3.7.12 LANDSLIDE

	Probability	Magnitude/Severity	Warning Time	Duration	CPRI
Landslide	1.13	1.00	3.63	1.38	1.49

Description

A landslide is the downhill movement of masses of soil and rock by gravity. The basic ingredients for landslides are gravity, susceptible soil or rock, sloping ground, and water. Typically, as the slope angle increases, so does the potential for landslides. Anything that increases the slope angle can trigger a landslide, including a stream actively eroding a hill or construction practices. Landslides may occur when soil on hillsides is saturated following extended periods of rainfall or snow melt, and may also be caused by:

- Earthquakes
- Fire (and resulting loss of vegetation)
- Excavation and mining
- Irrigation
- Construction activities

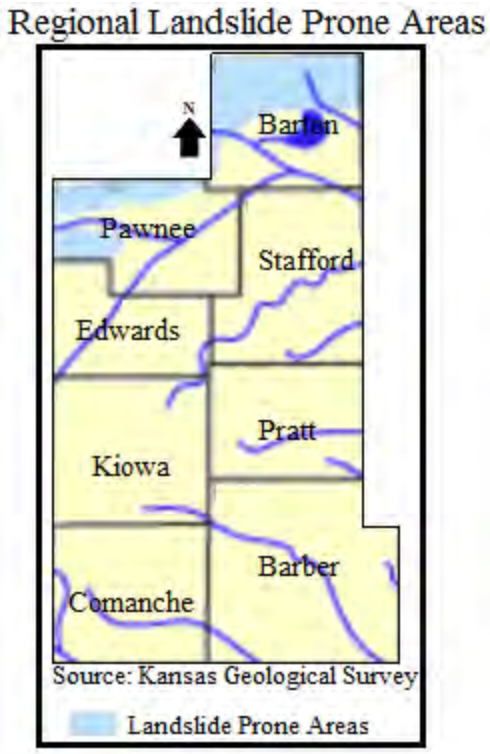
Landslides can damage or destroy structures, roadways, and utilities as well as block roadways with debris.

	Warning Time
Landslide	3.63

	Duration
Landslide	1.38

Hazard Location

Areas prone to landslides can cover broad geographic regions, but occurrences are generally localized. The entire planning area, including all participating jurisdictions, is potentially at risk to landslides. However, landslides require an earth or rock covered slope. The following map by the Kansas Geological Survey identifies slide prone areas in the region.



Previous Occurrences and Extent

There have been no notable recorded landslide events in south Kansas:

Hazard Vulnerability and Impact

Losses due to landslides in south Kansas will continue in those areas of the region that are prone to this hazard. Landslide losses are primarily related to damage to property. However, if a sudden landslide impacts an inhabited structure, injuries or deaths could occur. Historically, landslides in south Kansas have been isolated events impacting a few properties or a particular area. Often, damages in terms of estimated losses are not reported. Additionally, there is not a repository for damages to be reported, other than NCDC. The NCDC database does not include any previous landslide events in Kansas. This is likely because the events are generally isolated and do not impact large areas.

If construction is occurring in or near landslide hazard areas, more structures/population will be at risk to damage/injury from landslides. The effects of landslides on people and structures can be lessened by total avoidance of landslide hazard areas or by restricting, prohibiting, or imposing conditions on hazard-zone activity. The hazard from landslides can be reduced by avoiding construction on steep slopes and existing landslides, or by stabilizing the slopes. Stability increases when ground water is prevented from rising in the landslide mass by covering the landslide with an impermeable membrane, directing surface water away from the landslide, draining ground water away from the landslide, and minimizing surface irrigation. Slope stability

is also increased when a retaining structure and/ or the weight of a soil/rock berm are placed at the toe of the landslide or when mass is removed from the top of the slope.

It is not possible at this time to determine quantitative estimates for potential losses associated with the landslide hazard as there is no centralized data source upon which to base analysis.

	Magnitude/Severity
Landslide	1.00

Future Development

Future development in landslide prone areas would tend to increase the risk of this hazard. However, areas that have been identified with a landslide risk in the region tend to have stable populations showing little increase in development. However, in general, the region is experiencing a population decline which could potentially lessen the potential of a future event.

Probability of Future Hazard Events

There have been no reported landslide events in the region in the past 10 years. This would equate to approximately zero events per year. As such, it is unlikely that a future landslide event will cause a measurable impact.

	Probability
Landslide	1.13

Consequence Analysis

The information in the following table provides the Consequence Analysis.

Landslide Consequence Analysis

Subject	Ranking	Impacts of Landslide
Health and Safety of Persons in the Area of the Incident	Moderate to Severe	Localized impact could be moderate to severe for the incident area.
Responders	Minimal	Impact to responders would be minimal.
Continuity of Operations	Minimal	Minimal expectation of execution of the COOP, unless a facility is impacted.
Property, Facilities, and Infrastructure	Minimal to Severe	Localized impact to facilities and infrastructure in the incident area has the potential to do severe damage if they are on, or in, the area of the landslide.
Delivery of Services	Minimal	Impacts to the delivery of services could be severe if roads/utilities are affected. Otherwise impact would be non-existent to minimal.
Environment	Minimal	Impact to the area would be minimal other than the immediate area.
Economic Conditions	Minimal	Impacts to the economy will depend on the severity of the damage, i.e., are roads blocked, did any businesses get caught in the landslide.
Public Confidence in Governance	Minimal to Severe	Local development policies will be questioned.

3.7.13 LIGHTNING

	Probability	Magnitude/Severity	Warning Time	Duration	CPRI
Lightning	2.50	1.38	3.25	1.00	2.13

Description

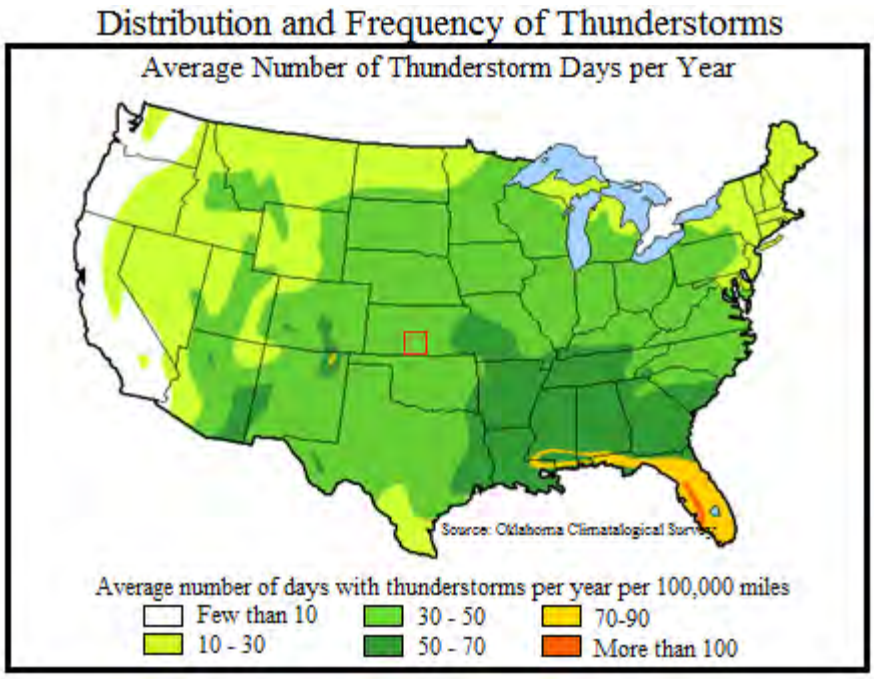
Lightning is a discharge of atmospheric electricity that is triggered by a buildup of differing charges within a cloud. According to the NWS, lightning is one of the most underrated severe weather hazards and is the second deadliest weather killer in the United States. Of the estimated 1,000 people who are struck by lightning each year in the United States, only 10 percent are killed, but survivors may suffer life-long disabilities.

	Warning Time
Lightning	3.25

	Duration
Lightning	1.00

Hazard Location

Severe thunderstorms strike south Kansas regularly, with accompanying lightning that can cause injury, death, property damage and wildfires. The widespread and frequent nature of thunderstorms makes lightning a relatively common occurrence. Of particular concern to south Kansas is protection of facilities and communications systems that are important to emergency response operations, protection of public health and maintenance of the region's economy. Most of south Kansas has an average 30-50 thunderstorm days per year.



Lightning occurs over broad geographic regions. The entire planning area, including all participating jurisdictions, is at risk to lightning.

Previous Occurrences and Extent

Information measured by the National Lightning Detection Network between 1997 and 2011 ranks Kansas 16th among the continental states in terms of cloud-to-ground flash densities with 934,368 flashes per year (11.4 flashes per square mile). According to the NCDC Storm Events database, there were 20 lightning events in south Kansas between 2004 and 2014 resulting in $15,000 in property damage**.** The NCDC receives storm data from the NWS, which receives information from a variety of sources, which include but are not limited to county, state, and federal emergency management officials, local law enforcement officials, Skywarn spotters, NWS damage surveys, newspaper clipping services, the insurance industry and the general public. Reporting of events and the historic events detailed here are likely not a true reflection of all the damaging lightning strikes.

NCDC Lightning Events 2003 - 2013

County	Total Events	Property Damage	Crop Damage	Deaths
Barber	1	$0	$0	0
Barton	1	$15,000	$0	0
Comanche	0	$0	$0	0
Edwards	0	$0	$0	0
Kiowa	0	$0	$0	0
Pawnee	0	$0	$0	0
Pratt	0	$0	$0	0
Stafford	0	$0	$0	0
Regional Total	2	$15,000	$0	0

Source: NCDC Storm Events Database, http://www.ncdc.noaa.gov/stormevents/

According to the USDA's Risk Management Agency the annualized crop insurance paid due to damages from lighting strikes for the period between 2010 and 2013 was $41,482. It is worth noting that in many cases the USDA classifies lightning as "other," lumping disparate events together. As such, it is impossible accurately determine an insurance paid figure, and the figure noted above is solely an estimate.

Based on NCDC data, showing $15,000 in damages over the 10 year period from 2004 to 2014, with 2014 data representing to date totals only, south Kansas can expect approximately $1,500 in lightning-related losses each year.

According to the NCDC, there have been no reported deaths and one reported injury from lightning in south Kansas from 2004 to 2014.

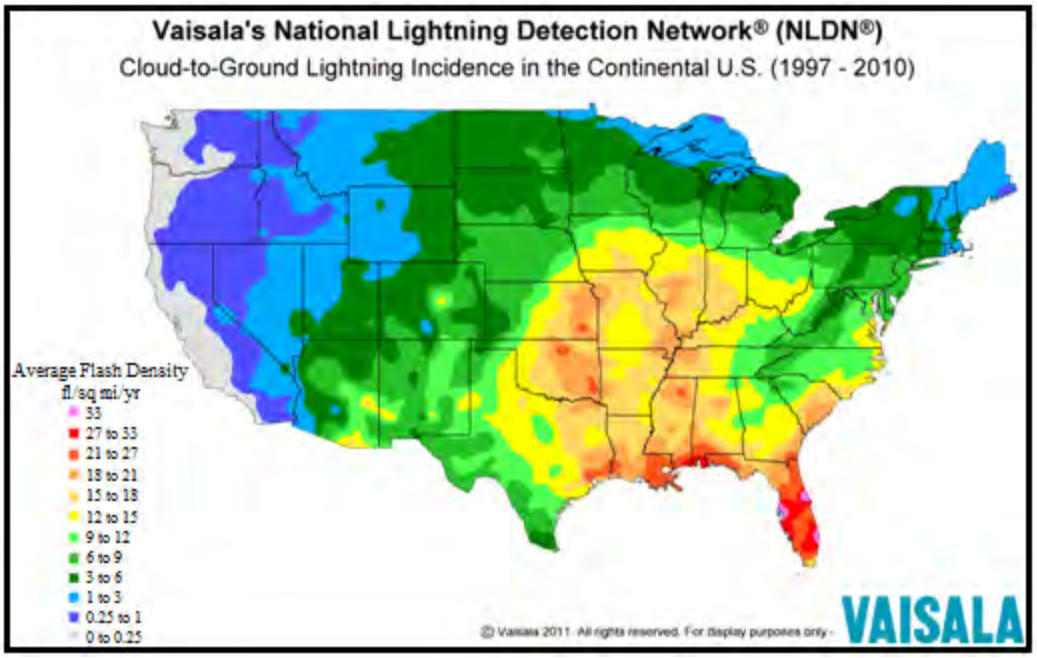
Local Events

Notable local lightning events include:

> **2012: Barton County, Rural Water District #1:** A lightning strike caused infrastructure damages, resulting in insured losses.

Hazard Vulnerability and Impact

In general, the frequency of occurrence of lightning is similar to the pattern of thunderstorm frequency. Data suggests that there are 18 to 27 flashes per square mile per year in south Kansas. The following figure, which is based on data from 1997 to 2010, shows that the distribution of lightning throughout the U.S.



The statistical analysis method was used to refine and assess the relative vulnerability of each of region's counties to lightning. The region assigned ratings to pertinent factors including social vulnerability index, prior events, prior annualized property damage, building exposure valuation, population density and crop exposure (annualized crop losses were not used since USDA did not have insured crop loss amounts to use in the tabulation).

The following information was used for this analysis:

- Social Vulnerability Index for Kansas from the Hazards and Vulnerability Research Institute at the University of South Carolina
- National Climatic Data Center storm events 2004 – 2014
- U.S. Census Bureau (2012)
- USDA's Census of Agriculture (2012).

Vulnerability Factor Amounts for Lightning

County	SoVI Rating (1-5)	Prior Events 2004-2014	Property Damages	Annualized Property Damages	Total Building Exposure ($000)	Population Density	Crop Exposure (2012 Census of Agriculture)
Barber	4	1	$0	$0	$388,136	4	$45,420,000
Barton	3	1	$15,000	$1,500	$1,772,118	21	$96,206,000
Comanche	5	0	$0	$0	$135,138	2	$21,783,000
Edwards	4	0	$0	$0	$232,382	5	$126,933,000
Kiowa	4	0	$0	$0	$237,655	3	$63,956,000
Pawnee	5	0	$0	$0	$449,592	9	$92,111,000
Pratt	3	0	$0	$0	$689,239	13	$52,353,000
Stafford	4	0	$0	$0	$295,331	6	$74,549,000
Regional Total	-	2	$15,000	$1,500	$4,199,591	8	$573,311,000

Using the above information, a value of 1-10 was assigned to the data obtained for each factor and then weighted equally and factored together to obtain overall vulnerability scores for comparison and to determine the greatest vulnerable counties. The Social Vulnerability Index is in a range of 1- 5. To give Social Vulnerability Index the same weight as the other factors, the numbers were multiplied by two.

Lightning Data Rating Determination

Ratings	Social Vulnerability	NCDC Prior Events	Annualized Property Damage	Building Exposure Valuation	Population Density *	Crop Exposure
1		1	$143 - $3,600	$117,421 - $4,492,825	1.6 - 116.3	0 - $18,548,500
2	1	2	$3,601 - $7,200	$4,492,826 - $8,868,229	116.4 - 231.1	$18,548,501 - $32,126,000
3		3	$7,201 - $10,800	$8,868,230 - $13,243,634	231.2 - 345.9	$32,126,001 - $45,703,500
4	2	4	$10,801 - $14,400	$13,243,635 - $17,619,039	346 - 460.7	$45,703,501 - $59,281,000
5		5	$14,401 - $18,000	$17,619,040 - $21,994,444	460.8 - 575.5	$59,281,001 - $72,858,500
6	3	6	$18,001 - $21,600	$21,994,445 - $26,369,848	575.6 - 690.3	$72,858,501 - $86,436,000
7		n/a	$21,601 - $ 25,200	$26,369,849 - $30,745,253	690.4 - 805.1	$86,436,001 - $100,013,500
8	4	n/a	$25,201 - $28,000	$30,745,254 - $35,120,658	805.2 - 919.9	$100,031,501 - $113,591,000
9		n/a	$28,801 - $33,000	$35,120,659 - $39,496,062	920- 1,034.7	$113,591,001 - $127,168,500
10	5	n/a	$33,001 and up	$39,496,063 - $43,871,468	1,034.8 - 1,149.6	$127,168,501 - $140,746,000

Note: n/a relates to not applicable because no county had more than 5 prior events

Based on the above ratings system, ranges were applied to each county to determine their potential vulnerability. The following related the scoring to a vulnerability assessment:

- **Low:** Score range of 7 -13
- **Medium-Low:** Score range of 14 - 18
- **Medium:** Score range of 19 - 23
- **Medium-High:** Score range of 24 - 28
- **High:** Score range of 29 - 34

Vulnerability of Kansas Counties to Lightning

County	SoVi Rating	NCDC Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Overall Vulnerability Rating	Lightning Vulnerability
Barber	8	1	0	1	1	4	15	Medium-Low
Barton	6	1	1	1	1	7	17	Medium-Low
Comanche	10	0	0	1	1	2	14	Medium-Low
Edwards	8	0	0	1	1	9	19	Medium
Kiowa	8	0	0	1	1	5	15	Medium-Low
Pawnee	10	0	0	1	1	7	19	Medium
Pratt	6	0	0	1	1	4	12	Low
Stafford	8	0	0	1	1	6	16	Medium-Low

	Magnitude/Severity
Lightning	1.38

Future Development

Future development would tend to increase the risk of this hazard. However, in general, the region is experiencing a population decline which could potentially lessen the potential of a future event.

Probability of Future Hazard Events

Severe thunderstorms and the associated lightning events will continue to cause damage to anything exposed to the weather elements. Lightning can damage many types of infrastructure, including electric lines/poles/transformers, telephone lines and radio communication equipment. These pieces of infrastructure are needed by both first response agencies and the general community to ensure safe transport, habitable homes and good communications abilities.

Residential and business properties are liable to receive damage either as a result of a lightning strike causing a fire or other type of direct damage or by overloading electronic equipment. The latter concern is especially important to business and government, which rely on computers and other electronic equipment for day to day operations. Virtually all structures and electrical components in south Kansas are vulnerable to lightning. Fires, electrical fires, electricity loss and damage to equipment are a few of the problems associated with lightning strikes.

Any increase in development will lead to a greater exposure to this hazard.

	Probability
Lightning	2.50

Consequence Analysis

The information in the following table provides the Consequence Analysis.

Lightning Consequence Analysis

Subject	Ranking	Impacts of Lightning
Health and Safety of Persons in the Area of the Incident	Minimal to Moderate	Impact to the health and safety of persons could be minimal to moderate if within the incident area.
Responders	Minimal	Impact to responders is expected to be minimal unless responders live within the affected area.
Continuity of Operations	Minimal	Temporary relocation may be necessary if government facilities experience damage.
Property, Facilities, and Infrastructure	Minimal to Severe	Impact could be severe if property, facilities or infrastructure take a direct hit which could result in fire or destruction.
Delivery of Services	Minimal to Severe	Delivery of services could be affected if there is any disruption to the roads and/or utilities due to damages sustained.
Environment	Minimal to Severe	Impact will be isolated, yet severe to any trees, animals, etc., that takes a direct hit, or is in the path of any fire that may be generated due to the lighting strike.
Economic Conditions	Minimal	Local economy impact should be fairly minimal, unless the lightening causes fires which damage businesses and stops revenue.
Public Confidence in Governance	Minimal	Response and recovery will be in question if not timely and effective, specifically if electricity and other utilities are affected.

3.7.14 MAJOR DISEASE OUTBREAK

	Probability	Magnitude/Severity	Warning Time	Duration	CPRI
Major Disease Outbreak	1.38	2.88	1.00	4.00	2.03

Description

Infectious diseases are human illnesses caused by microscopic agents, including viruses, bacteria, parasites, and fungi or by their toxins. They may be spread by direct contact with an infected person or animal, ingesting contaminated food or water, vectors such as mosquitoes or ticks, contact with contaminated surroundings such as animal droppings, infected droplets, or by aerosolization.

While there are a number of biological diseases/agents that are of concern to south Kansas, the following categories of disease are being addressed in this plan: vaccine preventable disease, food borne disease, and community associated infections as having significant recurring impact on the morbidity of south Kansans. The following descriptions are general and it should be noted that individuals may experience more or less severe consequences based upon their own circumstances.

Vaccine Preventable:

- **Measles:** a respiratory disease caused by a virus spread through the air by breathing, coughing or sneezing. It is so contagious that any child who is exposed to it and is not immune will probably get the disease.

- **Mumps:** a contagious disease that causes fever, headache, muscle aches, tiredness, and loss of appetite, and is followed by swelling of salivary glands. Most people with mumps recover fully.

- **Pertussis:** a highly communicable, vaccine-preventable disease that is typically results in severe coughing, whooping, and vomiting. Major complications are most common among infants and young children and include hypoxia, apnea, pneumonia, seizures, encephalopathy, and malnutrition. Young children can die from pertussis, with most deaths occur among unvaccinated children or children too young to be vaccinated.

- **Influenza:** a viral infection of the nose, throat, bronchial tubes, and lungs. There are two main types of virus, A and B, with each type including many different strain which tend to change each year. Influenza is highly contagious and is easily transmitted through contact with droplets from the nose and throat of an infected person during coughing and sneezing.

- **Pandemic Influenza:** A pandemic influenza is a influenza virus that causes a global outbreak of serious illness. A influenza pandemic occurs when a new virus emerges for which people have little or no immunity, and for which there is no

vaccine. Infection rate and mortality may be markedly higher than a normal influenza.

Food Borne Disease:

- **Norovirus:** a group of related viruses that cause acute gastroenteritis in humans, including diarrhea, vomiting, and stomach pain. Noroviruses are transmitted primarily through the fecal-oral route, either by consumption of fecal contaminated food or water or by direct person-to-person spread.

- **Salmonellosis:** an infection with bacteria that causes diarrhea, fever, and abdominal cramps. The illness usually lasts four to seven days, and most persons recover without treatment.

	Warning Time
Major Disease Outbreak	1.00

	Duration
Major Disease Outbreak	4.00

Hazard Location

The entire planning area is susceptible to a disease outbreak. However, more densely populated areas are more susceptible to the diseases that are transmitted person to person.

Previous Occurrences and Extent

There have been four a pandemics in the past century that have impacted south Kansas:

1918–19: Spanish flu (H1N1): This flu is estimated to have sickened 20-40% of the world's population, causing the death of 500,000 Americans. Recently, the origin of the pandemic was traced to an outbreak of influenza in Haskell County, Kansas, in January 1918. By the end of 1918, the Kansas death toll was around 12,000.

1957–58: Asian flu (H2N2): This virus was quickly identified because of advances in technology, and a vaccine was produced. In total, there were about 70,000 deaths in the United States. Information about how this pandemic affected south Kansas was not available.

1968–69: Hong Kong flu (H3N2): This strain caused approximately 34,000 deaths in the United States. It was first detected in Hong Kong in early 1968 and spread to the United States later that year.

2009 H1N1 Influenza: The 2009 H1N1 Pandemic Influenza began in Kansas with the first identified case on April 24, 2009. Kansas was the third state to positively identify this novel strain of influenza.

South Kansas is also impacted by a variety of communicable and non-communicable diseases. The following tables provide the numbers of reportable diseases by county from 2002 to 2013. Not all diseases are listed.

2002 - 2013 Reportable Diseases

County	Amebiasis	Arboviral Disease	Botulism	Campylobacteriosis	Cholera	Cryptosporidiosis	Ehrlichiosis/Anaplasmosis	Giardiasis	H. influenzae, invasive	Hemolytic Uremic Syndrome (HUS)	Hepatitis A	Hepatitis B, acute	Hepatitis C, acute	Legionellosis	Listeriosis
Barber	0	0	0	6	0	0	0	0	0	0	0	0	1	0	0
Barton	0	9	0	11	0	10	0	2	1	0	0	1	0	0	0
Comanche	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Edwards	0	3	0	4	0	0	0	0	0	0	0	0	1	0	0
Kiowa	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Pawnee	0	0	0	5	0	1	0	1	0	0	0	0	1	0	0
Pratt	0	1	0	4	0	0	0	2	0	0	0	0	0	1	0
Stafford	0	5	0	2	0	0	0	1	0	0	0	0	0	0	0
Regional Total	0	19	0	32	0	11	0	6	1	0	0	1	3	1	0

Source: Kansas Department of Health and Environment

2002 - 2013 Reportable Diseases Continued

County	Lyme Disease	Malaria	Meningitis, non-HiB, non-Neisseria	Meningococcal Disease	Mumps	Pertussis	Rabies, animal	Salmonellosis	Shiga toxin-producing E. coli	Shigellosis	Strep., Group A, invasive	Strep. pneumoniae, invasive	TSE or Prion Disease	Tuberculosis, active	Tularemia	Typhoid Fever	Varicella
Barber	0	0	0	0	0	2	0	1	1	0	0	1	0	0	0	0	3
Barton	0	0	0	0	1	5	1	11	9	3	0	1	0	0	0	0	11
Comanche	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Edwards	0	0	0	0	0	0	1	3	3	0	1	0	0	0	0	0	1
Kiowa	0	0	0	0	0	0	1	1	1	1	0	0	1	0	0	0	1
Pawnee	0	0	0	0	0	12	0	7	2	0	0	1	0	0	0	0	5
Pratt	0	1	0	0	0	0	1	3	5	0	2	0	0	0	0	0	2
Stafford	0	0	0	0	0	3	0	6	2	0	0	1	0	0	0	0	10
Regional Total	0	1	0	0	1	22	4	32	23	5	3	4	1	0	0	0	33

Source: Kansas Department of Health and Environment

Hazard Vulnerability and Impact

All people within the south Kansas region would be susceptible to a major disease outbreak. As the type of disease cannot be known in advance it is impossible to predict if any segment of the population would be a greater risk. However, the following generalities may be made:

- Population density will affect the rate of spread of a transmissible pathogen
- The young and old are usually more susceptible to deleterious effects of disease
- Access to medical care will impact the outcomes for infected individuals
- The novelty of the disease will impact availability of treatments and vaccines
- Inherent immunity may be present in some populations

As evidenced by annual infectious disease summaries (http://www.kdheks.gov/epi/index.html) and reports of investigations (http://www.kdheks.gov/epi/outbreaks.htm) completed by the KDHE Bureau of Epidemiology and Public Health Informatics, many south Kansas counties experience one or multiple disease outbreaks each year. Potential casualty losses are anticipated to be greatest in counties with higher populations, higher pediatric populations and higher elderly

populations. Health professional shortage areas and rural areas are more susceptible to having limited medical capabilities and by extension are more susceptible to the possibility of being overwhelmed because of a large surge of patients seeking care.

Although infectious diseases do not respect geographic boundaries, several populations in south Kansas are at specific risk to infectious diseases. Communicable diseases are most likely to spread quickly in institutional settings such as dormitories, long-term care facilities, day care facilities, and schools.

The HMPC ranked the disease outbreak as catastrophic based on a pandemic scenario. The magnitude of an infectious disease outbreak is related to the ability of the public health and medical communities to stop the spread of the disease. Most disease outbreaks that cause catastrophic numbers of deaths are infectious in nature, meaning that they are spread from person to person. The key to reducing the catastrophic nature of the event is to stop the spread of disease. This is generally done in three ways:

- Identification and isolation of the ill
- Quarantine of those exposed to the illness
- Education of the public about methods to prevent transmission.

The public health and health care providers in south Kansas routinely utilize all three methods to reduce morbidity and mortality from infectious disease. However, the capacity of the health care system is limited. For example, local health departments have specific pandemic influenza response plans, and mass prophylaxis plans, but most departments have only a few staff members. Most local health departments would need to rely on volunteers, pre-scripted messages and procedures and the cooperation of the public in order to respond effectively to a large scale pandemic. Similarly, hospitals in south Kansas have emergency response and pandemic influenza plans, but little excess capacity exists to care for and/or isolate hundreds, even thousands of patients. Because of these limitations in personnel and equipment, the health care community is planning to utilize “community containment” measures. These measures which could include closure of schools, day cares and other public events would have far-reaching economic impacts on the community and might shutdown facilities for 30 days or more. Closure of the day cares or schools would have a serious impact on business as parents might not be able to find child care elsewhere.

According to "The Annual Impact of Seasonal Influenza in the US: Measuring Disease Burden and Costs" by NA Molinari, nationally the economic burden of influenza medical costs, medical costs plus lost earnings, and the total economic burden were $10.4 billion, $26.8 billion and $87.1 billion respectively. The financial burden of healthcare-associated infections nationally has been estimated at $33 billion annually. There is no data currently available on the economic impact of previous illness in south Kansas. Using pandemic influenza as the worst case scenario for estimating potential losses, the Kansas Department of Health and Environment’s Pandemic Influenza Planning includes the following vulnerability estimates. It has been estimated that a medium-level pandemic could cause, in Kansas:

- Between 229,203 and 534,807 persons may require outpatient care
- Between 5,016 and 11,706 may require hospitalization
- Between 1,163 and 2,714 individuals may die

The majority of these deaths and hospitalizations would occur in more highly populated counties.

The U.S. Centers for Disease Control and Prevention (CDC) estimates 76 million people suffer food borne illnesses each year in the United States, accounting for 325,000 hospitalizations and more than 5,000 deaths. Food borne disease is extremely costly. Health experts estimate that the yearly cost of all food borne diseases in this country is $5 to $6 billion in direct medical expenses and lost productivity. Infections with the bacteria *Salmonella* alone account for $1 billion yearly in direct and indirect medical costs.

	Magnitude/Severity
Major Disease Outbreak	2.88

Future Development

Future development and population increases would tend to increase the risk of this hazard due to the potential for a more rapid spread of an agent or disease. Additionally, the further development of transportation infrastructure would increase the risk of a major disease event due to an influx of travelers to the region. As the population of Kansas ages, the vulnerability to this hazard is likely to increase. The impacts and potential losses are largely economic and are dependent on the type, extent, and duration of the illness. However, in general, the region is experiencing a population decline which could potentially lessen the potential of a future event.

Probability of Future Hazard Events

Each year, the Kansas KDHE produces a report that details the legally "reportable diseases" in each county in Kansas. While over time this report can serve as a predictor of the likelihood of future disease, it is impossible to predict outbreaks. Based on the relatively limited/controlled outbreak history in the state the possibility of a large-scale major disease outbreak is unlikely

	Probability
Major Disease Outbreak	1.38

Consequence Analysis

The information in the following table provides the Consequence Analysis.

Major Disease Outbreak Consequence Analysis

Subject	Ranking	Impacts of Major Disease Outbreak
Health and Safety of Persons in the Area of the Incident	Severe	Impact over a widespread area could be severe depending on type of outbreak and whether it is a communicable disease. Casualties are dependent on warning systems, warning times and the availability of vaccines, antidotes, & medical svc.
Responders	Severe	Impact to responders could be severe, especially if they reside in the area and or their type of exposure during response. With proper precautions and safety nets in place the impact is lessened.
Continuity of Operations	Minimal	Continuity of Operations will be greatly dependent on availability of healthy individuals. COOP is not expected to be exercised.
Property, Facilities, and Infrastructure	Minimal	Access to facilities and infrastructure could be affected until decontamination is completed
Delivery of Services	Minimal	Delivery of services could be affected if there are road blocks or mass hysteria of any level.
Environment	Severe	Impact could be severe for the immediate impacted area depending on the source of the outbreak. Impact could have far-reaching implications if disease is transferable between humans and animals or to wildlife.
Economic Conditions	Severe	Impacts to the economy could be severe if the disease is communicable. Loss of tourism, revenue, and business as usual will greatly affect the local economy and the state as a whole.
Public Confidence in Governance	Severe	Response and recovery will be in question if not timely and effective. Availability of medical supplies, vaccines, and treatments will come into question.

3.7.15 RADIOLOGICAL EVENT

	Probability	Magnitude/Severity	Warning Time	Duration	CPRI
Radiological Event	1.00	1.00	3.63	4.00	1.69

Description

An accident involving radioactive materials could occur from a variety of sources, including nuclear reactors, transportation accidents, industrial and medical uses and lost or stolen sources. Radiological accidents could cause injury or death, contaminate property and valuable environmental resources, as well as disrupt the functioning of communities and their economies.

	Warning Time
Radiological Event	3.63

	Duration
Radiological Event	4.00

Hazard Location

The entire planning region is at risk from a radiological event due to transportation accidents.

Previous Occurrences and Extent

There are no reported radiological events for south Kansas.

Hazard Vulnerability and Impact

There are over 300 licensees of various sizes for radioactive material within the State of Kansas. In general, the major usage of radioactive materials in south Kansas are for medical diagnostics and therapy, soil density testing in the construction industry, and in radiography cameras in pipeline construction and repair.

It is common for materials, including pharmaceuticals, industrial sources and nuclear fuel rods destined to nuclear reactors, to be transported across south Kansas highways and railroads. Areas near interstates and major highways have an increased risk of transportation accidents. Remote areas also have to account for long response times from hazardous materials and health physics personnel.

Counties within the 50-mile Emergency Planning Zone for commercial nuclear power plants have a slightly higher radiological risk than other counties within the region, but the potential for an incident is extremely low. Federal regulations require emergency planning for the area within up to a 50-mile radius of a nuclear power plant. The potential danger from an accident is exposure to radiation. This exposure could come from the release of radioactive material from the plant into the environment, usually characterized by a plume of radioactive gases and

particles. The major hazards to people in the vicinity of the plume are radiation exposure to the body from the cloud and particles deposited on the ground, inhalation of radioactive materials and ingestion of radioactive materials.

During all lawful operations of radioactive materials, the licensee is responsible for ensuring that the area around the source material is cordoned off or shielding is used to prevent unnecessary exposures. Inspections of practices and security measures are regularly conducted to ensure compliance and conformity to regulations in order to protect the public. The frequency of inspections can be adjusted in response to perceived risk. Public risk can be reduced by minimizing the duration of exposure, shielding the source material and maximizing the distance from the source.

	Magnitude/Severity
Radiological Event	1.00

Future Development

Additional development along transportation corridors would likely increase the potential exposure of the nearby population to a radiological event. Additionally, greater loads on the highways and rail corridors could increase the chances of an accident involving a radiological transport vehicle. However, in general, the region is experiencing a population decline which could potentially lessen the potential of a future event.

Probability of Future Hazard Events

Based on the lack of major or recurring notable radiological events in south Kansas during the last 10 years the probability of an event occurring is unlikely within the next ten years.

	Probability
Radiological Event	1.00

Consequence Analysis

The information in the following table provides the Consequence Analysis.

Radiological Event Consequence Analysis

Subject	Ranking	Impacts of Radiological Event
Health and Safety of Persons in the Area of the Incident	Severe	Impact expected to be severe for persons within the incident area. Protection capabilities and warning times will greatly affect the severity.
Responders	Severe	Impact to responders could be severe if not trained and properly equipped. Responders that are properly trained and equipped will have a low to moderate impact.
Continuity of Operations	Minimal to Severe	Temporary relocation could be necessary if government facilities are in close proximity to the incident area. This temporary relocation could become significant depending on clean-up.
Property, Facilities, and Infrastructure	Severe	Impact within the incident area could be severe to property, facilities, and infrastructure.
Delivery of Services	Minimal to Severe	Delivery of services could be affected within and around the affected area.
Environment	Severe	Localized impact within the incident area could be severe to native plants, wildlife and natural habitats. Clean up and remediation will be required.
Economic Conditions	Minimal to Severe	Economic conditions could be adversely affected and dependent upon time and length of clean up and investigation.
Public Confidence in Governance	Minimal to Severe	Impact will be dependent on whether or not the incident could have been avoided by government or non-government entities, clean-up and investigation times, and outcomes.

3.7.16 SOIL EROSION AND DUST

	Probability	Magnitude/Severity	Warning Time	Duration	CPRI
Soil Erosion & Dust	2.38	1.38	1.00	4.00	2.03

Description

Soil erosion and dust are both ongoing problems for south Kansas. Both can cause significant loss of valuable agricultural soils, damage crops, harm environmental resources and have adverse economic impacts. Soil erosion in south Kansas is largely associated with periods of drought, when winds are able to move tremendous quantities of exposed dry soil (wind erosion), and flooding (stream bank erosion). Improper agricultural and grazing practices can also contribute to soil erosion.

The United States is losing soil 10 times faster than the natural replenishment rate, and related production losses cost the country about $37.6 billion each year. On average, wind erosion is responsible for about 40 percent of this loss and can increase markedly in drought years. Wind erosion physically removes the lighter, less dense soil constituents such as organic matter, clays and silts. Thus it removes the most fertile part of the soil and lowers soil productivity, which can result in lower crop yields or poorer grade pastures and increase economic costs.

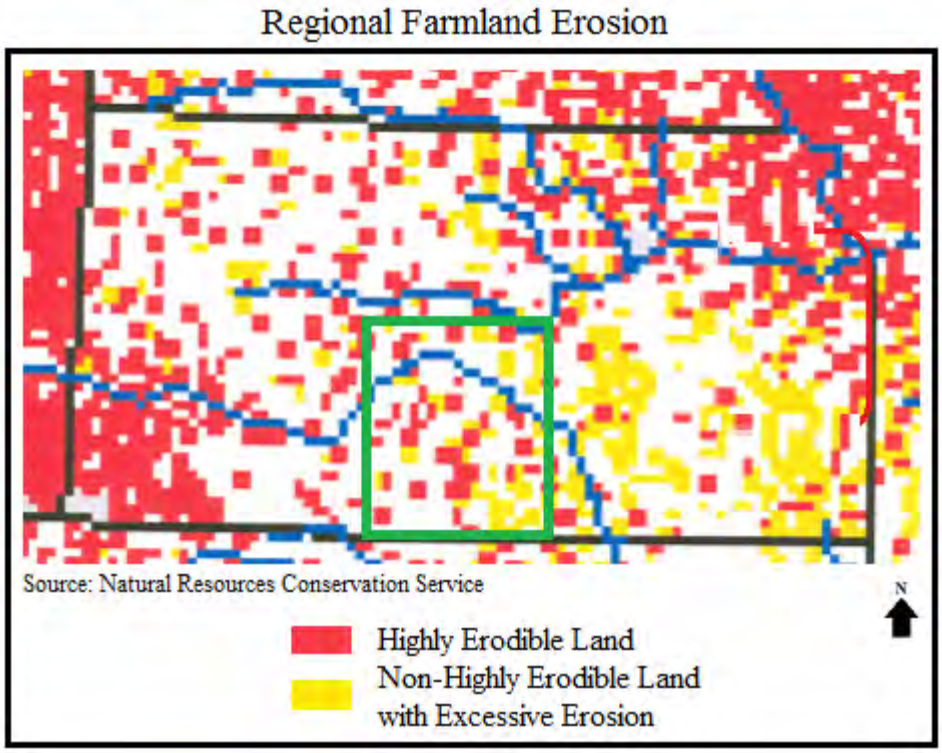
Stream bank erosion, which can remove agricultural land and damage or destroy roads and bridges and utility lines, occurs each year, particularly in the spring when high runoff is most common. A large proportion of all eroded soil material ends up in rivers, streams and lakes, which makes waterways more prone to flooding and contamination and reduces water supply storage space.

	Warning Time
Soil Erosion & Dust	1.00

	Duration
Soil Erosion & Dust	4.00

Hazard Location

The following figure shows areas of excessive erosion of farmland in Kansas based on a 1997 analysis. Each red dot represents 5,000 acres of highly erodible land, and each yellow dot represents 5,000 acres of non-highly erodible land with excessive erosion above the tolerable soil erosion rate. While south Kansas has smaller areas of highly erodible land, the entire area is susceptible to soil erosion and dust.



Previous Occurrences

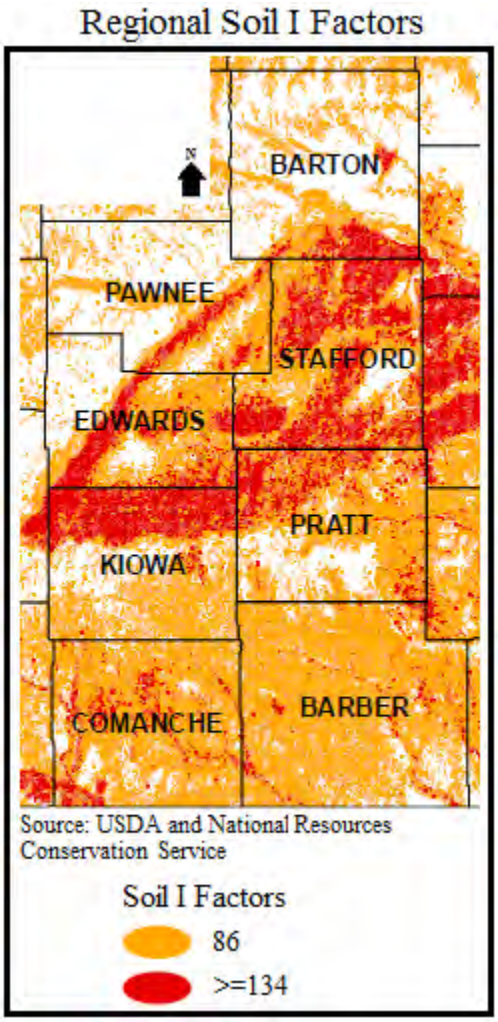
The most prominent soil erosion and dust event in south Kansas, known as the Dust Bowl, occurred across the mid-western United States from 1930-1936. South Kansas is situated to the east of the most severely impacted region (100 million acre across Oklahoma, the Texas panhandle, New Mexico, eastern Colorado and western Kansas) but was nonetheless significantly affected. Sustained drought, loss of native prairie and the agricultural practices of the time were primary causes for this unmitigated disaster. During the Dust Bowl years millions of tons of fertile soils were lost as well as a significant percentage of the region's population via migration, dust pneumonia and malnutrition. More recently, the Kansas State Hazard Mitigation Plan reports that during the 1970s and in the spring of 1996 wind erosion seriously damaged agricultural land throughout the Great Plains.

Notable historical erosion events include:

> **2007:** According to the 2007 Natural Resources Inventory (NRI) by the Natural Resources Conservation Service, Kansas lost 1.734 tons per acre to wind erosion on cultivated cropland.
>
> **1930s:** Kansas is well known for its role in the 1930s Dust Bowl, in which the Central Plains states suffered drought and resulting wind erosion for about a decade. It is estimated that 21.5 million acres were lost during this time.

Hazard Vulnerability and Impact

The map below indicates all south Kansas soils that have an "I" value, or wind erodibility index, of 86 or greater. In general, the higher the I value, the more susceptible it is to wind erosion. These are soils that should be further evaluated before recommending the use of emergency tillage or not. The evaluation of these soils will need to take into account the predominate particle size (i.e. classification of "sandy" would cause the soil to have characteristics more like a 134 soil), as well as the ability for the soil to form a stable clod.



There have not been any state-wide studies to estimate the dollar value of top soil lost to soil erosion and dust.

The 2007 Natural Resources Inventory by the Natural Resources Conservation Service shows the historical estimates for tons per acres soil lost annually for cultivated cropland, non-cultivated cropland and pastureland. This estimate can continue as potential soil losses in Kansas.

Kansas Average Wind Erosion in Tons per Acre per Year by Broad Cover/Use

Broad Cover/Use	1982	1987	1992	1997	2002	2007
Cultivated Cropland	2.747	2.963	2.062	1.482	1.463	1.734
Pastureland	0.009	0.016	0.022	0.015	0.019	0.034

Source: 2007 National Resources Inventory, April 22, 2010

Note: Estimated average annual wind erosion is tons per acre per year with margins of error.

The following table presents regional acreage data for cropland and pastureland .

Regional Acreage Data (2012)

	Acreage
Total Cropland Acres	2,350,603
Total Pasture Acres	1,474,729

Source: USDA National Agricultural Statistics Service

Based on the statewide wind erosion average figures and the total cropland and pasture acreage for the region, the following can be extrapolated for the south Kansas.

Regional Estimated Soil Tonnage Lost To Wind Erosion, 1982 - 2007

	1982	1987	1992	1997	2002	2007
Estimated Regional Tonnage Lost to Wind Erosion, Cultivated Cropland	6,457,106	6,964,837	4,846,943	3,483,594	3,438,932	4,075,946
Estimated Regional Tonnage Lost to Wind Erosion, Pastureland	13,273	23,596	32,444	22,121	28,020	50,141

Calculated using USDA and 2007 National Resources Inventory data

Soil erosion has also affected the regional federal reservoirs, with erosion depositing large quantities of sediment in these reservoirs, impacting water supply and quality as well as flood storage. Because of differing climatic conditions, land uses, and physical attributes in the various watersheds, sedimentation rates vary among the reservoirs. In 2001, the KWO completed a report that projected the affect of sedimentation on state-owned storage in federal reservoirs. While there are no major reservoirs in the region it is worth noting that by the year 2040 sedimentation was projected to reduce the total amount of state-owned storage from 1.2 million acre-feet to roughly 857,000 acre-feet, a rate of loss of 6,260 acre-feet per year.

	Magnitude/Severity
Soil Erosion & Dust	1.38

Future Development

Future development of agricultural resources and/or increases in population would tend to increase the risk of this hazard. However the region is experiencing a slight decrease in

agricultural acreage trending toward static which could potentially lessen the potential of a future event.

Probability of Future Hazard Events

While the occurrence of this hazard is on-going, based on data concerning historical occurrences and data on regional growth and development trends in agriculture and livestock, the probability of future occurrences of this hazard causing a greater measurable impact is possible.

	Probability
Soil Erosion & Dust	2.38

Consequence Analysis

The information in the following table provides the Consequence Analysis.

Soil Erosion and Dust Consequence Analysis

Subject	Ranking	Impacts of Soil Erosion and Dust
Health and Safety of Persons in the Area of the Incident	Minimal	Impact tends to be agricultural; however, dust can be a danger to susceptible individuals in the form of air pollutants.
Responders	Minimal	With proper preparedness and protection, impact to the responders is expected to be minimal.
Continuity of Operations	Minimal	Minimal expectation for utilization of the COOP.
Property, Facilities, and Infrastructure	Minimal to Moderate	Impact to property, facilities, and infrastructure could be severe, depending on the site of the soil erosion. This could adversely affect utility poles/lines, and facilities. Dust can also adversely affect machinery, air conditioners, etc.
Delivery of Services	Minimal	Impact on the delivery of services should be non-existent to minimal, unless roads and utilities are affected.
Environment	Severe	The impact to the environment could be severe. Soil erosion and dust can severely affect farming, ranching, wildlife and plants due to production losses and habitat changes.
Economic Conditions	Minimal	Impacts to the economy will be dependent on how extreme the soil erosion and dust are. Potentially it could severely affect crop yield and productivity. Seedling survival and growth is stressed by erosion and dust, as is the top soil which agriculture is dependent on.
Public Confidence in Governance	Minimal	Planning, response, and recovery may be questioned if not timely and effective.

3.7.17 TERRORISM, AGRI-TERRORISM

	Probability	Magnitude/Severity	Warning Time	Duration	CPRI
Terrorism, Agri-Terrorism	1.00	2.00	3.63	1.38	1.73

Description

The United States does not have a standardized definition of terrorism that is agreed upon by all agencies. The Federal Bureau of Investigation generally defines terrorism 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."

The USA Patriot Act expanded this definition to include domestic terrorism, defined as:

> "acts dangerous to human life that are a violation of the criminal laws of the United States or of any State" 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 mass destruction, assassination, or kidnapping" that are conducted primarily within the jurisdiction of the United States."

The Homeland Security Act of 2002, which created the Department of Homeland Security, extended the definition of terrorism further by including any act that:

> "involves an act that dangerous to human life or potentially destructive to critical infrastructure or key resources, and is a violation of the criminal laws of the United States or of any state or other subdivision of the United States and appears to be intended to intimidate or coerce a civilian population to influence the policy of a government by intimidation or coercion, or to affect the conduct of a government by mass destruction, assassination, or kidnapping"

The statement "potentially destructive to critical infrastructure or key resources" indicates that the act does not need to be dangerous to human life for it to be considered an act of terrorism. Terrorists may use a range of possible actions, including:

- Chemical attacks
- Biological attacks
- Radiological attacks
- Nuclear attacks
- Cyber-terrorism
- Agri-terrorism

	Warning Time
Terrorism, Agri-Terrorism	3.63

	Duration
Terrorism, Agri-Terrorism	1.38

Hazard Location

Kansas is home to a wide variety of criminal extremist groups. The Southern Poverty Law Center reported that in 2012, there were three active hate groups in Kansas: one neo-Nazi group, the National Socialist Movement in Lansing, one racist skinhead group, the Midland Hammerskins in Wichita, and one anti-homosexual group, the Westboro Baptist Church in Topeka. Other groups, such as the Animal Liberation Front, Earth Liberation Front, and People for the Ethical Treatment of Animal may have sympathizers in the region. Although no major terrorist acts have been attributed to any of these latter groups, their involvement in violent acts is meant to disrupt governmental functions and cannot be discounted.

Previous Occurrences

There have been no incidents or events reported in the region.

Hazard Vulnerability and Impact

Of particular concern to south Kansas is agri-terrorism Agri-terrorism consists of acts to intentionally contaminate, ruin, or otherwise make agricultural products unfit or dangerous for consumption or further use. The introduction of a biological agent into an animal or crop would be financially devastating and would have a major impact on the food supply of the state region , state and nation. Potential terrorists' targets for livestock disease introduction would be concentration points, such as the region's licensed feedlots and livestock markets. Additionally, Kansas has over 120 agricultural crop-dusters, many of which are configured for chemical spraying.

It is not possible to calculate a specific vulnerability for each county in south Kansas. However, because of the desire for publicity following attacks, it is more likely that counties with greater population densities would be the target of attacks. Sparsely populated rural counties are less desirable targets for publicity-seeking terrorists. It is expected that the likelihood of attack is directly related to population density or more likely to an event that is occurring or to a specific location of importance to the attacker. For example, a large venue event, such as a sporting event attended by tens of thousands of people might be considered a desirable target. Most large public venues occur in densely populated areas since those areas are able to provide the infrastructure support (hotels, eateries, etc) for large numbers of people.

Potential losses from Terrorism/Agri-Terrorism include all infrastructure, critical facilities, crops, humans and animals. The degree of impact would be directly related to the type of incident and the target. Potential losses could include cost of repair or replacement of damaged facilities, lost economic opportunities for businesses, loss of human life, injuries to persons, loss of food supplies, disruption of the food supply chain, and immediate damage to the surrounding environment. Secondary effects of infrastructure failure could include public safety hazards,

spread of disease, increased morbidity and mortality among the local and distant populations, public panic and long-lasting damage to the environment. Terrorism events are rare occurrences and specific amounts of estimated losses for previous occurrences are not available due to the complexity and multiple variables associated with these types of hazards. In some instances, information about these events is secure and unavailable to the public in order to maintain national security and prevent future attacks.

In general, it is difficult to quantify potential losses of terrorism due to the many variables and human elements and lack of historical precedence. Therefore, for the purposes of this plan, the loss estimates will take into account three hypothetical scenarios. The estimated impact of each event was calculated using the Electronic Mass Casualty Assessment and Planning Scenarios developed by Johns Hopkins University. The Electronic Mass Casualty Assessment and Planning Scenarios system usually rates the of worried well as equal to 9 times the number of infected cases.

Please note that the hypothetical scenarios are included for illustrative purposes only.

Scenario #1: Mustard Gas Release

Event: Mustard gas is released from a light aircraft onto a local downtown area during a heavily attended event. The agent directly contaminates the downtown area and the immediate surrounding area. This attack would cause harm to humans and could render portions of the downtown unusable for a short time period in order to allow for a costly clean-up. There might also be a fear by the public of long-term contamination of the stadium and subsequent boycott of games resulting in a loss of revenue and tourism dollars.

Event Assumptions: For this scenario the number of people in the downtown area is 5,000. The agent used, mustard gas, is extremely toxic and may damage eyes, skin and respiratory tract with death sometimes resulting from secondary respiratory infections. Death rate from exposure estimated to be 3%. The estimated decontamination cost is $12 person. For this scenario it is assumed that all persons with skin injuries will require decontamination.

Results: The following table presents the estimated human and economic impacts of the scenario.

Estimated Impact of Scenario #1, Mustard Gas Release

Impact	Post Exposure Onset Time	Effect
Severe Eye Injuries (1-2 hours)	1 -2 Hours	3,750 persons
Severe Airway Injuries (1-2 hours)	1 - 2 Hours	3,750 persons
Severe Skin Injuries (2 hrs to days)	2 Hours to Days	4,500 persons
Deaths	Immediate to Days	100 persons
Cost of Decontamination	N/A	$60,000

Scenario #2: Pneumonic Plague

Event: Two canisters containing aerosolized pneumonic plague bacteria are opened in public bathrooms of a heavily populated building. Each release location will directly infect 110 people; hence, the number of release locations dictates the initial infected population. The secondary infection rate of two is used to calculate the total infected population. This attack method would not cause damages to buildings or other infrastructure, only to human populations.

Event Assumptions:

Each canister contains 650 milliliters of pneumonic plague bacteria. The type of infectious agent used is identified on Day 4. After identification, the fatality rate is 10% for new cases. Pneumonic plague has a 1-15 percent mortality rate in treated cases and a 40-60 percent mortality rate in untreated cases.

Results: The following table presents the estimated human impacts of the scenario.

Estimated Impact of Scenario #2, Pneumonic Plague Release

Impact	Effect
Initial Infected Population	220 persons
Secondary Infected Population	440 persons
Deaths (7% of Infected)	46

Scenario #3: Improvised Explosive Device

Event: An improvised explosive device utilizing an ammonium nitrate/fuel oil (ANFO) mixture is carried in a panel van to a parking area around a local event. Potential losses with this type of scenario include both human and structural assets.

Event Assumptions:

The quantity of ANFO used is 1,000 pounds. The population density of the lot is assumed to be 1 person per every 25 square feet. The Lethal Air Blast Range for such a vehicle is estimated to be 50 feet according to the Bureau of Alcohol, Tobacco, Firearms and Explosives (BATF) Standards. The Falling Glass Hazard distance is estimated at 600 feet according to BATF Explosive Standards. In this event, damage would occur to vehicles and structures. The exact amount of these damages is difficult to predict because of the large numbers of factors, including the type of structures nearby and the amount of insurance held by vehicle owners. It is estimated that the average replacement cost for a vehicle is $20,000 and the average repair cost for damaged vehicles would be $4,000.

Results: The following table presents the estimated human impacts of the scenario.

Estimated Impact of Scenario #3, Improvised Explosive Device

Impact	Effect
Deaths	551 persons
Trauma Injuries	961 persons
Urgent Care Injuries	11,935
Injuries not Requiring Hospitalization	4,736
Repair Costs for 25 Vehicles	$100,000
Replacement Costs for 25 Vehicles	$500,000

	Magnitude/Severity
Terrorism, Agri-Terrorism	2.00

Future Development

In general, acts of terrorism have historically been conducted in major population centers or on targets of high significance within the United States. If more large public events are held in south Kansas, more potential may exist for these venues to become targets of attack. However, in general, the region is experiencing a population decline which could potentially lessen the potential of a future event.

With human-caused hazards such as this that can have multiple variables involved, increases in development are not necessarily always factors in determining risk, although the physical cost of the event may increase with the increased or newly developed areas.

Probability of Future Hazard Events

By nature, acts of terrorism are difficult to foresee. However, based on historic events the probability of future major regional terrorist attacks is unlikely.

	Probability
Terrorism, Agri-Terrorism	1.00

Consequence Analysis

The information in the following table provides the Consequence Analysis.

Terrorism, Agri-Terrorism Consequence Analysis

Subject	Ranking	Impacts of Terrorism, Agri-Terrorism
Health and Safety of Persons in the Area of the Incident	Severe	Impact could be severe for persons in the incident area.
Responders	Minimal to Severe	Impact to responders could be severe if not trained and properly equipped. Responders that are properly trained and equipped will have a low to moderate impact.
Continuity of Operations	Minimal to Severe	Depending on damage to facilities/personnel in the incident area, re-location may be necessary and lines of succession execution.
Property, Facilities, and Infrastructure	Severe	Impact within the incident area could be severe for explosion, moderate to low for Hazmat.
Delivery of Services	Minimal to Severe	Delivery of services could be affected if communications, road and railways, and facilities incur damage.
Environment	Minimal to Severe	Localized impact within the incident area could be severe depending on the type of incident.
Economic Conditions	Minimal to Severe	Economic conditions could be adversely affected and dependent upon time and length of clean up and investigation.
Public Confidence in Governance	Minimal to Severe	Impact dependent on if the incident could have been avoided by government entities, clean-up, investigation times and outcomes.

3.7.18 TORNADO

	Probability	Magnitude/Severity	Warning Time	Duration	CPRI
Tornado	3.50	3.25	4.00	1.13	3.26

Description

The NWS defines a tornado as "a violently rotating column of air extending from a thunderstorm to the ground." Tornados are the most violent of all atmospheric storms and are capable of tremendous destruction. Wind speeds can exceed 250 mph, and damage paths can be more than one mile wide and 50 miles long.

Although tornados have been documented on every continent, they occur most frequently in the United States east of the Rocky Mountains. South Kansas is situated in an area that is generally known as "Tornado Alley." Climatological conditions are such that warm and cold air masses meet in the center of the country to create conditions of great instability and fast moving air at high pressure that can ultimately result in formation of tornado funnels.

In south Kansas, most tornados and tornado-related deaths and injuries occur during the months of April, May, and June. However, tornados have struck in every month. Similarly, while most tornados occur between 3:00 p.m. and 9:00 p.m., a tornado can strike at any time.

Tornados are classified according to the Enhanced Fujita (EF) Scale. The EF scale ranks tornados according to wind speed and the resulting damage caused. This system is an update to the original Fujita Scale, and was implemented on February 1, 2007. The following table illustrates the changes in the scaling systems.

Fujita Scale and Enhanced Fujita Scale Comparison

Fujita Scale			Derived EF Scale		Operational EF Scale	
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)	EF Number	3 Second Gust (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

Source: NWS

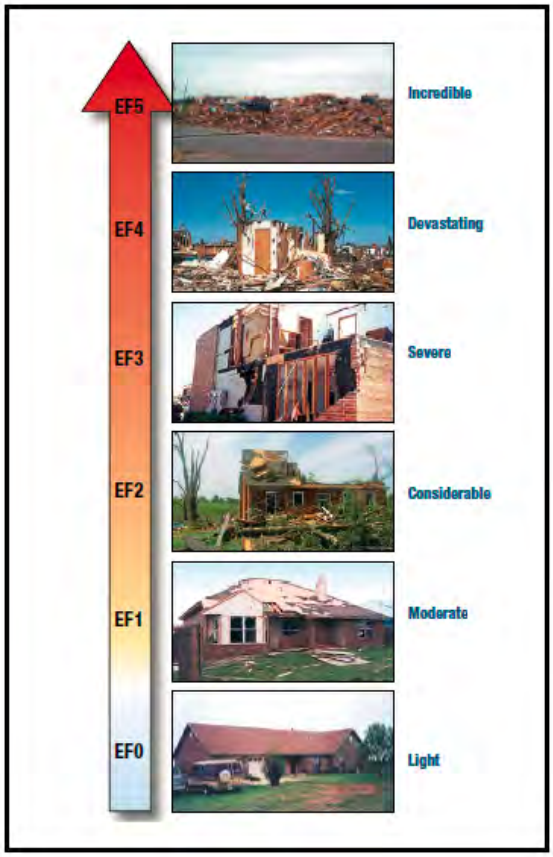
The wind speeds for the EF scale and damage descriptions are based on information from the NOAA Storm Prediction Center. The damage descriptions are summaries. For the actual EF scale it is necessary to look up the damage indicator (type of structure damaged) and refer to the degrees of damage associated with that indicator.

Enhanced Fujita Scale

Scale	Wind Speed (mph)	Relative Frequency	Potential Damage
EF0	65-85	53.5%	Light. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornados with no reported damage (i.e. those that remain in open fields) are always rated EF0.
EF1	86-110	31.6%	Moderate. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	10.7%	Considerable. Roofs torn off well constructed houses; foundations of frame homes shifted; mobile homes complete destroyed; large trees snapped or uprooted; light object missiles generated; cars lifted off ground.
EF3	136-165	3.4%	Severe. Entire stores of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	0.7%	Devastating. Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	<0.1%	Explosive. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 300 ft.; steel reinforced concrete structure badly damaged; high rise buildings have significant structural deformation; incredible phenomena will occur.

Source: NOAA Storm Prediction Center

The following picture, provided by FEMA, visually indicates expected damage from each tornado type.



Source: FEMA, Taking Shelter From the Storm, 2008

The best lead time for a tornado is about 30 minutes. Tornados have been known to change paths very rapidly, thus limiting the time in which to take shelter. Tornados may not be visible on the ground due to evening hours, blowing dust or driving rain and hail. Therefore, there is very little, or no, warning of when a specific tornado may be on the ground.

	Warning Time
Tornado	4.00

	Duration
Tornado	1.13

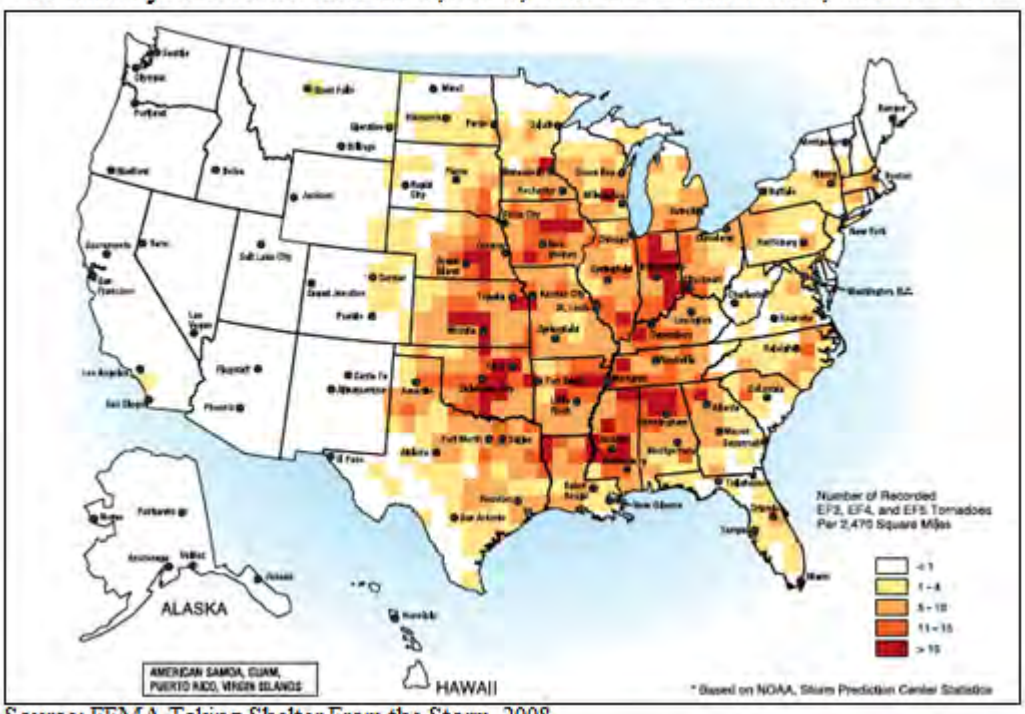
Hazard Location

Although tornados have been documented on every continent, they occur most frequently in the United States east of the Rocky Mountains. South Kansas is situated in an area that is generally known as Tornado Alley.

While tornados can occur in all areas of the State of Kansas, historically, some areas of the state have been more susceptible to this type of damaging storm. All of south Kansas, including all of the participating jurisdictions, is at risk to tornados.

The following figure illustrates the number of F3, F4, and F5 tornados recorded in the United States between 1950 and 2006. Each colored block indicates an area of approximately 2,470 square miles. Data from the map indicates the south Kansas region falls within areas that range from 5-10 to >15 recorded events.

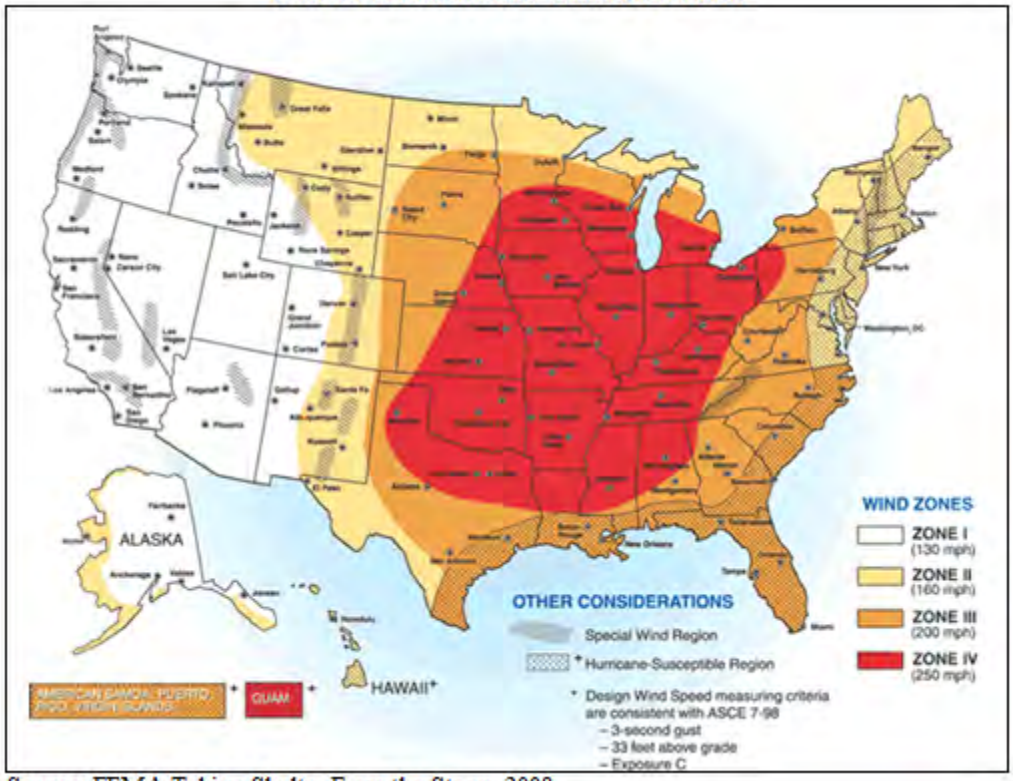
Tornado Activity in the United States
Summary of Recorded EF3, EF4, and EF5 Tornados, 1950-2006



Source: FEMA Taking Shelter From the Storm, 2008

Additionally, the following figure shows that south Kansas is in Wind Zone IV, indicating that the area has the strongest and most frequent tornado activity.

Wind Zones in the United States



Source: FEMA Taking Shelter From the Storm, 2008

By using the data derived from the above maps and the risk rating table from FEMA, it is possible to see that south Kansas is in a high risk area for tornados.

Area Risk Rating

		Wind Zone			
		I	II	III	IV
Number of Tornados Per 2,470 Square Miles	<1	Low Risk	Low Risk	Low Risk	Moderate Risk
	1-4	Low Risk	Moderate Risk	High Risk	High Risk
	5-10	Low Risk	Moderate Risk	High Risk	High Risk
	11-15	High Risk	High Risk	High Risk	High Risk
	>15	High Risk	High Risk	High Risk	High Risk

Source: Taking Shelter from the Storm, FEMA, 2008

Previous Occurrences and Extent

In the past ten years, tornados have impacted south Kansas repeatedly, including nine Presidential Disaster Declarations since 2004. Details about some of these events as well as the Presidential Disaster Declarations that included tornados can be found on the following pages.

Kansas Presidential Declarations Involving Tornados

Declaration Number	Declaration Date*	Disaster Description	Regional Counties Involved	Disaster Cost**
4150	10/22/2013 (7/22/2013 - 08/16/2013)	Severe Storms, Winds, **Tornados** and Flooding	Barber, Barton, Comanche, Edwards, Kiowa, Pawnee, Pratt and Stafford	$11,412,827
4063	05/24/2012 (4/14-4/15/2012)	Severe Storms, **Tornados**, Straight-line Winds and Flooding	Edwards, Kiowa and Stafford	$6,923,919
4010	07/29/2011 (5/19-6/4/2011)	Severe Storms, Straight-line Winds, **Tornados** and Flooding	Barton and Stafford	$8,259,620
1932	08/10/2010 (6/7-7/21/2010)	Severe Storms, Flooding and **Tornados**	Comanche, Kiowa and Pawnee	$9,279,257
1849	06/25/2009 (4/25-5/16/2009)	Severe Storms, Flooding, Straight-line Winds, and **Tornados**	Barber and Butler	$15,013,488
1808	10/31/2008	Severe Storms, Flooding, and **Tornados**	Butler	$4,167,044
1776	7/9/2008	Severe Storms, Flooding, and **Tornados**	Barber, Barton, Comanche, Edwards, Kiowa, Pawnee, Pratt and Stafford	$70,629,544
1699	5/6/2007 (5/4/2007)	Severe Storms, **Tornados**, and Flooding	Barton, Comanche, Edwards, Kiowa, Pawnee, Pratt and Stafford	$117,565,269
1535	8/3/2004 (6/12-7/25/2004)	Severe Storms, Flooding, and **Tornados**	Barton and Pawnee	$12,845,892

Sources: FEMA and Kansas Division of Emergency Management
* Incident dates are in parentheses.
** Disaster costs include Public Assistance and Individual Assistance and may include additional, unlisted counties

The following are brief descriptions of some of the above referenced tornado events:

FEMA-4150-DR: Severe Storms, Straight-line Winds, Tornados and Flooding – October 22, 2013 (July 22 to August 16, 2013): Severe storms affected the area with heavy rainfall causing flash flooding, high winds and tornados. The primary impact of this event was to roads and bridges, with a total public assistance cost estimate at $11,412,827.

FEMA-4063-DR: Severe Storms, Tornados, Straight-line Winds and Flooding – May 24, 2012 (April 14 to April 15, 2012): Multiple supercell thunderstorms affected central Kansas on April 14th. There was significant damage to homes and infrastructure.

FEMA-4010-DR: Severe Storms, Straight-line Winds, Tornados and Flooding – July 29, 2011 (May 19 to June 4, 2011): Supercell thunderstorms developed in advance of a cold front and dry line during the late afternoon of Saturday May 21st. Several of the supercell thunderstorms produced tornados..

FEMA-1932-DR: Severe Storms, Flooding and Tornados – August 10, 2010 (June 7 to July 21, 2010): There were thunderstorms that developed tornados during this timeframe, but no widespread tornado damage. The majority of the declaration damage was from flooding to public roads and bridges.

FEMA-1849-DR: Severe Storms, Flooding, Straight-line Winds and Tornados – June 25, 2009 (April 25 to May 16, 2009): On Aril 29th, severe thunderstorms produced very large hail and 5 tornados.

FEMA-1808-DR: Severe Storms, Tornados and Flooding - October 31, 2008 (September 11 to September 17, 2008): On October 22, 2008, Governor Kathleen Sebelius requested a major disaster declaration because of severe storms accompanied by tornados, lightning and torrential rains resulting in flooding and flash flooding during the period of September 11-18, 2008.

FEMA-1776-DR: Severe Storms, Flooding and Tornados - July 9, 2008 (May 22 to June 16, 2008): A series of intense supercell thunderstorms moved north across northwest Kansas during the afternoon and early evening hours of May 23rd. Long-track tornados, flash flooding, large hail and damaging winds were reported.

FEMA-1699-DR: Severe Storms, Tornados and Flooding - May 6, 2007 (May 4, 2007): A 1.7 mile-wide EF5 tornado with wind estimated at 205 mph struck Greensburg in Kiowa County, destroying approximately 90 percent of the town and severely damaging the remaining 10 percent. Tornado sirens sounded in the City twenty minutes before the tornado struck, and a tornado emergency was issued, undoubtedly saving many lives in the town of 1,580. Nevertheless, the storm killed 12 people, 10 in Greensburg, one in Pratt, and one in Stafford, and hospitalized 13 others.

The following provide further descriptions and other notable tornado events.

June 15, 2009: This tornado turned over four pivot irrigation sprinklers and destroyed two 80,000 bushel grain bins in Edwards County. In addition, a 500,000 bushel bin was heavily damaged. One of the 80k bins traveled nearly a mile. There was extensive rear flank downdraft damage in the vicinity of this tornado.

October 26, 2006: Twenty-eight tornados were reported in southwest Kansas, specifically the counties of Ford, Grant, Clark, Gray, Comanche, and Meade. Only two of the storms caused damage, which was relatively minor.

August 19, 2005: A tornado caused estimated $500,000 damage to Great Bend Airport where hangars were unroofed and an unspecified number of aircraft were overturned. A second touchdown in the Great Bend area caused $250,000 in damage to two farmsteads.

November 10, 1995: A tornado moved across Barton County, causing one million dollars in damage. One hundred and sixty homes were destroyed, and at least 1,000 sheep were killed. Debris was carried 85 miles and hundreds of dead ducks fell from the sky 25 miles northeast of the end of the tornado path.

The following table shows NCDC information for the 10 years from 2004 to 2014, with 2014 being an incomplete year. Additionally, the strongest rated tornado event is indicated.

NCDC Tornado Events, 2003-2013

County	Number of Days with Tornados	Strongest Tornado Event	Deaths	Total Property Damage	Crop Damage
Barber	7	F1	0	$10,000	$0
Barton	16	F1	0	$4,444,000	$0
Comanche	10	EF1	0	$0	$0
Edwards	8	EF3	0	$3,480,000	$50,000
Kiowa	10	EF5	0	$250,000,000	$0
Pawnee	7	EF4	0	$335,000	$0
Pratt	11	EF3	3	$65,000	$0
Stafford	9	EF3	3	$65,000	$0
Regional Total	78	EF5	6	$258,399,000	$50,000

Source: NCDC Storm Events Database

Local Events

The following detail locally reported events:

April 14, 2012: St. John, Stafford County: A tornado caused damages to both electric and wastewater utilities.

2007: Barton County, Claflin: An tornado damaged city property at the city pool, including trees. In addition, various local businesses were damaged.

Hazard Vulnerability and Impact

To refine and access the relative vulnerability of each of south Kansas' counties to tornados, ratings were assigned to pertinent factors at the county level. These factors are: social vulnerability index, prior events, prior annualized property damage, building exposure valuation, population density, crop exposure and annualized crop loss. Then a rating value of 1-10 was assigned to the data obtained for each factor and then weighted equally and factored together to obtain overall vulnerability scores for comparison and to determine the most vulnerable counties.

Tornados that touch-down can create a unique path of destruction. So using the prior events as a factor can give the perception that a county has a higher overall vulnerability to tornados.

The following information was used for this analysis:

- Social Vulnerability Index for Kansas from the Hazards and Vulnerability Research Institute at the University of South Carolina
- National Climatic Data Center storm events 2004 – 2014
- U.S. Census Bureau (2012)
- USDA's Census of Agriculture (20012)
- USDA Risk Management Agency (2010 – 2013)

Regional Counties Tornado Vulnerability Factors

County	SoVI Rating	Prior Events 2004-2014	Property Damages	Annualized Property Damage	Total Building Exposure ($000)	Population Density	Crop Exposure (2012 USDA Census of Agriculture)	Crop Loss Insurance Paid	Annualized Crop Loss Insurance Paid
Barber	4	7	$10,000	$1,000	$388,136	4	$45,420,000	$0	$0
Barton	3	16	$4,444,000	$444,400	$1,772,118	21	$96,206,000	$0	$0
Comanche	5	10	$0	$0	$135,138	2	$21,783,000	$0	$0
Edwards	4	8	$3,480,000	$348,000	$232,382	5	$126,933,000	$6,176	$1,544
Kiowa	4	10	$250,000,000	$2,500,000	$237,655	3	$63,956,000	$0	$0
Pawnee	5	7	$335,000	$33,500	$449,592	9	$92,111,000	$7,388	$1,847
Pratt	3	11	$65,000	$6,500	$689,239	13	$52,353,000	$0	$0
Stafford	4	9	$65,000	$6,500	$295,331	6	$74,549,000	$0	$0
Regional Total	-	78	$8,649,000	$864,900	$4,199,591	8	$573,311,000	$13,546	$3,391

Using the above information, a value of 1-10 was assigned to the data obtained for each factor and then weighted equally and factored together to obtain overall vulnerability scores for comparison and to determine the greatest vulnerable counties. The Social Vulnerability Index is in a range of 1- 5. To give Social Vulnerability Index the same weight as the other factors, the numbers were multiplied by two.

Ranges for Tornado Vulnerability Ratings

Ratings	Social Vulnerability	Prior Events	Annualized Property Damage	Building Exposure Valuation	Population Density *	Crop Exposure	Annualized Crop Loss Insurance Paid
1		3 - 7	$500 - $500,000	$117,421 - $4,492,825	1.6 - 116.3	0 - $18,548,500	$0 - $1,000
2	1	8 - 12	$500,001 - $1,000,000	$4,492,826 - $8,868,229	116.4 - 231.1	$18,548,501 - $32,126,000	$1,001 - $2,000
3		13 - 17	$1,000,001 - $1,300,000	$8,868,230 - $13,243,634	231.2 - 345.9	$32,126,001 - $45,703,500	$2,001 - $3,000
4	2	18 - 22	$1,300,001 - $2,000,000	$13,243,635 - $17,619,039	346 - 460.7	$45,703,501 - $59,281,000	$3,001 - $4,000
5		23 - 27	$2,000,001 - $3,000,000	$17,619,040 - $21,994,444	460.8 - 575.5	$59,281,001 - $72,858,500	$4,0001- $5,000
6	3	28 - 32	$3,000,001 - $4,000,000	$21,994,445 - $26,369,848	575.6 - 690.3	$72,858,501 - $86,436,000	$5,001 - $6,000
7		33 - 37	$4,000,001 - $7,000,000	$26,369,849 - $30,745,253	690.4 - 805.1	$86,436,001 - $100,013,500	$6,001 - $7,000
8	4	38 - 42	$8,000,001 - $11,000,000	$30,745,254 - $35,120,658	805.2 - 919.9	$100,031,501 - $113,591,000	$7,001 - $8,000
9		43 - 47	$11,000,001 - $13,000,000	$35,120,659 - $39,496,062	920- 1,034.7	$113,591,001 - $127,168,500	$8,001 - $9,000
10	5	48 - 54	Above $13,000,001	$39,496,063 - $43,871,468	1,034.8 - 1,149.6	$127,168,501 - $140,746,000	$9,001 and up

Based on the above ratings system, ranges were applied to each county to determine their potential vulnerability. The following related the scoring to a vulnerability assessment:

- **Medium:** Score range of 9 - 19
- **Medium-High:** Score range of 20 - 29
- **High:** Score range of 30 - 40

Vulnerability of Regional Counties to Tornados

County	SoVi Rating	Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Insurance Rating	Overall Vulnerability Rating	Tornado Vulnerability
Barber	8	1	1	1	1	4	0	16	Medium
Barton	6	3	1	1	1	7	0	19	Medium
Comanche	10	2	1	1	1	2	0	17	Medium
Edwards	8	2	1	1	1	9	2	24	Medium-High
Kiowa	8	2	10	1	1	5	0	27	Medium-High
Pawnee	10	1	1	1	1	7	2	23	Medium-High
Pratt	6	2	1	1	1	4	0	15	Medium
Stafford	8	2	1	1	1	6	0	19	Medium

Between 2001 and 2010 51 percent of those killed by tornados were living in mobile homes, according to the NOAA. The *2012 Kansas Severe Weather Awareness Week* reports people living in mobile homes are killed by tornados at a rate 20 times higher than people living in permanent homes. The following table represents the number of mobile homes per county, and the percentage of total housing stock.

Percentage of Mobile Homes per Regional County

County	Number of Housing Units	Number of Mobile Homes	Percentage Mobile Homes
Barber	2,754	254	9.22%
Barton	12,636	1,105	8.74%
Comanche	1,039	45	4.33%
Edwards	1,627	79	4.86%
Kiowa	1,230	57	4.63%
Pawnee	3,151	157	4.98%
Pratt	4,499	300	6.67%
Stafford	2,310	172	7.45%
Regional Total	29,246	2,178	7.45%

Sources: United States Census Bureau (2012) and U.S. Census Bureau American Community Survey(2008-2012)

	Magnitude/Severity
Tornado	3.25

Future Development

Future development, increases in population and additional development of agricultural resources and would tend to increase the risk of this hazard. New development anywhere in

south Kansas will be susceptible to tornado impacts. New manufactured housing development will be most susceptible to damage, particularly if not anchored properly. The extent of new manufactured housing development is not known. However, in general, the region is experiencing a population decline, from 61,087 persons in 2013 to a projected 45,250 person sin 2040, which could potentially lessen the potential of a future event.

Probability of Future Hazard Events

According to the NCDC, there were 78 tornados in south Kansas between 2004 and 2014. Based on this information, the probability that at least one tornado will occur in south Kansas in any given year is high.

The following calculations of probability are used for illustrative purposes only. The calculations were sourced from the FEMA Benefit-Cost Analysis Reengineering Tornado Safe Room Module Methodology Report, Version 4.5 Final, Dated May 2009. Revisions to the calculation methodology include using the entire area of the county as opposed to the 80 km by 80 km cell sized. Additionally, tornados reported on the Fujita Scale were converted to the Enhanced Fujita Scale using available data. Finally, probabilities were not calculated for EF class tornados with zero occurrence.

The following equation was used to determine probabilities equation:

Prob. Tornado(EF) = (EF count * EF area) / (Cell area * Years)

Where:

- EF count = Estimate tornado count for EF class from mapping
- EF area = Area of tornado for EF class in km2
- Cell area = Area of analysis cell, county size in KM2
- Years = Years of record from 2003 to 2013 or 11 years

Mean Tornado Length and Width

EF Class	Length (km2)	Width (km2)	EF Area
EF0	1.4	0.0284	0.03976
EF1	4.7	0.064	0.3008
EF2	10.7	0.1259	1.34713
EF3	22.5	0.2636	5.931
EF4	43.6	0.4607	20.08652
EF5	54.6	0.5555	30.3303

The following table details the illustrative calculated probability for the occurrence of a tornado in each regional county.

Illustrative Calculated Probability of Tornado

County	Approximate Area (KM2)	Tornado Rating (EF Scale)	Tornado Area (KM2)	Number of Occurrences	Number of Years	Probability
Barber	2,937	0	0.03976	6	10	0.0000081224
		1	0.30080	2	10	0.0000204831
		2	1.34713	1	10	0.0000458666
Barton	2,31,5	0	0.03976	21	10	0.0000360602
		1	0.30080	8	10	0.0001039275
Comanche	2,046	0	0.03976	9	10	0.0000174889
		1	0.30080	5	10	0.0000735057
		2	1.34713	1	10	0.0000658389
		3	5.931	1	10	0.0002898685
Edwards	1,611	0	0.03976	7	10	0.0000172764
		1	0.30080	7	10	0.0001307031
		2	1.34713	4	10	0.0003344871
		3	5.931	3	10	0.0011044830
Kiowa	1,896	0	0.03976	16	10	0.0000335549
		1	0.30080	6	10	0.0000951959
		2	1.34713	2	10	0.0001421113
		3	5.931	1	10	0.0003128363
		5	30.3303	1	10	0.0015998006
Pawnee	1,955	0	0.03976	5	10	0.0000101665
		1	0.30080	6	10	0.0000922959
		4	20.08652	1	10	0.0010272070
Pratt	1,906	0	0.03976	11	10	0.0000229436
		1	0.30080	5	10	0.0000788988
		2	1.34713	3	10	0.0002120085
		3	5.931	2	10	0.0006222721
Stafford	2,059	0	0.03976	8	10	0.0000154479
		1	0.30080	9	10	0.0001314781
		2	1.34713	4	10	0.0002616993
		3	5.931	4	10	0.0011521818

	Probability
Tornado	3.50

Consequence Analysis

The information in the following table provides the Consequence Analysis.

Tornado Consequence Analysis

Subject	Ranking	Impacts of Tornado
Health and Safety of Persons in the Area of the Incident	Severe	Impact of the immediate area could be severe depending on whether individuals were able to seek shelter and get out of the trajectory of the tornado. Casualties are dependent on warning systems and warning times.
Responders	Minimal	Impact to responders is expected to be minimal unless responders live within the affected area.
Continuity of Operations	Minimal to Severe	Temporary to permanent relocation may be necessary if government facilities experience damage.
Property, Facilities, and Infrastructure	Minimal to Severe	Localized impact could be severe in the trajectory path. Roads, buildings, and communications could be adversely affected. Damage could be severe.
Delivery of Services	Minimal to Severe	Delivery of services could be affected if there is any disruption to the roads and/or utilities due to damages sustained. Depending on the incident size the damage could be severe.
Environment	Minimal to Severe	Impact will be severe for the immediate impacted area. Impact will lessen as distance increases from the immediate incident area.
Economic Conditions	Minimal to Severe	Impacts to the economy will greatly depend on the trajectory of the tornado. If a jurisdiction takes a direct hit then the economic conditions will be severe. With an indirect hit the impact could be low to severe.
Public Confidence in Governance	Minimal to Severe	Response and recovery will be in question if not timely and effective. Warning systems and warning time will also be questioned.

3.7.19 UTILITY/INFRASTRUCTURE FAILURE

	Probability	Magnitude/Severity	Warning Time	Duration	CPRI
Utility/Infrastructure Failure	2.78	2.00	4.00	3.00	2.75

Description

Critical infrastructure involves several different types of facilities and systems including:

- Electric power
- Transportation routes
- Natural gas and oil pipelines
- Water and sewer systems, storage networks
- Internet/telecommunications systems

Failure of utilities or infrastructure components in south Kansas can seriously impact public health, functioning of communities and the region's economy. Disruptions to utilities can occur from many of the hazards detailed in this plan, but the most likely causes include:

- Floods
- Lightning
- Tornados and Windstorms
- Winter Storms

In addition to being impacted by another listed hazard, utilities and infrastructure can fail as a result of faulty equipment, lack of maintenance, degradation over time, or accidental damage.

	Warning Time
Utility / Infrastructure Failure	4.00

	Duration
Utility / Infrastructure Failure	3.00

Hazard Location

All of south Kansas is at risk for utility and/or infrastructure failure. The following sections discuss the major utilities in further detail.

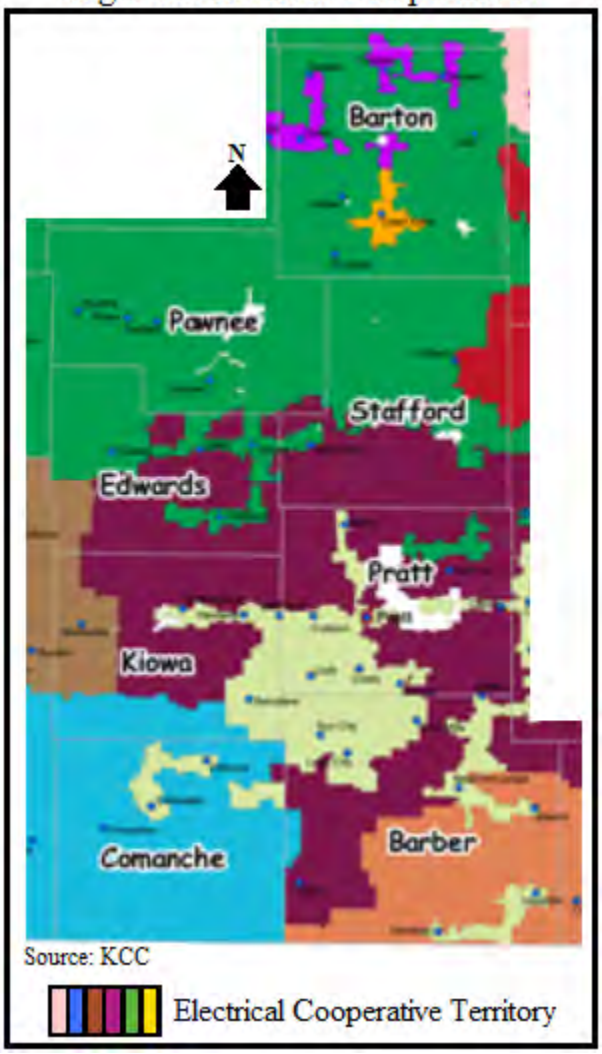
Electric Power

The most common hazards analyzed in this plan that may disrupt the power supply are flood, lightning, tornado, windstorm, and winter weather. In addition, extreme heat can disrupt power supply when air conditioning use spikes during heat waves resulting in brownouts or rolling blackouts.

Electricity in south Kansas is provided by either investor-owned utilities or rural electric cooperatives (RECs). Electric utilities in Kansas are regulated by both the KCC and the Federal Energy Regulatory Commission.

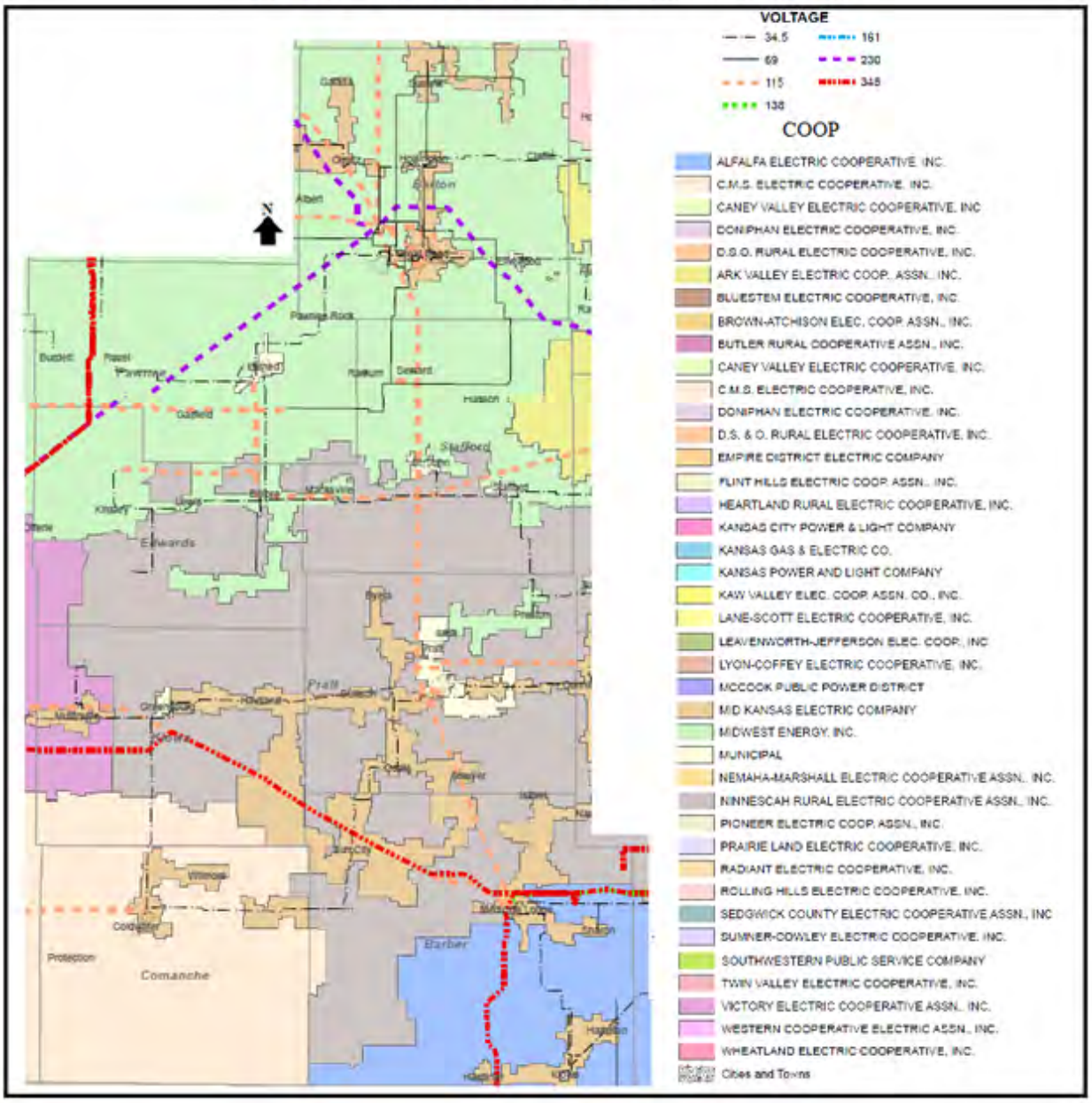
RECs are not-for-profit, member-owned electric utilities. Distribution cooperatives deliver electricity to consumers. Generation and transmission cooperatives generate and transmit electricity to distribution co-ops. Kansas RECs are governed by a board of trustees elected from the membership. Most Kansas RECs were set up under the Kansas Electric Cooperative Act, which, together with the federal Rural Electrification Act of 1934, made electric power available to rural customers. The majority of the region is covered by Midwest Energy (green), Ninnescah Electrical Cooperative (purple), CMS Electric Cooperative (light blue) and Alfalfa Electric Cooperative (pink-orange). Additional information may be found at www .kec.org/servicearea_map.html. The following map shows the coverage are of regional RECs:

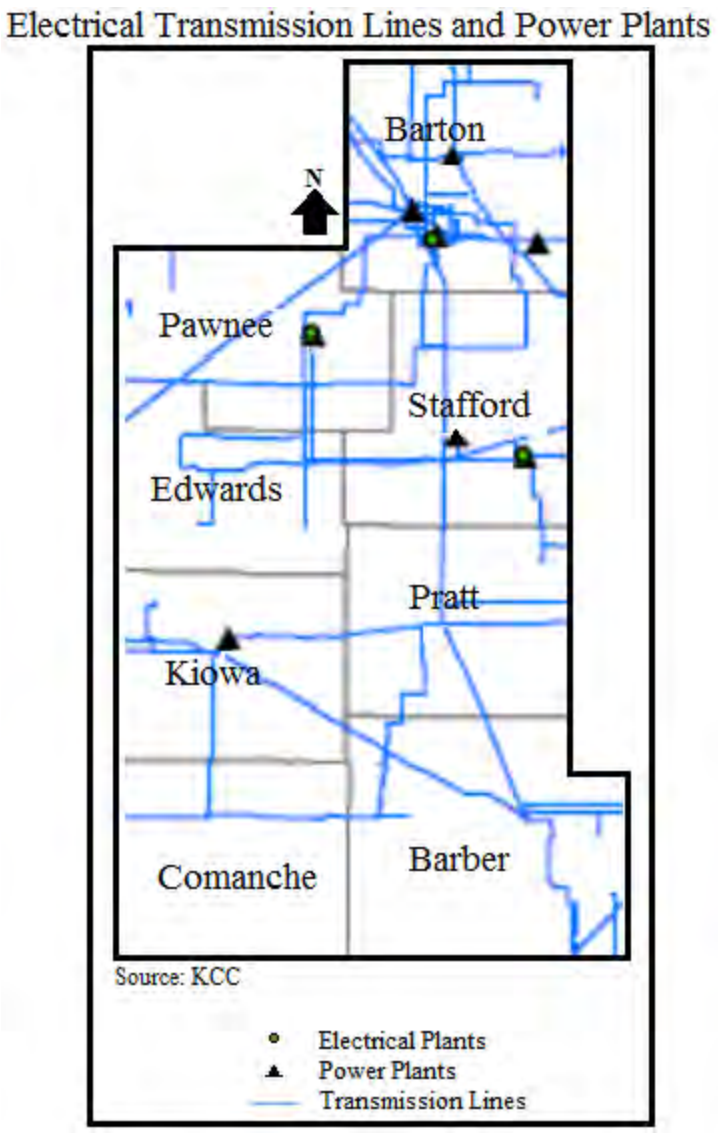
Regional Electrical Cooperatives



The following maps indicate the locations of electric certified areas, transmission lines and power plants in south Kansas.

Electric Certified Areas and Transmission Lines





Transportation Routes

Transportation routes can also be impacted by many of the hazards discussed in this plan. The primary hazards that impact transportation are flood, hazardous materials, and winter weather. Flood events can make roads and bridges impassible due to high water. Flood waters can also erode or scour road beds and bridge abutments. Highway and railroad accidents that involve hazardous materials can impact transportation routes through closures and/or evacuations. Winter weather frequently impacts transportation as roads become treacherous or impassible due to ice and snow. Other hazards that impact transportation routes include dam and levee failures if routes are in inundation areas, extreme temperatures that can cause damage to pavement, land subsidence that can damage roads/railroads, landslides that can cause debris and rock falls onto roadways, terrorism that can target routes, tornados that can directly damage infrastructure or deposit debris in routes, wildfires that can cause decreased visibility on transportation routes due to smoke, and windstorms that can cause vehicle accidents or overturning.

The following figure shows the highways in south Kansas.

Natural Gas and Oil Pipelines

Hazards that can impact natural gas and oil pipelines include earthquakes, expansive soils, land subsidence, landslide, and terrorism. Natural gas and oil pipelines have been previously discussed.

Water and Sewer Systems

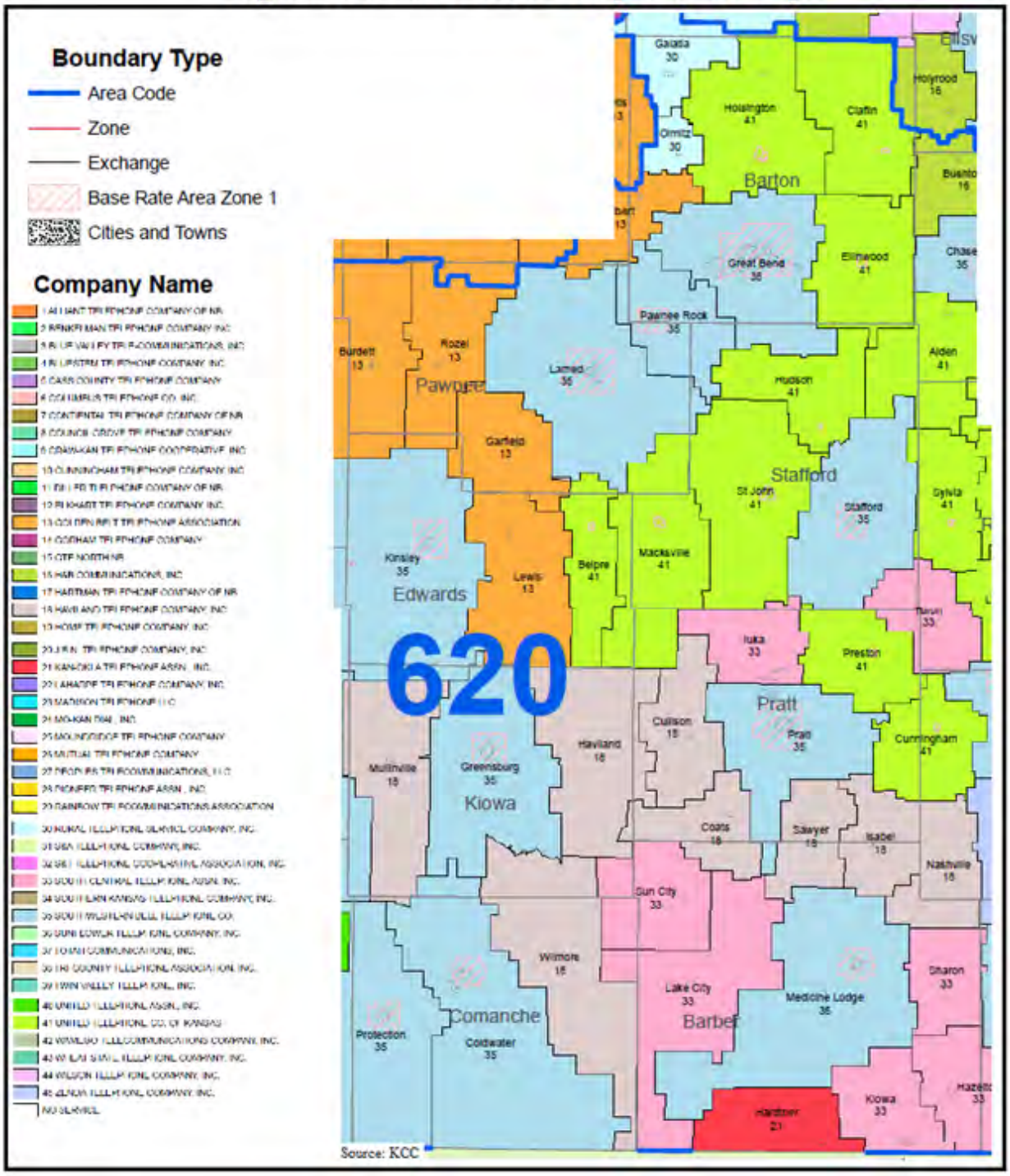
The primary hazards that can impact water supply systems include drought, floods, hazardous materials, and terrorism. Water district boundary maps were provided in section 2.16.

Internet and Telecommunications

Internet and telecommunications infrastructure can be impacted by floods, lightning, tornados, windstorms, and winter weather. Land line phone lines often utilize the same poles as electric lines, so when weather events such as windstorm or winter weather cause lines to break both electricity and telephone services may experience outages. With the increasing utilization of cellular phones, hazard events such as tornado that can damage cellular repeaters can cause outages. In addition, during any hazard event, internet and telecommunications systems can become overwhelmed due to the surge in call and usage volume. The following map indicates

telephone service providers in south Kansas, with further details available at www.kcc.state.ks.us/maps/ks_telephone_certified_areas.pdf.

Regional Certified Areas of Telephone Exchanges



Previous Occurrences and Extent

Each year disruptions to utility services ranging from minor to serious are a secondary result of other hazard events including drought, flood, tornado, windstorm, winter storm, lightning, and extreme heat. The following provide discussions of previous events that resulted in a utility or infrastructure failure.

> **FEMA-4010-DR:** Severe Storms, Straight-line Winds, Tornados, and Flooding: July 29, 2011: From May 10 to June 4, 2011 severe storms, straight-line winds, tornados, and flooding caused damages in 25 Kansas Counties. The primary impacts of this event were to public roads and bridges with an estimated $9,800,000 in damages.
>
> **FEMA-1932-DR:** Severe Storms, Flooding, and Tornados: August 10, 2010: From June 7 to July 21, 2010, severe storms, flooding, and tornados caused damages in 41 Kansas Counties. The primary impacts of this event were to public roads and bridges with an estimated $11,200,000 in damages.
>
> **FEMA-1741-DR:** February, 2008 (December 6-19, 2007): An ice storm caused numerous power outages and approximately 130,000 Kansas customers were without power. FEMA's Public Assistance costs were $355,651,857 for this disaster.
>
> **FEMA-1626-DR:** January 26, 2006 (November 27-28, 2005): Much of the state was affected by this storm. Winds of 40 to 60 mph combined with two to seven inches of snow resulted in a blizzard, which raged across parts of north central Kansas. The wind whipped the snow into drifts 10 to 15 feet high in some places. Interstate 70 was closed west of Russell, and numerous other highways were impassable during the storm. There were several reports of auto accidents, including a 25-car pileup, and sporadic power outages. At least three auto-related deaths were attributed to the storm. FEMA's Public Assistance costs were $50,281,517 for this disaster.

Hazard Vulnerability and Impact

While every community in the region is at risk to utility/infrastructure failure, the vulnerability is somewhat mitigated in south Kansas due to the lower population density, development, and economic activities in large portions of the region that would be disrupted by a major infrastructure failure event. However, regional counties with major cities, such as Topeka, and high population densities, including Shawnee County, would be at greater risk for disruptions.

Regionally smaller utility suppliers generally have limited resources for mitigation. Thus, the large number of small electric providers could mean greater vulnerability in the event of a major, widespread disaster, such as a major flood, severe winter storm or ice storm. In recent years, regional electric power grid system failures in the western and east-centralern United States have demonstrated that similar failures could happen in south Kansas. This vulnerability is most appropriately addressed on a multi-state regional or national basis.

Since utility/infrastructure failure is generally a secondary or cascading impact of other hazards, it is not possible to quantify estimated potential losses specific to this hazard due to the variables associated with affected population, duration of outages, etc..

Although the limitless variables make it difficult to estimate future losses on a statewide basis, FEMA has developed standard loss of use estimates in conjunction with their Benefit-Cost Analysis methodologies to estimate the cost of lost utilities on a per-person, per-use basis.

FEMA Benefit-Cost Analysis

Loss of Electric Power	Cost of Complete Loss of Service
Total Economic Impact	$126 per person per day
Loss of Potable Water Service	Cost of Complete Loss of Service
Total Economic Impact	$93 per person per day
Loss of Wastewater Service	Cost of Complete Loss of Service
Total Economic Impact	$41 per person per day
Loss of Road/Bridge Service	Cost of Complete Loss of Service
Vehicle Delay Detour Time	$38.15 per vehicle per hour
Vehicle Delay Mileage	$0.55 per mile (or current federal mileage rate)

Source: FEMA BCA Reference Guide, June 2009, Appendix C

	Magnitude/Severity
Utility / Infrastructure Failure	2.00

Future Development

Future development and increases in population would increase the risk of this hazard. In addition, lack of maintenance and system upgrades could also increase the risk of this hazard occurring on a more frequent basis. However, in general, the region is experiencing a population decline which could potentially lessen the potential of a future event.

Probability of Future Hazard Events

Based on historical records, utility failures occur annually across the region. As such, the likelihood of a utility failure event occurring is likely within the next year.

	Probability
Utility / Infrastructure Failure	2.78

Consequence Analysis

The information in the following table provides the Consequence Analysis.

Utility/Infrastructure Failure Consequence Analysis

Subject	Ranking	Impacts of Utility / Infrastructure Failure
Health and Safety of Persons in the Area of the Incident	Moderate to Severe	Localized impact will be moderate to severe for persons with functional and access needs, and the elderly, depending on length of failure and time of year.
Responders	Minimal	Impact to responders will be minimal if properly trained and equipped.
Continuity of Operations	Minimal	COOP plans are not expected to be activated If the recovery time is excessive then temporary relocation may become necessary.
Property, Facilities, and Infrastructure	Minimal	Impact is dependent on the nature of the incident, and electric, water, sewage, gas and communication disruptions.
Delivery of Services	Minimal	Delivery of services could be affected within and around the affected area.
Environment	Minimal	Impact should be minimal.
Economic Conditions	Minimal	Economic conditions could be adversely affected depending on extent of damage.
Public Confidence in Governance	Minimal	Impact will be dependent on whether response, recovery, and planning were timely and effective.

3.7.20 WILDFIRE

Hazard	Probability	Magnitude/Severity	Warning Time	Duration	CPRI
Wildfire	3.44	2.56	4.00	2.00	3.12

Description

Wildfires in south Kansas typically originate in pasture or prairie areas following the ignition of dry grasses (by natural or human sources). On occasion, ranchers and farmers intentionally ignite vegetation to restore soil nutrients or alter the existing vegetation growth. These fires have the potential to erupt into wildfires. Wildfires are also associated with lightning and drought conditions, as dry conditions make vegetation more flammable. Wildfires may also originate, or spread to forested areas, or other areas with concentrations of woody fuel that can cause wildfires to increase in intensity and spread. Since protecting people and structures takes priority, a wildfire's cost to natural resources, crops, and pastured livestock can be ecologically and economically devastating. In addition to the health and safety impacts to those directly affected by fires, the region is also concerned about the health effects of smoke emissions to surrounding areas.

The region experiences most of its wildfires in March and April when people are conducting controlled burns in grassland and fields. As the plant mass greens up later in the summer and the humidity is higher, the risk of wildfires is generally lower. This trend, however, does not continue in years of extreme drought when hot and dry weather prevail.

The wildland/urban interface is the area where human improvements such as homes, ranches and farms come in contact with the wildlands. Urban expansion has driven the increased building of homes in wildland areas. Wherever people are living in or adjacent to wildland areas, the threat of wildfire exists. As the rural population increases, so does the risk to life and property from wildfire.

	Warning Time
Wildfire	4.00

	Duration
Wildfire	2.00

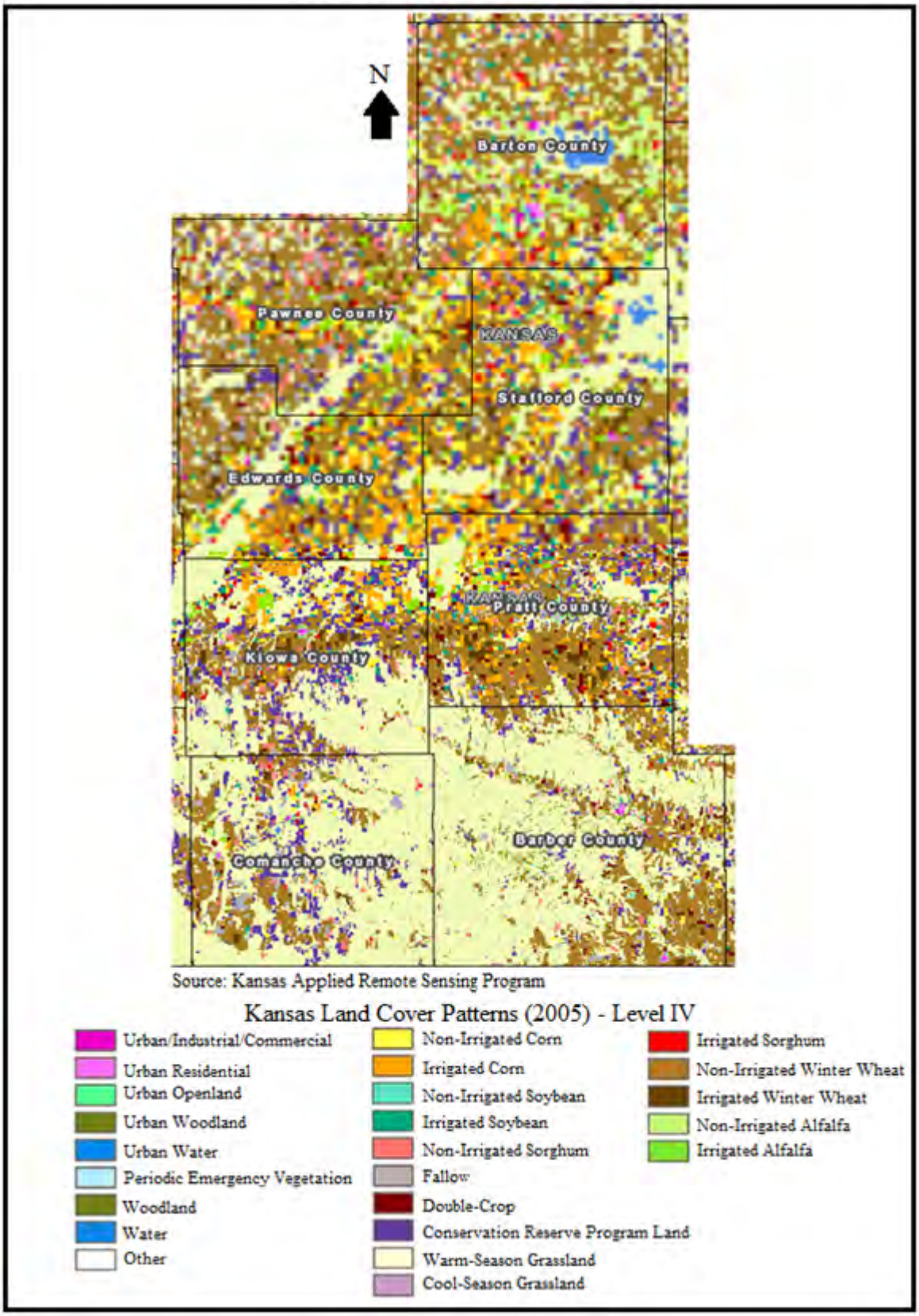
Hazard Location

Wildfires in south Kansas typically originate in pasture or prairie areas following the ignition of dry grasses (by natural or human sources). The Eastern Red Cedar is of concern in areas of south Kansas. This invasive evergreen species can take over fence rows and un-planted fields, adding to wildfire fuel and risk. Additionally, this type of fuel, as well as other tree plantings near structures can cause structures to be consumed by wildfires, putting inhabitants at risk.

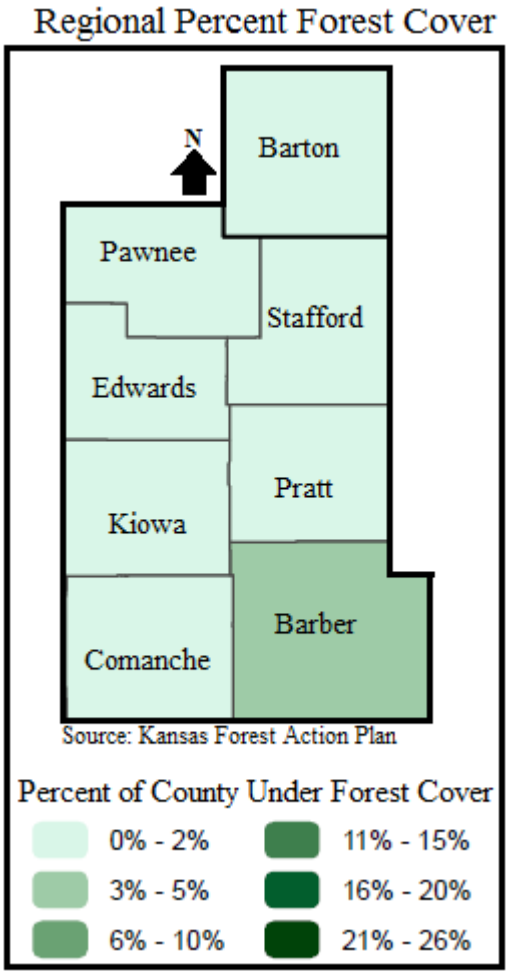
Due to the primarily rural and agricultural characteristics of the region, as well as the existence of wild land and grassland areas, the entire region is susceptible to wildfires. However, due to lower population densities in large areas of the region the number of people potentially affected by a wildfire is often minimal. Additionally, due to the built up nature of the larger cities in the region, the risk of wildfires in these areas is also lower.

According to the 2011 *Kansas Forest Action Plan*, with the exception of Eastern Redcedar/hardwood, most forest types in Kansas do not pose significant fire management issues. However, grasslands which make up a majority of the open areas in south Kansas due pose fire management issues. These areas, and the wild land-urban interface where development has occurred, are the focus of wild land fire management issues in Kansas. The following figure shows the land cover in south Kansas.

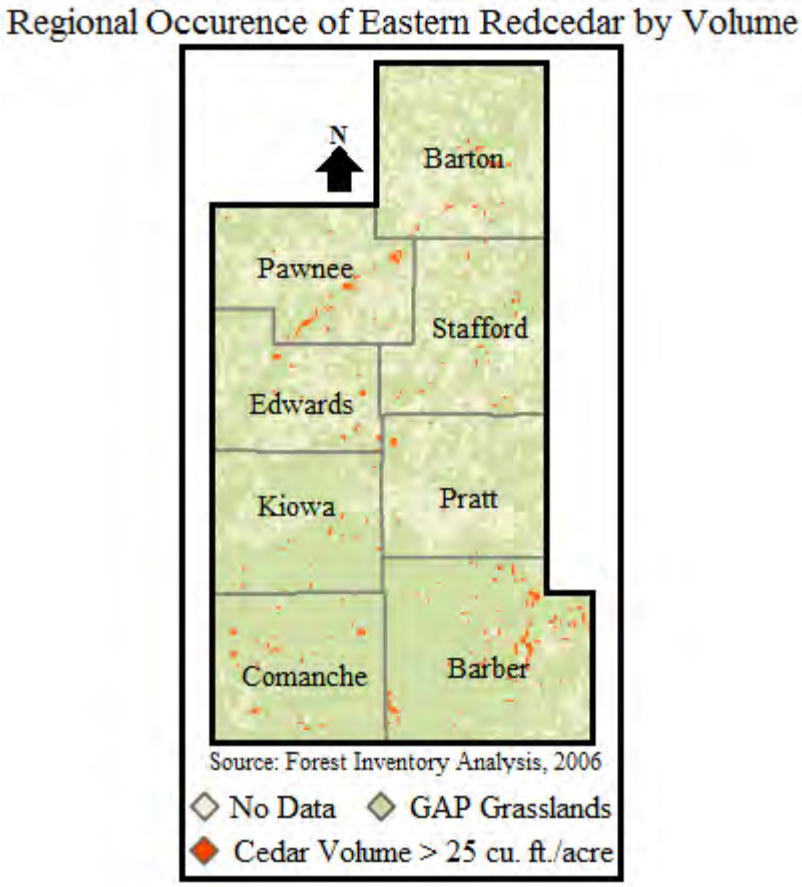
South Kansas Land Cover Map



Forests have increased in volume by a billion cubic feet and in density by 106 percent since 1965 with an estimated 74 million dry tons of total biomass. Growing stock volume has been increasing steadily for the past 40 years. The average age of Kansas forests is getting younger with the majority of volume and trees occurring between 30 and 59 years of age. The following figure shows the percent forest cover in south Kansas counties.



Although Eastern Redcedar makes up less than 4 percent of forest types, it has increased in volume by 23,000 percent since 1965 and is the primary specie of concern in grasslands. The following figure shows the occurrence of Eastern Redcedar by volume.



Previous Occurrences and Extent

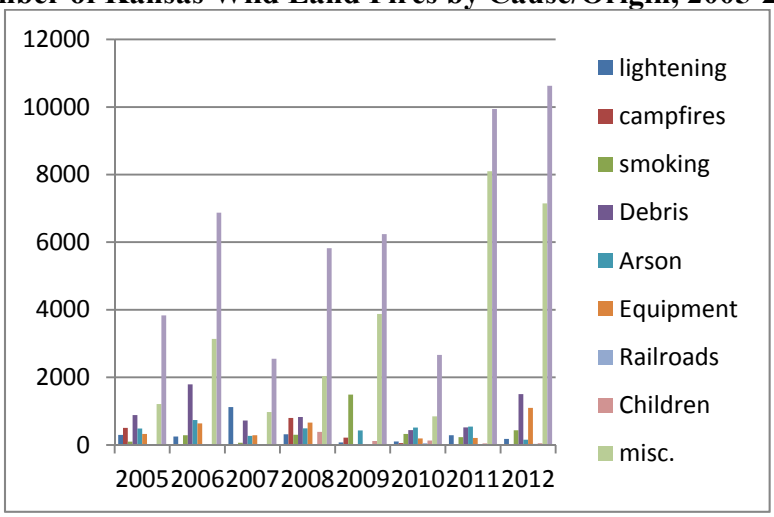
The following provide brief details on notable regional wildfire events.

> **2012**: More than 41,000 acres and 26 structures burned across the state from April through September due to extreme drought conditions. This places 2012 as one of the worst years for wildfires in Kansas on record.

Hazard Vulnerability and Impact

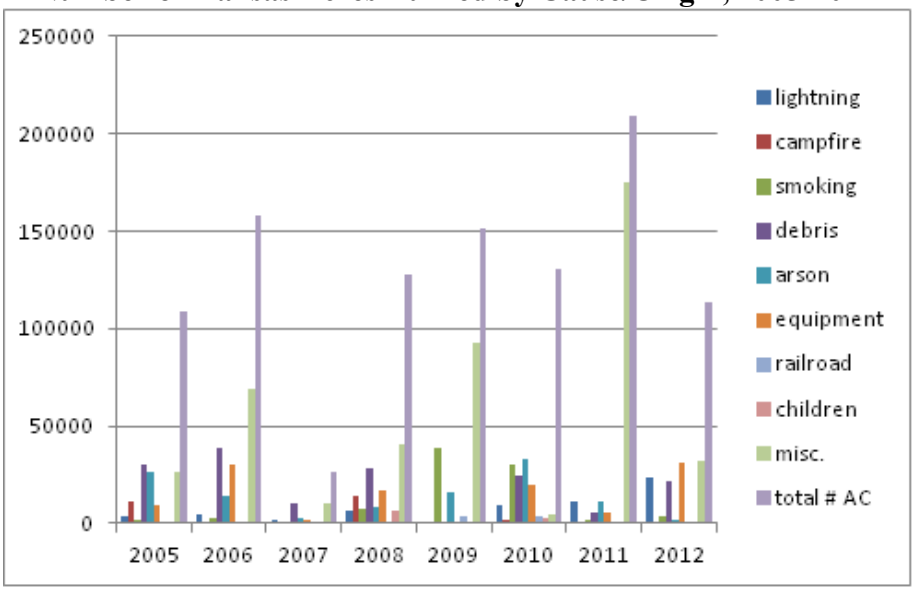
The Kansas Forest Service provided the following charts based on statistics from the National Fire Incident Reporting System regarding occurrence of wildfires in Kansas from 2005-2012. The first figure provides the total number of wild land fires in Kansas by cause/origin and the second figure provides the number of acres burned in Kansas each year by cause/origin.

Number of Kansas Wild Land Fires by Cause/Origin, 2005-2012



Source: Kansas Forest Service

Number of Kansas Acres Burned by Cause/Origin, 2005-2012



Source: Kansas Forest Service

USDA's Risk Management Agency on Crop insurance payments for loss of crops due to wildfire indicates that no payments were made as a result of wildfires to the south Kansas region.

Although some data is available from the National Fire Incident Reporting System (NFIRS) in terms of previous events, this data has limitations in providing useful statistical data for an overview regional vulnerability analysis. The most problematic issues are that not all fire departments report to NFIRS and of those that report, not all incidents are reported. This current lack of local level requirements and a past lack of enforcement of state statutes has led to a lack of fire occurrence data for both prescribed burns and wildfires being available in south Kansas. Changes in enforcement of wildfire reporting requirements at the state level, as well as

prescribed fire reporting requirements that are part of the EPA-mandated Kansas Flint Hills Smoke Management Plan (approved in 2011) will give the Kansas Forest Service a much greater opportunity to begin using real-time fire occurrence data to assist in making the best fire management decisions.

In light of the data limitations associated with available statistics, and with the publication of the 2011 *Kansas Forest Action Plan*, it has been determined that the best available data for the regional vulnerability analysis is the weighted sum analysis that was completed and utilized to develop a wildfire risk composite layer as part of the Forest Action Plan. The weighted sum analysis combined six data layers produced from a combination of eight separate datasets. In close consultation with the Kansas Forest Service's Fire Management Coordinator and other Fire Management staff six data inputs were developed to represent Wildfire Risk in Kansas. These data inputs and their corresponding analysis weight are listed below:

Kansas Forest Action Plan Wildfire Data Sets and Weighted Sums

Data Set	Analysis Weight
Wildland Urban Interface	0.85
ISO Fire Station Coverage Gaps	0.75
Conservation Reserve Program Lands	0.60
Eastern Redcedar in Grasslands	0.75
Moderate Fire Potential risk	0.53
High Fire Potential risk	0.80

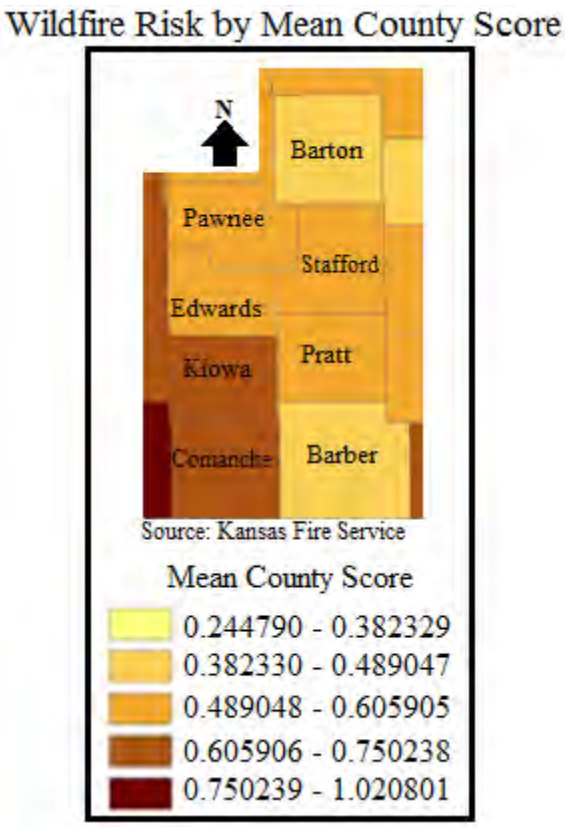
Source: *Kansas Forest Action Plan*,

The resulting score contains values ranging from 0 to 3.48, with the higher the numbers indicating higher wildfire risk. The following table provides the mean score for each county within the south Kansas region.

Wildfire Risk Score

County	Mean Wildfire Risk Score
Barber	0.48301097751
Barton	0.48904693127
Comanche	0.71569627523
Edwards	0.54626333714
Kiowa	0.72480762005
Pawnee	0.57326853275
Pratt	0.50816005468
Stafford	0.56549882889
Regional Average	0.57571906969

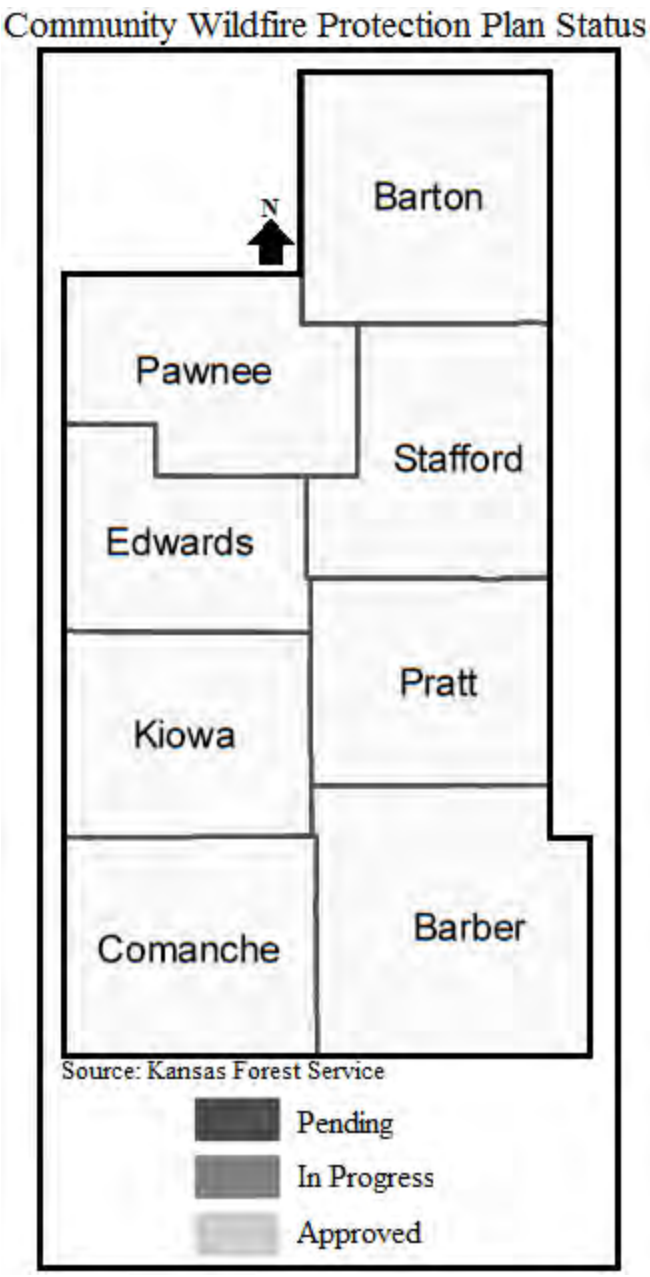
The following figure provides a map indicating the mean score for each county.



Community Wildfire Protection Plans

One way for communities at risk to wildfire to reduce their overall vulnerability is development of Community Wildfire Protection Plans (CWPP) to identify specific areas at risk and actions that can be taken to reduce risk. The Healthy Forests Restoration Act (HFRA) provided communities with an opportunity to influence where and how federal agencies implement fuel reduction projects on federal lands. A CWPP is the most effective way to take advantage of this opportunity. Additionally, communities with Community Wildfire Protection Plans in place are given priority for funding of HFRA hazardous fuels reduction projects.

The following figure shows the status of CWPPs in south Kansas counties.



	Magnitude/Severity
Wildfire	2.56

Future Development

Future development and increases in population would tend to increase the risk of this hazard. As cities continue to expand they often build in areas that are prone to wildfires and may not have adequate fire coverage. However, in general, the region is experiencing a population decline which could potentially lessen the potential of a future event.

Probability of Future Hazard Events

Wildfires occur on an annual basis in the region. Although wildfires occur every year, the outlook through June for south Kansas from the National Interagency Fire Center Predictive Services for a wildfire event in Kansas that will require mobilization of additional resources from outside the area in which the fire situation originated is considered to be in the normal range.

	Probability
Wildfire	3.44

Consequence Analysis

The information in the following table provides the Consequence Analysis.

Wildfire Consequence Analysis

Subject	Ranking	Impacts of Wildfire
Health and Safety of Persons in the Area of the Incident	Severe	Impact of the immediate area could be severe for affected areas.
Responders	Minimal to Severe	Impact to responders could be severe depending on the size and scope of the fire, especially for fire fighters. Impact will be low to moderate for support responders with the main threat as smoke inhalation.
Continuity of Operations	Minimal to Severe	Temporary relocation may be necessary if government facilities experience damage.
Property, Facilities, and Infrastructure	Severe	Localized impact could be severe to facilities and infrastructure in the incident area as all are vulnerable to destruction by wildfire.
Delivery of Services	Minimal to Severe	Delivery of services could be affected if there is any disruption to the roads and/or utilities due to damages sustained.
Environment	Severe	Impact will be severe for the immediate area with regards to trees, bushes, animals, and crops. Impact will lessen as distance increases.
Economic Conditions	Minimal to Moderate	Impacts to the economy could be moderate in the immediate area.
Public Confidence in Governance	Minimal to Severe	Response and recovery will be in question if not timely and effective. Evacuation orders and shelter availability could be called in to question.

3.7.21 WINDSTORM

Hazard	Probability	Magnitude/Severity	Warning Time	Duration	CPRI
Windstorm	3.94	2.75	3.00	2.13	3.26

Description

Relatively frequent strong winds are a weather characteristic of south Kansas. High winds, often accompanying severe thunderstorms, can cause significant property and crop damage, threaten public safety, and have adverse economic impacts from business closures and power loss.

Straight-line winds are generally any thunderstorm wind that is not associated with rotation. It is these winds, which can exceed 100 mph that represent the most common type of severe weather and are responsible for most wind damage related to thunderstorms. Since thunderstorms do not have narrow tracks like tornados, the associated wind damage can be extensive and affect entire counties or regions. Objects like trees, barns, outbuildings, high-profile vehicles, and power lines/poles can be toppled or destroyed, and roofs, windows, and homes can be damaged as wind speeds increase. In 2005, hail and wind damage made up 45% of homeowners' insurance losses. One type of straight-line wind is the downburst, which can cause damage equivalent to a strong tornado and can be extremely dangerous to aviation.

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

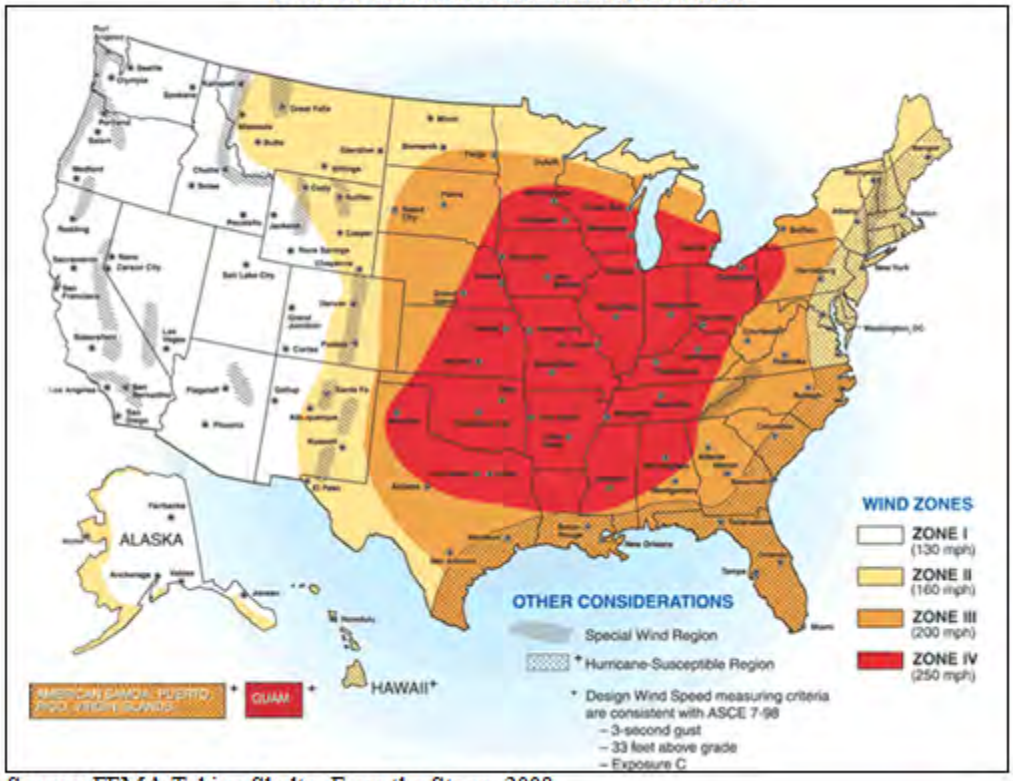
	Warning Time
Windstorm	3.00

	Duration
Windstorm	2.13

Hazard Location

The following figure shows the wind zones of the United States based on maximum wind speeds. South Kansas is located within wind zones IV, the highest inland category.

Wind Zones in the United States



Source: FEMA Taking Shelter From the Storm, 2008

Previous Occurrences and Extent

The following are notable high wind events that have occurred in the region.

February 28, 2012: A powerful storm system produced widespread severe weather across portions of central, south central and southeast Kansas during the evening hours.

August 9, 2011: Winds estimated at 70 to 80 mph moved across central and south central Kansas causing wide-spread damages to buildings in the area.

July 14, 2010: Damaging winds knocked down 23 power poles along Kansas Highway 4 in Barton County. This knocked out power to six small towns in the area and they remained without power for almost 12 hours. It also closed Kansas Highway 4 for a short time because of the damage.

August 19, 2005: The severe thunderstorms that brought a tornado to Great Bend were also packed with 75-80 mph winds, which caused an estimated $5 million in damage in and around the City. Many buildings sustained major roof and structural damage. Numerous vehicles sustained smashed or shattered windows. Twelve people were injured.

July 3, 2005: Severe thunderstorms struck central and south-central Kansas. Winds between 70 and 100 mph caused extensive damage.

According to the NCDC Storm Events database, there were 465 high wind, strong wind and thunderstorm wind events in south Kansas between 2004 and 2014, with 2014 being an incomplete data year. The average recorded high wind over that period was 73 mph, with the strongest wind measured at 78 mph. Total property damage for events between 2004 and 2014 is estimated at $9,181,500 with an estimated $40,000 in crop damages The data reported below is from the NCDC who receives storm data from the NWS, which receives information` from a variety of sources, which include but are not limited to county, state, and federal emergency management officials, local law enforcement officials, Skywarn spotters, NWS damage surveys, newspaper clipping services, the insurance industry and the general public. The wind events represent wind reports, not necessarily individual storms, and thus likely over count the actual number of windstorms.

NCDC Wind Events, 2004- 2014

County	Number of Days with Wind Events	Strongest Measured Wind (Knots)	Total Property Damage	Total Crop Damage
Barber	52	78	$36,000	$0
Barton	75	87	$5,655,000	$0
Comanche	31	70	$5,000	$0
Edwards	66	78	$12,500	$0
Kiowa	34	83	$50,000	$0
Pawnee	41	87	$131,000	$0
Pratt	92	87	$555,500	$0
Stafford	70	78	$250,000	$0
Regional Total	461	81 (average)	$6,695,000	$0

Source: NCDC Storm Events Database

Local Events:

The following detail locally reported events:

May 7, 2013: In Barton County a severe downburst damaged utility poles and caused limited roof damages top residences.

Spring, 2013: Pratt County, USD #438 - Skyline Schools: A windstorm caused a damages to the roof and gutters resulting in $74,666 in insured losses.

August 12, 2011: Barber County, USD #254 - Barber County North: Strong winds blew a dumpster into a car causing $1,242 in insured losses.

May 24, 2011: In Barton County high winds damaged five structures and power lines in four locations.

2011: Pawnee County, Coats: High winds blew the roof off the fire station causing $84,000 in insured losses.

Hazard Vulnerability and Impact

All counties in south Kansas are vulnerable to windstorms. To refine and access the relative vulnerability of each of south Kansas' counties to wind events, the region assigned ratings to pertinent factors that were examined at the county level. These factors are: social vulnerability index, prior events, prior annualized property damage, building exposure valuation, population density, crop exposure and annualized crop loss. Then a rating value of 1-10 was assigned to the data obtained for each factor and then weighted equally and factored together to obtain overall vulnerability scores for comparison and to determine the most vulnerable counties.

The following information was used for this analysis:

- Social Vulnerability Index for Kansas from the Hazards and Vulnerability Research Institute at the University of South Carolina
- National Climatic Data Center storm events 2004 – 2014
- U.S. Census Bureau (2012)
- USDA's Census of Agriculture (2012).

Vulnerability Factor Amounts for Wind

County	SoVI Rating (1-5)	Prior Events 2004-2014	Property Damages	Annualized Property Damages	Total Building Exposure ($000)	Population Density	Crop Exposure (2012 Census of Agriculture)	Crop Insurance Paid for Wind	Annualized Crop Insurance Paid
Barber	4	52	$36,000	$3,600	$388,136	4	$45,420,000	$216,800	$54,200
Barton	3	75	$5,655,000	$565,500	$1,772,118	21	$96,206,000	$821,804	$205,451
Comanche	5	31	$5,000	$500	$135,138	2	$21,783,000	$541,940	$135,485
Edwards	4	66	$12,500	$1,250	$232,382	5	$126,933,000	$1,645,844	$411,461
Kiowa	4	34	$50,000	$5,000	$237,655	3	$63,956,000	$582,792	$145,698
Pawnee	5	41	$131,000	$13,100	$449,592	9	$92,111,000	$2,304,708	$576,177
Pratt	3	92	$555,500	$55,550	$689,239	13	$52,353,000	$1,412,812	$353,203
Stafford	4	70	$250,000	$25,000	$295,331	6	$74,549,000	$1,363,288	$340,822
Regional Total	-	461	$6,695,000	$669,500	$4,199,591	8	$573,311,000	$8,889,988	$2,222,497

Using the above information, a value of 1-10 was assigned to the data obtained for each factor and then weighted equally and factored together to obtain overall vulnerability scores for comparison and to determine the greatest vulnerable counties. The Social Vulnerability Index is in a range of 1- 5. To give Social Vulnerability Index the same weight as the other factors, the numbers were multiplied by two.

Wind Data Rating Determination

Ratings	Social Vulnerability	NCDC Prior Events	Annualized Property Damage	Building Exposure Valuation	Population Density	Crop Exposure	Annualized Crop Loss
1		9 - 34	$0 - $200,000	$117,421 - $4,492,825	1.6 - 116.3	0 - $18,548,500	19 - $40,800
2	1	35 - 56	$200,001 - $400,000	$4,492,826 - $8,868,229	116.4 - 231.1	$18,548,501 - $32,126,000	$40,801 - $81,576
3		57 - 78	$400,001 - $600,000	$8,868,230 - $13,243,634	231.2 - 345.9	$32,126,001 - $45,703,500	$81,577 - $122,352
4	2	79 - 100	$600,001 - $800,000	$13,243,635 - $17,619,039	346 - 460.7	$45,703,501 - $59,281,000	$122,353 - $163,128
5		101 - 122	$800,001 - $1,000,000	$17,619,040 - $21,994,444	460.8 - 575.5	$59,281,001 - $72,858,500	$163,129 - $203,904
6	3	123 - 144	$1,000,001 - $3,000,000	$21,994,445 - $26,369,848	575.6 - 690.3	$72,858,501 - $86,436,000	$203,905 - $244,680
7		145 - 165	$3,000,001 - $5,000,000	$26,369,849 - $30,745,253	690.4 - 805.1	$86,436,001 - $100,013,500	$244,681 - $285,456
8	4	166 - 187	$5,00,001 - $7,000,000	$30,745,254 - $35,120,658	805.2 - 919.9	$100,031,501 - $113,591,000	$285,457 - $326,232
9		188 - 209	$7,000,001 - $9,000,000	$35,120,659 - $39,496,062	920- 1,034.7	$113,591,001 - $127,168,500	$326,233 - $367,008
10	5	210 - 232	$9,000,001 - $25,460,428	$39,496,063 - $43,871,468	1,034.8 - 1,149.6	$127,168,501 - $140,746,000	$367,009 - $407,783

Based on the above ratings system, ranges were applied to each county to determine their potential vulnerability. The following related the scoring to a vulnerability assessment:

- **Low:** Score range of 9 -14
- **Medium-Low:** Score range of 15 - 19
- **Medium:** Score range of 20 - 24
- **Medium-High:** Score range of 25 - 29
- **High:** Score range of 30 - 35

The following table provides the factor's amount per county that are considered for wind vulnerability.

Vulnerability of South Kansas Counties to Wind

County	SoVi Rating	NCDC Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Loss Rating	Overall Vulnerability Rating	Wind Vulnerability
Barber	8	2	1	1	1	3	2	18	Medium-Low
Barton	6	3	3	1	1	7	6	27	Medium-High
Comanche	10	1	1	1	1	2	4	20	Medium
Edwards	8	3	1	1	1	9	10	33	High
Kiowa	8	1	1	1	1	5	4	21	Medium
Pawnee	10	2	1	1	1	7	10	32	High
Pratt	6	4	1	1	1	4	9	26	Medium-High
Stafford	8	3	2	1	1	6	9	30	High

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	Magnitude/Severity
Windstorm	2.75

Future Development

Future development projects should consider windstorm hazard at the planning, engineering and architectural design stage with the goal of reducing vulnerability. However, in general, the region is experiencing a population decline which could potentially lessen the potential of a future event.

Probability of Future Hazard Events

Available data suggests that south Kansas has experienced 461 high wind days over the 10 year period from 2004 to 2014, with 2014 being an incomplete data year, with a total damage amount of $6,695,000. This would equate to an average of 46 high wind days per year with an average loss of $669,500 per year. As such, the probability of this hazard occurring during future years is likely.

	Probability
Windstorm	3.94

Consequence Analysis

The information in the following table provides the Consequence Analysis.

Windstorm Consequence Analysis

Subject	Ranking	Impacts of Windstorm
Health and Safety of Persons in the Area of the Incident	Minimal to Moderate	Impact of the immediate area could be minimal to moderate for affected areas.
Responders	Minimal	Impact to responders is expected to be minimal unless responders live within the affected area.
Continuity of Operations	Minimal	Temporary relocation may be necessary if government facilities experience damage.
Property, Facilities, and Infrastructure	Minimal to Severe	Localized impact could be minimal to moderate in the incident area. Utility lines would likely be severely affected.
Delivery of Services	Minimal	Delivery of services could be affected if there is any disruption to the roads and/or utilities..
Environment	Minimal to Severe	Impact may be severe for the immediate impacted area with regards to trees, bushes, and crops. Impact will lessen as distance increases from the immediate incident area.
Economic Conditions	Minimal to Severe	Impacts to the economy will greatly depend on the trajectory of the windstorm. Revenue could be impacted if businesses are halted due to structural damages and infrastructure damage.
Public Confidence in Governance	Minimal	Response and recovery will be in question if not timely and effective. Warning systems in place and the timeliness of those warnings could be questioned.

3.7.22 WINTER STORM

Hazard	Probability	Magnitude/Severity	Warning Time	Duration	CPRI
Winter Storm	3.88	3.06	1.88	3.25	3.27

Description

Winter storms in south Kansas usually come in the form of heavy snow or freezing rain. Regardless of form, they can have significant impacts to the region and its residents for days, weeks or months. They can immobilize a region by blocking roads and railways and closing airports, which can disrupt emergency and medical services, hamper the flow of supplies and isolate homes and farms. Heavy snow can collapse roofs and knock down trees and power lines. Unprotected livestock may be lost. Economic impacts include cost of snow removal, damage repair, business and crop losses, and power failures.

A major winter storm can last for several days and be accompanied by high winds, freezing rain or sleet, heavy snowfall, and cold temperatures. The NWS describes different types of winter storm events as follows:

- **Blizzard**—Winds of 35 mph or more with snow and blowing snow reducing visibility to less than 1/4 mile for at least three hours.
- **Blowing Snow**—Wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground picked up by the wind.
- **Snow Squalls**—Brief, intense snow showers accompanied by strong, gusty winds. Accumulation may be significant.
- **Snow Showers**—Snow falling at varying intensities for brief periods of time. Some accumulation is possible.
- **Freezing Rain**—Rain that falls onto a surface with a temperature below freezing. This causes it to freeze to surfaces forming a coating or glaze of ice. Most freezing-rain events are short lived and occur near sunrise between the months of December and March.
- **Sleet**—Rain drops that freeze into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects.

Heavy accumulations of ice, often the result of freezing rain, can bring down trees, utility poles, and communications towers and disrupt communications and power for days. Even small accumulations of ice can be extremely dangerous to motorists and pedestrians.

	Warning Time
Winter Storm	1.88

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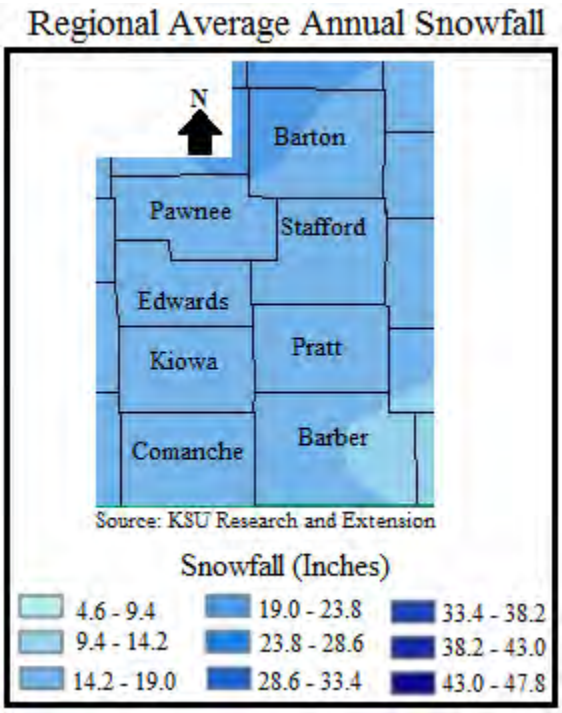
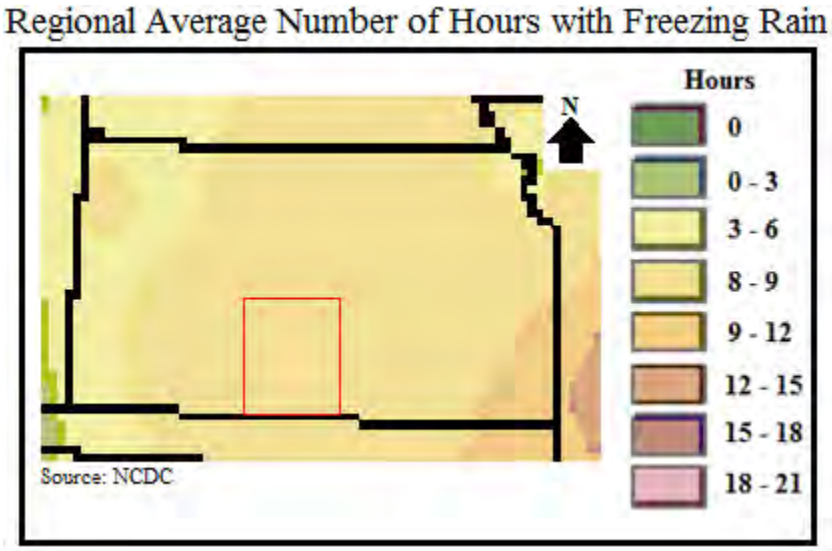
	Duration
Winter Storm	3.25

Hazard Location

The entire planning region is vulnerable to heavy snow and freezing rain. The following map illustrates the average annual snowfall for the region.



Freezing rains occurs frequently in south Kansas. The following map indicates the average number of hours of freezing rain per year.



In recent years, except the winter of 2011-2012, the weather patterns have created significant snow accumulations and ice storms throughout the region. Also future development could potentially increase vulnerability to this hazard by increasing the demand on the utilities and increasing the exposure of aging infrastructure networks.

Previous Occurrences and Extent

The following table lists the five most recent presidential disaster declarations for south Kansas.

Presidential Disaster Declarations, Winter Storm

Declaration Number	Declaration Date*	Disaster Description	Regional Counties Involved	Disaster Cost**
4112	04/25/2013 (02/20/2013 - 02/23/2013)	Severe Winter Storm	Barton, Barber, Pawnee, Pratt, Stafford	$1,286,885
1848	06/24/2009 (3/26-29/2009)	Severe Winter Storm and Record and Near Record Snow	Butler	$20,174,657
1741	02/01/2008 (12/06-19/2007)	Severe Winter Storms	Barber, Barton, Comanche, Edwards, Kiowa, Pawnee, Pratt and Stafford	$359,557,345
1675	1/7/2007 (12/28-30/2006)	Severe Winter Storm	Comanche, Edwards, Kiowa, Pawnee and Stafford	$315,201,639
1626	1/26/2006 (11/27-28/2005)	Severe Winter Storm	Edwards and Pawnee	$50,281,517
1579	2/8/2005 (1/4-6/2005)	Severe Winter Storm, Heavy Rains, and Flooding	Barber, Comanche, Kiowa and Pratt	$106,873,672
1402	2/6/2002 (1/29-2/15/2002)	Ice Storm	Barber, Comanche, Kiowa and Pratt	$60,185,754

Sources: FEMA and KDEM
* Incident dates are in parentheses.
** Disaster costs include Public Assistance and Individual Assistance for all impacted counties, including those not shown

The following are brief discussions of the above noted events.

FEMA-4112-DR— April 26, 2013 (February 20-23, 2013): A sever storm produced record or near record snowfall across parts of the region. Several areas reported power outages due to the snow, ice and wind. Federal assistance funding for this disaster was $1,286,885.

FEMA-1848-DR— June 24, 2009 (March 26-29, 2009): A late March blizzard produced record or near record snowfall of one to two feet across parts of central, south central and southwest Kansas. The heavy snow and high wind resulted in blizzard conditions on Friday into Saturday. Several areas reported power outages due to the snow, ice and wind. FEMA Public Assistance funding for this disaster was $20,174,657.

FEMA-1741-DR: February, 2008 (December 6-19, 2007): Winter weather started across central and southeast Kansas with two different ice storms that moved across the area and produced significant accumulations. The ice caused numerous power outage and approximately 130,000 Kansas customers were without power. Then a major winter storm moved through Kansas during the evening hours of December 14th and the heaviest snow targeted areas still suffering from the ice storm that hit earlier in the week. FEMA Public Assistance funding for this disaster was $355,651,857.

FEMA-1675-DR: January 7, 2007 (December 28–30, 2006): This storm was one of Kansas' worst disasters on record. It began on December 28, 2006, and increased in intensity December 29 overnight into December 30. Snow depths ranged from four inches in Saline County to 30 inches in Wallace County. Several counties set snowfall records. Numerous highways were closed for days in western Kansas, and there were major power outages because of icing. The ice was 1/4 inch thick on guide wires that brought several communication towers down. During the peak of the storm there were 46,300 meters off-line and 10,500 power poles down. Approximately 60,000 people were without power. There were three storm-related fatalities. The storm also severely impacted ranchers, making it temporarily impossible for some to feed and water livestock. The Kansas National Guard used Black Hawk helicopters to feed stranded cattle. FEMA Public Assistance funding for this disaster was $315,201,639.

FEMA-1626-DR: January 26, 2006 (November 27-28, 2005): Much of the State was affected by this storm. Winds of 40 to 60 mph combined with two to seven inches of snow resulted in a blizzard, which raged across parts of north central Kansas. The wind whipped the snow into drifts 10 to 15 feet high in some places. Interstate 70 was closed west of Russell, and numerous other highways were impassable during the storm. There were several reports of auto accidents, including a 25-car pileup, and sporadic power outages. At least three auto-related deaths were attributed to the storm. FEMA Public Assistance funding for this disaster was $50,281,517.

FEMA-1579-DR—February 8, 2005 (January 4-6): This was one of the worst ice storms on record to hit central, south central, and southeast Kansas. Although freezing

rain was the primary culprit, sleet also played a vital role in coating nearly the entire region with one-two inches of ice, which caused incredible damage to trees, power lines, and power poles. Roads and highways were blocked by tree debris and downed power poles and lines. Many areas were without power for more than a week. Three deaths were attributed to the storm. FEMA Public Assistance funding for this disaster was $106,873,672.

FEMA-1402-DR: Ice Storm—February 6, 2002 (January 29–February 15): Beginning on January 29, a three-day severe winter storm hit 35 Kansas counties in the southeast corner of the State with freezing rain, drizzle, sleet and snow. With one to two inches of ice accumulation, utility poles and power lines snapped, transportation was treacherous and fallen trees damaged many structures. The resulting power outages affected nearly the entire region and lasted nearly a week in some areas. Loss of power was particularly problematic for many nursing homes. There were seven fatalities. FEMA Public Assistance funding for this disaster was $45,020,240.

The following provide further descriptions and other notable winter storm events.

February 25, 2011: Periods of freezing drizzle and freezing fog affected much of south Kansas from the late evening on the 25th through the morning on the 26th. Area roads became very slick, producing numerous accidents and slide-offs.

December 23, 2010: Patchy light freezing rain and freezing drizzle during the evening hours on the 23rd produced a thin glaze of ice across south Kansas. The glaze of ice produced very slick roads through the early morning hours on the 24th. Several automobile accidents and slide-offs occurred as a result, producing numerous injuries.

December 7, 2009: A two pronged winter storm moved across south region of Kansas during the period of December 6th through December the 8th, 2009. The initial system on December 6th spread a thin layer of freezing drizzle which produced numerous automobile accidents. A more potent low pressure arrived on December 7th and 8th, 2009. This system led to a band of heavy snow with 6 to 12 inches along a line from Great Bend, Kansas to Salina, Kansas.

According to the NCDC there were 83 winter storms (ice storm and winter storm) in south Kansas between 2004 and 2014, with 2014 being an incomplete data year. Total property damage during that period was estimated by the NCDC at $0, whereas the total public assistance and individual assistance from the six Presidential Declarations listed above totaled over $912,274,584 for all involved counties, including the counties from the south Kansas region. This suggests that although there are more winter storm events recorded in NCDC than there have been declarations, and that damages to NCDC are likely under-reported.

NCDC Winter Storm Events, 2003 -2013

County	Number of Winter Storm Events	Total Property Damage Winter Weather and Storms	Number of Ice Storm Events	Total Property Damage, Ice Storms
Barber	8	$0	0	$0
Barton	8	$0	2	$9,800,000
Comanche	8	$0	2	$0
Edwards	11	$0	0	$0
Kiowa	10	$0	1	$0
Pawnee	11	$0	1	$0
Pratt	8	$0	1	$0
Stafford	11	$0	1	$0
Regional Total	75	$0	8	$9,800,000

Source: NCDC Storm Events Database

Local Events

The following are locally reported events:

February, 2013: Barton County, Great Bend: A winter closed local businesses and schools.

February 2013: Barton County, Hoisington: A winter closed local businesses and schools. $5,254 in federal disaster funding was received.

December 2012: Stafford County, City of Stafford: A winter storm damaged electrical utilities and downed trees. In addition , there were business and school closures.

March, 2008: Kiowa County, Haviland: An ice storm caused significant damage yo the city, including utilities, power poles and trees. In addition, many local businesses closed for numerous days.

December 10, 2007: Pawnee County: An ice storm damaged trees an downed lines throughout the county.

December 6, 2007: Barton County, Claflin: An ice storm knocked out electricity for approximately one week.

Hazard Vulnerability and Impact

All counties in south Kansas are vulnerable to winter storms. To refine and access the relative vulnerability of each of south Kansas' counties to winter storm events, the region assigned ratings to pertinent factors that were examined at the county level. These factors are: social vulnerability index, prior events, prior annualized property damage, building exposure valuation, population density, crop exposure and annualized crop loss. Then a rating value of 1-10 was

assigned to the data obtained for each factor and then weighted equally and factored together to obtain overall vulnerability scores for comparison and to determine the most vulnerable counties.

The following information was used for this analysis:

- Social Vulnerability Index for Kansas from the Hazards and Vulnerability Research Institute at the University of South Carolina
- National Climatic Data Center storm events 2004 – 2014
- U.S. Census Bureau (2012)
- USDA's Census of Agriculture (2012).

Vulnerability Factor Amounts for Winter Storm

County	SoVI Rating (1-5)	Prior Events 2004-2014	Property Damages	Annualized Property Damages	Total Building Exposure ($000)	Population Density	Crop Exposure (2012 Census of Agriculture)	Crop Insurance Paid	Annualized Crop Insurance Paid
Barber	4	8	$0	$0	$388,136	4	$45,420,000	$255,784	$63,946
Barton	3	10	$0	$0	$1,772,118	21	$96,206,000	$414,880	$103,720
Comanche	5	10	$0	$0	$135,138	2	$21,783,000	$752,140	$188,035
Edwards	4	11	$0	$0	$232,382	5	$126,933,000	$1,457,816	$364,454
Kiowa	4	1	$0	$0	$237,655	3	$63,956,000	$1,300,196	$325,049
Pawnee	5	2	$0	$0	$449,592	9	$92,111,000	$1,586,804	$396,701
Pratt	3	9	$0	$0	$689,239	13	$52,353,000	$823,484	$205,871
Stafford	4	12	$0	$0	$295,331	6	$74,549,000	$832,848	$208,212
Regional Total	-	63	$0	$0	$4,199,591	8	$573,311,000	$7,423,952	$1,855,988

Using the above information, a value of 1-10 was assigned to the data obtained for each factor and then weighted equally and factored together to obtain overall vulnerability scores for comparison and to determine the greatest vulnerable counties. The Social Vulnerability Index is in a range of 1- 5. To give Social Vulnerability Index the same weight as the other factors, the numbers were multiplied by two.

Winter Storm Data Rating Determination

Ratings	Social Vulnerability	NCDC Prior Events	Annualized Property Damage	Building Exposure Valuation	Population Density	Crop Exposure	Annualized Crop Loss
1		14 - 21	$2,000 - $50,000	$117,421 - $4,492,825	1.6 - 116.3	0 - $18,548,500	0 - $200,000
2	1	21 - 29	$50,001 - $100,000	$4,492,826 - $8,868,229	116.4 - 231.1	$18,548,501 - $32,126,000	$200,001 - $400,000
3		30 - 36	$100,001 - $300,000	$8,868,230 - $13,243,634	231.2 - 345.9	$32,126,001 - $45,703,500	$400,000 - $600,000
4	2	37 - 44	$300,001 - $500,000	$13,243,635 - $17,619,039	346 - 460.7	$45,703,501 - $59,281,000	$600,001 - $800,000
5		45 - 52	$500,001 - $700,000	$17,619,040 - $21,994,444	460.8 - 575.5	$59,281,001 - $72,858,500	$800,001 - $1,000,000
6	3	53 - 60	$700,001 - $900,000	$21,994,445 - $26,369,848	575.6 - 690.3	$72,858,501 - $86,436,000	$1,100,001 - $1,300,000
7		61 - 69	$900,001 - $1,100,000	$26,369,849 - $30,745,253	690.4 - 805.1	$86,436,001 - $100,013,500	$1,300,001 - $1,500,000
8	4	70 - 77	$1,100,001 - $1,700,000	$30,745,254 - $35,120,658	805.2 - 919.9	$100,031,501 - $113,591,000	$1,500,001 - $1,700,000
9		78 - 85	$1,700,001 - $2,200,000	$35,120,659 - $39,496,062	920- 1,034.7	$113,591,001 - $127,168,500	$1,700,001 - $2,700,000
10	5	86 - 93	$2,200,001 - $2,800,000	$39,496,063 - $43,871,468	1,034.8 - 1,149.6	$127,168,501 - $140,746,000	$2,700,001 - $3,700,000

Based on the above ratings system, ranges were applied to each county to determine their potential vulnerability. The following related the scoring to a vulnerability assessment:

- **Low:** Score range of 13 -17
- **Medium-Low:** Score range of 18 - 22
- **Medium:** Score range of 23 - 27
- **Medium-High:** Score range of 28 - 32
- **High:** Score range of 33 - 37

The following table provides the factor's amount per county that are considered for winter storm vulnerability.

Regional Vulnerability to Winter Storms

County	SoVI Converted Rating	Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Insurance Rating	Overall Vulnerability Rating	Winter Storm Vulnerability
Barber	8	0	0	1	1	3	1	14	Low
Barton	6	0	0	1	1	7	1	16	Low
Comanche	10	0	0	1	1	2	1	15	Low
Edwards	8	0	0	1	1	9	2	21	Medium-Low
Kiowa	8	0	0	1	1	5	2	17	Low
Pawnee	10	0	0	1	1	7	2	21	Medium-Low
Pratt	6	0	0	1	1	4	2	14	Low
Stafford	8	0	0	1	1	6	2	18	Medium-Low

In addition, the Kansas Department of Transportation (KDOT) incurs statewide annual costs for snow and ice removal. The average cost per year for snow and ice efforts for fiscal years 2008-2011 is $15,900,000 for labor, equipment and materials. However, the cost for snow and ice efforts in fiscal year 2012 was only $6,700,000 because it was a mild winter (source: Translines Express, KDOT, April 11, 2012).

	Magnitude/Severity
Winter Storm	3.06

Future Development

Future development projects should consider winter storm hazard at the planning, engineering and architectural design stage with the goal of reducing vulnerability. However, in general, the region is experiencing a population decline which could potentially lessen the potential of a future event.

Probability of Future Hazard Events

According to the NCDC there were 63 winter storm events in south Kansas between 2004 and 2014, with 2014 being an incomplete data year. Based on this information, it is likely that at least one winter storm will occur in south Kansas in any given year.

	Probability
Winter Storm	3.88

Consequence Analysis

The information in the following table provides the Consequence Analysis.

Winter Storm Consequence Analysis

Subject	Ranking	Impacts of Winter Storm
Health and Safety of Persons in the Area of the Incident	Severe	Impact of the immediate area could be severe for affected areas and moderate to light for other less affected areas.
Responders	Minimal	Impact to responders could be severe for unprotected personnel and moderate to light for prepared personnel.
Continuity of Operations	Minimal	Minimal expectation of execution of the COOP.
Property, Facilities, and Infrastructure	Minimal to Severe	Localized impact to facilities and infrastructure in the incident area. Utility lines most affected.
Delivery of Services	Minimal to Severe	Delivery of services could be affected if there is any disruption to the roads and/or utilities due to damages sustained.
Environment	Severe	Greatest impact will be to trees, bushes, foliage, crops, and wildlife, which could be severe.
Economic Conditions	Minimal to Severe	Impacts to the economy will greatly depend on the severity of the winter storm, longevity of the storm, and any damages sustained such as utilities and roads.
Public Confidence in Governance	Minimal to Severe	Response and recovery will be in question if not timely and effective. Utility failure could be called in to question if outages are persistent.

3.8 DATA SOURCES

The following table details the data sources used for this section.

Data on the past impacts and future probability of these hazards in the south Kansas planning area was collected from the following sources:

- Bureau of Alcohol, Tobacco, Firearms and Explosives Standards
- Electronic Mass Casualty Assessment and Planning Scenarios developed by Johns Hopkins University
- Emergency Management Accreditation Program
- Environmental Protection Agency
- Federal Bureau of Investigation
- Federal Emergency Management Agency
- Federal Emergency Management Agency Benefit-Cost Analysis Reengineering Tornado Safe Room Module Methodology Report, Version 4.5 Final, Dated May 2009
- Federal Emergency Management Agency Flood Insurance Administration
- Federal Emergency Management Agency Flood Insurance Rate Maps
- Federal Emergency Management Agency HAZUS-Multi Hazard-2.1
- Federal Emergency Management Agency Mid-Term Levee Inventory
- Federal Emergency Management Agency National Flood Insurance Program
- Federal Emergency Management Agency National Flood Insurance Program
- Federal Emergency Management Agency "Local Mitigation Planning Handbook, March 2013"
- Federal Emergency Management Agency, Taking Shelter From the Storm, 2008
- Federal Emergency Management Agency's "Policy and Loss Data by Community with County and State Data"
- Federal Emergency Management Agency's Policy and Claim Statistics for Flood Insurance
- Hazards and Vulnerability Research Institute at the University of South Carolina
- Homeland Security Act of 2002
- Kansas Corporation Commission
- Kansas Data Access & Support Center
- Kansas Department of Agriculture, Division of Animal Health
- Kansas Department of Agriculture, Division of Water Resources
- Kansas Department of Agriculture, Division of Water Resources, Water Structures Program
- Kansas Department of Agriculture, Plant Protection and Weed Control Division
- Kansas Department of Health & Environment, Bureau of Water, Livestock Waste Management
- Kansas Department of Health and Environment "Subsurface Void Space and Sinkhole/Subsidence Area Inventory for the State of Kansas", 2006

- Kansas Department of Health and Environment Bureau of Epidemiology and Public Health Informatics
- Kansas Department of Health and Environment Surface Mining Section
- Kansas Department of Health and Environment, Division of Environment
- Kansas Department of Health and Environment's Kansas Environmental Public Health Tracking Program
- Kansas Division of Emergency Management
- Kansas Division of Emergency Management 2012 Kansas Severe Weather Awareness Week
- Kansas Division of Emergency Management, Technological Hazards Section
- Kansas Fire Service
- Kansas Flint Hills Smoke Management Plan
- Kansas Forest Action Plan
- Kansas Forest Service
- Kansas Geological Survey
- Kansas Geological Survey, "Earthquakes in Kansas"
- Kansas Operations Plan
- Kansas Response Plan
- Kansas State University College of Engineering
- Kansas State University Research and Extension Climatic Map of Kansas
- Kansas Statutes Annotated
- Kansas Unified HazMat Response Program Statewide Contract # 35167
- Kansas Water Office
- Kansas Water Office Kansas Drought Stage Declarations
- Kansas Water Office, 2009 Kansas Water Plan
- Kansas Water Office, Kansas 2014 Drought Update
- Kansas University Geological Survey
- Kansas Commission on Emergency Planning and Response Annual Report, Managing the Risk: 2011
- Modified Mercalli Intensity Scale
- National Climatic Data Center
- National Dam Safety Act
- National Drought Mitigation Center Drought Impact Reporter
- National Fire Incident Reporting System
- National Fire Incident Reporting System
- National Interagency Fire Center Predictive Services
- National Oceanic and Atmospheric Administration Storm Prediction Center
- National Oceanic and Atmospheric Administration
- National Resources Conservation Service
- National Seismic Hazard Mapping Project
- National Weather Service
- National Weather Service Heat Index Program

- Oklahoma Climatological Survey
- Palmer Drought Severity Index
- Spatial Hazard Event and Loss Database
- Stanford University's National Performance of Dams Program
- "Surface Water in Kansas and its Interactions with Groundwater" 2000 M. A. Sophocleous, B. B. Wilson
- "The Annual Impact of Seasonal Influenza in the US: Measuring Disease Burden and Costs" by NA Molinari
- The Southern Poverty Law Center
- Tornado and Storm Research Organization
- Translines Express, Kansas Department of Transportation, April 11, 2012
- United States Army Corps of Engineers
- United States Army Corps of Engineers Levee Safety Program
- United States Army Corps of Engineers National Levee Database
- United States Bureau of Reclamation
- United States Census Bureau
- United States Census Bureau
- United States Census Bureau American Community Survey 2005 – 2009
- United States Centers for Disease Control and Prevention
- United States Department of Agriculture Kansas Crop Insurance Profile Report
- United States Department of Agriculture National Resources Inventory
- United States Department of Agriculture, Division of Water Resources
- United States Department of Agriculture, National Agricultural Statistics Service
- United States Department of Agriculture, Risk Management Agency
- United States Department of Agriculture's Census of Agriculture
- United States Department of Transportation Pipeline and Hazardous Materials Safety Administration
- United States Drought Monitor
- United States Fish and Wildlife Service
- United States Geological Survey Fact Sheet, "Water Use in Kansas 1990-2000"
- United States Geological Survey, Earthquake Hazards Program
- University of Kansas Institute for Policy and Social Research
- USA Patriot Act
- Vaisala's National Lightning Detection Network
- Other agencies and data collections as noted