3 RISK ASSESSMENT

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

The risk assessment process identifies and profiles relevant hazards and assesses the exposure of lives, property, and infrastructure to these hazards. The goal of the risk assessment is to estimate the potential loss in Harvey County, including loss of life, personal injury, property damage, and economic loss, from a hazard event. The risk assessment process allows communities in Harvey County to better understand their potential risk to natural hazards and provides a framework for developing and prioritizing mitigation actions to reduce risk from future hazard events.

The risk assessment for Harvey County and its jurisdictions followed the methodology described in the FEMA publication 386-2, *Understanding Your Risks: Identifying Hazards and Estimating Losses* (2002), which includes a four-step process:

- Identify Hazards
- Profile Hazard Events
- Inventory Assets
- Estimate Losses

This chapter is divided into four parts listed and described below

- **Section 3.1 Hazard Identification** identifies the hazards that threaten the planning area and describes why some hazards have been omitted from further consideration.
- **Section 3.2 Hazard Profiles** discusses the threat to the planning area and describes previous occurrences of hazard events and the probability of future occurrence.
- **Section 3.3 Vulnerability Assessment** assesses the County's total exposure to natural hazards, considering critical facilities and other community assets at risk, and assessing growth and development trends. Hazards that vary geographically across the planning area are addressed in greater detail. This section includes steps 3 and 4 from above.
- **Section 3.4 Summary of Key Issues** provides a summary of the key issues or problems identified in the Risk Assessment.

Multi-Jurisdictional Risk Assessment

For this multi-jurisdictional plan, the risk assessment assesses each jurisdiction's risks where they deviate from the risks facing the entire planning area. Harvey County is not a large county geographically (540 square miles) and is fairly uniform in terms of climate and topography as well as construction characteristics and development trends. Accordingly, overall hazards and

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vulnerability do not vary greatly across the planning area for most hazards. Weather-related hazards, such as drought, extreme heat, hailstorm, lightning, tornado, windstorm, and winter storm, affect the entire planning area.

The hazards that do vary across the planning area include agricultural infestation, flood, soil erosion, and wildfire. In Section 3.1, Hazard Identification, Table 3.2 indicates with a checkmark the hazards identified for each participating jurisdiction. In Section 3.2, Hazard Profiles, the Geographic Location section discusses how the hazard varies among jurisdictions across the planning area. The Previous Occurrences section lists the best available data on where past events have occurred and the associated losses to particular jurisdictions. Section 3.2.2, Community Asset Inventory, describes critical facilities and other community assets by jurisdiction. Section 3.3.3, Vulnerability by Hazard, identifies structures and estimates potential losses by jurisdiction where data is available and hazard areas are identified for hazards of moderate and high planning significance. Table 3.2 summarizes the hazard identification as it applies to each jurisdiction. Table 3.6 summarizes the overall planning significance of each hazard to the County.

The previous chapter, Chapter 2 Planning Area Profile and Capabilities, discussed the existing mitigation capabilities of each jurisdiction, such as plans and policies, personnel, and financial resources, which are currently used to reduce hazard losses.

3.1 Hazard Identification

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

3.1.1 Methodology

The Hazard Mitigation Planning Committee (HMPC) reviewed data and discussed the impacts of each of the following hazards for consideration of inclusion in the plan, which are listed alphabetically below:

- Avalanche
- Coastal Erosion
- Coastal Storm
- Dam/Levee Failure
- Drought
- Earthquake
- Expansive Soils
- Extreme Heat
- Flood
- Hailstorm
- Hurricane
- Land Subsidence
- Landslide
- Severe Winter Storm
- Tornado
- Tsunami
- Volcano
- Wildfire
- Windstorm

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In addition to reviewing these hazards for consideration, the HMPC also considered the following hazards profiled in the State of Kansas Hazard Mitigation Plan:

- Agricultural Infestation
- Fog
- Lightning
- Major Disease Outbreak
- Soil Erosion & Dust
- Utility/Infrastructure Failure

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

- Kansas Hazard Mitigation Plan (November 2007)
- Information on past extreme weather and climate events from the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) and National Severe Storms Laboratory (NSSL)
- Disaster declaration history from the Federal Emergency Management Agency (FEMA), the Public Entity Risk Institute, and the USDA Farm Service Agency Disaster Declarations
- Information on past hazard events from the Spatial Hazard Event and Loss Database (SHELDUS), a component of the University of South Carolina Hazards Research Lab that compiles county-level hazard data for 18 different natural hazard event types
- Information provided by members of the Hazard Mitigation Planning Committee
- The National Drought Mitigation Center Drought Reporter
- Various data and reports available on the internet (sources are indicated where data is cited)

The HMPC eliminated some hazards from further profiling because they do not occur in the planning area or their impacts were not considered significant in relation to other hazards. Table 3.1 lists these hazards and provides a brief explanation for their elimination.

Table 3.1 Hazards Not Profiled in the Plan

Hazard	Explanation for Omission
Avalanche	There are no mountains in the planning area.
Coastal Erosion	Planning area is not near coastal areas.
Coastal Storm	Planning area is not near coastal areas.
Earthquake	Planning area is not near known active fault zones.
Expansive Soils	Planning area soils are not of a type known to be expansive.
Fog	Although fog does occur in the planning area occasionally, the HMPC determined that the impacts are restricted primarily to traffic accidents and are difficult to mitigate.
Hurricane	Planning area is not near coastal areas.
Landslide	Planning area does not have known areas susceptible to landslides.
Major Disease Outbreak	Local health officials have completed sufficient planning regarding mitigation of major disease outbreaks in other plans available to the HMPC for review as needed.
Tsunami	Planning area is not near coastal areas.
Volcano	There are no volcanic mountains in the planning area.

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The HMPC identified 14 natural hazards that affect the planning area and organized these hazards to be consistent with the Kansas Hazard Mitigation Plan (2007). These hazards are listed below and profiled in further detail in the next section. The HMPC agreed not to address manmade hazards, which are planned for in other documents such as the emergency operations plan.

For purposes of this multi-jurisdictional plan, the hazards were identified for the unincorporated county as well as each incorporated city. This is summarized in Table 3.2. This analysis method ensures that all of the land area in the planning area is considered. For the school districts, colleges, and other special districts, their boundaries, assets, and facilities overlap city and county boundaries. To determine the hazards that impact specific assets within these other jurisdictional boundaries, refer to the county or city in which the assets are located. For the Dam and Levee failure hazard identification, all areas of the county were considered to be at risk. Without specific dam inundation maps it is difficult to determine with complete accuracy, what areas of the county would not be impacted by a major dam breach whether in or out of the planning area. For the Wildfire hazard identification, the hazard was considered to be present only for those areas that received a moderate or high risk rating in the Harvey County Community Wildfire Assessment Report prepared by the Kansas Forest Service discussed in detail in Section 3.2.16.

Table 3.2 Hazards Identified for Each Participating Jurisdiction (HMPC review)

Hazard	Harvey County	Burrton	Halstead	Hesston	Newton	North Newton	Sedgwick	Walton	USD 373	USD 439	USD 440	USD 460
Agricultural Infestation	x											
Dam and Levee Failure	X	X	X	X	X	X	X	X				
Drought	x	x	x	x	x	x	x	x	x	x	x	x
Extreme Heat	x	x	x	x	x	x	x	x	x	x	x	X
Flood	X		X	X	X	X	X			x	x	
Hailstorm	x	x	x	x	x	x	x	x	x	x	x	X
Land Subsidence	x	x	x	x	x	x	x	x	x	x	x	X
Lightning	x	x	x	x	x	x	x	x	x	x	x	x
Soil Erosion and Dust	x											

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Tornado	x	x	x	x	x	x	x	x	x	x	x	x
Utility/Infrastructure Failure	x	x	x	x	x	x	x	x	x	x	x	x
Wildfire	x		x				x	x				
Windstorm	x	x	x	x	x	x	x	x	x	x	x	X
Winter Storm	x	x	x	x	x	x	X	x	x	x	x	X

3.1.2 Disaster Declaration History

One method used by the HMPC to identify hazards was to examine events that triggered federal and/or state disaster or emergency declarations. Federal and/or state declarations may be issued when the severity and magnitude of an event surpasses the ability of the local government to respond and recover. Disaster assistance is supplemental and sequential. When the local government's capacity has been surpassed, a state disaster declaration may be issued, allowing the provision of state assistance. Should the disaster be so severe that both the local and state governments' capacities are exceeded; a federal emergency or disaster declaration may be issued allowing the provision of federal assistance.

The federal government may issue a disaster declaration through FEMA, the U.S. Department of Agriculture (USDA), and/or the Small Business Administration. FEMA also issues emergency declarations, which are more limited in scope and do not include the long-term federal recovery programs of major disaster declarations. Determinations for declaration type are based on scale and type of damages and institutions or industrial sectors affected.

A USDA disaster declaration certifies that the affected county has suffered at least a 30 percent loss in one or more crop or livestock areas and provides affected producers with access to low-interest loans and other programs to help mitigate the impact of the disaster. In accordance with the Consolidated Farm and Rural Development Act, all counties neighboring those receiving disaster declarations are named as contiguous disaster counties and, as such, are eligible for the same assistance.

Table 3.3 lists federal disaster declarations that include Harvey County. Each of the disaster events affected multiple counties; estimated damages reflect total losses to all counties.

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Table 3.3 Disaster Declaration History in Harvey County, 1965-2008

Declaration Number	Declaration Date	Disaster Description	Estimated Damage (2006 $)
Major Disaster Declarations			
1699	May 4,2007	Severe Storms, Tornadoes, and Flooding	65,979,498
1579	February 8,2005	Severe Winter Strom, Heavy Rains, and Flooding	84,447,071
1258	November 5,1998	Severe Storms and Flooding	20,179,021
1000	July 22,1993	Flooding, Severe Storms	137,038,990
403	September 28,1973	Severe Storms, Tornadoes, Flooding	18,851,282
378	May 2, 1973	Severe Storms, Flooding	8,829,200
201	June 23, 1965	Flooding	6,566,805
Emergency Declarations			
3236	September 10, 2005	Hurricane Katrina Evacuation	Not available
3126	June, 9, 1998	Grain Elevator Explosion	

Sources: Federal Emergency Management Agency, www.fema.gov/; Public Entity Risk Institute, www.peripresdecusa.org/

Table 3.4 lists U.S. Department of Agriculture (USDA) disaster declarations that included Harvey County and their related causes for the period 2005-2007.

Table 3.4 USDA Disaster Declarations in Harvey County 2005-2007

		Cause							
Number	**Date**	Drought	Tornado	Hail	Heat	Excessive Moisture	High Winds	Severe Storms	Winter Storms
M1711	6/26/2007					X		X	
M1699	7/5/2007		X			X		X	
S2525	4/4/2007				X				X
S2413	1/1/2006	X			X		X		
S2121	6/3/2005		X	X		X	X	X	
M1579	1/4/2005					X			X

Source: USDA Farm Service Agency, www.fsa.usda.gov, http://www.fsa.usda.gov/Internet/FSA_File/2005-2007_elig_co_031208.xls

3.2 Hazard Profiles

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

3.2.1 Methodology

Each hazard identified in Section 3.1 Hazard Identification is profiled individually in this section. The level of detail presented in the hazard profiles varies based on the best information available. With each update of this plan, new information will be incorporated to provide for better evaluation and prioritization of the hazards that affect Harvey County.

The sources used to collect information for these profiles include those mentioned in Section 3.1.1 as well as those cited individually in each hazard section. Detailed profiles for each of the identified hazards include information categorized as follows:

Hazard Description

This section consists of a general description of the hazard and the types of impacts it may have on a community. It also includes a ranking to indicate typical warning times and duration of hazard events. Definitions for these rankings are included in Table 3.5.

Geographic Location

This section describes the geographic extent or location of the hazard in the planning area. Where available, maps are utilized to indicate the areas of the planning area that are vulnerable to the subject hazard.

Previous Occurrences

This section includes information on historic incidents and their impacts based upon the sources described in Section 3.1 Hazard Identification and the information provided by the Hazard Mitigation Planning Committee.

Probability of Future Occurrence

The frequency of past events is used to gauge the likelihood of future occurrences. Where possible, the probability or chance of occurrence was calculated based on historical data. Probability was determined by dividing the number of events observed by the number of years and multiplying by 100. This gives the percent chance of the event happening in any given year. An example would be three droughts occurring over a 30-year period, which suggests a 10 percent chance of a drought occurring in any given year. The probability was assigned a rank as defined in Table 3.5.

Magnitude/Severity

The magnitude of the impact of a hazard event (past and perceived) is related directly to the vulnerability of the people, property, and the environment it affects. This is a function of when the event occurs, the location affected the resilience of the community, and the effectiveness of the emergency response and disaster recovery efforts.

The magnitude of each profiled hazard is classified in the following manner:

- **Level 4-Catastrophic**—More than 50 percent of property severely damaged; shutdown of facilities for more than 30 days; and/or multiple deaths
- **Level 3-Critical**—25-50 percent of property severely damaged; shutdown of facilities for at least two weeks; and/or injuries and/or illnesses result in permanent disability

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- **Level 2-Limited**—10-25 percent of property severely damaged; shutdown of facilities for more than a week; and/or injuries/illnesses treatable do not result in permanent disability
- **Level 1-Negligible**—Less than 10 percent of property severely damaged, shutdown of facilities and services for less than 24 hours; and/or injuries/illnesses treatable with first aid

Hazard Summary

To maintain a consistent reporting format, the Harvey County Hazard Mitigation Planning Committee (HMPC) used the methodology from the MitigationPlan.com planning tool to prioritize the hazards. This prioritization was based on a calculated priority risk index (CPRI) that considered four elements of risk: probability, magnitude/severity, warning time, and duration. Table 3.5 defines the rankings for each element of risk. The CPRI for each hazard is provided in this Hazard Summary section.

Table 3.5 Calculated Priority Risk Index (CPRI) Element Definitions

Element/Level	Characteristics
Probability	
4 - Highly Likely	Event is probable within the calendar year. Event has up to 1 in 1 year chance of occurring (1/1=100%) History of events is greater than 33% likely per year. Event is "Highly Likely" to occur
3 – Likely	Event is probable within the next three years. Event has up to 1 in 3 years chance of occurring (1/3=33%) History of events is greater than 20% but less than or equal to 33% likely per year Event is "Likely" to occur
2 – Occasional	Event is probable within the next five years. Event has up to 1 in 5 years chance of occurring (1/5=20%) History of events is greater than 10% but less than or equal to 20% likely per year Event could "Possibly" occur
1 – Unlikely	Event is possible within the next 10 years Event has up to 1 in 10 years chance of occurring (1/10=10%) History of events is less than or equal to 10% likely per year Event is "Unlikely" but is possible of occurring
Magnitude / Severity**	
4 - Catastrophic	Multiple deaths Complete shutdown of facilities for 30 or more days More than 50 percent of property is severely damaged
3 – Critical	Injuries and/or illnesses result in permanent disability Complete shutdown of critical facilities for at least two weeks 25–50 percent of property is severely damaged
2 – Limited	Injuries and/or illnesses do not result in permanent disability Complete shutdown of critical facilities for more than one week 10–25 percent of property is severely damaged
1 – Negligible	Injuries and/or illnesses are treatable with first aid Minor quality of life lost Shutdown of critical facilities and services for 24 hours or less Less than 10 percent of property is severely damaged
Warning Time	
4	Less Than 6 Hours
3	6-12 Hours
2	12-24 Hours
1	24+ Hours
Duration	

4	More Than 1 Week
3	Less Than 1 Week
2	Less Than 1 Day
1	Less Than 6 Hours

Source: MitigationPlan.com

* Based on history, using the definitions given, the likelihood of future events is quantified.

** According to the severity associated with past events or the probable worst case scenario possible in the state.

Using the ranking described in the table above, the formula used to determine each hazard's CPRI, which includes weighting factors defined by MitigationPlan.com, was:

(Probability x .45) + (Magnitude/Severity x .30) + (Warning Time x .15) + (Duration x .10) = CPRI

Based on their CPRI, the hazards were separated into three categories of planning significance; High (3.0-4.0), Moderate (2.0-2.9), and Low (1.1-1.9)

These terms relate to the level of planning analysis to be given to the particular hazard in the risk assessment process and are not meant to suggest that a hazard would have only limited impact. In order to focus on the most critical hazards, those assigned a level of significant or moderate were given more extensive attention in the remainder of this analysis (e.g., quantitative analysis or loss estimation), while those with a low planning significance were addressed in more general or qualitative ways.

Table 3.6 summarizes the results of the completed Hazard Profile Section using this methodology:

Table 3.6 Hazard Profile Summary for Harvey County

Hazard	Warning Time	Duration	Magnitude/ Severity	Probability of Future Events	Calculated Priority Index	Planning Significance
Hail Storm	4	1	3	4	3.40	High
Wildfire	4	2	2	4	3.20	High
Utility Infrastructure	4	3	3	3	3.15	High
Flood	2	3	4	3	3.15	High
Tornado	4	1	2	4	3.10	High
Winter Storm	2	3	3	3	2.85	Moderate
Drought	1	4	2	3	2.50	Moderate
Extreme Heat	1	4	2	3	2.50	Moderate
Dam & Levee Failure	2	4	3	2	2.50	Moderate
Wind Storm	2	2	2	3	2.45	Moderate
Lighting	4	1	2	2	2.20	Moderate
Agricultural Infestation	1	4	2	2	2.05	Moderate
Soil Erosion / Dust	1	4	2	2	2.05	Moderate
Land Subsidence	4	4	1	1	1.75	Low

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3.2.2 Agricultural Infestation

Description

Agricultural infestation is a naturally occurring infection of crops or livestock that renders them unfit for consumption or use. Typical causes can include insects, vermin, fungus, or diseases transferable amongst animals. The types and severity of agricultural infestations vary based on many factors, including cycles of heavy rains and drought. Because of the substantial importance of the agricultural industry in Kansas, agricultural infestation poses a risk to the economy of the entire state.

A certain level of agricultural infestation is normal for Kansas farmers and ranchers and is routinely mitigated. The problem is when the level of an infestation escalates suddenly, or a new infestation appears that overwhelms local control efforts. The potential introduction of animal diseases, such as foot and mouth disease and bovine spongiform encephalopathy disease is a key concern.

Field crops are also subject to various types of infestation. Wheat is susceptible to leaf rust, wheat streak mosaic, barley yellow dwarf virus, strawbreaker, and tan spot. Significant wheat crop losses due to these diseases are well documented in Kansas. Sorghum losses can occur when a crop is infected with sooty stripe early in the growing season. Gray leaf spot is a growing problem for corn crops. The significance of this agricultural sector in the local and regional economy makes crop infestation a serious concern. The levels and types of agricultural infestation appear to be influenced by many factors, including cycles of heavy rains and drought. Insect infestation can cause major losses to stored grain. The estimated damage to stored grain from the lesser grain borer, rice weevil, red flour beetle, and rusty grain beetle in the United States is approximately $500 million annually.

The onset for an agricultural infestation can be rapid. Controlling the spread of agricultural infestation is critical to limiting impacts, conducted through methods including quarantine, culling, premature harvest and/or crop destruction when necessary. Duration is largely affected by the degree to which the infestation is aggressively controlled, but is commonly more than one week. Warning time is critical for this hazard. Maximum warning time can be achieved through accurate monitoring of livestock and crop health by private individuals and regulatory agencies, and effective systems for distributing information and recommendations regarding the outbreak.

Warning Time: Level 1—more than 24 hours.

Duration: 4—more than one week.

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Geographic Location

According to the Kansas Agricultural Statistics Service 2006 Farm Facts Report, 345,000 acres are classified as farm land in Harvey County. All agricultural areas are subject to agricultural infestations, though a major infestation event would affect the entire county including urbanized areas either directly or indirectly.

The western and northeastern parts of the state of Kansas were somewhat less susceptible to leaf rust in 2007, a common disease affecting wheat crops. This geographic distribution for leaf rust corresponds with areas of the state with somewhat lower utilization of the land for crops and rangeland, and fewer feedlots. Figure 3.1 shows areas of moderate (yellow) and severe (red) leaf rust disease pressure in 2007.

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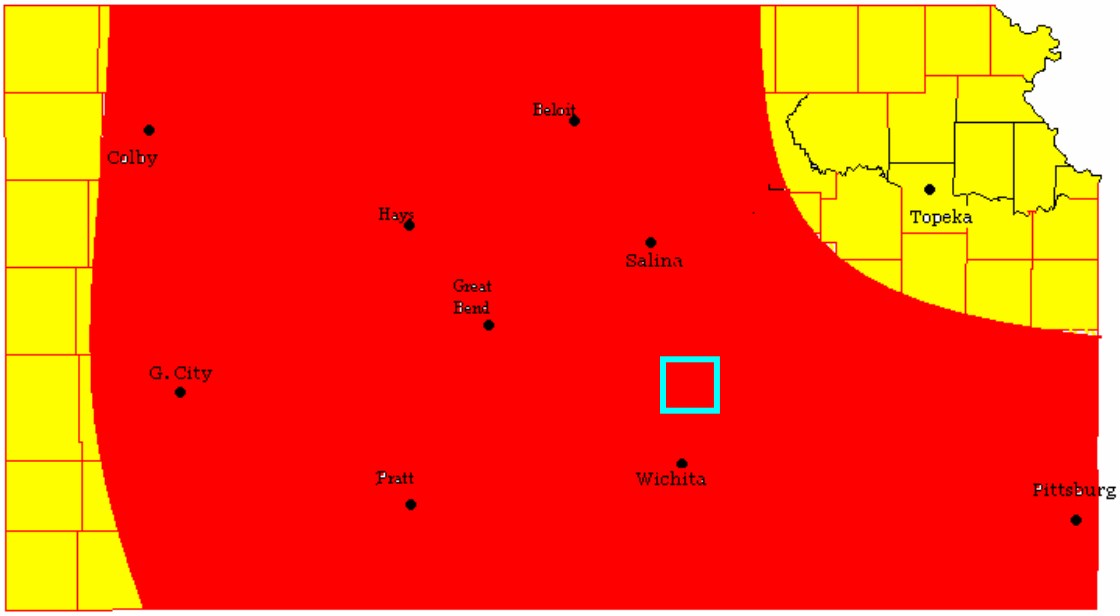
Figure 3.1. Leaf Rust Disease Pressure, Kansas 2007



Source: Kansas State Department of Agriculture, Kansas Cooperative Plant Disease Survey Report: Preliminary 2007 Kansas Wheat Disease Loss Estimates, www.ksda.gov/plant_protection/content/183/cid/611
Notes: Red = High to Severe, Yellow = Moderate. Blue square indicates approximate location of Harvey County

Other crop diseases and their primary locations include those listed in Table 3.7:

Table 3.7. Kansas Crop Disease Regions

Disease/Fungus	Primary Kansas Region	Primary Crop Affected
Septoria leaf disease	Eastern 2/3 of Kansas	Wheat, produce
Tan spot	Eastern 2/3 of Kansas	Wheat
Stripe rust	Entire state	Wheat
Powdery mildew	Eastern 2/3 of Kansas	Produce, vine crops
Scab	Eastern 2/3 of Kansas	Wheat

Source: USDA Agricultural Research Service

The USDA Agricultural Research Service notes the most serious global threat to wheat and cereal crops is stem rust race Ug99. This fungus is spreading across Africa, Asia, and the Middle East and is considered a serious threat to global food security.

Previous Occurrences

According to the USDA Risk Management Agency, insured crop losses in Harvey County as a result of agricultural infestation from 2005 to 2007 totaled $16,170. As Table 3.8 shows, $6,025 was caused by insect infestation and $10,145 from damage caused by plant disease.

Table 3.8 Crop Loss Claims Paid in Harvey County 2005-2007

Year	Crop	Hazard	Claims Paid
Insects			
2006	Wheat	Agricultural Infestation-Insects	$ 5,073.00
2006	Grain Sorghum	Agricultural Infestation-Insects	$ 210.00
2006	Soybeans	Agricultural Infestation-Insects	$ 742.00
		Insects Total	**$ 6,025.00**
Plant Disease			
2006	Wheat	Plant Disease	$ 5,434.00
2007	Wheat	Plant Disease	$ 4,711.00
		Plant Disease Total	**$ 10,145.00**
Total			**$ 16,170.00**

Source: USDA Risk Management Agency, 2008

Additional data regarding previous occurrences of agricultural infestation specific to Harvey County is limited, but statewide information is available. Cumulative losses for the Kansas wheat crop in 2007 were estimated at 17.8 percent of the crop (65.1 million bushels). This total exceeds the state's 20-year average loss (11.4 percent) and is the greatest cumulative loss since 1995. The 1995 wheat crop year was affected by a 20.4 percent loss due to foliar diseases and barley yellow dwarf virus in that year.

In 2007, leaf rust was epidemic statewide and constituted 80 percent of the total agricultural losses due to disease. This same year *Septoria* leaf disease complex was responsible for 1.8 percent of the statewide agricultural loss followed by tan spot at 1.3 percent. Impacts due to barley yellow dwarf, stripe rust, scab, and powdery mildew were estimated at 0.2 percent each

and were occasionally found at higher levels. Several other diseases were not found to any extent. Dominant in 2006, wheat streak mosaic was rarely reported. Take-all and other root and crown rots were almost nonexistent. Soil borne mosaic was reported in a few situations in western Kansas, while common bunt received a couple of reports in north central Kansas, and loose smut was reported infrequently during survey.

Table 3.9 shows wheat crop loss information for Kansas for 2006, 2007 and the 20-year average from 1987-2007.

Table 3.9. Kansas Statewide Wheat Crop Losses by Disease Type

Disease	2007 (% of yield)	2006 (% of yield)	20-Year Average (% of yield)
Leaf Rust	13.9	0.1	3.79
Septoria Complex	1.8	0.001	0.97
Tan Spot	1.3	0.2	0.96
Powdery Mildew	0.2	0.1	0.22
Barley Yellow Dwarf	0.2	0.8	1.21
Scab	0.2	0.001	0.21
Stripe Rust	0.2	0.001	1.31
Bunt And Loose Smut	0.02	0.05	0.01
Soil Borne Mosaic And Spindle Streak Complex	0.01	0.05	0.37
Wheat Streak Complex	0.01	7	1.94
Snow Mold	0.01	0	0.00
Root And Crown Rots	0.01	0.1	0.13
Take All	0.001	0.1	0.24
Bacterial Leaf Blight	0.001	0.001	0.02
Stem Rust	0	0	0.05
Strawbreaker	0	0	0.01
American Wheat Striate	0	0.001	0.001
Total	**17.8**	**8.5**	**11.43**

Source: Kansas State Department of Agriculture, Kansas Cooperative Plant Disease Survey Report: Preliminary 2007 Kansas Wheat Disease Loss Estimates, www.ksda.gov/plant_protection/content/183/cid/611

Probability of Future Occurrences

Harvey County experiences agricultural losses every year as a result of naturally occurring agricultural infestation. However, overall probability for this hazard is considered "possible" as the more significant events causing large losses do not occur annually.

Possible: Level 2—Event is probable in the next five years.

Magnitude/Severity

Economic impacts are the primary concern with agricultural infestation. Overall magnitude and severity is considered "limited".

Limited: Level 2—10–25 percent of property is severely damaged.

Hazard Summary

Calculated Priority Risk Index	Planning Significance
2.05	Moderate

3.2.3 Dam and Levee Failure

Description

A dam is defined as a barrier constructed across a watercourse for the purpose of storage, control, or diversion of water. A levee is generally defined as an embankment created to prevent a body of water from overflowing. Dams and levees are typically constructed of earth, rock, concrete, or mine tailings. The failure or breach of a dam or levee can result in severe flooding in the downstream floodplain. While levees are built solely for flood protection, dams often serve multiple purposes, one of which may be flood control.

Two primary factors influence the severity of a full or partial dam or levee failure: the amount of water impounded, and the density, type, and value of development and infrastructure located downstream. Dams and levees are usually engineered to withstand a flood with a computed risk of occurrence. If a larger flood occurs, then that structure will likely be overtopped. If during the overtopping, the dam fails or is washed out, the water behind is released as a flash flood. Failed dams can create floods that are catastrophic to life and property, in part because of the tremendous energy of the released water.

The hazard potential for dam failure is classified according to the following definitions accepted by the Interagency Committee on Dam Safety:

- High Hazard Dam—A dam located in an area where failure could result in any of the following: extensive loss of life, damage to more than one home, damage to industrial or commercial facilities, interruption of a public utility serving a large number of customers, damage to traffic on high-volume roads that meet the requirements for hazard class C dams or a high-volume railroad line, inundation of a frequently used recreation facility serving a relatively large number of persons, or two or more individual hazards described for significant hazard dams
- Significant Hazard Dam—A dam located in an area where failure could endanger a few lives, damage an isolated home, damage traffic on moderate volume roads that meet certain requirements, damage low-volume railroad tracks, interrupt the use or service of a utility serving a small number of customers, or inundate recreation facilities, including campground areas intermittently used for sleeping and serving a relatively small number of persons
- Low Hazard Dam—A dam located in an area where failure could damage only farm or other uninhabited buildings, agricultural or undeveloped land including hiking trails, or traffic on low-volume roads that meet the requirements for low hazard dams

Dam failures can result from any one or a combination of the following causes:

- Prolonged periods of rainfall and flooding, which causes most failures;
- Inadequate spillway capacity, resulting in excess overtopping flows;
- Internal erosion caused by embankment or foundation leakage or piping;
- Improper maintenance, including failure to remove trees, repair internal seepage problems, replace lost material from the cross section of the dam and abutments;
- Improper design, including the use of improper construction materials and construction practices;
- Negligent operation, including failure to remove or open gates or valves during high flow periods;
- Failure of upstream dams on the same waterway;
- Landslides into reservoirs, which cause surges that result in overtopping;
- High winds, which can cause significant wave action and result in substantial erosion; and
- Earthquakes, which typically cause longitudinal cracks at the tops of embankments and weaken entire structures.

In general, warning time depends on the causal factors. Dam failure can occur in as little as a few minutes or more slowly over the course of many months. In the event of a catastrophic failure of a large dam, evacuation time for locations directly downstream would be extremely brief. Floodplain characteristics largely determine the available warning time for locations further downstream. Duration of high water conditions that result from dam failure depends on the capacity and stage of the reservoir at time of breach as well as the severity of the breach. Warning time and duration of levee failure is generally shorter than dam failure.

Warning Time: Level 4— less than 6 hours

Duration: Level 2—less than 1 day

Geographic Location

Dams

Data obtained from the State of Kansas and National Inventory of Dams indicated that there are 44 dams in Harvey County, shown in Figure 3.2. Of those, 12 of them have an unknown risk hazard, 24 of them are low hazard dams, 3 of them are significant hazard dams, and there are 5 high hazard dams. There is a high hazard dam located north of North Newton on Sand Creek with a site name of FDR No. 1. The other high hazard dam that is about a mile northeast of Newton is on a tributary to Sand Creek with a site name of DD No. 107. There are 2 significant hazard dams in the northeast corner of Harvey County that are located on a tributary of Doyle Creek. There is a significant hazard dam on the Harvey County East Park Lake that feeds into Walnut Creek; it is named MPD No. 14. The other two high hazard dams are located in the southeast corner of the county on streams leading out of the county. They are located on Wildcat Creek and Gypsum Creek. According to the State data, there are not any High or Significant hazard dams in adjacent counties that threaten Harvey County. Detailed information about each of the high hazard dams is listed below:

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DD No. 107

There appears to be a significant amount of farmland and open space that will likely be affected by a dam failure. There are also five or six properties, in close proximity to the dam. The creeks that feed into this dam are as follows: Stribby, Buck, Chicken, and Eagle. US Highway 50 is southeast, 24th Street is south, and Spencer Road is west of the dam and will likely be affected by a dam failure. However, there does not appear to be any areas near the dam in danger of inundation.

FRD No. 1

There appears to be a significant amount of cropland and seven farm properties that could be affected by a dam failure. 96th Street is south, Hillside Road is east, and 106th Street is north of the dam and are all likely to be affected by a dam failure. The creeks that feed into this dam are as follows: Grasshopper, White Clay, Salt, Bull, Saline, Hickory, Shanghi, Amazon, Spring, Turkey, Rock, Lime, Dry, South Duck, Limestone, Seven Mile, Dry Walnut, Frog, Sand, and Timber. There are also two, small rivers that feed into this dam also; Delaware, Black Vermillion, and North Brown Little Walnut. There appears to be about twenty farmhouses in the flood zones that accommodate the dam. The cities of North Newton and Newton are near the end of the flood zone and may need assistance during flood events.

FRD No. 18

There appears to be a large lake, with accommodating streams that are likely to be affected by any dam failure. The streams, likely affected, are as follows: White Clay, Clear, North Cedar, South Fork Wildcat, Timber, Frog, So. Br Little Walnut River, Rock, Armstrong Branch, Wet Walnut, Salt, and Cole. However, there are two roadways that are also likely to be affected; 84th, and Webb. There are ten farm properties, along with crop and farmland, likely to be affected by a dam failure. But there does not appear to be any cities or towns near the flood zone.

MPD No. 14

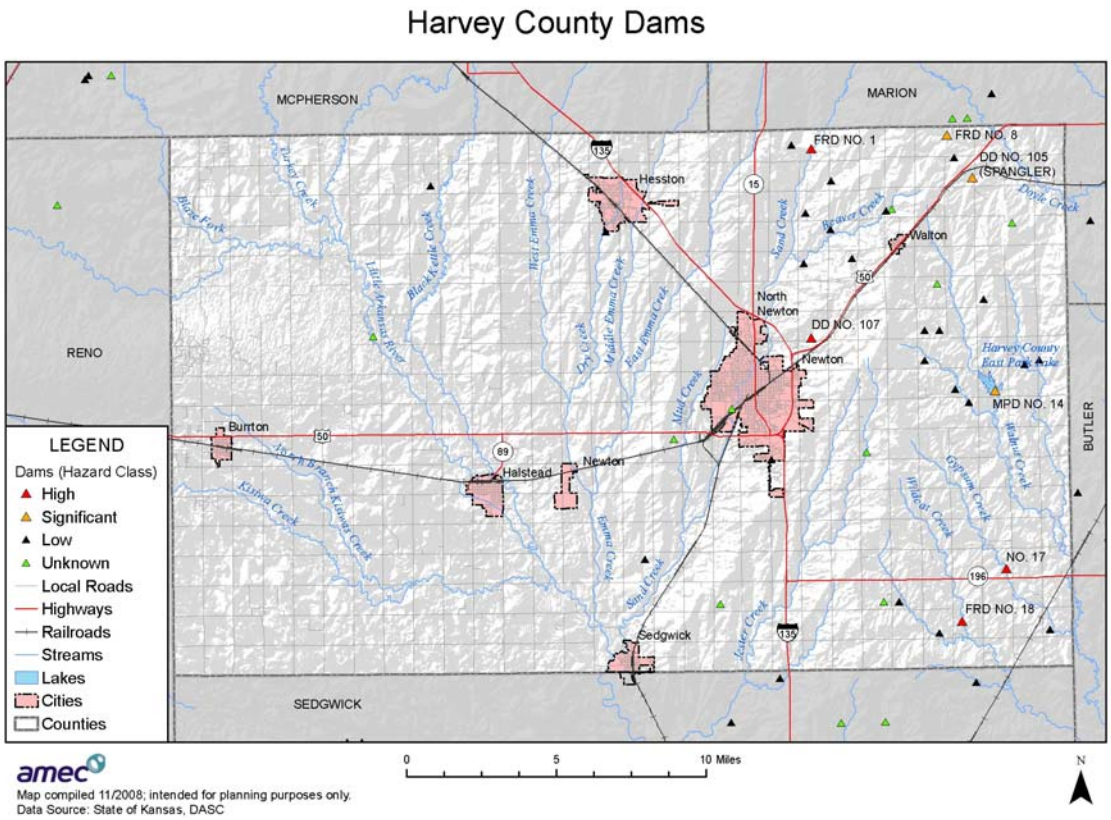
There appears to be several residential and farm properties in close proximity to the dam and the adjacent lake. There also seems to be an abundance of crop and farmland nearby that may be affected by a dam failure. East Lake Road is west, Grace Hill Road is east, and 1st Street is south of the dam and are likely to be affected by a failed dam. There are also three structures located in the nearby flood zone, likely to be affected during flood events. The City of Whitewater is adjacent to the accommodating flood zone and will likely need assistance during flood events.

No. 17

There appears to be an abundance of farm and cropland in the vicinity of the dam and stream, which is surrounded by trees. There also appears to be four properties in the flood zone.. The stream that feeds into the dam is Gypsum Creek. Grace Hill and 72nd streets are also nearby and

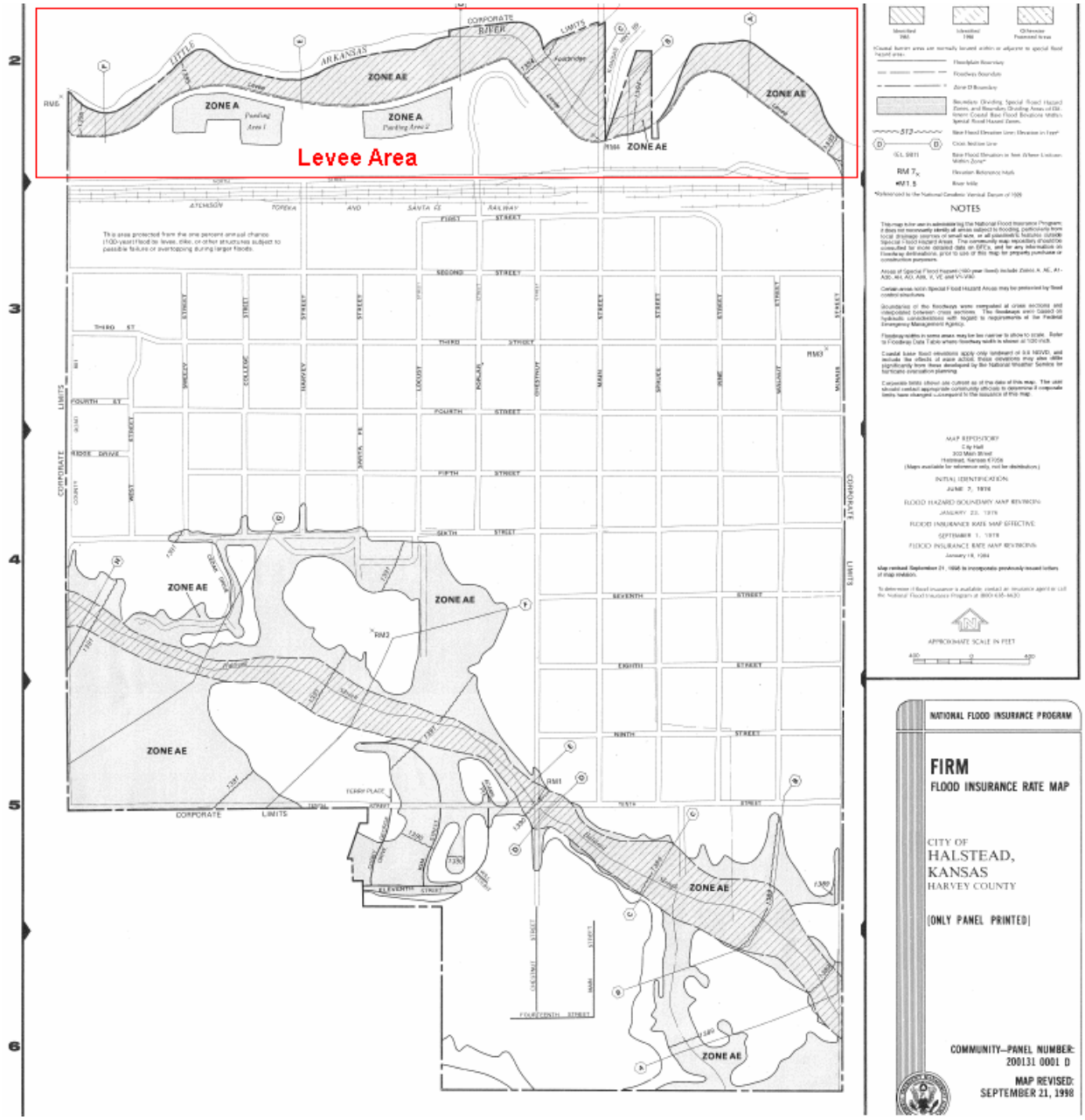
are likely to be affected, in the event of a dam failure. The City of Whitewater is adjacent to the accommodating flood zone and will likely need assistance during flood events.

Figure 3.2 Dams in Harvey County



Levees

The only know levee in Harvey County is the levee surrounding Halstead. The levee completed in 1995 is 25 miles long. The levee was built using federal flood control funds at a cost of $11,000,000. The levee was built to protect Halstead following the catastrophic Midwest flooding in 1993. A FIRMette created from the FEMA Map Service Center shows the location of the levee.


Levee Area
ZONE AE
ZONE A
ZONE A
ZONE AE
ZONE AE
ZONE AE
ZONE AE
ZONE AE
ZONE AE
NOTES
NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
CITY OF
HALSTEAD,
KANSAS
HARVEY COUNTY
(ONLY PANEL PRINTED)
COMMUNITY–PANEL NUMBER:
200131 0001 D
MAP REVISED:
SEPTEMBER 21, 1998

Previous Occurrences

Dams

Members of the HMPC did not know of any instances of catastrophic dam failures in Harvey County.

Levees

According to the August 2007 edition of the United States Army Corps of Engineers Tulsa District Project Update publication, "There is a success story from Halstead, Kansas. Their levee and flood walls, which were Federally constructed by the Tulsa District, held back the flooding in that area. The real-life flood test happened during the May 26th (2007) flooding that impacted central Kansas. During that period, the town was shut off from the world for a couple of days but the water stayed out." This time period saw the overtopping of several other USACE levees in Kansas. A photo from the same publication showing Halstead residents at the flood gates is below. There have been no instances of the Halstead Levee failing since it was installed in 1995.

Probability of Future Occurrences

Using the methodology adopted for natural hazards in this plan, the probability of dam breach or levee failure in Harvey County is considered unlikely based on the past performances of these structures during flood events. However, because dam failure is a manmade hazard, the methodology for calculating probability based on past occurrences does not necessarily reflect the actual risk of future occurrence.

The HMPC discussed issues relating to releases and overtopping of levees and determined that while this is not "failure" of the structure, the existence of the structure can impact and exacerbate flooding. This can occur by not allowing flood waters to flow out of an area in a timely manner, or by causing flood levels to rise very rapidly as occurs when flood gates are opened. With these impacts in mind, the HMPC determined probability level for this hazard to be "occasional."

Occasional: Level 2— Event could "Possibly" occur.

Magnitude/Severity

Due to the presence of both high and significant dams, as well as the non-regulated levee in Halstead, the HMPC determined that if a worst-case scenario dam or levee failure were to occur, the impacts would be critical in nature. By definition, impacts as a result of the failure of a high-hazard dam could include loss of life, damage to structures, utilities, high-volume roads, railroads, and recreation facilities.

Critical: Level 3— 25-50 percent of property severely damaged; shutdown of facilities for at least two weeks; and/or injuries and/or illnesses result in permanent disability.

Hazard Summary

Calculated Priority Risk Index	Planning Significance
2.50	Moderate

3.2.4 Drought

Description

Drought is generally defined as an extended period of below normal precipitation and soil moisture that adversely affects plants, animal life, and humans. A drought period can last for months, years, or even decades. Onset is gradual, and warning times are more than one week. It is rarely fatal, though the associated heat, dust, and stress can all contribute to increased mortality. Lack of precipitation over extended periods is the primary cause of drought, and poor water conservation practices can worsen the impacts. Based on information from the National

Weather Service for 2006, drought was the nation's 2nd most costly natural hazard, causing $2.6 billion in property and crop damages (flooding caused $3.9 billion in damages).

Drought significantly affects agriculture and recreation and thus has economic and environmental impacts. Drought also increases the probability and severity of wildfires and wind erosion. The Palmer Drought Severity Index and U.S. Drought Monitor are two common methods of tracking and reporting regional and national drought conditions.

Four types of drought are described below:

- **Meteorological drought** is usually defined by a period of below average water supply.
- **Agricultural drought** occurs when there is an inadequate water supply to meet the needs of the state's crops and other agricultural operations such as livestock.
- **Hydrological drought** is defined as deficiencies in surface and subsurface water supplies. It is generally measured as streamflow, snowpack, lake, reservoir, and groundwater levels.
- **Socioeconomic drought** occurs when a drought impacts health, well-being, and quality of life or when a drought starts to have an adverse economic impact on a region.

Periods of drought are normal occurrences in all parts of Kansas. Drought in Kansas is caused by severely inadequate amounts of precipitation that adversely affect farming and ranching, surface and ground water supplies, and uses of surface waters for navigation and recreation. The State of Kansas Operations Plan for the Governor's Drought Response Team utilizes a phased response to drought and identifies specific program actions related to each drought stage. The following provides a brief summary of this phased response approach. Additional detail is found in the Operations Plan.

Drought Watch – Impacts include some damage to crops and pastures, high rangeland fire danger and a growing threat of public water supply shortages. The Governor is notified and the Governor's Drought Response Team assembled. Open outdoor burning bans may be imposed. Public water systems may ask for voluntary water use restrictions.

Drought Warning – Crop and pasture losses are likely with some stock water shortages and very high rangeland fire danger. Public water supply shortages are present and some streamflow targets are not being met. Public water systems may impose mandatory water use restrictions. Urgent Kansas Water Marketing Program surplus water supply contracts can be authorized for municipal and industrial users. The Governor may request emergency haying and grazing authorization for Conservation Reserve Program acres.

Drought Emergency – Widespread major crop and pasture losses are accompanied by stock water shortages and extreme rangeland fire danger. Severe public water supply shortages are widespread with many streamflow targets not met. The Governor may declare an outdoor burning ban. Public water systems may impose additional mandatory water use restrictions. Emergency Kansas Water Marketing Program surplus water supply contracts can be authorized for municipal and industrial users. Emergency water withdrawals from Corps of Engineers reservoirs and state fishing lakes can be authorized. Corps of Engineers emergency water

assistance to municipalities is available if needed. The Governor may request a USDA Secretarial disaster designation for drought.

Warning Time: Level 1—more than 24 hours.

Duration: Level 4—more than one week.

Geographic Location

Drought tends to affect broad regions and the entire planning area is subject to drought occurrence at roughly equal probability. The impacts of prolonged drought are most significant in agricultural areas of the County.

In addition to impacts on Harvey County's agricultural areas, drought can affect cities by severely limiting public water supplies due to depletion of natural water sources and greatly increased demand.

Previous Occurrences

Information from the National Oceanic and Atmospheric Administration (NOAA) indicates that Harvey County has experienced several major periods of drought during the 19th and 20th century, including the 1930s, 1950s, 1901, 1874, and 1872. From 1933 to 1940, the planning area was part of the "Dust Bowl." The Dust Bowl occurred due to a long period of drought conditions and years of land management practices that left the dry topsoil especially susceptible to wind erosion. This period of drought and wind erosion devastated the agricultural base of the Great Plans, including Harvey County.

The planning area was also affected by drought conditions from 1952 to 1957. During this period, rainfall totals were below normal and temperatures were above normal. Figure 3.3 shows the precipitation levels across the United States during the droughts in the 1930s and 1950s. In 1953, Harvey County was part of the driest area of the country (shaded dark red). During this drought, President Eisenhower made $40 million available to 13 drought-stricken states, including Kansas. In 1937, Harvey County and other east central counties fared slightly better than the western portion of the state; but were nonetheless very short on precipitation.

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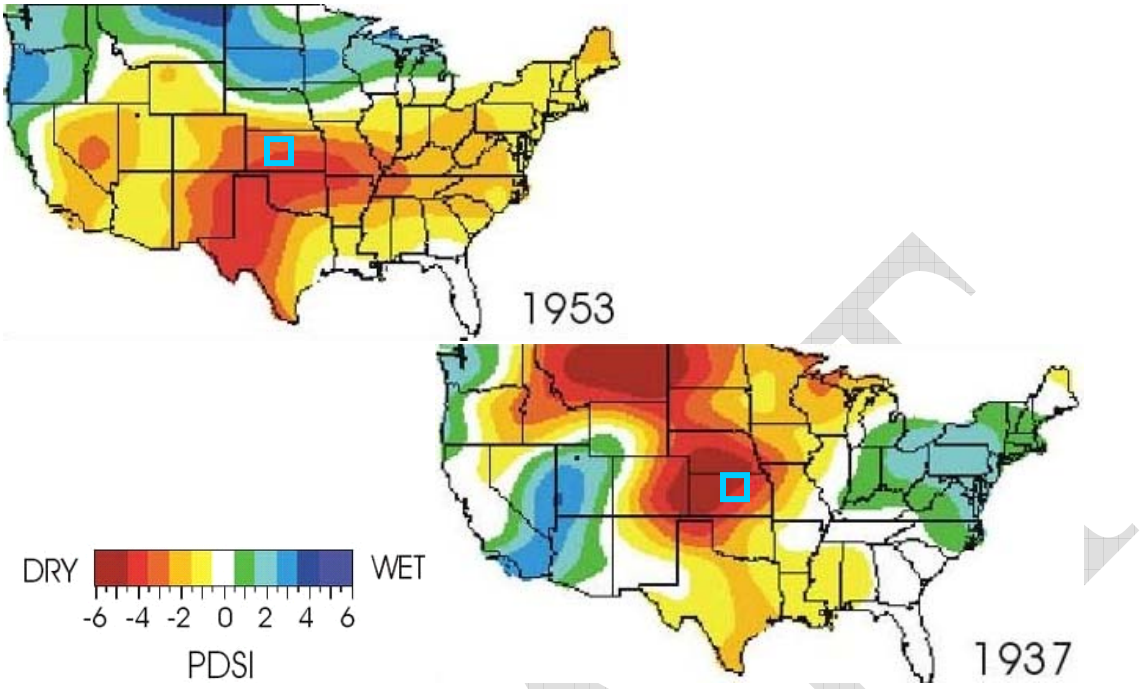
Figure 3.3 Historical Droughts 1953 and 1937



Source: National Oceanic and Atmospheric Administration, http://www.ncdc.noaa.gov/paleo/drought/images/temporal_spatial.jpg
Note: Blue square indicates the region of southeastern Kansas that includes Harvey County

The National Drought Mitigation Center developed the Drought Impact Reporter in response to the need for a national drought impact database for the United States. Information comes from a variety of sources: online drought-related news stories and scientific publications, members of the public who visit the website and submit a drought-related impact for their region, members of the media, and members of relevant government agencies. The database is being populated beginning with the most recent impacts and working backward in time.

Descriptions of recent drought impacts affecting Harvey County are provided by the National Drought Mitigation Center's Drought Impact Reporter:

- **2006-2007**—As a result of drought conditions in 2006, the USDA provided $948,511 to Kansas for the Livestock Assistance Grant Program. This program provided state block grants to the State of Kansas Department of Agriculture to help livestock producers recover forage production losses due to drought conditions in 2006. Eligible counties had to experience exceptional drought at Category D3 or D4 on the U.S. Drought Monitor.
- **1996**—Water levels in reservoirs and wells became so low that the USDA Rural Development Program gave $9.1 million to four states, including Kansas, to dig deeper wells and move intake valves into deeper areas of existing reservoirs.
- **1989**—During this drought, the Kansas Farm Bureau reported $600 million in losses to the state's winter wheat crop. It was estimated that 48 percent of the total crop was lost statewide. Cattle sent to slaughter increased by 50 percent as a result of the feed and water shortages that accompanied this drought.

The National Drought Mitigation Center's Drought Impact Reporter contains information on 59 droughts that affecting Harvey County from 1993 to 2009. The list captures only a portion of the overall impacts of drought. Most of the impacts, 28, were classified as affecting "agriculture." Other impacts include, "fire" (7), "water/energy" (9), and "other" (89). These categories are described as follows:

- **Agriculture**—Impacts associated with agriculture, farming, and ranching. Examples include damage to crop quality, income loss for farmers due to reduced crop yields, reduced productivity of cropland, insect infestation, plant disease, increased irrigation costs, cost of new or supplemental water resource development, reduced productivity of rangeland, forced reduction of foundation stock, closure/limitation of public lands to grazing, high cost/unavailability of water for livestock, and range fires.
- **Water/Energy**—Impacts associated with surface or subsurface water supplies (i.e., reservoirs or aquifers), stream levels or streamflow, hydropower generation, or navigation. Examples include lower water levels in reservoirs, lakes, and ponds; reduced flow from springs; reduced streamflow; loss of wetlands; estuarine impacts; increased groundwater depletion, land subsidence, reduced recharge; water quality effects; revenue shortfalls and/or windfall profits; cost of water transport or transfer; cost of new or supplemental water resource development; and loss from impaired navigability of streams, rivers, and canals.
- **Fire**—Impacts associated with forest and range fires that occur during drought events. The relationship between fires and droughts is very complex. Not all fires are caused by droughts and serious fires can result when droughts are not taking place.
- **Other**—Drought impacts that do not easily fit into any of the above categories.

As detailed in Table 3.10 according to the USDA Risk Management Agency, insured crop losses in Harvey County as a result of drought conditions from 2005 to 2007 totaled $ 851,816.

Table 3.10 Claims Paid in Harvey County for Crop Loss as a Result of Drought

Year	Crop	Claims Paid ($)
2005	Corn	19,104.00
2005	Grain Sorghum	31,514.00
2005	Wheat	11,693.00
2005	Soybeans	11,930.00
2006	Wheat	249,419.00
2006	Corn	141,512.00
2006	Grain Sorghum	185,584.00
2006	Soybeans	83,011.00
2007	Wheat	1,144.00
2007	Corn	7,605.00
2007	Grain Sorghum	21,370.00
2007	Soybeans	87,930.00
Total		**$ 851.816.00**

Source: USDA's Risk Management Agency, 2008

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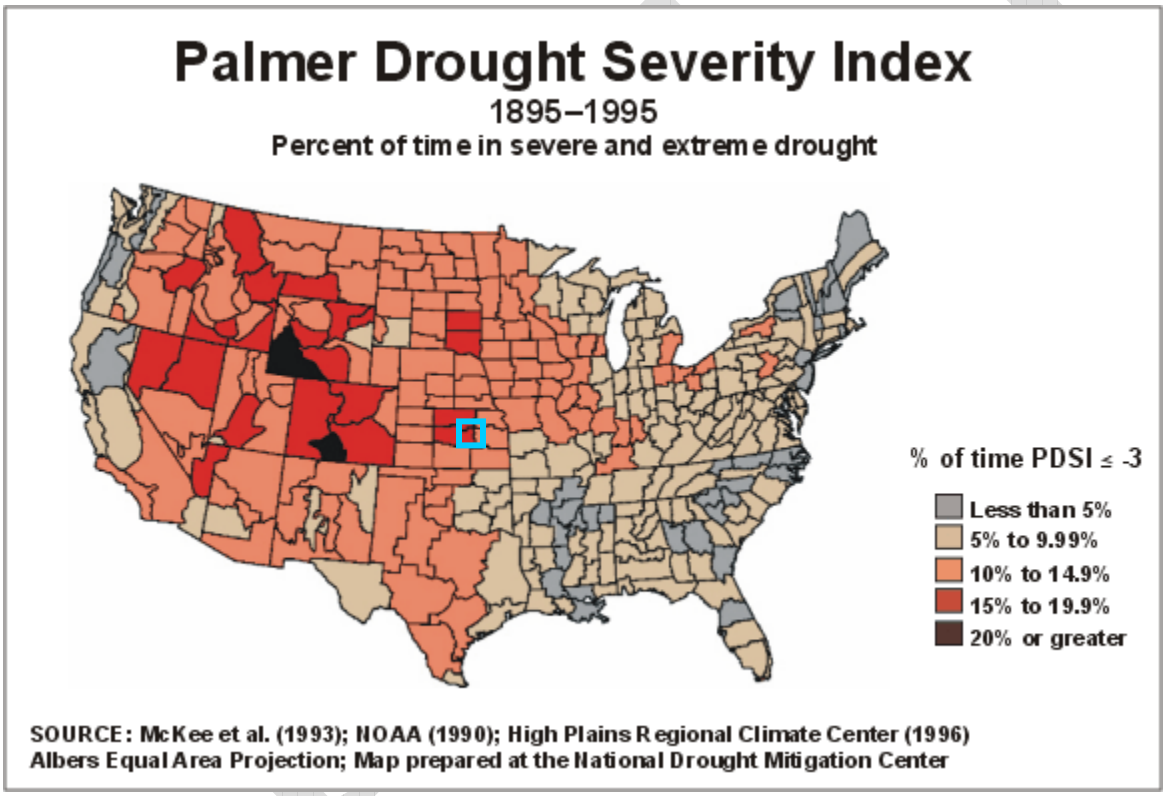
Probability of Future Occurrences

Over short timeframes it is difficult to determine the probability of drought, but the study of drought cycles over longer periods indicate certain levels of historic frequency that can assist forecasters. According to the Palmer Drought Severity Index 1895-1995, Harvey County experienced severe and extreme drought 15-19.9 percent of the time during that 100-year period. Figure 3.4 shows how Harvey County compared to the rest of the state and the nation with respect to the amount of time spent in drought during this 100-year period. As a result of drought conditions that have occurred during the last decade, the HMPC determined that this hazard should receive a probability ranking of "likely."

Likely: Level 3—Event is probable within the next three years.

Figure 3.4. United States Percent of Time in Drought, 1895–1995



Note: Blue square indicates the region of southeastern Kansas that includes Harvey County

Magnitude/Severity

Drought impacts are wide-reaching and may be economic, environmental, and/or societal. The most significant impacts associated with drought in Kansas are those related to agriculture, but can also cause soil to compact and not absorb water well, potentially making an area more susceptible to flooding. An ongoing drought may also leave an area more prone to wildfires.

Water supply can also be of concern during periods of prolonged drought. A 2006 assessment of 800 city or rural water district drinking water systems by the Kansas Water Office listed the following water suppliers in Harvey County as vulnerable to drought: City of Burrton, City of Hesston, and Sedgwick RWD #02, . Although not listed, privately-owned wells may also be vulnerable. Drought impacts increase with the length of a drought. Based on these assessments magnitude and severity of drought is considered "critical".

Limited: Level 2—10-25 percent of property severely damaged.

Hazard Summary

Calculated Priority Risk Index	Planning Significance
2.50	Moderate

3.2.7 Extreme Heat

Description

Extreme temperature events, both hot and cold, can have severe impacts on human health and mortality, natural ecosystems, agriculture, and other economic sectors. According to information provided by FEMA, extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Ambient air temperature is one component of heat conditions, with relative humidity being the other. The relationship of these factors creates what is known as the apparent temperature. The Heat Index chart shown in Figure 3.10 uses both of these factors to produce a guide for the apparent temperature or relative intensity of heat conditions.

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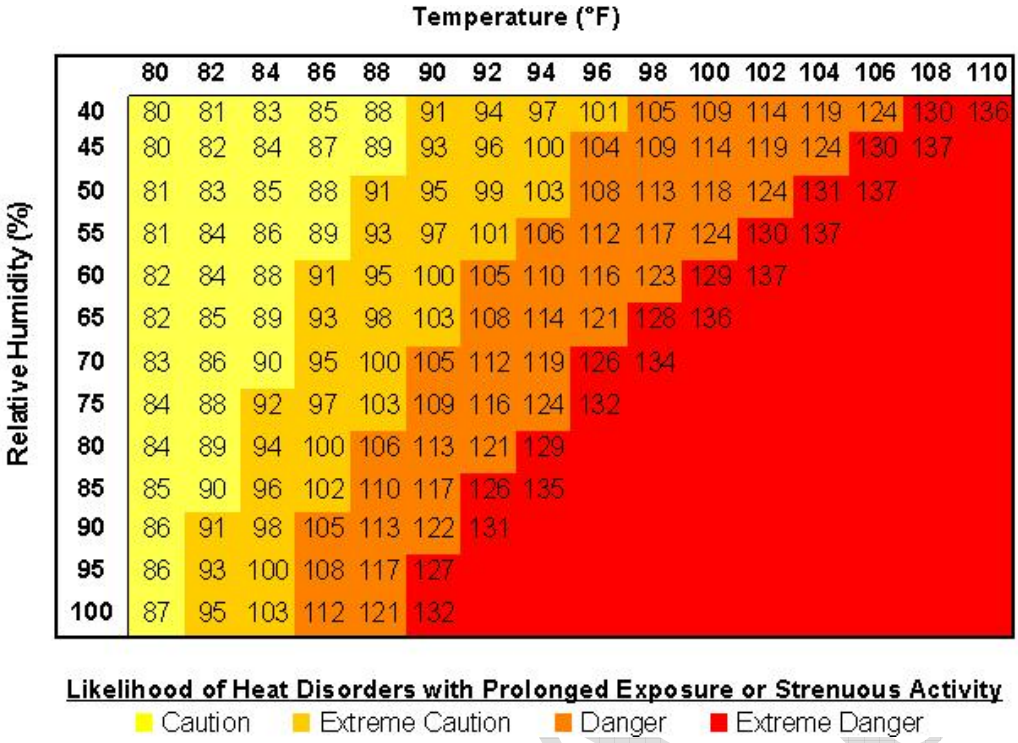
Figure 3.10 Heat Index (HI) Chart



Source: National Weather Service (NWS)

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

From 1995-2006, there were 230 fatalities in the U.S. attributed to are summer heat. According to the National Weather Service, among natural hazards, no other natural disaster—not lightning, hurricanes, tornadoes, floods, or earthquakes—takes a greater toll. Table 3.12 below shows number of heat related fatalities per year form 1995-2006.

Table 3.12 Extreme Heat Fatalities, U.S. 1995-2006

Year	Heat Related Fatalities
1995	1,021
1996	36
1997	81
1998	173
1999	502
2000	158
2001	166
2002	167
2003	36
2004	6
2005	158
2006	253
Total	**2,757**
Annual Avg. (1995-2006)	**230**

Source: National Weather Service, http://www.weather.gov/os/hazstats/images/67-years.pdf

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

Table 3.13 lists typical symptoms and health impacts of exposure to extreme heat.

Table 3.13.Typical Health Impacts of Extreme Heat

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

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

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

Warning Time: Level 1—more than 24 hours.

Duration: Level 4—more than one week.

Geographic Location

The entire planning area is subject to extreme heat events and all participating jurisdictions can be affected.

Previous Occurrences

During the period from 1993-2005, the NCDC database lists one incident of extreme heat in Harvey County in July 2006. From July 16-20, 2006 a deadly heat wave gripped much of central, south-central and southeast Kansas, and temperatures peaked in the 105-110 °F degree range, with afternoon heat indices about the same. The cover of darkness provided little in the way of relief, as overnight temperatures were slow to fall off, reaching only the upper 70s by sunrise for some locations. Available information indicates the prolonged heat claimed eight lives across south-central and southeast Kansas. Additionally, dozens of individuals across central, south-central and southeast Kansas were treated for heat-related illnesses. For the period 2005-2007, Harvey County received two USDA emergency designations for agricultural impacts from excessive heat: once in 2006 and once in 2007.

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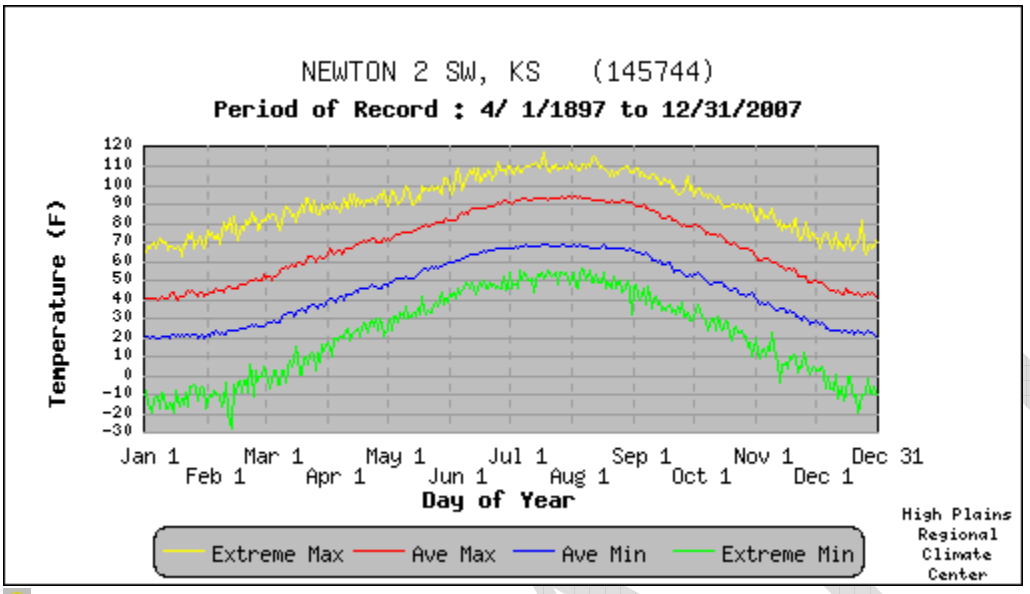
Figure 3.11 graphs the average and record temperatures by month from 1897 to 2007 for Independence.

Figure 3.11 Daily Temperature Averages and Extremes, Newton



- Extreme Max. is the maximum of all daily maximum temperatures recorded for the day of the year.
- Ave. Max. is the average of all daily maximum temperatures recorded for the day of the year.
- Ave. Min. is the average of all daily minimum temperatures recorded for the day of the year.
- Extreme Min. is the minimum of all daily minimum temperatures recorded for the day of the year.

Source: High Plains Regional Climate Center, http://www.hprcc.unl.edu/data/historical/index.php?state=ks&action=select_state&submit=Select+State

As shown in Table 3.14, according to the USDA Risk Management Agency, insured crop losses in Harvey County as a result of extreme heat conditions from 2005 to 2007 totaled $65,649.

Table 3.14 Claims Paid in Harvey County for Crop Loss as a Result of Extreme Heat

Year	Crop	Claims Paid ($)
2005	Corn	2,870.00
2005	Grain Sorghum	18,726.00
2005	Soybeans	3,756.00
2006	Corn	1,112.00
2006	Grain Sorghum	5,671.00
2006	Soybeans	9,910.00
2007	Corn	206.00
2007	Grain Sorghum	202.00
2007	Soybeans	23,196.00
Total		**$65,649.00**

Source: USDA Risk Management Agency, 2008

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Probability of Future Occurrences

Although periods of extreme heat occur on an annual basis, events that create a serious public health risk or threaten infrastructure capacity occur less often. Overall probability of future extreme heat events is considered “likely”.

Likely: Level 3—Event is probable in the next three years.

Magnitude/Severity

The primary concerns with this hazard are human health safety issues. Specific at risk groups identified were outdoor workers, farmers, and senior citizens. During previous periods of extreme heat in Harvey County, some churches, schools and other organizations have opened their doors to serve as cooling centers. Due to the potential for fatalities and the possibility for the loss of electric power due to increased strain on power generation and distribution for air conditioning, periods of extreme heat can severely affect the planning area. In addition, accompanying drought may compound the problem exacerbating agricultural and economic losses. Overall severity of this hazard is considered “limited”.

Limited: Level 2—10-25 percent of property severely damaged; shutdown of facilities for more than a week.

Hazard Summary

Calculated Priority Risk Index	Planning Significance
2.50	Moderate

3.2.8 Flood

Description

Floods are among the most frequent and costly natural disasters in terms of human hardship and economic loss. The National Weather Service reports that total property and crop damage due to flooding in the U.S. for 2006 was $3.96 billion. Nationally, 76 fatalities and 23 injuries were attributed to flooding that same year.

There are several different types of potential flood events in Harvey County including riverine, flash flooding, and urban stormwater. Riverine floods result from precipitation over large areas. This type of flood occurs in river systems whose tributaries may drain large geographic areas and include many independent river basins. Factors that directly affect the amount of flood runoff include precipitation, intensity and distribution, the amount of soil moisture, seasonal variation in vegetation, snow depth, and water-resistance of the surface areas due to urbanization. The term "flash flood" describes localized floods of great volume and short duration. In contrast to riverine flooding, this type of flood usually results from a heavy rainfall on a relatively small drainage area. Precipitation of this sort usually occurs in the spring and summer. Urban flood events result

as land loses its ability to absorb rainfall as it is converted from fields or woodlands to roads, buildings, and parking lots. Urbanization increases runoff two to six times over what would occur on undeveloped terrain. During periods of urban flooding, streets can become swift moving rivers.

Regardless of the type of flood, the ultimate cause in nearly all cases is attributed to excessive rainfall, either in the flood area or upstream reaches of the watershed. Other causes include dam or levee failure, downstream conditions such as channel restriction, blockages of waterways and/or high flow of a confluence stream that can result in what is known as backwater flooding.

The area adjacent to a river channel is its floodplain. In its common usage, "floodplain" most often refers to that area that is inundated by the 100-year flood, the flood that has a 1 percent chance in any given year of being equaled or exceeded. The 1 percent annual flood is the national standard to which communities regulate their floodplains through the National Flood Insurance Program.

The National Weather Service (NWS) provides the following definitions of warnings for actual and potential flood conditions:

General flooding

- Flood Potential Outlook: In hydrologic terms, An NWS outlook that is issued to alert the public of potentially heavy rainfall that could send rivers and streams into flood or aggravate an existing flood.
- Flood Watch: Issued to inform the public and cooperating agencies that current and developing hydro meteorological conditions are such that there is a threat of flooding, but the occurrence is neither certain nor imminent.
- Flood Warning: In hydrologic terms, a release by the NWS to inform the public of flooding along larger streams in which there is a serious threat to life or property. A flood warning will usually contain river stage (level) forecasts.
- Flood Statement: In hydrologic terms, a statement issued by the NWS to inform the public of flooding along major streams in which there is not a serious threat to life or property. It may also follow a flood warning to give later information.

Flash floods

- Flash Flood Watch: Issued to indicate current or developing hydrologic conditions that are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain or imminent.
- Flash Flood Warning: Issued to inform the public, emergency management and other cooperating agencies that flash flooding is in progress, imminent, or highly likely.
- Flash Flood Statement: In hydrologic terms, a statement by the NWS which provides follow-up information on flash flood watches and warnings.

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The onset of flooding varies depending on the cause and type, with flash flooding and dam/levee failure inundation occurring typically with little or no warning time, whereas flooding caused by long periods of excessive rainfall tend to have longer durations but more gradual onset. Overall warning time is usually 6-12 hours. The duration of flood conditions is generally less than one week, but in exceptional cases can extend significantly longer.

Warning Time: Level 2—12-24 hours.

Duration: Level 3—Less than one week.

Geographic Location

The best available data for flooding in Harvey County was generated by HAZUS-MH MR3, FEMA's software program for estimating potential losses from disasters. HAZUS was used to model a flood inundation zone with a one percent annual probability for major rivers and creeks in the County. The inundation zone, or flood depth grid, estimates flooding depth based on location and elevation relative to the creek or river. While not as accurate as official flood maps, these floodplain boundaries are useful for GIS-based loss estimation. Note that HAZUS floodplain modeling occurred only on streams with a minimum drainage area of 10 square miles. Thus flooding on smaller basins, including urban runoff, may not be represented. HAZUS also used 30m resolution DEM for terrain data, which normally does not have sufficient detail to show levee features, thus existing levee protection could be ignored by this analysis. Figure 3.12 shows the HAZUS flood depth grid for Harvey County.

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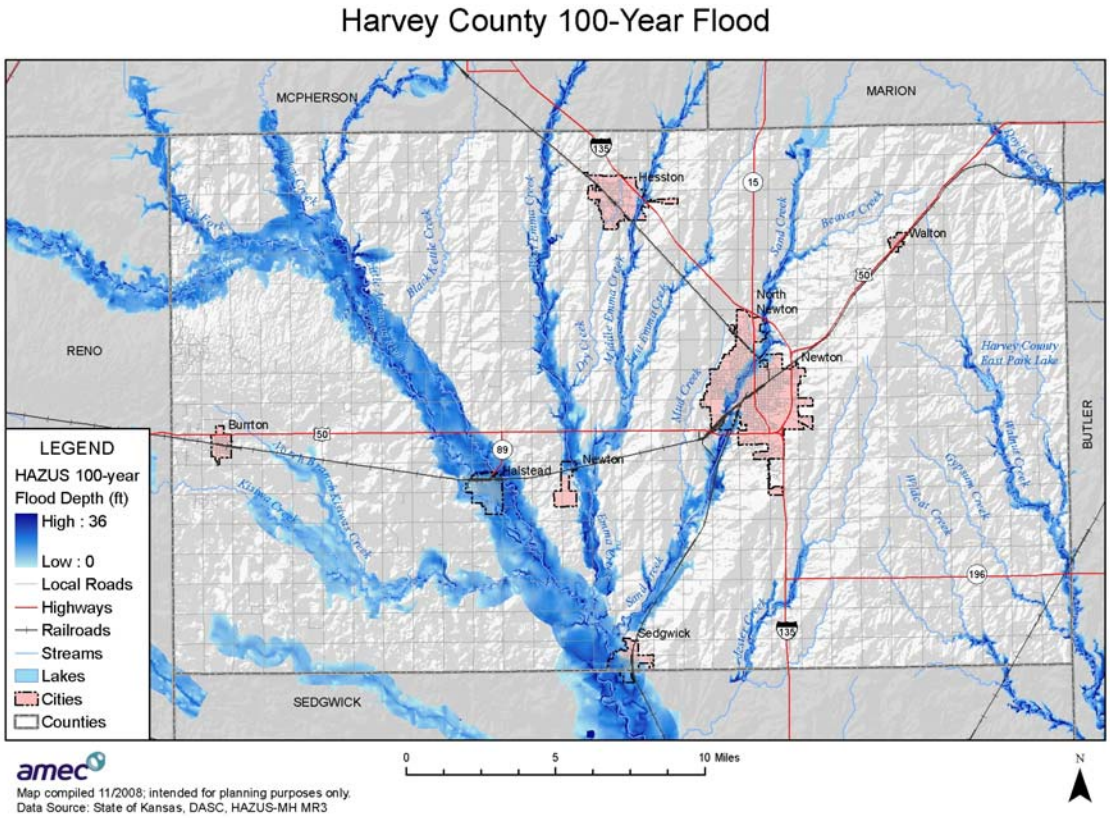
Figure 3.12 Harvey County HAZUS 100-Year Flood Hazard



Previous Occurrences

Riverine flooding is the most common type of flood hazard in Harvey County. Harvey County is also prone to flash flooding, which is defined as a rapid rise in water level, fast-moving water, and debris. Harvey County also has 44 dams (5 are high hazard dams) and one levee. The hazard profile for breach of dams and levees is described separately under section 3.2.3.

The National Climatic Data Center reports 9 flood events in Harvey County between 1993 and 2009. The NCDC database does not contain information on flooding prior to 1993.

Notable past flood events of which affected Harvey County are described below:

- **November 5, 1998:** Widespread heavy rains of 6-10 inches inundated South-Central and Southeast Kansas from the evening of October 30th thru November 1st while 4-8 inches drenched Central Kansas. As a result, record flooding occurred along the following rivers: Whitewater River: At Towanda: crest: 30.53 feet on 11/01/98. (Old record: 29.73

feet on 06/08/79). At Augusta: crest: 34.95 feet on 11/01/98. (Old record: 32.70 feet on 06/08/79). Arkansas River: At Derby: crest: 16.60 feet on 11/01/98. (Old record: 16.19 feet on 07/15/93). At Arkansas City, 28.89 feet on 11/03/98. (Old record: 27.62 feet on 05/11/93). Walnut River: At Arkansas City: crest: 32.45 feet on 11/03/98. (Old record: 29.22 feet on 06/11/95). Cottonwood River: At Florence: crest: 28.67 feet on 11/01/98. (Old record: 28.03 feet on 06/17/95). At Plymouth: crest: 36.77 feet on 11/01/98. (Old record: 35.70 feet on 06/05/65). The record flooding resulted in 1 confirmed death, 2 injuries, just over 5,300 evacuations, and $32 million in damage to crops, highways, property (both business and private), and soil erosion throughout the area (NOT all in Harvey County.).

- **May 8, 1993:** Runoff from heavy rainfall flooded and closed several county roads in Harvey County. The estimated damages to property from this storm in Harvey County was $50,000 and crop damage was estimated at $50,000.

- **June 5, 2001:** Significant street flooding occurred in downtown Newton.

- **June 11, 2002:** US Highway 50 flooded to a depth of 12 inches. By late the evening of June 11, 2002, several roads across the county had to be barricaded to prevent persons from entering the high water.

- **October 8, 2003:** Rainfalls of 3-5 inches caused widespread flash flooding. The most noteworthy flooding occurred when one bridge was washed out in Southeast Harvey County and just west of Hesston, where Dutch Avenue was barricaded.

- **June 8, 2005:** At 2114 CST: In Newton, street flooding in progress at most locations. At 2114 CST: 5 miles east of Newton, 1st Street flooded. At 2135 CST: In Newton, flooding worsened on several roads with one road barricaded. At 2314 CST: In Sedgwick, KFDI Radio reported sandbagging required at county maintenance building. At 2308 CST: In Newton, major flooding throughout city with most roads and streets barricaded and evacuations commenced. At 0100 CST: 6 miles south of Newton, on I-135 1 mile north of rest area, one car washed off road when Jester Creek overflowed. Emergency units dispatched. Most of Harvey County received 12-15 inches of rain in approximately 10 hours. Flooding countywide, but worst in Sedgwick. Extensive loses to farmland with crop/acreage breakdown as follows: Wheat: 69,062; Corn: 19,337; Grain sorghum: 35,912; Soybeans: 19,337; Alfalfa: 3,868. Total acreage affected: 147,515. (Agricultural narrative courtesy USDA Flash Situation report.) Total crop damages were estimated to be over $1.5 Million.

- **May 24, 2007:** Numerous, slow-moving thunderstorms produced 4 to 6 inches of rain across extreme northwest portions of Harvey County from the late afternoon hours on May 23rd, to the early morning hours on May 24th. Excessive runoff from this as well as heavy rainfall upstream across central Kansas caused the Little Arkansas River to flood. Several roads along the Little Arkansas were closed, and some homes and businesses

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received various magnitudes of flood damage. The Little Arkansas reached record flood stage at Halstead around midday on the 25th, forcing the community to close all three flood gates. Public and private damages suffered across the 7 townships affected were likely around $1 million.A stalled frontal boundary resulted in numerous, slow-moving strong to severe thunderstorms across portions of central and south-central Kansas from the afternoon hours on May 23rd, to the early morning hours on May 24th. In addition to large hail and high winds, very heavy rainfall amounts occurred over a short period of time, resulting in widespread urban and rural flash flooding across the area. Additionally, excessive runoff produced river and stream flooding for days, inflicting millions of dollars in damages to roads, businesses and homes. Property damage was estimated at $1.0 million.

As detailed in Table 3.16 according to the USDA Risk Management Agency, insured crop losses in Harvey County as a result of flood conditions and excessive moisture from 2005 to 2007 totaled $ 992,996.

Table 3.16 Claims Paid in Harvey County for Crop Loss as a Result of Flood and Excessive Moisture

Year	Crop	Hazard	Claims Paid ($)
2005	Wheat	Excess Moisture/Precip/Rain	98,810.00
2005	Cotton	Excess Moisture/Precip/Rain	1,263.00
2005	Corn	Excess Moisture/Precip/Rain	9,027.00
2005	Grain Sorghum	Excess Moisture/Precip/Rain	14,473.00
2005	Soybeans	Excess Moisture/Precip/Rain	6,879.00
2006	Grain Sorghum	Excess Moisture/Precip/Rain	624.00
2006	Soybeans	Excess Moisture/Precip/Rain	602.00
2007	Wheat	Excess Moisture/Precip/Rain	503,170.00
2007	Wheat	Flood	52,437.00
2007	Cotton	Excess Moisture/Precip/Rain	5,087.00
2007	Corn	Excess Moisture/Precip/Rain	40,000.00
2007	Corn	Flood	56,829.00
2007	Grain Sorghum	Excess Moisture/Precip/Rain	64,969.00
2007	Grain Sorghum	Flood	16,780.00
2007	Soybeans	Excess Moisture/Precip/Rain	32,503.00
2007	Soybeans	Flood	19,543.00
Total			**$922,996.00**

Source: USDA Risk Management Agency, April, 2008

Probability of Future Occurrences

Based on the detailed historical data available from 1993 to the present, there were 9 flood events in 16 years. Estimating future probability based on historic frequency, there is a 56 percent chance in any given year that major flooding will occur. Considering that some of the

flood reported to NCDC were minor flash flood events, it is reasonable to determine that the overall probability of future flooding occurrence is "likely".

Likely: Level 3—Event is probable in the next three years.

Magnitude/Severity

Some past flood events in Harvey County have caused significant damage to property and agriculture, endangered lives, and shut down critical facilities and infrastructure. Flood events that cause high water over the roadways have a significant impact to communities in Harvey County. For example, several roadways needed to evacuate communities such as the Main Street Bridge in Halstead, flood when even minor storms occur thus potentially preventing the population from being evacuated quickly and safely. The HMPC discussed the possibility of a serious flood that flooded roadways and decided on an overall magnitude and severity of "catastrophic".

Catastrophic: Level 4—More than 50 percent of property severely damaged; shutdown of facilities for more than 30 days

Hazard Summary

Calculated Priority Risk Index	Planning Significance
3.15	High

3.2.9 Hailstorm

Description

In the United States, hail causes more than $1 billion in damage to property crops and livestock each year. Because of the large agricultural industry in Kansas, crop damage and livestock losses due to hail are of great concern to the state. Even relatively small hail can cause serious damage to crops and trees. Vehicles, roofs of buildings and homes, and landscaping are the other things most commonly damaged by hail. Hail has been known to cause injury and the occasional fatality to humans, often associated with traffic accidents.

Hail is associated with thunderstorms that can also bring powerful winds and tornadoes. A hailstorm forms when updrafts carry raindrops into extremely cold areas of the atmosphere where they condense and freeze. Hail falls when it becomes heavy enough to overcome the strength of the updraft and is pulled by gravity towards the earth. Based on information provided by the Tornado and Storm Research Organization, Table 3.17 below describes typical damage impacts of the various sizes of hail.

Table 3.17. TORRO Hailstorm Intensity Scale

Intensity Category	Diameter (inches)	Size Description	Typical Damage Impacts
Hard Hail	0.2-0.4	Pea	No damage
Potentially Damaging	0.4-0.6	Mothball	Slight general damage to plants, crops
Significant	0.6-0.8	Marble, grape	Significant damage to fruit, crops, vegetation
Severe	0.8-1.2	Walnut	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
Severe	1.2-1.6	Pigeon's egg > squash ball	Widespread glass damage, vehicle bodywork damage
Destructive	1.6-2.0	Golf ball > Pullet's egg	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
Destructive	2.0-2.4	Hen's egg	Bodywork of grounded aircraft dented, brick walls pitted
Destructive	2.4-3.0	Tennis ball > cricket ball	Severe roof damage, risk of serious injuries
Destructive	3.0-3.5	Large orange > Soft ball	Severe damage to aircraft bodywork
Super Hailstorms	3.6-3.9	Grapefruit	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
Super Hailstorms	4.0+	Melon	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

Source: Tornado and Storm Research Organization (TORRO), Department of Geography, Oxford Brookes University
Notes: In addition to hail diameter, factors including number and density of hailstones, hail fall speed and surface wind speeds affect severity.

Warning Time: Level 4—less than 6 hours.

Duration: Level 1—less than 6 hours.

Geographic Location

Hailstorms occur over broad geographic regions. The entire planning area, including all participating jurisdictions, is at risk to hailstorms.

Previous Occurrences

The NCDC reports 147 hail events in Harvey County between 1960 and 2007. Multiple listings in one day were considered one event. Where more than one listing occurred on the same day, the largest recorded size for that day was utilized as the hail size for the event. Table 3.18 shows the number of hail events by the size of the hail.

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Table 3.18-1. Harvey County Hail Events Summarized by Size, 1960-2007
Table 3.18-2. Harvey County Hail Events Summarized by Year, 2000 - 2008

Hail Size (inches)	# of Events 1960 to 2007	Year	Number of Hail Events Hail Size > 0.88 inches
3	4	2008	1
2.75	3	2007	3
2.00	4	**2006**	2
1.75	36	**2005**	9
1.50	4	**2004**	1
1.25	6	**2003**	2
1.00	32	**2002**	3
0.88	10	**2001**	4
0.75	48	**2000**	4

Source National Climatic Data Center Storm Events Database

As shown in Table 3.19, according to the USDA Risk Management Agency, insured crop losses in Harvey County as a result of extreme heat conditions from 2005 to 2007 totaled $136,134.

Table 3.19 Claims Paid in Harvey County for Crop Loss as a Result of Hailstorm

Year	Crop	Claims Paid ($)
2005	Wheat	92,025.00
2005	Corn	11,891.00
2005	Grain Sorghum	1,514.00
2005	Soybeans	291.00
2007	Wheat	4,667.00
2007	Corn	25,926.00
Total		**$ 136,134.00**

Source: USDA Risk Management Agency, 2008

Probability of Future Occurrences

Based on this data, there have been 147 events in a 47-year period, producing an average of 3.13 hail events each year in Harvey County. When limiting the probability analysis to hail events producing hail 1.75 inches and larger, there have been 47 events in the 47-year period. Based on this pattern of previous occurrences, future probability of a moderately damaging hail event in a given year is 100 percent.

Regarding probability based on time of year, Figure 3.17 shows the daily probability of a hailstorm occurrence for Harvey County. Probability is highest in the spring months and overall probability is highest in the most recent reporting period of 1995-1999.

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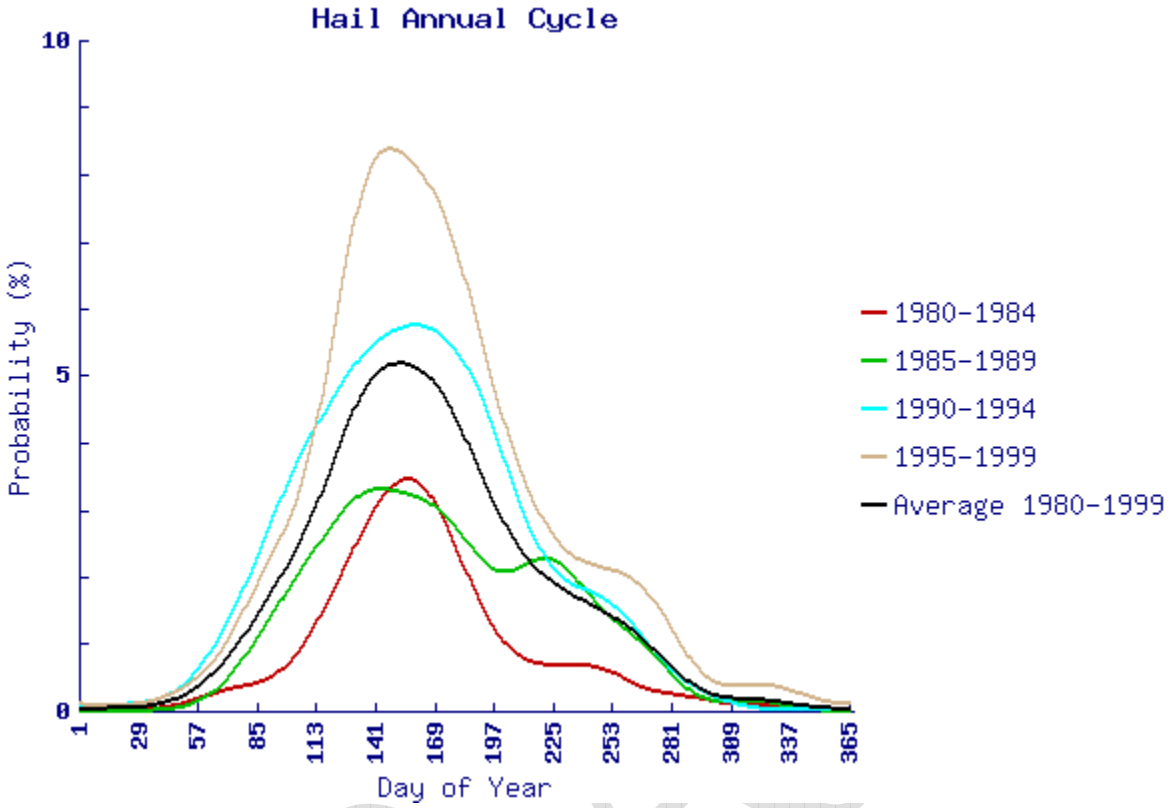
Figure 3.17. Daily Hailstorm Probability, 2" Diameter or Larger, Harvey County 1980-1999



Source: National Severe Storms Laboratory, http://www.nssl.noaa.gov/hazard/hazardmap.html

Figure 3.18 below is also based on hailstorm data from 1980-1994. It shows the probability of hailstorm occurrence (2" diameter or larger) based on number of days per year within a 12.5 mile radius of a given point on the map.

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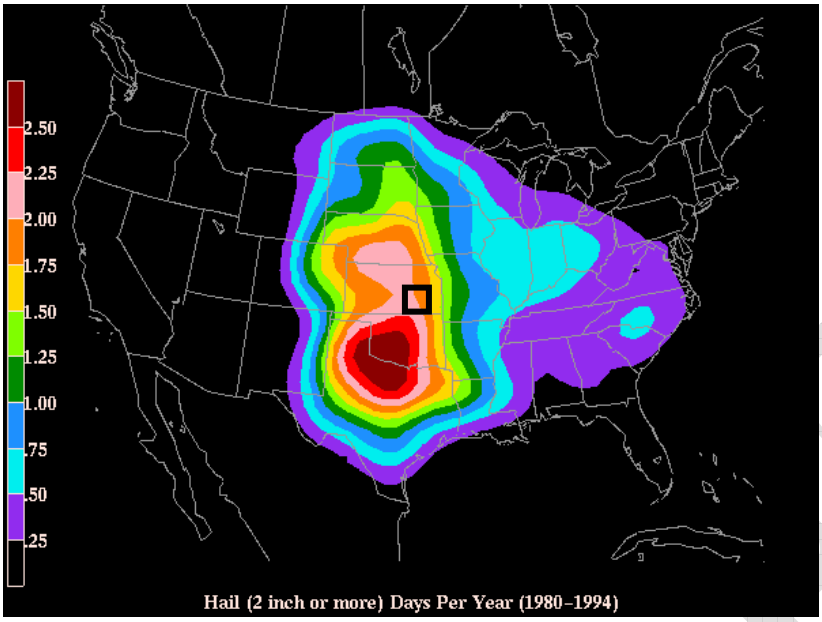
Figure 3.18. Annual Hailstorm Probability (2'' diameter or larger), United States 1980-1994



Source: NSSL, http://www.nssl.noaa.gov/users/brooks/public_html/bighail.gif
Note: Black rectangle indicates approximate location of Harvey County

Based on previous patterns and historic frequency, probability of future occurrence is considered "highly likely".

Highly Likely: Level 4—History of events is greater than 33% likely per year.

Magnitude/Severity

Based on the relatively minor impacts from of previous occurrences, magnitude and severity of hail is considered "negligible".

Critical: Level 3—25-50 percent of property severely damaged.

Hazard Summary

Calculated Priority Risk Index	Planning Significance
3.40	High

3.2.10 Land Subsidence

Description

The development of sinkholes and subsidence areas can be grouped into three major categories: (1) natural dissolution of soluble minerals, causing the development of sinkholes, (2) the

extraction of minerals by either solution mining or shaft mining which leaves a void space where subsidence can occur and (3) downward drainage of fresh water, via a drill hole or unplugged natural gas well which penetrated a soluble mineral formation and has an outlet for the solution cavity water to be disposed. The dissolution of the salt and gypsum that is present in the Wellington Formation results in the development of a large area commonly referred to as "The Lost Circulation Zone". Although the dissolution involves a large area, according to a 1996 repost from the Kansas Department of Health and Environment, the majority of the solution cavities and collapses are isolated and surface subsidence develops slowly. Nearly all of the sinkholes and subsidence areas develop slowly over a number of years and result in shallow surface depressions. On occasion, structures located over or near the subsidence areas can be severely damaged or destroyed.

Warning Time: Level 4—less than 6 hours.

Duration: Level 4—more than one week.

Geographic Location

The dissolution of salt and gypsum created a large area of discontinuous solution zones and subsurface subsidence areas that extend along the entire eastern edge of the Hutchinson Salt Member of the Wellington Formation. This dissolution area extends from north of Salina to The Oklahoma border. The 1996 KDHE report indicates that there are approximately 59 square miles in Harvey County that have been identified as susceptible to solution cavities and subsidence areas in the Wellington Formation. This accounts for a total of 37,760 acres. While the area is relatively small, there is no specific indication that the area of dissolution could not be extended into other areas.

Previous Occurrences

The HMPC reported a few previous occurrences of sinkholes. These types of subsidence activities cause only minor damage that is covered by private insurance. The HMPC thought that it was unlikely that a subsidence large enough to cause significant damage was unlikely based on past history.

Probability of Future Occurrences

Unlikely: Level 1—History of events is unlikely but is possible of occurring.

Magnitude/Severity

Based on limited information on previous impacts of sinkholes in the planning area, overall magnitude and severity of this hazard is considered "negligible".

Negligible: Less than 10 percent of property severely damaged, shutdown of facilities and services for less than 24 hours; and/or injuries/illnesses treatable with first aid

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Hazard Summary

Calculated Priority Risk Index	Planning Significance
1.75	Low

3.2.11 Lightning

Description

Severe thunderstorms strike Kansas on a regular basis with high winds, heavy rains, and the occasional subsequent flooding, often accompanied by lightning. Lightning is an electrical discharge between positive and negative regions of a thunderstorm. It is sudden, extremely destructive and potentially deadly. The National Weather Service reports that lightning caused 48 fatalities and 246 injuries nationwide in 2006 and causes 73 fatalities and 300 injuries in an average year.

The National Lightning Safety Institute reports that lightning causes more than 26,000 fires in the United States each year. The institute estimates that the total cost for direct and indirect impacts of lightning including property damage, increased operating costs, production delays, and lost revenue to be in excess of $6 billion per year.

Due to its nature as a powerful electrical phenomenon, lightning causes extensive damage to electronic systems that it contacts. A particular concern in Kansas is the protection of facilities and communications systems that are critical for maintaining emergency response systems, protecting public health, and maintaining the state's economy. The threat to communications systems includes tornado sirens, which could get knocked out just when they are needed most.

Average duration of each lightning stroke is 30 microseconds and overall duration of lightning storm events is usually less than six hours.

Warning Time: Level 4—less than 6 hours.

Duration: Level 1—Less than six hours.

Geographic Location

The entire planning area, including all participating jurisdictions, is at risk to lightning.

Figure 3.19 show parts of Harvey County located in an area with an average of 30-30 days with thunderstorms per year per 10,000 square miles and four to eight lightning strikes per square kilometer per year.

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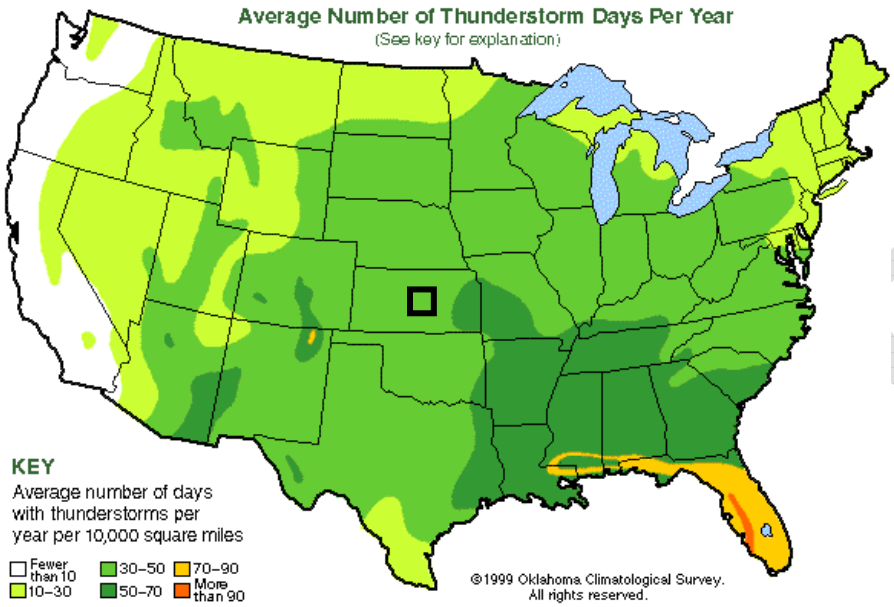
Figure 3.19. Distribution and Frequency of Thunderstorms



Source: Oklahoma Climatological Survey
Note: Black square indicates approximate location of Harvey County

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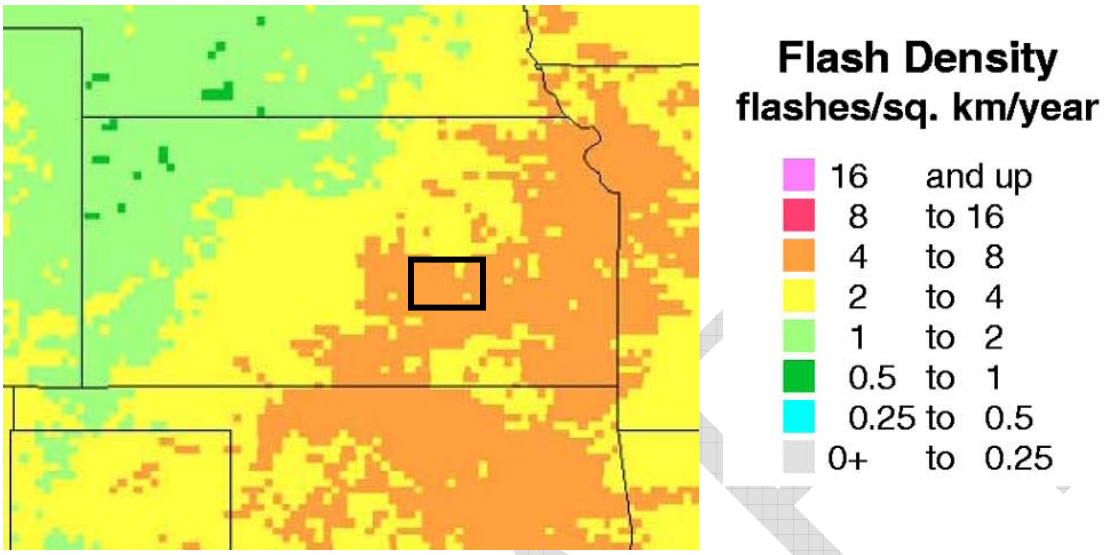
Figure 3.20 below indicates Harvey County is located in a region averaging four to eight lightning strikes per square kilometer per year.

Figure 3.20. Location and Frequency of Lightning in Kansas



Source: National Weather Service, www.lightningsafety.noaa.gov/lightning_map.htm
Note: Black square indicates approximate location of Harvey County

Previous Occurrences

The NCDC database has record of nine damaging lightning events in Harvey County from 1993 to 2003. The following event descriptions provided by the NCDC caused an estimated $273,000 in property damages.

- **August 2003** A home in Newton, Kansas was struck by lightning resulting in damage to the roof and electrical circuitry. Total loss was estimated at $5,000.
- **June 2000** One transformer in Burrton was struck and set afire as were numerous other transformers around Harvey County. The total cost was estimated at $50,000.
- **April 1999** Lightning struck a house, setting fire to the attic. Synoptic-scale high winds of 39-53kts with gusts to 63kts ripped across Central Kansas from mid-morning thru late afternoon. The total cost was estimated at $10,000.
- **August 1997** Lightning struck a duplex in Newton, setting it on fire and destroying the structure and contents. The total loss was estimated at $200,000.

Probability of Future Occurrences

National Weather Service data indicates that Harvey County is in a region that receives four to eight lightning strikes per square kilometer per year, though the majority of these lightning strikes do not result in damages. The HMPC determined the overall probability of a serious lightning occurrence is “possible” in any given year.

Possible: Level 2—Event is probable within the next five years.

Magnitude/Severity

Although the frequency of lightning events is high, overall severity is negligible. Damages are usually limited to single buildings and in most cases, personal hazard insurance covers losses.

Limited: 10-25 percent of property severely damaged

Hazard Summary

Calculated Priority Risk Index	Planning Significance
2.20	Moderate

3.2.13 Soil Erosion and Dust

Description

Soil erosion and dust are both ongoing problems for Kansas. Both can cause significant loss of valuable agricultural soils, damage crops, harm environmental resources, and have adverse economic impacts. Soil erosion in Kansas is largely associated with periods of drought, when winds are able to move tremendous quantities of exposed dry soil (wind erosion), and flooding (streambank 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 nation $37.6 billion each year. 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.

Streambank erosion, which can remove agricultural land and damage transportation systems and utility lines, occurs each year, particularly in the spring. A large proportion of all soil eroded ends up in rivers, streams, and lakes, which makes waterways more prone to flooding and contamination. One type of streambank erosion occurs after heavy rains when water is released from reservoirs causing water levels to rise in rivers and streams. The dry soil at the top of embankments becomes saturated. When reservoir gates are closed and flows return to normal, water levels suddenly drop and the heavy wet soil at the top of the embankments falls into the rivers and streams below.

Erosion increases the amount of dust carried by wind. Dust can also threaten agriculture and have economic impacts by reducing seedling survival and growth, increasing the susceptibility of plants to certain stressors, and damaging property and equipment (e.g., clogging machinery

parts). It is also a threat to health and safety. It acts as an abrasive and air pollutant and carries about 20 human infectious disease organisms (including anthrax and tuberculosis). There is evidence that there is an association between dust and asthma. Some studies indicate that as much as 20 percent of the incidence of asthma is related to dust. Blowing dust can be severe enough to necessitate highway closures because of low visibility, which can cause vehicle accidents.

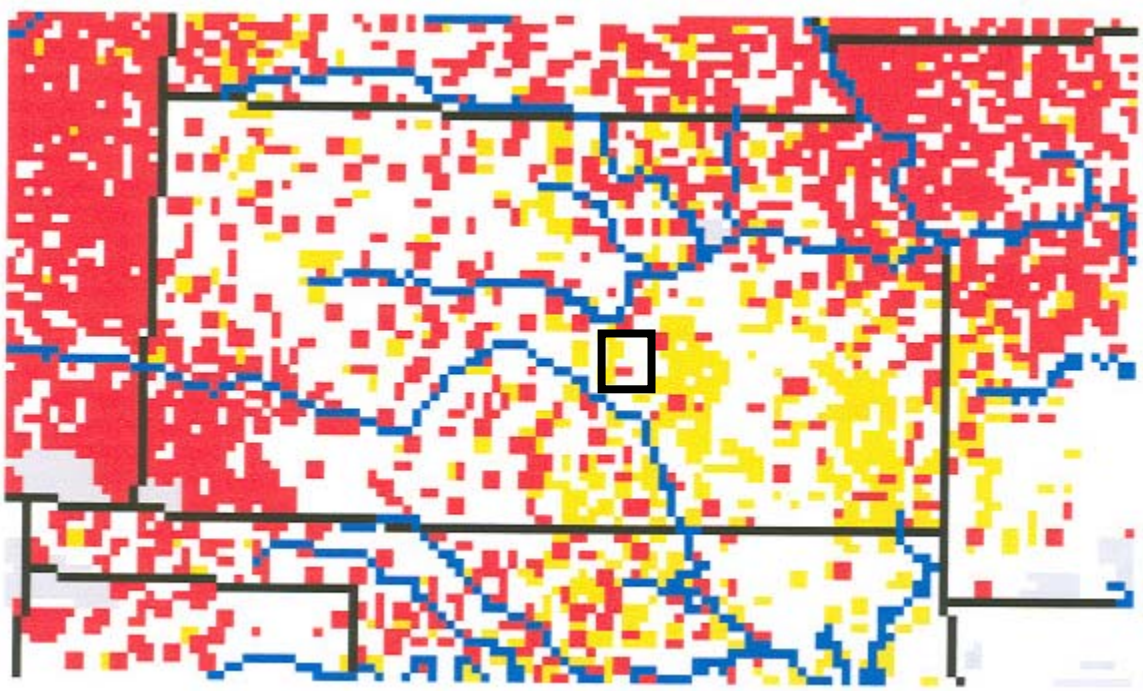
Warning Time: Level 1—More than 24 hours.

Duration: Level 4—More than one week.

Geographic Location

Figure 3.23 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. Harvey County and the south central portion of Kansas have less highly erodible land. However, it appears that Harvey County does have some sections of land that are considered highly erodible and non-highly erodible. The entire area is susceptible to soil erosion and dust.

Figure 3.23. Locations of Excessive Erosion of Farmland, 1997



Source: Kansas Hazard Mitigation Plan, 2007
Note: Black square indicates approximate location of Harvey County

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Previous Occurrences

The most prominent soil erosion and dust event in Kansas, known as the Dust Bowl occurred across the mid-western United States from 1930-1936. Harvey County 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 1970's and in the spring of 1996 wind erosion seriously damaged agricultural land throughout the Great Plains.

Probability of Future Occurrences

While soil erosion and dust occur annually as part of natural processes, the adverse effects of erosion are only fully realized as a cumulative function. Therefore, the probability of notable effects from soil erosion and dust events is considered "occasional"; meaning the cumulative effect of annual events reaches a notable level on the average of every five years.

Likely: Level 3—Event is probable within the next three years.

Magnitude/Severity

Limited: Level 2—10 to 25 percent of property severely damaged.

Hazard Summary

Calculated Priority Risk Index	Planning Significance
2.05	Moderate

3.2.14 Tornado

Description

The National Weather Service defines a tornado as a "violently rotating column of air extending from a thunderstorm to the ground." Tornadoes 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. In an average year, more than 900 tornadoes are reported in the United States, resulting in approximately 80 deaths and more than 1500 injuries. High winds not associated with tornadoes are profiled separately in this document in Section 3.2.17 Windstorm.

Although tornadoes have been documented on every continent, they occur most frequently in the United States east of the Rocky Mountains. 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 Kansas, most tornadoes and tornado-related deaths and injuries occur during the months of April, May, and June. However, tornadoes have struck in every month. Similarly, while most tornadoes occur between 3:00 p.m. and 9:00 p.m., a tornado can strike at any time.

Prior to February 1, 2007, tornado intensity was measured by the Fujita (F) scale. This scale was revised and is now the Enhanced Fujita scale. Both scales are sets of wind estimates (not measurements) based on damage. The new scale provides more damage indicators (28) and associated degrees of damage, allowing for more detailed analysis, better correlation between damage and wind speed. It is also more precise because it takes into account the materials affected and the construction of structures damaged by a tornado.

Table 3.22 shows the wind speeds associated with the original Fujita scale ratings and the damage that could result at different levels of intensity.

Table 3.22. Original Fujita Scale

Fujita Scale	Fujita Scale Wind Estimate (mph)	Typical Damage
F0	< 73	Light damage. Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
F1	73-112	Moderate damage. Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
F2	113-157	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
F3	158-206	Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
F4	207-260	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
F5	261-318	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yards); trees debarked; incredible phenomena will occur.

Source: National Oceanic and Atmospheric Administration Storm Prediction Center, www.spc.noaa.gov/faq/tornado/f-scale.html

Table 3.23 shows the wind speeds associated with the Enhanced Fujita Scale ratings. The Enhanced Fujita Scale's damage indicators and degrees of damage can be found online at www.spc.noaa.gov/efscale/ef-scale.html.

Table 3.23. Enhanced Fujita Scale

Enhanced Fujita (EF) Scale	Enhanced Fujita Scale Wind Estimate (mph)
EF0	65-85

EF1	86-110
EF2	111-135
EF3	136-165
EF4	166-200
EF5	Over 200

Source: National Oceanic and Atmospheric Administration Storm Prediction Center, www.spc.noaa.gov/faq/tornado/ef-scale.html

Warning Time: Level 4—Typical warning time is less than six hours.

Duration: Level 1—Typical duration is less than six hours.

Geographic Location

While tornadoes 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 Harvey County, including all of the participating jurisdictions, is at risk to tornadoes. Figure 3.24 illustrates the number of F3, F4, and F5 tornadoes recorded in the United States per 3,700 square miles between 1950 and 1998. Harvey County is in the section shaded dark orange, indicating 16-25 tornadoes of this magnitude during this 48-year period. Additionally, according to Figure 3.25 Harvey County is in Wind Zone IV, the zone in the United States that has experienced the most and the strongest tornado activity. All of Harvey County, including all of the participating jurisdictions, is at risk to tornadoes.

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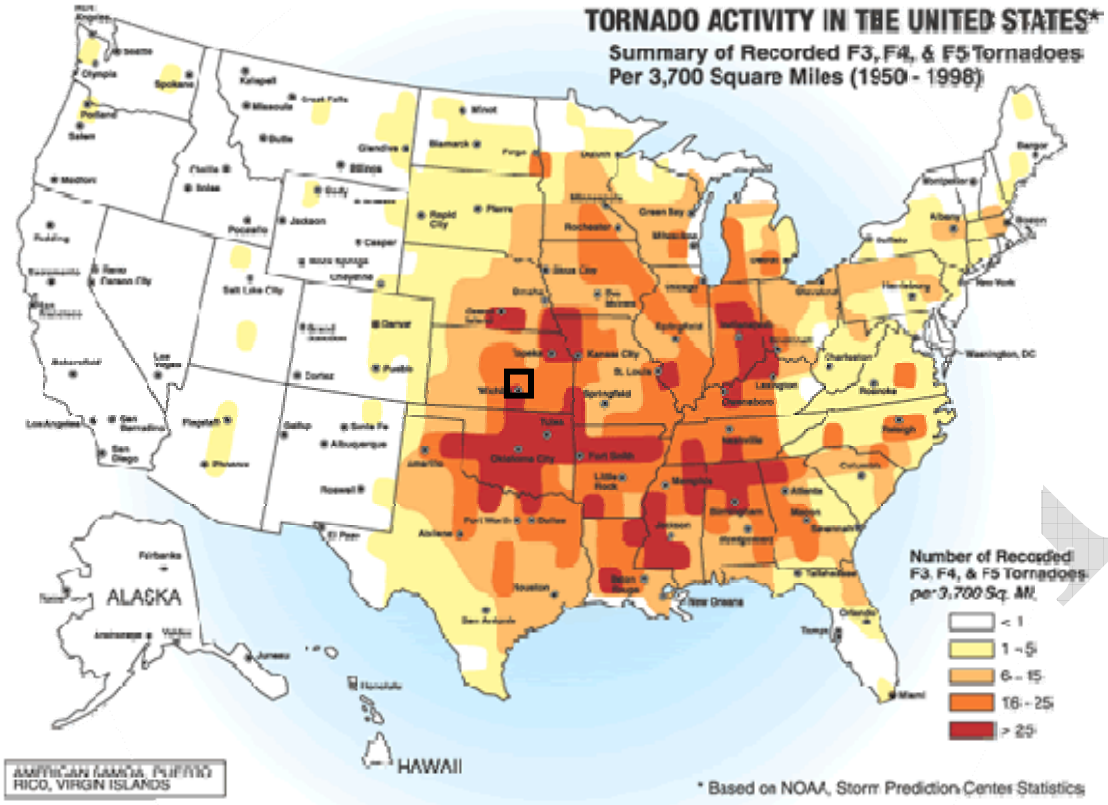
Figure 3.24. Tornado Activity in the United States



Source: NOAA, Storm Prediction Center
Note: Black rectangle indicates approximate location of Harvey County

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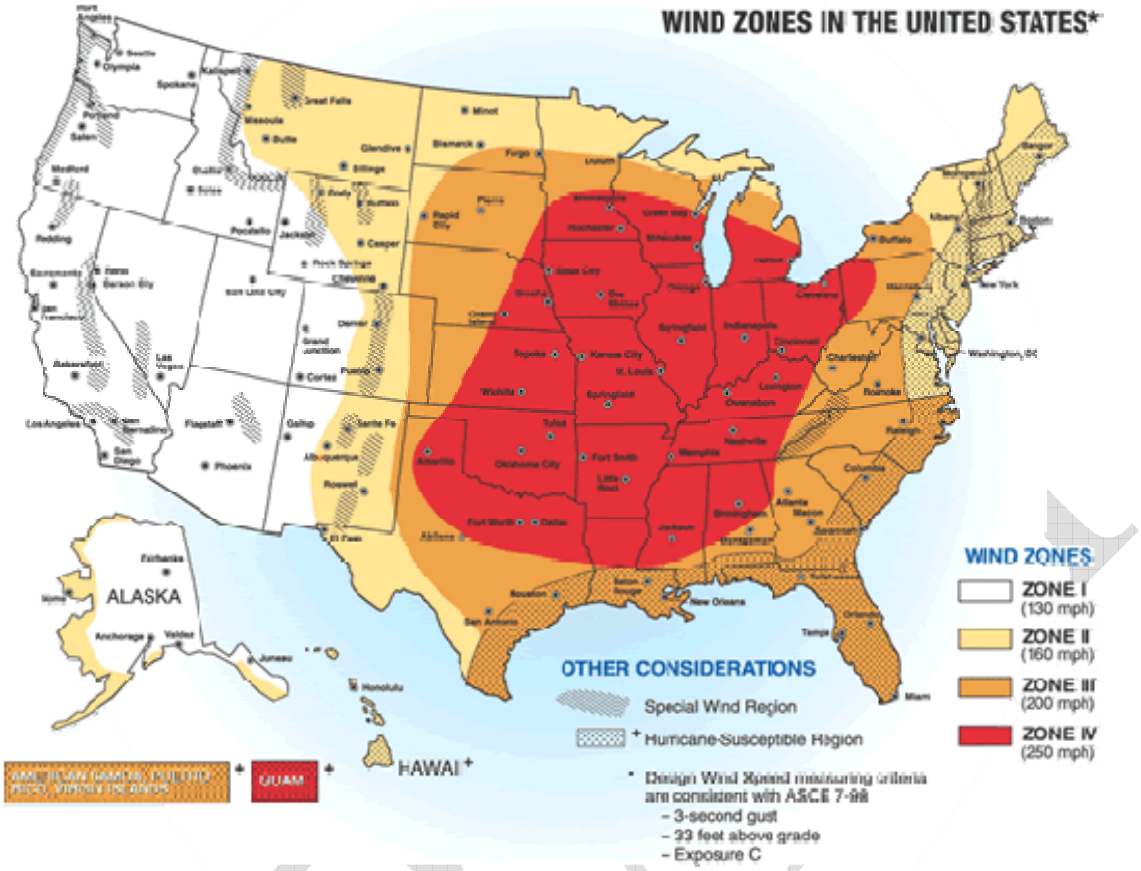
Figure 3.25. Wind Zones in the United States



Previous Occurrences

Harvey County has been included in two USDA disaster declarations that involved tornadoes. According to the NCDC database, 46 tornadoes occurred in Harvey County from 1954 to 2009, causing one fatality, 62 injuries and over $53 million in property damages. Of these, 22 were rated F0, five were rated F1, six were rated F2, three were rated F3, none were rated F4, and two were rated F5. There were 8 tornadoes in early years that were not assigned to the Fujita scale. Table 3.24 summarizes these events.

Table 3.24. Recorded Tornadoes in Harvey County, 1950-2009.

Location or County	Date	Magnitude	Deaths	Injuries	Property Damages
1 HARVEY	04/27/1955	F2	0	0	$25,000
2 HARVEY	05/27/1955	F	0	0	

3 HARVEY	05/27/1955	F	0	0	
4 HARVEY	05/27/1955	F	0	0	$25,000
5 HARVEY	07/21/1956	F2	0	0	
6 HARVEY	05/10/1959	F1	0	0	$3,000
7 HARVEY	03/31/1960	F	0	0	$25,000
8 HARVEY	05/25/1960	F1	0	0	
9 HARVEY	03/26/1961	F	0	0	
10 HARVEY	07/13/1961	F2	0	0	
11 HARVEY	05/24/1962	F3	0	0	$250,000
12 HARVEY	05/26/1963	F0	0	0	
13 HARVEY	07/12/1963	F2	0	1	
14 HARVEY	04/22/1964	F	0	0	$3,000
15 HARVEY	04/23/1964	F0	0	0	
16 HARVEY	05/23/1964	F	0	0	
17 HARVEY	05/13/1965	F3	0	0	$250,000
18 HARVEY	05/13/1965	F	0	0	
19 HARVEY	05/20/1966	F0	0	0	
20 HARVEY	05/20/1966	F0	0	0	
21 HARVEY	03/02/1970	F2	0	0	$2,500,000

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22 HARVEY	05/13/1974	F2	0	2	
23 HARVEY	11/29/1975	F0	0	0	$250,000
24 HARVEY	04/26/1984	F0	0	0	
25 HARVEY	06/03/1984	F0	0	0	$3,000
26 HARVEY	10/31/1984	F0	0	0	
27 HARVEY	05/31/1988	F0	0	0	
28 HARVEY	10/27/1989	F0	0	0	
29 HARVEY	10/27/1989	F0	0	0	
30 HARVEY	10/27/1989	F0	0	0	
31 HARVEY	03/13/1990	F5	1	59	$25,000,000
32 HARVEY	03/13/1990	F5	0	0	$25,000,000
33 HARVEY	03/13/1990	F3	0	0	$250,000
34 HARVEY	04/09/1990	F0	0	0	$25,000
35 HARVEY	05/15/1990	F0	0	0	
36 HARVEY	05/15/1990	F1	0	0	$3,000
37 HARVEY	04/26/1991	F1	0	0	
38 Halstead	05/22/1995	F0	0	0	
39 Patterson	05/25/1997	F0	0	0	
40 Burrton	05/25/1997	F1	0	0	$75,000

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41 Burrton	06/08/1998	F0	0	0	$150,000
42 Hesston	06/08/1998	F0	0	0	
43 Sedgwick	06/05/2001	F0	0	0	$50,000
44 Newton	04/11/2002	F0	0	0	
45 Newton	01/28/2006	F0	0	0	$100,000
46 Hesston	03/07/2009	F0	0	0	
TOTALS			1	62	$ 53,986,000

Source: National Climatic Data Center
Note: Zero (0) values may indicate missing data

Descriptions of recorded damages from tornado events are provided by the NCDC below:

- **January 28, 2006**: A landspout tornado touched down just northeast of Newton, blowing windows out of cars at an auto dealership, and downing light poles and large tree limbs.

- **June 8, 1998:** In Burrton, one farm sustained damage to three outbuildings while the residence sustained roof damage and had several windows blown out. A second farmstead sustained damage to it's roof, two barns and a metal shed.

- **June 5, 2001:** In Sedgwick, two large sheds were destroyed and siding stripped from one home**.**

- **March 7, 2009:** West of Hesston, a brief tornado touchdown occurred in open country. The interaction of a quasi-stationary front and a dryline lead to discrete supercells developing across portions of Central and South Central Kansas during the late afternoon and evening hours of March 7th, 2009. Brief tornado touchdowns occurred just to the south of Hutchinson with the supercells along with hail up to golf ball size.

Probability of Future Occurrences

Based on the previous recorded history of 46 tornadoes in a 59-year period, there is a 78 percent probability of a tornado in Harvey County in any given year.

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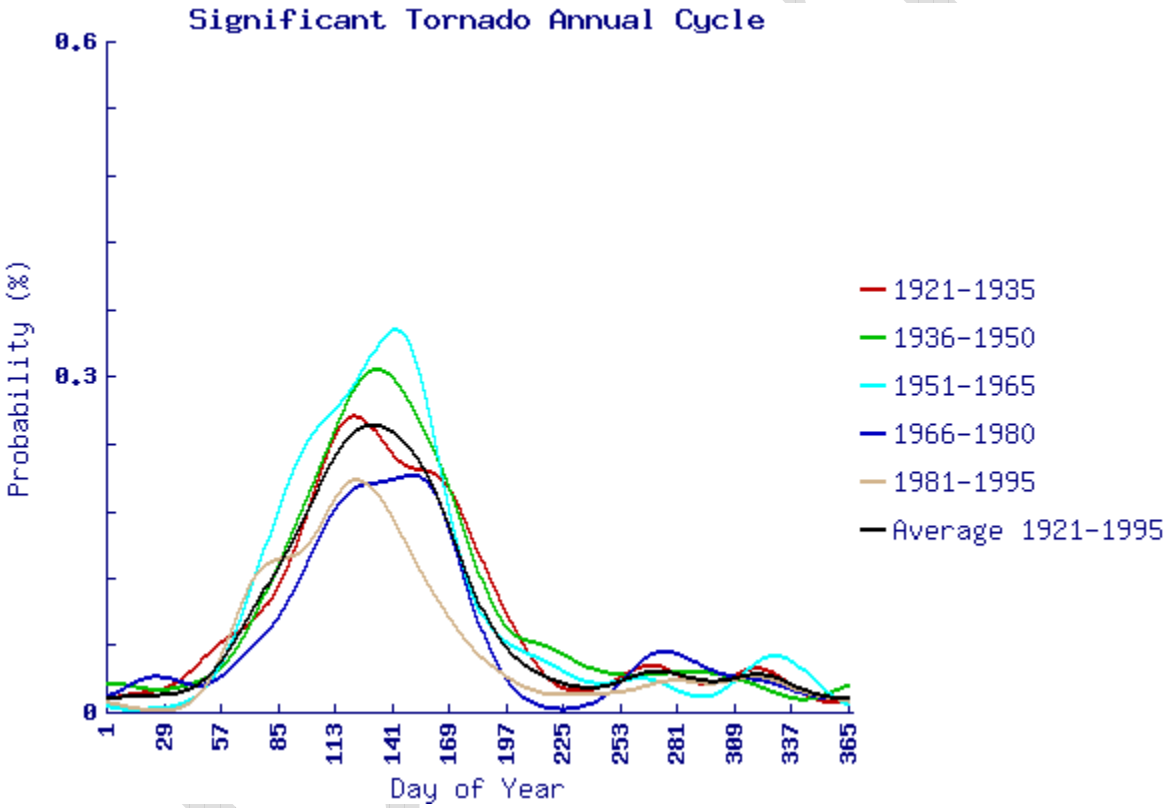
The National Severe Storms Laboratory calculated probability of violent tornadoes based on time of year for the period 1921-1995. Figure 3.26 below shows the probability of a F2 or larger tornado occurring on any given day at a location within a 25 mile radius of the center of Harvey County. For example, a y-axis value of 2.0 would indicate a two percent chance of receiving the chosen type of severe weather on the date indicated by the x-axis value. The 1951-1965 period was the peak in probability based on data from previous occurrences, with the most recent reporting period (1981-1995) showing a slightly lower probability of occurrence than the overall average. For both significant (F2 or larger) and violent (F4 and larger) tornadoes there is a pronounced peak in probability during the spring months.

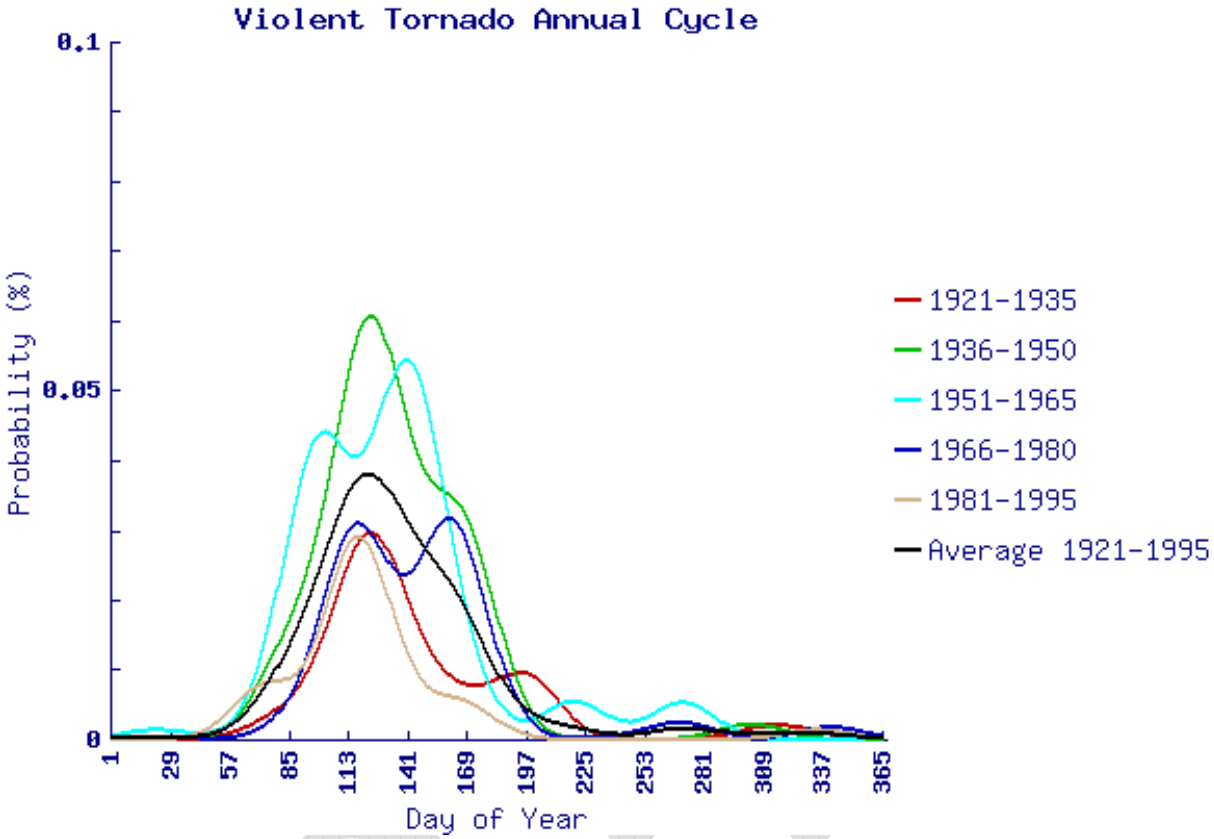
Figure 3.26. Daily Tornado Probability, F2+, Harvey County 1921-1995



Source: National Severe Storms Laboratory, http://www.nssl.noaa.gov/hazard/hazardmap.html

Based on the same methodology described for the previous graph, Figure 3.27 below shows the probability of an F4 or larger tornado occurring on a given day at a location within a 25 mile radius of the center of Harvey County.

Figure 3.27. Daily Violent Tornado Probability, F4+, Harvey County 1921-1995



Source: National Severe Storms Laboratory, http://www.nssl.noaa.gov/hazard/hazardmap.html

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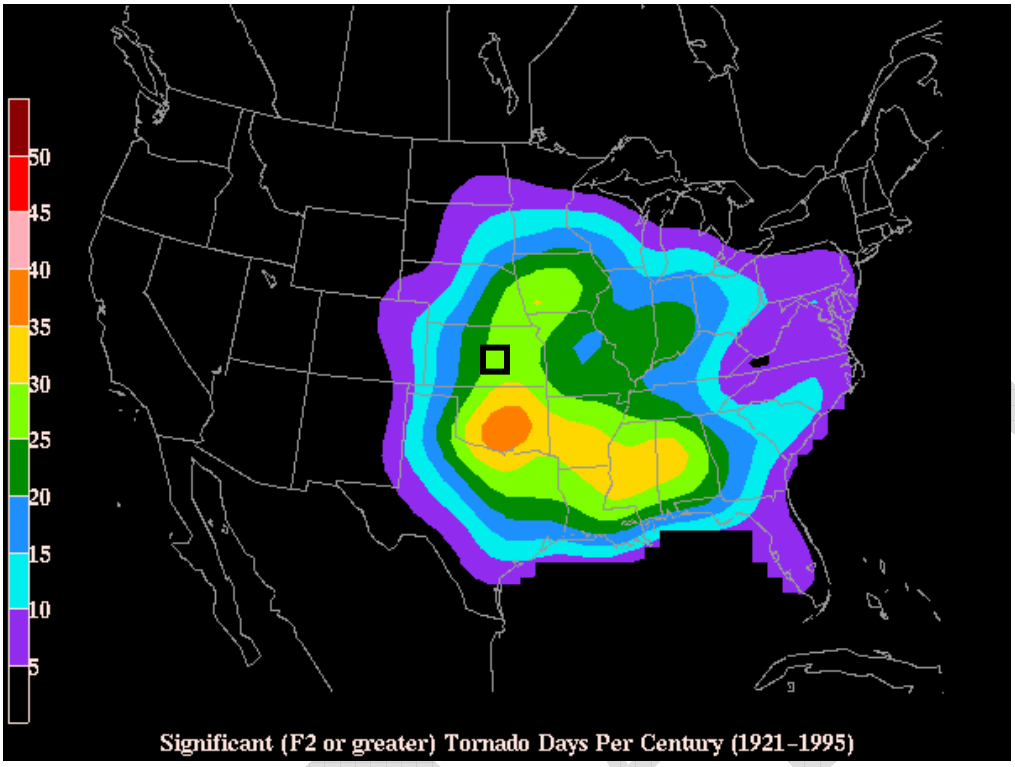
Figure 3.28 below shows the frequency of F2 or larger tornadoes based on location in the U.S.

Figure 3.28. Frequency of F2 or Larger Tornadoes, 1980-1994



Source: NSSL, http://www.nssl.noaa.gov/users/brooks/public_html/sigt2195.gif
Note: Black rectangle indicates approximate location of Harvey County

Highly Likely: Level 4—History of events is greater than 33% likely per year. Event is probable within the calendar year.

Magnitude/Severity

The Midwestern region of the U.S. that includes Harvey County can produce tornadoes capable of massive devastation. Most tornadoes in Harvey County are found in either open country or are of a lesser strength such as an F0 tornado. The HMPC rated the magnitude and severity as "limited".

Limited: Level 2—10-25 percent of property severely damaged; shutdown of facilities for at least two one week; and/or injuries and/or illnesses do not result in permanent disability.

Hazard Summary

Calculated Priority Risk Index	Planning Significance
3.10	High

3.2.15 Utility/Infrastructure Failure

Description

Critical infrastructure involves several different types of facilities and systems: transportation, power systems, natural gas and oil pipelines, water and sewer systems, storage networks, and telecommunications facilities. State and locally designated critical facilities, such as hospitals, government centers, etc., are also considered critical infrastructure. Failure of utilities or other components of the infrastructure in the planning area could seriously impact public health, the functioning of communities, and the economy. Disruption of any of these services could result as a secondary impact from drought, flood, tornado, windstorm, winter storm, lightning, and extreme heat (water systems are particularly vulnerable to drought). Solar storms can also potentially affect power and communication systems. The next 11-year cycle of solar storms will most likely begin around March 2008 and peak in late 2011 or mid-2012.

The largest electric utility providers in Harvey County include Butler Rural Electric Cooperative, Kansas Power and Light, and municipal services according to the Certified Electric Provider Map provided by the Utilities Division of the Kansas Corporation Commission. In recent years, regional electric power grid system failures in the western and northeastern United States have demonstrated that similar failures could happen in Kansas. This vulnerability is most appropriately addressed on a multi-state regional or national basis.

Warning Time: 4—less than 6 hours

Duration: 3—less than one week

Geographic Location

All jurisdictions within the planning area are vulnerable to utility/infrastructure failure. Figure 3.29 shows the location of utility infrastructure in the planning area.

Figure 3.29 Harvey County Utility Infrastructure

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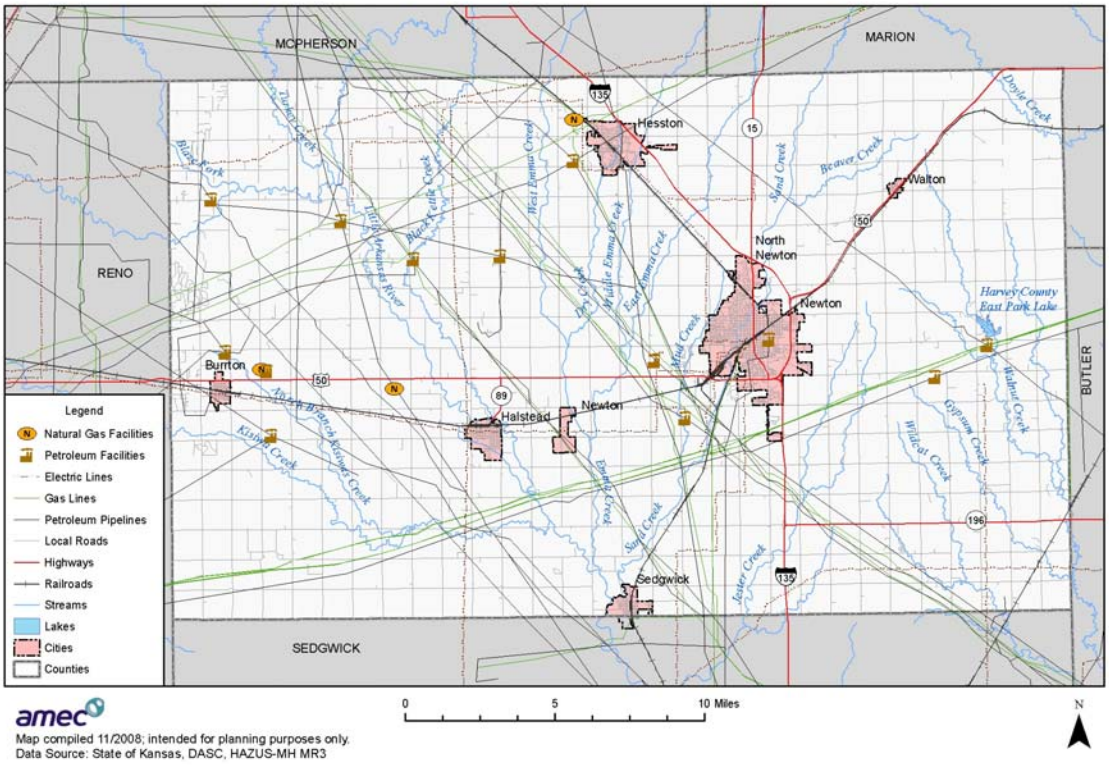
Harvey County Utiltiy Lines



Previous Occurrences

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. Butler Rural Electric Cooperative provided information regarding ice storms that caused significant electric power outages. They include:

- **December 2 – 7, 1973:** Power outages lasted up to 6 days. This storm was one of the most severe ice storms on record in Kansas. Communications towers were damaged.

- **November 23, to December 8, 1983:** This storm affected central Kansas to southeast Nebraska and into Iowa. In Kansas there were more than ½ inch of ice on power lines and outages lasted more than 1 week.

- **January 18-21, 1990:** This storm affected south central Kansas and north and also affected the Texas panhandle. Ice and snow build-up on high-voltage electric power lines in moderate to high winds causes high-amplitude low-frequency mechanical vibrations, called galloping. When power lines react aero-elastically to these conditions, undamped vibration tears apart transmission towers and fittings or propels lines into each other,

shorting out large circuits. Besides causing costly electric system outages and structural damage, this dramatic phenomenon steals power through higher electricity line losses that occur when other conductors have to carry more power to compensate for a tripped or damaged line. Galloping was experienced on the power lines which caused power outages.

- **October 28 to November 11, 1991:** This storm affected east central Kansas and power outages were caused by up to 2 inches of ice and windy conditions on the power lines.

- **March 15 -20, 1995:** This storm affected southwest Kansas east and north to north central Kansas. Windy conditions caused communications towers to blow down and up to 6 inches of ice accumulated on the power lines causing widespread power outages that listed up to 6 days in some places.

Probability of Future Occurrences

In recent years, failures of the regional electric power grid system in the western and northeastern United States have demonstrated that similar failures could happen in Kansas. This vulnerability is most appropriately addressed on a multi-state regional or national basis. While utility failures occur annually, this hazard's CPRI probability for significant events is considered "likely."

Likely: Level 3—Event is "Likely" to occur.

Magnitude/Severity

When utility/infrastructure failure does occur, utility providers generally respond quickly to restore service. Events of prolonged outage occur less frequently.

Critical: Level 3—25-50 percent of property severely damaged; shutdown of facilities for more two weeks.

Hazard Summary

Calculated Priority Risk Index	Planning Significance
3.15	High

3.2.16 Wildfire

Description

Wildfires in Kansas typically originate in pasture or prairie areas following the ignition of dry grasses (by natural or human sources). About 75 percent of Kansas wildfires start during spring due to dry weather conditions. 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 state is also concerned about the health effects of smoke emissions to surrounding areas.

Wildfires in Kansas are frequently associated with lightning and drought conditions, as dry conditions make vegetation more flammable. As new development encroaches into the wildland-urban interface (areas where development occurs within or immediately adjacent to wildlands, near fire-prone trees, brush, and/or other vegetation), more and more structures and people are at risk. 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.

Warning Time: Level 4—Less than six hours.

Duration: Level 2—Less than one day.

Geographic Location

There is an increased risk of wildfire in agricultural areas where Conservation Reserve Program (CRP) land is burned and in rural areas where individuals burn trash or debris. During high wind conditions, these small fires can get out of control and spread to dry vegetation such as native grasses, shrubs, and Eastern Cedar trees.

In April 2009, the Kansas Forest Service prepared a Community Wildfire Hazard Assessment Report. This report details the conclusions of the status of Wildland Urban Interface issues that might have an impact on the safety of persons and/or property in Harvey County Kansas. To complete the assessment, Forest Service personnel obtained baseline data on the Wildland Urban Interface boundaries from the USGS website Geo Mac (www.geomac.gov). This data was then confirmed with a “windshield” survey. The assessment, provided in its entirety in Appendix B concludes the following:

Figure 3.30 provides the locations of the areas surveyed as well as the risk level determination.

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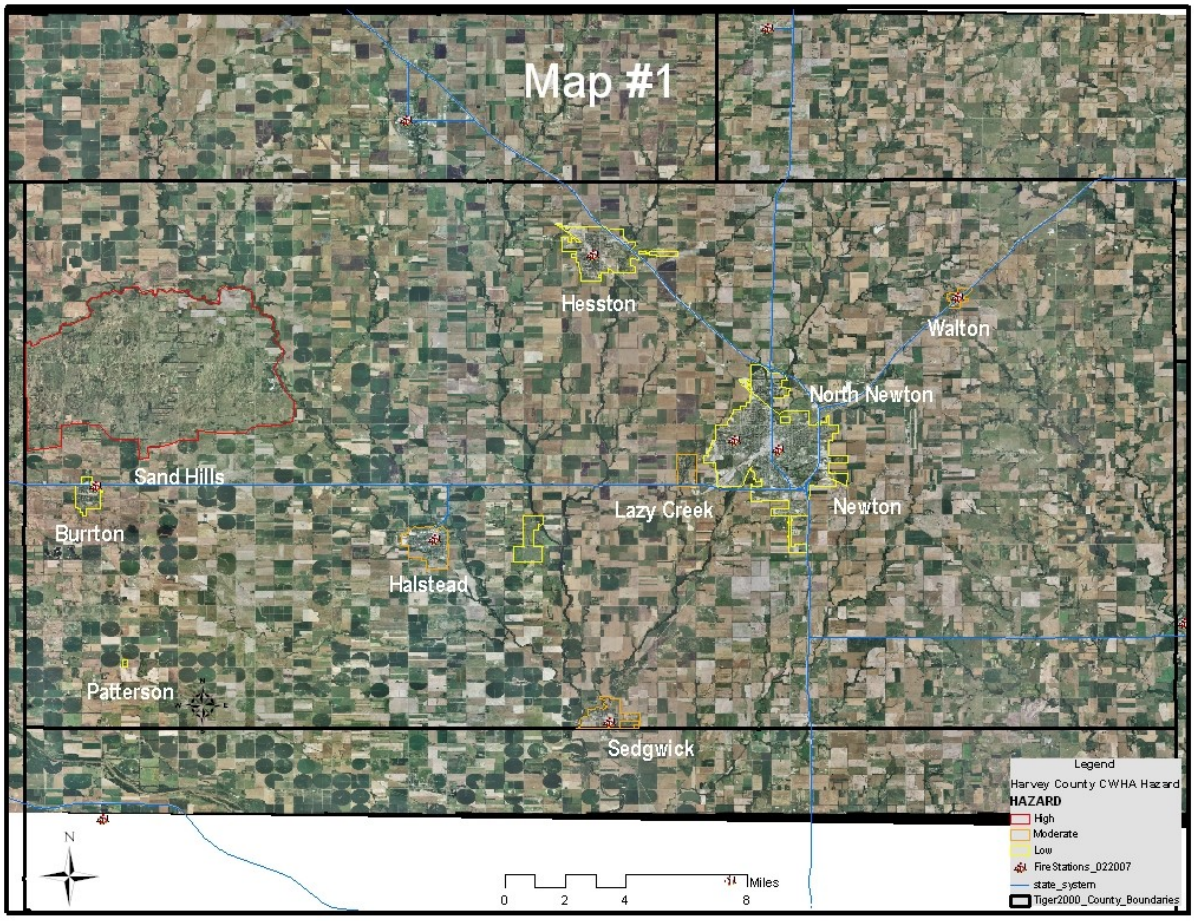
Figure 3.30 Harvey County Wildfire Assessment Findings



Previous Occurrences

According to the Kansas Fire Incident Reporting System, in 2006 Harvey County had 355 wildland fires burning a total of 11,774 acres. Total losses for the period 2003-2006 were estimated at $2.58 million in property damages. Table 3.25 outlines wildfire impacts for Harvey County for the period 2003-2006.

Table 3.25. Wildfires, Harvey County, 2003-2006

Year	# of Fires	Estimated Losses ($)	Acres Burned
2003	103	178,250	306
2004	50	118,950	547
2005	91	1,676,000	675
2006	111	615.500	10,246
Totals	**355**	**2,588,700**	**11,774**

Source: Kansas Fire Incident Reporting System

Probability of Future Occurrences

Although generally small, wildfires do occur in Harvey County on an annual basis and are expected to increase if development in wildland-urban interface areas increases. Future occurrences of this hazard are considered "highly likely" Drought conditions tend to exacerbate the problems of wildfire.

Likely: Level 4— Event is probable within the next year.

Magnitude/Severity

Although most wildfires in Harvey County do not result in significant threat to life or property, during 2005 even a small grass fire had a significant impact as several homes were damages and over a million dollars in damage was done even the total number of acres damaged that year was only slightly above average. The potential also exists to damage a significant number of acres of cropland. In 2006 for example over 10,000 acres were burned. For this reason, the HMPC rated the magnitude of this hazard as "limited" in its potential rather than negligible.

Limited: Level 2—10 to 25 percent of property severely damaged

Hazard Summary

Calculated Priority Risk Index	Planning Significance
3.20	High

3.2.17 Windstorm

Description

Relatively frequent strong winds are a weather characteristic of Kansas. Figure 3.31 shows the wind zones of the United States based on maximum wind speeds; Kansas is located within wind zones III and IV, the highest inland categories. All of Harvey County is in zone IV. 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 (i.e., is not a tornado). It is these winds, which can exceed 100 mph, which 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 tornadoes, the associated wind damage can be extensive and affect entire (and multiple) counties. 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 percent 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. It is important to note that in agricultural areas of Harvey County, pivot irrigation systems are susceptible to damage from high winds and are relatively expensive to repair or replace.

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

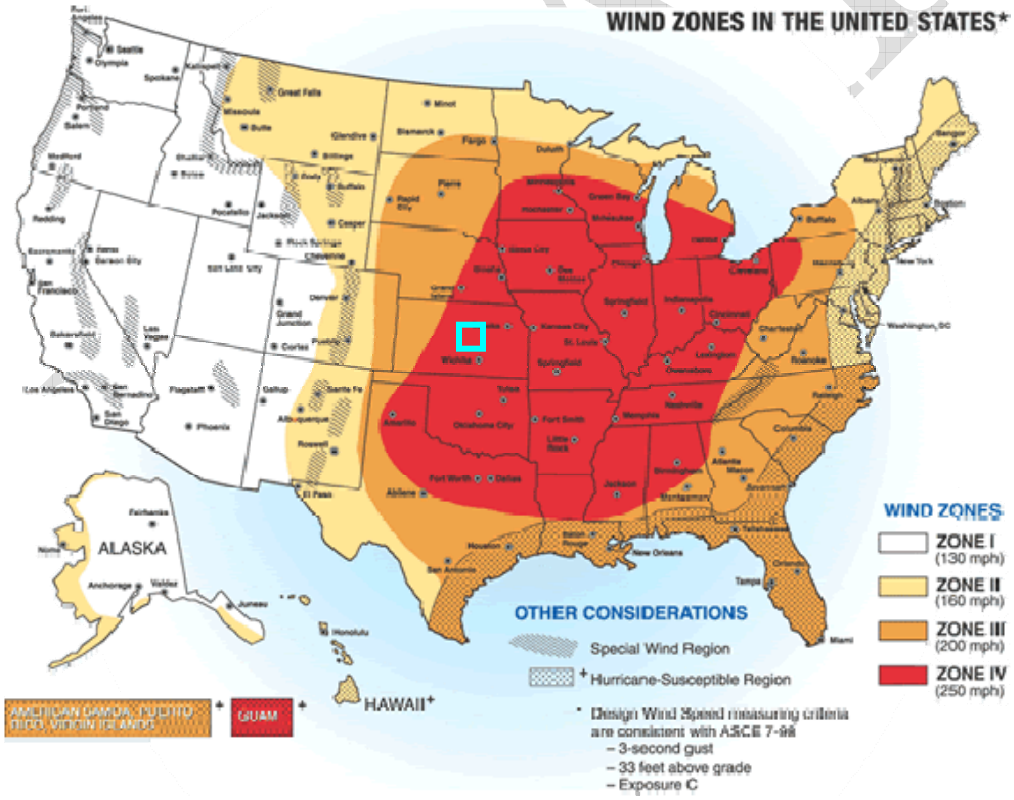
Warning Time: Level 2— 12-24 hours

Duration: Level 2—less than one day

Geographic Location

All of Harvey County is susceptible to high wind events. As shown in Figure 3.31 on the following page, Harvey County is situated near the geographic center of Wind Zone IV, which is susceptible to winds up to 250 mph.

Figure 3.31. Wind Zones in the United States



Source: FEMA; http://www.fema.gov/plan/prevent/saferoom/tsfs02_wind_zones.shtm
Note: Blue square indicates approximate location of Harvey County

Previous Occurrences

According to the NCDC database, there were 88 separate wind events in Harvey County between 1955 and 2007 during the months of March through October. During this time period there were no reported deaths or injuries as a result of windstorm events. Total property damage for events between 1993 and 2009 is estimated at over $1.5 Million.

Summaries of some of the more damaging events are provided below. Unless otherwise noted, these impacts are from the NCDC database:

- **April 7, 2008:** A bow echo moved across Harvey County producing wind damage from west of Halstead to several miles east of Newton. The Newton Airport AWOS recorded a 71 mph wind gust. A semi truck was flipped on Interstate 135 just south of Newton. A potent early Spring storm system brought severe weather to South Central Kansas the evening of April 7th into the early morning hours of April 8th. A few storms brought small hail to parts of Southeast Kansas during the day but it was a series intense bow echoes that caused extensive straight-line wind damage Sedgwick, Harvey and especially Butler and Greenwood Counties. This storm caused an estimated $25,000 in property damages.
- **October 14, 2007:** A 100 year old barn was destroyed. Major damage also occurred to the granary with minor damage to a tractor, a truck and gravity wagons stored inside the barn. A strong and dynamic storm system made slow progress across Kansas. Severe thunderstorms erupted along a cold front that made slow progress across the region. The areas hardest hit areas were Central and South Central Kansas where large hail and eventually a bowing segment of storms produced wind and hail damage. This storm caused an estimated $100,000 in property damages.
- **August 8, 2007:** Several power lines and trees were blown down at the intersection of 1st and Walnut as well as Share Drive and Meridian. A surface front stalled across parts of Southern and Central Kansas during the day of August 8th. Abundant moisture pooled along the front as a mid-level disturbance moved overhead. This triggered severe storms along the front leading to hail and damaging winds. The slow movement of storms led to some isolated very heavy rainfall amounts and localized flooding. This storm caused an estimated $30,000 in damages.
- **May 31, 2007:** In Hesston, a stoplight at the intersection of Main and Old 81 was blown down. Tree damage across town was minimal. Nearly a mile-long stretch of utility poles was downed along Emma Creek Road west of Hesston. A strong upper level disturbance approaching from the northwest spawned a powerful squall during the evening hours of May 31st. The squall line moved east to southeast across portions of central and south-central Kansas, producing large hail and high winds in its path. 90 to 100 mph winds hit the community of Moundridge in southeast McPherson County, inflicting a narrow swath of substantial damage. This storm caused an estimated $50,000 in damages.
- **June 16, 2006:** A powerful thunderstorm rolled through Harvey County producing countywide wind damage, mostly to trees. Some trees and tree limbs fell on automobiles. There were reports of mainly minor structural damage, along with street signs and power lines blown down. However, Newton's Westhill Apartment Complex received rather

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extensive roof damage. Information courtesy of the Newton Kansan newspaper. This storm caused an estimated $50,000 in property damages.

- **July 20, 2000:** Widespread tree and power line damage resulted in power losses to about 2,000 residences in and around Newton. Widespread tree damage, including many uprooted. One tree, snapping in half at the base, fell onto a garage smashing the roof to "within inches" of a car parked inside. A large tree limb fell onto the northeast corner of a second house inflicting damage to the roof as well as to a fifth wheel trailer parked along side. Two other homes also had large branches and/or uprooted trees fall onto them. One fallen tree punched a hole in the roof of a Mennonite church. The damage estimate for this storm is $100,000.
- **July 1, 1994:** In Burrton, winds estimated at 90 miles an hour caused trees to fall on a house. A picture window was shattered and two grain bins were blown away. A few miles away, winds blew away a machine shed. Lesser winds up to 60 miles an hour occurred at Hesston. The damage estimate for this storm is $50,000.

Crops are also affected by wind. According to USDA Risk Management Agency excess wind caused damage to the wheat crop in 2005.

Probability of Future Occurrences

According to NCDC, there were 88 reported wind storms (excluding events from October through March 1 and those associated with winter storms, see event description above) in Harvey County from 1956 to 2009 (53 years). Based on this information, the statistical probability that at least one significant wind event will occur in any given year is 100 percent.

The National Severe Storms Laboratory calculated probability of windstorms based on time of year for the period 1980-1999. Figure 3.32 below shows the probability of a windstorm 50 knots or greater occurring on any given day at a location within a 25 mile radius of the center of Harvey County. For example, a y-axis value of 2.0 would indicate a two percent chance of receiving the chosen type of severe weather on the date indicated by the x-axis value. The most recent reporting period had the highest probability based on data from previous occurrences, while overall probability was highest during the spring months across all reporting periods.

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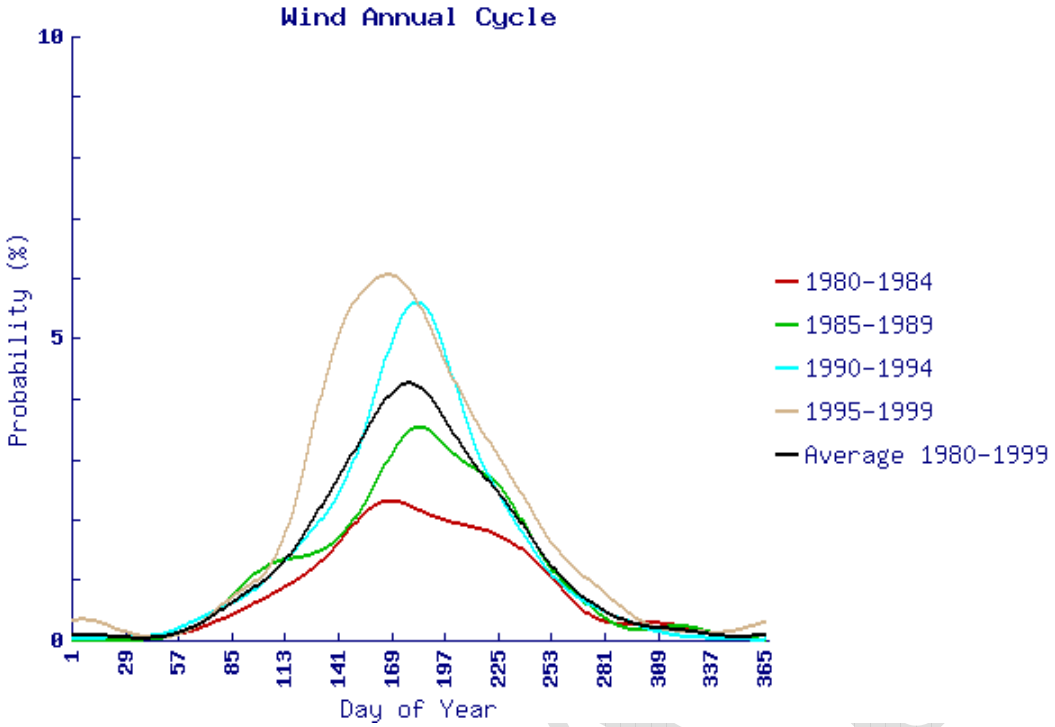
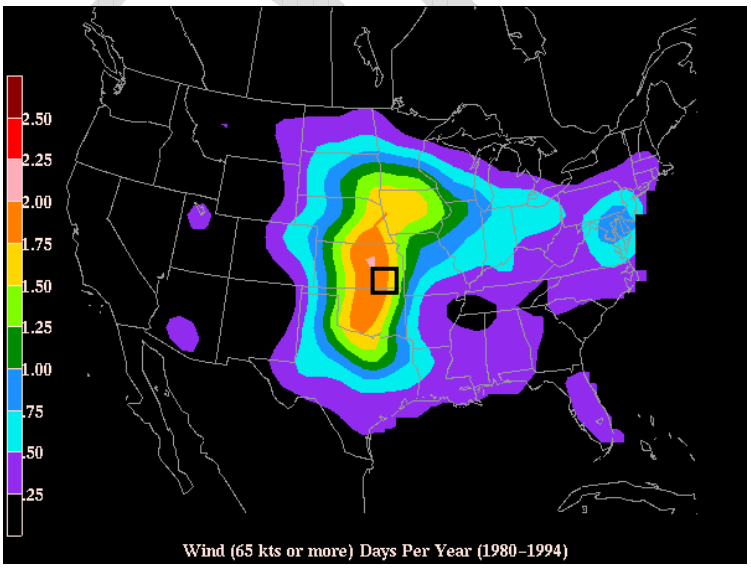
Figure 3.32. Daily Windstorm Probability, 50+ Knots, Harvey County 1980-1999



Source: National Severe Storms Laboratory, http://www.nssl.noaa.gov/hazard/hazardmap.html

Based on a similar methodology described for the previous graph, Figure 3.33 below shows the probability of a windstorm (65 knots or greater) occurring on any given day at a location within a 25 mile radius of the center of Harvey County.

Figure 3.33. Annual Windstorm Probability (65+ knots), United States 1980-1994



Source: National Severe Storms Laboratory, http://www.nssl.noaa.gov/users/brooks/public_html/bigwind.gif
Note: Black rectangle indicates approximate location of Harvey County

Based on patterns of past occurrences and Harvey County's proximity to the highest windstorm probability area in the country, probability of future occurrence is considered "likely".

Likely: Level 3— Event is "Likely" to occur.

Magnitude/Severity

Based on previous occurrences and potential impacts, overall magnitude and severity of windstorms is considered "limited". The largest potential impacts are to utility infrastructure and crops damaged due to high winds. Agricultural equipment such as pivot irrigation systems are also susceptible to wind damage.

Limited: Level 2—10-25 percent of property severely damaged; shutdown of facilities for more than one week; and/or injuries and/or illnesses do not result in permanent disability

Hazard Summary

Calculated Priority Risk Index	Planning Significance
2.45	Moderate

3.2.18 Winter Storm

Description

Winter storms in Kansas typically involve snow, extreme cold, and/or freezing rain (ice storms). These conditions pose a serious threat to public safety. Winter storms disrupt commerce, damage utilities and communications infrastructure, disrupt emergency and medical services and isolate homes and farms. Heavy snow can cause roofs to collapse and down trees onto power lines. Extreme cold conditions can stress unprotected livestock and freeze water sources. Direct and indirect economic impacts of winter storms include cost of snow removal, damage repair, increased heating bills, business and crop losses, power failures and frozen or burst water lines.

For humans, extreme cold can cause hypothermia (an extreme lowering of the body's temperature) and permanent loss of limbs due to frostbite. Infants and the elderly are particularly at risk, but anyone can be affected. According to the National Center for Health Statistics, approximately 600 adults die from hypothermia each year, with the isolated elderly being most at risk. Also at risk are those without shelter or live in a home that is poorly insulated or without heat. Other potential health and safety threats include toxic fumes from emergency heaters, household fires caused by fireplaces or emergency heaters, and driving in treacherous conditions.

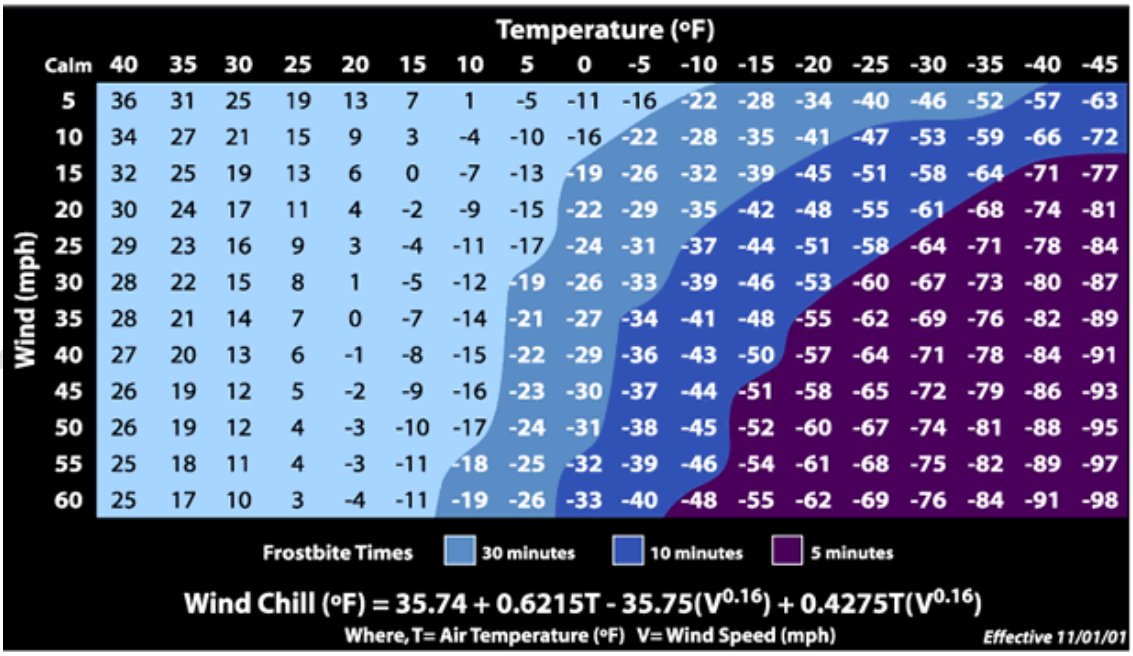
The National Weather Service describes different types of winter storm conditions as follows:

- **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**—Measurable rain that falls onto a surface whose temperature is below freezing. This causes the rain to freeze on surfaces, such as trees, cars, and roads, 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.

Wind can greatly amplify the impact of cold ambient air temperatures and thus the severity of winter storms. Provided by the National Weather Service, Figure 3.34 below shows the relationship of wind speed to apparent temperature and typical time periods for the onset of frostbite.

Figure 3.34. Wind Chill Chart



Source: NOAA, National Weather Service, http://www.weather.gov/om/windchill/

While ice storms generally are of more concern than snow storms due to the increased potential for power outage, snow storms do cause problems in Harvey County when significant snowfall drifts due to high winds.

Duration of the most severe impacts of winter storms is generally less than one week, though dangerous cold, snow, and ice conditions can remain present for longer periods in certain cases. Weather forecasts commonly predict the most severe winter storms at least 24 hours in advance, leaving adequate time to warn the public.

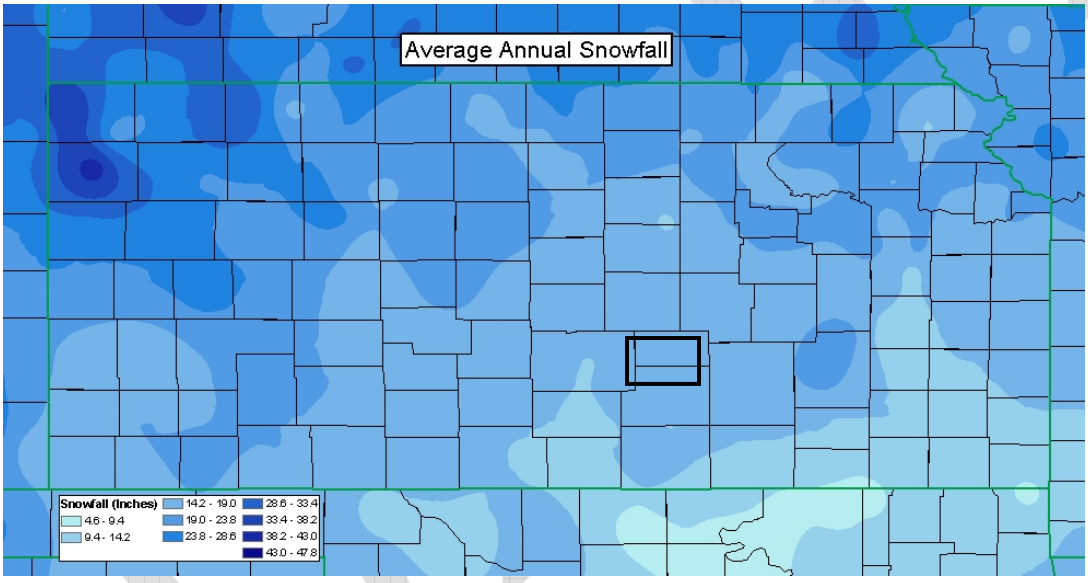
Warning Time: Level 2—12-24 hours.

Duration: Level 3—Less than one week.

Geographic Location

The entire State of Kansas is vulnerable to heavy snow and freezing rain. As indicated in Figure 3.35, northwestern Kansas receives the greatest average snowfall and the southeast, receives the least. Harvey County which is in south central Kansas receives moderate snowfall.

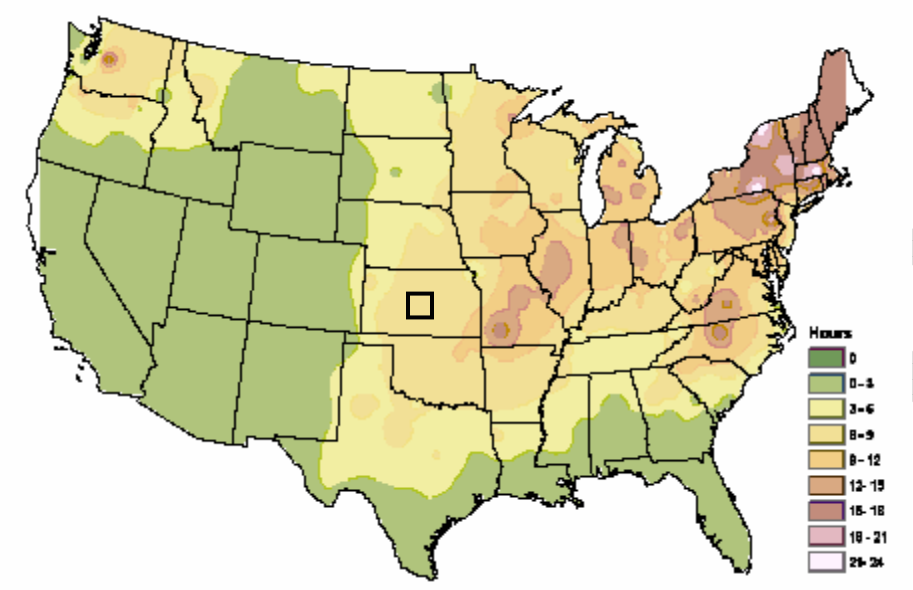
Figure 3. 35. Average Annual Snowfall in Kansas



Source: Kansas State University, Research and Extension, Weather Data Library, www.oznet.ksu.edu/wdl/Maps/Climatic/AnnualFreezeMap.asp
Note: Black square indicates approximate location of Harvey County

Figure 3.36 below shows that Harvey County is in a zone of the U.S. that receives 8-9 hours of freezing rain per year.

Figure 3.36 Average Number of Hours per Year with Freezing Rain in the United States



Source: American Meteorological Society. "Freezing Rain Events in the United States." http://ams.confex.com/ams/pdfpapers/71872.pdf.
Note: Black square indicates approximate location of Harvey County

Previous Occurrences

As shown in table 3.28, the county has two USDA declarations for this hazard.

Table 3.28 Disaster Declarations in Harvey County Involving Winter Storms

Declaration Date*	Disaster Description	Declaration Type	Disaster Number
4/4/2007	Excessive Heat, Winter Storms	USDA	S2525
1/4/2005	Winter Storms and Excessive Moisture	USDA	M1579

Sources: Federal Emergency Management Agency, www.fema.gov/; USDA Farm Service Agency, www.fsa.usda.gov, http://www.fsa.usda.gov/Internet/FSA_File/2005-2007_elig_co_031208.xls

NCDC records the following notable winter storms in Harvey County between 1994 and January 2009:

- **December 10, 2007:** A half to one inch of ice accumulated across Harvey County during the ice storm. This resulted in approximately 250 downed power poles and 500 downed lines. Damage to the electrical infrastructure is estimated at $3.7 million. There was also widespread damage to trees but the cost of the damage is unknown.A devastating freezing rain event unfolded across parts of Southern and Central Kansas from December 10th through the 11th. At the same time an Arctic air mass was moving south into the Central Plains, a mid and upper level storm system was spinning in the Four Corners

area. This storm system allowed for very warm and very moist conditions to override the Arctic air. The result was a very large swath of freezing rain that in some areas approached two inches thick. The weight of the ice encrusting everything, which adds nearly 2 tons of weight to a typical line span, resulted in thousands of downed power poles and tens of thousands of downed power lines. This naturally resulted in tens of thousands of Central and Southern Kansas residents losing power, some for more than a week. Some estimates place the number without power at one point was nearly 200 thousand across the state. An unknown number of trees were damaged or destroyed in the ice storm with some cities reporting more 80 percent of trees sustaining some form of damage. Damage to just the electric infrastructure will likely top $100 million. Damage to trees could add millions more to the final tally. The total estimated property damage, not including electric utility infrastructure is estimated at $3.7 million.

- **January 4, 2005:** On January 3rd, a strong cold front surged south across Kansas & Oklahoma before stalling along/near the Red River during the afternoon of the 4th. A shallow layer of moist, sub-freezing air spread south over all but Southeast Kansas, as an 850-mb cold front, oriented in a southwest to northeast manner from the Oklahoma Panhandle to near Kansas City, teamed with an inverted 850-mb trof positioned over Western Kansas to enable much warmer, moisture-laden air to overrun the layer of sub-freezing air beneath. The result was what many consider to be the worst ice storm since 1982 to ravage all of Central & most of South-Central Kansas from the afternoon of the 4th thru the morning of the 5th, coating almost the entire warning area with 1/2 to 1 inch of ice. Although freezing rain was the primary culprit, the winter storm was magnified considerably by periods of sleet that accumulated to depths of 1 to 2 inches. Damage to trees and power lines was major! In the latter case, the damage resulted both from heavy ice accumulations as well as from trees and limbs that fell onto the power lines in question. Trees as tall as 22 feet were split and either fell or were eventually felled, and limbs of 6-12 inches were downed at many locations. In some cases, the downed trees and limbs blocked roads and highways. No doubt, power outages were widespread, with many areas experiencing multiple outages. A few areas were without power for 1 1/2 weeks. Countless residents were forced to evacuate their homes, seeking refuge in designated shelters. On January 6th, more power outages resulted as melting ice fell from power lines, causing them sag further then whip or snap, as well as from damaged limbs that thawed and fell onto power lines. Other counties experiencing $1 million or more in damage: Harvey: $3,300,000; Harper: $1,730,420; Kingman: $1,199,000. Obviously, countless accidents occurred, and were not only traffic-related, but also occurred during the extensive cleanup of tree damage. Approximately 370 utility crews from 15 states assisted WESTAR Energy with power restoration. Working 12-16 hour days, the crews responded from as far as Illinois, Indiana, Kentucky, Minnesota, New Mexico, South Texas, Tennesee, and West Virginia. Kansas Governor Kathleen Sebulius issued a declaration of state disaster emergency to 56 counties, of which 20 are in the Wichita County Warning Area, and a federal disaster declaration was expected to be issued. In addition to law enforcement, emergency managers and trained spotters provided numerous and timely reports during this event.

- **January 29, 2002:** On the 28th, an Arctic Front surged south across Kansas, leaving a shallow layer of sub-freezing air in it's wake. Meanwhile, an 850mb low was positioned over New Mexico. As the 850mb low moved east across New Mexico on the 29th and 30th, much warmer, moisture-laden air was transported north across the southern plains in a layer approximately 3,000 feet thick, trapping the sub-freezing layer beneath. On the evening of the 30th, the 850mb low crossed the New Mexico/Texas border. A mid-upper level trough moving east across the southern Rockies provided sufficient lift across the region. Widespread freezing rain and sleet developed late in the afternoon of the 29th across south-central Kansas and continued through the night of the 30th, eventually changing to snow early on the morning of the 31st. The result was a major ice accumulation of 1-2 inches on trees and power lines across south-central Kansas that severed power to much of the area. The most prolonged power outages occurred across southeast Butler and Cowley Counties where the outages lasted for nearly a week. Trained spotters and area newspapers contributed greatly to this report.

According to the USDA's Risk Management Agency, insured crop losses in Harvey County as a result of freeze conditions from 2005 to 2007 totaled over $ 8.3 million. These losses are detailed in Table 3.30.

Table 3.30 Claims Paid in Harvey County for Crop Loss as a Result of Freeze, Frost and Cold Winter Conditions

Year	Crop	Hazard	Claims Paid ($)
2005	Wheat	Frost	3,925.00
2005	Wheat	Freeze	126,187.00
2005	Wheat	Cold Winter	133.00
2005	Wheat	Cold Wet Weather	35,847.00
2005	Corn	Freeze	1,350.00
2006	Wheat	Freeze	1,523.00
2006	Wheat	Cold Winter	167.00
2007	Wheat	Frost	461,869.00
2007	Wheat	Freeze	7,659,744
2007	Wheat	Cold Winter	41,124.00
2007	Corn	Freeze	771.00
Total			**$8,332,640.00**

Source: USDA's Risk Management Agency 2008

Probability of Future Occurrences

Based on data from the NCDC, for the 14-year period 1994-2008, there are 23 reported winter storm events in Harvey County. Based on those patterns of historic frequency, there is a statistical probability of 61 percent for severe winter storms in a given year. The probability rating for winter storms in Harvey County is "likely".

Likely: Level 3—History of events is greater than 20 percent likely per year

Magnitude/Severity

Based on assessments of probability and potential impact, overall magnitude and severity of winter storms is considered "critical".

Critical: Level 3—25 to 50 percent of property severely damaged; shutdown of facilities for at least two weeks; and/or injuries/illnesses result in permanent disability

Hazard Summary

Calculated Priority Risk Index	Planning Significance
2.85	Moderate

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3.3 Vulnerability Assessment

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

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

Requirement §201.6(c)(2)(ii)(B) :[The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.

Requirement §201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

Requirement §201.6(c)(2)(ii): (As of October 1, 2008) [The risk assessment] must also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged floods.

3.3.1 Methodology

The vulnerability assessment further defines and quantifies populations, buildings, critical facilities, and other community assets at risk to natural hazards. The vulnerability assessment for this plan followed the methodology described in the FEMA publication *Understanding Your Risks—Identifying Hazards and Estimating Losses* (2002).

The vulnerability assessment was conducted based on the best available data and the significance of the hazard. Data to support the vulnerability assessment was collected from the following sources:

- County and jurisdictional GIS data (hazards, base layers, and assessor's data)
- Statewide GIS datasets compiled by state and federal agencies
- FEMA's HAZUS-MH loss estimation software
- Written descriptions of assets and risks provided by participating jurisdictions
- Existing plans and reports
- Personal interviews with HMPC members and other stakeholders

The Vulnerability Assessment is divided into four parts:

- **Section 3.3.2, Community Assets,** first describes the assets at risk in Harvey County, including the total exposure of people and property; critical facilities and infrastructure; natural, cultural, and historic resources; and economic assets.
- **Section 3.3.3, Vulnerability by Hazard,** describes the vulnerability to each hazard identified in section 3.1 and profiled in section 3.2. This vulnerability analysis includes a

vulnerability overview for each hazard. For hazards of high and moderate significance, the vulnerability analysis includes evaluation of vulnerable buildings, infrastructure, and critical facilities; estimated losses and a discussion of the methodology used to estimate losses. The Flood Vulnerability sub-section of Section 3.3.3 also addresses the National Flood Insurance Program and repetitive loss properties.

- **Section 3.3.4, Land Use and Development Trends**, discusses development trends, including population growth, housing demand, and land use patterns and an analysis in relation to hazard-prone areas.
- **Section 3.3.5, Summary of Key Issues,** summarizes the key issues and conclusions identified in the risk assessment process.

3.3.2 Community Assets

This section assesses the population, structures, critical facilities and infrastructure, and other important assets in Harvey County that may be at risk to natural hazards.

Total Exposure of Population and Structures

Exposure is a term used to describe the inventory of all populations and structures potentially exposed to a hazard event. Table 3.31 shows the exposure of the total population, number of structures, and estimated value of structures by jurisdiction. Land values have been purposely excluded because land remains following disasters, and subsequent market devaluations are frequently short term and difficult to quantify. Additionally, state and federal disaster assistance programs generally do not address loss of land or its associated value (other than loss of crops through USDA). The greatest exposure of people and property is concentrated in the City of Newton and Unincorporated Harvey County.

Table 3.31. Maximum Population and Building Exposure by Jurisdiction

City Name	Population	Building Count	Total Exposure ($)
Burrton	932	521	78,852,000
Halstead	1,873	1,167	222,825,000
Hesston	3,509	1,506	394,836,000
Newton	17,190	8,444	1,981,602,000
North Newton	1,522	641	165,973,000
Sedgwick	1,326	692	132,640,000
Walton	284	133	27,198,000
Unincorporated Harvey County	32,869	16,949	3,626,798,000

Sources: Kansas Division of the Budget (population); HAZUS-MH (MR 3) (structures)

Critical Facilities and Infrastructure

A critical facility may be defined as one that is essential in providing utility or direction either during the response to an emergency or during the recovery operation. Table 3.32 is an inventory

of critical facilities and infrastructure in Harvey County based on State of Kansas and FEMA's HAZUS data.

Table 3.32. Inventory of Critical Facilities and Infrastructure by Jurisdiction

Facility	County	Unincorp County	Burrton	Halstead	Hesston	Newton	North Newton	Sedgwick	Walton
Airport	1	1							
Bridges	345	312		3	5	23	1	1	
Dam	44	42				2			
Elderly Facility	8			2	1	3	1	1	
EMS Station	6		1	1	1	2		1	
Fire Station	7		1	1	1	2		1	1
Health Care	7	1				6			
Hospital	1					1			
National Guard	1					1			
Natural Gas	3	3							
Petroleum Facility	14	13				1			
School	25	2	2	2	4	11	2	2	
Waste Water Facility	6	5				1			
Totals	468	379	4	9	12	53	4	6	1

Sources: State of Kansas, HAZUS-MH (MR 3)

Figures 3.38 through 3.47 on the following pages show the location of critical facilities, pipelines and infrastructure, and bridges in relation to cities and major highways in Harvey County.

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Figure 3.38 Harvey County Critical Facilities

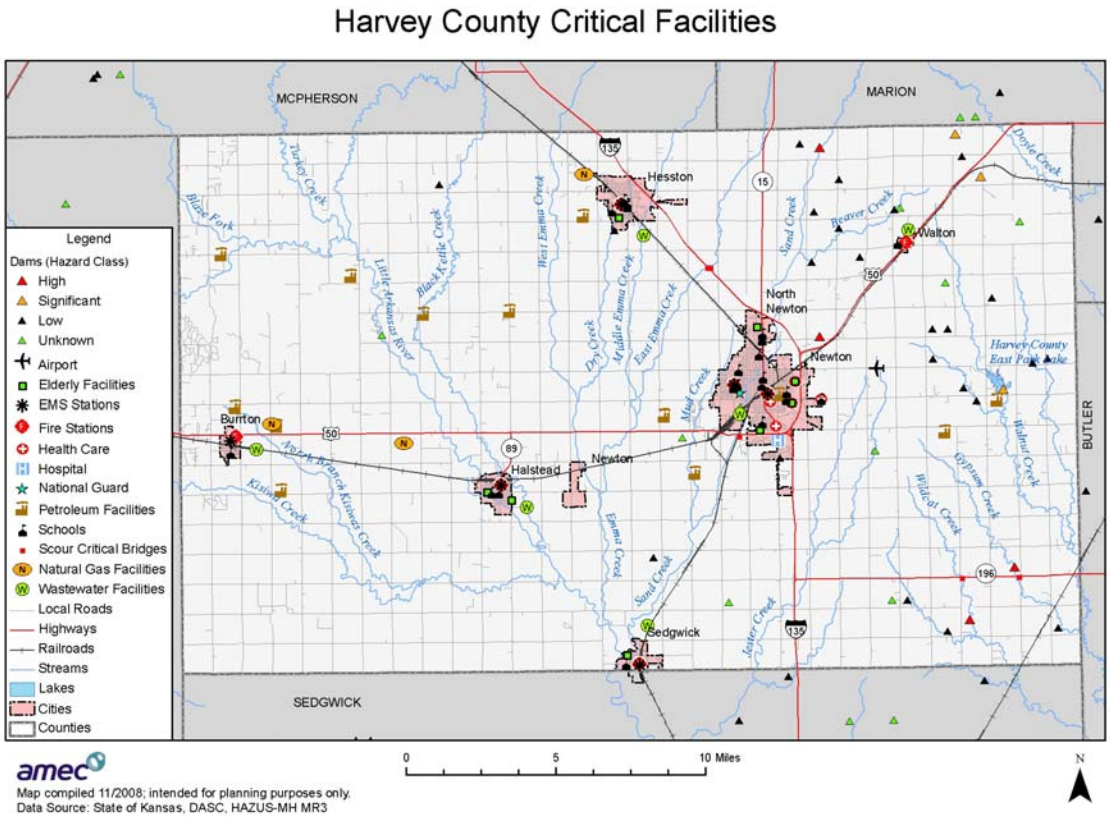

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Figure 3.39. Burrton Critical Facilities

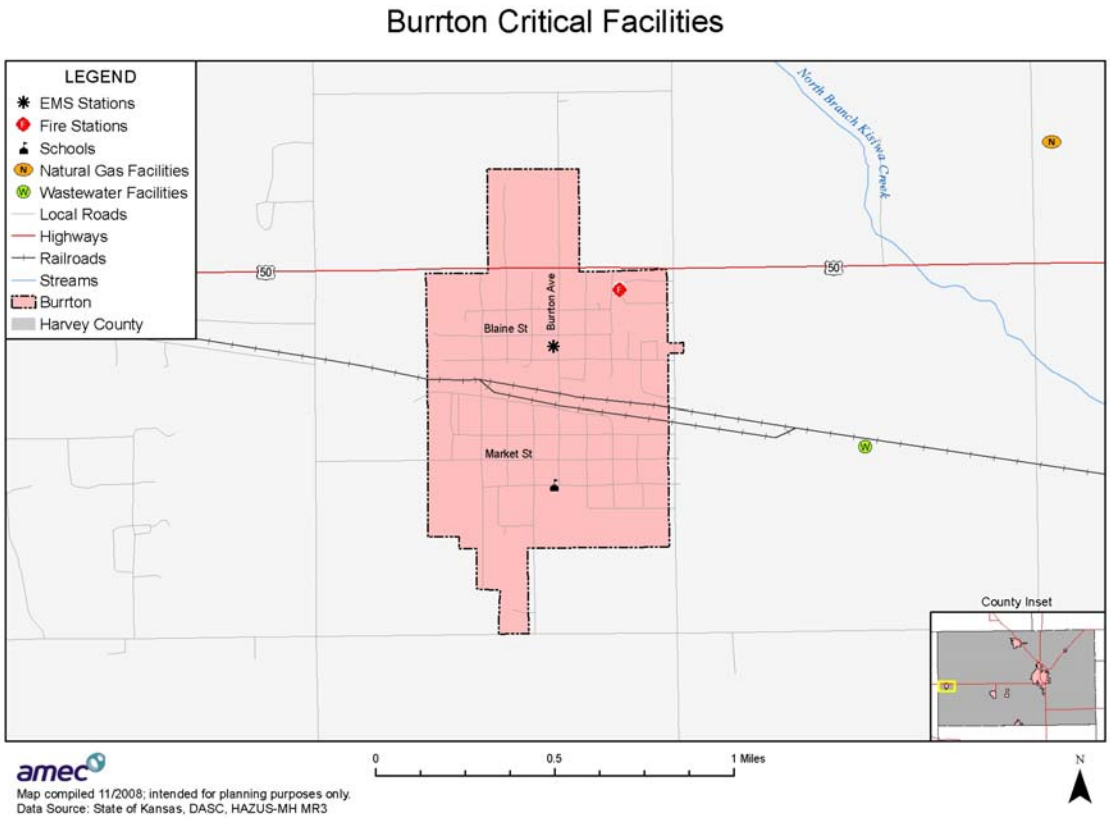

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Figure 3.40 Halstead Critical Facilities

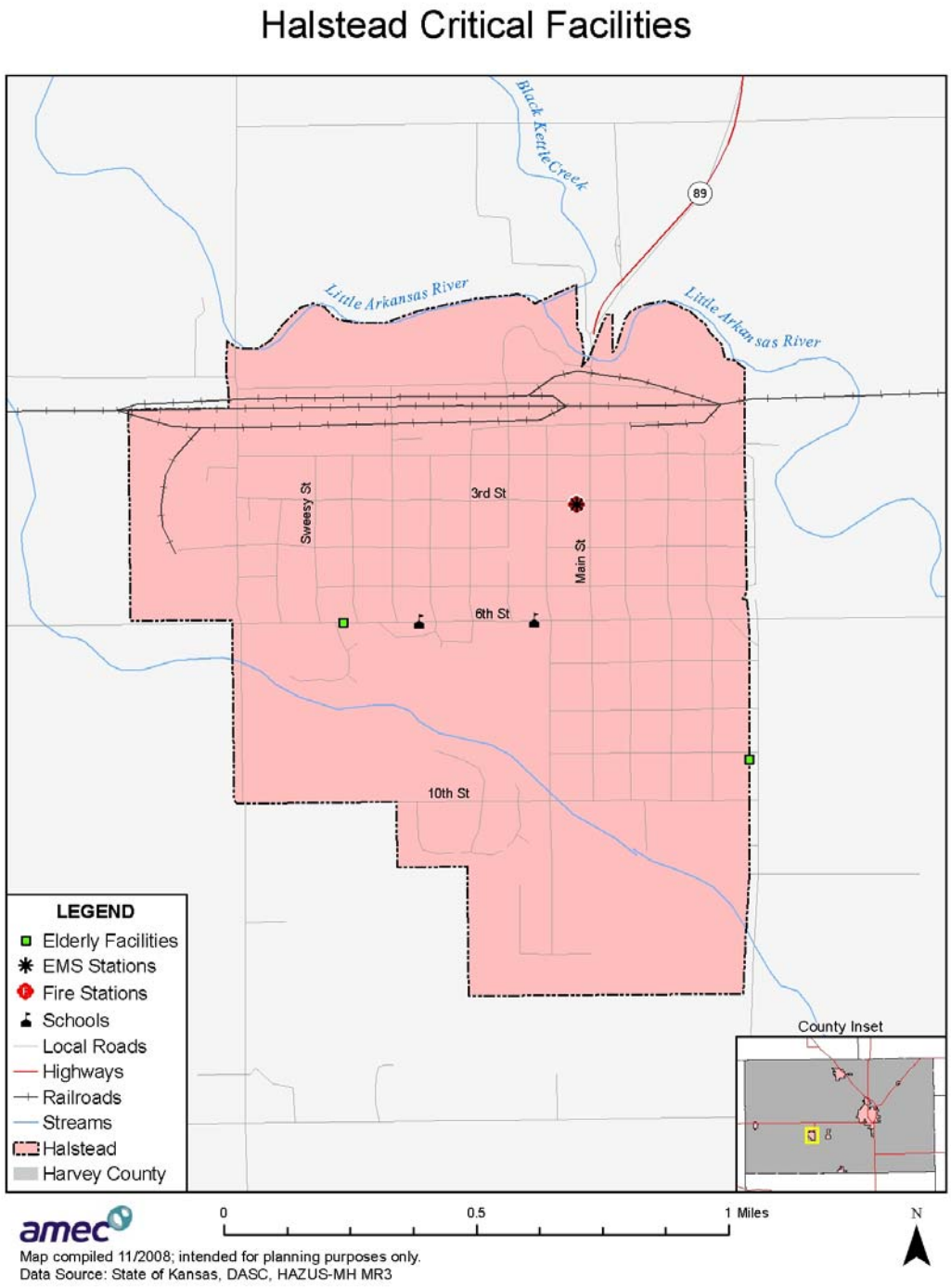

Figure 3.41. Hesston Critical Facilities

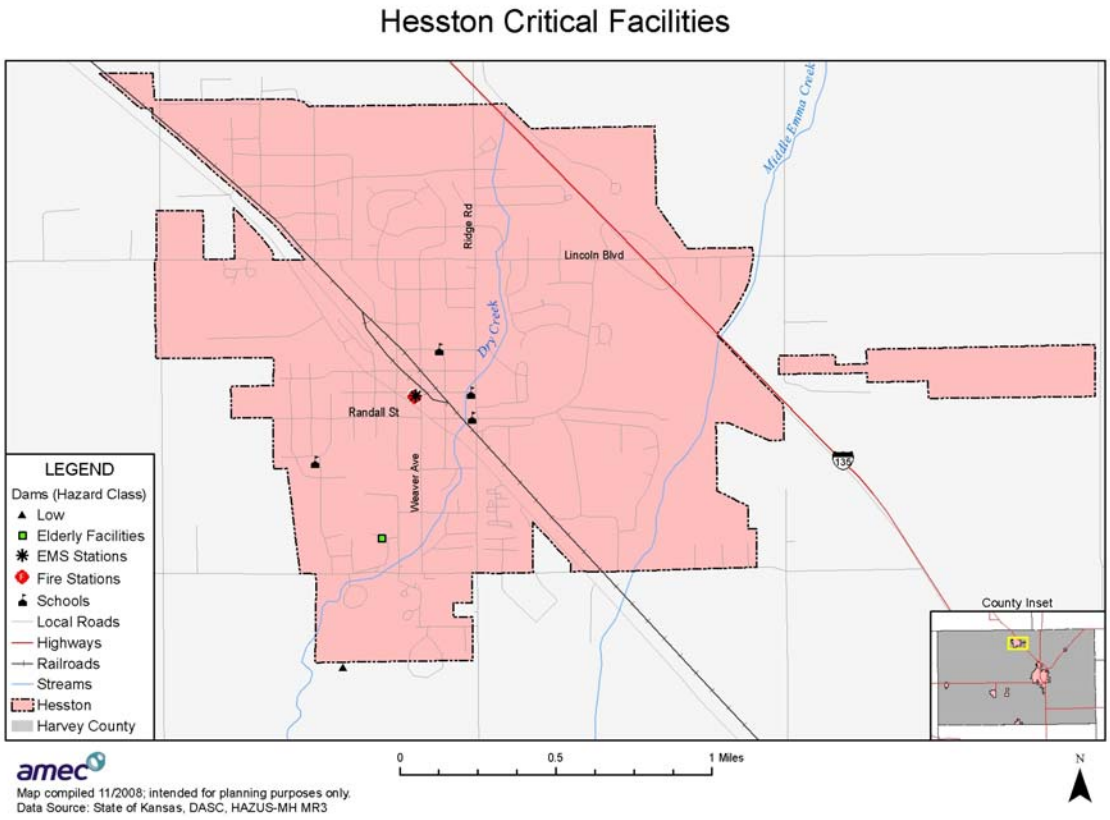

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Figure 3.42. Newton Critical Facilities

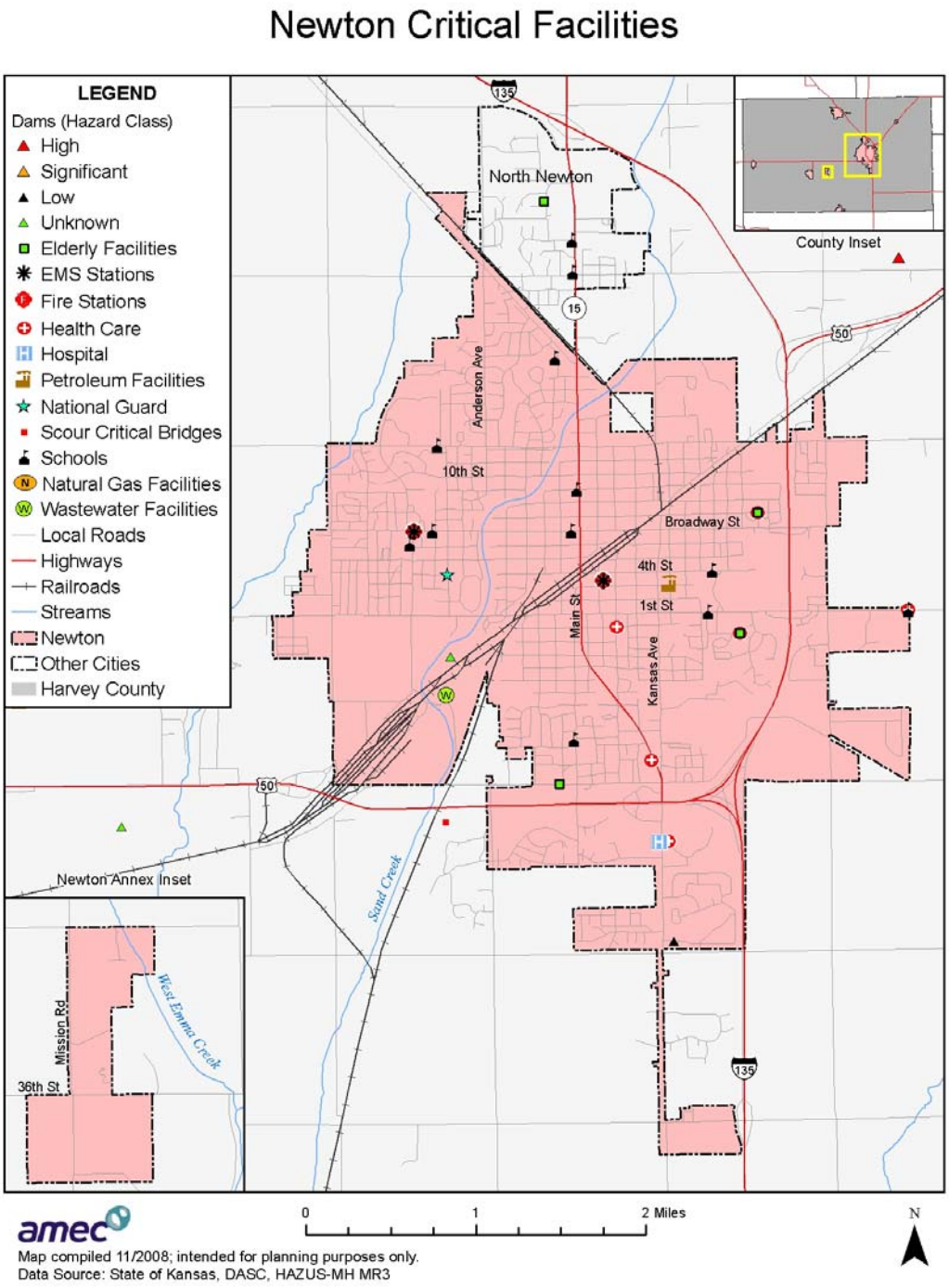

Figure 3.43. North Newton Critical Facilities

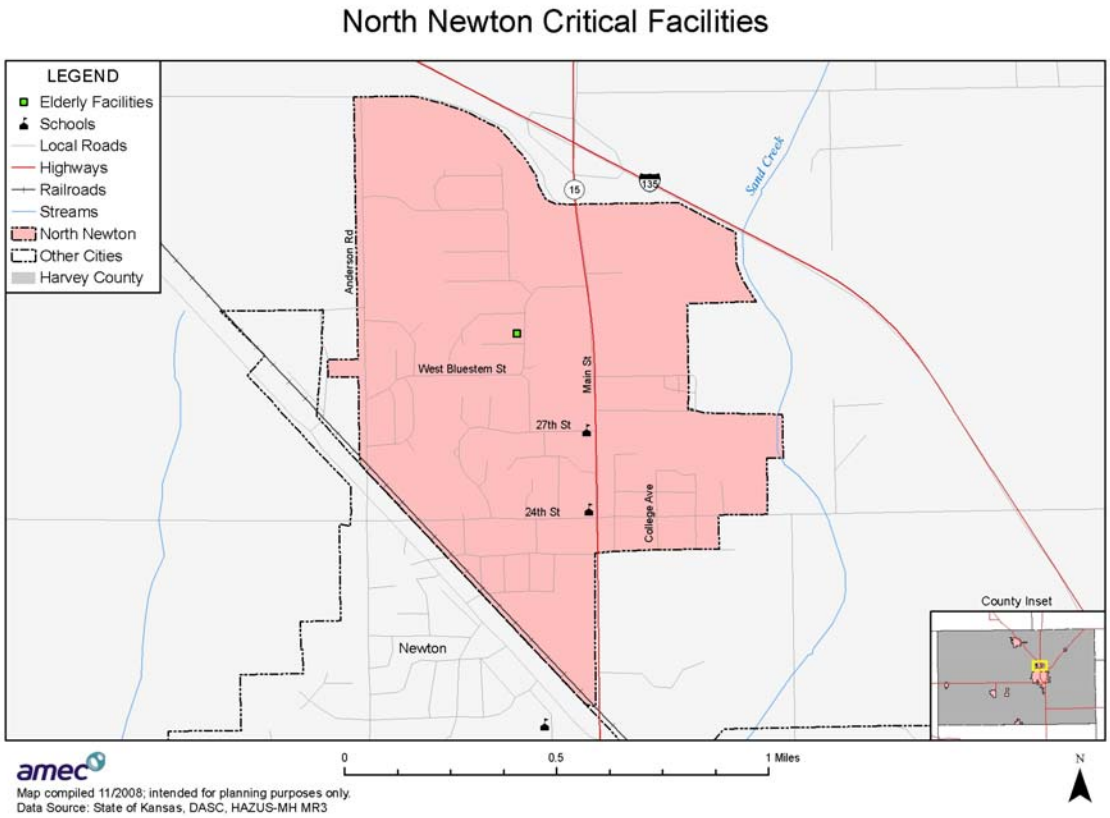

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Figure 3.44. Sedgwick Critical Facilities

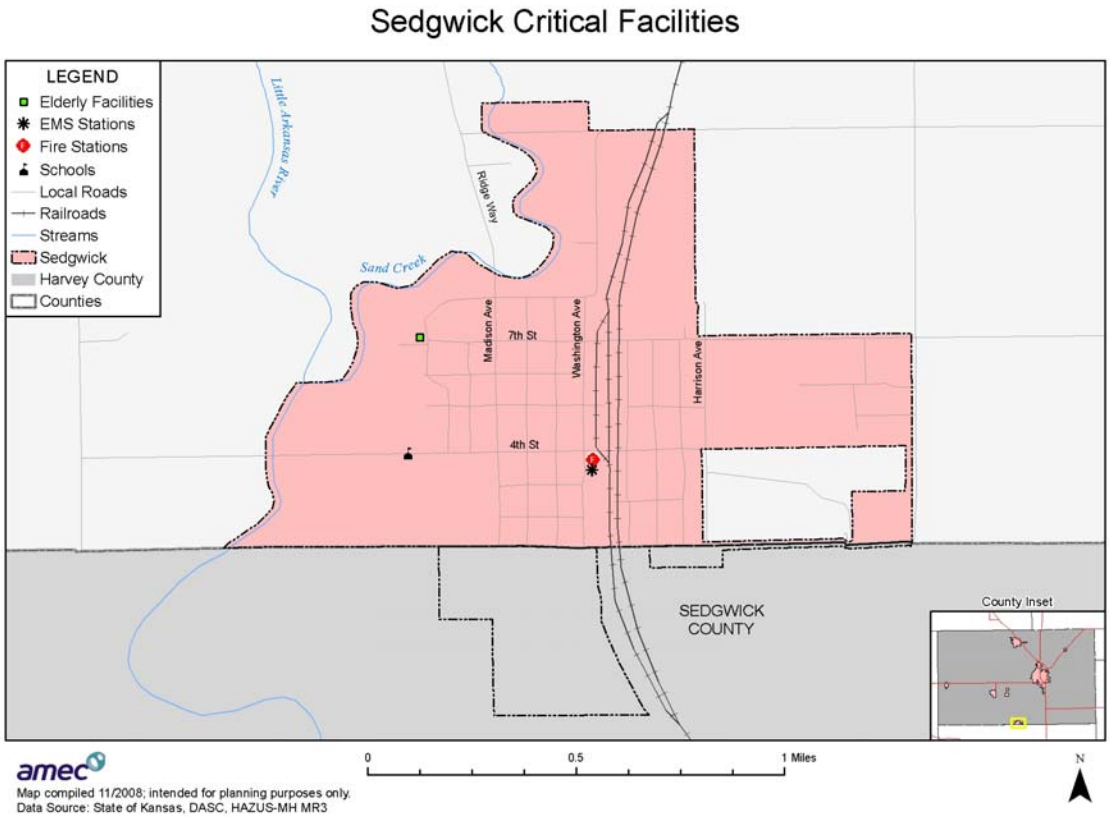

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Figure 3.45. Walton Critical Facilities

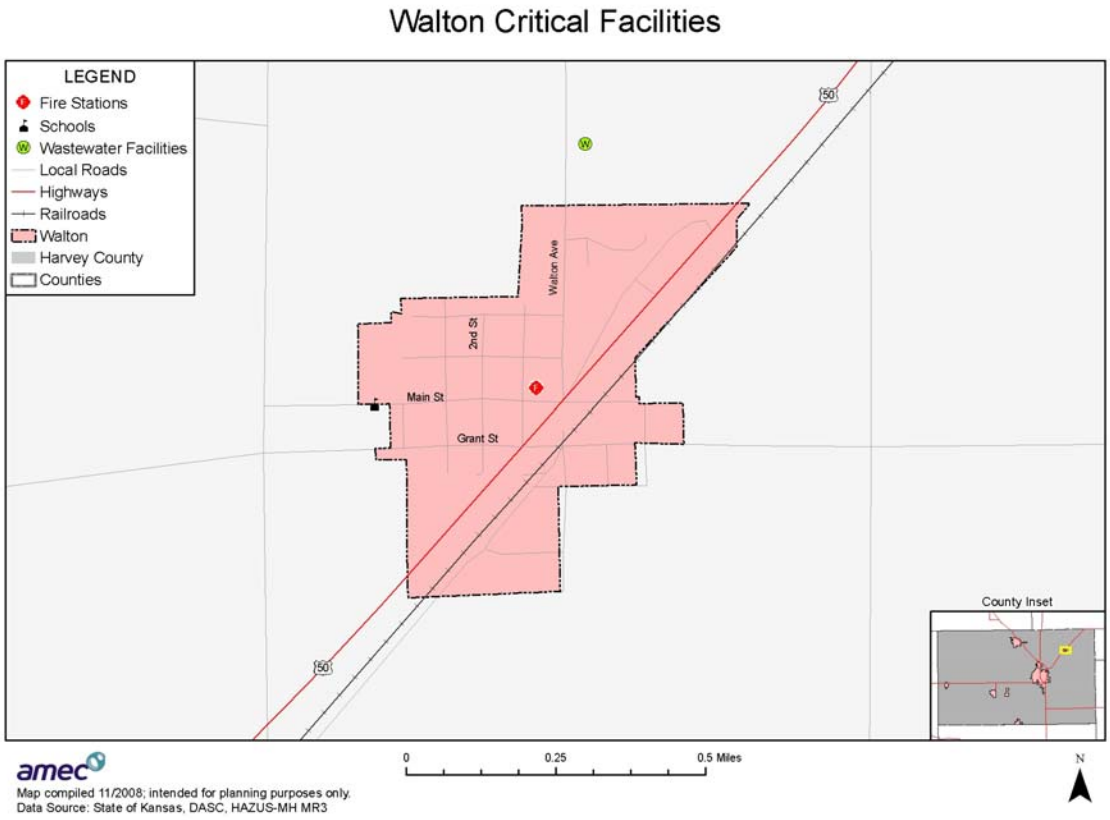

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Figure 3.46. Harvey County Pipelines and Power Infrastructure

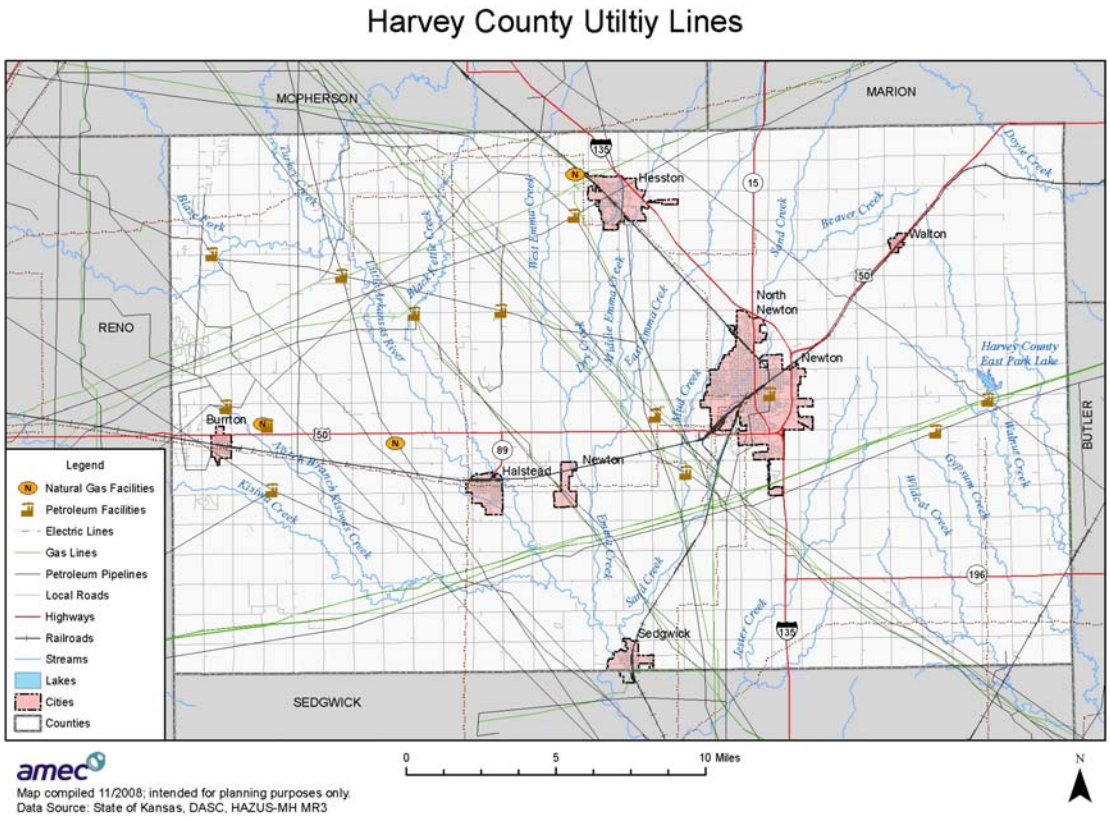

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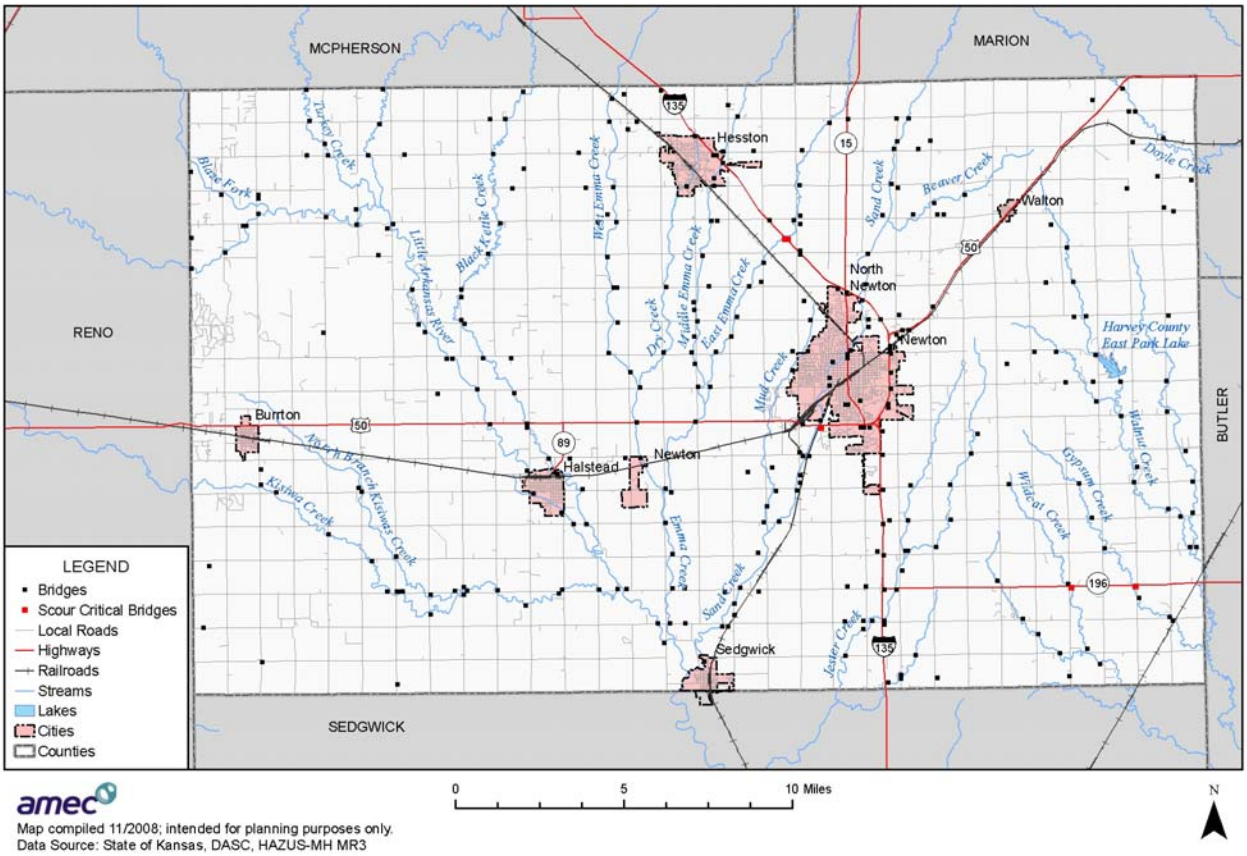
Figure 3.47. Harvey County Bridges



Other Assets

Assessing the vulnerability of Harvey County to disaster also involves inventorying the natural, historic, cultural, and economic assets of the area. This is important for the following reasons:

- The County may decide that these types of resources warrant a greater degree of protection due to their unique and irreplaceable nature and contribution to the overall economy.
- If these resources are impacted by a disaster, knowing about them ahead of time allows for more prudent care in the immediate aftermath, when the potential for additional impacts is higher.
- The rules for reconstruction, restoration, rehabilitation, and/or replacement are often different for these types of designated resources.
- Natural resources can have beneficial functions that reduce the impacts of natural hazards, such as wetlands and riparian habitat, which help absorb and attenuate floodwaters.
- Losses to economic assets (e.g., major employers or primary economic sectors) could have severe impacts on a community and its ability to recover from disaster.

In Harvey County, specific assets include the following:

- There is one endangered species in the County, the Whopping Crane (Grus americana). (United States Department of the Interior, Fish and Wildlife Service, Ecological Services, Kansas Field Office, May 2008)
- Historic resources: There are 28 Harvey County properties on the National Register of Historic Places. These properties are identified in Table 3.33.

Table 3.33. Harvey County Properties on the National Register of Historic Places

Property Name	Address	Location	Date Listed
Bergholdt House	205 East 5th	Halstead	10/10/1996
Bethel College Administration	300 E 27th Street	North Newton	3/16/1972
Brown, Samuel A House	302 West Sixth	Newton	10/17/1988
Carnegie Library	203 Main Street	Newton	5/31/1974
Coleman House	409 Mead Street	Newton	3/2/2001
Goerz (David) House	2512 North College Avenue	North Newton	10/31/2002
Halstead Santa Fe Depot	116 East First Street	Halstead	10/11/2001
Halstead US Post Office	319 Main Street	Halstead	10/17/1989
Hoag (E.H.) House	303 Broadway	Newton	4/12/2001
Lincoln School	406 West Sixth Street	Newton	1/13/2004
McKinley Residential Historic District	E. 5th Street, SE 3rd Street, Allison Street, Walnut Street	Newton	7/9/2008
Mennonite Settler Statue	Athletic Park Drive	Newton	2/26/1998
Neal (Jarius) House	301 East 4th Street	Newton	5/6/1982
Newton Main Street Historic Dist I	200 through 214 and 203 through 301 N. Main Street	Newton	11/15/2003
Newton Main Street Historic Dist II	411-825 N. Main Street and 414-726 N. Main Street	Newton	11/15/2003
Newton Stadium	Athletic Park	Newton	1/23/2004
Santa Fe Depot	414 North Main	Newton	4/11/1985
Warkentin Home	211 East First Street	Newton	1/12/1970
Warkentin Homestead		Halstead	2/15/1974
Warkentin Mill	3rd and Main	Newton	1/12/1970

Source: Kansas State Historical Society, www.kshs.org/resource/national_register/index.php

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