4.1 Floods

4.1.1 Hazard Profile

Flooding is defined as the accumulation of water within a watercourse or body of water and the overflow of excess water onto adjacent floodplain lands. The floodplains are the lands adjoining the channel of a river, stream, ocean, lake, or other watercourse or body of water that is susceptible to flooding.

Because of the huge convective thunderstorms that frequent Oklahoma and Canadian County, flooding is one of the region's most common natural hazards and can be expected along virtually every stream and river within the county at some time during the year, especially during spring and fall. Most floods occur during May and June. The frequency and severity of flooding depends upon the magnitude and location of the rain and the condition of the receiving systems. On-the-ground conditions, such as debris in creeks, can exacerbate flooding problems. No probability has been assigned for other potential causes of Canadian County flooding, such as waterline breaks or snowmelt, because these types of flooding are infrequent and cannot be predicted statistically.

Location

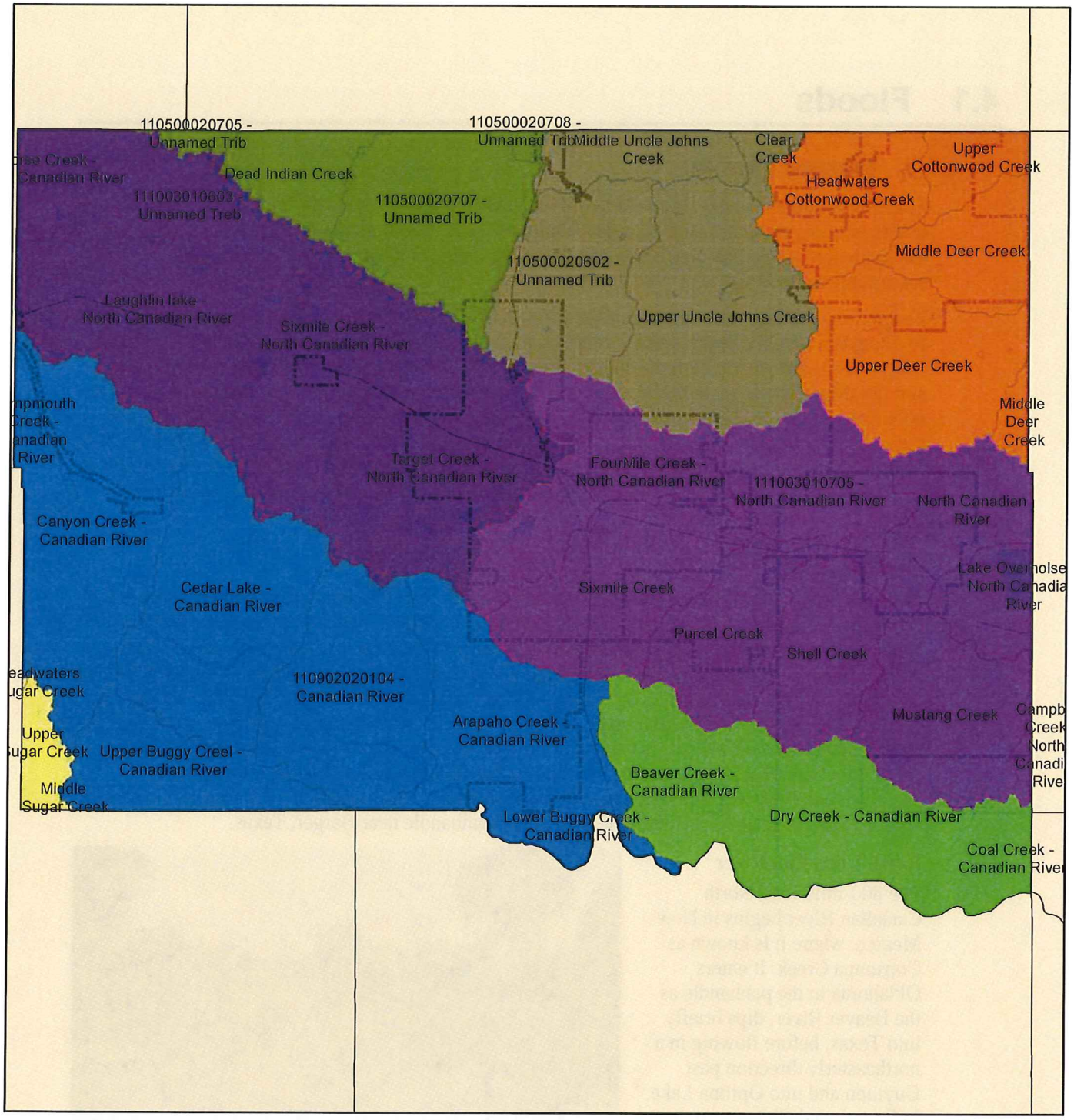
Canadian River

The Canadian River watershed (sometimes called the South Canadian), as shown in Figure 4-1, begins in the Sangre de Cristo Mountains in southern Colorado, and runs through northeastern New Mexico and the Texas panhandle before entering Oklahoma, and eventually joining the Arkansas River 40 miles west of the Arkansas border. With a length of 906 miles, and draining an area of 47,576 square miles, it is the Arkansas River's largest tributary. Stream flows on the Canadian are highly variable and range from a peak of 281,000 cfs, to average flows of 6,434 cfs, and minimal flows of 357 cfs. In Canadian County, the river drains an area of about 261 square miles. The Canadian River joins the North Canadian River at Lake Eufaula, a reservoir in McIntosh and Pittsburg counties. The major dam on the river upstream from Canadian County is Sanford Dam at Lake Meredith in the high plains panhandle near Borger, Texas.

North Canadian River

The 800-mile-long North Canadian River begins in New Mexico, where it is known as Corrumpa Creek. It enters Oklahoma in the panhandle as the Beaver River, dips briefly into Texas, before flowing in a northeasterly direction past Guymon and into Optima Lake. In Dewey and Blaine counties the river is dammed to create Canton Lake, and then flows in a southeasterly direction through Canadian County, more or less parallel with the Canadian River to the south. The North Canadian joins Lake Eufaula and the Canadian River north of McAlester, Oklahoma.

Downstream view of the North Canadian River at Yukon in Canadian County



LEGEND

HUC_10_Basin_Clip

- Buggy Creek - Canadian River
- City of Tutle - Canadian River
- Cottonwood Creek
- Kingfisher Creek
- Lake Overholser - North Canadian River
- Sugar Creek
- Town of Calumet - North Canadian River
- Uncle John Creek

0 2.5 5 Miles

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Figure 4-1

Canadian County Basins

Within Canadian County these two significant rivers create wide floodplains with many tributaries converging on them. The Canadian and North Canadian Rivers, as described above, are dominant water features within the county and affect many of incorporated areas as well as a large amount of the unincorporated County. The Canadian River is the boundary in the southeast between Grady and Canadian counties. The floodplains of both rivers are used for agriculture and ranching, but also contain oil and gas wells, sandpits, municipal water wells, and sewage disposal ponds. Canadian County streams and drainage basins are listed in Table 4-7. The combined 100-year floodplains of the North Canadian and Canadian River and their tributaries comprise more than 45 square miles, or 5% of the County's area, as shown in Figure 4-2.

Flooding problems within the urban areas of the county are more likely to be associated with runoff from sudden, heavy rains, while the areas near the major rivers are more vulnerable to riverine flooding. Current North Canadian and Canadian River levels in can be found at the National Weather Service Forecast Office website at: http://water.weather.gov/ahps2/hydrograph.php?wfo=oun&gage=yuko2.

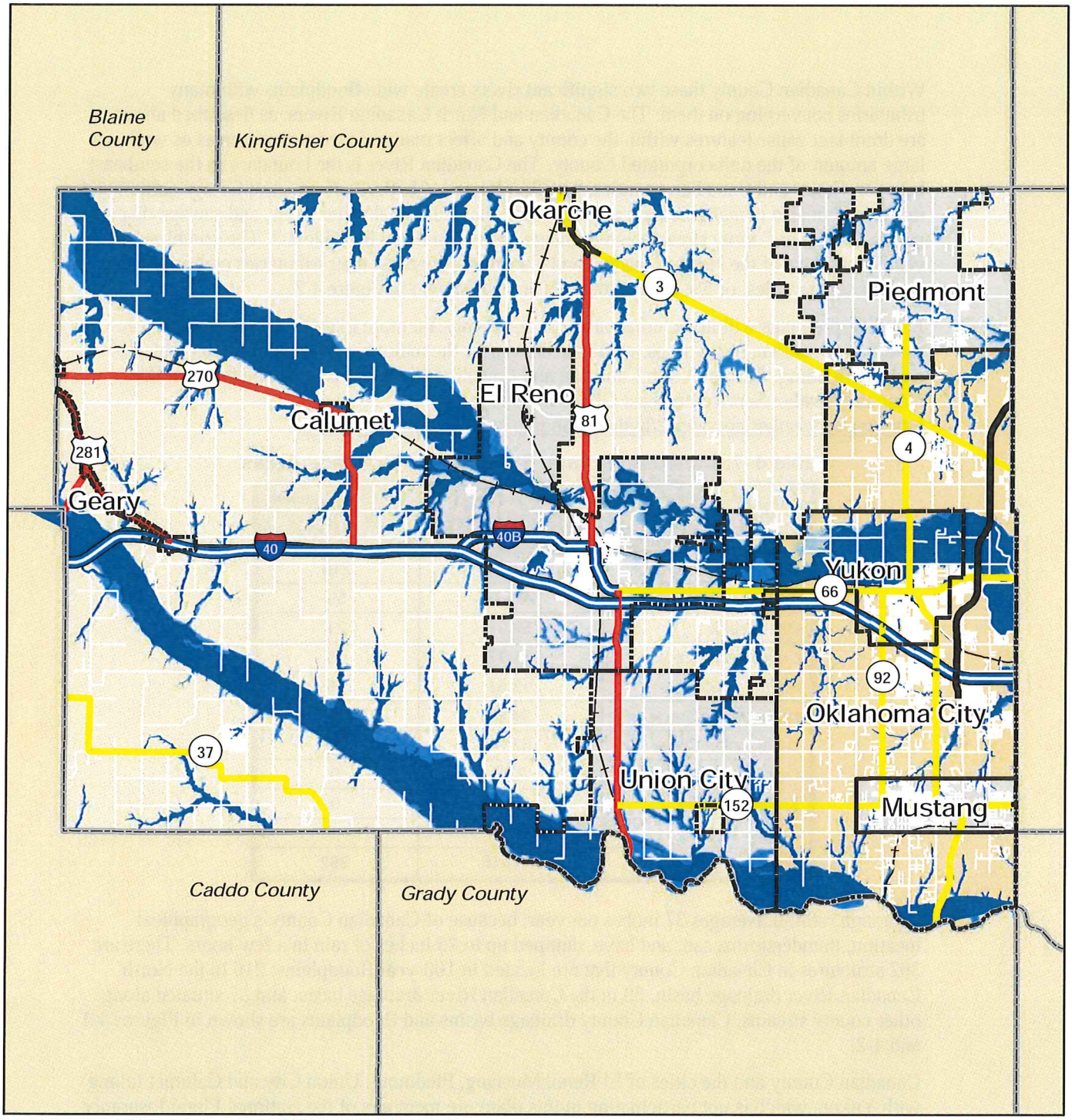
Table 4–7: Canadian County Streams and Drainage Areas

Rivers and Creeks	Total Drainage Area in Canadian County (sq. mi.)	Structures located in the 100-Year Floodplain
North Canadian River	373.52	216
Canadian River	261.44	59
Deer Creek	59.97	21
Cottonwood Creek	31.77	15
Soldier Creek	12.51	26
Uncle Johns Creek	94.89	4
Dead Indian Creek	52.64	20
Otter Creek	2.15	0
Kickapoo Creek	6.33	0
Buggy Creek	22.44	1
Total	**905.15**	**362**

Although rainfall averages 37 inches per year, because of Canadian County's geographical location, thunderstorms can, and have, dumped up to 15 inches of rain in a few hours. There are 362 structures in Canadian County that are located in 100-year floodplains: 216 in the North Canadian River drainage basin, 59 in the Canadian River drainage basin, and 87 situated along other county streams. Canadian County drainage basins and floodplains are shown in Figures 4-1 and 4-2.

Canadian County and the cities of El Reno, Mustang, Piedmont, Union City and Calumet (along with Yukon, which is not participating in this plan) are members of the National Flood Insurance Program (NFIP) and have adopted regulations establishing the 100-year flood level as the baseline for planning and development.

Unincorporated places in Canadian County are covered by the NFIP by virtue of Canadian County's membership and its compliance with NFIP regulations. Appendix F contains detailed maps illustrating the 100-year floodplains in the six Canadian County cities and towns covered by this Plan.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Railroads
- City Limits

- SFHA
- 500yr Floodplains
- 100yr Floodplains
- Not in Plan

0 2.5 5 Miles

N W E S

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Figure 4-2

Canadian County

100 yr. Floodplains

Measurement

Floodplain Management is based on what is termed "100-year floods," which is the flood that has a one percent (1%) chance of occurring in any given year. FEMA has established the Special Flood Hazard Area (SFHA), more commonly referred to as the 100-year flood level, as the base flood elevation (BFE) for planning and development along waterways.

As a part of its regulatory function the NFIP has established zones which are used in Flood Insurance Rate Maps (FIRM) and have a direct bearing on the flood insurance rates paid by the owner of a structure in the respective zones *(if the owner chooses to purchase flood insurance)*. Flood Insurance Rate Maps change from time-to-time based upon changing conditions within a community that affect the 100-year floodplain. Table 4-8 presents information on the flood zones.

Table 4–8: FEMA Flood Insurance Rate Map Flood Zones

Zone A	The 100-year or Base Floodplain. There are six types of A zones:	
	A	The base floodplain mapped by approximate methods, i.e., BFEs, are not determined. This is often called an unnumbered A zone or an approximate A zone.
	A1-30	These are known as numbered A zones (e.g., A7 or A14). This is the base floodplain where the FIRM shows a BFE (old format).
	AE	The base floodplain where base flood elevations are provided. AE zones are now used on new format FIRMs instead of A1-30 zones.
	AO	The base floodplain with sheet flow, ponding, or shallow flooding. Base flood depths (feet above ground) are provided.
	AH	Shallow flooding base floodplain. BFE's are provided.
	A99	Area to be protected from base flood by levees or Federal flood protection systems under construction. BFEs are not determined.
	AR	The base floodplain that results from the de-certification of a previously accredited flood protection system that is in the process of being restored to provide a 100-year or greater level of flood protection.
Zone V and VE	**V**	The coastal area subject to velocity hazard (wave action) where BFEs are not determined on the FIRM.
	VE	The coastal area subject to velocity hazard (wave action) where BFEs are provided on the FIRM.
Zone B and Zone X (shaded)	Area of moderate flood hazard, usually the area between the limits of the 100-year and the 500-year floods. B zones are also used to designate base floodplains or lesser hazards, such as areas protected by levees from the 100-year flood, or shallow flooding areas with average depths of less than one foot or drainage areas less than one square mile.	
Zone C and Zone X (unshaded)	Area of minimal flood hazard, usually depiction FIRMs as exceeding the 500-year flood level. Zone C may have ponding and local drainage problems that do not warrant a detailed study or designation as base floodplain. Zone X is the area determined to be outside the 500-year flood.	
Zone D	Area of undetermined but possible flood hazards.	

Source: ***Understanding Your Risks, Identifying Hazards and Estimating Losses, FEMA 386-2***

Extent/Severity

There are three common types of flooding in Canadian County: riverine flooding, flash flooding, and urban flooding. Riverine flooding occurs from excessive rainfall in upstream areas that forces rivers and streams to rise and overflow their banks, inundating the adjacent floodplains. Riverine flooding is usually a gradual process, with several hours to several days of warning time for downstream communities. This type of event usually remains in flood for a longer period than flash or urban flooding, and often causes more damage due to the length of time structures are inundated, the velocity and depth of water, and floating debris. Generally, a river rise of one foot above the SFHA is considered a flood of minor severity, with a major flood being a 500-year event.

Flash flooding in Canadian County is associated with the large convective thunderstorms that frequent the region that can drop between 1 and 5 inches of rain in the space of an hour. When the soil is already saturated, rainfall from such storms can converge in creeks and streams suddenly, with little warning. Although potentially hazardous to life and destructive of property, flash flooding usually lasts only a matter of hours.

Urban flooding occurs when heavy rainfall runs off of structures, parking lots and streets and converges in culverts and drainage ways, often clogged with debris, causing streets to flood and storm sewers to back up.

The extent and impact of flooding can be controlled, to a degree, by mapping urban development, soil conditions and 100-year floodplains, researching the extent of past flooding, assessing historical rainfall data, maintaining drainage ways and stormwater facilities, and estimating the likely contribution to flooding that will result from recent and future development. Most communities in Canadian County use such methods to limit the extent of flooding from thunderstorms.

Canadian County considers a flood event with a depth of less than three feet of water on a one story building to be a minor severity event and a flood event with a depth greater than three feet on a one story building to be a major severity event for both urban and flash flooding.

Frequency

Between 1995 and 2009 Canadian County reported 30 flooding events. Several of these (five) were county-wide events, but most reports were for communities: nine in Yukon, five each in El Reno and Piedmont, two in Mustang, and one each in Calumet, Union City and Okarche. Given this data, Canadian County, along with the communities of El Reno and Piedmont, can expect damaging flood events about once every three years; Mustang, Calumet, Okarche and Union City once every 15 years; and Yukon (not participating in this Plan) once every 1.7 years. (See Appendices F and G for detailed analyses of flooding for each of the County's incorporated communities and public schools that are covered by this Plan)

Impact

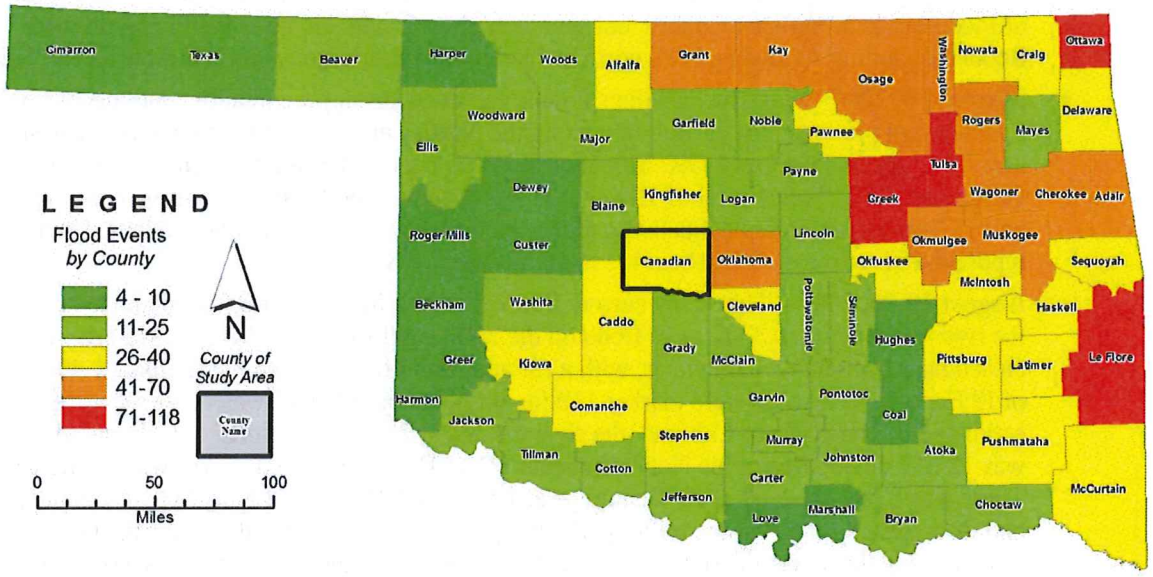
The impact of the flood hazard occurs during times of large convective thunderstorms and heavy rainfall. Roads become impassible, homes and businesses are inaccessible, and response to an emergency becomes limited or impossible. Flooded roadways create a financial and time hardship for citizens, school districts and others, forcing motorists to find alternate routes to their destinations.

4.1.2 History/Previous Occurrences

Central Oklahoma has generations of experience with flooding, with many of the causes having to do with location. The soils in floodplain bottomlands are rich for agriculture and very desirable

for development. Canadian County and the associated drainage basins are located in a zone of violent storms. The most serious floods in Canadian County occurred during the years of 1904, 1914, 1923, 1941, 1943, 1953, 1984 and 2007. The relative frequency of flooding in the county, compared with other counties in the state, is shown in Figure 4-3.

Figure 4–3: Floods in Oklahoma from 1989-2009



Source: National Climatic Data Center U.S. Storm Events Database

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As stated above, in the first half of the 20th Century flooding along the Canadian and North Canadian rivers was frequent and destructive. As a result, flood control dams were built in both basins: on the Canadian River: Conchas, Ute and Sanford dams, and on the North Canadian: Optima, Ft. Supply and Canton dams. In recent years the most catastrophic floods for the county have been along the North Canadian River. Canton Lake Dam was built by the U.S. Army Corps of Engineers in 1965, about 51 stream miles above the Canadian/Blaine County line. The flood control storage of the lake is 266,000 acre-feet of water and is designed to contain the runoff from the contributing 3,765 square miles of upstream drainage located between Canton and Fort Supply Lakes. This provides storage for a flood in excess of the 100-year flood. The lake is also used to store water for release to Lake Hefner and the Oklahoma City water system. Before the dams were built on the Canadian and North Canadian rivers, torrential rains in the headwater areas would send enormous flood surges downstream to wreak havoc to farms and communities that had no way of preventing or stopping them.

There have been 30 reported flood events in Canadian County between 1995 and 2009. These are summarized in Table 4-9.

Table 4–9: Floods in Oklahoma and Canadian County from 1995-2009

Location	Events	Deaths	Injuries	Damage Events	Property Damage
Canadian County	30	0	3	9	$3,042,000
Oklahoma	1,971	25	25	355	$79,668,000

From NOAA National Climatic Data Center

Canadian County Flood Events

- **May 10, 1993** – Flooding reached 21.12 feet in El Reno, and until the August 2007 event this was the flood of record for the river at Calumet, with flows of 9,310 cfs.
- **June 25, 2000** - A heavy downpour inundated drainage basins both upstream and in Piedmont, resulting in flooding in several areas of town. Most of the flooding occurred north of Piedmont in Kingfisher County, but several highways and streets in the Piedmont were flooded including Arrowhead Rd. north of Piedmont, Washington Ave. and Apache Rd. NE.
- **March 4-6, 2004** - Western Canadian County recorded storm precipitation amounts of up to 6 inches that produced minor flooding along the North Canadian River at the river gage sites near Watonga and Calumet, OK. Moderate flooding occurred along the Canadian River near Bridgeport, OK where a crest of 16.2 feet (2.2 feet above flood stage) was observed at 2:00 am CST on March 5. Residents living along the Canadian River in southern Blaine County reported that river rose 6 feet near the town of Geary, OK.
- **August 19-20, 2007** – This is the current flood of record for the North Canadian River, with the river cresting at 23.33 ft. at El Reno on the 20th, and flows of 23,000 cfs. US Hwy 81 was closed near I-40 due to high water, with a car and semi both stranded in the flood. I-40 west of El Reno was closed at mile marker 119 for six hours by 9 feet of water. Losses were estimated at $100,000. In Calumet, the river crested at 22,000 cfs. North of Calumet, there was 12 feet of flooding at the North Canadian River Bridge, where the river was 1 mile wide. There was 3 feet of water at the Standpipe at 122nd St. NW and S. Flynn Ave. in Calumet, and floodwaters impacted the trailer park along Walls Ave., inundated the sewage lagoons east of town, the sewer lift station near the high school, and the grain elevators along the AT&L railroad tracks. In Mustang, OK Hwy 152 was closed west of town. Numerous persons had to be rescued from their vehicles, but no injuries were reported. OK Hwy 4 was closed in Mustang due to the high water. In Okarche, the Prong Bridge east of town was closed due to water running over the top of it. In Piedmont, a car was washed off of Banner Road. It was the third highest flood on the Canadian River at Union City, where the river reached 13.5 feet. Bridgeport and Union City stations had not experienced crests of this height in the past half-century. Bridgeport's flood crest broke a record that had held since 1914, and Union City had the highest flood since 1937.
- **August 19, 2008** - Widespread flooding occurred over eastern Canadian county, with the greatest flooding occurring from NW 23rd Street and Richland Avenue to Highway 66 and Banner Road. Five people were rescued by boat here, with three of those from homes and two from cars. Many roads around Union City were covered by water
- **June 13, 2010** – Ten inches of rain in eastern Canadian and northwestern Oklahoma counties forced Mustang Creek out of its banks and over SW 59th St. One resident said it was the "absolute worst flooding" she had ever seen. Among areas flooded in Mustang were 74th St. east of Mustang Rd., and Cemetery Rd. and SW 59th St.

Probability/Future Events

Large storms and heavy rains will continue to frequent Canadian County, and the jurisdiction's streams will overflow their banks onto the surrounding floodplains. As mentioned above, there are a total of 362 structures in the floodway and 100-year floodplains of the county.

Canadian County, its communities and public school systems have a moderate probability of a future flood event, unless specified otherwise in Appendix F or Appendix G.

Flooding hazards from dam or levee breaks and forced reservoir releases are discussed in Section 4.14 Dam Break.

4.1.3 Vulnerability

This section summarizes information about Canadian County's vulnerability to flooding, including the impact on people, structures and buildings, critical facilities, and infrastructure. This information, as well as information provided by the County, incorporated communities and public schools, was used to determine the Vulnerability Criteria identified in Tables 4-2 and 4-3. HAZUS modeling was used to help generate these data.

Floodplains of Canadian County – Canadian County has approximately 8,504 parcels located within the SFHAs of its various rivers and creeks, with an estimated market value of approximately $561,099,955. This number is an approximation, based on GIS analysis and county assessor data.

Population

Those at greatest risk during major floods are people living in residences located in repetitive flood areas. Also at risk are those traveling by car and on foot in areas prone to flash flooding during periods of heavy rain. Motorists who ignore barricades and warnings against driving on flooded roads are also at high risk. Just two feet of water moving at 10 mph will float virtually any car, SUV or pickup.

Persons who are directed to evacuate an area due to rising water but are without appropriate transportation could also be at increased risk, as well as those who are unwilling to leave their homes for fear of looting or leaving pets behind.

Additionally, persons new to the area, or those whose English language skills are limited, may not understand the true nature of the hazard and take the necessary precautions.

All students, staff and faculty of Canadian County schools exposed to the Flood hazard, are vulnerable to flood events of all levels of intensity. Depending on the extent of the damage, floodwaters can cause schools to remain inaccessible for extended periods of time. Schools must be closed during flood cleanup and repair; schools located in a floodplain, may remain closed permanently

Structures/Buildings

Altogether, there are approximately 362 structures located in the SFHAs of Canadian County (not including Yukon), based on a visual survey of aerial photographs from 2010, and from data from the County Assessor's office.

Critical Facilities

There are two critical facilities situated in or near the 100-year floodplain and therefore vulnerable to flooding, as listed in Table 4-6.

Infrastructure

With Oklahoma's aging infrastructure, transportation facilities in Canadian County, such as roads and bridges, are vulnerable to flood damage.

4.1.4 Flood Scenario

Flood Scenarios for cities and towns and public schools are found in Appendices F and G.

4.1.5 Future Trends

Canadian County regulates the FEMA SFHA, ensuring that no insurable structure will be built with its first finished floor below the base flood elevation (BFE). However, buildings permitted

and built today in accordance with the National Flood Insurance Program's (NFIP) minimum standards could well flood in the future as the basins develop. Future urbanization and development will cause increases in storm water run-off and flood depth. This increase will widen floodplains and raise the BFE. Without the detailed modeling and analysis provided by a basin-wide Flood and Drainage Annex to the Multi-Hazard Mitigation Plan (FDAHMP), it is not possible to accurately predict the impacts of future development or the damage to future buildings and development that have been permitted to the minimum standard.

For information on future development areas in Canadian County, see Section 1.2.8.

Population

Canadian County's population increased 31.8% from 2000 to 2010. Growth is primarily in the eastern half of the county. Without careful planning, urbanization in Canadian County could increase runoff and the possibility of flooding.

Structures/Buildings

As development in new areas and revitalization of existing areas continues, locations and building techniques should be closely examined. Increasing the urban footprint in the community can potentially create water run-off to other areas that were previously at low or no risk of flooding.

An aggressive and ongoing public awareness program should be maintained to ensure new and existing development follows either NFIP guidelines, or construction industry best practices.

Critical Facilities

Canadian County currently has two critical facilities located in the SFHA. With the County's strong commitment to the enforcement of flood plain zoning guidelines, it is not anticipated that any new development of critical facilities will occur within the flood zones of the jurisdiction.

Any renovations or improvements made to existing critical facilities should be evaluated to ensure the improvements will mitigate potential flood damage.

Infrastructure

Transportation Systems (Highways, Public Transportation, Railway, Airports) and Wastewater Treatment – Currently, Canadian County's most likely threat from flooding would be road closures, damage to bridges and pipelines, and the release of pollutants from wastewater treatment plants and septic systems into rivers and streams. Plans for street, highway, and wastewater improvements should take such possibilities into account.

4.1.6 Conclusion

Although some parts of communities and schools have a high vulnerability to flooding, Canadian County was determined to be at moderate risk to the flood hazard. (See Table 4-2 Hazard Vulnerability Ranking, and Table 4-3, Summary of Hazard Vulnerability Ranking Criteria for an explanation of how the rankings were derived.) Appendices F and G identify flood vulnerabilities for cities and towns and public schools.

Data Limitations

While rain events and the extent of flooding produced can be reasonably predicted, other sources of floodwater, such as snowmelt, waterline breaks, or blocked storm drains cannot be as accurately defined and predicted. Theses sources of floodwater are, however, relatively less common than flooding caused by rainfall.

Update Changes

Identified significant changes made from previous Multi-Hazard Mitigation Plans from Canadian County, Calumet, El Reno, Mustang, Piedmont, and Union City are outlined in Appendix E. Changes are based on criteria outlined for Plan Updates in the Local Multi-Hazard Mitigation Planning Guidance document of July 1, 2008.

4.1.7 Sources

Extreme Weather and Climate Events at National Climatic Data Center website:
http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms

FEMA Flood Insurance Statistics at Website:
http://www.fema.gov/business/nfip/statistics/pcstat.shtm