Fortunately for Lincoln County, it lies within Category VIII, meaning the effects of a New Madrid quake should be relatively minor.

Figure 3.3. Projected Earthquake Intensities

MODIFIED MERCALLI INTENSITY SCALE

I People do not feel any Earth movement.

II A few people might notice movement.

III Many people indoors feel movement. Hanging objects swing.

IV Most people indoors feel movement. Dishes, windows, and doors rattle. Walls and frames of structures creak. Liquids in open vessels are slightly disturbed. Parked cars rock.

V Almost everyone feels movement. Most people are awakened. Doors swing open or closed. Dishes are broken. Pictures on the wall move. Windows crack in some cases. Small objects move or are turned over. Liquids might spill out of open containers.

VI Everyone feels movement. Poorly built buildings are damaged slightly. Considerable quantities of dishes and glassware, and some windows are broken. People have trouble walking. Pictures fall off walls. Objects fall from shelves. Plaster in walls might crack. Some furniture is overturned. Small bells in churches, chapels and schools ring.

VII People have difficulty standing. Considerable damage in poorly built or badly designed buildings, adobe houses, old walls, spires and others. Damage is slight to moderate in well-built buildings. Numerous windows are broken. Weak chimneys break at roof lines. Cornices from towers and high buildings fall. Loose bricks fall from buildings. Heavy furniture is overturned and damaged. Some sand and gravel stream banks cave in.

VIII Drivers have trouble steering. Poorly built structures suffer severe damage. Ordinary substantial buildings partially collapse. Damage slight in structures especially built to withstand earthquakes. Tree branches break. Houses not bolted down might shift on their foundations. Tall structures such as towers and chimneys might twist and fall. Temporary or permanent changes in springs and wells. Sand and mud is ejected in small amounts.

IX Most buildings suffer damage. Houses that are not bolted down move off their foundations. Some underground pipes are broken. The ground cracks conspicuously. Reservoirs suffer severe damage.

X Well-built wooden structures are severely damaged and some destroyed. Most masonry and frame structures are destroyed, including their foundations. Some bridges are destroyed. Dams are seriously damaged. Large landslides occur. Water is thrown on the banks of canals, rivers, and lakes. Railroad tracks are bent slightly. Cracks are opened in cement pavements and asphalt road surfaces.

XI Few if any masonry structures remain standing. Large, well-built bridges are destroyed. Wood frame structures are severely damaged, especially near epicenters. Buried pipelines are rendered completely useless. Railroad tracks are badly bent. Water mixed with sand, and mud is ejected in large amounts.

XII Damage is total, and nearly all works of construction are damaged greatly or destroyed. Objects are thrown into the air. The ground moves in waves or ripples. Large amounts of rock may move. Lakes are dammed, waterfalls formed and rivers are deflected.

Intensity is a numerical index describing the effects of an earthquake on the surface of the Earth, on man, and on structures built by man. The intensities shown in these maps are the highest likely under the most adverse geologic conditions. There will actually be a range in intensities within any small area such as a town or county, with the highest intensity generally occurring at only a few sites. Earthquakes of all three magnitudes represented in these maps occurred during the 1811 - 1812 "New Madrid earthquakes." The isoseismal patterns shown here, however, were simulated based on actual patterns of somewhat smaller but damaging earthquakes that occurred in the New Madrid seismic zone in 1843 and 1895.

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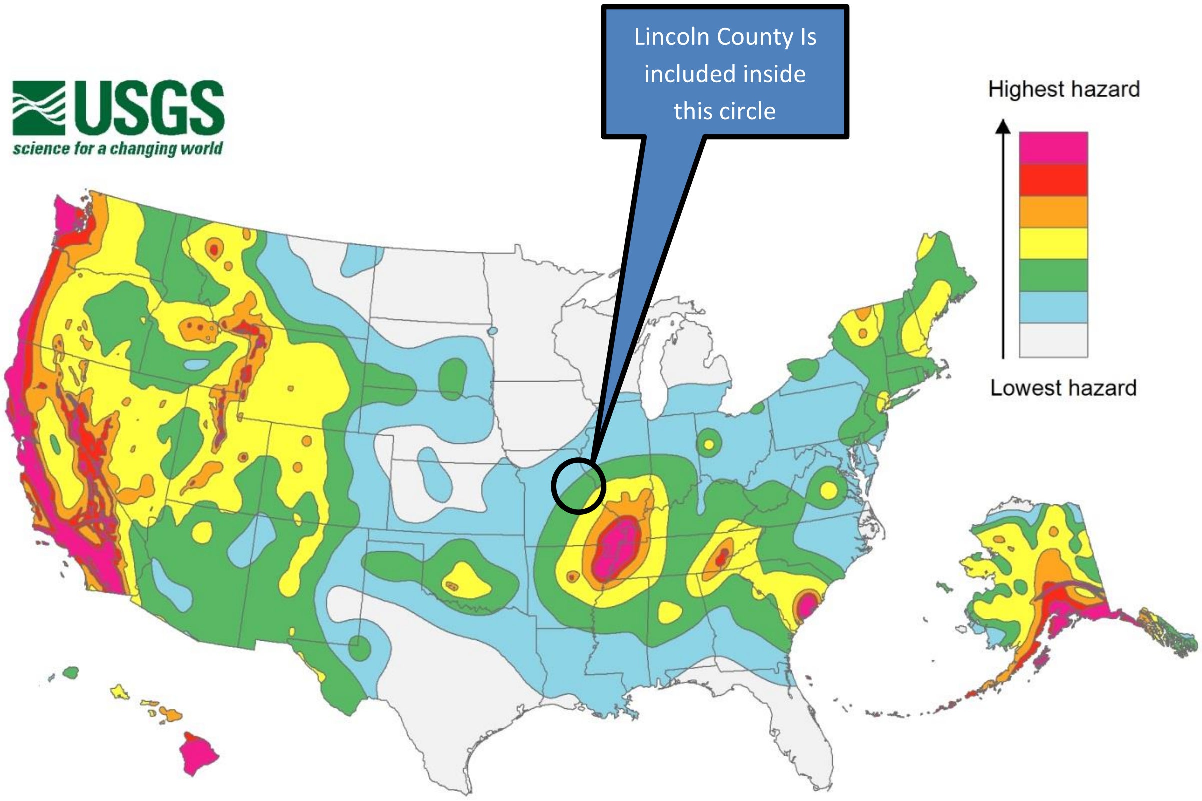
Figure 3.4. United States Seismic Hazard Map



Source: United States Geological Survey at https://earthquake.usgs.gov/hazards/hazmaps/conterminous/2014/images/HazardMap2014_lg.jpg

Strength/Magnitude/Extent

The extent or severity of earthquakes is generally measured in two ways: 1) the Richter Magnitude Scale is a measure of earthquake magnitude; and 2) the Modified Mercalli Intensity Scale is a measure of earthquake severity. The two scales are defined as follows.

Richter Magnitude Scale

The Richter Magnitude Scale was developed in 1935 as a device to compare the size of earthquakes. The magnitude of an earthquake is measured using a logarithm of the maximum extent of waves recorded by seismographs. Adjustments are made to reflect the variation in the distance between the various seismographs and the epicenter of the earthquakes. On the Richter Scale, magnitude is expressed in whole numbers and decimal fractions. For example, comparing a 5.3 and a 6.3 earthquake shows that the 6.3 quake is ten times bigger in magnitude. Each whole number increase in magnitude represents a tenfold increase in measured amplitude because of the logarithm. Each whole number step in the magnitude scale represents a release of approximately 31 times more energy.

Modified Mercalli Intensity Scale

The intensity of an earthquake is measured by the effect of the earthquake on the earth's surface. The intensity scale is based on the responses to the quake, such as people awakening, movement of furniture, damage to chimneys, etc. The intensity scale currently used in the United States is the Modified Mercalli (MM) Intensity Scale. It was developed in 1931and is composed of 12 increasing levels of intensity. They range from imperceptible shaking to catastrophic destruction, and each of the twelve levels is denoted by a Roman numeral. The scale does not have a mathematical basis, but is based on observed effects. Its use gives the laymen a more meaningful idea of the severity.

Previous Occurrences

According to Homefacts.com, there have been no recorded earthquakes in Lincoln County since 1931. In addition, the University of Memphis Center for Earthquake Research and Information shows no recent quakes within 100 miles of Lincoln County nor any record of earthquake damage.

Probability of Future Occurrence

There have been no earthquakes recorded in Lincoln for 85 years thereby the probability of an earthquake occurring in Lincoln County as 0 in any given year. Homefacts.com calculates the probability of a magnitude 5.0 or greater earthquake within the next 50 years at .74%

The two-percent probability of exceedance in 50 years map of peak ground acceleration (PGA) found at: https://earthquake.usgs.gov/hazards/hazmaps/conterminous/index.php#2014 shows peak ground acceleration as .1% of standard gravity. This indicates a low risk of an earthquake.

Changing Future Conditions Considerations

Chapter 3, Section 3.3.1., page 3-202 of the 2018 State Plan states, “Scientists are beginning to believe there may be a connection between changing climate conditions and earthquakes. Changing ice caps and sea-level redistribute weight over fault lines, which could potentially have an influence on earthquake occurrences. However, no studies quantify the relationship to a high level of detail, so recent earthquakes should not be linked to climate change.

Vulnerability

Vulnerability Overview

The 2018 State Plan, Chapter 3, Section 3.3.4, State Vulnerability Overview, annualized loss for Lincoln County as $240,000, with per capita loss at $4,600.

Missouri is the third largest market for earthquake insurance among the states, exceeded only by California and Washington. A study by the U.S. Geological Survey estimates the probability of a magnitude 7.5 or greater earthquake in the New Madrid zone over the next 50 years is 7-10 percent. The probability of an earthquake exceeding magnitude 6 over the same period is 25-40 percent. A joint assessment by the Mid-America Earthquake Center of the University of Illinois and the Federal Emergency Management Agency predicts the New Madrid event could constitute the highest total economic loss of any natural disaster in U.S. history. Earthquake coverage is not included on most homeowners’ insurance policies. It must be purchased as separate coverage, called an "endorsement." This type of insurance requires that the earthquake is the direct cause of damage to the property. Natural disasters can, in many instances, trigger other events that may also damage property. One example is earthquakes causing bodies of water to produce waves, resulting in flooding.

Earthquake insurance usually features two high deductibles: Rather than a dollar amount, it's a percentage of the cost of rebuilding the home and a separate deductible for the home's contents. Deductibles of 10-15 percent are common. For example, with a 15 percent deductible, the owner of a $200,000 home could expect to pay up to $30,000 in deductibles for damage to the dwelling before receiving any benefit from their earthquake insurance policy.

The material used to build the home can also determine premiums or whether your home is even insurable. For instance, rates may be cheaper for wood-frame homes, which withstand tremors better than homes made of masonry such as brick and stone. Single-story homes may also receive better rates as they tend to sustain less damage from an earthquake. Age of the home can also affect premiums. Some insurers will not offer earthquake insurance for masonry homes.

Potential Losses to Existing Development

The Hazus building inventory counts are based on the 2010 census data adjusted to 2014 numbers using the Dun & Bradstreet Business Population Report. Inventory values reflect 2014 valuations, based on RSMeans (a supplier of construction cost information) replacement costs. Population counts are 2020 decennial numbers from the U.S. Census Bureau.

Impact of Previous and Future Development

Future development is not expected to increase the risk other than contributing to the overall exposure of what could become damaged as a result of an event.

Hazard Summary by Jurisdiction

Earthquake intensity is not likely to vary greatly throughout the planning area so the risk will be the same throughout. Damages could differ if there are structural variations in the planning area built-environment; however, each community has roughly the same built-environment.

Problem Statement

Lincoln County is at low probability of suffering an earthquake with only superficial damage forecast. It will be helpful for the communities that don’t have building codes to adopt them and the ones that have building codes to update if needed to incorporate potential damages to future development.

3.4.4 Extreme Temperatures

Hazard Description

Extreme temperature events, both hot and cold, can impact human health and mortality, natural ecosystems, agriculture and other economic sectors. According to information provided by FEMA, extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Ambient air temperature is one component of heat conditions, with relative humidity being the other. The relationship of these factors creates what is known as the apparent temperature. The Heat Index chart shown below uses both of these factors to produce a guide for the apparent temperature or relative intensity of heat conditions.

Extreme cold often accompanies severe winter storms and can lead to hypothermia and frostbite for people without adequate clothing protection. Cold can cause fuel to congeal in storage tanks and supply lines, stopping electric generators. Cold temperatures can also overpower a building's heating system and cause water and sewer pipes to freeze and rupture. Extreme cold also increases the likelihood for ice jams on flat rivers or streams. When combined with high winds from winter storms, extreme cold becomes extreme wind chill, which is hazardous to health and safety.

The National Institute on Aging estimates that more than 2.5 million Americans are elderly and especially vulnerable to hypothermia, with the isolated elders being most at risk. About 10 percent of people over the age of 65 have some kind of bodily temperature-regulating defect, and 3-4 percent of all hospital patients over 65 are hypothermic.

Also, at risk, are those without shelter, those who are stranded, or who live in a home that is poorly insulated or without heat. Other impacts of extreme cold include asphyxiation (unconsciousness or death from a lack of oxygen) from toxic fumes from emergency heaters; household fires, which can be caused by fireplaces and emergency heaters; and frozen/burst pipes.

Geographic Location

Extreme heat and extreme cold are area-wide hazard events, and the risk of extreme heat and extreme cold does not vary across the planning area.

Strength/Magnitude/Extent

The National Weather Service (NWS) has an alert system in place (advisories or warnings) when the Heat Index is expected to have a significant impact on public safety. The expected severity of the heat determines whether advisories or warnings are issued. A common guideline for issuing excessive heat alerts is when for two or more consecutive days: (1) when the maximum daytime Heat Index is expected to equal or exceed 105 degrees Fahrenheit (°F); and the night time minimum Heat Index is 80°F or above. A heat advisory is issued when temperatures reach 105 degrees and a warning is issued at 115 degrees.

Table 3.19. Heat Index (HI) Chart

NWS Heat Index

Relative Humidity (%) \ Temperature (°F)	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

Source: National Weather Service (NWS); https://www.weather.gov/safety/heat-index

Note: Exposure to direct sun can increase Heat Index values by as much as 15°F. The shaded zone above 105°F corresponds to a HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

The NWS Wind Chill Temperature (WCT) index uses advances in science, technology, and computer modeling to provide an accurate, understandable, and useful formula for calculating the dangers from winter winds and freezing temperatures. The figure below presents wind chill temperatures which are based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Table 3.20. Wind Chill Chart

Source: https://www.weather.gov/safety/cold-wind-chill-chart

Wind Chill Chart

Temperature (°F)

Wind (mph) \ 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

Previous Occurrences

The NOAA Storm Events database records one Extreme Cold/Wind Chill event and two Cold/Wind Chill events for the years 2000 through 2020. No deaths or injuries were recorded.

December 16, 2000 – Extreme Cold and Wind Chill was reported for Lincoln and surrounding counties.

January, 2010 – The first twelve days of January 2010 was one of the coldest outbreaks in many years. For some locations throughout the state, it was the first time the temperature dropped below zero in about 10 years.

January 6, 2014 - The winter storm that brought heavy snow to much of the area followed that up with the coldest temperatures in 20 years.

The same database reports 51 Heat/Excessive Heat events during the same period. These are summarized in the table that follows. Deaths and Injuries referenced “outside county” were reported from nearby jurisdictions. Deaths and Injuries reported as “inside county” denotes issues that occurred within the planning area.

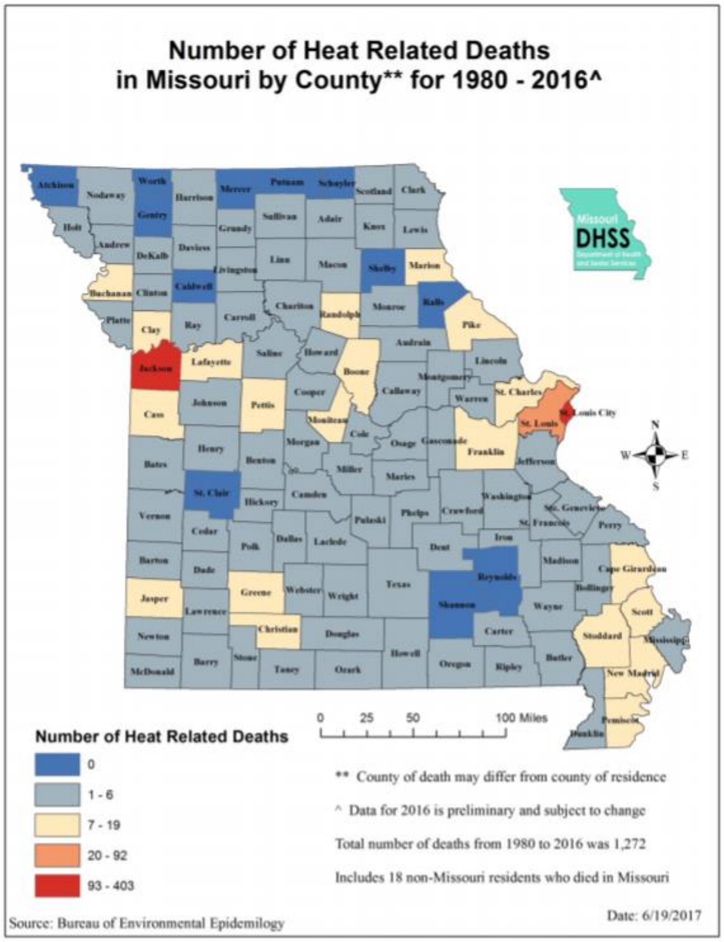
Table 3.21. Heat Events in Lincoln County, 2000-2020

Date	Event	Deaths	Injuries	Property Damage	Crop Damage	Summary
8/28/2000	H	0	7	0	0	
9/1/2000	H	0	3	0	0	
7/7/2001	H	0	0	0	0	Heat Index 105-110
7/17/2001	H	0	0	0	0	Heat Index 110-115
7/21/2001	H	0	0	0	0	Heat Index 105-115
7/29/2001	H	0	0	0	0	Heat Index 105-110
8/1/2001	H	0	0	0	0	Heat Index 105
8/7/2001	H	0	0	0	0	Heat Index 102-110
8/21/2001	H	0	4	0	0	Heat Index 105-110, four injuries in county
7/8/2002	H	0	0	0	0	Heat Index 105-110
7/20/2002	H	0	0	0	0	Heat Index 105-115
7/26/2002	H	0	1	0	0	Heat Index 105-115
8/1/2002	H	0	1	0	0	
7/3/2003	H	0	1	0	0	Heat Index 105-110
8/15/2003	H	0	0	0	0	Schools scheduled to half days
8/24/2003	H	0	0	0	0	Heat Index 105-110
7/20/2004	H	0	0	0	0	Heat Index 105-110
6/23/2005	H	0	0	0	0	Heat Index 100-105
7/20/2005	H	1	0	0	0	3rd warmest August on record, 1300 injuries state-wide
7/17/2006	H	0	0	0	0	Heat Index 105-110
7/29/2006	H	0	0	0	0	Heat Index 105-110
8/1/2006	H	0	0	0	0	5^{th} day over 100
7/1/2011	H	0	0	0	0	Heat Index 105
7/10/2011	H	0	0	0	0	Temperature 100, 1 death outside county
8/6/2011	H	0	0	0	0	Heat Index 105-110

Date	Event	Deaths	Injuries	Property Damage	Crop Damage	Summary
8/31/2011	H	0	0	0	0	Heat Index 105-110, 2 deaths outside county
9/1/2011	H	0	0	0	0	Heat Index 105, 2 deaths outside county
6/22/2016	H	0	0	0	0	Heat Index 105
7/24/2017	EH	1	1	0	0	1 Death and 1 Injury in county

Source: NOAA Storm Events Database

Figure 3.5. Heat Related Deaths in Missouri 2000-2016



Source: https://health.mo.gov/living/healthcondiseases/hyperthermia/pdf/stat-report.pdf

Extreme heat can cause stress to crops and animals. According to USDA Risk Management Agency, losses to insurable crops during the 21-year time period from year 2000 to 2020 were $2,697,094.70. Extreme heat can also strain electricity delivery infrastructure overloaded during peak use of air conditioning during extreme heat events. Another type of infrastructure damage from extreme heat is road damage. When asphalt is exposed to prolonged extreme heat, it can cause buckling of asphalt-paved roads, driveways, and parking lots.

From 1988-2011, there were 3,496 fatalities in the U.S. attributed to summer heat. This translates to an annual national average of 146 deaths. During the same period, no deaths were recorded in the planning area, according to NCEI data. The National Weather Service stated that among natural hazards, no other natural disaster—not lightning, hurricanes, tornadoes, floods, n o r earthquakes—causes more deaths. Lincoln County is a mix of urban rural area where heat islands are largely non-existent and people are able to open windows to catch a breeze; both these factors contribute to much fewer deaths in rural areas.

Probability of Future Occurrence

Fifty-one heat events were recorded for the 21-year period between 2000 and 2020. This equates to 13.80% chance of a heat related event in any given year. There are no recorded deaths attributable to extreme cold.

Changing Future Conditions Considerations

According to the 2018 State Plan, average daily temperatures in Missouri are expected to increase significantly between now and the end of this century which is happening as we speak. This will cause future heat waves to be more intense, affecting the elderly and infirm to a higher degree than young, able-bodied individuals. This will likely result in higher summertime electricity consumption & possible power outages, and shortages of heating oil and fuel. Winter temperatures are expected to moderate.

Vulnerability

Vulnerability Overview

Extreme heat and extreme cold events are common occurrences in Missouri. The method used to determine vulnerability to extreme temperatures across Missouri was statistical analysis of data from several sources; National Centers for Environmental Information (NCEI) storm events data (1996 to December 31, 2016), total population and percentage of population over 65 data from the U.S. Census (2015 ACS), and the calculated Social Vulnerability Index for Missouri counties from the Hazards and Vulnerability Research Institute in the Department of Geography at the University of South Carolina.

From the statistical data collected, four factors were considered in determining overall vulnerability to extreme temperatures as follows: total population, percentage of population over 65, likelihood of occurrence, and social vulnerability. Based on natural breaks in the statistical data, a rating value of 1 through 5 was assigned to each factor. These rating values correspond to the following descriptive terms:
1) Low
2) Low-medium
3) Medium
4) Medium-high
5) High

Table 3.27 Likelihood of Occurrence/Overall Vulnerability Rating for Extreme Temperature

HEAT					COLD				
Total Events	Likelihood of Occurrence	Likelihood Rating	Total Vulnerability	Total Vulnerability Description	Total Events	Likelihood of Occurrence	Likelihood Rating	Total Vulnerability	Total Vulnerability Description
51	2.43	4	8	Low Medium	2	0.1	1	5	Low

Source: 2018 State Plan

Those at greatest risk for heat-related illness include infants and children up to five years of age, people 65 years of age and older, people who are overweight, and people who are ill or on certain medications. However, even young and healthy individuals are susceptible if they participate in strenuous physical activities during hot weather. In agricultural areas, the exposure of farm workers, as well as livestock, to extreme temperatures is a major concern.

Table 3.28 Typical Health Impacts of Extreme Heat

Heat Index (HI)	Disorder
80-90° F (HI)	Fatigue possible with prolonged exposure and/or physical activity
90-105° F (HI)	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and/or physical activity
105-130° F (HI)	Heatstroke/sunstroke highly likely with continued exposure

Source: National Weather Service Heat Index Program, www.weather.gov/os/heat/index.shtml

Potential Losses to Existing Development

Historical data show two deaths for the last 21 years in Lincoln County. We can conclude a similar trend to continue. For agricultural losses, the historical USDA Crop Insurance payments can be estimated and annualized to determine average annual loss. Data shows 3,634 acres impacted by heat incidents for the 21 years between 2000 and 2020 at a loss of $399,408.39.

The NOAA Storm Events database records one Extreme Cold/Wind Chill event and two Cold/Wind Chill events for the years 2000 through 2020. No deaths or injuries were recorded. The risk of extreme cold does not vary across the planning area.

Impact of Previous and Future Development

Population growth can result in increases in the age-groups that are most vulnerable to extreme heat. Population growth also increases the strain on electricity infrastructure, as more electricity is needed to accommodate the growing population. There are no jurisdictions expected to experience significant growth in the next five years.

Hazard Summary by Jurisdiction

Those at greatest risk for heat-related illness and deaths include children up to five years of age, people 65 years of age and older, people who are overweight, and people who are ill or on certain medications. To determine jurisdictions within the planning area with populations more vulnerable to extreme heat, demographic data was obtained from the 2010 census on population percentages in each jurisdiction comprised of those under age 5 and over age 65. Data was not available for overweight individuals and those on medications vulnerable to extreme heat.

The NOAA Storm Events database records one Extreme Cold/Wind Chill event and two Cold/Wind Chill events for the years 2000 through 2020. No deaths or injuries were recorded.

The table below summarizes vulnerable populations in the participating jurisdictions. Note that school and special districts are not included in the table because students and those working for the special districts are not customarily in these age groups. For both extreme heat and extreme cold, the vulnerable populations are at higher risk. The risk of extreme heat and extreme cold does not vary across the planning area.

Table 3.22. Lincoln County Population Under Age 5 and Over Age 65, 2010 Census

Jurisdiction	% Under Age 5	Population 5 and Under	% 65 and Older	Population 65 and Older
Lincoln County	6.8%	3,643	11.6%	6,203
Chain of Rocks	9.4%	12	4.7%	6
Elsberry	6.3%	116	19.4%	358
Foley	1.9%	2	9.3%	10
Fountain N Lakes	9.9%	30	9.3%	28
Hawk Point	12.6%	92	8.2%	60
Moscow Mills	12.8%	320	6.4%	160
Old Monroe	5.6%	15	9.7%	26
Silex	1.2%	1	19.0%	16
Troy	9.0%	986	12.3%	1,360
Truxton	2.9%	2	8.8%	6
Winfield	7.1%	122	10.0%	172
Whiteside	0.0%	-	29.3%	22

Source: ESRI Business Analyst includes entire population of each city or county

All public schools serving Lincoln County have air-conditioned classrooms although not all have air conditioning throughout. Each school has a process for early dismissal due to extreme heat. All nursing homes are air conditioned.

Problem Statement

Aging residents and those who are extremely young are vulnerable to prolonged periods of extreme heat and cold. It will be helpful for communities to have generators in case of power outages during extreme weather events and to update the list of special needs vulnerable populations.

3.4.5 Flooding (Riverine and Flash)

Hazard Profile

Hazard Description

A flood is partial or complete inundation of normally dry land areas. Riverine flooding is defined as the overflow of rivers, streams, drains, and lakes due to excessive rainfall, rapid snowmelt, or ice. There are several types of riverine floods, including headwater, backwater, interior drainage, and flash flooding. Riverine flooding is defined as the overflow of rivers, streams, drains, and lakes due to excessive rainfall, rapid snowmelt or ice melt. The areas adjacent to rivers and stream banks that carry excess floodwater during rapid runoff are called floodplains. A floodplain is defined as the lowland and relatively flat area adjoining a river or stream. The terms “base flood” and “100-year flood” refer to the area in the floodplain that is subject to a one percent or greater chance of flooding in any given year. Floodplains are part of a larger entity called a basin, which is defined as all the land drained by a river and its branches.

Flooding caused by dam failure is discussed in a previous section and will not be addressed here.

A flash flood occurs when water levels rise at an extremely fast rate as a result of intense rain fall over a brief period, sometimes combined with rapid snow melt, ice jam release, frozen ground, saturated soil, or impermeable surfaces. Flash flooding can happen in Special Flood Hazard Areas (SFHAs) as delineated by the National Flood Insurance Program (NFIP), and can also happen in areas not associated with floodplains.

Ice jam flooding is a form of flash flooding that occurs when ice breaks up in moving waterways, and then stacks on itself where channels narrow. This creates a natural dam, often causing flooding within minutes of the dam formation.

In some cases, flooding may not be directly attributable to a river, stream, or lake overflowing its banks. Rather, it may simply be the combination of excessive rainfall or snowmelt, saturated ground, and inadequate drainage. With no place to go, the water will find the lowest elevations– areas that are often not in a floodplain. This type of flooding, often referred to as sheet flooding, is becoming increasingly prevalent as development outstrips the ability of the drainage infrastructure to properly carry and disburse the water flow.

Most flash flooding is caused by slow-moving thunderstorms or thunderstorms repeatedly moving over the same area. Flash flooding is a dangerous form of flooding which can reach full peak in only a few minutes. Rapid onset allows little or no time for protective measures. Flashflood waters move at very fast speeds and can move boulders, tear out trees, scour channels, destroy buildings, and obliterate bridges. Flash flooding can result in higher loss of life, both human and animal, than slower developing river and stream flooding.

In certain areas, aging storm sewer systems are not designed to carry the capacity currently needed to handle the increased storm runoff. Typically, the result is water backing into basements, which damages mechanical systems and can create serious public health and safety concerns. This combined with rainfall trends and rainfall extremes all demonstrate the high probability, yet generally unpredictable nature of flash flooding in the planning area.

Although flash floods are somewhat unpredictable, there are factors that can point to the likelihood of flash floods occurring. Weather surveillance radar is being used to improve monitoring capabilities of intense rainfall. This, along with knowledge of the watershed characteristics, modeling techniques, monitoring, and advanced warning systems has increased the warning time for flash floods.

Geographic Location

Riverine flooding can occur in any low-lying area of Lincoln County which is adjacent to rivers and creeks during periods of heavy rain when ground is saturated. Many rural roads within the county are dependent upon low water crossings which are not navigable during periods of high water. There are 37 low water crossings in Lincoln County any one of which can be inundated anytime three or more inches of rain falls within a short interval and ground is saturated. During times of flash flooding, these low water crossings can present a risk to life and property if an attempt to cross is made.

Lincoln County faces two major risk factors for flooding; the Mississippi River and Cuivre River basins. The Mississippi River basin drains the eastern third of the county. The river's floodplain, 3-4 miles wide, runs the length of the county's eastern border. The communities of Elsberry, Foley, Winfield, and Old Monroe line the edge of the floodplain along Missouri Highway 79. The Cuivre River basin drains the rest of the county.

Several individual communities are situated near streams or rivers. The Cuivre River, narrow and flashy, runs south and west of Silex and east of Moscow Mills. Both Chain of Rocks and Old Monroe lie next to the river. Town Branch and Buchanan Creek run through Troy. Bobs Creek and McLean Creek drain into the Mississippi at Winfield. Whiteside lies beside a tributary of Sandy Creek, which also runs west and north around Foley to reach the Mississippi. Lost Creek runs through southern Elsberry while the Old Kings Lake Creek runs north to south through the middle of the Mississippi floodplain.

Secondly, drainage is a major factor due to the predominately clay soils, which cover the rest of the county. With no place to go, the water will find the lowest elevations; often areas not in a floodplain. This type of flooding, often referred to as sheet flooding, is becoming increasingly prevalent as development outstrips the ability of the drainage infrastructure to properly carry and disburse the water flow. Combined with flooding due to overwhelmed storm and sanitary sewers, tremendous flows of water often accompany storm events in these developed areas. Typically, the water backs into basements, damages mechanical systems and can create serious public health and safety concerns.

The figure below illustrates a 100-year flood zone map of Lincoln County.