted to withstand potential flood events elevating structures and utilities.

RISK ASSESSMENT SUMMARY

Overall, the risk and vulnerability assessment shows that flooding is likely to occur annually and could have moderate impacts. Although there is not a great history of flooding, the number of parcels and CFs located in A and AE zones creates the potential for greater impacts in the future. The HAZUS scenario did not indicate catastrophic losses, but the area has experienced growth since 2000, the year on which the HAZUS data is based. Although this hazard is less of a concern to the local planning team than most other natural hazards, it would appear to pose a greater threat than a hazard such as wildfire.

MITIGATION ALTERNATIVES

The following bullet points identify some general mitigation strategies that can be used to reduce a community's vulnerability to the threat of flooding. Many of these strategies are identified and discussed in greater detail in the FEMA document, *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards*.

- Limit or restrict development in flood-prone areas
    - Most communities with floodplain areas have limited development in those areas and more severely restricted development within the floodway
- Preserve natural open spaces in floodplains
    - Many communities identified this as an ongoing project
- Incorporate permeable surfaces and other "green infrastructure" components into municipal designs; establish a "green infrastructure" program
- Enhanced building codes (i.e. require tie-downs for propane tanks and other gas and chemical storage containers; require water detention swales and retention ponds for new construction)
    - This is not standard within the planning area
- Revise and update floodplain maps
    - NDNR works with many communities in this effort
- Manage the Floodplain Beyond Minimum Requirements (i.e. adopting a "no-rise" in base elevation clause for the flood damage prevention ordinance)
    - The minimum standard for Nebraska requires all new construction to be build one foot above base flood elevation (BFE) or a one foot free board
- Participate in the NFIP
    - See list provided
- Encourage property owners in areas protected by dams and levees to purchase flood insurance
- Participate in the NFIP's CRS
    - City of Lincoln is currently a Level 6 community; Cass County, Cedar Creek , and Louisville are currently in the process of joining the CRS program
- Remove existing structures from flood-prone areas
    - This is an ongoing process for communities with structures in the floodplain
- Elevate or retrofit structures and utilities
- Incorporate ice jam prevention techniques into mitigation strategies and projects
- Develop incentives for structural floodproofing
    - This is not standard within the planning area
- Consider erosion control and bank stabilization programs for CFs
- Retain natural vegetative beds in stormwater channels
- Incorporate flood mitigation programs into comprehensive plans
    - Many comprehensive plan in the planning area identify the floodplain and outline growth objective related to the area
- Construct flood control measures
    - This is applicable for a small number of communities
- Evaluate and update municipal storm water systems
    - Identified as a mitigation project by many communities within the planning area
- Develop flood response plans for the community (incorporating information about pet and agricultural animal considerations)
    - County LEOPS address this area
- Establish education programs to educate the public about the risks of flooding and ways to protect their families and property
    - County EMAs offer materials related to regional hazards

Extreme Heat

HAZARD PROFILE

Extreme heat is often associated with periods of drought, but can also be characterized by long periods of high temperatures in combination with high humidity. During these conditions, the human body has difficulties cooling through the normal method of the evaporation of perspiration. Health risks arise when a person is overexposed to heat. Extreme heat can also cause people to overuse air conditioners, which can lead to power failures. For the planning area, the months with the highest temperatures are May, June, July, August, and September. The NWS is responsible for issuing excessive heat outlooks, excessive heat watches, and excessive heat warnings. Excessive heat outlooks are issued when potential exists for an excessive heat event in the next 3 to 7 days. Excessive heat outlooks can be utilized by public utility staffs, emergency managers, and public health officials to plan for extreme heat events. Excessive heat watches are issued when conditions are favorable for an excessive heat event in the next 24 to 72 hours. An excessive heat watch should provide local officials and residents in the area enough time to take appropriate actions to mitigate the effects of extreme heat. Finally, excessive heat warnings are issued when an excessive heat event is expected in the next 36 hours. Excessive heat warnings are issued when an extreme heat event is occurring, is imminent, or has a very high probability of occurring.

EXTENT

Another factor in extreme heat situations is the humidity level relative to the temperature. As is indicated in Figure 28, as the Relative Humidity increases, the temperature needed to cause a dangerous situation decreases. For example, for 100% Relative Humidity dangerous levels of heat begin at 86°F where as a Relative Humidity of 50%, requires 94°F. The combination of Relative Humidity and Temperature result in a Heat Index: 100% Relative Humidity + 86°F = 112° Heat Index.

Figure 28: NOAA Heat Index

NOAA's National Weather Service

Heat Index

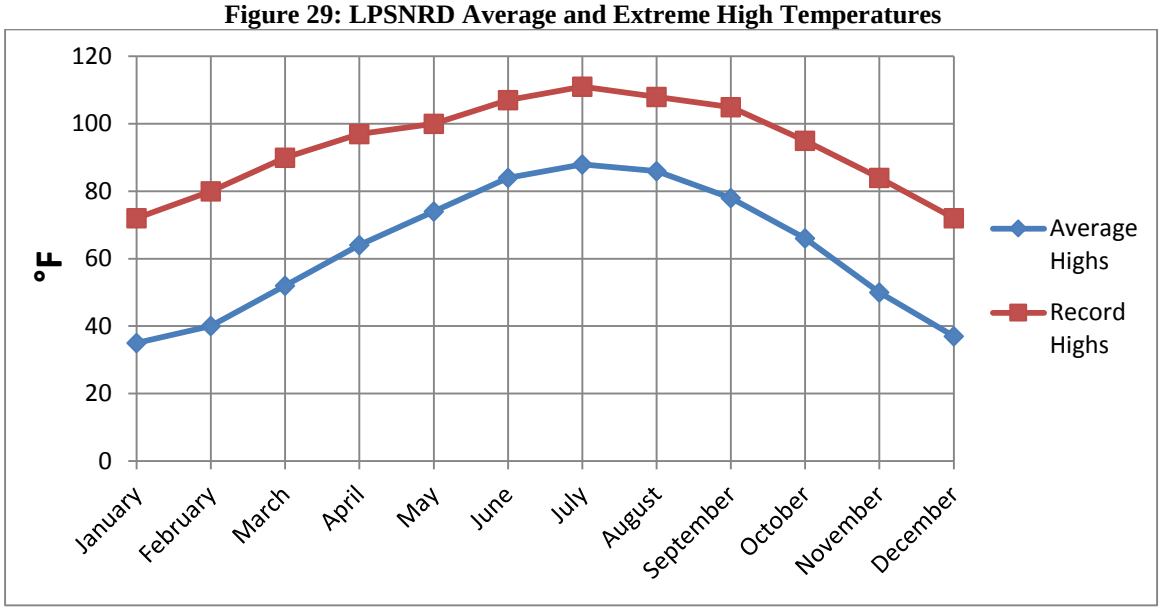
Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

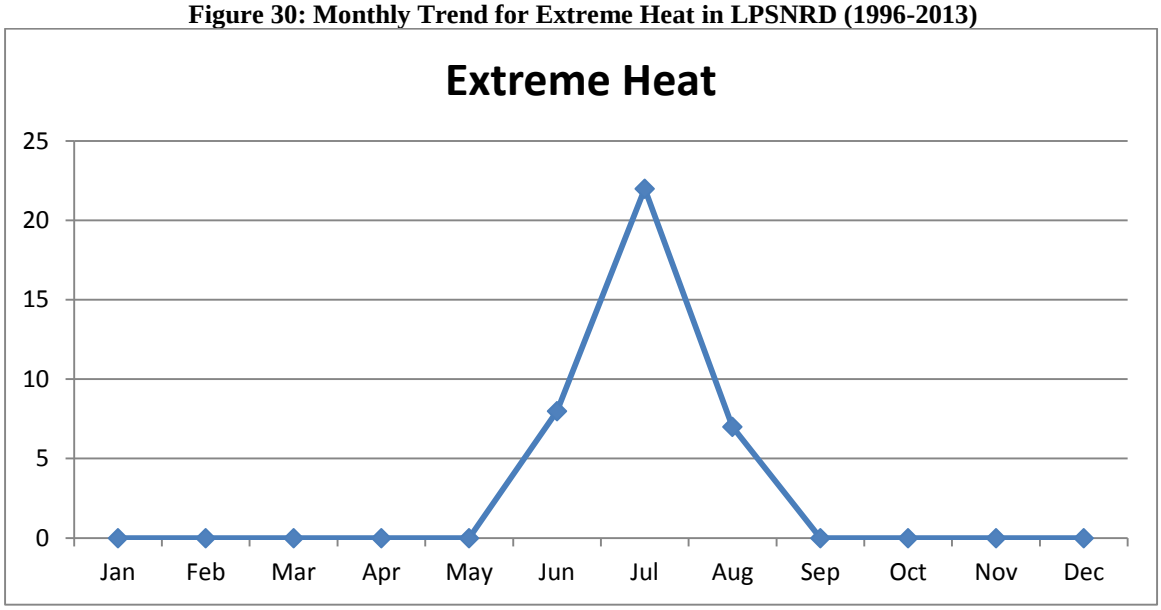
Caution | Extreme Caution | Danger | Extreme Danger

Figure 29: LPSNRD Average and Extreme High Temperatures



Source: The Weather Channel (weather.com)

Figure 30: Monthly Trend for Extreme Heat in LPSNRD (1996-2013)



Source: NOAA

Extreme heat events will be most likely to occur in June, July, and August, when temperatures reach their maximum each year. The real danger with extreme heat is not the day time temperature, but the night time temperatures not falling and remaining humid throughout the night.

Historical Occurrences

While there are no events with death, injuries, or losses reported by the NCDC, the High Plains Regional Climate Center reports approximately 41 days annually where temperatures greater than 90°F occur in the planning area. An extreme heat and drought event from the summer of 2012 was substantial, but did not warrant a presidential disaster declaration within Nebraska. The full effects of this event are still being assessed, and any future update should include details about its true extent.

AVERAGE ANNUAL DAMAGES AND FREQUENCY

The direct and indirect effects of extreme heat are difficult to quantify. There is no way to place a value on the loss of human life. Potential losses such as power outages could affect businesses, homes, and CFs. High demand and intense use of air conditioning can overload the electrical systems and cause damages to infrastructure.

Due to the limited reports of historical occurrences with recorded damages, it is not feasible to utilize the 'event damage estimate formula' to estimate potential losses for the planning area.

According to the FEMA publication "*What is a Benefit: Guidance on Benefit-Cost Analysis of Hazard Mitigation Project (June 2009)*", if an extreme heat event occurred within the planning area, the table below assumes the event could potentially cause a loss of electricity for 10% of the population at a cost of $126 per person per day. In rural areas, the percent of the population affected and duration may increase during extreme events. The assumed damages do not take into account physical damages to utility equipment and infrastructure.

Table 34: Loss of Electricity - Assumed Damage by Jurisdiction

Jurisdiction	2010 Population	Population Affected (Assumed)	Electric Loss of Use Assumed Damage
Alvo	132	13	$1,663
Ashland	2,453	245	$30,908
Avoca	242	24	$3,049
Bennet	719	72	$9,059
Brainard	330	33	$4,158
Cedar Creek	390	39	$4,914
Ceresco	889	89	$11,201
Davey	154	15	$1,940
Denton	190	19	$2,394
Eagle	1,024	102	$12,902
Elmwood	634	63	$7,988
Firth	590	59	$7,434
Greenwood	568	57	$7,157
Hallam	213	21	$2,684
Hickman	1,657	166	$20,878
Lincoln	258,379	25838	$3,255,575
Louisville	1,106	111	$13,936
Malcolm	382	38	$4,813
Manley	178	18	$2,243
Murdock	236	24	$2,974
Murray	463	46	$5,834
Nehawka	204	20	$2,570
Panama	256	26	$3,226
Plattsmouth	6,502	650	$81,925
Raymond	167	17	$2,104
Roca	220	22	$2,772
South Bend	99	10	$1,247

Jurisdiction	2010 Population	Population Affected (Assumed)	Electric Loss of Use Assumed Damage
Sprague	142	14	$1,789
Union	233	23	$2,936
Valparaiso	570	57	$7,182
Waverly	3,277	328	$41,290
Weeping Water	1,050	105	$13,230
Cass County	25,241	2524	$318,037
Lancaster County	285,407	28541	$3,596,128
LPSNRD	**594,297**	**59430**	**$7,488,142**

Source: FEMA

VULNERABILITY ASSESSMENT

The months of July and August are when most extreme heat events occur. These months also have lower amounts of precipitation, thus increasing the possibility for a drought event. Periods of high temperatures can make people vulnerable to heatstroke, heat cramps, heat exhaustion, and pose a threat to human life. Most at risk are young children, elderly, and those working and living in non-air-conditioned environments. Building stock, such as CFs, are not at risk, however periods of extreme heat place a significant demand on utilities, such as water and electricity that can cause a failure in the system. Power loss could occur with the high demand on energy, making an extreme heat event even more dangerous.

The agricultural economy, especially livestock, is highly vulnerable and at great risk during periods of extreme heat. Heat stress in feedlot cattle can cause reduced performance, and in the most severe cases, death of the animals, resulting in millions of dollars in losses to the cattle industry. According to the 2013 American Community Survey five-year estimates, agriculture represents 1.4% of the planning area's workforce.

All segments of the population are vulnerable to the effects of extreme heat, some specific groups have higher levels of vulnerability to extreme heat include the elderly (65 years and older), residents of nursing homes or care facilities, children, those isolated from social interactions, and low-income groups. Elderly residents and people living in nursing homes and care facilities have less tolerance for temperature extremes and can quickly feel the effects of extreme temperatures. Low-income elderly in urban areas are especially at risk from extreme temperatures. Young children under the age of 5 are highly susceptible to the effects of extreme heat. Young children have a smaller body mass to surface ratio making them more vulnerable to heat-related morbidity and mortality. Children also become dehydrated more quickly than adults making for greater concern. Low-income people and families may lack resources that mitigate the impacts of extreme heat such as air conditioning.

FUTURE DEVELOPMENT AND VULNERABILITY

Communities will always have some level of vulnerability related to extreme heat events. Any future development and future residents in the planning are will be vulnerable to the affects and losses sustained from extreme heat, especially the agricultural economy. The total losses that could occur in the future would increase as the population of the City increases. The education of the population is the best way to mitigate for extreme heat. There are few large scale "hard" projects that can be undertaken, but explaining policies and best practices can go a long way in dealing with this hazard. It is especially advisable to educate vulnerable populations. Elderly residents are often in the greatest danger when it comes to extreme heat. Children are also more vulnerable to extreme temperatures.

Communities can incorporate some strategies to reduce these impacts including: cool roofing materials, planting trees and vegetation, incorporating green roofs into urban design, and using cool pavements. Cool roof products are made of highly reflective and emissive materials that can remain approximately 50 - 60°f cooler than traditional roofing materials during peak summer heat. Trees, shrubs, grass, and ground covers help cool urban environments by providing shade as well as increasing evapotranspiration resulting in cooler temperatures. A green roof is a vegetative layer grown on a rooftop which helps to remove heat from the air through evapotranspiration. Cool pavements are designed to reduce solar energy absorption as well as reducing thermal emittance.

Risk Assessment Summary

Overall, the risk and vulnerability assessment shows that extreme heat has had limited damages and injuries, but has a disproportionate impact on vulnerable populations. The impacts of this hazard are difficult to quantify, but still sufficient to make this a moderately concerning hazard for the planning area.

Mitigation Alternatives

The following bullet points identify some general mitigation strategies that can be used to reduce a community's vulnerability to the threat of extreme heat. Some of these strategies, such as the use of warning systems, are already in place in the planning area. Many of these strategies are identified and discussed in greater detail in the FEMA document, *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards*.

- Reduce Urban Heat Island Effect (i.e., using cool roofing products that reflect sunlight and heat away from buildings)
    - This is not a concern for most of the planning area
- Increase Awareness of Extreme Heat Risk and Safety (i.e., educating citizens regarding the dangers of extreme heat and the steps they can take to protect themselves)
    - County EMAs offer materials related to regional hazards
- Assist Vulnerable Populations (i.e., creating a database to track those individuals at high risk such as the elderly)
    - Most communities in the planning area have identified this as an alternative, but have not started this
- Identify Existing Community Shelters/Centers

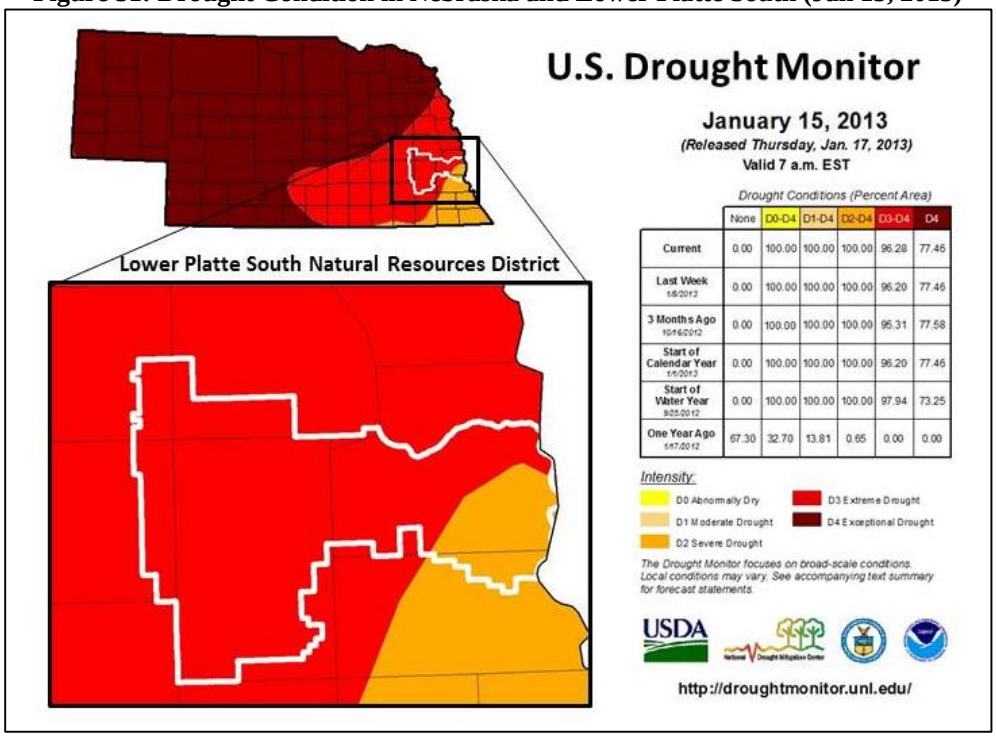
Drought

HAZARD PROFILE

Drought is generally defined as a natural hazard that results from a substantial period with lack of precipitation causing a serious hydrological imbalance. Although many consider it a rare and random event, drought is actually a normal, recurrent feature of climate. It occurs in virtually all climatic zones, but its characteristics vary significantly from one region to another. A drought often coexists with periods of extreme heat, which together can cause significant social stress, economic losses, and environmental degradation.

> *According to the NDMC, "**drought** is a normal, recurrent feature of climate, although many erroneously consider it a rare and random event. It occurs in virtually all climatic zones, but its characteristics vary significantly from one region to another."*

Figure 31: Drought Condition in Nebraska and Lower Platte South (Jan 15, 2013)



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	100.00	96.28	77.46
Last Week 1/8/2013	0.00	100.00	100.00	100.00	96.20	77.46
3 Months Ago 10/16/2012	0.00	100.00	100.00	100.00	95.31	77.58
Start of Calendar Year 1/1/2013	0.00	100.00	100.00	100.00	96.20	77.46
Start of Water Year 9/25/2012	0.00	100.00	100.00	100.00	97.94	73.25
One Year Ago 1/17/2012	67.30	32.70	13.81	0.65	0.00	0.00

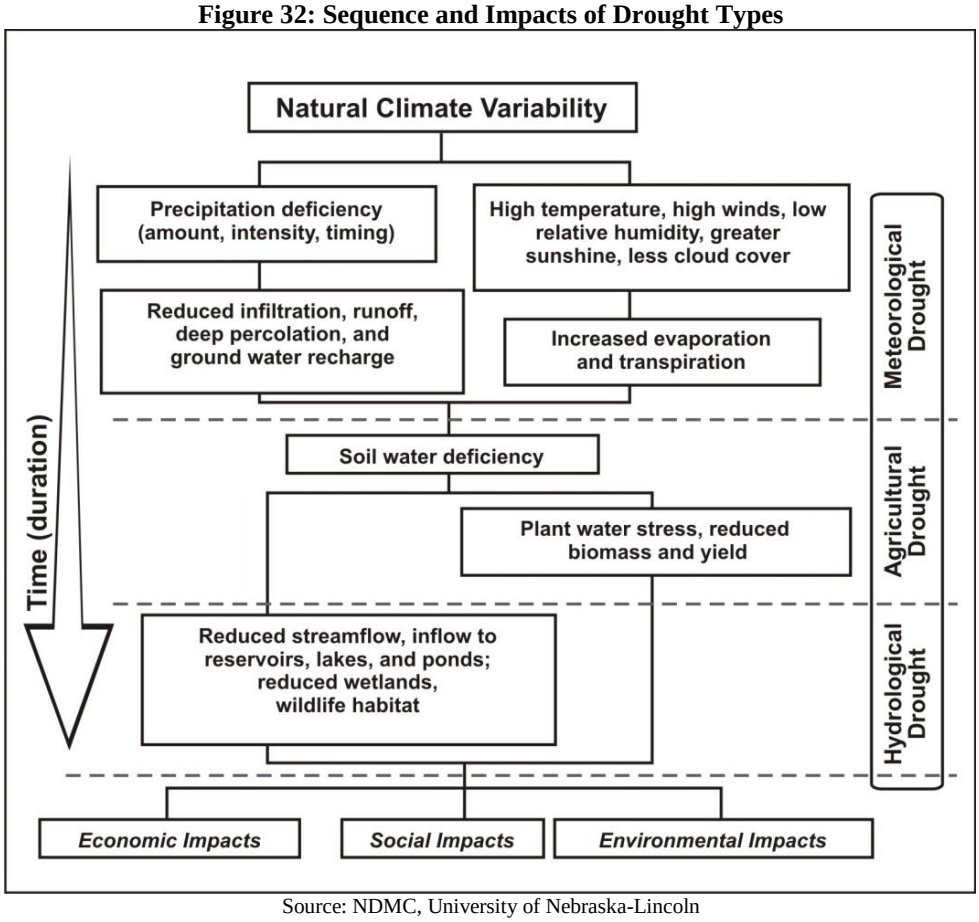
Source: NDMC, Drought Monitor

Drought is a slow-onset, creeping phenomenon and its impacts are largely non-structural. Drought normally affects more people than other natural hazards, and its impacts are spread over a larger geographical area. As a result, the detection and early warning signs of drought conditions, and assessment of impacts, are more difficult to identify than that of quick-onset natural hazards (e.g., flood and storm) that result in more visible impacts. In addition, drought has more than 150 definitions and this lack of a universal definition makes it even harder to decide the onset and end. Generally according to the NDMC, droughts are classified into four major types:

- ***Metrological Drought*** – is defined based on the degree of dryness and the duration of the dry period. Metrological drought is often the first type of drought to be identified and should be defined regionally as precipitation rates and frequencies ("norms") vary.
- ***Agricultural Drought*** – occurs when there is deficient moisture that hinders planting germination, leading to low plant population per hectare and a reduction of final yield. Agricultural drought is closely linked with metrological and hydrological drought, as agricultural water supplies are contingent upon the two sectors.

- ***Hydrologic Drought*** – occurs when water available in aquifers, lakes, and reservoirs falls below the statistical average. This situation can arise even where the area of interest receives average precipitation. This is due to the reserves diminishing from increased water usage, usually from agricultural use or high levels of evapotranspiration resulting from prolonged high temperatures. Hydrological drought often is identified later than metrological and agricultural drought. Impacts from hydrological drought may manifest themselves in decreased hydropower production and loss of water based recreation.
- ***Socioeconomic Drought***– occurs when the demand for an economic good exceeds supply due to a weather-related shortfall in water supply. The supply of many economic goods include, but are not limited to, water, forage, food grains, fish, and hydroelectric power.

Figure 32: Sequence and Impacts of Drought Types

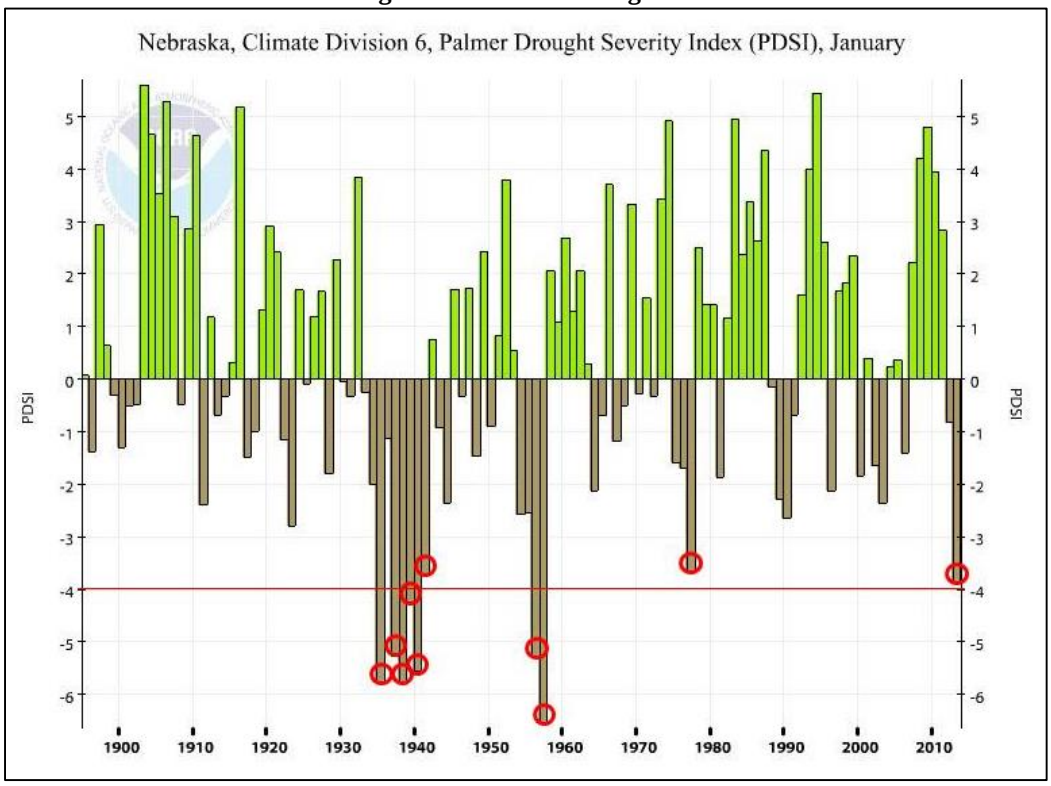


Source: NDMC, University of Nebraska-Lincoln

EXTENT

Due to drought's unique nature and characteristics, it is yet to be decided the best way to predict and monitor drought. Among the several indices, the Palmer Drought Severity Index (PDSI) has been widely used by various governments in the U.S. The USDA uses the U.S. Drought Monitor in determining when to grant emergency drought assistant. Figure 33 shows the PDSI with data from the NCDC. The graph illustrates historical PDSI for Division 6 - East Central Nebraska, which includes the planning area, between the years of 1895 and 2010. The negative Y axis represents a drought, for which '-2' indicates a moderate drought, '-3' a severe drought, and '-4' an extreme drought. Table 35 shows the details of the palmer classifications. According to this dataset, extreme droughts were recorded in 10 years dating back to the 1895 and major events include the Dust Bowl in the 1930s and the recent 2012 drought. Table 36 shows the classification for the Drought Monitor.

Figure 33: Palmer Drought SI



Source: NOAA, High Plains Regional Climate Center

Table 35: Palmer Classifications

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

Source: NOAA, NWS, Climate Prediction Center

Table 36: U.S. Drought Monitor Classification

Category	Description	Palmer Classification	Possible Impacts
D0	Abnormally Dry	-1.0 to -1.9	Going into drought: short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered.
D1	Moderate Drought	-2.0 to -2.9	Some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; voluntary water-use restrictions requested
D2	Severe Drought	-3.0 to -3.9	Crop or pasture losses likely, water shortages common; water restrictions imposed

Category	Description	Palmer Classification	Possible Impacts
D3	Extreme Drought	-4.0 to -4.9	Major crop/pasture losses; widespread water shortages or restrictions
D4	Exceptional Drought	-5.0 or less	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams and wells creating water emergencies.

Source: NDMC, NOAA

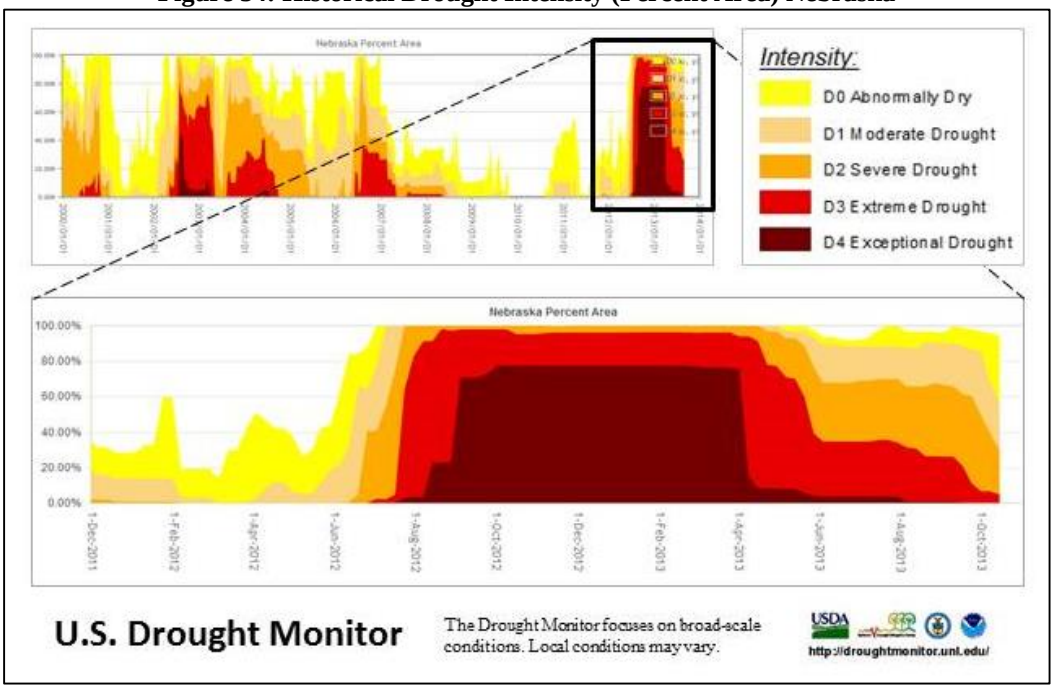
Based on historical records there is a chance for exceptional drought in the planning area.

HISTORICAL OCCURRENCES

The NDMC reported 31 months of at least D3 drought for the planning area from January 1996 to May 2013, including 11 months in 2012 into 2013. None of the reported events incurred recorded fatalities, injuries, or significant monetary damages within the planning area.

The extreme heat and drought event started in the summer of 2012 was substantial, but did not warrant a presidential disaster declaration within Nebraska. Figure 34 summarizes the historical drought conditions for Nebraska by intensity and percent area since 2000. According to the data acquired from NDMC, the whole state of Nebraska was in severe drought conditions from the middle of July in 2012 to the end of May in 2013 and over 70% of the state was in exceptional drought conditions for over eight months. Numerous cities implemented mandatory water restrictions and some encouraged voluntarily water conservation during the period of drought. The full effects of this event are still to be assessed, and any future update should include details about its true extent.

Figure 34: Historical Drought Intensity (Percent Area) Nebraska



Source: NDMC, University of Nebraska-Lincoln

The following drought events were reported by participants at the public meetings:

- 2012 and June to April, 2013: The City of Waverly reported lack of precipitation for at least 9 months.
- 2012: The whole natural resources district was in drought conditions.

The Drought Impact Reporter is a database of drought impacts throughout the United States. The Drought Impact Reporter has recorded a total of 228 drought related impacts throughout Cass and Lancaster County. Table 37 demonstrates the sectors that have previously reported impacts in both the Cass and Lancaster County. Examples of reported drought impacts include:

- Power generation down at power plants on the upper Missouri River (5/2013);
- 500 Nebraska firefighters will receive training in the preparation for another fire season across the state (2/2013); and
- Heat and drought increase demand on utilities in Nebraska (7/2012)

Table 37: Number of Reported Drought Impacts by Sector (January 2003 - October 2013)

County	Agricultural	Business & Industry	Energy	Fire	Plant & Wildlife	Relief, Response, & Restrictions	Society & Public Health	Tourism & Recreation	Water Supply & Quality
Cass & Lancaster	124	31	7	6	27	53	31	4	44

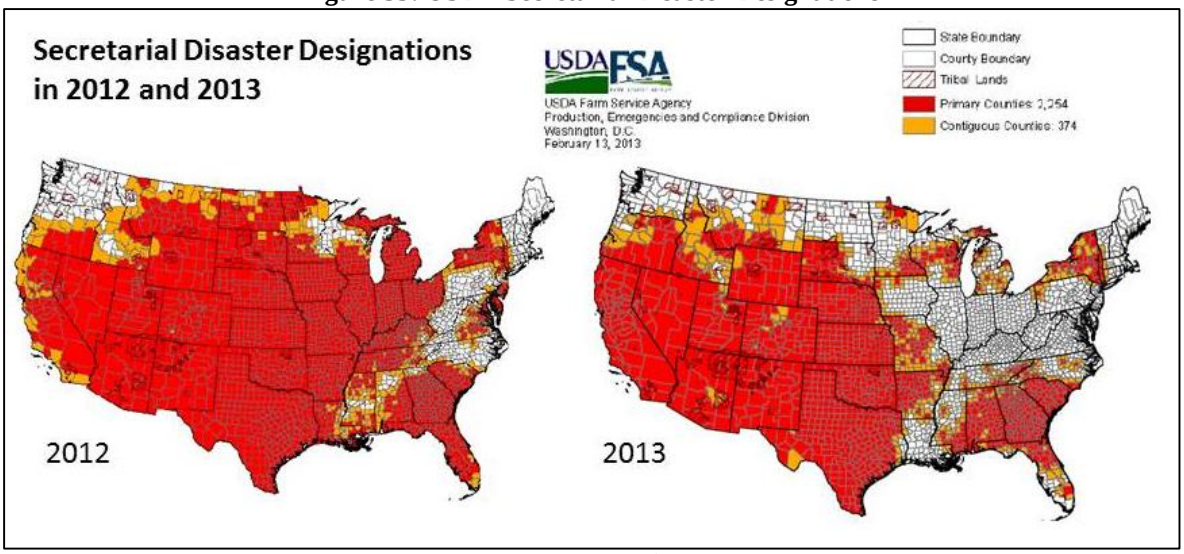
Source: NDMC – Drought Impact Reporter

AVERAGE ANNUAL DAMAGES AND FREQUENCY

Frequency of drought is calculated by the number of months reported as being in D3 drought as recorded by NMDC divided by the total number of months for the period of record (216). This more accurately represents the annual propability for drought. Using this method, the annual probability for drought is approximately 14%.

The severe drought in 2012 significantly affected the agricultural sector of the state. Although the full impacts is yet to be studied, USDA reported a total of $139,957,809 to Nebraska from 2008 to 2011 for all five disaster programs: Supplemental Revenue Assistance Payments (SURE), Livestock Forage Disaster Assistance Program (LFD), and Emergency Assistance for Livestock, Honeybees, Farm-Raised Fish Program (ELAP), Livestock Indemnity Program (LIP), and Tree Assistance Program (TAP). Regarding the planning area, Cass County and Lancaster County received a total of $2,434,671 and $1,204,395 respectively. Figure 37 shows the drought disaster designations by the USDA in 2012 and 2013 and the whole state of Nebraska is in the red zone, indicating that Nebraska, including our planning area, in a drought disaster during the time period shown.

Figure 35: USDA Secretarial Disaster Designations



Source: U.S. Department of Agriculture

VULNERABILITY ASSESSMENT

As identified in Nebraska's Drought Mitigation and Response Plan, drought is a common feature of the Nebraska landscape and often causes significant economic, environmental, and social impacts. Although agriculture is the major sector affected, impacts on rural and municipal water supplies, fish and wildlife, tourism, recreation, water quality, soil erosion, the incidence of wildland fires, electricity demand, and other sectors are also significant. Also, the indirect impacts of drought on personal and business incomes, tax revenues, unemployment, and other areas are also important. In general, drought produces a complex web of impacts that ripple through many sectors of the economy. This is largely due to the dependence of so many sectors on water for producing goods and providing services. It is impossible to predict all the potential impacts, but the common effects of drought have been compiled by the NDMC and are illustrated in Table 38.

Table 38: Classification of Drought-Related Impacts

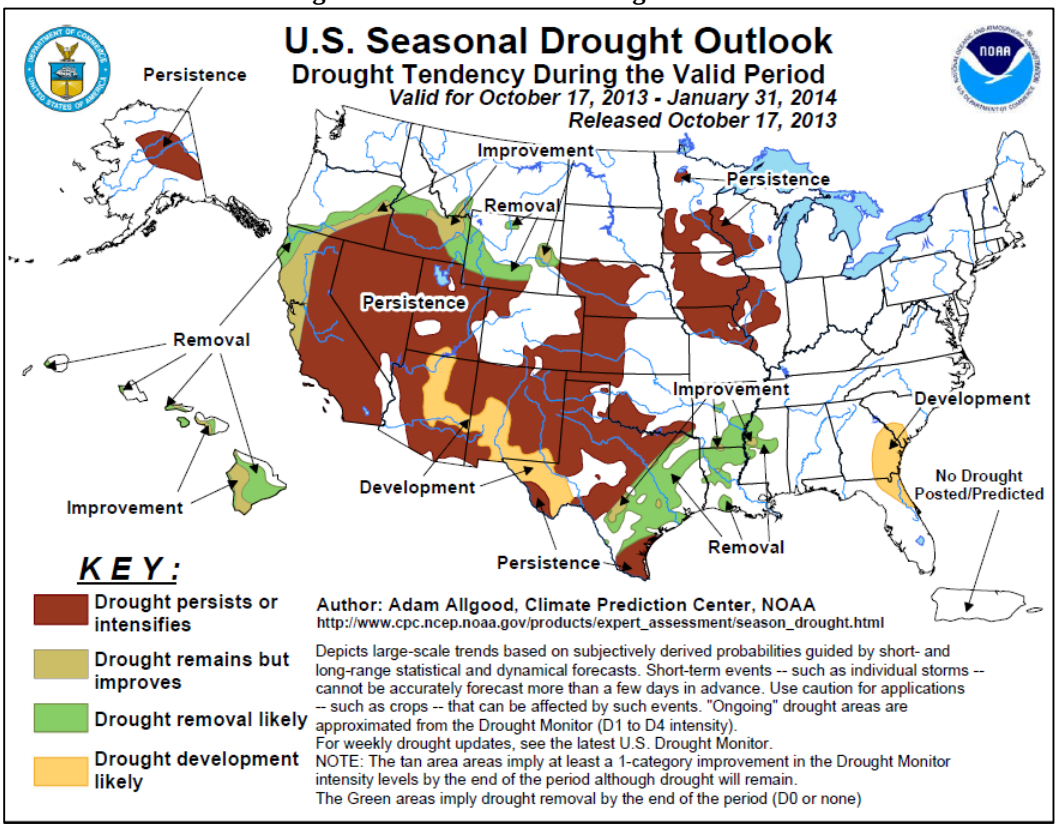
Problem Sectors	Impacts
Economic	○ Loss from crop production Annual and perennial crop losses; damage to crop quality Reduced productivity of cropland (wind erosion, etc.) Insect infestation Plant disease Wildlife damage to crops ○ Loss from dairy and livestock production Reduced productivity of range land Forced reduction of foundation stock Closure/limitation of public lands to grazing High cost/unavailability of water for livestock High cost/unavailability of feed for livestock High livestock mortality rates Increased predation Range fires ○ Loss from timber production Forest fires Tree disease Insect infestation Impaired productivity of forest land ○ Loss from fishery production Damage to fish habitat Loss of young fish due to decreased flows ○ Loss of national economic growth, retardation of economic development ○ Income loss for farmers and others directly affected ○ Loss of farmers through bankruptcy ○ Loss to recreational and tourism industry ○ Loss to manufacturers and sellers of recreational equipment ○ Increased energy demand and reduced supply because of drought-related power curtailments ○ Costs to energy industry and consumers associated with substituting more expensive fuels (oil) for Hydroelectric power ○ Loss to industries directly dependent on agricultural production (e.g., machinery and ○ Decline in food production/disrupted food supply Increase in food prices Increased importation of food (higher costs) ○ Disruption of water supplies ○ Unemployment from drought-related production declines ○ Strain on financial institutions (foreclosures, greater credit risk s, capital shortfalls, etc.) ○ Revenue losses to federal, state, and local governments (from reduced tax base) ○ Deterred capital investment, expansion ○ Dislocation of businesses ○ Revenues to water supply firms ○ Loss from impaired navigability of streams, rivers, and canals ○ Cost of water transport or transfer ○ Cost of new or supplemental water resource development
Environmental	○ Damage to animal species Reduction and degradation of fish and wildlife habitat Lack of feed and drinking water Disease Increased vulnerability to predation (e.g., from species concentration n ear water) ○ Loss of biodiversity

	○ Wind and water erosion of soils ○ Reservoir and lake drawdown ○ Damage to plant species ○ Water quality effects (e.g., salt concentration, increased water temperatures, pH, dissolved oxygen) ○ Air quality effects (dust, pollutants) ○ Visual landscape quality (dust, vegetative cover, etc.) ○ Increased fire hazard ○ Estuarine impacts; changes in salinity levels, reduced flushing
Social	○ Increased groundwater depletion (mining), land subsidence ○ Loss of wetlands ○ Loss of cultural sites ○ Insect infestation ○ Food shortages (decreased nutritional level, malnutrition, famine) ○ Loss of human life (e.g., food shortages, heat) ○ Public safety from forest and range fires ○ Conflicts between water users, public policy conflicts ○ Increased anxiety ○ Loss of aesthetic values ○ Health-related low flow problems (e.g., diminished sewage flows, increased pollutant concentrations, etc.) ○ Recognition of institutional constraints on water use ○ Inequity in the distribution of drought impacts/relief ○ Decreased quality of life in rural areas ○ Increased poverty ○ reduced quality of life, changes in lifestyle ○ social unrest, civil strife ○ population migration (rural to urban areas) ○ reevaluation of social values ○ increased data/information needs, coordination of dissemination activities ○ loss of confidence in government officials ○ recreational impacts

FUTURE DEVELOPMENT AND VULNERABILITY

According to the Climate Prediction Center at the NWS, drought in the near future is going to persist or intensify in the Central and West of Nebraska but for the East of Nebraska where the planning area is located drought conditions are not expected to persist in the next three months (figure 36). Besides climate variability that results in drought conditions, communities can be vulnerable and increase their drought risks with unwise land use decisions, urban development, and population growth etc.

Figure 36: U.S. Seasonal Drought Outlook



Source: *NOAA, NWS*

Communities will always have some level of vulnerability related to the phenomenon of drought. There are actions that can be taken to reduce this vulnerability in future development areas as well as potentially retrofitting existing developments and structures. Land-use regulations should consider the water supply and quality when considering areas to be developed in the future and ensure that future developments will not stress the existing water supply system or ultimately result in insufficient water supplies for the community. Communities can audit water systems as well to reduce water waste and loss through leaks and small breaks to the distribution system. It is estimated that communities lose between 10 – 20%of available water to inefficiencies in the distribution system. Building codes can also be changed to either reduce landscaped and irrigated areas or to require high efficiency irrigation systems as well as encouraging the use of low-flow fixtures in new construction areas. Xeriscaping can also be used to reduce water consumption and increase the resiliency of communities within the planning area.

Risk Assessment Summary

Overall, the risk and vulnerability assessment shows that drought has approximately a 10% chance of occurring every year. Drought does not cause significant property damage, but can impact individuals and agricultural interests adversely. Due to the way NCDC reports on drought events it is difficult to quantify the impacts. For that reason we used the Drought Impact Reporter and RMA to examine the annual damages from drought.

Mitigation Alternatives

The following bullet points identify some general mitigation strategies that can be used to reduce a community's vulnerability to the threat of drought. Many of these strategies are identified and discussed in greater detail in the FEMA document Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards. Addition information regarding drought mitigation and drought planning can be found in the NDMC's Drought-Ready Communities: A Guide to Community Drought Preparedness.

Once the full extent of the damages of the Drought of 2012 is known, this information should be incorporated into the update to this plan in 5 years.

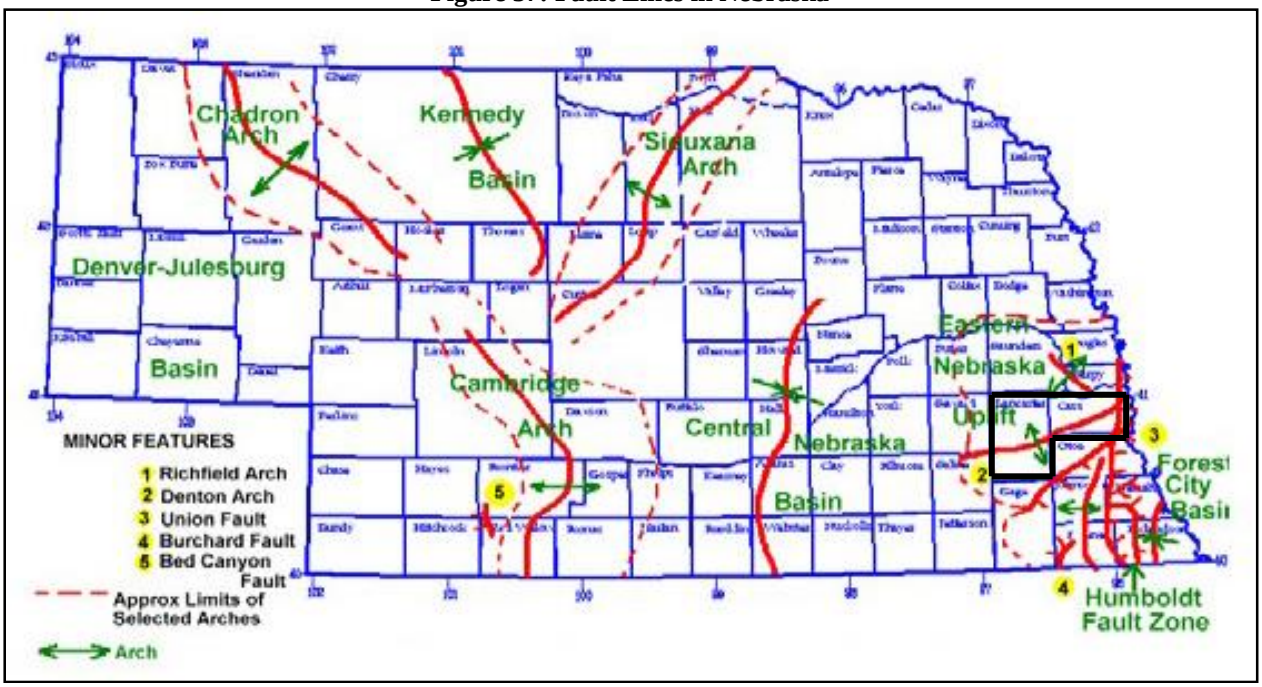
- Assess Drought Vulnerability (identify factors that affect drought severity for local jurisdictions)
- Establish a Drought Monitoring Board and drought reporting procedures
    - Lincoln/Lancaster County has a drought board
- Establish monitoring procedures for municipal water supply and distribution systems
    - Rural water districts monitor water supplies; LPSNRD is active in protecting ground and surface water resources
- Develop drought specific plans (this may include water conservation plans, drought preparedness plans, and wellhead protection plans)
    - This has not occurred
- Establish municipal water conservation programs
    - Many participating communities reported water conservation as an ongoing strategy
- Establish agricultural policies (agricultural irrigation standards, grazing policies, etc.)
    - Wellhead protection districts is under the purview of the LPSNRD
- Enhanced residential landscape standards (xeriscaping, irrigation systems requirements, etc.)
    - This has not occurred
- Enhanced building codes to require low-flow fixtures in new construction
    - This has not occurred
- Incentives to retrofit structures with low-flow fixtures
    - This has not occurred
- Incorporate permeable surfaces into municipal designs
    - Some communities utilize low-impact development practices and have identified that as either a new or ongoing mitigation strategy
- Investigate alternative water supply options
    - This is community specific; some communities have identified this as a mitigation strategy
- Participate in the Tree City USA program
    - Refer to participant sections
- Encourage agricultural businesses to purchase crop insurance as appropriate
    - Ongoing
- Drought education programs (residential and agricultural)
    - County EMAs have education programs related to regional hazards

Earthquakes

HAZARD PROFILE

An earthquake is the result of a sudden release of energy in the Earth's tectonic plates that creates seismic waves. The seismic activity of an area refers to the frequency, type, and size of earthquakes experienced over a period of time. Although rather uncommon, earthquakes do occur in Nebraska, and are usually small, generally not felt, and cause little to no damage. Figure 37 shows the fault lines in Nebraska.

Figure 37: Fault Lines in Nebraska



Source: NDNR

EXTENT

Earthquakes are measured by magnitude and intensity. Magnitude is measured by the Richter Scale, a base-10 logarithmic scale, which uses seismographs around the world to measure the amount of energy released by an earthquake. Intensity is measured by the Modified Mercalli Intensity Scale, which determines the intensity of an earthquake by comparing actual damage against damage patterns of earthquakes with known intensities. Tables 39 and 40 summarize the Richter Scale and Modified Mercalli Scale. If an earthquake did occur it would not be stronger than a 3 or 4 on the Richter Scale.

Table 39: Richter Scale

Richter Magnitudes	Earthquake Effects
Less than 3.5	Generally not felt, but recorded.
3.5 – 5.4	Often felt, but rarely causes damage.
Under 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1 – 6.9	Can be destructive in areas up to about 100 kilometers across where people live.
7.0 – 7.9	Major earthquake. Can cause serious damage over larger areas.
8 or greater	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

Source: FEMA

Table 40: Modified Mercalli Intensity Scale

Scale	Intensity	Description of Effects	Corresponding Richter Scale Magnitude
I	Instrumental	Detected only on seismographs	
II	Feeble	Some people feel it	< 4.2
III	Slight	Felt by people resting, like a truck rumbling by	
IV	Moderate	Felt by people walking	
V	Slightly Strong	Sleepers awake; church bells ring	< 4.8
VI	Strong	Trees sway; suspended objects swing, objects fall off shelves	< 5.4
VII	Very Strong	Mild Alarm; walls crack; plaster falls	< 6.1
VIII	Destructive	Moving cars uncontrollable; masonry fractures, poorly constructed buildings damaged	
IX	Ruinous	Some houses collapse; ground cracks; pipes break open	< 6.9
X	Disastrous	Ground cracks profusely; many buildings destroyed; liquefaction and landslides widespread	< 7.3
XI	Very Disastrous	Most buildings and bridges collapse; roads, railways, pipes and cables destroyed; general triggering of other hazards	< 8.1
XII	Catastrophic	Total destruction; trees fall; ground rises and falls in waves	> 8.1

Source: FEMA

Historical Occurrences

Figure 38 displays historical occurrences of earthquakes in and around the planning area and State of Nebraska. The information displayed is from the NEIC Earthquake Search database provided by the USGS Earthquake Hazards Program. Based on this information there have been no recorded earthquakes in the planning area dating back to 1975.

Figure 38: Nebraska Earthquakes

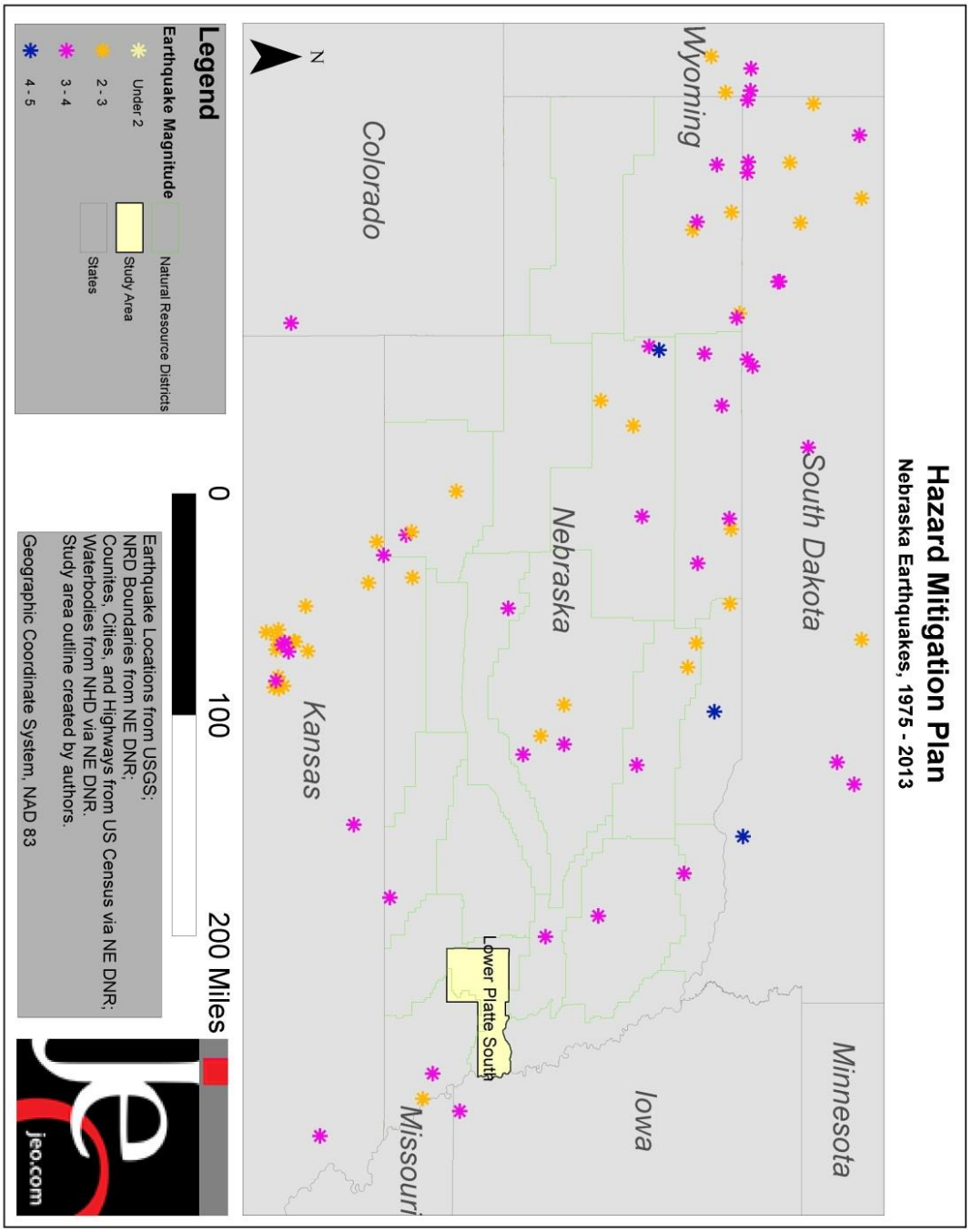


Figure 39: Nebraska Earthquakes

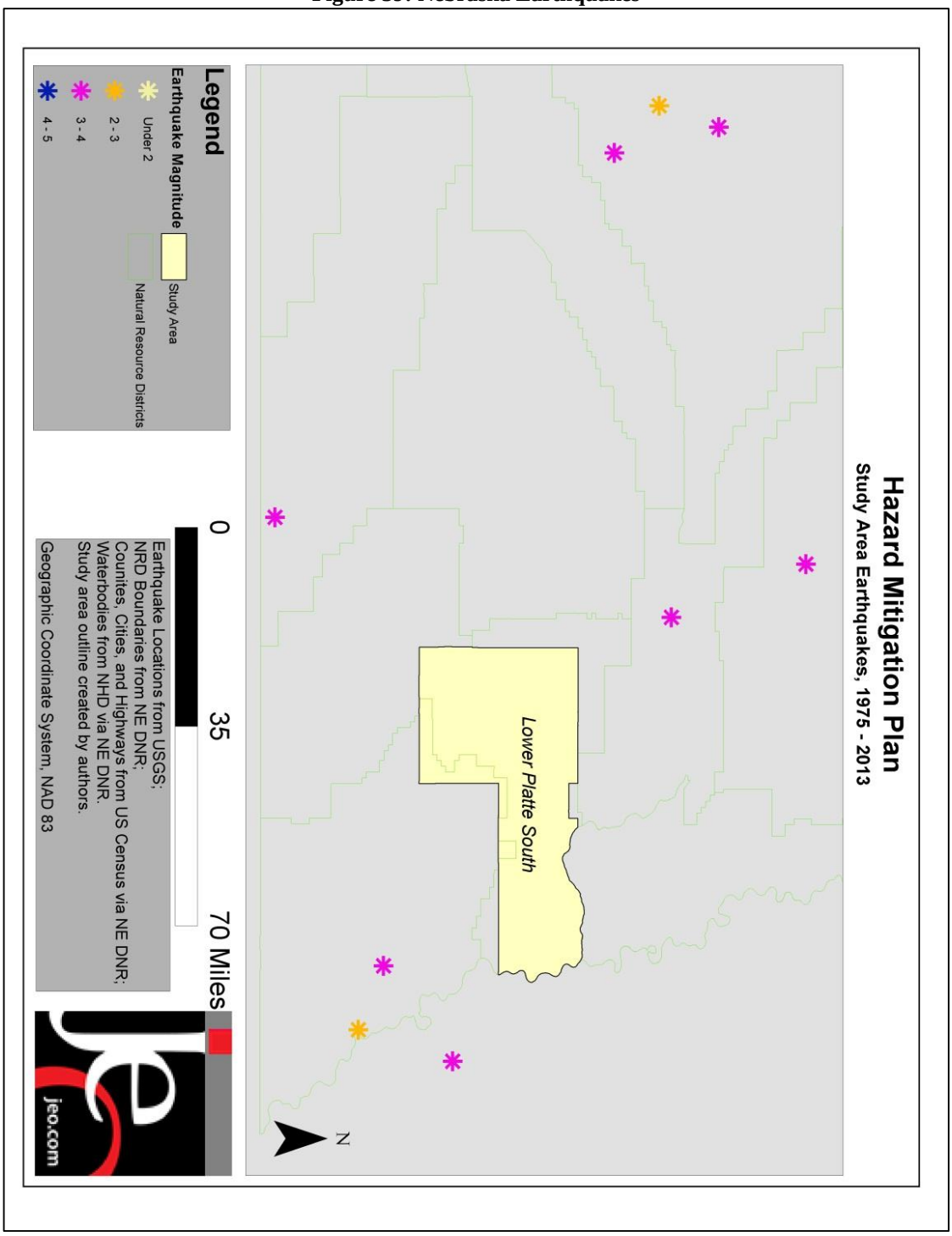
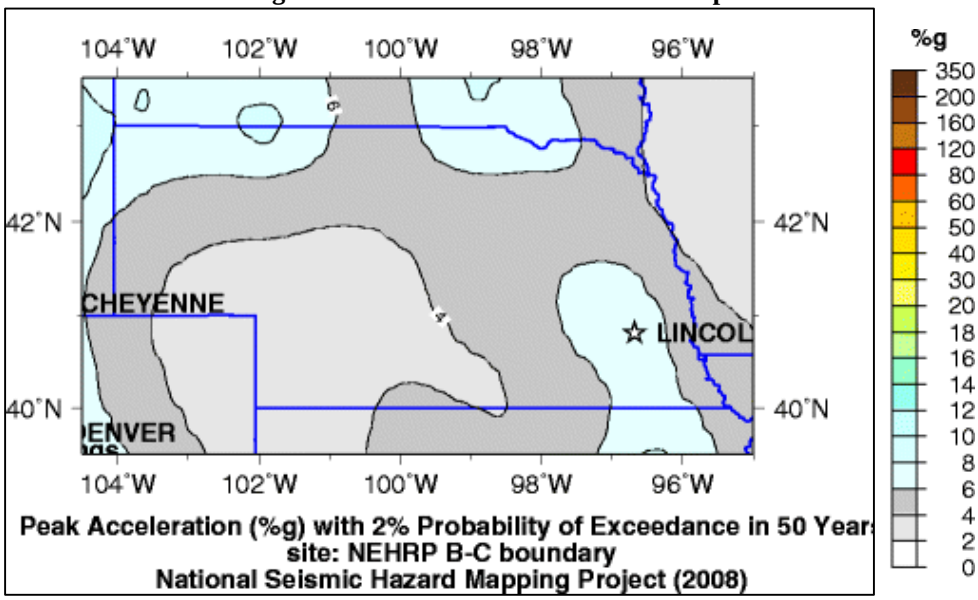


Figure 40: Nebraska Seismic Hazard Map



Source: USGS

Average Annual Damages and Frequency

Due to the lack of sufficient earthquake data, limited resources, extremely low earthquake risk for the area, and limited reports of historical occurrences with recorded damages, it is not feasible to utilize the 'event damage estimate formula' to estimate potential losses for the planning area. There has not been an earthquake recorded in the planning area.

Vulnerability Assessment

Low income individuals are particularly vulnerable to the threat of earthquake. Often, low income individuals and families live in lower cost homes (older homes, mobile homes) that are less able to withstand disaster. Older homes and mobile homes may not have been constructed using the most advanced building codes or have received updates and retrofits that would have increased their stability and ability to withstand seismic events. Damages resulting from the 1994 Northridge earthquake in California were disproportionately focused on low and moderate income rental housing units that were older and thus more vulnerable to seismic damages.

Future Development and Vulnerability

Earthquakes are not a significant concern for the planning area. All structures are vulnerable to earthquakes. Building codes can be enhanced to require great consideration for seismic events. Education programs can be implemented, informing homeowners and residents about anchoring or appliances.

Risk Assessment Summary

Earthquakes have approximately a 1% chance of occurring in a given year. These events are likely to be limited in extent to 4 or less on the Richter Scale. It is possible that critical facilities and services could be interrupted but it is not likely.

Mitigation Alternatives

The following bullet points identify some general mitigation strategies that can be used to reduce a community's vulnerability to the threat of earthquakes. Some of these strategies, such as the use of warning systems, are already in place in the planning area. Many of these strategies are identified and discussed in greater detail in the FEMA document *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards*.

- Adopt and enforce seismic building codes
    - Communities with building codes have adopted a version of the International Building Codes which includes some seismic requirements, but due to the low threat for the planning area this is not a great concern for most communities
- Incorporate Seismic Safety into all Local Plans (i.e., create a Seismic Safety Committee)
    - This is not standard in the planning area
- Conduct Inspections of Building Safety (i.e., identify seismic risk)
    - Building inspections take place in many communities but they do not focus on seismic threats
- Protect CFs and Infrastructure (i.e., installing shut off valves; bracing equipment; and reviewing all bridge construction plans)
    - CFs are constructed in accordance with local building codes
- Implement Structural Mitigation Techniques (i.e. membranes on windows to prevent glass shattering, steel bracing on chimneys; etc.)
    - This is not standard in the planning area
- Increase Earthquake Risk Awareness (i.e. outreach to businesses, schools, and individuals)
    - County EMAs offer materials related to regional hazards
- Conduct outreach to building inspectors, engineers and architects.

Grass/Wildfires

HAZARD PROFILE

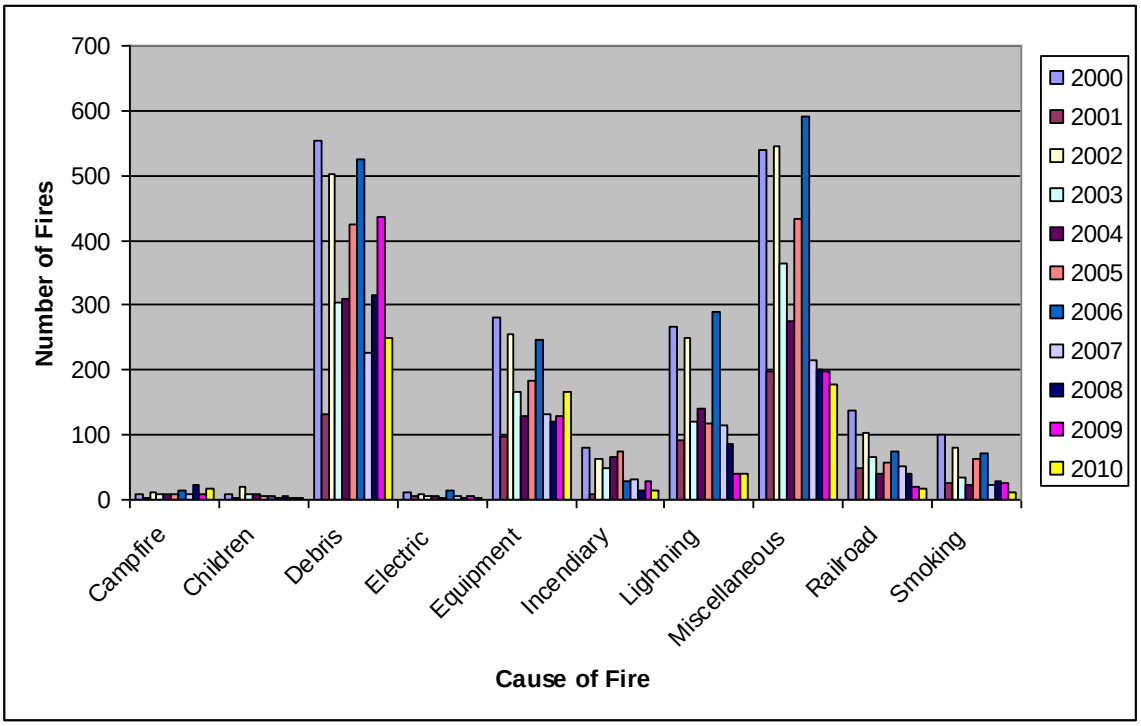
Wildfires, also known as brushfires, forest fires, or wildland fires, are any uncontrolled fire that occurs in the countryside or wildland. Wildland areas may include, but are not limited to, grasslands, forests, woodlands, agricultural fields, and other vegetated areas. Wildfires differs from other fires by their extensive size, the speed at which they can spread out from the original source, their ability to change direction unexpectedly, and to jump gaps, such as roads, rivers, and fire breaks. While some wildfires burn in remote forested regions, others can cause extensive destruction of homes and other property located in the wildland-urban interface, the zone of transition between developed areas and undeveloped wilderness.

Wildfires are a growing hazard in most regions of the United States, posing a threat to life and property, particularly where native ecosystems meet urban developed areas. Although fire is a natural and often beneficial process, fire suppression can lead to more severe fires due to the buildup of vegetation, which creates more fuel and increases the intensity and devastation of future fires.

Lightning starts approximately 10,000 ***forest fires*** *each year, yet four out of every five forest fires are started by humans.*

Wildfires are characterized in terms of their physical properties including topography, weather, and fuels. Wildfire behavior is often complex and variably dependent on factors such as fuel type, moisture content in the fuel, humidity, wind speed, topography, geographic location, ambient temperature, the effect of weather on the fire, and the cause of ignition. Fuel is the only physical property humans can control and is the target of most mitigation efforts. The NWS monitors the risk factors including high temperature, high wind speed, fuel moisture (greenness of vegetation), low humidity, small cloud cover in the state on a daily basis.

Figure 41: Number of Wildfires by Cause in Nebraska 2004-2010



Source: Nebraska Forest Service

In recent decades, as the population of the United States has decentralized and residents have moved farther away from the center of villages and cities, the area known as the wildland urban interface (WUI) has developed significantly, in both terms of population and building stock. The WUI is defined as the zone of transition

between developed areas and undeveloped wilderness, where structures and other human development meet wildland. The expansion of the WUI increases the likelihood that wildfires will threaten people and homes, making it the focus of the majority of wildfire mitigation efforts.

Historical Occurrences

The state of Nebraska, especially the western portion, is vulnerable to wildfires. For the planning area there were 931 reported wildfires by 23 different fire departments according to the Nebraska Forestry Service from 2000 to 2012. The reported events burned 6,804 acres of range land, 180 acres of forest land, and 850 acres of crop land. The reported fire events caused $39,535 in crop damages and $469,534 in structural damages.

Figure 42: Fires by Cause in LPSNRD (2000-2012)

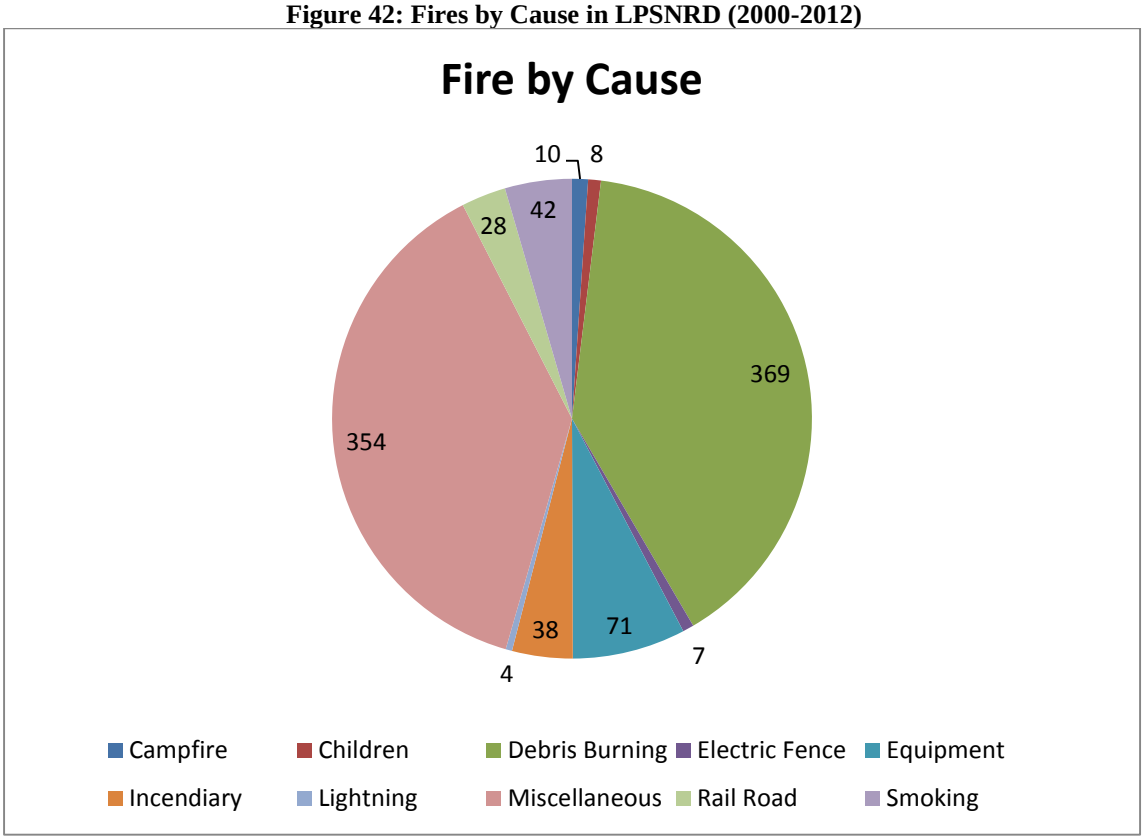


Figure 43: Fires per Year in LPSNRD

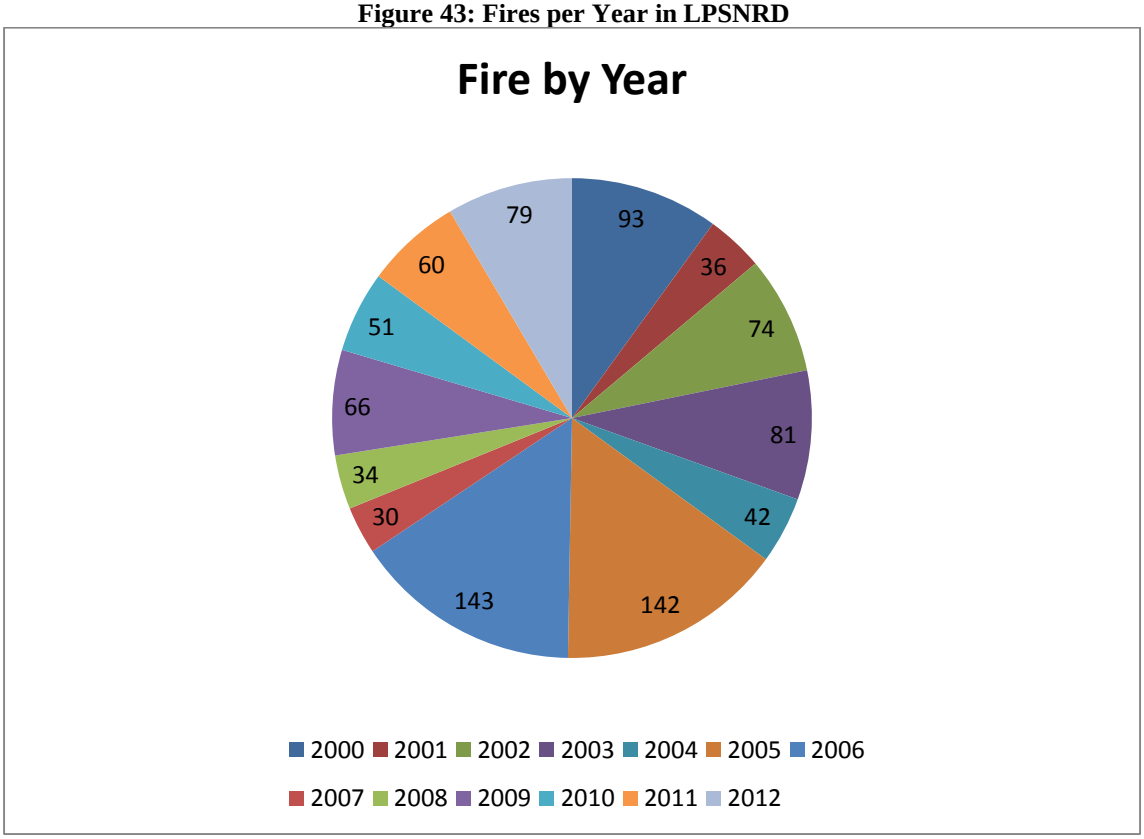


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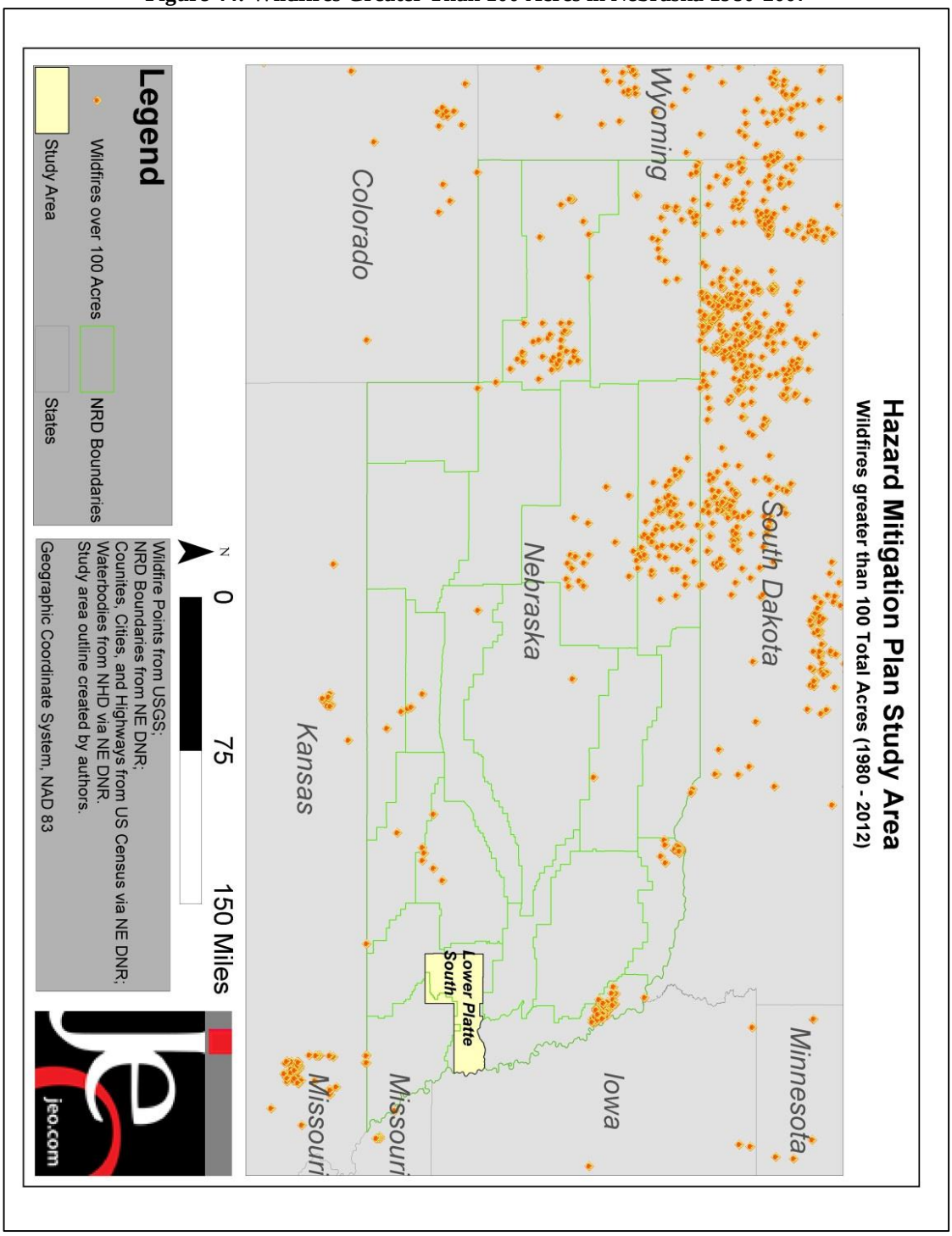
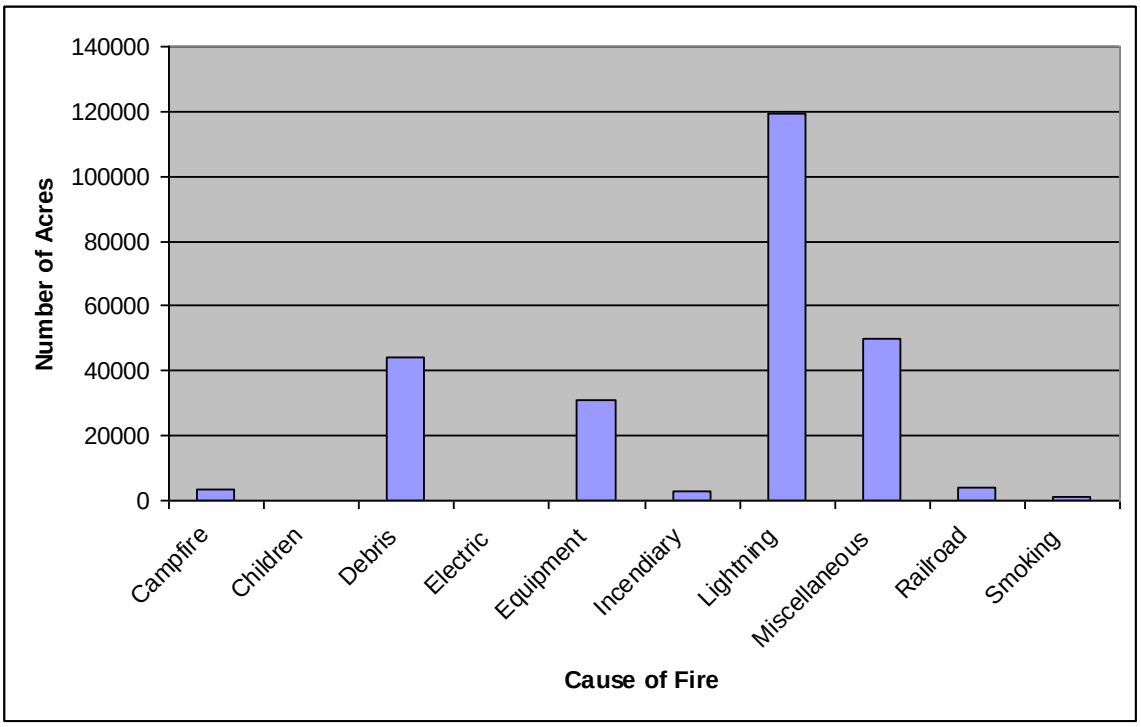
Figure 44: Wildfires Greater Than 100 Acres in Nebraska 1980-2007



EXTENT

Based on the Nebraska Forest Service's 'Wildfire by Cause' report, the most common causes of wildfires include lightning, debris burning, equipment use, and arson. Based on historical occurrences, wildfires in the planning area are likely to burn an average of 8.4 acres. Figure 45 illustrates the number of wildfires and acres burned by cause in Nebraska from 2004 to 2010.

Figure 45: Acres Burned by Cause in Nebraska 2004-2010



Source: Nebraska Forest Service

AVERAGE ANNUAL DAMAGES AND FREQUENCY

Due to the limited reports of historical occurrences with recorded damages, it is not feasible to utilize the 'damage estimate formula' to estimate potential losses for the planning area. There were 931 wildfires in the planning area from 2000-2012.

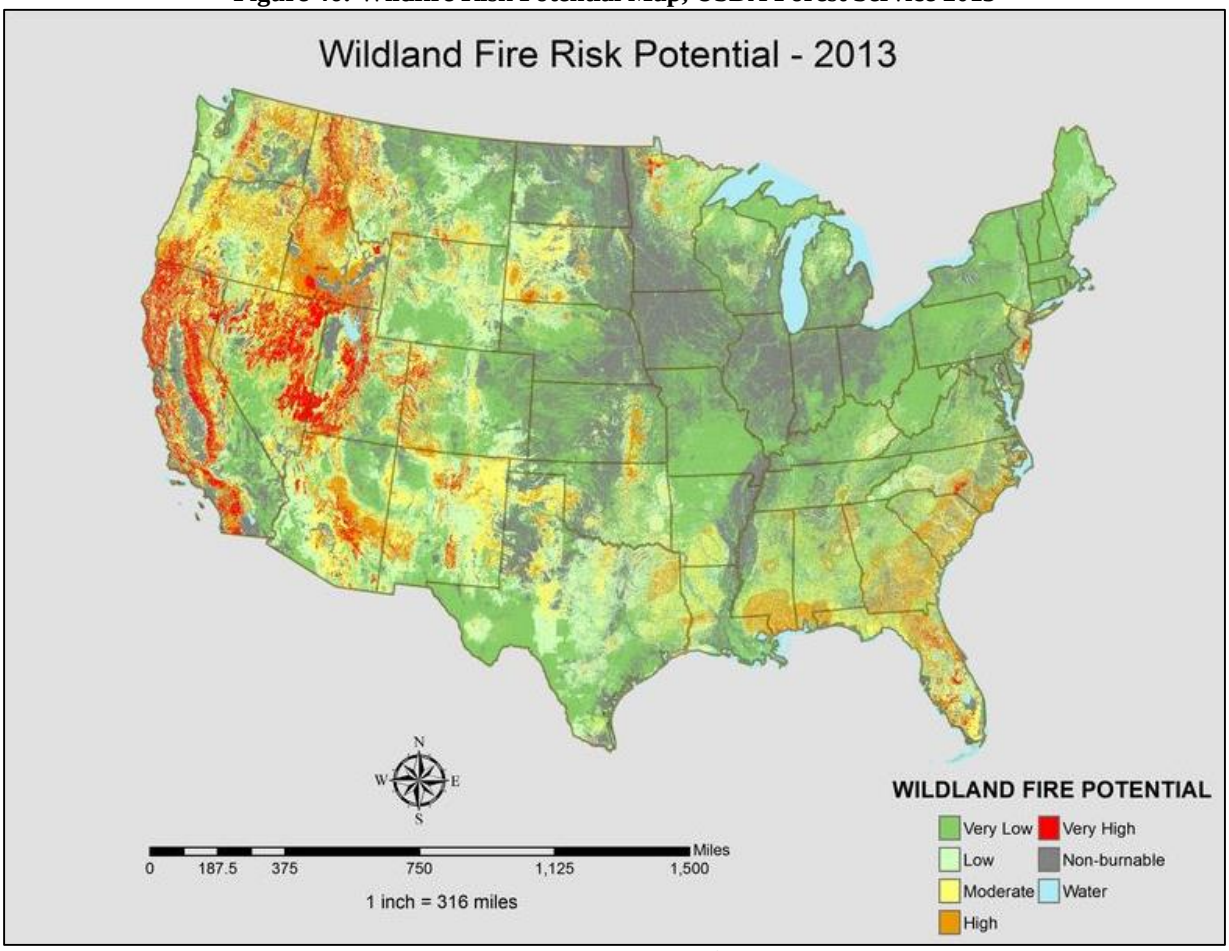
VULNERABILITY ASSESSMENT

According to FEMA, periods of drought and dry conditions throughout the year greatly increase the potential for wildland fires and contribute to extreme wildfires. During a severe drought, large wildfires are common with windy days and steep slopes, which can cause wildfires to spread rapidly and become out of control in a very short time period.

Wildfires can cause extensive damage, both to property and human life. The damages caused by wildfires extend past the loss of building stock, recreation areas, timber, forage, wildlife habitat, and scenic views. In addition, the secondary effects of wildfires, including erosion, landslides, introduction of invasive species, and changes in water quality, all increase due to the exposure of bare ground and loss of vegetative cover following a wildfire, are often more disastrous than the fire itself.

Wildfire poses a threat to a range of demographic groups. Wildfire and urban wildfire could result in major evacuations of residents in impacted and threatened areas. Groups and individuals lacking reliable transportation could be trapped in dangerous locations. Lack of transportation is common among the elderly, low income individuals, and families especially in urban areas. Homes and residents located in the Wildland/Urban Interface are also very vulnerable to wildfire and urban fires. The shift of homes and businesses into or near Wildland areas has resulted in an increase in structural fire losses related to wildfires.

Figure 46: Wildfire Risk Potential Map, USDA Forest Service 2013



Source: United State Department of Agriculture

Wildfires vary greatly depending on the location and severity of the event. Wildfires can cause extensive damage to both urban and rural building stock and properties including CFs and infrastructure, as well as crop and rangeland which support the local industry and economy. Wildfires can pose a significant threat to human life. Recreation areas, timber and forage land, wildlife habitat, and scenic views can also be threatened by wildfires.

The secondary effects of wildfires, including erosion, landslides, introduction of invasive species, and changes in water quality, all increase due to the exposure of bare ground and loss of vegetative cover following a wildfire. By directing the location of structures in relation to topography and fuels present as well as construction methods and materials, jurisdictions can guide growth and development to mitigate potential losses from wildfires.

FUTURE DEVELOPMENT AND VULNERABILITY

Areas for future development in the WUI will be vulnerable to the impacts of wildfire. Structures constructed in the WUI should incorporate a defensible area.

RISK ASSESSMENT SUMMARY

Wildfires will likely occur annually within the planning area. There have been no wildfires greater than 100 acres within the planning area. Based on historical occurrences, these events are likely to be limited to 8.4 acres.

MITIGATION ALTERNATIVES

The following bullet points identify some general mitigation strategies that can be used to reduce a community's vulnerability to the threat of wildfire. Some of these strategies, such as the use of warning systems, are already in place in the planning area. Many of these strategies are identified and discussed in greater detail in the *FEMA document Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards.*

- Map and Assess Vulnerability to Wildfire
    - This has not occurred in the planning area
- Incorporate Wildfire Mitigation in Comprehensive Planning (i.e., identify areas of risk per assessment of vulnerability)
    - This is not standard in the planning area
- Reduce Risk Through Land Use Planning (i.e., implement landscaping ordinances)
    - This is not standard in the planning area
- Develop a Wildland-Urban interface Code
    - This is not standard in the planning area
- Require or Encourage Fire-Resistant Construction (i.e., encourage the use of non-combustible materials)
    - This is not standard in the planning area
- Retrofit At-Risk Structures with Ignition-Resistant Materials (i.e., installing wall components that conform to ignition-resistant construction standards)
    - IBC codes address combustibility of building materials
- Create Defensible Space Around Structures and Infrastructure
    - This is not standard in the planning area
- Conduct Maintenance to Reduce Risk (i.e., perform arson prevention cleanup activities)
    - Members of Tree City USA have tree care ordinances that help reduce fuel loads
- Implement a Fuels Management Program (i.e., Nebraska Forest Service – Forest Fuels Reduction Program)
- Participate in Firewise Program
    - No communities are presently participating
- Increase Wildfire Risk Awareness (i.e., informing the public about proper evacuation procedures)
- Educate Property Owners about Wildfire Mitigation Techniques
- Wildland Fire Fighting Training for Fire Departments

Levee Failure

HAZARD PROFILE

According to FEMA's website:

> "The United States has thousands of miles of levee systems. These manmade structures are most commonly earthen embankments designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water to provide some level of protection from flooding. Some levee systems date back as far as 150 years. Some levee systems were built for agricultural purposes. Those levee systems designed to protect urban areas have typically been built to higher standards. Levee systems are designed to provide a specific level of flood protection. No levee system provides full protection from all flooding events to the people and structures located behind it. Thus, some level of flood risk exists in these levee-impacted areas."

Levee failure can occur several ways. A breach of a levee is when part of the levee breaks away, leaving a large opening for floodwaters to flow through. A levee breach can be gradual by surface or subsurface erosion, or it can be sudden. A sudden breach of a levee often occurs when there are soil pores in the levee that allow water to flow through causing an upward pressure greater than the downward pressure from the weight of the soil of the levee. This under seepage can then resurface on the backside of the levee and quickly erode a hole to cause a breach. Sometimes the levee actually sinks into a liquefied subsurface below.

Another way a levee failure can often occur is when the water overtops the crest of the levee. This happens when the flood waters simply exceed the lowest crest elevation of the levee. An overtopping can lead to significant erosion of the backside of the levee and result in a breach and thus a levee failure.

EXTENT

The Army Corps of Engineers who is responsible for levee oversight and inspection of Levees has 5 classifications for levee safety.

Table 41: Levee Safety Action Classification

Class	Urgency
I	Urgent and Compelling
II	Urgent
III	High Priority
IV	Priority
V	Normal

Based on historic records it is not likely to have a levee failure in the planning area. If a levee failure were to occur the most likely failure would be from a class I or II levee.

HISTORICAL OCCURRENCES

The only occurrence of a levee failure in the planning area was reported by Cass County SID #1 (Lake WaConDa). They recorded that 'in the spring of 2003, the river was one inch from cresting. The community used 7 dewatering pumps to keep the water down. Six homes were damaged and there was a broken levee.'

AVERAGE ANNUAL DAMAGES AND FREQUENCY

Due to the lack of sufficient data, limited resources, nature of damages, and limited reports of historical occurrences with recorded damages, it is not feasible to utilize the 'event damage estimate formula' to estimate potential losses for the planning area. The formula cannot be used, but damage can be estimated based on the known inundation area for the levee. The levee within the city of Lincoln does not provide any protection from the 1% annual floodplain. Due to this data limitation on what structures these levee failures would affect, these structures were not assessed.

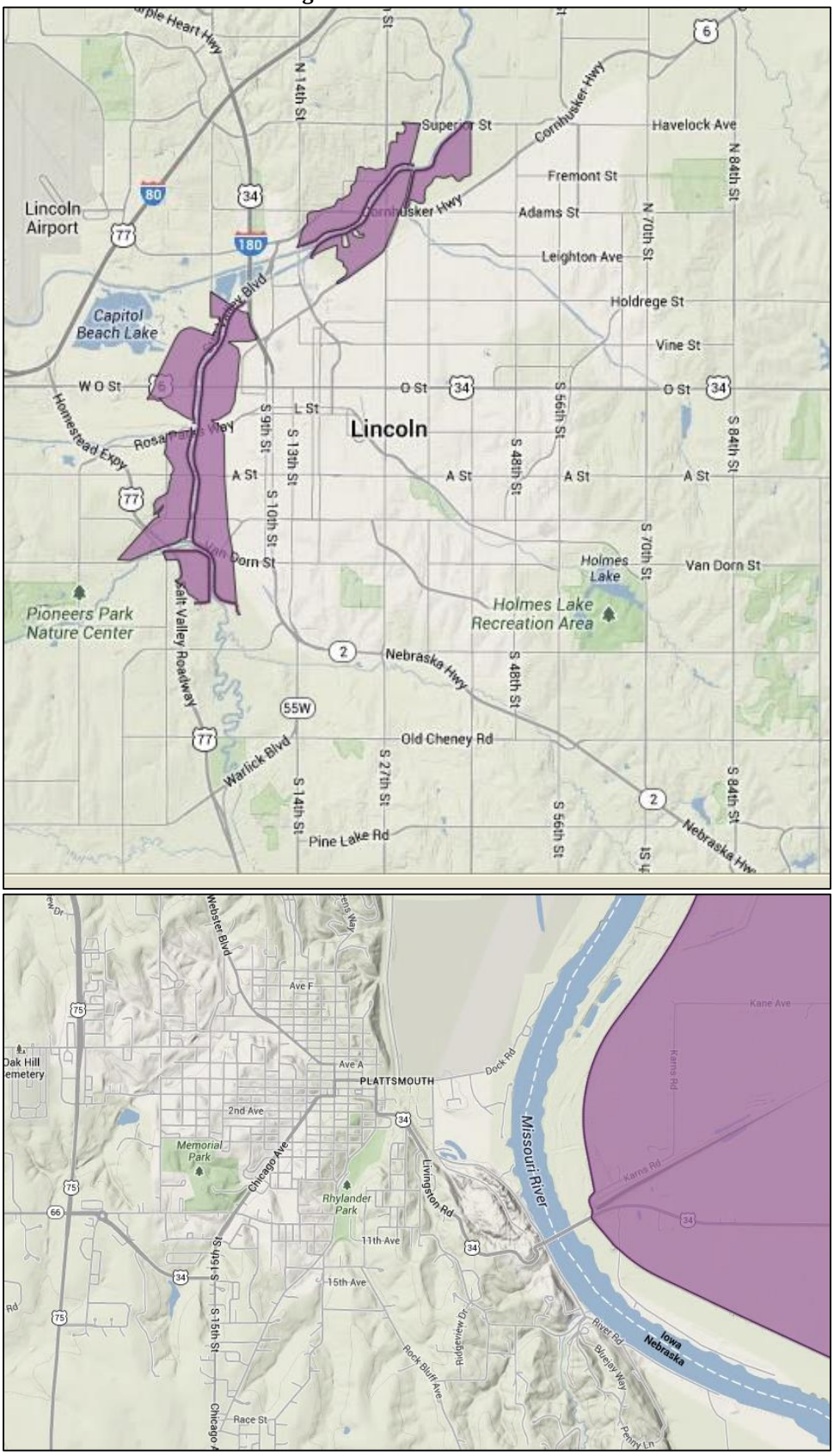
Within Cass County SID #1 there are 151 residential structures with the inundation area. Utilizing the median home value for Cass County an estimate of assets at risk relative to the residential structures can be established. The median home value in Cass County as reported by the Nebraska Department of revenue for 2013 was $238,494 for the 151 residential structures in the inundation area and estimated value of $36,055,390 can be assumed. The estimated $36 million assumes the total loss of the structures.

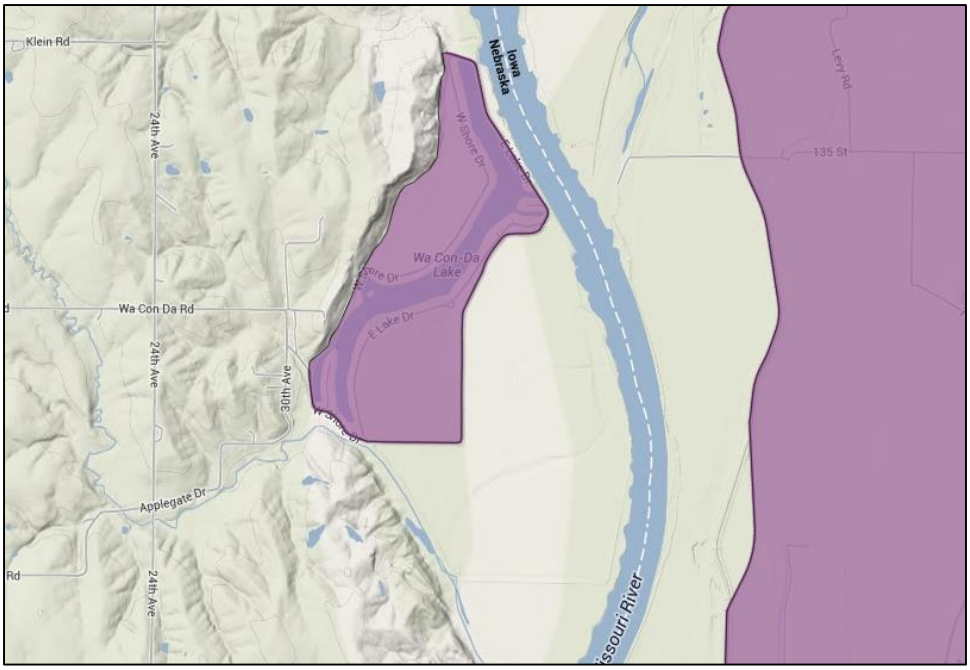
VULNERABILITY ASSESSMENT

It was deemed, by both the public and factual research that the planning area as a whole has one previous occurrence of levee failure. This event was in Cass County SID #1 (Lake WaConDa) and was reported by the community. The chance of a levee failure is less than 10% per year. Impacts to people and property were also determined to be low since a limited number of communities have or are near levees. Specifically, Cass County SID 1 (Lake WaConDa), the City of Lincoln, and Cedar Creek have some vulnerability related to levee failure. The damages of a levee failure will be limited to those areas behind the levee.

In the event that a levee failure occurred, effects would be similar to those of a flood. The effects, damages, and locations of flooding are covered under the "Flooding" sections. Damages which may be caused by flooding include loss of structures, destruction of infrastructure such as bridges and roads, loss of utilities and potential for loss of life. For more specific information regarding levee failure events in the jurisdictions within the Planning Area, refer to each jurisdiction's respective participant section. Levee failure only affects those jurisdictions that have levees. The jurisdictions that have levees are: Plattsmouth, Cass County, Cass County SID #1 (Lake WaConDa), Lancaster County and the City of Lincoln.

Figure 47: LPSNRD Levees





Source: National Levee Database

FUTURE DEVELOPMENT AND VULNERABILITY

Land-use regulations should prohibit development within floodplains and areas currently protected by existing levees and dams. Levee failure should not be a significant threat to future development and losses should be insignificant. Communities should encourage structures currently protected by levees to purchase flood insurance from the NFIP whether they are technically located in the floodplain or not.

RISK ASSESSMENT SUMMARY

Overall, the risk and vulnerability assessment shows that the potential impacts of a levee failure are low for the planning area. Although the levee failure scenario does illustrate a significant amount of property damage, it does not take into account the elevation of the structures in the 0.2% floodplain.

MITIGATION ALTERNATIVES

Land-use regulations should prohibit development within floodplains and areas currently protected by existing levees and dams. Levee failure should not be a significant threat to future development and losses should be insignificant. Communities should encourage structures currently protected by levees to purchase flood insurance from the NFIP whether they are technically located in the floodplain or not.

Hazard mitigation options for levee failure include most of the wide-range of actions described previously for flooding, as well as additional actions related to warning and evacuation

Dam Failure

HAZARD PROFILE

According to the Nebraska Administrative Code, Title 458, Chapter 1, Part 001.09, dams are " any artificial barrier, including appurtenant works, with the ability to impound water, wastewater, or liquid-borne materials and which is:

- is twenty-five feet or more in height from the natural bed of the stream or watercourse measured at the downstream toe of the barrier, or from the lowest elevation of the outside limit of the barrier if it is not across a stream channel or watercourse, to the maximum storage elevation or
- has an impounding capacity at maximum storage elevation of fifty acre- feet or more, except that any barrier described in this subsection which is not in excess of six feet in height or which has an impounding capacity at maximum storage elevation of not greater than fifteen acre-feet shall be exempt, unless such barrier, due to its location or other physical characteristics, is classified as a high hazard potential dam. Dam does not include:
    - an obstruction in a canal used to raise or lower water;
    - a fill or structure for highway or railroad use, but if such structure serves, either primarily or secondarily, additional purposes commonly associated with dams it shall be subject to review by the department;
    - canals, including the diversion structure, and levees; or
    - water storage or evaporation ponds regulated by the United States Nuclear Regulatory Commission."

The Department of Natural Resources uses a classification system for dams throughout the State including those areas participating this this plan. The classification system includes three classes such as Small, Intermediate, and Large, which are defined as:

Size	Effective Height (feet) x Effective Storage (acre-feet)	Effective Height
Small	≤ 3,000 acre-feet2	and ≤ 35 feet
Intermediate	> 3,000 acre-feet2 to < 30,000 acre-feet2	or > 35 feet
Large	≥ 30,000 acre-feet2	Regardless of Height

The effective height of a dam is defined as the difference in elevation in feet between the natural bed of the stream or watercourse measured at the downstream toe (or from the lowest elevation of the outside limit of the barrier if it is not across stream) to the auxiliary spillway crest. The effective storage is defined as the total storage volume in acre-feet in the reservoir below the elevation of the crest of the auxiliary spillway. If the dam does not have an auxiliary spillway, the effective height and effective storage should be measured at the top of dam elevation.

Dam failure, as a hazard, is described as a structural failure of a water impounding structure. Structural failure can occur during extreme conditions, which include but are not limited to:

- Reservoir inflows in excess of design flows
- Flood pools higher than previously attained
- Unexpected drop in pool level
- Pool near maximum level and rising
- Excessive rainfall or snowmelt
- Large discharge through spillway

- Erosion, landslide, seepage, settlement, and cracks in the dam or area
- Earthquakes

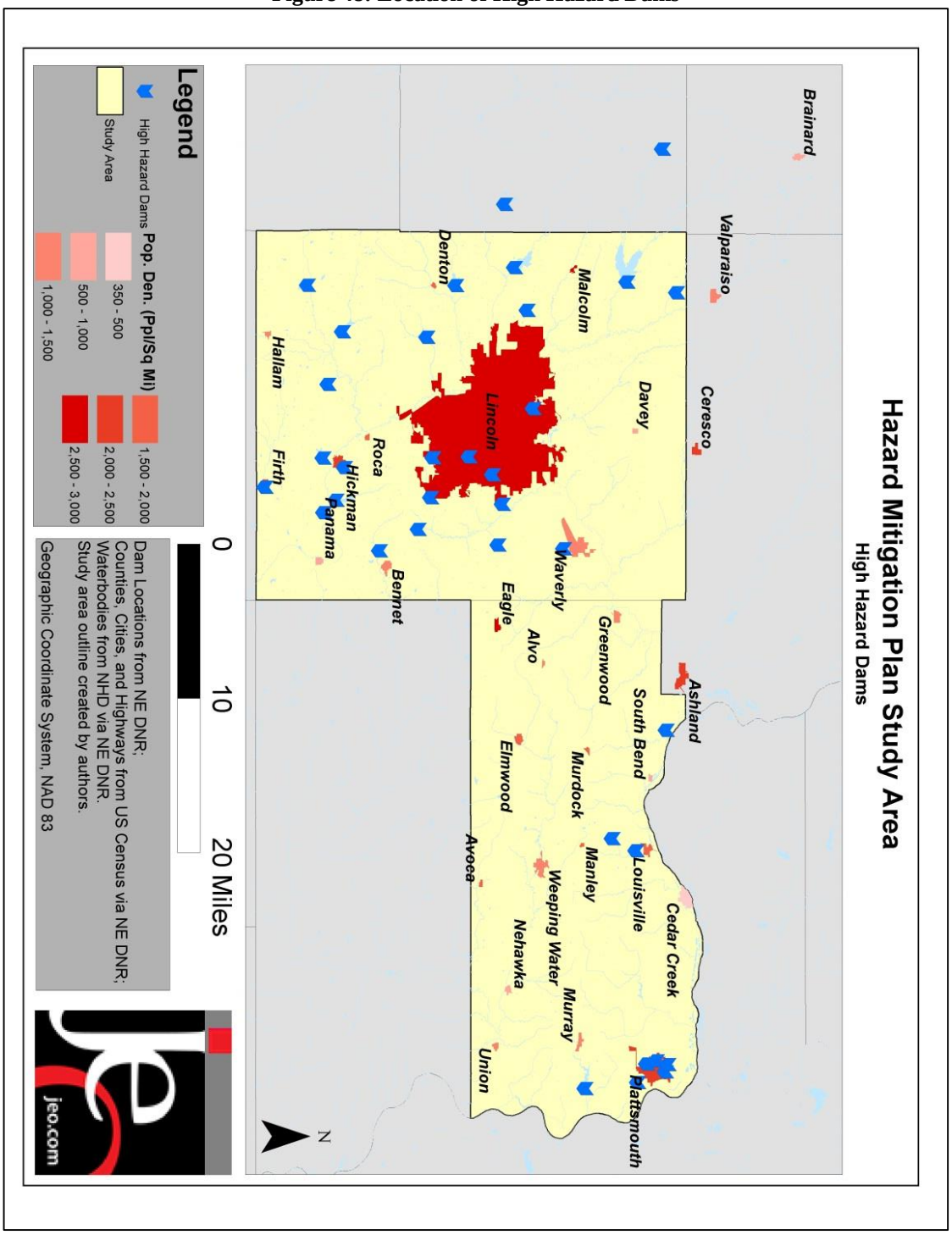
According to the DNR there are ten dams owned by LPSNRD, ten additional dams owned by the U.S. Army Corps of Engineers, along with an unconfirmed number of privately owned dams within the region. The high hazard dams are listed in Table 42 and depicted in Figure 48.

Table 42: Dams Summary for the LPSNRD

County	Total Number of Dams	Classification - Downstream Hazard Potential		
		High	Significant	Low
Cass	**67**	**8**	**23**	**35**
Lancaster	**147**	**25**	**17**	**105**
HMP Planning area	**214**	**34**	**40**	**140**

Source: NDNR
**Totals may not equal 100% due to boundary issues.*

Figure 48: Location of High Hazard Dams



NDNR regulates dam safety and has classified dams by the potential hazard each poses to human life and economic loss. The following are classifications and descriptions for each hazard class:

- **Minimal Hazard Potential** - failure of the dam would likely result in no economic loss beyond the cost of the structure itself and losses principally limited to the owner's property.

- **Low Hazard Potential -** failure of the dam would result in no probable loss of human life and in low economic loss. Failure may damage storage buildings, agricultural land, and county roads.

- **Significant Hazard Potential -** failure or misoperation of the dam would result in no probable loss of human life but could result in major economic loss, environmental damage, or disruption of lifeline facilities. Failure may result in shallow flooding of homes and commercial buildings or damage to main highways, minor railroads, or important public utilities.

- **High Hazard Potential -** failure or misoperation of the dam resulting in loss of human life is probable. Failure may cause serious damage to homes, industrial or commercial buildings, four-lane highways, or major railroads. Failure may cause shallow flooding of hospitals, nursing homes, or schools.

Dams that are classified with high hazard potential require the creation of an Emergency Action Plan (EAP). The EAP defines responsibilities and provides procedures designed to identify unusual and unlikely conditions which may endanger the structural integrity of the dam within sufficient time to take mitigating actions and to notify the appropriate emergency management officials of possible, impending, or actual failure of the dam. The EAP may also be used to provide notification when flood releases will create major flooding. An emergency situation can occur at any time; however, emergencies are more likely to happen when extreme conditions are present. The EAP includes information regarding the efficiency of emergency response entities so that proper action can be taken to prevent the loss of life and property. Local emergency response entities generally included in an EAP include but are not limited to 911 Dispatch, County Sheriffs, Local Fire Departments, Emergency Management Agency Director, County Highway Department, and the NWS. Table 43 lists those dams classified as "High Hazard Potential."

Table 43: High Hazard Dams in the LPSNRD

City	Name	NIDID	Purpose	Dam Height	Maximum Storage (acre-feet)	Last Inspection Date
Plattsmouth (Cass County)	Plattsmouth 10-A	NE00097	Flood Control	40	137	6/20/2012
Plattsmouth (Cass County)	Plattsmouth 18-A	NE00098	Flood Control	25	117	6/20/2012
Plattsmouth (Cass County)	Plattsmouth 12-A	NE00099	Flood Control	32	76	6/20/2012
Rural Rock Bluff (Cass County)	Beaver Lake Dam	NE00102	Recreational	96	12,760	8/31/2012
Plattsmouth (Cass County)	Plattsmouth 4-A	NE01888	Flood Control	25	16	6/20/2012
Plattsmouth (Cass County)	Plattsmouth 7-C	NE01889	Flood Control	26	19	6/20/2012
Rural Ashland (Cass County)	Qwest (Century Link) Dam	NE02322	Recreation	44	173	4/25/2012
Rural Louisville	Mill Creek Rd Site 7	NE02399	Flood Control	41	213	4/25/2012
Rural Louisville (Cass County)	Gaebel Dam	NE03241	Flood Control	37.5	None Given	None Given
Rural Sprague (Lancaster County)	Upper Salt Creek 3-A	NE00505	Flood Control	45	1,400	11/8/2012
Rural Hickman (Lancaster County)	Upper Salt Creek 35-A	NE00523	Flood Control	32	450	3/29/2012
Rural Lincoln (Lancaster County)	Wedgewood Lake Dam	NE00527	Recreation	16	236	10/24/2012
Rural Hickman (Lancaster County)	Upper Salt Creek 10-A	NE00533	Flood Control	36	1,689	4/10/2012
Firth (Lancaster County)	Upper Big Nemaha 11-A	NE00550	Flood Control	36	1,148	3/29/2012
Rural Denton (Lancaster County)	Salt Creek Site 12-Conestoga	NE001055	Flood Control	60	15,000	5/3/2012
Rural Hickman (Lancaster County)	Salt Creek Site 8-Wagon Train	NE001056	Flood Control	52	15,050	7/18/2012

City	Name	NIDID	Purpose	Dam Height	Maximum Storage (acre-feet)	Last Inspection Date
Rural Malcolm (Lancaster County)	Salt Creek site 14-Pawnee	NE01057	Flood Control	70	38,300	10/3/2012
Rural Denton (Lancaster County)	Salt Creek Site 10-Yankee Hill	NE01058	Flood Control	54	10,300	5/3/2012
Hickman (Lancaster County)	Salt Creek Site 9-Stagecoach	NE01059	Flood Control	48	10,200	7/18/2012
Lincoln (Lancaster County)	Salt Creek Site 17-Antelope Creek	NE01061	Flood Control	61	7,455	8/31/2011
Rural Sprague (Lancaster County)	Salt Creek Site 2-Olive Creek	NE01062	Flood Control	46	8,590	9/22/2010
Rural Raymond (Lancaster County)	Salt Creek Site 18-Branched Oak	NE01063	Flood Control	82	122,283	10/3/2012
Rural Sprague (Lancaster County)	Salt Creek Site 4-Bluestem	NE01064	Flood Control	59	17,550	8/31/2011
Rural Valparaiso (Lancaster County)	N Oak Creek 1-A	NE01665	Flood Control	48	3,168	8/23/2012
Lincoln (Lancaster County)	Hartland Homes North Dam	NE02516	Flood Control	21	27	11/9/2012
Rural Bennet (Lancaster County)	Upper Little Nemaha 21	NE02518	Flood Control	51	2,439	3/29/2012
Lincoln (Lancaster County)	Korver Dam	NE02652	Flood Control/ Other	35	383	5/17/2012
Rural Lincoln (Lancaster County)	Stevens Creek A2-1	NE02756	Flood Control	25	256	10/3/2012
Rural Lincoln (Lancster County)	Stevens Creek A17-1	NE02757	Flood Control	38	1,127	10/3/2012
Lincoln	Village Gardens Dam	NE02805	Flood Control	26	51	10/3/2012
Lincoln (Lancaster County)	Waterford Estates Dam	NE02837	Flood Control	38	2,081	10/3/2012
Waverly (Lancaster County)	Ash Hollow Dry Dam	NE08364	None Given	None Given	None Given	None Given

Location

For the purposes of this plan inundation areas for each of the dams identified in this plan are called breach routings. Breach routings are used to help delineate the area downstream of a dam potentially impacted by inundation should that dam fail and can be used in determining the dam's hazard potential. Breach routings used in conjunction with survey and topographic data can be used to determine the anticipated depth of flooding at specific structures or facilities. Due to the nature of this threat breach mapping will not be included in this document. If members of the public wish to view EAP and breach maps for dams in the planning area a request can be made to LPSNRD, Cass and Lancaster County Department of Emergency Management, or NDNR

Extent

Lives and properties in breach areas represent a very small portion of those in the planning area. Through a review of the EAPs for the dams in the planning area it was determined that less than 5% of the population live in breach inundation areas. There are a small number of CFs located in breach areas (six CFs including a city building, county shop, and other) as well as a small number of gathering places (five parks and golf courses). While a breach of a high hazard dam would certainly impact those in breach areas the total number of people and property exposed to this threat is very low. The communities with risks related to dam failure include: Ashland, Bennet, Cedar Creek, Firth, Greenwood, Hickman, Lincoln, Louisville, Plattsmouth, Roca, and Waverly.

HISTORICAL OCCURRENCES

No incidents of dam failure were reported throughout the LPSNRD either from dams owned privately, by local or county governments, by the U.S. Army Corps of Engineers, or by LPSNRD.

AVERAGE ANNUAL DAMAGES AND FREQUENCY

Due to lack of data and the sensitive nature of this hazard potential losses are not being calculated for this threat. Community members in the planning area that wish to quantify the threat of dam failure should contact LPSNRD, Cass or Lancaster County Department of Emergency Management, or the NDNR to view EAPs and breach inundation area maps.

VULNERABILITY ASSESSMENT

It was deemed, by both the public input and factual research that the planning area as a whole has not had previous occurrences of dam failure. The definition of dam failure for the purposes of this plan was considered 'sunny day failure,' of a full dam. This is a total dam failure in which the impounded water all flows downstream.

This was done because inundation maps are generated using this assumption. The probability of a dam failure to occur again is low with between 0 and 1 occurrence likely in a ten year span. Overall throughout the planning area, if a high hazard dam failure occurred, the majority of people and structures would not be affected by an inundation occurring as a result of a dam failure.

According to the NDNR dam database, there are thirty-four (34) high hazard dams within LPSNRD, which generally makes up the planning area. The vulnerability assessment for dam failure is discussed more specifically regarding dam failures in each jurisdiction's respective participant section. It shall be noted that the inundation maps for the high hazard dams in Nebraska are not available for public viewing because it is sensitive information. More detailed information can be sought after through the LPSNRD. EAPs and inundation areas were reviewed for the development of this plan. The planning team was very hesitant to include specific information related to dam inundation areas. It can be stated that less than 5% of structures and population are protected by dams. In addition, there are existing plans in place for the monitoring and inspection of dams.

Discussions were held with the NDNR to determine which high hazard dams could potentially inundate the incorporated cities, villages and towns within the jurisdictions of the planning area. Discussions on which dams can do this and their effects can be found in each participant section.

All dams are inspected on a regular basis and after extreme conditions have occurred. If problems are found during an inspection, the proper course of action is taken to ensure the structural integrity of the dam is preserved. In the event that dam failure is imminent, the EAP for the dam governs the course of action.

The unique characteristics of different jurisdictions allow dam failure to impact them differently. Villages, cities and SIDs are vulnerable in that structures could be inundated or destroyed and the loss of life or injury could occur. Residents in the rural areas of the counties can be affected by drought in the same way that incorporated communities are affected.

FUTURE DEVELOPMENT AND VULNERABILITY

According to the *Classification of Dams (2013)* developed and updated by NDNR, "the potential for future development must be taken into consideration when determining the hazard potential class for a dam. Any dam located in close proximity to a city or village as detailed in Table 44 must be designed to meet the requirements for a high hazard potential structure. The design requirements can be adjusted if development in the downstream breach inundation area is sufficiently curtailed due to zoning restrictions, easements, deed restrictions, or other methods of restriction acceptable to the Department."

Table 44: Dam Classification

Incorporated Class	Population	Located within or within given distance of jurisdictional limits of City of Village
Metropolitan	≥ 300,000	3 Miles
Primary	> 100,000 up to 300,000	3 Miles
First	> 5,000 up to 100,000	2 Miles
Second	> 800 up to 5,000	1 Mile
Village	100 up to 800	1 Mile

Land-use regulations should prohibit development within floodplains and areas currently protected by existing levees and dams with jurisdictions that are still able to grow. Dam failure should not be a significant threat to future development and losses should be insignificant. Communities should encourage structures currently protected by levees to purchase flood insurance from the NFIP whether they are technically located in the floodplain or not.

RISK ASSESSMENT SUMMARY

Overall, the risk and vulnerability assessment shows that dam failure has approximately a 1% chance of occurring every year, with limited impacts.

MITIGATION ALTERNATIVES

Hazard mitigation options for dam failure include most of the wide-range of actions described previously for flooding, as well as additional actions related to warning and evacuation.

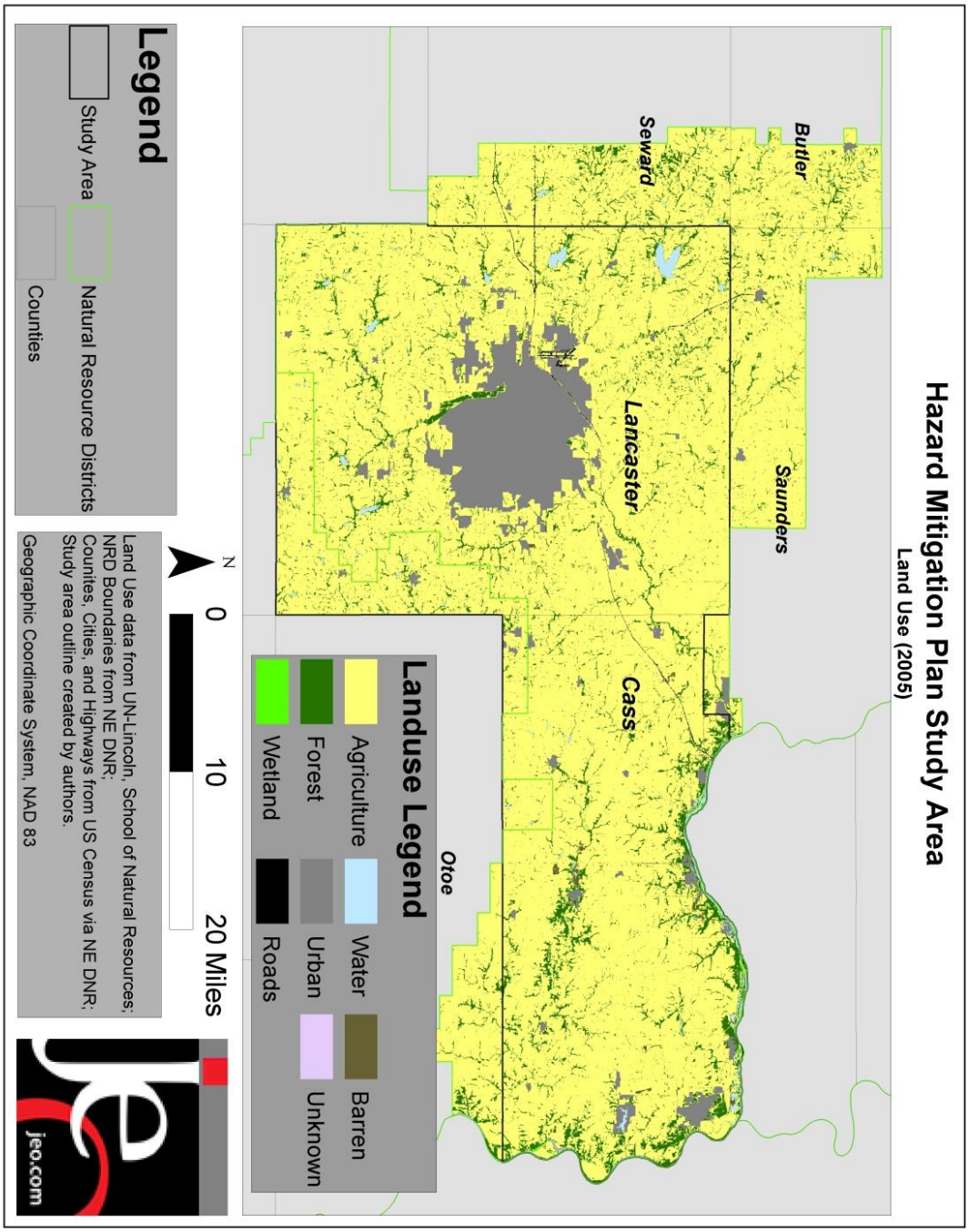
Agriculture Diseases

HAZARD PROFILE

Agriculture Disease (Ag Disease) is any biological disease or infection that can reduce the quality or quantity of either livestock or vegetative crops. This section looks at both animal disease and plant disease as both make up a significant portion of the Nebraska and the planning area's economy.

The state of Nebraska has one of the country's largest economies that is vested in both livestock and crop sales. According to the Department of Agriculture, in 2005, agriculture cash receipts totaled $11.4 billion dollars with $7.5 billion being livestock and $3.9 billion being in vegetative crops. In the state, one in three jobs are in the agriculture industry. Nebraska also totaled $2.8 billion in revenue due to agriculture exports with $498 million in livestock exports and $2.3 billion in vegetative exports.

Figure 49: Land Use in the LPSNRD



EXTENT

The likely extent of crop or livestock disease would be minor. Based on reports from participating jurisdictions most occurrences are limited in scope and geographic area. It is possible that large scale events could occur. Future updates could develop more statistics to provide a better quantification of extent related to agricultural diseases.

HISTORICAL OCCURRENCES

According to the State of Nebraska HMP Update (2011) and the Department of Agriculture the following four diseases were reported as having occurred throughout the 93 counties in Nebraska impacting livestock.

- **Chronic Wasting Disease (CWS)** – This disease was first reported in mule deer, white-tailed deer, black-tailed deer, and elk populations in the state's panhandle region beginning in 1998. Symptoms of the disease include weight loss, as well as incessant drinking and urination. An infected animal often stands listlessly, head down and ears drooping, with saliva dripping from its mouth. Between the years of 1997 and 2006 the Nebraska Game and Parks Commission confirmed 117 positive tests of CWS statewide. The livestock within the state have had no confirmed cases of the disease.

- **Vesticular Stomatitis (VS)** - In 2005, Nebraska had three horses test positive for VS. VS primarily affects cattle, horses, and swine, causing blisters on lips, tongues, and coronary bands. The blisters enlarge and break, leaving raw tissue that is so painful the animals refuse to eat or drink, and they become lame. Severe weight loss usually follows. In a herd affected by VS, nearly 90% of the animals may show clinical signs and nearly all develop antibodies. The disease is spread through direct contact between animals as well as through biting insects. If not properly handled, VS can be spread to humans and cause acute influenza like symptoms for four to seven days. There have been no new confirmed reports of VS in Nebraska since 2005.

- **Epizootic Hemorrhagic Disease (EHD)** - Commonly known as "blue tongue," is an acute, infectious, often fatal viral disease of some wild ruminants. It is characterized by extensive hemorrhaging, has been responsible for significant epizootics in deer in the northern United States and southern Canada. There have been ongoing confirmed reports of periodic outbreaks over the last fifty years in the state's deer population since the disease was first identified in 1955. All documented outbreaks of EHD have occurred during the late summer or early fall. Deer in the state's panhandle appear to be the most at risk when compared to other areas of the state. There have been no reports of EHD among the state's livestock; only wild game has been affected. The economic impact from such outbreaks could negatively impact businesses and communities that are reliant upon hunting for the majority of their sales or income.

- **Bovine Tuberculosis** - In the later stages of the disease it is easier to see the clinical symptoms of Bovine Tuberculosis. According to the USDA, symptoms include: emaciation, lethargy, weakness, anorexia, low-grade fever, and pneumonia with a chronic, moist cough. Enlarged lymph nodes may also be present. The disease gets into cattle herds by infected cattle, cervids, swine, and humans. Bovine Tuberculosis can be spread through the respiration of bacteria aerosols, contaminated feed or watering sites, or by drinking milk that is unpasteurized from infected animals. There is a high risk of contamination in enclosed areas such as barns that have poor ventilation. Bovine Tuberculosis primarily affects cattle but can be passed easily to any warm-blooded animal. In certain, but rare, conditions the disease can effect humans. In June of 2009, two beef cows in Rock County tested positive for the disease. In response to the findings, NDA staff coordinated with federal animal disease officials to properly respond. The NDA with the help of federal officials tested 21,764 head of cattle in association with the investigation. As the NDA traced cattle movement into and out of the affected herd, 61 herds of cattle were quarantined in 20 of Nebraska's 93 counties. By April 7, 2010 all but three of those herds were released from quarantine. The herd that was initially affected was also released from quarantine and endured tests that are part of the USDA federal test and remove strategy.

Between 1/1/2009 and 12/31/2009, 582 cases of the above described diseases were reported to the State of Nebraska from various counties.

Table 45 shows the population of livestock within Cass and Lancaster County. This count obviously does not include wild populations that are also at risk from agriculture diseases.

Table 45: Livestock Inventory Cass & Lancaster Counties

County	Market value of Livestock Sales	Head of Cattle	Hogs & Pigs	Chickens	Horses & Ponies	Pheasants
Cass County	**$9,992,000**	**10,848**	**5,698**	**2,514**	**634**	**--**
Lancaster County	**$27,085,000**	**23,323**	**13,207**	**3,122**	**--**	**1,981**

In regards to diseases involving animals, the NDA provides reports on diseases occurring in Cass and Lancaster Counties. Table 46 includes those diseases and numbers of occurrences within the planning area between January 1, 2013 and January 1, 2014.

Table 46: Animal Diseases Recorded by the NDA

Disease	Species Impacted	Number Of Occurrences
Anaplasmosis	Bovine	0
Bluetounge (Bovine EHD)	Bovine	8
Bovine Viral Diarrhea	Bovine	4
Caprine Arthritis/Encephalitis	Caprine/Ovine	1
Enzootic Bovine Leukosis	Bovine	1
EHD	Cervid	0
Leptospirosis	Bovine	0
Paratuberculosis	Bovine	2
Porcine Reproductive and Respiratory Disease	Porcine	3
West Nile Fever	Bovine	1

However, the above listed diseases are not the only ones that could impact animals. Information on diseases and rates of disease among “free range game” is lacking due to lack of laboratory testing, reporting, and field study.

For crops, according to the NDA, the primary crops grown throughout the state include alfalfa, corn, sorghum, soybeans, and wheat. The following table provides the value and acres planed of the top crops in the state.

Table 47: Crop Diseases Recorded by the NDA

Crop	Acres Planted	Value	U.S. Ranking in Sale
Alfalfa	2,563,515	$388,557,000	8th
Corn	9,192,656	$9,369,600,000	3rd
Sorghum	236,607	$38,690,000	4th
Soybeans	3,834,855	$2,971,658,000	7th
Wheat	1,964,302	$440,438,000	9th

Table 48: Land in and Value of Farms in Cass and Lancaster County

County	Number of Farms	Land in Farms	Market value of Crop Sales
Cass County	682	280,290	$88,160,000
Lancaster County	1,698	421,409	$98,824,000

Table 49: Crops Totals Cass & Lancaster County

Crop	Acres Planted: Cass County	Value	Acres Planted: Lancaster County	Value
Corn	114,816	$42,946,000	127,261	$46,919,000
Wheat	3,769	$826,000	16,176	2,927,000
Oats	136	NA	87	NA
Soybeans	NA	$42,132,000	NA	$40,695,000

The above list does not account for all crops in the region as there are others such as Sugar Beets, Dry Beans, Sunflowers, and Chickpeas. There are many diseases that can impact crops that vary from year to year. The Department of Agriculture provides information on some of the most common, being:

Table 50: Common Crop Diseases in Nebraska by Crop Types

Crop	Diseases	
Corn	• Anthracnose • Bacterial Stalk Rot • Common Rust • Fusarium Stalk Rot • Fusarium Root Rot • Gray Leaf Spot • Maize Chlorotic Mottle Virus	• Southern Rust • Stewart's Wilt • Common Smut • Goss's Wilt • Head Smut • Physoderma
Soybeans	• Anthracnose • Bacterial Blight • Bean Pod Mottle • Brown Spot • Brown Stem Rot • Charcoal Rot • Frogeye Leaf Spot • Phytophthora Root and Stem Rot • Pod and Stem Blight	• Purple Seed Stain • Rhizoctonia Root Rot • Sclerotinia Stem Rot • Soybean Mosaic Virus • Soybean Rust • Stem Canker • Sudden Death Syndrome
Wheat	• Barley Yellow Dwarf • Black Chaff • Crown and Root Rot • Fusarium Head Blight	• Leaf Rust • Tan Spot • Wheat Soil-borne Mosaic • Wheat Streak Mosaic
Sorghum	• Ergot • Sooty Stripe • Zonate Leaf Spot	

In addition to the viral and bacterial disease that could impact crops, pests can also result in crop loss or quality of crop. Those pests are:

- Grasshoppers,
- Western Bean Cutworm,
- European Corn Borer,
- Corn Rootworm,
- Corn Nematodes, Bean Weevil,
- Mexican Bean Beatle,
- Soybean Aphids, and
- Rootworm Beatles

With the lack of reporting and data gathering, it's hard to determine an accurate account of disease and pests that occur in livestock and plants each year.

AVERAGE ANNUAL DAMAGES AND FREQUENCY

Due to the variable nature of the event, regional implications, duration, potential number of sectors affected it is not feasible to utilize the 'damage estimate formula' to estimate potential losses for the planning area.

VULNERABILITY ASSESSMENT

Based on research and public input it is likely that agricultural diseases will continue to impact the planning area. There have not been significant impacts reported in the planning area previously. Obviously the agricultural sector is most vulnerable to this threat, but in large incidents it is likely that costs for food and basic essentials would increase resulting in impacts to the entire population. Future updates can do more to project possible vulnerabilities and impacts

FUTURE DEVELOPMENT AND VULNERABILITY

Overall, the planning area is experiencing slight growth. However, there is a wide range of growth and decline among the individual participating jurisdictions. There are many strategies that can be undertaken to protect both existing and future assets. As development continues in the State of Nebraska and LPSNRD, most development is estimated to be urban development within municipal boundaries and little development in the land designated for agriculture use.

RISK ASSESSMENT SUMMARY

Overall, the risk and vulnerability assessment shows that agricultural disease is likely to occur annually with limited impacts.

MITIGATION ALTERNATIVES

Hazard mitigation options for agricultural diseases focus primarily on education and outreach.

Fixed Site Hazards (Chemical & Radiological)

HAZARD PROFILE

The following description for hazardous materials is provided by the FEMA:

Chemicals are found everywhere. They purify drinking water, are used in agriculture and industrial production, fuel our vehicles and machines, and simplify household chores. But chemicals also can be hazardous to humans or the environment if used or released improperly. Hazards can occur during production, storage, transportation, use, or disposal. The community is at risk if a chemical is used unsafely or released in harmful amounts.

Hazardous materials in various forms can cause fatalities, serious injury, long-lasting health effects, and damage to buildings, homes, and other property. Many products containing hazardous chemicals are used and stored in homes routinely. These products are also shipped daily on the nation's highways, railroads, waterways, and pipelines.

Chemical manufacturers are one source of hazardous materials, but there are many others, including service stations, hospitals, and hazardous materials waste sites.

Varying quantities of hazardous materials are manufactured, used, or stored at an estimated 4.5 million facilities in the United States--from major industrial plants to local dry cleaning establishments or gardening supply stores.

Hazardous materials come in the form of explosives, flammable and combustible substances, poisons, and radioactive materials. These substances are most often released as a result of transportation accidents or because of chemical accidents in plants.

Hazardous material incidents are technological (meaning non-natural hazards created or influenced by humans) events that involve large-scale releases of chemical, biological or radiological materials. Hazardous materials incidents general involve releases at fixed-site facilities that manufacture, store, process or otherwise handle hazardous materials or along transportation routes such as major highways, railways, navigable waterways and pipelines.

The U.S. Environmental Protection Agency requires industry to report information on toxic chemical releases and water management activities, through the Toxics Release Inventory (TRI) Program. In the previous decade TRI reporting requirements were lessened; thereby limiting available data on chemical releases and disposal. The federal government in recent years reinstated stricter reporting requirements for industrial and federal facilities that release toxic substances with potential to threaten human health and the environment. Those requirements went into effect in April of 2009 and data from these reports is now available.

EXTENT

Fixed-sites are those that involve chemical manufacturing sites and stationary storage facilities. Table 51 demonstrates the nine classes of hazardous material according to the 2012 Emergency Response Guidebook.

Table 51: Classes of Hazardous Material

Class	Type of Material	Divisions
1	Explosives	Division 1.1 – Explosives with a mass explosion hazard Division 1.2 – Explosives with a projection hazard Division 1.3 – Explosives predominantly a fire hazard Division 1.4 – Explosives with no significant blast hazard Division 1.5 – Very insensitive explosives with a mass explosion hazard Division 1.6 – Extremely insensitive articles
2	Gases	Division 2.1 – Flammable gases Division 2.2 – Non-flammable, non-toxic gases Division 2.3 – Toxic gases
3	Flammable Liquids (and Combustible Liquids)	
4	Flammable solids; Spontaneously combustible materials	Division 4.1 – Flammable solids Division 4.2 – Spontaneously combustible materials Division 4.3 – Water-reactive substances/Dangerous when wet materials
5	Oxidizing substances and Organic peroxides	Division 5.1 – Oxidizing substances Division 5.2 – Organic peroxides
6	Toxic substances and infections substances	Division 6.1 – Toxic Substances Division 6.2 – Infectious substances
7	Radioactive Materials	
8	Corrosive Materials	
9	Miscellaneous hazardous materials/Products, Substances, or Organisms	

Based on historic record it is possible for all but Class 7 to occur within the planning area.

HISTORICAL OCCURRENCES

According to the Pipeline and Hazardous Materials Safety Administration (PHMSA), damages resultant from hazardous materials incidents total $1,205,554.00 from 1990 to 2012.

The following table provides the number of chemical spills going back to 1990 to 2012.

Table 52: Number of Fixed Site Chemical Spills

Year	Number of Chemical Spills	Number of Injuries	Total Damages	Evacuation
2012	12	0	$94,597.00	31 people evacuated
2011	7	0	$231,000.00	0
2010	4	0	$893.00	0
2009	3	0	$0.00	0
2008	11	0	$1,840.00	0
2000-2007	55	0	$596,805.00	0
1990-1999	68	3	$280,419.00	1 person evacuated

(PHMSA)

Planning team members report that on February 8, 2013 crews were working on replacing a gas vaporizer outside Conestoga High School when the propane gas line was broken. When the crews completed the replacement and charged the gas lines, propane gas leaked into the school with personnel reporting the smell of propane in the building. Three hundred and fifty students were evacuated and Hazardous Materials crews from Offutt, the Nebraska State Patrol, Cass County Sheriff and Emergency Management responded. No injuries or damages beyond the broken propane line were reported.

There are no reports of radiological incidents at fixed site locations within the Lower Platte South region.

Average Annual Damages and Frequency

Due to the variable nature of the event, regional implications, duration, and potential number of sectors affected it is not feasible to utilize the 'damage estimate formula' to estimate potential losses for the planning area. In future updates a scenario based risk assessment should be included to help quantify potential impacts.

Vulnerability Assessment

The communities of Manley and Bennet reported High vulnerability to people and CFs indicating that over 40% of their community's population and CFs could be impacted by hazardous materials incidents. The community of Valparaiso indicated a High vulnerability to CFs.

In reference to fixed-site events involving radiological materials, the overall vulnerability of population, CFs and infrastructure was low with less than 10% of people and property being impacted. The Lancaster County LEOP identifies facilities with radiological resources. The most significant threat for radiological fixed sites in the state are the Cooper Nuclear Station and the Fort Calhoun Nuclear Station. The planning area is outside of the evacuation areas for these facilities.

Individuals in close proximity to an incident could see minor to moderate health impacts depending upon the extent of the incident.

Future Development and Vulnerability

The impacts to people and property from chemical/radiological incidents are potentially severe. Most chemical/radiological transportation incidents occur on a weekday during times when day care centers and schools are likely to be in session. Other vulnerable facilities and groups include hospitals, nursing homes, and housing units with low mobility individuals and families. Vulnerable populations will live along major transportation routes or near chemical/radiological fixed site locations.

Risk Assessment Summary

Overall, the risk and vulnerability assessment shows that fixed site hazards are likely to occur annually within the planning area with limited impacts.

Mitigation Alternatives

Mitigation alternatives for this hazard include training; outreach and education; and planning to ensure that CFs are placed in lower risk areas when possible.

Transportation Incidents (Chemical, Radiological, and Severe Incidents)

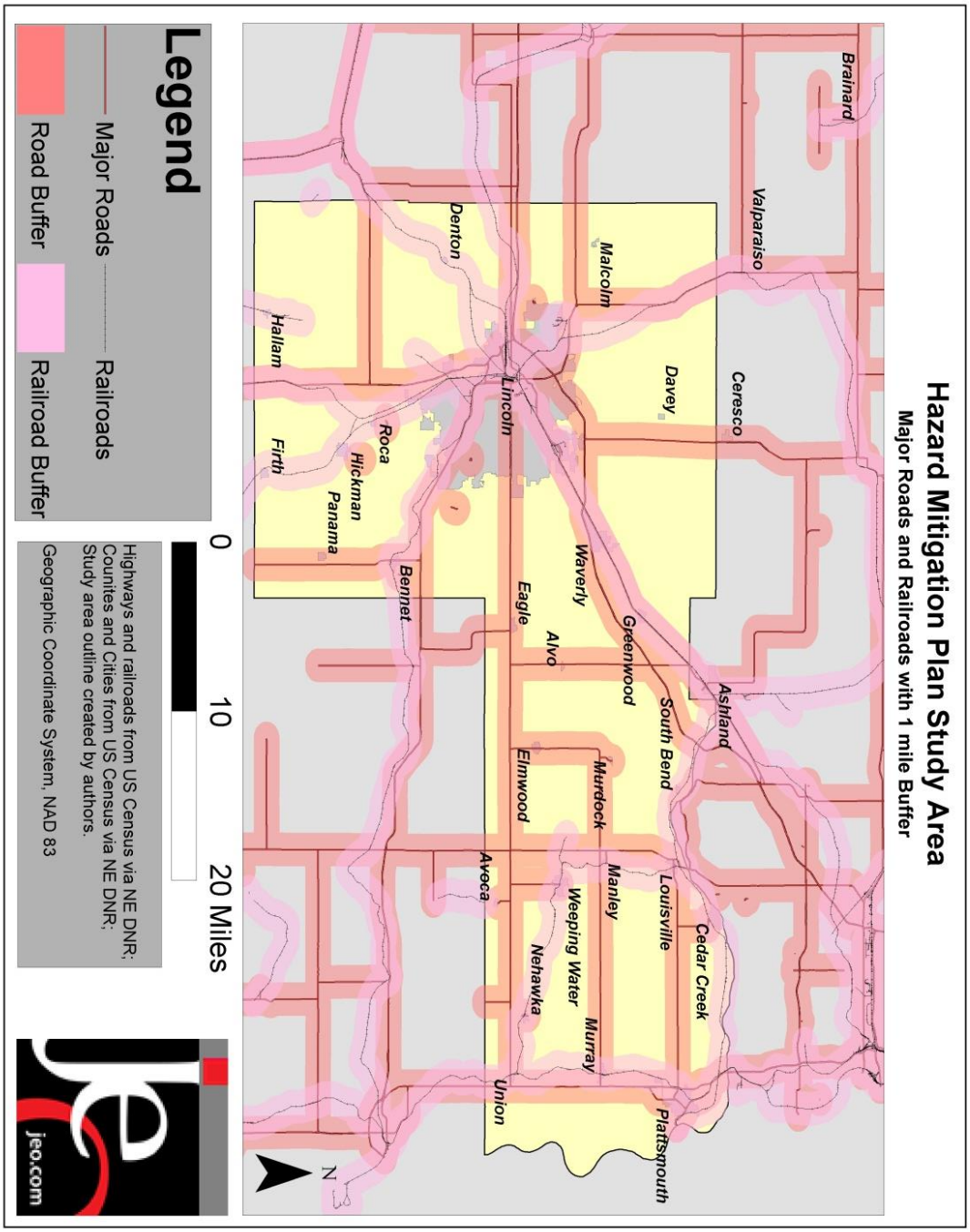
HAZARD PROFILE

The description for hazardous materials is provided by the FEMA can be found in the Fixed Site Hazards profile

EXTENT

Location

Figure 50: LPSNRD Transportation Routes



Based on historic records it is likely that any spill involving hazardous materials that occur will not affect any area larger than one mile around the spill that occurs.

HISTORICAL OCCURRENCES

In the State of Nebraska, according to the PHMSA, there have been 1,782 incidents involving hazardous materials being transported by air, highway, railway and water. These incidents involved at least 276 various forms of toxic materials across the classifications described by the Emergency Response Guidebook.

Of these 1,782 incidents, 385 of those occurred within in the planning area starting with the first reported on August 3, 1978 to October 10, 2012. During these events, there have been no fatalities, one injury requiring hospitalization, eight injuries not requiring hospitalization, and $1,883,963.00 in damages.

The following table provides a list of those events that have caused some of the most significant damages due to transportation incidents involving hazardous materials.

Table 53: Transportation Incidents Involving Hazardous Materials

Date of Event	Large Spill Events	Material Involved	Method of Transportation	Total Damage
9/29/2012	Eastbound Hwy 2 truck pulling a flatbed trailer crashed into another truck causing one container to slide off of the trailer. Lincoln/Lancaster Fire Department and Health Department responded. Hwy 2closed for 4 hours	Radioactive Materials	Highway	$86,371
5/29/2012	AT 3:54pm. Report of BNSF tank car leaking in Cass County near the Louisville State Recreation Area. Louisville SRA was evacuated; BNSF staff inspected train, no leak found.	Alcohol N.O.S.	Rail	$1,500

Date of Event	Large Spill Events	Material Involved	Method of Transportation	Total Damage
5/12/2012	Tractor-trailer struck the rear of another truck causing the load of 16 totes to move forward due to improper bracing. One tote crack open releasing the product throughout the trailer. Highway 2 closed for 4 hours.	Corrosive Liquid (Basic)	Highway	$5,000
6/9/2011	Westbound Hwy 80, truck loaded with Nutrisphere left the roadway, overturned, and discharged 250 LGA. The truck driver was taken to the hospital. Lincoln/Lancaster Fire Department, Health Department, and ESI responded to the incident.	Corrosive Liquids (N.O.S.)	Highway	$231,000
10/8/2004	Train derailment resulted in 10,200 LGA being released. The northbound lane of Hwy 77 was closed in the area for more approximately 8 hours.	Flammable Liquids (toxic)	Rail	$500,000

Date of Event	Large Spill Events	Material Involved	Method of Transportation	Total Damage
12/8/2003	Trailer overturned resulting in the release of 260 LGS of fuel oil.	Fuel Oil (NO. 1, 2,4 or 5)	Highway	$70,500
6/29/1998	Train derailment resulted in the release of 25,000 LGA of materials.	Elevated Temperature Liquid	Rail	$46,000
4/24/1995	Paint spotted leaking from a parked trailer, total release of 15 LGA.	Paint	Highway	$6,770
12/26/1994	Train derailed, one tanker car turned over resulted in the release of 23,000 LGA of Denatured Alcohol.	Denatured Alcohol	Rail	$101,050
3/1/1992	Tractor trailer overturned on westbound I80. Resulted in the release of 450 SLB of Hydrochloric Acid.	Hydrochloric Acid	Highway	$28,000

Date of Event	Large Spill Events	Material Involved	Method of Transportation	Total Damage
1/16/1992	Spill while delivering fuel to a service station. Resulted in the release of 4154 LGA of fuel oil.	Fuel Oil (NO. 1, 2, 4, 5 OR 6)	Highway	$12,054
3/10/1990	Truck overturned due to poor visibility and accidents blocking the roadway. Resulted in the release of 50 LGA of alcoholic beverages.	Alcoholic Beverages	Highway	$73,431

Source: PHMSA

There is no record of radiological releases having occurred within the planning area.

AVERAGED ANNUAL DAMAGES AND VULNERABILITY

The average damage per event estimate was determined based upon PHMSA since 1980 and number of historical occurrences of large spill events. This does not include losses from displacement, functional downtime, economic loss, injury, or loss of life. According to the table below, significant chemical releases have a 36% chance of occurring per year. They would cause $35,202 per year and $96,806 per event due to hazardous material spills for the whole LPSNRD area.

Table 54: Chemical Release Loss Estimation

Hazard Type	Number of Events	Annual Frequency	Total Property Loss	Annual Property Loss[1]	Total Crop Loss	Annual Crop Loss
Transportation Incidents	12	.36	$1,161,676	$35,202	$0	$0

Source: PHMSA

VULNERABILITY ASSESSMENT

The impacts to people and property from chemical/radiological transportation incidents are potentially severe. Most chemical/radiological transportation incidents occur on a weekday during times when day care centers and schools are likely to be in session. Other vulnerable facilities and groups include hospitals, nursing homes, and housing units with low mobility individuals and families. Vulnerable populations live along major transportation routes or near chemical/radiological fixed site locations.

Most people are vulnerable to some form of transportation related incident. Homes located near airports may statistically be more vulnerable to airplane related events.

RISK ASSESSMENT SUMMARY

Overall, the risk and vulnerability assessment shows that transportation incidents are likely low impact, however there is potential for severe impacts.

MITIGATION ALTERNATIVES

Mitigation actions related to this threat include:

- Drills and exercises within potential impact zones;
    - Cass and Lancaster EMAs regularly conduct exercises related directly to chemical release incidents
- Studies to identify the primary hazardous materials transported along specific routes;
    - Highly dangerous chemicals and radiological materials are required to provide routing information
- Restrict transportation of hazardous materials at high traffic times or in high traffic areas; and
    - Transportation of chemicals in monitored
- Provide shelter-in-place kits and training for vulnerable populations such as child care and nursing homes
    - Lancaster EMA has Decon Trailer distributed throughout the county

Terrorism

HAZARD PROFILE

According to the Federal Bureau of Investigation (FBI), there is no single, universally accepted, definition of terrorism. Terrorism is defined in the CFR as "the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives" (28 C.F.R. Section 0.85).

The FBI further describes terrorism as either domestic or international, depending on the origin, base, and objectives of the terrorist organization. For the purpose of this report, the FBI will use the following definitions:

- Domestic terrorism is the unlawful use, or threatened use, of force or violence by a group or individual based and operating entirely within the United States or Puerto Rico without foreign direction committed against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof in furtherance of political or social objectives.

- International terrorism involves violent acts or acts dangerous to human life that are a violation of the criminal laws of the United States or any state, or that would be a criminal violation if committed within the jurisdiction of the United States or any state. These acts appear to be intended to intimidate or coerce a civilian population, influence the policy of a government by intimidation or coercion, or affect the conduct of a government by assassination or kidnapping. International terrorist acts occur outside the United States or transcend national boundaries in terms of the means by which they are accomplished, the persons they appear intended to coerce or intimidate, or the locale in which their perpetrators operate or seek asylum.

There are different types of terrorism depending on the target of attack, which are:

- Political Terrorism
- Bio-Terrorism
- Cyber-Terrorism
- Eco-Terrorism
- Nuclear-Terrorism
- Narco-terrorism

Terrorist activities are also classified based on motivation behind the event such as ideology (i.e. religious fundamentalism, national separatist movements, and social revolutionary movements). Terrorism can also be random with no ties to ideological reasoning.

The FBI also provides clear definitions of a terrorist incident and prevention:

- A terrorist *incident* is a violent act or an act dangerous to human life, in violation of the criminal laws of the United States, or of any state, to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives.

- Terrorism *prevention* is a documented instance in which a violent act by a known or suspected terrorist group or individual with the means and a proven propensity for violence is successfully interdicted through investigative activity.

Note: *The FBI investigates terrorism-related matters without regard to race, religion, national origin, or gender. Reference to individual members of any political, ethnic, or religious group in this report is not meant*

to imply that all members of that group are terrorists. Terrorists represent a small criminal minority in any larger social context.

Primarily, threat assessment, mitigation and response to terrorism are federal and state directives and work primarily with local law enforcement. The Office of Infrastructure Protection within the Federal DHS is a component within the National Programs and Protection Directorate.

The Office of Infrastructure Protection leads the coordinated national program to reduce and mitigate risk within 18 national CIKR sectors from acts of terrorism and natural disasters and to strengthen sectors' ability to respond and quickly recover from an attack or other emergency. This is done through the National Infrastructure Protection Plan (NIPP).

Under the NIPP, a Sector-Specific Agency (SSA) is the federal agency assigned to lead a collaborative process for infrastructure protection for each of the 18 sectors. The NIPP's comprehensive framework allows the Office of Infrastructure Protection to provide the cross-sector coordination and collaboration needed to set national priorities, goals, and requirements for effective allocation of resources. More importantly, the NIPP framework integrates a broad range of public and private CIKR protection activities.

The Sector-Specific Agencies provide guidance about the NIPP framework to state, tribal, territorial and local homeland security agencies and personnel. They coordinate NIPP implementation within the sector, which involves developing and sustaining partnerships and information-sharing processes, as well as assisting with contingency planning and incident management.

The Office of Infrastructure Protection has Sector-Specific Agency responsibility for six of the 18 CIKR sectors. Those six are:

- Chemical
- Commercial Facilities
- Critical Manufacturing
- Dams
- Emergency Services
- Nuclear Reactors, Materials and Waste

Sector-Specific Agency responsibility for the other 12 CIKR sectors is held by other DHS components and other federal agencies. Those 12 are:

- Agriculture and Food – Department of Agriculture; Food and Drug Administration
- Banking and Finance – Department of the Treasury
- Communications – DHS
- Defense Industrial Base – Department of Defense
- Energy – Department of Energy
- Government Facilities – DHS
- Information Technology – DHS
- National Monuments and Icons – Department of the Interior
- Postal and Shipping – Transportation Security Administration
- Healthcare and Public Health – Department of Health and Human Services
- Transportation Systems – Transportation Security Administration; U.S. Coast Guard
- Water – Environmental Protection Agency

The NIPP requires that each Sector-Specific Agency prepare a Sector-Specific Plan, review it annually, and update it as appropriate.

The DHS and its affiliated agencies are responsible for disseminating any information regarding terrorist activities in the country. The system in place is the National Terrorism Advisory System (NTAS). NTAS replaced the Homeland Security Advisory System (HSAS) which was the color coded system put in place after the September 11th attacks by Presidential Directive 5 and 8 in March of 2002. NTAS replaced HSAS in 2011.

NTAS is based on a system of analyzing threat levels and providing either an imminent threat alert or an elevated threat alert.

An ***Imminent Threat Alert*** warns of a credible, specific and impending terrorist threat against the United States.

An ***Elevated Threat Alert*** warns of a credible terrorist threat against the United States.

The DHS, in conjunction with other federal agencies, will decide whether a threat alert of one kind or the other should be issued should credible information be available.

Each alert provides a statement summarizing the potential threat and what, if anything should be done to ensure public safety.

The NTAS Alerts will be based on the nature of the threat: in some cases, alerts will be sent directly to law enforcement or affected areas of the private sector, while in others, alerts will be issued more broadly to the American people through both official and media channels.

An individual threat alert is issued for a specific time period and then automatically expires. It may be extended if new information becomes available or the threat evolves. The ***sunset provision*** contains a specific date when the alert expires as there will not be a constant NTAS Alert or blanket warning that there is an overarching threat. If threat information changes for an alert, the Secretary of Homeland Security may announce an updated NTAS Alert. All changes, including the announcement that cancels an NTAS Alert, will be distributed the same way as the original alert.

EXTENT

Location

Due to the often times unforeseen nature of terrorist events, all CFs in the LPSNRD are at risk and vulnerable to terrorism.

HISTORICAL OCCURRENCES

Since January 1, 1980 there have been 104,000 terrorist incidents throughout the world with 1,005 of those occurring within the borders of the United States. The costliest terrorist incidents in United States history were the events of September 11, 2001 at the World Trade Center, the Pentagon, and Shanksville, Pennsylvania. Events that have occurred in the planning area meeting the definition of ‘terrorism’ include five incidents, all of which are centered on government buildings and the University of Nebraska.

Table 55: Terrorist Events

Date	Event	Area Impacts	Results	Injuries
06/12/13	White Powder Discovered in an Envelope	Nebraska Department of Motor Vehicles	Evacuation of DMV	None
01/21/13	White powder in an envelope	Apothecary Building, Lawyer's office	None	None
02/24/11	Gunman on UNL's East Campus	University of Nebraska-Lincoln, East Campus and Wesleyan College Campus	Campus locked down for 90 minutes	None
12/04/07	White powder in an envelope	Immigration and Naturalization Service Building	None	None
06/09/05	Powder Discovered in the mailroom	Immigration and Naturalization Service Building	Evacuation of INS	None

Average Annual Damages and Frequency

The "damage estimator" was not used for this hazard due to lack of data and historic impacts.

Vulnerability Assessment

Given the sensitive nature of this threat a full vulnerability assessment was not completed. It should be noted that there are currently plans, procedures, and monitoring in place related to this threat.

Future Development and Vulnerability

The impacts to people and property from terrorist incidents are potentially severe. Most terrorist incidents occur on a weekday when governmental, business, and other CFs are staffed to inflict the most damage, injuries, and fatalities possible. It is important that CFs be protected; in many of the villages in the planning area this could mean fences around water towers and wells or vehicular barriers around schools and community facilities.

Risk Assessment Summary

Overall, the risk and vulnerability assessment shows that events meeting the definition of Terrorism have a 55% chance to occur per year. Past impacts due to terrorism in the planning area have historically been minimal. However, impacts have the potential to be severe.

Mitigation Alternatives

Mitigation alternatives for terrorism include:

- Training and exercises;
- Education and outreach;
- Vehicular barrier and other building protection measures; and
    - Identified by multiple jurisdictions as a potential project
    - City of Lincoln already has these located at the Federal Building and other CFs throughout the community
- General awareness raising programs such as "See Something, Say Something."

Civil Disorder

HAZARD PROFILE

Civil disorder, also known as civil unrest or civil strife, is a broad term that is typically used by law enforcement to describe one or more forms of unrest caused by a group of people. Civil disturbance is typically a symptom of, and a form of protest against, major socio-political problems; the severity of the action coincides with public expression(s) of displeasure. Examples of civil disorder include, but are not necessarily limited to: illegal parades; sit-ins and other forms of obstructions; riots; sabotage; and other forms of crime. It is intended to be a demonstration to the public and the government, but can escalate into general chaos.

EXTENT

Location

Instances of civil disorder can occur anywhere at any time throughout the United States and more specifically throughout the LPSNRD. According to history, the most likely location of occurrence is at governmental offices and other gathering sites for large crowds such as sports arenas. The city of Lincoln has both governmental offices at the state and federal levels and two large sports arenas, Memorial Stadium and Pinnacle Bank Arena.

Based on historic record it is likely that any event of civil disorder in the planning area will remain peaceful.

HISTORICAL OCCURRENCES

Throughout American history civil disorder, at times, has been a part of our society. Since the 18th Century, there have been 349 recorded instances of civil disorder, with three occurring under the Articles of Confederation and then under the Constitution.

More recently, since 2010, there have been at least sixteen recorded incidents of civil disorder involving issues ranging from protests over economic injustice, sporting events and their outcomes, and racial incidents.

One in particular that garnered much news coverage is the Occupy Wall Street Movement that began around September 2011 in Zuccotti Park in New York City's financial district. The main issues raised by Occupy Wall Street were social and economic inequality, greed, corruption and the perceived undue influence of corporations on government—particularly from the financial services sector. Protesters were forced out of Zuccotti Park on November 15, 2011. After several unsuccessful attempts to re-occupy the original location, protesters turned their focus to occupying banks, corporate headquarters, board meetings, and college and university campuses. Occupy Wall Street Protests also took place in Brooklyn, New York and Oakland, California.

There is one instance of civil disorder in the planning area. From October 2011 to May 2012 Occupy Lincoln protesters were camped across the street from the state capital building in a city park.

AVERAGE ANNUAL DAMAGES AND FREQUENCY

The "loss estimator" was not used for this hazard due to lack of data and historic impacts.

VULNERABILITY ASSESSMENT

The future vulnerability to civil disorder for the planning area is low with the potential for occurrence zero to one time in the next 10 years.

FUTURE DEVELOPMENT AND VULNERABILITY

The impact to people and property from civil disorder is low as most protests are peaceful and generally dissipated by police without event. However, increases in population can proportionally increase the risk of major conflicts between police and protestors during instances of civil disorder.

In regards to structures and infrastructure, new structures and infrastructure developed in the future will be as equally vulnerable to potential civil disorder incidents as existing structures and infrastructure. Surveillance and defensible space could be used in the future to help deter this action.

RISK ASSESSMENT SUMMARY

Overall, the risk and vulnerability assessment shows that civil disturbance has a 5% chance of occurring every year with limited impacts.

MITIGATION ALTERNATIVES

Mitigation alternatives include training and education, as well as the use of vehicular barriers and other mechanisms to protect CFs.

Urban Fire

HAZARD PROFILE

Urban fires are classified as "uncontrolled burning in a residence or building from natural, human or technical causes". These fires have a potential to spread to adjoining structures. Local city and county fire departments are tasked with the response and control of urban fires. According to the State Fire Marshall Office, a report provided in July, 2013 lists 64 fire departments that are located within the Lower Platte South region.

According to the United States Fire Administration, fire risk "varies from region to region in the United States. This often is a result of climate, poverty, education, demographics, and other causal factors. Often times, all that is needed to cause an uncontrolled urban fire is a heat source to spark a fire, flammable materials that act as a fuel source, and oxygen.

EXTENT

Within the State of Nebraska, and LPSNRD specifically, urban fires can occur throughout the region. Incidents will likely be more severe in dense areas.

HISTORICAL OCCURRENCES

In Nebraska in a given year, based on the number of fires reported to the Nebraska State Fire Marshal between 2008 and 2012, the average number of fires is 1,124 a year with an average of $14,746,721 in damages per year. In 2012 Cass County fire departments reported a total of 42 fires, for Cass County Plattsmouth's fire department was the only reporting entity. For Lancaster County there were 807 reported fires with five reporting departments. For Lancaster County there was also a reported 1,158 false alarm calls. Local fire departments are encouraged to report annual calls to the Nebraska Fire Marshal's Office. While this is encouraged it is not required. Table 56 shows the number and nature of calls responded to by county from 2008 – 2012.

Table 56: Calls Responded to by Fire Departments within the Planning Area

Fire Department	Fire	Over Pressure Rupture	Rescue/ EMS	Haz Mat	Service Calls	Good Intent Calls	False Alarms	Severe Weather	Special Incidents
Bennet Rural Fire District	0	0	0	0	0	0	0	0	0
Firth Rural Fire District	64	1	244	7	16	50	21	2	1
Hallam Vol. Fire and Rescue	61	0	16	9	1	3	11	0	1
Hickman Rural Fire and Rescue	143	0	555	16	25	141	51	3	2
Lincoln Fire and Rescue	1,927	264	490	2,234	4,505	2,392	5,190	55	661
Malcolm Fire and Rescue	0	0	0	0	0	0	0	0	0

Fire Department	Fire	Over Pressure Rupture	Rescue/ EMS	Haz Mat	Service Calls	Good Intent Calls	False Alarms	Severe Weather	Special Incidents
Raymond Vol. Fire and Rescue	202	0	571	23	16	28	15	1	0
Southeast Rural Fire District	0	0	0	0	0	0	0	0	0
Southwest Rural Fire District	0	0	38	0	0	0	0	2	0
Waverly Fire and Rescue	171	0	860	35	58	143	54	1	1
Lancaster County	**2,568**	**264**	**2,774**	**2,323**	**4,621**	**2,757**	**5342**	**64**	**666**
Alvo Vol. Fire and Rescue	0	0	0	0	0	0	0	0	0
Avoca Rural Fire District	5	0	3	4	1	0	0	0	0
Cedar Creek Vol. Fire Dept.	0	0	0	0	0	0	0	0	0
Eagle Fire and Rescue	0	0	1	0	0	0	0	0	0
Elmwood Vol. Fire Dept.	0	0	0	0	0	0	0	0	0
Greenwood Vol. Fire and Rescue	26	0	99	9	2	117	0	3	1
Louisville Vol. Fire and Rescue	0	0	0	0	0	0	0	0	0
Manley Fire Dept.	0	0	0	0	0	0	0	0	0
Murdock Vol. Fire Dept.	0	0	0	0	0	0	0	0	0
Murray Fire and Rescue	0	0	0	0	0	0	0	0	0
Nehawka Rural Fire Dept.	7	0	20	2	3	1	1	6	0
Fire Department	**Fire**	**Over Pressure Rupture**	**Rescue/ EMS**	**Haz Mat**	**Service Calls**	**Good Intent Calls**	**False Alarms**	**Severe Weather**	**Special Incidents**

Plattsmouth Vol. Fire Dept.	152	7	317	197	52	47	133	6	1
Union Vol. Fire Dept.	1	0	0	1	0	0	0	0	0
Weeping Water Vol. Fire Dept.	1	1	8	2	0	0	0	0	1
Cass County	**185**	**8**	**448**	**215**	**58**	**164**	**134**	**15**	**3**
Ashland Fire Dept.	135	0	157	27	41	85	40	1	9
Brainard Vol. Fire Dept.	37	1	2	0	0	0	0	0	0
Ceresco Vol. Fire and Rescue	0	0	0	0	0	0	0	0	0
Valparaiso Fire and Rescue	0	0	0	0	0	0	0	0	0
LPSNRD	**2,925**	**273**	**3,381**	**2,565**	**8,101**	**3,006**	**5,516**	**80**	**678**

AVERAGE ANNUAL DAMAGES AND FREQUENCY

The "loss estimator" was not used for this hazard due to lack of data for the region.

VULNERABILITY ASSESSMENT

Fire death rates are based on all deaths in which exposure to fire, fire products, or explosion was the underlying cause of death or was a contributing factor in the chain of events leading to death."

According to the U.S. Fire Administration, "older adults (age 65 or older) were at higher risk from dying in a fire than the rest of the population. The very young (age 4 or younger) were also at higher risk of fire death and injury when compared to older children. Males, African-Americans, and American Indians/Alaska Natives also had a considerably higher risk of death from fire than did the population as a whole."

Because of the nature of urban fires, any structure identified in the planning are could possibly be damaged or destroyed by a fire for one of any number of reasons ranging from faulty or outdated electrical infrastructure, lightning strikes to accidents such as stoves being left on. As already stated, the threat of urban fires in populated areas is not only confined to the structure that initially caught on fire but to those surrounding the burning structure.

Fire death rates are based on all deaths in which exposure to fire, fire products, or explosion was the underlying cause of death or was a contributing factor in the chain of events leading to death." The following table was provided by the U.S. Fire Administration to depict death rates for the State of Nebraska.

Table 57: Death Rates Resulting from Fire in Nebraska

STATE	2005 Death Rate/Million Population	2006 Death Rate/Million Population	2007 Death Rate/Million Population	2008 Death Rate/Million Population	2009 Death Rate/Million Population	2010 Death Rate/Million Population
Nebraska	17.1	17.0	12.4	12.9	7.8	9.8

FUTURE DEVELOPMENT AND VULNERABILITY

Any future development that occurs in the region with respect to residential and non-residential structures has the potential for fire damage or destruction. The use of building codes, Fire Wise building practices will reduce some of the damages that could occur or reduce the risk that neighboring structures catch fire as easily. In any scenario, the risk of urban fire is high for the planning area as with any other populated area across the nation.

RISK ASSESSMENT SUMMARY

Overall, the risk and vulnerability assessment shows that urban fire is likely to occur several times annually, and is most likely to impact the denser communities in the planning area.

MITIGATION ALTERNATIVES

The use of building codes, community education, and Fire Wise building practices will reduce some of the damages that could occur or reduce the risk that neighboring structures catch fire as easily.

Hazards Not Profiled

For the planning area there have been no reported incidents related to expansive soils, sink holes, or landslides. For that reason these events have not been profiled for this plan. Should these hazards occur in the planning area they should be profiled in future updates.