### 3.7.8 FLOOD

| | Probability | Magnitude/Severity | Warning Time | Duration | CPRI |
|---|---|---|---|---|---|
| Flood | 3.25 | 2.88 | 2.50 | 3.13 | 3.01 |

**Description**

Flooding is the most frequent and costly natural hazard in the United States. During the twentieth century, floods were the leading natural disaster in the United States, representing 40 percent of all natural disasters in terms of number of lives lost, estimated at more than 10,000 deaths since 1990, and property damaged. Nearly 90% of presidential disaster declarations result from natural events where flooding was a major component. The USGS reports that nationwide, floods kill an average of 140 people each year and cause $6,000,000,000 in property damage.

Floods that threaten south Kansas are generally the result of excessive precipitation, and can be classified under three categories:

- **Flash Flood:** The product of heavy, localized precipitation in a short time period over a given location
- **Riverine Flood:** Occurs when precipitation over a given river basin for a long period of time causes the overflow of rivers, streams, lakes and drains
- **Urban Flood:** Occurs where man-made development has obstructed the natural flow of water and decreased the ability of natural groundcover to absorb and retain surface water runoff

The severity of a flooding event is generally determined by the following factors:

- The combination of stream and river basin topography and physiography
- Precipitation and weather patterns
- Soil moisture conditions
- Degree of vegetative clearing or impermeable ground cover

***Riverine Floods***

The NWS provides the following definitions of warnings for actual and potential flood conditions for Riverine and Urban Flooding:

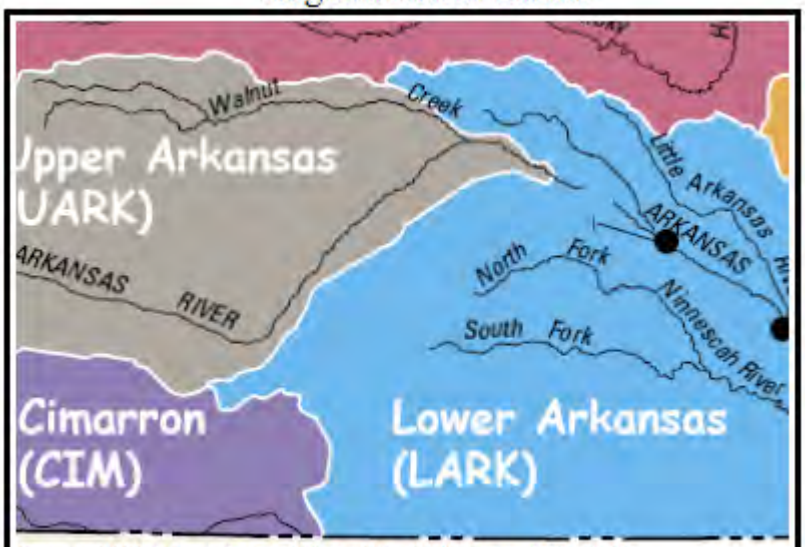
- **Flood Potential Outlook:** In hydrologic terms, a NWS outlook that is issued to alert the public of potentially heavy rainfall that could send rivers and streams into flood or aggravate an existing flood.
- **Flood Watch:** Issued to inform the public and cooperating agencies that current and developing 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.

Riverine flooding is defined as the overflow of rivers, streams, drains, and lakes due to excessive rainfall, rapid snowmelt or ice melt. The areas adjacent to rivers and stream banks that carry excess floodwater during rapid runoff are called floodplains. A floodplain is defined as the lowland and relatively flat area adjoining a river or stream. The terms "base flood" and "100-year flood" refer to the area in the floodplain that is subject to a one percent or greater chance of flooding in any given year. Floodplains are a larger entity called a basin, which is defined as all the land drained by a river and its branches.

A river basin is the land drained by a river and its branches. The surface waters of south Kansas flow through three river basins of the State as shown in the following figure.

Regional River Basins




Source: USGS Fact Sheet, Water Use in Kansas, 1990-2000

***Flash Floods***

The NWS provides the following definitions of warnings for actual and potential flood conditions for 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.

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.

A flash flood is an event that occurs with little or no warning where water levels rise at an extremely fast rate. Most flash flooding is caused by slow-moving thunderstorms or thunderstorms repeatedly moving over the same area. Flash flooding results from intense rainfall over a brief period, sometimes combined with rapid snowmelt, ice jam release, frozen ground, saturated soil or impermeable surfaces. Flash flooding may also occur from the breaching or failure of a dam or levee.

Flash flooding is an extremely dangerous event which can reach full peak in only a few minutes and allows little or no time for protective measures to be taken by those in its path. Flash flood waters move at very high speeds with walls of water that can reach heights of 10 feet. Flash flood waters and the accompanying debris can uproot trees, roll boulders, and damage or destroy buildings, bridges, and roads. Flash flooding often results in higher loss of life, both human and animal, than slower developing river and stream flooding.

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

***Other Floods***

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

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

Generally, floods are long-term events that may last for several days.

| | Warning Time |
|---|---|
| Flood | 2.50 |

| | Duration |
|---|---|
| Flood | 3.13 |

**Hazard Location**

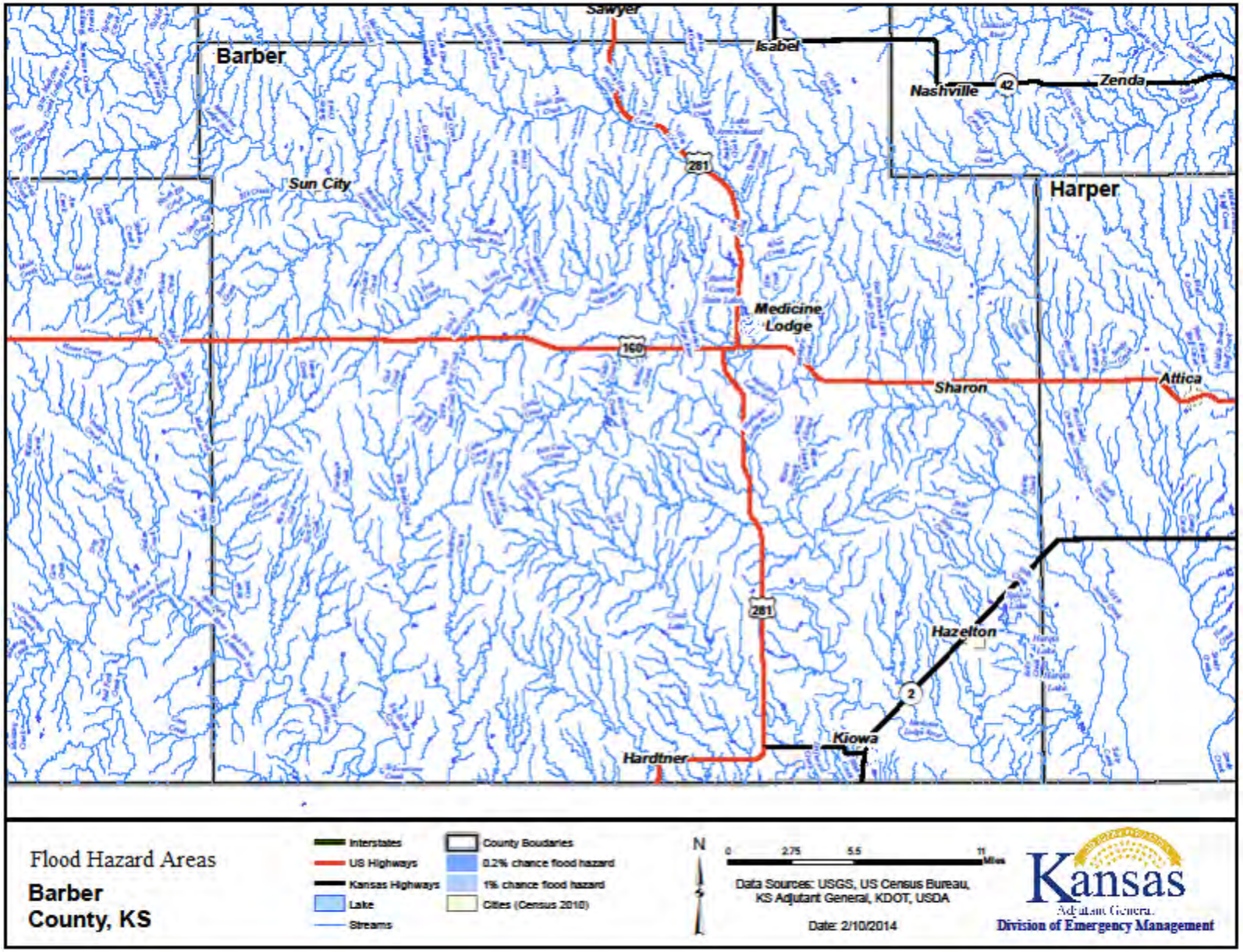
HAZUS-MH 2.1 was utilized to update the region's risk assessment for riverine flooding. Not all of the region's counties have available DFIRMS. As such, the Hazard Mitigation Planning Team decided to utilize the latest version of HAZUS, released in February 2012, as a GIS-based tool to update the Riverine Flooding Risk Assessment. HAZUS-MH 2.1 produces a flood polygon and flood depth grid that represents the base flood. While not as accurate as utilizing DFIRMs themselves, this approach ensures an "apples to apples" analysis to describe vulnerability in terms of the jurisdictions most threatened by riverine flooding, and most vulnerable to damage and loss associated with flooding events.

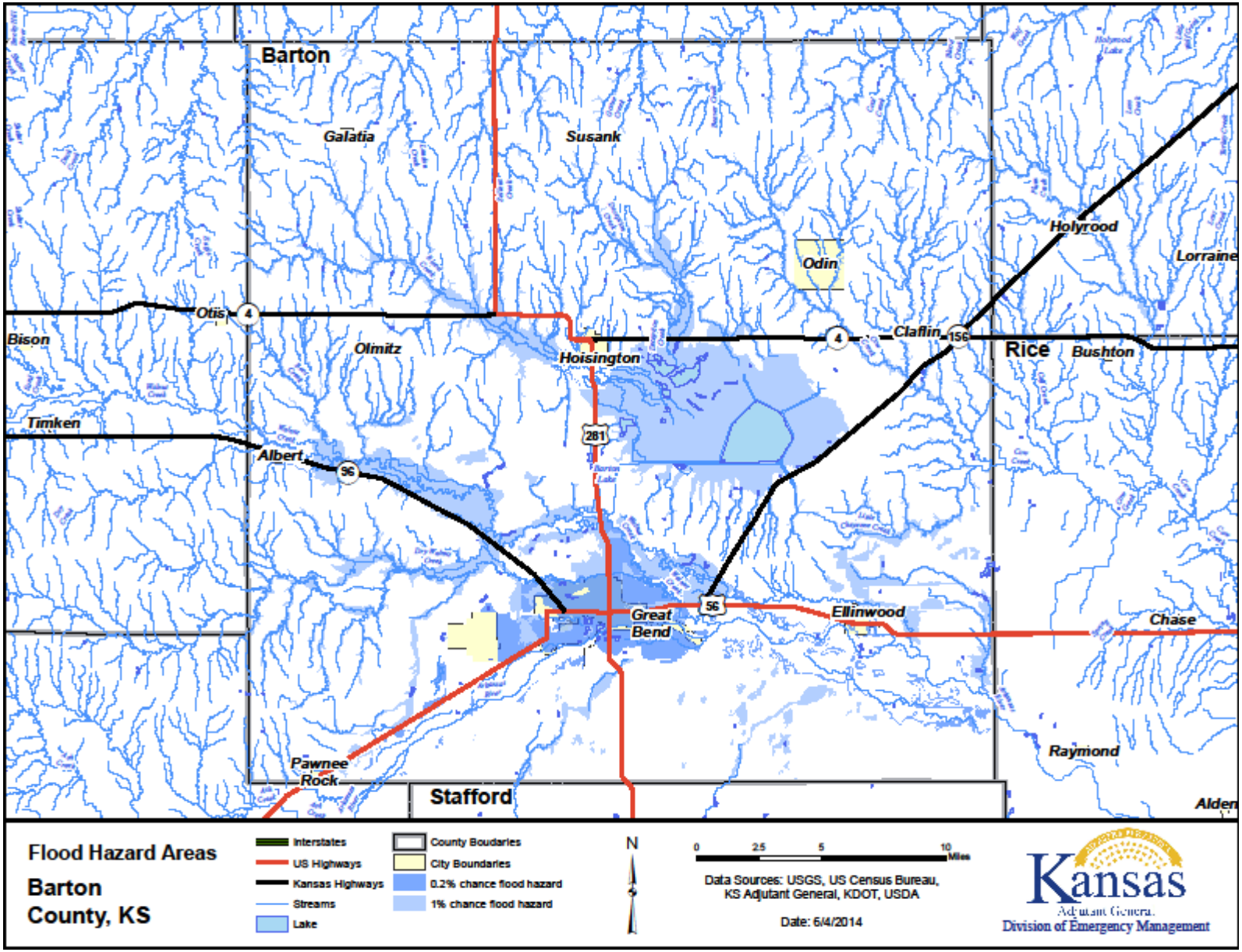
While riverine floods can and do occur at various levels, the one percent annual chance flood has been chosen as the basis for this risk assessment. This level is the accepted standard for flood insurance purposes.

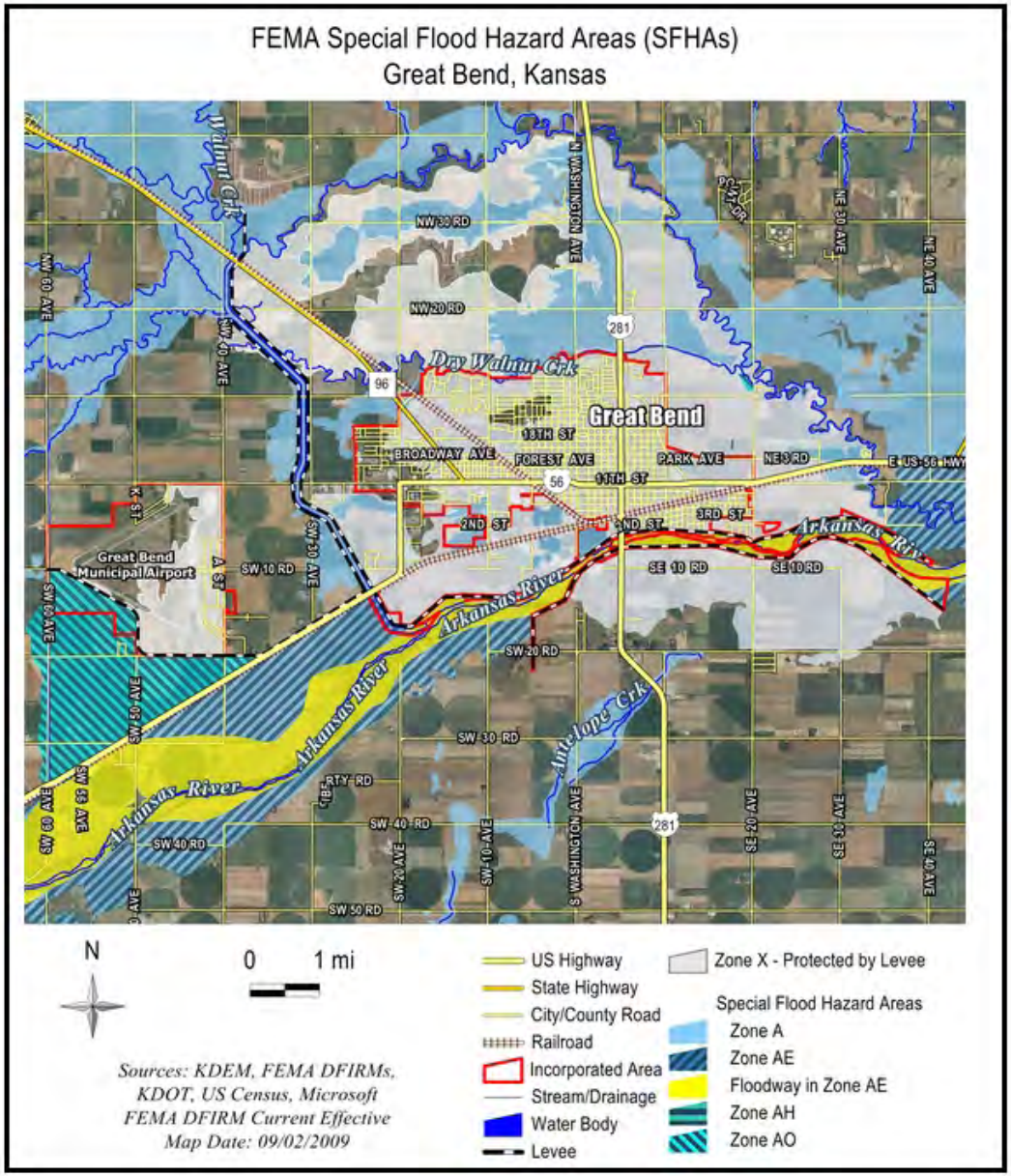
Results from the HAZUS-MH 2.1 analysis will be provided throughout this section to depict floodplain areas as well as varied vulnerability and potential loss estimates. The following map provides a regional overview of the one percent annual chance floodplains in south Kansas, generated by HAZUS MH 2.1.

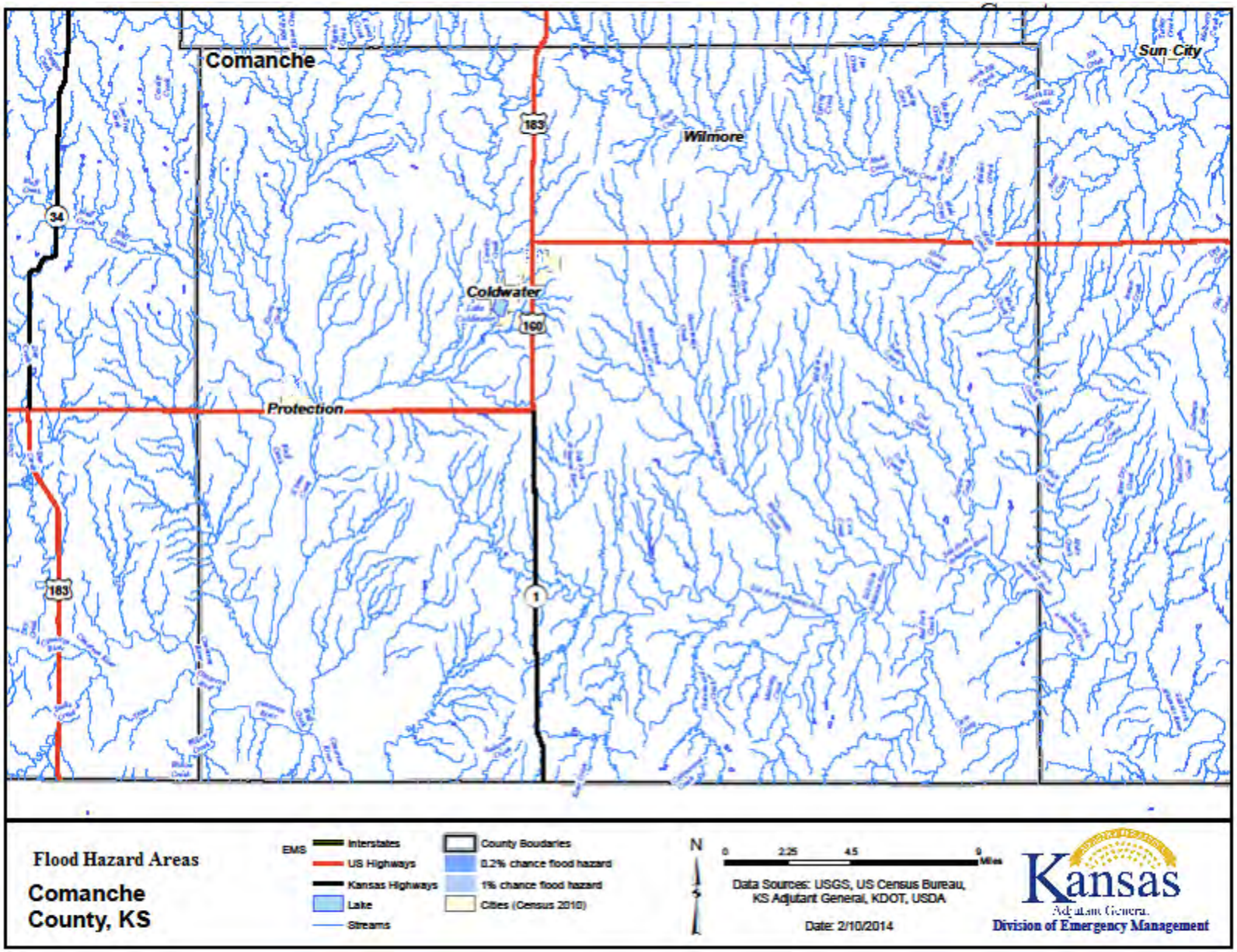
Regional HAZUS One Percent Annual Chance Floodplains

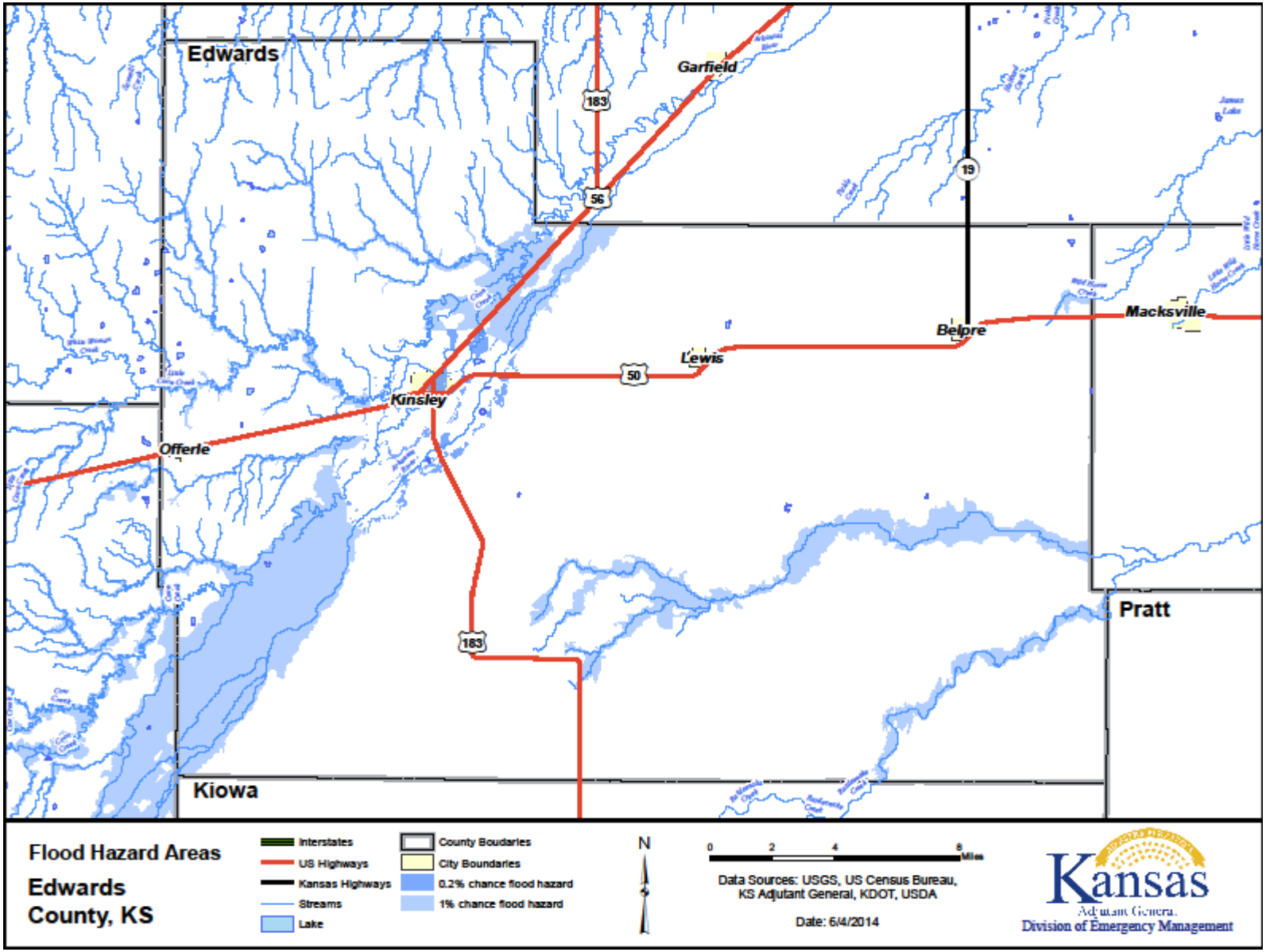
The following are available DFIRM maps for counties within south Kansas. Please note that at the time of this plan only two counties, Barton and Edwards, were fully mapped. If available, other relevant maps indicating potential flooding zones have been included.

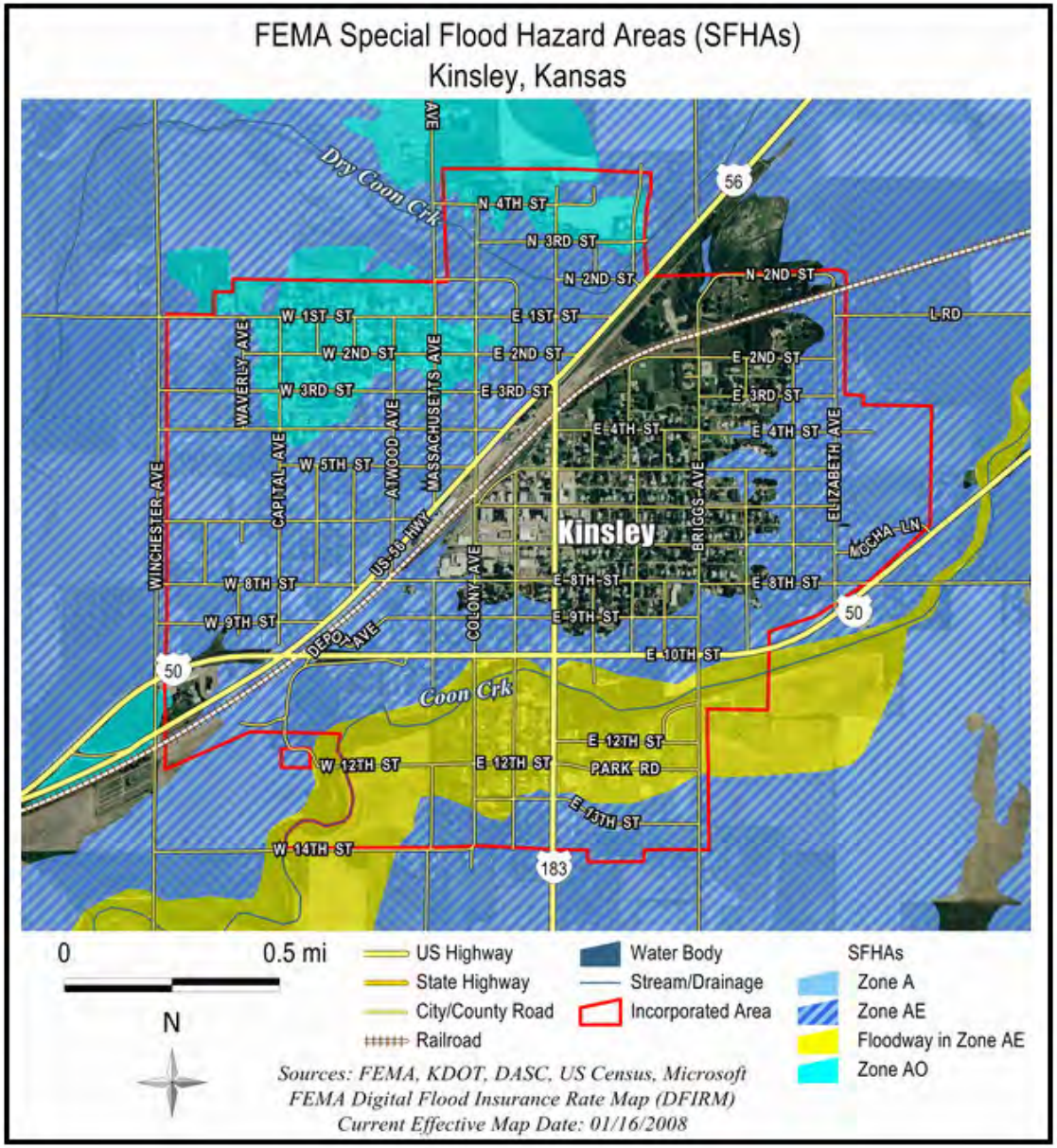

Barber
Harper
Sawyer
Isabel
Nashville
Zenda
Sun City
Medicine Lodge
Sharon
Attica
Hazelton
Kiowa
Hardtner
281
160
42
2
Flood Hazard Areas
Barber County, KS
Interstates
US Highways
Kansas Highways
Lake
Streams
County Boudaries
0.2% chance flood hazard
1% chance flood hazard
Cities (Census 2010)
N
0 2.75 5.5 11 Miles
Data Sources: USGS, US Census Bureau, KS Adjutant General, KDOT, USDA
Date: 2/10/2014
Kansas
Adjutant General
Division of Emergency Management

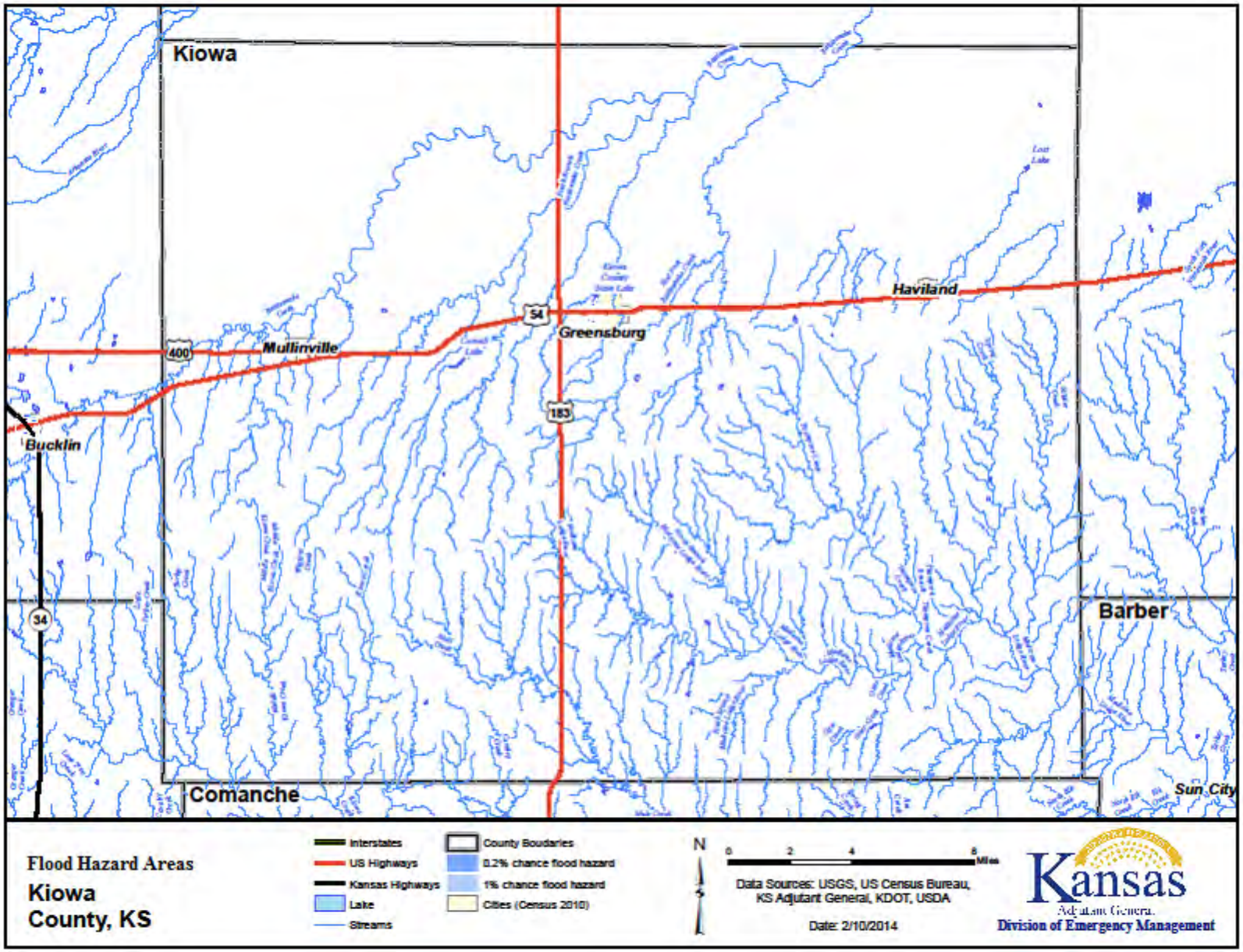

Barton
Galatia
Susank
Odin
Holyrood
Lorraine
Otis
Bison
Olmitz
Hoisington
Claflin
Rice
Bushton
Timken
Albert
Great Bend
Ellinwood
Chase
Raymond
Pawnee Rock
Stafford
Alden
Flood Hazard Areas
Barton County, KS
Interstates
US Highways
Kansas Highways
Streams
Lake
County Boudaries
City Boundaries
0.2% chance flood hazard
1% chance flood hazard
N
0 2.5 5 10 Miles
Data Sources: USGS, US Census Bureau, KS Adjutant General, KDOT, USDA
Date: 6/4/2014
Kansas
Adjutant General
Division of Emergency Management

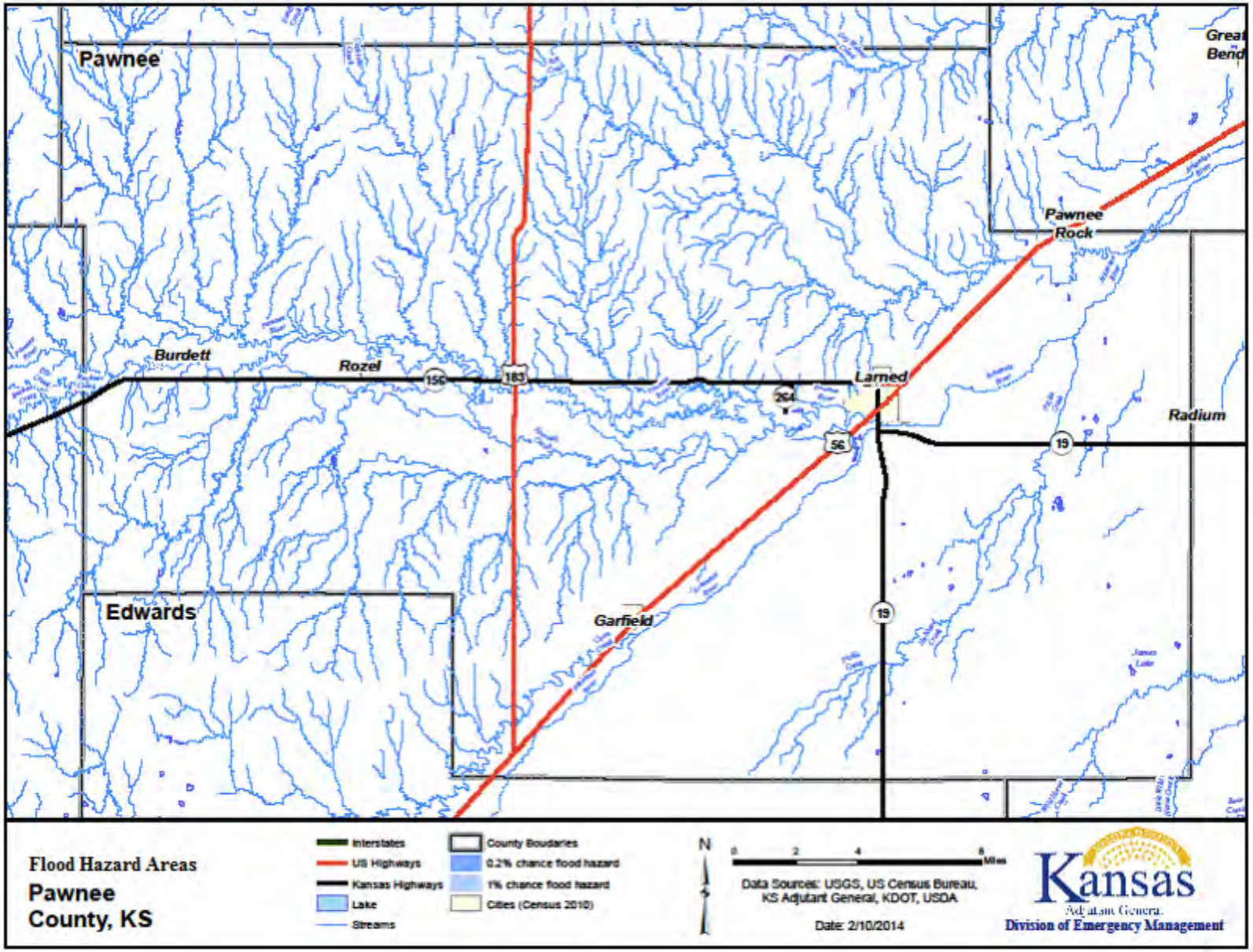

FEMA Special Flood Hazard Areas (SFHAs)
Great Bend, Kansas
Walnut Crk
Dry Walnut Crk
Great Bend
Great Bend Municipal Airport
Arkansas River
Antelope Crk
NW 30 RD
NW 20 RD
N WASHINGTON AVE
NE 30 AVE
NE 40 AVE
NW 60 AVE
NW 40 AVE
281
96
56
18TH ST
BROADWAY AVE
FOREST AVE
PARK AVE
NE 3 RD
E US-56 HWY
11TH ST
2ND ST
3RD ST
SE 10 RD
SW 10 RD
SW 30 AVE
SW 20 RD
SW 30 RD
SW 40 RD
SW 50 RD
SW 60 AVE
SW 50 AVE
SW 55 AVE
SW 20 AVE
SW 10 AVE
S WASHINGTON AVE
SE 20 AVE
SE 30 AVE
SE 40 AVE
N
0 1 mi
US Highway
State Highway
City/County Road
Railroad
Incorporated Area
Stream/Drainage
Water Body
Levee
Zone X - Protected by Levee
Special Flood Hazard Areas
Zone A
Zone AE
Floodway in Zone AE
Zone AH
Zone AO
Sources: KDEM, FEMA DFIRMs, KDOT, US Census, Microsoft
FEMA DFIRM Current Effective
Map Date: 09/02/2009


Comanche
Sun City
Wilmore
Coldwater
Protection
183
34
160
1
Flood Hazard Areas
Comanche County, KS
EMS
Interstates
US Highways
Kansas Highways
Lake
Streams
County Boudaries
0.2% chance flood hazard
1% chance flood hazard
Cities (Census 2010)
N
0
2.25
4.5
9
Miles
Data Sources: USGS, US Census Bureau, KS Adjutant General, KDOT, USDA
Date: 2/10/2014
Kansas
Adjutant General
Division of Emergency Management

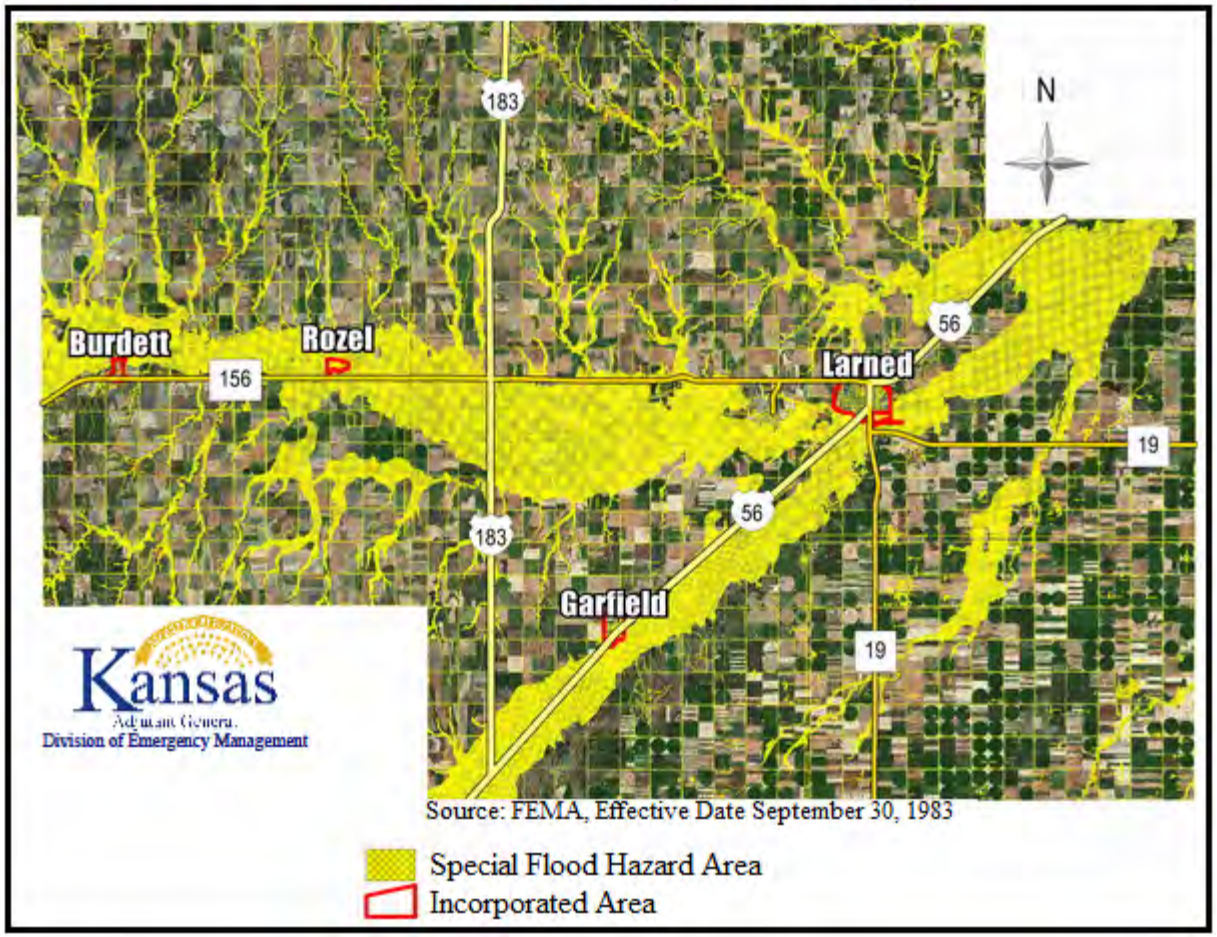

Edwards
Garfield
183
56
19
Belpre
Macksville
Lewis
50
Kinsley
Offerle
Pratt
183
Kiowa
Flood Hazard Areas
Edwards County, KS
Interstates
US Highways
Kansas Highways
Streams
Lake
County Boudaries
City Boundaries
0.2% chance flood hazard
1% chance flood hazard
N
0 2 4 8 Miles
Data Sources: USGS, US Census Bureau, KS Adjutant General, KDOT, USDA
Date: 6/4/2014
Kansas
Adjutant General
Division of Emergency Management


FEMA Special Flood Hazard Areas (SFHAs)
Kinsley, Kansas
Dry Coon Crk
Coon Crk
Kinsley
N 4TH ST
N 3RD ST
N 2ND ST
W 1ST ST
E 1ST ST
W 2ND ST
E 2ND ST
W 3RD ST
E 3RD ST
E 4TH ST
W 5TH ST
W 8TH ST
E 8TH ST
W 9TH ST
E 9TH ST
E 10TH ST
E 12TH ST
W 12TH ST
PARK RD
E 13TH ST
W 14TH ST
WAVERLY AVE
CAPITAL AVE
ATWOOD AVE
MASSACHUSETTS AVE
WINCHESTER AVE
COLONY AVE
BRIGGS AVE
ELIZABETH AVE
US 50 HWY
DEPOT AVE
MOCHA LN
L RD
56
50
183
0
0.5 mi
N
US Highway
State Highway
City/County Road
Railroad
Water Body
Stream/Drainage
Incorporated Area
SFHAs
Zone A
Zone AE
Floodway in Zone AE
Zone AO
Sources: FEMA, KDOT, DASC, US Census, Microsoft
FEMA Digital Flood Insurance Rate Map (DFIRM)
Current Effective Map Date: 01/16/2008

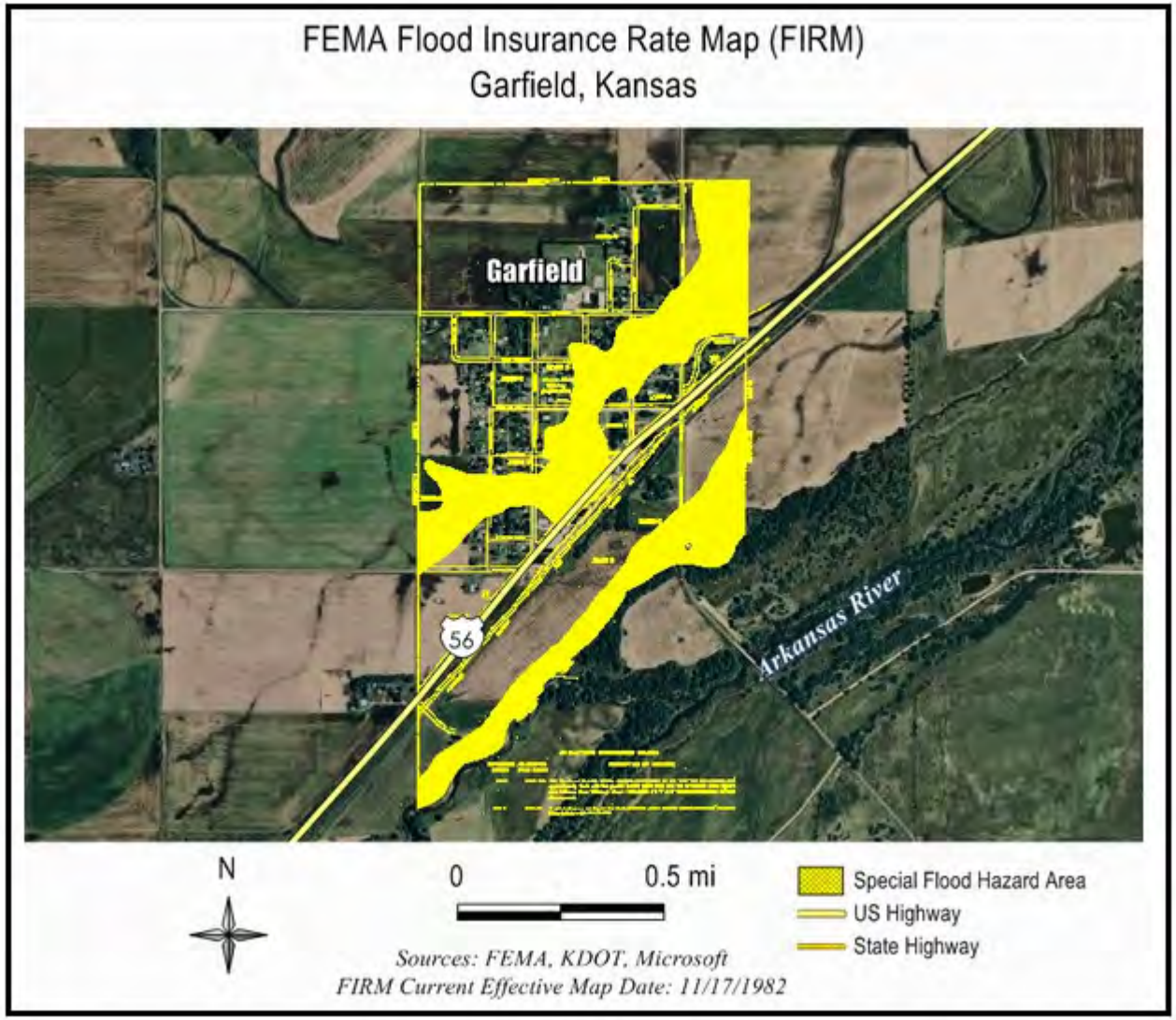

Kiowa
Haviland
Greensburg
Mullinville
Bucklin
Barber
Comanche
Sun City
54
400
183
34
Flood Hazard Areas
Kiowa
County, KS
Interstates
US Highways
Kansas Highways
Lake
Streams
County Boudaries
0.2% chance flood hazard
1% chance flood hazard
Cities (Census 2010)
N
0 2 4 8 Miles
Data Sources: USGS, US Census Bureau, KS Adjutant General, KDOT, USDA
Date: 2/10/2014
Kansas
Adjutant General
Division of Emergency Management

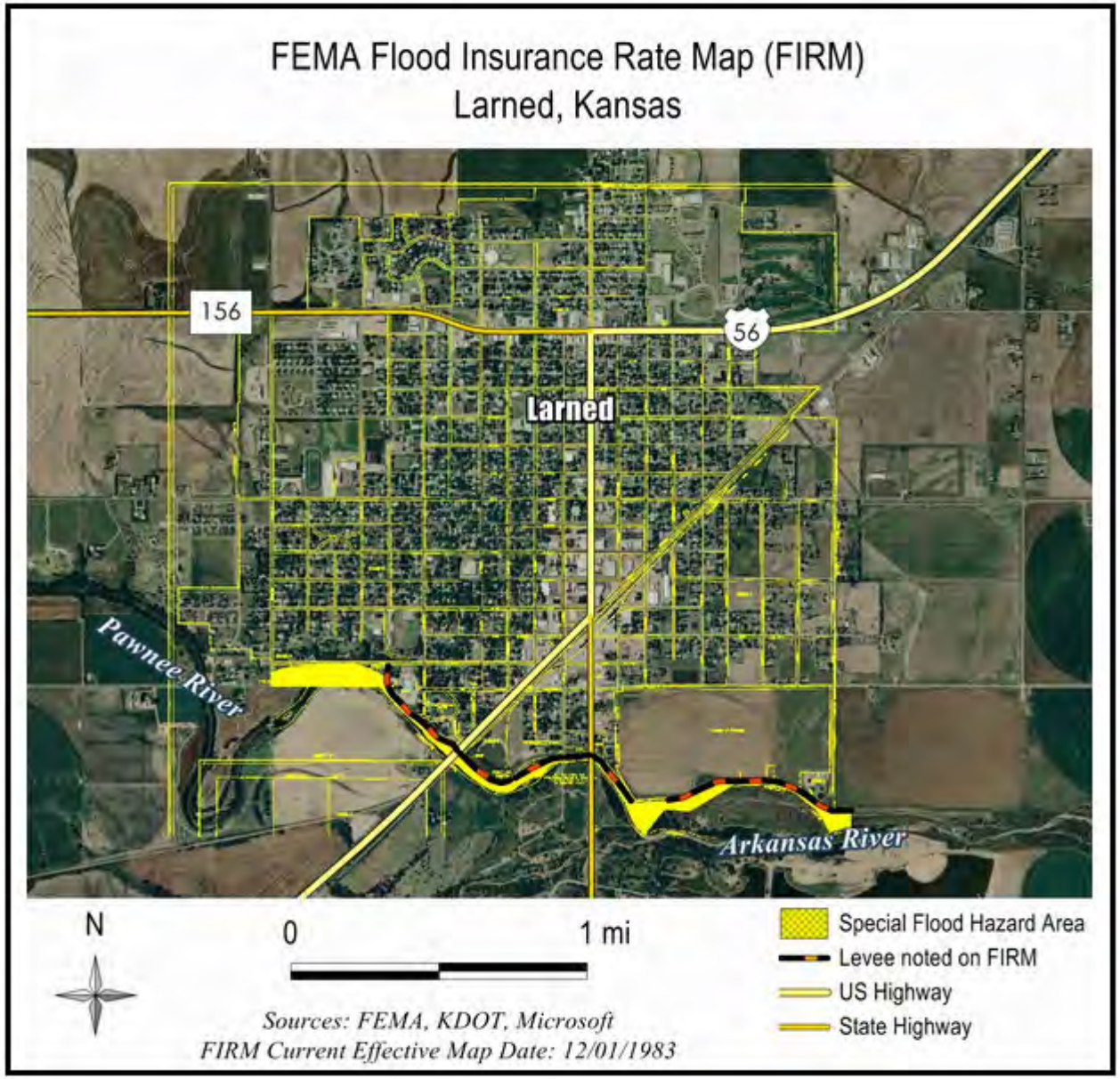

Pawnee
Great Bend
Pawnee Rock
Burdett
Rozel
156
183
Larned
264
56
19
Radium
Edwards
Garfield
Flood Hazard Areas
Pawnee County, KS
Interstates
US Highways
Kansas Highways
Lake
Streams
County Boudaries
0.2% chance flood hazard
1% chance flood hazard
Cities (Census 2010)
N
0 2 4 8 Miles
Data Sources: USGS, US Census Bureau, KS Adjutant General, KDOT, USDA
Date: 2/10/2014
Kansas
Adjutant General
Division of Emergency Management

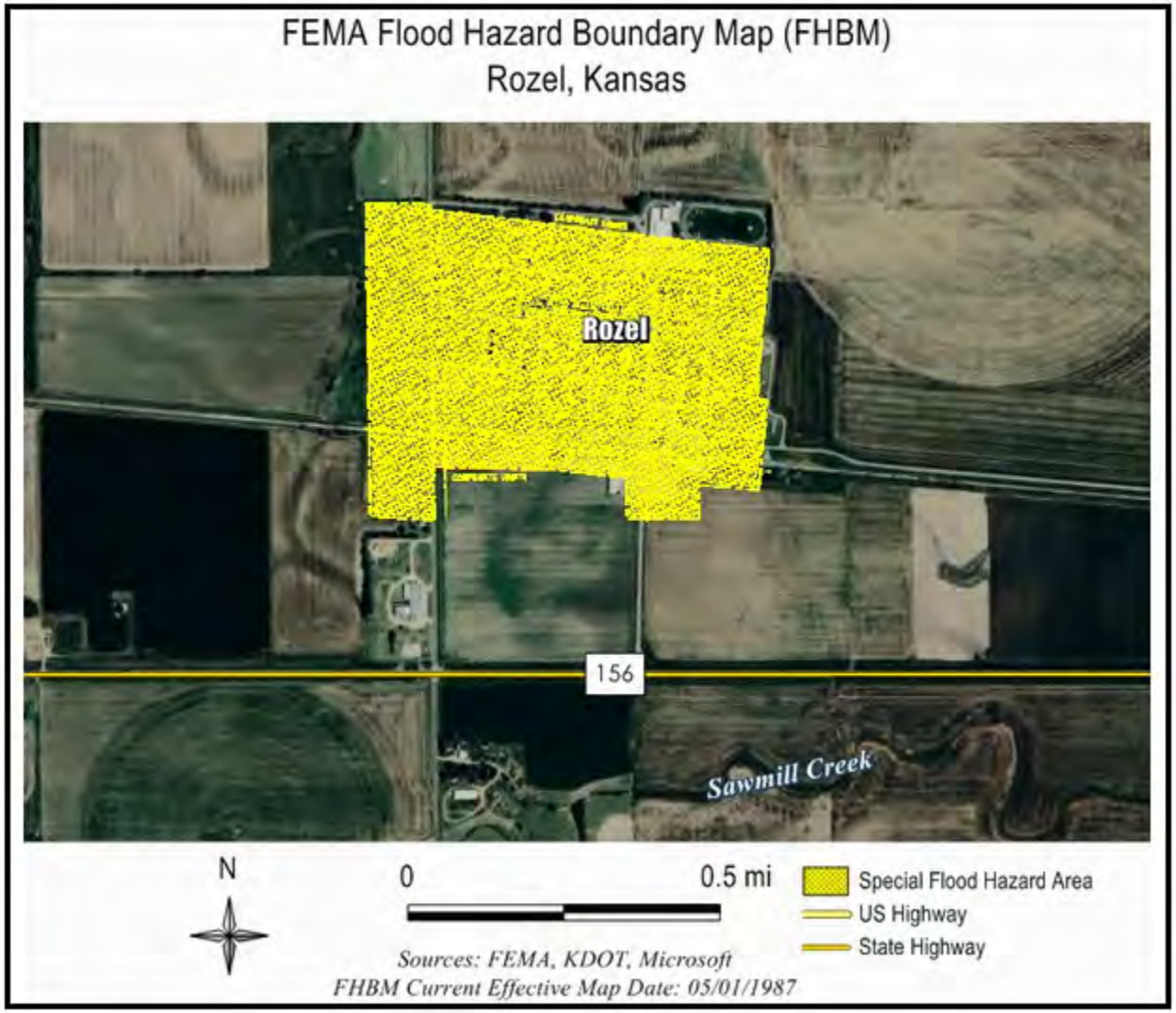
FEMA FIRM Panel, Pawnee County

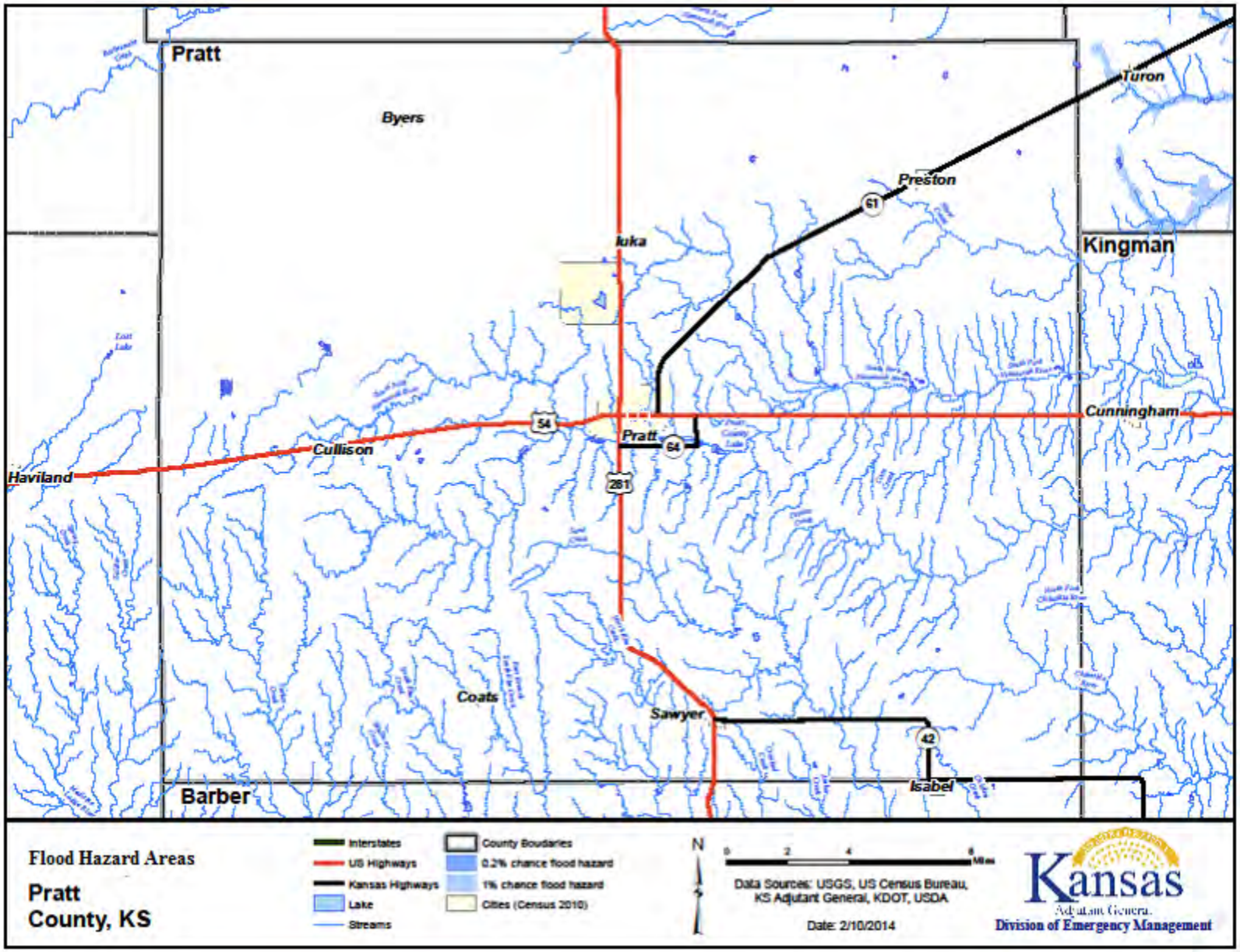



Source: FEMA, Effective Date September 30, 1983

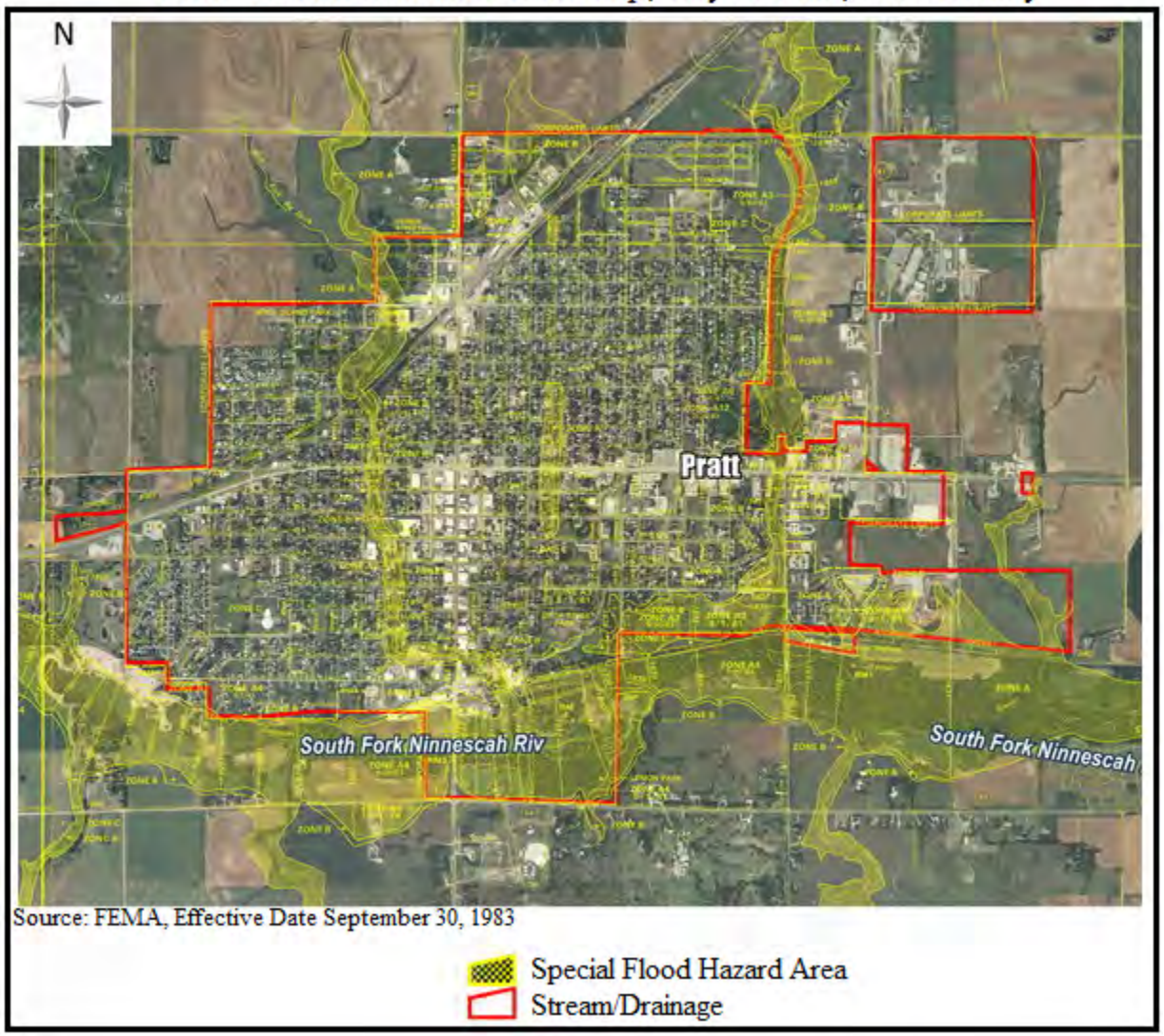

FEMA Flood Insurance Rate Map (FIRM)
Garfield, Kansas
Garfield
56
Arkansas River
N
0
0.5 mi
Special Flood Hazard Area
US Highway
State Highway
Sources: FEMA, KDOT, Microsoft
FIRM Current Effective Map Date: 11/17/1982


FEMA Flood Insurance Rate Map (FIRM)
Larned, Kansas
156
56
Larned
Pawnee River
Arkansas River
N
0
1 mi
Special Flood Hazard Area
Levee noted on FIRM
US Highway
State Highway
Sources: FEMA, KDOT, Microsoft
FIRM Current Effective Map Date: 12/01/1983


FEMA Flood Hazard Boundary Map (FHBM)
Rozel, Kansas
Rozel
156
Sawmill Creek
N
0
0.5 mi
Special Flood Hazard Area
US Highway
State Highway
Sources: FEMA, KDOT, Microsoft
FHBM Current Effective Map Date: 05/01/1987


Pratt
Byers
Turon
Preston
61
Iuka
Kingman
Cunningham
54
Pratt
64
Cullison
Haviland
281
Coats
Sawyer
42
Isabel
Barber
Flood Hazard Areas
Pratt
County, KS
Interstates
US Highways
Kansas Highways
Lake
Streams
County Boudaries
0.2% chance flood hazard
1% chance flood hazard
Cities (Census 2010)
N
Data Sources: USGS, US Census Bureau, KS Adjutant General, KDOT, USDA
Date: 2/10/2014
Kansas
Adjutant General
Division of Emergency Management

FEMA Flood Insurance Rate Map, City of Pratt, Pratt County



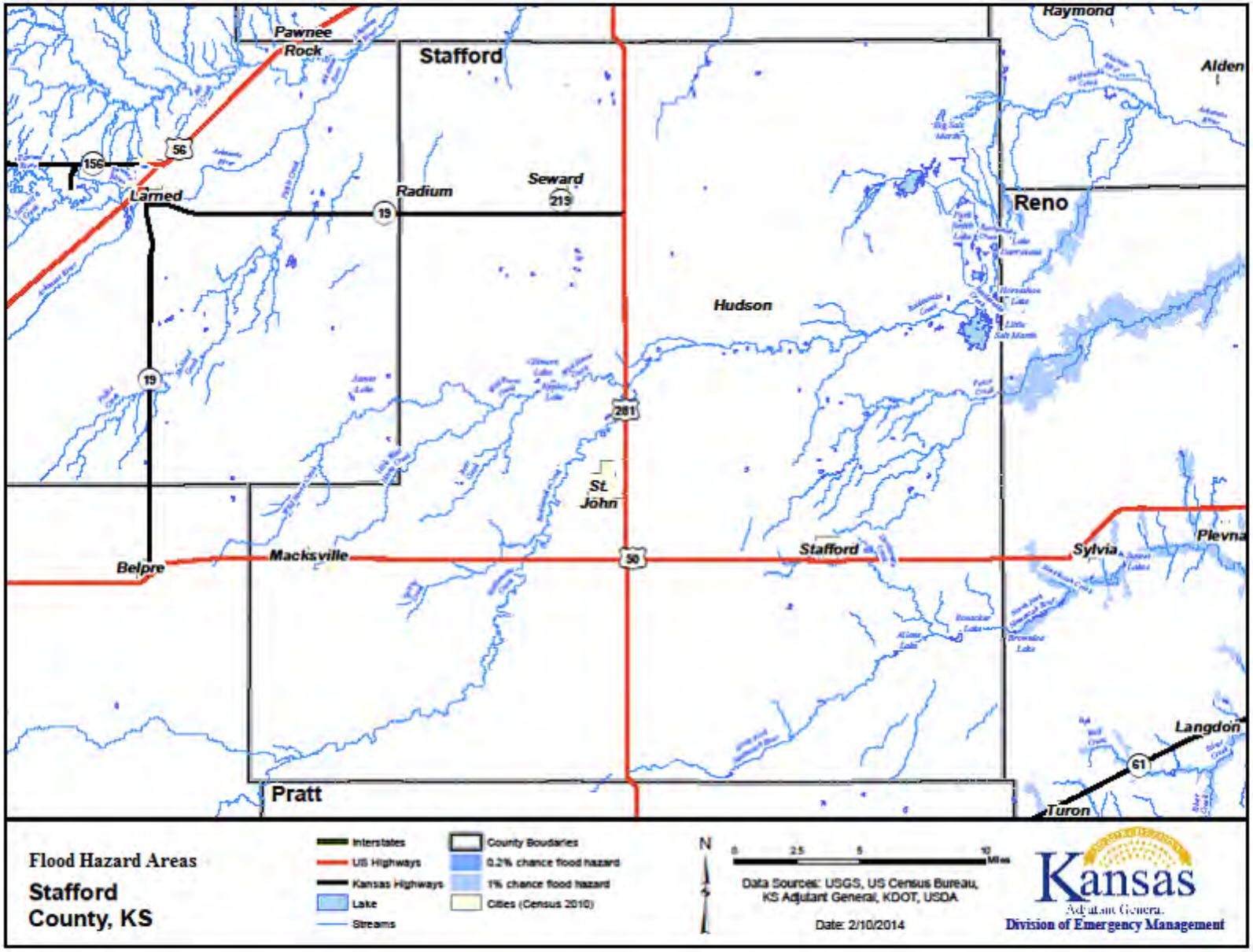

Source: FEMA, Effective Date September 30, 1983

Special Flood Hazard Area
Stream/Drainage

FEMA Flood Insurance Rate Map, City of Preston, Pratt County

Source: FEMA

Special Flood Hazard Area


Pawnee Rock
Stafford
Raymond
Alden
Larned
Radium
Seward
Reno
Hudson
St. John
Belpre
Macksville
Stafford
Sylvia
Plevna
Langdon
Turon
Pratt
Flood Hazard Areas
Stafford County, KS
Interstates
US Highways
Kansas Highways
Lake
Streams
County Boudaries
0.2% chance flood hazard
1% chance flood hazard
Cities (Census 2010)
N
Data Sources: USGS, US Census Bureau, KS Adjutant General, KDOT, USDA
Date: 2/10/2014
Kansas
Adjutant General
Division of Emergency Management

FEMA Flood Insurance Rate Map, City of Stafford, Stafford County

Source: FEMA, Effective Date August 26, 1980

Special Flood Hazard Area

**Previous Occurrences and Extent**

In the past ten years, 11 Presidential Disaster Declarations for major floods have been declared for south Kansas. Details about some of these events can be found on the following pages. Please note that some of the Presidential Disaster Declarations included flooding (primarily flash flooding) as a secondary cause of damages**.**

**Regional Presidential Declarations Involving Flooding**

| Declaration Number | Declaration Date* | Disaster Description | Regional Counties Involved | Disaster Cost** |
|---|---|---|---|---|
| 4150 | 10/22/2013 (7/22/2013 - 08/16/2013) | Severe Storms, Winds, Tornados and **Flooding** | Barber, Barton, Comanche, Edwards, Kiowa, Pawnee, Pratt and Stafford | - |
| 4063 | 05/24/2012 (4/14-4/15/2012) | Severe Storms, Tornados, Straight-line Winds and **Flooding** | Edwards, Kiowa and Stafford | $6,923,919 |
| 4010 | 07/29/2011 (5/19-6/4/2011) | Severe Storms, Straight-line Winds, Tornados and **Flooding** | Barton and Stafford | $8,259,620 |
| 1932 | 08/10/2010 (6/7-7/21/2010) | Severe Storms, **Flooding** and Tornados | Comanche, Kiowa and Pawnee | $9,279,257 |
| 1849 | 06/25/2009 (4/25-5/16/2009) | Severe Storms, **Flooding**, Straight-line Winds, and Tornados | Barber and Butler | $15,013,488 |
| 1808 | 10/31/2008 | Severe Storms, **Flooding** and Tornados | Butler | $4,167,044 |
| 1776 | 07/09/2008 | Severe Storms, **Flooding**, and Tornados | Barber, Barton, Comanche, Edwards, Kiowa, Pawnee, Pratt and Stafford | $70,629,544 |
| 1711 | 7/2/2007 (6/26-30/2007) | Severe Storms and **Flooding** | Edwards and Pawnee | $40,238,600 |
| 1699 | 5/6/2007 (5/4/2007) | Severe Storms, Tornados, and **Flooding** | Barton, Comanche, Edwards, Kiowa, Pawnee, Pratt and Stafford | $117,565,269 |
| 1579 | 2/8/2005 (1/4-6/2005) | Severe Winter Storm, Heavy Rains, and **Flooding** | Barber, Comanche, Kiowa and Pratt | $106,873,672 |
| 1535 | 8/3/2004 (6/12-7/25/2004) | Severe Storms, **Flooding**, and Tornados | Barton and Pawnee | $12,845,892 |

Sources: FEMA and Kansas Division of Emergency Management

* Incident dates are in parentheses.

** Disaster costs include Public Assistance and Individual Assistance for all affected counties, including those not listed

The following provide brief discussions of the most recent Presidential Disaster Declarations for the region:

**FEMA-4150-DR**: Severe Storms, Winds, Tornados and Flooding – November 22, 2013 - From July 22 to August 16, 2013 severe storms, winds, tornados, and flooding caused limited damages in all regional counties. The primary impacts of this event were to public roads and bridges with an estimated $11,412,827 in damages.

**FEMA-4063-DR:** Severe Storms, Tornados, Straight-line Winds and Flooding - May 24, 2012 - From April 14-16, three regional counties received damages due to severe storms, tornados, straight-line winds, and flooding. Primary damages were to utilities, mainly from winds associated with this event. However, there were some flood damages, primarily from flash flooding. Total damages to public utilities were estimated to be nearly $7,000,000.

**FEMA-4010-DR**: Severe Storms, Straight-Line Winds, Tornados and Flooding – July 29, 2011 - From May 10 to June 4, 2011 severe storms, straight-line winds, tornados, and flooding caused damages in 25 Kansas Counties. The primary impacts of this event were to public roads and bridges with an estimated $9,800,000 in damages.

**FEMA 1932-DR**: Severe Storms, Flooding and Tornados - August 10, 2010 - From June 7 to July 21, 2010, severe storms, flooding, and tornados caused damages in 41 Kansas Counties. The primary impacts of this event were to public roads and bridges with an estimated $11,200,000 in damages.

**FEMA-1849-DR:** Severe Storms, Flooding, Straight-line Winds, and Tornados - June 25, 2009 - From April 25 to May 15, 2009 severe storms and flooding impacted Kansas. Many roads and highways were inundated.

**FEMA 1808-DR:** Severe Storms, Flooding, and Tornadoes - October 31, 2008 (Sept. 11-17) - During the period of September 11-17, 2009, severe storms accompanied by tornados, lightning and torrential rains resulted in flooding and flash flooding across south central and eastern Kansas. Rainfall amounts were generally around 5 inches, Interstate 35 near Wellington was closed.

**FEMA 1776-DR:** Severe Storms, Flooding, and Tornados - July 9, 2008 - Beginning May 22, 2008 and continuing through June 16, 2008, severe storms across Kansas produced large hail, lightning, high winds, tornados and torrential rains. The severe weather produced widespread flooding. Several high water rescues were reported as local law and fire officials had to rescue individuals from on top of their vehicles and in one instance clinging to a tree. Street flooding was reported throughout the impacted areas.

**FEMA-1711-DR:** Severe Storms and Flooding - July 2, 2007 (June 26–30) - Beginning June 26 and continuing through June 30, 2007, strong storms across south central and southeast Kansas produced torrential rainfall and subsequent flooding/flash flooding. Some counties, which were still recovering from flooding in mid-May, received over a

foot of rain. In Miami County, the Kansas National Guard was sent to help with a mandatory evacuation of Osawatomie, one of the hardest hit communities in eastern Kansas. The town evacuated 40% of its 4,600 residents after Pottawatomie Creek and the Marais des Cygnes River rose out of their banks.

Further descriptions and other notable flooding events are detailed below

**May 5, 2007:** Flooding was reported throughout Barton County. Highway 96, nine miles west of Great Bend was closed as water started flowing over the road. An observer in the area reported 3.22 inches of rain in just 3 hours. Highway 56 in Pawnee Rock was closed because of flood water. In Hoisington the intersection of 3rd Street and Main was closed because of high water. An observer reported approximately 3 inches of rain in 3 hours in that part of Barton County. Seventy to eighty homes were flooded on the north side of Ellinwood. According to Barton County Emergency Management, the county documented roughly 30 Million dollars in damage. This includes damages to private property including crop damage, damage to farm equipment, farmsteads and public roads. The Great Bend Tribune contributed to this narrative.

**June 3-15, 2005:** Cheyenne, Edwards, Harper, Haskell, Linn, Rush, and Stanton Counties were designated as primary disaster areas by the U.S. Department of Agriculture because of losses caused by excessive rain, flash flooding, and flooding. Twenty-nine contiguous counties were also eligible for assistance.

The following table presents NCDC identified flood events and the resulting damage totals in the region from the period 2001 - 2014.

**NCDC Flood Events, 2004 - 2014**

| County | Number of Flash Flood Events | Number of Flood Events | Property Damages | Crop Damage | Deaths |
|---|---|---|---|---|---|
| Barber | 0 | 56 | $10,100,000 | $300,100 | 0 |
| Barton | 8 | 60 | $40,658,000 | $301,300 | 0 |
| Comanche | 0 | 52 | $10,080,000 | $300,000 | 0 |
| Edwards | 0 | 54 | $10,085,000 | $300,000 | 0 |
| Kiowa | 0 | 52 | $10,080,000 | $300,000 | 0 |
| Pawnee | 1 | 58 | $10,081,000 | $401,000 | 0 |
| Pratt | 1 | 53 | $10,080,000 | $300,000 | 0 |
| Stafford | 1 | 56 | $10,095,000 | $300,000 | 0 |
| Regional Total | 11 | 441 | $111,259,000 | $2,502,400 | 0 |

Source: NCDC Storm Events Database

**Local Events**

**August 4, 2013:** In Barton County heavy rains produced flash flooding in the eastern part of the county damaging roads, bridges and residences.

**August 2012:** In Kiowa County a flood caused significant damage to county roads and crops.

**June 10, 2010:** In Pawnee County, flooding damaged local roadways.

**October 23, 2008**: In Pawnee County, five miles north-northwest of Ray, slow runoff produced creek flooding that ran over secondary roads for several days. There was $100,000 in crop damage and $1,000 in property damage reported for this event. No injuries were reported.

**June 17, 2008:** In Barber County, flooding caused by heavy rains damaged roadways.

**May 23, 2008:** In Pawnee County, flooding caused by heavy rains caused roads to wash out and damaged crop fields.

**May 5, 2007:** In the City of Great Bend, Barton County, heavy rains and flooding caused a major sewer collapse and damage to a flood control ditch.

**May 5, 2007**: In Barton County, an observer reported 3.22 inches of rain in three hours. Highway 56 in Pawnee Rock was closed due to flood water. In Hoisington the intersection of 3rd Street and Main was closed due to high water. An observer reported approximately three inches of rain in three hours in that part of Barton County. Seventy to eighty homes were flooded on the north side of Ellinwood. According to Barton County Emergency Management, the county documented roughly $30,000,000 in damage. This includes damages to private property including crop damage, damage to farm equipment, farmsteads and public roads. No injuries were reported for this event.

**June 13, 2007:** In Comanche County a road was washed out near a bridge seven miles east south east of Buttermilk. Nearly all county roads in southeast Comanche County had water on them. An estimated 3 to 5 inches of rain fell.

**June 13, 2007:** In Comanche County a round of severe thunderstorms moved out of far southwest Kansas and into south central Kansas. Numerous roads washed out eight miles east of Buttermilk from the 5.80 inches of rain.

**July 13, 2007:** In Edwards County heavy rain and runoff flooded some homes around Rozel. Property damage was reported to be $5,000 for this event. There were no reported injuries or deaths for this event.

**July 13, 2007**: In Pawnee County, one mile east of Garfield, Highway 56 flooded with 6 to 8 inches of water due to heavy overnight rain. $1,000 in property damage, and $1,000 in crop damage, with no injuries was reported for this event.

**June 26, 2006**: In Barton County widespread flooding occurred from Hoisington to Great Bend. High water forced the closure of Highway 281 four miles south of Hoisington for two hours. Numerous rural and city roads and intersections, especially those in and

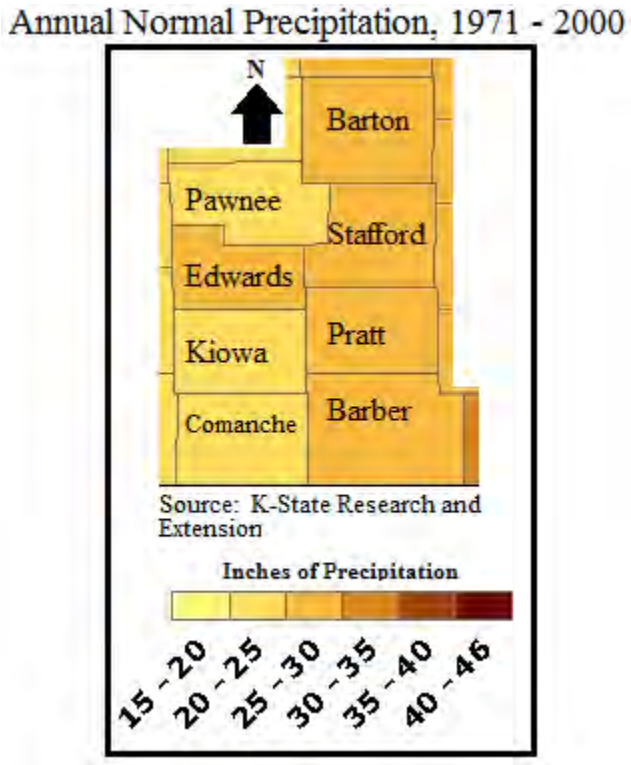
around Hoisington and Great Bend, were barricaded due to high water. Several businesses and homes received water damage. Property damage was reported to be $100,000, with no associated injuries.

**May 12, 2005**: In Stafford County heavy rains caused water to overflow across Highway 50 causing traffic to be diverted. There was no reported property or crop damages. Additionally, no injuries or deaths were reported for the event.

**July 3, 2005:** In Stafford County heavy rains caused water levels to rise one-foot above Highway 50 at a location approximately one mile west of Stafford. There was no reported property or crop damage. Additionally, there were no reported injuries or deaths for the event.

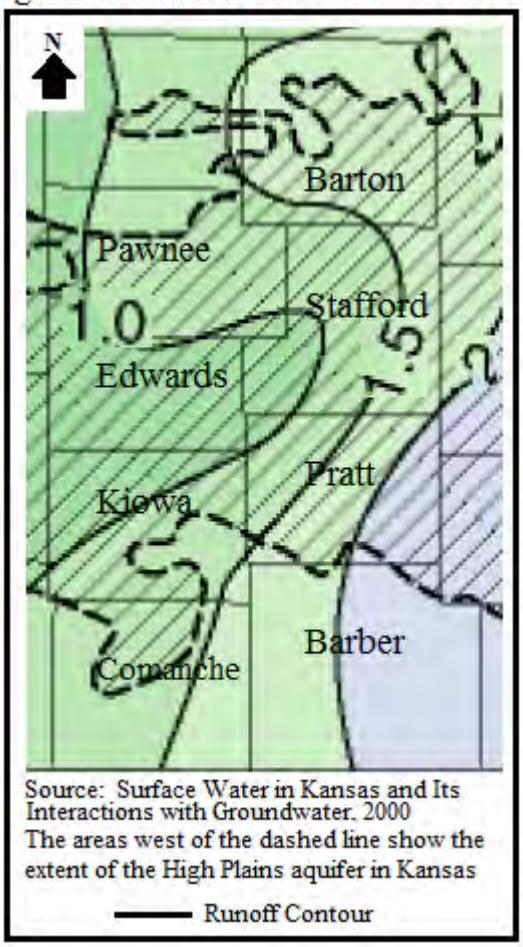
**Hazard Vulnerability and Impact**

Flash flooding occurs in those locations of the in the planning area that are low-lying and/or do not have adequate drainage to carry away the amount of water that falls during intense rainfall events. The average annual precipitation varies significantly across the region. Precipitation in the central part of the state averages approximately 35 inches. The following map shows how the annual normal precipitation varies across the region.



The following map shows the distribution of water runoff in south Kansas. This data indicates the approximate amount of water that does not infiltrate the ground and is potentially carried to streams and rivers. Although the climatically controlled rainfall variation is significant, average annual runoff across the state varies much more than the precipitation. The average runoff ranges from approximately one to two inches in the region. Both precipitation and runoff can impact flash flooding.

Regional Distribution of Water Runoff




The region acquired data from the USDA's Risk Management Agency to provide crop loss data based on crop insurance payments. Data was requested for the 10-year period from 2002 to 2011 for the State of Kansas. During this period, $321,995,951 in crop insurance payments was made to Kansas farmers as a result of flood, excess moisture/precipitation/rain, and hurricane/tropical depression. This translates to $321,995,951 annually. The most damaging year during this time-frame was 2007 which coincides with Presidential Declarations 1699 and 1711 for major flooding in south Kansas. The following table provides the crop insurance payments by year for this ten-year period. Please note that this data only applies to insured crops and for the entire State. According to the *2011 Kansas Crop Insurance Profile Report* issued by the USDA Risk Management Agency 82 percent of Kansas' row crops were insured in 2011.

**USDA Risk Management Agency Crop Insurance Payments Due to Flood Excess Moisture/Precipitation/Rain, and Hurricane/Tropical Depression**

| Year | Statewide Crop Insurance Paid |
|---|---|
| 2011 Total | $16,554,331 |
| 2010 Total | $51,325,423 |
| 2009 Total | $69,363,919 |
| 2008 Total | $58,422,531 |
| 2007 Total | $86,141,405 |
| 2006 Total | $1,510,143 |
| 2005 Total | $15,082,104 |
| 2004 Total | $16,276,418 |
| 2003 Total | $4,944,342 |
| 2002 Total | $2,375,336 |
| **Statewide Total** | **$321,995,951** |

Source: USDA Risk Management Agency, 2012;

To determine vulnerability to flooding and the jurisdictions most threatened by flooding and most vulnerable to damage and losses, the region analyzed data from several sources including:

- NCDC Storm Events Database
- USDA Risk Management Agency Crop Loss Statistics
- HAZUS MH-2.1 100-year Food Scenario
- NFIP Flood Insurance Claims
- Repetitive Loss Properties/Severe Repetitive Loss Properties

The NCDC Storm Events Database was the primary source of data to complete the vulnerability analysis of flash flood in the State; while the HAZUS-MH 2.1 analysis was utilized to describe vulnerability to riverine flooding. Flash flooding is not considered to be a geographic hazard. Due to the large number of variables that occur in rainfall amounts and intensity, it is not possible to predict all specific locations that are vulnerable to flash flooding. However, it is known that certain low-lying areas with poor drainage are more vulnerable than areas higher in elevation with good drainage. Additionally, historical statistics of areas that have been prone to flash flooding in the past can be utilized to determine potential vulnerability to future events.

The following table provides total crop insurance payments and annualized crop insurance payments for flood damage for each county over the 10-year period from 2002 to 2011. The USDA does not differentiate damages from riverine flooding and flash flooding. As such, these losses include combined losses for both types of flooding. The crop exposure value from the 2007 Census of Agriculture is provided to provide the basis for an annualized ratio of insurance payments to total value. Please note that this data only applies to insured crops. According to the *2011 Kansas Crop Insurance Profile Report* issued by the USDA Risk Management Agency 82 percent of Kansas' row crops were insured in 2011, the latest available data that allows for correlation. The crop exposure values have not been adjusted in the table below.

**Flood-Related Crop Insurance Payments Analysis, 2002-2011**

| County | Crop Exposure Value (2012 Census of Agriculture) | Flood-Related Crop Insurance Payments 2010-2013 | Annualized Crop Insurance Payments | Annualized Flood-Related Crop Insurance Payment Ratio |
|---|---|---|---|---|
| Barber | $45,420,000 | $116,172 | $29,043 | 0.06% |
| Barton | $96,206,000 | $272,836 | $68,209 | 0.07% |
| Comanche | $21,783,000 | $64,700 | $16,175 | 0.07% |
| Edwards | $126,933,000 | $254,040 | $63,510 | 0.05% |
| Kiowa | $63,956,000 | $83,588 | $20,897 | 0.03% |
| Pawnee | $92,111,000 | $234,768 | $58,692 | 0.06% |
| Pratt | $52,353,000 | $511,088 | $127,772 | 0.24% |
| Stafford | $74,549,000 | $222,864 | $55,716 | 0.07% |
| Regional Total | $573,311,000 | $1,760,056 | $55,002 | - |

Source: USDA Risk Management Agency; 2007 USDA Census of Agriculture

### *HAZUS-MH 2.1 One-Percent Annual Chance Food Scenario*

According to the HAZUS-MH 2.1 one percent annual chance flood scenario results, there are 2,809 buildings and 9,588 people in the one percent annual chance floodplain. It is worth noting that the results for Barton County are markedly higher than all other counties within the region, accounting for 86.9% of the vulnerable building and 80.0% of population vulnerable to displacement. The following table provides the HAZUS-MH 2.1 results for the number of vulnerable buildings and population vulnerable to displacement for each county in south Kansas.

**Vulnerable Buildings and Population, HAZUS One Percent Annual Chance Flood Scenario**

| County | Vulnerable Buildings | Population Vulnerable to Displacement |
|---|---|---|
| Barber | 43 | 233 |
| Barton | 2,440 | 7,682 |
| Comanche | 0 | 43 |
| Edwards | 120 | 453 |
| Kiowa | 0 | 26 |
| Pawnee | 58 | 430 |
| Pratt | 0 | 157 |
| Stafford | 148 | 564 |
| Regional Total | 2,809 | 9,588 |

Source: HAZUS MH 2.1

### *NFIP Flood Insurance Claims Analysis*

The region analyzed NFIP flood-loss data to determine areas of south Kansas with the greatest flood risk. South Kansas NFIP participation and flood loss statistics were obtained from FEMA's Policy and Claim Statistics for Flood Insurance (which provides losses from 1978 to the present). As of October 2012, 48 communities (including the counties) were NFIP participants, including four that do not have special flood hazard areas and seven that are only minimally flood-prone. The following table presents south Kansas NFIP communities.

**South Kansas NFIP Communities**

| Community | Initial Flood Hazard Boundary Map Identified | Initial Flood Insurance Rate Map Identified | Current Effective Map Date |
|---|---|---|---|
| **Barber County** | | | |
| City of Kiowa | 12/13/1977 | 09/12/75 | 06/03/86 |
| City of Medicine Lodge | 02/08/74 | 07/26/74 | 07/03/90 |
| City of Sharon | 11/22/1974 | 08/22/75 | - |
| **Barton County** | | | |
| Barton County | 08/02/77 | 08/16/88 | 09/02/09 |
| City of Claflin | 08/15/75 | 09/02/09 | 09/02/09(M) |
| City of Ellinwood | 03/15/74 | 09/01/78 | 09/02/09 |
| City of Great Bend | 03/19/76 | 05/16/83 | 09/02/09 |
| City of Hoisington | 02/22/74 | 02/05/86 | 09/02/09 |
| City of Pawnee Rock | 01/10/75 | 01/14/77 | 09/02/09 |
| City of Susank | - | 09/02/09 | NSFHA |
| **Comanche County** | | | |
| City of Protection | 07/02/76 | 02/01/05 | 02/01/05(L) |
| **Edwards County** | | | |
| Edwards County | - | 01/16/08 | 01/16/08 |
| City of Kinsley | 05/17/74 | 03/01/78 | 01/16/08 |
| **Kiowa County** | | | |
| City of Greensburg | 07/30/76 | 02/01/87 | 02/01/87(L) |
| City of Haviland | 08/22/75 | - | 08/22/75 |
| Louisburg | 03/01/74 | 08/19/08 | 08/19/08 |
| Osawatomie | 01/23/74 | 09/19/84 | 08/19/08 |
| Paola | 12/14/1973 | 04/17/78 | 08/19/08 |
| **Osage County** | | | |
| Pawnee County | 10/25/1977 | 02/01/90 | 02/01/90(L) |
| City of Burdett | 03/26/76 | 03/01/05 | 03/01/05 |
| City of Garfield | 06/04/76 | 11/17/1982 | 11/17/1982 |
| City of Larned | 02/01/74 | 09/29/78 | 12/1/1983 |
| City of Rozel | 01/03/75 | 05/01/87 | 05/01/87(L) |
| **Pratt County** | | | |
| Pratt County | - | - | - |
| City of Pratt | 04/05/74 | 11/1/1978 | 09/30/83 |
| City of Preston | 10/29/1976 | - | 10/29/1976 |
| **Stafford County** | | | |
| City of Stafford | 03/26/76 | 08/26/80 | 08/26/80(M) |

Notes: NSFHA: No Special Flood Hazard Area - All Zone C
(L): Original FIRM by letter - All Zone A, C and X
(M): No elevation determined - All Zone A, C and X
-: No Information Available

There are likely other communities in south Kansas that have flood hazard areas but have not yet been mapped by FEMA to show where those hazard areas are.

Kansas flood-loss information was pulled from FEMA's "Policy and Loss Data by Community with County and State Data," which documents losses from 1978 through August 31, 2012. There are several limitations to this data, including:

- Only losses to participating NFIP communities are represented
- Communities joined the NFIP at various times since 1978
- The number of flood insurance policies in effect may not include all structures at risk to flooding
- Some of the historical loss areas have been mitigated with property buyouts

Some properties are under-insured. The flood insurance purchase requirement is for flood insurance in the amount of federally-backed mortgages, not the entire value of the structure. Additionally, contents coverage is not required.

The following table shows the details of NFIP policy and loss statistics for each county in south Kansas. Loss statistics include losses through March 31, 2014.

**Kansas NFIP Policy and Loss Statistics, As of March 31, 2014**

| | Number of Policies in Force | Insurance in Force | Number of Closed Losses | Total Payments |
|---|---|---|---|---|
| **Barber County** | | | | |
| Medicine Lodge | 10 | $395,900 | 1 | $1,219.16 |
| **Barton County** | | | | |
| Barton County | 129 | $9,433,900 | 10 | $53,492.52 |
| Albert | 19 | $1,812,200 | 2 | $4,177.21 |
| Ellinwood | 41 | $4,058,000 | 11 | $131,951.65 |
| Great Bend | 16 | $3,013,000 | 414 | $2,220,944.32 |
| Hoisington | 19 | $1,529,700 | 7 | $32,574.40 |
| Pawnee Rock | 26 | $1,197,200 | 6 | $20,851.14 |
| **Comanche County** | | | | |
| Comanche County | 0 | $0 | 0 | $0 |
| **Edwards County** | | | | |
| Kinsley | 128 | $9,150,100 | 1 | $1,108.04 |
| **Kiowa County** | | | | |
| Greenburg | 3 | $269,000 | 0 | $0 |

**Kansas NFIP Policy and Loss Statistics, As of March 31, 2014**

| | Number of Policies in Force | Insurance in Force | Number of Closed Losses | Total Payments |
|---|---|---|---|---|
| **Pawnee County** | | | | |
| Pawnee County | 29 | $1,810,900 | 1 | $2,942.53 |
| Burdett | 1 | $185,100 | 0 | $0 |
| Larned | 3 | $230,000 | 0 | $0 |
| Rozel | 18 | $1,455,800 | 1 | $1,201.57 |
| **Pratt County** | | | | |
| City of Pratt | 26 | $4,053,700 | 5 | $2,009.02 |
| **Stafford County** | | | | |
| Stafford County | 0 | $0 | 0 | $0 |

Source: FEMA, "Policy and Loss Data by Community with County and State Data"

***Repetitive Loss Analysis***

A high priority in south Kansas and nationwide is the reduction of losses to repetitive loss structures. These structures strain the National Flood Insurance Fund. The NFIP defines a repetitive loss property as "any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. At least two of the claims must be more than 10 days apart."

South Kansas has made mitigation of repetitive loss properties a priority use of mitigation funds. Data from KDEM indicates that south Kansas currently has no repetitive loss properties.

***Severe Repetitive Loss Analysis***

The Flood Insurance Reform Act of 2004 identified another category of repetitive loss, categorized as Severe Repetitive Loss (SRL). The definition of severe repetitive loss as applied to this program was established in section 1361A of the National Flood Insurance Act, as amended, 42 U.S.C. 4102a. An SRL property is defined as a residential property that is covered under an NFIP flood insurance policy and:

- That has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or
- For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

For both of the above, at least two of the referenced claims must have occurred within any ten-year period, and must be greater than ten days apart.

As of 2013 there are no validated insured residential properties in south Kansas that meet the qualifications of SRL and the requirements to be considered for possible mitigation activities under FEMA's SRL criteria.

***History of Severe Repetitive Loss***

In addition to the verified residential, insured properties above, the NFIP tracks other categories of properties, including unverified properties, commercial properties, previously mitigated properties, and currently uninsured properties that meet the loss criteria.

As of 2013, there are no validated properties that have incurred flood-related damage for which four or more separate claims payments have been paid under flood insurance coverage with the amount of each claim payment exceeding $5,000 and with cumulative amounts of such claims payments exceeding $20,000; or for which at least two separate claims payments have been made with the cumulative amount of such claims exceeding the reported value of the property.

***Riverine Flooding***

The results of the HAZUS-MH2.1 analysis were utilized to estimate potential losses for riverine flooding. The intent of this analysis was to enable the region to estimate where flood losses could occur and the degree of severity using a consistent methodology. The HAZUS model helps quantify risk along known flood-hazard corridors as well as lesser streams and rivers that have a drainage area of ten square miles or more.

The HAZUS-MH 2.1 analysis provides the number of buildings impacted, estimates of the building repair costs, as well as the associated loss of building contents and business inventory. Building damage can also cause additional losses to a community as a whole by restricting a building's ability to function properly. Income loss data accounts for losses such as business interruption and rental income losses as well as the resources associated with damage repair and job and housing losses. These losses are calculated by HAZUS-MH 2.1 using a methodology based on the building damage estimates.

Among other factors, flood damage is related to the depth of flooding. HAZUS-MH 2.1 takes into account flood depth when modeling damage (based on FEMA's depth-damage functions). The HAZUS-MH 2.1 reports capture damage by occupancy class (in terms of square footage impacted) by damage percent classes. Occupancy classes in HAZUS-MH 2.1 include agriculture, commercial, education, government, industrial, religion, and residential. Damage percent classes are grouped by 10 percent increments 1-10 percent, 11-20 percent, etc., up to 50 percent. Buildings that sustain more than 50 percent damage are considered to be "substantially" damaged.

The displaced population is based on the inundation area. Individuals and households will be displaced from their homes even when the home has suffered little or no damage either because they were evacuated or there was no physical access to the property because of flooded roadways. Displaced people using shelters will most likely be individuals with lower incomes

and those who do not have family or friends within the immediate area. HAZUS-MH 2.1 does not model flood casualties.

The following table provides the HAZUS-MH 2.1 results for vulnerable populations and the population estimated to seek short term shelter as well as the numbers of damaged and substantially damaged buildings for each south Kansas county.

**HAZUS-MH 2.1 Flood Scenario Displaced Population and Number of Damaged Buildings**

| County | Population Vulnerable to Displacement (Number of People) | Short Term Shelter Needs (Number of People) | Vulnerable Buildings | Damaged Buildings | Substantially Damaged Buildings |
|---|---|---|---|---|---|
| Barber | 233 | 48 | 43 | 3 | 0 |
| Barton | 7,682 | 5,815 | 2,440 | 521 | 58 |
| Comanche | 43 | 0 | 0 | 0 | 0 |
| Edwards | 453 | 134 | 120 | 12 | 0 |
| Kiowa | 26 | 0 | 0 | 0 | 0 |
| Pawnee | 430 | 122 | 58 | 0 | 0 |
| Pratt | 157 | 41 | 0 | 0 | 0 |
| Stafford | 564 | 90 | 148 | 3 | 0 |
| Regional Total | 9,588 | 6,250 | 2,809 | 539 | 58 |

Source: HAZUS-MH 2.1

The following table provides total direct building loss and income loss for each south Kansas county.

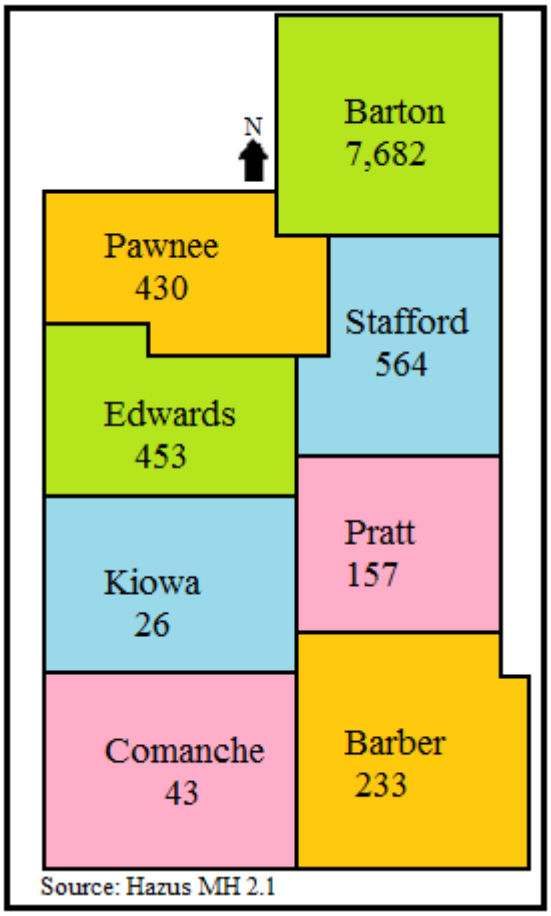
**HAZUS-MH 2.1 Flood Scenario Direct Building and Income Losses**

| County | Structural Damage | Contents Damage | Inventory Loss | Total Direct Loss | Total Income Loss | Total Direct and Income Loss | Structure and Contents Loss Ratio |
|---|---|---|---|---|---|---|---|
| Barber | $2,725,000 | $4,270,000 | $330,000 | $7,325,000 | $17,000 | $7,342,000 | 0.65% |
| Barton | $55,180,000 | $116,315,000 | $15,362,000 | $186,857,000 | $818,000 | $187,675,000 | 3.78% |
| Comanche | $387,000 | $203,000 | $1,000 | $591,000 | $0 | $591,000 | 0.09% |
| Edwards | $1,856,000 | $3,451,000 | $58,000 | $5,365,000 | $60,000 | $5,425,000 | 0.88% |
| Kiowa | $227,000 | $115,000 | $0 | $342,000 | $0 | $342,000 | 0.03% |
| Pawnee | $1,286,000 | $894,000 | $16,000 | $2,196,000 | $8,000 | $2,204,000 | 0.12% |
| Pratt | $1,369,000 | $1,189,000 | $71,000 | $2,629,000 | $1,000 | $2,630,000 | 0.10% |
| Stafford | $2,060,000 | $5,145,000 | $333,000 | $7,538,000 | $79,000 | $7,617,000 | 1.04% |
| Regional Total | $65,090,000 | $131,582,000 | $16,171,000 | $212,843,000 | $983,000 | $213,826,000 | - |

Source: HAZUS-MH 2.1

The following map depicts the potential population vulnerable to displacement

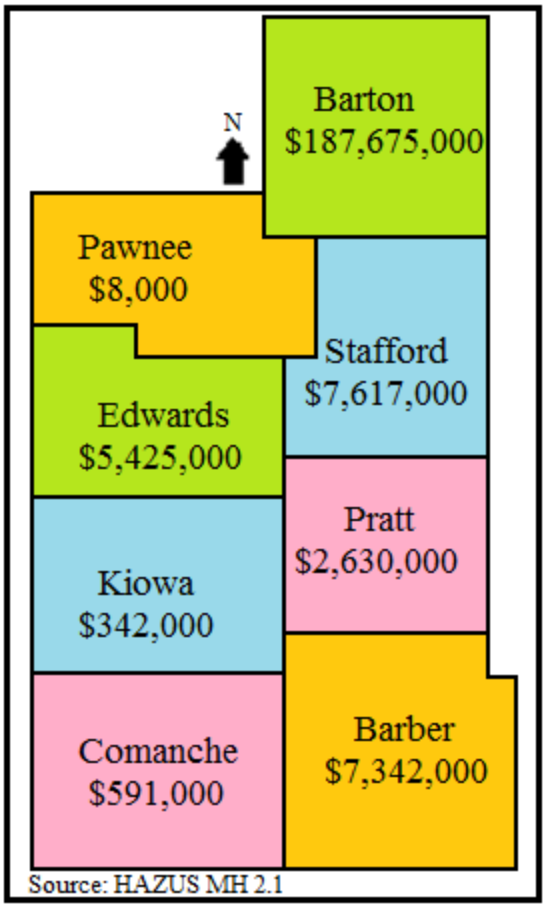
Population Vulnerable to Displacement




Source: Hazus MH 2.1

The following map illustrates the potential total direct building and income loss according to the HAZUS results for the region.

Total Direct Building and Income Loss




Barton County is in the top ten potentially impacted Kansas counties based on building loss, loss ratio, and displaced population indicators.

**Critical Facilities in Flood Plains**

The following county maps show critical facilities located in flood plains, if flood plain information was available for the county. If flood plain information was not available, the location of the facilities is shown in relation to streams and bodies of water. Identified critical facilities include:

- Schools
- Police Stations
- Fire Stations
- Hospitals (if information made available)
- Elderly care facilities (if information made available)

Please note that not all participating counties and/or jurisdictions had this data available.