STANDARD HAZARD MITIGATION PLAN UPDATE FOR THE GREAT STATE OF OKLAHOMA

FEBRUARY 17, 2011

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State of Oklahoma Adoption Resolution

ALBERT ASHWOOD
STATE DIRECTOR

MARY FALLIN
GOVERNOR

STATE OF OKLAHOMA
DEPARTMENT OF EMERGENCY MANAGEMENT

HAZARD MITIGATION PLAN ADOPTION

The 2011 State of Oklahoma Standard Hazard Mitigation Plan is hereby adopted.

The State of Oklahoma will continue to comply with all applicable federal laws and statues during the periods for which it receives grant funding, in compliance with 44 CFR §13.11(c), and will amend this plan whenever necessary to reflect changes in state or federal laws and statues as required in 44 CFR §13.11(d).

The State will also continue to pursue Enhanced State Hazard Mitigation Plan status (44 CFR §201.5) in the near future by showing improved performance in application development, historic preservation and basic grants management while continuing our dedication to risk reduction for the citizens of Oklahoma.

1/27/11

ALBERT ASHWOOD, Director
Oklahoma Department of Emergency Management
Governor's Authorized Representative

Dated

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Chapter One: Introduction

Each section of the plan update from the period of prior approval through October 26, 2010 was analyzed and reviewed by each member of the State Hazard Mitigation Planning Committee (SHMPC) and the administrative staff to determine whether updates to the plan were necessary. Chapter one was reviewed by the SHMPC who determined that updating was required. Information, maps and other material were updated to include changes that occurred during the planning period ending October 26, 2010. The mitigation committee listings were updated and a portion of the State Administrative plan was removed. Data from Local and Tribal plan summaries is added.

1.1 About the Plan

This document is the Standard Hazard Mitigation Plan Update for The Great State of Oklahoma February 17, 2011 hereafter known as the "Plan" or the Oklahoma State Hazard Mitigation Plan.
It is a strategic planning guide to be presented in fulfillment of requirements of the Disaster Mitigation Act (DMA) of 2000 which amends the Robert T. Stafford Disaster Relief and Emergency Assistance Act, to authorize a program for pre-disaster mitigation, to streamline the administration of disaster relief, to control the federal cost of disaster assistance, and for other purposes. This act broadens existing relief programs to encourage disaster preparedness plans and programs, coordination and responsiveness, insurance coverage, and hazard mitigation measures.
This updated plan maintains the qualification of the State of Oklahoma to obtain disaster assistance including hazard mitigation grants available through the Robert T. Stafford Disaster Relief and Emergency Assistance Act, P.L. 93-288, as amended. This Plan is designed to fulfill the requirements of the following programs available through the Federal Emergency Management Agency (FEMA):

- Pre-Disaster Mitigation Program (PDM);
- Post-disaster assistance through the Hazard Mitigation Grant Program (HMGP);
- Flood Mitigation Assistance Program (FMA),
- Community Rating System Floodplain Management Planning (CRS);
- Severe Repetitive Loss Program (SRL);
- Repetitive Flood Claims Program (RFC).

Certain Categories of Permanent Public Assistance in time of Emergency including:
Permanent Work:

Category C: Roads and Bridges,
Category D: Water Control Facilities,
Category E: Buildings and Equipment,
Category F: Utilities and
Category G: Parks, Recreational Facilities, and other Facilities

This State Plan addresses all natural hazards that have been identified as being a threat to the State of Oklahoma, as that is the requirement of the federal regulations cited above. Also included are the hazards associated with Special Events. In the future, the State will initiate additional studies to address technological and man-made hazards. The State of Oklahoma Emergency Operations Plan (EOP) contains an annex that addresses terrorism and man-made hazards.

1.1.1 Purpose

The escalating cost of emergency relief aid has prompted the Federal Emergency Management Agency (FEMA) to focus its priorities toward mitigation. This is a dramatic shift from FEMA's traditional charter of responding to disasters and being prepared to respond. As part of the national mitigation strategy, a state wide hazard mitigation plan is required by Federal law, in Robert T. Stafford Disaster Relief and Emergency Assistance Act, enacted in 1989, as a condition of disaster assistance. Current Federal strategy is moving toward greater local choice, responsibility and long-term strategic planning for mitigation.

The purpose of this plan is to provide the framework and guidance for an all-hazard approach to mitigation. It identifies hazard mitigation goals, objectives and recommended actions and initiatives that will reduce or prevent injury and damage from natural hazards. This plan points out hazard problems and measures to be implemented or continued, to alleviate the suffering and damage caused by disasters within the state. This process will encompass the following actions:

1. Access the ongoing hazard mitigation activities in the State of Oklahoma;
2. Identify and assess the hazards that pose a threat to citizens and property;
3. Evaluate additional mitigation measures that should be undertaken;
4. Outline a strategy for implementation of mitigation measures.

1.1.2 Scope

The scope of the Plan is statewide. To be as effective and complete as possible, the Oklahoma Natural Hazard Mitigation plan incorporated information on hazards and risk assessment from local plans.

One hundred and eighty five FEMA approved local and tribal plans covering four hundred sixty eight jurisdictions were reviewed and summarized. This data will be used throughout this plan.

The resources of the State via Oklahoma Climatological Survey and Oklahoma Geological Survey were found to exceed the local jurisdictional resources. The State gathered data and disseminated that information to all pertinent local jurisdictions to analyze and apply as needed to their local plans.

1.1.3 Authority

The current requirements, reflected in Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, 42 U.S.C. 5165, enacted under Section 104 of the Disaster Mitigation Act (DMA) of 2000 (P.L. 106-390), provides new and revitalized approaches to mitigation planning. Section 322, in concert with other sections of the Act, provides a significant opportunity to reduce the nation's disaster losses through mitigation planning. The act emphasizes the need for tribal, state, and local entities to closely coordinate mitigation planning and implementation efforts.

A major requirement of the law is the development of state and local hazard mitigation plans, including American Indian Tribes. The plans must be developed and approved by FEMA in order for the tribal, state and local jurisdictions to be eligible for mitigation funding. Local mitigation plans must be reviewed, updated and submitted to the State Hazard Mitigation Officer, and then re-approved by FEMA every five years to remain eligible. Tribal Plans follow a similar process but each tribe has the option to be a Grantee or Sub-Grantee. When the tribe chooses to be a Grantee they will submit their plan directly to FEMA Region VI. The Plan will be reviewed, updated, adopted by state officials and submitted to FEMA for approval every three years. This Mitigation Plan has been prepared to meet the requirements for a Standard State Plan under Interim Final Rule 44 CFR 201.4, published by the Federal Emergency Management Agency.

1.1.4 Funding

Funding for the Plan update was provided by a 75 percent PDM grant from FEMA, through Oklahoma Emergency Management (OEM). The State share, 25 percent, was provided by the State through OEM.

1.1.5 Strategy and Goals

In order to minimize the destruction and devastation resulting from disasters, the State of Oklahoma developed this Hazard Mitigation Plan to guide all levels of government, business and the public, and established goals to be achieved through implementation of a number of hazard mitigation measures. In addition to the daily oversight of Pre-Disaster Mitigation that will be provided by Oklahoma Emergency Management, the State Hazard Mitigation Team will play a key role relative to general

oversight, reviewing goals, objectives, and developing Pre-Disaster Mitigation implementation plans. The strategy of the State of Oklahoma is to utilize the mitigation programs of the Federal Government to minimize the loss of life and property to the citizens of the state. Each natural hazard that is identified to apply to any portion of the State of Oklahoma will be addressed and eliminated where possible through the implementation of the HMGP, PDM, SRL, FMA and RFC programs and grants. The approach of the strategy will be all-hazards as relates to the entire state, with a *specific* focus on prioritizing and mitigating those hazards statewide (overview of local plans) and developing the criteria for the State Plan pursuant to section 322 of the Stafford Act. The plan is intended to promote increased coordination among state agencies and local officials and to integrate hazard mitigation management capabilities and programs into everyday government functions. The primary goals of the plan are to:

- Protect public health and safety
- Eliminate losses from severe repetitive loss properties
- Eliminate losses from repetitive loss properties
- Improve government recovery capability
- Provide **pre** and **post**-disaster recovery guidance
- Reduce losses/damage to property and infrastructure
- Preserve natural and historic resources in vulnerable areas
- Preserve the environment
- Focus on those mitigation measures that are cost effective and provide the best benefit to communities.

The key measures to implement these goals include:

- Enhance communication between tribal, state, federal agencies and local governments to facilitate post-disaster recovery and pre/post-disaster mitigation;
- Coordinate federal, state, local, and private resources to enhance the preparedness and mitigation processes;
- Ensure consistency between federal and state regulations;
- Provide protection from hazards for critical facilities;
- Support legislation that protects hazardous areas from being developed.

Another important goal of this plan is to expand the focus of mitigation measures to include the major hazard threats to Oklahoma such as floods, tornado, severe weather, earthquakes, winter storms and wildfires.

1.1.6 Point of Contact

Oklahoma Emergency Management is the primary point of contact for information regarding this plan.

Bill Penka, State Hazard Mitigation Officer/Chair (SHMPC)
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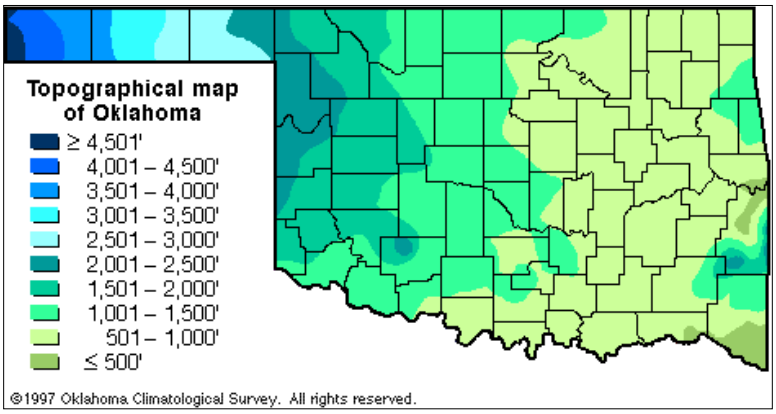
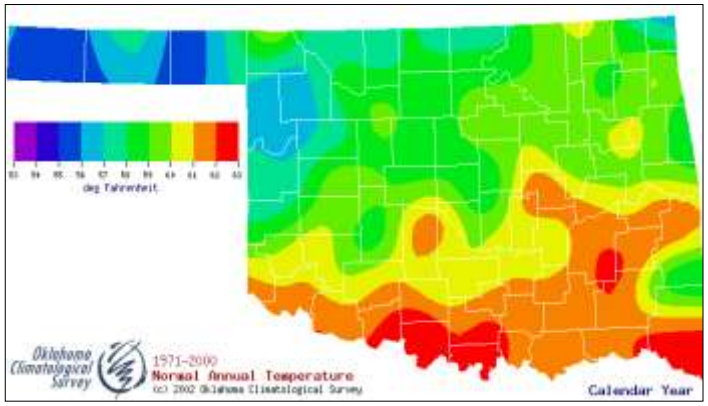
1.2 Jurisdiction Description

1.2.1 Oklahoma's climate: an overview

Oklahoma is located in the Southern Great Plains. Of the 50 states, it ranks 20th in size, with an area of 69,903 square miles, about 1,224 of which are covered by water. The terrain is mostly plains, varying from nearly flat in the west to rolling in the central and near east. The plains are broken by scattered hilly areas that include the Wichita Mountains in the southwest and the Arbuckle Mountains in the south central part of the state. The Ouachita Mountains dominate much of the southeast, with peaks that rise as much as 2,000 feet above their base. Extreme northeastern counties are part of the Ozark Plateau, which is marked by steep, Rocky River valleys between large areas of hills and rolling plains. The western tip of the panhandle features part of the Black Mesa complex, a fractured terrain featuring large mesas overlooking seasonal creek and riverbeds. Elevations range from 287 feet above sea level where the Little River exits in southeastern Oklahoma to 4,973 feet on Black Mesa near the New Mexico border.



Oklahoma lies entirely within the drainage basin of the Mississippi River. The two main rivers in the state are the Arkansas, which drains the northern two-thirds of the state, and the Red, which drains the southern third and serves as the state's southern border. Principal tributaries of the Arkansas are the Verdigris, Grand (Neosho), Illinois, Cimarron, Canadian and North Canadian. The Washita and Kiamichi serve as the Red's principal tributaries in Oklahoma, with the Little River flowing into the Red after it crosses into Arkansas.

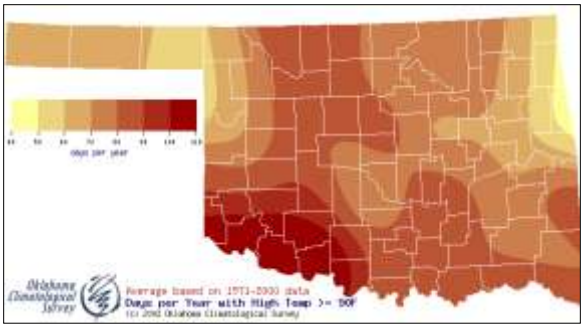


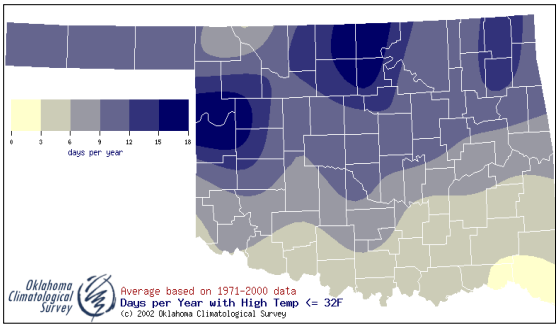
This series of maps shows the result of a thirty year average 1971 thru 2000 of weather statistics for the state of Oklahoma. This is not the latest historical data but a thirty year average for the purpose of leveling the peaks and valleys. These maps will be updated in 2011 after 2010 data is compiled so a new thirty average can be compiled for the period of 1981 thru 2010.

1.2.1.1 Temperature

The mean annual temperature over the state ranges from 62° F along the Red River to about 58° F along the northern border. Temperatures of 90° F or greater occur, on average, about 60-65 days per year in the western panhandle and the northeast corner of the state. Temperatures of 100° F or

higher occur, frequently during some years, from May through September, and very rarely in April and October. The western half of the state, excluding most of the
Panhandle, averages 15+ days of triple-digit temperatures, ranging from about 35 in the southwest corner to 25 in the northwest area. Years without 100° F temperatures are rare, ranging from about one of every seven years in the eastern half of the state to somewhat rarer in the west. The highest temperature ever recorded in the Oklahoma was 120° F.



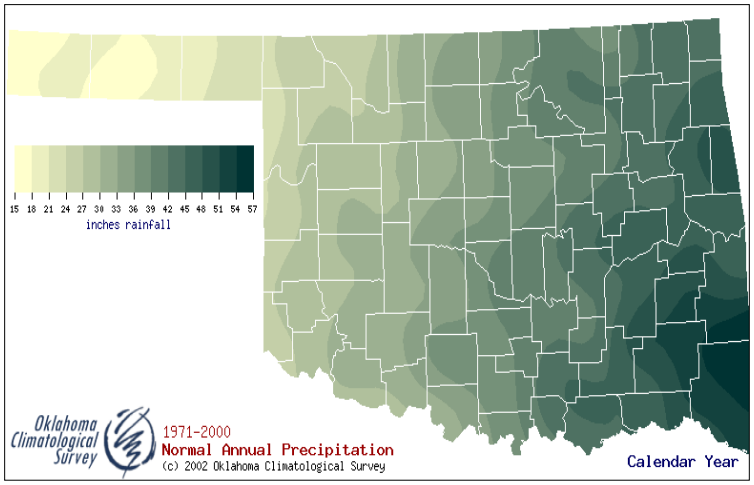


Temperatures of 32° F or less occur, on average, about 60 days per year in the southeast. The lowest temperature on record is -27° F, set originally at Vinita on February 13, 1905, and tied at Watts on January 18, 1930.

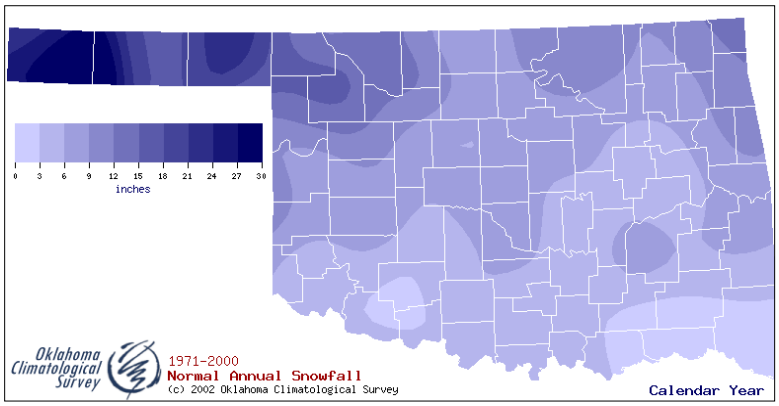
Frozen soil is not a major problem, nor much of a deterrent to seasonal activities. Its occurrence is rather infrequent, of very limited depth, and of brief duration. The average maximum depth that frost penetrates the soil ranges from less than three inches in the southeastern corner of the state to more than 10 inches in the northwestern reaches. Extreme frost penetration ranges from about 10 inches in the southeast to almost 30 inches in the western panhandle.

1.2.1.2 Precipitation

Although precipitation is quite variable on a year-to-year basis, average annual precipitation ranges from about 17 inches in the far western panhandle to about 56 inches in the far southeast. The greatest annual precipitation recorded at an official reporting station was 84.47 inches at Kiamichi Tower in the southeast in 1957. The least annual rainfall occurred during 1956, when Regnier, in the extreme northwestern panhandle, observed 6.53 inches.



Excessive rainfall occurs at times. Amounts of ten inches or more in 24 hours, while rare, have been recorded. The greatest official rainfall in a 24-hour period is 15.68 inches at Enid on October 11, 1973. Amounts up to 20 inches in a day have also been reported from non-standard sources.



Snowfall remaining on the ground more than a few days is an uncommon occurrence in northwestern Oklahoma, quite rare in central Oklahoma, and almost unheard of in the southeast. The greatest seasonal snowfall ever recorded in the state was 87.3 inches at Beaver during the winter of 1911-1912.

Freezing rain is a distinct wintertime hazard in Oklahoma. The resulting ice cover can down power lines and limbs, causing millions of dollars in damages and widespread power outages. These events make automobile travel very treacherous, especially on secondary roads, where the hazard can last several days. Significant icing events occur with nearly the same frequency as heavy snow events, especially in the southeastern half or so of the state. While ice accumulation is usually less than an inch, storms that deposit several inches can occur once or more per decade. The consecutive winters of 2000-01 and 2001-02 each featured a major ice storm that deposited more than three inches of ice in 24 hours across much of southeast and central Oklahoma. Two damaging ice storms affected Oklahoma in 2007. The first, in January, affected primarily southern and eastern Oklahoma. The latter, in December, was most severe in central and northeastern Oklahoma. Although ice accumulation in the latter event was generally one inch or less, it caused extensive damage to trees that subsequently took down power lines, knocking out power to more than 600,000 customers.

1.2.1.3 Floods and Drought

Floods of major rivers and tributaries may occur during any season, but they occur with greatest frequency during those spring and autumn months associated with greatest rainfall. Such floods cost many lives and property damage in the first 50 years of statehood, but flood prevention programs have reduced the frequency and severity of such events. Flash flooding of creeks and minor streams remains a serious threat, especially in urban and suburban areas, where development and removal of vegetation have increased runoff. See the following map depicting lakes and waterways throughout the State of Oklahoma.

RED AND ARKANSAS RIVER BASINS
AND MAJOR TRIBUTARIES

Drought is a recurring part of Oklahoma's climate cycle, as it is in all the plains states. Almost all of Oklahoma's usable surface water comes from precipitation that falls within the state's borders. Therefore, drought in Oklahoma is tied almost entirely to local rainfall patterns (i.e., the influence of upstream events on drought is very small). Western Oklahoma tends to be slightly more susceptible to drought because precipitation there tends to be more variable (percentage-wise) and marginal for dry land farm applications.

Drought episodes can last from a few months to several years. Those that last a few months can elevate wildfire danger and impact municipal water use. Seasonal droughts can occur at any time of the year, and those that resonate with crop production cycles can cause billions of dollars of damage to the farm economy. Multi-season and multi-year episodes can severely impact large reservoirs, stream-flow and groundwater.

Since modern Climatological record-keeping began in the late nineteenth century, the state has seen five major multi-year and multi-regional drought events. These occurred in the late 1890s, from 1909-18, 1930-40, 1952-58 and, to a lesser extent, 1962-72. Each of these episodes contained at least one year of above-normal rainfall. The drought of the 1930s is associated with the Dust Bowl of the Great Plains, when socio-economic conditions, agricultural practices and drought forced the largest emigration of Oklahomans in state history. It is yet to be determined if the drought of 2005-2006, while at times more severe than any on record, will be as extensive as these other events.

The agricultural impact of drought is increasingly mitigated on a farm-by-farm and year-by-year basis through irrigation of crops, mostly with fossil water. This practice dominates much of the panhandle and some of the rest of western Oklahoma.

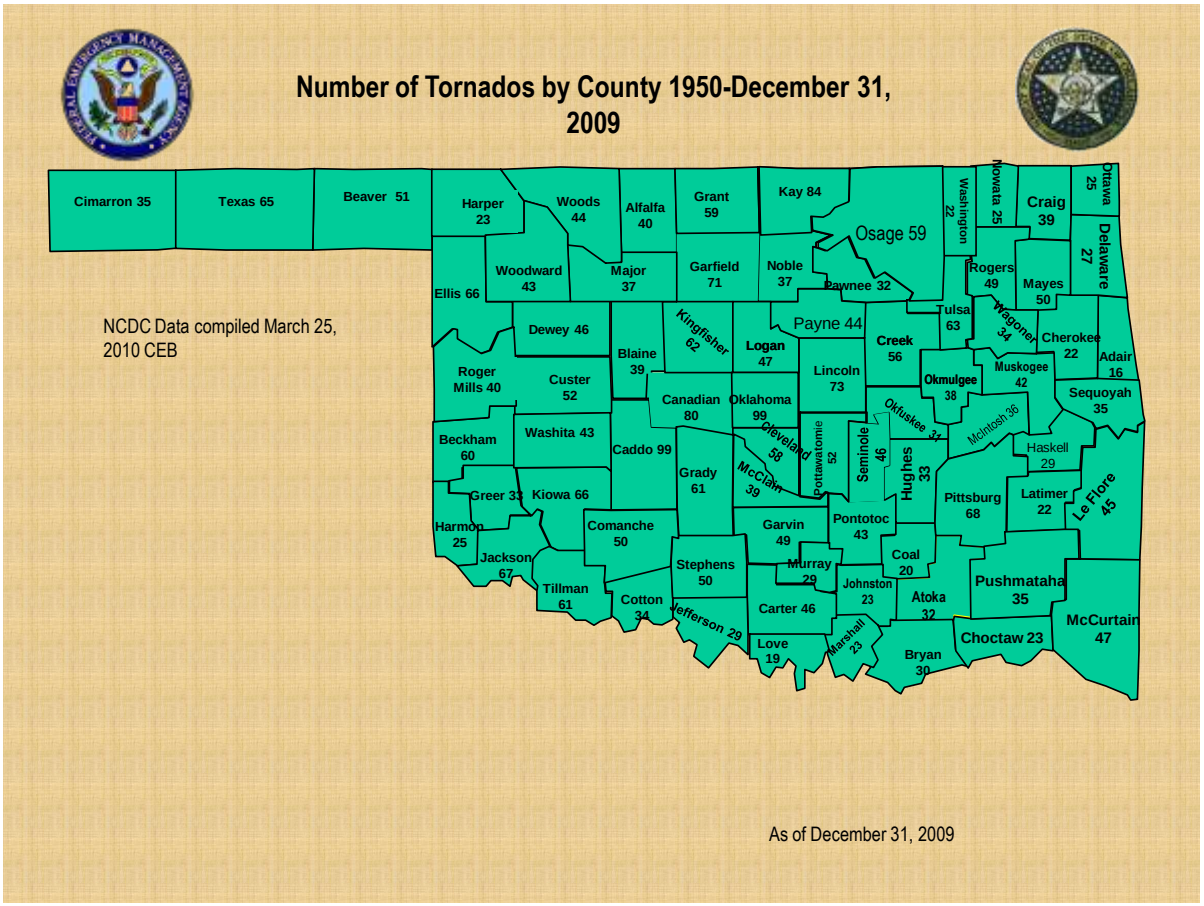
Development of water supplies has aided community resiliency, helped in large measure by the Oklahoma Water Resources Board's Financial Assistance Program. Upgrades to municipal and rural water district water/wastewater systems over the previous two decades allowed communities, which

previously may have run dry under such circumstances, to more effectively manage their water supplies during the most recent drought.

1.2.1.4 Severe Weather

Thunderstorms occur, on average, about 55 days per year in the east, decreasing to about 45 days per year in the southwest. Late spring and early summer are the peak seasons for thunder, averaging about eight thunderstorms per month per location during these seasons. For the southeastern two-thirds of the state, thunder occurs most often in May. June is the peak month for much of the remainder of the state, while the western panhandle observes the most thunder in July.
General thunderstorms are quite common in the summer, but tend to be less organized storms of relatively short duration. These storms can produce locally heavy rain and some hail. Severe weather can occur at any time of day, but the maximum frequency for severe weather is from mid-afternoon to sunset.

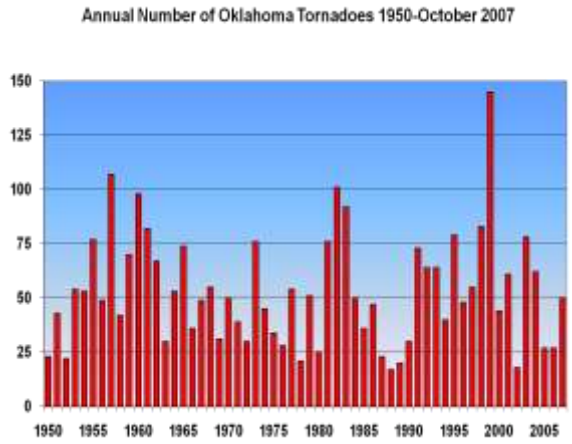
1.2.1.5 Tornados

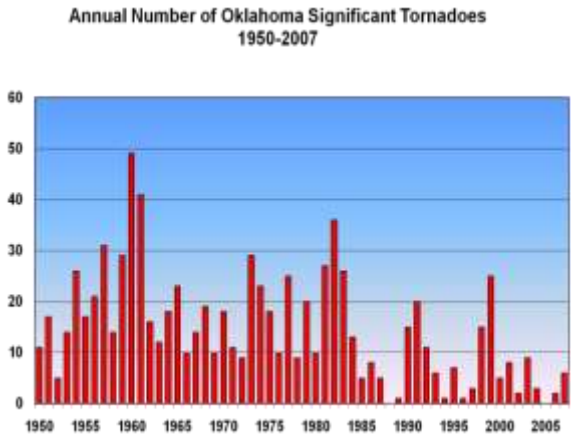


Tornados are a particular hazard, in that the frequency of occurrence per unit area is among the greatest in the world. Since 1950, an average of 54 tornados has been observed annually within the state's borders.

Tornados can occur at any time of year, but are the most frequent during springtime. April, May and June represent the months of peak occurrence with these three months accounting for about three-fourths of the observations. May's average of 20 tornado observations per month is the greatest. The

winter months each average less than one tornado per month. About 80 percent of tornados are observed between noon and midnight Central Standard Time, with the peak hours being between 4 pm and 8 pm. Most of Oklahoma's tornados travel from the southwest to the north and east. Although the annual number of tornados striking Oklahoma is increasing, the proportion of those ranking among the most severe has actually been declining. Improved technology and recording practices have improved counts and documentation of those at the weaker end of the spectrum, thus accounting for the increase in overall number. However, the number of significant tornados (those rating as F2 intensity or greater) has declined, particularly since 1982. In fact, the years with the greatest numbers of significant tornados were 1960 and 1961, with 49 and 41, respectively. Declining death tolls and declining numbers of significant tornados does not necessarily mean Oklahoma is becoming less at risk. As the May 3, 1999 tornado showed, one event could forever impact the lives of many Oklahomans.





Source: Oklahoma Climatological Survey

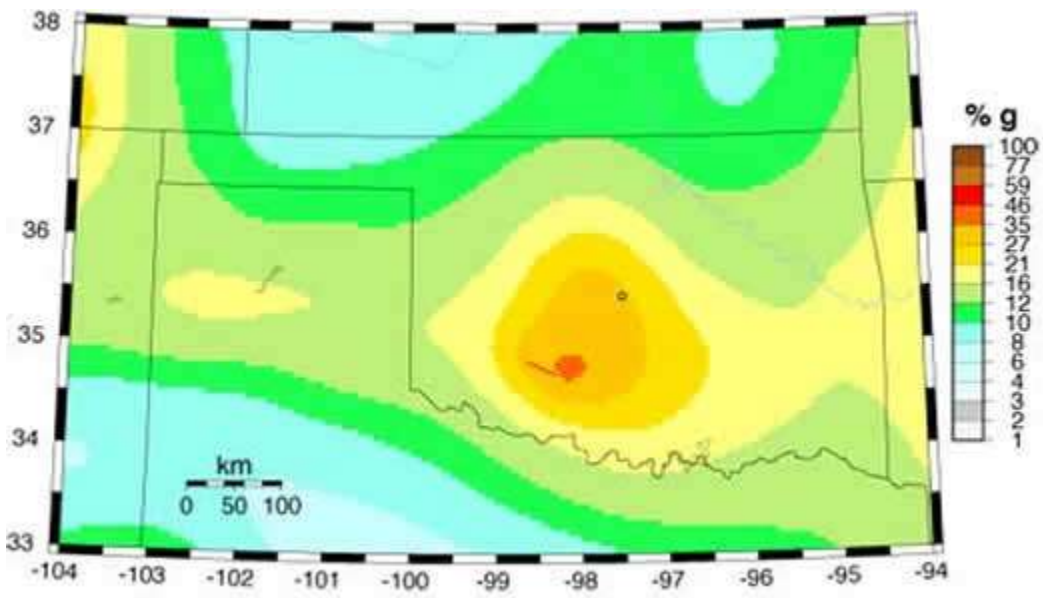
1.2.1.6 Earthquakes

On average there are about 50 measurable earthquakes each year in Oklahoma with only a few of these with shaking strong enough to be felt. 2009 was an exceptional year for seismic activity in Oklahoma with 43 felt earthquakes with 27 of those occurring in Oklahoma County. 2010 has been active as well. The Oklahoma Geological Survey has been running seismograph stations in partnership with volunteers since 1961. Since 1977 there have been more than 1,800 earthquakes located in Oklahoma.

The earliest documented earthquake in Oklahoma occurred on October 22, 1882, and while it cannot be precisely located, the strongest shaking, Modified Mercalli Intensity of VIII, was reported at Fort Gibson, Indian Territory. On April 9, 1952 the largest instrumentally recorded earthquake in Oklahoma occurred near El Reno in Canadian County. This earthquake had a magnitude of 5.7 according to Oklahoma Geologists and caused damage to the State Capitol Office Building in Oklahoma City. Its effects were felt as far away as Austin, Texas and Des Moines, Iowa.

The 1811 and 1812 New Madrid, Missouri, earthquakes were also felt in Oklahoma. For a more complete list of significant earthquakes in Oklahoma please visit the United States Geological Survey

(USGS) Oklahoma History. http://earthquake.usgs.gov/earthquakes/states/oklahoma/history.php



USGS hazard map for Oklahoma, showing the potential level of shaking associated with possible earthquakes in Oklahoma. This map is based on our current understanding of past earthquakes and where earthquakes are likely to occur in the future. This map shows the amount of shaking that has a 1 in 50 chance of occurring in the next 50 years. Shaking is expressed as a percentage of g, or the acceleration of gravity, with reds indicating more shaking than blues. The red line in southwestern Oklahoma represents the Meers fault, which has had a recent earthquake (1,200-1,300 years ago) rupture to the surface.

Earthquakes occur in response to forces, which build up over long time periods, and occur when two bodies of rock slide past each other. This slip can be large for big earthquakes (10's of meters) or as small as a millimeter. Earthquakes generally occur on pre-existing weaknesses in the rocks called faults. By far, the majority of the world's earthquakes occur on or near the boundaries of tectonic plates. Large earthquakes tend to be concentrated at plate tectonic boundaries where forces and faults are much larger. Generally away from plate boundary settings, such as Oklahoma, earthquakes will be smaller with magnitudes generally less than 6.5. Small earthquakes (magnitudes 5 or less) occur nearly everywhere in the world. These types of earthquakes can cause damage and loss of life, but damage is usually moderate and closely concentrated around the epicenter, where the earthquake occurred. Oklahoma earthquakes generally occur at shallow depths ranging from about 5 to 15 kilometers (3-10 miles) depth.

Oklahoma has a great number of faults of varying sizes, but they are not expected to have very large earthquakes. The Meers fault in Southwestern Oklahoma had an earthquake about 1,200 years ago, which ruptured to the surface and had about 3 to 5 m of slip.

Earthquake hazard is the unavoidable risk that an earthquake will disrupt daily activities or cause loss of property or life. Most damage associated with earthquakes is caused by waves generated during the earthquake. Estimates can be made for the chances of how much shaking will occur due to all possible earthquake sources. These estimates use recorded earthquakes and mapped faults to define possible sources and how often these earthquakes occur. Oklahoma has a greater earthquake hazard

than the rest of the mid-continent, but the hazard is still less than that for the New Madrid Seismic Zone to the east or the North America-Pacific plate boundary of the Western US.

For more information on seismic hazard maps please visit the USGS at:

http://earthquake.usgs.gov/learn/faq/?categoryID=27

1.2.1.7 Other Climactic Features

The climate of Oklahoma is continental, as is all of the Great Plains. Summers are long and usually quite hot. Winters are shorter and less rigorous than those of the more northern plains states. Periods of extreme cold are infrequent, and those lasting more than a few days are rare.

Annual average relative humidity ranges from about 60 percent in the panhandle to just over 70 percent in the east and southeast. Average annual lake evaporation varies from 48 inches in the extreme east to 65 inches in the southwest, numbers that far exceed the average yearly rainfall in those areas. Evaporation and percolation preclude use of about 80 percent of Oklahoma's precipitation.

Prevailing winds are southerly to southeasterly throughout most of the state during the spring through autumn months. These prevailing winds veer to south-to-southwest in far western Oklahoma, including the panhandle. March and April are the windiest months, while July August and September are the calmest.

Source: Oklahoma Climatological Survey

1.2.2 Population and Demographics

In 1910, shortly after Oklahoma became a state, its population was 1,657,155. The population increased each year until the 1930's when it reached a total of 2,396,040. Between 1930 and 1950, however, the population decreased. Oklahoma was hit both by the national economic depression and the drought that created the Dust Bowl in the 1930's.

In spite of its history, Oklahoma population is increasing. According to the 2008 census estimate Oklahoma's population was 3,642,361, an increase of 5.6% over 2000. In 2000 the average population density was 50.3 people per square mile with most of the population concentrated in the eastern half of the state. In 2008 whites made up 78.1% of the population and blacks 8.0%. Oklahoma has the nation's 4th largest population of American Indians, totaling 291,388 individuals, or about 8.0% of the population. The population aged 65 and older is estimated at 491,718 or 13.5% of the population.

In 2006 approximately 67.7% of all Oklahomans lived in areas defined as urban, and the rest lived in rural areas. The State's two largest cities are Oklahoma City (the capital) and Tulsa.

Oklahoma Population Statistics

US Census 2008 Total Population Estimate	**- 3,642,361**
US Census 2006 Total Population	**- 3,579,212**
US Census 2000 Total Population	**- 3,450,654**
US Census 1990 Total Population	**- 3,145,576**
US Census 1980 Total Population	**- 3,025,487**

1.2.3 Economy

The main elements of Oklahoma's economy include agriculture, oil drilling and refining, mining, cattle and tourism.

Agriculture is an important industry in the State of Oklahoma. Historically, cotton was the leading cash crop, but this has been succeeded by wheat. Other leading crops include hay, peanuts, sorghum, and soybeans.

Livestock and livestock products make up the majority of Oklahoma's yearly farm income. Most of the state's cattle ranches are concentrated in the Panhandle and northern portions of Oklahoma. Poultry and hogs are also significant sources of income, and are raised primarily in the eastern half of the state. The cattle industry is the largest agricultural industry in Oklahoma.

Mineral wealth is great throughout the state. Petroleum, including oil and natural gas, has been a major income-producing product for Oklahoma since 1888 when the first oil well was drilled. The State also mines large deposits of gypsum, iodine, coal, granite and limestone.

Each year, millions of visitors from out-of-state visit Oklahoma to enjoy the state's 57 state parks, Indian villages, and historic sites. Numerous reservoirs through the state provide many recreational opportunities for tourists.

Although during the twentieth century and into the twenty-first Oklahoma's economy has been based on agriculture, manufacturing has always played a role. Oklahoma has been most widely known for its extractive industries, particularly coal, lead and zinc, and petroleum, but under the heading of "manufacturing," defined as the creation of "value added" products, a considerable number of industries have successfully operated since the late nineteenth century. The availability of raw materials has stimulated some of these.

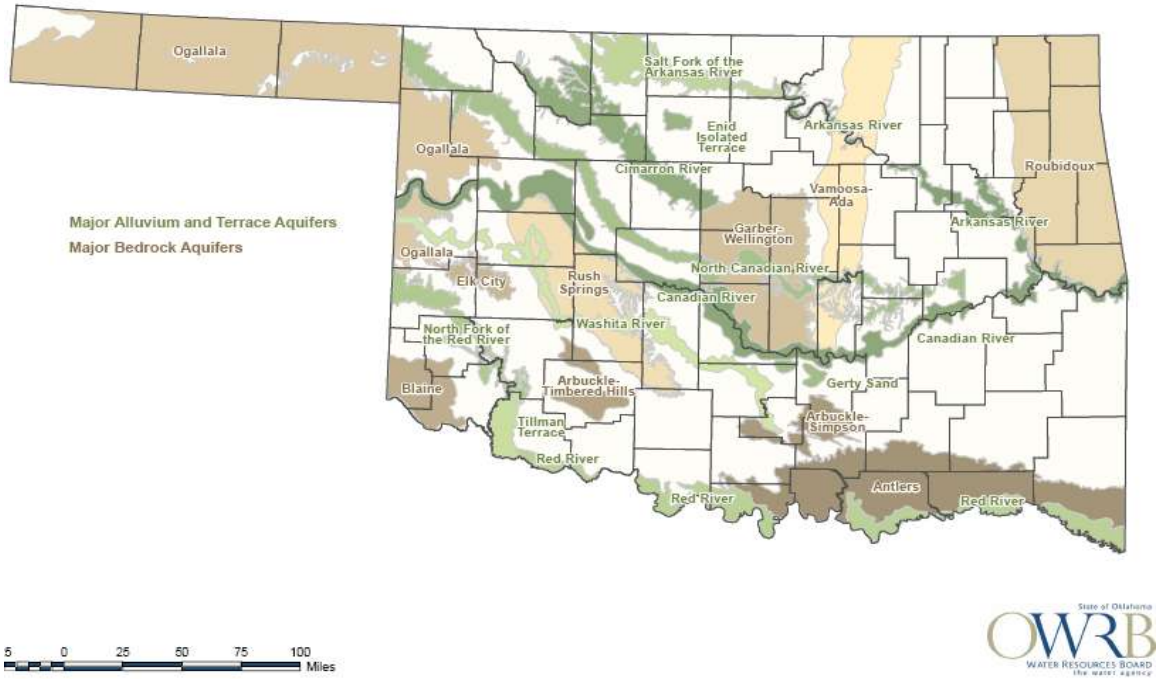
In 2007 the annual value of Oklahoma's agricultural production was $5,806,061,000. Of this amount, crops were responsible for $ 1,187,625,000 and livestock and poultry products for $4.6 billion. Wheat had become by far the main commercial crop, leading hay, cotton, sorghum, peanuts, and soybeans by a large margin. By the late twentieth century Oklahoma usually ranked second, third, or fourth in the nation in winter wheat production.

While the number of farms and the farm population declined sharply after World War II, agriculture continued to be a major factor in Oklahoma's economy. Farming not only supplied food and fiber for state, national, and world needs, it furnished the raw materials for processing and manufacturing industries that provided consumer goods and non-farm employment. Forests cover 17 percent of Oklahoma's total land area.

There are many large dams to utilize the water of the Arkansas and Red river systems as a source of energy for electricity. Among Oklahoma's largest hydroelectric dams are Tenkiller Dam on the Illinois River, Denison Dam on the Red River, Keystone Dam on the Arkansas River and Pensacola Dam on the Grand River. In central and western Oklahoma, steam plants using coal or gas generate most of the power. The large western lakes serve as sources of water supply for cities, for irrigation and for

recreation. In the state as a whole, 96 percent of electricity is generated in plants burning coal or natural gas, and the remainder comes from hydroelectric facilities.

Since a large part of Oklahoma's land area is rural, not served by municipal water systems, aquifers play a large part in Oklahoma's water resources by providing water for the many wells found in rural and urban areas. Following is a map showing the aquifers.



Oklahoma had 3,237 miles of railroad track in 2006. Clinton, El Reno, Enid, Oklahoma City, McAlester, Tulsa, Holdenville, Durant and Muskogee are important railroad centers. In 2006 Oklahoma was served by 13,085 miles of highways. Of those, 930 miles were part of the Federal interstate highway system. Interstates 40 and 44 are the principal east-west routes; Interstate 35 bisects Oklahoma going north to south. The State has three primary commercial airports. The two commercial airports handling the most passengers are at Oklahoma City and Tulsa. Pipelines, used to transport petroleum and natural gas, crisscross the state underground with a major pipeline crossroads in the center of the state.

1.2.4 Future Development

Since 1950, Oklahoma's population has gradually increased, and by 2008 it had reached 3,642,361. This figure represents an increase of 5.6 percent over 2000. Population densities generally decline from east to west across the state, and the highest densities are found in the metropolitan areas. The population in metropolitan counties increased by 2.0 percent from the year 2000 to 2006. Non-classified counties saw their populations decline by -0.6 percent. Oklahoma is the 20th largest state and the 28th most populous state in the United States.

The State of Oklahoma does not have adopted ordinances regulating areas of population growth or future development per se. Oklahoma agencies representing the state under authority granted to them by the legislation adopt rules/regulations regarding Storm Water Management or Stream Water

Management. Storm Water Management is addressed under the Federal National Pollution Discharge Elimination System (NPDES) program.

The Oklahoma Department of Environmental Quality (DEQ) has received delegation of that Federal program. They have adopted rules and established general and individual permits to require storm water management. Two basic types of storm water management are addressed. One is primarily aimed at sediment control and requires anyone disturbing one acre of ground or more to obtain a general permit and to use Best Management Practices. The other addresses storm water runoff from certain industrial areas. As part of the program, communities with a population of 10,000 or more must have a storm water management program in place (usually includes ordinances) that meets the conditions of the DEQ general permit or an individual permit issued by DEQ.

The water quality of streams in Oklahoma is described in terms of beneficial uses as defined by narrative descriptions and specific constituent numbers by the Oklahoma Water Quality Standards promulgated by the Oklahoma Water Resources Board. DEQ and the other state environmental agencies are required to protect the water quality of Oklahoma streams and lakes by implementing the Water Quality Standard (WQS) in administering their various regulatory responsibilities. For instance, when DEQ issues a wastewater discharge permit, the limits placed on that discharge are based on the WQS for the body of water that will receive the discharge. The beneficial uses of that body of water cannot be adversely impacted by the discharge.

Areas of future growth and development as they relate to known hazard areas are managed at the local level. Of the 77 counties in Oklahoma, over half of the counties have adopted rules/regulations for zoning management, subdivision management, land use plans, or Floodplain Boards in place. Additionally, a large percentage of the cities/towns over 1,000 in population have and enforce building and zoning requirements and have procedures in place for enforcing these requirements. Existing local policies and programs are discussed in greater detail in Chapter Four, under *Local Capability Assessment.*

1.2.5 Growth Trends

The Oklahoma economy has suffered tremendous downturn during the most recent national recession of 2009 and 2010 that is ongoing. The State continues to build on more than seven years of a broad based economic expansion prior to 2009, fueled in part by a revived energy sector, and has outperformed the nation in both job creation and income growth.

However, economic growth is rarely distributed evenly statewide and state totals often mask any disparities in economic performance across the various regions of the state. Differences in industry mix can generate vastly different results in terms of job and income growth at the local level, and often the state's overall performance relative to the nation is determined by a relatively small number of industries or geographic areas within the state.

Chapter Two: Planning Process

Each section of the plan update from the period of prior approval through October 26, 2010 was analyzed and reviewed by each member of the State Hazard Mitigation Planning Committee (SHMPC) and the administrative staff to determine whether updates to the plan were necessary. Chapter Two was reviewed by OEM SHMPC who determined that updating was required. Agency specific information was clarified and updated. Information that no longer applies or is inadequate was removed and replaced with up to date information. NFIP participation information was updated. Climatology, the Municipal League, Department of Commerce and the Department of Environmental Quality have provides updated input which is included in the February 17, 2011 plan update.

2.1 Existing Plans / Programs

There are various state and federal agencies and other organizational programs which are discussed in the State Hazard Mitigation Plan, and which coordinate or interact with the State HM Plan. Below is a list of the current state plans that were reviewed and integrated, where appropriate, into the State Hazard Mitigation Plan:

2.1.1 State Emergency Operations Plan (EOP)

The State Emergency Operations Plan (EOP) assigns responsibilities to designated state departments, agencies, commissions, boards and volunteer organizations in the event of a disaster. The plan directs state departments and agencies to provide guidance, relief and assistance to local communities and people in Oklahoma to mitigate, prepare for, respond to, and recover from the effects of a disaster. The plan is written expressly for the welfare and safety of the people of Oklahoma. It will provide them with the opportunity to be better prepared for and to quickly recover from disaster.

2.1.2 State Administrative Plan

The purpose of this document is to provide a description of the plans and procedures under which the Oklahoma Department of Emergency Management administers the emergency management program within the State of Oklahoma. The Oklahoma Department of Emergency Management is designated and authorized as the single state agency responsible for supervising and administering the Emergency Management program of the State of Oklahoma.

2.1.3 State Drought Plan

This document, which has been prepared as part of Oklahoma's Emergency Preparedness Planning effort is intended to delineate appropriate response actions for districts, cities, counties, state agencies and the federal government should a serious drought occur in Oklahoma. The plan describes and suggests primary lines of authority and responsibility, and points out request procedures for state or federal assistance. It is recommended that this plan be utilized in conjunction with the State Emergency Operations Plan.

2.1.4 Public Assistance Administrative Plan

The purpose of this plan is to establish a functional organizational structure and define the role, responsibilities and staffing of the Oklahoma Department of Emergency Management (OEM) as such

relate to the management and administration of grants, awards or contracts by the state, tribal, or local governments and qualified private non-profit organizations under the State of Oklahoma's Public Assistance program following the declaration of an emergency by the Governor of Oklahoma and or President of the United States. The administration of the State of Oklahoma's Public Assistance program shall have as its goal the delivery of eligible assistance, as expeditiously as possible, consistent with federal and state laws and regulations. Management and administration of this Public Assistance program shall be proactive and aggressive. With respect to Federal assistance, the State of Oklahoma shall specifically continue to comply with the requirements set forth in the Robert T. Stafford Disaster Relief and Emergency Assistance Act and 44 CFR Part 13.

2.1.5 Fire Management Plan

The purpose of this plan is to establish an effective system for the coordinated response to fire suppression during emergency or disaster situations. The Department of Agriculture will also be the state coordinating agency with the federal government for assistance provided with the National Response Plan's (NRP) Emergency Support Function (ESF) #4, Firefighting, in such areas as detecting and suppressing wildland, rural and urban fires resulting from, or occurring coincidentally with, a catastrophic earthquake, significant natural disaster or other event requiring federal response assistance.

2.1.6 State Hazard Mitigation Administrative Plan

The purpose of the State Hazard Mitigation Administrative Plan is to establish a functional organizational structure, define the role, responsibilities and staffing, and outline the management procedures that Oklahoma Emergency Management (OEM) will use to administer the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation Assistance Program (FMA), Repetitive Flood Claims Program (RFC), Severe Repetitive Loss Program (SRL) and the Pre-Disaster Mitigation Program (PDM).

2.1.7 State Business Plan (map modernization)

The Federal Emergency Management Agency's (FEMA's) flood hazard maps are essential tools for flood hazard mitigation in the United States. Unfortunately, many of these maps have become outdated and significant areas of the country remain unmapped. To address this problem, the President's budget request for Federal Fiscal Year (FY) 2003 included $351 million for initiating FEMA's national Map Modernization Program, resulting in a final appropriation of $149 million. The President's budget request of $200 million per year for FY2004 and 2005 and $200.1 million in FY2006 resulted in an appropriation of $198.8 million, $199.8 million and $200 million per year, respectively. CRS Report to Congress, Order Number RL33264_20060203

FEMA Region VI staff in Denton, Texas, currently handles overall management of the Oklahoma Map Modernization Program and leads study-scoping activities with the assistance from the National Service Provider (NSP) through FEMA Headquarters. The NSP serves as the Program Manager to develop, plan, manage, implement, and monitor the Flood Map Modernization Program for flood hazard mitigation across the United States and its territories. The NSP also coordinates with FEMA to work with state, local, and other federal partners to develop digital flood hazard data for the entire United States. The goal of the NSP is to support FEMA's strategic and program objectives.

2.1.8 Oklahoma Floodplain Management Act

The Oklahoma Floodplain Management Act, Title 82, O. S. 2001, §1601-1618, as amended, was passed by the state legislature in 1980 and revised several times. In approving the Act, the Legislature recognized the need for a united effort between local and state government to combat recurrent flood damages. The Act establishes a state and local partnership to reduce flood damages through sound floodplain management.

The State of Oklahoma recognized the personal and economic hardships caused by flood disasters, and recognized that it had become uneconomical for the private insurance industry to make flood insurance available to those in need of protection. Therefore, the Act paved the way for each community to implement wise floodplain management and thereby participate in the National Flood Insurance Program. This participation allows those citizens who need low-cost flood insurance to purchase it through the federal program. The act also addresses the need for the preservation and restoration of the natural resources and functions of the floodplains. Flood insurance through the NFIP becomes available when floodplain boards adopt floodplain regulations in compliance with certain requirements.

2.1.9 Other programs and funding sources are:

2.1.9.1 Federal Emergency Management Agency (FEMA)

The Federal Emergency Management Agency (FEMA) was established by Congress in 1979 to consolidate the emergency planning and response functions of several Federal agencies under one director. The FEMA mission is: "Reduce the loss of life and property and protect our institution from all hazards by leading and supporting the nation in a comprehensive, risk-based emergency management program of mitigation, preparedness, response and recovery." The Oklahoma State Hazard Mitigation Plan was written following this same precept. FEMA programs were reviewed and were integrated with the state mitigation planning process. The State of Oklahoma Hazard Mitigation Planning process aligns exactly with FEMA programs. The State of Oklahoma has added no other items to the planning process other than what is required by FEMA. The FEMA crosswalk and the latest FEMA guidance are followed exactly in an effort to satisfy FEMA planning requirements.

2.1.9.2 Hazard Mitigation Grant Program (HMGP)

The HMGP was created in 1988 by Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended. This program is activated during Presidential Disaster Declarations to assist in identifying mitigation projects and by funding these projects on a 75% federal and 25% non-federal cost share basis. The program is administered at the state level; in Oklahoma, it is managed through the department of Oklahoma Emergency Management. **Note**: In Oklahoma, the 25% share is absorbed by the applicant.

1) Objectives of this program include: Prevent future loss of lives and property due to disasters; implement state or local hazard mitigation plans; enable mitigation measures to be implemented during the immediate recovery of a disaster; and, provide funding for previously identified mitigation measures that benefit the disaster area.

2) Eligible applicants for the HMGP are: tribes, state and local governments, and certain non-profit organizations.

3) Types of projects that may be funded are: structural hazard control; retrofitting; acquisition/relocation of repetitive loss properties; and development of state and local standards to protect and substantially improve structures from disaster damage. See ***Appendix A*** for the 5% Set- Aside Initiative and the 7% Planning Initiative.

The HMGP is designed to reduce the states or local government's vulnerability to risk through a thoroughly coordinated all-hazards approach to mitigation activities, with a heavy emphasis on planning. This focus on planning includes updating plans; implementing the measures identified in all-hazard mitigation plans; developing local mitigation plans; developing state legislation; or adopting local ordinances. The key here is the coordination and implementation of an all-hazards approach using a strong partnership at the state and local level.

2.1.9.3 Pre-Disaster Mitigation (PDM) Program

FEMA has long been promoting disaster resistant construction and retrofit of facilities that are vulnerable to hazards in order to reduce potential damages due to a hazard event. The goal is to reduce loss of life, human suffering, economic disruption, and disaster costs to the federal taxpayer. This has been, and continues to be, accomplished through a variety of programs and grant funds.

Although the overall intent is to reduce vulnerability before the next disaster threatens, the bulk of the funding for such projects actually has been delivered through a "post-disaster" funding mechanism, the Hazard Mitigation Grant Program (HMGP). This program has successfully addressed the many hazard mitigation opportunities uniquely available following a disaster. However, funding of projects "pre-disaster" has been more difficult, particularly in states that have not experienced major disasters in the past decade. In an effort to address "pre-disaster mitigation," FEMA piloted a program from 1997-2001 entitled "Project Impact" that was community based and multi-hazard oriented. In Oklahoma, there were four "Project Impact" named cities: Tulsa, Miami, Durant and Lawton.

Through the Disaster Mitigation Act of 2000, Congress approved creation of a national Pre-disaster Hazard Mitigation program to provide a funding mechanism that is not dependent on a presidential disaster declaration. This authorization is in Section 203 of the Stafford Act, 42 USC 5121-5206, as amended by Section 102 of the Disaster Mitigation Act of 2000. For FY2002, $25 million was appropriated for the new grant program entitled the Pre-Disaster Mitigation Program (PDM). This new program builds on the experience gained from Project Impact, the HMGP, and other mitigation initiatives. There is a one-time grant each year for the state.

The high points of the PDM program are:

- Eligible projects include:
  - State and local hazard mitigation planning
  - Technical assistance (e.g. Risk assessments, project development)
  - Mitigation Projects:
    - Acquisition or relocation of vulnerable properties
    - Hazard retrofits
    - Minor structural hazard control or protection projects
  - Community outreach and education (up to 10% of state allocation)
- Each state establishes grant selection criteria and priorities based on:
  - The State Hazard Mitigation Plan
  - The degree of commitment of the community to hazard mitigation
  - The cost effectiveness of the proposed project
  - The type and degree of hazard being addressed
  - For project grants, "good standing" of the community in the National Flood Insurance Program (NFIP)
- The funding is 75% federal share, 25% non-federal, except as noted below.
- The non-federal match can be fully in-kind or cash, or a combination.
- The grant performance periods will be 18 months for planning grants, and 24 months for mitigation project grants.
- The PDM program is available to Indian tribes and to all jurisdictions through local government agencies.
- Special accommodation will be made for "small and impoverished communities," who will be eligible for 90% federal share, 10% non-federal.

2.1.9.4 Flood Mitigation Assistance (FMA) program

The Flood Mitigation Assistance program is a state administered cost-share program through which states and local communities can receive grants for flood mitigation planning; flood mitigation projects; and FMA technical assistance. It is a federal grant program, similar to the Hazard Mitigation Grant Program; however, FMA provides assistance to states and communities for flood mitigation planning and activities to fund cost-effective measures that reduce or eliminate the long-term risk of damage to buildings, manufactured homes, and other NFIP- insurable structures, and it is not disaster dependent. Note: In Oklahoma, the 25% local share will be absorbed by the local, city or county government, and one-half of the 25% (or 12.5% of the total grant) share must be a "hard match."

1) FMA is part of the National Flood Insurance Act of 1968, Sections 1366 and 1367 as amended by Sections 553 and 554 of the National Flood Insurance Reform Act (NFIRA) of 1994.
2) Goals of the program include: Reduce the number of repetitively damaged structures and associated claims against the National Flood Insurance Fund; and encourage long-term comprehensive mitigation planning.

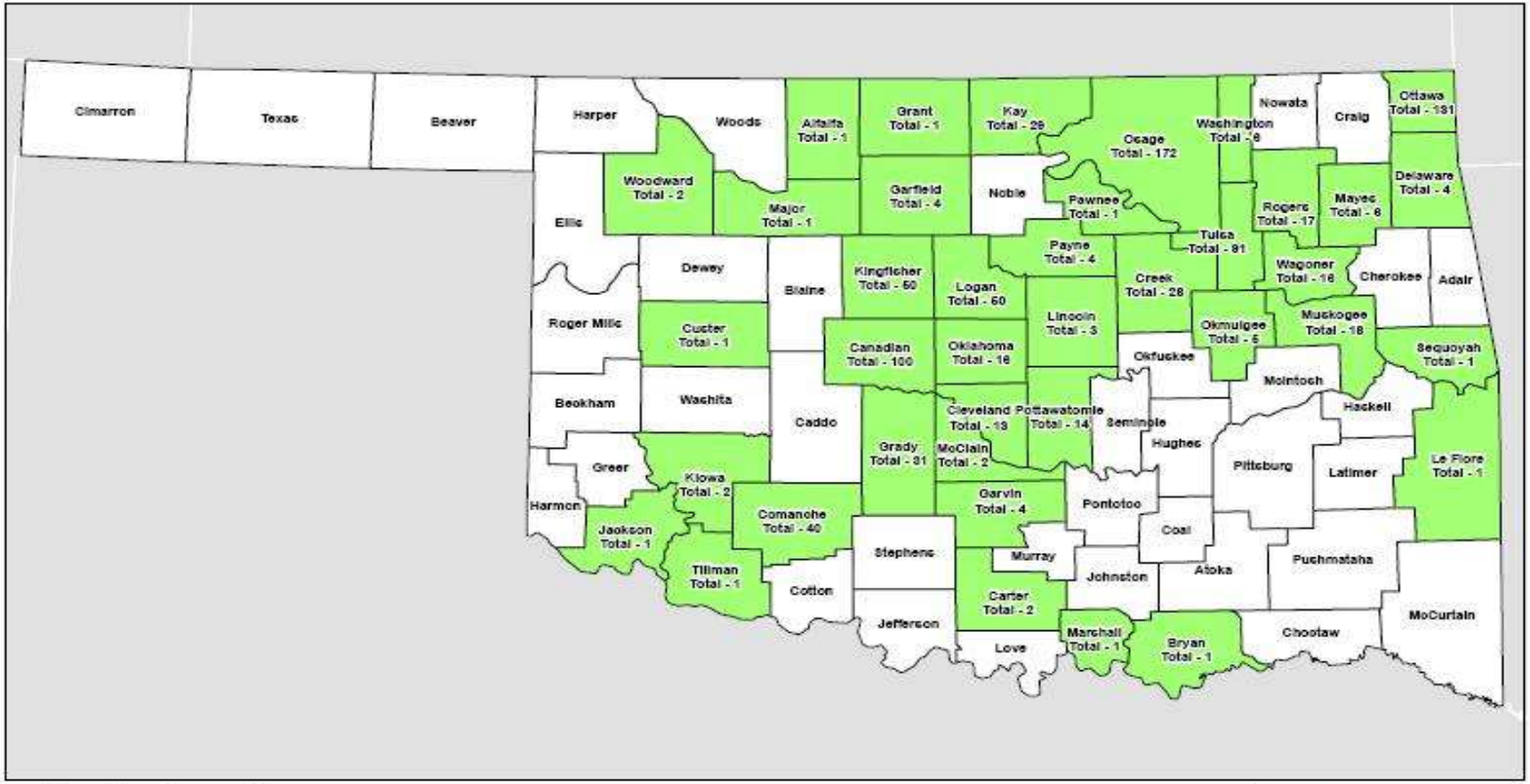
2.1.9.5 Repetitive Flood Claim (RFC) Program

The Repetitive Flood Claims (RFC) grant program provides mitigation funding for structures insured under the National Flood Insurance Program (NFIP) located in a state or community that cannot meet the requirements of the Flood Mitigation Assistance (FMA) program. The long-term goal of the RFC grant program is to reduce or eliminate claims under the NFIP through mitigation activities that are in the best interest of the National Flood Insurance Fund (NFIF).

2.1.9.6 Severe Repetitive Loss (SRL) Program

The Severe Repetitive Loss (SRL) grant program was authorized by the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004, which amended the National Flood Insurance Act of 1968 to provide funding to reduce or eliminate the long-term risk of flood damage to severe repetitive loss (SRL) structures insured under the National Flood Insurance Program (NFIP).

Oklahoma Repetitive Loss Status



Location Map

Oklahoma Repetitive Loss

- Needs to be Done
- Partially Investigated
- Under Investigation
- Done
- None

N W E S

Miles

0 20 40 80

As of 0800 CST March 6, 2006

Source:Rep Loss data maintained by Repetitive Loss Representative in FEMA Region VI Mitigation

OEM FEMA

FEMA-RVI-RRCC Denton, TX
Geospatial Intelligence Unit
Created by: Dane Wilson
MI_OK_RepLoss_20060306.pdf

The definition of severe repetitive loss as applied to this program was established in section 1361A of the National Flood Insurance Act, as amended (NFIA), 42 U.S.C. 4102a. An SRL property is defined as a residential property which has been covered under an NFIP flood insurance policy for more than thirty days and:

- 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 (a) and (b) above, at least two of the referenced claims must have occurred within any ten-year period, and must be greater than 10 days apart. The map shows current Eligible Floodplain Acquisition Candidates by county.

Eliminating Severe Repetitive loss properties is a high priority for Oklahoma.

While buyouts are not the only mitigation projects considered and undertaken by the State and local governments, they have been the type of project most frequently submitted and approved. OEM's highest priority in removing repetitive loss properties is to work with local governmental entities to acquire and remove, elevate, relocate or perform minor structural projects only on privately owned residential structures and/or privately owned lots that are located in the floodplain and/or floodway. In addition to the requirements listed above, these projects must also meet the following criteria:

1. The project chosen must independently solve or be a functional part of a solution to a problem that is repetitive or poses a significant risk to health and safety. The proposed solution must be the most practical, effective, cost-effective and environmentally sound alternative among a range of alternatives that contribute to a long-term solution of the problem, rather than temporary or short-term.

2. Local governmental entities (or certain private nonprofit entities) must apply through the State, specifically OEM, to FEMA for approval to perform a project or projects. The applications must specifically identify the properties to be included in the project or projects and must be proven cost-beneficial, in accordance with a determination method that is acceptable to OEM/FEMA and consistent with OMB Circular A-94. This is usually accomplished by using the FEMA benefit cost analysis module.

3. Local governmental/non-profit entities must be in good standing in the NFIP (or have not yet been mapped), and otherwise eligible to receive federal funding. Nonfederal matches and all other federal grant requirements must be satisfied by the local entity, sometimes with the monetary assistance of local property owners or possibly with assistance from CDBG.

4. Hazard Mitigation Grant Program, Pre-Disaster Mitigation (PDM) and Flood Mitigation Assistance (FMA) projects must be consistent with the overall State Hazard Mitigation

Plan. Projects also must conform to 44 CFR Part 9, Floodplain Management and Protection of Wetlands, and 44 CFR Part 10, Environmental Considerations.

5. Only local governmental/non-profit entities may manage the project or projects. All projects must be managed in accordance with local, State and federal ordinances, laws and regulations, and not contribute to or encourage development in the floodplain or other hazardous areas. Individual property owners are not eligible to receive federal funds directly as a grantee or sub-grantee and are not authorized to manage grant projects.

OEM considers a number of types of projects to be eligible for mitigation; with flood mitigation projects the highest priority. In each type of project below, the sellers' participation must be voluntary and the sellers must be able to prove ownership of the property involved in the project. The below eligibility criteria applies:

Property Acquisition

This is the State's most favored, and usually most cost effective, voluntary option because the people and property are totally and permanently removed from the path of flooding and danger. To be eligible to participate, the local governmental/non-profit entity must agree to the following:

1. Offer is based on pre-flood fair market value determined by a State of Oklahoma board certified appraiser or a post-flood sales contract value;

2. Duplication of Benefits (DOB), Small Business Administration (SBA) loans and private mortgages must be satisfied from proceeds first;

3. The buyout property must be demolished within 90 days of the closing;

4. Local governmental entities, or certain private non-profit entities, must accept all buyout property titles that are officially annotated to comply (in perpetuity) with federal Open Space deed restrictions;

5. The buyout property becomes ineligible for any future federal disaster assistance, except possibly Federal Crop Insurance.

2.1.9.7 National Flood Insurance Program (NFIP)

The National Flood Insurance Program, enacted in 1968, made federally subsidized flood insurance available to property owners located in communities participating in the flood program. Communities wanting to participate in the National Flood Insurance Program must establish minimum floodplain management regulations in their special flood hazard areas and enforce these regulations. The State of Oklahoma will continue to participate in the NFIP program and will encourage all jurisdictions in the state to do the same.

1) In 1973, Congress passed the Flood Disaster Protection Act. This law required the purchase of flood insurance as a condition for federally related loans or other federal financial assistance for property located in identified floodplain areas. This provided the incentive for participation in the program.

2) Most counties in the State of Oklahoma lacked proper authority concerning land use regulation necessary to participate in the Flood Insurance Program. In 1980, the legislature passed the Oklahoma Floodplain Management Act to allow citizens that desired to participate in this Program to procure flood insurance. This legislation enables any county or community in the state to form a floodplain board and enact floodplain regulations to allow participation in the program.

3) The National Flood Insurance Program requires communities to adopt and enforce a minimum amount of floodplain management criteria. These criteria includes such items as: requiring permits for construction within designated floodplains; reviewing development plans and subdivision proposals to determine if proposed building sites will be reasonably safe from flooding; requiring protection of water supply and sanitary sewage systems to minimize infiltration of flood water and discharges from the system into the flood waters; obtaining, reviewing, and utilizing all available base flood elevation data; and assuring the maintenance of flood carrying capacities within all water courses.

4) The National Flood Insurance Program (NFIP). Participation in NFIP by municipalities, counties, and tribal organizations is voluntary. OEM and FEMA have strongly encouraged non participating jurisdictions to join the NFIP since this plan was approved in 2008. The results are shown in the following figures. Prior to the 2008 plan approval there were 52 counties participating, currently there are 54. In 2008 there were 303 municipalities in Oklahoma participating in NFIP, today there are 411. The March 5th, 2010 Region VI report shows the Ponca and Kickapoo tribes as the only tribal jurisdictions participating in the NFIP program. See ***Appendix B***.

2.1.9.8 Community Rating System (CRS)

The Community Rating System (CRS) is an element of the NFIP. This program is designed to promote the availability of flood insurance; reduce future flood damages; and insure the accurate rating of flood insurance policies. Participating communities may receive credit for proven mitigation measures, thus reducing the cost of flood insurance within their communities. Oklahoma will continue to encourage participation in CRS. This program:

- allows communities to implement comprehensive floodplain management strategies;
- provides up to a 40% reduction in individual flood policies;
- will continue to encourage participation in CRS.

2.1.9.9 The Disaster Housing Program

The Disaster Housing Program is available to provide disaster hazard mitigation measures in the form of home repair grants to eligible homeowners following a federally declared disaster. (Grant is available regardless of cause of disaster, not just from flooding.) If the home repair costs exceed the Disaster Housing Grant, the applicant can be referred to the Individual and Family Grant Program for additional grants not to exceed the maximum grant limitations of the Individual and Family Grant Program.

2.1.9.10 Oklahoma Water Resources Development Act

Oklahoma Water Resources Development Act: Facilitates updates of the Oklahoma Comprehensive Water Plan through the creation of 11 regional water plans.

The mitigation planning process is integrated into the plans described above by providing information to the representatives of the State Hazard Mitigation Team who administrate these programs. This information regarding Strategy, Risk Assessment and progress made with actions in the State Plan is taken back to appropriate agency heads to be integrated into the plans which they administer. Input to FEMA proposing updates to their programs is provided through our regular contacts with the FEMA Region VI Officials.

2.2 Documentation of the Planning Process

Mitigation is defined as any sustained action taken to reduce or eliminate long-term risk to human life and property from a hazard event. The primary purpose of hazard mitigation planning is to identify state and local policies, actions, and tools for implementation over the long term that will result in a reduction in risk and potential for future losses state wide.

There are many benefits of hazard mitigation planning including:

- identifying cost effective and technically feasible mitigation measures that will reduce losses from future disasters;
- building partnerships with sectors not previously involved;
- facilitating funding priorities;
- creating more sustainable communities.

Effective planning forges partnerships that will bring together the skills, expertise, and experience of a broad range of groups to achieve a common vision for the state, and also ensure that the most appropriate and equitable mitigation projects will be undertaken. Hazard mitigation planning is most successful when it increases public and political support for mitigation programs, results in actions that also support other important community goals and objectives, and influences the state's decision making to include hazard reduction considerations.

Using a planning approach to reduce hazard losses can facilitate the incorporation of sustainable concepts in both pre and post-disaster timeframes. The mitigation planning process can support a more robust and sustainable planning effort by assuring that land use planning and development regulations guide development in directions that facilitate many goals simultaneously. The planning process can provide a framework within which state and local governments can link sustainability and loss reduction to other goals.

Communities across the state with up-to-date mitigation plans will be better able to identify and articulate their needs to state and federal officials, giving them a competitive edge when grant funding becomes available. Planning also enables communities and the state to better identify sources of technical and financial resources outside of traditional venues. To encourage planning, only those states and communities with FEMA-approved plans that meet the DMA 2000 criteria will be eligible to receive HMGP funds for mitigation projects. Under the new regulations, states with enhanced plans can receive HMGP funding up to 20% of the total estimated Stafford Act disaster assistance, rather than the 15% traditionally allocated.

The State of Oklahoma, through Emergency Management, has begun the process of updating the State Enhanced Hazard Mitigation Plan (see Chapter 7). Oklahoma has had a State Hazard Mitigation Team since March 1999 that has held regular quarterly meetings and met more frequently as needed.

Rather than form a new committee, it was decided to use this existing committee that already had representatives of the various departments and agencies of the state and selected federal agencies, to provide the benefits mentioned above, including the advantage of additional funding provided with an enhanced plan. This additional funding will provide further opportunity to decrease the damages and cost of disasters within Oklahoma through the implementation of effective mitigation strategies.

This February 17, 2011 mitigation plan is an update to the existing State Standard Hazard Mitigation Plan of June 2009 and the product of a rational thought process that reviewed the hazards, measured their impacts on the state facility operations, identified alternative mitigation strategies and selected and designed those that will work best for the state. This plan builds on a number of existing mitigation planning initiatives. The planning for the State of Oklahoma followed a ten-step process, based on guidance and requirements of FEMA, and outlined in the FEMA How-to-Guide series. The State Hazard Mitigation Officer, Bill Penka provided guidance for the process and coordinated the organizational structure for the SHMPC, assigned tasks to each member of the SHMPC to insure that all tasks were completed in a timely manner, and provided coordination with the State Hazard Mitigation Team. Several state agencies provided updated information for inclusion in this updated plan. Lester Wheeler gathered action plan status information from each jurisdiction of the state and compiled related statistics for the plan reviewers. Charles Balthrop summarized data from one hundred eighty five approved local and tribal plans in Oklahoma that qualify four hundred sixty eight jurisdictions for Hazard Mitigation funding. Greg Whitworth and Mike Bradford gathered statistical data, created charts and reviewed the progress of this plan.

2.2.1 Step One: Organization

Oklahoma's State Hazard Mitigation Team was established by state law, House Bill #1841, on March 9, 1999. Although it receives no direct funding support, it can tap the Emergency Fund for Public Infrastructure. This existing committee was used to form the base of the State Hazard Mitigation Planning Committee, (SHMPC) and to oversee the planning effort.

The Committee consists of team members from twenty one different departments and agencies of the state and federal governments plus private non-profit. These professionals, active in disaster planning, response, and mitigation interact with Oklahoma Emergency Management and each other on a daily basis and provided critical input in the development of the plan. The members of the team provided expertise and perspective to the planning process, including state and local emergency management, natural hazards, land-use planning, building codes, transportation, and infrastructure. They further identified potential vulnerable facilities, recommended goals, objectives, mitigation strategies and priorities for actions and wrote agency-specific descriptions of their coordination with the state and their available resources, including how their programs were implemented. The February 17, 2011 Natural Hazard Mitigation Plan update is the product of thousands of hours of work and the efforts of many individuals from the following organizations plus the one hundred eighty five local and tribal planning committees with approved plans who provided input specific to their jurisdiction. Climatology, Commerce and the Municipal League provided responses to our requests for input with email. Many other organizations including the Council of Governments (COGs) OEDA, SODA, EODD, NODA and SWODA provided input regarding changes during the planning period over the telephone. The list of Agencies does not change because it is established by state law Bill #1841, on March 9, 1999. Change of contact information for the individual representatives of the statutory agencies is included.

Oklahoma State Hazard Mitigation Committee		
Agency Represented	**Name**	**Contact Information (*Phone / E-mail*)**
Association Of County Commissioners Of Oklahoma	Dale Frech	dalef@okacco.com 405-516-5307
Oklahoma Climatological Survey	Mark Shafer	mshafer@mesonet.org 405-325-2541
Oklahoma Conservation Commission	Tammy Sawatzky	tammy.sawatzky@conservation.ok.gov 405-521-4823
Oklahoma Corporation Commission	Trish Weeden Bill White	tweeden@coxinet.net 405-521-2211
Oklahoma Department Of Agriculture	Mark Goeller Pat McDowell	mark.goeller@oda.state.ok.us 405-521-3864 405-609-8872
Oklahoma Department Of Commerce	Stacy Cramer	Stacy_Crane@okcommerce.gov 405-815-6552 800-879-6552
Oklahoma Department Of Emergency Management	Fred Liebe Bill Penka - Chairman	Bill.penka@oem.ok.gov 405-521-2481
Oklahoma Department Of Environmental Quality	Monty Elder	Monty.Elder@deq.state.ok.us 405-702-1000
Oklahoma Department Of Health	Ed Kostiuk	edk@health.ok.gov 405-271-5600
Oklahoma Department Of Human Services	John Coleman	John.coleman@okdhs.org 405-522-2097
Oklahoma Department Of Labor	Lloyd Fields	lloydfields@oklaosf.state.ok.us 405-528-1500
Oklahoma Department Of Transportation	Tom Wadley Kevin Bloss	tomwadley@odot.org kevinbloss@odot.org 405-521-2631
Oklahoma Department Of Wildlife Conservation	William Ray	wray@zoo.odwc.state.ok.us 405-521-3851
Oklahoma Historical Society	Melvena Heisch	mheisch@okhistory.org 405-521-2491
Oklahoma Insurance Commission	Marc Young	marcyoung@insurance.state.ok.us 405-522-8398
Oklahoma Municipal League	Missy Dean	missy@oml.org 405-528-7515 800-324-6651
Oklahoma Water Resources Board	Lou Klaver Ken Morris Gavin Brady	clklaver@owrb.ok.gov wkmorris@owrb.ok.gov jgbrady@owrb.ok.gov 405-530-8800
State Fire Marshall	Robert Doke, Director	firemar2@fire.state.ok.us 405-522-5005
U.S Army Corps Of Engineers	Joe Remondini	Joseph.remondini@usace.army.mil 918-669-7198

Oklahoma State Hazard Mitigation Committee		
Agency Represented	**Name**	**Contact Information (*Phone / E-mail*)**
U.S. Dept. of Housing and Urban Development	**Kevin McNeely**	**Kevin.L.mcneely@hud.gov** **405-609-8509**
Cherokee Nation	**Tamara Copeland**	**tcopeland@cherokee.org** **918-453-5404** **918-822-2764**
Muscogee Creek Nation	**James D. Nichols**	**jnichols@muscogeenation-nsn.gov** **918-732-7891**

Supporting the State Hazard Mitigation Planning Committee (SHMPC) is the State Hazard Mitigation Division Staff. The following staff has done most of the detail work:

Bill Penka, Chairperson, State Hazard Mitigation Officer
Charles Balthrop, Hazard Mitigation Plan Reviewer
Greg Whitworth, Hazard Mitigation Plan Reviewer
Mike Bradford, Hazard Mitigation Plan Reviewer

Quarterly briefings were conducted by Bill Penka, (Chair, SHMO) to keep Albert Ashwood, (Director, Oklahoma Emergency Management) and Fred Liebe, (Deputy Director) apprised of the situation. Reporting was also prepared for the quarterly meetings of the State Hazard Mitigation Team.

2.2.2 Step Two: State Agency Involvement

The State Hazard Mitigation Planning Committee undertook a number of initiatives to inform other state agencies of this effort and to solicit their input. These activities included emails, telephone calls and frequent one on one conference with various agencies and jurisdictions related to specific hazards and programs.

2.2.3 Step Three: Agency and Organization Coordination

Information was gleaned from the one hundred eighty five approved Local and Tribal plans and included in this plan. There are many, federal, state, academic, business, and non-profit-organizations that contend with natural hazards. Committee members contacted these organizations and collected updated information on their programs and the impact of the hazards on their operations, and determined how their programs could best support the state's mitigation program. For example the Oklahoma Municipal League, Department of Commerce, Department of Environmental Quality and the Oklahoma Department of Climatology provided updated information on their programs as did many others. Other organizations advised that no updates were required.

Oklahoma Emergency Management is responsible for coordinating and assisting all other state agencies and all political subdivisions in the state in the preparation, maintenance and implementation of emergency preparedness plans and programs. Oklahoma Emergency Management plans, prepares and implements programs designed to minimize the effects of natural, technological, and man-made disasters upon the people and resources of the state.

The State of Oklahoma requires that each grantee provide quarterly updates describing any and all activity relating to outstanding grants. This information is organized and made available to FEMA for management purposes.

In early 2006 there was a complete change of personnel in the Oklahoma Hazard Mitigation Division. New people were hired a new SHMO was appointed and the processes continue on as we learned the details of the operation. Coordination with FEMA was moving forward and sub-grants projects were being closed out by Oklahoma. In 2009 FEMA asked when Oklahoma was going to begin closing out projects. Oklahoma projects were closed out. We then learned that we must also close out the projects with FEMA. With FEMA Region VI guidance and technical support a massive close out of projects with FEMA was begun and continues on and will continue until all grant projects are closed.

Due to the numerous disasters of 2008-2010 and the technical assistance provided by FEMA Region VI to the State of Oklahoma, coordination and cooperation between the two groups have been cemented into a tight – cohesive working environment. During disaster response to DR#1876 at the JFO in Oklahoma City FEMA Region VI provided technical assistance to assist with Hazard Mitigation Plan review and grant processing. The Region VI planning staff at Denton, TX provided technical assistance and training with conference calls throughout the planning process and meetings at Denton to ensure that each of the states understood the same guidelines. Sections of this plan were provided a courtesy review to keep us on the right track. Coordination between OEM and FEMA has been enhanced by the addition of monthly conference calls and a visit to Region VI where training was provided along with the answers to many questions. The Regional approach has provided a better understanding of the issues faced by each State in implementing the Hazard Mitigation Planning Process. The US Corps of Engineers has provided Local planners with swash zone maps which are necessary for the Dam Failure Hazard profile.

With the implementation of FEMA Region VI Technical Assistance, the State of Oklahoma has been able to gain approval of over 80 Hazard Mitigation Plans during 2008, 2009 and 2010.

2.2.3.1 Major Disaster Declarations

= Active Disaster

Year	Date	Disaster Types	Active	Disaster Number
2010	07/26	Severe Storms, Tornadoes, Straight-line Winds, and Flooding	☐	1926
2010	05/24	Severe Storms, Tornadoes, and Straight-Line Winds	☐	1917
2010	03/05	Severe Winter Storm	☐	1883
2010	02/25	Severe Winter Storm	☐	1876
2009	06/19	Wildfires	☐	1846
2009	02/17	Severe Winter Storm	☐	1823
2009	02/15	Severe Storms and Tornadoes	☐	1820
2008	10/09	Severe Storms, Tornadoes, and Flooding	☐	1803
2008	07/09	Severe Storms and Flooding	☐	1775
2008	05/14	Severe Storms, Tornadoes, and Flooding	☐	1756
2008	05/09	Severe Storms, Tornadoes, and Flooding	☐	1754

2.2.3.2 Emergency Declarations

Year	Date	Disaster Types	Active	Disaster Number
2010	01/30	Severe Winter Storm	☐	3308
2009	06/23	Snow	☐	3305

2.2.3.3 Fire Management Assistance Declarations

Year	Date	Incident	Disaster Number
2009	04/10	Mulhall Fire	2813
2009	04/10	Velma Fire	2812
2009	04/10	Healdton Carter County Fire	2811
2009	04/10	McClain Fire	2809
2009	04/10	Midwest Choctaw Fire	2808
2009	03/05	Taloga Fire	2799
2008	06/05	Gotebo Fire	2769
2008	03/21	Quinlan Fire	2756

Since the adoption and implementation of the Oklahoma State Hazard Mitigation Plan in 2008, Oklahoma has had 20 disaster-related declarations; distribution statistics are provided in the table above. Because of this status, Oklahoma has developed a very close working relationship with the Federal Emergency Management Agency (FEMA) and other state and federal agencies. This working relationship has served well when OEM has contacted these other agencies for participation in updating this Hazard Mitigation Plan.

Coordination among the different federal, state, local, and voluntary agencies has always been good in the State of Oklahoma. When disaster strikes the different agencies work well together to meet the needs of the citizens and local governments affected. Many agencies such as FEMA, the Military department, Red Cross, Salvation Army, Homeland Security, Department of Agriculture, Forestry,

Department of Environmental Quality, Department of Public Safety, Oklahoma Department of Heath, Oklahoma Department of Transportation, Corporation Commission and many others are represented at the EOC (Emergency Operations Center) during a disaster. When a DRC (Disaster Recovery Center) is established many agencies all show up and lend whatever support they can. In Oklahoma DRC's it is not uncommon to find representatives from the State, FEMA, HUD,SBA, IRS, Red Cross, Salvation Army, Veterans Administration, State Insurance Commission, EPA, VOAD members and a multitude of others present and ready to assist. The agencies have always worked well together and continue to work well together since the development of the hazard mitigation plan.

2.2.3.4 Prioritization of Project Funding

Prior to the implementation of the State Hazard Mitigation Plan in 2008, the member agencies of the state hazard mitigation team dealt primarily with mitigation actions concerning flooding and flood prevention. Since the implementation of the hazard mitigation plan the team members are involved with overseeing hazard mitigation projects that deal with all hazards that affect the State of Oklahoma.
One major change that occurred was the formation of a subcommittee consisting of people from many facets of emergency management and mitigation activities appointed by the hazard mitigation team to review proposed mitigation actions.

Among some of the subcommittee's actions was the development of a formula to establish maximum funding amounts for planning (7%) grant funds which was reviewed and approved by the State Hazard Mitigation Team. To provide as fair and equitable distribution of grant funding, the subcommittee made recommendations to the State Hazard Mitigation Team on types of projects to be funded from (5%) grant funds and allowable dollar amounts for each type project. To ensure that an equitable consideration of each jurisdiction projects the following guidelines were developed.

OEM applies four criteria initially to each project.
1. Does the Jurisdiction have an approved Hazard Mitigation Plan?
2. Is the project in their Hazard Mitigation Plan?
3. Is the project a fundable mitigation project?
4. Is funding available for assignment to the project?

Due to the limited amount of project funding available, OEM employs a prioritization system for funding allocation. OEM reviews, ranks and scores proposed projects using certain criteria found in OEM scoring sheets below. The main categories for ranking project submissions include the natural hazard event, history of damages, type of mitigation, impact on community, impact on environment, community commitment to mitigation, and benefits of mitigation. Generally, non-structural projects such as acquisitions, demolitions, relocation and flood proofing of repetitive loss and severe repetitive loss properties receive the highest ranking and greatest consideration for funding. Additional criteria, such as participation in the CRS, may be required for other programs such as the FMA. Elimination of Repetitive loss and Severe Repetitive loss properties carries a high priority.

OEM Hazard Mitigation Project Score Sheet
Total Score_____
Applicant_____

Project Title_____

Date of NOI_____ Date Approved for Funding_____

Natural Hazards Addressed	Hazard Value 2 points each Dam Failure Drought Earthquake Expansive Soils Extreme Heat Flooding Hail High Winds Landslides Lightning tornado Wildfires Winter Storms	Max Score 25 points
History of Damage in Project Area Repetitive Loss properties Severe repetitive loss properties	Average of all Properties 5 points per events documented by NCDC Or BC Module predicts an Average of <5 year Hazard Return Interval 25 >5 and <10 Hazard Return Interval 20 >10 and <25 Hazard Return Interval 15 >25 and <50 Hazard Return Interval 10 >50 and <100 Hazard Return Interval 5 >100 Hazard Return Interval 0	Max 25 points
Type of Mitigation	Non Structural (e.g., flood proofing, retrofitting, elevation, acquisition, development/implementation of codes and standards, etc.) 5 Structural (e.g., levee, flood wall, storm water drainage improvements, or dam construction/retrofitting) 0	Max 5 points
Potential Impact on Community	Severe (failure to implement project results in loss of life or essential services) 15 High (Communities with the most intense development pressures) 7.5 Moderate (failure to implement project results in economic hardship) 5 None (project has minimal or no impact) 0	Max 15 points
Estimated Environmental impact	Insignificant (CATEX) 5 Moderate (EA required) 2.5 Major (EIS required) 0	Max 5 points
Intangible Factors	Storm Ready 1 CSR rating (6-10) 1 point for each class 5 Cost Share arrangements (.25%) 2 History of mitigation projects -10 + 5 Intangible factors can also result in negative scores	Max 10 points
Benefits	1 point per $5,00,00 benefits	Max 15 points
Total Points	100	
Bonus Point Section (Tie Breaker)	Quality of data in the application 10 Hazard Data (Zone) 2.5 Damage History 2.5 Cost Data 2.5 Environmental (Completeness) 2.5	Max 10 points

The subcommittee reviews different types of projects submitted and makes recommendations to the state hazard mitigation team on which types of projects would best serve the citizens and local jurisdictions of Oklahoma and provide the most cost effective use of the mitigation grant funds available. The formation of the subcommittee greatly improved the performance of the different state and federal agencies of the state hazard mitigation team and their ability to work together. Among the organizations and agencies contacted and providing assistance were:

Federal Agencies

Federal Emergency Management Agency (FEMA)
National Weather Service (NWS)
US Army, Corps of Engineers
US Fish and Wildlife Service
US Geological Survey
US Department of Housing and Urban Development (HUD)
US Bureau of Indian Affairs (BIA)
US Bureau of Reclamation

State Agencies

Association of County Commissioners of Oklahoma
Oklahoma Association of Regional Councils
Oklahoma Department of Agriculture—Forestry Division
Oklahoma Climatological Survey
Oklahoma Department of Commerce
Oklahoma Conservation Commission
Oklahoma Corporation Commission
Oklahoma Emergency Manager's Association
Oklahoma Emergency Management
Oklahoma Department of Environmental Quality
Oklahoma Floodplain Manager's Association
Oklahoma Geological Survey
Oklahoma Department of Health
Oklahoma Historical Society
Oklahoma Department of Human Services
Oklahoma Insurance Commission—Insurance Division
Oklahoma Municipal League
Oklahoma Department of Transportation
Oklahoma Water Resources Board
State National Flood Insurance Program (NFIP) Coordinator
State Dam Safety Coordinator
Oklahoma Department of Wildlife Conservation

Academia

Oklahoma Department of Education
Oklahoma State University

University of Oklahoma

Non Profits

Salvation Army
American Red Cross
Cedar Lake Volunteer Fire Department
Texanna Volunteer Fire Department
Eagle City Rural Fire Department
Charlie's Computer Service
Oklahoma VOAD (Voluntary Agencies Active in Disaster)

Private Business

Xerox A T & T MCI

The State of Oklahoma has reviewed the project evaluation procedures for the current planning period and determined that they are providing the desired results and are not in need of revision at this time.

2.2.4 Step Four: Hazard Identification

The State Hazard Mitigation Planning Committee (SHMPC) began in June 2003 identifying natural and man-made hazards that affect the State of Oklahoma. State department leaders and disaster professionals from throughout the state were contacted to identify those hazards to which Oklahoma citizens and property were most vulnerable. This is discussed in Chapter Three.

To ensure the accuracy and completeness of information on hazards, the Oklahoma Climatological Survey profiled each hazard to include a history and probability analysis. This information was then summarized to include county-level information where possible.

The analysis of these hazards included the impacts upon the state critical facilities, on society, the environment, the economy and on future development. The resources of the state were found to exceed the local jurisdictional resources. The State gathered data and disseminated that information to all pertinent local jurisdictions to analyze and apply as needed to their local plans. In this case, hazard identification information flowed from the state to the local level.

After the State Hazard Mitigation Planning Committee reviewed the natural and man-made hazards that could potentially impact the State of Oklahoma, they selected and provided an initial prioritization of the hazards to be included. The planning committee collected the data on the hazards from available sources, including historical incidents and disaster declarations, records from the National Climatic Data Center (NCDC), input from federal and state emergency management agencies, the National Weather Service (NWS), the National Severe Storms Laboratory (NSSL), local governmental entities, and community service organizations, such as the American Red Cross. The specific hazard identification and assessment justification, and methodology used, are included in Chapter Three, under Profiling Hazards.

In the Febraruy 17, 2011 update of this plan the data gleaned from the review of the one hundred eighty five FEMA approved local and tribal plans covering four hundred sixty eight jurisdictions has been compared to the top down data and the top down data was found to be lacking. Local plans have identified two additional hazards that impact Oklahoma: Levee Failure and Sinkholes.

2.2.5 Step Five: Hazard Assessment

The hazard data were analyzed in light of what it means to public safety, health, buildings, transportation, infrastructure, critical facilities and the state economy. Some of the work for Steps four and five had already been done in the preparation of the previous State Hazard Mitigation Plan. The State Hazard Mitigation Planning Committee used historical data to estimate potential losses from the various hazards. Discussion of the situation and vulnerability assessment for each hazard is further explained in Chapter Three.

2.2.6 Step Six: Goal Setting

Project and community hazard mitigation goals and objectives for the state were developed from those already reflected in the current state mitigation plan and further refined by the State Hazard Mitigation Planning Committee to guide the development of this plan. The goals, in the national and state context are discussed above in this chapter and the individual hazard goals and the goals-setting process are described in Chapter Four and continue to be valid.

2.2.7 Step Seven: Possible Mitigation Actions

A wide variety of mitigation strategies that can affect hazards or the damage from hazards were examined. These mitigation activities are organized under the following six categories from the FEMA guide 386-1 and 386-3 (see Chapter Four, "Mitigation Strategies and Priorities" for a more detailed description of each category)

1. Public Education and Awareness – Outreach projects and technical assistance
2. Preventive Measures – Zoning, building codes, storm water management
3. Natural Resource Protection – Wetlands protection, forest/vegetation management
4. Property Protection –Acquisition, retrofitting, relocation, elevation
5. Emergency Services – Warning, sandbagging, evacuation
6. Structural Projects – dams, reservoirs, retaining walls, safe rooms

2.2.8 Step Eight: Action Plan Draft

The results of the mitigation strategies review are summarized in the Action Plan. The Action Plan specifies what will be done, by what office and by what deadline. The draft Action Plan was widely circulated for comment and reviewed at meetings with state and federal agencies before it was sent to FEMA. The draft copy of the revised plan was posted on the OEM website for public review.

2.2.9 Step Nine: Plan Adoption

After a final review by OEM, the plan was approved and submitted to Albert Ashwood, Director, Oklahoma Emergency Management who is also the Governor's Authorized Representative, for approval prior to FEMA submission. The State will seek formal adoption of the plan by the appropriate officials once FEMA has pronounced the plan to be approvable.

2.2.10 Step Ten: Plan Maintenance

The State's adoption of the Hazard Mitigation Plan is only the beginning of the plan maintenance effort. State offices, other agencies and private partners will implement the plan's activities; Oklahoma Emergency Management, Hazard Mitigation Division, will monitor implementation progress, evaluate the effectiveness of the actions, and periodically recommend revisions to the action items. Progress in the implementation of the plan and the recommended action/mitigation strategies will be assessed annually. The Plan is a living document and will be reviewed, updated and adopted by state officials and submitted to the Federal Emergency Management Agency for approval every three years. The plan will be revised more frequently if conditions under which the plan was developed change; through new or revised state policy, a major disaster, or availability of funding, for example, to reflect the new reality of hazard mitigation in the State of Oklahoma. The State will continue to comply with all applicable federal statutes and regulations during the periods for which it receives grant funding, in compliance with 44 CFR 13.11 (c) and will amend this plan whenever necessary to reflect changes in state or federal laws and statutes as required in 44 CFR 13.11 (d) . The 44 CFR will be reviewed immediately after the annual 44 CFR updates.

Review and updates of the state plan will take place in several ways:

- Annually, for progress made on mitigation actions and projects identified in the Mitigation Strategy of the State Plan.

- After each major disaster in the State of Oklahoma declared by the President, to look for areas where the State Plan should be refocused due to the impact of the disaster.

- Every three years before the State Plan is resubmitted for approval to the Federal Emergency Management Agency.

2.3 Coordination among Agencies

2.3.1 Oklahoma Emergency Management (OEM)

Oklahoma Emergency Management (OEM) coordinates statewide emergency preparedness, response, recovery and hazard mitigation activities with other federal, tribal, state, and local agencies to develop and implement the strategies outlined in this document, obtain interagency feedback on the mitigation steps taken and use that information in updating this plan. Since June 1999, Oklahoma's State Hazard Mitigation Team (SHMT) has held regular quarterly meetings and met more often if needed. This coordination and interaction between agencies continues on a daily basis. Created by Oklahoma statute in 1999, the SHMT is comprised of state, federal, tribal and non-profit agencies.

OEM reviewed, evaluated and discussed the existing plan and concluded that although our primary goals have remained the same, we should expand our horizons by identifying new and improved methods to achieve those goals. The analysis presented evidence that goals identified in the original HM plan had been successfully accomplished and should, in fact, be continued and perhaps even expanded in their scope. However, in reviewing the disasters which have occurred during the years between 2004 and 2010, OEM realized that new vulnerabilities existed as well as new technologies created to mitigate previously-identified hazards. Identification and further discussion of these goal changes is discussed in Chapter Four of this document. Evaluation of the management and coordination methods used to achieve the state's mitigation goals indicates that the state capabilities have improved and that the current method of operation is proper, cost effective and well administered.

Those agencies that wished to participate in the development of the updated State Hazard Mitigation Plan are listed below, along with a description of their interaction and coordination with OEM and others. These various state agencies and Departments provided input regarding their own mitigation initiatives and other possible sources of funding for mitigation projects. In depth information about existing and proposed mitigation efforts by state agencies is included in the following agency description and summarized in the table below.

In the State of Oklahoma, each agency is required to prepare a yearly status report to present to the Governor and legislature. This report must describe and justify the activities of that agency as well as define its objectives and how it has completed its current objectives during the past year. A further description of its future objectives and requirements is also presented in the report. In preparing its yearly report, OEM and the SHMPC review the goals and anticipated mitigation action items found in the State Hazard Mitigation Plan. This report then serves to assist the legislature in identifying funding objectives to help the emergency management community fulfill its commitments and complete action items identified in the plan. OEM staff and the SHMT review completed action items and determine if they have been a mitigation success and whether to continue those activities.

2.3.1.1 Coordinating Agencies and Funding Sources

Agency	Coordination /Services	Available Funding	Supports Mitigation Efforts
National Weather Service	1) Hydro-Meteorological Studies 2) Weather Surveillance 3) NOAA Weather Radio 4) National Warning System 5) River Forecast Center		1) Yes 2) Yes 3) Yes 4) Yes 5) Yes
US Dept of Agriculture	1) Extension Services 2) Farmers Home Administration 3) Rural Electrification Admin 4) Natural Resource Cons Service 5) Watershed Protection/Flood Prevention (PL 83 566) 6) Flood Control Act 1944, (PL 78 534) 7) Floodplain Mgmt Studies 8) RC&D Program (PL 88 703) 9) Emergency Watershed Protection 10) Conservation Tech Assistance	1) Farm Service Agency loans 2) Emergency Loans 3) REA loans/tech asst 4) NRCS Financial/Tech assistance 5) Financial/Tech assistance 8) Financial/Tech assistance 9) Agricultural Credit Act of 1978	1) Yes 2) Yes 3) Yes 4) Yes 5) Yes 6) Yes 7) Yes 8) Yes 9) Yes 10) Yes
US Army, Corps of Engineers, Tulsa District	1) Feasibility Studies/Projects 2) Emergency Stream Bank Protection 3) Small Flood Control Projects 4) Flood Control/Snagging & Clearing 5) Emergency Operations (PL 84-99) 6) Floodplain Management Services 7) Permit Authority 8) Disaster Response 9) Flood Control 10) Dam Safety	8) Memorandum of Understanding	1) Yes 2) Yes 3) Yes 4) Yes 5) Yes 6) Yes 7) Yes 9) Yes 10) Yes
Department of Education (DOE)	1) Floodplain Management Guidelines		1) Yes
US Bureau of Reclamation	1) Water Supply 2) Hydroelectric Power 3) Flood Control		3) Yes
US Fish & Wildlife	1) Flood Hazard Mitigation		1) Yes
US Geological Survey (USGS)	1) Data Collection 2) Monitoring 3) Analysis 4) Predictive Modeling		1) Yes 2) Yes 3) Yes 4) Yes
National Park Service	1) Flood Hazard Mitigation (Chickasaw National Recreation Area) 2) Construction 3) Shoreline Processes		1) Yes 2) Yes 3) Yes
HUD	1) Community Planning and Development 2) Home Investment Partnership Act 3) FHA Single Family Programs 4) Multi-family Housing Programs 5) Public Housing 6) Native American Programs	1) Grant program (match HMGP/PDM) 2) Home program 3) Mortgage/loan insurance 4) Mortgage Insurance program 5) Funding & assistance 6) Indian home loan guarantee program 7) Indian Develop Block Grant Program	1) Yes 2) Yes 3) Yes 4) Yes 6) Yes 7) Yes
DOT	1) Post Flood Disaster Replacement and/or reconstruction highway facilities		1) Yes

Agency	Coordination /Services	Available Funding	Supports Mitigation Efforts
SBA	1) Financial Assistance-Disaster Loan Program	1) Home disaster loans 2) Business physical disaster loans 3) Economic injury disaster loans	
American Red Cross	1) Emergency & Health Services 2) Disaster Relief Programs		
Oklahoma Department of Agriculture-Forestry Division	1) Rural Fire Defense Program 2) Red Flag Fire Alerts 3) Technical Advice 4) Forest Stewardship Program 5) Forest Heritage Center 6) Project Learning Tree Program 7) Urban & Community Forestry Program 8) Water Quality Management Program 9) Regeneration/ Improvement Center		1) Yes 2) Yes 4) Yes 6) Yes 7) Yes 9) Yes
Oklahoma Climatological Survey	1) Oklahoma Mesonet 2) Flash Flood Guidance 3) Drought Monitoring Website 4) Historical Information		1) Yes 2) Yes 3) Yes 4) Yes
OK Dept/Commerce	1) Community Development Programs	1) Grant & Loan Programs	1) Yes
OK Conservation Commission	1) District Operation Division 2) Water Quality Division 3) Mine Land Reclamation Division	1) Small Watershed Flood Control Fund 2) Cost Share Program/Watersheds 3) Federally Funded	1) Yes 2) Yes 3) Yes
Oklahoma Emer. Mgmt. Assoc.	1) Storm Spotters Network 2) Emergency Operations Center 3) Disaster Preparedness Network		1) Yes 2) Yes 3) Yes
OK Dept Central Services	1) State Self Insurance Program		1) Yes
OK Dept Emer. Mgmt.	1) Preparedness, Response, Recovery, Mitigation Programs, Mitigation of repetitive loss property, Mitigation of Severe repetitive loss properties.	1) Federal Financial Assistance Programs 2) HMGP 3) FMA 4) SRL 5) PDM	1) Yes 2) Yes 3) Yes 4) Yes 5) Yes
Department of Environmental Quality	1) Customer Services Division 2) State Environmental Laboratory 3) Air Quality Division 4) Land Protection Division 5) Water Quality Division	1) Customer Assistance Program	4) Yes 5) Yes
Oklahoma Floodplain Mgrs Association	1) Floodplain Management 2) Member Services 3) Internal Development/OFMA Strategic Plan	2) Training/Education	1) Yes 2) Yes 3) Yes
Oklahoma Geological Survey	1) Earth Science Education 2) Geological Mapping 3) Geophysical Observatory		2) Yes 3) Yes
Oklahoma Historical Society	1) Administer Federal Historic Preservation Programs 2) Identification of Archeological/Historic Properties		
Oklahoma Department of Human Services	1) Temporary Emergency Assistance 2) Human Resource Management Division	1) Individual/Family Grants	1) Yes

Agency	Coordination /Services	Available Funding	Supports Mitigation Efforts
Oklahoma Water Resource Board	1) National Flood Insurance Program 2) Dam Safety Program 3) Administration of State Water Laws 4) Water Resource Planning 5) Floodplain Management Program 6) Drought/Weather Mitigation	1) Community Assistance Program 2) Training 4) Loan/Grant Programs 5) Flood Insurance	1) Yes 2) Yes 4) Yes 5) Yes 6) Yes
Oklahoma Department of Wildlife Conservation	1) Communications/Relay Towers 2) Fisheries Division/Construction 3) Wildlife Division	3) Tech. Assistance/Research/Education	1) Yes 2) Yes 3) Yes

Oklahoma has experienced a great deal of coordination and integration of services through the years.

2.3.2 The National Weather Service (NWS)

Virtually every local, state and federal agency in Oklahoma utilizes the services of the National Weather Service.

NWS is responsible for providing a full range of both meteorological and hydrological services to the Nation's citizens. The provision of weather warning, forecasting and informing the public is the primary NWS operation. These meteorological services are targeted towards the safety, health, welfare, comfort and convenience of the public. On a temporal, local basis these forecast services look forward for 48 hours in detail and from 48 hours to seven days in a more general fashion.

The primary mission of the hydrologic services program of NWS is to save lives and reduce property damage by public issuances of timely warnings of flood and flash flood events and river stage forecasts. Additional types of forecasts may include: River stage forecasts for navigation and control of pollutants and hazardous substance; reservoir inflow for generators of hydroelectric energy; and water supply for irrigation and energy.

Other services include hydro-meteorological studies used in planning and designing of dams, highways, airports, and flood insurance.

General flooding and flash flooding pose a great threat to life, where placid rivers and streams swell quickly from heavy rains. To cope with these dangerous situations, NWS has developed, or assists in, various warning methods, which may be used in a particular community.

A. <u>The River Forecast Center (RFC)</u> - Located in Tulsa, OK, the RFC was founded as the Tulsa River Forecast Center in December 1947 partially in response to the record floods of March-April 1945 in the Arkansas and Red River basins. The area of responsibility has essentially remained unchanged through the years, except that in its early years, the center forecast points on the Arkansas and Red Rivers extended all the way downstream to their confluence with the Mississippi River. By 1947, its forecast area had changed slightly to its current configuration, the Arkansas River basin above Pine

Bluff, AR and the Red River basin above Fulton, AR. This comprises over 208,000 square miles and includes portions of seven states. The RFC was selected as the first prototype site for modernized RFC technologies and operations. In this capacity, the RFC developed several advanced techniques and procedures that will be integral to hydro meteorological operations in the modernized era. In 1991, the center was renamed the Arkansas-Red Basin RFC to better convey the area of responsibility. The data used by the RFC is provided by the US Army, Corps of Engineers and USGS from water gauges on the rivers and streams from 200 river forecast points, 100 of which are located in Oklahoma, and combined with NWS satellite and radar data, then input to the hydrologic computer program model to develop the River Stage forecast.

B. W<u>eather Surveillance RADAR-NEXRAD (WSR-88D)</u> - The National Weather Service offices operate WSR-88D RADARs to detect and warn for severe thunderstorms, flash floods and tornados across Oklahoma. This radar system can predict rainfall patterns with more lead time when severe weather is occurring or anticipated. This radar is a state-of-the-art, computer-based, S-band (10 cm), Doppler weather radar system that covers all areas of the United States including Alaska and Hawaii, as well as parts of the Caribbean. Currently there are fourteen (14) such Radars that monitor Oklahoma.

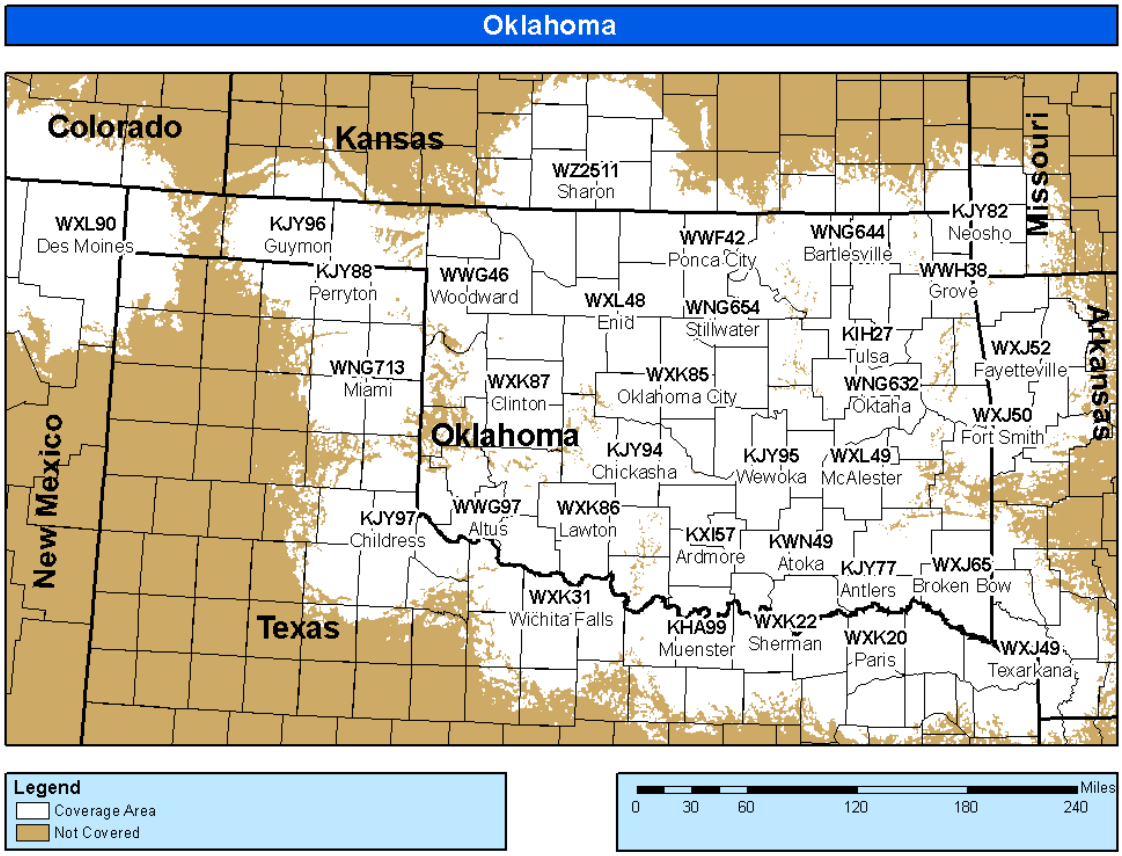
C. <u>NOAA Weather Radio (NWR) Network</u> -There are twenty (20) transmitting stations in operation from the Oklahoma City, Amarillo, Shreveport, and Tulsa Weather Offices. Also fringe areas of Oklahoma can hear stations at Wichita Falls, Sherman, Childress, Perryton, Muenster, Paris, and Texarkana, Texas; Ft. Smith, Mena and Fayetteville, Arkansas; Monett, Missouri; and Meade, Kansas; Des Moines, New Mexico. This system is effective in those areas covered, which includes a 40 mile or greater radius from each transmitter listed below. However, additional transmitters are needed to give 100% coverage to the state. The newest transmitter, Guymon, Oklahoma, was put in service May 9, 2007.

Oklahoma Station Listing

Call Sign	Site Name	Site Location	Frequency	Power
WWG97	Altus	Altus	162.425	1000
KJY77	Antlers	Antlers	162.400	300
WXK87	Arapaho	Clinton	162.525	1000
KWN49	Atoka	Atoka	162.500	300
KJY94	Chickasha	Chickasha	162.450	300
WXJ65	Choctaw	Broken Bow	162.450	1000
KXI57	Davis	Ardmore	162.525	300
WXL48	Drummond	Enid	162.475	1000
WWH38	Grove	Grove	162.500	300
KJY96	Guymon	Guymon	162.500	1000
WXK86	Lawton	Lawton	162.550	1000
WXL49	McAlester	McAlester	162.475	1000
WXK85	Oklahoma City	Oklahoma City	162.400	1000
WNG632	Oktaha	Oktaha	162.525	300
WWF42	Ponca City	Ponca City	162.450	500
WNG654	Stillwater	Stillwater	162.500	1000
KIH27	Tulsa	Tulsa	162.550	500
WNG644	Washington County	Bartlesville	162.425	1000
KJY95	Wewoka	Wewoka	162.550	1000
WWG46	Woodward	Woodward	162.500	1000

Number of Stations in Oklahoma = 20

NOAA Weather Radio sites Selection Page for Oklahoma



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D. <u>National Warning System (NAWAS)</u> – Although not an agency in and of itself the NAWAS program has been useful in maintaining contact with various jurisdictions on the local state and federal levels. Used extensively at one time, due to availability limitations, it is now primarily used when situations occur that require quick response by agencies. The National Warning System (NAWAS) is a comprehensive party line network of telephone circuits connecting state and Federal warning points throughout the United States. It is funded by the Federal Emergency Management Administration (FEMA). Although NAWAS is a national system, the day-to-day operation is under the control of individual states. Each state has its own plan for the use of NAWAS during weather emergencies. NWS offices should use this circuit only in accordance with individual state plans. Normally, all warnings and watches will be disseminated on the appropriate NAWAS by the issuing office. For Oklahoma weather situations, coverage by NAWAS drops (Oklahoma side only) are located in weather offices for direct communication with all the other NAWAS drops in this state, including Highway Patrol Headquarters (also the "primary warning point" under the state plan); most Troop Headquarters; and 17 city and county Emergency Operation Centers including the state EOC. Some weather offices are outside Oklahoma, which provides this state with additional advance information and more radar coverage. Each office with a NAWAS drop can hear current information and can anticipate weather action in their respective areas. National Weather Service drops are located at the

Norman and Tulsa Weather Offices and in Amarillo, Fort Worth, Texas; Shreveport, Louisiana; and Springfield, Missouri.

2.3.3 U.S. Department of Agriculture

Natural disaster assistance is provided by the following divisions within the U.S. Department of Agriculture:

A) Extension Service (ES) - Supports all USDA natural disaster missions through the land grant universities by providing the following:

(1) Informational and educational material to farmers, ranchers, and others on what they can do to protect themselves and their property against the hazards associated with disasters.

(2) Technical advice on cleanup of damaged property; sanitation precautions; insect control; food preparation in an emergency; recovery actions on damaged farms; and, renovation of damaged equipment and property.

(3) The Farm Service Agency can provide assistance for farms the Secretary of Agriculture declares a disaster. When this type of disaster is declared, the Small Business Administration can make loans to farmers for repair to dwellings if needed. However, repair or reconstruction should be supervised relative to building code or local ordinance enforcement.

B) Farmers Home Administration (FmHA) - The FmHA can make emergency loans following a natural disaster. The President or Secretary may implement the emergency loan program by naming a county a "disaster area."

(1) Eligible farmers, ranchers, and aquaculture operators may receive emergency loans that cover actual losses and may be used to repair, restore, or replace damaged or destroyed farm property and supplies; for expenses incurred for crop production; and, to pay farm debts owed to another creditor.

(2) Loan eligibility of applicants will be considered from anyone who has suffered property damage or severe production losses from a natural disaster; is a U.S. Citizen or a legal resident alien; is an established farm, ranch, or aquaculture operator (either tenant or owner/operator) who manages the enterprise; is of good character, and with the industry, ability, and experience to carry out the proposed farming operations.

C) The Rural Electrification Administration (REA) - Assists REA-financed electric and telephone cooperatives and companies with additional loans and technical assistance in obtaining resources for restoration of service after a natural disaster.

D) The Natural Resource Conservation Service (NRCS) - Provides technical and financial assistance for runoff retardation and soil erosion prevention as needed to reduce hazards to life and property from floods, drought, and the products of erosion on any watershed impaired by any natural disaster. The NRCS activities in Oklahoma includes emergency watershed protection and flood prevention projects, floodplain management studies, Resource Conservation and Development, conservation technical assistance, soil surveys, and

water supply forecasting. Today along with erosion control, the agency provides technical assistance and in some cases financial helps for:

(1) Rehabilitation of land and conservation systems for which NRCS provides cost sharing.
(2) Emergency protection against high water and rehabilitation of rural lands damaged by natural disasters.
(3) NRCS provides information and materials (maps and reports) on watershed projects, river basin studies, and resource conservation and development areas. It also makes available agency equipment for emergency use.
(4) Watershed Protection and Flood Prevention - The Watershed Protection and Flood Prevention Act (Public Law 83 566) authorizes NRCS to provide technical and financial assistance to local organizations to plan and install works of improvement for watershed protection, flood prevention, agriculture water management, and other approved purposes.
(5) Public Law 78 534 Flood Control Act of 1944 - The Act, as amended, gives to the U.S. Department of Agriculture (USDA) responsibility in 11 selected watersheds for watershed investigations and for planning and installing measures to reduce runoff and erosion and slow down stream flow. The NRCS and the Forest Service (FS) carry out this responsibility with assistance from other agencies within and outside USDA.
(6) Floodplain Management Studies - Assistance for cooperative floodplain management studies is provided to local communities or units of government by the NRCS. The objective of these studies is to provide information and large-scale mapping needed in alleviating potential flood dangers. The studies are conducted on a priority basis though the Oklahoma Conservation Commission. The cooperative studies require financial assistance from participating communities and the state, which provides at least 20 percent of the direct study costs. The final product includes a comprehensive report with detailed mapping and information to be used in implementing effective floodplain management programs. Section 6 of Public Law 83 566 provides authority for flood plain analysis.
(7) Resource Conservation and Development - NRCS administers the Resource Conservation and Development Program (RC&D) authorized under Public Law 88 703, Section 102 of the Food and Agriculture Act of 1962. Under this program, technical and financial assistance is available to groups within the five authorized RC&D areas in Oklahoma for installation of flood prevention measures. Assistance can be provided for control of erosion on critical eroding areas, flood damage reduction, recreation developments, fish and wildlife developments, water supply developments, and water quality improvement. Funding for this program is limited.
(8) Emergency Watershed Protection - Funding is authorized under Sections 403 4 5 of the Agricultural Credit Act of 1978 for SCS to provide emergency watershed protection assistance. This assistance is provided to reduce hazards to life and property in watersheds damaged by significant natural events.
(9) Conservation Technical Assistance - In addition to the specific program activities, NRCS can provide technical assistance under Public Law 74 46 to land users in the planning and application of conservation treatments to control erosion and reduce upstream flooding along with other purposes such as sediment reduction. The NRCS works through local conservation districts. These districts are subunits of state government that represents the local people on natural conservation issues.

2.3.4 US Army, Corps of Engineers (Tulsa District)

Member Oklahoma Hazard Mitigation Planning Committee

The United States Army Corps of Engineers has authority under Public Law 84-99, as amended (hereafter PL 84-99), to assist public agencies in responding to flood emergencies. Assistance can be in the form of technical assistance, direct assistance, or rehabilitation of federal and certain non-federal flood control works, damaged or destroyed by floods. It is involved in developing and implementing plans for flood control, and also has authority for emergency operations, stream bank protection, permit administration, and technical assistance. The Corp is also a member of the State Hazard Mitigation Planning Advisory Committee. The Corp's programs in Oklahoma include:

A) **Feasibility Studies and Projects** - Congress can authorize the Corps to perform feasibility studies that may result in projects for flood control, navigation, hydropower, water supply, and recreation.

B) **Continuing Authorities** – The Corps of Engineers has discretionary authority to implement certain types of water resource projects without specific Congressional authority. These projects are typically limited in scope and cost. Applicable continuing authorities' project and Federal cost limitations are:

(1) Emergency Stream Bank Protection of Public Facilities: $500,000
(2) Small Flood Control Projects: $7.5 million
(3) Snagging and Clearing for Flood Control: $500,000

C) **Emergency Operations** - Under the provisions of Public Law 84-99, the Corps of Engineers has the authority to respond to flood emergencies. The authority includes flood control operations, constructing advance measures (temporary) in anticipation of imminent flooding, and the repair of damaged flood control works after the flood event.

D) **Floodplain Management Services** - The Corps of Engineers can provide assistance in evaluating flood hazards to a site, floodplain delineation, technical assistance, guidance, and comprehensive floodplain management. Under this program assistance on all floodplain management and FEMA programs can be provided to local and state governments, Indian Tribes or authorized tribal organizations.

E) **Permit Authority** - The Corps of Engineers, by law, has the authority to issue Section 10 permits to cover construction, excavation, and other related work in or over navigable waterways and Section 404 permits covering the discharge of dredged or fill material in all waters of the United States, to include adjacent wetlands.

F) **Disaster Response** - The Corps of Engineers has a Memorandum of Understanding to coordinate with and support all FEMA response activities. The Corps established a Disaster Field Office in Oklahoma City after the 1995 bombing to coordinate public works and engineering in accordance with Emergency Support Function 3 of the Federal Response Plan. This effort included providing search and rescue personnel and structural engineering support. After the May 3, 1999, tornados that hit parts of Oklahoma, the Corps were involved in many

aspects of the response and recovery. Most notably the Corps handled contracting and monitoring of debris removal from the tornado areas.

G) **Flood Control** - The Corps of Engineers is responsible for controlling floodwater releases from all Corps' lakes. The Corps also has agreements to monitor and control flow releases from dams owned or controlled by Grand River Dam Authority (GRDA), Bureau of Reclamation, and other Federal agencies.

H) **Dam Safety** - The Corps of Engineers has mandatory annual training for personnel on dam safety and the dams are inspected every four years for safety standards and the integrity of the dams.

2.3.5 Department of Education (DOE)

Member of Oklahoma Hazard Mitigation Committee

Any Federal activity that includes providing federally undertaken, financed, or assisted construction and improvements must take into account the provisions of Executive Order 11988 and its accompanying Floodplain Management Guidelines. The objective of Executive Order 11988 is to avoid the long and short term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative.

Before taking any action, the Department of Education (DOE) representative shall determine whether the proposed action will occur in a floodplain. This determination shall be made using current floodplain maps if available. If such maps are not available, the DOE representative shall make a determination of the location of the floodplain based on the best available information.

If the damaged school facilities are not located in a floodplain, the DOE representative will so certify. If the damaged school facilities will be located in a floodplain, Federal support can be rendered only if there is no practicable alternative. The determination of "no practicable alternative" will be made in accordance with the provisions outlined in Executive Order 11988. If school facilities are located in a floodplain and there is no practicable alternative, the DOE representative is responsible for certifying that the local facility has flood insurance up to the maximum amount available or up to the amount of damage assistance provided by the Education Department, whichever is the lesser.

2.3.6 Department of the Interior

Cherokee and Muscogee Creek Nations are members of Oklahoma Hazard Mitigation Team and subcommittee

A) **US Bureau of Indian Affairs (BIA)** - The Bureau of Indian Affairs is responsible for managing and protecting natural resources on Indian trust lands and for assisting tribes to serve American Indians. It provides community services, operates or provides financial support to operate schools, maintains law enforcement systems, provides social services, and assists in farming, ranching, forestry and mining on reservations.

B) **US Bureau of Land Management (BLM**) - The BLM is responsible for the appropriate multiple use management of natural resources. BLM also has the responsibility for mineral leasing and supervision of mineral operations on Federal mineral estates that underlie other surface ownership and on Indian mineral estate lands held in trust. In Oklahoma the BLM is

responsible for 4,000 surface acres of Federal surface, 504,000 of Federal mineral estates and 407,000 acres of Indian mineral estates.

C) **US Bureau of Reclamation (BOR)**
Reclamation reconstructs, operates, and maintains multiple purpose Federal water projects in the 17 western states. Reclamation has constructed over 600 dams and reservoirs, including Hoover Dam, since the agency was established by the Reclamation Act of Congress in 1902. Authorized purposes at each project may include; water supply for agricultural irrigation and municipal uses, hydroelectric power, flood control, recreation, and fish and wildlife benefits. Reclamation constructed seven dams in Oklahoma including Altus, Arbuckle, Fort Cobb, Foss, McGee Creek, Mountain Park, and Norman. Operation and maintenance of these facilities has been transferred to the agencies that contracted with the United States for the development of each project.

D) **US Fish and Wildlife Service**
The Fish and Wildlife Service has a principal Federal responsibility to conserve, protect, and enhance fish and wildlife and their habitats. The Service manages the national wildlife refuge system. In addition, the Service manages fish hatcheries and is responsible for flood hazard mitigation in the following areas in Oklahoma:

(1) Salt Plains National Wildlife Refuge
(2) Optima National Wildlife Refuge
(3) Washita National Wildlife Refuge
(4) Wichita Mountains Wildlife Refuge
(5) Tishomingo National Wildlife Refuge
(6) Sequoyah National Wildlife Refuge
(7) Tishomingo National Fish Hatchery
(8) Deep Fork National Wildlife Refuge
(9) Little River National Wildlife Refuge

E) **US Geological Survey (USGS)**

Created by an act of Congress in 1879, the USGS stands as the sole science agency for the Department of the Interior. It is sought out by thousands of partners and is the science provider of choice in accessing the information and understanding to help resolve complex natural resource problems across the Nation and around the world. The USGS serves the Nation as an independent fact-finding agency that collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems. The value of the USGS to the Nation rests on its ability to carry out studies on a national scale and to sustain long-term monitoring and assessment of natural resources. The USGS provides impartial science, because it has no regulatory or management mandate. The diversity of scientific expertise enables the USGS to carry out large scale, multi disciplinary investigations that build the base of knowledge about the Earth. In turn, decision makers at all levels of government and citizens in all walks of life have the information tools they need to address pressing societal issues. The diversity of scientific issues that demand attention has prompted the USGS to focus its efforts into four major areas: natural hazards, resources, the environment, and information and data management.

Natural hazards are an ever-present national concern, and the USGS is committed to providing the science needed to reduce the loss of life and property they can cause. The USGS seeks to provide the understanding and scientific information needed to recognize and mitigate adverse impacts and to sustain the health of the Nation's environment. USGS scientific efforts include long-term data collection, monitoring, analysis, and predictive modeling. For example, major floods in Oklahoma have affected many people and have caused economic damage and loss of life. Although floods cannot be prevented, information furnished by USGS is critical to the operation of flood-warning systems and alerts. Information on the amount of water in reservoirs, river stages, and the arrival of floodwaters helps people prepare for flooding, thus reducing the destructive effects.

USGS scientists pioneered hydrologic techniques for gauging the discharge in rivers and streams and modeling the flow of complex ground-water systems. Innovative ventures with the private sector have given the world access to digital images of neighborhoods and communities in one of the largest data sets ever made available online.

F) **National Park Service (NPS)**

The NPS has the dual responsibility of protecting the natural and cultural resources of the park areas and providing for their use and enjoyment by the public. The NPS also conducts programs that promote and assist outdoor recreation planning, preservation of cultural and natural resources, and environmental compliance and review along with other federal agencies, state and local governments, and private organizations.

(1) The National Park Service is responsible for flood hazard mitigation in Oklahoma for the Chickasaw National Recreation Area.

(2) On August 6, 1979, the National Park Service revised its management policies on construction, shoreline processes, and limitation of visitor use. With respect to floodplains or wetlands, the revisions provide that facilities and structures will not be located, except where no practicable alternative exists, in 100 year floodplains, and schools, hospitals, and museums will not be located within 500 year floodplains. Furthermore, the impact from construction activities will be avoided in floodplains and wetlands, except where no "reasonable alternative" exists. Whenever new facilities and structures must be located in floodplains and wetlands; "their design and setting shall be based on scientific, engineering and architectural studies; consideration for protection of human life; natural processes and cultural resources; and consideration of their planned life span." The same scrutiny will be applied to existing structures and facilities needing rehabilitation or replacement. Such scrutiny will be one factor in the case of historic structures.

(3) In natural zones, shoreline processes, such as erosion, deposition, dune formation, and inlet formation, will be allowed to take place naturally, except where control measures are necessary to protect life and property in neighboring areas. In historic zones, the threat to the cultural resources and the imminence of the threat also are taken into account. In development zones, a management policy of phasing out, systematically relocating or providing alternative development to existing

development will be followed. No new development will be placed unless they are essential to meet the park's purpose and no practical alternative locations are available.

2.3.7 US Department of Housing and Urban Development (HUD)

Member of Oklahoma Hazard Mitigation Committee

As the name implies, the U.S. Department of Housing and Urban Development (HUD) is the agency of the Federal government whose primary mission is to assist in providing good quality housing and suitable living environments for all segments of the population. This is accomplished through a wide variety of programs that are administered by five Program Areas of HUD, as shown below.

HUD Program Areas:

- Community Planning and Development
- Single Family Housing
- Multifamily Housing
- Public Housing
- Native American Programs

There are a large number of programs, each with its own set of outcome goals, eligibility criteria, application procedures, and performance monitoring requirements. Funding opportunities occur on an annual basis subject to budget appropriations approved by the Congress and the President. HUD also has a Disaster Recovery Handbook and the capacity to wave or modify some policies and procedures in the event of Presidential Disaster Declarations.

The major programs of HUD are summarized in the following sections and described in terms of how they function under normal circumstances. However, for purposes of the Oklahoma Hazard Mitigation Plan, special emphasis has been placed on how these programs, and other assistance from HUD, may be used by local governments and individual households, both before and after a disaster.

It is very important to remember that the departure, if any from normal HUD rules during a local emergency situation depends on the circumstances of each disaster event. Local governments should immediately consult with the nearest HUD Office to ensure there is consensus on how HUD funds can be used.

A) Community Planning and Development (CPD)

The CPD Program Area of HUD administers the broadest range of HUD programs by addressing housing and related community development needs, with a particular emphasis on benefiting low- and moderate-income persons. Generally, approved projects are carried-out by cities and towns or non-profit organizations, and funding either comes directly to the local government or through the State of Oklahoma, depending on population size and other eligibility factors. Local needs may be addressed through eligible activities that are consistent with local priorities in HUD-approved Consolidated Plans.

B. **Community Development Block Grant Program (CDBG)**
The CDBG Program is authorized under Title I of the Housing and Community Development Act of 1974, as amended. Its purpose is to promote viable communities by providing decent housing, a suitable living environment, expanding economic opportunities, principally for persons of low and moderate income. Housing rehabilitation, down payment assistance, economic development, public facility and construction are among the many types of eligible activities. This program may be used to match HMGP and PDM grants.

C. **HOME Investment Partnerships Act (HOME Program)**
The primary purpose of the HOME Program is to strengthen public-private partnerships, to expand the supply of decent, safe, sanitary, and affordable housing with the primary emphasis on rental housing for low and very low-income families. Generally, HOME funds must be matched by nonfederal resources. Examples of eligible activities include housing construction, rehabilitation, acquisition, and tenant-based rental assistance. This may be accomplished through loans, grants, advances, equity investments, interest subsidies, and other forms of investment that HUD approves.

D. **Emergency Shelter Grant Program (ESG)**
The ESG Program is designed to help increase the quality and quantity of emergency shelters and transitional housing facilities for homeless individuals and families, to operate these facilities and provide essential social services, and to help prevent homelessness. I***n the State of Oklahoma***, the Oklahoma Department of Commerce administers the ESG Program. The State may provide ESG funds directly to non-profit organizations with the approval of the local government where the project is located. Eligible activities include building renovation, essential services such as case management, counseling, health care, job training, education and child care, operational costs, homeless prevention activities, and administrative costs.

E. **Supportive Housing Program (SHP**) - The SHP Program is designed to promote the development of supportive housing and supportive services to assist homeless persons in the transition from homelessness to independent living. Specific performance measures for the program are established based on the needs and characteristics of the homeless population to be served. Eligible applicants for funding are states, local governments, public housing authorities, tribes and Indian housing authorities, private non-profit organizations with 501 (c) (3) status, and community mental health associations that are public non-profit organizations.

F. **Housing Opportunities for People with AIDS (HOPWA)** - The HOPWA Program provides housing assistance and supportive services for low-income persons with HIV/AIDS and their families. Grants are provided by formula allocations to states and metropolitan areas with the largest number of cases and incidences of AIDS and by competitive selection of projects proposed by state and local governments and non-profit organizations.

G. **Section 108 Loan Guarantees** - Entitlement cities, and sometimes smaller communities through the state, may be able to apply for a Section 108 Loan from HUD with a repayment period of up to 20 years. These loans can be used to finance activities such as acquisition of real property, rehabilitation of publicly owned real property, housing rehabilitation, public facilities, and economic development. In general, the guaranteed loan funds must be used in accordance with all requirements that apply to CDBG funds received directly from HUD,

including the requirement that at least 70 percent of the funds be spent on activities that principally benefit low and moderate income persons.

1) *Pre-Disaster Mitigation: T*here may be opportunities to use HUD programs to reduce the risk of adverse impacts on communities prior to the occurrence of disaster. For example, houses and their occupants that are located in flood-prone areas have a heightened exposure to sustaining damage from floods. Cities and towns might use CDBG, HOME funds, and local public and/or private resources to avoid this risk by creating more suitable, good quality housing opportunities elsewhere in the city. Another example might be to include wind damage-resistant construction in public facility construction projects funded in whole or in part through HUD dollars.

2) *Post-Disaster Recovery: B*ecause the Federal government provides disaster relief, primarily through FEMA and SBA, to meet emergency, short term recovery needs, the most appropriate use of CDBG funds is generally for longer term needs such as economic redevelopment of affected areas. However, communities may elect to use their CDBG funds for emergency, short-term assistance if such activities are not funded by FEMA or SBA. Such CDBG activities typically include the following, if they are not fully covered by FEMA:

- Clearance of debris
- Provision of extra security patrols
- Demolition, clearance and/or reconstruction of damaged property posing an immediate threat to public safety
- Emergency reconstruction of essential water, sewer, electrical and telephone facilities
- Provide a variety of relief services to individuals and businesses
- Matching FEMA or other aid programs

The HUD Secretary may be able to waive some program requirements or otherwise provide extra assistance in areas covered by Presidential Declared Disaster Areas, in order to increase the flexible use of funds for disaster recovery. For the CDBG and HOME Programs, these may include:

- Expedite grant awards for entitlement grantees with program year start dates coming up in the near future,
- Permit grantees to use an earlier program year start date,
- Upon request, some CDBG statutory provisions might be suspended, such as restrictions of the repair of reconstruction of buildings used for the general conduct of government; prohibitions on new housing construction; and limitations on the amount of CDBG funds used for public services,
- For HOME funds designated to address damage in a disaster area, some HOME statutory and regulatory provisions might be suspended, such as requirements for written tenant selection criteria; tenant participation plan, fair housing lease and grievance procedures in Community Housing Development Organization (CHDO) set-aside projects; maximum per-unit subsidy limits for disaster-damaged properties; and the requirement that

assisted units meet housing quality standards for properties damaged by the disaster.

H**. FHA Single Family Programs**

Through the Federal Housing Administration (FHA), HUD provides insurance for mortgages and loans placed by private lenders on single-family properties. Under FHA's authorities, HUD's role is essentially that of a mortgage insurance company. Consistent with statutory requirements, HUD makes mortgage insurance available in connection with lenders, borrowers, and properties that meet minimum requirements. Down payment requirements vary by program, but are generally less rigorous than those required by conventional lenders.

In times of disaster, HUD seeks opportunities to help in new and creative ways. For example, during the weeks following the May 3, 1999 tornados in the Oklahoma City area, Single Family Housing staff from the HUD Oklahoma City Office was on-site at the Recovery Centers answering questions and giving suggestions to households that had been impacted by the disaster. These included renters as well as homeowners. A special service was provided for homeowners with FIIA-insured mortgages. HUD linked the Recovery Centers via computers to the FHA database, so that basic information (loan balances, etc.) could be verified in the field. This was a very important service for people who often had lost many of their legal documents as well as their homes.

(1) *Pre-Disaster Mitigation*: A "safe room" is an eligible amenity that can be included in a FHA mortgage. Mortgage lenders can give more specific information concerning the individual mortgage.

(2) *Post-Disaster Recovery*: For Presidential declared disasters; FHA issues a Mortgage Letter, which:

- Makes available mortgage insurance for disaster victims under the Section 203 (h) special mortgage insurance program, which provides 100 percent financing, with no down payment requirement for those whose homes were destroyed or substantially damaged.
- Makes available Section 203 (k) rehabilitation mortgages regardless of the age of the property (waiving the one-year requirement).
- Allows mortgagors whose homes are completely destroyed to qualify for a new FHA insured mortgage loan without consideration of the existing mortgage payments. This allows a higher loan-to-value ratio and allows the homeowner to begin the mortgage application process while insurance settlements are being processed.
- Extends the time for lenders on submission of FHA closed loans from 60 days to 90 days after the date of closing.
- Places a 90-days moratorium on FHA foreclosures (both initiation of foreclosures and foreclosures in process) for properties directly affected by the disaster.

- HUD strongly recommends servicing actions for homeowners whose properties were directly affected by the disaster, such as: special forbearance, mortgage modification, refinancing, and waiver of late charges.
- When feasible, HUD may also take some "HUD Homes" (REO properties) off the market temporarily in order to make them available for lease by disaster victims until they are able to find permanent housing.

I. Multi-Family Housing Programs

The Multifamily Housing Program Area of HUD provides assistance through various mortgage insurance programs for the purchase/refinance of existing or new construction properties. The intent is to increase the supply of quality and reasonably priced rental housing for low-to-middle-income households. The mortgage insurance reduces the risk to lenders by guaranteeing payment in the event of default. Several of the Multi-family insurance programs present particular opportunities for owners of multifamily properties damaged as the result of a disaster. An example is Mortgage Insurance for Rental and Cooperative Housing, Section 221(d) (3) [for non-profit owners] and Section 221(d) (4) [for profit owners].

These programs assist private industry in the construction or substantial rehabilitation of rental and cooperative housing for low-to-moderate-income and displaced families by reducing the risk of default for lenders, i.e. mortgage insurance for purchase or refinancing of existing multifamily rental housing, Section 223 (f). This program permits the restructuring of mortgages at lower interest rates to preserve an adequate supply of affordable rental housing and health care facilities. Properties financed under this program may not undergo substantial rehabilitation. The insured loans are originated by private, HUD-approved lenders. Many more multifamily mortgage insurance programs are available and are not limited to apartment-type communities. HUD also has insurance programs for nursing homes, assisted living centers, hospitals, board-and-care homes, and manufactured home parks.

1) *Pre-Disaster Mitigation*: During the loan approval process HUD is required to ensure that new construction projects comply with all FEMA requirements as they relate to development in a Special Flood Hazard Area.

2) *Post-Disaster Recovery*: The HUD Secretary has authority to waive some program requirements in areas covered by a Presidential Declared Disaster. The primary tool used in multifamily programs is to waive resident eligibility requirements to help house displaced families as quickly as possible. It is very important to remember that the departure, if any, from normal HUD rules during a local emergency situation depends on the circumstances of each disaster event.

J. Public Housing

The HUD Office of Public Housing in Oklahoma City provides funding and assistance to 103 public housing authorities which manage more than 13,000 housing units in the State of Oklahoma. Under the Public Housing Program, HUD provides grants to public housing agencies (PHAs) to finance the capital cost of construction, rehabilitation, or acquisition of public housing units developed by the PHAs. Eligible families and individuals must qualify as "low-income families," defined as having incomes no higher than 80% of the median income for the area. To cover the shortfall between tenant rents and operating expenses, HUD pays

operating subsidies to most PHAs. To cover modernization of existing public housing, HUD makes modernization grants to PHAs.

HUD's Office of Public Housing also provides housing assistance through the Section 8 Rental Certificate and Voucher Programs. HUD contracts with PHAs to provide certificates and/or vouchers primarily to very low-income households.

1) Section 8 Certificates - Certificates are "tenant-based." The qualifying household may use them in any rental unit where the landlord agrees to participate in the program. The PHA pays the landlord the difference between 30 percent of the household's adjusted income and the unit's rent. Landlords must agree to accept no more than fair market rent.

2) Section 8 Vouchers - The voucher program is similar to the certificate program, but gives households more choices, especially in high-demand housing markets where landlords may be reluctant to accept HUD's fair market rent level. The PHA generally pays the landlord the difference between 30 percent of household income and the PHA determined payment standard, usually approximately 80 - 100 percent of fair market rent.

Post-Disaster Recovery

- Public Housing Authorities may alter their admission and rental requirement to meet the needs of those affected by the disaster. Public Housing Authorities should contact the local HUD Office in order to determine the extent to which these modifications may be exercised.
- Public Housing Authorities may reprogram Comprehensive Grant Program or older modernization programs' funds to address damage to public housing property caused by the disaster. HUD will expedite requests for reprogramming from smaller Public Housing Authorities that receive Comprehensive Improvement Assistance Program funds.
- For disaster recovery costs not covered by insurance or other Federal assistance (e.g., the FEMA public assistance program), public housing authorities may contact the local HUD public housing office to request funds from the Reserve for Emergencies and Disasters.

K. Native American Programs

The Native American Housing Assistance and Self-Determination Act of 1996 (NAHASDA) reorganized the system of Federal housing assistance to Native Americans by eliminating several separate programs and replacing them with a single block grant program that recognizes the right of Indian self-determination and tribal self-governance. It provides for tribal governing bodies to name a tribally designated housing entity (TDHE) to prepare and submit an Indian Housing Plan to HUD for approval and subsequent award of an Indian Housing Block Grant. The six categories of eligible activities for providing affordable housing or related housing services are shown below.

- Indian housing assistance - modernization or operating assistance for housing previously developed or operated pursuant to a contract between HUD and an Indian Housing Authority,

- Development of additional affordable housing,
- Housing-related services for affordable housing,
- Management services for affordable housing'
- Safety, security, and law enforcement measures and activities appropriate to protect residents of affordable housing from crime, and
- Housing activities under model programs designed to carry out the purposes of NAHASDA, if specifically approved by HUD as appropriate.

The Indian Home Loan Guarantee Program (Section 184) is another example of HUD assistance available to Native Americans, in this case, providing access to sources of private mortgage financing by providing loan guarantees to lenders. Loans may pay for the construction, purchase, or rehabilitation of single-family dwellings that are in at least standard condition. Commercial structures are not eligible for Section 184 loan guarantees.

The Indian Community Development Block Grant Program provides funding to federally recognized Indian Tribes through a competitive process. The funding can be used for community facilities, infrastructure, housing rehabilitation, and economic development purposes.

1) *Pre-Disaster Mitigation*: Individual Tribes or their TDHE may choose to include eligible disaster mitigation items in their annual Indian Housing Plan.
2) *Post-Disaster Recovery*: Individual tribes or their TDHE may choose to request an amendment of their Indian Housing Plan to reprogram funds for disaster recovery.

2.3.8 U.S. Department of Transportation

The Federal Highway Administration (FHA) oversees and approves the design and construction of Federal aid highways. The regulations developed by FHA to implement Executive Order 11988 Floodplain Management, May 24, 1977, are contained in 23 CFR 650A. This regulation prescribes the policies and procedures for the location and hydraulic design of high encroachments on floodplains, including direct Federal highway projects administered by the FHWA. Any post flood disaster replacement or reconstruction of severely damaged highway facilities, using Federal aid funding, would support hazard mitigation. This is due to other Federal regulations requiring projects to be designed to the current standards contained in 23 CFR 650A.

2.3.9 Small Business Administration (SBA)

Created by Congress in 1953 and was given a mandate to provide financial assistance to victims of disasters. The purpose of the SBA's Disaster Loan Program is to offer financial assistance to those who are trying to rebuild their homes and businesses in the aftermath of a disaster. The SBA provides low interest loans, usually 4% or less, and/or long-term loans of up to 30 years for disaster victims. These loan proceeds may be used to repair or replace disaster-damaged property that is not fully covered by insurance.

The following are the three main types of disaster loans:

- Home Disaster Loans. Homeowners or renters can use loans to repair or replace damaged real estate or personal property as the result of a disaster.

- Business Physical Disaster Loans. Business owners are eligible for loans to repair or replace damaged property including real estate, machinery, equipment, inventory, and supplies. Nonprofit organizations are also eligible.

- Economic Injury Disaster Loans (EIDL). Loans in the form of working capital for small businesses and small agricultural cooperatives can be acquired under this program. EIDL is only available to applicants who have no other alternative or no credit elsewhere.

2.3.10 American Red Cross (ARC)

The American Red Cross provides a variety of essential emergency and health services through its many programs to people around the world. The Armed Forces Emergency Services paid and volunteer staffs deploy with U.S. Troops in operations and exercises worldwide and assist families in keeping in touch following the death or serious illness of an immediate family member, birth of a child or other family emergencies. Other important services include blood donation drives, disease prevention or protection services and information, health and safety training, such as CPR and First Aid, and international messaging and tracing services. All services are consistent with the American Red Cross mission of helping people prevent, prepare for, and respond to emergencies and are provided by trained paid and volunteer staff members. It is not a government agency, but its authority to provide disaster relief was formalized when, in 1905, the Red Cross was chartered by Congress to "carry on a system of national and international relief in time of peace and apply the same in mitigating the sufferings caused by pestilence, famine, fire, floods, and other great national calamities, and to devise and carry on measures for preventing the same." The Red Cross disaster relief focuses on meeting people's immediate emergency disaster-caused needs. The Red Cross provides shelter, food, physical health and mental health services, family reunification and other services to address basic human needs. The core of Red Cross disaster relief is the assistance to disaster victims to enable them to resume their normal daily activities independently.

2.3.11 Association of County Commissioners of Oklahoma (ACCO)

Member of Oklahoma Hazard Mitigation Committee

Made up of the commissioners from the 77 counties in Oklahoma, it provides orientation training and assistance to newly elected and existing commissioners in conducting their duties, such as workshops, written study materials, legal advice from the District Attorney and ACCO staff. There are 3 county commissioners in each county, one representing each of the three districts in the counties. County commissioners exercise the administrative powers given to them by the Oklahoma Statutes and the Oklahoma Constitution. ACCO is made up of the 231 County Commissioners in all 77 Oklahoma Counties working together for the health, safety and welfare needs of all county citizens. It serves as a statewide clearinghouse for leadership training, educational programming and a comprehensive array of services designed to meet the needs of its member counties. In addition they:

- Provide information to state lawmakers and officials relating to ACCO's position on a broad array of public policy issues.
- Advocate for legislation useful to counties and oppose bills detrimental to county government operations.
- Oppose unfunded mandates—state or federal initiatives requiring local governments to provide new programs or services with no revenue to support them.
- Provide high quality education and training programs for county commissioners through a variety of meetings throughout the year.
- Create opportunities for county leaders to exchange ideas, share experiences and take advantage of expert advice.
- Provide a statewide forum for building consensus among commissioners after fully debating issues that affect county government.
- Communicate effectively on the issues and challenges facing counties and how they impact the lives of local citizens and their communities.

2.3.12 Oklahoma Dept of Agriculture, Forestry Division

Member of Oklahoma Hazard Mitigation Committee

The Forestry Division of the Oklahoma Department of Agriculture serves the public, private landowners, forest industry, cities and towns, and other agencies and organizations through a wide variety of programs. These services include protection, management, improvement and use of Oklahoma's forests and their associated benefits. Oklahoma has an estimated 7.5 to 10 million acres of forestland. Professional foresters provide assistance in all 77 counties, contribute to the economy and improve the quality of life of all Oklahomans. Created by the Oklahoma Legislature in 1925, the Forestry Division began as an agency charged with public education, reforestation and wildfire control to help the forests recover from overcutting and uncontrolled burning. As the public's interest in conservation grew, and federal and state programs were enacted, Forestry Services began to address natural resource issues with a comprehensive program of service in forest management, forest protection, law enforcement, education, urban forestry, water quality, forest regeneration and tree improvement and fire department assistance.

Forestry helps maintain forest health by minimizing damage from destructive fires, insects and diseases and by helping improve the productivity of the state's forests.

These services are provided through the:

- Rural Fire Defense Program,
- Forest Fire Control and Management,
- Red Flag Fire Alerts, information and technical advice to landowners,
- Forest Stewardship Program,
- Utilization and Marketing advice to the forest industry,
- Forestry education through the Forest Heritage Center,
- Project Learning Tree programs,
- Urban and Community Forestry Program,
- Forest Water Quality Management Program,
- Forest Regeneration and Forest Tree Improvement Centers.

2.3.13 Oklahoma Climatological Survey (OCS)

Member of Oklahoma Hazard Mitigation Committee

The Oklahoma Climatological Survey (http://www.climate.ok.gov/) was established in 1980 to provide climatological services to the citizens of Oklahoma, conduct research on the impacts of climate on human activities, and serve as a support facility for the State Climatologist. OCS has a legislative mandate to acquire, process, and disseminate climate and weather data and information for use by the state's citizens. The Survey maintains an extensive array of climatological information; operates the Oklahoma Mesonet, the nation's premier environmental monitoring network, and hosts a wide variety of educational outreach and scientific research projects. The Oklahoma Climatological Survey is a research unit of the College of Atmospheric and Geographic Sciences at the University of Oklahoma.

Among the products provided by OCS and the Mesonet are real-time weather information, historical event and climate summaries, and several products tailored to public safety applications. Most real-time weather data, including radar images from sites around the state, are available online at http://www.mesonet.org. The Mesonet offers several products for real-time assessment of hazardous conditions, including:

- OK-FIRE: http://okfire.mesonet.org - wildland fire management system including assessment of current and projected burning conditions out to 4 days;

- Flash Flood Guidance: http://www.mesonet.org - real-time rainfall reports compared to county-level flood guidance from the National Weather Service;

- Oklahoma Rainfall Update: http://climate.mesonet.org/rainfall_update.html - rainfall accumulations, departures from average, and historical rankings in maps and tables for the past 30-365 days.

OCS historical information includes documenting tornado occurrences in the state, assessing the likelihood of severe weather, and documenting recent events that resulted in Federal disaster declarations in the state. OCS' climate data website, http://climate.mesonet.org/, offers monthly, seasonal and annual summaries of Oklahoma's climate and outlooks. The climate event summaries are also posted on that site, along with historical information, normal's, and extremes. The Weather Timeline gives a brief synopsis of notable events in Oklahoma's history dating back to 1900.
OCS also operates several outreach programs (http://climate.ok.gov/outreach/) that provide training, products, and decision-support systems tailored to the needs of different groups. Groups served by OCS outreach programs include K-16 education, emergency management, electric utilities, and agricultural producers.
A staff of climatologists at OCS is available to assist local decision-makers. OCS climatologists are adept at tailoring Oklahoma's climate records to provide information that can improve decision-making, whether in real-time or longer term risk analysis. Data archives allow staff to provide from the 'big picture' overview of Oklahoma climate, to local historical probabilities and occurrences of significant weather events.

A. The Oklahoma Mesonet

This is a statewide network of automated weather stations, with at least one station located in each county in Oklahoma. The network was developed through the cooperation of Oklahoma State University and The University of Oklahoma. It was commissioned in 1994. The Mesonet reports observations of temperature, rainfall, winds, humidity, pressure, solar radiation, and soil temperature and moisture at 5-minute increments, around-the-clock. Mesonet data serve as the backbone of a number of public-safety oriented products provided by OCS.

B. The OK-FIRST program,

This Program serves Oklahoma's emergency management and public safety communities, meets many of the requirements for the National Weather Service's Storm Ready community certification. Participants attend a workshop, where they learn how to access and interpret radar and other weather data sources, improve coordination of storm spotter activities with state and federal officials, and interact with colleagues and mentors from the state's meteorology community. Participants attend refresher workshops every 18 months to keep up-to-date on the latest technology and weather information. OK-FIRST was recognized with Harvard University's Innovations in American Government award in 2001.

C. Southern Climate Impacts Planning Program (SCIPP)

The Southern Climate Impacts Planning Program (SCIPP; http://www.southernclimate.org) is a new, southern United States focused climate hazards preparedness program which aims to bridge the gap between climate science and local level climate hazard planning processes. Focusing on the six-state region of Oklahoma, Texas, Louisiana, Arkansas, Tennessee, and Mississippi, SCIPP investigates major climate hazards of the region and actively engages community-level decision makers to:

- 1) determine hazard planning and climate data gaps,
- 2) collaboratively develop an all-hazards assessment tool, and
- 3) provide education and outreach.

Major climate hazards of interest of SCIPP include droughts, floods, hurricanes, and storms due to their frequency and impact across the region. As one of the National Oceanic and Atmospheric Administration's Regional Integrated Science and Assessment (RISA) program in the United States, SCIPP strives to continue the success of the RISA program in conducting critical, interdisciplinary research through stakeholder partnerships. SCIPP is a collaborative research effort between the Oklahoma Climatological Survey at the University of Oklahoma and the Department of Anthropology and Geography/Southern Regional Climate Center at Louisiana State University.

2.3.14 Oklahoma Department of Commerce (ODC),

Research and Policy Office

Member of Oklahoma Hazard Mitigation Committee

The Oklahoma Department of Commerce is the primary economic development arm of the State of Oklahoma government. The department's mission is to stimulate the creation, expansion and retention of jobs and growth of investment in Oklahoma. The agency cannot support the mission without critical communication, business process and customer interfaces.

The agency includes the operations of an Information Technology Division which serves the general needs of the agency. These include:

- Application and Database administration and development.
- Server technologies and network infrastructure implementation and support.
- Personal computer implementation and support.
- Training.
- Contract system development and business process support.

Disaster Response

The agency has a published and distributed Emergency Response Plan included in the Employment Handbook. The plan outlines personal security limited to mitigating loss of life. The Agency has actively developed and implemented a comprehensive plan following the Oklahoma Emergency Management guidelines which seek to mitigate the loss of physical and information assets.

The agency's plan outlines the development of the Safety and Security Team and team membership. The plan outlines an emergency response for fire, building evacuation, medical emergency general security, tornado and terrorist incident.

Response

There are incremental responses to the disaster encountered. Network based attacks against agency services must be dealt with by Information Technology Division associates to contain or deflect attacks. Disasters which impact the physical structure or theft of information assets must be handled differently which may include emergency response teams, or immediate termination of activities. Physical disasters must first follow the guidelines posted in the Employment Handbook to ensure personal safety. Evacuations must be conducted as outlined, and in the event of loss of life, professionals must be involved to mitigate operational suspension. Associate safety is the primary concern during a disaster. Immediate associate actions during a disaster will mitigate loss of information or equipment. Actions may include fire containment, water deflection and immediate removal of equipment from impacted areas.

Impact Analysis

Each area served must be ranked to the highest impact at the time of the disaster. This process must be impartial and used to determine the order of additional services that must be recovered following the crisis. Communications will be a primary service restored; including voice and data that will be initially recovered. Computer based procurement and accounting business systems will be established followed by the internet services and business process in order of stake holder needs.

Disaster Recovery

The recovery phase will work to restore full business activity following a disaster and will only be implemented following an event that disrupts normal business activity for an extended period of time. The plan will only be considered if there is substantial loss of information resources due to physical destruction, loss of life or use of primary assets as encountered with a biological attack. What are considered routine disasters encountered in computer services such as network attacks, equipment failure, or theft should be handled with the direct stakeholders, management, procurement and civil authorities.

2.3.15 Oklahoma Conservation Commission (OCC)

Member of Oklahoma Hazard Mitigation Committee

The mission of the Oklahoma Conservation Commission is to provide conservation districts the tools necessary for the responsible care of Oklahoma's natural resources.

A) Duties and Responsibilities: The Oklahoma Conservation Commission has the responsibility of providing assistance to the 88 conservation districts in Oklahoma to foster a sense of care, wise use and best management of Oklahoma's renewable natural resources. This includes assistance in protecting and developing the natural resources of the state. Assistance is given in erosion prevention, control and care of soil resources, prevention of flood and sediment damage, and development of water resources, pollution complaint tracking, environmental education coordination, water quality and maintenance of small upstream flood control structures. The Commission has authority over Non-Point source water quality programs; the reclamation of abandoned mine lands and the development of the state's wetland management strategy.

B) Administration Services Division provides accounting services for the agency as well as claims processing for state funds allocated to the 88 conservation district offices. Additional responsibilities include personnel management, data processing and procurement of equipment and supplies, pollution complaint tracking, and the development and implementation of a geographic information system for both the agency and local conservation districts. Policy decisions are made by this division, in cooperation with other divisions as well as numerous local, state, and federal entities.

C) District Operations Division primary objectives are quality. District Operations also administers the Small Watershed Flood Control fund. The Oklahoma Conservation Commission has authority to allocate any conservation district in the state, from the Small Watershed Flood Control fund, such sums as the Commission may deem necessary to enable

that district to acquire real property needed to install upstream flood control structures on rivers and streams. Funds can be allocated to a conservation district after 80% of all the necessary lands, easements and right-of-ways in the watershed project have been acquired. When any property acquired has been sold or leased, the Board of Directors of said district should remit to the Oklahoma Conservation Commission a pro-rata share of the proceeds. In addition, the Commission carries out a program of repair on upstream flood control dams that are applicable under a Presidential declared disaster. A design package, including plans, specifications, cost estimates and bid schedules, is presented for bid considerations.

D) Water Quality Division is responsible for the prioritization and management of non-point source pollution of the state's waters. Non-Point source pollution refers to the washing of materials from land areas into lakes and streams. The Water Quality Division has developed a monitoring strategy to monitor small feeder streams on a rotational basis to determine the impacts of non-point source pollution on the water resources of the state. This rotational monitoring program that rotates into two new basins every two years will support the state's ambient monitoring program. The division coordinates the development of the state's water quality assessment and management program required under section 319 of the Federal Clean Water Act. The division also manages a performance based cost-share program in priority watersheds where federal and state funds are made available to landowners to install conservation practices to reduce non-point source pollution. The division director chairs the State's Non-Point Source Working Group that is made up of federal, state and local agencies, environmental and producer groups, and Indian tribes. The Non-Point Source Working Group identifies the priority watershed where funds and technical assistance will be directed.

E) Abandoned Mine Land Reclamation Division conducts inventories, sets priorities, develops plans, lets bids for construction and supervises the reclamation of abandoned coalmines. The program is 100% federally funded through a $35 a ton tax on coal production. Oklahoma has approximately 30,000 acres of abandoned coal mined land that was mined prior to the passage of the 1977 Federal Surface Mining Control and Reclamation Act. The first reclamation project was completed in 1980. Through the end of Fiscal Year 1997, the Abandoned Mine Land Reclamation Division has completed 107 projects, which reclaimed 3195 acres. These projects include the elimination of dangerous high walls, the closure of mine openings, subsidence protection and reclamation of hazardous water filled strip pits.

2.3.16 Oklahoma Corporation Commission

Member of Oklahoma Hazard Mitigation Committee

A) The Executive Division is made up of three statewide elected officials and their staff. The commissioners sit as a panel to decide the outcome of hearings involved with energy, transportation, utilities and petroleum storage tanks. The decisions of the Commissioners may be appealed at the State Supreme Court.

B) The Administration Division consists of the General Administrator who is responsible for the daily operation of the Commission. Other offices that make up the Administration Division include the Human Resources Department, Finance Department, Public Information Office, Mail Room and the Commission Secretary. All of the following division directors report to the General Administrator.

C) Office of Administrative Proceedings is the court division of the Corporation Commission. This division includes administrative law judges, support staff, court reporters and the Court Clerk's Office. Filings are made and hearings conducted in the Western Regional Office, Oklahoma City and in the Eastern Regional Office, Tulsa.

D) Consumer Services Division serves as one the Commission's liaisons with the public. The Division investigates and mediates oil and gas related complaints and consumer complaints regarding regulated utilities. The Division conducts field investigations to ensure service quality provided by regulated utilities. The Division also maintains records of payments due by un-located mineral owners who have been force pooled by a Commission order. The Division interfaces with Oklahoma Emergency Management (OEM) during natural and/or man-made disasters as a liaison between OEM and regulated utilities to report damage assessments and restoration of service to their customers.

E) Information Technology Division enhances the efficiency and effectiveness of the Commission by providing technically advanced automation tools and services. This includes mapping capabilities corresponding to Global Positioning Systems (GPS) and Geographical Information Systems (GIS) and well as video teleconferencing, electronic messaging and internet capabilities.

F) Office of General Counsel provides advocacy and advisory legal services, represents the Corporation Commission and its employees before state and federal courts and advises the Commission concerning legislation, rules and contracts.

G) Oil and Gas Division is responsible to prevent waste and assure maximum recovery of hydrocarbons from the state's reservoirs, protect the correlative rights of all entities entitles to share in the proceeds generated from the production and sale of oil and gas, prevent and abate any pollution that may result from oil and gas exploration and production activities.

H) Petroleum Storage Tank Division enforces state and federal regulations and administers certain assistance programs applicable to refined petroleum products' storage, quality and delivery. The Division also administers the Oklahoma Petroleum Storage Tank Release Indemnity Fund to help storage tank owners meet a Federal requirement for $1 million of liability insurance for damage caused by leaking tanks. Oklahoma's fuel storage tank program is the only one in the nation that combines the regulatory aspect of remediation, field inspection and the Indemnity Fund.

I) Public Utility Division provides technical support and policy analysis to the Commission in:

(1) Assuring reliable public utility services at the lowest reasonable cost;
(2) Assuring open, workable, competitive markets in the transition to competition; and
(3) Fulfilling constitutional and statutory obligations. The division provides administering and enforcing Commission rules, regulations, and Orders concerning public utilities (electric, natural gas, water, cotton gins and telecommunications service providers).

J) Transportation Division administers licensing and certification of for-hire and private motor carriers that operate within and through Oklahoma; enforces motor carrier licensing requirements, federal motor carrier safety standards, certain federal and state railroad regulations, and pipeline safety regulations. Enforcement officers are CLEET certified and carry side arms in the performance of their duties.

2.3.17 Oklahoma Emergency Management Association (OEMA)

OEMA is a non-profit association whose goal is to assist local, state, tribal and federal agencies in the establishment and maintenance of effective emergency management organizations. Through research, legislative review, information exchange and education programs, OEMA strives to advance the professional standards of persons engaged in these activities. When local jurisdictions are awarded federal financial assistance, as a sub-grant recipient of funds made available through OEM, the Emergency Management Director will ensure the proper completion of federal funding documents and levied requirements as agreed upon between the state and the jurisdiction, in exchange for the receipt of such funds (including the submission of monthly, quarterly and annual reports to the state office, required attendance at training classes, meetings and conferences/workshops).

Local emergency managers coordinate and direct the planning, organization, control, and implementation of local emergency management activities. Such activities may include but shall not be limited to the development of a severe storm spotter network designed to provide advanced/early warning of impending severe weather threats to the community. Oklahoma local emergency managers manage, operate and maintain the Emergency Operations Center, and coordinate, develop and implement the Emergency Operations Plan (EOP) for their jurisdiction and update it annually. They coordinate with community officials and with Oklahoma Emergency Management (OEM) as necessary to ensure the effective administration of the emergency management program. They prepare and distribute disaster preparedness material to the citizens of their jurisdiction, with the intent of offering an appropriate means of educating the community as to how they may prepare for and protect themselves from the consequences of potentially dangerous disasters.

2.3.18 State of Oklahoma Department of Central Services (DCS)

The Department of Central Services is created by Section 61.2 of Title 74 of the Oklahoma Statutes and the successor to the Office of Public Affairs and the State Board of Public Affairs. The agency number is 580.

The primary statutory powers and duties of DCS are set forth in Section 1 of Title 61 and Section 61 et seq. of Title 74 of the Oklahoma Statutes.

2.3.19 Oklahoma Emergency Management (OEM)

Member/Chairperson of Oklahoma Hazard Mitigation Committee

Plans, prepares and implements programs designed to minimize the effects of natural, technological, and man-made disasters upon the people and resources of the state. The Department is responsible for coordinating and assisting all other state agencies and all political subdivisions in the state in the preparation, maintenance and implementation of emergency preparedness plans and programs. This Department coordinates preparedness, response, recovery and mitigation operations/programs.

The Department receives guidance and assistance from the Federal Emergency Management Agency and is responsible for supervising and administering an annual multimillion dollar Federal Financial Assistance Program obtained for disaster relief and emergency preparedness programs of the state and its political subdivisions.

The Department also procures and administers other funds for special emergency management research and construction projects. The Department provides professional assistance and information for, and maintains liaison with, all state agencies, various Federal agencies including the Military and Civil Air Patrol, local governments, industry, and the general public, with a primary purpose of providing protection for the citizens of Oklahoma in the event of a natural, technological or man-made disaster.

2.3.20 Oklahoma Department of Environmental Quality (DEQ)

Member of Oklahoma Hazard Mitigation Committee

The Oklahoma Environmental Quality Act (OEQA**),** passed in 1992, provides for the administration of environmental functions which will provide that environmental regulatory concerns of industry and the public will be addressed in an expedient manner; improve the manner in which citizen complaints are tracked and resolved; better utilize state financial resources for environmental regulatory services; and, coordinate environmental activities of state environmental agencies.

The OEQA provides that each state environmental agency shall be responsible for:

- fully implementing and enforcing the laws and rules within its jurisdictional areas of environmental responsibility:
- utilizing and enforcing the Oklahoma Water Quality standards;
- seeking to enforce and strengthen relationships between federal, state, regional, and local environmental planning, development and management programs;
- cooperate with all state environmental agencies and other entities to protect, foster and promote the general welfare and the environment and natural resources of the state.

The Oklahoma Department of Environmental Quality (DEQ) was created to meet those legislative requirements within its jurisdictional area of environmental responsibility. As outlined, DEQ has jurisdictional responsibility for all:

- point source and non-point-source discharges of pollutants
- storm water from all facilities, except those where specific authority has been designated to either the Department of Agriculture or the Oklahoma Corporation Commission;
- surface and groundwater;
- sole environmental jurisdiction to regulate air emissions from all facilities and sources subject to requirements of Title V of the Federal Clean Air Act;

- superfund responsibilities of the state under CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act) and amendments thereto;
- radioactive waste and all regulatory activities for the use of atomic energy, except for diagnostic x ray facilities; public and private water, and wastewater supply or treatment systems;
- solid waste and hazardous substances; environmental regulation of any entity or activity;
- the prevention, control and abatement of any pollution, not subject to the specific statutory authority of another state environmental agency.

In addition to its administration component and the Support Services Division, DEQ is composed of five Divisions that have specific responsibilities toward making the Department's vision a reality. The vision of DEQ is to eliminate the effects of unintended consequences of historic development, to prevent new adverse environmental impacts and to provide significant input into national decision making, all the while enhancing both the environment and the economy of Oklahoma.

A) Customer Services Division (CSD)

The division supports customers inside and outside DEQ through two major sections, the State Environmental Laboratory and the Customer Assistance Program.

B) State Environmental Laboratory
The lab provides analytical support to programs within DEQ, to other state agencies, to 1700 public water supply systems and to citizens who request services. DEQ's laboratory services are a valuable resource in response to natural disasters that impacted Oklahoma.

C) Customer Assistance Program
Customer Assistance Program administers programs for Pollution Prevention, Small Business Assistance, Risk Communication & Management, and DEQ's Waste Exchange. One of the primary roles of the Customer Assistance Program is to provide help by answering questions about programs for air, water and solid or hazardous waste. The Customer Assistance Program is an essential point of DEQ contact for citizens, federal and state agencies immediately after and during the recovery from natural disasters.

D) Air Quality Division (AQD)
Clean Air Act provides the national framework for efforts to protect air quality. The AQD implements the State and Federal Clean Air Acts. As part of this implementation, the agency recommends adoption of rules, promotes compliance efforts, enforces rules, and develops pollution prevention strategies to reduce emissions and improve air quality.

E) An EPA-approved State Implementation Plan (SIP)
SIP provides strategies and procedures for the daily operations of AQD. This SIP is reviewed and amended as necessary. It includes rules and strategies developed at the state level for implementing the various federal air quality programs. DEQ has acquired delegation of most of EPA air quality programs that are available.

AQD is an active participant in the response to and the cleanup of the aftermath of natural disasters. AQD assures the maintenance of Oklahoma's air while assisting in determining practical and appropriate methods for managing the debris often created by such events.

F) Land Protection Division (LPD)
LPD has diverse duties. It inspects and permits hazardous waste and solid waste treatment, storage and disposal facilities, permits and inspects certain underground injection wells, manages radioactive materials, restores contaminated land to safe and useful conditions (Brownfield's, Superfund and Land Restoration) and also coordinates agency environmental education for K-12, higher education and the general public. With its knowledge of waste management and recycling, LPD is a key resource and decision maker in the management of the waste that is a part of most disasters.

G) LPD's Toxicologists
Toxicologists provide support for all divisions as well as for emergency responders regarding releases of chemicals, and interaction between chemicals. They have extensive knowledge in this field and access to electronic databases of information regarding chemical hazards and control measures. They can be reached through the DEQ hotline during emergencies.

H) Environmental Complaints and Local Services Division (ECLS)
ECLS is responsible for bringing the environmental programs of the DEQ to the local level. Locally based environmental specialists, housed in 30 offices across the State, have some role in nearly all of the programs administered by the DEQ. They provide regulatory inspections as well as technical assistance for all facilities having a DEQ permit. All aspects of the on-site sewage program are handled by ECLS. This includes soil tests, design of systems, and inspection of system installations and regulatory oversight of certified installers and seepage pumpers and haulers. Most importantly, the local environmental specialists respond to all citizen complaints regarding environmental pollution. Being readily available in most locales, ECLS is a unique resource for assisting Oklahoma in its appropriate response to disasters. ECLS personnel possess or have direct access to a vast wealth of environmental knowledge and expertise.

I) Water Quality Division (WQD)
WQD's primary function is to maintain clean water for Oklahoma by regulating facilities that produce and distribute public drinking water and that treat, transport, store, and discharge wastewater. In addition to regulating facilities, WQD is also responsible, in cooperation with other State agencies, for maintaining water quality standards in Oklahoma's lakes, rivers, and streams. Each program in WQD has its own applicable rules, publications, reports, forms, and other information. The programs managed by WQD include:

* Wastewater Discharge Permits (NPDES/OPDES)
* Industrial Pretreatment
* Toxicity & Bio-monitoring
* Storm water
* Water Quality Certification (404/401)
* Water and Wastewater Operation Certification
* Public Water & Wastewater Construction Permits
* Public Water Supply
* Drinking Water State Revolving Fund
* Source Water Protection
* Integrated Water Quality Assessment [305(b)/303(d)]

* TMDLs (Total Maximum Daily Load) & Water Quality Modeling
* Water Quality Management Plan (208 Plan)
* Water Quality Data Map Browser

WQD is a storehouse of information for protecting surface and groundwater sources and public water supplies. WQD expertise in these areas is available to determine real world solutions in response to disasters in real time. The web-based Data Map Browser is GIS driven and has a proven track record of providing information essential in responding to emergency situations.

The DEQ has provided environmental assessments for safe room projects instituted by various counties.

2.3.21 Oklahoma Floodplain Manager's Association (OFMA)

The Oklahoma Floodplain Management Association was officially organized in November 1990, with the intent of bringing together those individuals who have a common interest in floodplain management. In the first year of its existence, membership more than tripled. In September 1999 the name was changed to Oklahoma Floodplain Manager's Association. The OFMA objectives are to:

- Promote interest in flood damage abatement
- Improve cooperation among various related local, State and Federal agencies
- Encourage innovative approaches to managing the nation's floodplain

The association issues a quarterly newsletter to broaden public awareness of Oklahoma's flood hazards. They also provide training to elected officials, floodplain managers, surveyors, engineers, lenders, and real estate agents and promote a Certified Floodplain Managers (CFM) program. OFMA holds an annual conference with guest speakers who discuss pertinent floodplain management issues. Interacting with other members provides opportunities for exchanging ideas and networking among agencies and companies to build cooperation. The association brings together those individuals who are experiencing similar problems with those who may have solutions. OFMA is a non-profit organization and has the ability to communicate a uniform position on current concerns, rule changes, local programs and other issues impacting floodplain management.

2.3.22 Oklahoma Geological Survey (OGS)

The Oklahoma Geological Survey is chartered in the State's constitution and charged with investigating the land, water, mineral, and energy resources of the State, and disseminating the results of those investigations to promote the wise use of Oklahoma's natural resources consistent with sound environmental practices. The programs of the OGS involve Fossil Fuels, Earth Science Education, Geologic Mapping, Industrial Minerals and Earthquakes.

A) Fossil Fuels - A fossil is the remains or any evidence of ancient life that is preserved in the rock record. Fossil fuels are those that arise through the accumulation and alteration of ancient organic matter. These are important resources in Oklahoma and include petroleum (oil), natural gas, and coal.

B) Earth Science Education – The OGS promotes the science of geology through the Rock hound Club and club newsletters, Oklahoma Geology Notes and a web page that lists events for people interested in rock hounding and collecting rocks, minerals and fossils in Oklahoma. There are regular meetings and frequent events, which fosters education, as well as the Sam Noble Natural History Museum. See the OGS website: http://www.ogs.ou.edu/programs.htm.

C) Geologic Mapping – The OGS has completed or has geologic mapping process underway for about half of the State. The State competes for the funding for this project that provides valuable information about the type and rocks and minerals prevalent in Oklahoma.

D. Industrial Minerals – The OGS provides the data for the mineral mining industry in Oklahoma, where the State is 28th in the nation in total non-fuel mineral production value, accounting for more than 1% of the U.S. total. (See more information under the State description in this plan.)

E) Earthquakes – The Oklahoma Geological Survey Observatory is a comprehensive geophysical observatory which records, identifies, and locates 30 to 167 earthquakes in Oklahoma each year, and also records about seven worldwide earthquakes per day. The data is depicted on maps provided with the centers of the seismic events starting in 1977, and is also available through their website.

2.3.23 Oklahoma Department of Health

Member of Oklahoma Hazard Mitigation Committee

A) Program administration - The State Department of Health has statutory responsibility for the public health of the people of Oklahoma. The nine member State Board of Health is appointed by the Governor and confirmed by the Senate. The Commissioner of Health is appointed by the Board and is responsible for the administration of public health programs in the State. The operations of the Department are carried out through organized programs delivered by the State Department of Health staff and county health departments. Certain services are also provided in the counties without organized health departments. The Central Office in Oklahoma City provides major administrative control and program support. These

activities include financial management, procurement, maintenance, personnel services, and affirmative action.

B) Special Health Services is responsible for food protection service and occupational licensing (Statutory Reference - Title 63, Section 1 101 et seq. of the Oklahoma Statutes).

2.3.24 Oklahoma Historical Society, State Historic Preservation Office (SHPO)

Member of Oklahoma Hazard Mitigation Committee

The State Historic Preservation Office (SHPO) is a division of the Oklahoma Historical Society, a State agency. The SHPO is responsible for administering the Federal historic preservation programs in Oklahoma. The National Historic Preservation Act (NHPA) established these programs and provides the framework for the preservation of our nation's heritage.

Section 106 of the NHPA requires that Federal agencies or their designees must consider the effect of their undertakings on archeological and historic resources listed in or eligible for listing in the National Register of Historic Places. The Advisory Council on Historic Preservation (Council), a Federal agency, has established the regulations (36CFR Part 800) that govern the Section 106 process and provides guidance to Federal agencies and the SHPO. Under the Council's regulations, the SHPO review proposed Federal undertakings (such as projects assisted with funding from the Federal Emergency Management Agency) and assists the Federal agencies to meet their responsibilities under the NHPA.

The section 106 process involves the identification of archeological and historic properties in the area of potential effect as a critical first step. Archeological sites, buildings, districts, objects, structures, landscapes, and Traditional Cultural Properties may all be eligible for the National Register of Historic Places. Once the historic properties are identified and evaluated, the next step of the process requires the assessment of the effect of the Federal undertaking on significant archeological and historic properties. The purpose of the Section 106 consultation is to find ways to avoid, minimize, or mitigate any adverse effects on these important properties. When adverse effects cannot be avoided, the SHPO works with the Federal agency to find ways to reduce the impacts. If the adverse effects cannot be avoided or minimized, the Memorandum of Agreement (MOA) will set forth the mitigation plan (such as documentation of a building or structure that must be demolished, excavation of an archeological site that will be destroyed, etc.).

The SHPO works in cooperation with the Oklahoma Archeological Survey (OAS) to carry out the Section 106 review. For further information and assistance, contact Tim Baugh, State Historic Preservation Office at 405-521-6381 and Robert L. Brooks, Oklahoma Archeological Survey at 405-325-7211.

2.3.25 Oklahoma Department of Human Services (DHS)

Member of Oklahoma Hazard Mitigation Committee

In order to promote the general welfare of the people of the State of Oklahoma, this Department will provide temporary emergency assistance to victims of emergencies. It mandates utilization of all services, equipment, supplies and facilities of existing departments, offices, and agencies of the State to carry out this purpose.

A) *The Individual and Family Grant (IFG)* Program provides grants to meet disaster related necessary expenses or serious needs of individuals and families affected by a major disaster. While many of the Department's programs are organized to assist people following a disaster or other misfortune, the Department and its staff are also interested in the element of prevention.

B) *The Policy Management and Analysis Unit* is responsible for providing leadership in the development and application of analytically based decision making which contributes to the fulfillment of the DHS mission and goals. It helps DHS managers develop and apply management planning systems, which will maximize the productivity and efficiency of their operations. Unit personnel aid in the development of sound policies attuned to Federal and State legislative and regulatory activity. Through the evaluation of current policies and programs, DHS is provided with timely, insightful feedback.

C) Field Operations, through its six area offices, coordinates the delivery of services across DHS program lines and provides supervision for the county directors and county office operations. Working through the area directors and county directors, Field Operations is responsible for administrative support and guidance in matters concerning the office space, necessary equipment, and personnel that are needed to carry out payments and services and other program functions. This Division is charged with the responsibility of reducing unnecessary complexity in field operations and for promoting area and county demonstrations addressing the coordination of services. The coordination effort is addressed not only within DHS but also to other State and community agencies and organizations.

D) Human Resource Management Division is divided into six units with the following responsibilities: The HRMD is responsible for planning, implementing, and monitoring the Agency's adherence to rules, regulations, and policies in the field of personnel administration; the Affirmative Action Unit develops the Affirmative Action Plan and monitors compliance with Federal and State Civil Rights Laws; the Employee Assistance Program Unit provides individual assessment and referral for employees with personal problems and acts as a consultation resource for supervisors who manage these employees; the Employee Relations Unit is responsible for handling employee grievances, developing personnel policy and procedures, and consulting with other divisional staff regarding adverse personnel actions; the Employee's Library maintains professional journals, books, historical information, reference materials and audiovisual aid for use by DHS staff; and, the Center for Professional Development provides training and education to DHS employees for the purpose of career development by improving skills, knowledge and abilities.

2.3.26 Oklahoma Insurance Department—Insurance Division

Member of Oklahoma Hazard Mitigation Committee

The elective office of State Insurance Commissioner is created by the constitution. Some of the major duties handled by the office of the Insurance Commissioner as part of the Insurance Code, include the following: The approval of the organization of domestic insurance companies of every authorized type; the approval of all applications by foreign and alien insurers seeking admission into the State of Oklahoma for the purpose of transacting any insurance business; the prior approval of certain life, accident, and health insurance policy forms before such contract can be lawfully offered for sale within the State; and, conduct of all delinquency proceedings whether involving conservator ships or

receiverships of financially weak companies, including ancillary conservator ships and receiverships where a foreign or alien company is concerned, which has assets in the State.

2.3.27 Oklahoma Municipal League (OML)

Member of Oklahoma Hazard Mitigation Committee

The Oklahoma Municipal League is a non-profit organization made up of a membership of Oklahoma cities and towns, with an affiliate membership composed of organizations and firms Statewide that recognize the importance of supporting local government. Representatives of the Oklahoma Municipal League work during the legislative sessions to explain the municipal viewpoint, support bills useful to cities and towns, and oppose legislation detrimental to municipalities. They meet with Federal and State agency personnel to insure that their policies and programs are compatible with and meet the needs of city and town officials, bring to public attention the issues confronting city and town officials and their impact on Oklahomans who live in municipalities, and appear in appellate court, with OML Board of Directors' approval, on cases that can have Statewide effects on municipal government. The OML provides guidance and training to existing and newly elected mayors, city managers through contact with the League staff, frequent workshops, such as those produce by the OK Communications Institute, their website, www.oml.org and a monthly newsletter.

2.3.28 Oklahoma Department of Transportation DOT

Member of Oklahoma Hazard Mitigation Committee

The Oklahoma State Department of Transportation, operating under rules, regulations and policies prescribed by the State Transportation Commission, is charged with the planning, construction, operation, maintenance, and coordination of designated multi modal transportation systems designed to meet present and future transportation needs of the State. Coordination of the development and operation of transportation facilities in the State includes, but is not limited to, highways, public transportation, and railroad, marine and aeronautic.

Major areas of activity include the budgeting and accounting for all State and Federal funds accruing to the Department; operation of the State's central data processing system; the development and implementation of a Statewide transportation plan - considering all modes of transportation, and incorporating by coordination and mutual agreement such transportation plans as may be developed by local units of government; the engineering and acquisition of rights-of way; the award and administration of construction contracts for the improvement of the designated State Highway System and other such transportation facilities as may be applicable under the Statutes; the development and implementation of fiscal and administrative costs; and, the development of administrative rules and guidelines as needed to insure compliance and compatibility with the objectives of various State and Federal transportation programs under the review of the Transportation Commission.

2.3.29 Oklahoma Water Resources Board (OWRB):

Member of Oklahoma Hazard Mitigation Committee

The OWRB is assigned the statutory responsibility of coordinating the National Flood Insurance Program Statewide, regulating dam safety, administering the water laws of the State, and planning and developing water resources to ensure water supplies are adequate to fulfill the present and future needs of Oklahoma. The OWRB currently coordinates with various local, State, and Federal agencies

regarding NFIP activities. Agency manpower is assigned to an Administrative Division and three action Divisions: Planning and Management, Water Quality Program and Financial Assistance.

A) Administrative Division - Provides administrative support for the three action divisions to achieve each Division's mission.

B) Planning and Management Division – This Division is comprised of three sections: Planning, Technical and Permitting. The Planning Section oversees the Floodplain Management Program, the National Flood Insurance Program and the Dam Safety Program, as well as drought and weather mitigation activities and statewide water resources planning and management.

C) The Floodplain Management Program responds to Oklahoma's frequent flooding incidents by coordinating with other State and Federal agencies and local governments to mitigate the catastrophic effects of these natural disasters. Members of the Division, as well as OWRB Field Office personnel, routinely serve on the State Hazard Mitigation Team. This Team inspects damages, identifies projects potentially eligible for hazard mitigation funding, and prepares recommendations to reduce future losses. The Team is coordinated with the Department of Civil Emergency Management and FEMA to help provide Federal funds for the mitigation of flood damages to public or private facilities.

D) The National Flood Insurance Program mitigates flood disasters through flood damage prevention and the control of development in designated hazard areas.

- Eligible communities must establish a floodplain board, recognize floodplain boundaries and regulate development in those areas. Affordable flood insurance is then available to property owners and renters anywhere in the community.
- Division staff provides guidance to communities in adopting these measures and visits with community officials to assess local floodplain management programs and assist program participants in understanding and implementing effective flood loss reduction techniques. These community assistance visits (CACs) and visits (CAV's) also allow the OWRB an opportunity to point out program deficiencies that need to be addressed to retain eligibility in the NFIP.
- The OWRB's efforts in floodplain management and hazard mitigation include community and public information assistance, and educational services. Primary funding for this program is through the Community Assistance Program administered by FEMA.

E) The Dam Safety Program is an integral part of the Board's role in hazard mitigation relative to ensuring the safety of nonfederal dams' 25 feet or more in height and/or impounding 50 acre-feet or more of water. Program staff maintains a current inventory of these dams.

- Many dams, mostly earth fill impoundments, are in need of maintenance or repair. Of particular concern are the structures that could cause loss of life and significant damage to property downstream in the event of failure.
- To check on the safety of these dams, the agency requires and/or conducts regular inspections to verify dam maintenance and integrity. If problems are discovered, the OWRB requires the dam owner or operator to make timely repairs. Agency staff

coordinates dam inspection training seminars to ensure that interested private engineers are qualified to conduct professional examinations of nonfederal dams in the State.

- To confirm that construction is accomplished in a safe and responsible manner, those wishing to construct, enlarge, alter or repair nonfederal dams must first submit an application to the Board, including plans for the proposed modification.

F) The Permitting Section oversees the appropriation of stream and groundwater.

G) The Technical Section conducts hydrologic studies to determine water available for appropriation as well as various other water resources, studies and programs. This section also houses the water well drillers' program that includes the licensing of water well drillers and enforcement of minimum standards for well construction.

H) Water Quality Programs Division develops the State's Water Quality Standards for surface and ground waters. Other programs include the Clean Lakes Program, Oklahoma Water Watch, the Statewide Lakes Water Quality Assessment and the Beneficial Use Monitoring Program.

I) *The Financial Assistance Division* administers loan and grant programs especially for the financing and implementation of sewer and water facilities. The Division makes long-term, low interest loans backed by the Statewide Water Development Revolving Fund. It also makes emergency grants to smaller communities facing infrastructure crises that could threaten life, health or property.

2.3.30 Oklahoma Department of Wildlife Conservation (ODWC)

Member of Oklahoma Hazard Mitigation Committee

The ODWC's mission is to manage Oklahoma's wildlife resources and habitat to provide scientific, educational, aesthetic, economic and recreational benefits for present and future generations of hunters, anglers and others who appreciate wildlife. The Governor appoints the eight-member Oklahoma Wildlife Conservation Commission, which serves as the Department of Wildlife's advisory, administrative and policy-making body. Appointments must be confirmed by the Oklahoma Senate. The Commission governs all Department operations and financial transactions. It oversees land and equipment purchases, public hunting and fishing areas and developments, refuges and game management areas. The director of the agency is responsible for supervising the entire wildlife management operation, the Administrative Division, including the control of Department funds and personnel issues. He is also responsible for both long-range programs and day-to-day progress, making sure the Department functions within the Commission's policy guidelines and budget.

A) Administration's Division's 22 employees perform a great variety of tasks to support the agency's 320 employees carrying out the Department mission. Administrative division consists of Accounting, Licensing, Data Processing, Human Resources, Communications and Property. The Communications Section operates and maintains the Department's two-way radio system. The radio network is composed of 25 relay towers located throughout the State and mobile unit in all Department vehicles. This system allows rapid communication between field and office personnel and enhances communication between field personnel and local agencies such as sheriff's offices and police departments.

B) Fisheries division manages Oklahoma's large number of introduced and native fish species. Fisheries management personnel work closely with private citizens, State and Federal agencies, municipalities, sportsmen's clubs and lake associations. They survey fish populations, construct manmade fish habitat, recommend water level plans for improved natural reproduction and recommend harvest restrictions. The Division's Research Section conducts extensive surveys on fisheries resources. These surveys and the resultant data analysis provide answers to problems facing fisheries managers before management plans or programs are enacted. The Division's Hatchery Section spawns and raises fish for stocking. The supplement populations in frequently fished waters, balance fish populations when segments or year classes of specific species are missing, initiate new species when management programs require them and stock rehabilitated or new impoundments. There are four State hatcheries in the State of Oklahoma that include Byron, Manning, Holdenville, and Durant (South central and Southeast Regions). There are six regional offices that include the Northwest, Northeast, Southwest, Central, South central and Southeast Regions.

C) Wildlife Division manages Oklahoma's wildlife resources and conducts wildlife research on both public and private land. The mission Statement of the Wildlife Division is to manage the State's wildlife resources and their habitats, and provide hunting and other outdoor recreational opportunities, through public lands acquisition and management, cooperative and technical assistance, research and surveys, and education. Wildlife management consists of managing land, wildlife and sportsmen, as well as monitoring and evaluating a wide variety of commercial activities to ensure that wildlife interests are considered. Wildlife Division enhances wildlife habitat and conducts public hunts on 70 Wildlife Management Areas (WMAs) across the State.

D) Information and Education informs Oklahoma Citizens about Department programs, policies and regulations. Personnel in the division encourage public support of the Wildlife Department and instill in Oklahomans a sense of conservation awareness as well as help them enjoy outdoor recreation opportunities. I&E Division is organized into two sections- Information and Education.

E) Law Enforcement enforces laws and regulations that protect Oklahoma's wildlife resources. Increasing demands on the State's wildlife resources mandate close observance of wildlife laws. This observance protects the resource while providing opportunities for fair and equitable usage by the sporting public. The Division consists of 116 employees, with a field force of 92 game wardens, 16 game warden supervisors and eight district chiefs. Central office staff includes the chief and assistant chief of enforcement, training coordinator and support staff. At least one game warden is assigned to each of the 77 counties.

F) Natural Resources Section was formed in 1992 to better coordinate the Department's Environmental and Wildlife Diversity Programs. This section works directly with the public to promote habitat improvement, environmental quality, conservation management and the enjoyment of Oklahoma's diverse fish and wildlife resources. The section is responsible for keeping the Director and Department abreast of issues concerning the State's natural resources and wildlife including State and Federal listed threatened and endangered and other sensitive species. In addition, the section provides information on natural resource concerns to conservation groups and the media to help maintain public awareness.

2.4 Integration With Other Planning Efforts (As Well As Other FEMA Mitigation Programs And Initiatives)

Many State and Federal organizations contend with natural hazards. The Oklahoma Emergency Management is responsible for coordinating and assisting all other State agencies and all political subdivisions in the State in the preparation, maintenance and implementation of emergency preparedness plans and programs. The Department plans, prepares and implements programs designed to minimize the effects of natural, technological, and man-made disasters upon the people and resources of the State.

As the Agency designated by the Governor to coordinate Statewide emergency preparedness, response, recovery and hazard mitigation activities, the Oklahoma Emergency Management (OEM) works with other State, Federal and local agencies to develop and implement the strategies outlined in this document, obtain interagency feedback on the mitigation steps taken and used that information in updating this plan. The methodology employed by OEM to obtain this feedback is through the active coordination of interagency mitigation actions being undertaken.

The mitigation planning process is integrated into the plans described below by providing information to the representatives of the State Hazard Mitigation Team who administrate these programs. This information regarding Strategy, Risk Assessment and progress made with actions in the State Plan is taken back to appropriate agency heads to be integrated into the plans which they administer. Input to FEMA proposing updates to their programs is provided through our regular contacts with the FEMA Region VI Officials.

The Mitigation Division within OEM has the following general responsibilities:

- Administering the mitigation program;
- Coordinating program activities with other State, Federal, and local governments; see Appendix F for the Mutual Aid Compact.
- Serves as Chair of the State Hazard Mitigation Team
  Identifying and reviewing cost-effective mitigation projects;
- Reviewing HM plans submitted by tribal and local jurisdictions for content prior to sending them to FEMA
- Inspecting completed mitigation projects;
- Preparing mitigation project close-out reports;
- Preparing and conducting presentations on various mitigation activities and programs including “how to” classes for local officials and contractors;
- Developing, reviewing, and updating the State Mitigation Plan.

Oklahoma Emergency Management works to implement the components of the state plan through the State Hazard Mitigation Team which is made up of those State agencies that participate in developing mitigation measures associated with Public Assistance projects. OEM also works with individual State educational institutions that have participated in the mitigation program.

Among the organizations and agencies involved:

Federal Emergency Management Agency (FEMA)
National Weather Service (NWS)
US Army, Corps of Engineers
US Fish and Wildlife Service
US Geological Survey
US Department of Housing and Urban Development (HUD)
US Bureau of Indian Affairs (BIA)
US Bureau of Reclamation
American Red Cross
Association of County Commissioners of Oklahoma
Oklahoma Department of Agriculture—Forestry Division
Oklahoma Climatological Survey
Oklahoma Department of Commerce
Oklahoma Conservation Commission
Oklahoma Corporation Commission
Oklahoma Emergency Management Association
Oklahoma Emergency Management
Oklahoma Department of Environmental Quality
Oklahoma Floodplain Manager's Association
Oklahoma Geological Survey
Oklahoma Department of Health
Oklahoma Historical Society
Oklahoma Department of Human Services
Oklahoma Insurance Commission—Insurance Division
Oklahoma Municipal League
Oklahoma Department of Transportation
Oklahoma Water Resources Board
- State National Flood Insurance Program (NFIP) Coordinator
- State Dam Safety Coordinator

Oklahoma Department of Wildlife Conservation

Several State agencies have used the Oklahoma Emergency Management, Hazard Mitigation Division, as a benchmark to implement their own mitigation programs across the State of Oklahoma.

The Mitigation Division of the Oklahoma Emergency Management monitors all information provided by State Agencies. This information is used to update the Oklahoma State Mitigation Plan.

Oklahoma is also a member of EMAC (Emergency Management Assistance Compact), which is a mutual aid agreement and partnership between States.

The State of Oklahoma is fully committed to an effective and comprehensive mitigation program. Oklahoma is somewhat unique in that the HMGP, FMA, PDM, RFC, SRL, and mitigation planning are all the direct responsibility of OEM Hazard Mitigation Division. In order for these programs to achieve their full potential, State activities should compliment appropriate mitigation goals and strategies. The best way to accomplish that task is to ensure that mitigation goals and initiatives are integrated to

the maximum extent into all possible planning activities for Tribal, Federal, State and local governments. Over the years, the works of these various entities have been incorporated into the State Natural Hazard Mitigation Plan along with the planning of other State agencies. For example, mitigation is a consideration to the extent possible by Oklahoma Statutes, in the earthquake plans of the Departments of Transportation, Insurance, Corrections, Natural Resources, the Office of Administration, the Department of Education, and the Public Service Commission, Oklahoma Seismic Safety Commission, Oklahoma Emergency Response Commission, etc. The Department of Transportation considers mitigation, especially floodplain management and open space issues, in their transportation plans. The Department of Conservation has partnered with FEMA in developing stream bank stabilization planning to help mitigate flooding problems in communities such as Piedmont, Oklahoma.

The State Hazard Mitigation Plan is only a part of the state's mitigation program. The Local Mitigation Plans comprise another part of the program. As such, the development process for the State plan takes into consideration the mitigation goals and objectives identified in the local plans. In addition, OEM routinely works with numerous State and Federal agencies on various issues. OEM intends to share the State Hazard Mitigation Plan with federal and state agencies and local governments to cross-reference mitigation information with as many as possible.

This section is described in more detail in the enhanced portion of this plan: Integration with Other Planning Initiatives, Chapter Seven.

Other Programs

The State hazard mitigation planning process is closely integrated with other mitigation programs and initiatives. The following is a partial list of plans and studies that reflect current conditions and approaches to addressing Oklahoma's hazards. The strategies and proposed actions within this plan conform to those presented in these other documents and in many cases are the same actions. Several employees of the Oklahoma Department Emergency Management participated in the groups that developed the following plans.

Planning Process and Funding Initiatives

The State hazard mitigation planning process is closely integrated with and is, in fact, dependent upon FEMA's mitigation programs and initiatives. The driving force behind the entire planning effort is the Disaster Mitigation Act of 2000 (DMA2K), which stipulates the necessity for and content of both state and local mitigation plans. DMA2K established a timeline for plan completion and describes penalties for non-compliance. States which did not have their mitigation plans approved by the specified date (November 1, 2004) would not be eligible to receive Public Assistance funding (Category C through G) for declared disasters occurring after that date, nor was any jurisdiction located within the state. Funding from the Pre-Disaster Mitigation (PDM) program and the Hazard Mitigation Grant Program (HMGP) are similarly denied until the state and local mitigation plans are approved.

Other FEMA programs that greatly influence the mitigation effort include:

- The National Flood Insurance Program (NFIP). Participation in NFIP by municipalities, counties, and tribal organizations is voluntary. OEM and FEMA have strongly encouraged non participating jurisdictions to join the NFIP since this plan was approved in 2008. The results are shown in the following figures. Prior to the 2008 plan approval there were 52 counties participating currently there are 54. In 2008

there were 303 municipalities in Oklahoma participating in NFIP, today there are 411. The March 5th, 2010 Region VI report shows the Ponca and Kickapoo tribes as the only tribal jurisdictions participating in the NFIP program. Several communities are making application to join NFIP. Within the NFIP program, the Community Rating System (CRS) is a program whereby individual communities may reduce their flood insurance rates by performing certain specified activities to enhance flood mitigation. These activities can be costly, and smaller communities would probably not be able to afford to participate in CRS.

- The Flood Mitigation Assistance (FMA) Program is another FEMA program through which local jurisdictions may obtain grant funds to complete flood mitigation plans and projects. OEM has worked diligently with local jurisdictions to assist them in integrating their FMA plan and HM plan to satisfy the criteria required of both programs.

- The Emergency Management Performance Grant (EMPG), a grant from FEMA to the state, funds a broad spectrum of emergency management activities. Part of those activities relate to mitigation, specifically the partial funding of a full time Mitigation Specialist. OEM also uses some EMPG funds for earthquake mitigation projects and educational efforts, and some EMPG funds have been used to assist with preparation of the local Hazard Mitigation Plans.

Chapter Three: Risk Assessment

Each section of the plan update from the period of prior approval through October 26, 2010 was analyzed and reviewed by each member of the State Hazard Mitigation Planning Committee (SHMPC) and the administrative staff to determine whether updates to the plan were necessary. Chapter Three was reviewed by the SHMPC who determined that updating was required.

ITEMS CHANGED IN THIS SECTION
Initial disasters identified
Added Disasters included in Local Approved Plans
Hazard Chart – How & Why identified
Researched, updated or deleted various charts and tables
Updated history and other segments of hazard profiles
Added pictures to hazards
Added Significant Previous Occurrences
Reviewed charts presented and added justification for charts shown.
Removed some charts and maps that were outdated or not viable
Verified and updated Cost Analysis information
Updated and reformatted the CPRI data

One hundred and eighty five (one hundred eighty five) Local and Tribal Hazard Mitigation Plans have been approved in the State of Oklahoma since The City of Tulsa Plan was approved on August 4, 2003. These plans include four hundred sixty eight local jurisdictions and Tribes. Based on the review of the one hundred eighty five local area planning committees findings, the following hazards are included in the February 17, 2011 State Plan update.

3.1 Identified Hazards:

The hazards are summarized in the following Hazard Identification Table, along with how and why they were identified. They are listed in alphabetical order and are not assigned any priority at this point.

Hazard	How Identified	Why Identified
Dam Failure **Hazard # 1**	1) Information from OWRB 2) Historical Records	Of 4600 dams in Oklahoma 361 are high hazard dams & 136 significant hazard dams. These could put people and structures at risk. Though not a natural hazard, flooding potential exists if dam failure occurs. **Identified in 146 Local and Tribal Plans**
Drought **Hazard # 2**	1) Information from Oklahoma Climatological Survey, 2) Oklahoma Water Resources Bulletin, 3) US Geological Survey 4) Declarations 5) Historical Data	Temperatures in Oklahoma can easily reach over 100 degrees & persist for many days and weeks. History of drought, i.e. 'Dust Bowl', and recent episodes of drought. **Identified in 177 Local and Tribal Plans**
Earthquake **Hazard # 3**	1) Information from Oklahoma Geological Survey 2) Past Historical Records 3) Newspaper Accounts	Past history, existing fault lines within State. Oklahoma has 2-3 per year that are large enough to be felt **Identified in 164 Local and Tribal Plans**
Expansive Soils **Hazard # 4**	1) Visual Inspections 2) Limited Historical Data	Oklahoma has soils that tend to shrink or swell due to changes in moisture content but damage estimates are incomplete and inconclusive. The State recognizes this hazard in some regions but available data is lacking. **Identified in 113 Local and Tribal Plans**
Extreme Heat **Hazard # 5**	1) Information from Oklahoma Climatological Group 2) Historical Data 3) National Weather Service	Oklahoma has prolonged periods of high temperatures and is prone to wide swings of temperature. Recorded High 120 degrees Recorded Low -27 degrees **Identified in 165 Local and Tribal Plans**

Hazard	How Identified	Why Identified
Flooding **Hazard # 6**	1) Oklahoma Climatological Survey 2) Historical Data 3) Declared Disasters 4) Oklahoma Water Resource Board	From 1960-2009, there have been over 100 deaths due to flooding in Oklahoma. Spring and Fall usually have flooding somewhere in Oklahoma. This is costly to the State. **Identified in 177 Local and Tribal Plans**
Hail **Hazard # 7**	1) Okla. Climatological Survey 2) Daily Oklahoman Archives 3) Oklahoma Mesonet Records 4) National Weather Service 5) Storm Prediction Center	Oklahoma experiences a high number of storms each year along with damaging hail. **Identified in 177 Local and Tribal Plans**
High Winds **Hazard # 8**	1) Oklahoma Climatological Survey 2) Historical Data	Winds are always part of severe storms, but Oklahoma can experience high winds at any time. **Identified in 166 Local and Tribal Plans**
Landslides (Rockslides) **Hazard # 9**	1) Oklahoma Department of Transportation 2) Limited Historical Data	In Oklahoma, landslides are infrequent and limited to rock fall in selected areas of the State. **Identified in 6 Local and Tribal Plans**
Lightning **Hazard # 10**	1) Okla. Climatological Survey 2) Daily Oklahoman Archives 3) Oklahoma Mesonet Records 4) National Weather Service 5) Storm Prediction Center	Oklahoma experiences a high number of storms each year along with damaging lightning. **Identified in 152 Local Plans**
Sinkholes/Subsidence **Hazard # 11**	1) Oklahoma Conservation Commission 2) Abandoned Mine Land Program 3) McAlester News-Capital & Democrat	Sixteen Counties in Oklahoma are vulnerable to sinkholes because of abandoned mine shaft collapse and erosion. **Identified in 1 Local Plan**

Hazard	How Identified	Why Identified
Tornados **Hazard # 12**	1) Oklahoma Climatological Survey 2) Historical Records 3) Declared Disasters 4) Daily Oklahoman Archives	Oklahoma has a distinction as the center of tornado Alley. State has had over 3269 past incidents. **Identified in 179 Local and Tribal Plans**
Wildfires **Hazard # 13**	1) Oklahoma Climatological Survey 2) Department of Agriculture Forest Service 3) FEMA Website 4) National Interagency Fire Center 5) Oklahoma Fire Danger Model	Wildfire is a natural part of Oklahoma's ecosystem. The fires of the last several years have been especially destructive to lives and property. The continued development of urban-wildland is part of a growing problem. **Identified in 178 Local and Tribal Plans**
Winter Storms/Ice/Freezing Rain **Hazard # 14**	1) Oklahoma Climatological Survey 2) Historical Data 3) Oklahoma Mesonet Archives 4) Daily Oklahoman Archives 5) The Tulsa World Archives 6) National Climate Data Center Storm Events Database 7) National Weather Service	Since 1993, the NCDC lists 199 snow and ice events within Oklahoma, causing nearly $400 million in damage. **Identified in 180 Local and Tribal Plans**
Special Events (Tar Creek Project) **Hazard # 15**	1) Information from local plans 2) State Records	Approximately 30,000 acres of Lead and Zinc mines, now abandoned, create hazardous conditions during rain runoff and flood events in this area. **Identified in 1 Local Plan**

The following overview of the natural hazards that could affect the State of Oklahoma includes an explanation of the Critical Priority Risk Index (CPRI) weighting factors and explains how each identified hazard was weighted according to the following criteria of probability, magnitude/severity, warning time and duration. The planning team initially went through all the hazards in a roundtable discussion, based on their personal knowledge and experience in Oklahoma. With a white board, the team talked through the rankings and the members re-adjusted the CPRI categories as needed based upon data provided by Oklahoma Climatological, Oklahoma Geological, and Oklahoma Emergency Management. Based on history in the State of Oklahoma, and the team's experience and expertise, a final logical CPRI ranking was arrived at.

The CPRI factors the elements of risk—Probability (P), Magnitude/Severity (M), Warning Time (WT) and Duration (D) -- to create an index that allows for the prioritization of mitigation activities based on

the level of risk. Each hazard is evaluated based on potential or probability using the elements of the index, and a weighting factor to determine the impact, in the following manner:

WEIGHTNING FACTORS			
.45 Probability of Occurrence	.30 Magnitude/Severity Expected of Hazard	.15 Warning Time Possible to Event	.10 Duration Of Event
4 Highly Likely 3 Likely 2 Possible 1 Unlikely	4 Catastrophic 3 Critical 2 Limited 1 Negligible	4 < than 6 hrs 3 6 – 12 hours 2 12 – 24 hours 1 24 + hours	4 > 1 week 3 ≤ 1 week 2 ≤ 24 hours 1 ≤ 6 hours

PROBABILITY OF OCCURRENCE	DEFINITION
4-HIGHLY LIKELY	Event is probable within the calendar year. Event has a 1 in 1 year chance of occurring.
3-LIKELY	Event is probable within the next three years. Event has up to 1 in 3 year's chance of occurring.
2-POSSIBLE	Event is probable within the next 5 years. Event has up to 1 in 5 year's chance of occurring.
1-UNLIKELY	Event is possible within the next 10 years. Event has up to 1 to 10 years chance of occurring.

MAGNITUDE / SEVERITY LEVEL	CHARACTERISTICS
CATASTROPHIC	≤ Multiple deaths. ≤ Complete shutdown of facilities for 30 or more days. ≤ More than 50% of property is severely damaged.
CRITICAL	≤ Injuries and/or illnesses result in permanent disability. ≤ Complete shutdown of critical facilities for at least two weeks. ≤ More than 25% of property is severely damaged.
LIMITED	≤ Injuries and/or illnesses do not result in permanent disability. ≤ Complete shutdown of critical facilities for more than one week. ≤ More than 10% of property is severely damaged.
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% of property is severely damaged.

The following table lists the Critical Priority Risk Index for each hazard that could affect the State of Oklahoma. The hazards are listed in the order of their Priority Risk. Because there is no way to estimate the probability, severity, warning time or duration of a man-made or special event (because by definition the event is usually unknown) that hazard ranking is a best guess estimate using the CPRI and is less than exact. For that reason, the special event hazard is listed last.

Hazard	Probability	Magnitude/ Severity	Warning Time	Duration	Priority Risk Index
Tornado Hazard Priority # 1	Highly Likely	Critical	Less 6 Hours	Less than 6 hours	3.4
Winter Storms/Ice/Freezing Rain Hazard Priority # 2	Highly Likely	Critical	12-24 Hours	Less than one week	3.3
Sinkholes/Subsidence Hazard Priority # 3	Likely	Catastrophic	Less than 6 hours	Less than 6 hours	3.25
Flooding Hazard Priority # 4	Highly Likely	Limited	12-24 Hours	Less than one week	3
Wildfires Hazard Priority # 5	Highly Likely	Negligible	Less 6 Hours	Less than one day	2.9
High Winds Hazard Priority # 6	Highly Likely	Limited	12-24 Hours	Less than 6 hours	2.8
Drought Hazard Priority # 7	Likely	Critical	24+ Hours	More than one week	2.8
Hail Hazard Priority # 8	Highly Likely	Limited	12-24 Hours	Less than 6 hours	2.8
Lightning Hazard Priority # 9	Highly Likely	Limited	12-24 Hours	Less than 6 hours	2.8
Extreme Heat Hazard Priority # 10	Likely	Limited	24+ Hours	Less than one week	2.4
Earthquake Hazard Priority # 11	Possible	Negligible	Less 6 Hours	Less than 6 hours	1.9
Dam Failure Hazard Priority # 12	Unlikely	Critical	24+ Hours	More than one week	1.9
Landslides (Rockslides) Hazard Priority # 13	Unlikely	Negligible	Less 6 Hours	Less than 6 hours	1.45
Expansive Soils Hazard Priority # 14	Unlikely	Negligible	24+ Hours	More than one week	1.3
Special Events (Tar Creek Project) Hazard Priority # 15	Possible	Limited	24 + hours	More than one week	2.05

The following lists the CPRI weighting factor for each hazard and shows how each was obtained.

Calculated Priority Risk Index (CPRI)

Tornado = 3.4

Probability		4 Highly Likely		
Magnitude/Severity		3 Critical		
Warning Time		4 Less than 6 Hours		
Duration		1 Less than 6 hours		
The CPRI for the Tornado hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(4 x .45)	+ (3 x .30)	+ (4 x .15)	+ (1 x .10)	= 3.4

Winter Storms/Ice/Freezing Rain = 3.3

Probability		4 Highly Likely		
Magnitude/Severity		3 Critical		
Warning Time		2 12-24 Hours		
Duration		3 Less than one week		
The CPRI for the Winter Storms hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(4 x .45)	+ (3 x .30)	+ (2 x .15)	+ (3 x .10)	= 3.3

Sinkholes/Subsidence = 3.25

Probability		3 Likely		
Magnitude/Severity		4 Catastrophic		
Warning Time		4 Less than 6 Hours		
Duration		1 Less than 6 Hours		
The CPRI for the Sinkholes hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(3 x .45)	+ (4 x .30)	+ (4 x .15)	+ (1 x .10)	= 3.25

Flooding = 3

Probability		4 Highly Likely		
Magnitude/Severity		2 Limited		
Warning Time		2 12-24 Hours		
Duration		3 Less than one week		
The CPRI for the Flooding hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(4 x .45)	+ (2 x .30)	+ (2 x .15)	+ (3 x .10)	= 3

Calculated Priority Risk Index (CPRI)

Wildfires = 2.9

Probability		4 Highly Likely		
Magnitude/Severity		1 Negligible		
Warning Time		4 Less than 6 Hours		
Duration		2 Less than one day		
The CPRI for the Wildfires hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(4 x .45)	+ (1 x .30)	+ (4 x .15)	+ (2 x .10)	= 2.9

High Winds = 2.8

Probability		4 Highly Likely		
Magnitude/Severity		2 Limited		
Warning Time		2 12-24 Hours		
Duration		1 Less than 6 hours		
The CPRI for the High Winds hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(4 x .45)	+ (2 x .30)	+ (2 x .15)	+ (1 x .10)	= 2.8

Drought = 2.8

Probability		3 Likely		
Magnitude/Severity		3 Critical		
Warning Time		1 24+ Hours		
Duration		4 More than one week		
The CPRI for the Drought hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(3 x .45)	+ (3 x .30)	+ (1 x .15)	+ (4 x .10)	= 2.8

Hail = 2.8

Probability		4 Highly Likely		
Magnitude/Severity		2 Limited		
Warning Time		2 12-24 Hours		
Duration		1 Less than 6 hours		
The CPRI for the Hail hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(4 x .45)	+ (2 x .30)	+ (2 x .15)	+ (1 x .10)	= 2.8

Calculated Priority Risk Index (CPRI)

Lightning = 2.8

Probability		4 Highly Likely		
Magnitude/Severity		2 Limited		
Warning Time		2 12-24 Hours		
Duration		1 Less than 6 hours		
The CPRI for the Lightning hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(4 x .45)	+ (2 x .30)	+ (2 x .15)	+ (1 x .10)	= 2.8

Extreme Heat = 2.4

Probability		3 Likely		
Magnitude/Severity		2 Limited		
Warning Time		1 24+ Hours		
Duration		3 Less than one week		
The CPRI for the Extreme Heat hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(3 x .45)	+ (2 x .30)	+ (1 x .15)	+ (3 x .10)	= 2.4

Earthquake = 1.9

Probability		2 Possible		
Magnitude/Severity		1 Negligible		
Warning Time		4 Less than 6 Hours		
Duration		1 Less than 6 hours		
The CPRI for the Earthquake hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(2 x .45)	+ (1 x .30)	+ (4 x .15)	+ (1 x .10)	= 1.9

Dam Failure = 1.9

Probability		1 Unlikely		
Magnitude/Severity		3 Critical		
Warning Time		1 24+ Hours		
Duration		4 More than one week		
The CPRI for the Dam Failure hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(1 x .45)	+ (3 x .30)	+ (1 x .15)	+ (4 x .10)	= 1.9

Calculated Priority Risk Index (CPRI)

Landslide (Rockslides) = 1.45

Probability		1 Unlikely		
Magnitude/Severity		1 Negligible		
Warning Time		4 Less than 6 Hours		
Duration		1 Less than 6 hours		
The CPRI for the Landslide hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(1 x .45)	+ (1 x .30)	+ (4 x .15)	+ (1 x .10)	= 1.45

Expansive Soils = 1.3

Probability		1 Unlikely		
Magnitude/Severity		1 Negligible		
Warning Time		1 24+ Hours		
Duration		4 More than one week		
The CPRI for the Expansive Soils hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(1 x .45)	+ (1 x .30)	+ (1 x .15)	+ (4 x .10)	= 1.3

Special Events (Tar Creek Project) = 2.05

Probability		2 Possible		
Magnitude/Severity		2 Limited		
Warning Time		1 24+ Hours		
Duration		4 More than one week		
The CPRI for the Special Events hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(2 x .45)	+ (2 x .30)	+ (1 x .15)	+ (4 x .10)	= 2.05

3.2 Profiled Hazard Events:

Following is an explanation of each hazard or threat confronting the State of Oklahoma. The following hazards are listed according to their priority risk index as identified in the table above.

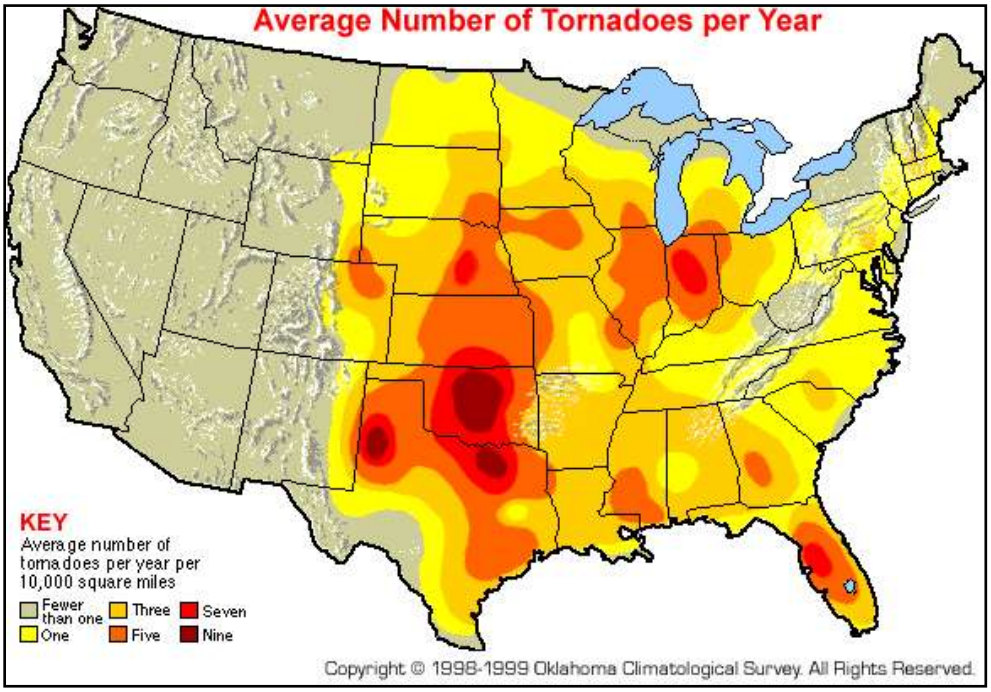
3.2.1 Tornado:

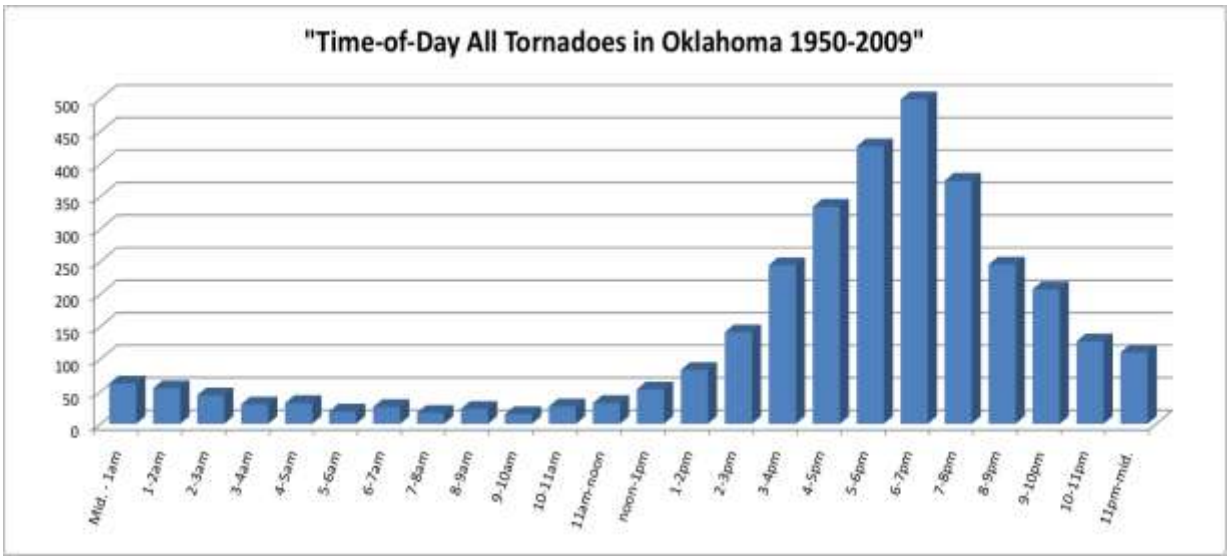
Hazard Priority # 1

3.2.1.1 Description

A tornado is a violently rotating column of air extending between, and in contact with, a cloud and the surface of the earth. Tornados are generally spawned by severe thunderstorms, though they have been known to occur without the presence of lightning. The stronger tornados attain an awe-inspiring intensity, with wind speeds from 70 to 200 mph and in extreme cases may exceed 300 mph. They tend to occur in the afternoons and evenings: over 80 percent of all tornados strike between 3PM and 9PM, but can occur anytime.

The United States has the highest incidence of tornados worldwide, with more than 1,000 occurring every year. This is due to the unique geography that brings together polar air from Canada, tropical air from the Gulf of Mexico, and dry air from the Southwest to clash in the middle of the country, producing thunderstorms and the tornados they spawn. Tornados can come one at a time, or in clusters, and they can vary greatly in length, width, direction of travel, and speed. They can leave a path 50 yards wide or over a mile wide. They may touchdown for only a matter of seconds, or remain in contact with the ground for over an hour. Oklahoma experiences the most tornados per square mile of any state in the plains.





3.2.1.2 Location:

The entire State of Oklahoma is at risk from tornados.

3.2.1.3 Extent:

Tornado wind speeds are estimated after the fact based on the damage they produce. Tornados are categorized on a scale of 0 (weakest) to 5 (strongest) according to the Enhanced Fujita Scale: Oklahoma may experience any of these levels at any time during the year anywhere in the state.

The Fujita Scale was first proposed by Dr. Fujita in 1971. It is used by meteorologists to estimate the speed of winds after a tornado by studying the damage caused by the tornado to structures.

Fujita Scale

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged.

The enhanced Fujita Scale replaced the original Scale on February 1, 2007 which made wind speed estimates become more accurate than the previous scale. All events from February 1, 2007 onward will be estimated using this scale. Reference to older storms however will still rely on the original scale developed by Dr. Fujita.

Enhanced Fujita (EF) Scale		
Enhanced Fujita Category	**Wind Speed (mph)**	**Potential Damage**
EF0	65-85	**Light damage.** Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	**Moderate damage.** Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	**Considerable damage.** Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	**Severe damage.** Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	**Devastating damage.** Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	**Incredible damage.** Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

The State of Oklahoma considers any event of EF3 and above to be a major severity.

3.2.1.4 Previous Occurrences:

Oklahoma's distinction as the epicenter of Tornado Alley has become fairly well established, a result of the sheer number of tornados it has experienced. This dubious honor has been punctuated by the lost lives and damaged property from tornados.

Total tornados	Total Deaths	Total Injured
3466 (Average of 57.25/yr) Ten Year Average	281	4353
Property damage figures based upon NCDC property damage costs since 1950 through 2010; tornado property damage has exceeded Three Billion Two Hundred Fifty Six Million Dollars in Oklahoma. Since the last plan update in 2008 there have been 154 tornados, 16 Deaths, 165 Injuries and $73,607 Million dollars in damages.		

*Damage costs listed below are estimates and have not been adjusted for inflation to current dollar amounts.

Significant Oklahoma Tornado History
January 1950 – May 2010
(Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center).

Date	Event Description	Prop. Damage	Fatalities	Injuries
May 10, 2010	** **Tornado – 55** tornados went across central, south central, and eastern Oklahoma causing three deaths and major property damage. The strongest two were EF-4, one of which destroyed a Love's station at Choctaw Rd. and I-40 after traveling 23 miles fromi-35 and Indian Hills Road just north of Norman.		3	120
Jun 1, 1999	**Tornado** - A cold front moving in from the NW moved into an extremely unstable air mass. Along the front, an isolated supercell thunderstorm developed around the Pryor/Locust Grove area and then moved in a slow and unusual SSW direction and produced at least 8 tornados through NE Oklahoma. Two tornados touched down in Checotah in McIntosh Co. The first tornado traveled through a more densely populated area of Checotah causing more damage, even though the second tornado had a stronger intensity rating. The tornado touched down on the W side of Checotah. The tornado then moved SE through town, eventually lifting near the 700 block of S Broadway St. Damage totals for both tornados indicated 75 homes damaged: 6 homes were destroyed, 21 homes sustained major damage, 48 homes sustained minor damage, 3 businesses sustained minor damage, and 28 head of cattle were killed. Most notably, a Wal-Mart sustained roof and window damage, and a Pizza Hut sustained roof damage. In addition, numerous trees were blown down, with some trees falling onto vehicles and homes. This storm produced very large hail in addition to the strong tornados. This storm also produced eastern Oklahoma's first killer tornado in at least half of a decade with 2 fatalities in the town of Hulbert.	$5.750M+	2	5

Significant Oklahoma Tornado History January 1950 – May 2010 (Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center).				
May 9, 2003	**Tornado - The thunderstorm developed in SW Okla. and moved NE eventually dissipating in NE Okla. The tornado began within the Bethany city limits and moved NE before dissipating in Warr Acres. The tornado damaged or destroyed approximately 70 airplanes and 40 hangers at Wiley Post Airport. Many of the airplanes damaged were inside hangers. Nine tornados that occurred on May 9 were produced by the same supercell. Most of the tornados occurred after dark. Three of the tornados affected western and northern portions of the Oklahoma City Metropolitan area making two tornadic days in a row for the area (see May 8, 2003). The strongest tornado, an F3, moved across portions of the northeastern metro area. Large hail and strong straight-line winds associated with this tornadic supercell. Other severe thunderstorms produced damaging large hail and strong winds across other portions of Okla.	$10.0M+	0	8
May 8, 2003	**A **tornado** that began in Cleveland Co. moved into Oklahoma Co. before dissipating 2.5 mi. SSE of Choctaw. The tornado began in the area of NW 5th Street and Santa Fe Avenue in Moore. Damage intensities increased quickly to F2 and F3 as the tornado move through Moore. The worst damage produced within the city of Moore was as the tornado approached W sides of I-35, just N of 12th Street. A church, child care center, and office building were leveled. Two hotels, both two-story, had their second floors partially or totally removed by the tornado. A Greyhound bus was hit by the tornado as it crossed I-35. The bus carried 23 passengers. Most of the passengers received injuries that were minor. The tornado crossed I-35 N of 12th Street, damaging or destroying several businesses along Broadway. The tornado continued through NE parts of Highland Park	410M+	0	45

Significant Oklahoma Tornado History January 1950 – May 2010 (Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center).				
	residential area, causing generally minor damage. It should be noted that the damage track of this tornado through Moore was nearly parallel to, and generally a quarter of a mile or less S of the track of the F5 tornado that struck Moore on May 3, 1999. This tornado continued into Okla. Co. becoming an F4 and traveling a total of 17.3 miles. Two tornadic supercells produced four tornados during the afternoon hours of May 8, 2003. One supercell produced three tornados that affected Moore, southern Oklahoma City, Midwest City, and Choctaw.			
Apr. 11, 2001	**Tornado** formed SE of Coalgate and tracked NE for 8 mi before crossing into NW Atoka Co. where minor roof damage was sustained to a mobile home, and numerous trees were damaged. The most notable tornado formed across Coal County in Oklahoma and resulted in one fatality and one injury as it destroyed a mobile home. In addition, a well-constructed frame home suffered severe roof damage and exterior wall damage. Six other tornados formed across southern Okla. and one tornado across western north Texas developed during the overnight hours of the 11th.	$75,000+	1	1
May 3-4, 1999	****Tornado** - A record outbreak of tornados struck Okla. from late afternoon of May 3, 1999, through early morning of May 4, 1999. Fifty eight tornados were recorded across portions of western and central Okla. Additional tornados were reported across eastern Oklahoma from late evening of May 3rd through the early morning of May 4th. All direct fatalities (40) and all direct injuries (675) occurred in the Norman NWS warning area. The most notable tornado was rated F5 and formed over Grady County near Amber and tracked NE for 37 miles eventually into the Oklahoma City metropolitan area. Bridge Creek, Oklahoma City, Moore, Del City, and Midwest City suffered	$1.5Billion+	40	675

Significant Oklahoma Tornado History
January 1950 – May 2010
(Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center).

	tremendous damage. There were many other significant tornados as well, including F4 tornados in Kingfisher and Logan Counties, and F3 tornados in Caddo, Grady, Kingfisher, Logan, and Lincoln Counties. There were 8 tornado producing thunderstorms, called supercells, and most of them spawned numerous tornados, one after another. Occasionally, these thunderstorms spawned tornados at the same time. The primary storm which formed near Amber struck Bridge Creek, Moore and Oklahoma Co. produced 14 tornados over a period of about 7 hours.			
Oct. 4, 1998	Tornado - A major severe weather outbreak occurred across W and central Okla. resulting in 19 tornados, straight-line wind damage, hail as large as baseballs, and significant flooding across portions of Oklahoma. The 13th tornado was one of the most destructive tornados of the outbreak, developing over the City of Moore in Cleveland Co. Many homes lost all or part of their roofs, leaving them uninhabitable, and one home lost a portion of an exterior wall. Sections of roofs were torn off a few warehouses and then dissipated just W of I-35. In total, 10 homes were either destroyed or severely damaged; 8 multi-family buildings were severely damaged; and hundreds of other homes and businesses sustained minor damage. In the 16th tornado of the series, a mobile home was lifted and thrown about 100 yards; all 6 family members who took shelter inside an interior closet were injured.	$6M+	0	11
May 24, 1998	**Tornado -** A large complex of severe thunderstorms moved from southern Kansas into northern and central Okla. during the evening of May 24th and the early morning of May 25th, resulting in 16 tornados, most of which occurred in Grant Co. Ten of the 16 tornados touched down with no damage. One of the other tornados was reported 8 mi. E	$2M+	0	1

	of Amorita. The tornado, damaged one house and knocked down power lines as it moved SE and weakened while crossing into western Grant Co. for a total damage path length of 5 mi. An unusual aspect of this tornado was that it was reported to be rotating anti-cyclonically. One house and a business were damaged by another tornado which occurred in Grant Co. 2 mi. S of Medford. The next damaging tornado was observed knocking down trees and power lines in a 5 mi. long damage path in southern Grant Co. An additional tornado snapped trees in half and damaged a private airstrip 4 mi. ENE of Pond Creek while another tornado, damaged several homes and knocked down trees and power lines 1 mi. N of Salt Fork. The most destructive tornado occurred near Lamont where damage estimates reached 2 million dollars. NWS meteorologists conducted a survey of the area and found a damage path 5 1/4 miles long and 3/4 of a mile wide with F3 damage occurring 2 mi. W of Lamont where a well-built brick home had all of its exterior walls destroyed. In addition, 6 single-family homes were destroyed 1.5 mi. S of Lamont, while in the city of Lamont 3 single-family dwellings sustained major damage. Nine single-family homes suffered minor damage. Nearly a dozen vehicles were destroyed, including automobiles, pickup trucks, farm trucks, and farm tractors. Several barns were destroyed including one barn where 30 sheep were also killed. More than 70 utility poles were ripped down in a 3 mi. stretch. In addition to these tornados, a large **microburst** containing damaging straight-line winds rated at 110 mph occurred from 13 mi. W of Medford in Grant Co. to 4 mi. WNW of Pond Creek. Satellite dishes owned by a cable company were flattened by the winds. Straight-line wind damage was also			

Significant Oklahoma Tornado History
January 1950 – May 2010
(Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center).

	reported in Alva where one man sustained minor injuries when he was blown into the bed of a pickup truck. Also in Alva at least 3 mobile homes suffered major damage; several carports were destroyed; awning and minor roof damage occurred to many homes; and trees and power lines were blown down. Other reports of straight-line wind damage include major roof damage to an old school gymnasium in Jefferson in Grant Co. A tree limb was blown through a picture window 14 mi. NNE of Camp Houston in Woods Co. Windows were also blown out of a shed and numerous trees were downed. Four to six inch tree limbs were blown down 9 mi, W of Cherokee in Alfalfa Co. In Thomas in Custer Co. one utility pole was snapped and large limbs were blown down. Power lines were knocked down in Edmond in N Oklahoma Co. Severe winds also damaged the roof of a park pavilion in Shawnee in Pottawatomie Co. The largest hail reported measured 3.5 in. and occurred in Medford in Grant Co. Three reported events of at least tennis ball size hail occurred in Goltry in Alfalfa Co. in less than 2 hrs: tennis ball size hail and baseball size hail. Between 30 and 100 percent of the wheat crop was destroyed due to large hail 2 mi. W of Jet to near Goltry and another area S of Cherokee, also sustained major wheat crop damage. In addition numerous vehicles had their windows broken. Tennis ball size hail also damaged the wheat crop and numerous vehicles in Okarche in Canadian Co. while in Watonga in Blaine Co. golf ball size hail damaged RV vehicles and street lights. Lightning struck a house in Piedmont causing a house to catch fire.			
1996-97	112 tornados occurred during these two years however few details are available through NCDC	$4M+	0	15
May 9,	Tornado – Occurred S of Seminole	$5M+	0	0

Significant Oklahoma Tornado History January 1950 – May 2010 (Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center).				
1995	however NCDC does not provide any additional details.			
May 30, 1993	Tornado - An isolated severe thunderstorm developed in Delaware County during the early afternoon of May 30th producing a tornado which first touched down 8 mi. E of Jay. The tornado moved SE, destroying two equipment sheds and damaging one other equipment shed. It continued SE, and damaged a chicken house 11 miles ESE of Jay before lifting. This tornado remained on the ground for three miles and was 100 yards wide.	$500,000+	0	0
Apr. 23, 1993	Tornado – The tornado went through the E side of Tulsa causing significant casualties and damage however there is no further information available.	$500,000+	7	100
1992-1993	123 tornados occurred during these two years however few details are available through NCDC	$60M+	2	113
Dec 31, 1991-	**Tornado** - Severe thunderstorms developed during the afternoon in central Okla. and spread into southern Okla. during the late afternoon and evening. In all, thirteen tornados were confirmed. Some minor injuries were reported with one of the tornados, but no fatalities or serious injuries occurred. Reports of 3-inch hail, severe straight-line winds, and lightning damage were also received. One particularly strong supercell storm tracked across central Okla. reaching its maximum strength and producing 3 tornados and extensive straight-line wind damage over Grady and McClain Counties. The first tornado, began 3 miles NE of Tabler and tracked just SE of east for 2.5 mi. before dissipating. Structural damage was confined to a dairy farm near the beginning of the track. The 2nd and more significant tornado began 5 mi E of Criner, in southern McClain Co. This tornado also tracked SE for 6 miles. Numerous power lines were downed, prompting the temporary closing of both Highways 24 and 74. At least 18	Unknown	Unknown	Unknown

Significant Oklahoma Tornado History January 1950 – May 2010 (Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center).				
	dwellings, including mobile homes and permanent dwellings, were destroyed or suffered major damage. A 3rd small tornado only lasted one or two minutes. It damaged an outbuilding and a few trees 2 miles NNE of Wayne in McClain Co., about 4 miles east of where the second tornado ended. The remaining 10 tornados were associated with other severe thunderstorms, mainly across central and southern Okla. The strongest was located S of Duncan in Stephens Co. The remaining 9 tornados resulted in little or no damage. Hail up to 3 inches in diameter fell S of Stratford in Garvin Co., and lightning damage was reported S of Duncan in Stephens Co.			
Jan 1, 1980-12/31/1989	522 tornados occurred during the decade however few details are available through NCDC	$871 million+	24	631
Jan 1, 1970-12/31/1979	476 tornados occurred during the decade however few details are available through NCDC	$402 million+	55	985
Jan 1, 1960 - 12/31/1969	615 tornados occurred during the decade however few details are available through NCDC	$68 million+	57	523
Jan 1, 1950-12/31/1959	579 tornados occurred during the decade however few details are available through NCDC	$73 million+	71	761

Additional Oklahoma Tornado Statistics - 1950 – 2009

	ALL TORNADOS				**Significant tornados F2**		**Violent tornados F3 & above**	
Year	**Number**	**Days**	**Fat.**	**Inj.**	**Number**	**Days**	**Number**	**Days**
00s Avg.	**57.25**	**14.9**	**1.7**	**35.3**	**5.5**	**3**	**0.4**	**0.4**
2009	38	12	8	4	8	5	1	1
2008	85	26	6	159	12	6	2	2
2007	39	17	2	2	6	3	0	0
2006	27	13	0	13	2	1	0	0
2005	27	12	0	0	0	0	0	0
2004	62	16	0	0	3	1	0	0

	ALL TORNADOS				Significant tornados F2		Violent tornados F3 & above	
2003	78	12	0	151	9	5	1	1
2002	18	11	0	1	2	2	0	0
2001	61	17	1	16	8	4	0	0
2000	44	13	0	7	5	3	0	0
90s Avg.	**68.1**	**16.3**	**5.5**	**111.4**	**10.6**	**3.9**	**0.8**	**0.4**
1999	145	21	42	786	25	6	3	1
1998	83	15	0	35	15	4	0	0
1997	55	13	0	5	3	2	0	0
1996	48	18	0	0	1	1	0	0
1995	79	19	3	8	8	5	0	0
1994	40	13	0	11	2	2	0	0
1993	64	23	7	133	6	3	1	1
1992	64	16	0	33	11	3	1	1
1991	73	17	2	71	20	8	3	1
1990	30	8	1	32	15	5	0	0
80s Avg.	**48.7**	**18.9**	**2.9**	**63.2**	**13.3**	**6.3**	**0.6**	**0.6**
1989	20	13	0	2	1	1	0	0
1988	17	12	1	2	0	0	0	0
1987	23	11	0	8	5	3	0	0
1986	47	16	0	18	8	6	0	0
1985	36	23	0	35	5	5	0	0
1984	50	16	13	214	13	6	2	2
1983	92	22	3	12	26	12	0	0
1982	101	30	6	224	38	15	2	2
1981	76	30	6	100	27	8	2	2
1980	25	16	0	17	10	7	0	0
70s Avg.	**51.4**	**22.2**	**6.2**	**77.5**	**19.2**	**9.3**	**1.3**	**1**
1979	51	22	7	140	23	9	3	2
1978	21	9	0	3	9	4	1	1
1977	54	20	1	18	25	12	1	1
1976	28	14	5	81	10	7	3	2
1975	34	14	3	98	18	8	0	0
1974	45	17	21	302	23	5	1	1

	ALL TORNADOS				Significant tornados F2		Violent tornados F3 & above	
1973	76	32	12	220	29	13	2	2
1972	30	20	5	8	9	6	1	1
1971	39	21	0	13	11	8	0	0
1970	50	23	6	158	18	8	1	1
1969	31	19	0	2	10	8	0	0
1968	55	25	0	15	19	15	0	0
1967	49	18	4	12	14	7	2	1
1966	36	15	0	21	10	5	1	1
1965	74	29	0	12	23	16	1	1
1964	53	25	0	4	18	11	0	0
1963	30	15	1	11	12	7	0	0
1962	67	28	0	16	16	11	2	2
1961	82	30	17	85	42	16	1	1
1960	98	29	35	3 14	49	14	5	2
1959	70	28	7	42	29	13	2	2
1958	42	26	0	21	14	6	0	0
1957	107	27	22	54	31	11	5	4
1956	49	25	5	161	21	10	2	2
1955	77	34	23	299	18	10	3	1
1954	53	23	2	107	27	10	2	1
1953	54	23	5	44	14	5	0	0
1952	22	15	0	2	5	4	0	0
1951	43	23	0	16	17	12	0	0
1950	23	17	6	45	11	8	1	1
TOTALS	3435	1167	288	4423	869	411	58	44
AVG./YR	**57.6**	**19.5**	**4.8**	**73.7**	**14.5**	**6.9**	**1.0**	**0.7**

Top Ten Costliest Oklahoma Tornados (1950 - 2010)			
Rank	**Location**	**Date**	**Damage ($)**
1.	Bridge Creek-OKC-Moore-Del City tornado	05/03/1999	$1 billion
2.	Moore-OKC-Choctaw tornados	05/08/2003	$370 million
3.	Altus-Altus AFB tornado	05/11/1982	$200 million
4.	Ardmore tornado	05/07/1995	$100+ million
5.	Cordell tornado	10/09/2001	$100 million
6.	Tulsa tornado	04/19/1981	$75-100 million
7.	Stroud tornado	05/03/1999	$60 million
8.	Catoosa tornado	04/24/1993	$50+ million
9.	Downtown Bartlesville	03/15/1982	$30-40 million
10.	Oologah	04/26/1991	$15 million

Note: S*ome of the damage costs listed here are estimates. In addition, the damage costs listed have not been adjusted for inflation to current dollar amounts.*

Violent Tornados (F4/F5) in Oklahoma (1950 - 2010)

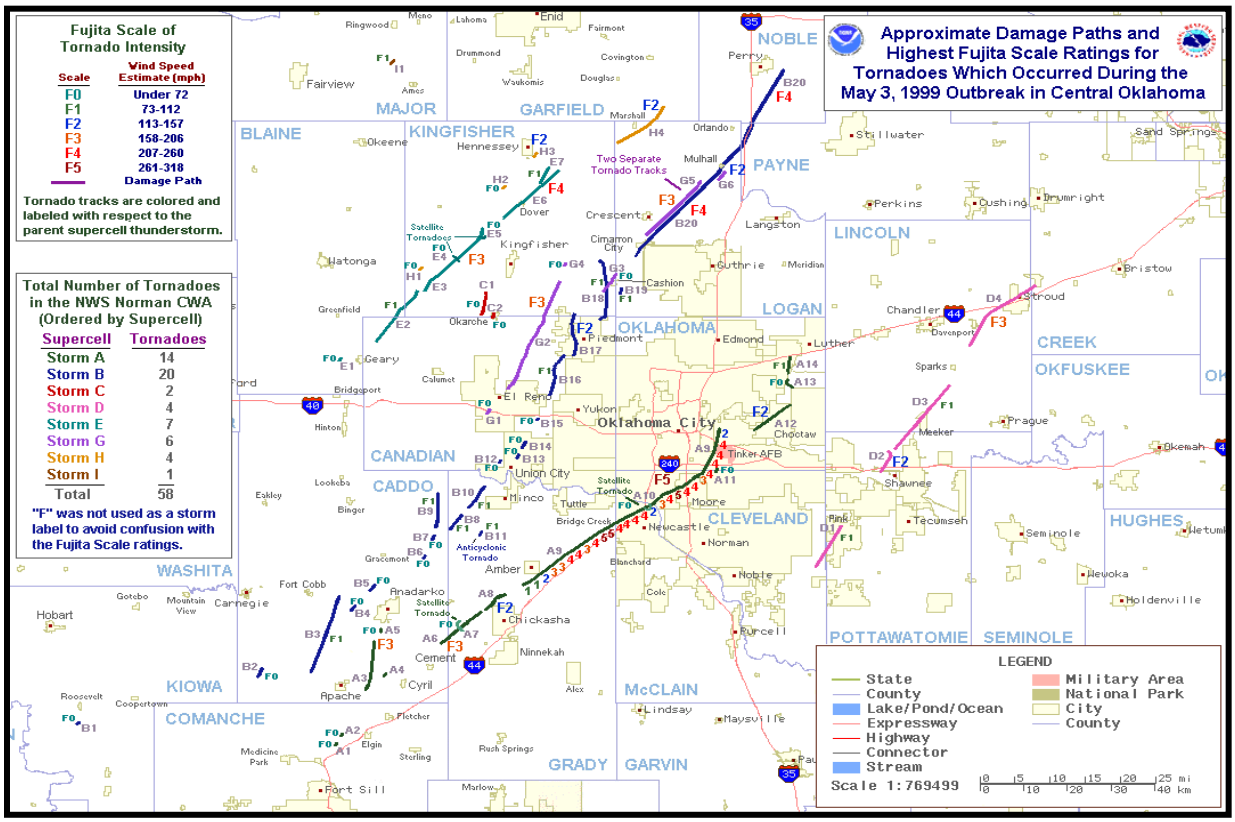
Date	Time (CST)	Length of Path (miles)	Width of Path (yards)	F-Scale	Killed	Injured	County
04/28/1950	1905	5	200	**F4**	5	32	Hughes
05/01/1954	1415	34	267	**F4**	0	0	Tillman/ Kiowa
05/01/1954	1800	59	N/A	**F4**	0	65	Pottawatomie/ Lincoln/ Creek
05/25/1955	1700	46	1100	**F4**	2	18	Roger Mills Co.
05/25/1955	2126	28	500	**F5**	20	280	Kay Co.
04/02/1956	2130	108	880	**F4**	2	29	Kay Co.
04/03/1956	0010	42	400	**F4**	0	59	Ottawa Co.
01/22/1957	0645	NA	880	**F4**	10	20	Sequoyah
04/02/1957	1729	5	200	**F4**	2	6	Marshall
04/02/1957	1758	8	200	**F4**	3	3	Bryan

Date	Time (CST)	Length of Path (miles)	Width of Path (yards)	F-Scale	Killed	Injured	County
05/24/1957	1730	22	880	**F4**	4	5	Cotton/ Comanche
09/14/1957	1730	68	440	**F4**	2	6	Cleveland/ Pottawatomie/ Seminole/ Hughes
05/09/1959	1840	6	900	**F4**	7	12	Pontotoc
09/27/1959	1800	20	440	**F4**	1	1	Craig Co.
05/04/1960	2005	8	N/A	**F4**	0	0	Pottawatomie/ Seminole Co.
05/04/1960	2116	31 *	150	**F4**	0	3	Choctaw/ Pushmataha Co.'s
05/05/1960	1700	72	800	**F5**	5	81	Pottawatomie/ Lincoln/ Okfuskee/ Creek Co's.
05/05/1960	1910	62	200	**F4**	16	106	Latimer/ Haskell/ Sequoyah Co's
05/05/1960	1940	5	n/a	**F4**	5	13	Sequoyah
05/05/1961	1720	26	400	**F4**	16	58	Le Flore
05/25/1962	1828	7	250	**F4**	0	9	Washita
05/26/1962	2000	10	400	**F4**	0	1	Cotton
03/16/1965	1640	83	300	**F4**	0	7	Grant/ Kay Co's
04/27/1966	1900	10	300	**F4**	0	2	Johnston/ Atoka
06/10/1967	1704	9	300	**F4**	4	1	Custer
06/10/1967	2045	N/A	N/A	**F4**	0	0	Blaine
10/05/1970	1542	25	150	**F4**	4	84	Pottawatomie/ Lincoln/ Okfuskee
04/19/1972	1700	28	n/a	**F4**	5	6	Carter/ Murray/ Garvin
05/24/1973	1600	13	300	**F4**	2	4	Canadian
05/26/1973	1600	4	500	**F4**	5	25	Muskogee
06/08/1974	1555	29	400	**F4**	14	150	Payne/ Creek/ Tulsa/ Osage
03/26/1976	1450	11	440	**F4**	1	4	Latimer/ Le Flore
03/26/1976	1528	12	440	**F5**	2	64	Le Flore
04/17/1976	0412	33	440	**F4**	0	6	Caddo

Date	Time (CST)	Length of Path (miles)	Width of Path (yards)	F-Scale	Killed	Injured	County
05/18/1977	1250	38	440	**F4**	0	0	Cimarron
5/10/2010	1621	23	1320	**EF-4**	2	100	Cleveland/Oklahoma
04/30/1978	1820	9	1760	**F4**	0	0	Canadian/ Oklahoma
04/10/1979	1520	11	880	**F4**	0	1	Tillman
04/10/1979	1830	11	1760	**F4**	0	0	Jefferson
05/02/1979	1615	21	880	**F4**	1	25	Major/ Garfield
05/17/1981	1900	34	600	**F4**	0	2	Seminole/ Okfuskee/ Okmulgee
05/22/1981	1849	17	1333	**F4**	0	0	Caddo/ Canadian
03/18-19/1982	0100	88	880	**F4**	0	12	Beaver
04/02/1982	1550	53	500	**F5**	0	29	Choctaw/ McCurtain
04/26/1984	2205	22	880	**F4**	3	37	Creek/ Pawnee
04/29/1984	0920	27	200	**F4**	1	60	Creek/ Pawnee/ Osage
04/26/1991	1730	66	1500	**F4**	0	6	Garfield/ Noble/ Osage
04/26/1991	1910	32	1700	**F4**	1	24	Pawnee/ Osage
04/26/1991	2045	4	1300	**F4**	0	22	Rogers
05/11/1992	1500	10	400	**F4**	0	3	Pittsburg
04/24/1993	1750-1803	6	250	**F4**	7	100	Tulsa/ Rogers
05/03/1999	1726-1848	38	1760	**F5**	36	583	Grady/ McClain/ Cleveland/ Oklahoma
05/03/1999	2010-2038	15	880	**F4**	1	11	Kingfisher
05/03/1999	2025-2145	39	1760	**F4**	2	26	Logan/ Payne/ Noble
05/08/2003	1615-1638	13.5	700	**EF4**	0	89	Cleveland/ Oklahoma
05/10/2008	16:25-16:54	24	1760	**EF4**	6	150	Ottawa
02/10/2009	19:09-19:43	21	880	**EF4**	8	0	Carter
05/10/2010	16:21-16:45	23	1320	**EF4**	2	100	Cleveland/Oklahoma
05/10/2010	16:33-16:54	16	Unknown	**EF4**	0	0	Cleveland/Pottawatomie

Above statistics provided through the National Weather Service, Norman, OK

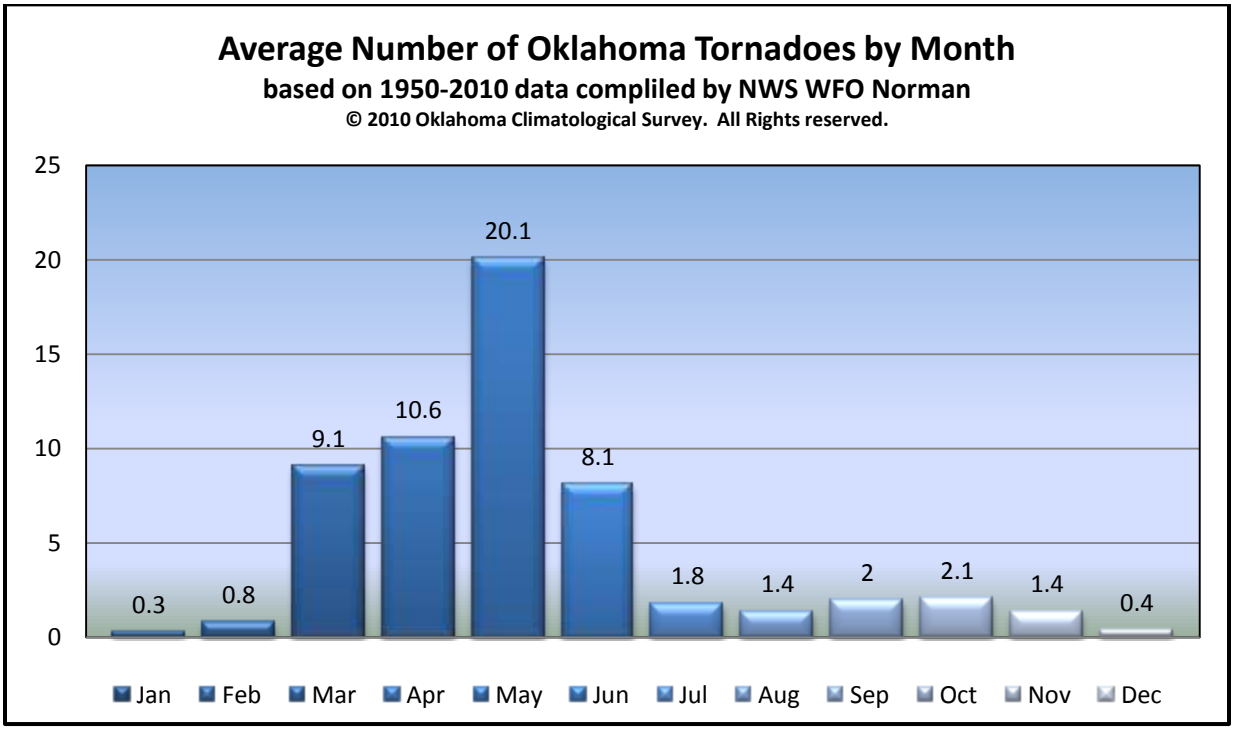
Since the latter part of the 19th century, two mitigating factors have been working in opposition to determine the State's risk from tornados: the increases in both population and technology. Obviously, an increase in population enhances the hazards posed by tornados. As the population grew, the threat of a tornado striking populated areas increased. The population growth is naturally accompanied by the necessary infrastructure and by-products of civilization, all of which increase the potential loss in the event of a tornado. The exodus of rural populations to urban areas is problematic as well. A tornado striking a larger population density significantly increases the chances for fatalities, as evidenced by the central Oklahoma outbreak of May 3, 1999, which caused more than $1 billion in damages and killed 40.



The hazard of population increase has been offset by the advancements in technology over the last half-century. Improvements in remote sensing, such as radar and satellites, coupled with improved communication systems, have increased the lead-time for warnings tremendously. Tornado warnings have improved significantly and the number of tornado casualties has decreased by nearly half since a network of Doppler weather radars, Doppler (WSR-88D), also known as NEXRAD, were installed nationwide by the National Oceanic and Atmospheric Administration's National Weather Service in the mid 1990's. Weather Surveillance Radar will soon undergo another significant upgrade with the Phased Array Radar which will reduce the scan rate of six minutes currently, to a minute or less, thereby making it more efficient in seeing smaller short lived or earlier stages of developing tornados.

The next step in NOAA's long-time research and advancement of weather radars is phased array radar. Using electronic controls of beams and frequencies, these new radars can scan more quickly, thereby increasing lead times for tornado warnings.

Better construction practices have also worked to limit the damage potential from all but the most violent tornados. The residences and businesses of today are more likely to withstand the damaging winds of weaker tornados than those structures built fifty years ago. The inclusion of safe rooms, below ground storm shelters, (Oklahomans have installed more than 10,500 safe rooms and storm cellars over the past decade) hurricane straps, and foundation anchor bolts in current construction plans, has helped reduce the hazard to both life and property.



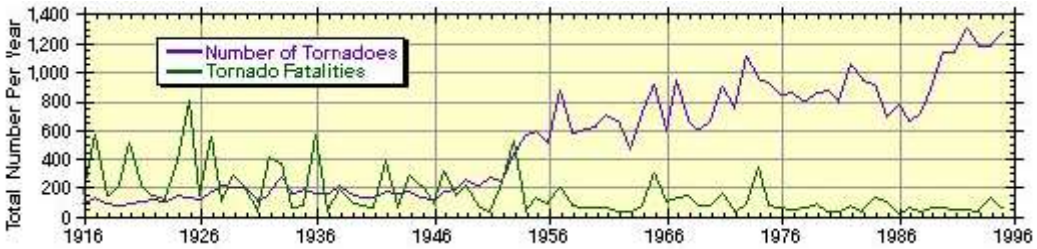
Tornado counts for a specific area, such as a county, are affected by several factors, including: size of the area, population base, and location. Some counties in Oklahoma have counts that reflect those factors quite well. Oklahoma and Tulsa counties both have high populations 716,704 and 601,961

respectfully, and a high tornado event counts with 99 and 63 reported tornados, respectively. Caddo (pop. 30,393) and Osage (pop. 45,051) counties, both with large land areas (1278 sq. mi.) and (2250 sq. mi.) respectfully, have high counts as well, at 99 (the State's highest) and 69, respectively. However, variations do occur. Lincoln County (pop. 32,199), neither overly populous nor large in area (957.74 sq. mi.), has a total of 73 tornados.

Top Ten Deadliest Oklahoma Tornados (1882 - 2009)					
Rank	**City/Town**	**Date**	**F-Scale**	**Fatal**	**Injuries**
1.	Woodward	04/09/1947	**F5**	116	Unk.
2.	Snyder	05/10/1905	**F5**	97	58
3.	Beggs	05/02/1920	**F4**	71	100
4.	Antlers	04/12/1945	**F5**	69	353
5.	Pryor	04/27/1942	**F4**	52	350
6.	Bridge Creek - Moore – Oklahoma City	05/03/1999	**F5**	40	583
7.	Oklahoma City	06/12/1942	**F4**	35	29
8.	Cleveland County	04/25/1893	**F4**	33	100
9.	Bethany	11/19/1930	**F4**	23	77
10.	McAlester	05/08/1882	**F3**	21	42

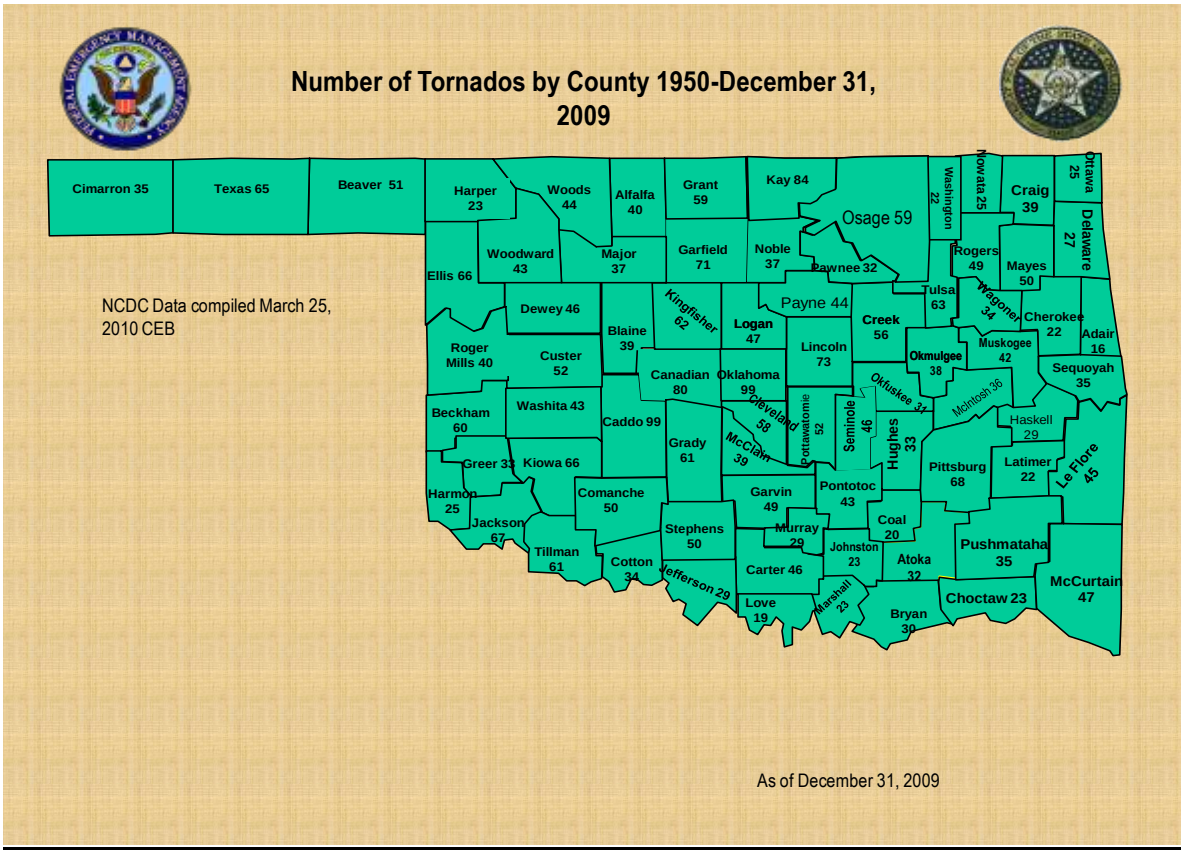
It is important to remember that while 69% of all tornados are considered weak; over 82% of all tornado deaths are due to violent tornados (F4-F5), despite only 2% of all tornados falling into that category. Between 1950 and 2009 of the 229 deaths attributed to tornados in Oklahoma, 190 (82.97%) were a result of F4 and F5 tornados. Additionally, the injury rate during F4 and F5 tornados was nearly as impressive with 2332 (55.99 %) out of 4165 injured during violent tornados in relation to the other. Nine of the top ten deadliest tornados in Oklahoma were in the violent category. Tornado deaths by county are dominated by singular events, and largely a result of significant (F2-F4) tornados. The State's most deadly tornado occurred before 1950, when an F5 tornado devastated the city of Woodward on April 9, 1947. The tornado, which was over a mile wide leveled over 1000 homes and businesses and left 116 dead in its wake as it crossed into Kansas.

Oklahoma Tornados by Fujita Scale and Month (1950 – 03/2010)								
Month	**F?**	**F0**	**F1**	**F2**	**F3**	**F4**	**F5**	**Total**
Jan	0	5	3	12	0	1	0	**21**
Feb	1	9	24	18	7	1	0	**60**
Mar	4	91	83	67	24	7	1	**277**
Apr	13	224	194	186	55	30	3	**705**
May	34	509	392	239	90	38	7	**1309**
Jun	7	218	150	85	29	5	0	**494**
Jul	4	36	43	25	3	0	0	**111**
Aug	4	35	34	13	2	0	0	**88**
Sep	3	74	23	17	3	4	0	**124**
Oct	1	65	45	21	8	3	0	**143**
Nov	1	21	38	17	11	0	0	**88**
Dec	0	0	10	12	2	0	0	**24**
Total	**72**	**1287**	**1039**	**712**	**234**	**89**	**11**	**3444**



Latest data available from Okla. Climatological Survey

The May 3, 1999 tornado (F5) and the May 8, 2003 (F4) and May 9, 2003 (F3) tornados which occurred in the heavily populated metropolitan area around Oklahoma City are prime examples of this. Since those events, over 10,000 personal and Community Safe Rooms and Shelters have been built by Oklahomans statewide to better prepare themselves for future such events.



3.2.1.5 Probability of Future Events:

Because tornados are random, every county in Oklahoma is at risk, there is a **HIGHLY LIKELY** probability of future events occurring.

Calculated Priority Risk Index (CPRI)

Tornado = 3.4

Probability		4 Highly Likely		
Magnitude/Severity		3 Critical		
Warning Time		4 Less than 6 Hours		
Duration		1 Less than 6 hours		
The CPRI for the tornado hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(4 x .45)	+ (3 x .30)	+ (4 x .15)	+ (1 x .10)	= 3.4

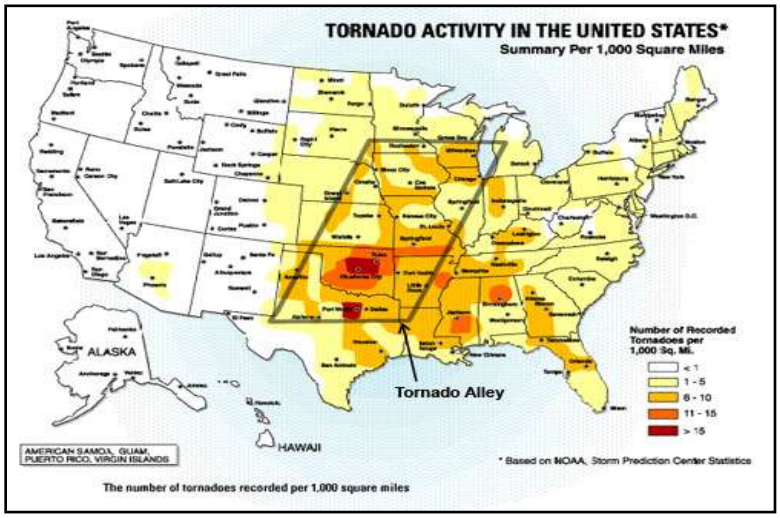
3.2.1.6 Vulnerability and Impact:

Oklahoma has the highest average number of tornados per square mile with an average of 57.25 per year. Tornados cause hundreds of thousands of dollars of damage to property every year. Houses and businesses, and government infrastructure often suffer extensive damage in tornados as well as the death of people, wildlife and livestock. Some people leave and never return leaving empty or debris riddled lots for someone else to deal with. Disruption of traffic flow occurs not only for citizen's day to day traffic but also critical services such as emergency police, fire, and ambulance. School bus and mail routes are also disrupted due to damaged or destroyed roads and bridges. Power and water outages have occurred which cause food spoilage and sanitation problems for communities. Schools, hospitals, grocery stores and other critical need and economically important facilities are damaged and closed for extended periods. Employment is often affected because of businesses that close due to the tornado damage and loss of business.

Even with the advances in meteorology, warning times may be short or sometimes not possible. Tornados and violent windstorms occur frequently in the State of Oklahoma and can be very deadly.

3.2.1.7 Vulnerable Populations:

Oklahoma is located in "Tornado Alley," the most tornado-prone area of the nation. Virtually all of the State is at risk. Poorly constructed or older homes and mobile home parks are at highest risk to sustain the greatest damage.



The greatest vulnerability to be faced would be in the event an EF3 or higher tornado was to hit a major metropolitan area such as Oklahoma City or Tulsa and their surrounding communities. Substantial damage could be incurred by State, Local, and Federal facilities. The damage to infrastructure would be enormous with lost power, water, sewer, gas, and communications. Roads and bridges could be damaged or at the least blocked and cluttered with debris. Continuity of government could be severely limited and emergency response would be greatly hindered. Many

people would lose their homes and be displaced from their primary residence with high numbers of injuries and fatalities possible.

This situation was realized on May 3, 1999 when the strongest recorded tornado in history made a path through South Oklahoma City and the surrounding community of Moore.

The following map shows the past history of tornado outbreaks in Oklahoma. Past history shows that the counties of Caddo, Oklahoma, Kay, Canadian, and Lincoln have had the highest incidence of recorded tornado out breaks and are therefore most at risk and vulnerable to tornados.

3.2.1.8 Conclusion:

The climatological records for Oklahoma indicate that a real danger to both life and property is faced by residents in Oklahoma from tornadic activity. The tornado casualty trend shows, other than the extreme event of May 3, 1999, a reduction in tornado casualties in the last 20 years, and while the number of reported tornados has been increasing recently, probably due to better detection equipment and spotter training, deaths and injuries caused by tornados are decreasing. State-owned property is vulnerable to severe weather the same as all other property. Special concerns may arise over critical facilities such as electric transmission lines, and communications towers being affected as well as highways that may be closed by debris on the highway.

3.2.2 Winter Storms, Ice, Freezing Rain

Hazard Priority # 2

3.2.2.1 Description:

A severe winter storm can range from moderate snow over a few hours to blizzard conditions with high winds, freezing rain or sleet, heavy snowfall with blinding wind-driven snow and extremely cold temperatures that lasts several days.

FLURRIES are snow events with light snow falling for short durations. No accumulation or only a light dusting is all that is expected with little or no effect on the population of the state.

SEVERE WINTER STORM is one that drops 4 or more inches of snow during a 12–hour period, or 6 or more inches during a 24- hour span.

WINTER STORM This term refers to a combination of winter precipitation, including snow, sleet, freezing rain, etc.

BLOWING SNOW is wind-driven snow that reduces visibility and causes significant drifting. Blowing snow may be snow that is falling and/or loose snow on the ground and picked up by the wind.

BLIZZARDS, though infrequent in Oklahoma are due to winds over 35 mph with snow and blowing snow reducing visibility to near zero.

ICE STORMS occur when freezing rain or sleet falls and freezes immediately on impact.

FREEZING RAIN is rain that falls onto a surface with a temperature below freezing. This causes it to freeze to surfaces, such as trees, cars, and roads, forming a coating or glaze of ice. Even small accumulations of ice can cause a significant hazard.

SLEET is rain drops that freeze into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects. However, it can accumulate like snow and cause a hazard to motorists.

WIND CHILL is used to describe the relative discomfort and danger to people from the combination of cold temperatures and wind. The wind chill chart below from the National Weather Service shows the wind chill derived from both wind speed and temperature. (Wind Chill Chart)

The gradient of average annual snowfall is nearly opposite that of precipitation, in that it increases from less than two inches in the extreme southeast to nearly 30 inches in the western panhandle. The greatest seasonal snowfall ever recorded in the State was 87.3 inches at Beaver during the winter of 1911-12. A review of significant winter storms over the last 30+ years shows a trend toward icy weather instead of major snowfall which plagued Oklahoma during the 1970's and 80's.

Oklahomans have been plagued with a series of major Ice Storms during the last decade. Ice storms are extended freezing rain events, lasting several hours to days at some locations, with heavy ice accumulations. The icy cover can down power lines and limbs, causing millions of dollars in damage and widespread power outages. These events which generally last several days are extremely paralyzing to communities and citizens affected. Significant icing events occur with nearly the same frequency as heavy snow events. While ice accumulation is often less than an inch, storms depositing several inches of ice have occurred. The consecutive winters of 2000-01 and 2001-02 each featured a major ice storm that deposited more than three inches of ice in 24 hours across much of SE and central Oklahoma. Similar events occurred in January 2007 in eastern Oklahoma and in December 2007 for central and western Oklahoma. For the electric utility industry, and businesses, freezing rain and ice storms are economic disasters. The December storm caused the largest power outage recorded in Oklahoma's history.

3.2.2.2 Location:

The entire State of Oklahoma is at risk from Winter Storms.

3.2.2.3 Extent:

The table below gives a range of physical intensities from winter storms along with the potential effect. The State of Oklahoma may experience a level anywhere on this chart.

Level	Type of Event	Effect
Level 1 – Nuisance Event No Major Impact	Little snow/ice accumulation. Roads not hazardous	Little to no effect.
Level 2 – Minor Event Caution Advised	Dusting to 3 inches of snow. No measurable ice. Winter Weather Advisory	Untreated roadways may become hazardous and slick. Livestock may need additional supplemental feed.
Level 3 – Major Event	Significant Snow Accumulations 4-8 inches. Ice Accumulations of ¼ to ½ inch. Reduced visibility. Wind causing drifting snow. Winter Storm Warning	Widespread hazardous road conditions. Travel discouraged. Areas isolated because of drifting snow. Isolated power outages because of down power lines from ice accumulation. Tree damage. Livestock loss potential increases, supplemental feed necessary.
Level 4 – Extreme Event	Crippling Event. Snow accumulations over 8 inches. Winds over 35 mph. Drifting snow, little to no visibility. Ice Accumulations of more than ½ inch. Blizzard Warning	Road conditions hazardous to impassable. People and livestock isolated. Widespread power and utility outages. Infrastructure damage. High potential for loss of livestock. Structures threatened from accumulating snow and ice. Communications infrastructure lost from ice accumulation. May be a long lasting event.

Wind chills also play a huge part in Oklahoma severe weather review. Wind Chill is the combination of wind and temperature that serves as an estimate of how cold it actually feels to exposed human skin. Wind chill values below -19 degrees are considered extremely dangerous to the population of the State of Oklahoma although hypothermia can occur at higher temperatures and cause deaths. Parts of the Oklahoma Panhandle have experienced wind chills of -19 degrees several times per year.

The National Weather Service implemented a new Wind Chill Temperature (WCT) index during the 2001/2002 winter season. The new Wind Chill/Temperature Index makes use of advances in meteorology, biometeorology and computer modeling to provide a more accurate, useful formula for calculating the dangers from winter winds and freezing temperatures.

Wind Chill Chart

Wind Chill Chart

Wind (mph)	Temperature (°F) 40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	29	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

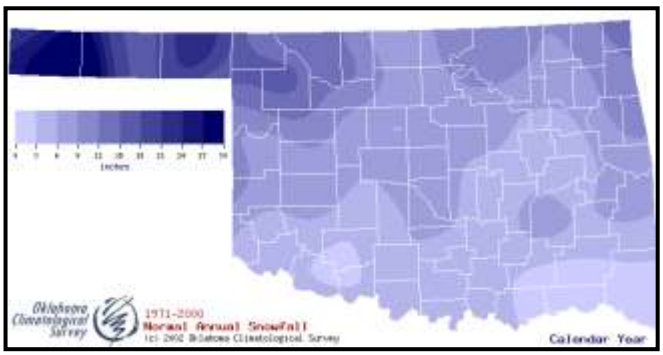
Frostbite Times: 30 minutes, 10 minutes, 5 minutes

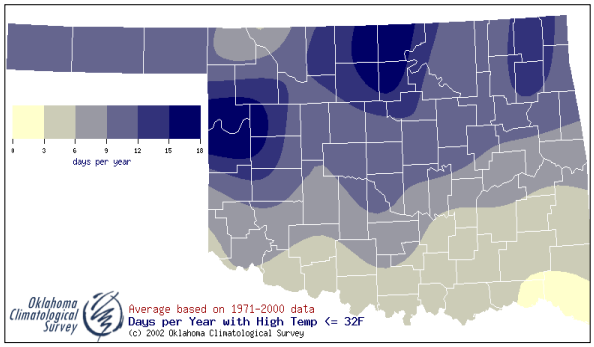
$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph) *Effective 11/01/01*

3.2.2.4 Previous Occurrences:

The following map shows the average number of days where the high temperature was at or below 32 degrees. The counties of Ellis, Roger Mills, Dewey, Custer, Grant, Kay, Garfield, Noble, Craig, Ottawa, Nowata, Rogers, Mays, and Delaware are the counties most vulnerable and have areas that average 15 – 18 days per year where the daily high temperature is at or below 32 degrees. The second map shows average normal snowfall where the panhandle counties of Cimarron, Texas, and Beaver are the most vulnerable with areas that receive over 24 inches annually.





The above maps are the latest available but is still representative of Oklahoma Winter Weather

Oklahoma's experience with severe winter weather is generally mild in comparison with other states because these events are not as frequent and regular. Severe winter weather tends to magnify the effects on the population when that weather actually does occur. Even slight amounts of snow or ice often snarl traffic due to drivers being unfamiliar with the hazard presented. Since 1993, the National Climatic Data Center (NCDC) lists 411 snow and ice events within Oklahoma, which caused over $738 million in damage.

Major damaging snow and ice storms have occurred over the state during the past several decades. NCDC indicates there have been 411 records of Snow and Ice Storms between 1950 and December 2010.

Significant Winter Storms, Ice, Freezing Rain History
Feb. 1971 - Jan. 2010
(Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center)

Date	Event Description	Property Damage	Fatalities	Injuries
Jan 28-29 2010	Ice Storm: Early Thursday morning freezing rain moved into southwest Oklahoma and spread northeast into Oklahoma City. This area of precipitation continued to spread east and northeast across the Tulsa area. Significant ice accumulations occurred in southwest Oklahoma aided by a meso-low pressure center, which formed in northwest Texas. This enhanced precipitation rates in southwest Oklahoma resulting in widespread 1 to 1.5 inches ice accumulations. Widespread power outages occurred with significant damage to power systems, including high voltage lines. In northwest Oklahoma/panhandle, snow occurred with common 6-8 inches accumulation. Central Oklahoma received common 0.5 inches of freezing rain, followed by sleet and ending with common 4-6 inches of snow. Northeast sections also saw freezing rain around 0.5 inches with widespread 6-8 inches of snow. East-central and southeast sections received a mixed bag (freezing rain, sleet, and snow). South-central Oklahoma also experienced widespread freezing rain around one inch, which led to power system damage and ultimately power outages. At the height of this storm, approximately 180,000 meters were without service. Numerous shelters were setup across the state with a focus on south-central and southwest sections. Department of Emergency	Unknown	**7**	**1242**

Significant Winter Storms, Ice, Freezing Rain History Feb. 1971 - Jan. 2010 (Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center)				
	Management dispatched generators to the impacted regions and also used FEMA supplied generators. Many towns were without power for days.			
Dec 24, 2009	** Snow Storm - On December 24, 2009, the ingredients for a powerful winter storm converged on the Southern Plains. Cold air deepened from the north, Gulf moisture increased from the south, and low pressure intensified rapidly, leading to severe, blustery winds. With the storm developing so quickly, the atmosphere responded with very strong lifting and heavy precipitation. Rain changed to sleet and then snow, resulting in the most widespread blizzard conditions to affect Oklahoma in decades. The record setting storm produced 4 to 8 inches of snow across Wichita Falls up through Oklahoma City and Stillwater. Local snow totals exceeded ten inches, including the most snow ever recorded in a single day at both Oklahoma City, 13.5 inches. For several hours, winds sustained at 40 mph and gusting to 60 mph created whiteout conditions with visibility of less than 100 feet. The winds built snow drifts at least three feet deep, and many vehicles had to be abandoned after becoming stuck in the snow. The number of stalled cars littering the roads and highways made travel impossible even for vehicles better equipped for travel in the snow. Blizzard and near blizzard conditions pummeled parts of eastern Oklahoma and northwest Arkansas Christmas Eve and into early Christmas morning, as an intense and deepening storm system moved through the Southern and Central Plains. Snowfall totals in excess of 6 inches were common across areas along and to the northwest of the Interstate 44 corridor, with lesser, but still significant amounts across much of the remainder of eastern Oklahoma and northwest Arkansas. Wind gusts in excess of 40 mph combined with the moderate to heavy snowfall to create dangerous blizzard	$2.25 Mil	9	1034

Significant Winter Storms, Ice, Freezing Rain History Feb. 1971 - Jan. 2010 (Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center)				
	and near blizzard conditions across much of the area. The wind gusts also resulted in isolated downed tree limbs and sporadic power outages.			
Dec. 8-11, 2007	****Ice storm** - This proved to be among the most devastating ice storms in recorded history. An upper-level storm system from the W sent out several waves of energy, each producing a wave of heavy icing. Each additional wave left an additional layer of ice on elevated surfaces and roadways. Both of the state's large metropolitan areas lay squarely within the storm's path. Precipitation total of up to four inches were recorded along the path of the storms. The storm left nearly 700,000 customers without power, catastrophic tree damage from central through northeastern Okla., and 29 fatalities. This storm resulted in the largest power outage recorded in Oklahoma history.	Estimates for debris removal and utility damage alone exceed $30.4 million.	29	0
Jan. 12-15, 2007	****Ice Storm** - A strong winter storm crippled much of Okla., spreading snow, freezing rain and sleet across the state. The freezing rain and sleet occurred mainly over central and southwest Oklahoma with mainly freezing rain over the southeast. The storm caused 14 indirect fatalities. Many trees and power lines were downed with thousands of residents without power, mainly over southern and eastern Okla. The severe cold that accompanied this storm also allowed for water main breaks in Clinton and Lawton. Damage included the roof collapses of two school gymnasiums and four greenhouses. The prolonged wintry precipitation closed airports, schools, malls, and other places of business, in some cases for a week or longer. This storm caused severe damage to the power systems in the eastern 1/3 of Oklahoma, where ice accumulations were more than 3" in localized areas. Over 100,000 customers were without power at the height of the storm many of which were without power for nearly a month.	Unavailable	32	0
Dec. 12-	**Heavy snow** - fell across portions of N Okla.	Unavailable	0	0

Significant Winter Storms, Ice, Freezing Rain History Feb. 1971 - Jan. 2010 (Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center)				
13, 2005	Much of the area received 4 to 8" with greater amounts falling across N-central Okla. The largest amount reported was W of Jefferson where 12 inches fell with 11" recorded at Medford, Nash, and Deer Creek. NW Okla. received snowfall amounts ranging from 1 to 4" with sustained winds at 25-35 mph. Winds combined with snowfall caused blowing and drifting snow. I- 40 was closed for a time due to numerous traffic accidents. Freezing rain, sleet, and 4 to 6" of snow fell across portions of W-central and central Okla. causing dangerous driving conditions across the area.			
Jan. 4-5, 2005	**Ice storm** - struck northern and central Okla. and was reminiscent of the ice storms that occurred in December 2000, and January 2002 although it did not produce as much widespread damage as they did. It did, however, create major power outages and disruptions to travel across NW and central Okla. Ice accumulations were from 1.5" in NW Okla. to ¼ in. in Central Okla.	Unavailable	0	0
Dec. 15, 2003	**Blowing snow -** A combination of high winds up to fifty-one knots and blowing snow reduced visibilities to near zero resulting in 4 accidents.	Unavailable	0	6
Dec. 23, 2002	****Snow storm** - dumped up to a foot of snow on parts of N and W Okla. Christmas Eve. Heavy snow fell N of I-40 with the greatest area from Hinton, in western Okla., NE to near Enid and Blackwell in N-central Okla. 7 to 10" were common in these areas, with a maximum of 12" reported in Enid.	Unavailable	0	0
Dec. 3, 2002	**Ice storm -** The third significant storm in as many years, left damage in a narrow band from W-central to N-central Okla. North of the icing area generally received 2-8" of snow. The main impact of the ice storm was damage to electrical distribution systems. Because much of the area is rural, the primary victims of the storms were members of rural electric coop's (REC's) with about 30,000 customers without power. Thousands of others were also affected by outages.	$4.5 million	0	0

Significant Winter Storms, Ice, Freezing Rain History Feb. 1971 - Jan. 2010 (Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center)				
Jan. 29-31, 2002	**Ice storm** - considered one of the worst ice storms in Okla. history by the NWS, this storm affected a significantly larger area than the Dec. 2000 storm. NW of a line from Chandler, to Norman, to Lawton and Frederick the freezing rain continued for 12 to 24 hours with ice accumulations of 1 to 2" common.	Unavailable	0	0
Jan 28-30, 2002	**Winter Storm** - This powerful storm wreaked havoc on the NW half of the state. A week later, 39,000 Okla. residents were still in the dark as utility companies worked around the clock to replace damaged poles and power lines due to ice more than an inch thick. Enid, (pop. 47,000), was entirely without electricity for days. Power companies estimated that power could be lost for up to 2 months in some rural areas of NW Okla. The Okla. Assoc. of Electric Cooperatives reported over 31,000 electrical poles destroyed due to the ice resulting in over 1,550 miles of destroyed power supply capabilities. The storm left over 255,000 residences and businesses without power. Dozens of towns were left completely without power for days. Snow across far NW Okla. left from 1 to 3" with Guymon reporting 6" of snow.	$300 million+	7	0
Dec. 25-27, 2000	****Winter Storm** - struck statewide, especially in SE quarter. Power was lost to at least 120,000 homes and businesses, including 90 percent of the residents of McIntosh, Latimer, and Pittsburg counties. Extended power outages also led to disruptions of local water supplies in some areas. The extreme weather conditions extended well into January 2001.	$76million+	27	0
Jan. 28, 2000	**Snow Storm** - Heavy snow across all of SE Okla. Snow totals between 6 and 10" were common. Numerous homes and businesses suffered from collapsed roofs crushing contents and vehicles including chicken house roofs that collapsed from the weight of the snow killing thousands of chickens.	$6 million+	0	0
Dec. 4-5, 1999	**Snow Storm** - The snow in the NW area of the state was mostly 6 to 8". The only	Unavailable	0	0

Significant Winter Storms, Ice, Freezing Rain History
Feb. 1971 - Jan. 2010
(Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center)

	exceptions were at Arnett and Laverne, where observers reported totals of 12- 10" respectively. Additionally the wind also presented problems. Gusts between 30 and 40 mph caused the snow to blow and drift. Serious travel difficulties also affected NW Okla. During the height of the storm.			
Mar. 13, 1999	***Snow Storm –** Heavy snow across portions of N. Okla. Resulting in hundreds of closed roads, traffic accidents, stranded motorists and power outages. The heaviest snow fell in a band across N-central Okla. From near Cherokee, extending E and SE to Medford, Pond Creek, Enid, and Perry. Reports indicated heaviest snow at Pond Creek with 20", Medford 19", and Jefferson 18". Numerous traffic accidents occurred with the most notable in central Lincoln County on the Turner Turnpike involving 30 vehicles. Chandler National Guard in Lincoln County accommodated 500 people, while the Perry National Guard in Payne County accommodated 400 people. Four churches in Stroud in Lincoln County accommodated a total of 1000 people.	Unavailable	5	0
Jan. 5-7, 1998	***Snow Storm** – 17" in Hennessey. Snow was reported over virtually the entire State.	Unavailable	8	0
Dec 23, 1997	**Snow Storm -** Heavy snow across the eastern Okla. Panhandle with Beaver Co. reporting from 12 to 16" of snow.	Unavailable	1	0
Oct. 25, 1997	**Winter Storm/ Blizzard** moved across the central plains states Cimarron and Texas counties. Reports from Okla. Mesonet sites in both Cimarron and Texas counties indicated wind gusts of 58 to 66 mph which produced snow drifts of 3 to 5 feet. About 12,000-15,000 head of cattle were lost in this storm mainly in Texas, Cimarron and Beaver counties.	Unavailable	1	0
Nov. 30, 1996	**Winter storm** - produced a narrow band of heavy snow from the Texas panhandle, into NW Okla. An area of NW Okla. Received 4 to 6" with a small area to the NW of Woodward receiving 8 to 10" of snow.	Unavailable	0	0
Jan. 1, 1993	**Winter Storm -** An upper-level storm system brought sleet and freezing rain to much of Okla. In Oklahoma City, a 35-car	Unavailable	0	0

Significant Winter Storms, Ice, Freezing Rain History Feb. 1971 - Jan. 2010 (Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center)				
	pileup occurred. The storm also caused problems for those flying as two 737s slid off icy runways at Will Rogers Airport also in Oklahoma City.			
Nov. 25, 1992	***Snow storm –** 22" of snow in Laverne. The heavy snow was confined to a small portion of extreme northwestern Oklahoma.	Unavailable	0	0
Jan. 18-19, 1990	***Snow Storm** – 18" of snow fell in Goodwell. Localized amounts between 12 and 18 inches fell in the western two-thirds of the Oklahoma Panhandle.	Unavailable	0	0
Mar. 4-5, 1989	***Snow Storm** - Near-blizzard conditions dropped 18" of snow from south central through SE Oklahoma.	Unavailable	0	0
Jan. 5-7, 1988	**Snow Storm** - Storm totals exceeded 4" over virtually the entire state, and exceeded 6" over all but a few areas near the Red River and far western Panhandle. Records indicate that the maximum storm total was 17" in Hennessey. The 12.1 inches at Oklahoma City stood as an all-time record for storm total snowfall until Dec 25, 2009.	Unavailable	0	0
Dec. 25-27, 1987	**Winter Storm** – Ice accumulations up to 2" from Duncan to Norman to Tulsa left many areas without power for a week or more. About 114,000 customers were left without power. Ranked as one of the costliest storms on utility company records. Several large broadcast antennas collapsed.	$10 million	0	0
Dec. 13-15, 1987	***Snow Storm** – 16" in Helena. Snowfall amounts of 4 inches or more were reported across much of northern and central Oklahoma.	Unavailable	0	0
Mar. 30-31, 1973	***Snow Storm** – 17" of snow fell in Kenton with a foot or more in Cimarron County in the western Panhandle.	Unavailable	0	0
Feb. 20-22, 1971	***Blizzard** -Although this was confined to a relatively small part of NW Okla., the storm total of 3 feet at Buffalo nearly doubles the maximum storm total of any other snow storm in Okla. history. Winds whipped snow into enormous drifts, forcing some people to use second-story windows to get out of their homes. *(see photo below)* Cattle and hogs were buried under the snow for many days. Remarkably, some of	Unavailable	0	0

Significant Winter Storms, Ice, Freezing Rain History Feb. 1971 - Jan. 2010 (Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center)				
	them were found alive by rescuers after the storm was over. Those who were not buried were still without a food source. After the storm, the National Guard searched for stranded herds from the air and dropped hay to them. In all, 11,000 cattle, 3,500 hogs, and 1,000 sheep were lost to the storm.			
Mar 16, 1970	***Snow Storm** - 20 inches in Bartlesville. Amounts of a foot or more were reported along the Kansas border in extreme north central and NE Oklahoma.	Unavailable	0	0
**** = One of the top 10 Oklahoma winter storms since 1951 (Courtesy of the NWS).*** ***** - Presidential Disaster Declarations (Courtesy of FEMA).***				

The top 10 Oklahoma snowstorms since 1951 (Table courtesy of the NWS).	
Date	**Highest Amount/Heavy Snowfall Event**
Feb. 21-22, 1971	Highest Snowfall Total: 36 inches in Buffalo.
Nov. 25, 1992	22 inches in Laverne. Heavy snow was confined to a small portion of extreme northwestern Oklahoma.
Mar 16, 1970	20 inches in Bartlesville. Amounts of a foot or more were reported along the Kansas border
Mar. 13, 1999	19 inches in Medford.
Mar. 4-5, 1989	18 inches in Kansas, Oklahoma. Near-blizzard conditions occurred from south central through southeast Oklahoma.
Jan. 18-19, 1990	18 inches in Goodwell. Between 12 and 18 inches fell in the western two-thirds of the Oklahoma Panhandle.
Mar. 30-31,	17 inches in Kenton. A foot or more in Cimarron County in the western Panhandle

1973	of Oklahoma.
Jan. 5-7, 1998	17 inches in Hennessey. Snow was reported over virtually the entire State.
Apr. 1-2, 1998	17 inches in Goodwell. Heavy snow was confined to the Oklahoma Panhandle.
Dec. 13-15, 1987	16 inches in Helena.

3.2.2.5 Probability of Future Events:

There is a **Highly Likely** probability of future Winter Storm events in Oklahoma.

Calculated Priority Risk Index (CPRI)

Winter Storms/Ice/Freezing Rain = 3.3

Probability		4 Highly Likely		
Magnitude/Severity		3 Critical		
Warning Time		2 12-24 Hours		
Duration		3 Less than one week		
The CPRI for the Winter Storms hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(4 x .45)	+ (3 x .30)	+ (2 x .15)	+ (3 x .10)	= 3.3

Resources:
Archived data from the Oklahoma Mesonet
Archived information from the Oklahoma Climatological Survey
The National Climate Data Center's (NCDC) Storm Events Database
The Federal Emergency Management Agency (FEMA)
The National Weather Service (NWS)

3.2.2.6 Vulnerability and Impact:

Winter storms can be accompanied by strong winds creating blizzard conditions with blinding wind-driven snow, severe drifting, and dangerous wind chill. Strong winds with these intense storms and cold fronts can knock down trees, utility poles, and power lines.

Extreme cold often accompanies a winter storm or is left in its wake. Prolonged exposure to the cold can cause frostbite or hypothermia and become life-threatening. Infants and elderly people are most susceptible. Freezing temperatures can cause severe damage to crops and other critical vegetation. Pipes may freeze and burst in homes or businesses that are poorly insulated or without heat. Structure fires occur more frequently in the winter due to lack of proper safety precautions and present a greater danger because water supplies may freeze, and impede firefighting efforts. People die of hypothermia from prolonged exposure to the cold. Indigent and elderly people are most vulnerable to winter storms and account for the largest percentage of hypothermia victims largely due to improperly or unheated homes, but the leading cause of death during winter storms is from automobile or other transportation accidents.

Heavy accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Communications and power can be disrupted for days while utility companies work to repair the extensive damage. Even small accumulations of ice may cause extreme hazards to motorists and pedestrians.

Heavy snow can immobilize an area and paralyze a city, stranding commuters, stopping the flow of supplies, and disrupting emergency services. Accumulations of snow can collapse buildings and knock down trees and power lines. In rural areas, homes and farms may be isolated for days, and unprotected livestock may be lost. The cost of snow removal, repairing damages, and loss of business can have large economic impacts on cities and towns.

3.2.2.7 Vulnerable Populations:

Virtually all of Oklahoma is vulnerable to winter storms. Winter storms are considered deceptive killers as they indirectly cause transportation accidents, and injury and death resulting from exhaustion/overexertion, hypothermia and frostbite from wind chill, and asphyxiation.

The highest vulnerability associated with a winter storm would be a severe winter storm hitting a major city such as Oklahoma City or Tulsa and their surrounding communities. Roads, bridges, utilities, and communications systems could be greatly impeded or completely brought to a total stop. Transportation and emergency response would be hampered in the least and utilities such as electricity, water, gas, sewer, and communications could be totally shut down. Buildings could become snow and ice laden and collapse. The elderly and young children are vulnerable to the cold temperatures and without power or other forms of heat could become sick or fall victim to the cold temperatures. State, local, and federal facilities located in the winter storm area would also be shut down and operations greatly hindered. Broken and falling tree limbs would endanger people, power lines, vehicles, and buildings they happen to fall on or strike. Severe winter storms often paralyze whole communities. State and local governments, charities, and others are often hard pressed to furnish shelter, food and warmth to the citizens of the jurisdiction. Other critical facilities such as police, fire, and medical are over taxed and burdened with an excess of calls and medical emergencies. Without backup power these institutions often become unable to operate due to lost

communications and power. The elderly, young children and homeless people are most vulnerable to extreme cold temperatures.

3.2.2.8 Conclusion:

We don't have to go back far in Oklahoma weather history to realize how dangerous and devastating winter storms can be. Oklahomans during the past decade have suffered the effects of a series of disastrous ice storms that crippled the state with downed trees and power lines causing extended power outages. The storms caused billions of dollars damage to structures and even cost at least 102 individuals their lives. State-owned property is vulnerable to winter weather the same as all others. Concerns may arise over critical facilities such as electric lines, and communications towers being affected as well as highways that may be closed due to drifting or ice conditions. As has been illustrated, virtually every county in Oklahoma is at risk for winter storms, including snow, ice, and freezing rain.

3.2.3 Sinkholes/Subsidence

Picher, Oklahoma

Hazard Priority # 3

3.2.3.1. Description:

Sinkhole/Subsidence, also known as a sink, shake hole, swallow hole, swallet, doline or cenote, is a natural depression or hole in the surface topography caused by the removal of soil or bedrock, often both, by water. Sinkholes may vary in size from less than a meter to several hundred meters both in diameter and depth, and vary in form from soil-lined bowls to bedrock-edged chasms. They may be formed gradually or suddenly. Mechanisms of formation may include the gradual removal of slightly soluble bedrock such as limestone by percolating water, the collapse of a cave or mine roof, or a lowering of the water table. This is a problem in several eastern Oklahoma counties, including Latimer County. Sub-surface mining induced subsidence is relatively predictable in its magnitude, manifestation and extent, except where a sudden pillar or near-surface underground tunnel collapse occurs (usually in very old workings). Mining induced subsidence is nearly always very localized to the surface above the mined area, plus a margin around the outside. The vertical magnitude of the subsidence itself typically does not cause problems, except in the case of drainage (including natural drainage) - rather it is the associated surface compressive and tensile strains, curvature, tilts and horizontal displacement that are the cause of the worst damage to the natural environment, buildings and infrastructure.

Abandoned Mine Land Program Emergency Program

An AML emergency is a sudden danger or impairment that presents a high probability of substantial physical harm to the health, safety, or general welfare of people before the danger can be abated under normal program operation procedures. The most common AML emergencies in Oklahoma are subsidence events where the roofs of abandoned underground coal mine collapses, leaving a depression or an open hole to the surface.

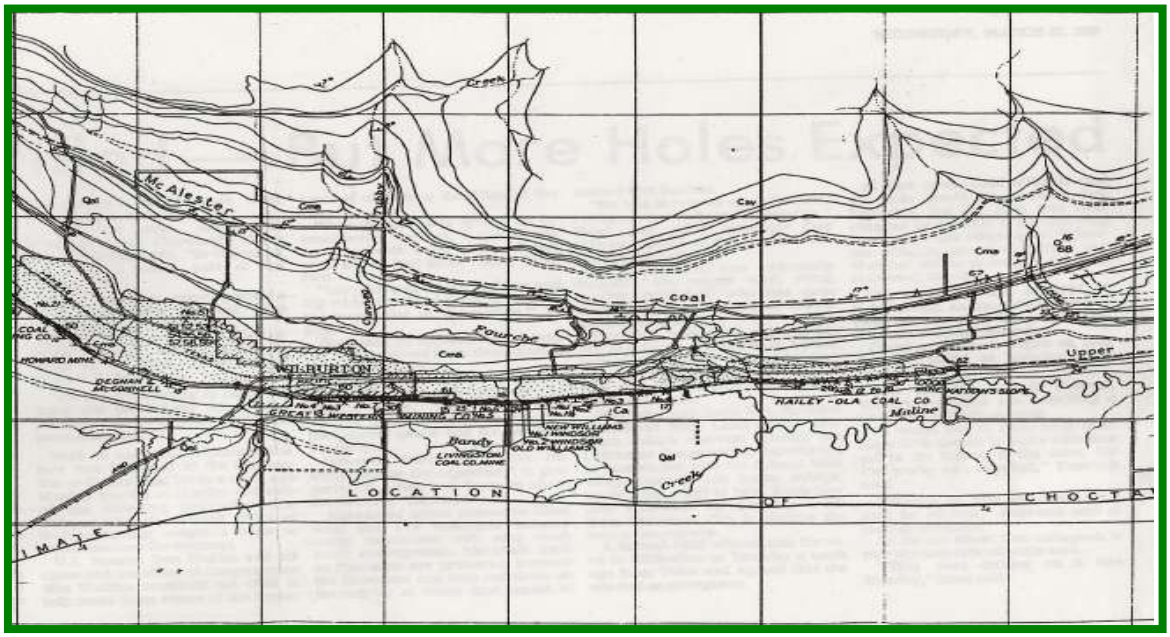
On February 17, 1998, the Oklahoma Conservation Commission became the state agency responsible for the AML Emergency Program in Oklahoma. After an emergency complaint is received, AML Program staff makes a site investigation. If conditions warrant, appropriate emergency assistance organizations and local authorities are notified of the conditions to ensure that immediate steps are taken to protect the public until abatement can be initiated. Once protective steps have been taken, AML Program staff submits a Complaint Investigation Report, based on criteria established during the site investigation, to the Office of Surface Mining Reclamation and Enforcement (OSM) Tulsa Field Office. The OSM Tulsa Field Office makes a declaration of either emergency or non-emergency. An emergency is declared by the signing of a Finding of Fact/Funding authorization.

Once an emergency has been declared, the AML Program staff identify the scope of work and a cost estimate, prepare the solicitation package and contact potential contractors, coordinate a pre-bid meeting at the site, award the contract, monitor the construction, perform a final inspection upon construction completion, and submit a final inspection report to the OSM Tulsa Field Office.

The funds for emergency abatement come from the OSM emergency account. A one-year grant is issued by OSM each year. Any unused funds are returned to the OSM emergency account at the end of the year. No state AML grant monies are used for these emergencies.

3.2.3.2. Location:

Eastern Oklahoma was an active coal mining region during the late 1800's until the mid 1900's. Latimer County experienced significant coal mining operations from 1896-1950 after which the mines were closed. Wilburton was a center of coal mining operations in Latimer County. Eastern Oklahoma State College began as the Oklahoma School of Mines and Metallurgy. The campus still houses the Oklahoma Miner Training Institute. Unfortunately the City of Wilburton and parts of Red Oak along with other rural areas of Latimer County are located over some of these mines. The map below shows the mining area and the City of Wilburton. OSM has identified 16 counties on the eastern side of Oklahoma that may experience Sinkholes.

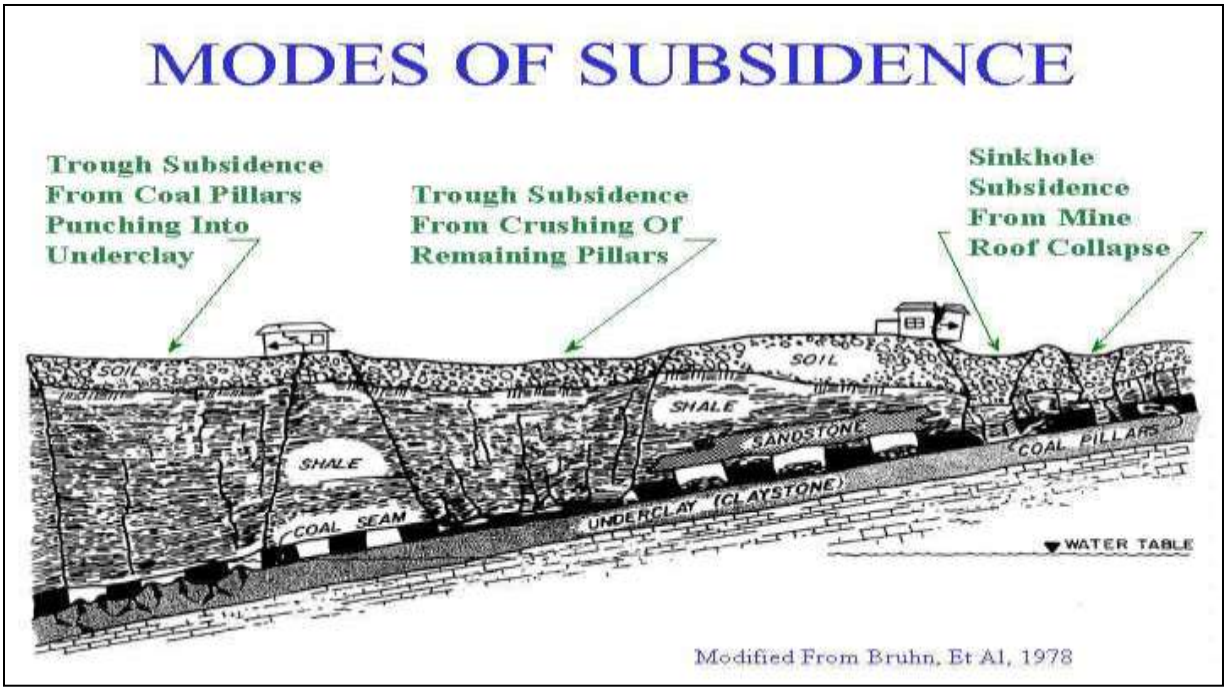


Location of coal mines in Wilburton area

3.2.3.3. Extent:

Local officials define sinkholes based on the amount of damage and threat level to the public, which is also the system used by the Bureau of Mines: i.e.;

- **Minor =** If a sinkhole develops in an unpopulated area not near structures such as roads or houses.
- **Major =** if a sinkhole develops in a road, next to a house, school or other structure where people would likely fall into it.
- **Catastrophic =** if houses or other structures that are totally destroyed o r fall into the sinkhole.



3.2.3.4. Previous Occurrences:

Street Collapses Into Mine Shaft; State Summoned

By JAMES BEATY

WILBURTON — Officials from the Oklahoma Conservation Commission in Oklahoma City were flying to Wilburton today to see for themselves where part of a residential street collapsed into an abandoned mine tunnel.

The area has been roped off by Wilburton officials, who immediately declared the situation "an emergency."

The collapse of a sink hole at a Wilburton street follows the collapse of similar holes near the Hartshorne and Haileyville schools in the past few months.

In Wilburton, the hole collapsed near the intersection of Birch Avenue and South Central. Near the hole this morning, city officials were ordering small children, including toddlers, to stay away from the site.

The hole is several feet in diameter on the surface, but opens into what appears to be an empty tunnel or underground "room" estimated to be about 30 feet deep.

Wilburton resident Frances Bailey, who lives near the site, said she looked out on the street Monday afternoon and everything was normal. Ten minutes later, she looked out, and the hole had appeared.

"It was scary," she said.

Today, Mayor Gerald Hood peered grimly into the hole and said he had tried to warn state officials that the street appeared to have several suspicious looking spots and he suspects there might be an abandoned mine tunnel under it.

"I had discussed this problem with the Soil Conservation Service about a year ago," Hood said.

"They said they couldn't do anything until something happened. Well, it's happened now and we want something done."

"This is a heavily traveled street," Hood said. "There are a lot of school kids around here. We don't know how far this extends."

Chamber of Commerce President Stoney Hardcastle, who visited the site today, cited the danger to children in the area and noted that school buses travel near the street every day.

Hardcastle said he considers the site "definitely" an emergency.

School bus driver Jack Wagner said he picks up about 35 children everyday not far from the site.

Veteran miner and former mine inspector Bill Reynolds of Adamson traveled to Wilburton to examine the site last night at the request of Wilburton officials.

"It's a bad one," Reynolds said.

Reynolds said that while he was at the scene "a blind man came walking by."

"If no one had reported the collapse of the hole and officials had not blocked off the area, he could have fell in," Reynolds said.

This morning, Junior Wilson of

(Continued on Page 2, Col. 6)

McAlester, Oklahoma, Sunday, March 19, 1989 — 4 Sections — 28 Pages

U.S. Surface Mining Officials Order Immediate Fill of Shaft

By JAMES BEATY

WILBURTON — After a quick change of plans, Don O'Bryan of the Federal Office of Surface Mining (OSM) in Denver, Colorado caught a plane to Oklahoma Friday to speed up the filling a dangerous sink hole collapsing into an abandoned mine in a residential street.

At first, OSM officials had said they would begin filling the hole last Thursday — but the date was suddenly changed to this Tuesday.

But after OSM officials received calls about the change of plans — from U.S. Senator Don Nickels, third District Congressman Wes Watkins' office, Wilburton officials and state conservation personnel, they decided to send a representative to Wilburton this weekend.

In a way, Wilburton residents are lucky the hole collapsed when it did last Monday — when no one was standing on it or driving over it, officials said.

"If the hole had not developed in the road, the void below the road would keep getting bigger until someone drove a car over it and the whole thing fell through," O'Bryan said on Saturday.

O'Bryan said he once saw a whole intersection that had collapsed into an abandoned mine under a street in Wyoming.

"This is by far the worst kind of hole," O'Bryan said, looking into a cavity an estimated 18-20 feet deep. Under the road at the intersection of West Central and Birch, there is a void of unknown depth.

That's one of the reasons that some Wilburton, state and federal officials were upset when the dates for filling the dangerous hole was pushed back five days by the OSM.

Last Tuesday, OSM officials had first told Wilburton city officials and Mike Kastl of the AML program that

(Continued on Page 2, Col. 3)

A REAL SINK — While a construction company official takes a turn peering into a sink hole that is collapsing into an abandoned mine under a Wilburton street, U.S. Surface Mining Engineer Don O'Bryan (second from left) talks with Jerry Williams. O'Bryan caught a flight to Oklahoma on Friday from Denver, Colorado to see

Local Public Safety records indicate a loss of two homes in the last three years. In both instances the losses were due to mine shafts below the structures when timbers collapsed. The newspaper clippings below are relating to collapses in March 1989. A residential street collapsed during the 1989 events. Over the last three years there have been collapses affecting housing in Wilburton.

McAlester News-Capital & Democrat

Area/State

WEDNE

Wilburton Hole Filled — But More Holes Exp

By JAMES BEATY

WILBURTON — Mayor Gerald Hood said he is pleased to see the sink hole that collapsed into an abandoned mine last week finally filled — but he is expecting more.

"I'm glad it's all over with," Hood said of this particular hole.

But the mayor feels that it's just a matter of time before another hole appears.

"We do expect them," he said. "The town is honeycombed underground," the mayor said of the abandoned mines that are under many towns in the area.

Wilburton Civil Defense Director Ray Fuertsch agreed that there will be more holes appearing around abandoned mines.

"We're going to have some more problems," he said. "There are a lot of entrances to abandoned mines."

Shortly after the sink hole first appeared in a Wilburton residential street last Monday, Fuertsch had called state Abandoned Mine Lands (AML) Reclamation Program Director Mike Kastl in Oklahoma City.

"We're lucky some little kid didn't fall in that hole," Fuertsch said Tuesday.

Kastl later cited the fact that he received the call from Civil Defense Director Fuertsch, along with veteran coal miner Bill Reynolds, and local Wilburton officials, as one of the reasons he decided to immediatley catch an airplane to Wilburton to see the hole for himself.

"That was the first time I had ever had a civil defense director call me about one of these holes," Kastl said later.

Kastl said the hole was definitely dangerous and promptly declared the situation an emergency.

The reason that Fuertsch was so concerned is simple — he grew up around similar collapsing mine holes in Frontenac, Kansas.

"My dad was a coal miner and I still remember how I used to carry his dinner bucket to him," Fuertsch said.

As for the town itself where Fuertsch grew up — "It was undermined, just like Wilburton," he said.

Unlike many of the mines in Wilburton, which came off a hill at a sleping angle, most of the mines in Kansas were shafts that went straight down, he said.

"They had some cave-ins at Frontenac and Pittsburgh (Kansas)," Fuertsch said. "In Galena in the 1960s, a whole part of the highway fell in.

"They had the same problems we're having here," he said. "The old timbers are rotting."

Meanwhile, Fuertsch and other officials are still working, trying to locate all the sites of underground mines in Wilburton.

"People are starting to come forward and point these things out," Fuertsch said. "We're looking at some other sites."

Work to begin the Wilburton sink hole that collapsed at the intersection of Central and Birch a week ago Monday started on Sunday and ended the following day after Don O'Bryan with the federal Office of Surface Mining caught a flight to Oklahoma over the weekend.

U.S. Senator Don Nickles and his office and the office of Congressman Wes Watkins constoeld the OSM to help make them aware of the importance of expediting the filling of the hole.

When the hole was opened up by construction workers, it opened into an abandoned mine about 25 feet wide and 25 feet deep, Mayor Hood said.

"They got some large boulders and big rocks and filled it full of rock all the way down to the bottom," he said.

Hood said he appreciated the help the town received from those outside of the community.

"Although our own resources are limited, we had to protect the general public," Hood said. "That was our main concern — to consider the general public and the needs of the public."

However, "We didn't have the equipment or the expertise," to properly fill a sink hole from an abandoned mine," the mayor said.

Abandoned mines cannot be filled with just any materials because many substances will soon wash away underground. Materials such as limestone are preferred, because the limestone can help cut down on the acidity of water that comes in contact with the coal.

"We had to rely on other financial resources and technical knowledge," Hood said. OSM Inspector Don O'Bryan stayed on the site until the job was finished.

"Bill Reynolds was extremely helpful," the mayor said, citing another individual who has done much to help with problems around abandoned mines.

Reynolds, who spent most of his life as either a coal miner or a mine inspector, has been credited by city, state and federal officials time and time again for his help around abandoned mine sites.

Hood also said Kastl with the state Abandoned Mine Land (AML) program, which operates through the Oklahoma Conservation Commission in cooperation with the federal OSM which controls the purse strings, made a big effort to help. Kastl flew into Wilburton on Tuesday week from Oklahoma City to declare the hole an emergency.

A federal OSM official also traveled to Wilburton on Tuesday a week ago from Tulsa and agreed that the site was an emergency.

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Resources:

Latimer County News-Tribune
McAlester News-Capital and Democrat
Oklahoma Conservation Commission/Abandoned Mine Land (AML) Program
Wikipedia, the free encyclopedia
Eastern Oklahoma State College
Flanagan & Associates, LLC
Hazard Mitigation Specialists LLC

3.2.3.5. Probability of Future Events:

There have been two losses in the past three years. Due to the losses in recent years, the public and official concern over the threat and the limited solutions, the potential for additional sinkholes in Latimer County and the state of Oklahoma is **Likely**.

Sixteen counties in eastern Oklahoma are **Likely** to experience a sinkhole event.

Calculated Priority Risk Index (CPRI)

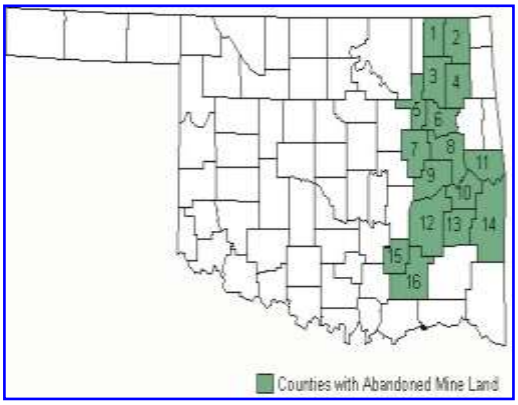
Sinkholes/Subsidence = 3.25

Probability			3 Likely	
Magnitude/Severity			4 Catastrophic	
Warning Time			4 Less than 6 Hours	
Duration			1 Less than 6 Hours	
The CPRI for the Sinkholes hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(3 x .45)	+ (4 x .30)	+ (4 x .15)	+ (1 x .10)	= 3.25

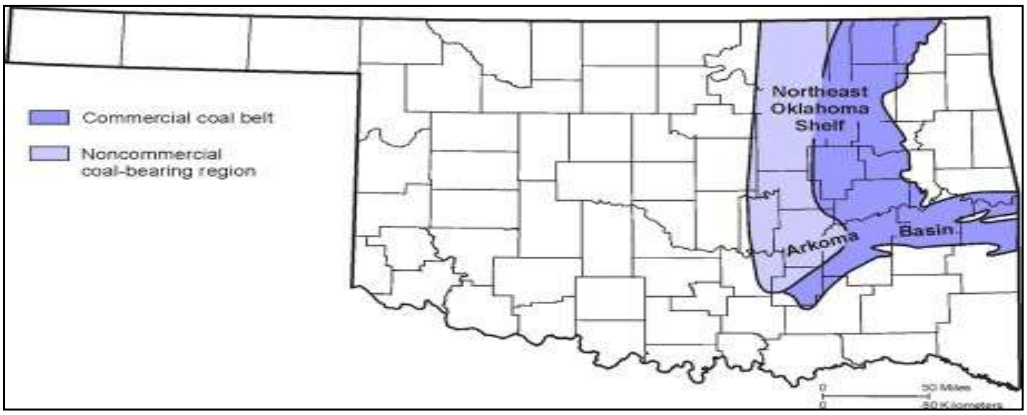
3.2.3.6. Vulnerability and Impact:

Maps below show the areas of Oklahoma most likely to have sinkholes.

Maps of the Coal Region in Oklahoma



1 - Nowata
2 - Craig
3 - Rogers
4 - Mayes
5 - Tulsa
6 - Wagoner
7 - Okmulgee
8 - Muskogee
9 - McIntosh
10 - Haskell
11 - Sequoyah
12 - Pittsburg
13 - Latimer
14 – Le Flore
15 – Coal
16 – Atoka



During the late 1800's and early 1900's coal mining was a major industry in Latimer County. Mine shafts were dug in the mining operations. Mine shafts were abandoned once the coal ran out and it was no longer profitable to mine in the area. Since that time homes and businesses have been built over the area. With time the wooden timbers in the mines have rotted and gradually have deteriorated to a point they cannot hold the weight above them. The slightest movement such as a

small earthquake or water running through the mines shifting the position of the weak timbers can cause a collapse. In the pictures below remains of the timbers can be seen in the sinkhole. Sinkholes may vary in size from less than a meter to several hundred meters both in diameter and depth.

3.2.3.7. Vulnerable Populations:

Sinkholes happen quickly with little or no warning. Citizens going about their daily business or household tasks could suddenly be impacted by a sinkhole opening below their business, their home, their school, or the road they are on. This would result in loss of the structure, loss of business, unemployment, loss of accessibility to normal transportation routes and general concern throughout the county. Loss of roads and highways would impact interstate commerce and local traffic forcing re-routing. Businesses impacted would have to close down or relocate. Persons whose vehicles or homes were impacted would likely have to relocate and purchase a new vehicle or home, creating undue strain, hardship and expense, General concern would likely occur due to fear of another event occurring immediately after the first one. This could be possible especially if the triggering mechanism for the collapse was a small earthquake. This could further weaken the mines located below and cause further losses. In any situation, the economic loss and emotional stability of the community could be disastrous.

Sinkholes/Subsidence content provided by Hazard Mitigation Specialists L.L.C. & Flanagan & Associates L.L.C.

3.2.3.8. Conclusion:

The threat in Latimer County of additional Sinkholes occurring is considered moderate to high due to previous incidents. The populated area of Wilburton is above numerous old mines that increase the threat of additional Sinkholes due to the rotting timbers in those mines such as those shown above. As time passes more timbers will rot and fail. Although the probability of additional occurrences is likely, the timing could be anytime.

3.2.4 Flooding

Hazard Priority # 4

3.2.4.1. Description:

Floods are one of the most common hazards in the United States including Oklahoma. Flooding is the deadliest severe thunderstorm hazard in the U.S. annually (followed by lightning). Flood effects can be local, impacting a neighborhood, a community, or very large, affecting entire river basins and multiple states. A flood is a natural event for rivers and streams. Riverine flooding is another way to say river floods. When a river reaches its flood stage, water can rise and spill over the banks of the river. The amount of flooding is usually a function of the amount of precipitation in an area, the amount of time it takes for rainfall to accumulate, previous saturation of local soils, and the terrain around the river system. For instance, a river located in a broad, flat floodplain will often overflow to create shallow and persistent flood waters in an area that do not recede for extended periods of time. The most widely recognized type of riverine flood is the overbank flood. Excess water from snowmelt, rainfall, or storm surge accumulates and overflows onto the banks and adjacent floodplains. Over 75% of Presidential disaster declarations result from flooding. Average annual flood losses total several billion dollars and continue to increase.

However, all floods are not alike. Some floods develop slowly, sometimes over a period of days. Several factors determine the severity of floods, including rainfall intensity (or other water source) and duration. Flash floods can develop quickly, sometimes in just a few minutes and without any visible signs of rain. Flash floods may have a dangerous wall of roaring water that carries rocks, mud, and other debris and can sweep away most things in its path, or may rise rapidly over frequently used roadways and low lying areas. Overland flooding occurs outside a defined river or stream, such as when dam breaks, producing effects similar to flash floods. A unique hazard in flash flooding is that many deaths attributed to floods are due to flash flooded roads that people are used to driving on and drive through the water only to be swept off by rushing water or onto missing roads or bridges hidden by the flood water.

3.2.4.2. Location:

Flash flooding may occur anywhere in the state of Oklahoma. Riverine flooding may occur anywhere in Oklahoma near a river, creek or stream. Residents and communities in the northeastern portion of Oklahoma who are downstream from US Corp of Engineers flood control dams are particularly at risk

from riverine flooding. There is a history of the excessive release of water from flood control dams when large amounts of water coming from upstream will overtax the flood control dams.

3.2.4.3. Extent

The State of Oklahoma considers a rainfall of 1 inch per hour or a river rise that stays within the rivers banks to be a minor severity. A major severity to Oklahoma is identified as a rainfall of 3 inches per hour and greater, or more than 1 inch in three hours on saturated ground, or a river rise that overflows the banks of the river.

3.2.4.4. Previous Occurrences:

Since 1950, the National Climate Data Center has registered 2150 flood records in Oklahoma. Of that number 41 flood events since 1955 have been severe enough to be determined by the Federal Government as Major Disaster Declarations with four occurring during the 2008 calendar year. There have been 35 flood and flash-flood related deaths in Oklahoma from 1950 through 2010.

Some of the more significant floods in Oklahoma history identified by the National Weather Service and Oklahoma Climatological Survey are listed in the table below.

Significant Oklahoma Flood History
January 1950 – June 2010
(Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center)

Date	Event Description	Prop. Dmg.	Fatalities	Injuries
Jun. 14, 2010	Another round of heavy rain occurred over parts of the Oklahoma City metro area. The heavy rain falling on already saturated ground quickly led to flash flooding. Several roadways had to be re-barricaded due to very high water. The water that had receded around some residences began to rise again. After the rain ended, some areas had received over a foot of rainfall for the day. Much of it fell in only a few hours. Total damages for the day were over $5 million. One hundred twenty-two homes were affected, 52 of those home receiving minor damage, 11 receiving major damage, and one home was completely destroyed. EPISODE NARRATIVE: Significant flooding occurred over parts of central Oklahoma. Numerous homes and cars were flooded. One person died, and at least 136 people were injured. Damage was estimated at $5.5 million in Oklahoma county alone. The first round of significant rain impacted central Oklahoma around 3	$5.5 M	1	136

Significant Oklahoma Flood History
January 1950 – June 2010
(Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center)

Date	Event Description	Prop. Dmg.	Fatalities	Injuries
	am. This round moved east before another, longer lived, thunderstorm complex developed over the Oklahoma City metro area. The heavy rain accumulated quickly immediately before and during the busy morning drive time. Numerous cars became stranded in the rapidly rising water. Roadways were covered by rapidly flowing water, and ponds, creeks, and rivers easily spilled over their banks. Navigating in and around the metro area became almost impossible, and many motorists had to be rescued by boat. After several hours, the persistent heavy rainfall tapered off around noon. Significant rain developed over southwest Oklahoma by early afternoon, and flash flooding once again became a problem. Lawton was hard hit, receiving between four and five inches of rain, resulting in several roadways becoming flooded. Numerous motorists had to be rescued from the high water. One motorist, unfortunately, lost his life when his vehicle stalled in flood waters. Widespread totals of five to nine inches were reported over much of Oklahoma City. Will Rogers World Airport reported its largest daily precipitation since records began in 1891, with 7.62 inches. Even higher totals were reported over the north-central portion of Oklahoma City, where nine to twelve inches was measured. Strong winds caused some power outages during the event. At the peak of the event, over 6700 people were without power.			
Sept. 2008	Alfalfa County: A prolonged area of southwest flow aloft developed over much of Oklahoma during the period from the 10th through the 12th. Numerous upper level disturbances moving through the flow, as well as a very moist air mass allowed for several rounds of showers and thunderstorms to develop and move northeast, much of the time moving over the same areas.	8M		

Significant Oklahoma Flood History
January 1950 – June 2010
(Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center)

Date	Event Description	Prop. Dmg.	Fatalities	Injuries
	Moisture associated with the remnants of Tropical Storm Lowell added to the mix, with an added depth of moisture that only made the situation worse. Rainfall rates of one to one-and-a-half inches were common, with some areas receiving near three inch per hour rates. Widespread flooding was reported over a large portion of northern Oklahoma. Numerous homes and business' were flooded. At least a half to two-thirds of the roadways from Woodward to Kay county were closed at some point during the event. Numerous roadways were damaged, with at least 125 miles of roadway damaged in Alfalfa county alone. Half of the roadways in Pond Creek and Lamont were damaged, and 40 percent of the bridges were damaged. Numerous rounds of the precipitation allowed for widespread river flooding as well. The Chikaskia River reached its highest level ever recorded. This caused several homes to be destroyed. In all, 20 homes were completely destroyed, 14 homes sustained major damage, 52 homes sustained minor damage, and 96 homes sustained at least some damage. Damage totals for the event reached over $8 million.			
Aug. 2007	Seminole: Three to four feet of water accumulated at the Seminole Ford/Mercury car dealership. Numerous city and county roads were closed due to the high water. A 67-year old woman drowned as her car was washed off the roadway into Magnolia Creek.	50K	1	
Aug. 2007	Historic flooding impacted the area in and around the city of Kingfisher. Four feet of water was flowing over HWY 33 in Kingfisher. Four to five feet of water was flowing over HWY 81 between Kingfisher and Dover. Several cars were stalled due to water over HWY 81 north of Okarche. An elderly couple had to be rescued by an OHP helicopter after their car was washed off US HWY 81. Both	500K	1	

Significant Oklahoma Flood History
January 1950 – June 2010
(Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center)

Date	Event Description	Prop. Dmg.	Fatalities	Injuries
	sustained minor injuries. A 52-year old man died as he tried to flee his vehicle after it had been washed off of HWY 33 14 miles west of Kingfisher. Several homes and businesses sustained major flood damage, with others faring slightly better. The First Baptist Church had 20,000 gallons of water in the basement, which included the kitchen. Most appliances sustained damage and most were a total loss. Monetary damages were estimated.			
Jul 2007	Bartlesville/Washington County EM report water levels in the Caney River at 21.7 feet. Durant/Bryan County Emergency Management reports a flood emergency remains in effect for southern portions of the county along the Red River. Lake Texoma was expected to flow over the spillway. Landowners were urged to move livestock and other necessary belongings away from river bottom and low lying areas and to be prepared to evacuate the area as waters could rise to extremely dangerous levels. Miami EM reported about 2,500 residents remained evacuated from the area as the Neosho River was at 30 feet. Flood stage is 15 feet. An estimated 250 to 300 homes have sustained flood damage. Steve Owens Boulevard is flooded cutting off east-west traffic in the center of the city. Payne County EM indicated all three highway districts had experienced significant road, bridge, and culvert damages. Payne Co. EM and the City of Stillwater, warned folks downstream and made preparations for evacuation.	Unknown	0	3
Jun. 2007	****Flood** - widespread showers and thunderstorms developed across Okla. This activity moved slowly N and produced excessive rainfall across Nowata and Washington Counties where 4-8 inches of rain fell. Due to repeated storms in specific areas, flash flooding	Unknown	1	3

Significant Oklahoma Flood History
January 1950 – June 2010
(Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center)

Date	Event Description	Prop. Dmg.	Fatalities	Injuries
	became a problem. Kiowa and Major Counties were hardest hit as 3-6 inches of rain fell in a few hours. This story was repeated in eastern Oklahoma early Friday with Creek County receiving excessive rainfall. Excessive rainfall has continued across parts of Okla. As of June 26, the general atmospheric pattern remains the same with areas of showers and thunderstorms mainly across the southeastern 2/3rds of the state			
May 2007	****Flood** - Approximately 1,500 to 2,000 people, 500 homes and 30 businesses in Miami, Okla. and the surrounding area have been evacuated. The Neosho River crested at 29.25 feet, its highest stage since 1951, lower than officials had predicted but still more than 14 feet above flood stage. Flash flooding occurred In downtown Medicine Park where evacuations began as a precautionary measure due to the potential of a dam failure. In Cache and Indiahoma local officials evacuated residents via boats and jet skis due to high water. In Apache, six families were evacuated due to flooding after storms moved through.	Unknown	1	2
Oct, 1986	****Flood** - Remnants of two Pacific tropical cyclones (Newton, and Paine) combined to produce widespread one-week rainfall totals of 10-20 inches across northern Oklahoma, leading to record river flooding.	Unknown	0	0
May 26-27, 1984	****Flash Flood** - Tulsa, (Memorial Day weekend). Arguably the most significant urban flash flood in Okla. History, as rainfall up to 15 inches (perhaps more - many gages overflowed) pounded the city overnight, leading to 14 deaths.	Unknown	14	0
Oct. 17-21, 1983	**Flood** - Moisture from the remains of Pacific hurricane Tico combined with a frontal system to produce widespread rainfall of 6-15 inches across SW, central, and NE Oklahoma, leading to extensive flooding. This event produced the current 24-hour rainfall record at	Unknown	0	0

Significant Oklahoma Flood History January 1950 – June 2010 (Information provided by National Weather Service, Oklahoma Climatological Survey and the National Climate Data Center)				
Date	**Event Description**	**Prop. Dmg.**	**Fatalities**	**Injuries**
	Oklahoma City of 8.95 inches.			
Oct. 10, 1973	**Flash Flood** - Enid. Rainfall of over 15 inches led to nine deaths.	Unknown	9	0
Dec. 9-10, 1971	Flood - Significant flooding occurred in western Arkansas and extreme southeastern Oklahoma	Unknown	0	0
Sept. 4-6 1971	****Flood** - As much as 16 inches of rain inundated a small area SW of Tulsa, causing Polecat Creek to crest more than 7 feet above flood stage at Sapulpa. Flooding was reported from just below Heyburn Dam to the confluence of Polecat Creek with the Arkansas River near Jenks. Other flooding was reported throughout the state.	Unknown	0	0
May 1957	****Flood** - with heavy rains and major flooding on the state's largest river systems.	Unknown	0	0
**** = One of the top 10 Oklahoma Floods since 1951 (Courtesy of the NWS).*** ***** - Presidential Disaster Declarations (Courtesy of FEMA).***				

3.2.4.5. Probability of Future Events:

The probability remains **Highly Likely** for future flood events occurring anywhere in Oklahoma.

Calculated Priority Risk Index (CPRI)

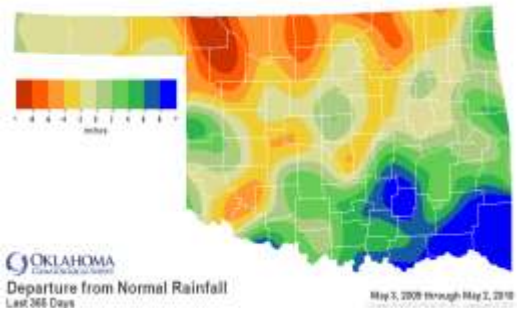
Flooding = 3

Probability		4 Highly Likely		
Magnitude/Severity		2 Limited		
Warning Time		2 12-24 Hours		
Duration		3 Less than one week		
The CPRI for the Flooding hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(4 x .45)	+ (2 x .30)	+ (2 x .15)	+ (3 x .10)	= 3

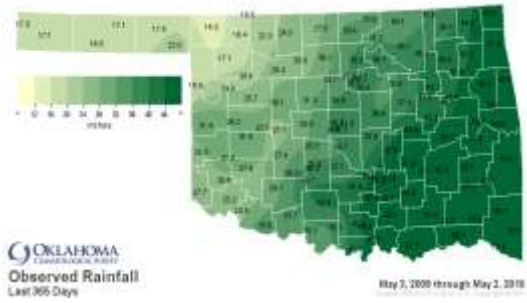
3.2.4.6. Vulnerability and Impact:

Flooding from rivers and streams or from the flash flooding that occurs from over taxed water drainage systems is a major destructive force in Oklahoma. Neither property nor lives are exempt

from its ravages. Oklahoma flooding and flash floods have caused deaths of people, wildlife and livestock and caused disruption of traffic flow not only for citizens day to day traffic but also critical services such as emergency police, fire, and ambulance. School bus and mail routes are also disrupted because flood waters damaged or destroyed roads and bridges. Power and water outages have occurred which cause food spoilage and sanitation problems for communities. Just the cleanup from flooding can be a threat to public health due to water and debris contamination. Employment is often affected because of businesses that close due to flood damage and loss of business. The local economy suffers sometimes to the point of difficulty in returning to pre-disaster operations.



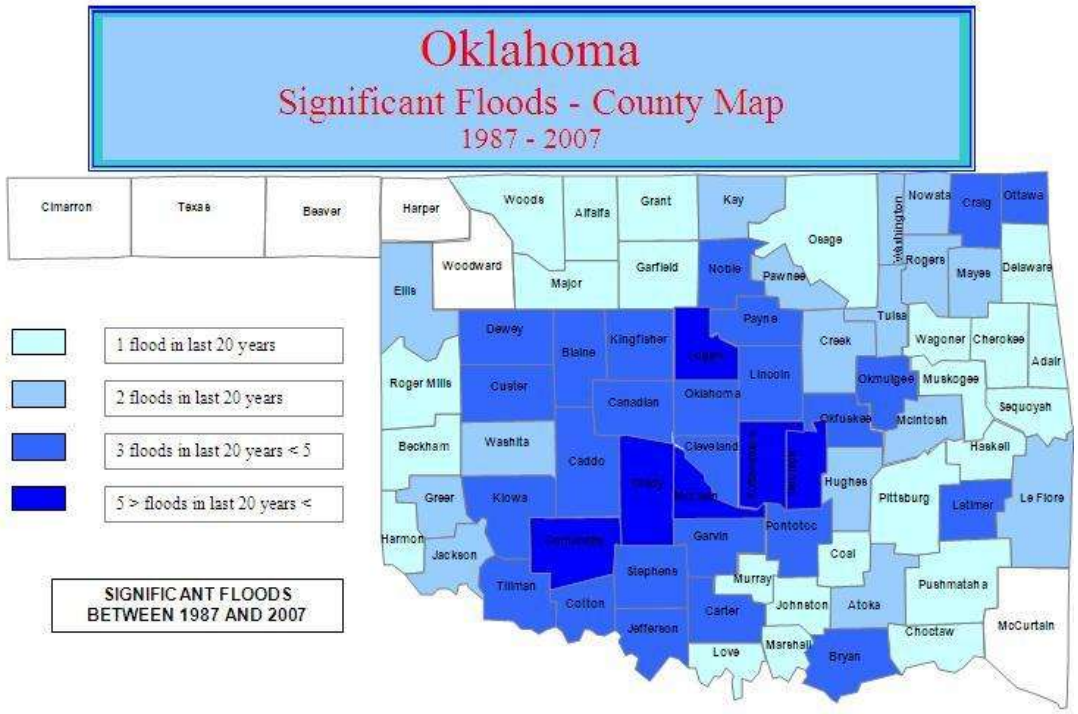
2009-2010 Flooding resulted from extensive rainfall



Observed Precipitation 2009-2010

3.2.4.7. Vulnerable Populations:

Flooding from rivers and streams, from dam failure or from the flash flooding that occurs from over taxed water drainage systems is a major destructive force in Oklahoma. Neither property nor lives are exempt from its ravages. Vehicles are driven into flooded roadways and are swept off by the heavy currents or drive off into a hole caused by a washed out roadway that was “hidden” by the flood water. Flooding rivers and streams invade homes and businesses destroying walls and contents. Farmers and ranchers lose millions of dollars worth of wheat, cotton, sorghum, hay, numerous other crops as well as livestock when flood waters overrun their fields. The impact of their losses not only affect the State of Oklahoma but also the national and world economies since many of them sell to buyers who deal in world markets. The following map shows past significant flooding that has occurred in the State of Oklahoma. The counties in dark blue are the most vulnerable to the hazard of flooding. These include Logan, Seminole, Pottawatomie, McClain, Grady, and Comanche counties.



Several factors combined to minimize the loss of life due to river flooding:

(1) Physical Floodwater Control – Widespread damming of rivers and upstream tributaries has dramatically reduced the frequency and magnitude of river flooding in Oklahoma.

(2) More Accurate Forecasting – Hydrological forecasting has improved, as has the timeliness and availability of rainfall observations. As a result, the forecast level of larger streams is much more predictable. River stage forecasting has matured to levels of accuracy that were impossible early in the century.

(3) Longer Warning Lead-Times – Because river flooding typically occurs hours to days after rainfall ceases, warnings for river flooding often provide much more lead time than those for flash flooding.

(4) Removal of repetitive loss and severe repetitive loss properties – These properties flood over and over placing residents at risk from loss of life and property. Consistent with OEM goals the State encourages each jurisdiction with repetitive loss properties to secure approved hazard mitigation plans and process grant applications to acquire funding for their removal.

3.2.4.8. Conclusion:

Oklahoma makes up the major part of the Arkansas-Red River Basin and river flood data from this area is monitored by the Arkansas-Red Basin River Forecast Center (**ABRFC)** in Tulsa, Oklahoma**. T**he Arkansas-Red Basin River Forecast Center is one of thirteen River Forecast Centers in the National

Weather Service that provides basic hydrologic forecast information, and technical support to the NWS's efforts to provide river and flood forecasts and warnings for protection of life and property.

Research continues though the National Weather Service Hydrologists and the **ABRFC** to improve the river forecasting and improve warning capability.

The Arkansas-Red Basin River Forecast Center is one of thirteen River Forecast Centers in the National Weather Service.

When a community chooses to join the National Flood Insurance Program (NFIP) they are required to adopt and enforce a minimum amount of floodplain management criteria. These criteria include such items as:

- requiring permits for construction within designated floodplains
- reviewing development plans and subdivision proposals to determine if proposed building sites will be reasonably safe from flooding
- requiring protection of water supply and sanitary sewage systems to minimize infiltration of flood water and discharges from the system into flood waters
- obtaining reviewing, and utilizing all available base flood elevation data
- assuring the maintenance of flood carrying capacities within all water courses

Oklahoma is a member of the NFIP. Fifty two of 77 counties, 3 Tribes and 411 communities are also members. A current list is provided in Appendix B. The State of Oklahoma, through the Oklahoma Water Resources Board, has aggressively pursued a policy of mitigation through incremental reclamation of flood-prone areas. This has gradually reduced the number of residences in harm's way.

As a result of these factors, the primary vulnerability to flooding is economic in nature. Most major economic damage is confined to a few very large events. The floods of the last 7 years in Oklahoma have generally surpassed previous flooding experienced during the 90's. State owned property is not

normally located in flood-prone areas, although certain segments of such as infrastructure in low areas. Oklahoma Department of Central Services, Risk Management is in process of re-evaluating facilities in relation to the BFE due to flooding that occurred during 2007, although this information will take several years to update and is not currently available.

3.2.5 Wildfires

Hazard Priority # 5

3.2.5.1 Description:

A wildfire is a raging inferno that rapidly spreads out of control. It happens most frequently in the summer, when the brush is dry and flames can move unchecked through a wooded area. The fire often begins unnoticed and spreads quickly, lighting brush, trees and homes. It may be started by a campfire that was not doused properly, a tossed cigarette, burning debris, lightning or arson.

Wildfire is a natural part of Oklahoma's ecosystem. Long before the State was settled, wildfires ran across the prairies, replenishing nutrients to the soils and controlling invasive plant species. With settlement, however, the interaction of wildfire and the environment has changed. Now, people and structures are at risk from flames spreading across the grasslands and forests of Oklahoma. Today, communities lie along side wildlands, creating an urban-wildland interface that is at risk of uncontrolled burns.

The development of such urban-wild land interfaces is part of a growing national problem. The urban-wild land interface is generally the first one block area on the edge of the built up area surrounding a community where structures and other human developments meet, or intermingle with, undeveloped wild lands which are most susceptible to wildfires. Fire losses and suppression costs have skyrocketed over the past decade, costing Federal agencies alone $1.6 billion in 2002. Western States have been particularly hard hit, as a prolonged, multi-year drought dried vegetation and forests, creating conditions ripe for raging infernos. As homes have edged up into canyons and forestlands, often far away from water sources that can be used to extinguish flames, costs of fire control have mounted.

Native to Oklahoma is a large population of Red Cedar trees. Red Cedar tree leaves are full of oil which is highly flammable. When a grass fire gets close to a Red Cedar tree it appears to explode into a ball of fire spreading the fire further and faster. Red Cedar eradication programs are in place but fail to keep pace with new growth.

Weather plays a major role in the birth, growth and death of a wildfire. Drought leads to extremely favorable conditions for wildfires, (2005-06) and winds aid a wildfire's progress. The combination of wind, temperature and humidity affects how fast wildland fires can spread. These combinations will

change throughout the day and night, and the presence of fire will impact each factor, causing even greater variation.

3.2.5.2 Location:

Today, communities lie along side wildlands, creating an urban-wildland interface that is at risk of uncontrolled burns. The development of such urban-wildland interfaces is part of a growing national problem. The urban-wildland interface is generally the first one block area on the edge of the built up area surrounding a community where structures and other human developments meet, or intermingle with, undeveloped wildlands which are most susceptible to wildfires. Urban population centers, such as the Oklahoma City metro area and Tulsa metro area are most at risk for wildfires because many of Oklahoma's largest cities have incorporated areas with parcels of undeveloped land, creating a vast wildland-urban interface. Arson is the number one cause of wildfires in the state, and centers for high population are where many of these fires originate. Western and Central Oklahoma's landscape feature occasional spotty areas of trees while eastern Oklahoma, east of Interstate 35, is generally forested. East of I-35 receives more rain, has more trees, less wind and does not have as many wildfires as the western part of the state. The lack of trees across the western half of the state allows for the air to dry out faster and the wind to be more brisk, often creating a riper situation for wildfires compared to the eastern half of the state. Western Oklahoma and especially Central Oklahoma have seen the majority of F-Mag FEMA declarations. Fortunately many of the large fires have been mainly in rural areas with few structures in the path.

3.2.5.3 Extent:

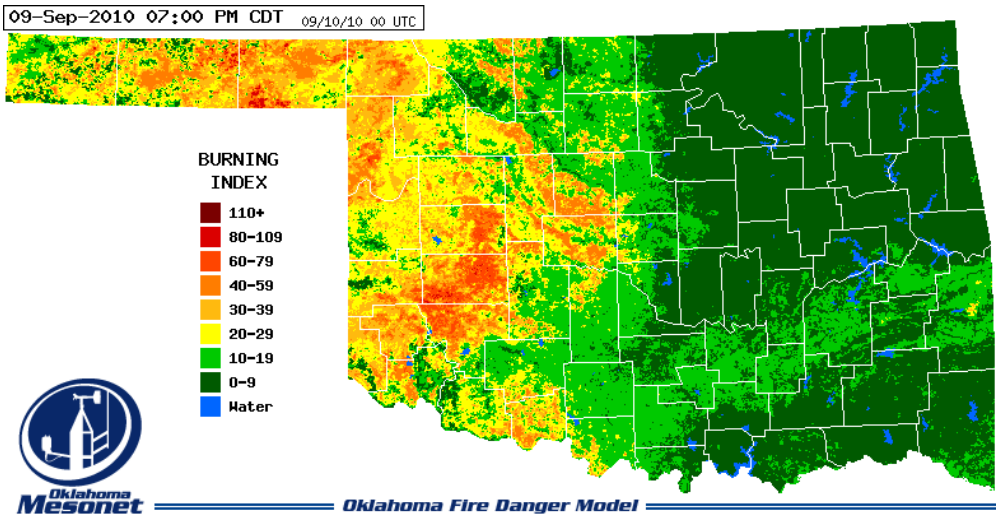
Oklahoma experiences a variety of wildfire conditions found in the Keetch-Byram Drought Index. Spring usually centers on the 0-200 rating while July through December are usually drier and depending on fuel and moisture usually will rate in the 400-600 range. During extreme dry and or drought times such as during 2005-2006, Oklahoma will be rated at 600-800.

There are three different classes of wildland or wildfires. A surface fire is the most common type and burns along the floor of a forest, moving slowly and killing or damaging trees. A ground fire is usually started by lightning and burns on or below the forest floor. Crown fires spread rapidly by wind and move quickly by jumping along the tops of trees. Wildfires are usually signaled by dense smoke that fills the area for miles around. Wildfires often begin unnoticed and spread quickly, igniting brush, trees, and homes.

The Keetch-Byram Drought Index (KBDI) *fire danger rating system*	
0 – 200	Soil and fuel moisture are high. Most fuels will not readily ignite or burn. However, with sufficient sunlight and wind, cured grasses and some light surface fuels will burn in spots and patches.
200 - 400	Fires more readily burn and will carry across an area with no gaps. Heavier fuels will still not readily ignite and burn. Also, expect smoldering and the resulting smoke to carry into and possibly through the night.
400 - 600	Fire intensity begins to significantly increase. Fires will readily burn in all directions exposing mineral soils in some locations. Larger fuels may burn or smolder for several days creating possible smoke and control problems.
600 - 800	Fires will burn to mineral soil. Stumps will burn to the end of underground roots and spotting will be a major problem. Fires will burn thorough the night and heavier fuels will actively burn and contribute to fire intensity

Fire Danger Rating System		
Rating	**basic description**	**detailed description**
CLASS 1: Low Danger (L) COLOR CODE: G**reen**	fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
CLASS 2: Moderate Danger (M) COLOR CODE: B**lue**	fires start easily and spread at a moderate rate	Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
CLASS 3: High Danger (H) COLOR CODE: Y**ellow**	fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.
CLASS 4: Very High Danger (VH) COLOR CODE: O**range**	fires start very easily and spread at a very fast rate	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.
CLASS 5: Extreme (E) COLOR CODE: R**ed**	fire situation is explosive and can result in extensive property damage	Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the Very High Danger class (4). Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks, until the weather changes or the fuel supply lessens.
source: http://www.wfas.net/content/view/34/51/		

Wildfires are generally started by humans, either through arson or by carelessness. This was the situation in 2005-2006 when numerous wildfires broke out virtually statewide, largely due to the dry drought conditions. Many were started by discarded cigarettes, careless trash burning or other miscellaneous methods. Nationally only 2% of wildfires are started by lightning. Few if any of these fires were started by lightning.



Above Maps provided by the Oklahoma Mesonet

Data analysis: OKFD Model Burning Index (BI) at 7:00 P.M. on **September 9, 2010**.
The BI yields expected flame height in tenths of feet. For example, values of 80-109 in much of Washita County suggest potential flame lengths of 8-11 ft. BI values are highly dependent on hour-to-hour weather changes. BI values often exceeded 100 across much of Oklahoma during several January afternoons.

Fire intensity is controlled by both short-term weather conditions and longer-term vegetation conditions. During intense fires, under story vegetation, such as leaves, small branches, and other organic materials that accumulate on the ground, can become additional fuel for the fire. The most explosive conditions occur when dry, gusty winds blow across dry vegetation. In order to represent both processes, the Fire Danger Model uses two measures: The Burning Index (BI) and Keetch-Byram Drought Index (KDBI).

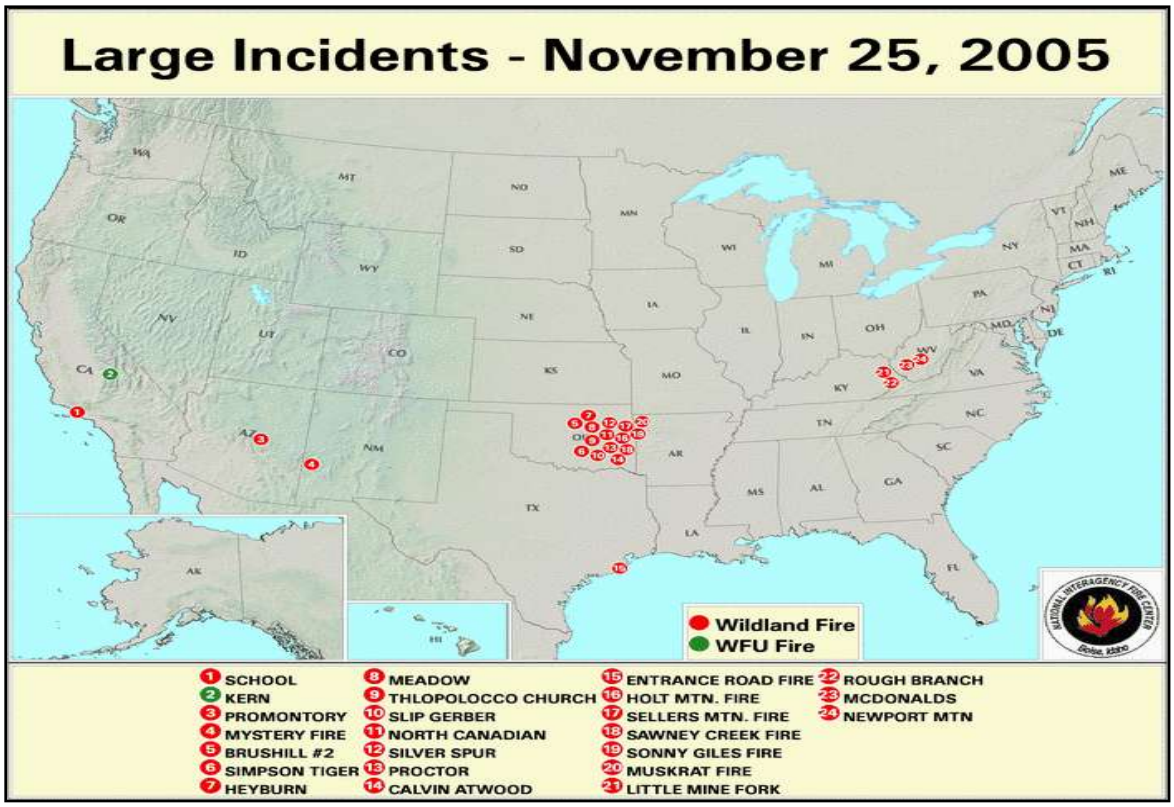
The Burning Index is a short-term response to meteorological factors. The burning index includes real-time observations of temperature, relative humidity, wind speed and solar radiation. It applies those factors to a vegetation model, which includes the "relative greenness" – a satellite-derived measure of the health of the vegetation – and fuel models for native vegetation, assigned on a 1-kilometer grid across the State. The model uses these inputs to produce four indices: Spread Component, Energy Release Component, Ignition Component, and Burning Index. Burning Index is a synthesis of the Spread and Energy Release components, and infers fire line intensity and flame length. The higher the number, the more difficult it is to fight a wildfire.

Flame Length (ft)	Fire Line Intensity (Btu/ft/s)	Interpretations
4 (BI <40)	<100	Fires can generally be attacked at the head or flanks by persons using hand tools. Hand line should hold the fire.
4-8 (BI=40-80)	100-500	Fires are too intense for direct attack on the head by persons using hand tools. Hand line cannot be relied on to hold fire. Equipment such as dozers, pumpers, and retardant aircraft can be effective.
8-11 (BI=80-110)	500-1,000	Fires may present serious control problems—torching out, crowning, and spotting. Control efforts at the fire head will probably be ineffective.
> 11 (BI > 110)	> 1,000	Crowning, spotting, and major fire runs are probable. Control efforts at head of fire are ineffective.

Fine fuels, such as small twigs and vegetation litter, respond quickly to changing weather conditions and can dry quickly following a rain. Locations with a higher average burning index most likely have experienced repeated episodes of high fire danger, although individual events can peak at locations that are not as prone to high fire danger. Nearly one in three of the 120 Oklahoma Mesonet stations, which have continuous records from July 1996 – present, have peaked in the upper category of the Burning Index (BI >110). Many of these locations are in western Oklahoma, where wind speeds are higher and humidity is lower, contributing to more favorable burning conditions.

The State of Oklahoma considers a Fire Line Intensity of < or = 500 to be a minor severity and a Fire Line Intensity of >500 to be a major severity.

3.2.5.4 Previous Occurrences:



From November 2005 through May 2006, wildfires scorched drought stricken Oklahomans.

Significant Oklahoma Wildfire History
January 1950 – July 2010
(Information provided by National Weather Service, Oklahoma Climatological Survey, FEMA, Oklahoma Agriculture and Forestry Department)

Date	Event Description	Fatalities	Injuries
Apr 9, 2009	A strong storm system moved into Oklahoma during the afternoon, pushing a dry line east of I-35. This boundary marked warm and moist air to the east, from hot and dry air to the west. Winds to the west of the dry line were from the southwest and west at 20-40 mph, with higher	0	0

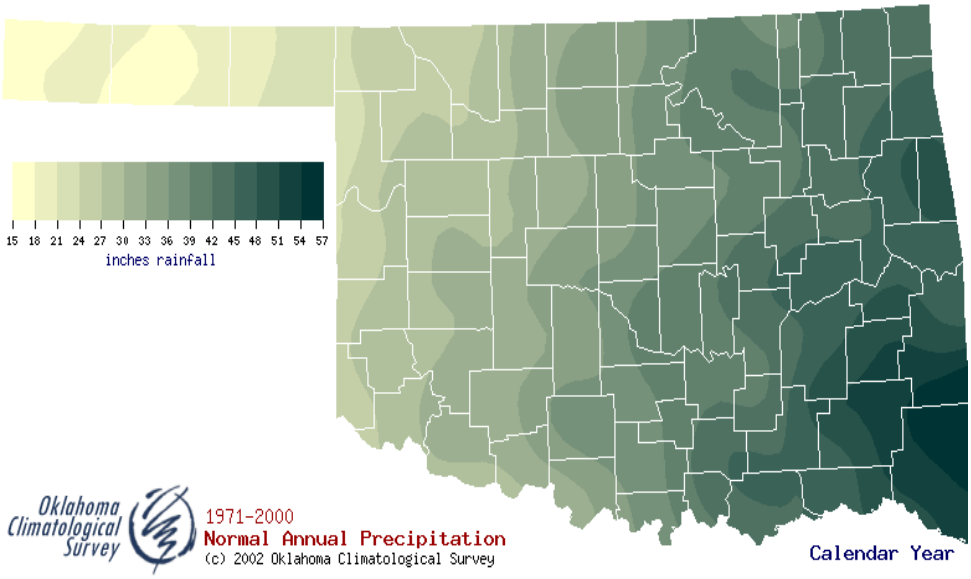
Date	Event Description	Fatalities	Injuries
	gusts. These winds and hot temperatures combined with dry ground and semi-dormant vegetation to create an environment favorable for rapid wildfire growth. Numerous, large grass fires developed, with several structures burned. The wind shifts made firefighting efforts difficult for several hours. The most costly fire occurred in the Midwest City area, with several homes burning to the ground.		
Mar 5, 2009	A wildfire developed in Dewey county and spread rapidly northeast under favorable weather conditions. Temperatures had soared into the upper 80s/low 90s behind a dry line in central Oklahoma. Additionally, the air was quite dry with relative humidity values below 15% and strong southwest winds of 25-35mph, with higher gusts. These conditions combined with seasonably dormant vegetation lead to rapid fire growth and spread. The above wildfire spread towards Taloga in northeast Dewey County. The town was evacuated Thursday afternoon and a Fire Warning issued by the Norman NWS Office. The fire was extinguished on Friday but hotspots remained for a few more days.	0	0
Aug. 16, 2006	**Wildfire** - **Murray County** - Hundreds of people who were going to be in the Turner Falls Recreation Area lost out when a massive wildfire in southern Okla. produced clouds of thick smoke forcing authorities to close a 15-mile section of I- 35 and U.S. 77, near the Arbuckle Mountains. Officials estimated the fire in the sparsely populated area had burned more than 100 acres in about six hours. More than 15 FD's in the area battled the blaze. Helicopters also dumped water on the flames. The fire eventually jumped I-35 near mile marker 50 and mostly burned land between the interstate and Highway 77. Campers in the area were evacuated while Interstate 35 between mile marker 40 and 59 and parts of Highway 77 was shut down for about 7 hours. The traffic was diverted into the town of Sulphur which caused a traffic jam approximately 15 miles long. The flames of the fire reportedly shot 80 feet into the air. Two planes, at least 3 helicopters, and 51 fire departments were used to fight this large fire. Only one structure was known to have been damaged.	**0**	0.
Apr. 2006	***Wildfires** - One of the worst days for wildfires for the month was on April 6, due to strong winds, warm temperatures, and dry conditions. A fire near Cement in Caddo county caused the evacuation of the town and burned at least 7 homes. Another fire near Newcastle in McCain county caused an evacuation of some residents and also burned 7 homes. This fire also caused the closure of portions of Interstate 44 and Highways 37 and 76 during rush hour. Several fires also burned homes	**0**	0.

Date	Event Description	Fatalities	Injuries
	and structures in Kingfisher and Oklahoma counties, with several other fires burning many acres across the area. The largest fire occurred in Roger Mills Co. where approximately 30,000-50,000 acres were scorched. This fire began just W of the Oklahoma - Texas state line in the Texas Panhandle. The strong westerly winds caused the fire to quickly spread E. into Roger Mills Co. The fire burned an area between about 4 miles south of Reydon to 6 miles N of Sweetwater to within about 5 miles or less of Cheyenne. Despite the size of the fire, only three vacant homes were destroyed, a few head of livestock were lost, and no injuries or deaths occurred. Firefighters from 45 different departments in Oklahoma and Texas along with aircraft were used to fight this fire. Many of the wildfires that occurred on April 6 were believed to have been started by sparks from power lines blowing together in the strong winds.		
Jan. 2006	****Sperry Fire** **Paoli Fire** **Ryan Fire** **Kiefer Fire** **Stecker Fire** **North Stillwater Fire** **Ratcliff Fire** **Henrietta Fire** **McNally Flats Fire** Since November, wildfires have inundated Oklahoma, leaving 869 homes damaged - 300 of those destroyed. Nearly 2,800 fires have left more than 550,000 acres scorched across the state. Firefighting assistance also came from North Carolina, Alabama and Tennessee, in addition to BIA firefighters from within Okla. providing extra manpower, fire brush-pumpers and bulldozers. The BIA has also extended to Oklahoma the use of Single Engine Air Tankers. They are assisting National Guard Helicopters equipped with large buckets for carrying and releasing large amounts of water. Many federal, state, tribal, and local assets along with assistance from other states were used to fight the fires. ****Hughes County Fire Complex**, Hughes and Seminole counties, which has burned more than 2,600 acres. **Depew Fire Complex** in Creek County, which has burned more than a thousand acres and threatened 1,450 homes in Bristow. **Wainwright Fire Complex** in Muskogee County, which has burned more than 4,000 acres and threatened nearly	4	**0**

Date	Event Description	Fatalities	Injuries
	12,000 homes in Muskogee. **Shamrock Fire Complex** in Creek County, which threatened more than 300 homes in Drumright and Shamrock, Okla. **Bethel Acres Fire** in Pottawatomie County, which has burned more than 600 acres and threatened 50 homes in Bethel. **Cashion Fire Complex** in Kingfisher County, which has burned more than 12,800 acres and threatened more than 100 homes in Cashion. **Guthrie Fire** in Logan County, which has burned more than 1,000 acres and threatened approximately 100 homes in Guthrie. **Sapulpa Fire Complex** in Creek County, which has burned more than 800 acres and threatened more than 6,500 homes near Kellyville. **Prague Fire Complex** in Lincoln and Okfuskee counties which has burned more than 640 acres and threatened 2,650 homes in eight communities. **63rd Street Fire** in Oklahoma County, which has burned some 700 acres near Oklahoma City. The fire threatened 85 homes outside the city. **Eastern Oklahoma County Fire Complex**, which has destroyed 12 homes and threatened 680 residents. **Achille Fire Complex**, Bryan County, Oklahoma, which is burning on each side of Achille. Ten homes have been destroyed and another 165 are threatened.		
Nov-Dec 2005	**Wildfires occurred in nine eastern Oklahoma counties including Cherokee, Mayes, McIntosh, Muskogee, Okfuskee, Osage, Pittsburg, Tulsa and Wagoner. At least 60 homes were destroyed with numerous outbuildings also lost. Perhaps hardest hit was Mayes County, where 19 homes were destroyed in the Choteau and Mazie areas, with another 12 destroyed in rural portions of the county. More than 20 families in Mayes County were displaced by the fires. Also hard hit was McIntosh County where 29 homes were destroyed in the Shady Grove and Central High areas. About 50,000 acres were reported to have burned across Oklahoma between November 27th and 30th including 5,000 acres in Okfuskee County alone.	0	0.

Date	Event Description	Fatalities	Injuries
Dec. 27, 2005	The Oklahoma Department of Emergency Management (OEM) has received reports of wildfires occurring in the following 20 counties Bryan, Canadian, Carter, Cherokee, Cotton, Garvin, Grady, Hughes, Johnston, Love, McCurtain, McIntosh, Muskogee, Oklahoma, Okmulgee, Pontotoc, Pushmataha, Rogers, Seminole and Tulsa. The largest ongoing fires are in Seminole and Hughes counties to include the City of Wewoka. A Chinook helicopter equipped with a 1,320 gallon bucket was deployed to Wewoka to provide aerial fire suppression when 13 structures were threatened. Additionally, a Blackhawk helicopter (660 gallon bucket) was deployed when fires threatened Achille, a community of 506 in Bryan County. Forestry officials have also provided ground crews, brush pumpers, bulldozers and engines to the Wewoka and Achille fires. Grady Co EM reported three wildfires burned about 20 acres on Tuesday. One firefighter was slightly injured. 8 fire units composed of 20 firefighters provided mutual aid at a fire southeast of Lindsay in Garvin County which burned at least 1,000 acres. Hughes County EM reported the Town of Yeager was evacuated**.** Johnston Co EM reported 5 fire departments responded to a fire south of Mill Creek. The fire spread rapidly due to the winds and an estimated 600 acres burned. The fire spread to the east-southeast and threatened several homes. McIntosh Co EM experienced one wildfire when a little more than 500 acres were burned. Nine of the 15 area fire departments worked the fire. Oklahoma City OCFD responded to 16 fires in the Oklahoma City metro area, including a mutual aid response in Mustang. Numerous homes and outbuildings were destroyed in the fires and 4 minor injuries were reported. Oklahoma Co EM advised 8 homes and 20 outbuildings destroyed, primarily in the Choctaw area. 2 fires were continuing to burn near Triple X and Meridian, 29th Street and Reno. Rogers Co - A fire in the NW portion of the county required mutual aid from numerous departments including Washington, Nowata and Tulsa. One mobile home was destroyed during the four large wildfires that occurred and at one point US 169 near Talala was closed briefly as flames jumped the road. Seminole Co - portions of Wewoka remained evacuated due to fires. Valliant reported Choctaw, and Pushmataha counties were hit hard by fires. Choctaw Co lost some homes in a 1,200 acre fire.	1	5
Dec. 2, 2005	*Texanna Road Fire – Fire destroyed 20 homes and heavily damaged approximately 30 others. 28,500 acres	0	0.

Date	Event Description	Fatalities	Injuries
	burned during the course of this wildfire.		
Nov. 29-30 2005	*Antioch Fire Velma Complex Fire Flat Rock Complex Fire	0	0
Jul. 22 2003	*Big Rock Fire	0	0
Sep. 22, 2000	**Logan County** - At least 31 homes were destroyed by wildfires that swept across Logan County. Crews in orange trucks worked on gravel roads that snaked through thick woods to replace burned utility poles. Black patches of burned earth cut across pastures and through woodland in random patterns. The fire destroyed five of six buildings at the Woodlands Equestrian Centre, including the home of the owners. The cross-country equestrian courses at the center were also ruined.	0	0
1996	The State received fire management assistance from FEMA for fires in Cleveland, Creek, Comanche, Leflore, Logan, Murray, Osage, Payne, Stephens, and Woods counties. In 1996, more than 633,000 acres – nearly 1,000 square miles – were burned in Oklahoma not including the cost of property and crop losses.	0	0
**** Federal Emergency Declaration*** ***** - Presidential Disaster Declarations (Courtesy of FEMA).***			



3.2.5.5 Probability of Future Events:

There is a **Highly Likely** probability of future Wildfire events in Oklahoma.

Calculated Priority Risk Index (CPRI)

Wildfire = 2.9

Probability			4 Highly Likely	
Magnitude/Severity			1 Negligible	
Warning Time			4 Less than 6 Hours	
Duration			2 Less than one day	
The CPRI for the Wildfires hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(4 x .45)	+ (1 x .30)	+ (4 x .15)	+ (2 x .10)	= 2.9

3.2.5.6 Vulnerability and Impact:

In recent years, Oklahoma has experienced a surge in home construction on its rural landscape and in its small towns and cities. These areas of growth are often referred to as the urban-wildland interface. Residents within the interface are surrounded by fuels that, should they ignite, present a significant risk to their homes and surrounding improvements. In Oklahoma, most rural residents depend on their local volunteer fire departments to protect their property from loss. There are 875 volunteer fire departments in communities of less than 10,000 people in our state. Since 1980, the Forestry Division's Rural Fire Defense program has targeted these smaller communities and provided assistance to their fire departments in the form of technical advice, financial aid, grants and equipment. This has been a tremendous resource to rural fire departments especially in providing equipment, grants and suppression assistance.

Wildfires leave problems behind them, even when the last ember is extinguished. Post-fire events can trigger additional consequences that cascade into other serious hazard events. The loss of ground-surface cover from a fire and the chemical transformation of burned soils make watersheds more susceptible to erosion from rainstorms. Subsequent unchecked debris flows can then carry mud, rock, chemicals, and other debris into water supplies, reducing water quality. Houses and businesses, often suffer extensive damage in wildfires as well as death of people, wildlife and livestock. Disruption of traffic flow occurs particularly in the fire area. School bus and mail routes may also be disrupted due to smoke or roadblocks making “delivery” difficult or impossible. Power outages and water shortages may also occur.

In drought conditions, wildfires can be easily started and are extremely dangerous. Protecting structures in the wildland from fires poses special problems, and can stretch firefighting resources to the limit. Weather conditions leading to wildfires can change rapidly. Thus, there are few measures, other than rapid-response, that can contain wildfires and limit their threat to property.

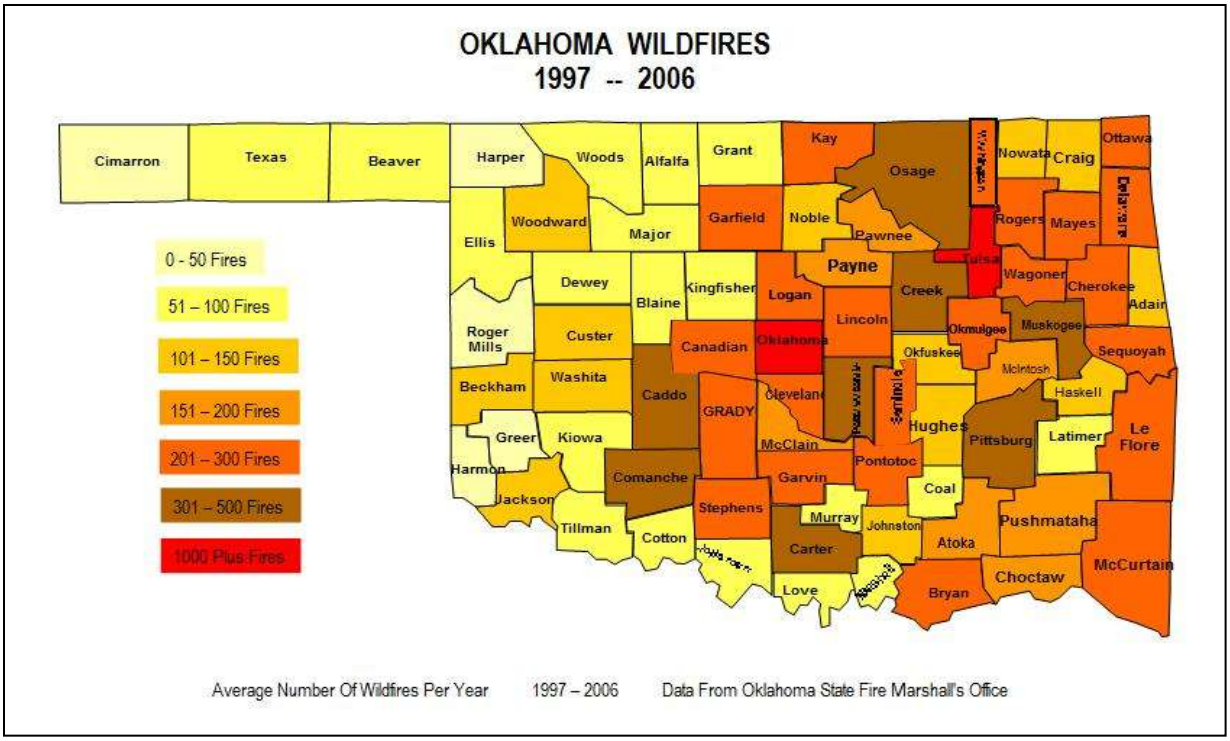
Local economic impacts from catastrophic wildfires include disruptions to both consumption and production of local goods and services. Immediate effects may include decreased recreation / tourism and timber harvest in the fire region, as well as disruptions from evacuations and transportation delays. Increased use of local goods and services for fire protection also impacts local economies. Other effects include direct property losses (in the form of buildings, timber, livestock, and other capital), damage to human health, and possible changes in the long-term structure of the local economy.

There are many secondary effects to wildfire. All vegetation may be destroyed as well as the organic material in the soil may be burned away or may decompose into water repellent substances that prevent water from absorbing into the soil. In effect, normal rainfall after a wildfire may result in unusual erosion or flooding from burned areas; depending on the topography of the burned area, heavy rain can produce destructive debris flows.

Wildfires also have an effect on water supplies. The loss of ground-surface cover, such as pine needles and small branches, and the chemical transformation of burned soils make watersheds more susceptible to erosion from rainstorms.

3.2.5.7 Vulnerable Populations:

Oklahoma has a significant wildfire hazard due to its climate, the types of fuels present and the cultural practices used. The State is south of the Snow Belt, leaving its grassy fuels exposed and vulnerable to fire in the dormant season. It is far enough north of the Gulf of Mexico that it is influenced by the continental climate in the winter. Summers are hot and usually dry, with daytime highs in the mid-90s and generally less than 4 inches of rain in July and August. The State recognizes 10 months as fire season. Wildland fuels are prone to burning from July through April. Only May and June are not considered “fire season”. Most at risk are those people who make their homes in woodland settings in or near forests, rural areas, or remote mountain sites. The following map was created using data collected from the Oklahoma State Fire Marshall’s office and shows the average number of grass/wildland fires reported for all 77 counties over the 10 year period from 1997 – 2006. The most vulnerable counties by far are Oklahoma and Tulsa counties with an average of over 1000 fires per year.



3.2.5.8 Conclusion:

Oklahoma has a number of programs through the Oklahoma Forestry Services Department and others to mitigate wildfires in Oklahoma. Following are several of those programs:

PRESCRIBED BURNS – Okla. Forestry Services

Fire remains an excellent tool for managing forest and rangeland. Periodic burning helps control hardwood encroachment onto old fields and into managed pine stands. It also reduces the annual fuel accumulation in forests and grasslands reducing wildfire intensity.
Periodic burning improves habitat for Oklahoma wildlife by modifying cover, food quality and volume. It also induces environmental changes that result in plant and animal communities that are adapted to fire.

Community Wildfire Preparedness Planning – Okla. Forestry Services

Oklahoma Forestry Services is assisting communities in the development of Community Wildfire Protection Plans and Firewise Plans. These plans are wildfire mitigation plans that help communities develop actions that will reduce the loss of property in their communities. This assistance includes:

- Grants for Development of Community Wildfire Protection Plans and Firewise Plans.
- Template for development of Community Wildfire Protection Plans
- Templates for writing Firewise Plans

Rural FD's Receive 360 New Fire Vehicles - Okla. Forestry Services

Rural Fire Departments across the state received 120 new 1 ton trucks the middle of January 2008 with others receiving similar vehicles since 2006. The $2.5 million from the state legislature will strengthen the rural fire departments capability to protect the population.
Factors to receive the vehicles included condition of currently owned department vehicles, the number of fire responses made, the number of citizens served and the location. The departments receiving the vehicles were responsible for equipping the new vehicles with fire fighting apparatus such as water tanks, pumps and hoses.

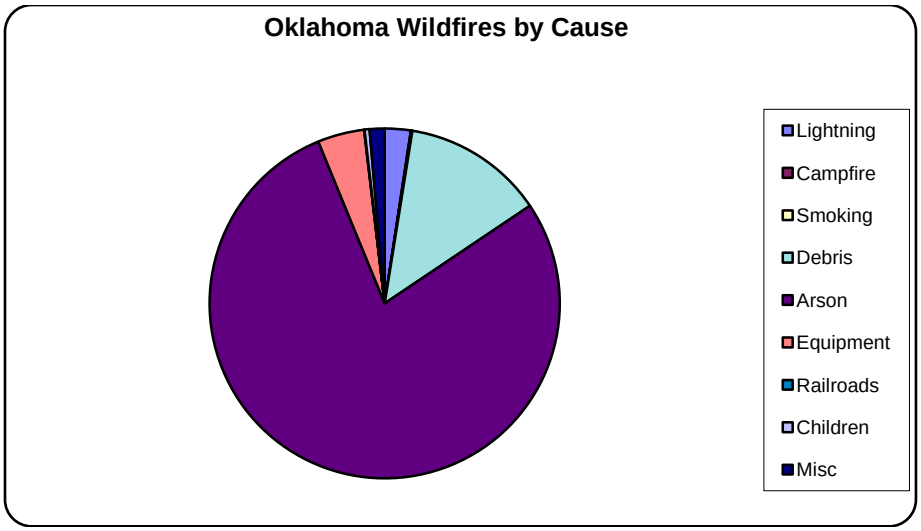
Oklahoma Wildfire Prevention Coalition - Bureau of Indian Affairs

The Bureau of Indian Affairs has taken a leading role in the creation and early stages of the newly developed Oklahoma Wildfire Prevention Coalition. A BIA Regional Fire Prevention Specialist was recently elected co-chair of the group, along with a representative of the State of Oklahoma. Membership is open to those who support the concept that many of Oklahoma's wildfires are preventable. This diverse group was brought together by the 2005-06 extreme fire and severe drought conditions throughout Oklahoma.

Oklahoma Mesonet

Since 1994, real-time weather information has been available from every county in Oklahoma, via the Oklahoma Mesonet. Data from the Mesonet is integrated with vegetation information in a Fire Danger Model). The Oklahoma Fire Danger (OKFD) Model produces 1-km resolution colored maps of four NFDRS fire danger indices (dimensionless): Spread Component (SC), Energy Release Component (ERC), Burning Index (BI), and Ignition Component (IC). Colored maps of 1-hr dead fuel moisture and the Keetch-Byram Drought Index (KBDI) are also produced, the latter map once per day. In addition, for each model run, a table of fire danger indices, fuel moistures, KBDI, and selected weather variables is produced for each Mesonet site. http://agweather.mesonet.org/models/fire/

This vulnerability to wildfire results in over 18,000 wildfires in the State each year. These fires historically burn about 300,000 acres. Over 97% of these wildfires are human caused. In fact, Oklahoma's fire risk is more closely associated with the presence of people than with fire danger or fuel types. Since human activity accounts for such a high percentage of the wildfires, there is unlimited opportunity for mitigation through public awareness and education.



Various parts of the state are more susceptible at different times of the year depending on precipitation. During prolonged periods of drought, hundreds of thousands of acres will be vulnerable. The majority of fires happen near urban population centers, but large wildfires have been known to happen especially in Central and Western Oklahoma where the wind frequently gusts.

Most state-owned facilities are not located in areas that are subject to wildfire hazards. Critical facilities, especially transportation routes, pipelines, electrical transmission lines, communications towers and Forestry offices and annexes are sometimes located in forest environments. At times smoke from wildfires may affect patients in healthcare facilities located nearby forcing evacuation if the smoke becomes extreme.

3.2.6 High Winds

Hazard Priority # 6

3.2.6.1 Description:

Wind is defined as the motion of air relative to the earth's surface. High winds can result from thunderstorm inflow and outflow, or downburst winds when the storm cloud collapses, and can result from strong frontal systems, or gradient winds (high or low pressure systems) moving across Oklahoma. High winds are speeds reaching 58 mph or greater, either sustaining or gusting

Downdraft winds are a small-scale column of air that rapidly sinks toward the ground, usually accompanied by precipitation as in a shower or thunderstorm. A downburst is the result of a strong downdraft associated with a thunderstorm that causes damaging winds on or near the ground. These speeds can range from light breezes to sustained speeds of 80 to 100 mph. Any efforts made to mitigate for tornados or thunderstorm winds should address the hazard of high winds.

In April of 2010 NCDC has further defined high winds into three categories.

High Wind:

- Sustained non-convective winds of 35 knots (40 mph) or greater lasting for 1 hour or longer or winds (sustained or gusts) of 50 knots (58 mph) for any duration (or otherwise locally/regionally defined), on a widespread or localized basis. In some mountainous areas, the above numerical values are 43 knots (50 mph) and 65 knots (75 mph), respectively. The High Wind event name will not be used for severe local storms, tropical cyclones, or winter storm events.

Strong Wind:

- Non-convective winds gusting less than 50 knots (58 mph), or sustained winds less than 35 knots (40 mph), resulting in a fatality, injury, or damage. Consistent with regional guidelines, mountain states may have higher criteria. A peak wind gust (estimated or measured) or maximum sustained wind will be entered.

Thunderstorm Wind:

- Winds, arising from convection (occurring within 30 minutes of lightning being observed or detected), with speeds of at least 50 knots (58 mph), or winds of any speed (non-severe thunderstorm winds below 50 knots) producing a fatality, injury, or damage. Maximum sustained winds or wind gusts (measured or estimated) equal to or greater than 50 knots (58 mph) will always be entered. Events with maximum sustained winds or wind gusts less than 50 knots (58 mph) should be entered as a Storm Data event only if they result in fatalities, injuries, or serious property damage. Storm Data software permits only one event name for

encoding severe and non-severe thunderstorm winds. The Storm Data software program requires the preparer to indicate whether the sustained wind or wind gust value was measured or estimated.

3.2.6.2 Location:

The entire State of Oklahoma may experience high winds at any time.

3.2.6.3 Extent:

Wind: Beaufort wind scale;

Force	Wind (Knots)	WMO Classification	Appearance of Wind Effects	
			On the Water	On Land
0	Less than 1	Calm	Sea surface smooth and mirror-like	Calm, smoke rises vertically
1	1-3	Light Air	Scaly ripples, no foam crests	Smoke drift indicates wind direction, still wind vanes
2	4-6	Light Breeze	Small wavelets, crests glassy, no breaking	Wind felt on face, leaves rustle, vanes begin to move
3	7-10	Gentle Breeze	Large wavelets, crests begin to break, scattered whitecaps	Leaves and small twigs constantly moving, light flags extended
4	11-16	Moderate Breeze	Small waves 1-4 ft. Becoming longer, numerous whitecaps	Dust, leaves, and loose paper lifted, small tree branches move
5	17-21	Fresh Breeze	Moderate waves 4-8 ft taking longer form, many whitecaps, some spray	Small trees in leaf begin to sway
6	22-27	Strong Breeze	Larger waves 8-13 ft, whitecaps common, more spray	Larger tree branches moving, whistling in wires
7	28-33	Near Gale	Sea heaps up, waves 13-20 ft, white foam streaks off breakers	Whole trees moving, resistance felt walking against wind
8	34-40	Gale	Moderately high (13-20 ft) waves of greater length, edges of crests begin to break into spindrift, foam blown in streaks	Whole trees in motion, resistance felt walking against wind
9	41-47	Strong Gale	High waves (20 ft), sea begins to roll, dense streaks of foam, spray may reduce visibility	Slight structural damage occurs, slate blows off roofs
10	48-55	Storm	Very high waves (20-30 ft) with overhanging crests, sea white with densely blown foam, heavy rolling, lowered visibility	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	56-63	Violent Storm	Exceptionally high (30-45 ft) waves, foam patches cover sea, visibility more reduced	
12	64+	Hurricane	Air filled with foam, waves over 45 ft, sea completely white with driving spray, visibility greatly reduced	

Source: www.wikipedia.org

The State of Oklahoma considers a reading of 9 and below a minor severity and a reading of 10 and above on the Beaufort scale above to be a major severity.

3.2.6.4 Previous Occurrences:

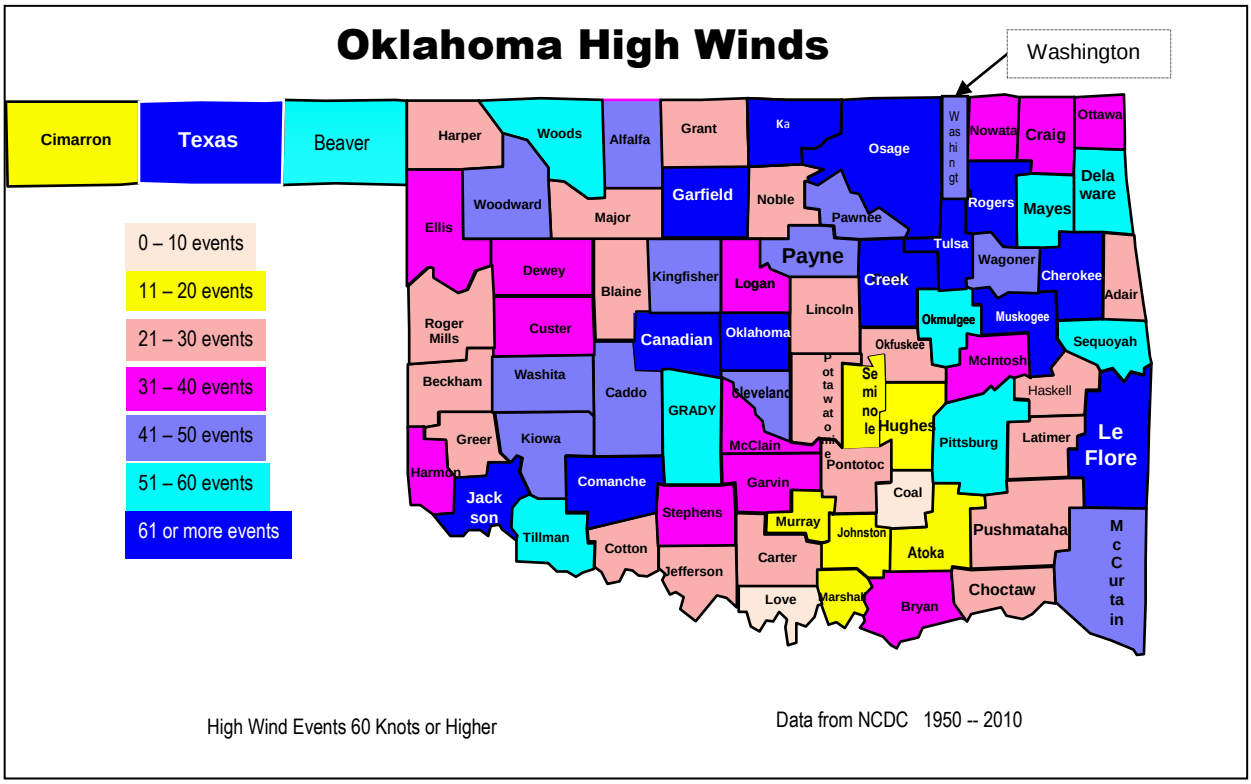
Little historical data exists for the hazard of high winds separately. The vast majority of available data has been grouped with tornado or thunderstorm winds. The table below provided by the Oklahoma Climatological Survey provides a record of the greater speeds recorded between 1994 through 2007.

Wind speeds of 90 mph or greater recorded by the Oklahoma Mesonet (1994-2007).		
Location	Wind Speed (mph)	Date
Lahoma	113	08/17/1994
Idabel	106	05/04/2006
Bowlegs	102	11/09/1998
Marshall	100	06/16/2005
Cherokee	97	08/25/2006
Grandfield	94	06/04/1995
Bessie	92	06/12/2005
Stigler	92	05/20/2001
Eufaula	91	10/17/2007
Hobart	91	03/08/1994
Mangum	91	05/31/1999
Stigler	91	04/11/2001
Cloudy	90	03/02/2000
Hooker	90	05/15/2003

THE 13 MOST DESTRUCTIVE WIND EVENTS 1993 - 2010

CITY	DATE	DAMAGE (MILLIONS)
Altus	6/5/2008	750.0
Moore/OKC	07/23/1995	50.0
Lawton	05/27/2001	11.0
Ft. Sill	05/27/2001	10.0
Kingston	02/09/2001	10.0
Beaver	09/12/1999	8.0
Lahoma	08/17/1994	7.0
Indiahoma	05/31/1999	5.0
Altus AFB	06/03/1995	5.0
Catoosa	04/24/1993	5.0
Healdton	05/08/1993	5.0
Prague	08/07/1994	5.0
Union City	06/03/1995	5.0
Waurika	03/29/1993	5.0

Provided through Oklahoma Climatological Survey



Significant Oklahoma High Wind History
May 2005 – July 2010
National Weather Service and local news reports.

Date	Event Description	Fatalities	Injuries
Aug. 9, 2008	**High Winds –** 5 miles north of Eufaula (McIntosh County) - Thunderstorm winds measured by a storm spotter at 85 miles an hour overturned several camper trailers and severely damaged boat docks at Lake Eufaula State Park. Three boats were capsized by the wind. Four people were transported to the hospital with injuries. Property damage estimated to be one million dollars.	0	2
Jun. 5, 2008	**High winds –** Altus (Jackson County) - Substantial wind damage was reported in Altus. One hundred and seventy-nine homes sustained some kind of damage, with two destroyed, five with major damage, forty-three with minor damage, and one hundred twenty-nine affected. Seventeen businesses were damaged, with two destroyed, four with major damage, and eight with minor damage. One hundred and seventy power poles and numerous trees were blown down. Sixty percent of the town was without power at one point. Roof damage was reported to several buildings. Part of the roof at Altus Junior High caved in. Several buildings on East Broadway had roofs blown off or collapsed. Highway 62 was closed on the east side of town due to debris. One injury was reported when a semi-truck was blown over injuring the driver. A train car also was overturned on the southeast side of town. No injuries were reported with it. Monetary damages were estimated at 750 million dollars.	0	0
Apr. 9, 2008	**High Winds –** Muldrow (Sequoyah County) - Thunderstorm winds estimated up to 100 miles an hour and hail up to golf ball size damaged 477 homes and 25 businesses along a couple of mile wide swath. Over 30 power poles were blown down leaving thousands without power. Damage estimated at one million dollars.	0	0
Jan. 8, 2008	Tornado sirens wailed Monday night in several NE Okla. Towns and cities as funnel clouds were spotted trying to form. Although no tornados touched down, heavy rain risked the lives of residents and motorists, and the high winds damaged property. A tin roof was removed from a mobile home after high winds hit the Wagoner area late Monday. At Lake Region Electric Cooperative in Hulbert, the storm knocked out power to 2,347 customers at its peak. They had 21 broken poles and cross arms with most of the damage being N of Tahlequah, in the area of Beggs, Moody and Lowrey.	Unk.	Unk.
Jan 4, 2008	**High Winds** – Comanche County - grass and swift winds from the south created a problem for firefighters that ended with more than 800 acres of	Unk.	Unk.

Significant Oklahoma High Wind History May 2005 – July 2010 National Weather Service and local news reports.			
	blackened pasture south of Fletcher and at least four other grass fires throughout Comanche Co. Firefighters from at least 16 departments worked for about 3 hours to contain the wind-fueled flames, which shut down traffic on I-44 and U.S. 277. There was no reported structure damage from any of the fires.		
Oct. 17, 2007	**High winds** -Severe storms raked across Oklahoma on Wednesday, packing high winds, heavy rain, hail and a possible tornado. Kingfisher Co. EM reported an 86-mph wind gust came through about 8:15 A.M. and along with some localized street flooding. Other high-wind reports included a 73-mph gust at Weatherford and a 62-mph gust in west Tulsa, according to the weather service.	Unk.	Unk.
Aug. 19, 2007	Many areas of Oklahoma remain impacted by high winds and flooding as the remnants of Tropical Storm Erin continues to move through the state. Two Watonga residents were injured after their home was destroyed by straight line winds or a possible tornado. The two were treated for reportedly non-life threatening injuries at the hospital in Watonga. OG&E reports 15,833 customers without power statewide. The Oklahoma Association of Electric Cooperatives reports 250 to 500 Cimarron Electric customers, primarily in the Watonga area, are without power. Numerous power poles are down in the area.	0	2
Jun. 01, 2007	**High winds** and rain stormed through Enid last night and left damaged trees, homes and businesses in its wake. The major portion of the damage runs along the west end of Chestnut from Oakwood to Van Buren. Areas around Grand and Willow and 4th and Willow were also hit hard. Most all neighborhoods have limbs down and some people are without electricity.	Unk.	Unk.
Feb 25, 2007	**High Winds** -Two mobile homes were destroyed and 20 sustained minor damage when straight-line winds between 30 and 40 miles per hour moved through Spiro. The Oklahoma Emergency Management said 3 people suffered minor injuries, and a shelter was opened at the Spiro Senior Citizens Center. Oklahoma Gas and Electric reported more than 10,000 homes were without power. The utility reported that the largest outages were 1900 in Durant, 1300 in Mannsville and 1200 in Norman. The Oklahoma Highway Patrol reported the northbound lanes of I-35 were shut down briefly in southern Oklahoma after high winds overturned a pickup with a travel trailer. Three lanes of I-44 also were shut down after a tractor-trailer overturned.	Unk.	3

Significant Oklahoma High Wind History May 2005 – July 2010 National Weather Service and local news reports.			
Sep. 2006	**High Winds –**Woods/ Woodward Co. A strong surface low pressure developed across parts of eastern parts of Colorado and Kansas causing wind gusts up to 52 knots (60 mph). The high winds caused some damage including large tree limbs, trees and minor roof damage in the town of Alva in Woods County. The high winds combined with the drought conditions which caused blowing dust which severely reduced visibilities in some locations.	Unk.	Unk.
May 24, 2005	**High winds** -Haskell County - McCurtain Thunderstorm winds estimated at 80 miles an hour damaged outbuildings and blew down power lines. The winds damaged several homes as well. In Keota Thunderstorm winds estimated at 80 miles an hour damaged a house. Le Flore County - Panama -Thunderstorm winds estimated at 70 miles an hour blew a mobile home over and blew down numerous trees. Also a camper trailer and mobile home were destroyed as was the roof of a business in Poteau. In Heavener, 70 mile an hour winds blew down numerous outbuildings and power lines. At Hodgen, thunderstorm winds estimated at 70 miles an hour blew down large trees and demolished a home which was under construction. Sequoyah County – Vian – 80 mile an hour winds blew down trees and a large barn.	Unk.	Unk.

3.2.6.5 Probability of Future Events:

All counties in the State of Oklahoma are at risk from high winds and the probability is **Highly Likely** of future hazard events.

Calculated Priority Risk Index (CPRI)

High Winds = 2.8

Probability		4 Highly Likely		
Magnitude/Severity		2 Limited		
Warning Time		2 12-24 Hours		
Duration		1 Less than 6 hours		
The CPRI for the High Winds hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(4 x .45)	+ (2 x .30)	+ (2 x .15)	+ (1 x .10)	= 2.8

3.2.6.6 Vulnerability and Impact:

State-owned property is vulnerable to severe weather the same as all other property. Special concerns may arise over critical facilities such as electric transmission lines, and communications towers being affected as well as highways that may be closed to debris on the highway. Some relatively insignificant buildings such as garages or maintenance buildings that are made of metal materials could also receive damages.

High winds can be a part of severe storm systems but do not have to accompany a storm to be dangerous. Straight-line winds, downbursts and microbursts can all cause death, injury, and property damage. Very little available data exists separate from that of thunderstorm or tornado data. Houses and businesses, and government infrastructure often suffer extensive damage in high winds as well as an occasional death usually due to falling trees or other debris. Disruption of traffic flow can occur for citizens' day to day traffic but also critical services such as emergency police, fire, and ambulance due to trees and other debris in the roadways. Power outages have occurred which cause food spoilage and sanitation problems for communities.

3.2.6.7 Vulnerable Populations:

Property damage and loss of life from windstorms are increasing due to a variety of factors. Use of manufactured housing and mobile homes is on an upward trend, and this type of structure provides less resistance to wind than conventional construction. Poor condition of older homes can sometimes result in wind damage as well as the fact Oklahoma has thousands of trees, many in populated neighborhoods that high winds often destroy. The map in previous occurrences depicts past history high wind events of 60 knots and higher for the State of Oklahoma. These historical events show Kay, Osage, Tulsa, and Oklahoma counties to be the most vulnerable for High Winds.

3.2.6.8 Conclusion:

Uniform building codes for wind-resistant construction are not adopted by all States, however Oklahoma added the International Building Code on November 1, 2001 to the list of approved codes. (BOCA National Building Code, as last revised, the Southern Standard Building Code Congress International (SBCCI), the Uniform Building Code is still acceptable) With the deteriorating condition of older homes, and the increased use of aluminum-clad mobile homes, and poorly designed homes, the impacts of wind hazards will likely continue to increase.

3.2.7 Drought

Hazard Priority # 7

3.2.7.1 Description:

Drought is a persistent and abnormal moisture deficiency having adverse impacts on vegetation, animals or people. There are dozens of more specific drought definitions used around the world based on the lack of rain over various time periods or measured impacts such as reservoir levels or crop losses. Because of the various ways people measure drought, no one has produced an objective drought definition upon which everyone can agree.

Drought Types: There are four main ways to consider drought.

1. Meteorological drought is usually based on long-term precipitation departures from normal, though high temperatures often play a role.
2. Hydrological drought refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow, and as lake, reservoir, and ground water levels.
3. Agricultural drought occurs when there isn't enough soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought is typically evident after meteorological drought but before a hydrological drought.
4. Socioeconomic is when it starts to affect people, the communities and the economy.

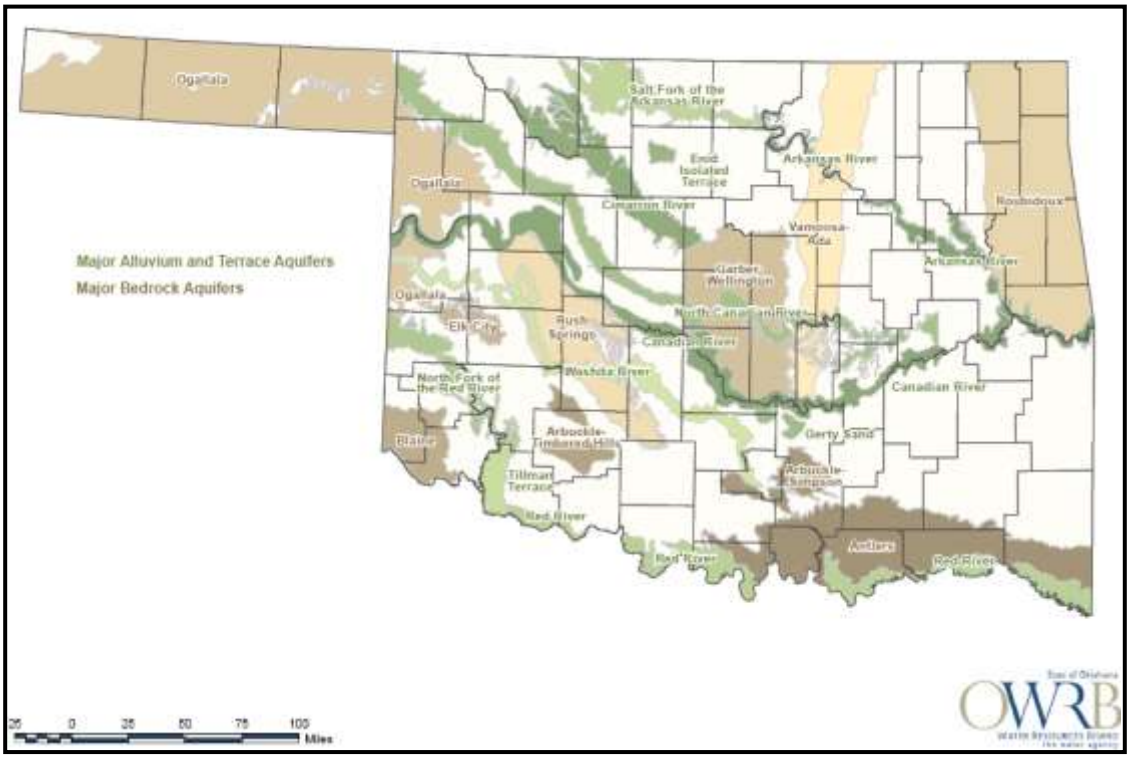
Source: National Weather Service

Precipitation (rain or snow) falls in uneven patterns across the state. When no rain or only a small amount of rain falls, soils can dry out and plants die. When rainfall is less than normal for several weeks, months, or years the flow of streams and rivers declines, water levels in lakes and reservoirs and even aquifers fall, causing the depth of water in wells to decrease. If dry weather persists and water supply problems develop, the dry period can become a drought. The first evidence of drought usually is seen in records of decreased rainfall. Within a short period of time, the amount of moisture in soils can begin to decrease. The effects of a drought on flow in streams and rivers or on water levels in lakes and reservoirs may not be noticed for several weeks or months. Water levels in wells may not reflect a shortage of rainfall for a year or more after the drought begins due to aquifer availability.

A period of below-normal rainfall does not necessarily result in drought conditions.

A variety of measures are used to predict the severity and impact of droughts, but each one measures different aspects or types of drought. Any single index cannot describe everything about the original data, and the indices are only approximations of real-world phenomena.

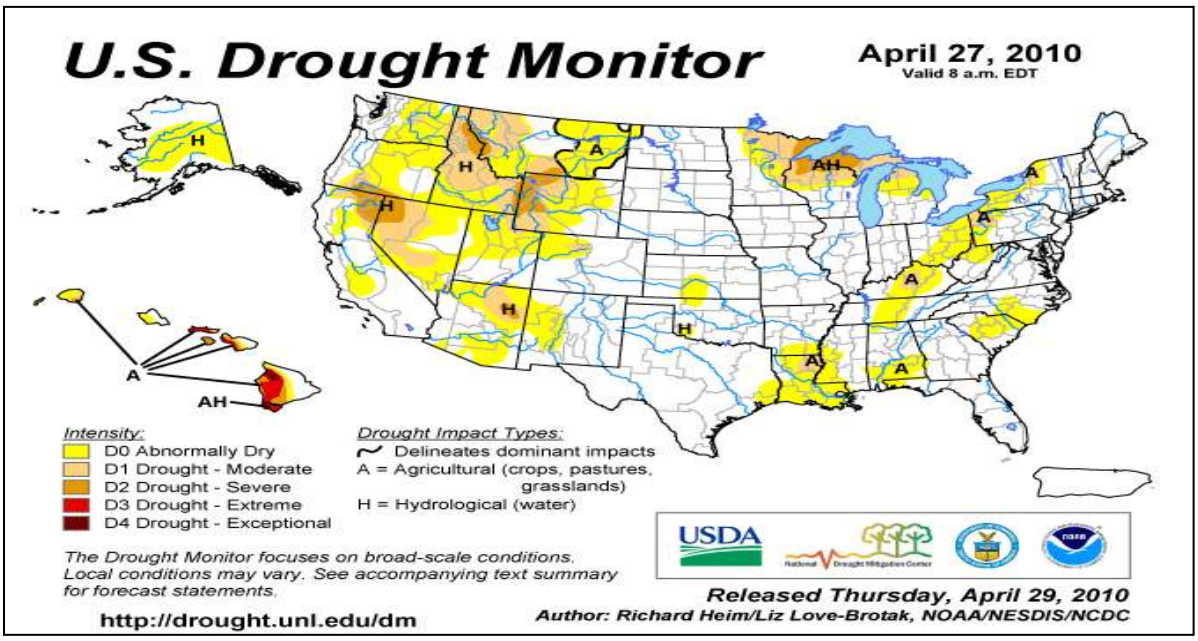
Oklahoma's Aquifers – provided by Oklahoma Water Resources Board



3.2.7.2 Location:

Drought may be experienced anywhere in the State of Oklahoma.

3.2.7.3 Extent:



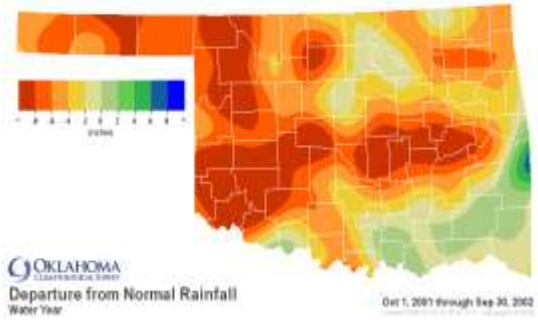
Based on the intensity scale above the State of Oklahoma considers a reading of D2 and below to be a minor severity and a reading of D3 and above to be a major severity.

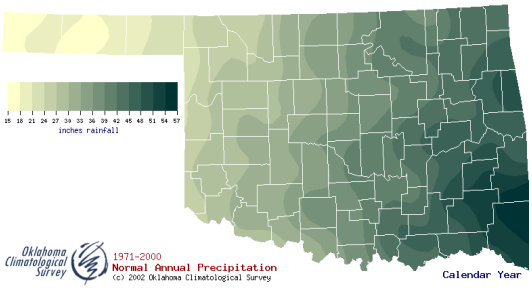
3.2.7.4 Previous Occurrences:

Drought is a "creeping hazard" that is a recurring and a natural part of Oklahoma's climate cycle. It does not produce images and descriptions as compelling as those of violent weather. Despite the relative inattention paid to drought, its larger coverage and longer timescales make it Oklahoma's costliest natural hazard.

A severe, multi-year drought impacted all regions of Oklahoma, beginning in February 2005 and finally terminating about April 2007. At its height, the drought was as severe as any Oklahoma has experienced in the past century. Oklahoma's wheat crop in 2006 was particularly hard-hit, posting the lowest yield since the major drought years of the 1950s. The cattle industry was similarly impacted, as hay rose as high as $90 per bale. Many cattlemen were forced to sell off part or all of their herds. The drought claimed property and lives through one of, if not the single most severe wildfire episodes in the state's history.

The drought of 2005-2006 was preceded by several other, smaller episodes, dating back to a severe wintertime drought of 1995-1996. Fire management assistance was frequently requested during these events, particularly during spring 1996, spring 1998, fall 2000, and winter 2005-2006. The 1995-1996 drought in the Southern Plains caused an estimated $5 billion damages, with at least $1 billion damage in Oklahoma alone. Thereafter, short summertime droughts occurred in 1998 and 2000. A longer drought, similar to the 1995-1996 events in timing, occurred from mid-2001 into mid-2002. Agricultural losses again approached $1 billion.





The vast majority of water used in Oklahoma falls in Oklahoma, unlike many western U.S. States that rely on precipitation from other parts of the country for their water needs. The maps above show a major drought year (2002 on the left) when rain was below a normal and normal precipitation map showing normal levels between 1971 and 2000. (On the right) This simplifies the assessment of drought somewhat for Oklahoma, such that precipitation versus historical values is a strong indicator of drought severity. Drought's ability to produce widespread economic damage is far greater than that of violent weather. In fact, the numbers associated with drought damage are staggering. On a national scale, ten of the 58 billion-dollar disasters from 1980-2003 were related to drought or associated heat. However, those ten disasters accounted for nearly half (41.2%) of the group's economic damage.

Significant Oklahoma Drought History
January 1930 – July 2010
(Information provided by National Weather Service, Oklahoma Climatological Survey, F.E.M.A, Oklahoma Agriculture and Forestry Department and NCDC)

Date	Event Description	Property Damage	Crop Damage	Fat.	Inj.
Jun 2008	**Drought** – Alfalfa, Ellis Counties - Although much of the state of Oklahoma reported above average rainfall totals, the spring and early summer rainfalls did not materialize over far northwest Oklahoma. As a result, D2 drought set in over a small area of Harper and Ellis counties. The drought was not near as severe as the Oklahoma panhandle, but the sting was still felt by local farmers. The wheat harvest was minimal, and some farmers were forced to sell off their cattle. The drought caused Gov. Brad Henry sent a letter to U.S. Secretary of Agriculture Ed Schafer requesting disaster assistance for farmers and ranchers. Luckily in this area, the rains returned, albeit a little late, to northwest Oklahoma, prompting officials to lower the drought monitor to D1 and then D0. Monetary damages were estimated.	100K	Unknown	0	0
2005-2007	**Drought** - Alfalfa, Atoka, Beckham, Blaine, Bryan, Caddo, Canadian, Carter, Cleveland, Coal, Comanche, Cotton, Custer, Dewey, Ellis, Garfield, Garvin, Grady, Grant, Greer, Harmon, Harper, Hughes, Jackson, Jefferson, Johnston, Kay, Kingfisher, Kiowa, Lincoln, Logan, Love, Major, Marshall, McClain, Murray, Noble, Oklahoma, Payne, Pontotoc, Pottawatomie, Roger Mills, Seminole, Stephens, Tillman, Washita, Woods and Woodward counties were all included in an area of drought during the period. Drought levels ranged from severe to exceptional, with the driest conditions in SE Oklahoma. Wildfires became a serious problem also during this period, throughout most of the state.	Unknown	Unknown	0	0
Aug. 1, 2006	**Drought** conditions continued across parts of Oklahoma through the month of August. A few areas did show some improvement by the end of the month, however. At the first of the month drought conditions ranged from extreme to exceptional, with the worst conditions in southern Okla. By the end of the month, extreme to exceptional drought conditions were still in place across southern and parts of central Okla. Northern and the rest of central Okla. improved to severe conditions. The dry conditions maintained an increase in wildfire potential across the region with burn bans being issued by the state. Many communities continued to institute voluntary or mandatory water rationing programs. Low lake levels caused problems for recreation and wildlife. Two fish	$100,000K +	$2 M+	**0**	**4**

Significant Oklahoma Drought History
January 1930 – July 2010
(Information provided by National Weather Service, Oklahoma Climatological Survey, F.E.M.A, Oklahoma Agriculture and Forestry Department and NCDC)

	kills were reported. One occurred at Great Salt Plains Lake in Alfalfa Co. in northern Okla. Officials estimated 10,000 fish were killed due to the low water levels and hot temperatures. Another fish kill occurred on Lake Texoma in south central Okla. Several thousand fish were found dead in the Wilson Creek Cove area of the lake. For the recreation industry, some lakes were closed to boating, swimming, and fishing. Receding shorelines caused many boat ramps and docks to become dry. Boaters on area lakes also had several accidents due to the low water levels bringing objects on the floor of the lakes closer to the surface. The agriculture community continued to be hit hard by the drought conditions. Okla. was declared a disaster area allowing federal assistance. Ranchers and farmers continued to sell part or all of their livestock herds due to dried up farm ponds, lack of pasture land, and the lack of hay. Summer crops were also affected by the dry conditions. Officials say part of the cotton crop suffered from the dry and hot conditions. Those crops or areas that rely on irrigation were also adversely affected by the drought.				
Apr. 1, 2006	**Drought** - Despite some rainfall across portions of Okla., the drought across the area persisted and actually worsened from severe drought to an extreme drought across most of the area by the end of the month. The drought conditions continued to cause an increased wildfire potential. One of the worst days for wildfires for the month was on April 6, 2006 due to strong winds, warm temperatures, and dry conditions. Many of the wildfires that occurred on April 6 were believed to have been started by sparks from power lines blowing together in the strong winds. The dry conditions and strong winds also caused blowing dust on April 6 that reduced visibilities across parts of western and central Oklahoma. In parts of western Okla. visibilities were reduced to less than ½ mile. The drought conditions along with above normal temperatures (several days above 90 degrees) had also continued to impact other groups across the area. The persistent drought continued to cause problems for farmers and ranchers by causing farm ponds to dry up and available food for livestock to decrease. The decrease in water for livestock led to programs to assist farmers and ranchers in building new wells. However, due to the low water and shortage in hay or pasture from the fires, some people have been forced to sell some or their entire herd. Being the month	$1.5 M+	$750K+	0	0

Significant Oklahoma Drought History
January 1930 – July 2010
(Information provided by National Weather Service, Oklahoma Climatological Survey, F.E.M.A, Oklahoma Agriculture and Forestry Department and NCDC)

	before the winter wheat harvest began farmers and agriculture professionals predicted the worst wheat crop since 1957. As of April many fields of crops had already been declared disasters. The agriculture community was not the only area feeling the effects of the drought. The recreation industry has been affected due to low lake levels with some piers or docks unusable. Some towns were also beginning to institute volunteer water rationing programs.				
Jan. 1, 2006	**Drought** conditions persisted and expanded across the area into the first month of 2006. Drought levels ranged from severe to exceptional with the driest conditions in SE Okla. Some precipitation did fall during the month, mainly in the form of snow, which did not do much to alleviate the dry conditions over the area. Wildfires caused by the severe dry conditions, created major problems throughout Oklahoma. Crop damage was estimated at $750,000.	$15M+	$750 K+	0	0
2001-2002	**Drought** of 2001-02 was the latest (and longest, at places) of a series of dry episodes dating to the winter of 1995-96. (See figure 1 below.) The timing, location and duration of the event made it most damaging to Oklahoma's agricultural sector. The largest sectors to be adversely affected were winter wheat producers and those livestock operations that rely on what for winter forage. Row crops were injured by the lack of rainfall and associated heat wave during summer 2001. Hay operations also suffered greatly from the event. The Panhandle recorded the 2nd-driest Jun-Jul (14 mos.) period on record; west central and N central experienced 5th-driest and 6th-driest Jun-May on record, respectively.	Unknown	$ 1B+	0	0
July 4, 2001	**Drought** - An extended period of excessive heat affected all of western and central Oklahoma in July. Daily mean temperatures ranged from the mid 80s to near 90 degrees, which is four to five degrees above normal. Most areas regularly experienced high temperatures at or above 100 degrees, particularly western and north central Oklahoma. Eight fatalities resulted from the heat. In addition to the excessive heat, rainfall averaged about one-third of normal, resulting in a drought.	Unknown	Unknown	0	8
Aug. 2000	***Drought -** An extended period of unusually dry weather began in early August and lasted for 2 months. Many parts of the state did not receive rain in August, with portions of southwest and south central Okla. Remaining dry for almost 90 days, starting in June. Due largely to Oklahoma's major crops of wheat, cotton,	Unknown	Unknown	0	0

Significant Oklahoma Drought History
January 1930 – July 2010
(Information provided by National Weather Service, Oklahoma Climatological Survey, F.E.M.A, Oklahoma Agriculture and Forestry Department and NCDC)

	and peanuts, which greatly suffered, total agricultural losses were estimated between 600 million and 1 billion dollars statewide. Seven Oklahoma counties near the Texas border, including Carter, Comanche, Cotton, Jefferson, Love, Marshall, and Tillman, were declared federal disaster areas. Reservoir levels were also low across SW and south central Okla., averaging 50 percent of normal.				
July 1998	**Drought -** A devastating drought and heat wave affected SE Okla. Farmers during the month of July. At McAlester, the only rainfall during July was 0.19" on the first two days of the month. The SE Oklahoma climate division (which includes Choctaw, Pushmataha, Latimer and Le Flore Counties) received 50 percent of normal rainfall from May 1 through July 31. By the end of July, SE Okla. was classified by the Palmer Drought Index as being in the midst of a "severe drought", while east-central Okla. was experiencing "moderate drought". From a historical perspective, the period from June 1-July 31 was the third driest on record in SE Okla., while the period from April 1-July 31 was the fourth driest on record in east-central Oklahoma. When combined with 100+ degree temperatures on 24 out of 31 days during the month (at McAlester) and relative humidity's under 25 percent on many afternoons, crops stood little chance of survival. The Oklahoma Agriculture Secretary estimated crop damage throughout Oklahoma at $2 billion, of which $500 million might have taken place in southeast and east central Oklahoma. The President declared the counties listed here as a drought disaster area, nine of sixty-six counties throughout southern and central Oklahoma receiving this designation. For more information on the heat wave, please refer to the Excessive Heat entry in eastern Oklahoma's July Storm Data.	Unknown	Unknown	0	0
May 1, 1996	**Drought** - May was one of the driest and hottest on record for McCurtain County. The effects were felt especially hard in the timber, livestock, and poultry industry. Many lakes and reservoirs suffered near record low water levels.	Unknown	Unknown	0	0
1952-1958	**Drought** was accompanied by intense summer heat, insect invasions and crop failures. The State's "Wheat Belt", in central and north-central Oklahoma, was particularly injured by the event. The mid-50s years of 1952-1956 were easily the driest five consecutive years in State history. Ironically, 1957 was the wettest year on record, one year after 1956 became the second-	Unknown	Unknown	0	0

Significant Oklahoma Drought History January 1930 – July 2010 (Information provided by National Weather Service, Oklahoma Climatological Survey, F.E.M.A, Oklahoma Agriculture and Forestry Department and NCDC)					
	driest year on record.				
1930-1940	**Drought** in Oklahoma, the climate's contribution to the Dust Bowl, was not as statistically severe as those of the 1910s or 1950s, but it left the deepest scar on the State's economy and psyche. The Dust Bowl was at its worst in Oklahoma during the mid 1930s, when severe drought, intense heat, immature and/or inappropriate agricultural practices and overall economic conditions combined to cause the greatest exodus of citizens in State history. Reaction to the event revolutionized farm and conservation practices in much of the U. S.	Unknown	Unknown	0	0
1909-1918	**Drought** consisted of two severe multi-year episodes, interrupted by 1915, one of the wettest years of the 20th Century. This event comprises the lowest ten-year statewide rainfall on record. 1910 was the smallest annual rainfall Statewide and for four of Oklahoma's nine climate divisions.	Unknown	Unknown	0	0
**** Federal Emergency Declaration*** ***** - Presidential Disaster Declarations (Courtesy of FEMA).***					

The following map depicts the drought of 2001 – 2002 in which the western half of Oklahoma received an agricultural disaster declaration. The western half of the state from I-35 west is most vulnerable to drought situations due to its normally drier climate.

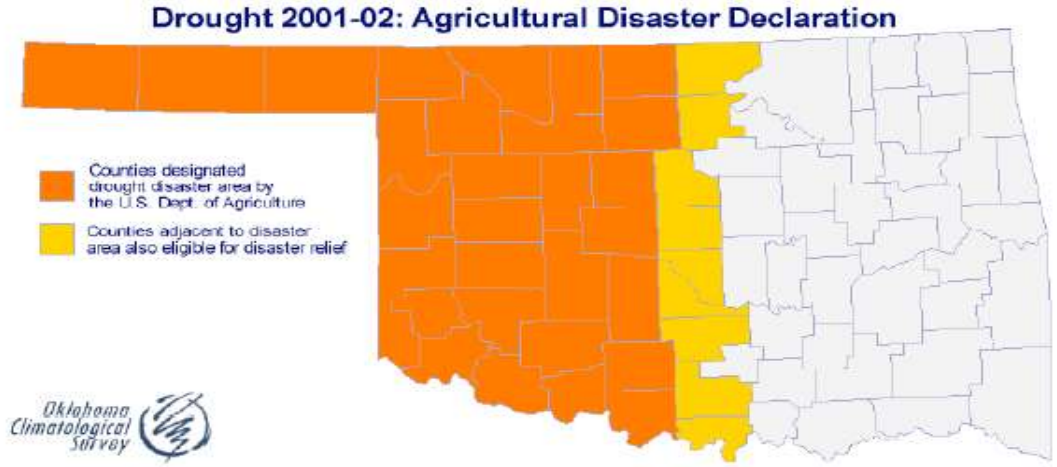


Fig. 1. Agricultural disaster areas associated with the Drought of 2001-02, as determined by the U.S. Department of Agriculture.

3.2.7.5 Probability of Future Events:

All counties in the State of Oklahoma have a Likely probability of future drought events.

Calculated Priority Risk Index (CPRI)

Drought = 2.8

Probability		3 Likely		
Magnitude/Severity		3 Critical		
Warning Time		1 24+ Hours		
Duration		4 More than one week		
The CPRI for the Drought hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(3 x .45)	+ (3 x .30)	+ (1 x .15)	+ (4 x .10)	= 2.8

Resources: Oklahoma Climatological Survey; Oklahoma Mesonet; Oklahoma Water Resources Board; National Drought Mitigation Center; National Integrated Drought Information System; National Weather Service

3.2.7.6 Vulnerability and Impact:

Throughout its known history, Oklahoma has been susceptible to drought. Short-term events (1-2 months) are fairly common, and tend to occur somewhere within the State during most years. Increased fire danger and/or crop stress often accompany these episodes. Medium-term (up to a year) drought episodes can encompass a crop cycle, causing significant economic damage, or cause water supply/distribution problems for municipalities. Longer-term droughts (several years) add the issue of reservoir and aquifer depletion. Because these long-term events are often composed of intermittent episodes, their onset and conclusion are often difficult to identify until long after the event is over.

Drought produces a complex web of impacts that spans many sectors of the economy and reaches well beyond the area experiencing physical drought. This complexity exists because water is integral to our ability to produce goods and provide services.

Impacts are commonly referred to as direct or indirect. Reduced crop, rangeland, and forest productivity; increased fire hazard; reduced water levels; increased livestock and wildlife mortality rates; and damage to wildlife and fish habitat are a few examples of direct impacts. The consequences of these impacts illustrate indirect impacts. For example, a reduction in crop, rangeland, and forest productivity may result in reduced income for farmers and agribusiness, increased prices for food and timber, unemployment, reduced tax revenues because of reduced expenditures, increased crime and foreclosures on bank loans to farmers and businesses, and disaster relief programs. **The impacts of drought can be categorized as economic, environmental, or social.**

Not all impacts of drought are negative. Some agricultural producers outside the drought area or with surpluses benefit from higher prices, as do businesses that provide water-related services or alternatives to water-dependent services.

Many **economic** impacts occur in agriculture and related sectors, including forestry and fisheries, because of the dependence of these sectors on surface and subsurface water supplies. In addition to

obvious losses in yields in crop and livestock production, drought is associated with increases in insect infestations, plant disease, and wind erosion. Droughts also bring increased problems with insects and diseases to forests and reduce growth. The incidence of forest and range fires increases substantially during extended droughts, which in turn places both human and wildlife populations at higher risk.

Income loss is another indicator used in assessing the impacts of drought because so many sectors are affected. Reduced income for farmers has a ripple effect. Retailers and others who provide goods and services to farmers face reduced business. This leads to unemployment, increased credit risk for financial institutions, capital shortfalls, and loss of tax revenue for local, state, and federal government. Less flexible income affects the recreation and tourism industries. Prices for food, energy, and other products increase as supplies are reduced. In some cases, local shortages of certain goods result in the need to import these goods from outside the stricken region such as hay for cattlemen. Hydropower production may also be curtailed significantly.

Environmental losses are the result of damages to plant and animal species, wildlife habitat, and air and water quality; forest and range fires; decay of landscape quality; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes, and vegetation. However, many species will eventually recover from this temporary abnormality. The decay of landscape quality, including increased soil erosion, may lead to a more permanent loss of natural production of the landscape. Although environmental losses are difficult to measure, growing public awareness and concern for environmental quality has forced public officials to focus greater attention and resources on these effects.

Social impacts mainly involve public safety, health, reduced quality of life, and inequities in the distribution of impacts and disaster relief. Many of the impacts specified as economic and environmental have social components as well. During the warm season, municipalities are often faced with more demand for water than they are able to distribute. This leads to inconveniences of rationing and curtailment by the public, and businesses that rely on heavy water usage (car washes, landscapers) may suffer financially.

Longer-term droughts threaten the water supply itself. During extended droughts, declining aquifers reduce stream flows. Coupled with high evaporation, lake levels may drop rapidly, negatively impacting municipal and rural water supplies. Grand Lake, in northeastern Oklahoma, generates hydropower, which may also be affected by low lake levels. In addition, navigation in the Kerr-McClellan Waterway, along the Arkansas River, may be diminished by low stream flows and low storage from upstream reservoirs.

This is often complicated by municipalities during the first several months of an extended drought. Municipalities often rely on water sales for revenue especially in smaller communities, where the water utility makes up a majority of the operating budget. Because of this, communities often operate their water systems at full-tilt until the extended drought forces them to curtail consumption. Citizens are then left with severe usage restrictions because supplies were depleted. The associated revenue shortfall often leaves communities without adequate resources to address the immediate issues, let alone the long-term ones.

Timescale of Drought Vulnerability					
Drought Issue or Vulnerable Community	**Approx. Time scale of onset**	**Some prominent impacts**	**Approx. Avg. Time between significant events on this time scale**	**Contributing factors and circumstances**	**Related notes**
Drought-enhanced Wildfire Danger	1-2 months	Dried organic soil material can act as additional fuel to wildfire; more frequent wildfires; more intense wildfires	Fairly common. Tends to occur at least somewhere in the State during most years.	Time since last burn; density of undergrowth (often enhanced by preceding prolonged wetness); severity of drought.	Somewhat seasonal.
Horticulture / Urban, Suburban Lawns	1-2 months	Increased municipal water use; horticultural failure; lawn damage; increased pest damage	Somewhat common. Most growing seasons will undergo one or two fairly dry months. Consecutive dry months are slightly rarer.	Effectiveness of conservation and mitigation practices; severity of drought; severity of heat.	Highly Seasonal.
Municipal Water Distribution	1-2 months	Short-term water rationing (on the order of weeks); loss of revenue for water-use-dependent municipalities	Somewhat common.	Capacity and quality of distribution system; quality of conservation and mitigation practices; severity of drought; severity of heat.	Highly seasonal.
Agriculture	2-6 months	Crop failure; poor crop yield; depressed livestock prices due to sell-offs.	Severe drought-related losses struck 6-8 times since 1980 (note: highly variable by crop). Catastrophic failures occur 1-2 times per decade *on average.*	Timing of event versus crop cycle; availability and cost of irrigation water; agricultural techniques; conservation practices; crop selection; drought-tolerant varieties.	Highly tied to crop cycle; example: very dry Apr-May can help wheat harvest while destroying row crops.
Reservoir depletion	1+ years	Severe, prolonged rationing; widespread water shortages;		Effectiveness of conservation and mitigation practices; demand; size and engineering of reservoir.	Smaller reservoirs are more sensitive at shorter timescales.

Timescale of Drought Vulnerability					
		irrigation denied			
Aquifer depletion	10+ years	Widespread farm & ranch failure;	Many aquifer levels are dropping in recent decades.	Financial / physical ability to drill deeper; demand.	Still little known about aquifer depletion

3.2.7.7 Vulnerable Populations:

Agriculture is an important industry in the State of Oklahoma. Historically, cotton was the leading cash crop, but this has been succeeded by wheat. Other leading crops include hay, peanuts, sorghum, and soybeans.

Livestock and livestock products make up the much of Oklahoma's yearly farm income. Most of the state's cattle ranches are concentrated in the Panhandle and northern portions of Oklahoma. Poultry and hogs are also significant sources of income, and are raised primarily in the eastern half of the state. The cattle industry is the largest agricultural industry in Oklahoma In all droughts agriculture feels the impact, especially in non-irrigated areas such as dry land, farms and rangelands.

Other heavy water users, from landscapers to the local car wash may also be negatively impacted. Water related activities of residential users may be restricted such as watering lawns, filling swimming pools or washing vehicles.

In northeastern Oklahoma, an area referred to as "Green Country" because of its forests, lakes and streams, immunity from the spread of a drought is not often possible. The big lakes in this area such as Keystone, Eufaula, Tenkiller, Broken Bow and Fort Gibson have been affected by low water levels which cause disruption in normal water supplies and recreation for numerous communities.

Power supplies throughout Oklahoma are often adversely affected by low water levels because much of the state's power comes from hydroelectric plants. Therefore, heavy electrical users are affected, usually by having to purchase more expensive replacement power.

3.2.7.8 Conclusion:

Human behavior and adaptation are dominant mitigating factors in drought's consequences. Examples of these concepts can be found in the Oklahoma experience during the 20th Century. Across much of western Oklahoma, the rainfall statistics of the 1950s were more severe than those of the more famous 1930s "Dust Bowl" drought.

However, improved agricultural practices such as crop selection were in use in the 1950s. More drought resistant crops (for example, winter wheat versus corn) did not fail as dramatically as those from the 1930s. Conservation practices improved dramatically in two decades. During the 1930s, drought conditions (vegetation loss, exposed soils, etc.) exacerbated the erosion processes. Consequently, much of western Oklahoma's topsoil was lost in the few torrential storms that occurred during the great drought. Two decades later, shelterbelts, terrace farming and retention ponds helped minimize topsoil loss due to erosion. These practices continue today.

Surface water storage was much more prevalent during the 1950s, compared to just two decades before. On large and small scales, more dams were built in the 1950s than ever before or since in Oklahoma. Ironically, most of the structures were primarily intended for flood control, but have paid great dividends as irrigation sources.

While drought does not usually cause damage to buildings and critical facilities, work and living locations do affect people. State property managers can engage in drought mitigation through water conservation plans, practices, and educational programs.

Improved remote sensing from satellites and radar as well as the use of thousands of precipitation measurements daily have improved the ability to monitor drought, but the most exciting developments in mitigating drought impacts may be advances made in forecasting the conditions that result in drought. Meteorologists at NWS' Climate Prediction Center (CPC) are using the medium-range forecast models to forecast soil moisture two weeks into the future. For the longer term, they are using statistical techniques and historical drought information to construct analogues to current conditions. They then create forecasts up to several seasons ahead of time based on what happened in the past. CPC is also using sophisticated computer models that link ground and ocean conditions to the overlying atmosphere to create forecasts of temperature, precipitation, and soil moisture months ahead of time.

In short, there is a sea of change going on in the ability to monitor and forecast drought, and in the coming months and years will bring even more developments in this area.

3.2.8 Thunderstorms: (Hail)

Hazard Priority # 8 (Hail) &
Hazard Priority # 9 (Lightning)

Event Profile

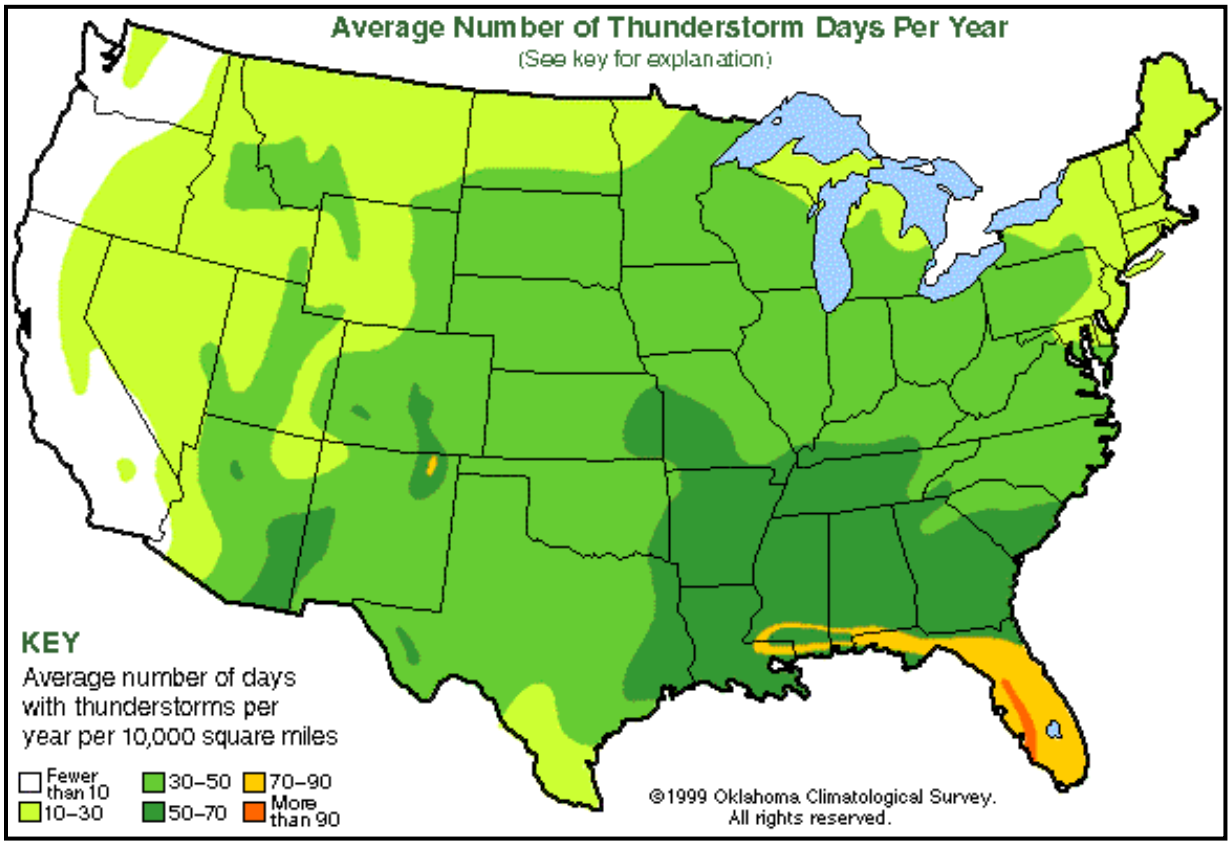
Thunderstorms are events that produce the hazards of heavy rain, which causes flooding, accompanied by lightning, thunder, wind, and sometimes hail. Thunderstorms occur when moist air near the ground becomes heated, especially in the summer, and rises, forming cumulonimbus clouds that produce precipitation. Electrical charges accumulate at the bases of the clouds until lightning is discharged. Air in the path of the lightning expands as a result of being heated, causing thunder.

Thunderstorms affect relatively small areas when compared with hurricanes and winter storms. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Nearly 1,800 thunderstorms are occurring at any moment around the world. That's 16 million a year.

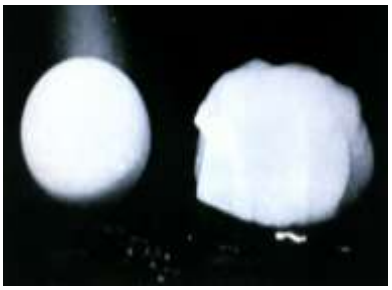
Despite their small size, all thunderstorms are dangerous. Every thunderstorm produces lightning, which kills more people each year than tornados. Heavy rain from thunderstorms can lead to flash flooding. Strong winds, hail, and tornados are also dangers associated with most thunderstorms.

Oklahoma sometimes is host to the “remnants” of Hurricanes from the Gulf of Mexico or the Pacific Ocean. By the time they arrive in Oklahoma they have been downgraded to Tropical Storms or Tropical Depressions. These storms tend to produce extremely heavy rains over a sustained period of time and often lead to flooding.

A **severe thunderstorm** as defined by the National Weather Service is a storm with hail equal to or > than 1" in diameter or convective wind gusts equal to or > than 58 mph. Even if a storm is not severe, it still remains a potential killer. Lightning, flash flooding, windblown hail (even small hail), and general thunderstorm wind gusts pose a threat to life and property. Severe thunderstorms also have the potential of producing a tornado with little or no advanced warning.
Thunderstorms sometimes referred to as “thunder events” are recorded and observed as soon as a peal of thunder is heard by an observer at a NWS first-order weather station. A thunder event is composed of lightning and rainfall, and can intensify into a severe thunderstorm with damaging or deadly hail, high winds, tornados, and flash flooding. Thunderstorms spawn as many as 1,000 tornados each year.



Hazard Priority # 8 (Hail)



3.2.8.1 Description:

Hail - usually occurs during severe thunderstorms, which also produce frequent lightning, flash flooding and strong winds, with the potential of tornados. The size ranges from smaller than a pea to as large as a softball, and can be very destructive to buildings, vehicles and crops in Oklahoma.

Hail is a form of solid precipitation which consists of balls or irregular lumps of ice, that are individually called hail stones. Hail stones on Earth consist mostly of water ice and measure between 5 millimeters (0.20 in) and 150 millimeters (5.9 in) in diameter (some record size stones have been larger), with the larger stones coming from severe thunderstorms. The METAR reporting code for hail 5 millimeters (0.20 in) or greater in diameter is GR, while smaller hailstones and grapple are coded GS. Hail is possible with most thunderstorms as it is produced by cumulonimbi (thunderclouds), usually at

the leading edge of a severe storm system. Hail is possible within 2 nautical miles (3.7 km) of its parent thunderstorm. Hail formation requires environments of strong, upward motion of air with the parent thunderstorm (similar to tornados) and lowered heights of the freezing level. Hail is most frequently formed in the interior of continents within the mid-latitudes of Earth, with hail generally confined to higher elevations within the tropics. Hail formation is preferred during the summer months in the afternoon and evening hours of the day. Hail storms normally last three to fifteen minutes.

Unlike ice pellets, hail stones are layered and can be irregular and clumped together. Hail is composed of transparent ice or alternating layers of transparent and translucent ice at least 1 millimeter (0.039 in) thick, which are deposited upon the hail stone as it cycles through the cloud multiple times, suspended aloft by air with strong upward motion until its weight overcomes the updraft and falls to the ground. There are methods available to detect hail-producing thunderstorms using weather satellites and radar imagery. Hail stones generally fall at faster rates as they grow in size, though complicating factors such as melting, friction with air, wind, and interaction with rain and other hail stones can slow down their descent through Earth's atmosphere. Severe weather warnings are issued for hail when the stones reach a damaging size, as it can cause serious damage to man-made structures, and most commonly, farmers' crops. In the United States, the National Weather Service issues severe thunderstorm warnings for hail 1" or greater in diameter. This threshold, effective January 2010, marked an increase over the previous threshold of 3/4" hail. The change was made for two main reasons: a) public complacency and, b) recent research suggesting that damage does not occur until a hailstone reaches 1" in diameter.

Source: www.noaa.gov and www.torro.org

3.2.8.2 Location:

The entire State of Oklahoma is at risk from Hailstorms.

3.2.8.3 Extent

Even small hail can cause significant damage to young and tender plants. Hail usually lasts an average of 10 to 20 minutes but may last much longer in some storms. Hail causes $1 billion in damage to crops and property each year in the U.S. Anyone out of doors during a thunderstorm is exposed and at risk of injury from lightning. The peak periods for hailstorms, late spring and early summer, coincide with the Midwest's most critical agricultural seasons for wheat, corn, barley, oats, rye, tobacco, and fruit trees. The State of Oklahoma considers any hail of H4 or higher on the NOAA/TORRO hail scale to be a Major Severity.

Combined NOAA/TORRO Hailstorm Intensity Scales

Size Code	Intensity Category	Typical Hail Diameter (inches)	Approximate Size	Typical Damage Impacts
H0	Hard Hail	up to 0.33	Pea	No damage
H1	Potentially Damaging	0.33-0.60	Marble	Slight damage to plants, crops
H2	Potentially Damaging	0.60-0.80	Dime	Significant damage to fruit, crops, vegetation
H3	Severe	0.80-1.20	Nickel to Quarter	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	1.2-1.6	Half Dollar to Ping Pong Ball	Widespread glass damage, vehicle bodywork damage
H5	Destructive	1.6-2.0	Silver dollar to Golf Ball	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	2.0-2.4	Lime or Egg	Aircraft bodywork dented, brick walls pitted
H7	Very destructive	2.4-3.0	Tennis ball	Severe roof damage, risk of serious injuries
H8	Very destructive	3.0-3.5	Baseball to Orange	Severe damage to aircraft bodywork
H9	Super Hailstorms	3.5-4.0	Grapefruit	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
H10	Super Hailstorms	4+	Softball and up	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

3.2.8.4 Previous Occurrences:

The table below lists the 20 most damaging Oklahoma hail events since 1993, as reported by NCDC.

THE 20 MOST DESTRUCTIVE HAIL EVENTS

Query Results

20 HAIL event(s) were reported in **Oklahoma** between **01/01/1950** and **05/16/2010** with **at least $500,000 in Property Damage**.

*Click on **Location or County** to display Details.*

Mag: Magnitude
Dth: Deaths
Inj: Injuries
PrD: Property Damage
CrD: Crop Damage

Oklahoma

Location or County	Date	Time	Type	Mag	Dth	Inj	PrD	CrD
1 Waurika	03/29/1993	2305	Hail	2.75 in.	0	0	500K	0
2 Pontotoc	04/02/1994	1815	Hail	2.50 in.	0	0	500K	0
3 Ada	04/02/1994	1845	Hail	2.50 in.	0	0	500K	0
4 Ada	04/02/1994	1842	Hail	2.00 in.	0	0	500K	0
5 Bromide	04/26/1994	1301	Hail	2.00 in.	0	0	500K	0
6 Shattuck	05/25/1994	1435	Hail	2.50 in.	0	0	500K	0
7 Turpin	06/10/1994	0110	Hail	2.75 in.	0	0	500K	0
8 Turpin	06/10/1994	0110	Hail	2.75 in.	0	0	500K	0
9 Hardesty	06/10/1994	0229	Hail	2.75 in.	0	0	500K	0
10 Hardesty	06/10/1994	0229	Hail	2.75 in.	0	0	500K	0
11 Agra	06/02/1995	1358	Hail	3.00 in.	0	0	500K	0
12 Norman	06/08/1998	05:00 PM	Hail	1.75 in.	0	0	500K	0
13 Okmulgee	10/04/1998	10:43 PM	Hail	2.25 in.	0	0	600K	0
14 Altus	05/03/1999	04:13 PM	Hail	4.50 in.	0	0	800K	0
15 Altus	05/25/1999	06:50 PM	Hail	4.50 in.	0	0	500K	100K
16 Tulsa	05/06/2000	03:06 AM	Hail	2.50 in.	0	0	500K	0
17 Owasso	05/06/2001	05:05 PM	Hail	1.75 in.	0	0	500K	0
18 Norman	07/30/2003	05:12 AM	Hail	1.75 in.	0	0	500K	0

19 Okarche	05/29/2004	07:21 PM	Hail	2.75 in.	0	0	500K	0
20 Oklahoma City	05/16/2010	2:58 PM	Hail	4.25 in.	0	1	5M	Unk
TOTALS:					0	1	14.900M	100K

3.2.8.5 Probability of Future Events:

The entire State of Oklahoma is at risk from hail and the probability of future events is **Highly Likely**.

Calculated Priority Risk Index (CPRI)

Hail = 2.8

Probability		4 Highly Likely		
Magnitude/Severity		2 Limited		
Warning Time		2 12-24 Hours		
Duration		1 Less than 6 hours		
The CPRI for the Hail hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(4 x .45)	+ (2 x .30)	+ (2 x .15)	+ (1 x .10)	= 2.8

Resources:
The National Weather Service
The Storm Prediction Center
National Climatic Data Center

3.2.8.6 Vulnerability and Impact

NCDC reports 22,442 Hail Records for the State of Oklahoma. Virtually all structures, infrastructure and individuals in Oklahoma are vulnerable to hail. Automobiles, roofs, windows and metal siding are severely damaged by large hail. This can result in heavy out of pocket costs for underinsured residents and unexpected costs for municipalities. Oklahoma residents have suffered bruises from large stones. Large hail is also a threat to small mammals and it kills many birds. Large hail is generally two inches in diameter or larger and can cause a great deal of damage. Large hailstones can fall at speeds faster than 100 mph.

3.2.8.7 Vulnerable Populations:

People caught outside, doing recreational activities or attending sporting events are most vulnerable, as in many cases they are not notified before a hailstorm arrives. Farmers' incomes are affected when crops suffer extreme damages almost every year. Oklahoma has a significant hazard due to its climate; the State is southeast of the Rockies which provide the cool air, north of the Gulf of Mexico that provides the moisture and northeast of the dry hot air from the arid southwest. The highest period of hail is generally through the middle to late spring months of April, May and June which coincidentally also aligns with Oklahoma's major tornado season.

3.2.8.8 Conclusion:

Oklahoma has significant exposure to Hail events. Hail damage to automobiles, roofs, windows and farm crops is staggering although data is not available to show how much occurs since most of that information is through private insurers. State owned property is vulnerable to hail as any other property. Damage usually occurs to infrastructure such as power transmission lines and communications towers; however occasional damage can occur to structures. Early warning research is ongoing through the National Weather Service (NOAA) and other private organizations to improve warning and threat information for the public.

3.2.9 Thunderstorms (Lightning)

Hazard Priority # 9 (Lightning)

3.2.9.1 Description:

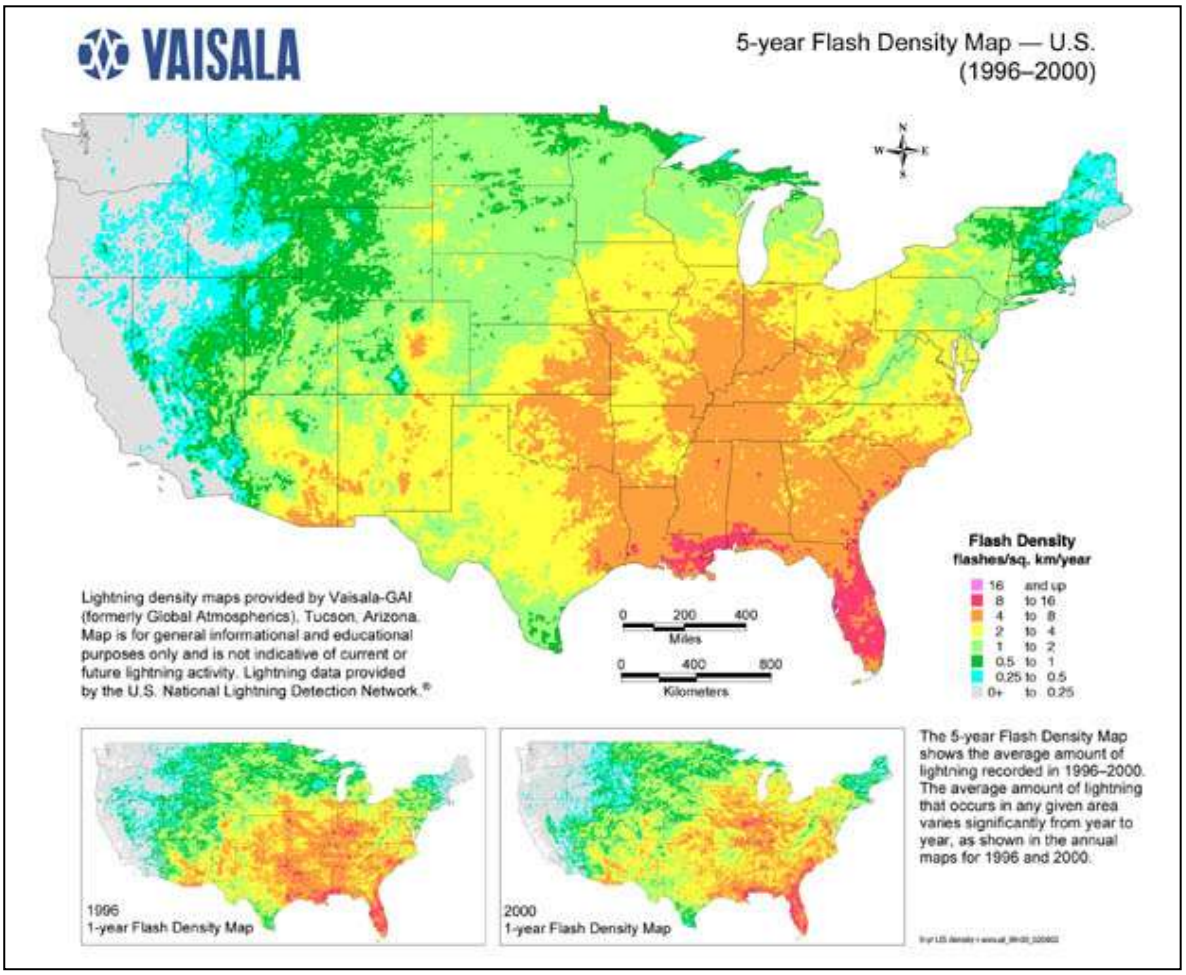
Lightning is a discharge of atmospheric electricity, accompanied by a vivid flash of light, from a thunderstorm, frequently from one cloud to another, sometimes from a cloud to the earth. The sound produced by the electricity passing rapidly through the atmosphere causes thunder.

Lightning is a thunderstorm's number two killer each year (flooding remains number one) in the U.S. Usually single events caused by lightning are less dramatic than single events caused floods or tornados. New data shows half the flashes are some 9 km apart. According to statistics from the National Climatic Data Center (NCDC), in 548 lightning events there have been 13 deaths and 87 injuries resulted from lightning in Oklahoma since 1993. Included in that total is an incident where lightning struck the support pole of a tent on Fort Sill Army Base near Lawton, injuring all 26 occupants. Nine of the marines were admitted to the hospital for the night, three into the Intensive Care Unit.

3.2.9.2 Location:

The entire State of Oklahoma is at risk from lightning.

3.2.9.3 Extent:



The State of Oklahoma considers a flash density of 1 and below to be a minor severity and a flash density of 2 and above to be a major severity. In addition, the State of Oklahoma considers any lightning strike that causes death or property damage to be a major severity.

3.2.9.4 Previous Occurrences:

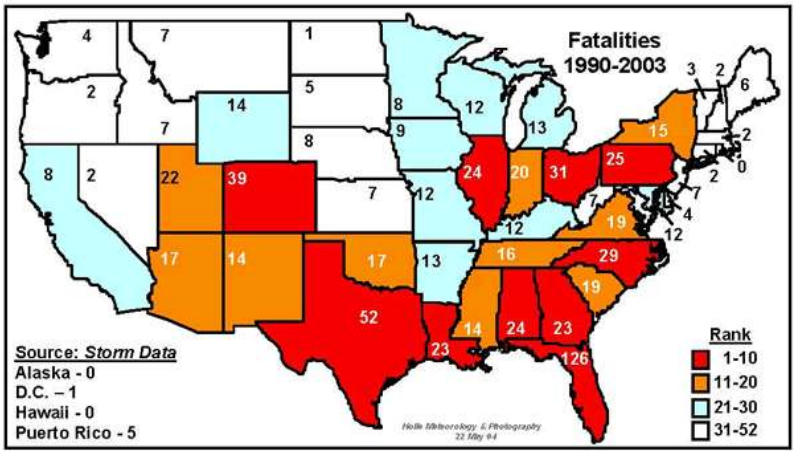
NCDC records show that Oklahoma had 548 lightning events between 1/1/1950 and 1/31/2010. There were 13 deaths, 87 injuries and $34 Million in damages.

Oklahoma Lightning Events with Deaths reported to NCDC

Location or County	Date	Time	Type	Mag	Dth	Inj	PrD	CrD
1 Ne Oklahoma City	06/19/1994	1300	Lightning	N/A	2	1	0	0
2 Kansas	05/13/1995	1800	Lightning	N/A	1	0	0	0
3 Red Oak	06/23/1995	1140	Lightning	N/A	1	0	0	0
4 Guymon	07/08/1996	06:15 PM	Lightning	N/A	1	0	0	0

5 Claremore	07/21/1997	08:30 PM	Lightning	N/A	1	0	0	0
6 Boise City	08/18/1997	05:04 PM	Lightning	N/A	1	0	0	0
7 Wagoner	08/09/1998	07:05 AM	Lightning	N/A	1	0	0	0
8 Muldrow	04/24/1999	07:30 AM	Lightning	N/A	1	1	0	0
9 Hulbert	07/06/2002	06:45 PM	Lightning	N/A	1	1	0	0
10 Calera	04/19/2003	08:30 PM	Lightning	N/A	1	0	0	0
11 Eufaula	08/01/2003	07:00 PM	Lightning	N/A	1	0	0	0
12 Broken Arrow	07/23/2005	04:30 PM	Lightning	N/A	1	1	0	0
				TOTALS:	13	4	0	0

Number of Lightning Deaths in the United States, 1990-2003



3.2.9.5 Probability of Future Events:

The entire State of Oklahoma is at risk from lightning and the probability of future events is **Highly Likely**.

Calculated Priority Risk Index (CPRI)

Lightning = 2.8

Probability		4 Highly Likely		
Magnitude/Severity		2 Limited		
Warning Time		2 12-24 Hours		
Duration		1 Less than 6 hours		
The CPRI for the Lightning hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(4 x .45)	+ (2 x .30)	+ (2 x .15)	+ (1 x .10)	= 2.8

3.2.9.6 Vulnerability and Impact:

Virtually all structures, infrastructure and individuals in Oklahoma are vulnerable to lightning. Power systems are also heavily affected by lightning as is the Agricultural community. Farmers suffer monetary loss and crops suffer extreme damages almost every year due to lightning strikes and the resulting fires. Oklahoma has a significant hazard due to its climate; the State is southeast of the Rockies which provide the cool air, north of the Gulf of Mexico that provides the moisture and northeast of the dry hot air from the arid southwest. The highest period of lightning is generally through the middle to late spring months of April, May and June which coincidentally also aligns with Oklahoma's major tornado season. Lightning is an underrated killer events experienced in every region of Oklahoma where people and property are exposed to damage, injury and loss of life. Lightning is responsible for significant structural damage to buildings, forest and wildfires, tank battery fires and split trees.

Lightning causes millions of dollars in damage to homes, businesses, churches, and barns each year. Lightning is a problem for all communities in Oklahoma. Electrical fires, electricity loss, and damage to equipment are a few of the hazards associated with lightning strikes. In Oklahoma between 1990 and 2003, 17 people were killed by lightning, ranking Oklahoma as 16th in the number of deaths in the U.S. Additionally, more people are killed by lightning strikes while participating in some form of recreation than any other activity. Lightning deaths are more frequent in August than during any other month.

3.2.9.7 Vulnerable Populations:

The vulnerability of the entire State of Oklahoma to future lightning damage is high likely. People who are at outdoor sporting events are especially vulnerable to lightning strikes.

3.2.9.8 Conclusion:

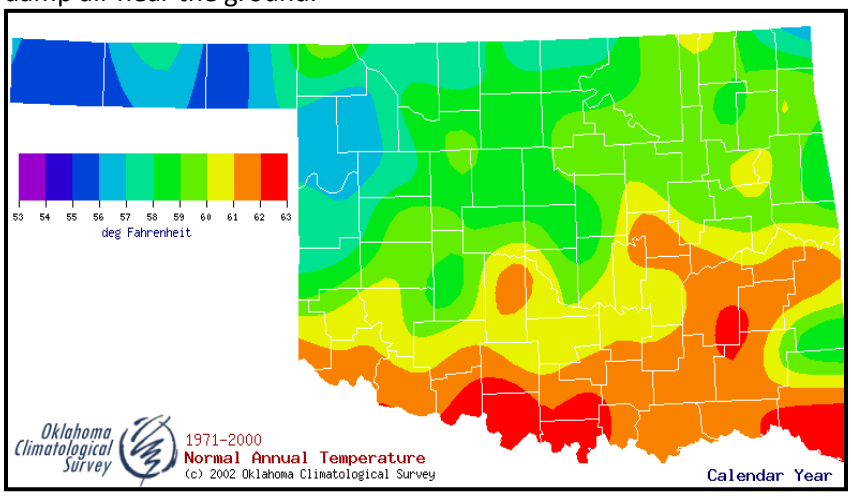
Oklahoma has significant exposure to lightning events. State owned property is vulnerable to lightning as any other property. Damage usually occurs to infrastructure such as power transmission lines and communications towers; however occasional damage can occur to structures. Early warning research is ongoing through NOAA researchers in Norman, Oklahoma and other private organizations to improve warning and threat information for the public.

3.2.10 Extreme Heat

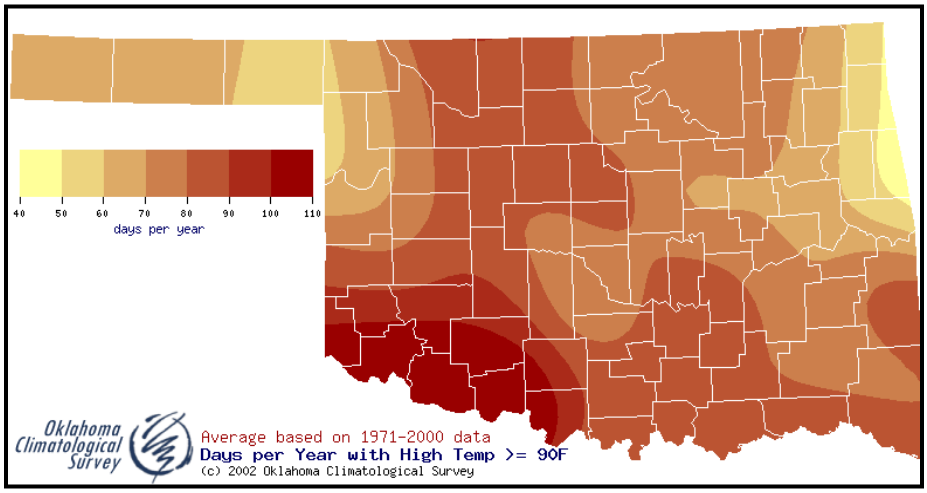
Hazard Priority # 10

3.2.10.1 Description:

Oklahoma, as part of the Southern Great Plains is prone to wide swings of temperature. Summertime temperatures routinely climb above the 100-degree mark, and wintertime temperatures dip below zero. Beaver, in the Oklahoma Panhandle, averages an annual temperature swing of 113 degrees. Temperatures that hover 10 degrees or more above the average high temperature for the area and last for several weeks are defined as extreme heat. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when a "dome" of high atmospheric pressure traps hazy, damp air near the ground.



The hottest period of the Oklahoma summer extends from mid-July through mid-August. The gradually shortening days and the occasional arrival of cooler weather from the North frequently bring the state modest relief from the heat by late August. Overall, August, the third and final month of the climatological summer, is Oklahoma's second hottest, fifth driest, and least windy month. The normal statewide monthly temperature is 80.9 degrees Fahrenheit.



Days/year >= 90˚- Latest available map from the Okla. Climatological Survey

3.2.10.2 Location:

The entire State of Oklahoma may experience extreme heat.

3.2.10.3 Extent:

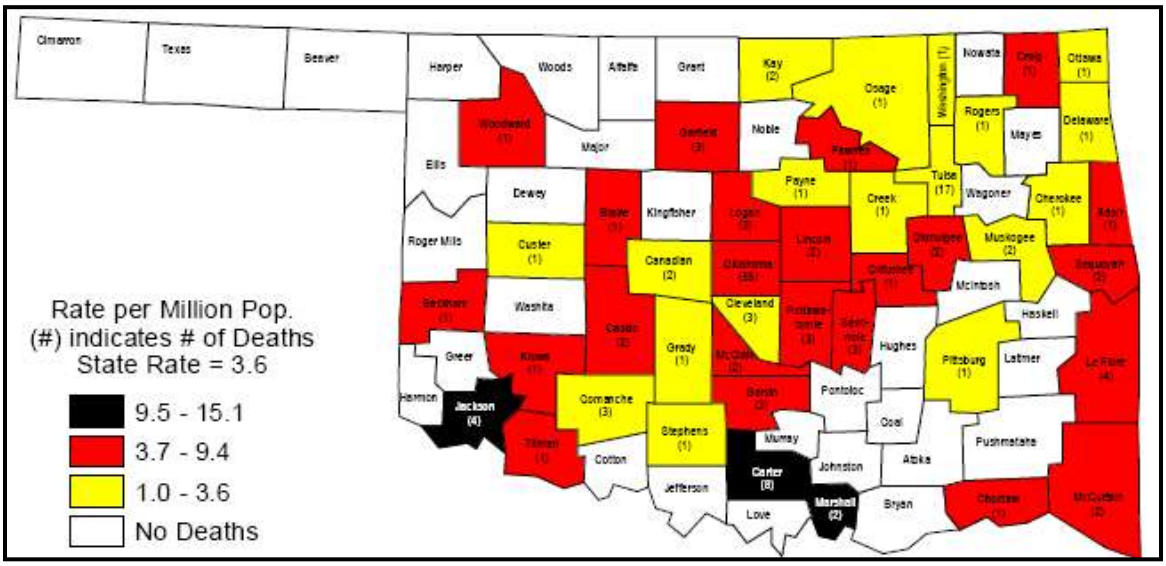
The Heat index is how the heat and humidity in the air combine to make individuals feel. Higher humidity plus higher temperatures often combine to make us feel a superficial temperature that is higher than the actual air temperature. The State of Oklahoma considers any reading 105 degrees and hotter to be a major severity.

Heat Index Chart

	% Relative Humidity																
		15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
Temperature	110	108	112	117	123	130											
	105	102	105	108	113	117	122	130									
	100	97	98	102	104	107	110	115	120	126	132						
	95	91	93	95	96	98	100	104	106	109	113	119	124	130			
	90	86	87	88	90	91	92	95	97	98	100	103	106	110	114	117	121
	85	81	82	83	84	85	86	87	88	89	90	92	94	96	97	100	102
	80	76	77	78	78	79	79	80	81	82	83	84	85	86	87	88	89

Legend	
80-89 degrees	Fatigue is possible with prolonged exposure and/or physical activity.
90-104 degrees	Sunstroke, heat cramps and heat exhaustion are possible with prolonged exposure and/or physical activity.
105-129 degrees	Sunstroke, heat cramps and heat exhaustion are likely. Heat stroke is possible with prolonged exposure and/or physical activity.
130+ degrees	Heatstroke/sunstroke is highly likely with continued exposure.

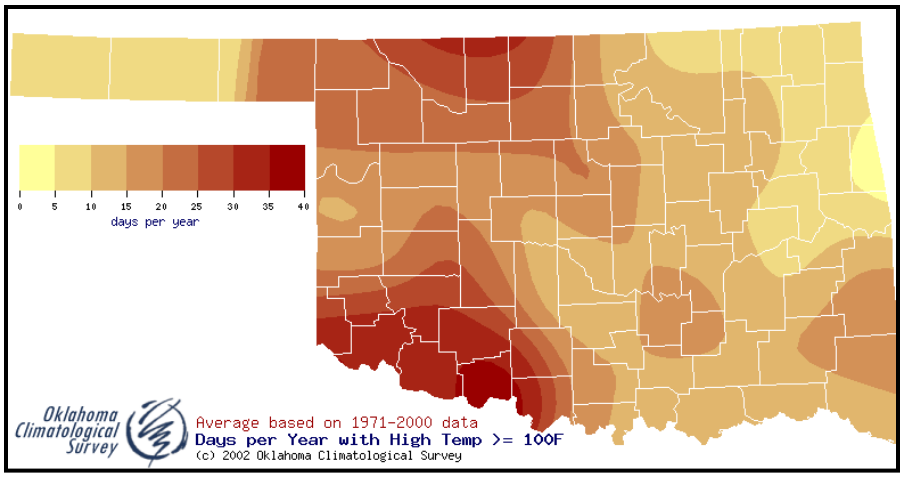
3.2.10.4 Previous Occurrences:



Map by Oklahoma State Health Department

Oklahoma's hottest August, according to National Weather Service records that date from 1892, occurred in 1936 when the state's average monthly temperature was a scorching 87.9 degrees. This is the second highest statewide-averaged monthly temperature (all months) recorded in Oklahoma during the 112 years with comprehensive records. The State's record daily maximum temperature of 120°F was equaled by two reporting stations (Altus and Poteau) on August 12, 1936. Again on June 27, 1994, the NWS recorded a high of 120°F at Tipton.

The mean annual temperature over the State ranges from 62°F along the Red River to about 58°F along the northern border. Temperatures of 100°F or higher occur, frequently during some years, from May through September, but very rarely in April and October. The western half of the State, excluding the panhandle, averages 15 or more days with triple-digit temperatures, ranging from about 35 in the SW corner to 25 in the NW. The eastern half of the state, as well as most of the Panhandle averages less than 15 such days. Years without 100°F temperatures are rare, ranging from about one of every seven years in the eastern half of the State to somewhat rarer in the west. On the other extreme, the heat wave of the summer of 1980 will be well remembered as the most prolonged and severe heat wave outside of the Dust Bowl years. The 50 days of triple-digit temperatures at Oklahoma City stands as an all-time record; the maximum of 110°F is the hottest day on record outside of the Dust Bowl.



Days/year >= 100˚- Latest available map from the Okla. Climatological Survey

SIGNIFICANT OKLAHOMA EXTREME HEAT HISTORY JANUARY 1950 – AUGUST 2010 Information provided by the National Climate Data Center (NCDC)					
DATE	**DESCRIPTION**	**PROP. DAMAGE**	**CROP DAMAGE**	**FATAL**	**INJ.**
Jul.-Aug. 2010	Temperatures were above normal with daytime readings reaching the upper 90s to near 102 and overnight temperatures only falling into the mid to upper 70s. Very humid conditions resulted in afternoon heat index values between 105 and 115 degrees. At least eleven people were treated for heat-related illness on the 30th and 31st in the Tulsa area.	Unknown	Unknown	0	11
Jul.-Aug. 2008	A prolonged period of excessive heat occurred across much of central and eastern Oklahoma during the early part of August. Daytime high temperatures reached the 100 to 105 degree range, daily maximum heat index values reached the 105 to 115 degree range, and morning low temperatures only fell into the upper 70s to lower 80s. Two direct fatalities resulted from this heat in Tulsa County and dozens of others were treated for the heat by EMSA. One man died due to a heat-related illness while driving a tractor six miles north of Lone Wolf. Another person hospitalized after collapsing from heat exhaustion in Oklahoma City.	Unknown	Unknown	3	47

SIGNIFICANT OKLAHOMA EXTREME HEAT HISTORY

JANUARY 1950 – AUGUST 2010

Information provided by the National Climate Data Center (NCDC)

DATE	DESCRIPTION	PROP. DAMAGE	CROP DAMAGE	FATAL	INJ.
Aug. 2007	**Extreme Heat -** Temperatures were in the upper 90s and heat indices were around 103. A 47 year old railroad worker collapsed of heat exhaustion after working all day in the summer heat. The man died shortly after being transported to a hospital. Aug. 12 – A strong ridge of high pressure developed over the south central United States resulting in abundant sunshine and hot temperatures. The humidity was also high as a result of the spring rains that continued well into the summer. The combination of hot temperatures and high humidity resulted in daytime heat index values from 105 to 113 degrees across much of eastern Oklahoma. Overnight temperatures remained above 75 degrees, which didn't allow much relief from the heat. Two hundred other people were treated by EMSA in Tulsa for heat related illnesses. Many of those victims were in attendance at the PGA Championship.	Unknown	Unknown	3	200
Aug. 2006	**Extreme Heat-** Triple digit heat that began at the end of July continued through the first half of August across central and eastern Okla. Overnight lows also remained high with temperatures only falling into the upper 70s to low 80s most nights. The heat caused the deaths of 5 women and 3 men across the area. Emergency services also made numerous calls across the area due to heat related illnesses. The heat caused several streets to buckle across the area. Afternoon heat indices ranged from 105 to 111 degrees and morning low temperatures were in the upper 70s to middle 80s.	Unknown	Unknown	9	0
July 2006	**Extreme Heat -** Temperatures reached triple digits across Okla. Starting in mid-July and continued through the end of the month. Many locations at times reached 105 degrees of greater with higher heat index values. Overnight lows remained warm for much of this time also with most locations only falling to 75+ degrees. The heat caused 10 fatalities across the area during this time period. Many fatalities occurred in homes that did not have fans or working air conditioners. Paramedic services also made numerous calls for heat-related illnesses during this time. The heat also caused a portion of Interstate 44, on the W side of Oklahoma City, to buckle. The heat also caused a strain on several power grids causing local authorities to ask people	Unknown	Unknown	13	100

SIGNIFICANT OKLAHOMA EXTREME HEAT HISTORY JANUARY 1950 – AUGUST 2010 Information provided by the National Climate Data Center (NCDC)					
DATE	**DESCRIPTION**	**PROP. DAMAGE**	**CROP DAMAGE**	**FATAL**	**INJ.**
	to minimize the consumption of power during the hottest parts of the day to prevent brown outs.				
Jul 31, 2001	**Extreme Heat -** An extended period of excessive heat affected all of western and central Oklahoma in July. Daily mean temperatures ranged from the mid 80s to near 90 degrees, which is four to five degrees above normal. Most areas regularly experienced high temperatures at or above 100 degrees, particularly western and north central Oklahoma. In addition to the excessive heat, rainfall averaged about one-third of normal, resulting in a drought. During the middle of July strong high pressure in the upper atmosphere became anchored over the south central part of the United States. This high pressure brought extreme heat to parts of NE Okla. At the Tulsa International Airport eight days out of eleven from July 16 to July 26 had high temperatures above 100. Meanwhile, on six of those days the low temperature did not fall below 80. Humidity was also a problem with dew points generally in the lower to mid 70s. This resulted in afternoon heat indexes around 115.	Unknown	Unknown	9	0
Aug 28-29, 2000	**Extreme Heat -** The high temperature in Oklahoma City was 103, which was the 12th day in a row at or above 100 degrees. One of the victims was found dead in her home in S Oklahoma City due to heat exhaustion. The control switch for the central air heating and cooling system was set in the heat position rather than the cool position.	Unknown	Unknown	2	0
Jul 26- 31, 1999	**Extreme Heat -** A period of very hot temperatures with highs ranging from the upper 90s to near 105 and lows ranging from the lower 70s to near 80, affected portions of central and southwest Oklahoma. Eight persons died, and 1 serious injury resulted from the excessive heat. Except for one fatality in Altus (Jackson Co.), the majority of persons who died from the heat owned an air conditioner, but it wasn't being used, and the windows of their homes were closed.	Unknown	Unknown	8	1+
Sep 1998	****Excessive heat** - Affected western and central Okla. From May through early October with the most intense heat and severe drought conditions occurring from mid-June through early September across central and southern Okla. The excessive heat and drought was less severe across NW and north central Okla. Sixty of Oklahoma's 77 counties	Unknown	$2 B	19	3+

SIGNIFICANT OKLAHOMA EXTREME HEAT HISTORY JANUARY 1950 – AUGUST 2010 Information provided by the National Climate Data Center (NCDC)					
DATE	**DESCRIPTION**	**PROP. DAMAGE**	**CROP DAMAGE**	**FATAL**	**INJ.**
	were declared federal disaster areas. Heat and drought conditions began in May, intensified in July and August, and diminished in September and early October. The heat and drought then ended in early October when widespread rain and cooler temperatures returned.				
Aug 1-4, 1998	**Extreme Heat -** On August 1, 1998, the high temperature at the McAlester Regional Airport was 107 degrees. On August 2, 1998, the high temperature at the McAlester Regional Airport was 108 degrees, breaking the record high temperature for the second day in row. Also on August 2, the low temperature for the day was 82, making that the warmest low temperature on record for that date in McAlester. These two days were the continuation of a heat wave that gripped SE Okla. In July 1998. The heat wave finally broke on August 4, which was the first day since July 16 that the temperature failed to reach at least 100 degrees in McAlester. August 2 marked eleven days in a row with high temperatures of at least 105 degrees in McAlester.	Unknown	Unknown	4	0
Jul 1998	**Extreme Heat -** A blistering heat wave struck the south-central part of the nation during July 1998, including much of eastern Okla. A drought also accompanied the heat wave in SE Okla., combining with the heat wave to cause devastating crop damage. Temperatures in some portions of SE Okla. Rose above 100 degrees on all but two days of the month, particularly further S. In Choctaw and Pushmataha Counties. At McAlester, 100+ degree temperatures were recorded on 24 out of 31 days during July. In fact, there were 15 consecutive days above the century mark from the 17th through the 31st, and the mercury soared to at least 105 degrees every day from the 23rd through the 31st, rising as high as 107 on three days. The average high temperature for the entire month of July in McAlester was 102.0 degrees. The average monthly temperature was 89.3 degrees, or 7.4 degrees above normal. The temperature failed to fall below 80 degrees on eight days of the month. Further N at Muskogee conditions were similar as temperatures reached at least 100 degrees on all but one day from the 18th through the 31st. The temperature rose as high as 107 on the 26th. The high temperature that day in Tulsa reached 99 degrees after a morning low of 80 with afternoon heat indices near 110 degrees.	Unknown	Unknown	12	452

SIGNIFICANT OKLAHOMA EXTREME HEAT HISTORY JANUARY 1950 – AUGUST 2010 Information provided by the National Climate Data Center (NCDC)					
DATE	**DESCRIPTION**	**PROP. DAMAGE**	**CROP DAMAGE**	**FATAL**	**INJ.**
	The temperature at Tulsa rose that day to 106, and McAlester rose to 105. Five deaths in eastern Okla. During July are blamed on the heat. The State Health Department reported that Emergency Medical Services throughout Oklahoma had responded to 452 heat-related injuries during the period June 1 to July 31.				
Jun 22-26, 1998	**Extreme Heat -** In the wake of a thunderstorm in Tulsa in the early morning of June 21, about 25,000 PSO customers in Tulsa lost electricity on Monday evening, June 22. The loss of air conditioning left many people vulnerable to afternoon temperatures of 96 degrees and heat indices in excess of 105 degrees. Local hospitals reported about half of a dozen cases of heat-related illnesses on June 22.	Unknown	Unknown	2	0
Jul 1, 1996	**Extreme Heat -** High temperatures topped the century mark in central Okla. Through the first week of July. On July 1, the high in Oklahoma City (at OKC) reached 102 degrees, then 104 on the 2nd, 103 on the 3rd, 105 on the 4th, 108 on the 5th, 110 on the 6th, and 106 on the 7th. During this prolonged period of hot temperatures statewide there were 7 deaths attributed to the excessive heat. All of the victims were elderly and all but one were in their homes without air conditioning.	Unknown	Unknown	7	0
Jun. 27, 1994	**Extreme Heat -** temperatures climbed to above 110 degrees in SW Okla. with readings in excess of 100 in NW and central Okla. The high temperature of **120 degrees** from the Oklahoma Mesonet four miles S of **Tipton** tied the record for the highest temperatures ever recorded in the state. Additional high temperatures included 119 degrees three mi. S of Altus, 116 degrees three mi. W of Gould, in Hollis and in Chattanooga and 115 in Frederick. An 84-year-old man who was working on his car in NW Okla. City during the afternoon hours died from hypothermia.	Unknown	Unknown	1	0
** - ***Presidential Disaster Declarations (Courtesy of FEMA).***					

The highest temperature ever recorded in the State was 120°F. This reading was first observed during the brutally hot summer of 1936: at Alva on July 18, at Altus on July 19 and August 12, and at Poteau on August 10. Tishomingo observed 120 F on July 26, 1943 and Tipton on June 27, 1994.

3.2.10.5 Probability of Future Events:

The probability is **Likely** that Extreme Heat will continue to be a major concern throughout Oklahoma.

Calculated Priority Risk Index (CPRI)

Extreme Heat = 2.4

Probability		3 Likely		
Magnitude/Severity		2 Limited		
Warning Time		1 24+ Hours		
Duration		3 Less than one week		
The CPRI for the Extreme Heat hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(3 x .45)	+ (2 x .30)	+ (1 x .15)	+ (3 x .10)	= 2.4

Resources:
Federal Emergency Management Agency
National Weather Service
Oklahoma Climatological Survey
OSU ***Southeast Oklahoma Extension***

3.2.10.6 Vulnerability and Impact:

The entire State of Oklahoma is at risk for extreme heat.

Oklahoma has a significant Extreme Heat hazard due to its climate. Summers are hot and usually dry, with daytime highs in the mid-90s and generally less than 4 inches of rain in July and August. Power supplies throughout Oklahoma are often adversely affected due to high use by the population (see resultant affect on population in "Vulnerable Populations".

Roads are also affected by extreme heat. Some older asphalt roads tend to "melt" or get soft with continued heat. Many of these roads are used by school buses and mail carriers. Concrete roads "explode" and crack due to the heat.

Agriculture is an important industry in Oklahoma and extreme heat can be extremely damaging to various crops during the summer months.

Livestock and livestock products make up the majority of Oklahoma's yearly farm income however the industry suffers when grass dries up and ranchers are unable to properly feed their livestock. Most of the state's cattle ranches are concentrated in the Panhandle and northern portions of Oklahoma. Beef producers particularly will be more concerned with the lack of moisture, short forage supplies, the distance they have to go to find hay, and the price they have to pay when they find it. They also have to be concerned about the impact the high daily temperature and humidity have on their cattle.

Cattle have an upper critical temperature that is 20 degrees cooler than humans. At 82 degrees and 75% humidity some humans may start to feel a little uncomfortable, but most cattle will be in the danger zone for heat stress. At 90 degrees and 65% humidity cattle are at extreme risk for heat stress. The humidity makes it difficult for cattle to dissipate body heat at these temperatures.

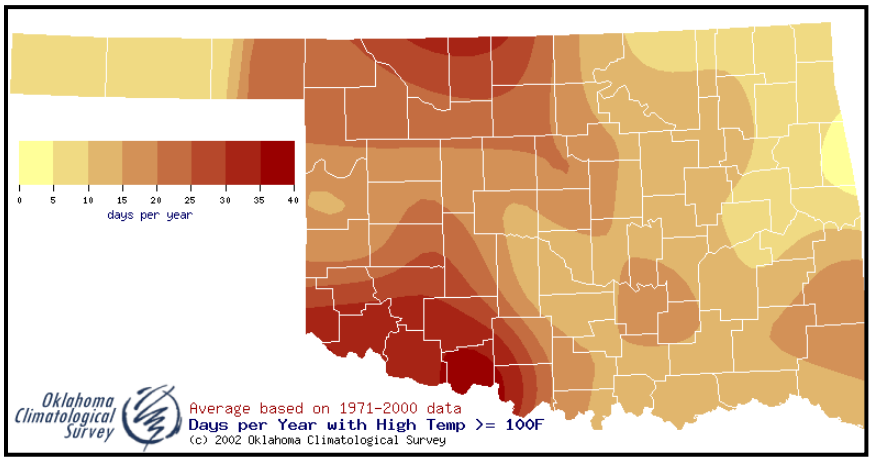
The heat index can however be used to determine when cattle can be safely handled without losing them to heat prostration.

Prolonged periods of high temperatures will result in the heat becoming a hazard to life and property. It can cause water shortages, intensify fire potential, and prompt excessive demands for energy. Extreme heat often causes power outages due to over use of power due to air conditioners. Food spoilage and sanitation problems begin occurring if the power is out for more than a few hours. Disruption of traffic flow occurs, and water outages sometimes occur, again due to overuse or low water supplies because of lack of precipitation.

Air pollution can also be a problem during summer months in Oklahoma. Ozone is a highly reactive form of oxygen. In the upper atmosphere, ozone forms a protective layer that shields us from the sun's ultraviolet rays. At ground level, ozone is a harmful air pollutant and a primary constituent of urban smog. Ozone is produced when air pollutants from automobile emissions and manufacturing operations interact with sunlight. Long-term exposure to high concentrations of ozone can cause a significant reduction in lung function, inflammation of the airways, and respiratory distress. The stagnant, dirty, and toxic air does not move away until a weather front arrives to disperse it.

Employment is often affected through outdoor construction or labor type jobs that either close down or limit activity due to the extreme heat. Damage to property during extreme heat is largely related to expanding and contracting soil and is covered under Hazard # 14, "Expansive Soils".

The following map depicts the average number of days where the daily high temperature is at or above 100 degrees. The southwest corner of the state which includes all or part of the counties of Harmon, Greer, Kiowa, Comanche, Stephens, Jefferson, Jackson, Tillman, Cotton, and parts of Woods, Alfalfa, and Grant counties along the northern border of Oklahoma are the most vulnerable to the hazard of extreme heat.



3.2.10.7 Vulnerable Populations:

Some elderly citizens either do not have air conditioners or fans that work or do not use them because of electric cost concerns and many become victims of the severe temperatures. People working

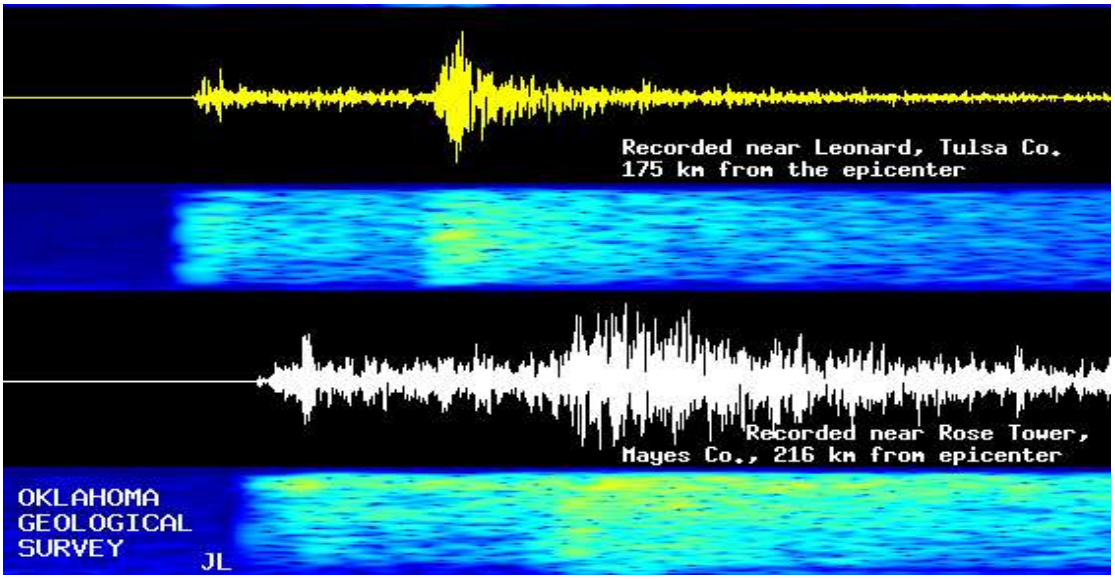
outside are also vulnerable to extreme temperatures. Both groups can become victims of heat exhaustion or heat stroke which can be fatal.

Young children, elderly and those who are sick or overweight are more likely to become victims. Heat kills by pushing the human body beyond its limits. Under normal conditions, the body's internal thermostat produces perspiration that evaporates and cools the body. However, in extreme heat and high humidity, evaporation is slowed and the body must work extra hard to maintain a normal temperature.

3.2.10.8 Conclusion:

While extreme heat is a hazard for Oklahomans most summers, efforts are being made throughout the state to mitigate the effects of the Extreme Heat hazard. The National Weather Service is now issuing Excessive Heat Warnings. They are issued when the combined effect of high temperatures and high humidities result in daytime heat indices greater than or equal to 105°F and nighttime ambient temperatures greater than or equal to 80°F that will persist for two days or longer.
State infrastructure can be damaged by extreme heat conditions. Roadways and highways can be damaged as can some equipment. State personnel can also be affected by extreme heat and critical work may have to be reduced or halted during heat situations.
Most heat related deaths (see above previous history table) involves the elderly who are either unable or unwilling to use their air conditioners/fans, the Red Cross, Salvation Army and even business owners are making efforts to see that those in need receive fans or air conditioners and then check to be sure they are using them. Other groups and communities are establishing "cooling stations" and shelters for individuals to use during high heat periods.

3.2.11 Earthquake

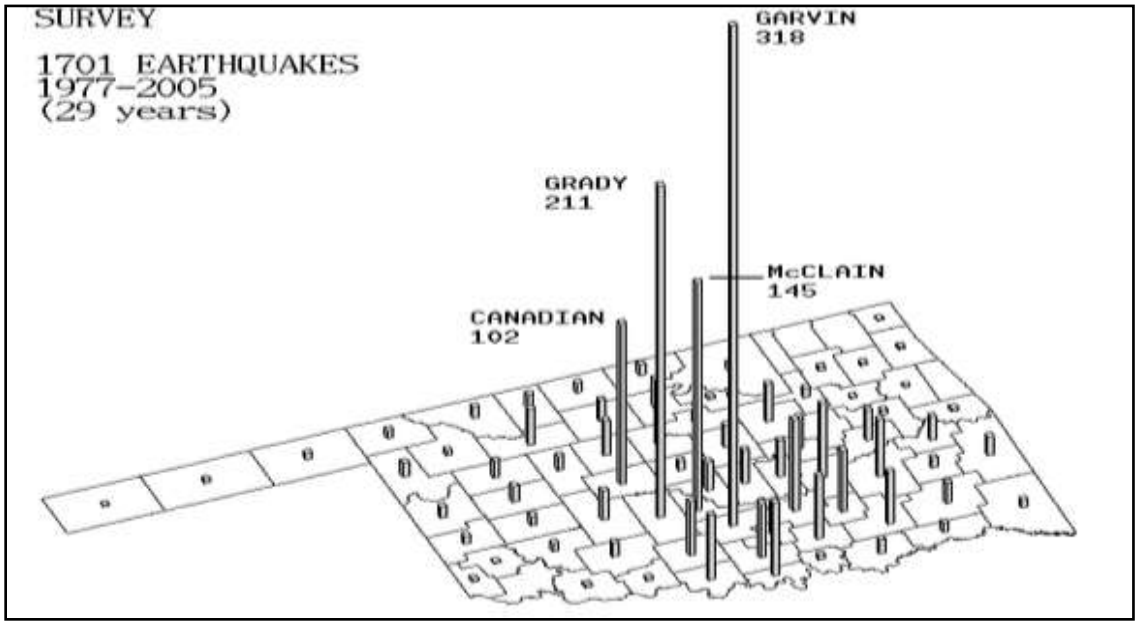


Hazard Priority # 11

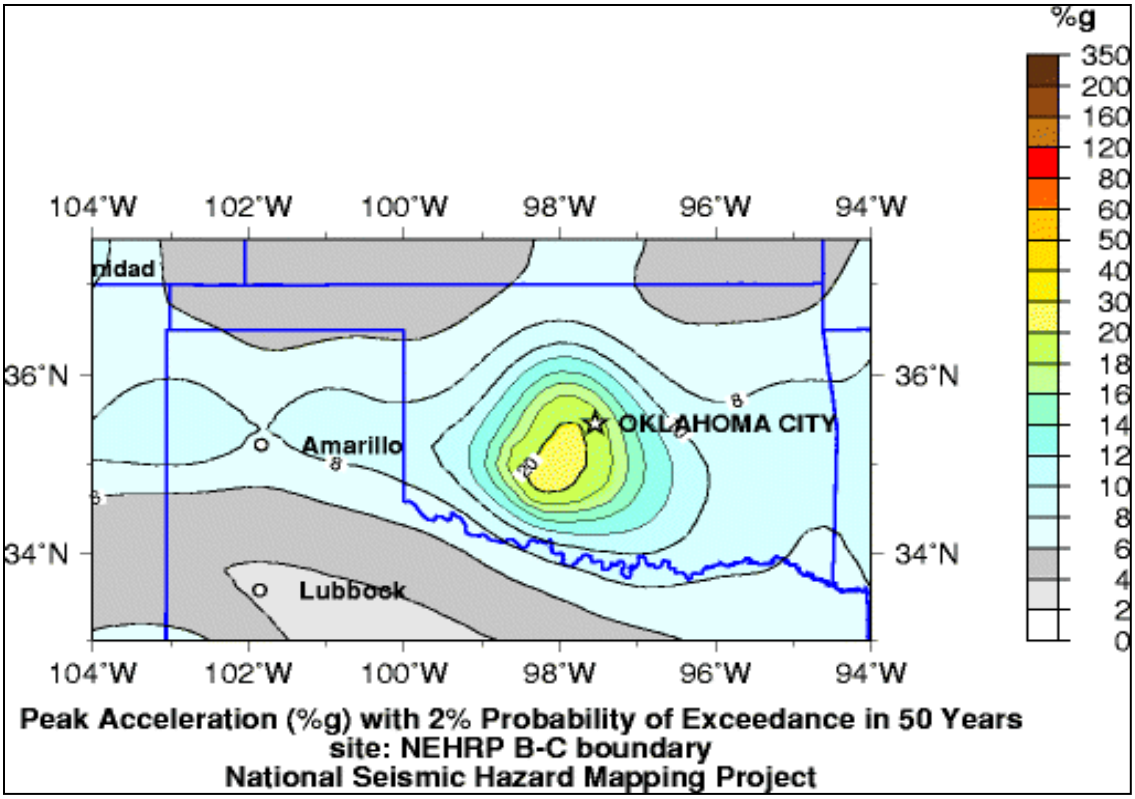
3.2.11.1 Description:

Most earthquakes occur as the result of slowly accumulating pressure that causes the ground to slip abruptly along a geological fault plane on or near a plate boundary. The resulting waves of vibration within the earth create ground motion at the surface that vibrates in a very complex manner.
From 1975-1995 there were only four states that did not have any earthquakes. They were: Florida, Iowa, North Dakota, and Wisconsin. Oklahoma experienced 1701 earthquakes from 1977 – 2005 which averages out to 58.6 per year. (OGSO)

Oklahoma Geological Survey

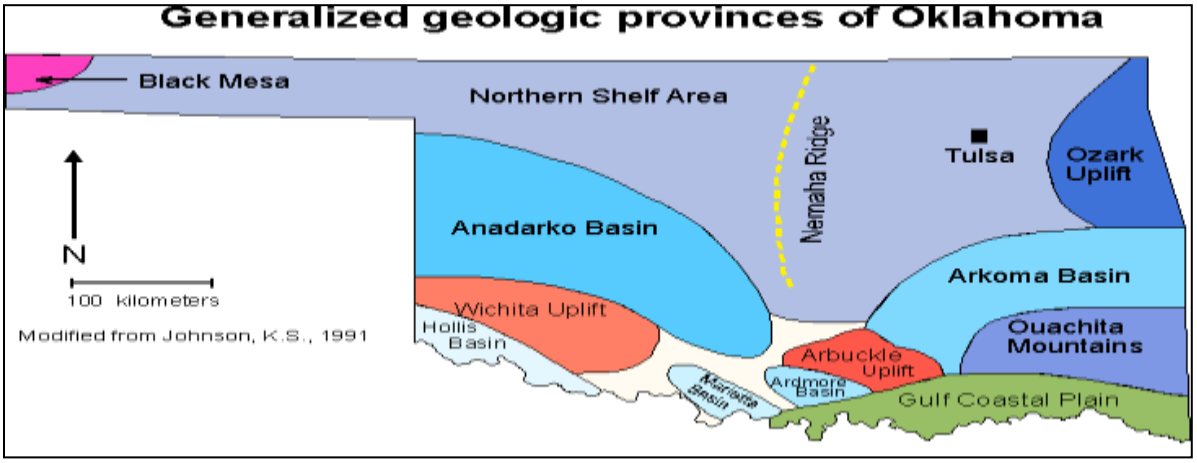


A series of great earthquakes in the New Madrid, Missouri region in 1811 - 1812, and a strong earthquake centered in Arkansas in Oct. 1881 were probably felt in what is now Oklahoma.
This area in Missouri can still have an impact on Oklahoma if the New Madrid fault becomes active.



The above chart indicates the Peak Acceleration which is primarily the area of increased activity within Oklahoma over the last few years. A review of the earthquake event chart on the previous page would bear out that the area shown on the PA map is almost exactly the boundaries of the event location map between 1977 and 2005. The most recent event on December 16, 2007 (a 2.5 magnitude) near McAlester in eastern Oklahoma was outside the major activity area.
In Oklahoma only a few earthquakes per year are not large enough to be felt, while the rest are not felt nor do any visible damage.

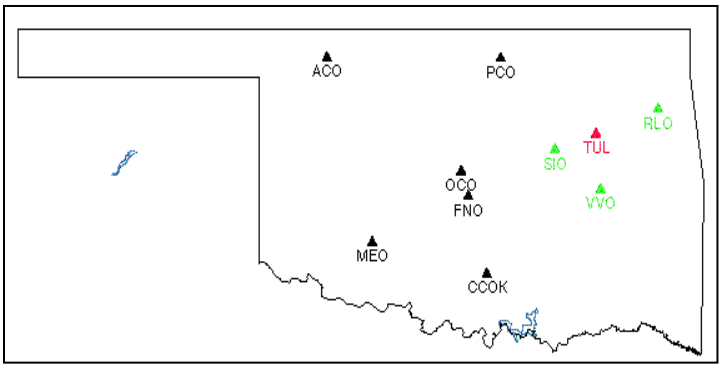
3.2.11.2 Location:



Oklahoma is at moderate risk for an earthquake, as a result of the State's proximity to the New Madrid Seismic Zone. **Seven main regions of earthquake activity exist in Oklahoma:**

- *the El Reno-Mustang area in central Oklahoma*;
- *Love and Carter counties*;
- an area in *southeastern Oklahoma north of the Ouachita Mountains in the Arkoma Basin*;
- *the Meers fault, located near Meers on the eastern edge of the Anadarko Basin;*
- *the area around Lindsay in Garvin County;*
- *an area near Ada in Pontotoc County;*
- *and in eastern Oklahoma County near Jones (Memorial Rd. / Indian Meridian Rd.)*

The Oklahoma Geological Survey Observatory (OGS) in rural Tulsa County, south of Leonard is a comprehensive geophysical observatory which records, identifies, and locates 30 to 167 Earthquakes in Oklahoma each year, and also records about five worldwide earthquakes per day. The (OGS) operates a statewide network of earthquake detecting equipment. The Oklahoma Geophysical Observatory operates eight satellite seismograph stations and records seismological data. Earthquake data has been recorded for the State of Oklahoma since January 1, 1962; however, the statewide network did not become operational until 1977.



OKLAHOMA SEISMOGRAPH STATION LOCATIONS		
STATION	**LOCATION**	**EQUIPMENT UTILIZED**
TUL	Near Leonard Okla. (Tulsa Co.)	Oklahoma Geological Survey Observatory
RLO	Rose Lookout (Mayes Co.)	Telemeter remote location – (sends to Leonard)
SLO	Slick (Creek Co.)	Telemeter remote location – (sends to Leonard)
VVO	Vivian (McIntosh Co.)	Telemeter location – (sends to Leonard)
CCOK	No information	No information
ACO	Alabaster Caverns (Woods Co.)	Seismometer - volunteer operated
PCO	Ponca City (Kay Co.)	Digitizers communicating with SCREAM software running on PCs. SCREAM send packets over the internet to Leonard.
OCO	Oklahoma City (Oklahoma Co.)	Seismometer - volunteer operated

MEO	Meers (Comanche Co.)	Digitizers communicating with SCREAM software running on PCs. SCREAM software sends packets over the internet to Leonard.
FNO	Franklin (Cleveland Co.)	S-13 Seismometer - volunteer operated
		Seismometer - (Seismograph)

The earthquake database can be used to develop numerical estimates of earthquake risk, which give the theoretical frequency of earthquakes of any given size for different regions of Oklahoma. Numerical risk estimates are used in the design of large-scale structures, such as dams, high-rise buildings, and power plants, as well as providing information needed to establish insurance rates.

3.2.11.3 Extent:

Earthquake: Richter scale, Mercalli Scale

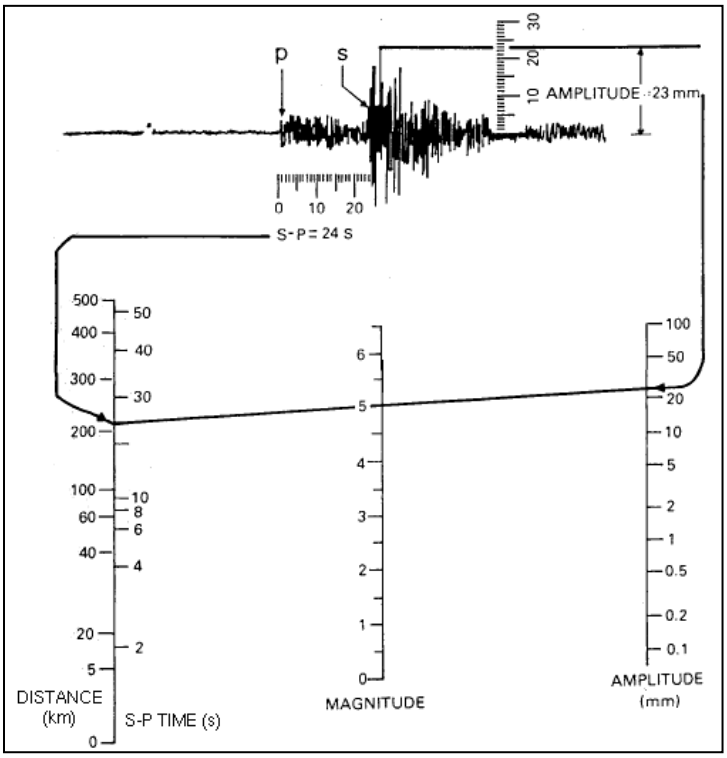
Mercalli/Richter Scale Comparison

Mercalli Scale	Richter Scale	Full Description
I.	**0 – 1.9**	Not felt. Marginal and long period effects of large earthquakes.
II.	**2.0 -2.9**	Felt by persons at rest, on upper floors, or favorably placed.
III.	**3.0 – 3.9**	Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.
IV.	**4.0 - 4.3**	Hanging objects swing. Vibration like passing of heavy trucks. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink the upper range of IV, wooden walls and frame creak.
V.	**4.4 - 4.8**	Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Pendulum clocks stop, start.
VI.	**4.9 - 5.4**	Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Books, etc., off shelves. Pictures off walls. Furniture moved. Weak plaster and masonry D cracked. Small bells ring. Trees, bushes shaken.
VII.	**5.5 - 6.1**	Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices. Some cracks in masonry C. Waves on ponds. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.
VIII.	**6.2 - 6.5**	Steering of motor cars affected. Damage to masonry C; partial collapse. Some damage to masonry B. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.

IX.	**6.6 - 6.9**	General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. (General damage to foundations.) Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluvial areas sand and mud ejected, earthquake fountains, sand craters.
X.	**7.0 - 7.3**	Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.
XI.	**.7.4 - 8.1**	Rails bent greatly. Underground pipelines completely out of service.
XII.	**> 8.1**	Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.

Masonry A: Good workmanship, mortar, and design; reinforced, especially laterally, and bound together by using steel, concrete, etc.; designed to resist lateral forces.
Masonry B: Good workmanship and mortar; reinforced, but not designed in detail to resist lateral forces.
Masonry C: Ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at corners, but neither reinforced nor designed against horizontal forces.
Masonry D: Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.
Source: http://www.abag.ca.gov/bayarea/eqmaps/doc/mmigif/m10.html

The State of Oklahoma considers a reading of 5.4 and below on the Richter scale a minor severity and 5.5 and above to be a major severity.
The Richter magnitude scale was developed in 1935 by Charles F. Richter of the California Institute of Technology as a mathematical device to compare the size of earthquakes. This scale is usually the one referred to by news media when making public reports. The **RICHTER SCALE** is most familiar to the public. The diagram below shows how to use the Richter's original method to measure a seismogram for a magnitude estimate.

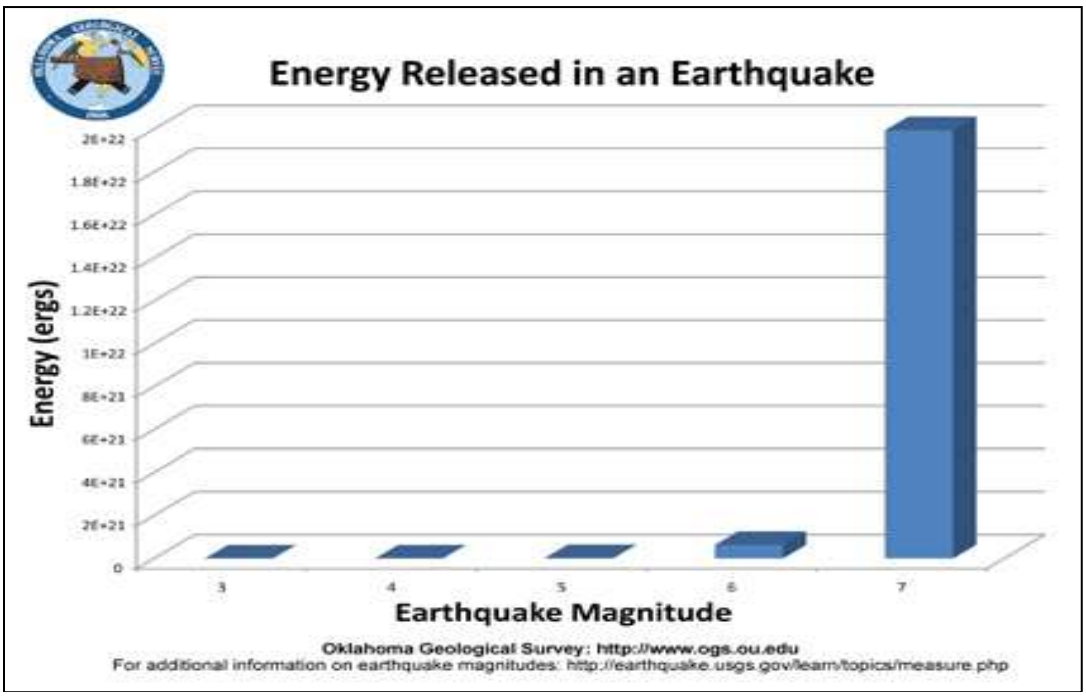


The scales in the diagram above form a **nomogram** that allows you to do the mathematical computation quickly by eye. The equation for Richter Magnitude is:

$$M_L = \log_{10} A(mm) + (\text{Distance correction factor})$$

Modified Mercalli Intensity Scale:

The scale currently used by the scientific community in the United States is the Modified Mercalli (MM) Intensity Scale. It does not have a mathematical basis; instead it is an arbitrary ranking based on observed effects. An abbreviated description of the 12 levels of Modified Mercalli intensity and both scales are shown on the table above.

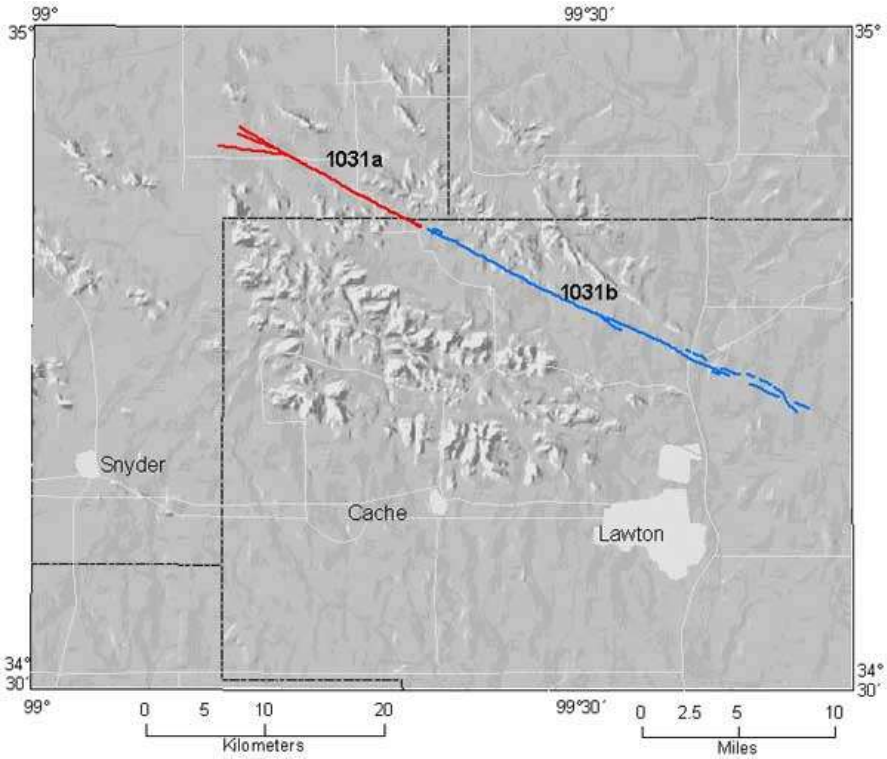


3.2.11.4 Previous Occurrences:

The Meers Fault

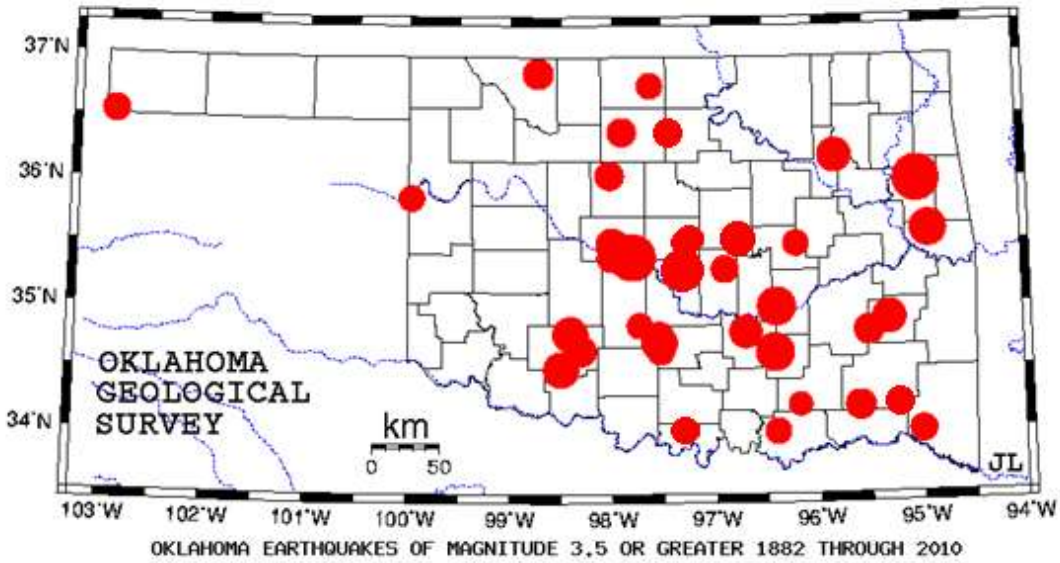
An earthquake that happened many thousands of years ago created the Meers fault and it is one of the many visible faults in the United States. The fault is considered a profound structural dislocation, and forms the frontal fault zone between the Wichita Uplift to the south and the Anadarko Basin to the north. The Meers fault is part of the Pennsylvanian Frontal Fault System that stretches from the southeast to the northwest through south central and southwest Oklahoma and into the Texas Panhandle.

A distinct fault trace is visible for 15 miles from near Saddle Mountain to Cache Creek. The Meers fault would appear to belong in California, where young faults are plentiful, but it is the only surface-breaking rupture east of the Rocky Mountains. The Meers fault is the first documented movement of a fault in the last 10,000 years in the Central Mid-Continent region of the United States - Oklahoma, Kansas, Nebraska, South Dakota, and North Dakota. Recent studies show the time of the last major movement occurred 500 to 2000 years ago, and that the Meers fault could produce a magnitude 7.0 earthquake in the future. The Meers fault has been extremely quiet, with only one small quake occurring in 1981. This quietness makes some scientists uncomfortable, but most believe there is little cause for immediate concern. Geologically speaking, 1500 to 2000 years is quite recent.

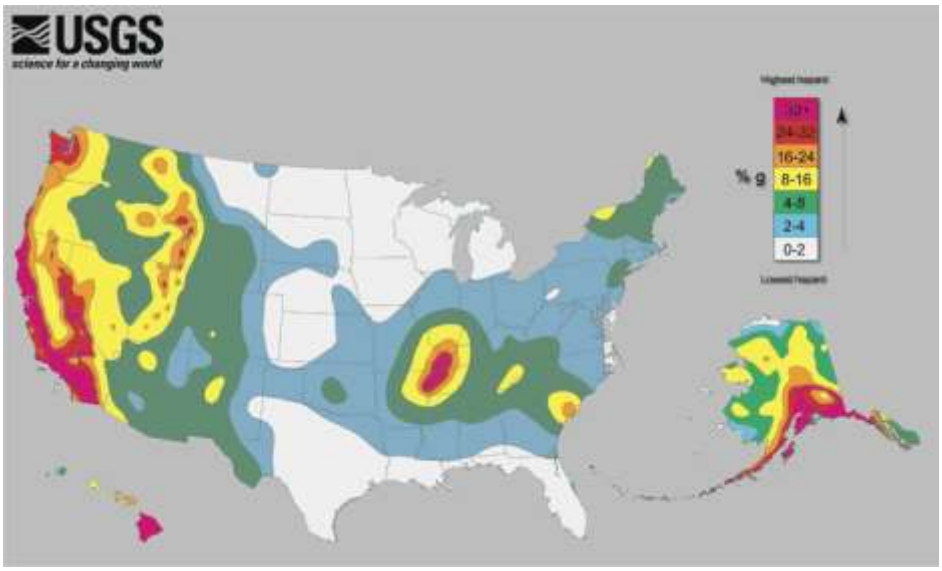


New studies suggest that earthquakes occur in the Meers fault at very long intervals. It could be another thousand years before another major quake occurs.
On average, only about one or two earthquakes are reported as "felt" by Oklahoma residents each year. The Oklahoma Seismograph Network was not really complete until 1979. Some of the apparent increase in the number of recorded earthquakes in Oklahoma lately is due to further improvements in the ability to detect and locate earthquakes.

“Felt” earthquakes in Oklahoma while in the minority are also those that tend to concern people the most. The map shown below plots the locations of earthquakes from 1882 through 2003 that were 3.5 magnitude or greater. Although there have been significant events in the area of the Meers Fault, there has been significant activity in other areas also. One particularly active area since 2008 is in eastern Oklahoma County, near Jones. Between 2009 and September 2010, at least nine earthquakes of magnitude 3.5 have occurred in this area. A magnitude 4.1 quake happened in southeast Lincoln County near Sparks on February 27, 2010. This was topped by a 4.7 earthquake, rated the second strongest in the history of Oklahoma, on October 13, 2010. This earthquake occurred just south of the aforementioned active area and was felt widely across much of the eastern 2/3rds of the State and into the Dallas-Fort Worth area.



The map below appears to indicate the activity in Eastern Oklahoma could be a part of the low intensity area of the New Madrid Fault in Missouri.



Oklahoma Earthquakes with Magnitude 4.0 or Greater			
Date	**County**	**Nearest Town**	**Magnitude**
April 9, 1952	Canadian	El Reno	5.7
October 13, 2010	Cleveland	Norman	4.7
June 1, 1939	Hughes	Spalding	4.4
September 6, 1997	Coal	Stonewall	4.4
June 20, 1926	Sequoyah	W Marble City	4.3
June 17, 1959	Comanche	NE Faxon	4.2
January 18, 1995	Garvin	Antioch	4.2
April 28, 1998	Comanche	NW Richards Spur	4.2
October 30, 1956	Rogers	Catoosa	4.1
February 27, 2010	Lincoln	Sparks	4.1
April 27, 1961	Latimer	Wilburton	4.1
December 27, 1929	Canadian	El Reno	4.0
June 15, 1959	Pontotoc	Ada	4.0
November 15, 1990	Garvin	Lindsay	3.9

SIGNIFICANT OKLAHOMA EARTHQUAKE HISTORY
JANUARY 1918 – OCTOBER 13, 2010
(Information provided by the Oklahoma Geological Survey)

DATE	DESCRIPTION	PROP. DAMAGE	FATALITIES	INJURIES
Oct 13, 2010	**Earthquake –** During updating this plan, the second strongest earthquake in the history of Oklahoma struck about 8 miles southeast of Norman, south of Lake Thunderbird near E Post Oak Road and 84th Avenue SE. Official reports rated the 9:06 a.m. quake as magnitude 4.7 It was heard as a low rumble for about 20 seconds at the OEM office north of the Capitol, and evidence could be seen as a slight shaking seen in a cup of coffee. USGS received reports of it being felt all over the eastern 2/3rds of the state, mainly east of highway U.S. 281 and west of U.S. 269. Residents and emergency managers confirm the earthquake was felt in Bryan, Caddo, Canadian, Cleveland, Coal, Comanche, Garvin, Johnston, Kingfisher, McClain, Muskogee, Nowata, Oklahoma, Osage, Pontotoc, Pottawatomie,	Unknown	0	2

SIGNIFICANT OKLAHOMA EARTHQUAKE HISTORY
JANUARY 1918 – OCTOBER 13, 2010
(Information provided by the Oklahoma Geological Survey)

	Stephens, Tulsa and Washington counties. OEM has received a few reports of minor damage, primarily to windows and due to items falling from shelves. EMSA reports two patients suffering from a fall required medical care. USGS reports the shaking was felt south of Dallas-Fort Worth and into NW Arkansas, with a few reports in Wichita. No reports of fatalities have been received and damage is very minor, with isolated reports of broken windows and items that fell from shelves.			
Jan 7, 2008	**Earthquake -** The Oklahoma Geological Survey says an earthquake was reported in south-central Okla. It happened at about 1:43 p.m. About 4 miles SE of Purdy in Garvin County. Only one person reported feeling the quake, saying she heard windows rattling and her dog was 'acting berserk'. The quake was a magnitude 2.0, which is one of the smallest felt by humans. It's the first earthquake in Garvin Co. in nearly 17 months. Garvin Co is the most active in the state when it comes to earthquakes, registering 319 temblors since 1997.	Unknown	Unknown	Unknown
Oct. 19, 2002	**Earthquake** - This earthquake occurred at 9:18PM. The epicenter was about 6 miles N of Darwin, 19 miles E of Atoka (Atoka Co.), or 40 miles NE of Durant (Bryan Co.). The magnitude was 3.4 on the mbLg scale (one version of the Richter scale). The earthquake was felt widely in Bryan County and Atoka County. It was also felt in	Unknown	Unknown	Unknown

SIGNIFICANT OKLAHOMA EARTHQUAKE HISTORY JANUARY 1918 – OCTOBER 13, 2010 *(Information provided by the Oklahoma Geological Survey)*				
	Coleman (Johnston Co). It reportedly sounded like an explosion or sonic boom, sometimes accompanied followed by a slight shaking and rattling of dishes and windows. Flower pots were knocked off a shelf 9 mi S. of Bentley (Atoka Co.). The Bryan Co., Sheriff's office, and the Atoka Co. S.O. received some calls concerned that the loud boom might have been a terrorist explosion.			
Jun 19, 2002	**Earthquake:** Cimarron Co. Earthquake had an epicenter 7.2 mi. W of Felt and 26 mi. SW of Boise City (both in Cimarron Co.). This is very near the point where the borders of Oklahoma, Texas, and New Mexico meet. The earthquake was also felt in Dalhart TX, and Clayton NM. This was the first earthquake in Cimarron Co. in 26 years. The only known previous earthquakes in Cimarron Co. were a magnitude 2.1 and magnitude 2.7 on March 30, 1976. Cimarron Co. residents have felt some earthquakes with epicenters outside their county. The magnitude 5.7 earthquake centered W of Okla. City in Canadian Co. was felt in all Oklahoma Counties in 1952.	Unknown	Unknown	Unknown
Nov. 15, 1990	Earthquake: Meers Geological Survey station (Comanche Co.) recorded a trembler, magnitude 3.6 in northern Garvin Co., about 55 miles E of Meers. It rattled windows in Lindsay (Garvin Co.) and Rush Springs (Grady Co.). It was the largest earthquake in Oklahoma since December 8, 1987 when a magnitude 3.7 occurred in Kingfisher County.	Unknown	Unknown	Unknown
May 2, 1969	**Earthquake** - A magnitude 4.6 earthquake caused some	Unknown	Unknown	Unknown

SIGNIFICANT OKLAHOMA EARTHQUAKE HISTORY
JANUARY 1918 – OCTOBER 13, 2010
(Information provided by the Oklahoma Geological Survey)

	cracked plaster at Wewoka (Seminole Co). Intensity V effects were reported at several other towns in the region. The total felt area was in eastern Oklahoma.			
Oct. 14, 1968	**Earthquake** - An earthquake caused minor damage at Durant (Bryan Co.). Walls cracked and glass in two structures broke. The press reported that a 5 ft. tall advertising stand fell over, and canned goods fell from a rack in a supermarket. Slight foreshocks were felt at Durant (Bryan Co.) on Oct. 10 and 11. Intensity IV effects from the area were felt.	Unknown	Unknown	Unknown
June 17, 1959	**Earthquake** - A broad area of SW Okla. and the adjacent portion of Texas were affected by an early morning shock. Slight damage, consisting of cracks in plaster, pavement, and a house foundation, occurred in Comanche Co. and Stephens Co. Houses were shaken, buildings swayed, and many persons alarmed. Dishes were reported broken and a trembling motion was observed.	Unknown	Unknown	Unknown
Oct. 30, 1956	**Earthquake** - An area in northeastern Oklahoma was shaken. The maximum intensity of VII was reported W. of Catoosa (Rogers Co.), where a slippage of the formation caused an oil well to be shut down. Minor damage occurred at Beggs (Okmulgee Co.) and Tulsa Co.; and an isolated felt report was received from Electra, Texas.	Unknown	Unknown	Unknown
Apr. 2, 1956	**Earthquake** – SE Okla. was disturbed by an earthquake that produced thundering, rattling, and bumping noises that were heard by many citizens. Buildings shook and objects fell	Unknown	Unknown	Unknown

SIGNIFICANT OKLAHOMA EARTHQUAKE HISTORY
JANUARY 1918 – OCTOBER 13, 2010
(Information provided by the Oklahoma Geological Survey)

	at Antlers (Pushmataha Co.), alarming many. Minor effects were reported from other nearby towns.			
Feb. 16, 1956	**Earthquake** – a shock at Edmond broke windows and cracked plaster. It was also felt strongly in Logan Co. and Pawnee Co.	Unknown	Unknown	Unknown
Mar. 17, 1953	**Earthquake** -Minor damage to a building foundation and plaster at Concho resulted from two earthquakes about an hour apart. The felt area included Canadian Co., parts of Oklahoma Co. and Grady Co.	Unknown	Unknown	Unknown
Oct. 7, 1952	**Earthquake** - felt at Holdenville (Hughes Co.) and Wewoka (Seminole Co.) apparently was unrelated to the April 9th event. Homes and buildings shook and some persons were awakened in Canadian Co. Felt reports were also received from Kingfisher Co., Oklahoma Co., and Tulsa Co.	Unknown	Unknown	Unknown
Apr. 9, 1952	**Earthquake -** The largest Okla. Earthquake ever recorded was the El Reno earthquake, with a magnitude of about 5.7 on the Richter scale. (There has been some debate as to whether it was a 5.5 or 5.7.) The event was caused by slippage along the Nemaha fault. This earthquake caused moderate damage in El Reno (Canadian Co.), Oklahoma Co., and Ponca City (Kay Co.), including toppled chimneys and smokestacks, cracked and loosened bricks on buildings, and broke windows and dishes. One crack in the State Capitol at OKC was 15 meters long. Slight damage was reported from many other towns in Okla. and some towns in Kansas, Arkansas, Iowa, Kansas, Missouri, Nebraska, and Texas.	Unknown	Unknown	Unknown

SIGNIFICANT OKLAHOMA EARTHQUAKE HISTORY JANUARY 1918 – OCTOBER 13, 2010 *(Information provided by the Oklahoma Geological Survey)*				
	Aftershocks were felt on April 11, 15, and 16, July 16, and August 14.			
Dec 27, 1929	**Earthquake -** another tremor centered in the El Reno area was felt in portions of central and western Oklahoma. Some plaster cracked and at least one chimney fell at El Reno. In addition, clocks stopped, objects moved, and some reports indicated the walls and floors seemed to sway. In several cities, people rushed from their homes in alarm.	Unknown	Unknown	Unknown
Sep. 10 1918	**Earthquake -** The first known to have been centered in the State. A series of shocks at El Reno produced only minor effects; the strongest was intensity V. Objects were thrown from shelves. Other shocks occurred on the next day.	Unknown	Unknown	Unknown

On average there are about 50 measurable earthquakes each year in Oklahoma with only a few of these having shaking strong enough to be felt. A total of 43 felt earthquakes in 2009 made this an exceptional year for seismic activity in Oklahoma. Twenty-seven of the felt earthquakes occurred in Oklahoma County, and another 7 were located in Lincoln County.
Is the number of felt earthquakes occurring northeast of Oklahoma City, unusual? Perhaps, however at this point there is no reason to be alarmed. Small earthquakes such as these can occur anywhere in the world. The US Geological Survey (USGS) estimates that there are as many as 3,000 of these small earthquakes occurring every day. Earthquake swarms like this can go on for many months, and usually do not lead up to a major earthquake.

Do we know what is causing the earthquakes? No, without further study it is not possible to determine what is causing the earthquakes. The USGS and the Oklahoma Geological Survey are working together to conduct a limited field study to better measure any future earthquakes that could occur in eastern Oklahoma County.

3.2.11.5 Probability of Future Events:

The potential of future Earthquake events is a threat in most of Oklahoma although slight because of slow geological movement. The most likely areas are in the counties shown on the map above. The danger of additional earthquakes in Oklahoma is **Possible.**

Calculated Priority Risk Index (CPRI)

Earthquake = 1.9

Probability		2 Possible		
Magnitude/Severity		1 Negligible		
Warning Time		4 Less than 6 Hours		
Duration		1 Less than 6 hours		
The CPRI for the Earthquake hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(2 x .45)	+ (1 x .30)	+ (4 x .15)	+ (1 x .10)	= 1.9

Resources: United States Geological Survey: Oklahoma Geological Survey Observatory (OGS)

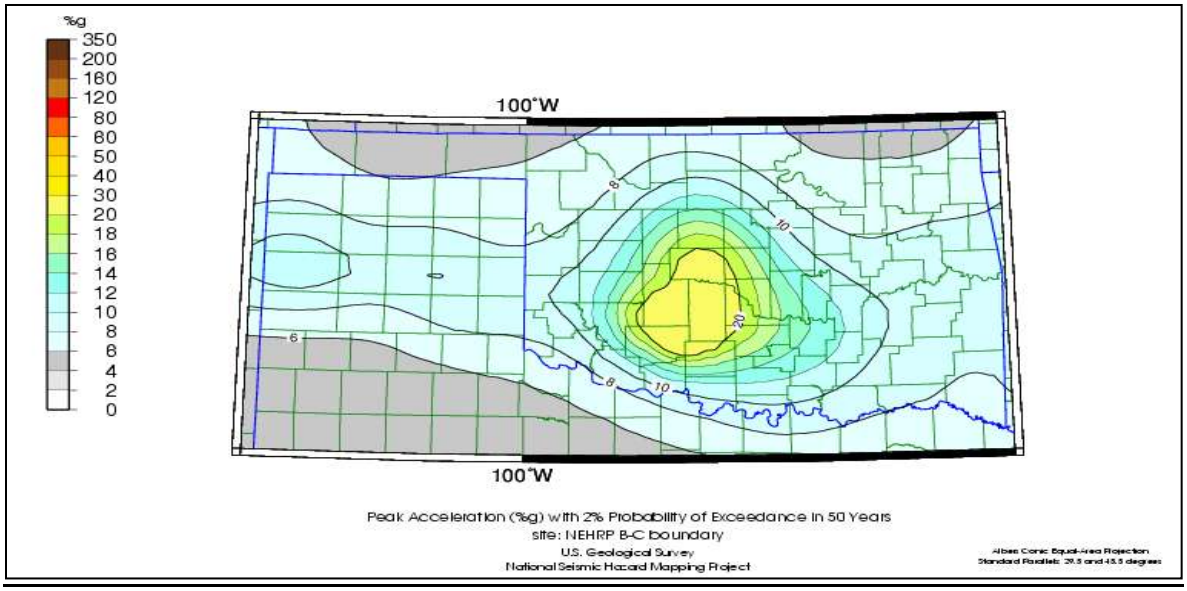
3.2.11.6 Vulnerability and Impact:

Buildings with foundations resting on unconsolidated landfill and other unstable soil, and trailers and homes not tied to their foundations are at risk because they can be shaken off their mountings during an earthquake. The effect of earthquakes on state-owned property and critical facilities is largely unknown due to the fact that there have not been any serious earthquakes since 1952. Areas of particular concern are bridges and highway overpasses which are currently undergoing upgrades or replacement. Even a small earthquake in the right location could cause a dam to begin leaking and eventually break.

Although Oklahoma is within the stable interior of the United States and we only average 58 minor earthquakes each year and most are too small to be felt, that could change. Even small magnitude earthquakes can cause damage. Should an earthquake as large as the 1952 El Reno earthquake, or larger, occur in the future, houses and businesses, and government infrastructure will suffer extensive damage possible deaths and injuries from falling debris. Disruption of traffic flow would probably occur not only for citizen's day to day traffic but also critical services such as emergency police, fire and ambulance. School bus and mail routes would also be disrupted due to damaged or destroyed roads and bridges. Power and water outages have occurred in the past which causes food to spoil and could also cause sanitation problems for communities due to broken sewer lines. Schools, hospitals, grocery stores and other critical need and economically important facilities would likely be damaged and could be closed for extended periods. Employment would be affected because of businesses that close due to the damage and loss of business.

3.2.11.7 Vulnerable Populations:

When an earthquake occurs in a populated area, it may cause deaths and injuries and extensive property damage. The following map shows peak ground acceleration with a probability of exceedance in 50 years. The counties of Canadian, Caddo, Grady, Comanche, Stephens, and McClain are the most vulnerable to the hazard of earthquake.



3.2.11.8 Conclusion:

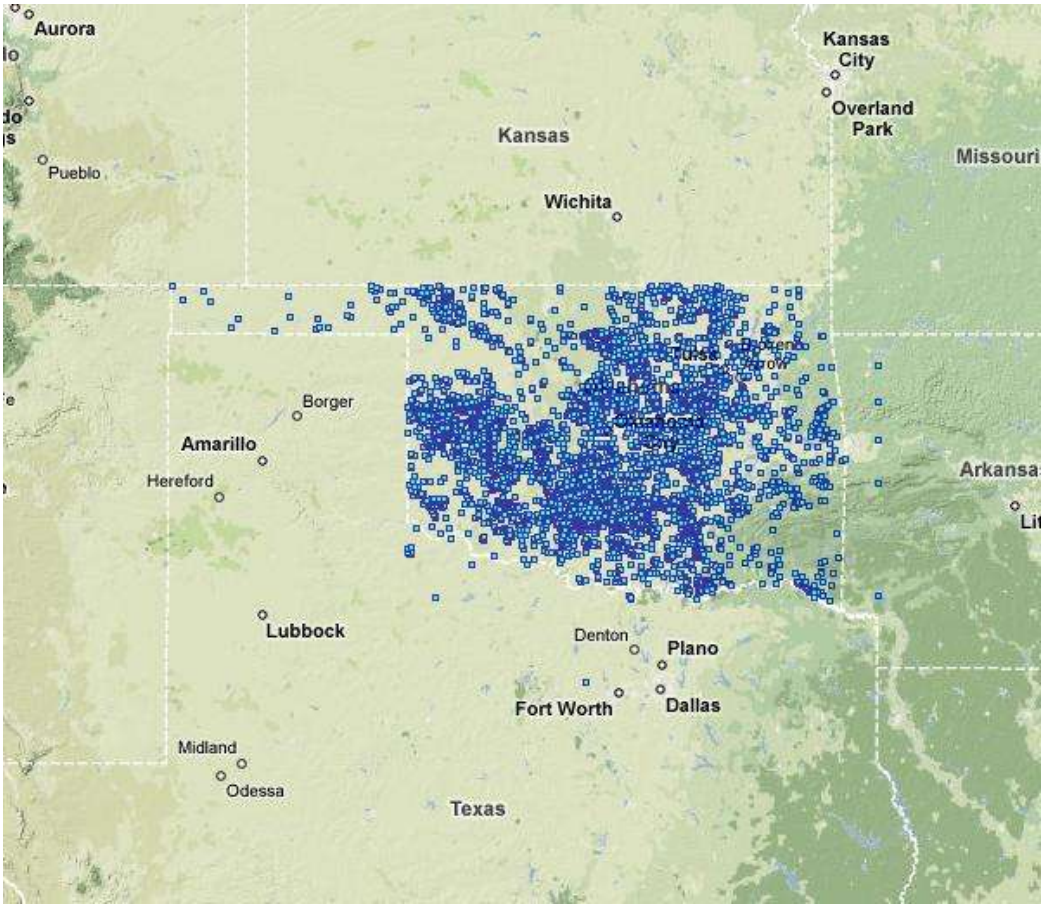
Oklahoma averages about 50 to 100 recorded earthquakes per year but only about one or two, on average, are felt and no damage estimates are available by facility. Several counties within the State of Oklahoma are at higher risk than others, but the probability of a future event of any significance along the Meers fault is still being debated by scientists.

3.2.12 Dam Failure

Hazard Priority # 12

3.2.12.1 Description:

According to the U.S. Army Corps of Engineers, Oklahoma has 4755 dams. Many are small farm and ranch ponds, or small lakes. Follow this link for a current listing of Oklahoma Dams. http://oklahoma.hometownlocator.com/features/cultural,class,dam,alpha,a.cfm



A dam is an artificial barrier usually constructed across a stream channel to impound water. Timber, rock, concrete, earth, steel or a combination of these materials may be used to build the dam. In Oklahoma, most dams are constructed of earth or concrete. Dams must have spillway systems to safely convey normal stream and flood flows over, around, or through the dam. Spillways are commonly constructed of non-erosive materials such as concrete. Dams should also have a drain or other water-withdrawal facility for control of the pool or lake level and to lower or drain the lake for normal maintenance and emergency purposes.

A dam that impounds water in the upstream area is referred to as a reservoir. The amount of water impounded is measured in acre-feet. An acre-foot is the volume of water that covers an acre of land to a depth of one foot. As a function of upstream topography, even a very small dam may impound or detain acre-feet of water. Two factors influence the potential severity of a full or partial dam failure: the amount of water impounded, and the density, type, and value of development and infrastructure located downstream.

Dam failures are generally catastrophic if the structure is breached or significantly damaged. There are about 84,000 dams in the United States, according to the 2009 update to the Corps of Engineers' National Inventory of Dams. Approximately one third of these pose a "high" or "significant" hazard to life and property if failure occurs.

Dam failure or levee breeches can occur with little warning. Intense storms may produce a flood in a few hours or even minutes for upstream locations. Flash floods occur within six hours of the beginning of heavy rainfall, and dam failure may occur within hours of the first signs of breaching. Other failures and breeches can take much longer to occur, from days to weeks, as a result of debris jams or the accumulation of melting snow.

Dam failures are of particular concern because the failure of a large dam has the potential to cause more death and destruction than the failure of any other man-made structure. This is because of the destructive power of the flood wave that would be released by the sudden collapse of a large dam.

Dam failures are most likely to happen for one of five reasons:

- Overtopping caused by water spilling over the top of a dam
- Structural failure of materials used in dam construction
- Cracking caused by movements like the natural settling of a dam
- Inadequate maintenance and upkeep
- Piping when seepage through a dam is not properly filtered and soil particles continue to progress and form sinkholes in the dam

Dams are innately hazardous structures. Failure or mis-operation can result in the release of the reservoir contents--this includes water, mine wastes or agricultural refuse--causing negative impacts upstream or downstream or at locations remote from the dam. Negative impacts of primary concern are loss of human life, economic loss including property damage, lifeline disruption and environmental damage.

Some dams are considered to have a greater hazard potential than others. There are approximately 10,000 state-regulated "high hazard" potential dams in the U.S. "High hazard" is a term used to

determine how hazardous a dam's failure might be to the downstream area. While the definition varies from place to place, it generally means if failure of a high hazard dam occurs, there probably will be loss of life. It must be emphasized that this determination does not mean that these dams are in need of repair--these dams could be in excellent condition or they could be in poor condition.

High hazard potential dams exist in every state and affect the lives of thousands downstream. The current issue and debate is over the increasing number of these high hazard structures--not because more high-hazard dams are being built, but that more development is occurring downstream. Dam safety regulators generally have no control over local zoning issues or developers' property rights.

Routine deformation monitoring of seepage from drains in, and around, larger dams is necessary to anticipate any problems and permit remedial action to be taken before structural failure occurs. Most dams incorporate mechanisms to permit the reservoir to be lowered or even drained in the event of such problems. Another solution can be rock grouting – pressure pumping Portland cement slurry into weak fractured rock.

The main causes of dam failure include spillway design error, geological instability caused by changes to water levels during filling or poor surveying, poor maintenance, especially of outlet pipes, extreme rainfall, and human, computer or design error.

Embankment dams overtop due to inadequate spillway discharge capacity to pass flood waters. National statistics show that overtopping due to inadequate spillway design, debris blockage of spillways, or settlement of the dam crest account for approximately 34% of all U.S. dam failures. This is one of the most common causes of dam failures and has nothing to do with the geology of the dam site. Any embankment dam will fail if the spillway is too small and flood waters rise high enough to flow over the top of the dam wall. The estimation of the size of the maximum flood a dam will have to survive during its life is a science which has undergone continuing evolution over the last century with the result that many dams built decades ago may now be judged to have inadequate spillways even though the spillways were designed to standards of safety which were accepted as adequate at the time of construction of the dam.

Foundation defects, including settlement and slope instability, cause about 30% of all dam failures.

Another 20% of U.S. Dam failures have been caused by piping (internal erosion caused by seepage). Seepage often occurs around hydraulic structures, such as pipes and spillways; through animal burrows; around roots of woody vegetation; and through cracks in dams, dam appurtenances, and dam foundations.

Earthquakes can certainly cause damage to dams but complete failure of a large dam due to earthquake damage appears to be very rare.

Other causes of dam failures include structural failure of the materials used in dam construction and inadequate maintenance.

3.2.12.2 Location:

Each dam in the inventory is assigned a downstream hazard classification based on the potential loss of life and damage to property should the dam fail. The three classifications are high, significant and low. With changing demographics and land development in downstream areas, hazard classifications are updated continually. Due to security concerns, the list of hazard classifications and dams is not included in this plan.

The hazard classification is not an indicator of the adequacy of a dam or its physical integrity. Dam failures typically occur when spillway capacity is inadequate and excess flow overtops the dam, or when internal erosion through the dam or foundation occurs.

According to 2009 U.S. Army Corp of Engineers statistics, Oklahoma has 361 high hazard dams and 136 significant hazard dams. Although dams are not a natural hazard, the flooding that could occur from a dam could be. Even a small earthquake in the right location could cause a dam to begin leaking and eventually break. These initial hazard classifications are based upon current conditions, including population and land-use patterns below the dams. Such conditions can shift over time, such that a structure that is not considered high hazard may receive such designation in the future, should, for example, dwellings are built within the floodplain below the dam. Other high hazard dams may have such designation lowered should land use patterns change, reducing the threat of loss to life or property. Mitigation aspects, such as relocations of vulnerable properties, can reduce the number and magnitude of high hazard dams.

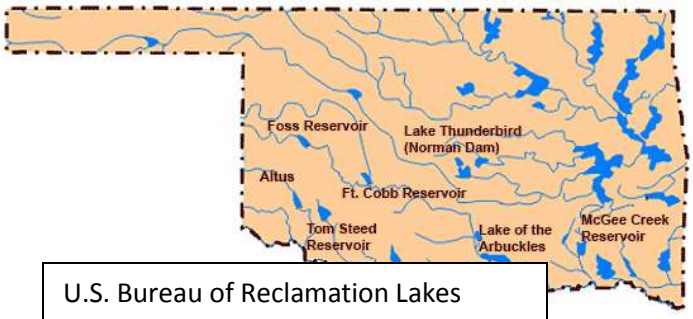
The Oklahoma Water Resources Board (OWRB) coordinates the Oklahoma Dam Safety Program to ensure the safety of more than 4,755 dams in the state that falls within its jurisdiction, especially those that could impact downstream life and property. Dams falling within the OWRB's jurisdiction are non-Federally constructed and maintained dams which are: 1) greater than 6 feet in height with storage capacities of 50 acre-feet or more; and/or 25 feet or greater in height with storage capacities of 15 acre-feet or more. The program requires inspections every five and three years for low and significant hazard structures, respectively. It requires annual inspection of the State's high hazard dams, so designated due to the presence of one or more habitable structures downstream with loss of life likely to occur if a dam were to fail. The 361 high hazard dams in Oklahoma include federally constructed and maintained dams that are not regulated by the OWRB. For security reasons, these dams and their locations are not listed in this plan.

The Natural Resources Conservation Service (NRCS) is involved in rehabilitation of a number of Oklahoma dams.

Oklahoma has many dams that need major rehabilitation. According to the NRCS there are:

- 80 dams build to protect agricultural lands now have homes or other structures built downstream that were not there when the dam was constructed.
- 110 dams need repairs that if not corrected, will have significant adverse environmental, economic and social impacts.
- An estimated $53 million is needed to rehabilitate these dams.
- There are 2,094 upstream flood-control dams in 126 watersheds. These dams provide flood protection for more than 2 million acres and make up close to a $2 billion infrastructure.

Additional dams are operated on federally built and controlled lakes throughout Oklahoma that are under control of Federal Agencies including the U.S. Corps of Engineers and the U.S. Bureau of Reclamation.



U.S. Bureau of Reclamation Lakes

For the purpose of this plan we have chosen to highlight dams located on the Arkansas River, Neosho (Grand) River and the North Canadian. Two of these rivers merge with the Arkansas in eastern Oklahoma. These three rivers are some of the most active rivers in the state. The impact of the dams on the Arkansas, Neosho and North Canadian mirror the effects the other dams in the state would have on the economy and the population if there was a dam breach. Impact is assessed in several ways: the benefits to human society arising from the dam (agriculture, water, damage prevention and power), the harm or benefits to nature and wildlife (especially fish and rare species), the impact on the geology of an area – whether the change to water flow and levels will increase or decrease stability, and the disruption to human lives (relocation, loss of archeological or cultural matters underwater). The lakes formed by the dams also provide recreational activities for local citizens as well as tourists and travelers. A dam failure anywhere in the state could be an economic disaster for Oklahoma.

Officials with Oklahoma's conservation districts said the state's dam control system is flooded with problems and desperately needs money to fix them.

The OACD received $30 million, half of which is to fix dams, officials said. The other half will go to fix breached farm ponds and washed-out roads, terraces and waterways.

Resources:
Assoc. Of State Dam Safety Officials (ASDSO)
Corps of Engineers
Oklahoma Association of Conservation Districts

NEOSHO (GRAND) RIVER AND DAMS

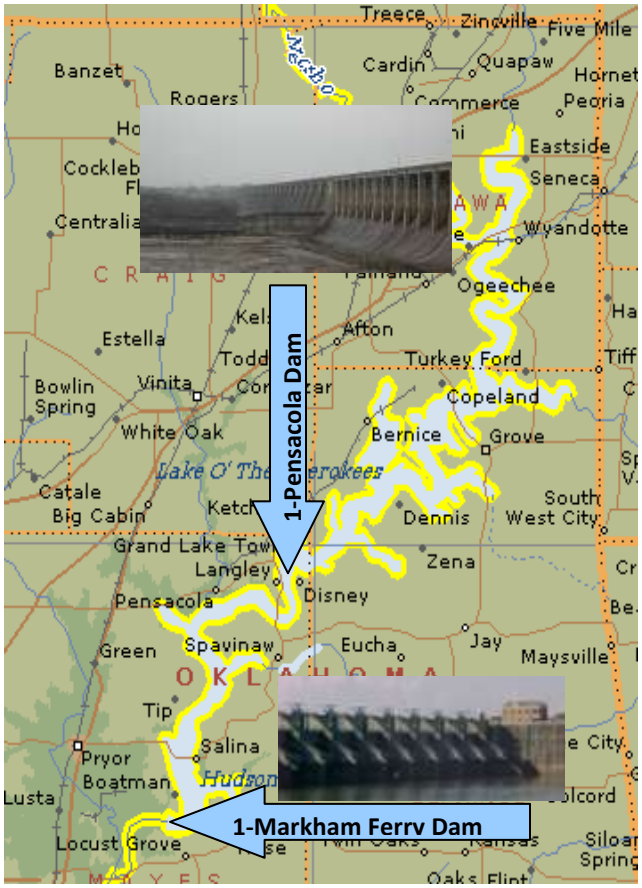
The Neosho River flows through Kansas entering Oklahoma in extreme northeastern Craig County northwest of Miami, Oklahoma. In Ottawa County the river turns south-southwest for the remainder of its course through Oklahoma. It meets the Arkansas River near the city of Muskogee, about a mile downstream of the confluence of the Arkansas River and the Verdigris River.

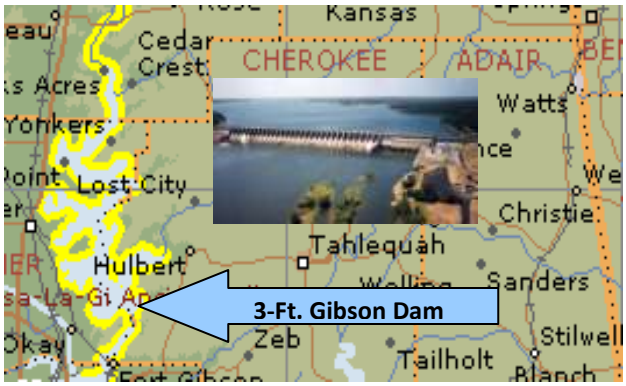
In Oklahoma, the Neosho ends at its union with Spring River at Grand Lake. From that point on it has been the Grand River since the early 1800s. The Neosho has been dammed at several points along its course, in most cases by the U.S. Army Corps of Engineers. In Oklahoma, a dam at Langley forms the Neosho's largest reservoir, the Grand Lake of the Cherokees. A dam near Locust Grove forms Lake Hudson (also known as Markham Ferry Reservoir), and a dam upstream from Fort Gibson forms Fort Gibson Lake. Tributaries in Oklahoma include the Spring River in Ottawa County and the Elk River in Delaware County.

There are three dams located along the Neosho (Grand) River in Oklahoma:

1 – Pensacola Dam – Grand Lake
2 – Markham Ferry Project – Lake Hudson Lake
3 – Fort Gibson Dam – Ft. Gibson Lake

The Neosho (Grand) River joins the Verdigris River and Arkansas River at a point near Hyde Park, Oklahoma southwest of Ft. Gibson Dam and north of the City of Muskogee.





1 - Pensacola Dam

In 1935 the Grand River Dam Authority (GRDA) was created when the 15th Oklahoma legislature passed State Senate Bill 395 (the Grand River Dam Authority Enabling Act). Not only did this authorize construction of the **Pensacola Dam**, which would impound Grand Lake but it also created a state agency that helped bring thousands of jobs to northeastern Oklahoma. In 1941 with the threat of World War II looming on the horizon, the federal government, via the Federal Power Act, took control of Pensacola Dam. All the country's resources, including electricity, were to be directed toward the war effort. In 1945 with World War II coming to an end, GRDA officials begin the long and grueling process to regain control of the dam from the government. By July of 1946, after a year and a half of struggles, Congress passed a bill authorizing the return of the dam to GRDA and the people of the State of Oklahoma.

GRDA built Pensacola Dam between December 1938, and March 1940, when depression-era labor was abundant, Pensacola Dam was the first hydroelectric facility constructed in Oklahoma. It is located between the communities of Langley and Disney, spanning a mile across the Grand River Valley and holding back the 43,500 acres of water that initially formed Grand Lake O' the Cherokees. It is located in Mayes and Delaware Counties. Pensacola Dam generates power for the Grand River Dam Authority to provide electric service in 24 counties, plus businesses both in and outside the State of Oklahoma. The generating units at Pensacola Dam have a combined generation capacity of approximately 1,274 megawatts (MW). The dam has 21 floodgates on the main spillway and 21 on the east spillways.

The Pensacola Dam remains today a true wonder, and still the largest multiple arch dam in the world, spanning 6565 feet long with 51 arches and 21 spillways. Rising 150 feet above the river bed, the dam holds the waters that form Grand Lake's 1,300 mile shoreline, surrounding approximately 60,000 surface acres of water and a surface elevation of 742 feet above sea level. Plus, of course, the dam also provides flood control for the Grand (Neosho) River. Should a breach occur in the Pensacola Dam, power would be lost to 24 Oklahoma counties and countless businesses in and out of Oklahoma. Following are the cities and towns that would be impacted by the resulting flood waters: Pensacola

(71), Hoot Owl, Strang (100), Tip, Salina (1422) and Boatman near the Lake Hudson (Robert S. Kerr) Dam northeast of Locust Grove. (Populations are provided if available). All of the towns are small enough that a major dam breach would cause catastrophic losses. Because of the large influx of water into Hudson Lake, some unincorporated communities around the Lake would also receive flooding. Highway 20 in the town of Salina, a major connector highway for commercial traffic for Delaware Adair and eastern Mayes County to and from Highways 69, 169 and Will Rogers Turnpike near Tulsa would likely be flooded and unusable. Highway 82, a major north south route through the town of Salina would also be unusable due to flood waters. This highway is a major commercial connector between I-40 near Vian north to Will Rogers Turnpike north to Joplin, Missouri and the northeastern U.S.

2 – Robert S. Kerr Dam (Markham Ferry Project)

In 1962 after much controversy, Grand River Dam Authority (GRDA) won the authorization tug-of-war with the Corps of Engineers and began construction of the Markham Ferry Project (**Robert S. Kerr Dam**). Lake Hudson was created in 1964 with GRDA's completion of the Markham Ferry Project (also known as Robert S. Kerr Dam). Not only did this project add to hydroelectricity production of Pensacola Dam on Grand Lake, but it also furthered flood control for Grand (Neosho) River. This was the second hydroelectric facility constructed by GRDA. Kerr Dam's powerhouse houses four generators that combine to produce 114 total megawatts of electricity and with an average water year can provide 211,000,000 kWh. Kerr Dam has 17 floodgates and a total discharge potential of 599,000 cubic feet per second.

Lake Hudson - Located in the heart of Cherokee Nation, is 2nd in a chain of 3 lakes along the Grand (Neosho) River, Lake Hudson is nestled between Grand Lake and Fort Gibson Lake at the foothills of the Ozarks. Significantly smaller than its "big sister," Grand Lake O' The Cherokees, Lake Hudson has 12,000 surface acres of water surrounded by 200 miles of shoreline. Hudson has an average elevation of 619 feet above sea level. Besides Grand, it is the only other major lake in the state where residents can own lakefront property on the water's edge.

Should a dam breech occur at the Robert S. Kerr Dam (Markham Ferry) only a few towns would be inundated by flood waters: Pin Oaks Acres (427), Cedar Crest (308) Taylor Ferry (unknown). These are all small towns and would likely be totally or mostly destroyed. Highways 412, 82, 51, 80 and 251A would all be inundated by the resulting floods and commerce in the area would be severely affected.

Because of the large influx of water into Ft. Gibson Lake, some unincorporated communities around the Lake would also receive flooding.

3 - Ft. Gibson Lake Dam

One of Oklahoma's many man-made lakes, **Fort Gibson Lake** is located in Eastern Oklahoma on the Grand (Neosho) River about 5 miles northwest of historic Fort Gibson, Oklahoma, from which it draws its name. It is about 7.7 miles above the confluence of the Grand (Neosho) and Arkansas Rivers. This 26 mile long body of water lies in Wagoner, Cherokee, and Mayes Counties and extends upriver to the Markham Ferry Dam (Lake Hudson). Fort Gibson is the downstream unit of a three-lake system for flood control and hydroelectric power. Pensacola Dam on Grand Lake and Markham Ferry Dam on Lake Hudson are the other two units in the system. The first two are owned and operated by the Grand River Dam Authority (GRDA), a State of Oklahoma agency, while Ft .Gibson was built and is operated by the U.S. Corps of Engineers.

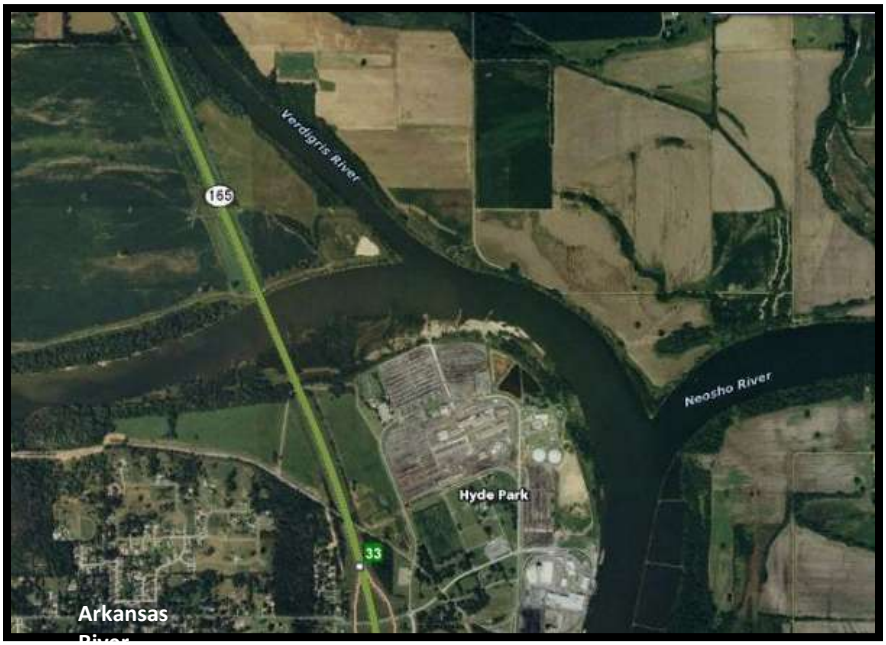
The Fort Gibson project was authorized by the Flood Control Act of 1941 and incorporated in the Arkansas River multiple-purpose plan by the River and Harbor Act of July 1946. The project was started in 1942, suspended during World War II, and completed in September 1953. Constructed by the Corps of Engineers, Fort Gibson Dam was built for flood control and hydroelectric power generation. It is one of eight Corps of Engineers Lakes in Oklahoma that provide hydroelectric power.

Lake Fort Gibson is the seventh largest Oklahoma lake by surface area. At normal level, Lake Fort Gibson is 20,000 acres in size and approximately 35 miles from the dam to the upper headwaters**.** The top of the flood pool for Lake Ft. Gibson spillway is 636 feet. Flood control pool storage filled is 34190 acre-feet which is equivalent to 0.06 inches of runoff over the entire drainage basin. The streambed elevation is 554.00 feet with the top of the dam elevation being 645 feet.

A breach in this dam would have little effect on towns downstream. There would however be massive flooding in Ft. Gibson (4.054), Hyde Park (2,847) and Muskogee (36,635) due to the influx of water. Additionally 7 miles downstream the Grand (Neosho) River joins with the Verdigris and Arkansas and the arrival of water from Lake Ft. Gibson as far north as the Robert S. Kerr Dam would cause massive problems along this 7.7 mile stretch of the Grand (Neosho) River. It should be remembered that the

Verdigris River is the access point for commercial shipping traffic from the Mississippi River and New Orleans to the Port of Catoosa for the McClellan – Arkansas Navigation System. At the convergence point and down the Arkansas, massive flooding would continue to occur. Cities and towns southeast of the convergence point on the Arkansas include the towns of Gore and Webbers Falls. Tamara which is at the mouth of the Robert S. Kerr Lake would also be inundated by floodwaters entering the Lake. Continued flooding downriver into Arkansas and the Mississippi River also would be probable.

CONVERGENCE POINT OF VERDIGRIS, NEOSHO AND ARKANSAS



A worst case scenario for a dam failure on the Ft. Gibson Dam would be a period of “historically heavy” rains and flooding along the lower Arkansas River basin.

NORTH CANADIAN RIVER

The **Beaver (North Canadian) River** flows through the full length of Oklahoma from its entry point in the panhandle 30 miles west of Boise City. It is dammed near Canton forming Canton Lake in Blaine County and from that point is known as the **North Canadian River** and becomes a significant river in Oklahoma. It then flows to Oklahoma City where both Lake Hefner and Lake Overholser receive water from Canton Lake through the North Canadian. In 2004 a seven-mile portion of the river was renamed the Oklahoma River and has several low water dams creating a series of small lakes. From Oklahoma City the North Canadian continues to meander through central Oklahoma, where it enters Lake Eufaula northeast of Stidham. It converges with the Deep Fork and South Canadian Rivers ending its 500+ mile journey through Oklahoma which form Lake Eufaula and then flows to the Arkansas River and through Robert S. Kerr Lake and into Arkansas. Three dams are addressed in this plan on the Canadian:

1 – Canton Lake Dam – Canton Lake
2 – Overholser Dam - Overholser Lake
3 – Eufaula Dam – Lake Eufaula

Optima Lake is an artificial lake in Texas Co. The lake is located near the town of Hardesty in the Oklahoma Panhandle. The lake has never reached more than 4 percent of its design capacity, and now is effectively empty. Rapid declines in stream flow (related to large-scale pumping from the High Plains Aquifer) coincided with the completion of dam construction to make this lake a dramatic example of unanticipated environmental impacts. Due to the fact this lake has never reached more than 4% of its design capacity, the **Optima Lake Dam** will not be considered in the Hazard Mitigation plan.

Canton Lake Dam
Overholser Lake Dam
Eufaula Lake Dam
Canton Lake
Arcadia Lake
Lake Stanley Draper
Lake Thunderbird
Eufaula Lake
Oklahoma City
Midwest City
Yukon
Norman
Moore
Edmond
Stillwater
Tulsa
Broken Arrow
Sapulpa
Muskogee
Okmulgee
Henryetta
Wetumka
Seminole
Shawnee
Ada
Stigler
Longtown
Eufaula
Canadian
Lawton
Duncan
Chickasha
Anadarko
Ponca City
Enid
Guthrie
Shawnee
Bethany
Edmond
Norman
Moore
Mustang
Yukon
Bethany
Warr Acres
Spencer
Choctaw
Midwest City
Del City
Tinker AFB
Valley Brook
Nicoma Park
Harrah
Jones
Luther
Arcadia
Edmond
Guthrie
Cashion
Okarche
Kingfisher
Hennessey
Watonga
Geary
Calumet
Concho
El Reno
Piedmont
Union City
Minco
Tuttle
Newcastle
Pocasset
Goldsby
Cleveland
Pink
Lexington
Purcell
Cyril
Anadarko
Chickasha
Tuttle
Binger
Eakly
Lookeba
Cogar
Scott
Hinton
Bridgeport
Hydro
Weatherford
Clinton
Sayre
Elk City
Cordell
Colony
Corn
Cowden Junction
Albert
Spring Creek
Alfalfa
Gracemont
Dutton
Cement
Fort Cobb
Anadarko
Binger
Niles
Powers
Mangum
Altus
Frederick
Tipton
Hollis
Granite
Gotebo
Hobart
Mountain View
Cordell
Sentinel
Foss
Burns Flat
Sayre
Erick
Elk City
Cheyenne
Sweetwater
Reydon
Elmer

1 – Canton Dam

Canton Dam is located in northwest Oklahoma on the North Canadian River, 2 miles north of the town of Canton. The construction of Canton Dam was completed in 1948. Dams along the North Canadian River are in place to aid in water management and the prevention of flooding. Primary functions are flood control and recreation. Canton Lake Dam located in Blaine County is an earthen embankment with a gate controlled concrete gravity chute-type spillway located on the right abutment. The dam is a 15,140-foot-long structure with a 640-foot gated, concrete spillway which rises to a maximum height of 68 feet above the streambed. State Highway 58-A extends across the embankment and spillway. Canton Lake Dam was completed in 1948. The total amount of water stored in Canton Lake is 114,370 acre-feet, and the total drainage area for the lake is 12,483 square miles (including upstream projects). The spillway discharges are controlled by 16 tainter gates. The dam provides flood control protection as well as water storage on the Canadian River in Oklahoma. Oklahoma City obtained water rights to Canton Lake so water from Canton flows to Oklahoma City's Lake Hefner and Lake Overholser.

The stability of the Canton Dam spillway and the amount of floodwater the dam could safely hold was the subject of concern and discussion for over 30 years. Restrictions on the amount of water the dam could safely hold affected the dam's ability to provide flood protection to the level for which it was designed. Due to these restrictions, downstream flooding could occur. This potential flooding could impact even downtown Oklahoma City. About 60,000 people live downstream of the dam and could be affected by an uncontrolled release of water with potential economic losses between $1.75 and $2.84 billion. In 2005 the Corps of Engineers received funding to make the appropriate adjustments in the dam to stabilize its operation.

If a breach occurred in this dam, several communities downstream would be affected and some possibly destroyed. Much of the area between Canton and Oklahoma City is agricultural and several highways and two railroads would be unusable so the economic loss would be huge as highlighted above. The Town of Canton (618) is located only two miles below the Canton Dam and would likely be almost totally inundated with floodwaters. Other towns that would be affected would include Greenfield (123) Watonga (4,658), parts of El Reno (16,212), parts of Yukon (21043) and parts of downtown Oklahoma City.

2 - Lake Overholser Dam

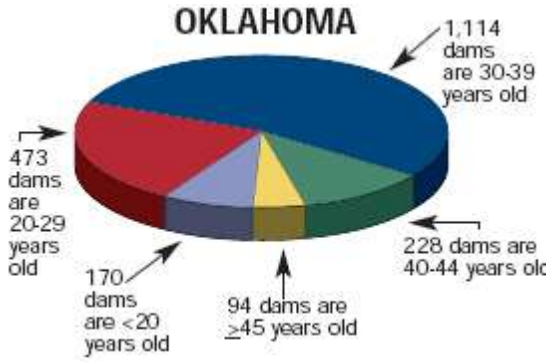
The **Overholser Dam** was built in 1917 and 1918 to impound water from the North Canadian River. By 1910 the City's population was at 32,000, a growing meatpacking industry was in place, and the City had been newly designated as the state capital. From the Land Run forward, Oklahoma City had depended on raw water from the North Canadian and a handful of water wells. But it was now clear to City leaders that wells would not produce enough water to satisfy the needs of future growth. In 1913, the United States Reclamation Service (now the U.S. Bureau of Reclamation) recommended a dam and reservoir be built upriver from the City. In 1916, under the leadership of Mayor Ed Overholser, citizens voted to build the dam and reservoir at a location that was then eight miles west of town. The dam is 62 feet high and 1,258 feet long using concrete buttresses to support a slab of concrete that holds back the water. Today, Lake Overholser is a 'backup' reservoir, tapped during the summer to meet the increased seasonal demand. The dam was added to the National Register of Historic Places in 2007. The lake is owned by Oklahoma City and covers 1700 surface acres with an average depth of 6 ft. and only 13 ft. At the deepest point. Shoreline length is 7 miles. In August 2007 even though the flood gates were fully opened, water still flowed over the dam due to Tropical Storm Erin.

A breach in the Overholser Dam would cause flooding in part of downtown Oklahoma City (506,132), part of Forest Park (1,066), Spencer (3,746), parts of Jones (2,517), and part of Harrah (4,719). Flooding could continue as far as Mcloud (3,548) and Shawnee (28,692). The effects of a dam failure would be catastrophic to the area around Oklahoma City, whether it was from Canton Lake Dam or from Lake Overholser Dam.

3 - Eufaula Lake Dam

Lake Eufaula, an entirely manmade lake, began when the River and Harbor Act was approved July 24, 1946. The U.S. Army Corps of Engineers constructed the dam for flood control, water supply, and hydroelectric power and navigation resources. Power was first generated in July, 1964. The project was completed for full flood control operation on February 10, 1964. Formed by the South Canadian River, North Canadian River and Deep Fork River, the lake is located approximately 40 miles south of the City of Muskogee. The lake located in McIntosh, Pittsburg, and Haskell Counties has over 600 miles of shoreline and 102,000 surface acres of water (223 square miles). Construction of the 3,199 ft. long rolled earth dam began in 1956 and was completed in1964. The dam rises to a maximum height of 114 feet above the streambed and holds back a lake area of over 256 square miles. The maximum discharge rate is 465,000 cubic feet per second. The hydroelectric power station is capable of generating ninety thousand kilowatts of power. Top of Dam Elevation: 612.00 feet. It is owned by the U.S. Army Corps of Engineers.

Lake Eufaula is the largest lake located entirely in the State of Oklahoma. Nicknamed the "gentle giant" it is located on the Canadian River, 27 miles upstream from its confluence with the Arkansas River. Oklahoma State Highway 71 crosses the crest of the dam. The lake's maximum depth is eighty-seven feet, and the mean depth is about twenty-three feet.
Should the Eufaula Dam breach, the small towns of Hoyt and Whitefield (231) are the only towns between the dam and its drainage area at the Arkansas River just before it enters Robert S. Kerr Lake (population shown if available).



3.2.12.3 Extent:

The State of Oklahoma considers a dam failure that is seepage or small breach where the water stays within the downstream river channel to be a minor severity. A breach large enough to exceed the capacity of the river or creek channel and overflow causing damage to homes, businesses, critical facilities, state buildings and putting people at risk is considered a major severity. This includes situations where the dam flow control manager releases more water than can be contained in the banks of the downstream river or creek channel.

3.2.12.4 Previous Occurrences:

The Oklahoma Water Resources Board related there have been two high hazard dams break in Oklahoma since 1950. The dams at Sapulpa Lake and Cedar Lake both failed however both were slow seepage failures which caused some flooding downstream. There was only property damage with no loss of life occurring.

During recent flood events several small earth dams on farm or ranch ponds broke usually due to either erosion caused by the heavy rains.

3.2.12.5 Probability of Future Events:

The Water Resources Board requires submittal and subsequent approval of plans and specifications prior to dam construction or modifications to ensure the structures will meet minimum dam safety standards. OWRB staff also coordinates periodic training sessions and workshops on dam safety issues and regulations for dam owners and engineers. The Natural Resource Conservation Service offers technical assistance in the construction of small farm ponds and related structures.

The potential for future dam breaks, while **Unlikely** is possible considering the age of many of the dams in the state.

Calculated Priority Risk Index (CPRI)

Dam Failure = 1.9

Probability		1 Unlikely		
Magnitude/Severity		3 Critical		
Warning Time		1 24+ Hours		
Duration		4 More than one week		
The CPRI for the Dam Failure hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(1 x .45)	+ (3 x .30)	+ (1 x .15)	+ (4 x .10)	= 1.9

Resources: Oklahoma Conservation Commission; Oklahoma Association of Conservation Districts; Oklahoma Water Resources Board (OWRB); U.S. Corp of Engineers; U.S. Natural Resources Conservation Service (NRCS)

3.2.12.6 Vulnerability and Impact:

Houses and businesses, and government infrastructure could suffer extensive damage in a major loss of water from the high hazard or significant hazard dams, as well as the death of citizens, wildlife and livestock. Disruption of traffic flow occurs not only for citizen's day to day traffic but also critical services such as emergency police, fire, and ambulance. School bus and mail routes would also be disrupted due to damaged or destroyed roads and bridges. Power and water outages would likely occur which would cause food spoilage and sanitation problems for communities. Schools, hospitals, grocery stores and other critical need and economically important facilities are damaged and closed for extended periods. Employment is often affected because of businesses that close due to the flood damage and loss of business.

As with any location in which man-made structures are built, potential failure of the structure could place lives and property at risk. The best way to minimize potential failure is to identify structures whose failure could cause the greatest loss of life and/or property, and to require those structures to undergo a rigorous inspection regime. Such is the case in Oklahoma. From a hazard management perspective, the most noteworthy structures are those categorized as high hazard dams.

This designation relates solely to potential impacts of a structural breach; it is not an indication of the quality of construction or maintenance. Dam failures can result from any one or a combination of the following causes:

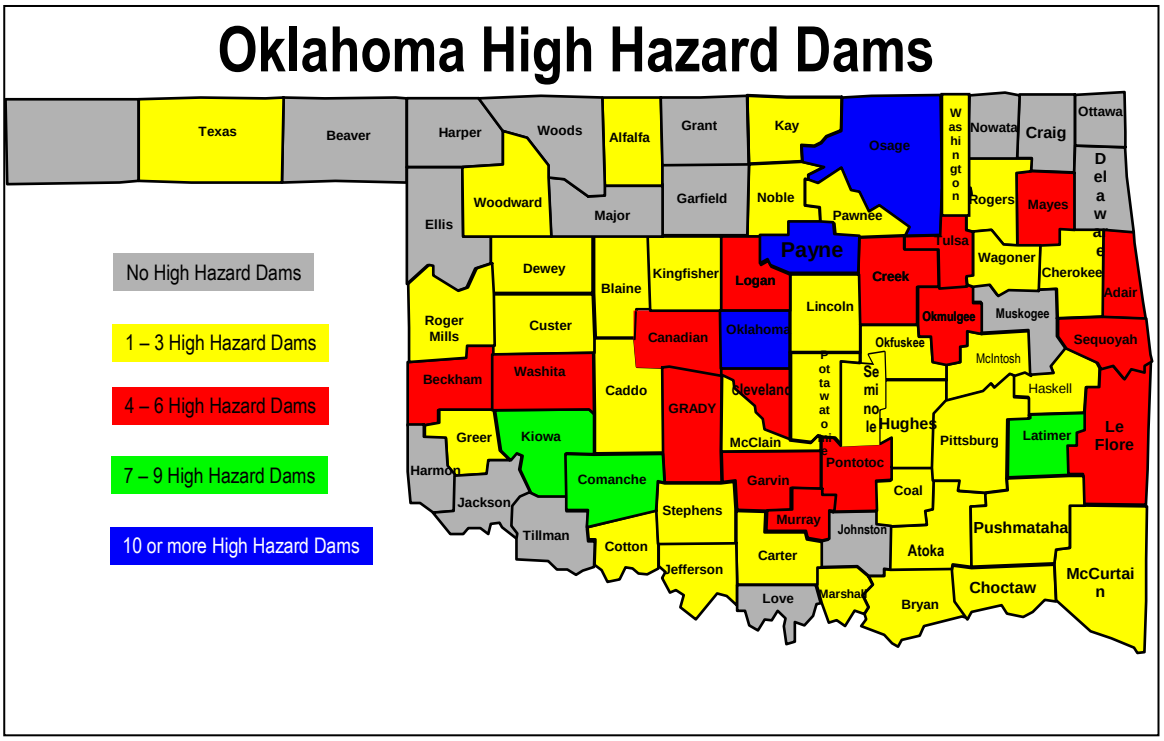
- Prolonged periods of rainfall and flooding, which causes most failures; Inadequate spillway capacity, resulting in excess overtopping flows;
- Internal erosion caused by embankment or foundation leakage or piping;
- Improper maintenance, including failure to remove trees, repair internal seepage problems, 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 resulting in substantial erosion; and earthquakes, which typically cause longitudinal cracks at the tops of embankments that weaken entire structures.

3.2.12.7 Vulnerable Populations:

Many of the larger lake dams in Oklahoma were constructed through Federal Projects and come under the control of the U.S. Corps of Engineers.

Oklahomans living below any dam structure, whether small or large should have plans in case of a break or major overflow of the dams in Oklahoma. All structures and persons in these locations are vulnerable to a dam failure.

The following map depicts the number of high hazard dams by county for the State of Oklahoma. Osage, Payne, and Oklahoma counties have the highest vulnerability to the hazard Dam Failure.



Data from National Inventory of Dams

3.2.12.8 Conclusion:

Oklahoma has hundreds high hazard and significant hazard dams that could possibly put people and structures at risk, but there have been only 2 recorded dam failures in the State of Oklahoma since 1950. Flooding potential exists if dam failure should occur at these high hazard dams.

The OWRB coordinates the Oklahoma Dam Safety Program to ensure the safety of, especially of those that could impact downstream life and property. The program requires inspections every five and three years for low and significant hazard structures, respectively. It requires annual inspection of the state's high hazard dams, so designated due to the presence of occupied dwellings immediately downstream.

A number of programs from Dam Safety to Dam Rehabilitation projects have been and continue to be produced throughout Oklahoma by State and Federal Agencies.

Education:

Because many of these dams are very old structures that need periodic repair, the Water Board requires submittal and subsequent approval of plans and specifications prior to dam modifications. Staff also coordinates periodic training sessions and workshops on dam safety issues and regulations for dam owners and engineers. The Natural Resource Conservation Service offers technical assistance in the construction of small farm ponds and related structures.

Oklahoma - Watershed Program Leader:

Oklahoma leads the nation in the number of small watershed upstream flood control dams constructed with 2,101. The State has always been a leader in flood control beginning with the construction of the first flood control dam in the nation in 1948, Cloud Creek Dam Number 1. The dam located near Cordell, Oklahoma, is in the Cloud Creek Watershed, a tributary to the Washita River and was built by local watershed project sponsors with assistance from the USDA Soil Conservation Service (now Natural Resources Conservation Service). Funding and technical assistance was authorized by the Flood Control Act of 1944 (Public Law 78-534).

Legal Controls:

State Law 785:25-7. Warning and evacuation plans.

- Owners of existing or proposed dams classified as high hazard, regardless of the size of such dams, and any other dam as determined by the Board, shall provide an adequate warning system and written evacuation plan to protect downstream lives and property, with a written description of said system and written evacuation plan to be approved by and filed with the local Civil Defense authorities.
- Additionally, the written description of the warning system and approved evacuation plan shall be filed with the OWRB.

Rehabilitation:

Many of the early-constructed flood control dams in the state were built with a designed life span of 50 years. Oklahoma has 59 dams that were 50 years old by 2003. By 2005, that number was 132; by 2010 it will reach 463; and by 2015, 1,090 or more than one half of the dams will have reached or exceeded their design life. Some dams need rehabilitation to ensure they continue to function as they were designed and remain safe.

Today many dams are in a far different setting than when they were originally constructed. Population has grown; residential and commercial development has occurred both upstream and downstream from dams; land uses have changed; sediment pools have filled; and concrete and metal components have deteriorated. Today some dams do not meet current dam safety regulations that have been enacted and revised with more stringent requirements than when the dams were built.

U.S. Natural Resources Conservation Service has undertaken rehabilitation of some of the dams. The federal government provides 65 percent of the funding for rehabilitation projects and project sponsors provide 35 percent. Projects are selected on a priority basis with those with high safety and health concerns receiving the highest priority. Oklahoma was the first state to complete a rehabilitation project. Sergeant Major Creek Dam Number 2 in Roger Mills County was rehabilitated as part of a pilot project in July 2000. Sergeant Major Creek Dam Number 1 was rehabilitated a few months later. Sandstone Creek Dam Number 17A in Roger Mills County was the first dam in the nation to be rehabilitated under the 2000 Watershed Rehabilitation Amendments. The project was completed in June 2003.

By 2005 Oklahoma had rehabilitated six watershed dams and 19 more were in various stages of planning, design or construction. Another 34 dams had initial rehabilitation studies completed. It is estimated that it will take $30 million to rehabilitate the highest priority dams in the next five years. In 2007 there was $6.5 million from the legislature available through the Oklahoma Association of Conservation Districts with a potential of $2.6 – 2.7 million in Rural Economic Action Plan (R.E.A.P) allocations possible.

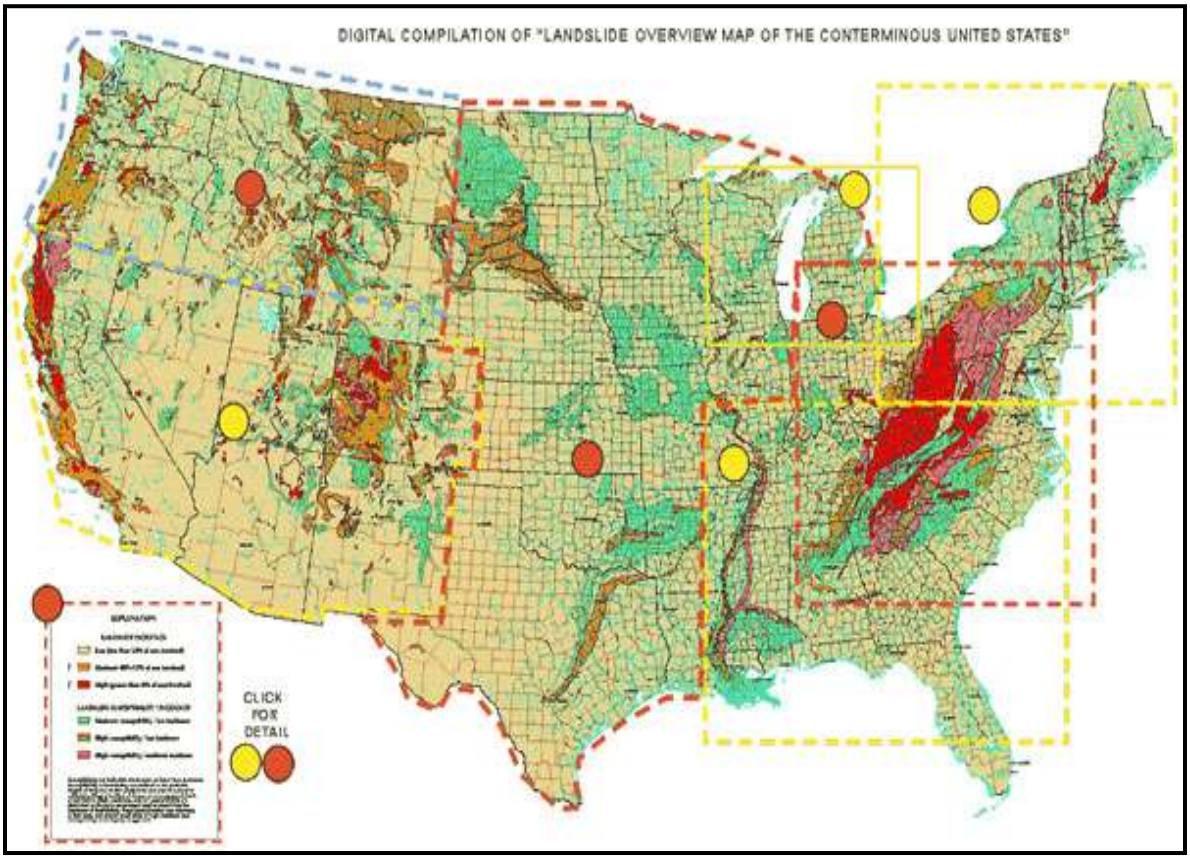
Most State-owned facilities in the state are not located in floodways or areas that would be affected by dam failure. It is difficult to estimate costs associated with dam failure because only two minor occurrences have happened in Oklahoma.

3.2.13 Landslides (Rockslides)

Hazard Priority # 13

3.2.13.1 Description:

Landslides and smaller slumps are a common highway construction problem in parts of Oklahoma. Most of the landslides occur in the eastern one-third of the State, probably due to a wetter climate and the steeper slopes associated with a more mountainous terrain. The map shows the general areas in the U.S. most susceptible to landslides. Generally, the threat of landslides is high where natural slopes exceed a gradient of 2:1. “Rotational slump” is the most common type of landslide that occurs in Oklahoma. Rotational slumps can occur on either excavated slopes or embankments. In Oklahoma, highway engineers use a process called *benching* to minimize the possibility of landslides. A bulldozer is used to make several benches or platforms parallel to the roadway alignment. The embankment is then built upon the benches.



Map provided by USGS

Some slopes are susceptible to landslides whereas others are more stable. Many factors contribute to the instability of slopes, but the main controlling factors are the nature of the underlying bedrock and soil, the configuration of the slope, the geometry of the slope, and ground-water conditions.

Three distinct physical events occur during a landslide: the initial slope failure, the subsequent transport, and the final deposition of the slide materials. Landslides can be triggered by gradual processes such as weathering, or by external mechanisms including: undercutting of a slope by stream erosion, wave action, glaciers, or human activity such as road building.

- Intense or prolonged rainfall, rapid snowmelt, or sharp fluctuations in ground-water levels.
- Shocks or vibrations caused by earthquake or construction activity
- Loading on upper slopes
- A combination of these and other factors

Once a landslide is triggered, material is transported by various mechanisms including sliding, flowing and falling. Landslides often occur along planes of weakness that may parallel the hill slope. In bedrock, planes of weakness are usually beds, joints or fractures. Soils such as silt and clay are weaker than rock and commonly have complexes or multiple planes of weakness.

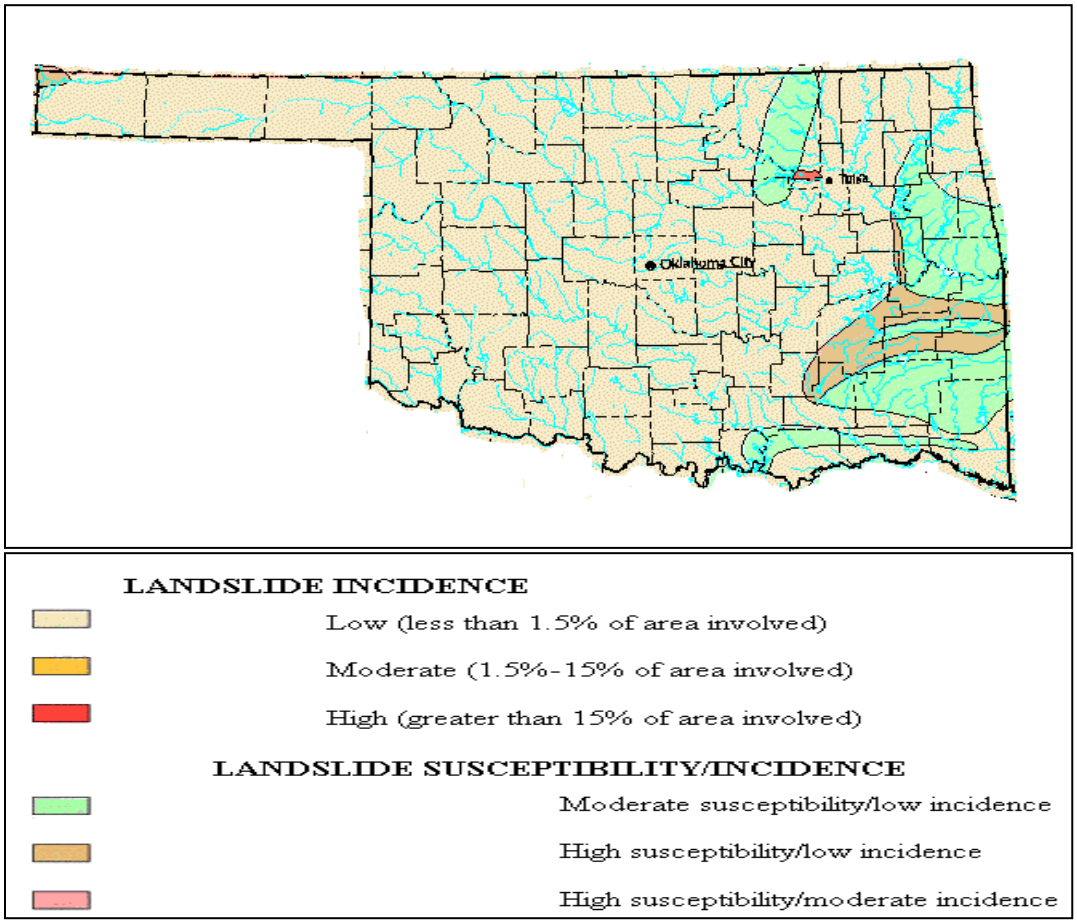
3.2.13.2 Location:

Landslides may occur anywhere in Oklahoma but generally east of I-35. Most of the area west of I-35 is flat land where landslides are not an issue. Few counties in Oklahoma will consider that landslides are a hazard.

3.2.13.3 Extent:

The State of Oklahoma considers any landslide that blocks highways, roads or causes human injury to be a major severity.

3.2.13.4 Previous Occurrences:



No damage amounts are available for this hazard, primarily because the State has no reported history of events, damages or loss. A mitigation action is in this plan to gather data.

3.2.13.5 Probability of Future Events:

The potential for serious landslide hazards in Oklahoma is **Unlikely** but feasible.

Calculated Priority Risk Index (CPRI)

Landslide (Rockslides) = 1.45

Probability		1 Unlikely		
Magnitude/Severity		1 Negligible		
Warning Time		4 Less than 6 Hours		
Duration		1 Less than 6 hours		
The CPRI for the Landslide hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(1 x .45)	+ (1 x .30)	+ (4 x .15)	+ (1 x .10)	= 1.45

Resources: Oklahoma Department of Transportation; United States Geological Survey (USGS)

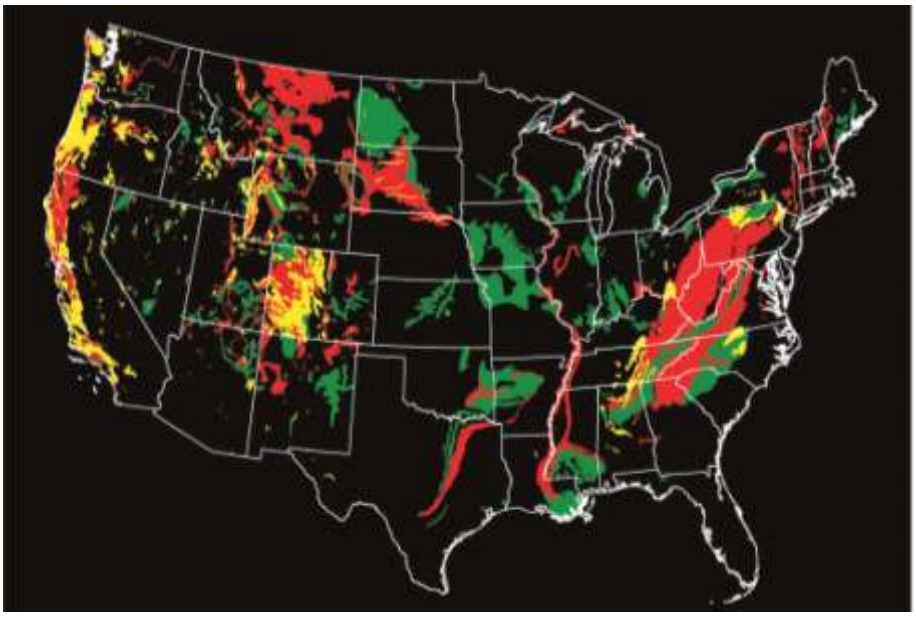
3.2.13.6 Vulnerability and Impact:

In Oklahoma, landslides are an uncommon event, and are limited to selected areas in the eastern part of the State. Most of the threat is in relatively unpopulated areas along roadways and railways. As the population grows and spreads out however, homes and businesses are built in areas that could become vulnerable to landslides. Should a landslide event happen, those homes and businesses would be severely damaged or destroyed. Roadways blocked for more than a few hours can also affect economical factors in the area. Government infrastructure could also be affected through damage to roads, underground utilities and possibly power supplies.

3.2.13.7 Vulnerable Populations:

The Oklahoma Department of Transportation recognizes that landslides could be a potential hazard to the traveling public in some areas and has conducted a landslide-recognition and landslide-stabilization program as it relates to highway construction. Nationwide, small-scale maps have been prepared for Oklahoma and other States, and these maps are updated as new data becomes available (Radbruch-Hall and others, 1982).

The following maps show the areas of the state that have the highest vulnerability to Land / Rockslides. LeFlore, Haskell, Latimer, Pittsburg, Coal, Atoka, McIntosh, and Muskogee counties have land in this area of the state. The location map above is an inset created from the following U.S. map.



Red -Very high potential; Yellow - High potential; Green – Moderate potential

Primarily, the vulnerable population is the vehicular traffic on the roadways that are affected as well as railroads. Structures can be affected especially if they are on the side of a rocky bluff or slope that becomes unstable.

Landslides or rock slides are usually in the mountainous areas where one or more lanes of the highway are vulnerable and become blocked. This also creates a potential danger by injury to people traveling along the highway. The State Department of Transportation has the responsibility of initial response to divert traffic and remove the debris. Preventive measures are evaluated to reduce or eliminate a recurrence, often by altering the slope of the incline in those areas that may be prone to slides.

3.2.13.8 Conclusions:

The Oklahoma Department of Transportation recognizes landslides as a potential hazard in some areas of the State but little historical data is available. They have conducted their own landslide recognition and landslide stabilization program as it relates to highway construction. This assessment is on-going and no damage amounts are available for this hazard, primarily because the State has no reported history of damages or loss. Most state buildings are not located in landslide potential areas. When events occur, they are handled as general maintenance and cleaned up as traffic hazards.

Most of the east and virtually the entire SE quadrant of the state are susceptible to Landslides (rockslides). There may be other isolated areas in the state that could also have occasional problems but not serious ones.

3.2.14 Expansive Soils

Hazard Priority # 14

3.2.14.1 Description:

A little known but damaging hazard in Oklahoma is Expansive Soils. Expansive Soils have been identified as a hazard in 113 Local and Tribal Jurisdiction Hazard Mitigation Plans.
Expansive or swelling soils, as their name implies, are soils that swell when subjected to moisture. These swelling soils typically contain clay minerals that attract and absorb water. Another category of expansive soil known as swelling bedrock contains a special type of mineral called clay stone.

When water is added to these expansive clays, the water molecules are pulled into gaps between the clay plates. As more water is absorbed, the plates are forced further apart, leading to an increase in soil pressure or an expansion of the soil's volume.
Soils containing expansive clays become very sticky when wet and usually are characterized by surface cracks or a "popcorn" texture when dry. Therefore, the presence of surface cracks is usually an indication of an expansive soil.

Changes in soil volume present a hazard primarily to structures built on top of expansive soils. The most extensive damage occurs to highways and streets. The effect of expansive soil is most prevalent in regions of moderate to high precipitation, where prolonged periods of drought are followed by long periods of rainfall. Expansive soils can be recognized either by visual inspection in the field or by conducting laboratory analysis.

The following pictures are examples of expansive soil damage to structures:

Create (1996) reported that uninsured losses to property owners throughout the nation might be as high as $6 billion per year. However, because the hazard develops gradually and seldom presents a threat to life, expansive soils have received limited attention, despite their costly effects in Oklahoma. Most engineering problems caused by volume changes in swelling soils results from human activities that modify the local environment. They commonly involve swelling clays beneath areas covered by buildings and slabs or layers of concrete and asphalt, such as those used in construction of highways, walkways, and airport runways.

3.2.14.2 Location:

One hundred thirteen Hazard Mitigation Plans from all parts of the State of Oklahoma have identified expansive soils as a hazard in their communities. Expansive soils may occur anywhere in the State of Oklahoma.

3.2.14.3 Extent:

There is little risk of fatalities or injuries unless the soil situation caused a partial or full collapse of a building.

State of Oklahoma Expansive Soils

Expansion Potential	Area	% of Total State
Very High	**7.34**	**3.66**
High	**54.37**	**27.12**
Moderate	**49.1**	**24.45**
Low	**83.2**	**41.5**
Water	**4.9**	**2.44**

The State of Oklahoma considers High and above on the above chart to be a major severity.

3.2.14.4 Previous Occurrences:

Oklahoma does not have disaster information on Expansive Soils because a catastrophic event has not and probably won't occur. This hazard develops gradually and is difficult to attribute dollar amounts to this hazard. No history is available because there are no reported losses.

3.2.14.5 Probability of Future Events:

The potential for serious Expansive Soil events in Oklahoma is **Unlikely** but could occur under the right soil conditions. The counties of McCurtain, Choctaw, Pushmataha, Bryan, Atoka, Marshall, Johnston, Love and Carter Counties are the most susceptible to severe Expansive Soils while other counties could have isolated areas that could experience problems that are currently generally unknown.

Calculated Priority Risk Index (CPRI)

Expansive Soils = 1.3

Probability		1 Unlikely		
Magnitude/Severity		1 Negligible		
Warning Time		1 24+ Hours		
Duration		4 More than one week		
The CPRI for the Expansive Soils hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(1 x .45)	+ (1 x .30)	+ (1 x .15)	+ (4 x .10)	= 1.3

Resources: Oklahoma Department of Transportation (ODOT); U.S. Department of Agriculture; Natural Resources Conservation Services (NRCS)

3.2.14.6 Vulnerability and Impact:

Houses and one-story commercial buildings are more apt to be damaged by the expansion of swelling clays than are multi-story buildings, which usually are heavy enough to counter swelling pressures. The principal geologic units in the State that have high shrink-swell potential are the cretaceous shale's that crop out in southern Oklahoma.

Considerable information on soil and/or rock properties is available for building foundations designed to withstand the effects of the existing soil conditions. Oklahoma Department of Transportation (ODOT) and the U.S. Department of Agriculture, Natural Resources Conservation

Services (NRCS), have evaluated the expansive properties of soils and shale formations in Oklahoma. ODOT has released a series of district reports containing information on engineering characteristics. At this time, there is not enough data available for the State of Oklahoma to estimate losses due to this hazard. The southern and eastern part of the state which includes McCurtain, Pushmataha, Choctaw, Atoka, Bryan, Johnston, Marshall, Carter and Love counties as those areas most vulnerable to expansive soil.

The most obvious manifestations of damage to buildings are sticking doors, uneven floors, and cracked foundations, floors, walls, ceilings, and windows. If damage is severe, the cost of repair may exceed the value of the building. The most extensive damage from expansive soils occurs to highways and streets.

3.2.14.7 Vulnerable Populations:

Because the expansive soil hazard develops gradually, it seldom presents a threat to life.

3.2.14.8 Conclusion:

Some counties in Oklahoma are at higher risk to expansive soils than others, but a dollar amount for damages is difficult to ascertain or assign to this particular hazard since very little incident record keeping is done. State buildings are built to stronger building codes because they host the public. Although no records exist concerning damage to state buildings from expansive soils, some damages due to this may have occurred. Highways probably are most susceptible to damage from soil problems but those are usually resolved by using improved construction methods.

Soil engineers and engineering geologists test soils for swell potential when designing a building's foundation. Simple observation often can reveal the presence of expansive soils. Soils with a high percentage of swelling clay usually have cracks or a puffy appearance when dry and are sticky when wet. There are several ways of dealing with Expansive Soils:

"Engineered" fills include: replacing existing soil with an impermeable soil, or by compacting the soil. Contractors may replace the top 3 to 4 feet of soil with a non-expansive, impermeable soil. In this case, the main landscaping problem is dealing with a soil that does not take in water. The normal treatment for impermeable soil is to increase permeability with soil amendments. However, this leaves the foundation vulnerable to damage. Contractors also may compact the soil to reduce permeability and minimize the shrink-swell action. In this case, do not try to increase permeability.

Chemical soil treatments are not common in residential construction. They are mostly used on commercial building sites and roads.

3.2.15 Special Events

(Tar Creek Project)

Hazard Priority # 15

3.2.15.1 Description:

Occasionally, a manmade event occurs of such magnitude that it develops into a Natural Hazard event. Such is the case with the Tar Creek Super Fund Site in northeastern Ottawa County, dubbed by the EPA as one of the most problematic such sites in the country. It was first designated in the 1980s.

3.2.15.2 Location:

The communities of Picher (pop. 1640), Cardin (pop. 150), Commerce, (pop. 2,645), North Miami (pop 443), and Quapaw (pop. 984) make up the Tar Creek Superfund Site. Ottawa County is most vulnerable to the hazards associated with Tar Creek but other counties are vulnerable also due to storm water runoff and flooding. These counties include Delaware, Mayes, Wagoner, Cherokee, Muskogee, Sequoyah, Haskell, and Leflore. These counties carry the run off waters from Tar Creek to Arkansas and the Arkansas River. The runoff water from Tar Creek is a three-state issue: Oklahoma, Kansas and Missouri although this plan deals only with Oklahoma issues.

3.2.15.3 Extent:

EPA declared the tar creek area a Superfund Site. Oklahoma considers this to be a major severity.

3.2.15.4 Previous Occurrences:

A Lead and zinc mining came to northeastern Oklahoma in the Picher area in 1891. During the peak mining years of 1907 through 1946 almost two million tons of lead and zinc were mined in the area. But what once brought economic prosperity to the far NE part of the state soon led to a legacy of human health and environmental calamity.

Tangible natural resource threats were first realized in 1979 when metals-laden mine water began discharging to surface streams in the Tar Creek watershed. The 50 square mile site was added to the first National Priorities List (NPL) when Congress created the Superfund program in 1983.

3.2.15.5 Probability of Future Events:

The potential of additional problems with flood waters flowing into and out of contaminated areas into recreational waterways is **Possible**.

Calculated Priority Risk Index (CPRI)

Special Events (Tar Creek Project) = 2.05

Probability		2 Possible		
Magnitude/Severity		2 Limited		
Warning Time		1 24+ Hours		
Duration		4 More than one week		
The CPRI for the Special Events hazard for the State of Oklahoma is:				
Probability	+Magnitude/Severity	+ Warning Time	+ Duration	= CPRI
(2 x .45)	+ (2 x .30)	+ (1 x .15)	+ (4 x .10)	= 2.05

3.2.15.6 Vulnerability and Impact:

With the abandonment of mining activities in the county by the 1950's, the area was left with hundreds of open or unsafely capped mine shafts, thousands of disintegrating air shaft, large areas of subsidized land and land areas with the potential of subsidence, huge chat piles and contaminated ground water. Recent floods have added to the contaminated runoff problems. Concerns about flooding from the Neosho River and any consequent contamination of parks, particularly Riverview Park are a primary concern.

A 2006 report showed that the EPA was part of a multi-state effort in 2006 to study sediment and surface water throughout the Spring and Neosho river basins. The Neosho River is huge and muddy. Metals attach to mud and settle out. The study was created to deal with surface mining and discharges. Additionally runoff from chat piles can enter the streams and flood events causing health and environmental concerns. The study area was divided into eight areas: upper Spring River, the Spring River main stem, Center Creek, Shoal Creek, Turkey Creek, Lost Creek,

Neosho River and Tar Creek. Different rivers and creeks feed into the Spring River and Neosho Rivers, and eventually flow into Grand Lake.

Acid Mine Drainage into Tar Creek at Douthat Bridge
In the study, 241 locations were sampled during a five-day period and turned up sediment samples, including metals. Some of the areas of concern are zinc, lead and cadmium.

3.2.15.7 Vulnerable Populations:

Several public health concerns are presented by the Superfund site, including mine shaft hazards, poor air quality due to lead-laden dust, acid mine drainage, soils contamination associated with chat piles and mine waste, and exposure of children and other susceptible populations to contaminated materials in particular flood water runoff. Additional health risks are associated with consumption of fish and other wild food from the Tar Creek Superfund Site, as well as the Neosho River and Spring River watershed. All of these environmental and human health concerns are being examined by the EPA, the Department of Human Services, and other state and local agencies.

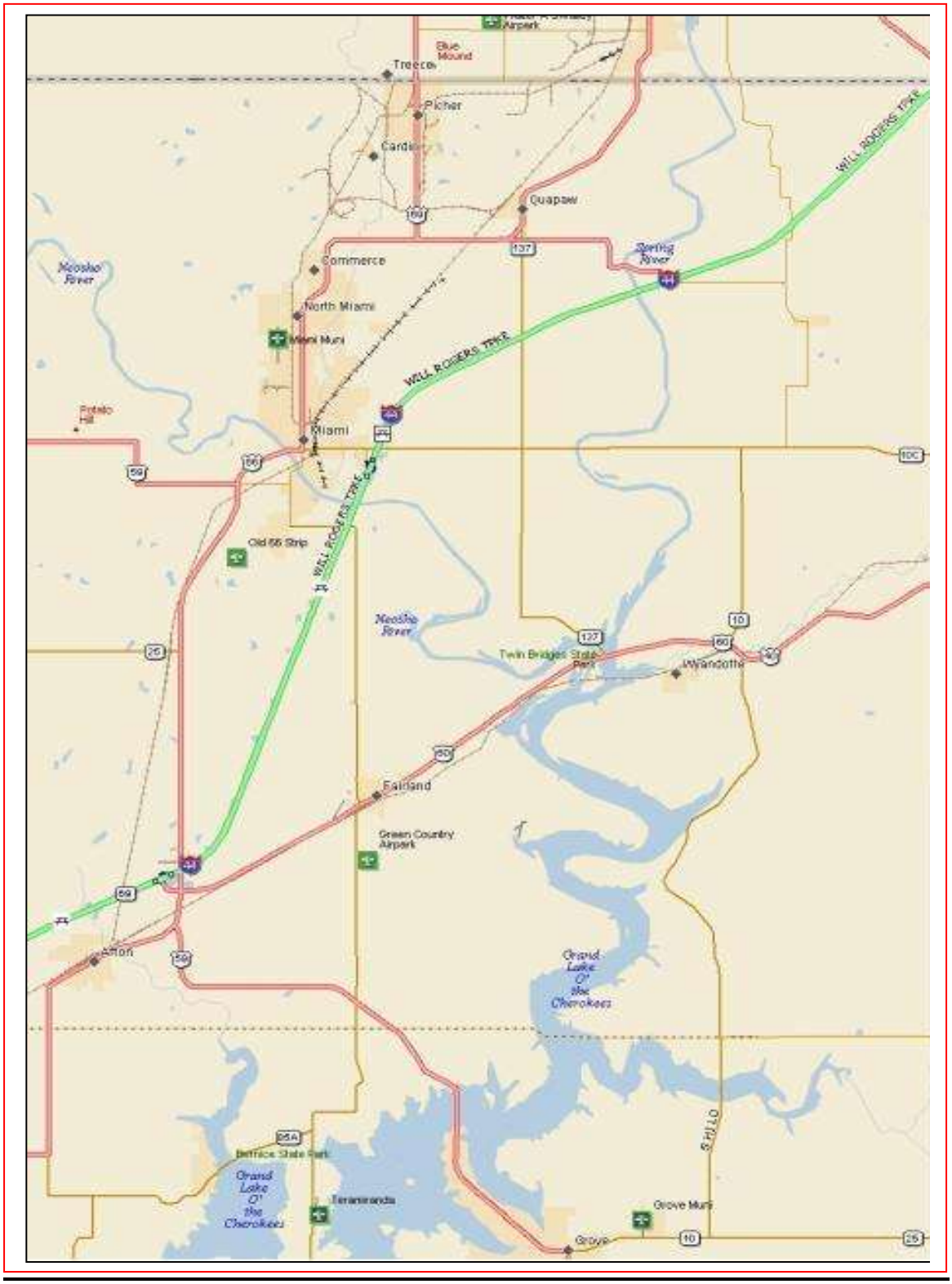
3.2.15.8 Conclusions:

It's been more than 100 years since mining began in the tri-state district and more than 20 since cleanup started at the nation's longest-standing superfund site. Tremendous challenges remain. The State of Oklahoma recognizes that there are some secondary hazards associated with the approximately 30,000 acres of abandoned coal mined land which was mined prior to the passage of the 1977 Federal Surface Mining Control and Reclamation Act.

In 2003, three federal agencies, the Environmental Protection Agency, the Department of Interior (DOI), and the U.S. Army Corps of Engineers, signed a Memorandum of Understanding (MOU) that facilitates cooperation of the agencies to bring a holistic response to the risks posed at the Tar Creek Superfund Site.

Elected officials and community leaders are coordinating and considering long-term options for residents and property owners at the sites. These options include clean up and mitigation of the above mentioned problems at an estimated cost of upwards of 145 million dollars and/or total property buyouts and construction of wetland reserves. These options are currently under consideration and subject to funding by both the Federal and State levels of government.

The EPA and the State of Oklahoma will continue to look for answers and authorities to address problems in the area. Although this hazard originates in the northeast corner of the state, the effects of this hazard are far reaching and not limited to this area only.



3.3 Risk Assessment: Conclusions

Oklahoma has seen a 1.01% annual growth rate since 2004. Oklahoma now ranks 22nd in population growth which is up from 28th in 2004 while it remains 28th in population among the 50 states.

Many jurisdictions in Oklahoma have experienced growth, some faster than others. The large jurisdictions of Oklahoma and Tulsa counties have experienced the largest growth especially on the outskirts where the existing communities are entering into what had been pasture or woodlands. Expansion into these areas often increases the risks faced by Oklahomans and the destruction of property or loss of life potential. Most new construction in Oklahoma consists of brick homes. Some mobile homes are still being placed in communities where restrictions don't prevent them. More buildings and infrastructure mean more exposure to natural events.

Oklahoma statutes provide a tax credit incentive for installing a safe room inside new construction. Therefore more buildings are being constructed with safe rooms and as such, structures are more exposed to hazards than people.

Development into the wild land urban interface puts more people and property at risk. At this time no state facilities have been built in recently developed areas. Local leaders must be cognizant of the new risks, and work toward implementing zoning, and building codes to reduce the exposure. Both Oklahoma and Tulsa counties have flood plain ordinances to prevent development in the SFHA. The addition of new areas of development put more of a strain on utilities. Without improvement these utilities are more apt to fail and leave people without gas, power, and communications during and after a hazard event. The flood plain ordinances and better building practices cut down the amount of damage from natural hazard disasters. As Severe Repetitive Loss properties are purchased or removed from the flood plain the damage from flooding is reduced even further. See **Appendix G** for a listing of state critical facilities and their jurisdictional vulnerability.

Roadways are more heavily traveled and as such have a higher chance of being crowded with commuters during and after a hazard event. This also exposes the motorist to the hazard more openly and creates delays for emergency response personnel.

The State of Oklahoma owns buildings throughout Oklahoma. A list of those buildings, the county they are in and specific data concerning each building is provided in Appendix G of this plan. As with the local jurisdictions, the security of these facilities is imperative to ensure the public's health and safety in the aftermath of a hazard event and although the State Facilities are shown in the Appendix, it is critical that this Appendix remain out of public view. This Appendix contains information for some State Agencies that are critical to the health, safety and security of the public in Oklahoma. Due to this, **Appendix G is to be withheld from public disclosure. For information regarding release of this data please contact the State Hazard Mitigation Officer at (405)521-2481.**

State owned buildings, the majority of which are accessible to the public are generally built to more stringent building codes than are private residences and businesses. Although values of the buildings and their contents are shown in **Appendix G (not available for public viewing**)

potential dollar losses would depend on the amount of damage done to the facility by the "hazard event". In the case of total destruction of the property the loss would obviously be determined by the total value of the building and its contents. Lesser damage would be determined by repair costs.

The best way to identify which state-owned properties are subject to specific hazards is to overlay a map which shows where those facilities are located onto a map showing the probability area of each hazard. Unfortunately, those maps do not exist in Oklahoma. We do not have maps, digital or otherwise, showing state facility locations. We do have maps showing some hazard probability areas such as landslide and expansive soils but not in relation to state facilities in those counties. All maps need to be the same scale to be readily comparable.

This hazard analysis and risk assessment is based on the best and most up to date data available. It presents a reasonable range of hazards that have affected the State in the past and could, of course, affect it in the future. Hazard Mitigation Plans from the local jurisdictions throughout the State of Oklahoma were reviewed by the SHMPC and were found to have hazard profiles, goals, and mitigation strategies much in line with those as presented in the State Hazard Mitigation Plan. The critical facilities from local plans were reviewed and found to contain less information than that prepared in the State's analysis. State properties are not identified in the local plans and therefore the State's critical facilities list is used.

Nevertheless, there are a number of conclusions that we can make from the hazard analysis and risk assessment.

- State owned and critical facilities are no more exposed to natural hazards than are other structures in the same general vicinity.
- Critical facilities deserve additional mitigation attention because of the higher potential life and property loss or environmental harm in the unlikely event that they suffer significant damage.
- Oklahoma Co. (506,132), Tulsa Co. (393,049), Cleveland Co. (95,694) and Comanche Co. (92,757) have the highest populations in Oklahoma and are therefore more vulnerable to natural hazards.
- Oklahoma and Tulsa Counties have the highest vulnerability in terms of transportation infrastructure, respectfully.
- Oklahoma and Tulsa Counties have the highest vulnerability in terms of the number of state owned facilities.
- Oklahoma and Tulsa Counties have the highest vulnerability in terms of the total dollar exposure to state owned facilities, respectfully.

OEM is happy to announce that with this update that both the City of Tulsa plan update and the Tulsa County plan have recently been approved. The other jurisdictions mentioned above have had approved plans for some time.

Is important to note that although some hazards are classified as only possible or unlikely in probability of occurrence, it does not mean that they cannot affect Oklahoma in a significant way, but only that such an occurrence is relatively less likely. The hazard analysis in this

document provides helpful insights for planning purposes and determination of priorities but does not offer any guarantees.

In order to get a realistic picture of a jurisdictions vulnerability to natural hazards, each jurisdiction must conduct its own hazard identification and risk analysis. Oklahoma Emergency Management will make reasonable attempts to standardize the format of hazard information in local mitigation plans through review. This standardization may include the following:

- Maps of the jurisdiction showing population centers, critical facilities, transportation routes, floodplains, and other information specific to the jurisdiction.
- Encourage use of maps of the same scale as other jurisdictions.
- Information the number and type of structures in the floodplain.
- Historical data related to the occurrence of the principal natural hazards that affect the area.
- Analysis of the severity of those hazard events.
- Analysis of damage that occurred in the jurisdiction due to those hazards.
- Review of mitigation actions that might have reduced damage or loss of life.
- Determination of the potential financial losses if significant natural hazard events were to occur.
- Use of available data to determine areas of social and economic vulnerability for the jurisdiction.

While conducting the risk assessment, it was found that the State's capabilities and available data exceeded that of the local jurisdictions. In this instance the information flowed from the State to the local level. Vulnerability in terms of the jurisdictions most threatened by the identified hazards and most vulnerable to damage has been covered in the previous section.

Review of the one hundred eighty five approved local jurisdictional plans and the local risk assessments confirmed that the local vulnerability analysis and risk assessments corresponded with the state analysis and with the prior local hazard analyses which were conducted under the State and Local Assistance (SLA) Program. Mitigation action items were pulled from the individual local jurisdiction and county plans and assembled onto a spreadsheet. This was then used as a basis to e-mail the jurisdiction for updates on planned, in-progress, and completed mitigation action items. The local plans were reviewed for possible hazards that were not part of the State plan and Sinkholes/Subsidence was added to the State plan. OEM identified that local jurisdiction plans tend to identify flood as one group and all other hazards as another single group in their potential dollar loss section. OEM has encouraged each local jurisdiction to figure a potential dollar loss and vulnerability for each hazard individually in their local plan. Most of the planners have stated that they are not going to spend the time need to create accurate and complete potential dollar loss and vulnerability data until FEMA takes these items out of the gray area of the Crosswalk and make them required to pass the plan. OEM will develop a format for potential dollar loss data and share it with planners in the state to try and gain consistency so data from local plans may be included in the State plan.

As additional local plans are received and reviewed, special attention will be paid to the local risk assessments, in the event a local jurisdiction's risk assessment differs from the State's risk assessment.

The potential losses to identified vulnerable structures in each county and municipality are best determined at the local level and reported in local mitigation plans. Not every community has a mitigation plan in place, and those that do have not consistently provided critical facilities data. The Disaster Mitigation Act of 2000 does not require this of local mitigation plans. These are the buildings and services, however, without which residents and businesses cannot survive for long, such as police stations and fire stations. Therefore, the security of these facilities is imperative to ensure the public's health and safety in the aftermath of a hazard event and have not been included in this plan.

Chapter Four: Goals and Objectives

Each section of the plan update from the period of prior approval through October 26, 2010 was analyzed and reviewed by OEM administrative staff to determine whether updates to the plan were necessary. Chapter Four was reviewed by OEM who determined that updating was required. Action Items were added and others were updated. Current information was provided. The list of hazards was updated to correct previous errors and include additional hazards identified in local plans. Mitigation actions were added that were found in Local Mitigation Plans. Goals were reviewed and continue to be valid.

In developing the goals, objectives and action items of the Mitigation Actions, the State Hazard Mitigation Planning Committee (SHMPC) discussed in a roundtable format the S.T.A.P.L.E.E. method and used it for guidance and also considered the following:

***The Governor's goals for State Government*:** *"Our fellow citizens deserve opportunity, safety and security -- no matter where they reside within the borders of our state. We Oklahomans are known for our ability to weather any storm. The pioneers who settled this land were strong in spirit and determination. We are rightly renowned around the world for our compassion and the way in which we band together in the face of challenges.*

Tragedy brings out the best of the Oklahoma character. We know all too well the potential dangers of springtime and tornado season. Oklahomans came to the aid of their friends and neighbors hit hard by the May 3, 1999, tornados. Nature can be cruel, but Oklahomans are a resilient people, and face crises with strength and resolve."

In the meantime, the State of Oklahoma is poised to take all actions necessary to facilitate recovery and rebuilding efforts. In August 2004, Governor Brad Henry announced the results of an ambitious and wide-ranging study that results in equally ambitious and wide-ranging progress for Oklahoma: EDGE initiative (Economic Development Generating Excellence), calling it a "powerful strategy" and "bold economic agenda" to benefit all of Oklahoma. Among the recommendations in the final plan:

Biotechnology and science: The State needs to embrace the burgeoning biotech industry, despite the risks, with public investments designed to create private investment. It should seek to expand weather research efforts now blossoming in Norman, Oklahoma.

Among the Governor's goals for public safety are reducing injury and loss of life and property due to natural or human caused disasters, increasing readiness to respond to emergencies, and increasing citizens' confidence in the safety of their communities.

The mission of Oklahoma Emergency Management is to: "minimize the effects of all disasters and emergencies upon the people of Oklahoma through preparedness, response, recovery and mitigation." The State EOP guides the emergency management functions and establishes the emergency management responsibilities of the agencies of state government.

The vision of Oklahoma Emergency Management: The vision of the agency is for "Partnerships for a safer future through a process of coordination between the private sector, volunteer organizations, individuals and families, and all levels of government."

The mitigation goals and objectives of the State agencies that participated in the development of this plan and of the goals and objectives from approved local plans: Each of the state agencies participating in the state plan, and the communities developing local plans, established agency or community-specific goals and objectives for their mitigation activities and initiatives. A synopsis of these goals and objectives was prepared, and themes identified for the team to consider for the state plan as a whole.

Addressing the state's priority hazards: They are identified as: dam failure, drought, earthquake, expansive soils, extreme heat, flooding including Repetitive loss and Severe Repetitive loss properties, hail, high winds, landslides/rock fall, lightning, sinkholes/subsidence, tornados, wildfires, winter storms/icy hazards and special events (e.g., Tar Creek hazard). (See Risk Assessment, Chapter Three).

Out of the State Hazard Mitigation Planning Committee's discovery and deliberation process, the following goals were developed for hazard mitigation. The goals represent a vision for hazard mitigation and disaster resistance for the State government of Oklahoma. The following Goals were reviewed by OEM for this update who determined that they continue to be valid.

State Mitigation Goals

1. Protect Life
2. Protect Property
3. Protect the Environment
4. Increase Public Preparedness for Disasters

4.1 Prioritizing Mitigation Actions

The Mitigation Actions represents the mitigation actions and initiatives identified by the State Hazard Mitigation Planning Committee for the State government of Oklahoma to pursue during the next three years. These actions were reviewed by the State agencies participating in the State plan, other non-participating but interested state agencies, local emergency management organizations, and others before being submitted to the Governor's Authorized Representative for approval and promulgation. The identified mitigation actions and initiatives in both this section and in the state agency annexes are not in a 1-2-3 priority order, but are categorized as being of high, medium or low priority for the purpose of this plan. Although the actions have been prioritized and reviewed using the S.T.A.P.L.E.E. method (see Mitigation Strategies /Actions later in this chapter), they will be implemented as funding and resources become available. In order to assign a priority, the state considered whether the action addressed multiple hazards, reduced repetitive loss, was important to accomplish first or could be accomplished in a relatively short period of time. The State is currently working nineteen (19) open disasters (with two additional ones planned for closure) and has had no low priority actions at this time. Furthermore, the State of Oklahoma retains the right of Oklahoma State government to do what it deems is right and proper for the State of Oklahoma in any given situation. An action that is ranked as low or medium may actually be completed prior to a high priority action if funding becomes available. (See Chapter 7 for Evaluation and Prioritization process). The philosophy of the State Hazard Mitigation Program is to foster holistic state agency and local programs that make hazard mitigation a way of doing business. Rather than encouraging eligible agencies to just develop a list of planning and construction projects for federal hazard mitigation grants when they become available, the program encourages agencies and organizations to include mitigation as they consider construction and location of new buildings, make existing facilities safer, and as they develop strategic plans for organization operations.

The State Hazard Mitigation Program also does not target available resources to a handful of local jurisdictions or to just a few hazards. The reason for this is two-fold:

(1) In Oklahoma local governments are responsible for maintaining government services and actions at the lowest possible level, rather than the state providing top-down direction to control decisions that affect local citizens.

(2) Pouring most or all available resources into a small area (three to five flood prone counties, for example) or for limited mitigation tasks (for elevating or purchasing of repetitive loss properties, for example) is politically untenable and it discourages non-funded jurisdictions from developing hazard mitigation programs.

Rather than establish project priorities, the State Hazard Mitigation Program requires any mitigation project proposed for funding through the federal hazard mitigation grant programs administered by the State Emergency Management Mitigation Division (including state agency projects) to:

(1) Support the goals and objectives of the State Hazard Mitigation Plan and its mitigation strategies, goals and objectives;

(2) Reduce identified hazard risk;
(3) Prevent repetitive losses and severe repetitive losses;
(4) Protect critical areas, including frequently flooded areas and geologically hazard areas.

Proposed state projects must compete with projects proposed by eligible local governments; this ensures that federal grant-funded state and local projects address state hazard mitigation priorities.

Addressing Cost-Effectiveness, Environmental Soundness, Technical Feasibility

Any state government construction project – regardless of potential funding source – has to be cost-effective, technically feasible and meet all appropriate federal, state, and local environmental laws and regulations before it is started. State government projects funded by federal hazard mitigation grant programs administered by the State Emergency Management Mitigation Division have to meet specific criteria related to cost-effectiveness, environmental soundness, and technical feasibility.

4.1.1 Mitigation Goal #1 – Protect Life

Protecting people from harm is one of the primary responsibilities of state government. Many state laws contain a declaration of purpose that includes protecting public health and safety. For example, the Oklahoma Emergency Management Act [Oklahoma Statutes, Title 63], the legislature declares that emergency management is a necessary function of state government "…to protect the public peace, health and safety, and to preserve the lives and property of the people of the state…" from the increasing possibility of the occurrence of disasters of unprecedented size and destructiveness.

Oklahoma has fifteen natural hazards that threaten life and property – dam failure, drought, earthquake, expansive soils, extreme heat, flooding, hail, high winds, landslides /rock fall, lightning, sinkholes/subsidence, tornados, wildfires, winter storms/ice/freezing rain and special events/(Tar Creek Project) hazards. The threat each poses to human life varies and depends on many factors, such as knowledge of the hazard, locations of areas most at risk, frequency of hazard event occurrence, whether and (and how many) people live in hazard zones, the availability of warning systems, whether first responders have necessary training and equipment, and adequacy of building codes and building inspections.

<u>Public Awareness:</u> The intent is to make the residents of Oklahoma aware of the hazards and risks that could arise from natural or man-made hazards and how they could impact their lives. In hope that residents will learn how to be prepared and take the appropriate actions to be prepared before a major emergency or disaster strikes, OEM is working to enhance the awareness of natural and man-made hazard issues to the public, media, and government officials.

A major function of OEM is educating the public about the nature and impact of hazards and the state's efforts to combat the effects. Change in public attitudes about natural hazards can effectively be addressed through education at the state and local levels. Every year press releases on hazards are distributed to both daily and weekly newspapers, radio and TV stations,

resulting in thousands of articles on different aspects of the hazards. Oklahomans want to know how to protect their families in their communities. There are many issues to explore, including understanding the factors for risk and the protective factors that can help.

Reliable Communications: Communication systems provide urgent information on an actual or potential hazard event to people who live in or near hazard areas and to emergency responders can be critical to protecting lives. A variety of warning systems exist in Oklahoma to inform decision makers, emergency responders, and the public about various types of impending or occurring hazard events. A number of warning systems are used through the state, including the system used by the National Weather Service to disseminate information on floods and potentially dangerous weather systems. Advanced warning systems, when combined with public education programs, provide communities and their decision makers with a significant tool to save lives from an impending hazard event.

Vulnerable populations: Many of the schools housing the state's K-12 students are older structures built before safe room/shelter designs were developed. This presents a substantial life safety and injury risk to children as well as school staff and visitors. While school districts are strengthening buildings as part of capital improvement plans and taking on structural mitigation efforts, an accurate inventory of schools vulnerable to tornado hazards and without shelter does not exist. Safe rooms are designed to protect children and teachers from severe storms that produce high winds and deadly tornados common to the state. When severe weather threatens, individuals need advance warning and protection from the dangerous forces of extreme winds. Schools in high-risk tornado areas continue to address the need and combined benefits of structurally sound shelters and early alert systems.

In a world where "if anything can go wrong, it will go wrong" seems to be all too common, Oklahoma schools must be prepared. For the safety of students, employees and visitors to school facilities, an Emergency Preparedness Plan would include procedures for evacuations and for locking down buildings. The plan's objectives are to respond to any emergency, crisis or disaster; to know where the students are; and to communicate with parents and the media. In this planning period OEM has encouraged Hazard Mitigation planners to include all school districts in new and updated plans. Many school districts now have approved Hazard Mitigation plans and are coming to OEM with NOI's and grants applications for school safe rooms.

Building codes and inspections: Local building departments are responsible for enforcing federal, state and local codes related to building construction projects. A study of structural failures following the declared disasters in Oklahoma, DR-1355 and DR-1401 (winter storms) recommended more education and better communication for all parties involved in construction of buildings, including construction plans examiners and local building inspectors.

Building code certification for plans examiners and building inspectors assures that the individuals responsible for reviewing building projects for code compliance complete a course of continuing education. Education is critical to consistent and effective application of the codes, resulting in compliant buildings designed and built to mitigate hazards. The Oklahoma State Building Code is amended on a regular cycle to incorporate new knowledge about hazards, to address changes in construction methods and materials, and to incorporate new designs and technologies. Certification incorporates the changes adopted in new codes and provides a structured method to educate the code enforcement community. The organization that writes

model-building codes provides a rigorous program of training and certification for their codes. The focus of the action agenda that follows is protecting life from the impact of hazard events.

Goal #1 – Protect Life						
Strategy	Action	Responsible Agency	Projected Timeline	Projected Resources	Rationale for Action	How Action Contributes to Mitigation Strategy
1.1 Protect Oklahomans and their property by education, community awareness and the National Flood Insurance Program (NFIP)	1.1.1 Maintain the NFIP through the CAP-SSSE program grant by annually conducting five regional workshops	Oklahoma Emergency Management; Oklahoma Water Resource Board	Ongoing **High Priority**	CAP-SSSE	Educate community officials on floodplain management, NFIP regulatory, administrative requirements, and hazard mitigation techniques.	Education reduces the likelihood of federal payouts for flood loss and potential loss of life by discouraging building in the flood plain and encourages local regulation.
	1.1.2 Conduct one "Regulating Floodplain Development through the NFIP" course each fiscal year.	Oklahoma Emergency Management; Oklahoma Water Resource Board	Ongoing **High Priority**	CAP-SSSE	Educate community officials on floodplain management, NFIP regulatory, administrative requirements, and hazard mitigation techniques.	Education reduces the likelihood of federal payouts for flood loss and potential loss of life by discouraging building in the flood plain and encourages local regulation.
1.2 Develop reliable communications capability to provide coordination, operations management and information gathering.	1.2.1 An annual exercise or an actual event will be used to test the functionality of the State EOC.	Oklahoma Emergency Management	Ongoing **High Priority**	Existing State Resources	Communities rely on OEM to provide coordination during a disaster event. Each State disaster has identified necessary actions that require the need for reliable communications statewide.	A reliable communications system will allow OEM to coordinate with local government thus providing necessary resources that will save lives and property.
	1.2.2. Develop a plan and seek funding to expand the EAS to all-hazards	OK Emergency Management	1 year **Medium Priority**	Existing State Resources	Communities are seeking inexpensive ways to expand warning and emergency communication with the public.	Expanding this system improves local and State capability to protect life and property.
	1.2.3 Assist National Weather Service in expanding NOAA Weather Radio listeners	OK Emergency Management; National Weather Service	Ongoing **High Priority**	Existing State Resources, HMGP	Improved coverage increases the number of people able to receive warning of potentially life threatening weather events.	Expanding the NOAA Weather Radio system improves local and State capability to protect life.
1.3 Insure that every public school (K-12) in Oklahoma has a tornado safe room, shelter (or retro-fit) for protection of students, teachers and support personnel. Provide the safest possible environment for staff,	1.3.1 Develop an evaluation checklist that will prioritize the schools that do not have a safe room.	Oklahoma Emergency Management	Ongoing **Medium Priority**	HMGP, PDM, 406 Mitigation	The safe rooms will protect the students, faculty, staff, and volunteers in attendance during the school day. Some safe rooms / shelters may be used for the community during non-school hours.	Improving the structural integrity of schools, or adding a safe room / shelter, will improve the safety of thousands of students, teachers, and support personnel.

Goal #1 – Protect Life						
Strategy	Action	Responsible Agency	Projected Timeline	Projected Resources	Rationale for Action	How Action Contributes to Mitigation Strategy
faculty and students.						
	1.3.2 Continue the comprehensive all-hazard emergency preparedness for Public Education Program.	Oklahoma Emergency Management; Oklahoma Department of Education; Oklahoma Department of Homeland Security.	Ongoing **Medium Priority**	Existing State and Local Resources, HMGP, DHS	This program includes development of sheltering and evacuation plans, anti school violence mitigation, disaster mitigation, hazardous analysis of school buildings and if requested the forming of a School Threat Assessment Team (STAT). The School Threat Assessment Team would facilitate the intervention of students who are in various stages of planning violent acts in their schools. STAT training allows the school administration to deal with potential violence with the least amount of disruption to the learning environment.	Benefits of the program are to give the school districts the tools to reduce injuries and loss of life. State Preparedness Officers will make recommendations to school officials that will reduce or eliminate the existing environmental dangers within their respective school buildings. These recommendations serve to reduce the potential for injury and damage from fire and most natural disasters.
1.5 Strengthen State and local building codes and enforcement.	1.5.1 Pursue certification of building inspectors through code organizations and provide continuing education to improve the quality of building inspections.	State Building Code Council; Central Oklahoma Home Builders Association	2 Years **Medium Priority**	Building	Additional education and training of building inspectors will improve inspections.	Improving building inspections will improve the integrity of structures and protect occupants during hazard events.

4.1.2 Mitigation Goal #2 – Protect Property

Mitigation actions taken to protect life often also protect property, especially actions with a structural element, such as those designed to strengthen a building from the forces of a violent tornado, high winds, or snow loads. Hazards such as earthquakes, floods, and landslides are likely to lead to major disruption of transportation corridors and facilities, lifelines (including water, sewer and power), and facilities critical to the ongoing operation of state government or to provide essential services to people in need such as the poor, unemployed, disabled, or mentally ill. The same is true for buildings that house large numbers of people such as school children and college students, or provide important public services such as police, fire protection or health care. Critical facilities identification has improved with the advent of homeland security, but initiatives to prioritize and protect such facilities from the effects of natural hazard events have been lacking.

A published goal of OEM is to identify and build a portfolio of all repetitive loss structures in the State of Oklahoma and encourage local jurisdictions to place higher importance on reducing or eliminating repetitive loss properties.

When a series of storms affect the State that combine rain, ice, snow and wind in back to back events – repeated and prolonged utility outages can be expected as well as disruption to transportation corridors and facilities. Backup power and telecommunication systems are necessary in facilities used to provide essential public services that must remain available when hazard events adversely affect communities and their vulnerable populations.

The focus of the action agenda that follows is protecting property from the impact of hazard events.

Goal #2 – Protect Property						
Strategy	Action	Responsible Agency	Projected Timeline	Projected Resources	Rationale for Action	How Action Contributes to Mitigation Strategy
2.1 Protect critical assets	2.1.1 Prioritize structural and non-structural retrofits for critical State-owned facilities based on their vulnerability to natural hazards.	Department of Central Services, Risk Assessment Division	3 Years **Medium Priority**	Existing State resources, capital budget funds	Prioritizing will address the most vulnerable structures first.	Retrofitting facilities based on their vulnerability will preserve important State buildings, as well as protect their records, systems and occupants from hazard events.
	2.1.2 Develop an evaluation checklist that will prioritize the school's that does not have a safe room / shelter.	Oklahoma Emergency Management	Ongoing **Medium Priority**	HMGP, PDM, 406 Mitigation	The safe rooms will protect the students, faculty, staff, and volunteers in attendance during the school day. Some safe rooms / shelters may be used for the community during non-school hours.	Improving the structural integrity of schools, or adding a safe room / shelter, will improve the safety of thousands of students, teachers, and support personnel.
	2.1.3 Develop a plan to examine the vulnerability of transportation infrastructure and lifelines. The plan should include strategies to obtain funding for this work.	Oklahoma Department of Transportation; Oklahoma Emergency Management	3 Years **Medium Priority**	Existing and future State resources.	Understanding vulnerability will help frame discussion by decision makers on how to preserve and protect assets critical to the economy of the State from hazard events.	
2.2 Reduce repetitive losses	2.2.1 Identify and build a portfolio of all repetitive loss structures in the State of Oklahoma	Oklahoma Emergency Management; Oklahoma Water Resource Board	2 years **High Priority**	FMA, SRL, RFC, HMGP	Identifying repetitive loss areas and properties helps Federal, State and local officials develop a strategy to reduce future losses. This portfolio will give the State a correct listing of repetitive loss structures statewide.	Retrofitting, elevating or removing repetitive loss properties from known hazard areas protects property and lives as well as preserve personal, State and federal financial resources.
	2.2.2 Reduce by 10% each fiscal year the number of repetitive loss structures identified	Oklahoma Emergency Management; Department of Commerce	Ongoing **High Priority**	HMGP, PDM, FMA, CDBG	Identifying repetitive loss areas and properties helps Federal, State and local officials develop a strategy to reduce future losses.	Retrofitting, elevating or removing repetitive loss properties from known hazard areas protects property and lives as well as preserve personal, State and federal financial resources.
	2.2.3 Streamline the permitting and funding processes for flood damage reduction and	Oklahoma Water Resource Board; Department of Fish and Wildlife;	3 Years **Medium Priority**	Existing State resources required	Allows important damage reduction strategies to be completed more quickly.	The quicker flood improvement projects are completed, the less property damage future flood events will cause.

Goal #2 – Protect Property						
Strategy	Action	Responsible Agency	Projected Timeline	Projected Resources	Rationale for Action	How Action Contributes to Mitigation Strategy
	stream improvement projects.	Governor's Office of Regulatory Assistance				
	2.2.4 Develop guidelines for comprehensive flood hazard management plans, the State model flood damage prevention ordinance, and policy guidance to reduce flood losses.	Oklahoma Water Resource Board – Floodplain Management	3 Years **High Priority**	Additional State resources	Updated plans, ordinances and policies will take into account current land-use regulations and the status of development in hazard-prone communities.	Up-to-date planning guidelines, policy guidance and model flood ordinance will lead to improved local strategies to prevent property damage caused by flood.
	2.2.5 Encourage communities to record high water marks to improve or update flood maps or develop other measures to reduce flood damage.	Oklahoma Water Resource Board – Floodplain Management	Ongoing **Medium Priority**	Existing resources	Recording high water marks from flood events will allow for development of up-to-date flood maps.	Better information on past flood events will improve decisions on floodplain management and strategies to protect lives and property.
	2.2.6 Seek additional resources to expand the Flood Hazard Mitigation Program (HB 1841)	Oklahoma Water Resource Board – Floodplain Management	Ongoing **Medium Priority**	Additional resources required	Program resources were not funded	The Flood Hazard Mitigation Program supports local projects to reduce property damage caused by flood.
	2.2.7 Establish database to record effectiveness of hazard mitigation projects.	Oklahoma Emergency Management	3 Years **High Priority**	Existing State resources	Existing State process for collecting and storing such information is ineffective and time consuming.	Understanding effectiveness of existing mitigation projects will improve the process of developing and selecting new projects.

4.1.3 Mitigation Goal #3 – Protect the Environment

Hazard events can wreak havoc on the physical environment, beyond damage to buildings. Floods can ruin critical habitat and foul domestic water systems. Ground shaking of an earthquake can cause spills of hazardous materials into the environment. Dead and diseased trees make for an unhealthy forest and provide fuel for wildland fires; a 2002 study showed that nearly 10 percent of Oklahoma's forestlands contained trees killed or defoliated by forest insects or diseases. High winds can knock down power lines that can spark and ignite nearby fuels. At times, debris from hazard events is disposed of in ways that foul areas of habitat critical to the survival of endangered species or into environmentally sensitive areas.

The focus of the action agenda that follows is protecting the environment from the direct and secondary impacts of natural hazard events.

Goal #3 – Protect the Environment						
Strategy	Action	Responsible Agency	Projected Timeline	Projected Resources	Rationale for Action	How Action Contributes to Mitigation Strategy
3.1 Develop hazard mitigation policies that protect the environment.	3.1.1 Establish a working group with electric utilities to explore development of recommendations for selective de-energizing of power lines to reduce the risk of wildland fire in interface areas during emergencies.	Department of Agriculture, Forestry Division; Corporation Commission; Rural Electric Coop	2 Years **Medium Priority**	Existing resources	A standardized protocol for de-energizing power lines does not currently exist.	Reducing the potential for power line caused fires in the interface area helps limit property damage and protects forest resources already at risk to wildfire.
	3.1.2 Establish a working group with electric utilities to explore development of recommendations on cost-effective use of underground cable in high-risk areas, including fire interface areas.	Department of Agriculture, Forestry Division; Bureau of Indian Affairs, Oklahoma Fire Center; Corporation Commission; Rural Electric Coop	2 Years **Medium Priority**	Existing resources	Burying power cables may reduce the number of outages and fires caused by energized above ground lines during hazard events.	Reducing the potential for power line outages and fires in the interface area helps limit property damage and protects forest resources already at risk to wildfire.
	3.1.3 Develop and implement effective strategies that improve the health of forests and reduce the amount of fuels available for wildland fires from dead and dying trees.	Department of Agriculture, Forestry Division; Bureau of Indian Affairs, Oklahoma Fire Center; NRCS	1 Year to develop plan; ongoing. **Medium Priority**	Existing resources and Fire Plan grants	About 10 percent of the State's forests have trees killed or defoliated by forest insects or diseases.	Improving the health of the forest will make fuel available for wildland fire and protect forest resources.
	3.1.4 Establish Fire wise Communities in the State	Department of Agriculture, Forestry Division; Bureau of Indian Affairs, Oklahoma Fire Center; Oklahoma Emergency Management	Ongoing **High Priority**	Existing resources	The goal is to encourage and acknowledge action that minimizes home loss to wildfire.	The Fire wise Communities recognition program enables communities in all parts of the State to achieve a high level of protection against wildland/urban interface fire as well as sustainable ecosystem balance.

4.1.4 Mitigation Goal #4 – Increase Public Preparedness for Disasters

Preparing for disasters caused by natural hazards can take many forms, including strengthening structures or securing items such as bookshelves to reduce potential damage and injuries during hazard events; keeping development out of hazard areas; providing information on hazards, vulnerability and preparedness to individuals and organizations; and providing training to responders.

Among the steps taken by state agencies to promote or increase public preparedness for disasters, include:

- Conducting research to further knowledge about hazards and vulnerability.
- Providing information on hazards and maps of their locations.
- Delivering an annual disaster preparedness campaign to the public.
- Providing grants for structural and non-structural actions to prevent or reduce future hazard-caused damage.

Despite the effort by state agencies to promote or increase public preparedness for disasters, a variety of factors hinder this work including:

A lack of up-to-date information and data sets for natural hazards needed to guide development of land-use regulations and to prepare emergency response and hazard mitigation plans. For example, flood maps are inadequate and badly out of date; landslide mapping is limited, at best, statewide; and while development continues, research and mapping in Oklahoma is limited, leading to an incomplete understanding of the risk. A lack of resources to learn more about natural hazards limits expansion of knowledge about hazards and vulnerability. Cities and counties are required to use the concept of best available science in identifying critical areas such as frequently flooded areas and geologically hazardous areas and in developing regulations to protect and prevent development in those areas. Emergency managers even need up-to-date and real-time data and information on which to base decisions before and during hazard events.

Decisions can only be as good as current hazard information and data networks provide. Only as the scientific knowledge of natural hazards grows will decisions on land use policy, various planning initiatives, and emergency response improve. The desired result is safer communities.

Between June 1, 1955 and July 26, 2010 Oklahoma had 113 emergency management, fire management and presidentially declared disasters. In each instance, partnerships with respective state or federal agencies were a key in providing for the delivery of response and recovery programs to assist all citizens of Oklahoma.

The reasons individuals and communities do not prepare for a disaster can be many, including lack of knowledge about hazards and of their vulnerability; lack of resources to mitigate potential damage or take other steps to prepare; or lack of political will or incentive to take action. Public action during and following the May 8, 2003, tornado demonstrated the success of the state's preparedness education program, but also pointed out that additional work is needed. Many businesses, schools, public agencies and individuals completed structural projects, to include building safe rooms and shelters. However, television news reports continue to show adults reacting dangerously; 911 call centers

overloaded with non-emergency calls; and many public and private organizations releasing their employees, jamming roadways before they can be evaluated for damage.

A better understanding of what the public knows about the hazards and risk they face, and what motivates – or does not motivate – people and organizations to prepare for hazard events, is necessary to improve the effectiveness of local and state preparedness education efforts.

The focus of the action agenda that follows is increasing public preparedness for disasters.

Goal #4 – Increase Public Preparedness for Disasters						
Strategy	Action	Responsible Agency	Projected Timeline	Projected Resources	Rationale for Action	How Action Contributes to Mitigation Strategy
4.1 Develop new policies to enhance hazard mitigation initiatives	4.1.1 Educate key officials and policy makers about the State's natural hazards, the threats they pose and the strategies to reduce the risk.	Oklahoma Emergency Management; State Hazard Mitigation Team	Ongoing **High Priority**	Existing resources	Many elected State officials and their appointees lack knowledge of the hazards the State faces and strategies to reduce the risk.	Improving knowledge of key State officials of the State's hazards and the risks they pose will lead to development of better policies and improved funding for hazard reduction strategies.
4.2 Improve public knowledge of hazards and protective measures so individuals appropriately respond during hazard events.	4.2.1 Assess the State's public school education program on emergency preparedness and disaster resistance to determine its effectiveness and establish a baseline for future education efforts.	Oklahoma Emergency Management	2 Years **Medium Priority**	Existing program resources, State mitigation programs	Knowledge of what mitigation steps the schools have taken and how they will respond during a hazard event is unknown.	Understanding what public schools know about hazards and whether they know what to do before and during an event will help the State improve the public school preparedness program strategy and the appropriate material to improve knowledge of hazards and preparedness.
	4.2.2 Develop and maintain a comprehensive public education program that increases awareness of the wildland interface fire risk and promotes actions that reduce the risk of fire to life and property.	Oklahoma Department of Agriculture, Forestry Division; Bureau of Indian Affairs, Oklahoma Fire Center; Council of Government, Rural Fire Coordinators	Ongoing **Medium Priority**	Existing resources	Development in interface areas is increasing, but the public, property developers and local planners do not fully understand the wildfire risk in those areas.	Increasing the knowledge of the public, property developers and local planners of the wildland fire risk and mitigating that risk will improve public safety in interface areas.
4.3 Improve hazard information including databases and maps.	4.3.1 Develop and maintain an inventory of existing geographical databases for natural hazards.	Oklahoma Department of Commerce; Oklahoma GIS Council; Oklahoma Emergency Management	3 Years **High Priority**	Existing and additional resources	Many land-use planners and emergency managers do not know where to turn to for geographical (GIS) databases for hazards or whether such a database exists.	Maintaining a centralized library of hazard databases will improve their accessibility and expand their use by land-use planners and emergency managers, resulting in better plans and mitigation initiatives.
	4.3.2 Accelerate mapping of natural hazard areas, including floods, and develop GIS-compatible database products for them.	Oklahoma Department of Commerce; Oklahoma Water Resource Board	3 Years **Medium Priority**	Dependent on continued funding.	Few GIS databases for natural hazards exist.	Availability of GIS databases for natural hazards would greatly improve mitigation initiatives and land-use planning.

4.2 Mitigation Strategies/Actions

4.2.1 S.T.A.P.L.E.E. - Prioritization and Review Criteria for State

Evaluation Category	Sources of Information and Considerations
Social	Over 30 state, federal, local and non-profit agencies were contacted and had input throughout the planning process. While many were team members, others participated by identifying potentially vulnerable facilities, resources they were able to contribute, and efforts each agency is making to integrate mitigation in their operations. Approved local natural hazard mitigation plans were incorporated wherever possible. The selected mitigation actions/projects were considered to do the most good for the largest amount of people without adversely affecting any significant section of the population.
Technical	The following persons/agencies were consulted as to the technical feasibility of the various projects: FEMA, NWS, US Army Corps of Eng., US Fish & Wildlife, USGS, HUD, BIA, US Bureau of Reclamation, American Red Cross, OKACO, OK Dept of Ag., OCS, ODOC, OK Cons. Comm., OK Corp. Comm., OEMA, ODEQ, OFMA, OGS, OK Dept. of Health, SHPO, OK Dept. of Human Services, OK Ins Comm., OML, ODOT, OWRB, NFIP Cord., State Dam Safety Cord., OK Dept of Wildlife Cons. The mitigation actions/projects implemented were also based upon the judgments of these experts and existing literature/studies regarding the hazards and technically feasible mitigation actions for repetitive loss properties. It was felt the selected actions/projects would provide the best long-term solutions and have minimal secondary impacts.
Administrative	Based upon available funding, capability assessment and organizational responsibilities, staffing for implementation of the state plan will rely on existing personnel in OEM and members of the SHMPC.
Political	Representatives from state, federal, local and non-profit agencies attended the SHMPC meetings and were consulted on all aspects of the plan and mitigation actions/projects and provided input.
Legal	The State Natural Hazard Mitigation Plan was made available to all state agencies, governing bodies, and promulgation authorities. In their opinion, no significant legal issues were involved in the state mitigation strategies/actions that were selected.
Economic	Economic issues were discussed by all involved. It was felt that based upon the state's benefit-cost analysis methodology, economic impact assessment, priorities and funding capabilities the mitigation actions/projects selected would do the most good at eliminating or reducing loss of life, repetitive loss properties and other property, help break the cycle of damage, reconstruction, and repeated damage and have the most benefits. Each project is subjected to a cost benefit review.
Environmental	All environmental concerns are addressed through their respective state agencies before any mitigation actions/projects are undertaken at the state or local level. Coordination with state and federal resource agencies during the formation of the plan and before any mitigation actions/projects are implemented insures compliance with all relevant statutes and regulations.

4.3 Pre-Disaster Hazard Management Policies and Programs

Reducing hazards has long been a priority of the State of Oklahoma. Staff from the Mitigation Division of Oklahoma Emergency Management worked with the State Hazard Mitigation Team and State agencies to evaluate the State regulations, policies and state-funded or administered programs that benefit hazard mitigation activities to develop a better understanding of state government activities related to hazard mitigation. The following state hazard mitigation capability matrix is the result of this effort.

Among the best examples of hazard mitigation in Oklahoma are the Flood Control Programs, Repetitive Loss, Severe Repetitive Loss programs and the FEMA funded, state-administered hazard mitigation programs; however, a myriad of other programs, funding sources, executive orders, and interagency agreements have elements that support or facilitate hazard mitigation. Recent legislation established a Flood Hazard Mitigation Program to allow the State of Oklahoma to eliminate the repetitive loss of properties within flood zones in flood-prone areas of the state. The bill establishes a fund from which municipalities can draw loans or grants to acquire repetitive loss structures in their floodplain areas and move them to higher ground.

Federal hazard mitigation programs – The Hazard Mitigation Grant Program, Flood Mitigation Assistance Program, and the Pre-Disaster Mitigation Program have been the state's major tools for hazard mitigation in recent years. In 2003, the Oklahoma Water Resource Board applied for the FMA planning and technical assistance grants in order to gather portfolio information on all repetitive loss structures in Oklahoma, the number one mitigation priority. These portfolios will provide the correct information along with the digital location. HMGP has funded a wide range of hazard-reduction projects, ranging from the purchase of repetitive flood loss properties to purchase of NOAA Weather Radios and other advanced warning systems.

Since early 2002, Oklahoma Emergency Management has required recipients of Mitigation Grant Programs to develop a hazard mitigation plan as a condition of receipt of the grant. Much smaller investments from the Flood Mitigation Assistance and the Pre-Disaster Mitigation programs have paid for the flood element of the local hazard mitigation plan (FMA) or for entire local plans (PDM planning). With its most recent revision, November 2009, the state's administrative plan for hazard mitigation programs requires all construction-related mitigation projects to support the general mitigation objectives in the state's hazard mitigation strategy. These policies have remained the same and changed as indicated above. These policies have been proven to be effective.

As found in the State Administrative Plan, (Section II. Responsibilities), the Oklahoma Department of Emergency Management is designated (by the legislature) to administer Section 404 of the Stafford Act, Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance Program (FMA), Repetitive Flood Claims Program (RFC), Severe Repetitive Loss Program (SRL), and the Pre-Disaster Mitigation Assistance Program (PDM).

In order to insure adequate staffing and management capability of pre-disaster programs, post-disaster response, recovery and mitigation programs, as well as on-going disaster activities, Oklahoma has instituted a program very similar to the FEMA DAE (Disaster Assistance Employee) program. Oklahoma maintains a cadre of trained and experienced disaster-response and mitigation personnel (aka: contractors or reservists) who are pre-contracted on a yearly basis to augment full-time employee

staffing. This has proven successful for several years and allows for immediate and sustained response to disasters. The on-the-ground experience during disaster response proves valuable in understanding and effectively administering mitigation programs. For example, Hazard Mitigation Plan Reviewers have first-hand knowledge and experience when working with local jurisdictions in the preparation and review of all phases of their Hazard Mitigation Plan.

Although the OEM full-time employee staffing level has not altered for several years, the number of trained and experienced disaster contractors has increased dramatically, and can be adjusted to adequately staff the agency in order to properly manage the state's responsibilities for disaster response, recovery and mitigation.

OEM currently operates with a full-time staffing authorization of 25 personnel. These full-time employees fill the positions as agency and division leadership, including: Director, Deputy Director, Division Chiefs (Accounting and Finance, Field Services (includes area coordinators), Human Services (includes Individual Assistance), Response and Recovery (includes Hazard Mitigation and Public Assistance), and Training. These positions have been consistently filled to capacity, with many of the employees having tenure greater than ten years. The full-time employees are augmented by the cadre of contractor/reservists, many of whom also have greater than seven to ten years in service with the agency.

In May 2006, OEM began a comprehensive program to upgrade its capacity for assisting local jurisdictions with their Hazard Mitigation Plan completion. In August, 2006, a cadre of plan reviewers was trained in the latest regulatory documentation established by FEMA for HM plans. In February, 2007, OEM hosted a four-day training session on HM plan preparation. Again in March, 2007, FEMA Region VI brought an updated version of other HM plan preparation training to Oklahoma City. Within months of these events, every jurisdiction which had attended the February, 2007, session had received FEMA approval on their HM plans. Many of those who attended the March, 2007 training have also received approval of completed plans. Since this program began 18 months ago, more than 89 local jurisdictional plans have been approved. The results of this concerted effort are already positively evident. All but one of the group of 6 trained in August 2006 have moved on to other assignments. The current group, of three plan reviewers, has reviewed the July 1, 2008 update and use the G-318 guidance along with the current Blue Book and Region VI conference call training to guide them in plan reviews.

In similar fashion, OEM has addressed its management of the entire grant programs administered through OEM and has developed improved programs. The new programs dictate increased staffing levels, as well as improved reporting and auditing staffing and procedures. Although these include the yearly programs authorized by the federal government (PDM, FMA, RFC and SRL), the largest and most comprehensive to manage is the HMGP. For the first two years following the approval of the original Oklahoma State Hazard Mitigation Plan, there were only two disasters which resulted in HMGP, and these were not huge pots of funding allocations. However, because of seven declared disasters during CY 2007, Oklahoma was able to put the new management program into action and many new mitigation projects are finished and underway in local jurisdictions.

In 2009 & 2010 OEM implemented WEB EOC software to allow for better management of active disaster response efforts.

4.4 Recent Disaster Declarations:

4.4.1 Major Disaster Declarations

Year	Date	Disaster Types	Active	Disaster Number
2010	07/26	Severe Storms, Tornadoes, Straight-line Winds, and Flooding	☐	1926
2010	05/24	Severe Storms, Tornadoes, and Straight-Line Winds	☐	1917
2010	02/25	Severe Winter Storm	☐	1876
2009	06/19	Wildfires	☐	1846
2009	02/17	Severe Winter Storm	☐	1823
2009	02/15	Severe Storms and Tornadoes	☐	1820
2008	10/09	Severe Storms, Tornadoes, and Flooding	☐	1803
2008	07/09	Severe Storms and Flooding	☐	1775
2008	05/14	Severe Storms, Tornadoes, and Flooding	☐	1756
2008	05/09	Severe Storms, Tornadoes, and Flooding	☐	1754
2008	05/05	Severe Storms, Tornadoes, and Flooding	☐	1752
2007	12/18	Severe Winter Storms	☐	1735
2007	08/31	Severe Storms, Flooding, and Tornadoes	☐	1723
2007	08/24	Severe Storms, Tornadoes, and Flooding	☐	1718
2007	07/07	Severe Storms, Flooding, and Tornadoes	☐	1712
2007	06/07	Severe Storms, Tornadoes, and Flooding	☐	1707
2007	02/01	Severe Winter Storms	☐	1678
2007	02/01	Severe Winter Storm	☐	1677
2006	04/13	Severe Storms and Tornadoes	☐	1637
2006	01/10	Severe Wildfire Threat	☐	1623
2003	05/10	Severe Storms and Tornadoes	☐	1465
2003	02/04	Severe Ice Storm	☐	1452
2002	02/01	Ice Storm	☐	1401
2001	10/25	Severe Storms & Flooding	☐	1395
2001	06/29	Severe Storms	☐	1384
2001	01/05	Severe Winter Storm	☐	1355
2000	11/27	Severe Storms And Flooding	☐	1349
1999	05/04	Tornadoes, Severe Storms, and Flooding	☐	1272
1995	09/01	Tornado, Flooding	☐	1066
1995	06/26	Flooding, Severe Storm, Tornado	☐	1058
1995	04/26	Explosion at Federal Courthouse in Oklahoma City	☐	1048
1994	04/21	Severe Storms, Flooding	☐	1024
1993	05/12	Flooding, Severe Storm, Tornadoes	☐	991
1993	04/26	Severe Storm, Tornadoes	☐	987

1991	05/08	Severe Storm, Tornado	☐	905
1990	05/18	Flooding, Severe Storm, Tornado	☐	866
1987	07/09	SEVERE STORMS, FLOODING	☐	794
1986	10/14	SEVERE STORMS, FLOODING	☐	778
1984	05/31	SEVERE STORMS, FLOODING	☐	709
1984	05/03	SEVERE STORMS, TORNADOES	☐	704
1983	10/26	SEVERE STORMS, FLOODING	☐	693
1983	06/10	SEVERE STORMS, FLOODING	☐	685
1982	06/18	SEVERE STORMS, FLOODING	☐	662
1981	11/04	SEVERE STORMS, FLOODING	☐	649
1979	04/13	SEVERE STORMS, TORNADOES	☐	576
1976	06/05	SEVERE STORMS, FLOODING	☐	504
1976	04/01	SEVERE STORMS, TORNADOES	☐	497
1975	12/10	SEVERE STORMS, TORNADOES	☐	491
1975	07/09	SEVERE STORMS, FLOODING, TORNADOES	☐	474
1974	11/26	SEVERE STORMS, FLOODING	☐	453
1974	06/10	SEVERE STORMS, FLOODING	☐	441
1974	03/22	Heavy Rains, Flooding	☐	419
1973	12/10	SEVERE STORMS, FLOODING	☐	409
1973	10/13	SEVERE STORMS, FLOODING	☐	404
1973	06/13	SEVERE STORMS, FLOODING, TORNADOES	☐	392
1972	01/14	SEVERE STORMS, FLOODING	☐	317
1971	09/28	Heavy Rains, Floods	☐	314
1970	10/14	Heavy Rains, Tornadoes, Flooding	☐	297
1968	05/29	Heavy Rains, Flooding	☐	241
1960	07/15	Heavy Rains, Hail, Floods, Tornadoes	☐	104
1959	11/09	Heavy Rains, Floods	☐	95
1959	07/08	FLOOD	☐	92
1957	05/18	FLOOD	☐	74
1956	04/07	TORNADOES	☐	54
1955	06/01	Tornado, Flood	☐	35

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4.4.2 Emergency Declarations

Year	Date	Disaster Types	Active	Disaster Number
2010	01/30	Severe Winter Storm	☐	3308
2009	06/23	Snow	☐	3305

2007	12/10	Severe Winter Storms	☐	3280
2007	01/15	Severe Winter Storms and Flooding	☐	3272
2005	09/05	Hurricane Katrina Evacuation	☐	3219
2000	12/28	Snow Storm	☐	3158
1996	03/06	Fire Emergency	☐	3118
1995	04/19	Explosion At Federal Courthouse In Oklahoma City	☐	3115

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4.4.3 Fire Management Assistance Declarations

Year	Date	Incident	Disaster Number
2009	04/10	Mulhall Fire	2813
2009	04/10	Velma Fire	2812
2009	04/10	Healdton Carter County Fire	2811
2009	04/10	McClain Fire	2809
2009	04/10	Midwest Choctaw Fire	2808
2009	03/05	Taloga Fire	2799
2008	06/05	Gotebo Fire	2769
2008	03/21	Quinlan Fire	2756
2008	02/25	South Woodward Fire	2746
2006	04/06	New Castle Fire	2635
2006	04/06	Cement Fire	2634
2006	04/06	Ponca City Fire	2633
2006	01/19	Sperry Fire	2628
2006	01/19	Paoli Fire	2627
2006	01/19	Ryan Fire	2626
2006	01/19	Kiefer Fire	2625
2006	01/19	Stecker Fire	2624
2006	01/19	North Stillwater Fire	2623
2006	01/13	Ratcliff Fire	2618
2006	01/09	Henryetta Fire	2616
2006	01/08	McNalley Flats Fire	2615
2006	01/03	Eufaula Fire	2608
2006	01/02	63rd Street Fire	2607
2006	01/02	Prague Fire Complex	2606
2006	01/02	Sapulpa Fire Complex	2605
2006	01/02	Guthrie Fire	2604
2006	01/02	Cashion Fire Complex	2603

2006	01/02	Bethel Acres Fire	2602
2006	01/02	Shamrock Fire Complex	2601
2006	01/01	Wainwright Fire Complex	2599
2006	01/01	Depew Fire Complex	2597
2005	12/29	Eastern Oklahoma County Fire Complex	2595
2005	12/28	Achille Fire Complex	2594
2005	12/28	Hughes County Fire Complex	2592
2005	12/02	Texanna Road Fire	2590
2005	11/30	Antioch Fire	2589
2005	11/30	Velma Complex Fire	2588
2005	11/29	Flat Rock Complex Fire	2587
2003	07/22	Big Rock Fire	

Indicates Active Disasters:

4.5 Post-Disaster Hazard Management Policies and Programs

The matrix below identifies the most significant State funded or State administered programs, policies, regulations or practices related to hazard mitigation or loss reduction. Many of the listed programs provide funding for various hazard mitigation activities. Other State and Federal programs or initiatives may support or facilitate hazard mitigation or loss reduction.

*Denotes post-disaster hazard management policies and programs

Agency	Programs, Plans, Regulations, Funding, or Practices	Effect on Loss Reduction (X)			Provides Funding for Mitigation Initiatives	Description
		Support	Facilitate	Hinder		
Oklahoma Emergency Management	* HMGP	X			Yes	Available after a Federal Declaration, funds mitigation plans and cost effective projects that reduce or eliminate the effects of hazards. A high priority is placed on the elimination of repetitive loss properties through buy outs or elevation projects.
	PDM	X			Yes	Annual Nationally competitive program funds mitigation plans and cost effective projects that reduce or eliminate the effects of hazards.
	FMA	X			Yes	Funds Flood mitigation plans, provides technical assistance, and funds construction projects that reduce flood risk to insured, repetitive loss properties.
	RFC	X			Yes	Reduce or eliminate the long term risk of flood damage to structures insured under the NFIP that have had one or more flood claims for flood damages.
	SRL	X			Yes	Eliminate or reduce the long term risk of flood damage to severe repetitive loss residential properties and the associated drain on the NFIF (National Flood Insurance Fund) from such properties.
	* Public Assistance: 406 Mitigation	X			Yes	Available after a Federal Declaration, allows mitigation measures to be designed into projects to repair or restore public facilities damaged by the disaster event.
	Community Assistance Program (CAP-SSSE)	X	X		Yes	Provides funds for assistance to NFIP communities directed at the administration of each community's floodplain development to insure compliance
	Earthquake Program		X			Provides coordination and oversight of seismic safety programs, supports public education and mitigation planning, and provides tools to support seismic hazard reduction.
	School Preparedness Program		X			The OEM Emergency Preparedness for Public Education (EPPE) is a comprehensive all hazard program, used by over 200 school districts throughout the State in cooperation with the Oklahoma Department of Education. The program began in 1999 and was completely funded by the State. This program includes development of sheltering and

Agency	Programs, Plans, Regulations, Funding, or Practices	Effect on Loss Reduction (X)			Provides Funding for Mitigation Initiatives	Description
		Support	Facilitate	Hinder		
						evacuation plans, anti school violence mitigation, disaster mitigation, hazardous analysis of school buildings and if requested the forming of a School Threat Assessment Team (STAT). The School Threat Assessment Team would facilitate the intervention of students who are in various stages of planning violent acts in their schools. STAT training allows the school administration to deal with potential violence with the least amount of disruption to the learning environment. The most important benefit of the program is to give the school districts the tools to reduce injuries and loss of life. State Preparedness Officers will make recommendations to school officials that will reduce or eliminate the existing environmental dangers within their respective school buildings. These recommendations serve to reduce the potential for injury and damage from fire and most natural disasters. In May of 2003 Title 63 O.S. 2001, Section 681 was passed making it mandatory for schools to develop an emergency plan and have that plan filed with their local emergency manager. Because of the growing demand for this program, HMGP Federal funds have been made available to continue this much needed program to the 540 Oklahoma School Districts.
Department of Natural Resources	Runoff retardation and soil erosion prevention	X			Yes	To reduce hazards to life and property from floods, drought, and the products of erosion on any watershed impaired by any natural disaster
	Rehabilitation of land and conservation systems	X			Yes	Cost share
	Watershed Protection and Flood Prevention	X			Yes	Provides technical and financial assistance to plan and install works of improvement for watershed protection, flood prevention, agriculture water management

Agency	Programs, Plans, Regulations, Funding, or Practices	Effect on Loss Reduction (X)			Provides Funding for Mitigation Initiatives	Description
		Support	Facilitate	Hinder		
	Resource Conservation & Development Program	X			Yes	Provided for control of erosion on critical eroding developments, water supply and water quality
	Emergency Watershed Protection	X			Yes	Provides emergency watershed protection assistance to reduce hazards to life and property in watersheds damaged by significant natural events.
	Conservation Technical Assistance		X			Assistance in planning and application of conservation treatments to control erosion and reduce upstream flooding
Oklahoma Corporation Commission	Floodplain Management Studies	X			Yes	Provide information & large-scale mapping needed in alleviating potential flood dangers.
Oklahoma Water Resource Board	National Floodplain Management Program		X			Responds to Oklahoma's frequent flooding incidents by coordinating to mitigate the effects.
	Dam Safety Program		X			Integral role in hazard mitigation relative to ensuring the safety of non-Federal dams.
	State-wide Water Development	X			Yes	Provides loans and grants for the financing and implementation of sewer and water facilities. Also available are smaller community emergency grants that are facing infrastructure crises that could threaten life, health or property.
Tulsa Division of the Army Corps of Engineers	Feasibility Studies and Projects		X			Studies that may result in projects for flood control, navigation, hydropower, water supply, recreation
	Emergency Stream bank Protection of Public Facilities	X			Yes	Limited in scope and cost: $500,000
	Small Flood Control Projects	X			Yes	Limited in scope and cost: $5 million
	Snagging and Clearing for Flood	X			Yes	Limited in scope and cost: $500,000

Agency	Programs, Plans, Regulations, Funding, or Practices	Effect on Loss Reduction (X)			Provides Funding for Mitigation Initiatives	Description
		Support	Facilitate	Hinder		
	Control					
	Floodplain Management Services		X			Provide assistance in evaluating flood hazards to a site, floodplain delineation, technical assistance, guidance, and comprehensive floodplain management.
	Permit Authority		X			Section 10 permits to cover construction, excavation, and other related work in or over navigable waterways. Section 404 permits covering the discharge of dredged or fill material in all waters.
	Flood Control		X			Responsible for controlling floodwater releases from all Corps lakes and has agreements with others to monitor and control flow releases.
	Dam Safety		X			Mandatory annual training for personnel on dam safety. Dams are inspected every four years.
Oklahoma Dept of Agriculture- Forestry Division	Oklahoma Forest Regeneration and Forest Tree Improvement	X			Yes	Assist landowners expand forest cover, reduce erosion, improve water quality and establish food and cover for wildlife. Conservation seedlings are grown from genetically improved seed, engineered to thrive in Oklahoma's challenging climate.
	Oklahoma Forest Water Quality Management program	X				Technical training and assistance in best management practices- enabling loggers and landowners to harvest timber while maintaining premium water quality.
	Oklahoma Forest Stewardship Program	X				Assist Oklahomans in managing their forestlands for multiple natural resources and mitigate against natural disasters.
Oklahoma Climatological Survey (OCS)	Oklahoma Mesonet	X				Statewide network of automated weather stations, one station located in each county in the State.
	OK-First	X			Yes	Serves Oklahoma Emergency Managers and public safety communities: access and interpret radar and other weather data sources, improve coordination of storm spotter activities with State and Federal officials, and interact with colleagues and mentors from the State's meteorology community.
Oklahoma	Capital	X			Yes	Assist communities in identifying and updating their inventory of

Agency	Programs, Plans, Regulations, Funding, or Practices	Effect on Loss Reduction (X)			Provides Funding for Mitigation Initiatives	Description
		Support	Facilitate	Hinder		
Department of Commerce	Improvement Planning					publicly owned and controlled assets. This information is then available as computerized data and will assist communities in identification of hazards and mitigation projects.
	* Community Development Block Grant (CDBG)	X			Yes	Administered by the State of Oklahoma, assist communities with an array of publicly owned infrastructure needs. Can be used to match HMGP and PDM.
	Community Revitalization Reuse Program	X			Yes	Assist communities with Fire truck / equipment, street overlays, and emergency vehicles or emergency equipment.
	Rural Economic Action Plan	X			Yes	Assist communities with development projects.
	Community Services Block Grant	X			Yes	Contracted to Community Action Agencies for locally determined initiatives in housing, education, nutrition, health, emergency assistance and economic development.
	Oklahoma Century Community Program	X			Yes	Created to give communities a process in which to conduct a "self evaluation" of community strengths and weaknesses, community planning, and plan implementation.
Oklahoma Conservation Commission	Conservation Cost-Share Program	X			Yes	Provides assistance to landowners to apply soil and water conservation practices, to improve water quality and control soil erosion in Oklahoma.
	Small Watershed Flood Control	X			Yes	Enables a district to acquire real property needed to install upstream flood control structures on rivers and streams.
	Priority Watersheds	X			Yes	Assist landowners in installing conservation practices to reduce non-point source pollution.
	Abandoned Mine Land Reclamation		X			Projects include elimination of dangerous high walls closure of mine openings, subsidence protection and reclamation of hazardous water filled strip pits.

Agency	Programs, Plans, Regulations, Funding, or Practices	Effect on Loss Reduction (X)			Provides Funding for Mitigation Initiatives	Description
		Support	Facilitate	Hinder		
Oklahoma Department of Environmental Quality	Customer Assistance Program		X			Provides help for Pollution Prevention, Small Business Assistance, Risk Communication and Management, and Waste Exchange. Essential contact for citizens, Federal and State immediately after and during recovery from natural disasters.
Oklahoma Department of Human Services	* Individual and Family Grant (IFG)	X			Yes	Provides grants to meet disaster related necessary expenses or serious needs of individuals and families affected by a major disaster.
Oklahoma Department of Fish and Wildlife	Natural Resources Program	X				Promotes habitat improvement, environmental quality, conservation management, provides information on natural resource concerns to conservation groups and the media to help maintain public awareness.

4.6 Local Capability Assessment

The State Hazard Mitigation Planning Committee (SHMPC) has been actively working with local governments to identify those actions most effective for hazard mitigation planning. The State has a history of being a strong property rights state, but support is growing for policies that will help with hazard mitigation. Through working with the local governments, the SHMPC has identified policies currently in place and their effectiveness.

Local governments have policies, programs and capabilities designed to mitigate or assist in mitigation of impacts of natural hazard events. Each community differentiates depending upon such factors as size, area, population, and amount of funding available through local resources. The existing and planned future policies of local governments are indicated in the following table:

Existing Local Policies and Programs			
Policy	***Description***	***Applicability***	***Effectiveness***
Building Codes	***Oklahoma Sunset Law***	**Regulates the plumbing, electrical and mechanical trades, and building and construction inspectors through the powers and duties set forth in the respective licensing acts for such trades. Adopted: the National electric, plumbing and mechanical codes.**	**Local government's codes must meet but may exceed the national codes. Regardless of its size, each community will have a core set of policies, programs and capabilities at its disposal in addition to the national codes, related to hazard reduction and mitigation.**
Zoning	**Laws and ordinances regulate development by dividing the community into zones and by setting development criteria for each zone.**	**Zoning can keep inappropriate development out of hazard-prone areas and can designate certain areas for such things as conservation, public use or agriculture. Zoning can also be used to control construction by dedicating areas for cluster development or planned unit development.**	**Several counties have adopted rules/regulations for Zoning Management Ordinances, Erosion Management Ordinances, Land Use Plans, and Building Codes. Most larger cities have recent land use plans, while smaller cities usually have out-of-date plans.**
Floodplain Management	**Ordinances, which require the elevation of any new structure at or above the 100 year flood level. *Oklahoma Floodplain Management Act*, *Title 82, Sections 1601-1620, amended in 2004*). This act allows counties and cities to adopt floodplain regulations and gives authority to Oklahoma Water Resource Board to regulate development in floodplain on State property. This act also calls for annual training**	**Regulates structures in the floodplain. A high priority is placed on the elimination of repetitive loss properties through buy outs or elevation projects.**	**Oklahoma currently boasts 381 NFIP member communities, which consist of municipalities, counties, and tribes. They have ordinances, which require the elevation of any new structure at or above the 1% chance flood level. This is the same for mobile homes but they must be tied down and on permanent foundations. Only 93 communities, with**

Existing Local Policies and Programs			
Policy	***Description***	***Applicability***	***Effectiveness***
	of the local floodplain manager and protection of the natural and beneficial uses of the floodplain, if work is in a wetland that is in a designated high risk flood hazard area. In a NFIP community the developer must comply with all local, State and Federal requirements, such as Section 404 of the Clean Water Act. Communities also must comply with the Storm Water Permit requirements enforced by the Department of Environmental Quality.		**special flood hazard areas identified, are not in the NFIP, which leaves 264 municipalities in the State with no FEMA flood hazard area identified. Overall 95% of the State's population has access to Federal flood insurance as a result of participation in the NFIP.**
Storm Ready	**Gives communities the skills and education needed to survive severe weather before and after the event. Communities are better prepared to save lives from the onslaught of severe weather through better planning, education and awareness.**	**A community must: establish a 24-hr warning point and EOC, have more than one way to receive weather forecasts and warnings and to alert the public, create a system that monitors local weather conditions, promote the importance of public readiness through community seminars, and develop a formal hazardous weather plan, which includes training severe weather spotters and holding emergency exercises.**	**As of December 2009, Oklahoma had 24 counties, 44 communities, 2 University and 1 Military Base, designated Storm Ready.**
Natural Hazard Mitigation Plan	**DMA 2000 (Public Law 106-390): Encourages and rewards local and State pre-disaster planning, promotes sustainability as a strategy for disaster resistances and is intended to integrate State and local planning with the aim of strengthening Statewide mitigation planning.**	**Enables local, tribal and State governments to articulate accurate and specific needs for mitigation, resulting in faster allocation of funding and more effective risk reduction projects.**	**As of May, 2010, Oklahoma has a combined total of one hundred eighty five FEMA approved plans to include state, tribal, multi and single jurisdictional plans. These cover a total of four hundred sixty eight jurisdictions.**
Emergency Management	***Title 63 Oklahoma Statutes*: Oklahoma Emergency Management Act requires each county to have an Emergency Manager and an Emergency Management Program. Each city with population over 10,000 must have the same or adopt the**	**Responsible for all aspects of emergency management in their jurisdiction including: conducting a hazard analysis detailing risks and vulnerabilities, annually updating the existing all-hazard Emergency**	**The State of Oklahoma currently has 347 local Emergency Managers, 77 of these being county or city/county. In carrying out the provisions of this act, each political subdivision, in which any disaster as described in**

Existing Local Policies and Programs			
Policy	***Description***	***Applicability***	***Effectiveness***
	county program.	**Operations Plan (EOP), conducting and arranging for necessary training of all relevant personnel, conducting annual exercises to evaluate the plan, managing resources, determining shortfalls in equipment, personnel and training, revising the EOP as necessary, establishing and maintaining an office of emergency management, communications, warnings, conducting or supervising damage assessment and other pre- and post-disaster-related duties. Emergency Management Program must carry out the four phases: Response, Recovery, Preparedness and Mitigation.**	**Section 683.3 of this title occurs, shall have the authority to declare a local emergency and the power to enter into contracts and incur obligations necessary to combat such disaster, protecting the health and safety of persons and property, and providing emergency assistance to the victims of such disaster. Each political subdivision is authorized to exercise the powers vested under this section in the light of the exigencies of the extreme emergency situation without regard to time-consuming procedures and formalities prescribed by law (excepting mandatory constitutional requirements) pertaining to the performance of public work, entering into contracts, the incurring of obligations, the employment of temporary workers, the rental of equipment, the purchase of supplies and materials, and the appropriation and expenditure of public funds.**
Local Emergency Planning Committee (LEPC)	***Title 27 A – Oklahoma Response Act*: Each local emergency planning committee shall include, at a minimum, representation from each of the following groups or organizations:** **1. Elected State and local officials;** **2. Law enforcement;** **3. Civil defense;** **4. Fire fighting;** **5. First aid;** **6. Health;** **7. Environmental;** **8. Hospital;** **9. Transportation personnel;** **10. Broadcast and print media;**	**Each local emergency planning committee shall:** **1. Complete preparation of an emergency plan in accordance with the Federal Superfund Amendments and Reauthorization Act. After completion of an emergency plan under this paragraph for an emergency planning district, the local emergency planning committee shall submit a copy of the plan to the Oklahoma Hazardous Materials Emergency Response Commission.**	**As of this date, all 77 counties in the State of Oklahoma have a Local Emergency Planning Committee.**

Existing Local Policies and Programs			
Policy	***Description***	***Applicability***	***Effectiveness***
	11. Community groups; and l2. Owners and operators of facilities, which manufacture, store, or use in any manner those substances specified as extremely hazardous by the administrator of the Federal Environmental Protection Agency.	**The Commission shall review the plan and make recommendations to the committee on revisions of the plan that may be necessary to ensure coordination of such plan with emergency response plans of other emergency planning districts. To the maximum extent practicable, such review shall not delay implementation of such plan. The committee shall review such plan once a year, or more frequently as changed circumstances in the community or at any facility may require; 2. Evaluate the need for resources necessary to develop, implement, and exercise the emergency plan, and shall make recommendations with respect to additional resources that may be required and the means for providing such additional resources; 3. Comply with the Oklahoma Open Meeting Law; and 4. Take such other action as may be required by the Oklahoma Hazardous Materials Emergency Response Commission or as otherwise deemed necessary to implement the provisions of this act or the Federal Superfund Amendments and Reauthorization Act. Added by Laws 1993, c. 145, § 243, eff. July 1, 1993.**	
Land Use Planning	**Comprehensive land use planning provides a mechanism to prevent development in hazardous areas or allows development in a manner that minimizes damage from hazards. Land**	**Local governments can use land use planning to identify those areas subject to damage from hazards and work to keep inappropriate development out of these**	**At this time, Oklahoma does not have local land use planning legislation. This is an objective of the State in which new development will be minimized in identified**

Existing Local Policies and Programs			
Policy	***Description***	***Applicability***	***Effectiveness***
	use planning gives local governments "the big picture" of what is happening to their jurisdiction.	**areas. Land use planning can also be used for a more regional approach when local governments work together.**	**hazard areas. In 1995, the Oklahoma Emergency Managers Association (OEMA) adopted a resolution to partner with the Oklahoma Floodplain Managers Association (OFMA) to ensure continuity for land-use planning sources of best available science for frequently flooded areas and geologically hazardous areas.**
Subdivision Regulations	**Sets construction and location standards for subdivision layout and infrastructure.**	**Contains standards for such things as storm water management and erosion control.**	**New subdivisions in flood hazards areas will be required to cluster homes outside of the floodplain, and will be given more flexibility in using varied densities within the subdivision.**
Capital Improvements Planning	**Identifies where major public expenditures will be made over the next 5 to 10 years.**	**Capital Improvement Plans can secure hazards prone areas for low risk uses, identify roads or utilities that need strengthening, replacement, or realignment, and can prescribe standards for the design and construction of new facilities.**	**A community is better prepared to meet the financial requirements for enhancing its local infrastructure, which then paves the way for future community and economic growth and stability. Federal, Low-to-Moderate Income requirements have basically made a rural program.**
Critical Areas Protection	**Require local government to identify and protect the functions and values of critical areas. Critical areas would be defined as: frequently flooded areas, geologically hazardous areas, fish and wildlife habitat conservation areas, wetlands, and recharge areas for aquifers used for potable water. The concept of protecting the function and values of critical areas includes protecting humans from flood and geologic hazards.**	**All local governments must develop regulations to designate and protect critical areas. Critical area regulations should be updated within a specified time. Must use best available science to develop policies and regulations to protect the function and values of critical areas.**	**Among the issues facing local governments preparing critical area regulations include balancing the use of scarce available resources for detailed planning and regulation development versus providing other services, and balancing the protection of critical areas with rights of owners to use or develop their property. Some might believe that critical area protection requires communities to prevent development on too much land.**

4.7 State Mitigation Actions and Funding

The State of Oklahoma has been proactive in hazard reduction and management for a long time. In addition to the mitigation actions the state is considering and which are listed in the following Mitigation Action Table; there are also those prior and on-going mitigation activities the state has identified through its planning process and local plans and which are described under each hazard heading. OEM has mounted an aggressive program to encourage planners and local jurisdictions to include zoning ordinances in their local plans as action projects to protect their communities from building in hazard prone areas. Action OK 2 in the Mitigation Action Table in this plan lists zoning ordinances that were gleaned from local Hazard Mitigation Plans.
The following is a summary and description of each of these mitigation actions and then a listing of each hazard that they address and mitigate. In an effort to minimize the effects of all disasters and emergencies upon the people of Oklahoma through preparedness, response, recovery and mitigation, each on-going or completed action addresses a specific hazard and was evaluated and determined to be cost-effective, environmentally sound and technically feasible.
All hazard mitigation projects within the state are designed to mitigate the effects of disasters on one or more of the following:

- Life safety of the at-risk population;
- National Flood Insurance Program (NFIP) repetitive loss properties;
- Private structures and properties;
- Government facilities;
- Public infrastructure (through Section 404 HMGP program funds);
- Environmental resources;
- Functionality of critical facilities; and
- Public facilities and infrastructure damaged by a disaster that can be mitigated through FEMA's Public Assistance program funding.

The process used to identify cost-effective and technically feasible mitigation projects/actions will be based, primarily, on the source of the mitigation funds.

4.7.1 Disaster Funds:

Mitigation funds that are available as a result of a presidentially declared disaster are based on a percentage of the overall estimated federal share of disaster assistance provided as a result of that disaster. Mitigation funds can be used anywhere in the state and on any hazard, however, priority will be given to:

1. Mitigation projects related to the hazard that necessitated the disaster declaration; and
2. Those jurisdictions included in the disaster declaration.

OEM Mitigation Division will work with FEMA mitigation staff to determine the approximate amount of hazard mitigation funds available to the State. Then, State officials will determine the specific hazard mitigation issues to be addressed with projected mitigation funds, and OEM will notify all potential

applicants of the availability of mitigation funds and request the submission of proposed mitigation projects.

OEM Mitigation Division will review these proposals for the following criteria:

1. Does the project compliment existing State and local mitigation goals and objectives?
2. Is the project cost-effective, based on applying the submitted project data to FEMA's benefit cost analysis module?
3. Are sufficient mitigation funds available to complete the project?
4. Does the applicant have sufficient funds (if other funds are not available) to meet the local share of the project?
5. Does the project solve a problem?
6. Is the applicant located within the declared areas for the applicable disaster? (This does not prevent a mitigation project from being approved.)

If necessary, OEM Mitigation Division may coordinate, in conjunction with FEMA and the applicant, with other State and/or federal agencies to ensure that the project complies with all State and/or federal laws and regulations. These requirements include, but are not limited to, the Endangered Species Act, the Historic Preservation Act, Floodplain Management and National Environmental Policy Act requirements.

OEM Mitigation Division will forward the final mitigation project application to FEMA Region VI mitigation staff for final approval.

4.7.2 Federal Unmet Needs Programs:

Mitigation funds associated with a federal unmet needs program are generally available only if the U.S. Congress directs funding towards the program. These mitigation funds can only be used in those jurisdictions identified for the applicable unmet needs allocation. These jurisdictions are generally associated with specific presidential disaster declarations. The State's flexibility in identifying potential mitigation projects is somewhat limited because the unmet needs funding allocation will usually specify the types of mitigation projects that can be funded with unmet needs money.

OEM Mitigation Division will work with FEMA mitigation staff to determine the approximate amount of unmet needs hazard mitigation funds available to the State. State officials will determine the specific hazard mitigation issues to be addressed with projected mitigation funds. OEM will notify all potential applicants of the availability of unmet needs mitigation funds and request the submission of proposed mitigation projects.

OEM Mitigation Division will review these proposals for the following criteria:

1. Does the project compliment existing State and local mitigation goals and objectives?
2. Is the project cost-effective, based on applying the submitted project data to FEMA's benefit cost analysis module?
3. Are sufficient mitigation funds available to complete the project?
4. Does the applicant have sufficient funds (if other funds are not available) to meet the local share of the project?

5. Does the project solve a problem?
6. Is the applicant located within the areas designated by the unmet needs funds allocation?

If necessary, OEM Mitigation Division may coordinate, in conjunction with FEMA and the applicant, with other State and/or federal agencies to ensure that the project complies with all State and/or federal laws and regulations. These requirements include, but are not limited to, Endangered Species Act, Historic Preservation Act, Floodplain Management and National Environmental Policy Act requirements.

OEM Mitigation Division will forward the final mitigation project package to FEMA Region VI mitigation staff for final approval.

The FY 2003 budget provided $150 million to initiate a new competitive Pre-Disaster Mitigation (PDM) Grant Program for state, tribal and local government mitigation planning activities and projects. The new competitive program is intended to provide technical and financial assistance to states and local governments to assist in the implementation of pre-disaster hazard-mitigation measures that are cost-effective and that are designed to reduce injuries, loss of life, and damage and destruction of property, including damage to critical services and facilities under the jurisdiction of the states or local governments and to create an interagency task force to address pre-disaster mitigation. Eligible entities were required to provide a 25 percent non-federal match for these grants, with small, impoverished communities eligible for a 10 percent non-federal match. About $13.5 million was set aside for planning purposes and $3.6 million for a Disaster Resistant University program. A cap of $3 million was established for mitigation projects. Up to 10 percent may be used for information dissemination activities related to the project. Management costs are capped at 10 percent. OEM Mitigation Division will review proposals for the following criteria:

1. Does the project compliment existing State and local mitigation goals and objectives?
2. Is the project cost-effective, based on applying the submitted project data to FEMA's benefit cost analysis module?
3. Are sufficient mitigation funds available to complete the project?
4. Does the applicant have sufficient funds (if other funds are not available) to meet the local share of the project?
5. Does the project solve a problem?

4.7.3 Other Mitigation Programs:

The availability of mitigation funds associated with other federal/state programs is dependent on the specific program in question. These mitigation funds can only be used in those jurisdictions identified by the applicable program. These funds are generally available based on applications submitted by specific jurisdictions, and only those applying jurisdictions will have access to the funds.

The State's flexibility in identifying potential mitigation projects is somewhat limited because of the particular requirements associated with each program. We encourage every jurisdiction that submits mitigation projects do so in such a manner that the project compliments current State and local hazard mitigation goals and objectives. Local officials will usually determine the specific hazard mitigation issues to be addressed with projected mitigation funds.

Since these programs are usually initiated between the jurisdiction and the applicable program staff, OEM Mitigation Division will review local mitigation proposals only upon request and if personnel are

available. If that review is requested, OEM Mitigation Division will review the project based on the same criteria used for disaster related mitigation projects. Those criteria are as follows:

1. Does the project compliment existing State and local mitigation goals and objectives?
2. Is the project cost-effective based on applying the submitted project data to FEMA's benefit cost analysis module?
3. Are sufficient mitigation funds available to complete the project?
4. Does the applicant have sufficient funds (if other funds are not available) to meet the local share of the project?
5. Does the project solve a problem?

OEM Mitigation Division will advise the jurisdiction to coordinate with other State and/or federal agencies to ensure that the project complies with all State and/or federal laws and regulations. These requirements include, but are not limited to, the Endangered Species Act, the Historic Preservation Act, Floodplain Management and National Environmental Policy Act requirements.

OEM Mitigation Division will forward their comments to the jurisdiction for their final review and determination.

When evaluating mitigation projects that have been submitted for review and possible approval, several factors must be taken into consideration. These factors include, but are not limited to, the following:

1. The specific requirements and/or restrictions placed on the projects by the funding source.
2. There will always be more requests for mitigation funds that there will be available funds.
3. Federal and State funding for mitigation projects will be limited and in some instances may not be available.
4. Whenever possible, local jurisdictions should develop mitigation projects and initiatives that can be funded locally.
5. Local jurisdictions should actively pursue public-private partnerships, where appropriate, to achieve desired mitigation goals.
6. The requested mitigation project should complement the goals and objectives of the State and local mitigation strategy.

The State Local Plan Reviewers and the State Hazard Mitigation Planning Committee has identified future projects in the local plans, current mitigation projects, and future State mitigation projects. These projects have been reviewed and relevant information has been gathered to include a cost benefit estimate. The summary of results is included in the table below. In cases where the probabilities, costs or benefits were difficult to calculate due to lack of data, the SHMPC considered the amount of damage from past occurrences or the geographical extent of the hazard area, to assign rank. The State is continuing to focus its mitigation efforts on reducing repetitive loss structures.

4.8 Mitigation Action Table

Project #	Description	Associated Hazards	Lead Agency	Schedule / Completion Date
OK 1	State Facility Mapping-The State is currently using its Emergency Management network to systematically verify each location of its State owned and operated facilities.	Dam Failure Earthquake Flooding Tornado Wildfire	Oklahoma Emergency Management	On-going
OK 2	All current local jurisdiction Hazard Mitigation Projects, i.e., Reverse 911, GIS Mapping, 911 Training, School Safe Rooms, Shelter Models, Acquisitions, Natural Hazard Mitigation Plans, etc.	Dam Failure, Drought, Earthquake, Severe Thunderstorms / Hail / Lightning, Expansive Soils, Extreme Temperatures Heat/ Cold, Flooding, High Winds, Landslides/ Rockslides, Tornados, Wildfires, Winter Storms/ Icy Hazards	Oklahoma Emergency Management, Hazard Mitigation Division	There are multiple completion dates ranging from one to three years, Ongoing
OK 3	Tornado Shelter Seminars. Oklahoma Emergency Management presents free seminars across the State specifically discussing community and school shelters.	Tornados High Winds	Oklahoma Emergency Management, Hazard Mitigation Division	April/May Annually
OK 4	Blaine Gypsum Groundwater Recharge Demonstration Project effective in offsetting seasonal and long-term water level declines in an aquifer heavily pumped for irrigation.	Drought	Oklahoma Water Resource Board	Ongoing
OK 5	McReady Oklahoma- State wide severe weather preparedness campaign designed to prepare families for emergencies, increase awareness of severe weather threats and build better prepared communities.	Floods Tornados Lightning Thunderstorm	Oklahoma Emergency Management	Ongoing
OK 6	Emergency Preparedness Public Education Program provided to requesting school districts to educate and help them with an emergency preparedness plan.	Dam Failure, Drought, Earthquake, Expansive Soils, Extreme Temperatures Heat/Cold, Flooding, High Winds, Landslides/ Rockslides, Severe Thunderstorms/ Hail/Lightning, Tornados, Wildfires, Winter Storms/Icy	Oklahoma Emergency Management	Ongoing

Project #	Description	Associated Hazards	Lead Agency	Schedule / Completion Date
		Hazards		
OK 7	Oklahoma Weather Modification Program to augment water supplies and prevent future drought and/or hail damage to crops and property.	Drought Hail Damage	Oklahoma Bureau of Reclamation	Ongoing
OK 8	Hazard Mitigation Grant Program Workshops hosted at various locations throughout the State describing what Hazard Mitigation Planning is, why it is important to communities, counties and tribes and options on how to create a plan.	Dam Failure, Drought, Earthquake, Expansive Soils, Extreme Temperatures Heat/Cold, Flooding, High Winds, Landslides/ Rockslides, Severe Thunderstorms/Hail/ Lightning, Tornados, Wildfires, Winter Storms/Icy Hazards	Oklahoma Emergency Management, Hazard Mitigation Division	Ongoing
OK 9	Individual Safe room Project #1272-an initiative to promote and support the construction of storm shelters in homes.	Tornados High Winds	Oklahoma Emergency Management	Completed, Closed 2010
OK 10	OK-WARN Project #1355 creates a system for advance warning of emergency weather on a statewide basis, directed to the deaf and hard of hearing population. This project will provide service throughout all 77 counties of the State.	Flooding High Winds Tornados Thunderstorms Winter Storms	Oklahoma Emergency Management, Hazard Mitigation Division	Completed May 2004
OK 11	NFIP Compliance Workshops-The OWRB, FEMA and OEM sponsors workshops throughout the State to update city and county floodplain administrators on NFIP compliance requirements, mitigation and assistance in the development, administration and enforcement of local flood damage prevention ordinances that guide floodplain development.	Flooding Thunderstorms	Oklahoma Water Resource Board	Ongoing
OK 12	Upstream Flood Control Program-Oklahoma leads the nation in the number of small watershed upstream flood control dams constructed. The concept behind this program is to build small flood control dams on tributaries upstream from rivers or large streams.	Flooding	Oklahoma Water Resource Board	Ongoing
OK 13	Abandoned Mine Land Reclamation Program for land damaged by past oil field or mining operations. Some hazards include dangerous high walls, hazardous water bodies, unstable banks, subsidence such as caving, potholes, etc.	Landslides/ Rock fall, Flooding Expansive Soils/ Man Made	Oklahoma Conservation Commission	Ongoing
OK 14	Watershed Protection & Flood Prevention	Flooding	Department of	Ongoing

Project #	Description	Associated Hazards	Lead Agency	Schedule / Completion Date
	Program (Public Law 83-566) has been used as an effective tool to conserve natural resources by thousands of local communities.	Drought	Agriculture, Natural Resources Conservation Service	
OK 15	March is "Flood Insurance Month", part of a State campaign to spread the word about the availability of affordable flood insurance through the Federal Emergency Management Agency's National Flood Insurance Program.	Flooding	Oklahoma Water Resource Board	Every March
OK 16	May is "Flood Awareness Month", part of a State campaign to remind citizens and educate the public on flood safety procedures and floodplain management techniques.	Flooding	Oklahoma Water Resource Board	Every May
OK 17	Tar Creek Relocation Project. Senate Bill 1490 authorizes a voluntary relocation program for families with young children in the most hazardous part of the abandoned mining area in northeastern Oklahoma.	Man Made Hazards	GGEDA	Ongoing
OK 18	Landslide/Rockslide Mitigation Policy is the result of nearly a one and a half year study that sets forth in a Policy Statement the Department's recognition of landslide/ rockslide/ as a hazard to the traveling public, specifying a hazard rating system, stating guidelines for rock slope design and maintenance of rock slopes.	Landslides	Oklahoma Department of Transportation	Ongoing
OK 19	Individual Safe room Project #1465- The second initiative to promote and support the construction of storm shelters in homes.	High Winds Tornados	Oklahoma Emergency Management	Completed, Closing out 2010
OK 20	Oklahoma Red Flag Fire Alert limits the use of fire outdoors and may cancel all burning authorizations when outdoor burning of any kind would be more risky than normal.	Wildfires	Oklahoma Forestry Service	Ongoing
OK21	Dam Safety Program to ensure the safety of more than 4,755 dams in the State, especially those that could impact downstream life and property.	Dam Failure Flooding	Oklahoma Water Resource Board	Ongoing
OK22	OK-FIRST Program has been recognized internationally for its innovative approach in providing instant access to a wealth of vital weather data for fire, police, and emergency management agencies.	High Winds Thunderstorms Tornados Winter Storms	Oklahoma Climatological Survey	Ongoing
OK23	Bioretention Cells for reducing storm water Runoff Research being conducted in Bio	Flooding	Oklahoma State	Ongoing

Project #	Description	Associated Hazards	Lead Agency	Schedule / Completion Date
	systems and Agricultural Engineering		University	
OK24	FMA Tech 031 Grant to conduct site visits and collect information for 750+ repetitive loss properties in the State.	Flooding	Oklahoma Water Resource Board	Completed August 2010
OK25	FMA Planning 031 to assemble information gathered and created portfolios for 750+ repetitive loss properties in the State.	Flooding	Oklahoma Water Resource Board	Ongoing
OK26	Winter Weather Preparedness Day - to better educate Oklahomans of the preparedness steps to take in order to mitigate the effects of the storms that include widespread, lengthy power outages and treacherous travel conditions	Winter Storms	Oklahoma Emergency Management	Ongoing
OK27	Electric Meter Assistance Pilot Program – Pilot program designed to restore power to tens of thousands of Oklahoma homes due to electric meter and weather-head problems. The pilot program was quickly reviewed and approved by FEMA.	Winter Storms	Oklahoma Emergency Management	Ongoing
OK28	Resolve data deficiencies	Tornado, Winter Storms, Sinkholes, Flooding, Wildfires, High Winds, Drought, Hail, Lightning, Extreme Heat, Earthquake, Dam Failure, Landslides, Expansive Soils, Special Events	Oklahoma Emergency Management	Ongoing

4.8.1 OK01-State Facility Mapping

Overview:
The State of Oklahoma is currently using its Emergency Management network to systematically verify each location of its State owned and operated facilities. The facility list, derived from Oklahoma Department of Central Services, did not have adequate address information for over fifty percent of locations listed. Oklahoma Emergency Management developed an accurate database to be used for planning and response.

Strategy Implementation:
County maps were produced and mailed out to each county Emergency Manager with a list of Oklahoma State owned and operated facilities in each region. The local administration then marked the maps with each location of each facility. Emergency managers were encouraged to also provide specific addresses as well as GPS coordinates for each location if possible. Some provided digital pictures as well.

Lead Agency:
Oklahoma Emergency Management

Schedule/Completion Date:
Ongoing

Funding:
State of Oklahoma

4.8.2 OK02- All current local jurisdiction Hazard Mitigation Projects

Overview:
These are FEMA approved projects that are in various stages of completion. Oklahoma Emergency Management, Hazard Mitigation Division, monitors and administers all aspects of these projects from the application stage through completion of the projects, which could last upwards of several years.

We coordinate closely with FEMA, State, county, and city officials to ensure complete compliance with all Federal, State, and local laws, codes and environmental, archeological and historical considerations.

Oklahoma Emergency Management utilizes a benefit cost analysis model on all regular projects prior to approval by this office and before submission to FEMA for final review. This does not include 5% or 7% projects. Some hazard mitigation measures are difficult to evaluate against traditional program cost-effectiveness criteria. Up to 5 percent of the total Hazard Mitigation Grant Program (HMPG) funds may be set aside by the State to pay for measures such as these.

To be eligible for the 5% Set-Aside Initiative, measures must:

- Be identified in the State Hazard Mitigation Plan as a measure that would reduce or prevent damage to property or prevent loss of life or injury.
- Be submitted for review with a narrative rationale that identifies the mitigation benefits and indicates that there is a reasonable expectation that future damage or loss of life or injury will be reduced or prevented.
- Continue to comply with any other applicable HMPG eligibility criteria, and Federal, State, and local laws and ordinances.

On a daily basis we monitor and coordinate with local entities to ensure the proper use of all obligated Federal and State monies and ensure these monies are utilized to maximize the public benefit for which they were intended. Quarterly reports are submitted, reviewed and monitored for administrative and financial oversights. These projects include the following:

- Reverse 911
- GIS Mapping
- 911 Training
- School Safe Rooms

- Seminars
- Shelter Models
- Spanish Communication
- Storm water Projects
- Technical Disaster Plan
- TV Cable
- Water Plan
- Weather Radios
- Acquisitions
- Elevate Structures
- Elevate Roads
- Elevate Bridges
- NOAA Weather Radios
- Natural Hazard Mitigation Plans
- Continued participation in NFIP
- Map Special Needs Population
- Warming Stations
- Private Safe Rooms
- Flood Gauges
- Dam Monitoring Equipment
- Inspect Dams
- Building Tie Downs
- Rectify Data Limitations
- Identify Safe Room Locations
- Building Codes
- Zoning Ordinances
- Outdoor Drinking Fountains
- Bury Electric Lines
- Snow Fences
- Irrigation Program
- Evergreen Eradication Program
- Controlled Burns
- Xeriscape
- Landslide Barrier
- Fund Flood Plain Administrator
- Flexible Pipe Lines
- Flood Plans
- Gauge Studies
- Gauges
- EOC Generators
- Generators
- Wiring for Generators
- GIS
- GIS Media
- GPS Mapping
- Hearing Impairment

- Lamination
- Radios
- Amateur Radios
- Brochures
- Communication Tower
- Warning Sirens or Messaging
- GPS Flood Plain Data
- GPS Mapping
- Lightning Protection
- Lightning Detection
- Protective Window Film
- Steel Roof
- Dry Hydrants
- Fire Wise Program
- Fire Breaks
- Additional Water Wells
- Build Reservoirs
- Cooling Stations
- Drainage
- EAS Software
- Education/Safety Preparedness
- Enhanced Plan
- EOC Propane
- Fire Communication

Lead Agency:
Oklahoma Emergency Management/Hazard Mitigation Division

Schedule/Completion Date:
Ongoing

Funding:
All projects are administered under 75% Federal money and 25% is locally matched by the community, unless they are considered an impoverished community. In the case of an impoverished community the funds are distributed based upon a 90/10 match.

Five percent and seven percent projects are not subjected to a benefit cost analysis

4.8.3 OK03-Tornado Shelter Seminars

Overview:
As Oklahoma faces another tornado season, Oklahoma Emergency Management presents seminars specifically discussing community and school shelters. Topics include evaluating structural and nonstructural performance of buildings against the risks from high winds and tornados, identifying appropriate sheltering alternatives and ranking alternatives.

Strategy Implementation:
The free, one-day classes are offered annually across the State during April and May. "School shelters are a high priority for OEM and these seminars will educate attendees in protecting our children and families," said Albert Ashwood, OEM Director. "Information gained from attendance will assist representatives from schools, health care facilities, design professionals, code inspection personnel and other attendees in the task of inspecting existing facilities and evaluating the ability of the building to provide occupants shelter from high winds and tornados," he added.

Lead Agency:
Oklahoma Emergency Management, Hazard Mitigation Division

Schedule/Completion Date:
April/May Annually

Funding:
Oklahoma Emergency Management (OEM) hosted the training, "Design and Construction Guidance for Community Shelters" (FEMA Publication 361).

4.8.4 OK04-Blaine Aquifer

Overview:
The recent Blaine Gypsum Groundwater Recharge Demonstration Project shows artificial recharge to be effective in offsetting seasonal and long-term water level declines in an aquifer heavily pumped for irrigation. According to Geologist Noel Osborn, principal investigator, the cooperative State-Federal project successfully recharged the cavernous Blaine aquifer utilizing five gravity-flow recharge wells located near the town of Hollis.

Strategy Implementation:
The Blaine aquifer utilizes five gravity-flow recharge wells, which contributed an estimated 1,056 acre-feet of water to the aquifer, averaging 70 acre-feet per well, per year. Each recharge will replenish about half the amount produced from one irrigation well. The study concluded that to optimize the effectiveness of the recharge wells and prevent irrigation wells from going dry, wells should be placed up gradient of or within irrigation pumping centers. The recharge system is still being managed by the local conservation district.

Lead Agency: Oklahoma Water Resource Board

Schedule/Completion Date:
Ongoing

Funding Description:
A study by the Oklahoma Water Resource Board concluded the artificial recharge in southwest Oklahoma was economically feasible with a benefit-to-cost ratio greater than four to one. See the

report, "Demonstration and Evaluation of Artificial Recharge to the Blaine Aquifer in Southwestern Oklahoma," by N.I. Osborn, E. Eckenstein, and R.S. Fabian.

4.8.5 OK05-McReady Oklahoma

Overview:
McReady Oklahoma is a public awareness campaign held statewide every April through the efforts of state and local emergency managers and nearly 20 partnering public and private organizations. The goal of McReady Oklahoma is to provide preparedness information to a diverse audience causing individuals to take action that ultimately mitigates the effects of tornados and other severe weather which in turn provides better prepared communities. There are six major elements to the program: in-store informational displays with preparedness literature, educational tray liners, bag stuffers and table tents; media sponsorship to promote the program; the opportunity for local emergency managers to customize the program with weather radio programming and other local events; a weather safety show presented at schools; a weather safety DVD provided to schools, libraries and local emergency managers; and the Web site, www.mcready.org. McReady Oklahoma is well-timed with message delivery in April because the state's heaviest month for tornado outbreaks is May.

Strategy Implementation:
On April 2, 2004, Governor Brad Henry announced the kickoff of the McReady Oklahoma severe weather public awareness program. Since then, he has proclaimed every April McReady Oklahoma Family Preparedness Month and local officials have approved similar proclamations. Brochures and booklets on the McReady displays explain the steps to take to prepare for and mitigate the effects of severe weather. In 2007, these included a Family Preparedness Guide and a Child Activity Book, along with brochures titled *Weathering the Storm*, *Sheltering in Place* and *OK WARN*, which is a severe weather warning service provided by OEM for the deaf and hard of hearing. All total, 225,000 pieces were delivered statewide during the 2007 campaign.

Nearly 5 million individuals were exposed to the 2010 campaign. The campaign reach is identified by considering the weather safety show and DVD delivered to schools and the displays and other items provided at McDonald's restaurants. Each of the 166 restaurants serves an average of 1,000 customers per day during the 30-day campaign period. This includes both walk-in customers who are exposed to the displays, tray liners and table tents and drive-through customers who received the bag stuffers.

OEM manages the program. Local emergency managers set up and keep the displays stocked. They also hold storm spotter, weather radio programming and other events every April as part of the McReady program.

McReady Oklahoma also advocates preparedness for businesses. As part of this initiative, McDonald's owners placed NOAA weather radios in each of the restaurants across the state.

Lead Agency:
Oklahoma Department of Emergency Management

Schedule/Completion Date:

Ongoing

Funding Description:
Funding and/or technical assistance was provided by the following agencies and organizations acting in partnership:

American Red Cross, Clear Channel Radio, R.D. Flanagan & Associates, Gov. Brad Henry's Office, KOCO Channel 5 in Oklahoma City, KOTV Channel 6 in Tulsa, McDonald's owner/operators, MOROCH, National Weather Service, OG&E Electric Services, Oklahoma Citizen Corps, Oklahoma Department of Emergency Management, Oklahoma Emergency Management Association, Oklahoma Office of Homeland Security, Oklahoma Floodplain Managers Association, The Oklahoman, The Salvation Army and Tulsa Partners, Inc.

4.8.6 OK06-Emergency Preparedness Public Education Program

Overview:
This is an Emergency Preparedness Public Education Program provided to requesting school districts to educate and help them with an emergency preparedness plan.

Strategy Implementation:
This program is an all hazard, all disaster, and fully integrated program. It combines community awareness and participation with their school district, a comprehensive hazard analysis of the school district, development of planning documents tailored to that school district and community, and comprehensive staff and faculty training for school personnel.

Together with local emergency management, law enforcement, fire service and other community leaders, this program provides specialized training materials to assist teachers in educating students in disaster preparedness, improved and more realistic exercise programs which incorporate community response agencies, and an expanded system of oversight and support to the school district from both governmental and non-governmental agencies to insure the program remains strong and vital.

Lead Agency:
Oklahoma Emergency Management

Schedule/Completion Date:
Ongoing

Funding Description:
HMGP-Although Title 63, May 2003, of State law, requires that all "schools, administration buildings and institutions of higher learning, shall have written plans and procedures in place for protecting students, faculty, administrators and visitors from natural and manmade disasters and emergencies", Oklahoma Emergency Management cannot provide the program to a school unless requested by school officials.

School districts may elect to either take the funded State program of "Emergency Preparedness for Public Education" or fulfill the requirements of the law without assistance.

It is the desire and hope of the State that all schools, both public and private, technology centers and institutions of higher education will elect to participate in the State program. The program covers the costs of the printed planning documents, as well as NOAA Weather radios for each school within the school district and supplementary materials for classroom and student use. Other materials provided by the program include; a comprehensive bus driver training program, a community awareness program and computer training programs developed by the Federal Emergency Management Agency and the American Red Cross for elementary education.

4.8.7 OK07-Weather Modification Program

Overview:
The Oklahoma Weather Damage Modification Program's primary goals are to augment water supplies and prevent future drought and/or hail damage to crops and property.

Strategy Implementation:
Rather than a fleeting "drought relief" effort, the Oklahoma program has been designed as a long-term water resource management and hazard mitigation tool. The effort has been modeled after operational programs in Kansas, North Dakota and Texas where rainfall has increased 20 percent or more and losses to hail decreased as much as 45 percent. The regional, multi-State research program will seek to scientifically verify the potential benefits of weather modification technology in mitigating weather-induced hazards.

Lead Agency:
Oklahoma Bureau of Reclamation

Schedule/Completion Date:
Ongoing

Funding Description:
Congress appropriated more than $3 million to establish the Weather Damage Modification Program (WDMP), a multi-state weather modification research program, including Oklahoma.

4.8.8 OK08-Hazard Mitigation Grant Program Workshops

Overview:
Oklahoma Emergency Management will host workshops at various locations in the State describing what Hazard Mitigation Planning is, why it is important to communities, counties and tribes and options on how to create a plan.

Strategy Implementation:

The workshops will be held at various locations across the State to make it easy for all participants to attend. Meetings for 2007 were held in February, March, September, October, and November. Two of the training classes were provided on writing and developing Tribal Hazard Mitigation Plans.

Participants were taken through each phase of creating a Hazard Mitigation Plan, showed examples of successful plans and provided information and resources. The State Hazard Mitigation Team was available to answer questions and hand out FEMA's How-To guides for mitigation planning.

Lead Agency:
Oklahoma Emergency Management, Hazard Mitigation Division

Schedule/Completion Date:
Ongoing

Funding Description:
Oklahoma Emergency Management

4.8.9 OK09 Individual Safe Room Project #1272

Overview:
On May 3, 1999, more than 70 tornados tore through Oklahoma. As a result of these tornados, 44 persons died and almost 800 were injured. The State of Oklahoma launched an initiative to promote and support the construction of storm shelters in homes. The initiative was the first large-scale effort to build thousands of safe rooms through a rebate program and its success is a direct result of the involvement and strong support of the Governor of Oklahoma and the participation of partners in industry, business, government and the private sector.

Thousands of safe rooms were built and, although funding for this rebate program has ended. It resulted in the construction of safe rooms throughout the State through #1465 and #1355. As of the fall of 2010, another safe room project is being considered.

Strategy Implementation:
An extensive public education campaign was launched by FEMA's Office of Public Affairs and supported by the State of Oklahoma. The campaign included a wide range of outreach projects, including:

- Public Service Announcements (PSAs)
- Speakers Bureau
- Resource and Educational Materials

In the first six weeks following the May 3 tornados, a little over 1,000 people requested information about safe rooms and how to reduce property losses. To make sure Oklahomans could see how their families and properties could be better protected, a mitigation tour called the "Safe Room Traveling Road Show" was created to provide this information where people worked, lived, and shopped. Teams of FEMA mitigation advisors fanned out across the State in vans to show people how to build disaster-resistant residential structures. Four thousand people were reached in a 1-week period from June 13-19, 1999.

1) Homeowners called the State's 1-800 hotline to register and verify qualification for the rebate.
2) State sends homeowner a safe room information packet and homeowner's information is sent to the locality where damage occurred.
3) Homeowner contacts local jurisdiction to obtain a 'safe room' building permit. Local authorities verify property ownership and the damage sustained. Letter of eligibility is sent to the State.
4) Safe room construction and installation.
5) On completion of safe room installation, contractors sign a safe room validation form that States the structure meets FEMA regulations. The safe room validation form is then notarized.
6) Homeowner files the notarized safe room validation form with the State.
7) Homeowner calls local building inspectors or, if in a rural area, the county emergency management officer to inspect the completed safe room and verify that a safe room was constructed.
8) After verifying that a safe room was constructed, the State pays the local government, which in turn issues the safe room rebate to the homeowner.

Lead Agency:
Oklahoma Emergency Management

Schedule/Completion Date:
State closed out in 2010 – Oklahoma Emergency Management is providing guidance to other states so they can duplicate the success of the Oklahoma safe room projects.

Funding Description:
HMGP-With the goal of saving lives in future tornados and severe storms, Federal and State agencies developed a first-in-the-Nation safe room rebate program, "Oklahomans Can Survive," to help Oklahomans cover the cost of constructing safe rooms.

The program offered a $2,000 rebate for installing a safe room. The State provided rebates to local jurisdictions on a worst first basis from $12 million dollars in Hazard Mitigation Grant Program (HMGP) funds. The funds were made available by FEMA for projects to reduce loss of lives and property from future severe storms. To be eligible for the rebate, the construction of a safe room above or below ground had to meet FEMA guidelines and State, county and city standards.

To handle the large number of interested homeowners, a 1-800 number was established for rebate questions. The State maintained this line and referred all requests to local jurisdictions. Because the HMGP funds were limited, a three-phase process based on a worst first criterion was established to ensure that those who experienced the worst damage were given priority.

Cost:
Because the HMGP funds were limited, a three-phase process based on a worst first criterion was established to ensure that those who experienced the worst damage were given priority.

Total cost: $17,171,226.
Federal: $12,878,420.
State: $4,292,806.

4.8.10 OK10-OK WARN Project #1355

Overview:
This project creates a system for advance warning of emergency weather on a statewide basis, directed to the deaf and hard of hearing population. This project will provide service throughout all 77 counties of the State.

Strategy Implementation:
Because we cannot completely resolve to remove the problem of hazardous weather, we must improve our ability to notify the public of approaching hazards as early as possible. Traditional early warning systems are inadequate for the deaf and hard of hearing population. This system will be administered by Oklahoma Emergency Management and warning notices will be transmitted much earlier than through other paging sources. The proposed system will also allow for county-specific advance notification for more exact early warning in these counties.

Lead Agency:
Oklahoma Emergency Management, Hazard Mitigation Division

Schedule/Completion Date:
Completed, State Closed May 2004.

Funding Description:
Oklahoma Emergency Management

Cost:
The population, which will receive primary benefit from this project, will include an estimated population of 175,799 individuals (Oklahoma Department of Commerce, Report of Demographics: 1990). This represents 13,674 deaf and 162,125 hard of hearing. These statistics would be increased based upon (1) more current data when available; and (2) the addition of family members of those participating. However, the numbers will simply depend upon the number of qualified individuals who chose to participate in the program.

4.8.11 OK11-NFIP Compliance Workshops

Overview:
As an integral part of Oklahoma's spring flood awareness campaign, the OWRB, Federal Emergency Management Agency (FEMA) and Oklahoma Emergency Management (OEM) sponsor one-day workshops throughout the State to update city and county floodplain administrators on NFIP compliance requirements, mitigation and assistance in the development, administration and enforcement of local flood damage prevention ordinances that guide floodplain development. The certified floodplain manager (CFM) exam will be offered to pre-approved candidates at the close of each training day. These workshops are free.

Strategy Implementation:

Because spring marks the unofficial beginning of the State's flood season and to make citizens aware of flooding problems and solutions, Governor Brad Henry has designated May as "Flood Awareness Month" in Oklahoma.

"We remind citizens that heavy rains and severe storms typically occur in the early spring months, making this one of the most dangerous times of the year," says the Executive Director of the Oklahoma Water Resources Board (OWRB). "This proclamation will be of tremendous help to the Water Board in educating the public on flood safety procedures and floodplain management techniques". Earlier, Governor Henry proclaimed March as "Flood Insurance Month," part of a State campaign to spread the word about the availability of affordable flood insurance through the Federal Emergency Management Agency's National Flood Insurance Program (NFIP). Oklahoma currently boasts 381 NFIP member communities, (See Appendix B), which consist of municipalities, counties, and tribes. One-day workshops are offered throughout the State.

Lead Agency:
(OWRB) Oklahoma Water Resources Board

Schedule/Completion Date:
Ongoing

Funding Description:
CAP-SSSE

4.8.12 OK12 –Upstream Flood Control Program

Overview:
Oklahoma leads the nation in the number of small watershed upstream flood control dams constructed. The State has always been a leader in flood control beginning with the construction of the first flood control dam in the nation in 1948-Cloud Creek Dam Number 1. The dam, located near Cordell, Oklahoma, is in the Cloud Creek Watershed, a tributary to the Washita River and was built by local watershed project sponsors with assistance from the USDA Soil Conservation Service (now Natural Resources Conservation Service). Funding and technical assistance was authorized by the Flood Control Act of 1944 (Public Law 78-534).

Oklahoma also has the first completed watershed project in the nation, Sandstone Creek Watershed Project in Roger Mills County. Twenty-four dams were built in the watershed between 1950 and 1953.

Public Law 78-534 authorized pilot projects in eleven watersheds in the nation, including the Washita River Watershed in Oklahoma. In 1954 Congress saw the success and benefits of these pilot projects and passed the Watershed Protection and Flood Prevention Act of 1954 (Public Law 83-566) that expanded the program approved watersheds.

Strategy Implementation:
The concept behind the upstream flood control program is to build small flood control dams on tributaries upstream from rivers or large streams. The series of dams in a watershed trap water during

heavy rainstorms and slowly release it over a period of several days preventing it from all reaching the river at one time, which reduces flooding.

Conservation practices such as terraces, ponds, diversions, grass plantings, and grade stabilization structures are applied to the land in the watershed to prevent erosion, reduce sediment and to help extend the life of the watershed.

Local watershed project sponsors request assistance with a feasibility study on a watershed project from the USDA Natural Resources Conservation Service. If the project is determined feasible and project sponsors agree to proceed with the project, NRCS provides assistance in developing a watershed plan. This plan may need Congressional approval before funds can be allocated to the project. Once the plan is approved, construction is started on sites where local sponsors have obtained easements and rights-of-way. Congress allocates watershed funds to States on an annual basis. Watershed sponsors, usually conservation districts in Oklahoma, assume operation and maintenance for the dams after they are constructed.

Lead Agency:
Oklahoma Conservation Commission

Schedule/Completion Date:
Ongoing

Funding Description:
The 2,098 upstream flood control dams constructed in the State have established a $1.8 billion infrastructure, which provides multiple benefits to thousands of citizens. It is estimated that the dams and the established conservation practices in the watersheds provide approximately $147 million in benefits each year.

The lakes not only provide flood control, but they are sources of water for livestock and irrigation, and they provide wildlife habitat and recreational areas. The dams provide protection to over two million acres of agricultural land in flood plains. Many of the lakes formed by flood control dams provide municipal and rural water supplies to local communities.

4.8.13 OK13-Abandoned Mine Land Reclamation Program

Overview:
Okmulgee County has over 3,000 acres of land that have been damaged by past oil field or mining operations. Some of the hazards associated with these abandoned mine lands include dangerous high walls which endanger public health and safety; hazardous water bodies which result from some AML-related feature such as steep or unstable banks and underwater ledges; subsidence such as caving, potholes, troughs, tension cracks or shearing which damage property and pose a danger to the public; and clogged streams which result in flooding of roads and/or residences and pose a danger to improved property and the public. The operations that created these situations were carried out prior to current laws that regulate reclamation and management of such areas.

On May 19, 1981, Governor George Nigh signed Senate Bill 217 implementing the AML Program in Oklahoma and the following spring Cecil Andrus, Secretary of the U.S. Department of the Interior, approved Oklahoma's AML Reclamation Plan. Out of 23 States with an approved AML Program, Oklahoma is one of the few States where conservation districts are actively involved with the reclamation efforts on a day-to-day basis.

Strategy Implementation:
The reclamation of these damaged lands is a partnership effort between many agencies and local units of government. Successful projects take good cooperation with landowners and assistance from many agencies. The USDA Natural Resources Conservation Service develops erosion control plans, DEQ provides funding and equipment, and OERB often shapes the areas and prepares them for the application of organic matter. The Oklahoma Conservation Commission designs and contracts land shaping on the abandoned coalmine projects. The conservation district helps coordinate the projects and does much of the actual work of applying the organic matter, constructing fences and re-vegetating reclamation sites.

Leveling and shaping the damaged site is the first step in the reclamation process. Soil amendments, if needed, are applied following the shaping. Organic matter is applied to the land to help restore soil structure. Mulch is applied after the site is sprigged or seeded to provide erosion control and conserve moisture.

Lead Agency:
Oklahoma Conservation Commission

Schedule/Completion Date:
Ongoing

Funding Description:
On August 3, 1977, President Jimmy Carter signed the Public Law 95-87, known as the "Surface Mining Co and Reclamation Act of 1977." This Federal legislation established a nationwide system for controlling the surface effects of active coal mining. The act also established a trust fund for the purpose of reclaiming of coalmine land that endangers public health and/or safety. Money for the Abandoned Mine Land (AML) Fund is generated from a tax on active coal mining.

By law, a State is to receive at least one half of the fees collected in that State. The United States Department of the Interior, Office of Surface Mining (OSM) is the Federal agency responsible for allocating the reclamation trust fund.

4.8.14 OK14-Watershed Protection & Flood Prevention Program

Overview:
The Watershed Protection and Flood Prevention Act of 1954 (Public Law 83-566) has been used as an effective tool to conserve natural resources by thousands of local communities for over 50 years. The Deer Creek Watershed flood control lake is a good example of how the watershed program can benefit a community. The Pottawatomie County, Oklahoma, lake provides flood control, rural and municipal water, and fish and wildlife habitat. The lake is one component in the watershed plan along with a variety of conservation practices to protect the land from erosion and improve water quality.

Strategy Implementation:
There are numerous watershed projects in the nation that provide multiple benefits to thousands of citizens including:

- Reduced Flooding
- Erosion Control
- Reduced Sediment in streams and rivers
- Reduced agricultural related pollutants
- Municipal and rural water supplies
- Water quality protection
- Wildlife habitat
- Groundwater recharge

Local communities identify resource problems to be addressed, practices to be installed, and carry out major portions of a watershed plan, such as obtaining easements, rights of ways, permits and local cost-share funding.

Lead Agency:
Department of Agriculture, Natural Resources Conservation Service (NRCS)

Schedule/Completion Date:
Ongoing

Funding Description:
Watershed projects are planned and carried out jointly by local, State and Federal agencies with support of community landowners and citizens in the watershed.

Entities of State and local government or a tribe may apply for USDA assistance. The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) provides technical and financial assistance to local project sponsors. Federal assistance is available for engineering and construction costs of flood control measures, conservation practices for water quality and erosion and sediment control, and for municipal and industrial water supplies.

4.8.15 OK15-March is Flood Insurance Month

Overview:
Governor Brad Henry proclaimed March as "Flood Insurance Month", part of a State campaign to spread the word about the availability of affordable flood insurance through the Federal Emergency Management Agency's National Flood Insurance Program (NFIP). Oklahoma currently boasts 381 NFIP member communities, which consist of municipalities, counties, and tribes.

Strategy Implementation:
"Severe flooding episodes occur in Oklahoma virtually every year, most frequently in the spring and fall," says the Oklahoma State Floodplain Manager. "Implementation of sound floodplain management and

building strategies, particularly through the NFIP, is the most effective way for communities to avert potential flood damages."

However, he encourages communities to go "above and beyond" minimum NFIP standards, consistent with the National Association of State Floodplain Manager's ongoing "No Adverse Impact" initiative.

A complete media campaign supports this effort to spread the word.

Lead Agency:
OWRB

Schedule/Completion Date:
Every March

Funding Description:
The Floodplain Managers Association and the Emergency Managers Association are very active in the State of Oklahoma. These associations meet frequently with the Governor to pass proclamations that enhance public education and awareness regarding the natural hazards of the State. These public awareness campaigns are conducted at minimum cost to the taxpayer.

4.8.16 OK16-May is Flood Awareness Month Campaign

Overview:
Because spring marks the unofficial beginning of the State's flood season and to make citizens aware of flooding problems and solutions, Governor Brad Henry has designated May as "Flood Awareness Month" in Oklahoma.

"We remind citizens that heavy rains and severe storms typically occur in the early spring months, making this one of the most dangerous times of the year," says the Executive Director of the Oklahoma Water Resources Board (OWRB). This proclamation is of tremendous help to the Water Board in educating the public on flood safety procedures and floodplain management techniques. The OWRB also works closely with the Oklahoma Insurance Department (OID) to educate State property/casualty agents and adjusters on NFIP rules and procedures. Because the Water Board's workshops are accredited by the OID, agents and adjusters can earn up to six continuing education credits for attending at least one workshop every two years.

Strategy Implementation:
As an integral part of Oklahoma's spring flood awareness campaign, the OWRB, Federal Emergency Management Agency (FEMA) and Oklahoma Emergency Management are sponsor one-day workshops throughout the State to update city and county floodplain administrators on NFIP compliance requirements and provide assistance in the development, administration and enforcement of local flood damage prevention ordinances that guide floodplain development. The certified floodplain manager (CFM) exam will be offered to pre-approved candidates at the close of each training day.

Lead Agency:
Oklahoma Water Resource Board

Schedule/Completion Date:
Every May

Funding Description:
The Oklahoma Floodplain Managers Association and the Oklahoma Emergency Managers Association are very active in the State of Oklahoma. Meeting frequently with the Governor, these associations get proclamations passed to enhance public education and awareness regarding the natural hazards of the State. The public awareness campaigns were conducted at minimum cost to the taxpayer and the workshops were offered at no charge to the candidates.

4.8.17 OK17-Tar Creek Relocation Project

Overview:
The Tar Creek Superfund Site is a forty square mile area in the northernmost segment of the Ottawa County and the location of one of the nation's largest lead and zinc mining productions. With the abandonment of mining activities in the 1950's, the area was left with hundreds of open or unsafely capped mine shafts, large areas of subsided land and land areas with the potential of subsidence, huge chat (mine tailings) piles and contaminated ground water. Currently numerous State, Federal and local agencies are performing tests, studies, property and soil abatement activities, community education, water studies and chat removal options in order to address this huge and expensive environmental problem. To date, public costs for clean-up, testing, education, etc. is in excess of $150 million dollars. Elected officials and community leaders are also coordinating and considering long-term options for residents and property owners at the site.

Strategy Implementation:
Governor Brad Henry has signed into law legislation that will deliver long-awaited assistance to many residents in the Tar Creek Superfund Site. Senate Bill 1490, an initiative spearheaded by the governor, authorizes a voluntary relocation program for families with young children in the most hazardous part of the abandoned mining area in northeastern Oklahoma. Research indicates children aged six years and younger are most at risk for the kind of lead exposure that has commonly occurred around the old mining sites in the area.

Governor Henry announced the $5 million voluntary relocation effort in January 2004 after discussing the issue with local residents. The governor reiterated that local input would continue to play a vital role in the program.

Under the provisions of Senate Bill 1490, families with children age six years and younger in the towns of Picher and Cardin will receive State assistance to relocate to a safer area. It is estimated that 100 families could qualify for the voluntary relocation.

Lead Agency:
GGEDA

Schedule/Completion Date:
Ongoing

Funding:

Senate Bill 1490 established a local trust authority to help implement the $5 million relocation program. The governor stressed that the State initiative did not relieve the Federal government or the mining companies of their continued responsibilities in the Superfund area.

Because of a lack of progress in addressing other human health, safety, and environmental threats at the Tar Creek Superfund Site, Executive Order 2000-02 was signed by Governor Frank Keating on 26 January 2000 establishing his Tar Creek Superfund Task Force. The ten-member task force, chaired by Oklahoma's Secretary of Environment was created to help Oklahoma develop a final, holistic action plan for re-mediating the Tar Creek Superfund Site.

Once the Subcommittee recommendations were compiled, it became apparent that addressing each concern on an individual basis would prove unwieldy and cost prohibitive. To adequately protect area residents from subsidence threats alone would cost an estimated $10 to $61 billion...unless, of course, residents would agree to move from the areas most heavily undermined, which includes primarily the towns of Picher and Cardin. This realization, coupled with the frequently mentioned remedy of using constructed wetlands, formed the basis of the Task Force's ultimate goal for a comprehensive solution to the Tar Creek dilemma.

Additional information may be found in Governor Keating's Tar Creek Superfund Task Force, Final Report-1 October 2000, and in Ottawa County Hazard Mitigation Plan 2004.

4.8.18 OK18-Landslide/Rock fall Mitigation Policy

Overview:
The results of nearly a one and a half year study on the assessment of landslides/rock fall on the State of Oklahoma highway system, concludes that the State does have a rock fall/landslide hazard in some areas.

Strategy Implementation:
The Oklahoma Department of Transportation, Soils and Foundations Division is working on developing a landslide/rock fall mitigation policy. The landslide/rock fall mitigation policy is comprehensive in that it will set forth in a Policy Statement the Department’s recognition of Landslide/Rock fall as a hazard to the traveling public, specifying a Landslide/Rock fall hazard rating system, stating guidelines for rock slope design and maintenance of rock slopes.

Lead Agency:
Oklahoma Department of Transportation

Schedule/Completion Date:
Ongoing

Funding:
Though it would appear that landslide hazards are infrequent in Oklahoma, the development of a policy to address this hazardous condition would be in the best interest of everyone involved. The Landslide/Rock fall mitigation policy will set forth the Department's recognition of Landslide/Rock fall as a hazard, specifying guidelines for rock slope design and maintenance of rock slopes. It has been found

from the experience of more mountainous western States that having such a policy is invaluable in lessening the tort liability from the landslides.

4.8.19 OK19-Individual Safe room Project #1465

Overview:
On May 8-9, 2003, tornados and storms once again swept through Oklahoma. After Oklahoma's outbreak of tornados on May 3, 1999, the nation's first Safe Room rebate program was implemented. Through a partnership with FEMA, the 1999 program helped pay for more than 6,000 safe rooms, many of which are credited with saving lives in the May 8-9, 2003 tornados. In fact, there were numerous cases where a safe room was the only portion of a structure left standing after the May 2003 tornados moved through Oklahoma.

Strategy Implementation:
On October 6, 2003, Governor Brad Henry kicked off the second Operation Safe Room during a news conference at the State Capitol. With his announcement, more than $3 million in rebates was made available to Oklahomans for the construction of safe rooms and storm shelters.

"I urge everyone in this State to have a safe room constructed in their home," said Governor Henry. "This program will help eliminate or reduce the financial burden of building a safe room so Oklahomans can better protect themselves in the face of severe weather. The program provides a 75% rebate--up to $2,000--to eligible Oklahomans who install safe rooms. Safe rooms and storm shelters must be built or installed by December 31, 2004 in order to qualify for the rebate program. The Safe Room project was prioritized in four phases:

- PHASE ONE-Homes that were destroyed in the tornados and storms between May 8, 2003 and May 16, 2003.
- PHASE TWO-Homes that were damaged by the tornados and storms between May 8, 2003 and May 16, 2003 where homeowners registered for individual assistance and/or filed a claim for damages with their homeowners insurance.
- PHASE THREE-Homes that applied and were approved in the 1999 rebate program if they built their safe room shelter between May 3, 1999 and December 31, 2000 and can provide a receipt documenting the building date.
- PHASE FOUR-The remainder of the State

To register for rebate funds, a 1-800 number was established, and safe room rebate registration was conducted for 30 days. To be eligible for the rebate, the construction of a safe room above or below ground had to meet FEMA guidelines and State, county and city standards.

Lead Agency:
Oklahoma Emergency Management

Schedule/Completion Date:
Ongoing – Oklahoma Emergency Management is providing guidance to other states so they can duplicate the success of the Oklahoma safe room projects.

Funding:
HMGP #1465, #1355
Because HMGP funds were limited, a four-phase process was established to ensure that those that experienced the worst damage were given priority.

Governor Henry cited the partnership that made the program a reality. The Federal Emergency Management Agency (FEMA) delivered the funding, Oklahoma Emergency Management (OEM) managed the program, and the employees of the Oklahoma City, General Motors plant, who are members of United Auto Workers Local 1999, staffed the safe room registration phone lines.

4.8.20 OK20-Oklahoma Red Flag Fire Alert

Overview:
When high winds, low humidity, and dry forest fuels occur together, the number of wildfires and the amount of land burned increases dramatically. Along with this is a greater than normal loss of forest resources-timber, soil, wildlife, and increasingly, dwellings, and other structures. This means that outdoor burning of any kind would be more risky than normal

Strategy Implementation:
During periods when weather and wildland fuel conditions combine to create abnormal wildland fire hazards the Oklahoma Forestry Service will issue a Red Flag Fire Alert. Emergency measures are in place to limit the use of fire outdoors when conditions reach the truly critical stage. The forestry service may cancel all burning authorizations and citizens are urged to cooperate. An Oklahoma Red Flag Fire Alert:

- Alerts all fire protection agencies to the increased risk, so that quick response to reported wildfires might be made.

- Reminds people who normally burn trash outdoors to take extra care to contain their fire and be sure it is out before leaving it, or consider postponing burning until conditions are safer.
- Cautions members of the public to be extra careful with outdoor fires, smoking materials, and matches.
- Cautions residents whose homes are in or next to woodlands to take measures to protect their property if a forest fire or grass fire should break out nearby.
- Alerts law enforcement personnel and community residents to report any activity, which may indicate someone is intentionally setting fire to woodlands.
- Alerts landowners to keep close watch on their lands and carry out protection measures.

Lead Agency:
Oklahoma Forestry Service

Schedule/Completion Date:
Ongoing

Funding:
An Oklahoma Red Flag Alert brings together the fire protection agencies, law enforcement agencies, landowners, and other citizens to concentrate on the immediate and imminent danger of wildland fires. Through this coordinated effort at the time of greatest risk the State of Oklahoma can be spared the loss of valuable natural resources. The Oklahoma Red Flag Fire Alert publication is printed by the office of Public Affairs Central Printing Division. 7000 copies have been prepared at a cost of $618.35 to the taxpayers of the State of Oklahoma.

4.8.21 OK21-Dam Safety Program

Overview:
The OWRB coordinates the Oklahoma Dam Safety Program to ensure the safety of more than 4,755 dams in the State, especially those that could impact downstream life and property.

Strategy Implementation:
The Dam Safety Program requires inspections every five and three years for low and significant hazard structures, respectively. It requires annual inspection of the State's 165 high hazard dams, so designated due to the presence of occupied dwellings immediately downstream. Because many of these dams are very old structures that need periodic repair, the Water Board requires submittal and subsequent approval of plans and specifications prior to dam modifications. Staff also coordinates periodic training sessions and workshops on dam safety issues and regulations for dam owners and engineers.

Lead Agency:
Oklahoma Water Resource Board

Schedule/Completion Date:
Ongoing

Funding:
State of Oklahoma

4.8.22 OK22-OK-FIRST Program

Overview:
OK-FIRST is the public safety outreach program of the Oklahoma Climatological Survey. The program has been recognized internationally for its innovative approach in providing instant access to a wealth of vital weather data for fire, police, and emergency management agencies.

Strategy Implementation:
The information and instructional resources available from the OK-FIRST program, is critical for the protection of life and property and are useful for decision-making before, during, and after any situation impacted by the weather. OK-FIRST was one of five winners of the prestigious 2001 Innovations in American Government Award from the Kennedy School of Government at Harvard University and the Ford Foundation.

The OK-FIRST Program provides the following key capabilities:

- Comprehensive environmental data products designed specifically for the public safety community.
- Real-time data from NEXRAD radars and surface observation from the Oklahoma Mesonet and the National Weather Service
- Forecasts, watches, warnings, and advisories from the NWS

Lead Agency:
Oklahoma Climatological Survey

Schedule/Completion Date:
Ongoing

Funding:
State of Oklahoma

4.8.23 OK23-Bioretention Cells

Overview:
Bio-retention cells for Reducing Storm water Runoff Research Being Conducted in Bio-systems and Agricultural Engineering

Strategy Implementation:
A relatively new storm water control system, known as Bioretention cells (BRCs), is being introduced to control storm water volume, peak discharge, and water quality for storms with a frequency of two years or less. Located near the source of runoff, these relatively new storm water control devices work by

allowing rapid infiltration and subsurface storage of storm water runoff from urbanized and industrial areas. The stored storm water is either released slowly, much like a wet weather spring, or allowed to further infiltrate to the groundwater, depending on local geologic conditions and regulations. As water infiltrates, pollutants are absorbed onto the organic material typically included in the BRC media.

Lead Agency:
Oklahoma State University

Schedule/Completion Date:
Ongoing

Funding:
HMGP
PDM Grant

4.8.24 OK24-FMA Tech 031 Grant

Overview:
OWRB is conducting visits and collecting information for 750+ repetitive loss properties in the State of Oklahoma. The top 106 "target repetitive loss properties" have been completed. This project will continue the process of inventory to include: verification of address, latitude and longitude, and date of inspection. Digital photographs of each property and/or structure will be included.

All repetitive loss properties are included within jurisdictions that participate in the NFIP.

Strategy Implementation:
The 750+ properties are located at various locations and within the boundaries of various jurisdictions throughout the State of Oklahoma with the largest concentration being in central and northwest Oklahoma. This project will serve to enhance OWRB and the State Repetitive Loss List and enhance the State Natural Hazard Mitigation Plan by identifying potential future mitigation projects.

The repetitive loss project will provide information to be included in the Enhance State Natural Hazard Plan and will be identified as potential future mitigation opportunities. The information will further be shared with FEMA to be used to update the repetitive loss database. In addition the information will be shared with the local jurisdictions and floodplain managers for planning future mitigation projects.

Lead Agency:
Oklahoma Water Resource Board

Schedule/Completion Date:
Ongoing

Funding:
FMA Tech 031 Grant
Total: $16,760.

Federal: $12,570.
Applicant: $ 4,190.

4.8.25 OK25-FMA Planning 031

Overview:
Oklahoma Water Resource Board collected information for 750+ repetitive loss properties in the State of Oklahoma under FMA Tech 031. This information will now be assembled and portfolios will be created for these same repetitive loss properties.

Strategy Implementation:
Portfolios will include compilations into an Access database, linked to digital photographs of the properties and link-digitized maps showing floodplains and latitude and longitude coordinates. The portfolios will be used to identify future mitigation projects in the State Hazard Mitigation Plan.

Lead Agency:
Oklahoma Water Resource Board

Schedule/Completion Date:
Completed August 2010

Funding:
FMA planning Grant 031
Total: $19,333.
Federal: $14,500.
OWRB: $ 4,833.

4.8.26 OK26 Winter Weather Preparedness Day

Overview:
Following two deadly ice storms in 2000 and 2002 a need was identified to better educate Oklahomans of the preparedness steps to take in order to mitigate the effects of the storms that include widespread, lengthy power outages and treacherous travel conditions. In order to meet this need, OEM strengthened its weather preparedness initiatives to include an expanded Winter Weather Preparedness Day campaign.

Strategy Implementation:
Every year, OEM partners with local emergency managers and the National Weather Service (NWS) to hold Winter Weather Preparedness Day. The Governor proclaims the date as such and a joint news release and a fact sheet giving answers to commonly asked winter weather preparedness questions are distributed to the media. Similar information is also distributed to federal and other state government agencies as well as associations representing businesses. OEM and NWS officials provide media availabilities which include EOC tours, demonstration of family disaster supply kits and weather forecasting practices and technology.

Local emergency managers are provided sample news releases, fact sheets and proclamations which they customize and use in local Winter Weather Preparedness Day initiatives.

Lead Agency:
Oklahoma Department of Emergency Management

Schedule/Completion Date:
Ongoing

Funding Description:
Funding was provided by the Oklahoma Department of Emergency Management and the National Weather Service.

4.8.27 OK27 Electric Meter Assistance Pilot Program

Overview:
More than a week after the Dec. 8th, 2007 ice storm, tens of thousands of Oklahoma homes remained without power, due to electric meter and weather head damage. The number of homes in this situation coupled with a limited number of available electricians to make the repairs represented a health and safety issue for the state. Officials with the Oklahoma Department of Emergency Management (OEM) met with representatives of the electric providers, impacted cities, electricians' association and the municipal league and out of those meetings the pilot program was born. OEM presented the program to FEMA as a local initiative to be reimbursed with FEMA Public Assistance funds. The pilot program was quickly reviewed and approved by FEMA.

Strategy Implementation:
Under the Meter Repair Program, the city, serving as the public assistance applicant, pays the electrician for the work (a maximum of $500). The city submits the expense for reimbursement with FEMA paying 75% and the State paying 12.5%. The applicant (the city) is left with the remaining 12.5% of the cost. The eligible amount ($500) came from an assumption that no homeowner's insurance policy contains a deductible of less than $500. Therefore, regardless of income level, the fee would come out of a victim's pocket.

City of Tulsa officials were the first to implement the program. They recognized thousands of homes required work by an electrician before power could be restored. Additionally, in many cases there was a three to four week waiting list to get an electrician to do the work. Tulsa's "Operation Power Up" began Dec. 18th. The State presented the program to other cities where similar outages were experienced. Currently, there are about a dozen participating communities, including Oklahoma City and Tulsa.

Lead Agency:
Oklahoma Department of Emergency Management

Schedule/Completion Date:

Ongoing

Funding Description:

Funding and/or technical assistance was provided by each municipal applicant, the State of Oklahoma and FEMA.

4.8.28 OK28-Resolve Data Deficiencies

Overview:
Many data deficiencies are identified in local hazard mitigation plans

Strategy Implementation:
Data deficiencies will be reduced by studying the various areas where deficiencies exist and compiling appropriate data into an organized system that will be assessable to local jurisdictions

Lead Agency:
Oklahoma Emergency Management

Schedule/Completion Date:
Ongoing

Funding: Management costs.

The mitigation actions contained in this plan are implemented as funds became available. Due to their success they have been continued along with three additional actions that were added (Chapter Seven – State Action Items Table). Funding for the mitigation projects is provided with the detailed project description in Chapter Four.

4.9 Project Closeout

Upon completion of a hazard mitigation grant project, the SHMO or their designee will conduct a closeout site visit to review all files (or a representative sample) and all documents pertaining to the use of 404 and State General Revenue funds. In addition, all procurement files and contracts to third parties will be reviewed. Worksheets have been created to aid in the closeout review.

All reports generated at the closeout site visit are compared with Request for Funds submitted throughout the duration of the program. Any significant findings are reported to the SHMO for final determination in corrective action. Corrective Action notices will be sent to sub-grantees and another site visit will be conducted, if necessary, prior to the release of remaining funds.

Closeout reports will be submitted for each sub-grantee upon expiration of the grant. The closeout report will summarize the following:

- Grant application and approval award
- Procurement
- State Historical Preservation Office
- Use of administrative allowance
- Final list of properties acquired, if a buyout project
- Summary of costs incurred
- Verification of project monitoring and correspondence
- Demolition (open space), if a buyout project
- Certificate of Completion

Closeout reports will be submitted 90 days after notification by quarterly report that a project has been completed, to include demolition (if applicable).

Analyses of the initiation, status and completion of mitigation activities revealed that these methods, schedules and processes are proper, effective and will continue to be appropriate for use in the future.

4.10 Actions that have been implemented to reduce the number of Repetitive Loss and Severe Repetitive Loss properties.

Acquisition Projects:

Jurisdiction	**Completion Month**
Bixby	March 2008
Bixby	May 2009
Durant	January 2008
Miami	March 2009
Miami	November 2009
Sapulpa	January 2008
Pending Projects	
Jurisdiction	**Funding**
Ottawa County	HMGP
Ottawa County	HMGP
Oklahoma County	HMGP
Oklahoma County	HMGP
Miami	SRL
Bartlesville	HMGP

4.11 Progress Review for Mitigation Goals and Objectives

In order for any program to remain effective, the goals and objectives of that program must be reviewed periodically. The State Hazard Mitigation Officer is responsible for this review on an ongoing basis. That review should address, as a minimum, the following issues:

1. Are the established goals and objectives realistic? Take into consideration available funding, staffing, and State/local capabilities, and the overall State mitigation strategy.
2. Has the State clearly explained the overall mitigation strategy to local governments?
3. Are proposed mitigation projects evaluated based on how they help the State and/or local government meet their overall mitigation goals and objectives?
4. How have approved mitigation projects complemented existing State and/or local government mitigation goals and objectives?
5. Have completed mitigation projects generated the anticipated cost avoidance or other disaster reduction result?

A thorough and realistic evaluation of the benefits of a mitigation project may be delayed until the area of the project is impacted by another disaster. The lack of realized benefits from a completed mitigation project may result in the disapproval or modification of similar projects in the future. At the same time, mitigation projects that have proven their worth may be repeated in other areas of the State.

Based on the results of the review/evaluation mentioned above, the State may need to adjust its goals and objectives to meet the current and future mitigation needs of the State and local governments. A formal mitigation status report will be prepared by the State Mitigation Officer of the Oklahoma Emergency Management Mitigation Division on an annual basis. This report will be provided to the Oklahoma Emergency Management Director and Deputy Director for review and distribution, as needed. The report will address, as a minimum, the following items:

1. Completed mitigation projects

    a. Affected jurisdiction
    b. Brief description of the project
    c. Source of funding
    d. Brief summary of any problem areas, with proposed solution
    e. Brief summary of effectiveness (cost-avoidance) of project, if available

2. Mitigation projects in progress

    a. Affected jurisdiction
    b. Brief description of the project
    c. Source of funding
    d. Brief summary of project status
    e. Anticipated completion date

3. Pending (under review) mitigation projects

a. Affected jurisdiction
b. Brief description of the project
c. Source of funding
d. Brief summary of project status

Oklahoma Emergency Management has reviewed the mitigation actions and determined that they were implemented as planned when funds and personnel allowed. The action items were reviewed and it was determined that each project contributed to meeting the States Goals and Objectives.

4.12 Current Sources of Federal, State, local and private funding

The State of Oklahoma has a variety of programs available to assist with funding for hazard mitigation projects. They include but are not limited to the following:

4.12.1 Hazard Mitigation Grant Program (HMGP)

The Hazard Mitigation Grant Program (HMGP) was created in 1988 by Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended. This program is activated during Presidential Disaster Declarations to assist in identifying mitigation projects, and funding these projects on a 75% Federal / 25% non-Federal cost share basis. The program is administered at the State level; in Oklahoma, through Emergency Management. Note: In Oklahoma, the 25% share is normally absorbed by the local, city or county government.

- Objectives of this program include: Prevent future loss of lives and property due to disasters; implement State or local hazard mitigation plans; enable mitigation measures to be implemented during the immediate recovery of a disaster; and, provide funding for previously identified mitigation measures that benefit the disaster area.
- Eligible applicants for the HMGP are: State and local governments; certain non-profit organizations; and Indian tribes.
- Types of projects that may be funded are structural hazard control; retrofitting; acquisition/relocation; and development of State and local standards to protect and substantially improve structures from disaster damage. See Appendix A for the 5% Set-Aside Initiative and the 7% Planning Initiative.

The HMGP is designed to reduce the State's or local government's vulnerability to risk through a thoroughly coordinated all-hazards approach to mitigation activities, with a heavy emphasis on planning. This focus on planning includes updating plans; implementing the measures identified in all-hazard mitigation plans; developing local mitigation plans; developing State legislation; or adopting local ordinances. The key here is the coordination and implementation of an all-hazards approach using a strong partnership at the State and local level.

4.12.2 Pre-Disaster Mitigation (PDM) Program

FEMA has long been promoting disaster resistant construction and retrofit of facilities that are vulnerable to hazards in order to reduce potential damages due to a hazard event. The goal is to reduce loss of life, human suffering, economic disruption, and disaster costs to the Federal taxpayer. This has been, and continues to be, accomplished through a variety of programs and grant funds.

Although the overall intent is to reduce vulnerability before the next disaster threatens, the bulk of the funding for such projects actually has been delivered through a "post-disaster" funding mechanism, the Hazard Mitigation Grant Program (HMGP). This program has successfully addressed the many hazard mitigation opportunities uniquely available following a disaster. However, funding of projects "pre-disaster" has been more difficult, particularly in States that have not experienced major disasters in the past decade. In an effort to address "pre-disaster mitigation," FEMA piloted a program from 1997-2001 entitled "Project Impact" that was community based and multi-hazard oriented. In Oklahoma, there were four "Project Impact" named cities: Tulsa, Miami, Durant and Lawton.

Through the Disaster Mitigation Act of 2000, Congress approved creation of a national Pre-disaster Hazard Mitigation program to provide a funding mechanism that is not dependent on a Presidential disaster declaration. This authorization is in Section 203 of the Stafford Act, 42 USC 5121-5206, as amended by Section 102 of the Disaster Mitigation Act of 2000. For FY2002, $25 million was appropriated for the new grant program entitled the Pre-Disaster Mitigation Program (PDM). This new program builds on the experience gained from Project Impact, the HMGP, and other mitigation initiatives. There is a one-time grant each year for the State for this program.

The high points of the PDM program are:

(1) The program will be administered by each State.

Eligible projects include:

- State and local hazard mitigation planning
- Technical assistance (e.g. Risk assessments, project development)
- Mitigation Projects
- Acquisition or relocation of vulnerable properties
- Hazard retrofits
- Minor structural hazard control or protection projects
- Community outreach and education (up to 10% of State allocation)

(2) The emphasis for FY2002, the first year of the program, was on mitigation planning, to help localities meet the new planning requirements of DMA 2000.

Each State establishes grant selection criteria and priorities based on:

- The State Hazard Mitigation Plan
- The degree of commitment of the community to hazard mitigation
- The cost effectiveness of the proposed project
- The type and degree of hazard being addressed

(3) For project grants, "good standing" of the community in the National Flood Insurance Program (NFIP)

(4) The funding is 75% Federal share, 25% non-Federal, except as noted below.

- The non-Federal match can be fully in-kind or cash, or a combination
- The grant performance periods will be 18 months for planning grants, and 24 months for mitigation project grants
- The PDM program is available to regional agencies and Indian tribes

(5) Special accommodation will be made for "small and impoverished communities," who will be eligible for 90% Federal share, 10% non-Federal.

4.12.3 Flood Mitigation Assistance (FMA) program

The Flood Mitigation Assistance program is a State administered cost-share program through which States and local communities can receive grants for flood mitigation planning; flood mitigation projects; and FMA technical assistance. It is a Federal grant program, similar to the Hazard Mitigation Grant Program; however, FMA provides assistance to States and communities for flood mitigation planning and activities to fund cost-effective measures that reduce or eliminate the long-term risk of damage to buildings, manufactured home, and other NFIP-insurable structures in some cases by providing funds for acquisitions and removal or Repetitive loss and Severe Repetitive loss properties, and it is not disaster dependent. Note: In Oklahoma, the 25% local share will be absorbed by the local, city or county government, and one-half of the 25% (or 12.5% of the total grant) share must be a "hard match."

(1) FMA is part of the National Flood Insurance Act of 1968, Sections 1366 and 1367 as amended by Sections 553 and 554 of the National Flood Insurance Reform Act (NFIRA) of 1994.

(2) Goals of the program include: Reduce the number of repetitively damaged structures and associated claims against the National Flood Insurance Fund; and encourage long-term comprehensive mitigation planning.

4.12.4 National Flood Insurance Program (NFIP)

The National Flood Insurance Program, enacted in 1968, made federally subsidized flood insurance available to property owners located in communities participating in the flood program. Communities wanting to participate in the National Flood Insurance Program must establish minimum floodplain management regulations in their special flood hazard areas and enforce these regulations.

(1) In 1973, Congress passed the Flood Disaster Protection Act. This law required the purchase of flood insurance as a condition for Federal or Federally-related loans or other Federal financial assistance for property located in identified floodplain areas. This provided the incentive for participation in the Program.

(2) Most counties in the State of Oklahoma lacked proper authority concerning land use regulation necessary to participate in the Flood Insurance Program. In 1980, the legislature passed the Oklahoma Floodplain Management Act to allow citizens that desired to participate in this Program to procure flood insurance. This legislation enables any county or community in the State to form a Floodplain Board and enact floodplain regulations to allow participation in the Program.

(3) The National Flood Insurance Program requires communities to adopt and enforce a minimum amount of floodplain management criteria. These criteria includes such items as: Requiring permits for construction within designated floodplains; reviewing development plans and subdivision proposals to determine if proposed building sites will be reasonably safe from flooding; requiring protection of water supply and sanitary sewage systems to minimize infiltration of flood water and discharges from the system into the flood waters; obtaining, reviewing, and utilizing all available base flood elevation data; and assuring the maintenance of flood carrying capacities within all water courses.

(4) A current list of Oklahoma communities participating in the Program, consists of counties (unincorporated areas), tribes and municipalities, is provided in ***Appendix B*** of this plan. The list was compiled from the FEMA web page and was last updated June 14, 2010.

4.12.5 Community Rating System

The Community Rating System (CRS) is an element of the NFIP. This program is designed to promote the availability of flood insurance, reduce future flood damages and insure the accurate rating of flood insurance policies. Participating communities may receive credit for proven mitigation measures, thus reducing the cost of flood insurance within their communities.

4.12.6 Disaster Housing Program

The Disaster Housing Program is available to provide disaster hazard mitigation measures in the form of home repair grants to eligible homeowners following a federally declared disaster. If the home repair costs exceed the Disaster Housing Grant, the applicant can be referred to the Individual and Family Grant Program for additional grants not to exceed the maximum grant limitations of the Individual and Family Grant Program.

4.12.7 Oklahoma Water Resource Board

In addition, the Oklahoma Water Resource Board (OWRB) has several financial assistance programs available to Oklahoma communities. Applicants eligible for water/wastewater project financial assistance vary according to the specific program's purpose and requirements, but include towns and other municipalities with proper legal authority, various districts established under Title 82 of Oklahoma Statutes (rural water, master/water conservancy, rural sewage, and irrigation districts), counties, public works authorities, and/or school districts.

FAP LOANS-provides loans for water and wastewater system improvements in Oklahoma. CWSRF LOANS-created in 1988 to provide a renewable financing source for communities to draw upon for their wastewater infrastructure needs.

- The CWSRF program is Oklahoma's largest self-supporting wastewater financing effort, providing low-interest loans to communities in need.
- DWSRF LOANS is an initiative of the OWRB and Oklahoma Department of Environmental Quality to assist municipalities and rural water districts in the construction and improvement of drinking water systems.
- REAP GRANTS were created by the State Legislature in 1996. REAP grants, used for water/wastewater system improvements, target primarily rural communities with populations of 7,000 or less, but priority is afforded to those with fewer than 1,750 inhabitants.
- EMERGENCY GRANTS, limited to $100,000 are awarded to correct situations constituting a threat to life, health, and/or property and are an indispensable component of the agency's financial assistance strategy
- CAP_SSSE (Community Assistance Program-State Support Services Element): The State administers the CAP-SSSE Grant available through the Emergency Management Preparedness Grant (EMPG). The grant provides funds for assistance to communities

participating in the National Flood Insurance Program. This assistance is directed at the administration of each community's floodplain development permit system to insure compliance with flood loss reduction guidelines.

Funding sources have remained the same throughout this planning period.

Chapter Five: Coordination of Local Mitigation Planning

Each section of the plan update from the period of prior approval through October 26, 2010 was analyzed and reviewed by each member of the State Hazard Mitigation Planning Committee (SHMPC) and the administrative staff to determine whether updates to the plan were necessary. Chapter Five was reviewed by the SHMPC who determined that updating was required. Updated Storm Ready and poverty community information is provided.

5.1 State Assistance for development of local mitigation plans

The State of Oklahoma has many systems already in place to support through funding and technical assistance, the development of local mitigation plans. To further this objective, the State is divided into eleven Councils of Governments (COGS) with major responsibilities as follows: assist in improving communication between citizens; aid in local, State, and Federal responsiveness to local needs; assist in making a more effective government by undertaking beneficial programs and activities; provide a coordinating center for local governments in the Districts for processing Federal grant programs; and serve local units of government by being a mechanism to obtain Federal assistance in technical, administrative, and financial areas. The State achieves this by the following methods:

1) The State of Oklahoma helps communities to determine the optimal planning areas in which they will work. This is frequently based on State planning goals, initiatives already underway and available resources. Local jurisdictions with limited resources are being encouraged when it is time to update their plan to consider joining with a larger or even several jurisdictions in a multi-jurisdictional plan.

2) The State assists local jurisdictions in assessing support for mitigation planning. In addition, the State builds its own support for mitigation planning by educating new State officials and department heads and seeks to build collaborative relationships.

3) The States strategy encourages local jurisdictions through funding and technical assistance to prepare and continue to keep updated hazard mitigation plans in areas where repetitive loss and severe repetitive loss properties have been identified. The state plan review process includes steps to ensure that action items to resolve repetitive loss and severe loss properties are included in Hazard Mitigation Plans.

4) The State has established eligibility criteria for multi-hazard mitigation measures which are also contained in the State Administrative Plan. (Also see chapter 7 – Sec. 7.5) While it is not practical to meet all of the listed criteria in most projects, effort should be made by the jurisdiction to include as many as possible:

A. Show adoption of a FEMA approved local Hazard Mitigation Plan.
B. Be in conformance with the State Mitigation Plan.
C. Protect lives and reduce public risk.
D. Reduce the level of disaster vulnerability in existing structures by removing repetitive loss and severe repetitive loss properties where possible.
E. Reduce the number of vulnerable structures through acquisition, relocation, flood proofing, or seismic retrofitting.

F. Avoid inappropriate future development in areas known to be vulnerable to future disasters.
G. Solve a problem independently, or function as a beneficial part of an overall solution with assurance that the whole project will be completed.
H. Provide a cooperative, inter-jurisdictional solution to reduce future disaster damage.
I. Provide a long-term mitigation solution.
J. Address emergency hazard damage issues such as urban storm water, trees in power right of ways, etc.
K. Restore or protect natural resources, recreation, open spaces, and other environmental values. Be in conformance with 44CFR part 9, Floodplain Management and protection of Wetlands, and 44CFR part 10, Environmental Considerations.
L. Develop and implement comprehensive programs, standards, and regulations that reduce disaster damage.
M. Increase public awareness of natural hazards, preventative measures, and emergency responses to disasters.
N. Upon completion, have affordable operation and maintenance costs.
O. Illustrate how the project improves the applicant's ability to protect its critical areas.

4) During the 2008 – 2010 planning period the State of Oklahoma has provided no funding for the hazard mitigation planning process other than the 75% FEMA grants. The State provides guidance and assists local communities in the development of hazard mitigation plans. The repetitive loss list is reviewed and the jurisdictions with these properties are encouraged to request funding and submit hazard mitigation plans for approval. E-mails are sent to local jurisdiction officials, COG's, Planners and anyone writing hazard mitigation plans for Oklahoma jurisdictions to make them aware when funding is available for planning. Assistance is provided in planning grant preparation and application. OEM constantly contacts local jurisdictional planners to update them on mitigation strategies and information on approvable mitigation projects. Contractors provide local jurisdictional planners with the latest interpretations of acceptable terminology to be included in plans from recently approved plans. These procedures and techniques have proven successful by the approval of over 188 plans through 2010. OEM contractors will continue this hands on and proactive method of technical support to keep jurisdictions up to date with the latest concepts, applications and policy in the hazard mitigation planning environment.

5) Planning sessions providing technical assistance were held across the State of Oklahoma in the cities of Ardmore, Beaver, Big Cabin, Burns Flat, Cleveland, Duncan, Durant, Idabel, Lawton, Mangum, McAlester, Muskogee, Oklahoma City, Okmulgee, Perkins, Roman Nose Lodge, Sallisaw, Shawnee, Tahlequah, Tulsa, Watonga and Woodward, in 2005, 2006, 2007 and 2008, to assist the local jurisdictions with their natural hazard mitigation plans. Planning sessions have continued during the 2008 – 2010 planning period where the need is identified. Plans are reviewed using EMI G-318 guidance and the current crosswalk, the document by which hazard mitigation plans are graded against FEMA requirements. Jurisdictions with severe repetitive loss properties are reviewed to ensure that repetitive loss action items are included in the plan to correct this hazardous situation. When a plan is found to be below FEMA standards "**Required Revision:**" statements are made in the appropriate section of the crosswalk. The crosswalk is returned to the planner with guidance to help them correct the problem. Telephone and email contacts are made with the planner to answer questions and encourage the

planner to correct the plan and return it to OEM is short order. This has been proven successful in getting a large number of plans approved by the State and forwarded on to FEMA Region VI reviewers.

6) "Contractors" (formerly reservists) were hired with management cost funds to assist local jurisdictions with their planning efforts and to review local plans before they were sent to FEMA for final approval.

7) As local jurisdictions applied to develop plans and were approved for funding, FEMA How-To Guides for mitigation planning along with other FEMA publications, notices and web sites were distributed to the applicant or their designated planner by the Mitigation Division.

8) DMA 2000 amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act by repealing the previous Mitigation Planning Section 409 and replacing it with Section 322. This new section emphasizes the need for State, Tribal and local entities to closely coordinate mitigation planning and implementation efforts. Section 322 established the requirement for these plans and authorized up to 7% of Hazard Mitigation Grant Program (HMGP) funds available to the state for developing plans. The State of Oklahoma Department of Emergency Management, Mitigation Division, has exercised this authority and funded 300 planning applications at the sum of $4,475,350.50 federal share. Of these 300 applicants, 188 plans have been approved by FEMA Region VI as of May 15, 2010. These 188 plans include 471 jurisdictions in the State of Oklahoma that are now eligible for Hazard Mitigation Grant Program funds. An additional 15 plans are pending approval. Since November 1, 2004, all applicants are required to have an adopted and approved Natural Hazard Mitigation Plan in order to be eligible for the Hazard Mitigation Grant Program funds.

9) The State helps further by providing general information to local jurisdictions about prior disasters within the State.

Oklahoma Emergency Management (OEM)

OEM is the primary state coordinating agency for all local emergency operations plans and hazard mitigation plans. The Mitigation Division has the primary responsibility to work with local governments in developing, reviewing, and updating local hazard mitigation plans. Through its assigned Contractors, OEM works with local governments in developing, reviewing, and updating local emergency operations plans.

As part of the state mitigation planning initiative, local mitigation plans are being developed for each city/town and/or county. The multi-jurisdictional plans will address the mitigation issues/initiatives for the unincorporated parts of the county as well as the incorporated jurisdictions and schools within the county. In order to facilitate cost effectiveness, in May 2008 the OEM Hazard Mitigation Division developed and implemented a formula which provides a standardized cost for plans that is justified by the work needing to be done on a plan. Above a base price, it considers the number of incorporated jurisdictions participating, school campuses, and the population of the jurisdiction. In addition small jurisdictions (fewer than 5000 population) are encouraged to join with their larger neighbors and develop a multi-jurisdictional plan. Even further the counties are encouraged to include all of their communities, incorporated and unincorporated in their plan along with all of the public educational institutions in the county. Because HMGP funds are post-disaster funds and their availability from year to year is uncertain and limited, OEM will only allow funding through this cost effective process. This will help ensure that, as many jurisdictions as possible remain involved in the mitigation planning

process. The Local Hazard Mitigation Plan will normally be a separate stand-alone plan by county. Any political entity within a county may prepare a mitigation plan specific to that entity, separate from the county mitigation plan as long as they are over the 5000 population threshold.

All 77 counties in Oklahoma have a Local Emergency Operations Plan. These plans are scheduled for review and/or update by an OEM planner/area coordinator once every five years. In addition, many towns and cities maintain separate Local Emergency Operations Plans. These plans are also included in the five year OEM review/update process.

The local governments, private contractors and COGs are using the information contained in the State Hazard Mitigation Plan to help develop the multi-jurisdictional hazard mitigation plans. As the local hazard mitigation plans are developed, the information provided in those planning efforts can be incorporated into the State Hazard Mitigation Plan, thereby contributing to the continuous improvement of all the plans when they are reviewed and updated.

5.2 Integrating Planning Information with Other Mitigation Partners

The State Hazard Mitigation Plan identifies Oklahoma's hazards, risks, vulnerabilities, goals, objectives, priorities and strategies for mitigation. The plan is the basic document that has been used by OEM to focus many efforts to improve the lives of Oklahoma citizens. Over the years, OEM has worked continuously to identify partners (Federal, State, local, and business) interested in participating in the State's mitigation efforts. Integration of other Federal, State, and local agencies, business and industry, and private non-profit organizations into the State mitigation program has been an ongoing process that also has helped educate OEM's partners concerning the importance of mitigation. This educational process also has resulted in OEM's partners using mitigation in their programs and plans over time. These discussions and/or meetings have involved reviews of current programs and policies that promote or could potentially promote mitigation initiatives throughout the State and reviews of existing and proposed plans to identify mitigation opportunities. Many of the mitigation successes since the May 3, 1999 tornado have been as a direct result of these meetings. The lessons learned through these programs and activities have contributed to the development of this plan and have been integrated into their own plans and programs.

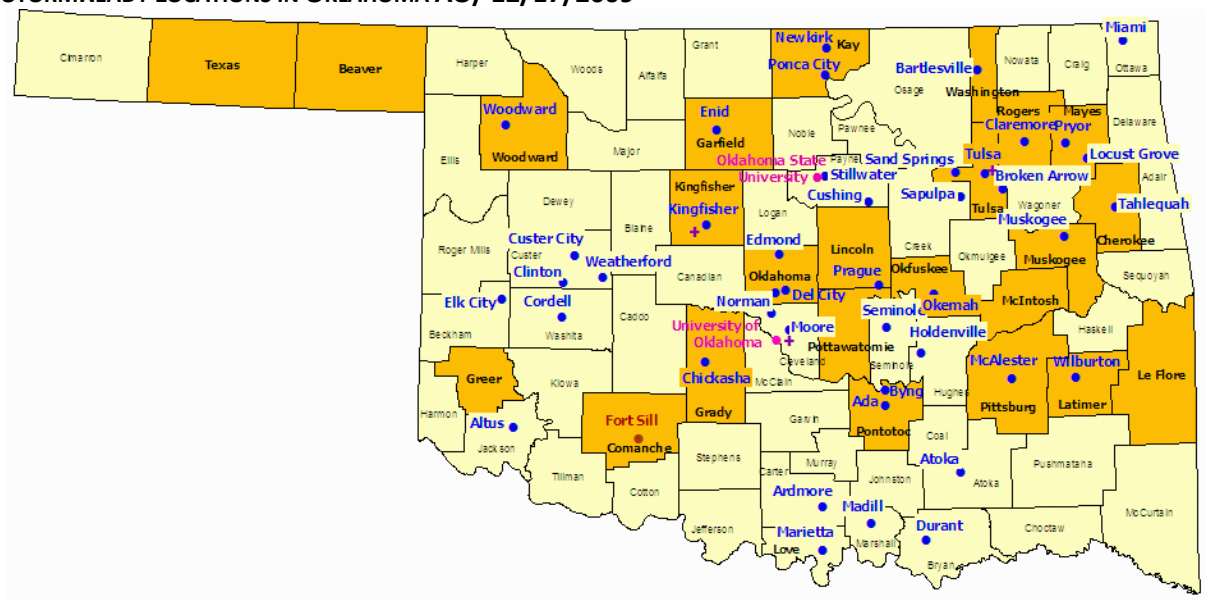
In addition to working with FEMA in all aspects of hazard mitigation projects and plans, OEM has worked with multiple other mitigation partners to integrate mitigation into projects and plans. The members of the State Hazard Mitigation Team, Oklahoma Home Builders Association, Oklahoma Portland Cement Association, Oklahoma Lumberman's Association, Oklahoma Vocational and Technical, and Dr. Ernest W. Kiesling of Texas Tech provided input and advice regarding the safe room initiative. The successful combination of OEM's HMGP safe room project, the cities of Lawton and Tulsa's safe room initiative project, and Logan County's safe room project, are an excellent example of support.

The Department of Agriculture has complimented the OEM safe room initiative program in offering a low interest safe room loan throughout the State. The OEM program has concentrated on primary family residences within the declared area, while the USDA program has concentrated on low-income family residence. The Chickasaw Nation has endorsed the safe room program by building underground shelters for their citizens. Together these programs have made a significant impact on the overall vulnerability of individuals to tornados.

The Oklahoma Insurance Commission supports OEM in promoting flood and earthquake insurance, preparedness, response and mitigation issues and plans. The Department of Natural Resources (DNR) has worked with OEM on flood buyouts, hazardous material planning, earthquake mitigation and dam safety plans and issues. The Oklahoma Department of Transportation, the U.S. Department of Transportation and the Federal Highway Administration have worked with OEM on flood buyouts, open space restriction issues, and earthquake planning and bridge retrofits. In addition to the State and Federal transportation agencies, the U.S. Geological Survey, the Central U.S. Earthquake Consortium (CUSEC), the Oklahoma Insurance Commission, the American Institute of Architects [AIA/OK], the American Society of Civil Engineers [ASCE], the Oklahoma Society of Professional Engineers [OSPE], the University of Oklahoma, Oklahoma State University work with OEM on earthquake mitigation, including retrofits, public education, soil mapping and seismic studies.

The National Weather Service (NWS), USDA, the Electric Cooperatives, and private businesses combined their resources to support the expansion of the State's weather radio transmitters. In four years this project has expanded weather radio coverage to include almost the entire State. OEM supports the NWS StormReady program in Oklahoma, with 24 counties, 44 communities, 2 University, 1 Military Base and 3 StormReady Spotters and the many mitigation measures are included in that program and its plans.

STORMREADY LOCATIONS IN OKLAHOMA AO/ 12/17/2009



Counties: Gold Shading		Communities: Blue Dot			University: Purple Dot	Government Site: Brown Dot:
Beaver	McIntosh	Ada	Edmond	Newkirk	University of Oklahoma	Fort Sill
Cherokee	Muskogee	Altus	Enid	Norman		
Comanche	Okfuskee	Ardmore	Elk City	Okemah		
Creek	Muskogee	Ada	Edmond	Okemah	Oklahoma	Fort Sill

Garfield	Okfuskee	Altus	Elk City	Ponca City	State	
Grady	Oklahoma	Ardmore	Enid	Prague	University	
Greer	Pittsburg	Atoka	Holdenville	Pryor		
Kay	Pontotoc	Bartlesville	Kingfisher	Sand Springs	University	
Kingfisher	Rogers	Broken Arrow	Locust Grove	Sapulpa	of	
Latimer	Pottawatomie	Byng	Madill	Seminole	Oklahoma	
Le Flore	Texas	Chickasha	Marietta	Shawnee		
Lincoln	Tulsa	Claremore	McAlester	Stillwater		
Mayes	Washington	Clinton	Miami	Tahlequah		
McIntosh	Woodward	Cordell	Midwest City	Tulsa		
		Cushing	Moore	Weatherford		
		Custer City	Muskogee	Wilburton		
		Del City	Newkirk	Woodward		
		Durant	Norman			
	Supporters: Purple Plus Sign					
	The Sun Building					
	Pioneer Telephone Cooperative: Kingfisher					
	Sooner Mall					

5.3 Local Plan Integration

OEM has identified many instances where the information contained in this State Hazard Mitigation Plan could be, and in many cases previous versions of this plan over time, have been integrated into the planning of other State and Federal departments, local governments, universities, businesses and private associations. OEM asks that all interested entities freely use the information provided in this plan in the development of and management of their plans and programs. For example, the information contained in this plan should be of interest and useful in general for all local governments, universities, businesses and private associations.

Free compact disk copies of this plan may be requested from OEM for planning, program management and public education purposes by contacting the Oklahoma Emergency Management, Mitigation Division.

In an effort to streamline the review and approval of local plans, coordinate local and State planning efforts, and create a common knowledge base; the State of Oklahoma Emergency Management Hazard Mitigation Division has a designated planning team that reviews each local Natural Hazard Mitigation Plan before it is sent to FEMA for final review. A full time plan review team has been designated to work with local jurisdictions to encourage and support local hazard mitigation planning since publication of hazard mitigation planning regulations in the Federal Register in February 2002. The local plan review team provides ongoing assistance through on-site visits by coordinating information requests from local jurisdictions, and by participating in local plan development activities.

The hazard mitigation local plan review team has in place an extensive network of assistance that provides support, guidance, and information to local jurisdictions preparing local hazard mitigation plans. Working closely with FEMA Region VI who has provided on site Technical Assistance, this team

has assisted local jurisdictions with modifications and adjustments to their plans as feedback from FEMA has been received and through the mitigation planning process. The assistance provided includes:

1) Meeting with local jurisdictions to review hazard mitigation planning requirements or provide training to assist with plan development activities, or to review draft plans. Since 2003, the OEM Mitigation Division has conducted over 50 meetings involving over 100 jurisdictions to discuss hazard mitigation planning requirements, and provide training or other assistance. The Oklahoma Emergency Management, Mitigation Division, reviews draft plans from each contractor/planner prior to final submission of a completed plan. These drafts have been cross-walked according to FEMA's guidelines and comprehensive reviews along with suggestions have been provided to each planner in an effort to assist them with their final plans. Working closely with planners and applicants via telephone, email and personal visits, the department has attempted to support and streamline the planning process as much as possible.

2) The Mitigation Division acts as the primary point of contact and provider of technical assistance for each jurisdiction. Examples of technical assistance include reviewing sections of developing plans and providing feedback, providing information from FEMA regional planning meetings to local planners, identifying information sources at State and National levels, interpreting State and Federal guidelines, and distributing planning examples and approved plans.

3) Providing planning grants through the Hazard Mitigation Grant Program, Pre-Disaster Mitigation Program, and Flood Management Assistance Program: Since 2001, 300 local jurisdictions (counties, cities, tribes, etc.) received more than $4,475,350.50 (Federal Share) from these mitigation programs to assist in developing local hazard mitigation plans.

4) Providing Planning Development Workshops: The Mitigation Division hosted twenty two workshops at various locations in the State to propagate information regarding cost-effective mitigation technologies. These workshops described what Hazard Mitigation Planning was, why it was important to communities, counties and tribes, included project, training and education as related to plan development and gave options on how to create a plan. Workshop participants were taken through each phase of creating a Hazard Mitigation Plan, shown examples of successful plans and provided information and resources. The purpose of these workshops was to provide assistance and training relative to evaluating and prioritizing mitigation projects in accordance with the Oklahoma State Strategic Natural Hazard Mitigation Plan. These planning workshops were made available at no charge to local jurisdictions including but not limited to, local emergency managers, Council of Governments, State personnel, Flood-plain Administrators, Professional Planners and design professionals to brief them on DMA planning requirements as well as providing the knowledge and skills needed to enable participants to fulfill mitigation project and planning strategies.

5) Distributing hazard profiles, socioeconomic descriptions of the different regions of the State and assessments of regional vulnerability for the State-identified hazards to local jurisdictions. These hazard profiles and documents are included in the State hazard mitigation plan. It was found that the State had more available resources than the majority of the local jurisdictions. Therefore hazard risk assessment data flowed from the State to the local jurisdictions. The purpose of distributing these documents was to help shorten the local plan development cycle by allowing local jurisdictions to tailor well-researched hazard information to their own conditions and to perform risk assessments on local facilities.

6) Connecting local jurisdictions with other State and Federal agencies that have information useful for hazard mitigation planning. For example:

- Federal Emergency Management Agency
- Oklahoma Emergency Management
- Institute for Business and Home Safety
- USGS-Hazards Page
- Oklahoma Water Resource Board
- Oklahoma Floodplain Managers Association
- U.S. Army Corps of Engineers
- National Flood Insurance Program
- Storm water Manager's Resource Center
- National Climatic Data Center
- National Lightning Safety Institute
- National Weather Service-Heat Index
- OWRB-Drought Monitoring Page
- U.S. Department of Agriculture
- Natural Resource Conservation Service
- Oklahoma State Fire Marshal's Office
- National Fire Protection Association
- USGS Wildfires
- U.S. Geological Survey
- Oklahoma Geological Survey
- National Geophysical Data Center
- National Response Center
- National Transportation Safety Board
- Oklahoma Department of Environmental Quality
- Environmental Protection Agency Universities:

7) The Mitigation Division writes and distributes numerous documents regarding lessons learned and successes, based on the efforts of early local jurisdiction planning efforts. On August 4, 2003, the City of Tulsa, Oklahoma had the first FEMA approved Natural Hazard Mitigation plan in the State of Oklahoma and in Region VI. This information was provided to jurisdictions just starting their planning and formed the basis of initial planning committee visits and information exchanges with many jurisdictions.

8) The Mitigation Division also wrote or emailed local jurisdictions monthly with the latest information, guidance and suggestions related to hazard mitigation planning: Local emergency planners as well as recipients of recent hazard mitigation grants received these information packets.

9) The OEM, Mitigation Division, provided further information and assistance in map development. GIS mapping has been made available to various local communities to map their critical facilities. As each county is completed, this information flows up to the State plan and is used to form a collated State risk assessment, which is added to the overall State Natural Hazard Mitigation Plan.

10) After November 1, 2004, all applicants are required to have an adopted and approved Natural Hazard Mitigation Plan in order to be eligible for the Hazard Mitigation Grant Program funds.

11) The OEM, Mitigation Division has three full time reviewers to review local Hazard Mitigation Plans. Any plans received are reviewed on a first come, first served basis. Each plan is received at the State Recovery Office, it is date stamped and logged in. An extensive log is kept on the local plans with such information as date received, reviewers name and date review started, approval or rejection status after review, date sent to FEMA if approved, or date corrected plan is expected, FEMA approval date, and applicant notification date. Reviews take approximately one week from the date the reviewer starts to the time the plan is mailed to FEMA for their review. If the local plan is denied at the State level, a completed crosswalk is provided to the applicant with an in depth explanation of the missing criteria. The applicant is further counseled and assisted with numerous phone calls and emails in an effort to streamline the process. Depending upon the extent and scope of the work required to pass the plan at the State level, the applicant is allowed one to two weeks to make the needed corrections and resubmit the plan. The OEM plan review objective is to have the plan acceptable to pass the State review and forwarded on to Region VI within 45 days of the original receipt of the plan.

12) The Oklahoma Emergency Management, Mitigation Division will play a key role relative to general oversight, reviewing goals and objectives, and developing a Pre-Disaster Mitigation implementation planning strategy. After reviewing approved plans as well as multiple drafts that were submitted for State approval, the State Hazard Mitigation Planning Committee determined which goals and objectives of the local plans most closely tracked with the State goals and incorporated them into the State plan. This review also indicated that hazards and risks were evaluated in a similar manner and supported the findings found within this State plan. FEMA approved plans are reviewed within 30 days of approval and stored in the State of Oklahoma Plan Data Base where they are linked and coordinated with the State of Oklahoma Hazard Mitigation Plan. The **Project Status** information is a part of this coordination and is shown in Appendix E: Table E.2 of this plan update.

The State of Oklahoma has 77 counties and 1922 communities. As of May 24, 2010, the State has 188 local plans approved, which covers 45 counties and four hundred sixty eight communities. An additional 28 county and 31 local plans are pending. In addition, of the 37 federally-recognized tribes in Oklahoma, two have approved plans and 18 additional plans are in some stage of the preparation and approval process. It should be noted that in some jurisdictions, the school system is included in the local plan, but in some instances, the Independent School System may be preparing their Hazard Mitigation Plan separately. There are 28 school plans in Oklahoma, including The University of Central Oklahoma and Oklahoma State University.

After reviewing the above-referenced plans, as well as a number of draft plans submitted for state review, it has been determined that the goals and objectives of these local plans and the goals and objectives of this state plan closely track with one another. Further, the review indicated that based upon information provided by the state, local jurisdictions evaluated hazards and risks in a similar manner and came to similar conclusions as those found within this state plan. One hazard, Sinkholes/Subsidence has been added to the State plan.

After a plan receives Approved Pending Adoption status from FEMA Region VI the local jurisdictions are required to send to the State 2 CD's that are the same, each having the complete plan including resolutions as one file and all of the resolutions as a separate file. When these CD's are received they are checked for accuracy by the State and saved in the FEMA Approved Plans file on the OEM network drive. The plans are reviewed immediately for information that needs to be included into the State Plan Updates in the future. When found the information is noted and placed in a State plan update file for inclusion in the next State Plan update. When this process is complete one of the CD's is sent on to

FEMA Region VI for final approval. This process is ongoing and is applied to this planning period ending in 2010 and will continue on until this practice is changed.

The State Hazard Mitigation Planning Committee has reviewed each risk assessments and mitigation strategies of approved local plans when preparing this edition of the State plan. Information in local plans that supplements and improves the accuracy and depth of the State plan have been added to the plan.

Such information may include, but not be limited to:

- Locations of hazard areas identified by the local jurisdiction
- Information on populations and structures located in or near local hazard/critical areas
- Information on projected growth in or near identified hazard/critical areas.
  Identify mitigation goals and strategies that require State attention through inclusion in the State plan

Consideration will be given to communities with the highest risks, repetitive loss properties, and most intense development pressures. For non-planning grants, a principal criterion for prioritizing grants shall be the extent to which benefits are maximized according to a Benefit Cost Analysis of proposed projects and their associated costs.

5.4 Prioritization of Communities /Jurisdictions for Planning Grants

This section provides a description of the criteria by which the State will prioritize communities and local jurisdictions that would receive planning and project grants under the Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA), Pre-Disaster Mitigation (PDM), Severe Repetitive Loss (SRL), Repetitive Flood Claim (RFC) and other available funding programs.

Federal and State funding for mitigation planning will be limited and in some instances may not be available. There will always be more requests for mitigation planning funds that there will be available funds. Approval of funds for mitigation planning will be based on the availability of funds and the determination as to whether the requesting jurisdiction has demonstrated the desire and ability to complete the plan. Local jurisdictions should develop mitigation plans based on their unique capabilities and needs.

Since funding for mitigation planning grants is limited, available funds must be distributed to those communities that have clearly demonstrated both the ability and the desire to complete the plan and to follow through with the initiatives developed in the plan. This desire to comply with the initiatives in the local mitigation plan should not be dependent on the availability of State or Federal funds. In an effort to allow some flexibility in the distribution of mitigation planning funds the following general guidelines have been developed. These guidelines are not all inclusive and compliance with all of the issues listed below may not be required for approval of a planning grant.

1. The jurisdiction must have a FEMA approved Hazard Mitigation Plan. This criterion does not apply to initial planning grants.

2. The community must meet the criteria for the specific source of funds.

3. OEM will consider the Benefit Cost Analysis for each non planning project presented. The Benefit Cost Analysis will be considered and projects with the maximum benefits to their cost receiving the highest priority for available funding.

4. OEM will consider its past experience in dealing with the community on other grants (such as disaster grants, mitigation projects, etc.).

5. OEM may contact the State Department of Commerce (ODOC) Community Development Block Grant (CDBG) program, other State agencies/departments, and/or the local Regional Planning Commission (RPC) to check on their past experiences with the requesting community.

6. The State and local risk assessment will be reviewed to determine the susceptibility of the community to natural and human caused disasters. Consideration will be given to communities with the highest risk.

7. OEM will review previous presidential disaster declarations to determine the number of times the requesting community has been impacted by declared disasters and the magnitude of damages resulting from those disasters. This review would consider impact on community infrastructure, as well as families and businesses.

8. OEM will also consider the number of non-declared disasters that have impacted the community. This review would consider impact on community infrastructure, as well as families and businesses.

9. OEM will consider whether the community participates in the National Flood Insurance Program (NFIP).

10. OEM will consider the number of insured, repetitive loss structures in the community.

11. OEM will also consider the community's status as a small-impoverished community and communities with special developmental pressures, if applicable.

12. The community has identified natural disaster hazards in areas under its jurisdiction.

13. The community has demonstrated the ability to form effective public-private natural disaster hazard mitigation partnerships.

14. OEM will give special consideration to jurisdictions that are experiencing extreme growth. Example: A new employer moves to town creating new jobs and housing demands.

The State has evaluated and revised the prioritization process from the State Plan approved in 2008 and updated this process as shown above. The challenges and successes have mostly been seen in the planning process. Delays in plan reviews at both the state and federal level due to the lack of personnel (often due to disaster response and recovery activities) have caused some jurisdictions to lose their planning grants. The addition and training of personnel at both the state and FEMA level have led to a large number of plans approved and close outs completed in a timely manner.

5.5 Administration of the Pre-Disaster Mitigation (PDM) Program:

OEM will administer the Pre-Disaster Mitigation Program based on the requirements and guidelines established by FEMA under the Disaster Mitigation Act of 2000. The Mitigation Division will have the primary responsibility for implementing this program within the State. All jurisdictions are potential candidates for the pre-disaster mitigation program. Ideally, all communities would participate in some form of pre-disaster mitigation; however, due to differences in local capabilities and priorities, the degree of participation will vary greatly from community to community.

The pre-disaster mitigation program is designed to provide technical and financial assistance to State and local governments to assist in the implementation of pre-disaster hazard mitigation measures that are:

Cost-effective; Designed to solve a problem to reduce injuries, loss of life, and damage or destruction of property (including damage to critical State or local government services and facilities; and complement current State and local mitigation goals and objectives.

Technical assistance will be primarily through the use of personnel from Oklahoma Emergency Management Agency (OEM) Mitigation division and funding assistance will be based on the availability of funds through the programs administered.

Financial assistance under PDM is provided with a Federal cost share of up to 75% of the total cost of approved mitigation activities. Funds provided to communities shall be used principally to implement cost-effective pre-disaster mitigation measures. They may also be used to:

- Support effective public-private natural disaster hazard mitigation partnerships;
- Improve the assessment of a community's vulnerability to natural hazards; or
- Establish hazard mitigation priorities, and an appropriate hazard mitigation plan, for a community.

The State will use the criteria mentioned above to assist in determining which communities should receive technical and financial assistance under this program. In addition to those criteria, the State will also consider the basic Criteria for Assistance Awards established in the Disaster Mitigation Act of 2000. Those criteria are as follows:

1. The jurisdiction must have a FEMA approved Hazard Mitigation Plan.
2. The extent and nature of the hazards to be mitigated.
3. The degree of commitment of the local government to reduce damages from future natural disasters.
4. The degree of commitment of the local government to support the hazard mitigation measures to be carried out using the technical and financial assistance.
5. The extent to which the hazard mitigation measures to be carried out using the technical and financial assistance contribute to established State/Local mitigation goals and priorities;
6. The extent to which prioritized, cost-effective mitigation activities that produce meaningful and definable outcomes are clearly identified,
7. If the local government has submitted a mitigation plan, the extent to which the activities identified under paragraph (5) above is consistent with the mitigation plan,
8. The opportunity to fund activities that maximize net benefits to society, and
9. The extent to which assistance will fund activities in small impoverished communities.

5.6 Small and Impoverished Community Provisions

Small and impoverished communities means a community of 3,000 or fewer individuals that is identified by the State as a rural community, and is not a remote area within the corporate boundaries of a larger city; is economically disadvantaged, by having an average per capita annual income of residents not exceeding 80 percent of national, per capita income, based on best available data; the local unemployment rate exceeds by one percentage point or more, the most recently reported, average yearly national unemployment rate; and any other factors identified in the State Plan in which the community is located.

OEM has received assistance from the Oklahoma Department of Commerce in determining those communities that meet the criteria. These communities appear to meet the intent of the Disaster Mitigation Act of 2000's definition of small and impoverished.

The President may increase the Federal cost share to 90% of the total cost of mitigation activities carried out by small impoverished communities.

For non-planning grants, the FEMA funding programs and the State require that projects be cost-effective and consideration of the extent to which benefits are maximized is one of the criteria that must be met. Prioritizing criteria is discussed in greater depth in Chapter Seven.

For several years, OEM has worked directly with FEMA Region VI NFIP coordinator and the NFIP coordinator for the State of Oklahoma to assist them in public education with local jurisdictions and tribal nations throughout Oklahoma. OEM has incorporated NFIP information in most of its public education programs where the subject was relevant to the program. Because the NFIP program is administered directly by FEMA, this is simply a matter of coordination and making public information available by OEM. In addition, OEM Hazard Mitigation Planning staff members have encouraged local jurisdictions to incorporate FMA planning, repetitive loss and severe repetitive loss property issues into their local mitigation plans.

In March, 2008, Oklahoma Emergency Management received the latest report regarding repetitive loss properties from FEMA Region VI and will be receiving a new one prior to the approval of this 2010 plan. Using this report indicating repetitive loss properties by counties, OEM will be contacting those jurisdictions with eligible repetitive loss properties to provide technical assistance in the eligibility and application process. Because of severe flooding on several occasions during 2007, the number of eligible properties has almost tripled. OEM will aggressively approach the reduction of repetitive loss properties by specifically contacting eligible jurisdictions to encourage and assist them in applying for mitigation funds through available programs which address repetitive loss properties. These programs currently include HMGP, RFC, SRL, PDM and FMA.

Chapter Six: Plan Maintenance Process

Each section of the plan update from the period of prior approval through October 26, 2010 was analyzed and reviewed by each member of the State Hazard Mitigation Planning Committee (SHMPC) and the administrative staff to determine whether updates to the plan were necessary. Chapter Six was reviewed by the SHMPC who determined that updating was required. The Monitoring, Evaluating and Updating sections of this plan were reviewed and found to be effective. A statement regarding this effectiveness has been added.

6.1 Monitoring, Evaluating, and Updating

The Oklahoma Emergency Management Hazard Mitigation Staff has been designated by the Hazard Mitigation Officer to keep the Hazard Mitigation Plan updated.

After two and one half years experience with Monitoring, Evaluating and Updating the State Hazard Mitigation Plan, Oklahoma Emergency Management has analyzed the effectiveness of the methods and schedule used and has determined that it has worked very well. Oklahoma Emergency Management has taken the opportunity at this update to further define Monitoring, Evaluating and Updating and it has been found to be appropriate for this 2010 version of the Hazard Mitigation Plan.

6.1.1 Plan Monitoring

The plan maintenance section of this document describes the formal process that will insure that the Oklahoma Hazard Mitigation Plan remains an active and relevant document with continued public participation. The plan maintenance process includes annual evaluations, revisions or updates, as needed by the state. The plan will be resubmitted for FEMA review every three years.

Oklahoma Emergency Management Hazard Mitigation Staff, along with the Hazard Mitigation Planning Committee will be responsible for evaluating and updating the plan. The State Hazard Mitigation staff will be responsible for monitoring the plan. A monitoring report will be written and submitted to the State Hazard Mitigation Team on a quarterly basis.

The Hazard Mitigation staff will perform any necessary site visits. They will also be the lead contact for phone calls and scheduling meetings. The Hazard Mitigation Plan will be kept on record in the State Hazard Mitigation Officer's office in the State Alternate EOC and on the OEM Website (http://www.oem.ok.gov). Any interested party may request a copy of the plan through the Hazard Mitigation Officer.

The State Hazard Mitigation Team has identified hazard mitigation projects to be included in the Hazard Mitigation Plan.

The Hazard Mitigation Planning Staff will work with the public, local jurisdictions and state, federal, and private agency officials to evaluate potential projects. Each project will be judged and ranked according to state priorities and impact. When necessary, the staff will also look at past occurrences and historical trends to aid in assigning priority.

6.1.2 Technical Assistance and Project Monitoring

Oklahoma Emergency Management (as grantee) recognizes the responsibilities laid out in 44 CFR 206.438(a): The State serving as grantee has primary responsibility for project management and accountability of funds as indicated in 44 CFR part 13. The State is responsible for ensuring that sub-grantees meet all program and administrative requirements.

Oklahoma Emergency Management has made a commitment to monitor and provide technical assistance to all eligible and funded sub-grantees. The SHMO or their designee will attend sub-grantee meetings to ensure the policies and procedures are explained correctly.

When necessary, the SHMO or their designee will attend the first closing of a buyout project to offer assistance in ensuring the necessary FEMA forms are completed.

6.1.3 Plan Evaluating

The Hazard Mitigation Planning Staff will evaluate the Hazard Mitigation Plan every year to determine the effectiveness and/or progress of mitigation actions and the implementation of other actions at both the state and local levels.

Plan evaluation will address the following questions

- Do actions address current and expected hazardous conditions?
- Has the nature or magnitude of risks changed?
- Are the current resources appropriate for implementing mitigation actions?
- Are there any implementation problems, such as technical, political, legal, or coordination issues with other agencies and jurisdictions?
- Did progress and outcome of mitigation actions occur as expected?
- Do actions contribute to the progress of meeting goals in the Mitigation Strategy?

Following evaluation review, the staff will update the plan with any changes needed. The State will resubmit the plan for FEMA review every three years.

The State Hazard Mitigation staff will make a report to the State Hazard Mitigation Team every year to evaluate the effectiveness and/or progress of mitigation actions and the implementation of other actions.

Items covered during the evaluation process and report should include:

- Evaluate magnitude of risk and determine if it has changed.
- Following a disaster in the state, whether declared or not, large or small, the State Hazard Mitigation staff will review the losses in that disaster and maintain a data base for updating the plan.
- Maintain contact with local jurisdictions concerning major changes in populations or development.
- Evaluate current state resources and determine if they are appropriate for implementing mitigation actions. Work with state Risk Management Department and Oklahoma

Transportation Department to better maintain damage reports on state facilities and transportation systems to a format facilitating the State Hazard Mitigation Plan

- Determine if there were any implementation problems, such as technical, political, legal, or coordination issued with other agencies
- Evaluate how other agencies and partners have participated
- Send a survey statewide to agencies and jurisdictions regarding the current priority of action plans due to the disasters during the past two years, and the status of the goals established
- Evaluate mitigation actions and determine if outcome occurred as expected
- Was the intended purpose of the original mitigation action met?
- Was the mitigation action met in the proposed timeline?
- Did the listed agencies participate in the mitigation action?
- Did mitigation action stay within proposed budget?
- Maintain closer contact with local jurisdictions regarding the status of their plans and mitigation projects.

The evaluation process assesses goals, objectives, and current/expected conditions; change in the nature or magnitude of risks; current resources for implementation; mitigation action item outcomes; and whether agencies and other partners participated as originally proposed.

6.1.4 Plan Updating

The plan will continue to be evaluated and updated annually during the three-year cycle process and anytime there is a disaster. Beginning the second year, the Hazard Mitigation Staff will review all plan revisions to be finalized based on review of the evaluation data received and sent to FEMA six months before the end of the third year so that Oklahoma will maintain eligibility for federal assistance programs. The plan will be resubmitted for FEMA review every three years.

Oklahoma Emergency Management has reviewed the initiation, status, and completion of mitigation activities and determined that modifications to the system identified in the previously approved plan to track the initiation, status, and completion of mitigation activities was satisfactory and works well.

6.2 Plan Maintenance Process Effectiveness

Analyses of the monitor, evaluate and update section of this plan revealed that these methods, schedules and processes are proper, effective and will continue to be appropriate for use in the future.

Chapter Seven: Enhanced Hazard Mitigation Planning

Each section of the plan update from the period of prior approval through October 26, 2010 was analyzed and reviewed by each member of the State Hazard Mitigation Planning Committee (SHMPC) and the administrative staff to determine whether updates to the plan were necessary. Chapter Seven was reviewed by the SHMPC and determined that updating was required. Agency specific information was clarified and updated. Information that no longer applies or is inadequate was removed and replaced with current information.

7.1 Executive Summary

Under FEMA guidance for Enhanced Plans, a state must detail how its plan is specifically integrated into other state, regional, and FEMA initiatives providing primary guidance for mitigation-related activities. Integration of plans, as manifested in day-to-day action has various dimensions. Legislative and policy integration has taken place incrementally over time as issues emerged in response to specific disasters. Formal institutional coordination at the state level has been solidified through the work of the State Hazard Mitigation Team (SHMT) and through outreach to local governments, tribal governments, and the private sector. The SHMT has been involved at every significant step of the 2010 State Hazard Mitigation Plan.

Several legislative bills that have a direct impact on mitigation issues are (summarized):

- 2005 - Senate Bill 121 (Title 36 § 999.3) – An Act related to insurance, creating the Oklahoma Subsidence Insurance Act; authorizing certain additional coverage, providing for right of subrogation. Effective date: January 1, 2006.

- 2007 – Senate Bill 517 (2 O.S. Supp. 206 §16-2, §16-4.1, §16-26, and §16-28.2) – An Act relating to the Oklahoma Forestry Code expanding scope of lawful burns, modifying actions constituting unlawful burning, modifying penalty, specifying circumstances and procedures for a lawful burn; modifying certain assessments and declaring an emergency. Effective date: May 23, 2007.

- 2008 – Senate Bill 2047 (amending Title 74 O.S. 2001, Section 324.11) An Act related to state government adding certain structures required to have certain type of building permits (assisted living facilities, specifically relating to facilities housing residents incapable of reacting to emergency situations without physical assistance from staff), requiring such facilities to install fire sprinkler protection and alarm system and meeting terms of the International Fire Code and declaring an emergency. Effective date May 23, 2008.

Funding for mitigation planning and projects in Oklahoma comes from a variety of sources. For example, FEMA mitigation grant funds provided support for 58 HM plans over the last three years. Ninety nine school safe rooms, acquisitions, storm water projects, GIS programs, digital mapping programs, weather radios, flood gauges, educational material, generators, and reverse 911 projects have all been funded through FEMA mitigation funding over the last three years. Recently funding for

burying utility lines has become available through HMGP. Special funds and the state general fund provide support for various other legislatively mandated programs including Homeland Security and Oklahoma Water Resources Board dam safety programs.

The Enhanced Plan must document the state's project implementation capability, identifying and demonstrating the ability to implement the plan including establishing eligibility criteria for multi-hazard mitigation measures and a system to determine cost effectiveness of mitigation measures. Before forwarding applications to FEMA, Oklahoma Emergency Management determines that an activity meets FEMA eligibility criteria. Each disaster has particular characteristics related to specific hazards that influence the mitigation priority determination. To maximize the effectiveness of the competitive mitigation grants, OEM has established criteria for ranking proposed activities.

The Enhanced Plan must also demonstrate that the state has the capability to effectively manage all mitigation grant programs and complete all mitigation grant activities, including financial reconciliation, within established performance periods. Oklahoma has a successful record of meeting all mitigation grant application timeframes and submitting complete, technically feasible and eligible proposed activities applications with appropriate supporting documentation. Oklahoma must also describe how it tracks potential losses avoided for each action taken. OEM maintains an extensive project database that contains numerous projects.

OEM ensures that all applicants have provided all required environmental information and benefit–cost analyses. Quarterly reports are generated by the sub-grantee and reported to OEM. OEM then compiles the reports and assesses the programmatic and financial components before timely submission to FEMA.

The Enhanced Plan must demonstrate that the state effectively uses existing mitigation programs to achieve its mitigation goals. The State must document that it has fully and effectively made use of FEMA and other funding already at its disposal to fund mitigation actions. FEMA mitigation funds allocated are closely linked to the plan goals.
Under FEMA guidance for Enhanced Plans, a state must also detail how its plan reflects a commitment to a comprehensive mitigation program. Oklahoma's commitment to a comprehensive mitigation program is manifested through active implementation of programmatic efforts by all major state agencies that operate in concert with Oklahoma's built environment.

Finally, Oklahoma must monitor, evaluate and update its plan on a regular basis. Upon adoption of the 2010 State Hazard Mitigation Plan the Hazard Mitigation Division of OEM along with assistance from the State Hazard Mitigation Sub-Committee and State Hazard Mitigation Team was charged with the responsibility for monitoring, evaluating and updating the 2010 plan. These groups meet at least quarterly to carry out these functions. This will ensure:

- Continuing and active participation of key state agencies in the monitoring, evaluating and updating of the Oklahoma State Hazard Mitigation Plan;

- Integration of mitigation and preparedness, response, and recovery related aspects of OEM and other state agency functions.

- Initiation of strategic planning is designed to clarify mitigation priorities and targets in moving toward preparation of the 2011 State Hazard Mitigation Plan.

7.2 Integration with Other Planning Initiatives

Clearly, the concept of hazard damage reduction and / or state hazard mitigation planning should be integrated into other important state planning initiatives such as economic development, capital improvement, comprehensive emergency management, disaster recovery, and restoration planning. Hazard mitigation planning is integrated into several key state planning initiatives and mitigation programs. Among the best examples are the Floodplain Management Programs and the FEMA-funded, state administered hazard mitigation programs.

In 1999, HB 1841 established the *first* State of Oklahoma flood mitigation program. This amended the Oklahoma Emergency Management Agency enabling legislation; created a flood mitigation account, and set criteria for flood assessment and mitigation projects. The Oklahoma Water Resources Board (OWRB) coordinates state efforts under the National Flood Insurance Program including floodplain management activities of 381 member communities throughout Oklahoma (see Oklahoma Floodplain Management Association).

As the NFIP State Coordinator, the Oklahoma Water Resources Board (OWRB) partners with other state and federal agencies and local governments to prevent and mitigate the catastrophic effects of flooding disasters in Oklahoma. There is a close working relationship between Oklahoma Emergency Management and the Oklahoma Water Resources Board whose programs and input are solicited and integrated into the State Hazard Mitigation Plans as appropriate. The OWRB promotes community enrollment in the NFIP and advises its 381 current members on steps to ensure future participation. The Water Board's aggressive and proactive efforts to mitigate the impacts of flooding in Oklahoma have been consistently recognized by FEMA and other organizations as the best in this region and one of the top programs in the country.

The Community Rating System (CRS) is an element of the NFIP. This program is designed to promote the availability of flood insurance; reduce future flood damages; and insure the accurate rating of flood insurance policies. Participating communities may receive credit for proven mitigation measures, thus reducing the cost of flood insurance within their communities.
The Oklahoma Department of Commerce provides the CDBG Capital Improvement Planning (CIP) grant funds to help communities update an existing Local Inventory of Governmental Capital Assets and a Local Capital Improvement Plan and Budget. The CIP process requires communities to create strategic plans for addressing the needs for publicly owned capital assets. By prioritizing capital budget needs, a community is better prepared to meet the financial requirements for enhancing its local infrastructure and paving the way for future community and economic growth and stability.

Both the Oklahoma Water Resources Board and the Oklahoma Department of Commerce are active members of the Oklahoma State Hazard Mitigation Team.

State hazard mitigation planning is integrated into the 1) Hazard Mitigation Grant Program; 2) Flood Mitigation Assistance (FMA) Program, 3) Pre-Disaster Mitigation Assistance (PDA) Program, 4) Repetitive Flood Claims (RFC) Program, and the 5) Severe Repetitive Loss (SRL) Program. The State requires recipients of Hazard Mitigation Grant Program grants to develop a natural hazard mitigation plan according to the Disaster Mitigation Act of 2000 (DMA 2000), 44 CFR Parts 201.6 requirements as amended, as a condition of receipt of a project grant. This requirement added approximately 200

hazard mitigation plans for communities and counties that otherwise might not have developed a plan. For several years the Flood Mitigation Assistance (FMA) Program has required that all applicants have an approved Flood Mitigation Plan. These requirements may now be met by incorporating the FMA language into the jurisdictions hazard mitigation plan.

Since the inception of the Capital Improvement Planning (CIP) program, the Oklahoma Department of Emergency Management and the Oklahoma Department of Commerce have been in a partnership with the state's eleven regional Councils of Government (COG). Each individual COG is responsible for converting information gathered with the CIP toolkit into a digital data format.

Benefits:

- Provides an inventory and mapping of community owned assets.
- Establishes a local administrative and policy framework for making responsible capital budgetary decisions.
- Clarifies and projects economic and demographic trends likely to influence the needs for new and expanded local capital facilities.
- Estimates the cost for repairs, replacements and expansions that incorporate mandatory, essential, desirable and deferrable needs.

7.3 Capital Improvement Planning (CIP)

CIP aids in validating to the county and municipal residents the amount of fiscal resources available to devote to natural hazard mitigation actions/projects during any given fiscal year. It should be noted that after the occurrence of a natural hazard event, CIP priorities might have to be rearranged or new priorities adopted.

7.4 Emergency Operation Plans

Present an overview of the ideal responses to a natural hazard occurrence and also provide a prioritization of what post disaster actions should occur and in what order. Both of these planning efforts should be consulted while constructing mitigation plans, actions/projects, and priorities.

7.5 State Administrative Plan

For all Federal mitigation programs: HMGP, PDM, FMA, RFC and SRL requires all construction-related mitigation projects to support the general mitigation objectives in the state's hazard mitigation strategy, adopted and published in 2008 as the strategy of record.

Oklahoma's State Hazard Mitigation Team was used to form the base of the State Hazard Mitigation Planning Committee. By incorporating team members from 21 different departments and agencies, plus private non-profit agencies and tribal nations, the State of Oklahoma insures that its Hazard Mitigation Plan is integrated into as many key state planning initiatives as practicable. For example, O.S. Title 63 §695.5 Oklahoma Emergency Management Act of 2003 amends certain sections to include:

1. Providing for the rendering of mutual aid among the political subdivisions of this state and with other states to cooperate with the Federal government with respect to carrying out emergency management functions and hazard mitigation;

2. Provide sufficient organization to meet, prevent or reduce emergencies in the general interest and welfare of the public and this state.

3. It is the purpose of the Oklahoma Emergency Management Act of 2003 and the policy of the State of Oklahoma that all emergency management and hazard mitigation functions of the state be coordinated with the comparable functions of the Federal government, including its various departments and agencies, with local government, and where necessary with other states, and with private agencies in order to expedite the most effective preparation and use of available workforce, resources and facilities for dealing with disasters and hazard mitigation.

4. It is also mandated that each state agency, board, commission, department or any other state entity having responsibilities in the State Emergency Operations Plan or by the nature of the service it provides to the citizens of Oklahoma will have written plans and procedures in place to protect individual employees, administrators and visitors from natural and man-made disasters and emergencies.

Hazard Mitigation Team members are familiar with the Oklahoma Hazard Mitigation Plan goals and action items.

Quarterly meetings will continue to ensure an exchange of ideas, problems and solutions and allow team members to incorporate new and existing mitigation ideas into each of their planning initiatives. State agencies will use this plan in conjunction with their Emergency Operations Plan (EOP)

- For example, the Oklahoma State Mitigation Plan complements and integrates with the recommendations of the Oklahoma Comprehensive Water Plan (OCWP). The OCWP recommended coordination for hazard mitigation activities within federal, state and local regulatory activities. Examples of activities include encouragement of local community buyouts of repetitive loss properties in floodplains, structural measures to reduce flood losses, emergency action planning below high hazard dams, annual engineering inspections of high hazard dams, encouragement of above minimum standard floodplain ordinances and activities, formation of the Oklahoma Drought Management Team and development/implementation of the Oklahoma Drought Management Plan, financing of water system improvements to mitigate the effects of drought through the State Financial Assistance Program and creation of the State Hazard Mitigation Fund. In 2009 the OCWP anticipates complete a water demand assessment. Following this, an assessment of ground and surface water will be done. The results of these two assessments will be compared to define any needs for which supply is inadequate.

  DEQ has developed a program to help municipalities eliminate dilapidated buildings in an economical and environmentally sound manner. The program has many positive features such as:

  1 Eliminating eyesores and safety hazards
  2 Saving thousands of dollars in landfill disposal costs
  3 Saving valuable space in landfills
  4 Reclaiming land damaged by such things as strip mining or erosion

The State of Oklahoma through DEQ has the ***State of Oklahoma Environmental Quality Code***. *T*his can be used for enforcement and funding in the Tar Creek Superfund area. The Tar Creek Superfund Site is one of the special event/man-made hazards profiled in the Plan.

The Waste Management Division of DEQ has the responsibility of carrying out the activities as required by the *State of Oklahoma Environmental Quality Code* and the EPA's CERCLA laws. In January 2000 DEQ completed a pilot project by closing three mine shafts northeast of Quapaw, Oklahoma. There are several state and local agencies such as DEQ, the Oklahoma Conservation Commission, the Oklahoma Department of Environmental Quality and the Ottawa Reclamation Authority, which have been and continue to be involved with reclamation of abandoned mines that pose a threat to public health and safety in Oklahoma. Their respective laws allow technical, legal, and financial help to be provided to the communities and citizens in the Tar Creek Superfund area.

Oklahoma Natural Hazard Mitigation Plan integrates with the goals and objectives of the Oklahoma Conservation Commission (OCC). The OCC is responsible for reclaiming over 32,000 acres of abandoned surface coal mines and another 40,000 acres of abandoned underground coal mines in a 16-county area of eastern Oklahoma.

7.6 The Oklahoma State Enhanced Plan

The Oklahoma State Enhanced Plan complements and is integrated with the goals of the:

- **Oklahoma Water Resource Board (OWRB)** The OWRB coordinates the Oklahoma Dam Safety Program to ensure the safety of more than 4,755 dams in the state, especially those that could impact downstream life and property. Because many of these dams are very old structures that need periodic repair, the Water Board requires submittal and subsequent approval of plans and specifications prior to dam modifications.
- The **Oklahoma Water Resources Board** further issues the *Oklahoma Water Resources Bulletin,* a regular publication that monitors drought and moisture conditions in Oklahoma. The *Bulletin*, published weekly during drought episodes, is a key component of the Oklahoma Drought Management Plan, which is referenced in the Hazard Mitigation Plan. During drought emergencies, Oklahoma Emergency Management also issues regular updates of drought and wildfire conditions.
- The OWRB is also able to provide funding to additional small Oklahoma communities for water and wastewater system improvements. The REAP program, created by the state legislature in 1996, targets primarily small towns. As a result, it is a key component of the state's overall economic development program for rural Oklahoma. As of December 14, 2004, the Board has approved 408 REAP grants for more than $35 million. When combined with other funding sources, REAP grants have contributed to the construction of water/wastewater projects totaling more than $64 million throughout the State of Oklahoma.

- **Natural Resource Conservation Service (NRCS)** offers technical assistance in the construction of small farm ponds and structures. Coordination between OWRB and other local agencies help prevent and mitigate the catastrophic effects of flooding disasters in Oklahoma. Board officials **stress** implementation of land-use strategies that reduce the likelihood of future flood damages and encourage the safe conveyance of floodwaters. The Water Board's aggressive and proactive efforts to mitigate the repetitive flooding in Oklahoma have been consistently recognized by FEMA and other organizations as the best in this region and one of the top ten programs in the country.

- **The Oklahoma Department of Commerce** is the primary economic and workforce development arm of the state. The Oklahoma Natural Hazard Mitigation Plan integrates well with the goals and objectives of DOC. In addition to many services and products, the agency develops economic incentives and provides funding to Oklahoma rural communities for programs and activities aimed at sustainability and economic growth, while encouraging strategic community planning with mitigation in mind. For example:

- To help communities and business leaders map out a plan for infrastructure development and economic expansion, commerce representatives frequently hold workshops that provide an overview of the *Community Development Block Grant/Economic Development Infrastructure Financing* program (CDBG-EDIF).
- The Main Street Program is a nationally recognized model for revitalizing historic downtowns and neighborhood business districts. The Oklahoma Department of Commerce has successfully implemented the Main Street Program since 1986 using the proven Four Point Approach that emphasizes organization, promotion, design and economic restructuring. In Oklahoma, for every dollar the state spends on community revitalization, the volunteers in our communities provide a return on investment of more than $55.00. Almost 400 million has been invested revitalizing the downtown areas of 41 Oklahoma communities participating in the Department of Commerce's Main Street Program.
- In a growing number of Oklahoma communities, the participation of a significant Spanish-speaking population is critical to the success of the planning process. The **Oklahoma Community Institute (OCI)**, in conjunction with the **Oklahoma Department of Commerce** is working to implement its community planning processes as part of a broader set of objectives for the state. The Spanish-language materials eliminate barriers and ensure that Hispanic families have the opportunity to access valuable information and resources.

- Hazard Mitigation planning is integrated into many key aspects and mitigation programs of the **Oklahoma Climatological Survey (OCS)** such as OK-FIRST. OK-FIRST is an initiative by the OCS to improve access to current weather information and to develop a decision-support system for the State's Public Safety agencies (fire, police and emergency management) agencies. OK-FIRST has provided computers, training and support to participating agencies. Each agency has obtained access to a rich suite of real-time products based upon the Oklahoma Mesonet, 15 NEXRAD radars and sophisticated computer models.

  OK-FIRST is built upon the foundation laid by a similar outreach program for K-12 education, known as EARTHSTORM. EARTHSTORM has been expanded to include over 150 schools as part of the K-12 Educational Outreach activities at OCS. The impact of OK-FIRST in the local community has been varied and wide-ranging. A few examples:

- During the May 3, 1999 tornado outbreak, an ambulance transporting a tornado victim was safely halted before crossing the path of a second tornado. In addition, rescue crews responding to the disaster in Oklahoma City were maneuvered around intervening tornadic storms. One crew temporarily closed I-40 to prevent motorists from driving into a tornado.

- One participant used OK-FIRST to estimate that over 6 inches of rain fell in portions of his county. County officials were then alerted that a particular bridge might fall. The bridge was closed before it eventually washed away.

- OK-FIRST was instrumental in notifying an incident commander overseeing a major wildfire of an approaching wind shift. The incident commander was able to reposition equipment to protect structures at the new head of the fire.

- Local officials have used information available from OK-FIRST to protect crowds during little league baseball games, parades and other outdoor events.

- Local communities and counties have benefited through improved scheduling of public works projects like paving and painting.

The previous Enhanced Plans integrated with other state and regional initiatives. The **Oklahoma Emergency Managers Association (OEMA)** adopted a resolution to partner with the **Oklahoma Floodplain Managers Association (OFMA)** to ensure continuity for land-use planning sources of best available science for frequently flooded areas and geologically hazardous areas. In addition during recent years, the OFMA has organized a Disaster Response Team (DRT) to go to flood affected communities or those near flooding to assist the local floodplain administrator and community staff to deal with necessary tasks to evaluate flood damage. Funding for the reimbursable expenses are anticipated through the Hazard Mitigation Program or other state and federal disaster relief programs. This basically does takes on the responsibilities of the Flood Hazard Mitigation Team authorized by the legislature in 1999.

The **next resolution adopted** pertained to supporting Hazard Mitigation legislation. Also adopted was a resolution in 2000, supporting **FEMA's Map Modernization Program.** In 2001 a resolution for supporting pre-disaster mitigation was adopted. In 2001, the Oklahoma Floodplain Managers Association co-sponsored HB 1329 with the **Association of County Commissioners** that amended the **Oklahoma Floodplain Management Act** to allow floodplain boards to set administrative fees to offset program costs. Governor Keating signed this into law April 1, 2001.

The Plan is integrated with local units of government Capital Improvement Plans, for example:

In 1992 the Oklahoma State Legislature passed a law encouraging local units of governments (municipalities, counties, and special districts) to create a Capital Improvement Plan (CIP). Title 62: § 910 – 912 and Title 62: § 912 - subsection D

> *"A local capital improvement plan shall include an inventory and analysis section addressing state goals under this act and issues of local or regional significance. The analysis shall include ten-year projections of local and regional growth in population and residential, commercial and industrial activity, the projected need for public facilities and the vulnerability of and potential impacts on natural resource.''*

1. The inventory and analysis section shall include but not be limited to:

    a. *"a legal description and general area description of the area address,"*
    b. *"land use information which describes current and projected development patterns."*
    d. *"an assessment of the age of all capital facilities and an assessment of the existing technology of all capital projects."*

When this law was enacted there were no funds provided for its implementation. In 1996 the **Department of Commerce** allowed eligible Community Development Block Grant cities to apply for funding to establish a CIP. Some of the eligible communities that applied for funding contracted with the Council of Governments (COGs) and prepared their CIP. This has been an ongoing project since 1996. In 2001 the state legislature appropriated $500,000 to implement additional CIPs for communities that weren't eligible for CDBG funding. These funds were divided equally between the eleven (11) COGs. In 2004 the Department of Commerce made available to eligible CDBG communities another $500,000 to update their CIPs. Due to this legislation and funding much of the information used in the State Hazard Mitigation Plan was already available.

7.7 Project Implementation Capability

The Oklahoma Department of Emergency Management Mitigation Division and the Oklahoma State Hazard Mitigation Team developed state criteria for determining eligibility of proposed multi-hazard mitigation measures. The following criteria are listed in the state administrative plan (latest edition May 2008) and used for all Federal mitigation programs, i.e. HMGP, PDM, FMA, RFC and SRL.

7.7.1 State Eligibility Criteria

In addition to published Federal eligibility criteria, a project must also support the general hazard mitigation objectives contained in the state mitigation plan. Specifically, these projects should implement as many of the following as practical:

1. Show adoption of a FEMA approved local hazard mitigation plan.
2. Protect lives and reduce public risk.
3. Reduce the level of disaster vulnerability in existing structures.
4. Reduce the number of vulnerable structures through acquisition, relocation, flood proofing, or seismic retrofitting.
5. Avoid inappropriate future development in areas known to be vulnerable to future disasters.
6. Solve a problem independently, or function as a beneficial part of an overall solution with assurance that the whole project will be completed.
7. Provide a cooperative, inter-jurisdictional solution to reduce future disaster damage.
8. Provide a long-term mitigation solution.
9. Address emergency hazard damage issues such as urban storm water, trees in power right of ways, etc.
10. Restore or protect natural resources, recreation, open spaces, and other environmental values.
11. Develop and implement comprehensive programs, standards, and regulations that reduce disaster damage.
12. Increase public awareness of natural hazards, preventative measures, and emergency responses to disasters.
13. Upon completion, have affordable operational and maintenance costs.
14. Illustrate how the project improves the applicant's ability to protect its critical areas.

Applicants are responsible for prioritizing projects by urgency of the need with the disaster being mitigated, financial impact to the jurisdiction, human losses, and timeframe for completion. The State is responsible for prioritizing each project application with respect to how much and when state assistance

is available. The form previously used for this purpose was ambiguous, subject to personal interpretation, and an irrational grading system. Following is the form now used to prioritize projects submitted to OEM for approval.

The State provides support to the applicants in several ways, including actual project implementation, seeking other funding resources, project support, public involvement activities and the provision of additional information.

The Mitigation Division tracks when and how projects are being implemented, as well as how their funding is being used. If there is a problem or conflict with a project, the state acts as a mediator to resolve the problem as quickly and efficiently as possible. As projects are completed, the state performs closeout procedures and all files are maintained in each applicant folder.

Project Evaluation and Prioritization Sheet

Parameter	Yes	No	Score Yes=1 No=0
Is applicant an eligible entity? (Tribe, County, City, etc.)	Yes	No	

Planning Projects - (7%) Use section **A** below

Discretionary Projects - (5%) Use section **B** below

Construction Projects - Use section **C** below

A.	**Planning Projects (7%)**			**Score**
	Is jurisdiction in Federal Declaration Area?	Yes	No	
	Is this funding request for a **New** plan?	Yes	No	

B.	**Discretionary Projects (5%)**			**Score**
	FEMA approved Hazard Mitigation Plan?	Yes	No	
	Is jurisdiction in Federal declaration area?	Yes	No	
	Is project one of the state's priority projects?	Yes	No	
	Project in local hazard mitigation plan?	Yes	No	

C.	**Construction Projects**	**Score**

FEMA approved hazard mitigation plan?	Yes	No	
Is jurisdiction a member of the NFIP?	Yes	No	
Is this a FEMA approvable project?	Yes	No	
Is jurisdiction in federal declaration area?	Yes	No	
Is project one of the state's priority projects?	Yes	No	
Project in local hazard mitigation plan?	Yes	No	
Cost benefit analysis provided?	Yes	No	
Past project performance? (Incomplete/Overdue Closeout)	Yes	No	

The State Hazard Mitigation Plan addresses the eligibility criteria for multi-hazard mitigation projects. The criteria listed in this section of the plan are the basic criteria for each type of project. These criteria may be modified based on any of the following issues:

- The specific disaster situation;
- Location of affected areas;
- Availability of funds;
- Unique program requirements of the fund source;
- Current state and/or local hazard mitigation priorities; and
- Number/type of mitigation projects submitted by local governments.

All hazard mitigation projects submitted for consideration must meet the criteria outlined in Code of Federal Regulations (CFR) 44, Section 206.434. There are additional requirements established by the state that must be met before a project is considered for approval. (HM Plan Chapter 5)

To meet FEMA's Minimum Hazard Mitigation Project Criteria, the project must:

1. Be in conformance with the hazard mitigation plan developed as a requirement of Section 322;
2. Have a beneficial impact upon the designated disaster area, whether or not located in the designated area;
3. Be in conformance with 44 CFR part 9, Floodplain Management and Protection of Wetlands, and 44 CFR part 10, Environmental Considerations;
4. Solve a problem independently or constitute a functional portion of a solution where there is assurance that the project as a whole will be completed. Projects that merely identify or analyze hazards or problems are not eligible; and
5. Be cost-effective and substantially reduce the risk of future damage, hardship, loss, or suffering resulting from a major disaster.

The project must also meet the following state criteria:

1. The project must complement existing or proposed state mitigation goals and objectives;
2. The project must complement existing or proposed mitigation goals and objects for the jurisdiction submitting the project;

3. The jurisdiction requesting the project must be able to complete the project as submitted;
4. The jurisdiction submitting the project must be able to meet any matching funds requirements (if required).
5. The project must be able to make a bigger impact on the local and state mitigation program than other non-selected projects.

While buyouts are not the only mitigation projects considered and undertaken by the state and local governments, they have been the type of project most frequently submitted and approved. In general, OEM works with local governmental entities to acquire and remove, elevate, relocate or perform minor structural projects only on privately owned residential structures and/or privately owned lots that are located in the floodplain and/or floodway. In addition to the requirements listed above, these projects must also meet the following criteria:

1. The project chosen must independently solve or be a functional part of a solution to a problem that is repetitive or poses a significant risk to health and safety. The proposed solution must be the most practical, effective, cost-effective and environmentally sound alternative among a range of alternatives that contribute to a long-term solution of the problem.
2. Local governmental entities (or certain private non-profit entities) must apply through the state, specifically OEM, to FEMA for approval to perform a project or projects. The applications must specifically identify the properties to be included in the project or projects. All projects must be proven cost-beneficial, in accordance with a determination method that is acceptable to OEM/FEMA. This is usually accomplished by using the FEMA benefit cost analysis module.
3. Local governmental/non-profit entities must be in good standing in the NFIP (or have not yet been mapped), and otherwise eligible to receive federal funding. Non-federal matches and all other federal grant requirements must be satisfied by the local entity, sometimes with the monetary assistance of local property owners or possibly with assistance from CDBG.
4. Hazard Mitigation Grant Program, Pre-Disaster Mitigation (PDM) and Flood Mitigation Assistance (FMA) projects must be consistent with the overall State Hazard Mitigation Plan. Projects also must conform to 44 CFR Part 9, Floodplain Management and Protection of Wetlands, and 44 CFR Part 10, Environmental Considerations.
5. Only local governmental/non-profit entities may manage the project or projects. All projects must be managed in accordance with local, state and federal ordinances, laws and regulations. Individual property owners are not eligible to receive federal funds directly as a grantee or sub-grantee and are not authorized to manage grant projects.

OEM considers a number of types of projects to be eligible for mitigation; with flood mitigation projects the highest priority. In each type of project below, the sellers' participation must be ***voluntary*** and the sellers must be able to prove ownership of the property involved in the project. The below eligibility criteria applies:

7.7.1.1 Property Acquisition

This is the state's most favored and usually most cost effective, voluntary option because the people and property are totally and permanently removed from the path of flooding and danger. To be eligible to participate, the local governmental/non-profit entity must agree to the following:

1. Offer is based on pre-flood fair market value determined by a State of Oklahoma board certified appraiser or a post-flood sales contract value.
2. Duplication of Benefits (DOB), Small Business Administration (SBA) loans and private mortgages must be satisfied from proceeds first.
3. The buyout property must be demolished within 90 days of the closing.
4. Local governmental entities, or certain non-profit entities, must accept all buyout property titles that are officially annotated to comply (in perpetuity) with federal Open Space deed restrictions.
5. The buyout property becomes ineligible for any future federal disaster assistance, except possibly Federal Crop Insurance.

7.7.1.2 Elevation

This voluntary option may be used as a more cost-effective and desirable method over the long term, for example, when the cost of the land is so high that a buyout is impractical. To be eligible to participate, the local governmental/non-profit entity must agree to the following:

1. Elevation project must be a practical, cost-effective and structurally sound alternative (in compliance with local building code and zoning rules) that elevates the lowest floor at or above the flood level or in compliance with local governmental entity floodplain management, if more stringent, by:
   - Extending the walls of the house upward and raises the lowest floor; or
   - Converting the existing lower area of the house to non-habitable space and builds a new second story for living space; or
   - Lifting the entire house, with the floor slab attached, and builds a new foundation to elevate the house.
2. In A zones, where flood hazards are less severe, property owners may elect to elevate buildings either on an open foundation or on continuous foundation walls that extend below the Base Flood Elevation (BFE). If continuous walls are used below the BFE, they must be equipped with openings that allow floodwaters to flow into and out of the area enclosed by the walls.
3. Owners of substantially damaged houses in Special Flood Hazard Areas must be willing to voluntarily demolish the remnants of the house and build a new house on the same site with an elevated lowest floor at or above the flood level or in compliance with local governmental entity floodplain management rules, if more stringent.
4. As an alternative, owners of substantially damaged houses in Special Flood Hazard Areas may elect to repair the house and elevate the lowest floor at or above the flood level or in compliance with local governmental entity floodplain management rules, if more stringent, as part of the repair process.

7.7.1.3 Relocation

This voluntary option may be used if it is more practical/cost effective or when the threat is so repetitive and/or severe that it is more advantageous to relocate a structure or structures, up to and including entire communities entirely out of harm's way. To be eligible to participate, the local governmental/non-profit entity must agree to the following:

1. Structures relocated from acquired property must be placed entirely outside the 100-year floodplain.
2. Structures generally must be relocated from acquired property within 90 days of closing.
3. Ownership of acquired property may not be conveyed to private citizens or entities; ownership may be conveyed to other public entities or nonprofit organizations with the approval of the state and FEMA.
4. Local governmental entities, or certain non-profit entities, must accept any buyout property titles that are officially annotated to comply (in perpetuity) with federal Open Space deed restrictions.
5. Any buyout property (i.e., any vacated lots acquired through the project) becomes ineligible for any future federal disaster assistance, except possibly Federal Crop Insurance.

7.7.1.4 Flood-proofing

This voluntary option may be most practical in limited danger areas. To be eligible to participate, the local governmental/non-profit entity must agree that this measure will best resolve the danger to the property:

1. The property is in an area that is not subject to flash flooding.
2. Extensive cleanup normally is not required after a flood event.
3. One of the two flood proofing processes described below is the most advantageous measure to employ over the long term.

Wet flood-proofing allows water to enter the structure, thereby equalizing pressure on walls and floors. Building contents such as furnaces and appliances are relocated out of reach of the floodwater.

Dry flood-proofing is a process that uses waterproofing compounds, sheeting or other impermeable materials to prevent floodwaters from entering the structure.

7.7.1.5 Structural Mitigation Projects

This option applies to infrastructure type mitigation projects associated with the Public Assistance (PA) program and/or the 406 mitigation program. To be eligible to participate, the jurisdiction must meet all of the eligibility criteria of the federal/state public assistance program. Those criteria include, but are not limited to, the following:

1. The project is required as a result of the declared event.
2. The project is within the designated disaster area.

3. The project is the legal responsibility of an eligible applicant.

If structural projects are not eligible to participate in PA or 406 Mitigation, the jurisdiction must meet all of the eligibility criteria of the federal/state mitigation program.

7.7.1.6 Tornado Safe Rooms

In addition to the requirements for flood mitigation projects, projects to protect people from tornados and high winds must also comply with FEMA Publications 320 and 361.

7.7.1.7 Other Mitigation Projects

The majority of Oklahoma's approved mitigation projects have been generated by flood related disasters. Other projects shown below also may be approved depending on the availability of funds, state and local priorities and proof of cost-benefit and project submissions:

- tornado safe-rooms (Individual and Schools)
- Structural seismic retrofit of non-damaged critical facilities
- Non-structural seismic retrofit of non-damaged critical facilities (such as filming windows, strapping and bracing equipment, etc.)
- Drainage / Channelization Improvement
- Development of educational programs and materials
- 5% State Initiative Projects
- 7% Planning

Before proposed project applications are submitted to the State Hazard Mitigation Team for scoring and ranking, staff from the OEM Mitigation Division work closely with the applicants to ensure that their proposals are cost-effective. Only projects with a benefit-cost ratio of at least "1" are forwarded to the Team for further consideration and evaluation against federal and state criteria.

In order to effectively analyze the cost effectiveness of the proposed projects, the Mitigation Division received FEMA special benefit cost analysis training at FEMA Region VI JFO in Oklahoma City, Oct. 23-24, 2007 and May of 2010. The State Hazard Mitigation Officer received training at the Emergency Management Institute in November 8, 2006. OEM hosted another class for BCA training was held on December 11-12, 2008.

To assist potential applicants in developing mitigation projects that are as cost-effective as possible, the Mitigation Division provides or sponsors:

- Workshops to help potential grant applicants understand the benefit cost concept, and to help them assemble the necessary data for the analysis. OEM hosted classes taught by FEMA in Oklahoma City December 11-12, 2008.

- Individual training and technical support to potential grant applicants, upon request. Such support includes walking applicants through appropriate benefit-cost modules and providing feedback to ensure development of the best possible benefit-cost ratio.

Benefit-cost analysis for proposed mitigation projects use FEMA-approved benefit-cost modules, which are based on the benefit-cost criteria established in OMB Circular A-94, Guidelines and Discount Rates For Benefit-Cost Analysis of Federal Programs.

7.7.2 Screen Project Application Data

The first part of the process is screening the project application to gather data relating to cost-effectiveness. This includes economic, environmental, and engineering data. Often, this data is missing or limited. The amount of data available will determine the type of benefit cost analysis you use. The screening process involves three separate but related tasks. Each task is conducted simultaneously and is essential to developing an overall profile of the project before conducting the benefit cost analysis.

1. Engineering Review - This review establishes whether the project is feasible from an engineering standpoint and whether it will reduce damages as claimed. The reviewer may suggest changes to make the project more efficient in reducing damage and loss.
2. Environmental Assessment - This part of the screening process alerts reviewers to any potential environmental concerns raised by the project.
3. Project Application Data - This part of the screening process determines whether the application contains sufficient information and data for input into the benefit-cost model.

Ideally, the project application would contain all the data needed. However, project applications often have incomplete or limited data. This is one of the main reasons that a streamlined process was developed to determine project cost-effectiveness without all the data. It is also the reason that federal, state, and local mitigation specialists must work closely together to ensure that all proposed mitigation projects are thoroughly reviewed and comply with the mitigation goals and objectives. Rather than require additional information - which may or may not be available and which can cost valuable time and money - FEMA devised shortcuts. With these shortcuts, additional data does not necessarily need to be collected in order to do a benefit cost analysis. Screening the project data will assist in determining which type of analysis to perform.

There is basic data that must be obtained from hazard mitigation applications before a benefit cost analysis can be performed. This data is entered into the benefit cost module to assess whether the project is cost-effective or not. While the table addresses flood and earthquake project applications, the same basic “subject data” information and analysis is needed for mitigation projects related to any type of hazard. The following are examples of key data that are typically used for analyzing flood and earthquake hazard mitigation projects:

7.7.2.1 Key Data Needed for Analyzing Project Applications

Subject	Flood Project Data	Earthquake Project Data
Hazard Data (often not included in application)	Flood Insurance Study (FIS) data, or historical flood data from application	Seismic hazard data from a credible source
First Floor Elevation	Is this available from engineering surveys or can it be estimated from observed flood depths?	Not applicable
Scope	What problem does the project address? How vulnerable is the building, item, or area?	Same as flood
Cost	Is there a well-documented cost-estimate or only a rough estimate?	Same as flood
Useful Lifetime	How long will the project provide protection (mitigation) against damages and losses?	Same as flood
Economic Considerations	What is the square footage of the building? What are the replacement values of the building (or other facility) and contents?	Same as flood
Occupancy	Not usually applicable	What are the levels of occupancy and visitors during various times throughout the day?
Function	What is the function of the facility and is it entirely or partially related to emergency response and recovery?	Same as flood
Damage Estimates - Before Mitigation	1. What type of building it is, or 2. Why do damages occur? 3. What are the historically observed damages?	1. Same as flood 2. Are engineering reports available that describe building/ facility's seismic vulnerabilities?
Damage Estimates - After Mitigation	How effective will the mitigation project be in reducing future damages? (Reduced damages can be percent or dollar values)	Same as flood

7.7.2.2 Benefit Cost Analysis:

The State mitigation division performs the analysis on all project applications that require benefit cost analysis. The State Hazard Mitigation Team serves as the reviewers of the cost effective analysis for all projects. The Division completes a benefit-cost analysis that meets FEMA criteria for every hazard mitigation project submitted for funding. For each project's benefit cost analysis, applicants must provide a narrative that describes the project including the project's life-cycle cost, the value of the property it will protect, documented damage that has occurred in past disaster events as a result of no

project, an estimate of the damage and associated costs that the project would prevent over its useful life. A benefit cost worksheet must be completed that shows total project costs, project life in years, effectiveness of the project, repair costs to pre-disaster condition, annual maintenance costs, total of all past disaster related costs, displacement costs, and frequency of occurrence of the recent disaster event. For flood projects, applicants must provide information on past flood events, frequency of each event type, and estimated damage expected for each event type before mitigation.

The second part of the process is to determine which benefit cost analysis tool to use. If the project application data is limited or incomplete, then a benefit cost analysis that uses limited data should be employed. If, however, the data in the project application is more or less complete, then a more robust method of analysis can be used.

Benefit cost analysis is used for all cost effectiveness determinations. Although the following sample analysis is an oversimplification, the concepts it illustrates are important. At its most basic level, benefit cost analysis determines whether the cost of investing in a mitigation project today (the "cost") will result in sufficiently reduced damages in the future (the "benefits") to justify spending money on the project. If the benefit is greater than the cost, then the project is cost-effective; if the benefit is less than the cost, then the project is not cost effective. This analysis provides an example of the kind of comparative benefit and cost data you might see after conducting a benefit cost analysis.

It is important to understand that benefit cost analysis is basically the same for each type of hazard mitigation project. The only differences are the types of data that are used in the calculations, depending on what the project is.

1. Cost effectiveness is determined by comparing the project cost to the value of damages prevented after the mitigation measure. Given an example, the project cost is $1,000 and the value of damages prevented after the mitigation measure is $2,000.
2. Because the dollar-value of benefits exceeds the cost of funding the project, the project is cost-effective. This relationship is depicted numerically by dividing the benefits by the costs, resulting in a benefit cost ratio (BCR). The BCR is simply a way of stating whether benefits exceed projects costs, and by how much.
3. To derive the BCR, divide the benefits by the cost ($2,000/ $1,000). If the result is 1.0 or greater, then the project is cost-effective. In this instance, the BCR is 2.0, which exceeds the 1.0 level.
4. On the other hand, if the cost of the project is $2,000 and the benefits are only $1,000, the project would have a BCR of 0.50 ($1,000/ $2,000) and would not be cost-effective.

While the example mentioned above may be a simple one, the process and the benefit cost analysis calculations associated with it are basically the same for all mitigation projects.

Three approaches are used to determine a project's benefit cost ratio: lower-bound analysis, upper-bound analysis, and best estimate. The lower bound and upper-bound methods are used in many cases to make final determinations of cost-effectiveness even when there is limited data. In these cases, no further benefit cost analysis is needed. In other cases, quick screening analysis with these approaches yields inconclusive results and additional data and screening may be required.

7.7.2.3 Lower-Bound Analysis

Lower-bound analysis is a powerful tool that can often demonstrate that projects are cost-effective, in many cases regardless of whether the available data is complete or not. This is an important point, because a project's cost-effectiveness can sometimes be determined by using only one or two key pieces of data. The lower-bound analysis was developed with this in mind.

The lower-bound analysis considers only some of a project's benefits (those that are the most important or those for which data exist) and ignores other benefits that may be difficult to estimate or for which data may not be available. In other words, this analysis purposely uses only a few pieces of information to determine the project's cost-effectiveness and undercounts, or ignores other benefits that will be gained by funding the project. If this data indicates that a project is cost-effective, then no further analysis is needed. No additional data has to be collected.

Lower-Bound Analysis at a Glance

1. It should be used when data is incomplete.
2. It can determine that a project is cost-effective.
3. It cannot determine that a project is not cost-effective.
4. It uses data for one or two significant benefits.

7.7.2.4 Upper-Bound Analysis

Sometimes an upper-bound analysis is used if, at first glance, the project appears not to be cost-effective. Like lower-bound analysis, upper-bound analysis relies on limited project data. Upper-bound analysis, however, also uses professional judgment to estimate about input data that give the highest reasonable benefits that can be expected from a mitigation project.

It is extremely important to note that upper-bound analysis cannot determine that a project is cost-effective. Upper-bound analysis can only determine that a project is not cost-effective.

Because it relies on the highest, reasonable estimate of benefits (prevention of damage by the project), an upper-bound analysis can only determine that the project BCR is not cost-effective (less than 1.0). The project can only be rejected as not cost-effective with this analysis. In other words, because the highest reasonable estimate of damages is used in the calculation, if the BCR is still less than 1.0, one can only conclude that the project is not cost-effective.

Upper-Bound Analysis as a Glance

1. It can only determine that a project is not cost-effective.
2. It is used as the next step if the lower-bound analysis is negative (not cost-effective).
3. It is used if a project appears, at first glance, unlikely to be cost-effective.
4. It uses the highest reasonable estimate of benefits for a project.
5. It analyzes, as much data as are possible, assigning the highest reasonable value to each.

7.7.2.5 Best Estimate Analysis

A best estimate analysis is used when the project application data is complete, or almost complete. This analysis provides a more accurate BCR than either lower-or upper-bound analysis because more data are considered in the analysis. As discussed earlier, however, in many cases lower bound or upper-bound analysis can provide firm decisions about cost-effectiveness, without requiring as much data as a best estimate analysis.

If a best estimate analysis is conducted, then a project is either cost-effective or not cost-effective, because all significant data are considered. Because this method of benefit cost analysis provides the best estimate of cost-effectiveness, it can be used to rank (set priorities among) competing projects. Neither lower bound nor upper-bound analysis are used to rank or set priorities among projects. They do not consider enough data to determine accurately specific BCRs, the product only "bounds" on BCRs (i.e. BCR > 1.0 or BCR < 1.0).

Best Estimate Analysis at a Glance

1. It should be used when the project application data is complete, or almost complete.
2. It produces a more accurate analysis than Lower Bound and Upper-Bound analyses.
3. It determines whether a project is cost-effective or not cost-effective.
4. BCR can be used for ranking or setting priorities among projects.

7.7.2.6 Results of Benefit Cost Analysis

The final aim of the review process is to determine whether a project is cost-effective, or whether further analysis is required. If the project is cost-effective, the application moves to the next level in the funding process. If it is not cost-effective, the project is rejected. In some cases, additional information may be requested, or the applicant may be shown how the mitigation effort can be re-directed.

By conducting a benefit cost analysis, you determine one of three things; either the project is cost-effective (BCA > 1.0), the project is not cost-effective (BCA < 1.0), or additional data is required.

If the project is cost-effective, then no further analysis or additional data collection is required. If a project is determined to be cost-effective, either by a lower bound or best estimate analysis, then the project moves to the next step in the application process.

If the project is not cost-effective, then no further analysis or additional data collection is required. If the project is determined not to be cost-effective, either by an upper bound or a best estimate, then the project is not eligible for funding. Some projects require additional information to determine cost-effectiveness because the applications are very incomplete.

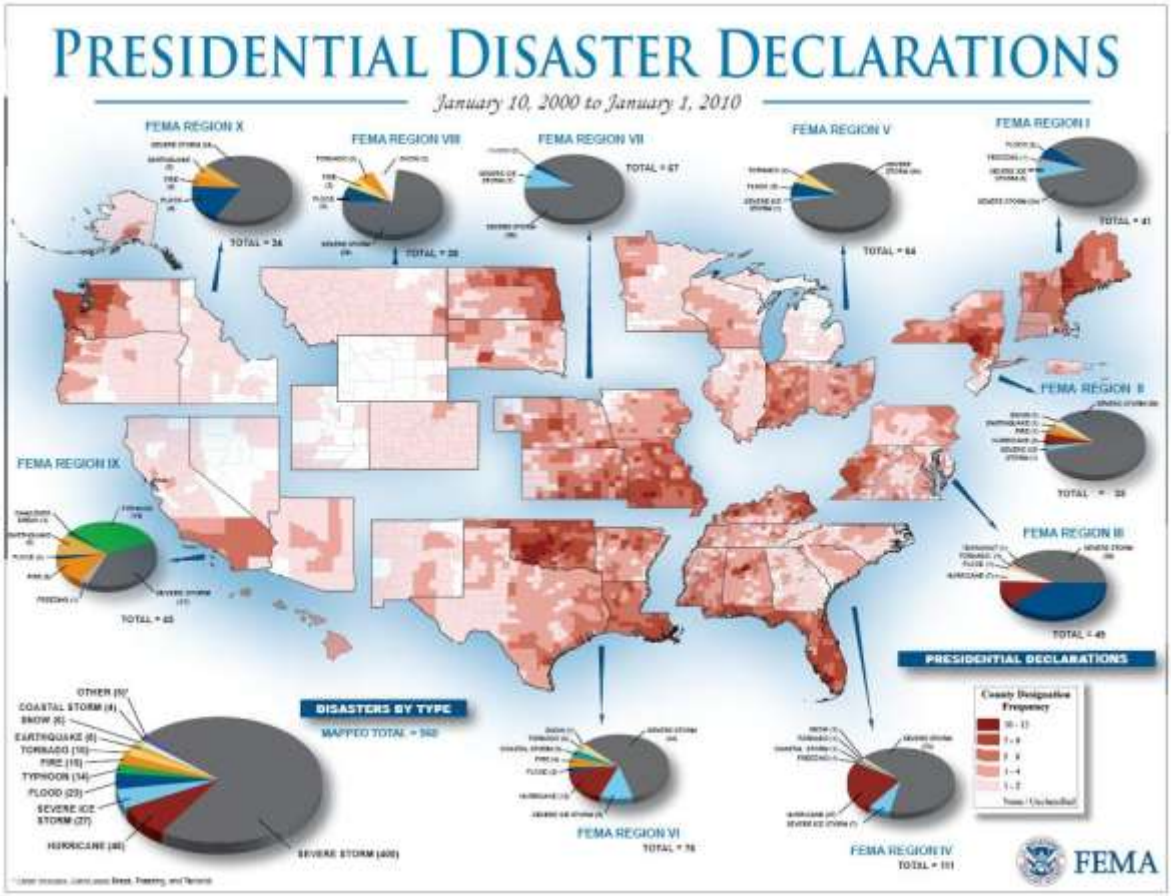
If the cost-effectiveness of a project cannot be determined, then additional data must be collected. It is important to recognize that only the minimum data necessary to reach a decision on project cost-effectiveness must be collected. In many cases, the collection of one or two more pieces of information are sufficient to reach a decision. A complete analysis is conducted in those relatively few cases where the BCA is close to 1.0.

7.8 Program Management Capability

It should be noted that the major funding activity the past three years has been based on the Hazard Mitigation Program due primarily to the number of disasters Oklahoma has suffered. Oklahoma has experienced 9 declared disasters and 30 F-mag declarations from 2005 when the previous version of this plan was approved through 2008. In 2009 and 2010 there have been 12 declared disaster declarations, 2 emergency declarations accompanied by 9 F-mag declarations.

The map below shows Oklahoma has the highest county frequency of declarations during this period of anywhere in the continental United States. During this period, Oklahoma has experienced major ice storms, major wildland fires, major tornados, severe storms, and major flooding

In 2005 and 2006 a number of state staff left Oklahoma to work with various contractors involved in the Katrina projects including the State Hazard Mitigation Officer. Over 200 HMGP plans were in various stages of preparation by jurisdictions and some plans were ready to be reviewed with no staff to review them. Additional staff was hired in late 2006 and trained to review plans. FMA, SRL, RFC, and PDM projects, while reviewed, were not a priority and therefore a lot were not received. The Oklahoma Hazard Mitigation Plan also suffered and some state projects and interactions with other agencies did not receive the attention they should have although interaction with some agencies not normally involved did occur. This problem has been rectified and all but one of the old plans has been either approved or approved pending adoption. The one plan remaining is in the hands on a different planner and we expect to be in for review in November of 2010. The current staff of three planners is up to date with plan reviews and is able to meets our objective plan review interval of 60 working days.



The Mitigation Division of Oklahoma Emergency Management effectively manages the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM), Flood Mitigation Assistance (FMA), Repetitive Flood Claims (RFC) and the Severe Repetitive Loss (SRL) program application process once notice of mitigation grant funding becomes available.

FY 2005 to FY 2010: the state is successfully administering over $61 million in Federal grant funds. The State has proven that it can effectively manage the additional funds provided through the DMA 2000 as 95% of these funds were at the 20% rate. The State has a good record of managing project funding and maintaining all necessary reporting and documentation requirements.

The following narrative describes the way the mitigation division handles the application process. Details are in the state administrative plan but summarized below. Initially, notices of intent (NOI) are solicited from potential applicants; eligible organizations submitting NOI's are provided with full applications.

- As soon as possible following notice from FEMA, the state distributes to potential eligible applicants in the declared area, a notice of funding, notice of intent, funding criteria, application deadlines, and other pertinent information. Even though mitigation funds are available state-wide, Oklahoma gives priority to the declared areas.

- Once received, letters of intent are reviewed, and eligible organizations are provided with a full application. Depending upon the disaster and the project, organizations will have 60 to 90 days to complete their applications.

- Applicants are required to provide extensive information on proposed projects, including;
    - Data on the project and project site.
    - Designation of the applicant agent.
    - Project budget and identification of funding sources.
    - Description of how the project meets federal and state mitigation goals, and public involvement.
    - Discussion of three alternatives and their impacts.
    - Information on potential environmental impacts and data for the benefit cost analysis (see section below for more details on preparing and submitting accurate environmental review and benefit-cost analyses).

- Once received, at least two mitigation staffers review each application using a checklist to ensure all information necessary for the state to make an eligibility determination, technical feasibility, and cost-effectiveness of the proposed project. Additionally, staffs from appropriate state agencies review the environmental information presented. The State team must approve all applications.

- State staff provides technical assistance to help applicants prepare complete applications, and provides guidance and training to help applicants develop their benefit-cost analyses. Upon request, state staff assists applicants in preparing their benefit-cost analyses when necessary.

HMGP: Within the last three years, the Mitigation Division has managed 421 mitigation projects and plans currently in progress and closed-out 291 projects. Projects closed out include: Plans-177, NOAA Weather Radios-23, School Safe Rooms-56, Acquisitions projects-6, Window Safety Film-3, Generators-2, 911 Projects-6, GIS/GPS-3, Digital Mapping-1, Flood Gauges-4, Spanish brochures-1, Shelter Model Display-1, TV Cable for state EOC-1, Brochures-3, Emergency Alert System Software-1, Emergency Preparedness for Public Education-3. All the projects are up to date on documentation requirements. During 2007-2008, over 1000 project NOI's were received and over 200 of those were submitted as new project applications.

FMA: Since 2005 only two communities have received grants from this program. All applicants made progress in mitigating flooding actions through either plans or projects. The Oklahoma Water Resource Board gathers portfolio information on all repetitive loss structures in Oklahoma. All reporting requirements are being met.

PDM: One Disaster Resistant University Plan, 14 Hazard Mitigation Plans, two HM plans updated (including the OEM Hazard Mitigation Plan update), and one school safe room project have been funded through PDM grants. All reporting requirements are being met.

SLA: Four projects involving SLA properties occurred during 2008. All reporting requirements are being met.

7.9 Environmental Review:

The State mitigation division relies on the staff of the Federal Emergency Management Agency Region VI to conduct environmental reviews for construction projects seeking hazard mitigation grant funding from the Mitigation Grant Programs. Before recommending FEMA approval for a hazard mitigation grant, the state requires applicants to ensure their proposed projects and alternatives comply with all applicable federal, state and local codes and standards, including the National Environmental Policy Act (PL 91-190, as amended) and all federal laws covered within the act, and for securing the necessary permits and approvals.

The provisions of this section specify the jurisdictional areas of responsibility for each state environmental agency and state agencies with limited environmental responsibility:

- Department of Environmental Quality
- Oklahoma Water Resources Board
- State Department of Agriculture
- Corporation Commission
- Department of Mines
- Department of Wildlife Conservation
- Department of Public Safety
- Department of Labor
- Department of Emergency Management

Below is a synopsis of the information, documentation, and assurances that applicants must provide to the state and to FEMA to ensure compliance with applicable historic preservation and environmental protection laws and regulations:

- **Historic and Archaeological Resources (PL 96-515, Section 106)** – Applicants must determine whether there is a potential for historical or archaeologically significant resources on or near the site of the project. Oklahoma "State Antiquities Act" (53 OS 361) requires a permit to undertake investigations or conduct archeological excavations on state controlled or owned land. The permit is issued by the State Archeologist.

- **Floodplains and Wetlands Disclosure**: (Presidential Executive Orders EO-11988 and EO-11990, and the Oklahoma Floodplain Management Act, Title 82, Sections 1601-1620, amended in 2004).
- The Act establishes a state and local partnership to reduce flood damages through sound floodplain management.
- This act allows counties and cities to adopt floodplain regulations and gives authority to Oklahoma Water Resource Board to regulate development in floodplain on state property.
- This act also calls for annual training of the local floodplain manager and protection of the natural and beneficial uses of the floodplain, if work is in a wetland that is in a designated high risk flood hazard area. In a NFIP community the developer must comply with all local, state and federal requirements, such as Section 404 of the Clean Water Act.

Communities also must comply with the Storm Water Permit requirements enforced by the Department of Environmental Quality.

- **Environmental Justice:** (Presidential Executive Order 12898) – Applicants must determine whether concentrations of minority or low income populations live in or near the project area, whether those populations would be disproportionately impacted by the project, and how the project's benefits would outweigh identified impacts.

- **Toxic and Hazardous Substances:** Applicants must provide a waiver of liability if there are any toxic and hazardous substances, including underground or above ground storage tanks, septic systems, or other potential contaminants, in the project area.

- **Endangered Species and Habitats:** Applicants must determine whether there are any threatened, endangered or sensitive species or habitats on or near the project site.

- **Code Compliance Assurance:** Applicants must state whether their project meets all applicable codes and standards for the area in which it is located, and if not, to describe the exemptions and variances that will be required.

7.10 Quarterly Reports:

Applicants are required to submit quarterly progress and financial reports within 10 days of the end of the quarter, regardless of progress on the funded project or plan during the quarter. Using these reports, along with financial reports generated by the finance office, the Mitigation Division compiles narrative and financial information and submits a comprehensive report to the FEMA Region VI office within four weeks of the end of the quarter.

- Mitigation staff of the State Emergency Management Division use the terms of grant agreements/quarterly reports provided by the project grant recipient to monitor progress and ensure the project is on track.

- On-site visits are scheduled for projects requiring additional assistance. Final inspections are conducted by mitigation staff contractors, to ensure the project is completed to specifications.

- Post-completion inspections are conducted regularly by state mitigation staff to ensure the property owner is complying with the terms of the grant agreement related to maintenance of the mitigation project. For example, such an inspection will make sure that a park developed from a site of property acquisitions remains a park.

- Finally, financial reconciliation is conducted to validate all reimbursement requests before payment is made. Requests are validated against Office of Management and Budget circulars to ensure only allowable costs are reimbursed and that no more than the maximum amount provided for in the grant agreement is reimbursed.

7.11 Assessment of Mitigation Actions

The 44 CFR 201.5(b) (2) (iv) states the Enhanced Plan must document the system and strategy by which the State will conduct an assessment of the completed mitigation actions and include a record of the effectiveness (actual cost avoidance) of each mitigation action.

7.12 System to Assess Mitigation Actions

The State or Oklahoma will utilize the Access data base management program to conduct an assessment of completed mitigation actions and include the effectiveness or actual losses avoided for each action. Much work has been accomplished over the past three years towards the task of setting up a system for which the State can track the effectiveness and success of all mitigation actions.
In 2008, the concept of developing a mitigated properties database was finalized and an Access application was created to help capture site specific information about each completed mitigation project in the State of Oklahoma.

Some of the key information collected for this database includes:

• Applicant
• Property Address
• Parcel Number
• GIS Coordinates
• Mitigation Activity Completed
• Structure Type
• Structure Size
• Replacement Value of property mitigated (Structure and Contents)
• Damage Source
• Hazard Data
• Elevation Data
• Benefits

The State Hazard Mitigation Division is currently populating the database for all completed and closed projects within the HMGP, RFC, SRL, FMA, and PDM programs. The database is updated by State Hazard Mitigation Division staff on completed mitigation projects as part of the closeout process.

7.13 Strategy to Assess Mitigation Actions

The following action steps will be taken to effectively assess completed mitigation actions in Oklahoma:

• Continue the process of populating the Mitigated Properties Database on all completed mitigation projects that are administered by OEM.
• Incorporate mitigation activities completed by other agencies into the Mitigated Properties database.
• Review Hazard Event information submitted to OEM to determine the potential for loss reduction as a result of all completed mitigated actions documented in the Mitigated Properties Database.
• Upon determination that the completed mitigation action resulted in a reduction of damages, data will be entered into the Mitigated Properties database and a computation of damages avoided for each structure mitigated will be computed.

Each local mitigation plan update will have a section that discusses completed mitigation actions and successes, which will be consistent with the State maintained database. Local governments will be able to access the data by contacting OEM who will provide reports for their counties and municipalities on completed mitigation actions and any avoided losses as a result of hazard events documented in the project area after the projects are completed.

7.14 Record of Actual Cost Avoidance

A critical component to estimate the actual avoided losses is having accurate information on the hazard event and information about the exposure of the property to damages. Scenario losses are computed based on established hazard damage relationships such as depth damage curves for wind and flood events provided by FEMA in benefit-cost modules. For flood events, avoided losses can be computed by knowing how much flooding would have occurred at the site by comparing the finished floor elevation data with the water surface elevation of the hazard event. Applying the depth damage curves and additional information collected allows one to compute scenario losses at the site that would have occurred if the structure had not been mitigated.

This database will be an ongoing tool to capture success stories on future disaster events. By capturing information at the property level, the State can at any time create a report on the effectiveness of any completed mitigation project. The State has utilized most of the initiative funding within the HMGP on projects to improve the warning and communication capabilities of local governments. The State is working with the National Weather Service on measuring the effectiveness of warning and communication improvements in communities that have been designated Storm Ready. Preliminary studies have been completed that show a significant decrease in injuries and loss of life from severe weather events in those communities that have achieved the storm ready status. This information, when finalized will be utilized to help measure the effectiveness of future warning and communication improvements in Storm Ready Counties.

7.15 Effective Use of Available Mitigation Funding

The 44 CFR 201.5(b) (3) states the Enhanced Plan must demonstrate that the State effectively uses existing mitigation programs to achieve its mitigation goals.

The State of Oklahoma continues to effectively implement hazard mitigation programs towards achieving its goals to:

1. Protect Life;
2. Protect Property
3. Protect the Environment; and
4. Increase Public Preparedness for Disasters

The mitigation programs utilized in implementing mitigation measures throughout the state are primarily federally funded, each is state administered. These include the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation Assistance Program (FMA), the Pre-Disaster Mitigation

Program (PDM), the Severe Repetitive Loss Program (SRL) and the Repetitive Flood Claims Program (RFC). The projects that have been approved and funded through these programs support the State's hazard mitigation goals and specific program eligibility criteria.

The table below lists the number and type of projects funded by federal and local funding sources since 1990. The list ties each project with the associated State mitigation goal and task, along with a corresponding level of effectiveness. All projects are implemented and funded to reduce or remove the possibility of future property damage and/or human vulnerability.
To the extent these projects accomplish their goals will determine their effectiveness.
Effectiveness can be defined as the ability of a mitigation project to reduce or eliminate the possibility of future damage or human suffering. We have broken the ranges of project effectiveness into three levels: High, Medium and Low. A rating of High would be given to projects that create the most effective type of mitigation such as property acquisition or relocation where no damage would occur in the event of future disaster. Medium effectiveness would entail projects that reduce the likelihood of future damage, however, in the event of an uncommonly severe disaster event, property damage or human vulnerability may still occur. Examples of a medium effective project would be drainage improvements, wind retrofits, warning initiatives and building elevations.
A low effectiveness rating would entail projects that provide relatively low and relatively short term limited hazard prevention levels. Since 1990, Oklahoma has not processed a project that would fall into this category.

Program	**Project Type**	**Number of Projects**	**Goal**	**Project Level of Effectiveness**
HMGP	911 Mapping	1	1,2,3,4	High
HMGP	911 Trainer	1	1,2,3,4	High
HMGP	Acquisitions	20	2	High
HMGP	Amateur Radio	1	1	Medium to High
HMGP	Brochures	1	1,2,3,4	High
HMGP	Digital Mapping	1	1,2,3,4	High
HMGP	EAS Software	1	1	High
HMGP	Education Preparation	3	1,2,3,4	High
HMGP	Emergency Management Weather Information Network	1	1,2,3,4	Medium to High
HMGP	EOC Retrofit & Upgrade	1	1	Medium to High
HMGP	Flood Gauge	2	1	Medium to High
HMGP	Gauges	1	1	Medium to High
HMGP	Generators	24	1,2,3	High
HMGP	GIS	1	1,2,3,4	Medium to High
HMGP	GIS Multimedia	1	1,2,3,4	Medium to High
HMGP	GIS/GPS	1	1,2,3,4	Medium to High
HMGP	Hardwire Switch	1	1,2,3	High
HMGP	Hrg Imp	1	1,2,3	High
HMGP	Individual Safe Rooms	1	1,2,4	Medium
HMGP	Laminate	1	1	Medium to High
HMGP	Management Costs	16	1,2,3,4	High
HMGP	NOAA	34	1	Medium to High
HMGP	NOAA Radios	1	1	Medium to High

Program	Project Type	Number of Projects	Goal	Project Level of Effectiveness
HMGP	NOAA Weather Repeaters	1	1	Medium to High
HMGP	Planning	330	1,2,3,4	High
HMGP	Plan Update	5	1,2,3,4	High
HMGP	Radios	1	1	Medium to High
HMGP	Reverse 911	5	1	Medium to High
HMGP	Safe Rooms	81	1,2,4	Medium
HMGP	Safety Brochures	1	1	Medium to High
HMGP	School Safety Film	2	1	Medium to High
HMGP	Shelter Model	1	1,2,4	Medium
HMGP	Sirens	22	1	Medium to High
HMGP	Spanish Translations	1	1	Medium to High
HMGP	Storm Water	2	2	Medium
HMGP	Tech Plan	1	1,2,3,4	High
HMGP	TV Cable	1	1	Medium to High
HMGP	Warning System	7	1	Medium to High
HMGP	Water Plan	1	2	Medium
HMGP	Weather Radios	1	1	Medium to High
FMA	Plan	4	1,2,3,4	High
FMA	Seminars	1	1	Medium to High
FMA	Data Assistance	1	1,2,3,4	High
FMA	Data Plan	1	1,2,3,4	High
PDM	Enhanced Plan	1	1,2,3,4	High
PDM	Enhanced Plan Update	1	1,2,3,4	High
PDM	Management Costs	3	1,2,3,4	High
PDM	Plan	14	1,2,3,4	High
PDM	Plan Update	1	1,2,3,4	High
PDM	Safe Room	3	1,2,4	Medium
PDM	Seminars	1	1	1 Medium to High
RFC	Acquisitions	2	2	High
RFC	Management Costs	2	1,2,3,4	High
SRL	Acquisitions	3	2	High
SRL	Management Costs	1	1,2,3,4,	High
Total		618		

OEM's Hazard Mitigation Division will continue to provide technical assistance to all counties, their municipalities, Tribes and state agencies.
This Plan provides information on the history of the State's federal declarations including the HMGP. The State of Oklahoma and OEM has fully made use of funding available through FEMA mitigation programs, including the HMPG, PDM, SRL, FMA and RFC programs. Any unused mitigation program funding was a result of unavailable non-federal match by counties, uninterested property owners, and/or insufficient program funds to implement prioritized mitigation actions. Shown below is a summary of the mitigation projects funded in each program/disaster and program highlights.

7.15.1 Hazard Mitigation Grant Program (HMGP)

The State of Oklahoma has facilitated the use of HMGP funds for post-disaster hazard mitigation projects. The State establishes priorities for these funds and works closely with tribes, state agencies and local governments to utilize the post-disaster funds in the declared counties for projects that have the greatest impact on reducing future disaster expenditures. The 5% set-aside for initiative funds are targeted at improving state and local warning enhancements. In addition, the State utilizes the 7% planning set-aside for the declared counties needing planning funds for plan development/update. The table below lists information about the HMGP and the funds approved for each federally declared disaster from 2002 through 2010.

Disaster	Total Approved	Federal Share	Local Share	Approved Projects
1349	$646,291	$484,718	$161,573	1
1355	$34,239,997	$25,679,815	$8,560,182	150
1384	$1,340,985	$1,005,739	$335,246	16
1395	$307,740	$236,831	$70,909	7
1401	$26,716,628	$20,037,464	$6,679,164	247
1452	$966,285	$724,714	$241,571	9
1465	$1,071,620	$803,715	$267,905	3
1623	$2,225,909	$1,669,432	$556,477	9
1637	$303,788	$227,841	$70,025	2
1677	$389,392	$292,044	$97,348	9
1678	$9,282,006	$6,961,492	$2,320,514	45
1707	$244,239	$183,180	$61,059	5
1712	$1,620,156	$1,215,191	$404,965	31
1718	$515,357	$386,519	$128,838	9
1723	$135,593	$101,695	$33,898	3
1735	$5,272,023	$3,918,248	$1,353,775	50
1754	$88,000	$66,000	$22,000	1
1775	$123,667	$46,125	$31,417	2
1803	$33,400	$25,050	$8,350	1
1820	$321,679	$16,259	$5,420	1
1823	$46,200	$34,650	$11,550	2
1846	$18,320	$13,740	$4,580	1
TOTALS	$85,909,275	$64,130,462	$21,426,766	605

7.15.2 Flood Mitigation Assistance (FMA) Program

The State has facilitated the use of FMA funds by local governments for the development of flood hazard mitigation plans and projects. In Oklahoma, the 25% local share will be absorbed by the local, city or county government, and one-half of the 25% (or 12.5% of the total grant) share must be a “hard match” in cash. Because half of the 25% cannot be “in kind” we have processed very few requests for this type of grant. Since 2005 only two communities have received grants from this program. All

applicants made progress in mitigating flooding actions through either plans or projects. OEM received a grant in 2003 for seminars related to the program. Oklahoma Water Resources Board has received 2 grants, one of which updated the database of repetitive loss properties across the State in 2010, a high priority action item. The table below lists information through 2010 about the FMA funds approved for each year the program has been in existence.

Disaster	Total Approved	Federal Share	Local Share	Approved Projects
FMA	$72,853	$54,640	$18,213	4
FMA 05	$18,266	$13,600	$4,666	1
FMA 07	$27,751	$15,375	$12,376	1
TOTALS	$118,870	$83,615	$35,255	6

7.15.3 Pre-Disaster Mitigation (PDM) Program

The State has facilitated the use of PDM competitive funds by local governments for the development of 44 CFR compliant hazard mitigation plans and the implementation of projects which have been identified or support goals and objectives of the local mitigation plans. The State provides technical assistance to local governments in the development of fundable PDM applications. The table below lists information about the PDM program through 2010, and the funds approved for each year the program has been in existence.

Disaster	Total Approved	Federal Share	Local Share	Approved Projects
PDM 02	$390,699	$331,629	$59,070	1
PDM 03	$331,167	$248,375	$82,792	2
PDM 04	$82,500	$75,000	$27, 500	1
PDM 05	$1,190,794	$890,455	$331,439	13
PDM 06	$31,120	$28,470	$3,650	2
PDM 07	$721,475	$466,331	$255,144	4
TOTALS	$2,747,755	$2,040,260	$ 759,595	23

7.15.4 Repetitive Flood Claims (RFC) Program

The State has facilitated the use of RFC funds by local governments for the development of acquisition projects to permanently mitigate flood damages to NFIP insured structures. The table below lists information about the RFC funding received through 2010.

Disaster	Total Approved	Federal Share	Local Share	Approved Projects
RFC 06	$1,103,772	$1,103,772		2
RFC 07	$378,194	$378,194		2
RFC 09	$5,392,060	$5,392,060		2

TOTALS	$6,874,026	$6,874,026		6

7.15.5 Severe Repetitive Loss (SRL) Grant Program

The State has facilitated the use of SRL funds by local governments for the development of flood hazard mitigation plans and projects. The table below lists information through 2010 about the SRL funds approved for each year the program has been in existence.

Disaster	**Total Approved**	**Federal Share**	**Local Share**	**Approved Projects**
SRL 08	$2,306,444	$2,075,799	$230,645	4

State Action Item Status Table

STATE ACTION ITEM STATUS							
No.	**Action Item**	**Agency responsible**	**Funded?**	**Ongoing**	**Pending**	**Completed**	**Other**
OK1	State Facility Mapping-The State is currently using its Emergency Management network to systematically verify each location of its state owned and operated facilities.	**OEM & DEPT. Of CENTRAL SERVICES Risk Mgmt. Div.**			**Funding**		
OK2	All current local jurisdiction Hazard Mitigation Projects, i.e., Reverse 911, GIS Mapping, 911 Training, School Safe Rooms, Shelter Models, Acquisitions, Natural Hazard Mitigation Plans, etc	**OEM**	**FEMA**				**JURISDICTION BASED**
OK3	Tornado Shelter Seminars. Oklahoma Emergency Management presents free seminars across the state specifically discussing community and school shelters.	**OEM**	**OEM**	**APRIL/MAY ANNUALLY**			
OK4	Blaine Gypsum Groundwater Recharge Demonstration Project effective in offsetting seasonal and long-term water level declines in an aquifer heavily pumped for irrigation.	**OWRB & BUREAU OF RECLAIMATION**	**X**			**X**	
OK5	McReady Oklahoma-a state wide severe weather preparedness campaign designed to prepare families for emergencies, increase awareness of severe weather threats and build better prepared communities.	**OEM**	**X**	**APRIL ANNUALLY**			
OK6	Emergency Preparedness Public Education Program provided to requesting school districts to educate and help them with an emergency preparedness plan					**X**	

STATE ACTION ITEM STATUS							
No.	**Action Item**	**Agency responsible**	**Funded?**	**Ongoing**	**Pending**	**Completed**	**Other**
OK7	Oklahoma Weather Modification Program to augment water supplies and prevent future drought and/or hail damage to crops and property.	**OKLA BUREAU OF RECLAIMATION**		**X**			
OK8	Hazard Mitigation Grant Program Workshops hosted at various locations throughout the state describing what Hazard Mitigation Planning is, why it is important to communities, counties and tribes and options on how to create a plan.	**OEM HM**		**X**			
OK9	Individual Safe room Project #1272-an initiative to promote and support the construction of storm shelters in homes.	**OEM**				**X**	
OK10	OK-WARN Project #1355 creates a system for advance warning of emergency weather on a statewide basis, directed to the deaf and hard of hearing population. This project will provide service throughout all 77 counties of the state.	**OEM HM**				**X**	
OK11	NFIP Compliance Workshops-The OWRB, FEMA and OEM sponsors workshops throughout the state to update city and county floodplain administrators on NFIP compliance requirements, mitigation and assistance in the development, administration and enforcement of local flood damage prevention ordinances that guide floodplain development.	**OWRB**		**X**			

STATE ACTION ITEM STATUS							
No.	**Action Item**	**Agency responsible**	**Funded?**	**Ongoing**	**Pending**	**Completed**	**Other**
OK12	Upstream Flood Control Program-Oklahoma leads the nation in the number of small watershed upstream flood control dams constructed. The concept behind this program is to build small flood control dams on tributaries upstream from rivers or large streams.	**OWRB**		**X**			
OK13	Abandoned Mine Land Reclamation Program for land damaged by past oil field or mining operations. Some hazards include dangerous high walls, hazardous water bodies, unstable banks, subsidence such as caving, potholes, etc.	**OKLA CONSERVATION COMMISSION**		**X**			
OK14	Watershed Protection & Flood Prevention Program (Public Law 83-566) has been used as an effective tool to conserve natural resources by thousands of local communities.	**DEPT OF AGRICULTURE**		**X**			
OK15	March is “Flood Insurance Month”, part of a state campaign to spread the word about the availability of affordable flood insurance through the Federal Emergency Management Agency’s National Flood Insurance Program.	**OWRB**		**MARCH**			
OK16	May is “Flood Awareness Month”, part of a state campaign to remind citizens and educate the public on flood safety procedures and floodplain management techniques.	**OWRB**		**MAY**			

STATE ACTION ITEM STATUS							
No.	**Action Item**	**Agency responsible**	**Funded?**	**Ongoing**	**Pending**	**Completed**	**Other**
OK17	Tar Creek Relocation Project. Senate Bill 1490 authorizes a voluntary relocation program for families with young children in the most hazardous part of the abandoned mining area in northeastern Oklahoma.	**GRAND GATEWAY ECONOMIC DEVELOPMENT DISTRICT**		**X**			
OK18	Landslide/Rock fall Mitigation Policy is the result of nearly a one and a half year study that sets forth in a policy statement the Department's recognition of landslide/ rock fall/ as a hazard to the traveling public, specifying a hazard rating system, stating guidelines for rock slope design and maintenance of rock slopes.	**OKLA DEPT. OF TRANSPORTATION**		**X**			
OK19	Individual Safe room Project #1465- The second initiative to promote and support the construction of storm shelters in homes.	**OEM**				**X**	
OK20	Oklahoma Red Flag Fire Alert limits the use of fire outdoors and may cancel all burning authorizations when outdoor burning of any kind would be more risky than normal.	**FORESTRY**		**X**			
OK21	Dam Safety Program to ensure the safety of more than 4,755 dams in the state, especially 361 high hazard dams that could impact downstream life and property.	**OWRB**		**X**			

STATE ACTION ITEM STATUS							
No.	**Action Item**	**Agency responsible**	**Funded?**	**Ongoing**	**Pending**	**Completed**	**Other**
OK22	OK-FIRST Program has been recognized internationally for its innovative approach in providing instant access to a wealth of vital weather data for fire, police, and emergency management agencies.	**OKLA CLIMATOLOGICAL SURVEY**		**X**			
OK23	Bioretention Cells for reducing storm water Runoff Research being conducted in Biosystems and Agricultural Engineering	**OKLA. STATE UNIVERSITY**		**X**			
OK24	FMA Tech 031 Grant to conduct site visits and collect information for 750+ repetitive loss properties in the state.	**OWRB**				**X**	
OK25	FMA Planning 031 to assemble information gathered and create portfolios for 750+ repetitive loss properties in the state.	**OWRB**		**X**			
OK26	Winter Weather Preparedness Day - to better educate Oklahomans of the preparedness steps to take in order to mitigate the effects of the storms that include widespread, lengthy power outages and treacherous travel conditions	**OEM**		**X**			
OK27	Electric Meter Assistance Pilot Program – Pilot program designed to restore power to tens of thousands of Oklahoma homes due to electric meter and weather-head problems. The pilot program was quickly reviewed and approved by FEMA.	**OEM**		**X**			

STATE ACTION ITEM STATUS							
No.	**Action Item**	**Agency responsible**	**Funded?**	**Ongoing**	**Pending**	**Completed**	**Other**
OK28	Resolve data deficiencies	**OEM**		**X**			
OK29	Storm Ready Community Preparedness program.	**NATIONAL WEATHER SERVICE**		**X**			
OK30	Hazard Mitigation Grant Program	**OEM**		**X**			
OK31	Hazard Mitigation Sub-committee has been initiated to review procedures and funding for jurisdictional plans.	**OEM**		**X**			

7.16 Effective Use of Available Mitigation Funding (Continued)

The State of Oklahoma effectively uses mitigation programs to achieve its mitigation goals. Among the primary mitigation programs of the state are the federally funded, state-administered hazard mitigation programs: Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation Program (PDM), Flood Mitigation Assistance (FMA), Repetitive Flood Claims (RFC) and the Severe Repetitive Loss (SRL) floodplain management programs.

The State-administered hazard mitigation grant program requires applicants to develop projects that support the hazard mitigation goals, strategies and objectives of the state's hazard mitigation strategy, as well as the local planning strategies. Applicants seeking funds from the Hazard Mitigation Grant Program, Pre-Disaster Mitigation Program, Flood Mitigation Assistance Program, Repetitive Flood Claims program and Severe Repetitive Loss programs are reviewed by the following criteria:

1. Must have a FEMA approved local hazard mitigation plan.

2. Project will help protect lives and reduce public risk.

3. Reduces the level of disaster vulnerability in existing structures.

4. Reduces the number of vulnerable structures through acquisition, relocation, flood- proofing, or seismic retrofitting.

5. Avoid future development in areas known to be susceptible to future disasters as practical.

6. Solve a problem independently, or function as a beneficial part of an overall solution with assurance that the whole project will be completed.

7. Provides a cooperative, inter-jurisdictional solution to reduce future disaster damage.

8. Provides a long -term mitigation solution.

9. Addresses emergency hazard damage issues such as urban storm water, trees in power right of ways, new earthquake faults, etc.

10. Restores or protects natural resources, recreation, open spaces, and other environmental values.

11. Develops or implements comprehensive programs, standards, and regulations that reduce disaster damage.

12. Increases public awareness of natural hazards, preventative measures, and emergency responses to disasters.

13. Upon completion, have affordable operation and maintenance costs.

14. Provide damages and losses that have been avoided by implementing their mitigation strategies. (See Oklahoma mitigation success stories in Appendix D)

Additionally, the state requires applicants to submit mitigation projects that are cost effective; projects that reduce or prevent at least $1 of damage for every $1 invested in the project. Only projects receiving a BCA score of 1 meet Oklahoma standards and are forwarded to FEMA requesting funding. Oklahoma emphasizes cost effectiveness in the hazard mitigation programs it administers. The State does this, in part, by advertising the programs to all eligible applicants through e-mail and/or mail notices and then working with them to develop the best possible projects. For the Hazard Mitigation Grant Program (HMGP), the state typically receives plan applications that request 10 times the amount of available funding. In order to combat this trend, the OEM Hazard Mitigation Division has developed a formula which provides a standardized cost for plans that is justified by the work needing to be done on a plan. Above a base price, it considers the number of incorporated jurisdictions participating, school campuses, and the population of the jurisdiction. Because HMGP funds are post-disaster funds and their availability from year to year is uncertain and limited, the state will only allow funding through this cost effective process.

The following list provides some general types of projects that have been approved as part of the state's mitigation program. This list is not all-inclusive and is subject to a variety of issues, such as the completion and/or change of established goals and objectives, availability of funds, cost-effectiveness determinations, etc.

- **Acquisition of Primary Residences in Flood-prone Areas**

The State has placed a priority on the acquisition of primary residences in flood-prone areas. Hazard Mitigation Grant Program (HMGP) funds from previous disasters in the state have been used to fund this program. This program eliminated the threat of flooding and the associated financial and emotional hardship on those families that participated in the program, reduced the cost of future disasters to the federal, state, and local government, and provided the participating community with open space to develop parks for the entire community to enjoy.

- **Increase Weather Radio Listenership**

The State of Oklahoma, through the Oklahoma Department of Emergency Management (OEM) and in cooperation with the National Weather Service, the Department of Agriculture, local governments, electric cooperatives, and private enterprises, has significantly increased the number of people receiving alerts by the NOAA weather radio warning system through HMGP dollars provided to jurisdictions such as: City of Cordell, Carter Co., Muskogee Co., Town of Dewey, City of Ponca City, Town of Atoka along with many others. Currently there are 12 more applications pending. This has been one of the more popular mitigation programs.

The warnings provided by the weather radios will give Oklahoma citizens the advance time they need to protect their families and their property in the event of severe weather or other emergency event.

- **Prepare/Update Floodplain Maps**

Funds from a variety of programs have been used to develop flood maps for previously unmapped areas and to revise/update older existing maps. This initiative will enable more communities within the state to join the National Flood Insurance Program (NFIP). As a result, more individuals, families, and businesses can obtain insurance to cover flood related losses in the future.

- **Develop Local Hazard Mitigation Plans**

Funds from these programs have been used to assist communities throughout the state in developing much needed hazard mitigation plans. As part of this process, these communities have developed public-private partnerships that have taken the opportunity to expand their work into other mitigation related initiatives. As a result of these initial planning activities, communities have become more aware of the benefits of an active mitigation program and have instituted mitigation projects using their own funds. This has also been a popular grant program under HMGP in Oklahoma with over 259 HM Plans approved. Currently there are 25 first time Tribal Plans/applications in progress.

- **Public Outreach**

OEM has made an effort to educate the public, local officials, government officials, schools, private associations and businesses concerning the value and importance of mitigation programs. OEM has offered mitigation workshops, participated in public forums, provided one-on-one counseling, presented programs at conferences, provided written materials, developed guidebooks and manuals, published success stories, sent out press releases, provided training materials to local emergency managers, floodplain managers, businesses and offered information on the Internet.

7.17 Commitment to a Comprehensive Mitigation Program

The Mitigation Division of the Oklahoma Department of Emergency Management is committed to support local jurisdiction hazard mitigation planning through HM staffers being available for and encouraging calls for assistance. Such assistance includes:

- Meeting with local jurisdictions or contractors to review hazard mitigation planning requirements, to provide assistance with plan development activities, or to review draft plans.

- Providing planning grants through the Hazard Mitigation Grant Program, Pre-Disaster Mitigation Program, and the Flood Mitigation Assistance Program.

- Providing planning development workshops state-wide at no cost to the local governments.

- Providing a two-day FEMA risk assessment workshop intended to help communities overcome challenges in developing sound, actionable risk assessments in fulfillment of DMA 2000 planning requirements.

- Distributing information and data local jurisdictions need to develop risk assessments on local facilities.

- Helping local jurisdictions connect with appropriate state and local agencies with information appropriate research information for planning.

- Providing the latest information, guidance and suggestions on hazard mitigation planning.

- Comprehensively reviewing local plans, providing feedback and working with each jurisdiction or contractor to ensure their plans meet federal requirements.

- Presentations made concerning state mitigation strategies and planning at various workshops and conferences to include emergency management and floodplain management.

The Oklahoma Emergency Managers and the Oklahoma Floodplain Managers are actively involved in the local planning process. One requirement to qualify as a certified emergency manager is that you must participate in a planning process. The test given to achieve Certified Floodplain Manager status is quite extensive in the planning process. The Oklahoma Emergency Managers Association (OEMA) and the Oklahoma Floodplain Managers Association (OFMA), supported by OEM and OWRB through the agency's state management coordination efforts, established the first nationally accredited Certified Emergency Manager (CEM) program and Certified Floodplain Manager (CFM) program in the U.S.

The State of Oklahoma places considerable value on partnerships in Emergency Management, particularly in the areas of hazard mitigation and damage reduction. In recent years, a number of public-private partnerships have been established and still continue to function.

The Oklahoma State Hazard Mitigation Team was established by state law on March 9, 1999. The team consists of members from twenty-one (21) different departments and agencies of the state and federal governments plus private non-profit agencies:

- Oklahoma Department of Emergency Management; Team Coordinator/SHMO/GAR
- Oklahoma Climatological Survey,
- Oklahoma Department of Commerce,
- Oklahoma Conservation Commission,
- Oklahoma Corporation Commission,
- Oklahoma Department of Environmental Quality (DEQ),
- Oklahoma Department of Health,
- Oklahoma Historical Society,
- Oklahoma Department of Human Services (DHS),
- Oklahoma Insurance Commission
- State Fire Marshal,
- Oklahoma Department of Transportation (ODOT),
- Oklahoma Water Resources Board,
- Oklahoma Department of Wildlife Conservation,
- Oklahoma Department of Labor
- Oklahoma Municipal League (OML),
- Oklahoma Department of Agriculture (Forestry Division),
- Other state agencies if necessary by Team Coordinator
- Association of County Commissioners (ACCO),
- US Army Corps of Engineers; Tulsa District,
- U.S. Department of Housing and Urban Development (HUD),
- Native American Tribes

- The State continues to work in partnership with the National Weather Service and local communities to establish Storm Ready Communities. The State provides funds through HMGP for NOAA Weather Radios, which is a requirement of the Storm Ready Program. The Storm Ready program started in 1999 in Tulsa, Oklahoma. The program helps Oklahoma's communities with communication and safety skills needed to save lives and property before and

during the event. Storm Ready helps community leaders and emergency managers strengthen local safety programs.

- The State continues to work in partnership with the National Weather Service and local communities/counties to promote the OK FIRST Program. OK-FIRST is an outreach project of the Oklahoma Climatological Survey (OCS) and Oklahoma Mesonet. It provides training and real-time weather data to public safety officials, including Emergency Management, for use in weather-impacted situations. OK-FIRST training and data are provided at no cost to qualified applicants in Oklahoma. This program provides basic meteorological training to Emergency Managers primarily, but also to emergency response personnel and high tech software for receiving real-time radar information and a wealth of other important weather data. This program was developed by Dr. Kenneth Crawford and his staff at the University of Oklahoma.

- OEM continues to represent the State of Oklahoma on many different committees. In 2005, the Director of Oklahoma Emergency Management served as President of the National Emergency Management Association and served on the National Emergency Management Assistance Compact (EMAC) Operations sub-committee. EMAC is an inter-state agreement that streamlines the assistance one governor can lend another after a natural disaster or terrorist attack by providing a framework for flexible response. Additionally the Director represents OEM on numerous state and regional groups including:

  International Association of Emergency Managers (IAEM)
  National State Hazard Mitigation Officer Committee
  National Emergency Management Association (NEMA)
  Oklahoma Emergency Management Association (OEMA)
  Oklahoma Floodplain Managers Association (OFMA)
  Federal Executive Board Training Committee
  Oklahoma Senior Advisory Council
  Oklahoma State Emergency Board
  Oklahoma Food and Agriculture Council
  FEMA Region VI RISC Committee
  Oklahoma Safety Council
  Oklahoma Dept. of Agriculture Food Safety Task Team
  FEMA Region VI Regional Response Team (RRT)
  Center for Risk and Crisis Management Community Advisory Board (University of OK)

Through membership in these committees and many others, input concerning Hazard Mitigation Actions can be discussed or suggested when appropriate.

Fire Wise, administered by the **Department of Agriculture Forestry Division**, is a state and federal partnership that helps communities learn how to reduce unnecessary losses due to wildland fire in areas of rapid development or in areas historically recognized as susceptible to fire. F**ire Wise** is a program to help families protect their property from wildfires. **Fire Wise** provides a toolbox approach for implementing practices and measures that reduce the risk of becoming a wildfire victim. The ultimate goal of this program is to reduce the susceptibility of homes, buildings and communities to wildfire through cooperative education.

Title 145 Chapter 10 of the Oklahoma Administrative Code states that the State of Oklahoma will provide "State Disaster Assistance" for public assistance only in the event of a disaster that is not federally funded. Because the state has chosen to provide these type funds, portions of the non-Federal match for HMGP, PDM or FMA, RFC will not be provided.

The Office of the **Oklahoma State Fire Marshal** provides information about code enforcement; overview of the building permit process and fee schedule; list of types of buildings that require the seal of an architect before plan inspections; downloadable plan review transmittal form; information about school inspections; list of adopted codes. The agency sets the minimum building requirements for the state. The State-adopted national building code is the International Building Code.

The **Oklahoma Corporation Commission** provides industry standards and national codes adopted for the regulation of entities:

- National Electrical Safety Code - industry standard for all electric distribution and transmission systems and telecommunications companies.
- National Electric Code - industry building standard for inside electric wiring.
- National Fire Code - also applies to electric and natural gas companies among others.
- US Department of Transportation - Codes for railroads and inter-state and intra-state natural gas and hazardous materials pipelines.

The Oklahoma Department of Emergency Management requires all individual safe rooms/shelters, built employing HMGP funds in the "Operations Safe Room" initiative program, meet the FEMA Publication 320 specifications. All school safe rooms built using HMGP funds are required to meet the FEMA Publication 361 specifications. All safe rooms/shelters must be validated and inspected. Applicants are required to meet all local building codes and inspections. In May, 2009, OEM hosted a class taught by FEMA contractor, URS, which covered the requirements of these two publications. The three day training program, "Community Safe room Construction", was attended by 50 local jurisdictions and FEMA regional staff.

The State of Oklahoma is developing a multi-year plan to mitigate the risks posed to existing buildings identified as necessary for post-disaster response and recovery operations through the **Oklahoma Office of Homeland Security** (OHS). The multi-year strategic plan is currently under development and has not been approved by the National Homeland Security as of this date. Although the plan emphasis is on terrorism, the risk assessment includes identification of the characteristics and potential consequences of all hazards, natural and man-made. The plan is available to the Oklahoma Department of Emergency Management but has not been included for security reasons.

Projects funded by the OHS made it possible to renovate the Oklahoma Department of Emergency Management (OEM) Emergency Operations Center (EOC).The redesign will address the sustainability of the EOC in the event of a disaster. The current emergency generating system was replaced to provide dependable long-term emergency electrical power to the EOC. The upgrade included the installation of an underground fuel storage tank and an all-inclusive filtering system was with sensors and alarms that greatly reduced the vulnerability of the EOC from the outside.

OEM also utilized HMGP funds to purchase 18 generators to assist state and local critical facilities in times of emergency and disasters.

The **Oklahoma Department of Central Services** (DCS), Risk Management Division has a multi-year plan to complete a risk assessment of all state facilities as outlined in the State of Oklahoma. The Risk Management Division is responsible for procuring and providing property insurance to provide financial protection for all state owned/leased buildings and inventory. This coverage is written for all risks and provides protection including all types of natural disasters. The coverage will provide funds for rebuilding damaged state property. Agencies are responsible for accurately reporting owned property and status. A list of state owned and leased property is available through the OEM Hazard Mitigation Officer on a need to know basis.

Additionally, the Risk Management Division (RM) of Department of Central Services (DCS) randomly inspects state owned properties to determine insurability of the properties. The Risk Management Division also conducts loss investigations in cooperation with the state's insurance underwriter's claims adjusters when a loss does occur. All of these tasks are performed on an on-going basis and are not restricted to any time frame. Typical projects are in progress for as long as two to three years.

Hazard mitigation is an integral part of Oklahoma's post-disaster recovery operations. Staff from the Mitigation Division of the Emergency Management Division, co-locate with mitigation staff from the Federal Emergency Management Agency at the Joint Field Office (JFO) as soon as it opens. Staffs from other state agencies that may have particular interest in the disaster and in recovery operations also may co-locate at the JFO. State and FEMA staffs work to identify mitigation opportunities through both the human services and public assistance programs. The Oklahoma Hazard Mitigation Team, may be convened after a disaster has been declared. Inspections of disaster sites are performed after a declared disaster, and determinations are made if any funding will be needed. State and federal mitigation staffs work together to identify public education opportunities and use existing materials or develop new materials specific to the hazard and disaster event. Public assistance program staff encourages potential project applicants to identify mitigation elements in repair and restoration projects. Mitigation and public assistance program staff, often jointly conduct applicant briefings to discuss mitigation opportunities through both public assistance and hazard mitigation grant programs. State mitigation staff quickly disseminates notices of intent and information on the Hazard Mitigation Grant Program to potential applicants, and provide technical assistance to potential applicants on the grant application process.

APPENDICES

Appendix A: ***7% Planning & 5% Discretionary Initiatives***

Appendix B: ***Communities Participating in NFIP***

Appendix C: ***Planning Meetings***

Appendix D: ***Mitigation Success Stories***

Appendix E: ***Proposed Mitigation Projects/Local Plans***

Appendix F: ***Oklahoma Intrastate Mutual Aid Compact***

Appendix G: ***State Facilities***

Appendix H: ***Detailed Hazard Data for Oklahoma Planners***

Appendix: A

Each section of the plan update from the period of prior approval through October 26, 2010 was analyzed and reviewed by the OEM administrative staff to determine whether updates to the plan were necessary. Appendix A was reviewed by the OEM staff who determined that updating was not required.

A.1 HMGP 7% Planning grants and the 5% initiative

INITIATIVES

The 7% Planning Initiative:

Post-disaster funding of the Hazard Mitigation Grant Program (HMGP) is made available to state and local governments, tribal governments and certain private-non-profit (PNP) agencies. However, eligibility for this funding hinges upon one primary criterion: the jurisdiction must have a federally-approved Hazard Mitigation Plan (HMP). This criterion is further explained and defined in 44 CFR 201. There are currently four types of authorized plans: (1) standard state plan; (2) enhanced state plan; and (3) tribal jurisdiction plan (4) local plans. A mitigation plan outlines processes for identifying the natural hazards, risks, and vulnerabilities of the area under the jurisdiction of the government and proposed mitigation measures to reduce loss of life and damage. Under the guidance of 44 CFR 206.434, et seq., the state or tribal government may apply to the federal government for receipt of HMGP funds. As a grantee, that governmental entity may then set aside 7% of the total HMGP funds to be used to fund Hazard Mitigation Plans to be prepared and submitted by sub-grantees (local levels of government and/or tribal governments). These grants are currently funded at a level of not more than 75% federal funds for the project and 25% or more in local funding. Plan guidance includes the following requirements:

- Local and tribal government plans shall:
    - Describe actions to mitigate hazards, risks, and vulnerabilities identified under the plan; and
    - Establish a strategy to implement those actions.

- The State process of development of a mitigation plan under this section shall:
    - Identify the natural hazards, risks, and vulnerabilities of areas in the state;
    - Support development of local mitigation plans;
    - Provide for technical assistance to local and tribal governments for mitigation planning; and
    - Identify and prioritize mitigation actions that the state will support, as resources become available.

The 5% Set-Aside Initiative:

Some hazard mitigation measures are difficult to evaluate against traditional program cost-effectiveness criteria. Up to 5 percent of the total Hazard Mitigation Grant Program (HMGP) funds may be set aside by the state to pay for measures such as these.

To be eligible for the 5% Set-Aside Initiative, measures must:

- Be identified in the State Hazard Mitigation Plan as a measure that would reduce or prevent damage to property or prevent loss of life or injury.

- Be submitted for review with a narrative rationale that identifies the mitigation benefits and indicates that there is a reasonable expectation that future damage or loss of life or injury will be reduced or prevented.

- Comply with any other applicable HMGP eligibility criteria, and federal, state, and local laws and ordinances.

NOTE: Proposed measures may include activities traditionally considered "preparedness-related" as long as they meet all other HMGP criteria.

The 5% Set-Aside Initiative, like all HMGP funds, should not be used as a substitute for other federal programs. Projects that fall under the responsibilities of other federal agencies are not eligible.

The State may also submit project applications under the 5% Set-Aside Initiative that have previously been denied by the HMGP due to difficulty in measuring their cost-effectiveness. This avenue is preferable to the state submitting an appeal.

Types of projects that could be funded under the 5% Set-Aside Initiative include:

- The use, evaluation, and application of new, unproven mitigation techniques, technologies, methods, procedures, or products that are developmental or research based.

- Equipment and systems for the purpose of warning residents and officials of impending hazard events.

- Hazard identification or mapping and related equipment that is tied to the implementation of mitigation measures.

- Geographical Information System software, hardware, and data acquisition whose primary aim is mitigation (this may be included in 7% funding if being used in preparation, or maintenance of a Hazard Mitigation Plan).

- Development of studies or plans that are expected to lead to reduction of losses.

- Other activities, clearly falling under the goal of mitigation, for which benefits are unproven or not clearly measurable and which the state has identified as a priority in its Hazard Mitigation Plan.

Appendix: B

Each section of the plan update from the period of prior approval through October 26, 2010 was analyzed and reviewed by the OEM administrative staff to determine whether updates to the plan were necessary. Appendix B was reviewed by the OEM staff who determined that updating was required. Current NFIP participation data is provided.

B.1 Current NFIP Participation Data

CID	Community	County	Init FHBM Identified	Init FIRM Identified	Curr Eff Map Date	Reg-Emer Date	Tribal
400173#	ADA, CITY OF	PONTOTOC COUNTY	02/08/74	07/16/80	07/16/80	07/16/80	No
400501#	ADAIR COUNTY*	ADAIR COUNTY	01/06/81	04/01/88	02/05/97	04/01/88	No
400256#	ADAIR, TOWN OF	MAYES COUNTY	04/02/76	09/26/03	09/26/03	01/25/10	No
400155#	AFTON, TOWN OF	OTTAWA COUNTY	02/07/75	01/03/86	08/05/10(>)	01/03/86	No
400257#	ALDERSON, CITY OF	PITTSBURG COUNTY	04/09/76	07/22/10	07/22/10(>)	03/04/86	No
400063#	ALEX, TOWN OF	GRADY COUNTY	11/26/76	02/02/83	02/02/83	02/02/83	No
400258	ALINE, TOWN OF	ALFALFA COUNTY	02/14/75	10/15/85	10/15/85(M)	10/15/85	No
400072#	ALTUS, CITY OF	JACKSON COUNTY	06/28/74	07/02/80	07/19/05	07/02/80	No
400341	ALVA, CITY OF	WOODS COUNTY	07/11/75		(NSFHA)	03/30/79	No
400018#	ANADARKO, CITY OF	CADDO COUNTY	02/15/74	09/17/80	09/27/91	09/17/80	No
400182	ANTLERS, TOWN OF	PUSHMATAHA COUNTY	12/28/73	03/01/86	03/01/86(L)	03/01/86	No
400019#	APACHE, CITY OF	CADDO COUNTY	07/26/74	05/15/85	09/27/91	05/15/85	No
400342	ARAPAHO, TOWN OF	CUSTER COUNTY	12/17/76		(NSFHA)	04/15/82	No
400551#	ARCADIA, TOWN OF	OKLAHOMA COUNTY		07/02/02	12/18/09	08/15/05	No
400031#	ARDMORE,CITY OF	CARTER COUNTY	03/29/74	01/06/82	04/19/10	01/06/82	No
400343#	ARKOMA, TOWN OF	LE FLORE COUNTY	08/13/76	04/19/83	04/19/83(M)	04/19/83	No
400508#	ATOKA COUNTY *	ATOKA COUNTY	08/14/81		08/14/81	02/09/06(E)	No
400008#	ATOKA, CITY OF	ATOKA COUNTY	06/07/74	07/20/82	11/16/95	07/20/82	No
400147#	AVANT, TOWN OF	OSAGE COUNTY	09/13/74	07/16/80	04/02/08	07/16/80	No
400148#	BARNSDALL, CITY OF	OSAGE COUNTY	12/14/73	07/16/80	04/02/08	07/16/80	No
400220#	BARTLESVILLE, CITY OF	OSAGE COUNTY/WASHINGTON COUNTY	08/30/74	07/16/80	09/26/08	07/16/80	No
400009	BEAVER, TOWN OF	BEAVER COUNTY	06/28/74	07/01/87	07/01/87(L)	07/01/87	No
400487#	BECKHAM COUNTY *	BECKHAM COUNTY		07/17/02	07/17/02	10/23/02	No
400345#	BEGGS, CITY OF	OKMULGEE COUNTY	04/09/76	09/19/78	12/29/81(M)	09/19/78	No
400260#	BENNINGTON, TOWN OF	BRYAN COUNTY	08/13/76	08/19/85	09/30/92	08/19/85	No
400559#	BERNICE, TOWN OF	DELAWARE COUNTY		04/16/03	08/05/10(>)	12/22/03	No
400261	BESSIE, TOWN OF	WASHITA COUNTY	08/15/75	05/01/85	05/01/85(M)	05/01/85	No
400254#	BETHANY, CITY OF	OKLAHOMA COUNTY	10/18/74	05/02/95	12/18/09	07/31/79	No
400346#	BETHEL ACRES, TOWN OF	POTTAWATOMIE COUNTY	12/31/76	12/01/89	09/03/10(>)	12/01/89	No
400347	BILLINGS, TOWN OF	NOBLE COUNTY	08/13/76	06/19/85	06/19/85(M)	06/19/85	No

CID	Community	County	Init FHBM Identified	Init FIRM Identified	Curr Eff Map Date	Reg-Emer Date	Tribal
400020#	BINGER, TOWN OF	CADDO COUNTY	01/16/76	11/19/87	09/27/91	11/19/87	No
400207#	BIXBY, CITY OF	WAGONER COUNTY/TULSA COUNTY	06/28/74	09/28/79	08/03/09	09/28/79	No
400078#	BLACKWELL, CITY OF	KAY COUNTY	02/01/74	05/01/80	09/25/09	05/01/80	No
400011#	BLAINE COUNTY*	BLAINE COUNTY		08/02/95	08/02/95	08/02/95	No
400348#	BLAIR, TOWN OF	JACKSON COUNTY	06/25/76	08/03/82	08/03/82(M)	08/03/82	No
400101#	BLANCHARD, CITY OF	MCCLAIN COUNTY/GRADY COUNTY	09/13/74	01/03/86	11/16/07(M)	01/03/86	No
400262	BLUEJACKET, TOWN OF	CRAIG COUNTY	04/16/76	10/24/78	10/24/78(M)	10/24/78	No
400042	BOISE CITY, CITY OF	CIMARRON COUNTY	05/24/74	11/01/85	11/01/85(M)	11/01/85	No
400349#	BOKCHITO, TOWN OF	BRYAN COUNTY	08/13/76	10/19/82	09/30/92	10/19/82	No
400350#	BOKOSHE, TOWN OF	LE FLORE COUNTY	09/19/75	04/17/79	04/17/79(M)	04/17/79	No
400138	BOLEY,TOWN OF	OKFUSKEE COUNTY	04/12/74	03/01/87	03/01/87(L)	03/01/87	No
400468#	BOWLEGS, TOWN OF	SEMINOLE COUNTY	05/02/78	08/19/85	07/02/92	08/19/85	No
400120#	BOYNTON, TOWN OF	MUSKOGEE COUNTY	04/23/76	09/28/79	09/21/01	09/28/79	No
400121#	BRAGGS, TOWN OF	MUSKOGEE COUNTY	12/27/74	09/21/01	(NSFHA)	05/25/78	No
400051#	BRISTOW, CITY OF	CREEK COUNTY	06/28/74	05/04/82	05/18/09(M)	05/04/82	No
400236#	BROKEN ARROW, CITY OF	WAGONER COUNTY/TULSA COUNTY	10/18/77	08/17/81	08/03/09	08/17/81	No
400107#	BROKEN BOW, CITY OF	MCCURTAIN COUNTY	06/28/74	09/01/87	07/22/10(>)	09/01/87	No
400469#	BROOKSVILLE, CITY OF	POTTAWATOMIE COUNTY	04/18/78	08/19/85	09/03/10(>)	08/19/85	No
400482#	BRYAN COUNTY *	BRYAN COUNTY	12/06/77	09/18/91	09/30/92	09/18/91	No
400351	BUFFALO, TOWN OF	HARPER COUNTY	07/25/75	09/01/87	09/01/87(L)	09/01/87	No
400005#	BURLINGTON, TOWN OF	ALFALFA COUNTY	08/23/74	12/15/90	12/15/90	12/15/90	No
400266	BUTLER, TOWN OF	CUSTER COUNTY	11/05/76	05/15/85	05/15/85(M)	05/15/85	No
400267#	BYARS,TOWN OF	MCCLAIN COUNTY	08/13/76	06/05/85	11/16/07(M)	06/05/85	No
400048#	CACHE,TOWN OF	COMANCHE COUNTY	05/17/74	03/18/87	07/20/09	03/18/87	No
400479#	CADDO COUNTY *	CADDO COUNTY	01/03/78	09/27/91	09/27/91	06/12/95	No
400353#	CADDO, TOWN OF	BRYAN COUNTY	04/16/76	09/18/91	(NSFHA)	05/25/78	No
400354#	CALERA, TOWN OF	BRYAN COUNTY	08/13/76	06/03/86	09/30/92	06/03/86	No
400268#	CALUMET, TOWN OF	CANADIAN COUNTY	04/09/76	01/01/92	09/26/08(M)	01/01/92	No
400269	CALVIN, TOWN OF	HUGHES COUNTY	09/19/75	03/01/87	03/01/87(L)	03/01/87	No
400271	CAMERON,TOWN OF	LE FLORE COUNTY	08/13/76	04/19/83	04/19/83(M)	04/19/83	No
400485#	CANADIAN COUNTY*	CANADIAN COUNTY	08/13/82	09/01/87	09/26/08	09/01/87	No
400272#	CANADIAN, TOWN OF	PITTSBURG COUNTY	04/16/76	07/22/10	07/22/10(>)	05/15/85	No
400012	CANTON, TOWN OF	BLAINE COUNTY	06/28/74	05/15/85	05/15/85(M)	05/15/85	No
400274	CANUTE, TOWN OF	WASHITA COUNTY			(NSFHA)	06/03/84	No
400021#	CARNEGIE, TOWN OF	CADDO COUNTY	12/07/73	07/20/82	09/27/91	07/20/82	No
400276	CARTER, TOWN OF	BECKHAM COUNTY	04/02/76	05/15/85	05/15/85(M)	05/15/85	No
400185#	CATOOSA, CITY OF	WAGONER COUNTY/ROGERS COUNTY	09/06/74	08/01/80	06/15/88	08/01/80	No
400237#	CHANDLER, CITY OF	LINCOLN COUNTY	08/13/76	11/04/87	08/19/10(>)	11/04/87	No
400238	CHECOTAH, CITY OF	MCINTOSH COUNTY	08/13/76	06/19/85	06/19/85(M)	06/19/85	No
400187#	CHELSEA, CITY OF	ROGERS COUNTY	12/21/73	09/01/87	12/19/97	09/01/87	No
400488#	CHEROKEE COUNTY*	CHEROKEE COUNTY	01/10/78	03/18/91	12/03/09	03/18/91	No
400006#	CHEROKEE, CITY OF	ALFALFA COUNTY	06/14/74	12/02/80	01/19/82	12/02/80	No
400183#	CHEYENNE, TOWN OF	ROGER MILLS COUNTY	06/28/74	08/05/85	08/09/00(M)	08/05/85	No
400234#	CHICKASHA, CITY OF	GRADY COUNTY	05/24/74	09/30/80	12/03/93	09/30/80	No
400470#	CHOCTAW COUNTY*	CHOCTAW COUNTY		01/17/97	01/17/97	01/17/97	No
400357#	CHOCTAW, CITY OF	OKLAHOMA COUNTY	01/21/77	04/15/81	12/18/09	04/15/81	No

CID	Community	County	Init FHBM Identified	Init FIRM Identified	Curr Eff Map Date	Reg-Emer Date	Tribal
400115#	CHOUTEAU, TOWN OF	MAYES COUNTY	05/24/74	09/26/03	09/26/03(M)	01/26/83	No
400553#	CITIZEN POTAWATOMI NATION	POTTAWATOMIE COUNTY		09/03/10	09/03/10(>)	12/01/00(E)	Yes
405375#	CLAREMORE, CITY OF	ROGERS COUNTY	08/28/71	07/25/75	11/02/95	08/27/71	No
400358	CLAYTON, TOWN OF	PUSHMATAHA COUNTY	11/05/76	05/01/85	05/01/85(M)	05/01/85	No
400280	CLEO SPRINGS, TOWN OF	MAJOR COUNTY	09/12/75	06/05/85	06/05/85(M)	06/05/85	No
400475#	CLEVELAND COUNTY*	CLEVELAND COUNTY	06/11/82	06/01/89	09/26/08	06/01/89	No
400162	CLEVELAND, CITY OF	PAWNEE COUNTY	05/03/74		(NSFHA)	04/15/82	No
400054#	CLINTON,CITY OF	WASHITA COUNTY/CUSTER COUNTY	01/18/74	07/02/80	04/03/87	07/02/80	No
400510#	COAL COUNTY*	COAL COUNTY		06/03/86	01/18/89	06/03/86	No
400047	COALGATE, CITY OF	COAL COUNTY	12/21/73	08/08/78	08/08/78(M)	08/08/78	No
400359#	COLBERT, TOWN OF	BRYAN COUNTY	04/09/76	04/15/86	09/30/92	04/15/86	No
400360#	COLLINSVILLE, CITY OF	ROGERS COUNTY/TULSA COUNTY	02/25/77	07/02/81	08/03/09	07/02/81	No
400253#	COLONY, TOWN OF	WASHITA COUNTY	08/13/76	02/16/83	02/16/83	09/10/84	No
400489#	COMANCHE COUNTY *	COMANCHE COUNTY	06/20/78	02/19/92	07/20/09	02/19/92	No
405376#	COMANCHE, CITY OF	STEPHENS COUNTY		12/28/71	09/29/10(>)	12/23/71	No
400156#	COMMERCE, CITY OF	OTTAWA COUNTY	06/04/76	07/18/85	08/05/10(>)	07/18/85	No
400361#	COPAN, TOWN OF	WASHINGTON COUNTY	09/26/75	07/26/77	09/26/08(M)	07/26/77	No
400225	CORN, TOWN OF	WASHITA COUNTY	01/10/75		01/10/75	11/22/02(E)	No
400513#	COTTON COUNTY*	COTTON COUNTY	09/06/89	09/27/91	09/27/91	09/06/89	No
400362#	COVINGTON, TOWN OF	GARFIELD COUNTY	04/25/75	05/01/85	09/30/95	05/01/85	No
400216#	COWETA, CITY OF	WAGONER COUNTY	06/04/76	09/18/86	09/18/86	09/18/86	No
400097#	COYLE, TOWN OF	LOGAN COUNTY	08/13/76	12/05/89	09/29/10(>)	07/01/87	No
400540#	CRAIG COUNTY*	CRAIG COUNTY		04/17/96	04/17/96	04/17/96	No
400490#	CREEK COUNTY*	CREEK COUNTY	05/19/81	06/01/87	05/18/09	06/01/87	No
400098#	CRESCENT, CITY OF	LOGAN COUNTY	05/10/74	03/16/82	09/29/10(>)	03/16/82	No
400283#	CROWDER, CITY OF	PITTSBURG COUNTY	04/02/76	07/22/10	07/22/10(>)	02/19/86	No
400165#	CUSHING, CITY OF	PAYNE COUNTY	01/04/74	07/16/80	05/16/07	07/16/80	No
400486	CUSTER COUNTY *	CUSTER COUNTY			01/01/50	07/20/94(E)	No
400365#	DAVENPORT, TOWN OF	LINCOLN COUNTY	08/22/75	10/31/78	08/19/10(>)	10/31/78	No
400204#	DAVIDSON, TOWN OF	TILLMAN COUNTY	10/31/75	08/05/97	08/05/97	08/05/97	No
400366#	DAVIS, CITY OF	GARVIN COUNTY/MURRAY COUNTY	07/30/76	06/18/10	06/18/10(M)	06/19/85	No
400233#	DEL CITY, CITY OF	OKLAHOMA COUNTY	03/08/74	03/18/80	12/18/09	03/18/80	No
400502#	DELAWARE COUNTY *	DELAWARE COUNTY	03/03/81	03/01/90	08/05/10(>)	03/01/90	No
400143#	DEWAR, TOWN OF	OKMULGEE COUNTY	06/28/74	06/05/85	11/06/91	06/05/85	No
400221#	DEWEY, CITY OF	WASHINGTON COUNTY	05/31/74	07/06/82	09/26/08	07/06/82	No
400081#	DOVER, TOWN OF	KINGFISHER COUNTY	05/13/77	01/17/91	08/19/10(>)	01/17/91	No
400527#	DRUMMOND, TOWN OF	GARFIELD COUNTY		09/30/95	(NSFHA)	01/08/08	No
400052#	DRUMRIGHT, CITY OF	PAYNE COUNTY/CREEK COUNTY	11/23/73	07/02/80	05/18/09	07/02/80	No
400202#	DUNCAN, CITY OF	STEPHENS COUNTY	05/24/74	08/01/79	01/16/92	08/01/79	No
400460#	DURANT, CITY OF	BRYAN COUNTY	05/10/74	09/30/80	09/30/92	09/30/80	No
400371	DUSTIN, TOWN OF	HUGHES COUNTY	09/19/75	06/28/77	06/28/77(M)	06/28/77	No
400252#	EDMOND, CITY OF	OKLAHOMA COUNTY	01/17/75	05/15/80	12/18/09	05/15/80	No
405377#	EL RENO, CITY OF	CANADIAN COUNTY		08/17/73	09/26/08	08/17/73	No
400010#	ELK CITY, CITY OF	BECKHAM COUNTY	05/24/74	06/01/82	12/16/03(M)	06/01/82	No
400374#	ELMORE, CITY OF	GARVIN COUNTY	11/05/76	06/18/10	06/18/10(M)	07/20/82	No
400062#	ENID, CITY OF	GARFIELD COUNTY	02/22/74	03/15/79	09/30/95	03/15/79	No

CID	Community	County	Init FHBM Identified	Init FIRM Identified	Curr Eff Map Date	Reg-Emer Date	Tribal
400376	EUFAULA, CITY OF	MCINTOSH COUNTY	09/17/76		(NSFHA)	09/01/81	No
400150#	FAIRFAX, TOWN OF	OSAGE COUNTY	12/21/73	11/15/85	04/02/08(M)	11/15/85	No
400377#	FAIRLAND, TOWN OF	OTTAWA COUNTY	04/09/76	01/01/92	08/05/10(>)	01/01/92	No
400112#	FAIRVIEW, CITY OF	MAJOR COUNTY	05/24/74	03/04/88	03/04/88	03/04/88	No
400522#	FAXON, TOWN OF	COMANCHE COUNTY		11/02/95	(NSFHA)	06/20/08	No
400379#	FOREST PARK, CITY OF	OKLAHOMA COUNTY	06/25/76	07/03/85	12/18/09	07/03/85	No
400022#	FORT COBB, TOWN OF	CADDO COUNTY	12/07/73	09/27/91	09/27/91	09/27/91	No
400123#	FORT GIBSON, TOWN OF	CHEROKEE COUNTY/MUSKOGEE COUNTY	07/23/76	07/16/80	12/03/09	07/16/80	No
400205	FREDERICK, CITY OF	TILLMAN COUNTY	04/23/76		(NSFHA)	05/25/78	No
400227	FREEDOM, TOWN OF	WOODS COUNTY	11/08/74	06/05/85	06/05/85(M)	06/05/85	No
400060	GAGE, TOWN OF	ELLIS COUNTY	08/23/74		(NSFHA)	03/30/81	No
400380#	GARBER, CITY OF	GARFIELD COUNTY	04/25/75	08/05/85	09/30/95	08/05/85	No
400473#	GARFIELD COUNTY*	GARFIELD COUNTY		09/27/91	09/30/95	09/27/91	No
400381	GEARY, CITY OF	CANADIAN COUNTY/BLAINE COUNTY	10/29/76	09/26/08	09/26/08(M)	09/26/08	No
400032#	GENE AUTRY, TOWN OF	CARTER COUNTY	11/08/74	11/01/07	04/19/10(M)	11/01/07	No
400208#	GLENPOOL, CITY OF	TULSA COUNTY	06/28/74	03/02/81	08/03/09	03/02/81	No
400102#	GOLDSBY, TOWN OF	MCCLAIN COUNTY	11/19/76	09/15/89	11/16/07	09/15/89	No
400383	GOODWELL, TOWN OF	TEXAS COUNTY	04/02/76	01/18/88	01/18/88(M)	01/18/88	No
400195#	GORE, TOWN OF	SEQUOYAH COUNTY	09/06/74	01/02/91	09/29/10(>)	09/01/81	No
400023#	GRACEMONT, TOWN OF	CADDO COUNTY	12/06/74	08/19/85	09/27/91	08/19/85	No
400066	GRANITE, TOWN OF	GREER COUNTY	06/28/74		(NSFHA)	05/25/78	No
400544	GREER COUNTY*	GREER COUNTY			01/01/50	10/03/94(E)	No
400385#	GROVE, CITY OF	DELAWARE COUNTY	10/29/76	02/18/81	08/05/10(>)	02/18/81	No
400099#	GUTHRIE, CITY OF	LOGAN COUNTY	12/21/73	12/02/80	09/29/10(>)	12/02/80	No
400243	GUYMON, CITY OF	TEXAS COUNTY	05/20/77	06/19/85	06/19/85(M)	06/19/85	No
400167#	HAILEYVILLE, CITY OF	PITTSBURG COUNTY	07/26/74	07/22/10	07/22/10(>)	08/05/85	No
400386#	HAMMON, TOWN OF	CUSTER COUNTY/ROGER MILLS COUNTY	08/13/76	07/13/82	08/09/00(M)	07/13/82	No
400545	HARMON COUNTY*	HARMON COUNTY			01/01/50	01/27/95(E)	No
400140#	HARRAH, CITY OF	OKLAHOMA COUNTY	08/02/74	07/16/80	12/18/09	07/16/80	No
400387#	HARTSHORNE, CITY OF	PITTSBURG COUNTY	08/06/76	07/22/10	07/22/10(>)	08/05/85	No
400124#	HASKELL, TOWN OF	MUSKOGEE COUNTY	04/12/74	12/04/79	09/21/01	12/04/79	No
400033#	HEALDTON, CITY OF	CARTER COUNTY	12/28/73	01/03/86	04/19/10(M)	01/03/86	No
400090#	HEAVENER, CITY OF	LE FLORE COUNTY	05/24/74	03/16/82	03/16/82(M)	03/16/82	No
400388	HELENA, TOWN OF	ALFALFA COUNTY	04/02/76		(NSFHA)	03/16/92	No
400389#	HENNESSEY, TOWN OF	KINGFISHER COUNTY		05/05/03	08/19/10(>)	08/26/05	No
400144#	HENRYETTA, CITY OF	OKMULGEE COUNTY	01/18/74	03/04/80	12/03/91	03/04/80	No
400084#	HOBART, CITY OF	KIOWA COUNTY	12/07/73	06/29/82	06/29/82(M)	06/29/82	No
400285	HOFFMAN, TOWN OF	OKMULGEE COUNTY	06/25/76	08/05/85	08/05/85(M)	08/05/85	No
400244	HOLDENVILLE, CITY OF	HUGHES COUNTY	07/02/76	08/15/78	08/15/78(M)	08/15/78	No
400068	HOLLIS, CITY OF	HARMON COUNTY	06/28/74	08/05/85	08/05/85(M)	08/05/85	No
400151#	HOMINY, CITY OF	OSAGE COUNTY	12/21/73	11/19/80	04/02/08	11/19/80	No
400091#	HOWE, TOWN OF	LE FLORE COUNTY	07/02/76	04/15/82	04/15/82	04/15/82	No
400467#	HUGHES COUNTY *	HUGHES COUNTY	08/09/77	12/01/89	12/01/89(L)	12/01/89	No
400040	HUGO, CITY OF	CHOCTAW COUNTY	01/18/74		(NSFHA)	02/12/79	No

CID	Community	County	Init FHBM Identified	Init FIRM Identified	Curr Eff Map Date	Reg-Emer Date	Tribal
400036#	HULBERT, TOWN OF	CHEROKEE COUNTY	04/12/74	04/15/82	12/03/09	04/15/82	No
400286#	HUNTER, TOWN OF	GARFIELD COUNTY	07/11/75	09/27/91	(NSFHA)	05/25/78	No
400024#	HYDRO, TOWN OF	CADDO COUNTY	07/26/74	11/01/89	09/27/91	11/01/89	No
400108#	IDABEL, CITY OF	MCCURTAIN COUNTY	01/23/74	07/16/80	07/22/10(>)	07/16/80	No
400287#	INDIAHOMA, TOWN OF	COMANCHE COUNTY	11/05/76	02/19/92	07/20/09(M)	04/15/82	No
400456#	INOLA, TOWN OF	ROGERS COUNTY	12/26/75	07/16/87	09/16/88	07/16/87	No
400480#	JACKSON COUNTY*	JACKSON COUNTY		06/19/99	07/19/05(M)	06/16/99	No
400057#	JAY, TOWN OF	DELAWARE COUNTY	01/16/76	04/16/03	08/05/10(>)	07/05/78	No
400065	JEFFERSON, TOWN OF	GRANT COUNTY	11/22/74	09/01/87	09/01/87(L)	09/01/87	No
400209#	JENKS, CITY OF	TULSA COUNTY	01/09/74	02/17/82	08/03/09	02/17/82	No
400141#	JONES CITY, TOWN OF	OKLAHOMA COUNTY	07/11/75	01/02/81	12/18/09	01/02/81	No
400477#	KAY COUNTY*	KAY COUNTY		03/05/90	09/25/09	03/05/90	No
400391	KEOTA, TOWN OF	HASKELL COUNTY	10/01/76	07/18/85	07/18/85(M)	07/18/85	No
400563#	KICKAPOO TRIBE	OKLAHOMA COUNTY/LINCOLN COUNTY/POTTAWATOMIE COUNTY		08/19/10	09/03/10(>)	02/26/02(E)	Yes
400393#	KIEFER, TOWN OF	CREEK COUNTY	08/13/76	04/15/82	05/18/09	04/15/82	No
400471#	KINGFISHER COUNTY*	KINGFISHER COUNTY		09/18/91	08/19/10(>)	09/18/91	No
400082#	KINGFISHER, CITY OF	KINGFISHER COUNTY	04/12/74	09/30/76	08/19/10(>)	09/30/76	No
400394	KINGSTON, TOWN OF	MARSHALL COUNTY	04/02/76		04/02/76	09/25/08(E)	No
400071	KINTA, CITY OF	HASKELL COUNTY	11/08/74	08/01/87	08/01/87(L)	08/01/87	No
400543	KIOWA COUNTY*	KIOWA COUNTY			01/01/50	09/20/94(E)	No
400190#	KONAWA, CITY OF	SEMINOLE COUNTY	04/05/74	10/26/82	07/02/92	10/26/82	No
400169#	KREBS, CITY OF	PITTSBURG COUNTY	12/21/73	07/22/10	07/22/10(>)	08/05/85	No
400293#	KREMLIN, CITY OF	GARFIELD COUNTY	04/09/76	09/27/91	(NSFHA)	05/25/78	No
400294#	LAHOMA, TOWN OF	GARFIELD COUNTY	12/03/76	09/27/91	09/30/95	08/27/93	No
400295	LAMONT, TOWN OF	GRANT COUNTY	04/09/76	08/19/85	08/19/85(M)	08/19/85	No
400535#	LATIMER COUNTY*	LATIMER COUNTY		05/15/91	05/15/91	05/15/91	No
400069	LAVERNE, TOWN OF	HARPER COUNTY	05/03/74		(NSFHA)	07/05/78	No
400049#	LAWTON, CITY OF	COMANCHE COUNTY	08/09/74	12/01/78	07/20/09	12/01/78	No
400484#	LE FLORE COUNTY *	LE FLORE COUNTY	01/10/78	06/01/03	06/01/03(L)	06/01/03	No
	FHBM CONVERTED TO FIRM EFFECTIVE 6/1/2003. ZONE A AND X.						
400299	LEHIGH, CITY OF	COAL COUNTY	10/29/76	05/01/85	05/01/85(M)	05/01/85	No
400043#	LEXINGTON, CITY OF	CLEVELAND COUNTY	06/28/74	12/02/80	09/26/08	12/02/80	No
400457#	LINCOLN COUNTY*	LINCOLN COUNTY		02/03/93	08/19/10(>)	02/03/93	No
400245#	LINDSAY, CITY OF	GARVIN COUNTY	12/27/74	06/18/10	06/18/10	01/06/83	No
400116#	LOCUST GROVE, TOWN OF	MAYES COUNTY	04/12/74	09/26/03	09/26/03	09/11/78	No
400096#	LOGAN COUNTY *	LOGAN COUNTY	12/27/74	12/05/89	09/29/10(>)	12/05/89	No
400395#	LONE GROVE, TOWN OF	CARTER COUNTY	11/26/76	03/16/89	04/19/10	03/16/89	No
400085#	LONE WOLF, TOWN OF	KIOWA COUNTY	05/03/74	06/29/82	06/29/82(M)	06/29/82	No
400025#	LOOKEBA, TOWN OF	CADDO COUNTY	10/25/74	07/13/82	09/27/91	07/13/82	No
400396#	LUTHER, TOWN OF	OKLAHOMA COUNTY	06/25/76	02/17/88	12/18/09	02/17/88	No
400114#	MADILL, CITY OF	MARSHALL COUNTY	11/23/73	07/18/85	09/30/97	07/18/85	No
400067	MANGUM, CITY OF	GREER COUNTY	05/17/74		(NSFHA)	05/29/79	No
400302#	MANITOU, TOWN OF	TILLMAN COUNTY	04/09/76	08/03/82	08/03/82(M)	08/03/82	No

CID	Community	County	Init FHBM Identified	Init FIRM Identified	Curr Eff Map Date	Reg-Emer Date	Tribal
400303	MANNSVILLE, TOWN OF	JOHNSTON COUNTY	09/26/75		09/26/75	09/15/00(E)	No
400304#	MARBLE CITY, TOWN OF	SEQUOYAH COUNTY	09/26/75	08/19/85	09/29/10(>)	08/19/85	No
400400#	MARIETTA, CITY OF	LOVE COUNTY	10/29/76	07/03/85	07/03/85(M)	07/03/85	No
400203#	MARLOW, CITY OF	STEPHENS COUNTY	12/28/73	09/01/87	01/16/92	09/01/87	No
400306#	MARSHALL, TOWN OF	LOGAN COUNTY	08/13/76	12/05/89	09/29/10(>)	08/01/87	No
400307	MARTHA, TOWN OF	JACKSON COUNTY	03/18/77		(NSFHA)	08/08/97	No
400401#	MAUD, CITY OF	SEMINOLE COUNTY/POTTAWATOMIE COUNTY	04/02/76	07/03/85	09/03/10(>)	07/03/85	No
400458#	MAYES COUNTY*	MAYES COUNTY	11/22/77	12/01/89	09/26/03	12/01/89	No
400402#	MAYSVILLE, TOWN OF	GARVIN COUNTY	12/17/76	06/18/10	06/18/10	09/30/81	No
400170#	MCALESTER, CITY OF	PITTSBURG COUNTY	02/15/74	07/22/10	07/22/10(>)	02/15/79	No
400538#	MCCLAIN COUNTY*	MCCLAIN COUNTY	09/10/90	06/02/95	11/16/07	02/03/93	No
400397	MCCURTIN, CITY OF	HASKELL COUNTY	08/13/76	08/19/85	08/19/85(M)	08/19/85	No
400398#	MCLOUD, TOWN OF	POTTAWATOMIE COUNTY	08/13/76	10/16/87	09/03/10(>)	10/16/87	No
400403	MEDFORD, CITY OF	GRANT COUNTY	04/02/76	09/04/85	09/04/85(M)	09/04/85	No
400404#	MEEKER, CITY OF	LINCOLN COUNTY	08/13/76	04/15/86	08/19/10(>)	04/15/86	No
400157#	MIAMI, CITY OF	OTTAWA COUNTY	01/25/74	12/16/80	08/05/10(>)	12/16/80	No
400405#	MIDWEST CITY, CITY OF	OKLAHOMA COUNTY	06/03/77	05/19/81	12/18/09	05/19/81	No
400196#	MOFFETT, TOWN OF	SEQUOYAH COUNTY	07/16/76	04/15/82	09/29/10(>)	04/15/82	No
400044#	MOORE, CITY OF	CLEVELAND COUNTY	06/07/74	12/02/80	09/26/08	12/02/80	No
400230	MOORELAND, TOWN OF	WOODWARD COUNTY	03/15/74	06/19/85	06/19/85(M)	06/19/85	No
400407#	MORRIS, CITY OF	OKMULGEE COUNTY	04/23/76	06/29/82	06/29/82(M)	06/29/82	No
400133	MORRISON, TOWN OF	NOBLE COUNTY			(NSFHA)	06/30/76	No
400086#	MOUNTAIN PARK, TOWN OF	KIOWA COUNTY	04/09/76	08/03/82	08/03/82(M)	08/03/82	No
400087	MOUNTAIN VIEW, TOWN OF	KIOWA COUNTY	11/01/74	12/12/78	12/12/78(M)	12/12/78	No
400197#	MULDROW, TOWN OF	SEQUOYAH COUNTY	06/28/74	04/15/82	09/29/10(>)	04/15/82	No
400491#	MUSKOGEE COUNTY *	MUSKOGEE COUNTY	03/14/78	03/04/91	09/21/01	03/04/91	No
400125#	MUSKOGEE, CITY OF	MUSKOGEE COUNTY	03/22/74	07/02/80	09/21/01	07/02/80	No
400409#	MUSTANG, CITY OF	CANADIAN COUNTY	04/09/76	07/02/80	09/26/08	07/02/80	No
400311#	NASH, TOWN OF	GRANT COUNTY	07/02/76	09/27/91	09/27/91	09/27/91	No
400224#	NEW CORDELL, CITY OF	WASHITA COUNTY	06/28/74	05/02/83	05/02/83	05/02/83	No
400103#	NEWCASTLE, CITY OF	MCCLAIN COUNTY	06/07/74	12/15/83	11/16/07	12/15/83	No
400422#	NEWKIRK,CITY OF	KAY COUNTY	04/30/76	08/05/85	09/25/09(M)	08/05/85	No
400423#	NICHOLS HILLS, CITY OF	OKLAHOMA COUNTY	12/20/74	01/20/82	12/18/09	01/20/82	No
400424#	NICOMA PARK, TOWN OF	OKLAHOMA COUNTY	08/13/76	07/16/80	12/18/09	07/16/80	No
405382#	NINNEKAH, TOWN OF	GRADY COUNTY		02/15/85	02/15/85(M)	02/15/85	No
400132#	NOBLE COUNTY*	NOBLE COUNTY		11/18/92	06/18/96	11/18/92	No
400045#	NOBLE, CITY OF	CLEVELAND COUNTY	08/30/74	07/02/81	09/26/08	07/02/81	No
400046#	NORMAN,CITY OF	CLEVELAND COUNTY	08/23/74	11/01/79	09/26/08	11/01/79	No
400425#	NORTH ENID, TOWN OF	GARFIELD COUNTY	01/24/75	04/01/81	09/30/95	04/01/81	No
400504	NOWATA COUNTY	NOWATA COUNTY			01/01/50	09/08/08(E)	No
400136#	NOWATA, CITY OF	NOWATA COUNTY	06/28/74	01/03/86	06/16/93	01/03/86	No
400313	OAKLAND, TOWN OF	MARSHALL COUNTY	10/29/76	08/05/85	08/05/85(M)	08/05/85	No
400217	OKAY, TOWN OF	WAGONER COUNTY	08/16/74	09/28/82	09/28/82(M)	09/28/82	No
400015	OKEENE, TOWN OF	BLAINE COUNTY	06/28/74	11/15/85	11/15/85(M)	11/15/85	No
400429	OKEMAH,CITY OF	OKFUSKEE COUNTY	08/13/76	08/01/87	08/01/87(L)	08/01/87	No

CID	Community	County	Init FHBM Identified	Init FIRM Identified	Curr Eff Map Date	Reg-Emer Date	Tribal
405378#	OKLAHOMA CITY, CITY OF	POTTAWATOMIE COUNTY/OKLAHOMA COUNTY/MCCLAIN COUNTY/CLEVELAND COUNTY/CANADIAN COUNTY		12/31/74	09/03/10(>)	07/14/72	No
400466#	OKLAHOMA COUNTY*	OKLAHOMA COUNTY	07/13/82	02/15/84	12/18/09	02/15/84	No
400492#	OKMULGEE COUNTY *	OKMULGEE COUNTY	02/07/78	09/27/91	09/27/91	09/27/91	No
400145#	OKMULGEE, CITY OF	OKMULGEE COUNTY	02/01/74	02/04/81	12/03/91	02/04/81	No
400126#	OKTAHA, TOWN OF	MUSKOGEE COUNTY	11/29/74	03/04/91	(NSFHA)	05/25/78	No
400430#	OLUSTEE, TOWN OF	JACKSON COUNTY	04/09/76	08/03/82	08/03/82(M)	08/03/82	No
400189	OOLOGAH, TOWN OF	ROGERS COUNTY	02/25/77	03/01/87	03/01/87(L)	03/01/87	No
400146#	OSAGE COUNTY*	OSAGE COUNTY	12/23/80	12/01/89	04/02/08	12/01/89	No
400154#	OTTAWA COUNTY *	OTTAWA COUNTY	05/20/77	12/02/88	08/05/10(>)	12/02/88	No
400210#	OWASSO, CITY OF	ROGERS COUNTY/TULSA COUNTY	01/16/74	07/02/81	08/03/09	07/02/81	No
400092	PANAMA, TOWN OF	LE FLORE COUNTY	05/28/76		(NSFHA)	09/01/81	No
400317#	PAOLI, TOWN OF	GARVIN COUNTY	11/05/76	06/18/10	06/18/10	12/02/04(E)	No
400246#	PAULS VALLEY, CITY OF	GARVIN COUNTY	07/05/77	06/18/10	06/18/10	09/17/80	No
400152#	PAWHUSKA, CITY OF	OSAGE COUNTY	03/15/74	07/16/80	04/02/08	07/16/80	No
400163#	PAWNEE, CITY OF	PAWNEE COUNTY	01/16/74	06/19/85	06/02/95	06/19/85	No
400493#	PAYNE COUNTY*	PAYNE COUNTY	10/23/81	11/19/87	05/16/07	11/19/87	No
400431#	PERKINS, CITY OF	PAYNE COUNTY	04/09/76	05/16/07	05/16/07	05/16/07	No
400134#	PERRY, CITY OF	NOBLE COUNTY	07/26/74	10/10/78	06/18/96	10/10/78	No
400159#	PICHER, CITY OF	OTTAWA COUNTY	07/23/76	09/21/82	08/05/10(>)	09/21/82	No
400027#	PIEDMONT, CITY OF	KINGFISHER COUNTY/CANADIAN COUNTY	07/19/77	02/17/82	08/19/10(>)	02/04/85	No
400494#	PITTSBURG COUNTY *	PITTSBURG COUNTY	08/17/82	11/01/07	07/22/10(>)	11/01/07	No
400171#	PITTSBURG, TOWN OF	PITTSBURG COUNTY	11/08/74	07/22/10	07/22/10(>)	10/15/85	No
400432#	POCOLA, TOWN OF	LE FLORE COUNTY	04/09/76	07/04/89	07/04/89	07/04/89	No
400080#	PONCA CITY, CITY OF	KAY COUNTY	02/01/74	07/02/80	09/25/09	07/02/80	No
400239#	PONCA INDIANS OF OKLAHOMA, TRIBE OF	KAY COUNTY/NOBLE COUNTY		06/18/96	05/19/97	07/15/08	Yes
	Tribe of Ponca Indians of Oklahoma adopted the FIS for Kay County dated 5/19/1997 and the FIS for Noble County dated 6/18/1996.						
400433	POND CREEK, CITY OF	GRANT COUNTY	11/12/76	03/01/87	03/01/87(L)	03/01/87	No
400495#	PONTOTOC COUNTY *	PONTOTOC COUNTY	01/10/78		01/10/78	02/09/06(E)	No
400434	PORTER, TOWN OF	WAGONER COUNTY	04/09/76		(NSFHA)	01/26/83	No
400127#	PORUM, TOWN OF	MUSKOGEE COUNTY	06/28/74	04/15/80	09/21/01	04/15/80	No
400093#	POTEAU, CITY OF	LE FLORE COUNTY	11/01/74	01/20/82	01/20/82	01/20/82	No
400496#	POTTAWATOMIE COUNTY*	POTTAWATOMIE COUNTY	05/25/82	06/01/88	09/03/10(>)	06/01/88	No
400435#	PRAGUE, CITY OF	LINCOLN COUNTY	04/09/76	09/04/85	08/19/10(>)	09/04/85	No
400117#	PRYOR CREEK,CITY OF	MAYES COUNTY	02/01/74	07/16/87	09/26/03	07/16/87	No
400104#	PURCELL, CITY OF	CLEVELAND COUNTY/MCCLAIN COUNTY	09/06/74	07/02/81	11/16/07	07/02/81	No
400172#	QUINTON, TOWN OF	PITTSBURG COUNTY	08/16/74	07/22/10	07/22/10(>)	08/05/85	No
400164	RALSTON, TOWN OF	PAWNEE COUNTY	08/13/76	07/03/85	07/03/85(M)	07/03/85	No
400222#	RAMONA, TOWN OF	WASHINGTON COUNTY	07/19/74	02/01/88	09/26/08(M)	03/31/88	No
400318#	RANDLETT, TOWN OF	COTTON COUNTY	08/13/76	09/12/78	09/27/91	09/12/78	No

CID	Community	County	Init FHBM Identified	Init FIRM Identified	Curr Eff Map Date	Reg-Emer Date	Tribal
400320	RAVIA, TOWN OF	JOHNSTON COUNTY	08/13/76	07/03/85	07/03/85(M)	07/03/85	No
400321#	RED BIRD, TOWN OF	WAGONER COUNTY	06/27/75	10/09/79	10/09/79(M)	10/09/79	No
400437	RED OAK, TOWN OF	LATIMER COUNTY	12/20/74	07/18/85	07/18/85(M)	07/18/85	No
400135	RED ROCK, CITY OF	NOBLE COUNTY	10/10/75		(NSFHA)	05/25/78	No
400322#	REYDON, TOWN OF	ROGER MILLS COUNTY	11/12/76	07/18/85	08/09/00(M)	07/18/85	No
400176#	ROFF, TOWN OF	PONTOTOC COUNTY	03/22/74	11/27/79	11/27/79(M)	11/27/79	No
400542#	ROGER MILLS COUNTY*	ROGER MILLS COUNTY		08/09/00	08/09/00	08/09/00	No
405379#	ROGERS COUNTY*	ROGERS COUNTY		11/05/71	12/19/97	11/05/71	No
400198#	ROLAND, TOWN OF	SEQUOYAH COUNTY	07/09/76	01/20/82	09/29/10(>)	01/20/82	No
400088#	ROOSEVELT, TOWN OF	KIOWA COUNTY	11/01/74	03/23/82	03/23/82(M)	03/23/82	No
400064	RUSH SPRINGS, TOWN OF	GRADY COUNTY	06/14/74	07/03/85	07/03/85(M)	07/03/85	No
400439#	RYAN, TOWN OF	JEFFERSON COUNTY	11/05/76	07/20/82	07/20/82(M)	07/20/82	No
400118#	SALINA, TOWN OF	MAYES COUNTY	07/02/76	09/04/85	09/26/03(M)	09/04/85	No
400199#	SALLISAW, CITY OF	SEQUOYAH COUNTY	04/05/74	01/02/80	09/29/10(>)	01/02/80	No
400211#	SAND SPRINGS, CITY OF	TULSA COUNTY	07/26/74	06/15/81	08/03/09	06/15/81	No
400053#	SAPULPA, CITY OF	CREEK COUNTY	05/11/73	12/01/77	08/03/09	12/01/77	No
400191#	SASAKAWA, TOWN OF	SEMINOLE COUNTY	11/08/74	02/16/90	07/02/92	03/01/87	No
400441	SAYRE, CITY OF	BECKHAM COUNTY	06/11/76	08/19/85	08/19/85(M)	08/19/85	No
400058	SEILING, TOWN OF	DEWEY COUNTY	05/24/74		(NSFHA)	09/01/81	No
400497#	SEMINOLE COUNTY*	SEMINOLE COUNTY	06/08/82	02/16/90	07/02/92	02/16/90	No
400192#	SEMINOLE, CITY OF	SEMINOLE COUNTY	06/07/74	11/17/82	07/02/92	11/17/82	No
400442	SENTINEL, TOWN OF	WASHITA COUNTY	11/12/76	07/03/85	07/03/85(M)	07/03/85	No
400503#	SEQUOYAH COUNTY *	SEQUOYAH COUNTY	04/21/81	01/02/91	09/29/10(>)	01/02/91	No
400178#	SHAWNEE, CITY OF	POTTAWATOMIE COUNTY	12/27/74	07/02/80	09/03/10(>)	07/02/80	No
400410#	SHIDLER, CITY OF	OSAGE COUNTY	04/09/76	07/03/85	04/02/08(M)	07/03/85	No
400212#	SKIATOOK, TOWN OF	TULSA COUNTY/OSAGE COUNTY	06/07/74	07/16/80	08/03/09	07/16/80	No
400539#	SLAUGHTERVILLE, TOWN OF	CLEVELAND COUNTY		04/15/92	09/26/08	04/15/92	No
400089#	SNYDER, CITY OF	KIOWA COUNTY	01/09/74	04/15/80	04/15/80	04/15/80	No
400507	SOPER, TOWN OF	CHOCTAW COUNTY			(NSFHA)	12/19/84	No
400411	SOUTH COFFEYVILLE, TOWN OF	NOWATA COUNTY	06/25/76	09/14/82	09/14/82(M)	09/14/82	No
400328#	SPAVINAW, TOWN OF	MAYES COUNTY	08/13/76	09/21/82	09/26/03(M)	09/21/82	No
400412#	SPENCER, CITY OF	OKLAHOMA COUNTY	12/27/74	07/16/80	12/18/09	07/16/80	No
400213#	SPERRY, TOWN OF	TULSA COUNTY	12/07/73	07/16/81	08/03/09	07/16/81	No
400413#	SPIRO, TOWN OF	LE FLORE COUNTY	10/01/76	04/20/82	04/20/82(M)	04/20/82	No
400498#	STEPHENS COUNTY *	STEPHENS COUNTY	04/20/82	12/15/90	01/16/92	12/15/90	No
400414#	STERLING, TOWN OF	COMANCHE COUNTY	01/10/75	02/19/92	07/20/09(M)	07/05/78	No
400415	STIGLER, CITY OF	HASKELL COUNTY	06/25/76	03/04/86	03/04/86(M)	03/04/86	No
405380#	STILLWATER, CITY OF	PAYNE COUNTY		06/22/73	05/16/07	06/22/73	No
400001#	STILLWELL, CITY OF	ADAIR COUNTY	11/22/74	08/04/87	02/05/97	08/04/87	No
400416#	STRATFORD, TOWN OF	GARVIN COUNTY	08/13/76	06/18/10	06/18/10(M)	11/15/85	No
400329#	STRINGTOWN, TOWN OF	ATOKA COUNTY	08/13/76	07/04/89	07/04/89	07/04/89	No
400417#	STROUD, CITY OF	CREEK COUNTY/LINCOLN COUNTY	07/16/76	08/23/00	08/19/10(>)	03/06/00	No
400119#	SULPHUR, CITY OF	MURRAY COUNTY	11/28/73	02/18/81	02/18/81	02/18/81	No
400128#	TAFT, TOWN OF	MUSKOGEE COUNTY	06/28/74	08/01/87	09/21/01	08/25/87	No
400037#	TAHLEQUAH, CITY OF	CHEROKEE COUNTY	06/14/74	11/01/79	12/03/09	11/01/79	No
400094	TALIHINA, TOWN OF	LE FLORE COUNTY	04/05/74		(NSFHA)	09/01/81	No

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400059	TALOGA, TOWN OF	DEWEY COUNTY	11/22/74		(NSFHA)	05/26/78	No
400179#	TECUMSEH, CITY OF	POTTAWATOMIE COUNTY	07/19/74	07/16/80	09/03/10(>)	07/16/80	No
400420#	THE VILLAGE, CITY OF	OKLAHOMA COUNTY	10/29/76	07/16/80	12/18/09	07/16/80	No
400206	TIPTON, TOWN OF	TILLMAN COUNTY	08/13/76	08/17/82	08/17/82(M)	08/17/82	No
400077#	TISHOMINGO, CITY OF	JOHNSTON COUNTY	01/04/74	01/15/88	01/15/88	01/15/88	No
400079#	TONKAWA, CITY OF	KAY COUNTY	11/23/73	02/04/81	09/25/09	02/04/81	No
400218	TULLAHASSEE, CITY OF	WAGONER COUNTY	07/16/76		(NSFHA)	09/01/81	No
400462#	TULSA COUNTY *	TULSA COUNTY	08/23/77	09/16/82	08/03/09	09/16/82	No
405381#	TULSA, CITY OF	WAGONER COUNTY/OSAGE COUNTY/ROGERS COUNTY/TULSA COUNTY		04/16/03	08/03/09	08/13/71	No
400443#	TUTTLE, CITY OF	GRADY COUNTY	06/25/76	04/19/05	04/19/05(L)	11/01/89	No
400334#	UNION CITY, TOWN OF	CANADIAN COUNTY	01/14/77	01/19/00	09/26/08(M)	11/26/02	No
400445#	VALLEY BROOK, TOWN OF	OKLAHOMA COUNTY	01/24/75	09/30/81	12/18/09	09/30/81	No
400248#	VERDEN, TOWN OF	GRADY COUNTY	04/30/76	10/26/82	02/03/93	10/26/82	No
400200#	VIAN, TOWN OF	SEQUOYAH COUNTY	05/03/74	01/02/91	(NSFHA)	05/25/78	No
400448	VICI, TOWN OF	DEWEY COUNTY	11/05/76	01/01/92	01/01/92(L)	01/01/92	No
400050#	VINITA, CITY OF	CRAIG COUNTY	05/24/74	06/01/81	07/16/91	06/01/81	No
400215#	WAGONER COUNTY*	WAGONER COUNTY	04/27/82	12/02/88	12/02/88	12/02/88	No
400219#	WAGONER, CITY OF	WAGONER COUNTY	06/28/74	10/19/82	10/19/82(M)	10/19/82	No
400129#	WAINWRIGHT, TOWN OF	MUSKOGEE COUNTY	12/13/74	08/08/78	09/21/01(M)	08/08/78	No
400249#	WALTERS, CITY OF	COTTON COUNTY	07/02/76	07/06/82	09/27/91	07/06/82	No
400337	WAPANUCKA, TOWN OF	JOHNSTON COUNTY	05/28/76	09/01/87	09/01/87(L)	09/01/87	No
400130#	WARNER, TOWN OF	MUSKOGEE COUNTY	08/13/76	03/04/91	09/21/01	05/25/78	No
400449#	WARR ACRES, CITY OF	OKLAHOMA COUNTY	12/20/74	12/16/80	12/18/09	12/16/80	No
400459#	WASHINGTON COUNTY*	WASHINGTON COUNTY		11/20/91	09/26/08	11/20/91	No
400223	WASHITA COUNTY*	WASHITA COUNTY			01/01/50	12/06/93(E)	No
400016#	WATONGA, CITY OF	BLAINE COUNTY	09/06/74	06/15/88	06/15/88	06/15/88	No
400002	WATTS, CITY OF	ADAIR COUNTY	12/06/74	08/05/85	08/05/85(M)	08/05/85	No
400076#	WAURIKA, CITY OF	JEFFERSON COUNTY	06/28/74	01/06/83	01/06/83	01/06/83	No
400450#	WAYNE, CITY OF	MCCLAIN COUNTY		11/16/07	(NSFHA)	11/16/07	No
400228#	WAYNOKA, CITY OF	WOODS COUNTY	05/24/74	06/15/88	06/15/88	06/15/88	No
400056#	WEATHERFORD, CITY OF	CUSTER COUNTY	03/29/74	12/18/79	12/18/79	12/18/79	No
400131#	WEBBERS FALLS, TOWN OF	MUSKOGEE COUNTY	01/10/75	05/01/80	09/21/01	05/01/80	No
400139	WELEETKA, TOWN OF	OKFUSKEE COUNTY	06/14/74	11/23/82	11/23/82(M)	11/23/82	No
400003#	WESTVILLE, TOWN OF	ADAIR COUNTY	10/18/74	06/29/82	06/29/82(M)	06/29/82	No
400453	WETUMKA, CITY OF	HUGHES COUNTY	10/22/76	01/03/86	01/03/86(M)	01/03/86	No
400193#	WEWOKA, CITY OF	SEMINOLE COUNTY	06/14/74	07/16/80	07/02/92	07/16/80	No
400250#	WILBURTON, CITY OF	LATIMER COUNTY	04/09/76	04/24/79	04/24/79(M)	04/24/79	No
400035#	WILSON, CITY OF	CARTER COUNTY	06/28/74	07/03/85	04/19/10(M)	07/03/85	No
400095#	WISTER, TOWN OF	LE FLORE COUNTY	04/14/76	04/14/76	04/01/80	04/14/76	No
400481#	WOODS COUNTY *	WOODS COUNTY		01/17/97	01/17/97	01/17/97	No
400500#	WOODWARD COUNTY *	WOODWARD COUNTY		01/17/97	01/17/97	01/17/97	No
400232#	WOODWARD, CITY OF	WOODWARD COUNTY	06/14/74	12/16/80	12/16/80	12/16/80	No
400109#	WRIGHT CITY, CITY OF	MCCURTAIN COUNTY	01/10/75	05/17/89	07/22/10(>)	05/17/89	No
400161#	WYANDOTTE, TOWN OF	OTTAWA COUNTY	06/28/74	12/17/87	08/05/10(>)	12/17/87	No

CID	Community	County	Init FHBM Identified	Init FIRM Identified	Curr Eff Map Date	Reg-Emer Date	Tribal
400251#	WYNNEWOOD, CITY OF	GARVIN COUNTY	10/29/76	06/18/10	06/18/10	01/15/88	No
400028#	YUKON, CITY OF	CANADIAN COUNTY	05/24/74	09/28/78	09/26/08	09/28/79	No
400255#	ACHILLE, TOWN OF	BRYAN COUNTY	04/02/76	09/18/91	09/30/92	04/02/77	No
400074	ADDINGTON, TOWN OF	JEFFERSON COUNTY	10/18/74		04/16/76	10/18/75	No
400174#	ALLEN, TOWN OF	PONTOTOC COUNTY	06/28/74	11/30/82	08/03/98	04/10/97(W)	No
400259#	ASHER, TOWN OF	POTTAWATOMIE COUNTY	06/04/76	04/02/92	09/03/10	06/04/77	No
400263	BRADLEY, TOWN OF	GRADY COUNTY	08/13/76		08/13/76	08/13/77	No
400264#	BRAMAN, TOWN OF	KAY COUNTY	06/27/75	09/25/09	09/25/09	09/28/09(S)	No
400530#	BRECKENRIDGE, TOWN OF	GARFIELD COUNTY		09/27/91	09/30/95	09/27/92	No
400465#	BRIDGEPORT, TOWN OF	CADDO COUNTY	04/01/77	09/27/91	09/27/91	04/01/78	No
400265	BROMIDE, TOWN OF	COAL COUNTY	11/05/76		01/01/50	11/05/77	No
400149#	BURBANK, TOWN OF	OSAGE COUNTY	01/10/75	04/02/08	04/02/08	01/10/76	No
400273	CANEY, TOWN OF	ATOKA COUNTY	04/09/76		04/09/76	04/09/77	No
400355	CARMEN, TOWN OF	ALFALFA COUNTY	09/19/75		09/19/75	09/19/76	No
400030#	CARTER COUNTY*	CARTER COUNTY	07/05/77	04/19/10	04/19/10	07/05/78	No
400277#	CASHION, TOWN OF	LOGAN COUNTY,KINGFISHER COUNTY		05/05/03	09/29/10	05/05/04	No
400278	CASTLE, TOWN OF	OKFUSKEE COUNTY	09/05/75	05/07/76	05/07/76	09/05/76	No
400533#	CEMENT, TOWN OF	CADDO COUNTY		09/27/91	09/27/91	09/27/92	No
400281#	COLCORD, TOWN OF	DELAWARE COUNTY	11/19/76	04/16/03	08/05/10	11/19/77	No
400184#	COLE, TOWN OF	MCCLAIN COUNTY		11/16/07	11/16/07	11/16/08	No
400122#	COUNCIL HILL, TOWN OF	MUSKOGEE COUNTY	12/13/74	03/04/91	09/21/01	12/13/75	No
400363	COWLINGTON, TOWN OF	LE FLORE COUNTY	03/11/77		03/11/77	03/11/78	No
400282#	CROMWELL, TOWN OF	SEMINOLE COUNTY	08/13/76	02/16/90	07/02/92	08/13/77	No
400364#	CYRIL, TOWN OF	CADDO COUNTY	04/02/76	09/27/91	09/27/91	04/02/77	No
400226	DACOMA, TOWN OF	WOODS COUNTY	11/08/74		12/12/75	11/08/75	No
400512#	DELAWARE TRIBE OF WESTERN OKLAHOMA	CADDO COUNTY		01/18/88	09/27/91	11/20/95(W)	Yes
400367	DELAWARE, TOWN OF	NOWATA COUNTY	04/09/76		04/09/76	04/09/77	No
400368#	DEPEW, TOWN OF	CREEK COUNTY	11/19/76	05/18/09	05/18/09	11/19/77	No
400537#	DEVOL, TOWN OF	COTTON COUNTY		09/06/89	09/27/91	09/06/90	No
400153#	DIBBLE, TOWN OF	MCCLAIN COUNTY		11/16/07	11/16/07	11/16/08	No
400369#	DICKSON, TOWN OF	CARTER COUNTY	07/30/76	04/19/10	04/19/10	07/30/77	No
400554#	DISNEY, TOWN OF	MAYES COUNTY		09/26/03	09/26/03	09/26/04	No
400524#	EARLSBORO, TOWN OF	POTTAWATOMIE COUNTY		04/02/92	09/03/10	04/02/93	No
400373#	ELGIN, TOWN OF	COMANCHE COUNTY		02/19/92	07/20/09	02/19/93	No
400528#	FAIRMONT, TOWN OF	GARFIELD COUNTY		09/27/91	09/30/95	09/27/92	No
400572#	FALLIS, TOWN OF	LINCOLN COUNTY		08/19/10	08/19/10	08/19/11	No
400039	FORT TOWSON,TOWN OF	CHOCTAW COUNTY	01/10/75	08/01/87	08/01/87	08/01/87(S)	No
400194#	GANS, TOWN OF	SEQUOYAH COUNTY	11/29/79	04/15/82	09/29/10	04/15/82(S)	No
400472#	GARVIN COUNTY*	GARVIN COUNTY	03/26/82	06/18/10	06/18/10	03/26/83	No
400483#	GRADY COUNTY*	GRADY COUNTY	04/03/85	09/27/91	07/19/05	07/20/05(S)	No
400555#	GRAND LAKE TOWNE, TOWN OF	MAYES COUNTY		09/26/03	09/26/03	09/26/04	No
400013	GREENFIELD, TOWN OF	BLAINE COUNTY	08/30/74		02/20/76	08/30/75	No
400591#	HAWORTH, TOWN OF	MCCURTAIN COUNTY		07/22/10	07/22/10	07/22/11	No
400288#	INDIANOLA, TOWN OF	PITTSBURG COUNTY	04/02/76	07/22/10	07/22/10	04/02/77	No
400007	JET, TOWN OF	ALFALFA COUNTY	12/06/74		12/06/74	12/06/75	No

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400242#	JOHNSON, TOWN OF	POTTAWATOMIE COUNTY		09/03/10	09/03/10	09/03/11	No
400290#	KANSAS, TOWN OF	DELAWARE COUNTY	09/26/75	04/16/03	08/05/10	09/26/76	No
400291#	KAW CITY, CITY OF	KAY COUNTY		09/25/09	09/25/09	09/25/10	No
400235#	KELLYVILLE, TOWN OF	CREEK COUNTY		05/18/09	05/18/09	05/18/10	No
400168#	KIOWA, TOWN OF	PITTSBURG COUNTY	06/28/74	07/22/10	07/22/10	06/28/75	No
400297#	LANGSTON, TOWN OF	LOGAN COUNTY	09/19/75	07/06/82	09/29/10	08/04/88(S)	No
400547#	LIBERTY, TOWN OF	OKMULGEE COUNTY,TULSA COUNTY	08/23/77	09/16/82	08/03/09	08/23/78	No
	Per "Oklahoma Almanac, Oklahoma Municipal Government," Liberty is an unincorporated town within Tulsa and Okmulgee Counties. Land use is controlled by the respective counties. http://www.odl.state.ok.us/almanac/2005/12-muni.pdf						
400301#	LIMA, TOWN OF	SEMINOLE COUNTY	12/10/76	02/16/90	07/02/92	12/10/77	No
400083#	LOYAL, TOWN OF	KINGFISHER COUNTY	04/25/75	05/05/03	08/19/10	04/25/76	No
400399#	MANNFORD, TOWN OF	CREEK COUNTY	11/12/76	05/18/09	05/18/09	05/19/09(S)	No
400305	MARLAND, TOWN OF	NOBLE COUNTY	08/13/76		08/13/76	08/13/77	No
400511#	MARSHALL COUNTY*	MARSHALL COUNTY		11/02/90	09/30/97	12/19/06(W)	No
400106#	MCCURTAIN COUNTY*	MCCURTAIN COUNTY	07/11/78	07/22/10	07/22/10	07/11/79	No
400214#	MEDICINE PARK, TOWN OF	COMANCHE COUNTY		07/20/09	07/20/09	07/20/10	No
400515#	MERIDIAN, TOWN OF	LOGAN COUNTY		12/05/89	09/29/10	12/05/90	No
400308	MILBURN, TOWN OF	JOHNSTON COUNTY	09/26/75	06/19/85	06/19/85	08/04/88(S)	No
400309	MILL CREEK, TOWN OF	JOHNSTON COUNTY	08/13/76		08/13/76	08/13/77	No
400406#	MINCO, TOWN OF	GRADY COUNTY	01/28/77		12/05/78	01/28/78	No
400408#	MOUNDS, TOWN OF	CREEK COUNTY	06/25/76	04/15/82	05/18/09	06/25/77	No
400310#	MULHALL, TOWN OF	LOGAN COUNTY	05/28/76	12/05/89	09/29/10	05/28/77	No
400312#	NEW PRUE, TOWN OF	OSAGE COUNTY	05/21/76	04/02/08	04/02/08	05/21/77	No
400426#	NORTH MIAMI, TOWN OF	OTTAWA COUNTY	04/09/76	08/05/10	08/05/10	04/09/77	No
400314#	OAKS, TOWN OF	CHEROKEE COUNTY,DELAWARE COUNTY	08/29/75	04/16/03	08/05/10	08/29/76	No
400315#	OCHELATA, TOWN OF	WASHINGTON COUNTY	04/09/76	09/26/08	09/26/08	04/09/77	No
400427#	OILTON, CITY OF	CREEK COUNTY	11/12/76	05/18/09	05/18/09	11/12/77	No
400017#	OSAGE, TOWN OF	OSAGE COUNTY		04/02/08	04/02/08	04/02/09	No
400569#	PARADISE HILL, TOWN OF	SEQUOYAH COUNTY		09/29/10	09/29/10	09/29/11	No
400158#	PEORIA, TOWN OF	OTTAWA COUNTY	11/22/74	08/05/10	08/05/10	11/22/75	No
400523#	PINK, TOWN OF	POTTAWATOMIE COUNTY		04/02/92	09/03/10	04/02/93	No
400436#	QUAPAW, TOWN OF	OTTAWA COUNTY	08/13/76	08/05/10	08/05/10	08/13/77	No
400319#	RATLIFF CITY, CITY OF	CARTER COUNTY		04/19/10	04/19/10	04/19/11	No
400324#	RIPLEY, TOWN OF	PAYNE COUNTY	06/21/77	05/16/07	05/16/07	06/21/78	No
400576#	SAC & FOX TRIBAL INDIAN	PAYNE COUNTY,LINCOLN COUNTY,POTTAWATOMIE COUNTY		08/19/10	09/03/10	08/19/11	Yes
400440#	SAVANNA, TOWN OF	PITTSBURG COUNTY	04/09/76	03/01/87	07/22/10	08/04/88(S)	No
400327#	SHAMROCK, TOWN OF	CREEK COUNTY	06/25/76	05/18/09	05/18/09	06/25/77	No
400231	SHARON, TOWN OF	WOODWARD COUNTY	08/13/76		08/13/76	08/13/77	No
400061#	SHATTUCK, TOWN OF	ELLIS COUNTY	05/24/74	03/23/82	03/23/82	08/04/88(S)	No

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400186#	SLICK, TOWN OF	CREEK COUNTY		05/18/09	05/18/09	05/18/10	No
400574#	SPARKS, TOWN OF	LINCOLN COUNTY		08/19/10	08/19/10	08/19/11	No
400558#	SPORTSMEN ACRES	MAYES COUNTY		09/26/03	09/26/03	09/26/04	No
400034#	SPRINGER, TOWN OF	CARTER COUNTY	12/17/76	04/19/10	04/19/10	12/17/77	No
400326#	ST. LOUIS, TOWN OF	POTTAWATOMIE COUNTY		04/02/92	09/03/10	04/02/93	No
400177	STONEWALL,TOWN OF	PONTOTOC COUNTY	06/28/74	08/01/87	08/01/87	08/01/87(S)	No
400557#	STRANG, TOWN OF	MAYES COUNTY		09/26/03	09/26/03	09/26/04	No
400100#	STRONG CITY, TOWN OF	ROGER MILLS COUNTY		08/09/00	08/09/00	08/09/01	No
400330	STUART, CITY OF	HUGHES COUNTY	11/12/76	02/05/86	02/05/86	10/28/97(W)	No
400418#	TEMPLE, TOWN OF	COTTON COUNTY	07/16/76	09/06/89	09/27/91	07/16/77	No
400421#	TRIBBEY, TOWN OF	POTTAWATOMIE COUNTY		09/03/10	09/03/10	09/03/11	No
400333	TUPELO, CITY OF	COAL COUNTY	09/17/76		09/17/76	09/17/77	No
400446#	VALLIANT, TOWN OF	MCCURTAIN COUNTY		07/22/10	07/22/10	07/22/11	No
400447#	VELMA, CITY OF	STEPHENS COUNTY	02/11/77	12/15/90	01/16/92	02/11/78	No
400180#	WANETTE, TOWN OF	POTTAWATOMIE COUNTY	12/20/74	04/02/92	09/03/10	12/20/75	No
400575#	WARWICK, TOWN OF	LINCOLN COUNTY		08/19/10	08/19/10	08/19/11	No
400338#	WAUKOMIS, TOWN OF	GARFIELD COUNTY	02/04/77	09/27/91	09/30/95	02/04/78	No
400075#	WEBB CITY,TOWN OF	OSAGE COUNTY		04/02/08	04/02/08	04/02/09	No
400451	WELCH, TOWN OF	CRAIG COUNTY	07/16/76		07/16/76	07/16/77	No
400452#	WELLSTON, TOWN OF	LINCOLN COUNTY	04/09/76	08/19/10	08/19/10	04/09/77	No
400339#	WEST SILOAM SPRINGS, TOWN OF	DELAWARE COUNTY	04/09/76	04/16/03	08/05/10	04/09/77	No
400455#	YALE, CITY OF	PAYNE COUNTY	08/22/75	05/16/07	05/16/07	08/22/76	No

FEDERAL EMERGENCY MANAGEMENT AGENCY

Community status report

OKLAHOMA

Summary:

Total not in flood program	**220**
Total suspended from emergency program	**0**
Total suspended from regular program	**9**
Total withdrawn communities not in program	**4**
Total not on program with hazard area identified	**220**
Total not in program with hazard area identified <1 year	**4**

Legend:

(E)	**Indicates Entry in Emergency Program**
NSFHA	**No Special Flood Hazard Area – All Zone C**
(>)	**Date of Current Effective Map is after the Date of This Report**
N/A	**Not Applicable at this time**
(S)	**Suspended Community**
(W)	**Withdrawn Community**
(M	**No elevation determined – All Zone A, C and X**
(L)	**Original FIRM by letter – All Zone A, C and X**

Appendix: C

Each section of the plan update from the period of prior approval through October 26, 2010 was analyzed and reviewed by the OEM administrative staff to determine whether updates to the plan were necessary. Appendix C was reviewed by the OEM staff who determined that updating was required. No planning meetings were conducted for this update. Planning meeting data from previous updates was deleted.

C.1 Planning Meetings

THIS SECTION IS RESERVED FOR FUTURE USE

PLANNING MEETINGS WERE NOT CONDUCTED FOR THIS PLAN UPDATE.

THE OEM STAFF REVIEWED ONE HUNDRED EIGHTY FIVE APPROVED PLANS AND USED THAT DATA FOR THE CURRENT UPDATE.

Appendix: D

Each section of the plan update from the period of prior approval through October 26, 2010 was analyzed and reviewed by the OEM administrative staff to determine whether updates to the plan were necessary. Appendix D was reviewed by the OEM staff who determined that updating was not required.

D.1 Oklahoma Mitigation Success Stories

D.1.1 (Guthrie, Oklahoma):

The City of Guthrie is a small community in central Oklahoma located along Cottonwood Creek. After repetitive flooding, the citizens and local officials said enough was enough. A comprehensive flood hazard mitigation plan that detailed a downtown rehabilitation and flood mitigation project outlined a multi-year project combining historic rehabilitation with acquisition and demolition involving 100 structures. Guthrie has also prevented future development near the creek by acquiring land and converting it to recreational space. This was all accomplished with a grant from the Department of Commerce. The City's priority was and is: economic development, historic preservation, and Tourism and flood mitigation.

D.1.2 (Miami, Oklahoma):

Another good example of innovative, sustainable thinking can be found in Miami, Oklahoma. This is a town of about 13,000 on the banks of the Neosho River and Tar Creek in northeast Oklahoma. With the occurrence of repeated flooding, the residents decided to relocate outside of the floodplain rather than construct levees. Citizens chose to work with the river rather than attempt to control it. EM Director, Terry Durborrow, applied for HMGP funds to acquire and demolish 10 structures under DR 1058. Additional funding is being applied for under DR 1355.

On May 3, 1999, more than 70 tornados tore through Oklahoma.

As a result of these tornados, 44 persons died, and almost 800 were injured. The State of Oklahoma launched an initiative to promote and support the construction of storm shelters in homes. The initiative was the first large scale effort to build thousands of safe rooms through a rebate program and its success is a direct result of the involvement and strong support of the Governor of Oklahoma and the participation of partners in industry, business, government and the private sector. Thousands of safe rooms were built and although funding for this rebate program has ended, the initiative continues to result in the construction of safe rooms throughout the State through #1465 and #1355.

The Oklahoma Safe Room Initiative continues through Project Impact and HMGP. The city of Lawton and Logan County are constructing over 1000 shelters to protect their citizens. The Chickasaw Nation is building shelters for over 400 in their area. Through the USDA, citizens can apply for a 1% interest loan to build a safe room or shelter. Following the May 8, 2003 tornado disaster, a $3.6 million HMGP project will acquire approximately 1800 more shelters for the citizens of Oklahoma.

D.1.3 (Moore, Oklahoma):

*Above ground safe room: D*on Stanley and his family are no strangers to storms and tornados. Their first home was hit twice by tornados, in October 1998 and then again on May 3, 1999, when it was destroyed. In December 2000, the Staley's new home was ready in Moore, Oklahoma. Shortly after moving in, they had an above ground safe room constructed on the back patio. When the warning sirens sounded on Thursday, May 8, 2003, Don along with his dog and two cats took shelter in the safe room. When he later emerged from the shelter, he found his house in shambles with the roof ripped off.

This house was among the more than 300 homes destroyed in the City of Moore, Oklahoma. Moore also was hit by a severe tornado in May of 1999, which claimed 44 lives; there were no deaths in 2003. The absence of fatalities is being attributed to community preparedness, improved early warning systems and the many safe rooms and shelters that have been built since the last tornado. Mr. Staley summed it all up, "The safe room saved my life. It came through with flying colors. It's worth a million bucks to me."

D.1.4 (Moore, Oklahoma):

*In-Ground Safe room: C*harles Atchley and his wife escaped unscathed after the 1999 Oklahoma tornado, but decided not to take their good fortune lightly. They took advantage of the tornado initiative ($2,000 rebate) and installed a belowground safe room. During the tornado of May 8, 2003, which struck Moore, Oklahoma, Mr. Atchley took shelter in his safe room along with his three

grandchildren. When the storm passed, his family left the shelter, safe and sound. Mr. Atchley said the storm shelter gives him "peace of mind" that he wouldn't trade for anything."

D.1.5 (Oklahoma):

*Below Ground Safe room: T*he Price family has lived in Oklahoma for many years. Severe storms and tornados are frequent occurrences in the area and are a cause of great anxiety for the residents. Twenty seven years ago, Mr. Price had a below ground storm shelter installed in the backyard. On May 9, 2003, Mrs. Price heard about the approaching storm on TV. A tornado watch was in effect. Mrs. Price described the sounds of the storm as a lot of noise like rocks hitting the door of the shelter and a loud roar. When they opened the door, debris had blown and blocked visibility to the house and the power poles were all down. There was some roof and window damage to the Price home and the car was damaged. "Fifteen people walked out of the shelter without a scratch. I don't have one thing in this house worth a life. I feel safe in the shelter" stated Mrs. Price. She is going to give tornado shelters as a lifetime gift to each of her four children.

D.1.6 (Porum, Oklahoma):

Public School Safe room

In September of 2002, Porum Public Schools requested a grant through the Hazard Mitigation Grant Program (HMGP) under FEMA 1355-DR-OK to build an above ground storm shelter that would hold approximately 700 people. The grant was approved in March of 2003 and construction began on the safe room, along with a new gym and auditorium. The project was completed on time and closed out the 2nd quarter of 2005.

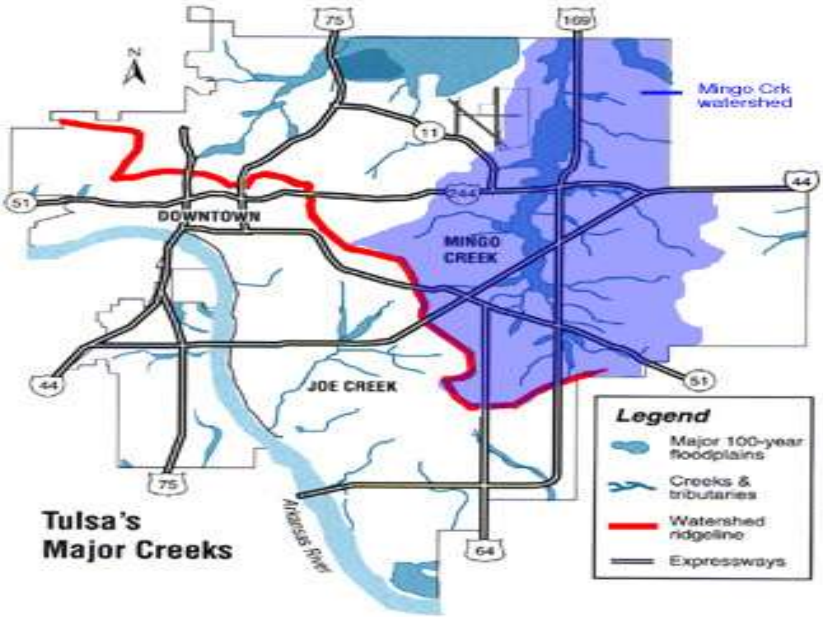
D.1.7 (Skiatook, Oklahoma):

The river overflowed the banks of the Bird Creek Basin and inundated Skiatook in 1985, 1986, 1988, 1990, 1993, and 1995. The flooding affected the city of about 5000 people. In a referendum after the flood, the people of Skiatook decided they would not try to rebuild back in the same path of the flooding. They voted to relocate to higher ground. In 1998, City Manager Eric Wiles applied for HMGP funding, to acquire and demolish 19 structures, completing this project in May 2002. This project was also incorporated into a FMA grant to include several additional structures.

D.1.8 (Tulsa, Oklahoma)

Mingo Creek Greenway Corridor:

Mingo Creek Basin in Tulsa, Oklahoma had caused over $216 million in flood damage since 1959 and $180 million in property damage and the loss of five lives in 1984. Plans designed to control flooding were developed. The City of Tulsa retained R.D. Flanagan & Associates to review the designs, work with the U.S. Corps of Engineers and to develop and refine an alternative plan sensitive to the ecological, visual and cultural needs of the community. This effort resulted in the development of an open multi-jurisdictional, multi-objective design process that changed the way drainage and flood control facilities are planned and designed.

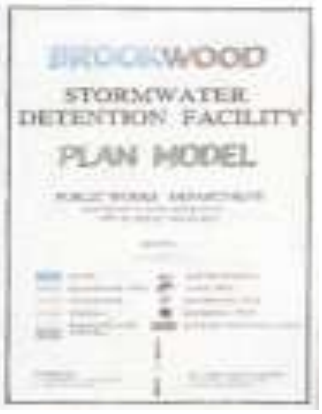


D.1.9 (Tulsa, Oklahoma)

Vensel Creek Master Drainage Plan:

R.D. Flanagan & Associates was retained by the Engineering Department, City of Tulsa, to develop a process for the comprehensive planning of drainage basins within the city. The project included performing a pilot study on a developing basin in south Tulsa and development of a standard planning format for subsequent studies. Since the Vensel Creek Trail Plan, the City of Tulsa has completed master drainage plans on all drainage basins and multi-use trails within its jurisdiction of over 150 square miles.

Detailed design and implementation plans were developed for the Brookwood Detention Facility. This plan involved extensive citizen participation and resulted in a park-like facility with a permanent water feature, landscaping and trails.



D.1.10 (Tulsa, Oklahoma)

Cooley/Tupelo Corridor Plan:

R.D. Flanagan & Associates was the design team leader in a consortium of planners and landscape architects retained to develop multi-use plans and detailed designs for eight regional storm water detention facilities in the Cooley Creeks drainage basins. The drainage basins are major tributaries to Mingo Creek in eastern Tulsa. The Cooley Lake and Sampson Lake sites were designed to serve as passive recreation facilities with a permanent water feature and trail systems.

D.1.11 (Tulsa, Oklahoma)

Mooser Creek Greenway Corridor:

R.D. Flanagan & Associates was selected as the chief planner in assisting the City of Tulsa and the Rivers, Trails, and Conservation Assistance Program of the National Park Service in the development of a pilot greenway and trails project for the Mooser Creek Basin in southwest Tulsa. The solution presented was to create artificial sites that imitate nature by ponding runoff during spring and fall rains, but for the rest of the year serve as parks, playing fields and wildlife habitat. The project involved extensive citizen involvement, interagency inter-governmental cooperation and coordination, extensive inventory, alternative development and refinement of the selected plan.

D.1.12 (Tulsa, Oklahoma)

Tulsa Trails:

R.D. Flanagan & Associates developed the first Tulsa Trails Master Plan for the City of Tulsa in 1987. This first "Blue-Greenway" plan illustrated the trails concept utilizing the River Parks trail system, major drainage corridors, traffic ways, and connector systems linking public facilities, parks, schools, commercial and employment centers, and storm water detention ponds. This early trails master plan served as the basis for the later INCOG Tulsa Area Parks and Trails Plan. In July 1992, FEMA selected Tulsa for its Outstanding Public Service Award because of the city's "Significant contributions and distinguished leadership" to the nation in floodplain management.

D.1.13 (Tulsa, Oklahoma)

Community Rating System:

A 1976 study identified Tulsa, Oklahoma as the most flood-prone community in the nation. In 1984, Tulsa lost 14 people and $180 million in damages to nearly 7,000 homes and businesses. Tulsa County was leading the nation in flood frequency. Due to the dedicated effort of citizens and the government, less than 20 years later Tulsa was generally recognized as having the best floodplain management program in the nation. In September 2003 the City of Tulsa was honored by FEMA under the Department of Homeland Security for becoming the first city in the nation to receive a Community Rating System rating of 2. As a result Tulsans in the Special Hazard Flood Areas receive a 40% discount on flood insurance. Today, Tulsa's floodplain and storm water program is based on respect for the natural systems. It includes comprehensive watershed management, dedicated funds for maintenance and operation, a prototype alert system, and a $200 million capital improvements program.

Tulsa's Acquisition Program began in the mid 1970s as a part of the storm water management and flood control program. It now is part of the city's larger Natural Hazards Mitigation Plan that began in 2002. To date, Tulsa has cleared more than 900 buildings from its floodplains under the Acquisition program and the land is now managed as open space. Prior to 1995, Tulsa had acquired demolished and removed structures with only local funding. Now the primary source of funding for the Acquisition Program is HMGP and FMA so the program has become entirely voluntary. Local match comes from sales tax and bond issue packages.

D.1.14 (Tulsa, Oklahoma)

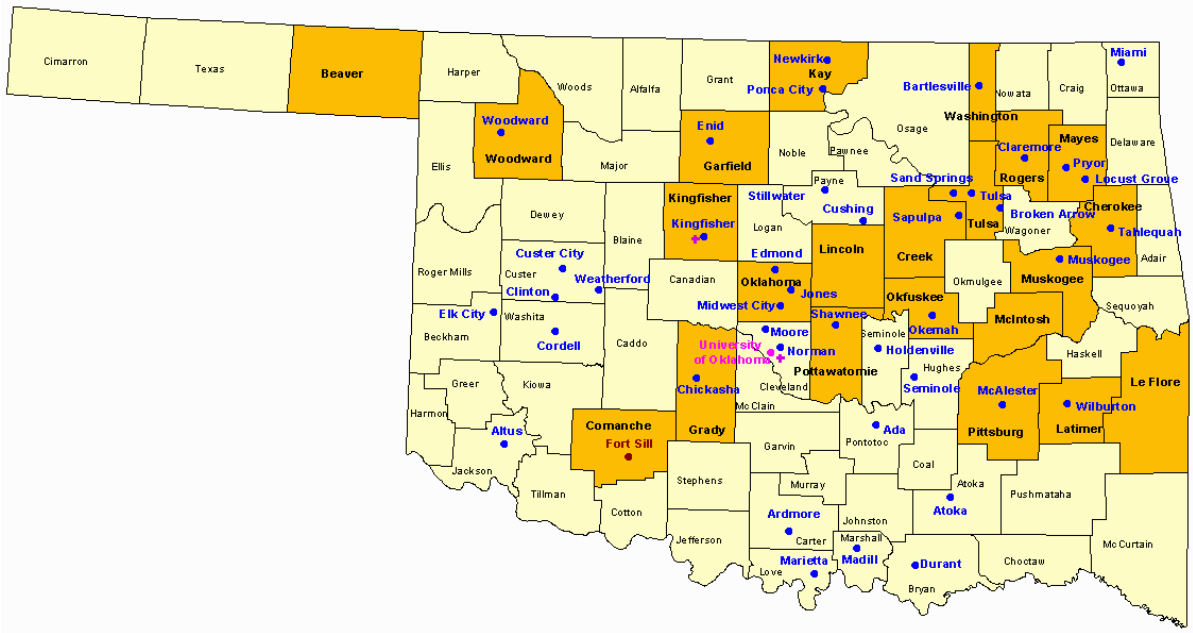
StormReady

Some 90% of all presidentially declared disasters are weather related, leading to around 500 deaths per year and nearly $14 billion in damage. StormReady, a program started in 1999 in Tulsa, Oklahoma, gives communities skills and education needed to survive severe weather-before and during the event. StormReady communities are better prepared to save lives from the onslaught of severe weather through better planning, education, and awareness. To be recognized as StormReady, a community must:

1. Establish a 24-hour warning point and emergency operations center,
2. Have more than one way to receive severe weather forecasts and warnings and to alert the public,
3. Create a system that monitors local weather conditions,

4. Promote the importance of public readiness through community seminars,
5. Develop a formal hazardous weather plan, which includes training severe weather spotters and holding emergency exercises.

Oklahoma: 65 StormReady Designations: 22 Counties and 41 Communities 1 University, 1 military base, 2 StormReady supporters (most current data)



StormReady Counties: Gold Shading		StormReady Communities: Blue Dot			University: Purple Dot
• Beaver • Cherokee • Comanche • Creek • Garfield • Grady • Kay • Kingfisher • Latimer • Le Flore • Lincoln • Mayes	• McIntosh • Muskogee • Okfuskee • Oklahoma • Pittsburg • Rogers • Pottawatomie/ Shawnee • Tulsa • Washington • Woodward	• Ada • Altus • Ardmore • Atoka • Bartlesville • Broken Arrow • Chickasha • Claremore • Clinton • Cordell • Cushing • Custer City • Durant	• Edmond • Elk City • Enid • Holdenville • Jones • Kingfisher • Locust Grove • Madill • Marietta • McAlester • Miami • Midwest City • Moore • Muskogee	• Newkirk • Norman • Okemah • Ponca City • Pryor • Sand Springs • Sapulpa • Seminole • Stillwater • Tahlequah • Tulsa • Weatherford • Wilburton • Woodward	University of Oklahoma **Government Site: Brown Dot:** Fort Sill Supporters: Purple Plus Sign Pioneer Telephone Cooperative Kingfisher Sooner Mall

Appendix: E

Each section of the plan update from the period of prior approval through October 26, 2010 was analyzed and reviewed by the OEM administrative staff to determine whether updates to the plan were necessary. Appendix E was reviewed by the OEM staff who determined that updating was required. The E2 Chart below was updated to show current data.

E.1 Proposed Mitigation Projects/Local Plans

Place holder for future mitigation projects.

E.2 Current Project Status Summary

CATEGORY	NUMBER			COMPLETED		
Acquisitions	2008; 2009; 2010			2008; 2009; 2010		
	7	7	5	3	3	5
Bridges	0			0		
Codes	0			0		
Drainage	0			0		
EOC	1	1	1	0	0	0
Equipment	0			0		
Fire	0			0		
Flood	0			0		
Generator	0	30	34	0	0	7
Haz-Mat	0			0		
Mapping	2	2	2	0	0	0
Other	7	21	19	0	2	2
Plans	174	153	104	45	54	40
Preparedness	0			0		
Public Education	0			0		
Safe Rooms	6	4	0	6	0	0
Safety	0			0		
Training	0			0		
Warning	8	30	30	0	6	9
Totals	205	248	195	54	65	63

Other = NOAA Weather Radios, Reverse 911, Hardwire Switch, Fixed Weather Stations, Hearing Impaired, NOAA Weather Repeaters, EMWIN (Emergency Management Weather Information Network)

Appendix: F

Each section of the plan update from the period of prior approval through October 26, 2010 was analyzed and reviewed by the OEM administrative staff to determine whether updates to the plan were necessary. Appendix F was reviewed by the OEM staff who determined that updating was not required.

F.1 Oklahoma Intrastate Mutual Aid Compact

Title 63. Public Health and Safety

Oklahoma Statutes Citationized

Title 63. Public Health and Safety

Chapter 29A - Oklahoma Intrastate Mutual Aid Compact

Section 695.2 - Purpose - Definitions

Cite as: O.S. §, __ _

A. The purpose of the Oklahoma Intrastate Mutual Aid Compact is to create a system of intrastate mutual aid between participating jurisdictions in the state.

B. As used in the Oklahoma Intrastate Mutual Aid Compact:

1. "Jurisdiction" means any county, city, town or municipal corporation of the State of Oklahoma represented by an elected governing body.

Sovereign Tribal Nations in the State of Oklahoma shall also be considered jurisdictions under the Oklahoma Intrastate Mutual Aid Compact and participating unless electing not to participate or later withdrawing from the system;

2. "Emergency" means any occasion or instance for which assistance is needed to supplement local efforts and capabilities to save lives and to protect property and public health and safety, or to lessen or avert the threat of a catastrophe; and

3. "Emergency responder" means anyone with special skills, qualifications, training, knowledge, and experience in the public or private sectors that would be beneficial to a participating jurisdiction in response to a local emergency as defined in applicable law or ordinance or authorized drill or exercise.

C. Each participant of the system shall recognize that emergencies transcend political jurisdictional boundaries and that intergovernmental coordination is essential for the protection of lives and property and for best use of available assets both public and private. The system shall provide for mutual assistance among the participating jurisdictions in the prevention of, response to, and recovery from, any disaster that results in a formal state of emergency in a participating jurisdiction subject to the criterion for declaration of that participating jurisdiction. The system shall provide for mutual cooperation among the participating jurisdictions in conducting disaster-related exercises, testing, or other training activities outside actual declared emergency periods. This legislation provides no immunity, rights, or privileges for any individual responding to a state of emergency that is not requested and/or authorized to respond by a

participating jurisdiction. Participating jurisdictions will be ensured eligibility, to the fullest extent possible, for state and federal disaster funding.

D. All jurisdictions within the state, upon enactment of this legislation, are automatically a part of the statewide mutual aid system. A jurisdiction within the state may elect not to participate or to later withdraw from the system upon enacting an appropriate resolution by its governing body declaring that it elects not to participate in the statewide mutual aid system and providing a copy of the resolution to the Oklahoma Department of Emergency Management. This legislation does not preclude participating jurisdictions from entering into supplementary agreements with another jurisdiction and does not affect any other agreement to which a jurisdiction may currently be a party or decide to be a party to.

E. Many disasters begin as emergencies where local jurisdictions require fire service and/or law enforcement assistance. These services would normally be requested and provided at the department level as normal day-to-day operations with no reimbursement. If an incident response expands beyond a normal day-to-day emergency into a disaster situation, reimbursement for mutual aid services may be necessary and will be in accordance with the Federal Emergency Management Agency reimbursement policy.

F. In support of the Emergency Management Compact, Section 684.1 et seq. of Title 63 of the Oklahoma Statutes, the Governor or the representative of the Governor may request mutual aid assistance from local jurisdictions for other states or their jurisdictions. In such situations, the assisting local jurisdiction shall be considered an agent of the state.

Historical Data

Added by Laws 2006, HB 2585, c. 199, § 4, emerg. Eff. May 26, 2006.

Citationizer© Summary of Documents Citing This Document

Cite	Name	Level
None Found.		

Citationizer: Table of Authority

Cite	Name	Level
None Found.		

Appendix: G

G.1 State Critical Facilities

Each section of the plan update from the period of prior approval through October 26, 2010 was analyzed and reviewed by the OEM administrative staff to determine whether updates to the plan were necessary. Appendix G was reviewed by the OEM staff who determined that updating was required. A current listing of all state facilities follows at the end of this appendix.

THE INFORMATION CONTAINED IN THIS ANNEX IS NOT TO BE DISTRIBUTED TO THE PUBLIC DUE TO SECURITY CONCERNS. FOR ADDITIONAL INFORMATION ON THIS APPENDIX CONTACT THE STATE HAZARD MITIGATION OFFICER AT 405-521-2481.

Appendix G

State Critical Facilities

NOTE: This Appendix contains information for some State Agencies that are critical to the health, safety and security of the public in Oklahoma.

Withheld from public disclosure.

For information regarding release of this data please contact:

State Hazard Mitigation Officer

(405) 521-2481

CRITICAL FACILITIES

(APPENDIX IS NOT FOR PUBLIC RELEASE DUE TO SECURITY CONCERNS)

For the purpose of this plan *critical facilities* means: State owned assets which are vital to health, safety and well being of Oklahomans during a time of Natural Disaster.

H.1 Detailed Hazard Data

Provided by: Oklahoma Climatological Survey

For the use of planners writing plans for Oklahoma Jurisdictions

Drought – Oklahoma's Costliest Natural Hazard

Drought is a "creeping hazard" that is a recurring and natural part of Oklahoma's climate cycle. It does not produce images and descriptions as compelling as those of violent weather. For this reason, it often receives little attention until it is too late for decisive mitigating action. Despite the relative inattention paid to drought, its larger coverage and longer timescales make it Oklahoma's costliest natural hazard.

A Definition of Drought

Drought is a very complex natural phenomenon, because its very identity is intimately tied to society. There is no single universal definition of drought, but perhaps the most widely accepted definition is deceptively simple: drought occurs when the water resources (*supply*) are unable to meet established water needs (*demand*). This definition identifies two distinct factors in determining the existence or severity of a drought:

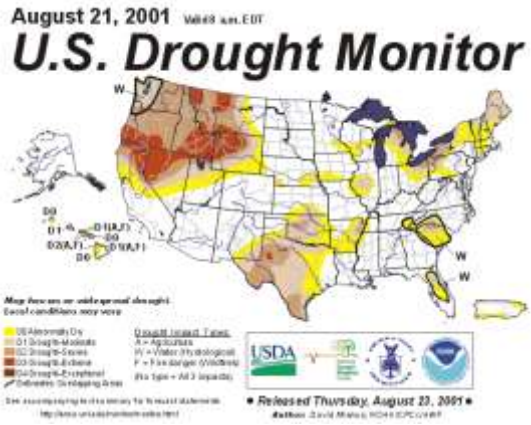
1. The available supply of usable water, which is heavily influenced by natural factors.
2. The demand for water, which is heavily influenced by social customs.

Oklahoma and several of its Plains States neighbors differ from much of the rest of the country, especially the West, in that it imports very little surface water through rivers. The vast majority of water used in Oklahoma falls in Oklahoma, unlike many western U.S. States that rely on precipitation from other parts of the country for their water needs. This simplifies the assessment of drought somewhat for Oklahoma, such that precipitation versus historical values is a strong indicator of drought severity.

Drought's ability to produce widespread economic damage is far greater than that of violent weather. In fact, the numbers associated with drought damage are staggering. On a national scale, ten of the 58 billion-dollar disasters from 1980-2003 were related to drought or associated heat. However, those ten disasters accounted for nearly half (41.2%) of the group's economic damage.

Keeping an Eye on Drought Conditions

One way that the possibility of a drought can be monitored is through the U.S. Drought Monitor. This is a tool used by the Climate Prediction Center to monitor rainfall trends and determine how harsh a drought might be. It gives a good idea of the lack of rainfall as compared to normal, average values. There are five different categories on the drought monitor. D0 is abnormally dry, D1 is a moderate drought, D2 is a severe drought, D3 is an extreme drought, and D4 is an exceptional drought. It should be noted, however, that the Drought Monitor focuses on broad-scale conditions and that local conditions may vary.



Differing Timescales of Vulnerability / Differing Times of Vulnerability in Oklahoma

Throughout its known history, Oklahoma has been susceptible to drought. Short-term events (1-2 months) are fairly common, and tend to occur somewhere within the state during most years. Increased fire danger and/or crop/lawn stress often accompany these episodes. Medium-term (up to a

year) drought episodes can encompass a crop cycle, causing significant economic damage, or cause water supply/distribution problems for municipalities. Longer-term droughts (several years) add the issue of reservoir and aquifer depletion. Because these long-term events are often composed of intermittent episodes, their onset and conclusion are often difficult to identify until long after the event is over.

Different interests are vulnerable to drought episodes over differing timescales. The following timescales are approximate, and vary due to several contributing circumstances (see below).

Some Timescales of Drought Vulnerability					
Drought Issue or Vulnerable Community	**Approx. Time scale of onset**	**Some prominent impacts**	**Approximate *average* time between significant events on this time scale**	**Contributing factors and circumstances**	**Related notes**
Drought-enhanced Wildfire Danger	1-2 months	Dried organic soil material can act as additional fuel to wildfire; more frequent wildfires; more intense wildfires	Fairly common. Tends to occur at least somewhere in the state during most years.	Time since last burn; density of undergrowth (often enhanced by preceding prolonged wetness); severity of drought.	Somewhat seasonal.
Horticulture / Urban, Suburban Lawns	1-2 months	Increased municipal water use; horticultural failure; lawn damage; increased pest damage	Somewhat common. Most growing seasons will undergo one or two fairly dry months. Consecutive dry months are slightly rarer.	Effectiveness of conservation and mitigation practices; severity of drought; severity of heat.	Highly Seasonal.
Municipal Water Distribution	1-2 months	Short-term water rationing (on the order of weeks); loss of revenue for water-use-dependent municipalities	Somewhat common.	Capacity and quality of distribution system; quality of conservation and mitigation practices; severity of drought; severity of heat.	Highly seasonal.
Agriculture	2-6 months	Crop failure; poor crop yield; depressed livestock prices due to sell-offs.	Severe drought-related losses struck 6-8 times since 1980 (note: highly variable by crop). Catastrophic failures occur 1-2 times per decade *on average.*	Timing of event versus crop cycle; availability and cost of irrigation water; agricultural techniques; conservation practices; crop selection; drought-tolerant varieties.	Highly tied to crop cycle; example: very dry Apr-May can help wheat harvest while destroying row crops.
Reservoir depletion	1+ years	Severe, prolonged rationing; widespread water shortages; irrigation denied		Effectiveness of conservation and mitigation practices; demand; size and engineering of reservoir.	Smaller reservoirs are more sensitive at shorter timescales.
Aquifer depletion	10+ years	Widespread farm & ranch failure;	Still very little known, but many aquifer levels are dropping in recent decades.	Financial / physical ability to drill deeper; demand.	Still little known about aquifer depletion

Table A: Various timescales of drought and some vulnerable communities.

Consequences of Drought

Some socio-economic impacts:

The overwhelming consequence of drought is economic disruption. Drought's "footprint" is quite large compared to most other weather and climate disasters. It can impact many counties, and even many states, at a time. This large area of impact can raise damages into the billions of dollars, even for one state.

Multiple timescales of drought complicate its assessment. Shorter droughts may impact just a segment of society or the economy, but as drought drags on it will force greater portions of each into stress. The low reliability of long-term forecasting often makes it difficult to assess whether a current episode will turn out to be short or long. Likewise, it is often difficult to assess whether recent rainfall will provide only temporary or lasting relief from drought.

In Oklahoma, agriculture is a particularly drought-sensitive sector. Dry land farmers rely on precipitation to water their crops. Crop failure, by itself, is hard enough on the individual grower. Multiple crop failures within a region are a common consequence of drought. The effect of multiple crop failures on the rural economy can be devastating. Livestock operators that rely on pasture for forage, particularly winter forage, are very exposed to drought.

During the warm season, municipalities are often faced with more demand for water than they are able to distribute. More often than not, the supply reservoirs have adequate storage, but the distribution system (tank storage, pumping and treatment) simply cannot keep up with the pace of demand. This leads to inconveniences of rationing and curtailment by the public, and businesses that rely on heavy water usage (car washes, landscapers) may suffer financially.

Longer-term droughts threaten the water supply itself. This is very often complicated by the behavior of municipalities during the first several months of an extended drought. Municipalities often rely on water sales for revenue. This is especially true in smaller communities, where the water utility makes up a majority of the operating budget. Because of this, these communities often operate their water systems at full-tilt until extended drought (and vanishing water supply) forces them to curtail consumption. Citizens are left with severe usage restrictions because supplies were depleted during the dry down. The associated revenue shortfall often leaves communities without adequate resources to address the immediate issues, let alone the long-term ones.

Some public safety impacts:

All droughts will act to increase fire danger. This occurs several ways. Drought-stressed vegetation may wither or die, making it a more volatile fuel for wildfire. As a drought progresses from a several-week event to a several-month event, organic material in the topsoil ("duff") dries out and becomes additional potential fuel for a wildfire.

In Oklahoma, as in much of the interior United States, summertime temperatures are tied strongly to precipitation patterns, such that summertime droughts are often accompanied by heat waves. Excessive heat threatens the well-being of several more vulnerable groups, namely the elderly, the poor and those who work outdoors. During summer in Oklahoma, the air can be quite humid, even during periods of extended drought. Humid conditions further exacerbate the excessive heat problems.

Historical Perspective

Major Drought Events in Oklahoma History

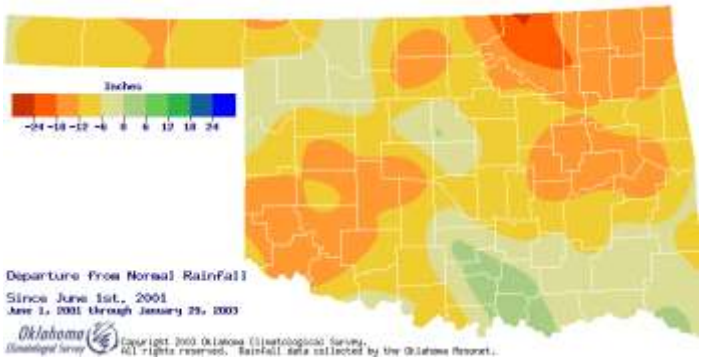
Since modern climate observation began in the mid-1890s, three such long-term episodes have severely impacted Oklahoma:

- The 1909-18 events consisted of two severe multi-year episodes, interrupted by 1915, one of the wettest years of the 20th Century. This event comprises the lowest ten-year statewide rainfall on record. 1910 was the smallest annual rainfall statewide and for four of Oklahoma's nine climate divisions.

- The Drought of 1930-40 in Oklahoma, the climate's contribution to the Dust Bowl, was not as statistically severe as those of the 1910s or 1950s, but it left the deepest scar on the state's economy and psyche. The Dust Bowl was at its worst in Oklahoma during the mid 1930s, when severe drought, intense heat, immature and/or inappropriate agricultural practices and overall economic conditions combined to cause the greatest exodus of citizens in state history. Reaction to the event revolutionized farm and conservation practices in much of the United States.

- The Drought of 1952-58 was accompanied by intense summer heat, insect invasions and crop failures. The state's "Wheat Belt", in central and north-central Oklahoma, was particularly injured by the event. The mid-50s years of 1952-1956 were easily the driest five consecutive years in state history. Ironically, 1957 was the wettest year on record, one year after 1956 became the second-driest year on record.

Recent Drought Episodes



The drought of 2001-02 was the latest (and longest, at places) of a series of dry episodes dating to the winter of 1995-96 (Table B). Agricultural losses due to the event approached one billion dollars. A winter 1995-96 episode was similar in timing to the 2001-02 drought, albeit shorter in duration. Heavy rains broke the drought in spring 1996. A summer dry spell and heat wave encompassed the state from April through

September 1998, causing water shortages in many municipalities. A severe but short-lived dry spell and heat wave occurred in late summer 2000.

Ironically, until 2001, each of these years was wetter than the established normal on a statewide annual basis. The dry episodes were masked in the annual rainfall statistics by very wet periods in the interim months.

Recent Drought and Dry Episodes					
Event	**Approx. Dates**	**Primary Areas**	**Notable Statistics (records date to 1895)**	**Primary Impacts**	**Notes**
Winter 1995-96	Oct 1995 - May 1996	Statewide, chiefly western two-thirds.	Driest Oct-May on record for west central and north central climate divisions (CDs), and statewide-averaged rainfall; 2nd-driest Oct-May on record for northeast, central and southwest CDs; South central and panhandle CDs ranked 3rd, 4th, respectively.	Smallest wheat yield in state history; cattle sell-offs brought depressed prices; February 1996 wildfire disasters in several counties	Modern Oklahoma Drought Management Plan established in event's wake. Event began shortly after remnants of Tropical Storm Dean drenched the western half of the state in August 1995.
Summer 1998	Apr 1998 – Sep 1998	Southern two-thirds of state, chiefly southwest quarter.	Driest Apr-Sep on record for west central, southwest and south central CDs. Southwest CD received 1/3 of normal rainfall.	Associated heat wave during Jun-Aug; summer crops decimated (esp. Cotton, peanuts, watermelon); arson and wildfire prevalent; municipal water rationing.	Drought broke during Sep for east central and southeast CDs, early Oct for southwestern quarter of state. Northern third of state also somewhat dry and quite hot. "Operation Haymaker" initiated to transport hay from neighboring counties and states with adequate supply. Ironically, dry Apr-May allowed ideal curing conditions for spring 1998 winter wheat harvest (largest in state history).
Late Summer 2000	Aug 2000 – Sep 2000	Statewide.	All CDs received 1/3 or less of normal rainfall; driest Aug-Sep on record for panhandle, north central, northeast, west central and south central CDs, as well as statewide; west central and north central CDs observed 1% and 6% of normal rainfall, respectively	Intense heat wave.	Short but intense episode followed a very wet Jun-Jul 2000.
2001-2002	Jun 2001 – Jul 2002	Statewide, but gradually more severe in western half.	Panhandle CD recorded 2nd-driest Jun-Jul (14 mos.) period on record; west central and north central CDs experienced 5th-driest and 6th-driest Jun-May on record, respectively.	USDA declared 30 counties agricultural disaster areas; ag losses approached $1 billion.	Much of western OK's winter precip came during devastating ice storm of Jan 2002. Drought eased in eastern half of state by early 2002 and in southwest by spring 2002. Whether panhandle fully recovered from this or recent prior episodes is debatable.

Table B. Recent drought and dry spell episodes impacting Oklahoma.

Complicating Circumstances and Mitigating Action: An Example from History

Human behavior and adaptation are dominant mitigating factors in drought's consequences. Examples of these concepts can be found in the Oklahoma experience during the 20th Century.

Across much of western Oklahoma, the rainfall statistics of the 1950s were more severe than those of the more famous 1930s "Dust Bowl" drought. However, improved agricultural practices such as crop selection were in use in the 1950s. More drought resistant crops (for example, winter wheat versus corn) did not fail as dramatically as those from the 1930s.

Conservation practices improved dramatically in two decades. During the 1930s, drought conditions (vegetation loss, exposed soils, etc.) exacerbated erosion processes. Consequently, much of western Oklahoma's topsoil was lost in the few torrential storms that occurred during the great drought. Two decades later, shelterbelts, terrace farming and retention ponds helped minimize topsoil loss due to erosion.

Surface water storage was much more prevalent during the 1950s, compared to just two decades before. On large and small scales, more dams were built in the 1950s than ever before or since in Oklahoma. Ironically, most of the structures were primarily intended for flood control, but have paid great dividends as irrigation sources.

The prevailing socio-economic conditions of the 1930s also enhanced the sensitivity of many Oklahomans to an unfriendly turn of climate. In contrast, the relatively prosperous 1950s provided a stronger economic floor of support that helped a greater percentage of the population weather the climate's signal.

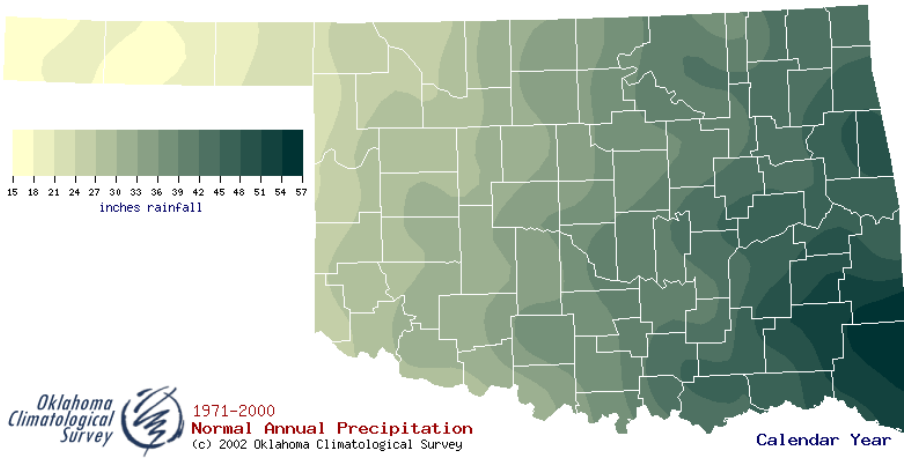
Appendix A: Variability of Precipitation

"Normal" rainfall is often misrepresented, not just in Oklahoma, but everywhere. Normal rainfall is nothing more than a 30-year average. It does not necessarily mean "should" or "supposed to" or "typical". In fact, the average rainfall is only one piece of information that can describe a region's precipitation climate. Another equally-important piece of information is variability. This represents the amount of "give or take" or "spread" around the average value.

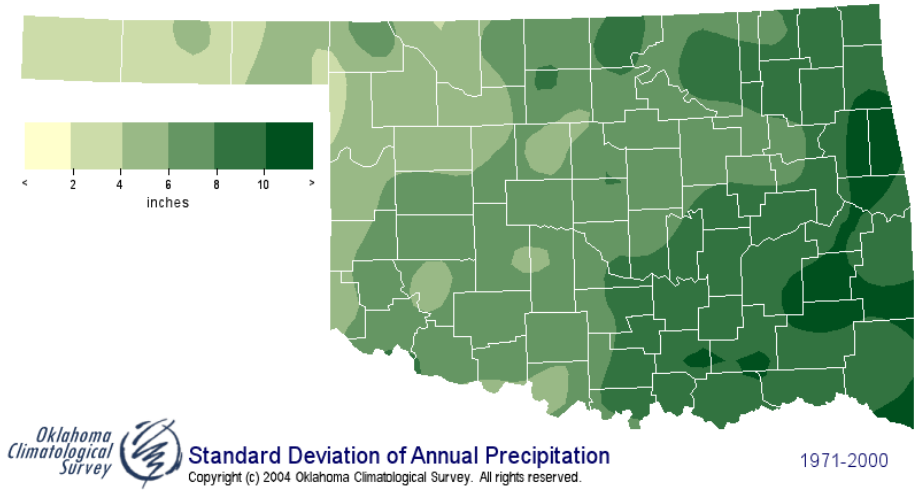
One way of expressing variability is the standard deviation. This statistical tool provides a glimpse of how much rainfall totals vary. Larger standard deviations indicate a broader naturally-occurring spread around the average. The standard deviation can be even more illustrative by examining the ratio of it with the average rainfall.

For example, normal October precipitation shows that average rainfall increases from west to east across Oklahoma. The standard deviations also increase from west to east. But upon closer inspection, the standard deviations in the west are larger than the average precipitation! This shows that October is very much an "all or nothing" month in the west, whose average precipitation is composed of a large number of dry months mixed in with some very wet months.

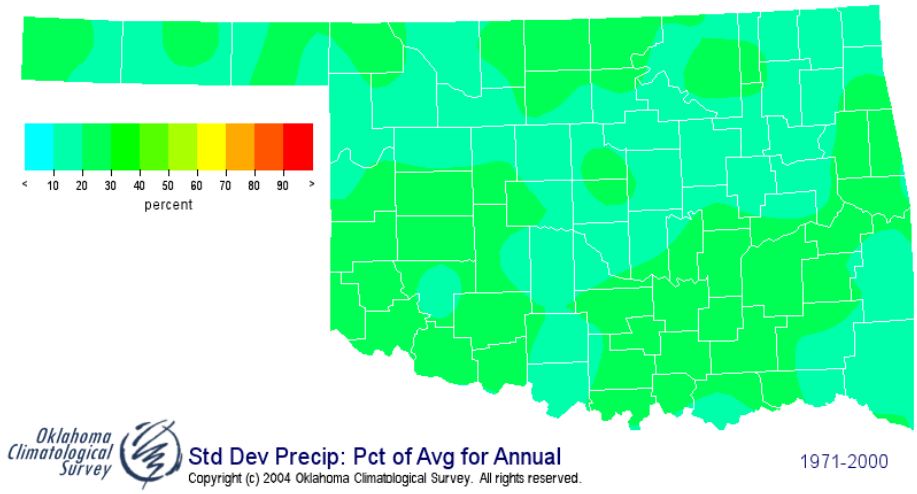
Annual Precipitation



Average annual precipitation, inches.

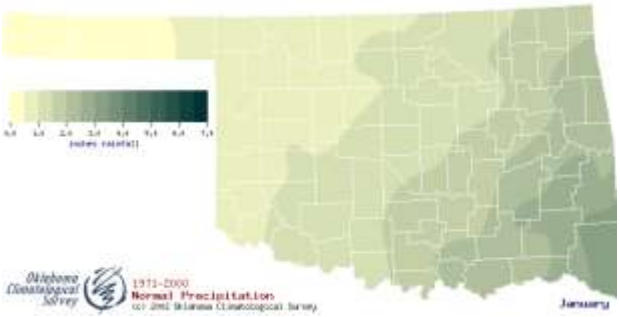


Standard deviation of annual precipitation, inches.

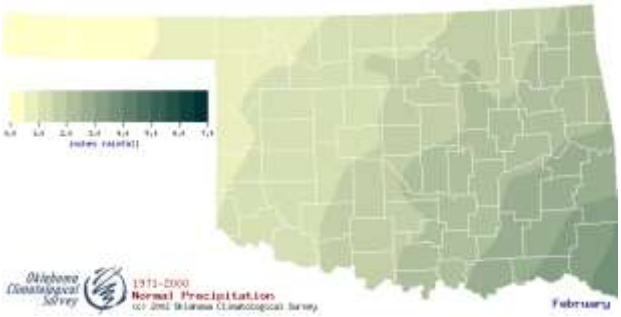


Ratio of standard deviation of annual precipitation to annual average, percent.

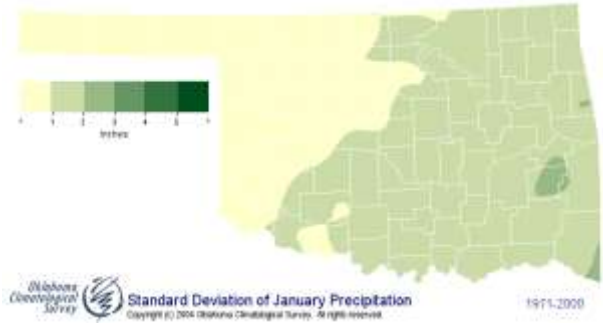
January-February



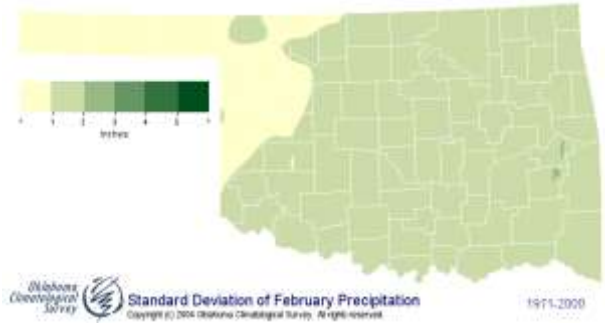
Average January precipitation, inches.



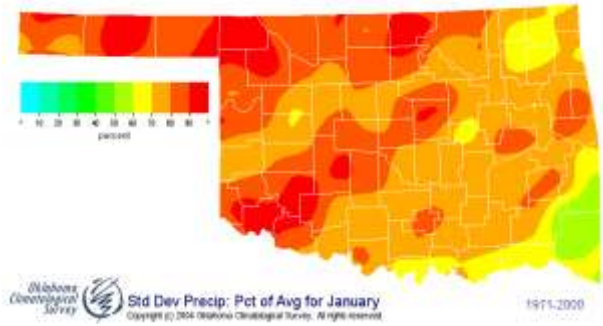
Average February precipitation, inches.



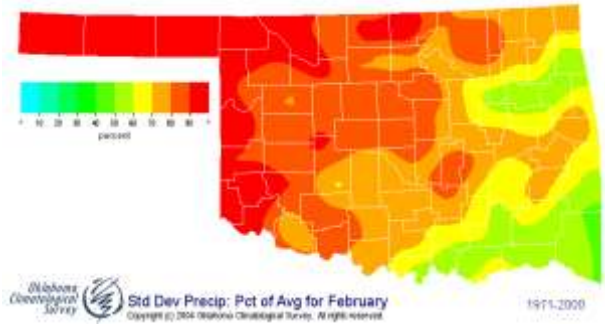
Standard deviation of January precipitation, inches.



Standard deviation of February precipitation, inches.

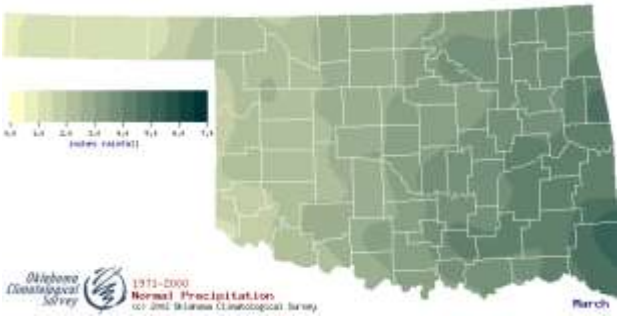


Ratio of standard deviation of January precipitation to January average, percent.

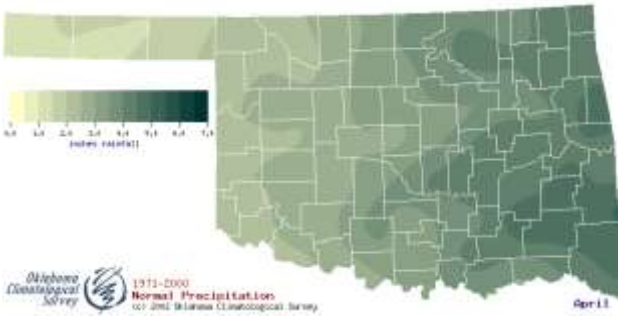


Ratio of standard deviation of February precipitation to February average, percent.

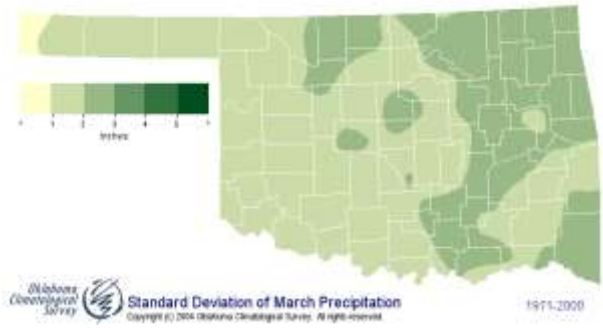
March-April



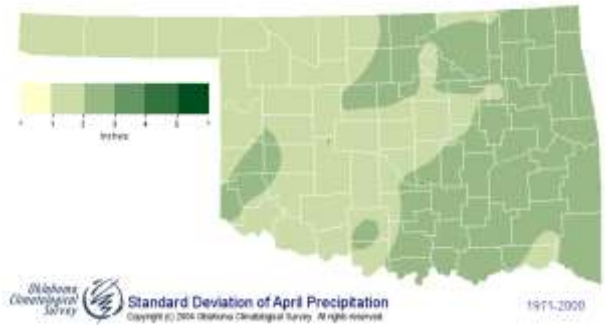
Average March precipitation, inches.



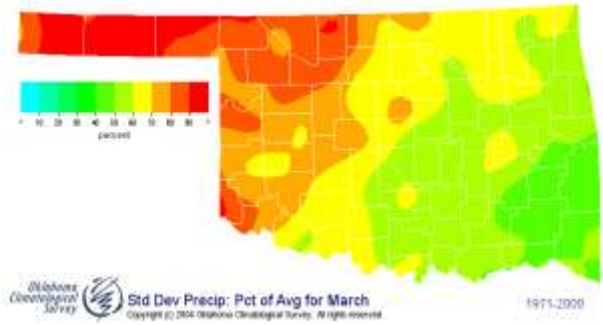
Average April precipitation, inches.



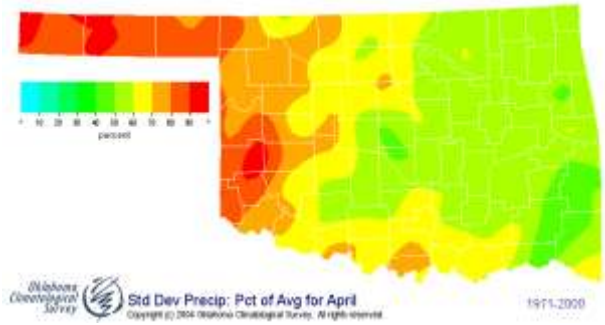
Standard deviation of March precipitation, inches.



Standard deviation of April precipitation, inches.



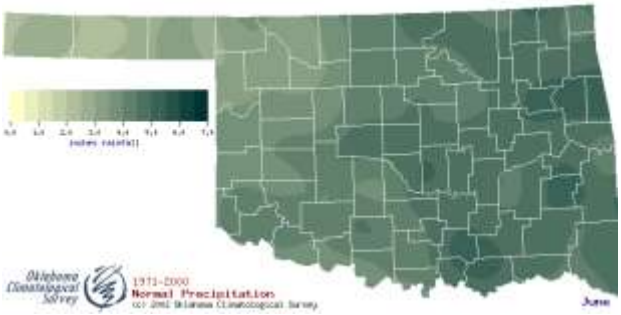
Ratio of standard deviation of March precipitation to March average, percent.



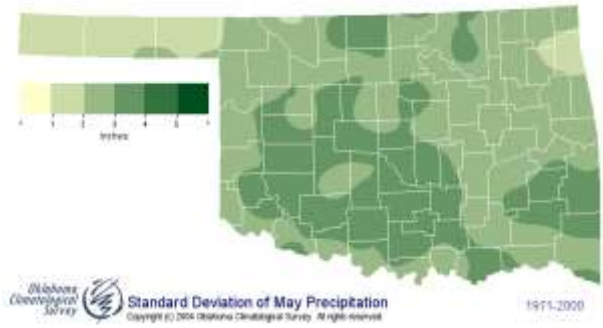
Ratio of standard deviation of April precipitation to April average, percent.

May-June

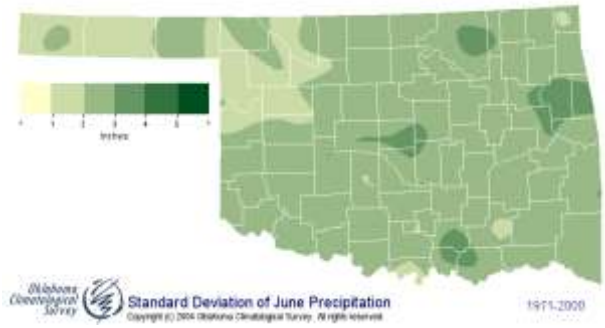
Average May precipitation, inches.



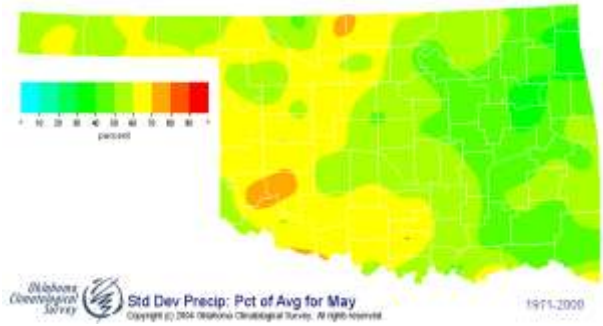
Average June precipitation, inches.



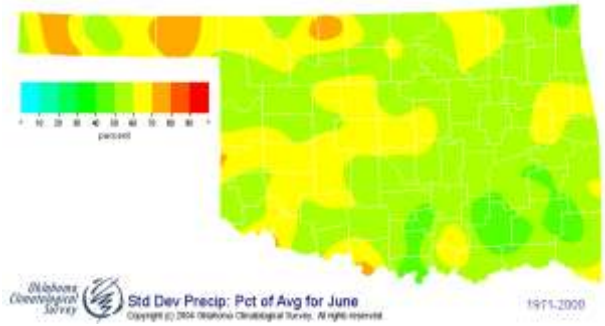
Standard deviation of May precipitation, inches.



Standard deviation of June precipitation, inches.

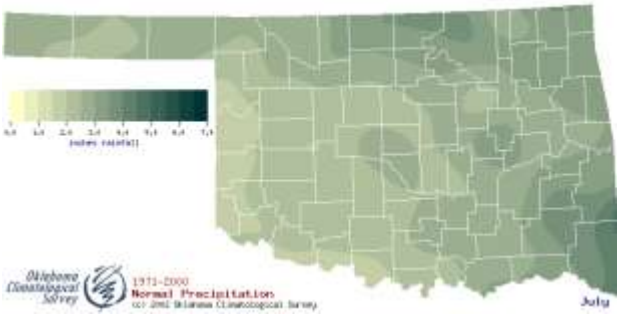


Ratio of standard deviation of May precipitation to May average, percent.

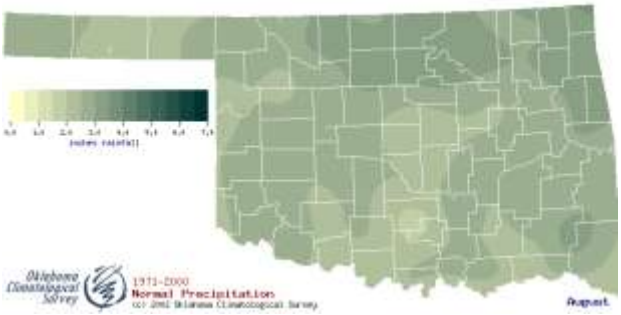


Ratio of standard deviation of June precipitation to June average, percent.

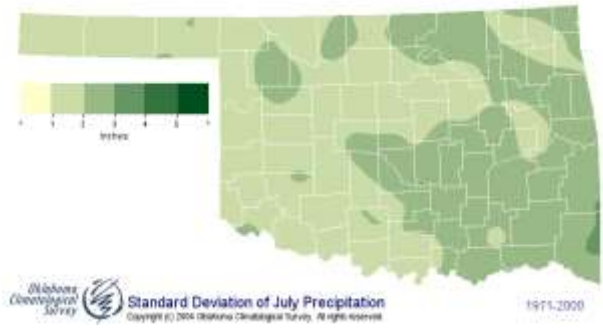
July-August



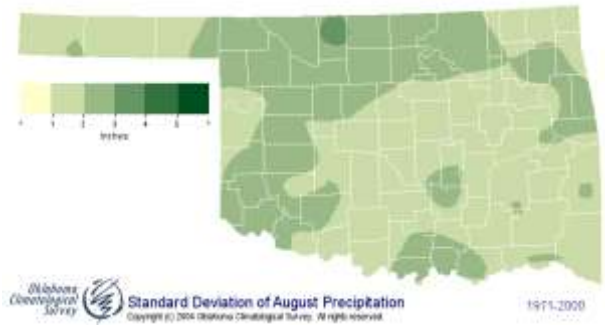
Average July precipitation, inches.



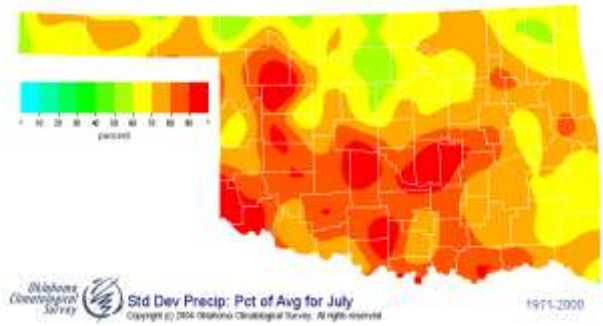
Average August precipitation, inches.



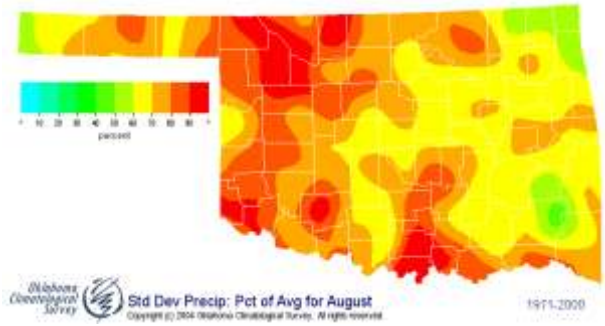
Standard deviation of July precipitation, inches.



Standard deviation of August precipitation, inches.

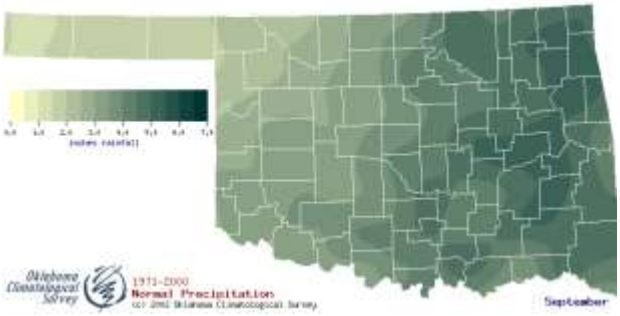


Ratio of standard deviation of July precipitation to July average, percent.

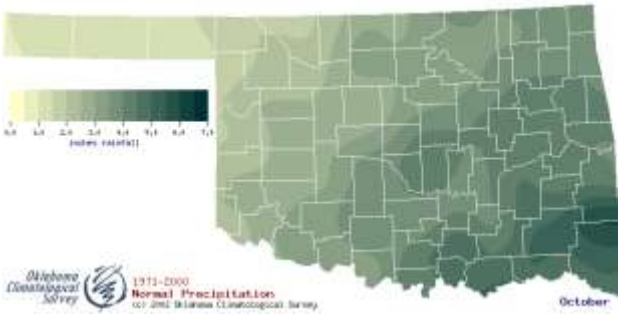


Ratio of standard deviation of August precipitation to August average, percent.

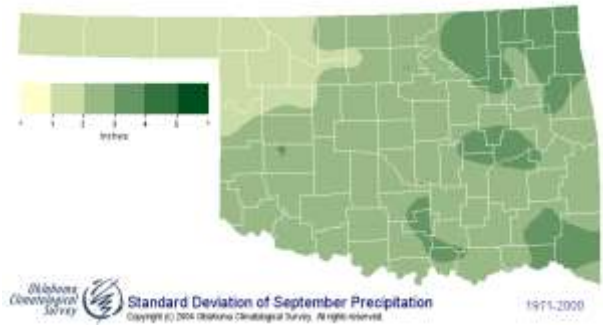
September-October



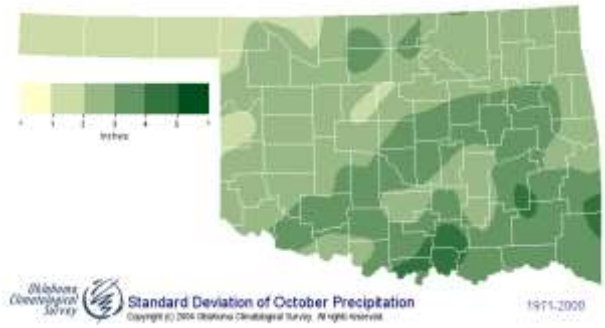
Average September precipitation, inches.



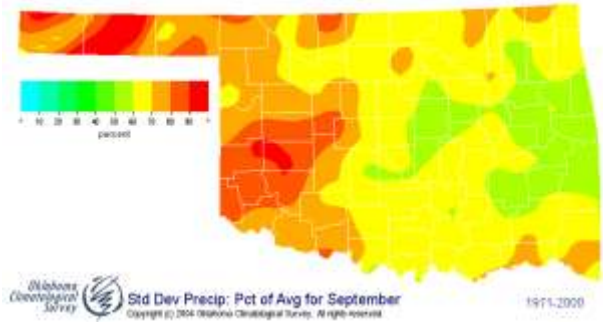
Average October precipitation, inches.



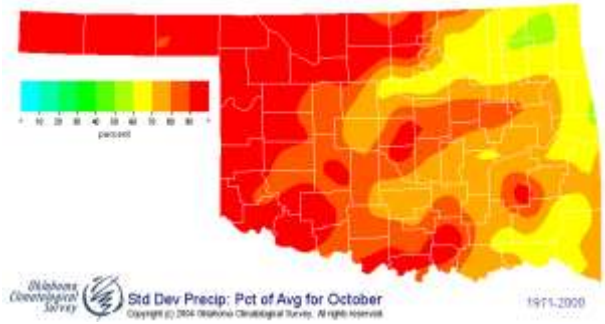
Standard deviation of September precipitation, inches.



Standard deviation of October precipitation, inches.

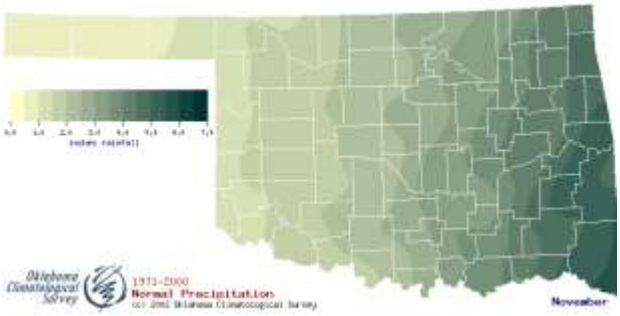


Ratio of standard deviation of September precipitation to September average, percent.

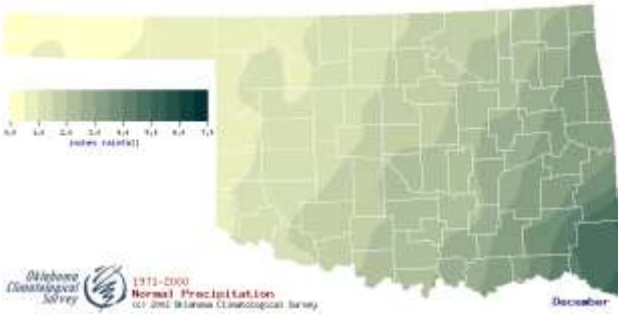


Ratio of standard deviation of October precipitation to October average, percent.

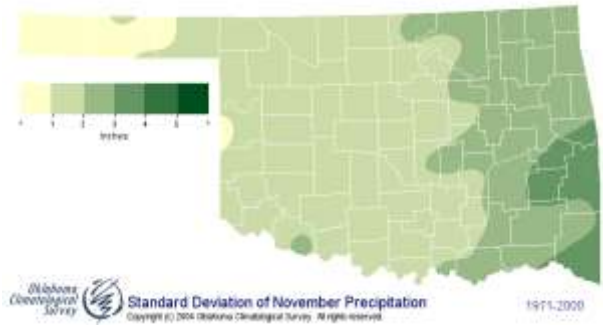
November-December



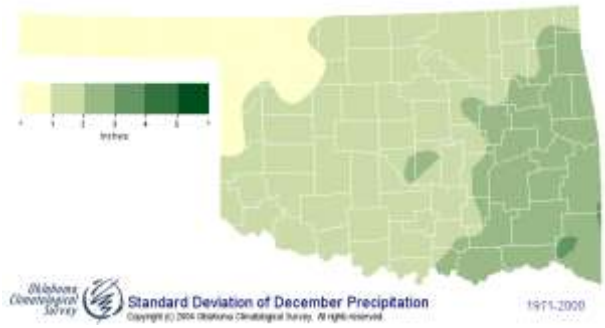
Average November precipitation, inches.



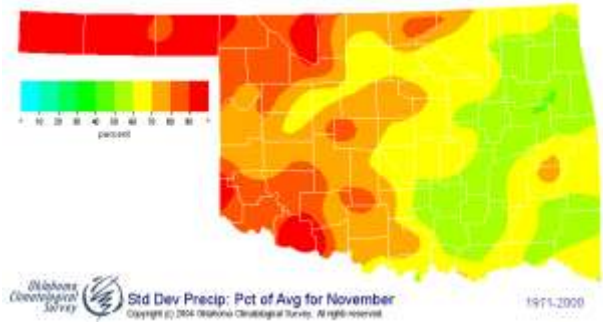
Average December precipitation, inches.



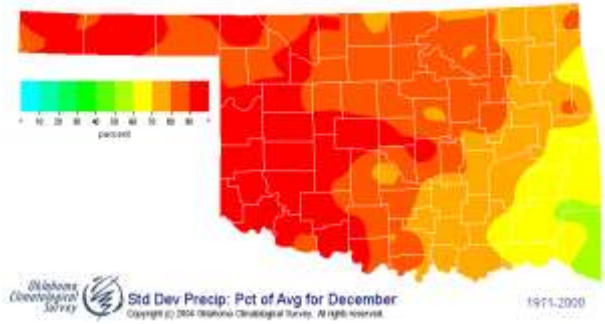
Standard deviation of November precipitation, inches.



Standard deviation of December precipitation, inches.



Ratio of standard deviation of November precipitation to November average, percent.



Ratio of standard deviation of December precipitation to December average, percent.

Appendix B: SPI values for different timescales

The following graphics provide some insight into the recurrence interval of drought on various timescales. The data points represent the Standardized Precipitation Index (SPI) on six different timescales (1-, 3-, 6-, 12-, 24- and 60-month SPI). The SPI is a measure of the "unusualness" of precipitation over that time period. Values near zero are near the middle of the population. Increasingly negative values indicate increasingly severe lack of precipitation, and increasingly positive values indicate more abnormally wet conditions.

The following table helps interpret SPI values:

SPI Value	Brief Description	Estimated Likelihood
2.00 and greater	Extremely Wet	About 2.3% of events (roughly 1 out of 40) are expected to exceed 2.00
1.50 to 1.99	Very Wet	About 6.7% of events (roughly 1 out of 15) are expected to exceed 1.50
1.00 to 1.49	Moderately Wet	About 16% of events (roughly 1 out of 6) are expected to exceed 1.00
-0.99 to 0.99	Near Normal	About 68% of events (roughly 2 out of 3) are expected to fall in this range
-1.00 to –1.49	Moderately Dry	About 16% of events (roughly 1 out of 6) are expected to exceed –1.00
-1.50 to –1.99	Severely Dry	About 6.7% of events (roughly 1 out of 15) are expected to exceed –1.50
-2.00 and beyond	Extremely Dry	About 2.3% of events (roughly 1 out of 40) are expected to exceed -2.00

For example, the 3-month statewide SPI for August 1934 was –2.50. This means that the precipitation total for the three-month period (June, July and August) was considered "extremely dry". Furthermore, based on the state's precipitation history, the statistical likelihood of receiving that little precipitation would be less than 1 out of 40 (because –2.50 is even more severe than –2.00, which is associated with a 1 out of 40 likelihood).

The first set of six SPI graphics is valid for statewide precipitation. The next nine sets represent historical SPIs for each of Oklahoma's nine climate divisions (CDs). The SPI information for each CD is based on that CD's own unique precipitation history, and provides more insight into its historical behavior.

Table B0: Statewide Historical SPIs for 1-, 3-, 6-, 12-, 24- and 60-month periods

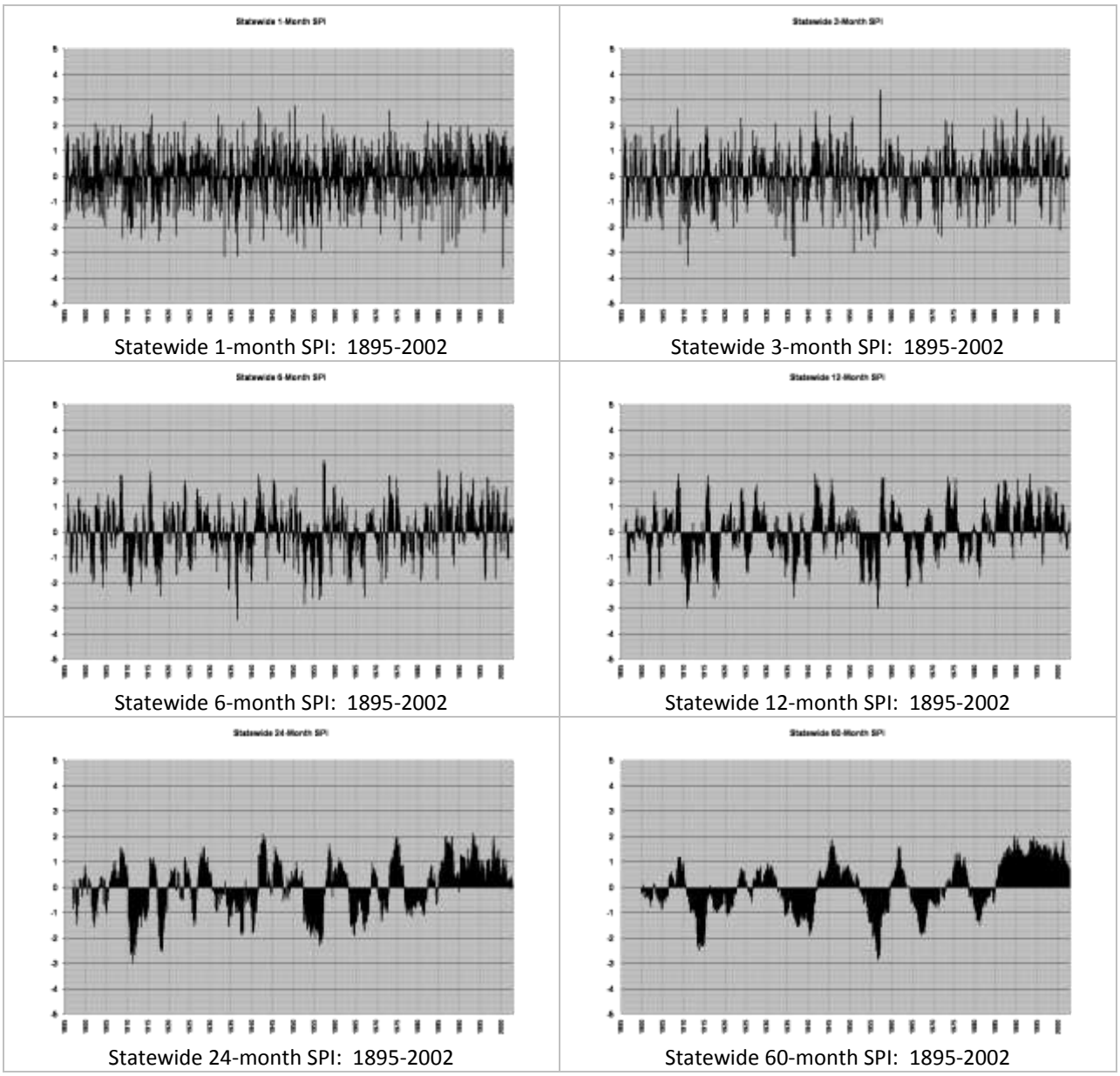
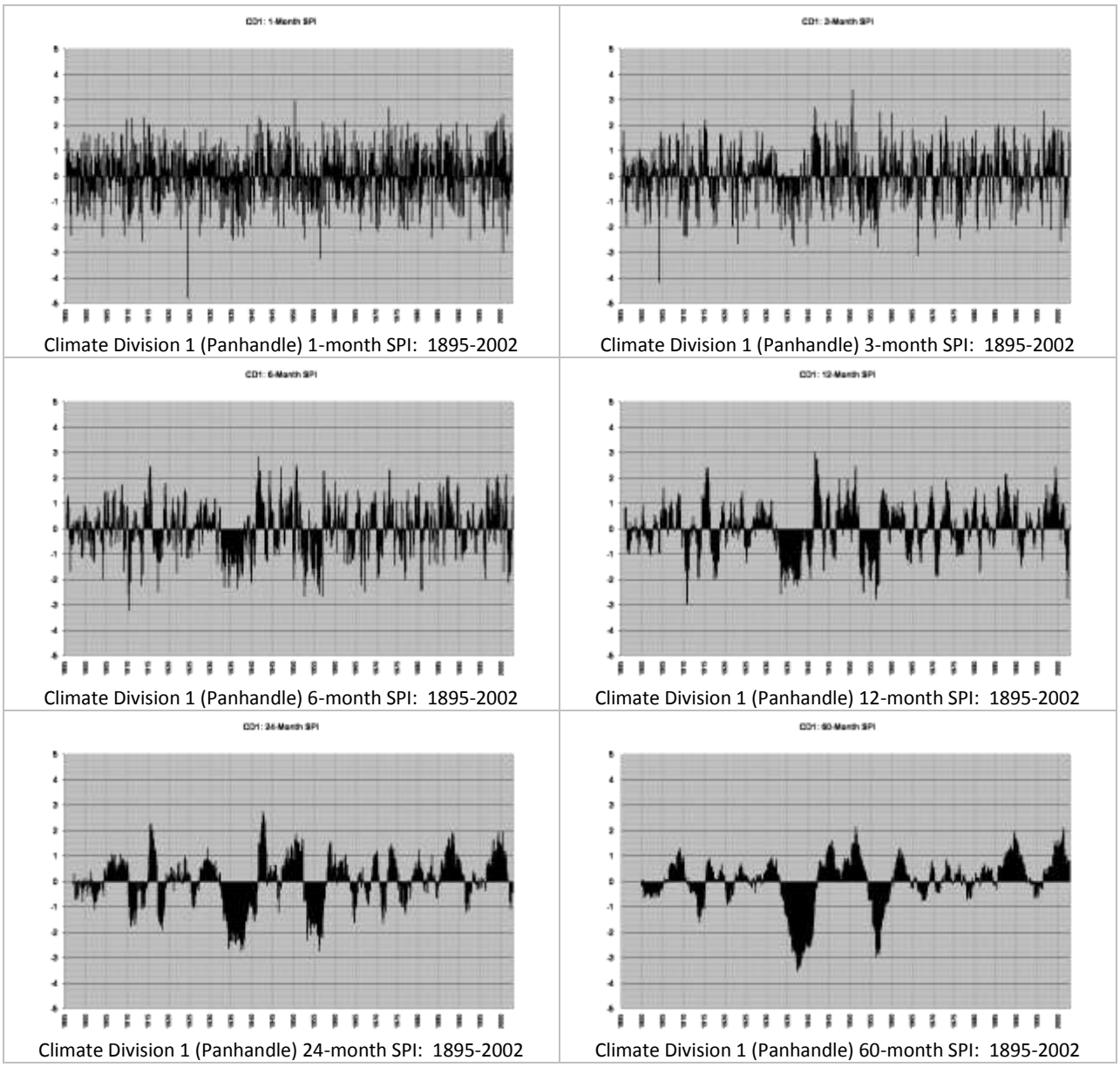


Table B1: CD 1 (Panhandle) Historical SPIs for 1-, 3-, 6-, 12-, 24- and 60-month periods



Climate Division 1 (Panhandle) 1-month SPI: 1895-2002

Climate Division 1 (Panhandle) 3-month SPI: 1895-2002

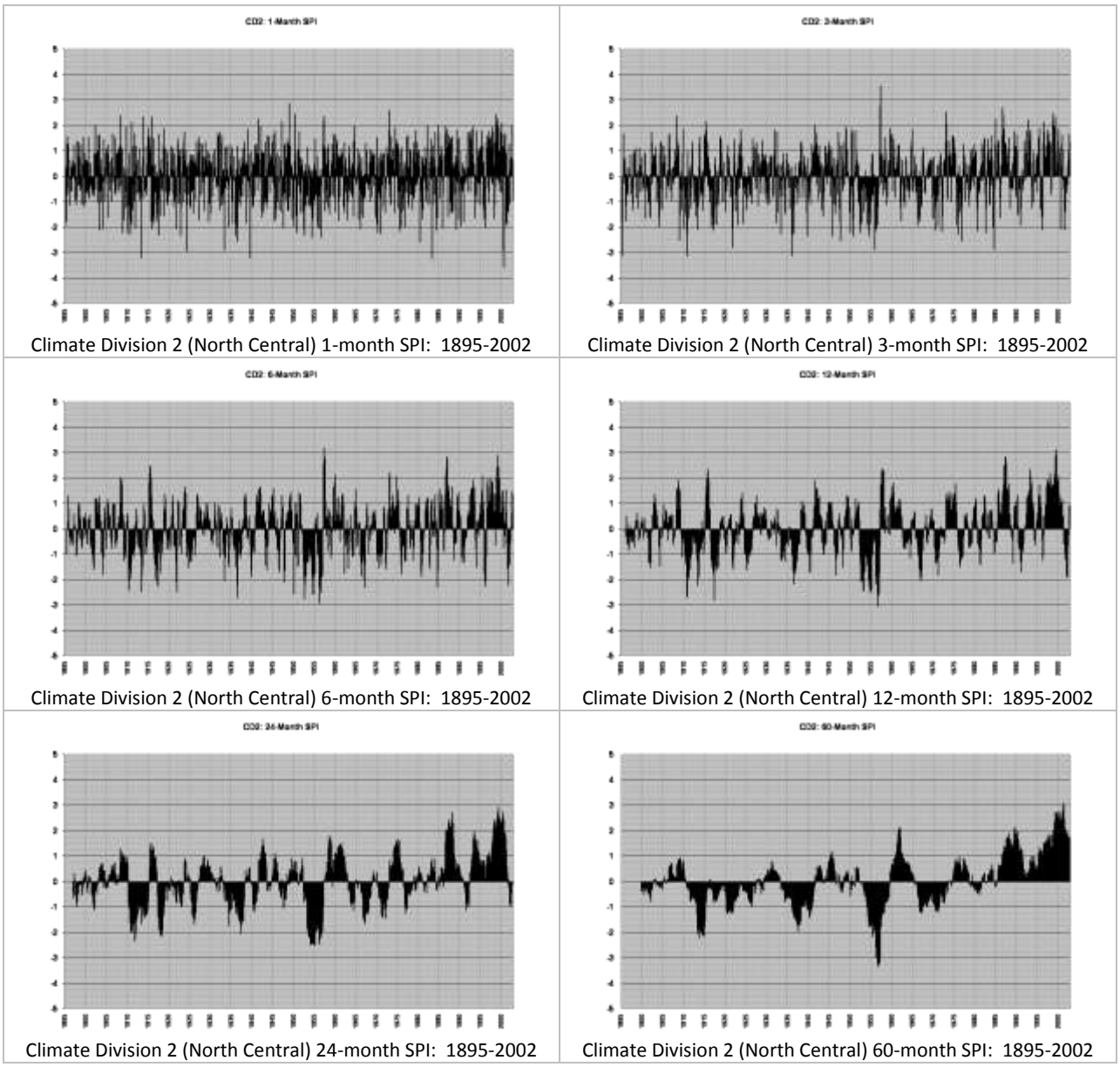
Climate Division 1 (Panhandle) 6-month SPI: 1895-2002

Climate Division 1 (Panhandle) 12-month SPI: 1895-2002

Climate Division 1 (Panhandle) 24-month SPI: 1895-2002

Climate Division 1 (Panhandle) 60-month SPI: 1895-2002

Table B2: CD2 (North Central) Historical SPIs for 1-, 3-, 6-, 12-, 24- and 60-month periods



Climate Division 2 (North Central) 1-month SPI: 1895-2002

Climate Division 2 (North Central) 3-month SPI: 1895-2002

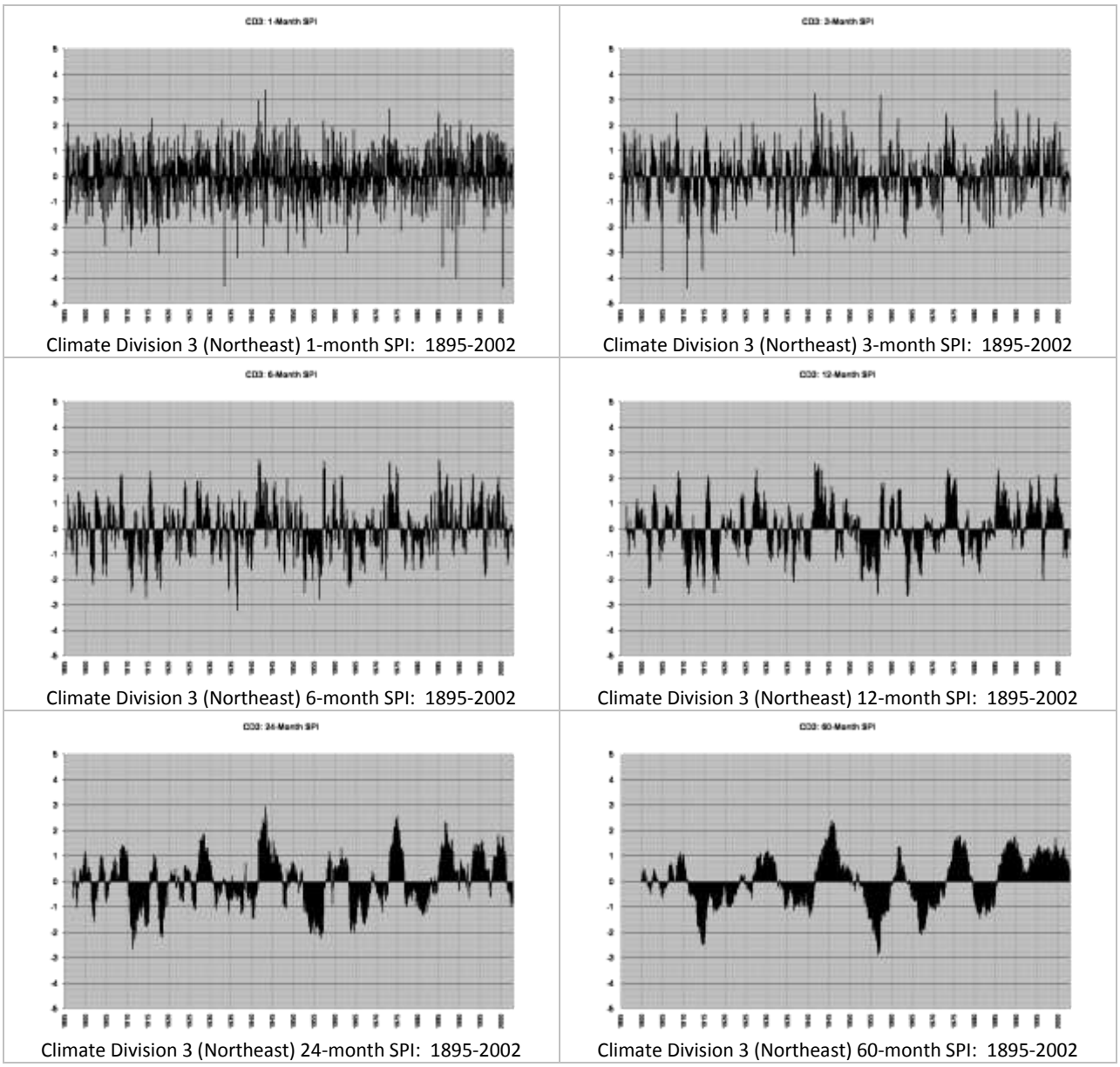
Climate Division 2 (North Central) 6-month SPI: 1895-2002

Climate Division 2 (North Central) 12-month SPI: 1895-2002

Climate Division 2 (North Central) 24-month SPI: 1895-2002

Climate Division 2 (North Central) 60-month SPI: 1895-2002

Table B3: CD3 (Northeast) Historical SPIs for 1-, 3-, 6-, 12-, 24- and 60-month periods



Climate Division 3 (Northeast) 1-month SPI: 1895-2002

Climate Division 3 (Northeast) 3-month SPI: 1895-2002

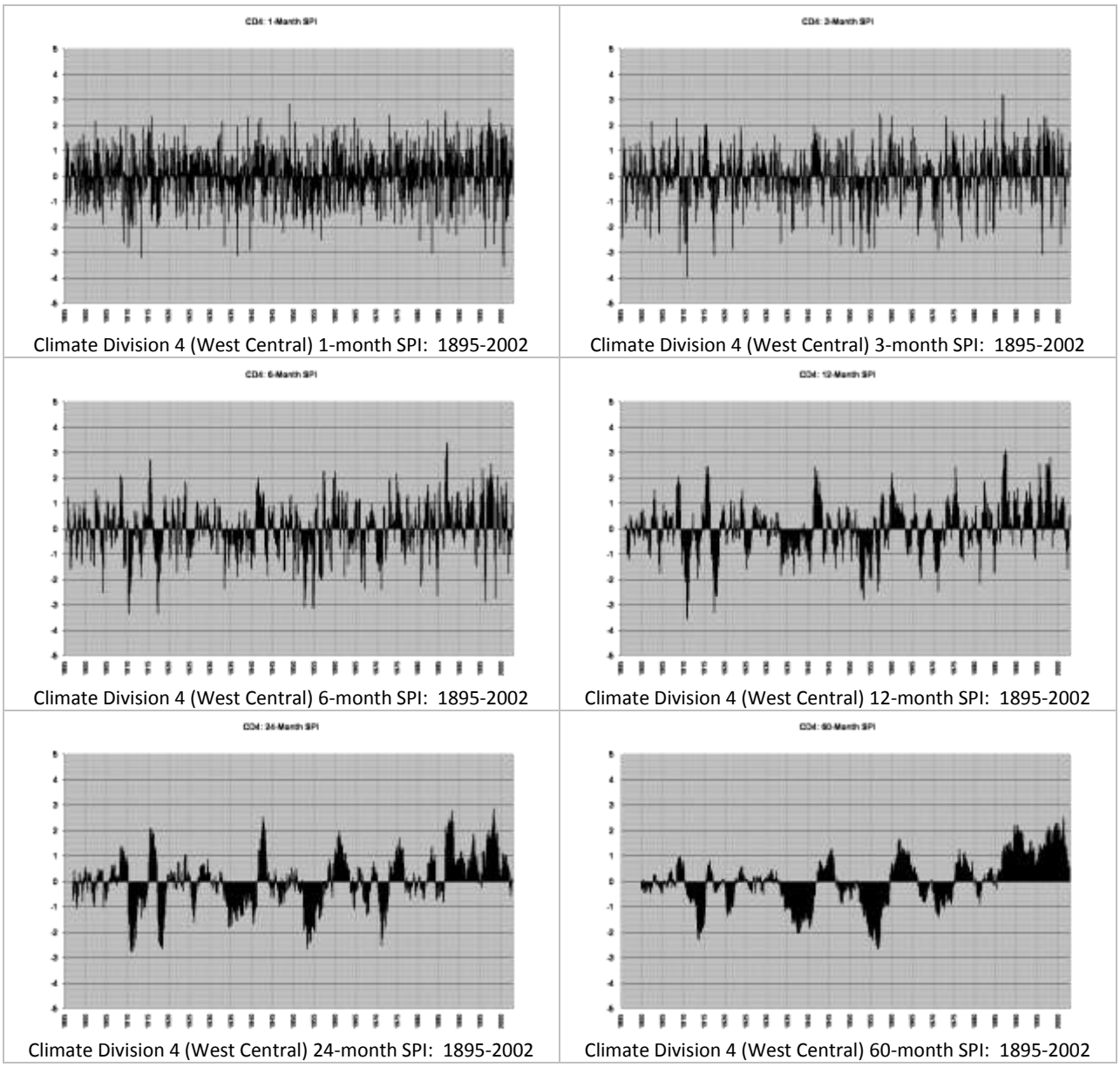
Climate Division 3 (Northeast) 6-month SPI: 1895-2002

Climate Division 3 (Northeast) 12-month SPI: 1895-2002

Climate Division 3 (Northeast) 24-month SPI: 1895-2002

Climate Division 3 (Northeast) 60-month SPI: 1895-2002

Table B4: CD4 (West Central) Historical SPIs for 1-, 3-, 6-, 12-, 24- and 60-month periods



Climate Division 4 (West Central) 1-month SPI: 1895-2002

Climate Division 4 (West Central) 3-month SPI: 1895-2002

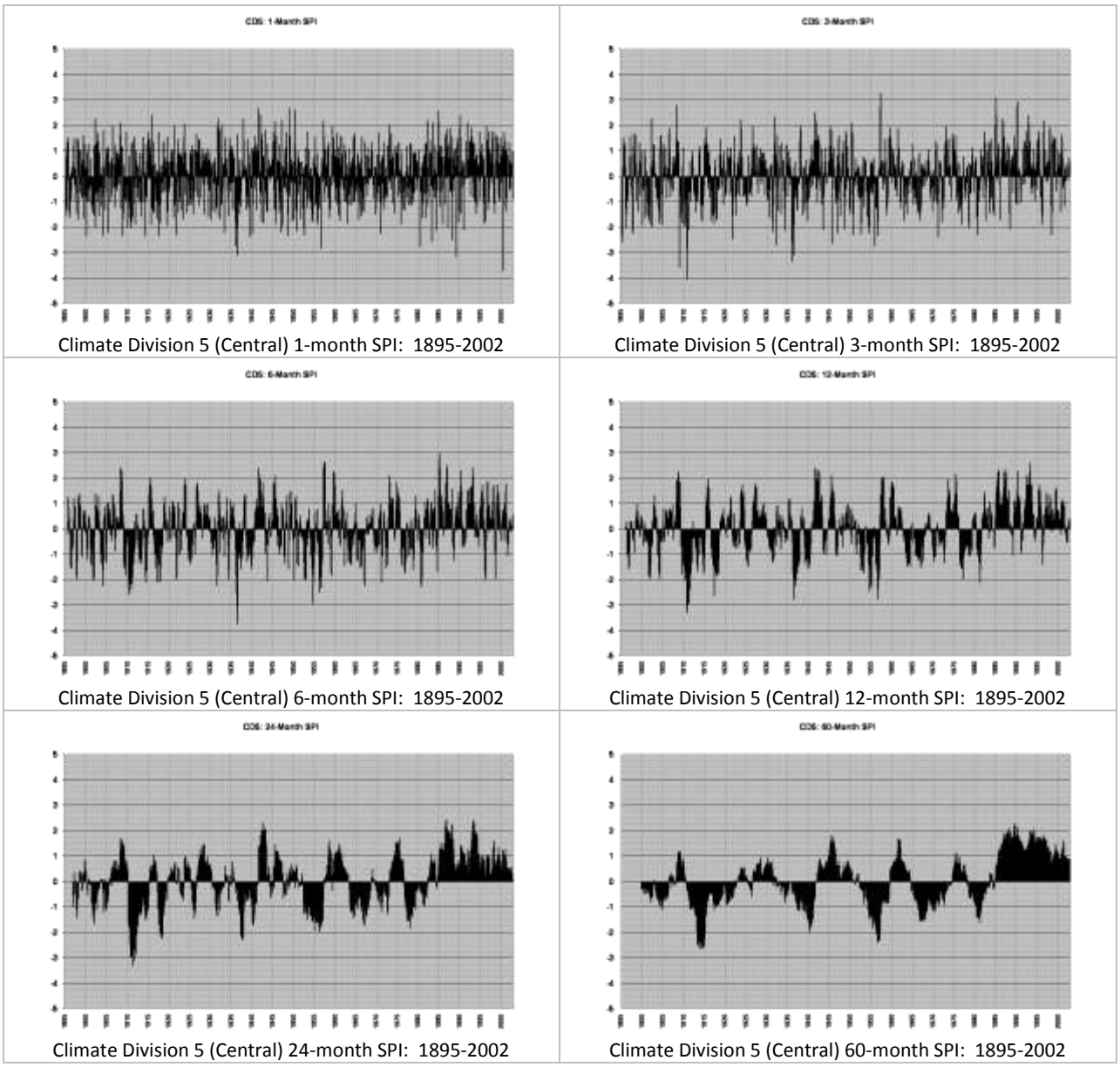
Climate Division 4 (West Central) 6-month SPI: 1895-2002

Climate Division 4 (West Central) 12-month SPI: 1895-2002

Climate Division 4 (West Central) 24-month SPI: 1895-2002

Climate Division 4 (West Central) 60-month SPI: 1895-2002

Table B5: CD5 (Central) Historical SPIs for 1-, 3-, 6-, 12-, 24- and 60-month periods



Climate Division 5 (Central) 1-month SPI: 1895-2002

Climate Division 5 (Central) 3-month SPI: 1895-2002

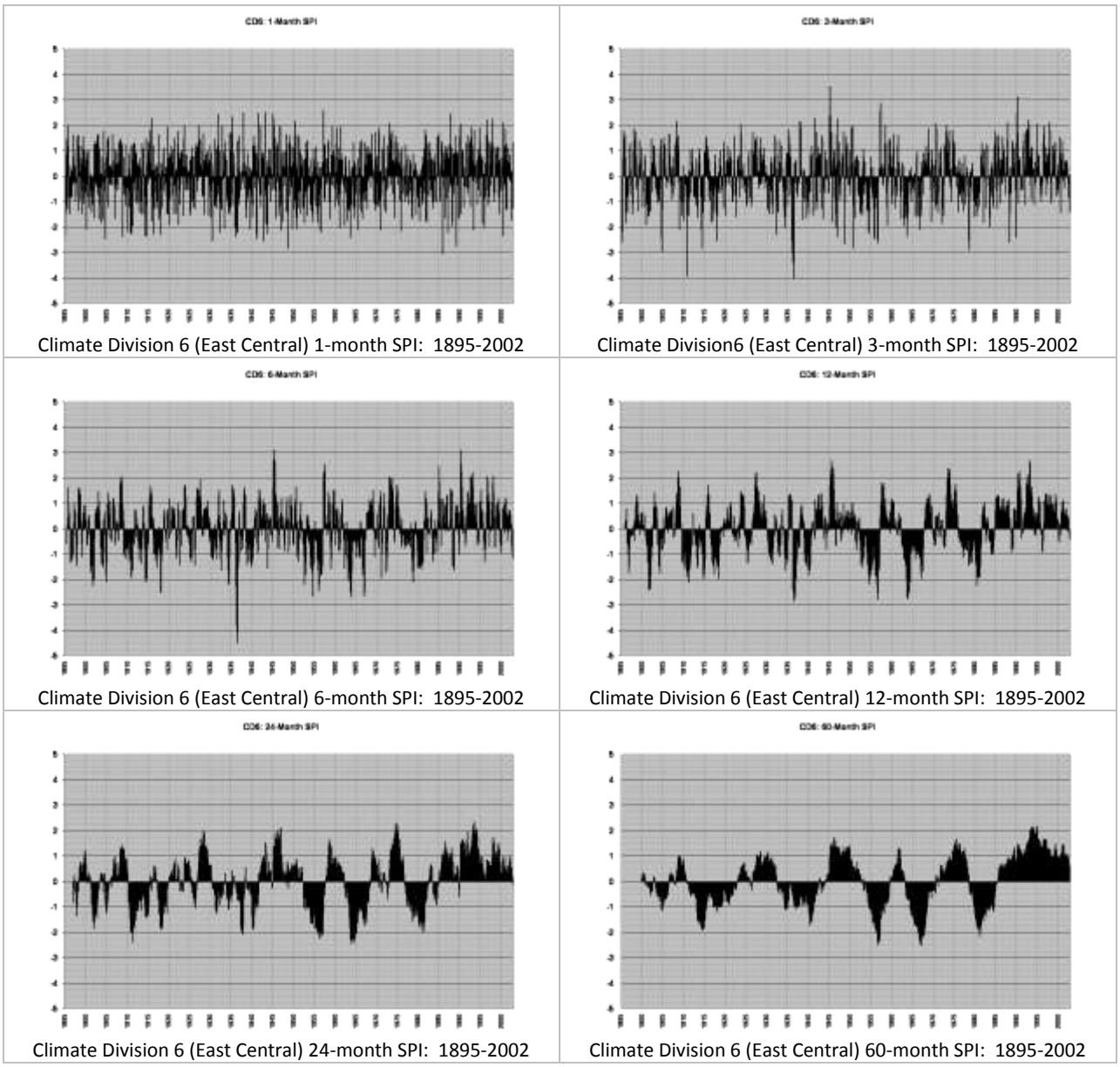
Climate Division 5 (Central) 6-month SPI: 1895-2002

Climate Division 5 (Central) 12-month SPI: 1895-2002

Climate Division 5 (Central) 24-month SPI: 1895-2002

Climate Division 5 (Central) 60-month SPI: 1895-2002

Table B6: CD6 (East Central) Historical SPIs for 1-, 3-, 6-, 12-, 24- and 60-month periods



Climate Division 6 (East Central) 1-month SPI: 1895-2002

Climate Division6 (East Central) 3-month SPI: 1895-2002

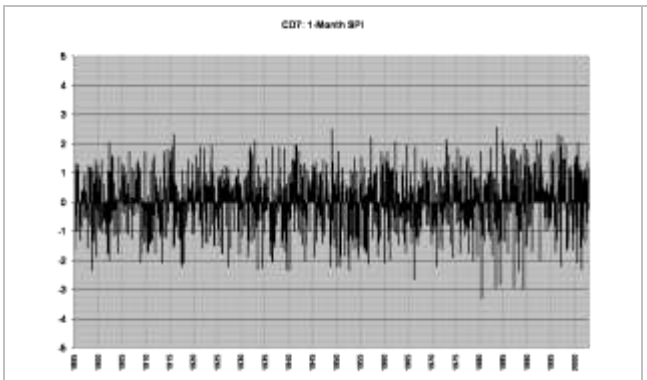
Climate Division 6 (East Central) 6-month SPI: 1895-2002

Climate Division 6 (East Central) 12-month SPI: 1895-2002

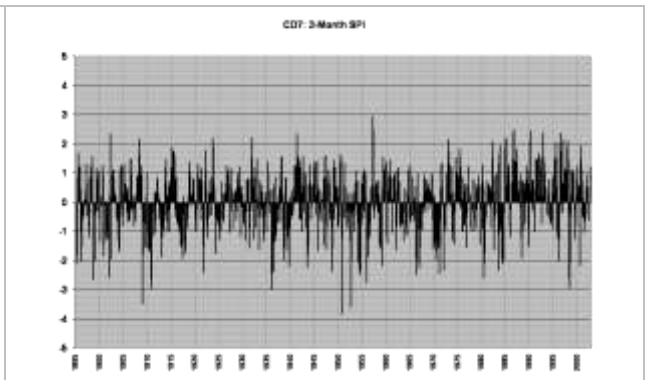
Climate Division 6 (East Central) 24-month SPI: 1895-2002

Climate Division 6 (East Central) 60-month SPI: 1895-2002

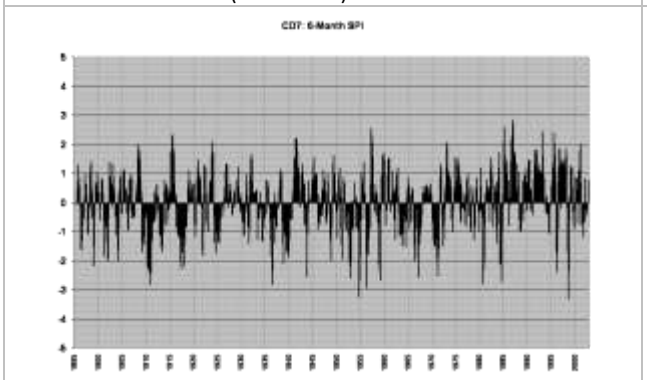
Table B7: CD7 (Southwest) Historical SPIs for 1-, 3-, 6-, 12-, 24- and 60-month periods



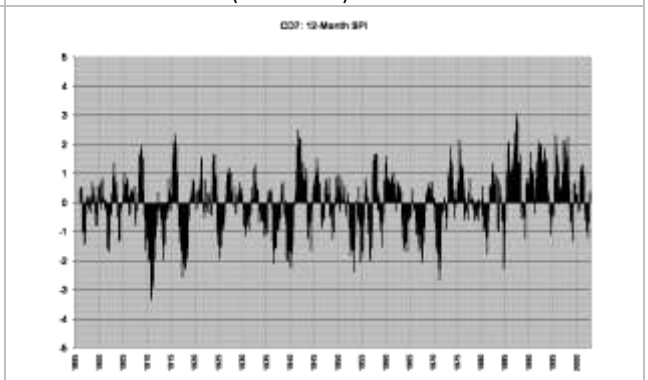
Climate Division 7 (Southwest) 1-month SPI: 1895-2002



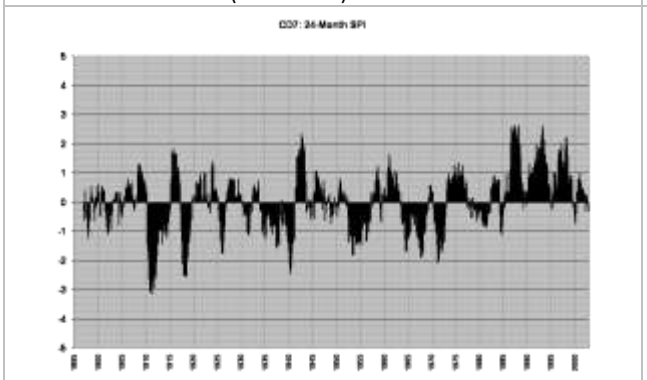
Climate Division 7 (Southwest) 3-month SPI: 1895-2002



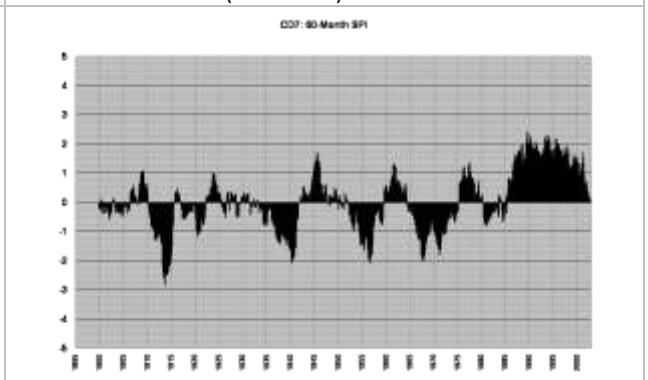
Climate Division 7 (Southwest) 6-month SPI: 1895-2002



Climate Division 7 (Southwest) 12-month SPI: 1895-2002

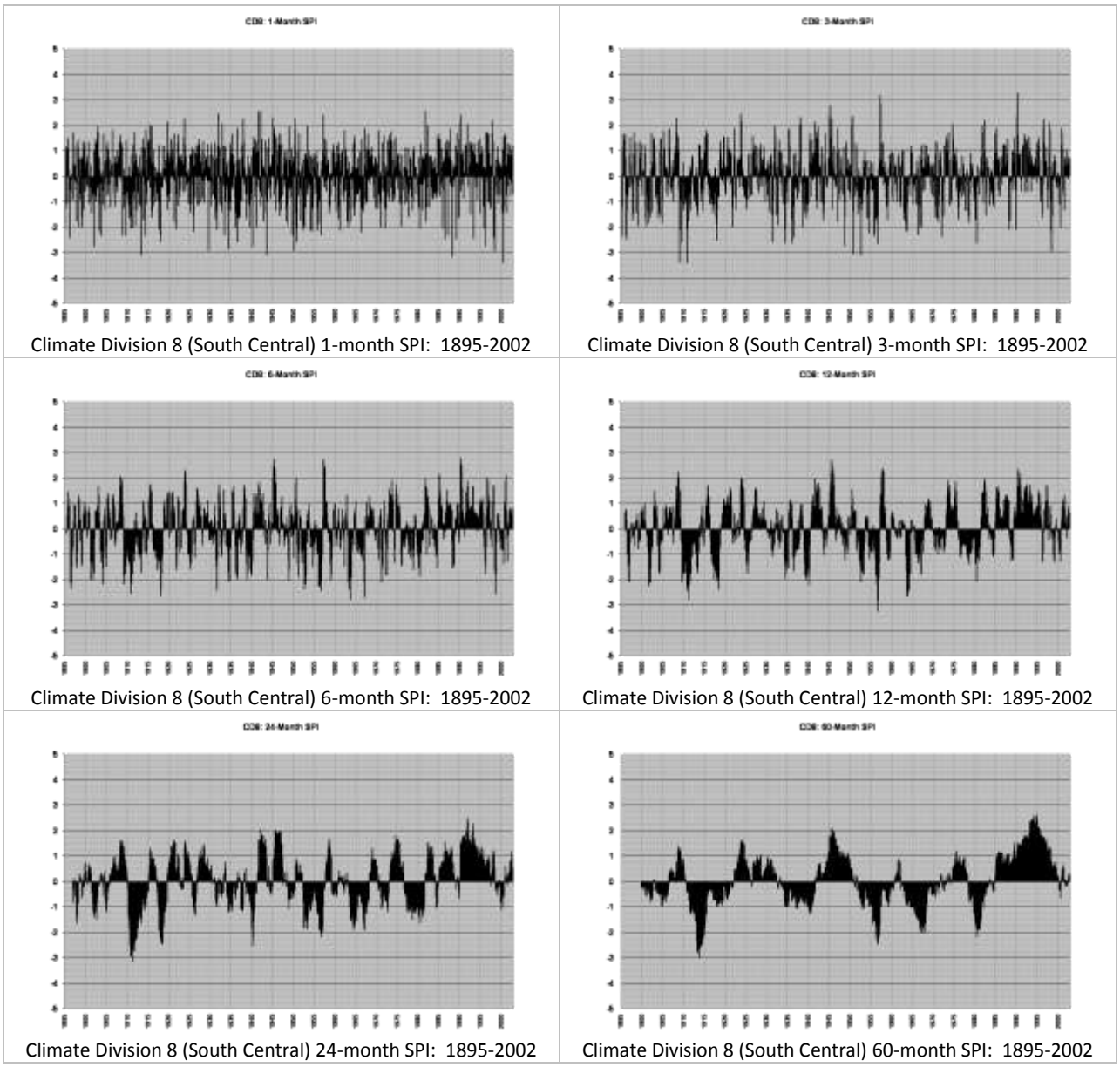


Climate Division 7 (Southwest) 24-month SPI: 1895-2002



Climate Division 7 (Southwest) 60-month SPI: 1895-2002

Table B8: CD8 (South Central) Historical SPIs for 1-, 3-, 6-, 12-, 24- and 60-month periods



Climate Division 8 (South Central) 1-month SPI: 1895-2002

Climate Division 8 (South Central) 3-month SPI: 1895-2002

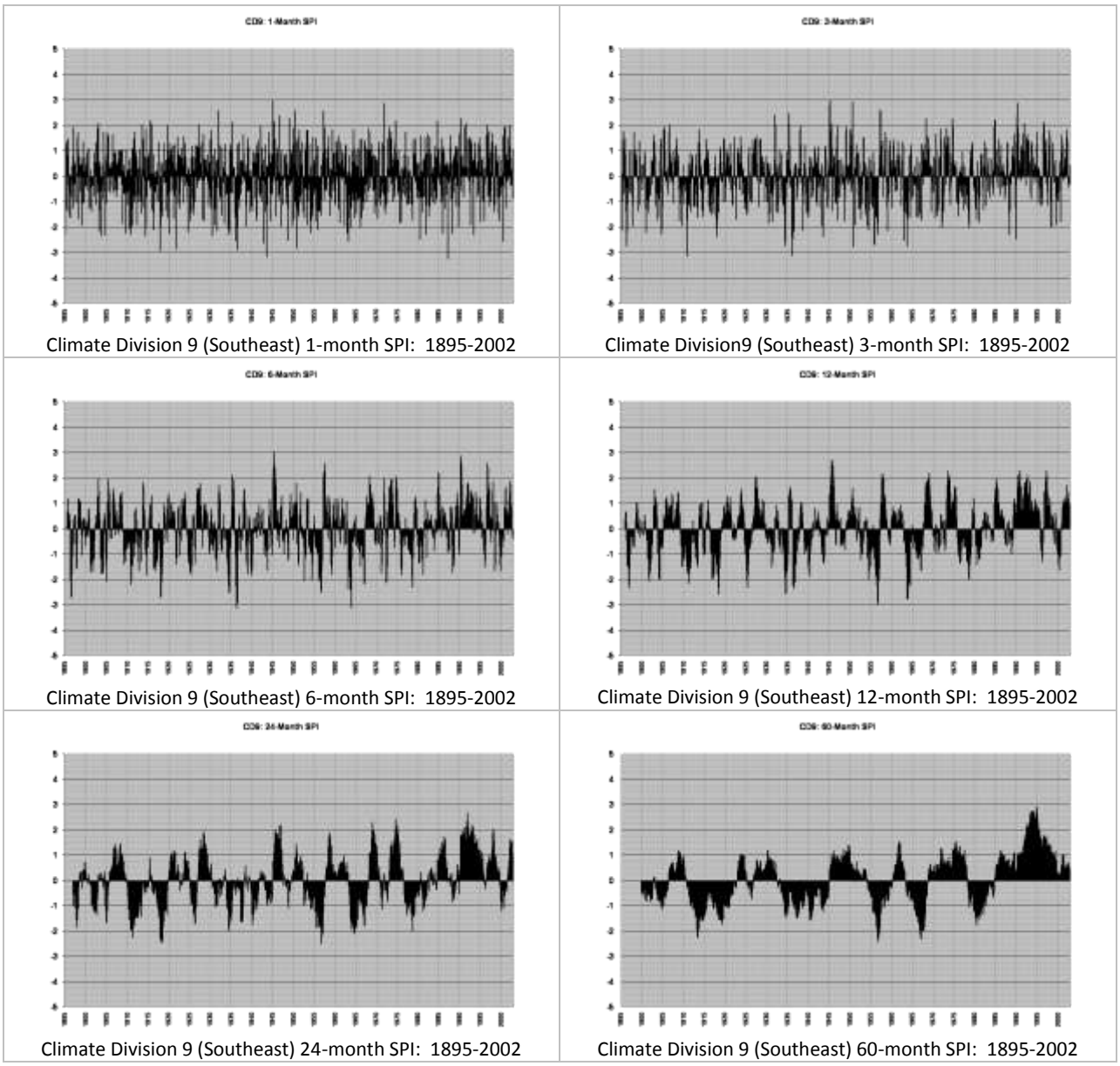
Climate Division 8 (South Central) 6-month SPI: 1895-2002

Climate Division 8 (South Central) 12-month SPI: 1895-2002

Climate Division 8 (South Central) 24-month SPI: 1895-2002

Climate Division 8 (South Central) 60-month SPI: 1895-2002

Table B9: CD9 (Southeast) Historical SPIs for 1-, 3-, 6-, 12-, 24- and 60-month periods



Climate Division 9 (Southeast) 1-month SPI: 1895-2002

Climate Division9 (Southeast) 3-month SPI: 1895-2002

Climate Division 9 (Southeast) 6-month SPI: 1895-2002

Climate Division 9 (Southeast) 12-month SPI: 1895-2002

Climate Division 9 (Southeast) 24-month SPI: 1895-2002

Climate Division 9 (Southeast) 60-month SPI: 1895-2002

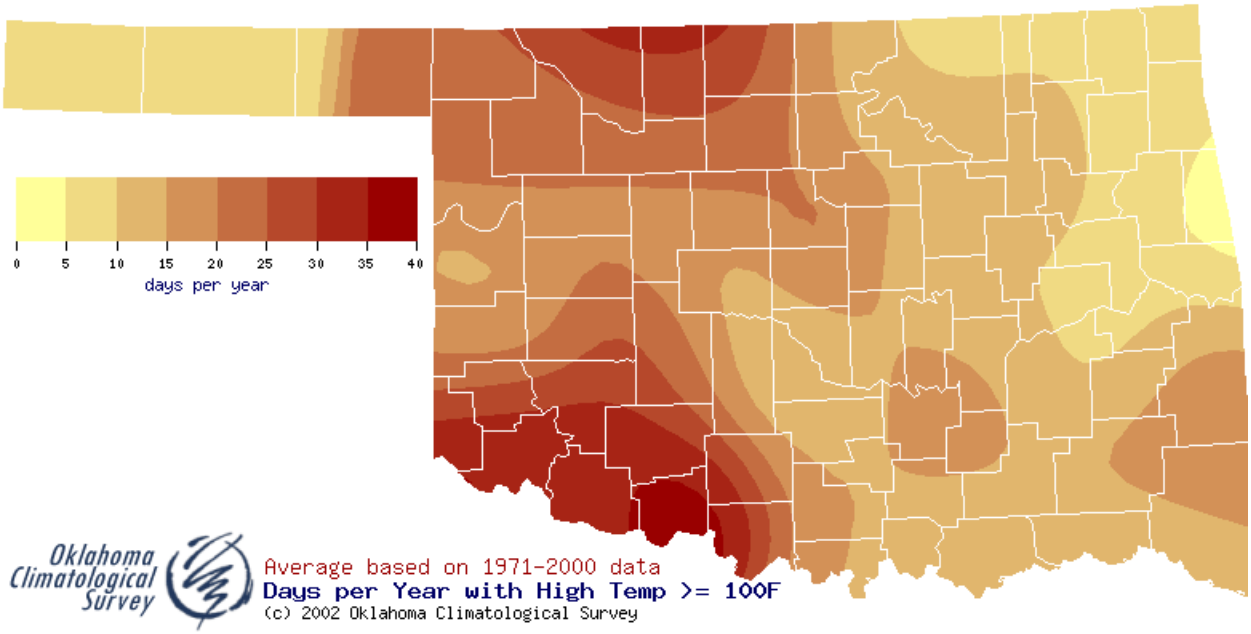
Oklahoma's Hazards: Extreme Temperatures

Oklahoma is well-known for its severe weather, but as part of the Southern Great Plains, it is also prone to wide swings of temperature. Summertime temperatures routinely climb above the 100-degree mark, and wintertime temperatures dip below zero. Most places in Oklahoma have an annual temperature range of 100 degrees or more. Beaver, in the Oklahoma Panhandle, averages an annual temperature swing of 113 degrees. Temperatures can change suddenly too. Oklahoma City set an unusual record on November 11, 1911. On that date, Oklahoma City went from a high of 83 degrees to a low of 17. The temperatures established daily records for the date; marks which still stand nearly 100 years later.

The mean annual temperature over the state ranges from 62 F along the Red River to about 58 F along the northern border. It then decreases westward to 56 F in Cimarron County. Temperatures of 90 F or greater occur, on average, about 60-65 days per year in the western panhandle and the northeast corner of the state. In the southwest, the average is about 115 days, and in the southeast about 85 days. Temperatures of 100 F or higher occur, frequently during some years, from May through September, and very rarely in April and October. The western half of the state, excluding most of the panhandle, averages 15 or more days with triple-digit temperatures, ranging from about 35 in the southwest corner to 25 in the northwest. The eastern half of the state and most of the panhandle average less than 15 such days. Years without 100 F temperatures are rare, ranging from about one of every seven years in the eastern half of the state to somewhat rarer in the west.

Locations with most 100-degree days annually		
Location	**County**	**# Days**
Hollis	Harmon	34
Frederick	Tillman	29
Mangum	Greer	29
Chattanooga 3 NE	Comanche	25
Altus	Jackson	25
Cloud Chief 2 SE	Washita	24
Alva	Woods	24
Buffalo	Harper	24
Cherokee	Alfalfa	24
Waurika	Jefferson	24

Temperature ranges and extremes for each long-term observing station in Oklahoma are presented in the attached table. The number of years of



observation is given to identify those stations that have captured a greater portion of Oklahoma's weather history. In addition to all-time station records, exceedance temperatures – the annual highest

and lowest temperatures likely to occur in two out of ten years – are given. These are more common than extremes, but would be considered toward the outer reaches of typical weather. The table also shows the number of days with single-digit temperatures and triple-digit temperatures for each site, and the average annual range between the highest and lowest temperatures observed during the year.

Highest Temperatures Recorded in Oklahoma			
Location	**County**	**Date**	**Temperature**
Alva	Woods	1936\07\18	120
Altus	Jackson	1936\07\19	120
Poteau	Leflore	1936\08\10	120
Altus	Jackson	1936\08\12	120
Tishomingo National Wildlife Ref	Johnston	1943\07\26	120
Tipton Mesonet	Tillman	1994\06\27	120
Wagoner	Wagoner	1901\07\13	119
Cloud Chief 2 SE	Washita	1936\07\19	119
Meeker	Lincoln	1936\08\10	119
Cloud Chief 2 SE	Washita	1936\08\11	119
Altus Mesonet	Jackson	1994\06\27	119
Oakwood 3 SW	Dewey	1922\08\24	118
Cloud Chief 2 SE	Washita	1936\07\18	118
Tahlequah	Cherokee	1936\07\18	118
Nowata	Nowata	1936\08\09	118
Tahlequah	Cherokee	1936\08\09	118
Chandler	Lincoln	1936\08\10	118
Durant USDA	Bryan	1936\08\10	118
Holdenville	Hughes	1936\08\10	118
Hugo	Choctaw	1936\08\10	118
Muskogee	Muskogee	1936\08\10	118
Tahlequah	Cherokee	1936\08\10	118
Jefferson	Grant	1936\08\11	118
Kingfisher 2 SE	Kingfisher	1936\08\11	118
Meeker	Lincoln	1936\08\11	118
Alva	Woods	1936\08\12	118
Cloud Chief 2 SE	Washita	1936\08\12	118
Enid	Garfield	1936\08\12	118
Jefferson	Grant	1936\08\12	118
Kingfisher 2 SE	Kingfisher	1936\08\12	118
Altus	Jackson	1943\08\03	118
Vinita 2 N	Craig	1954\07\14	118
Jay 1 NE	Delaware	1954\07\18	118

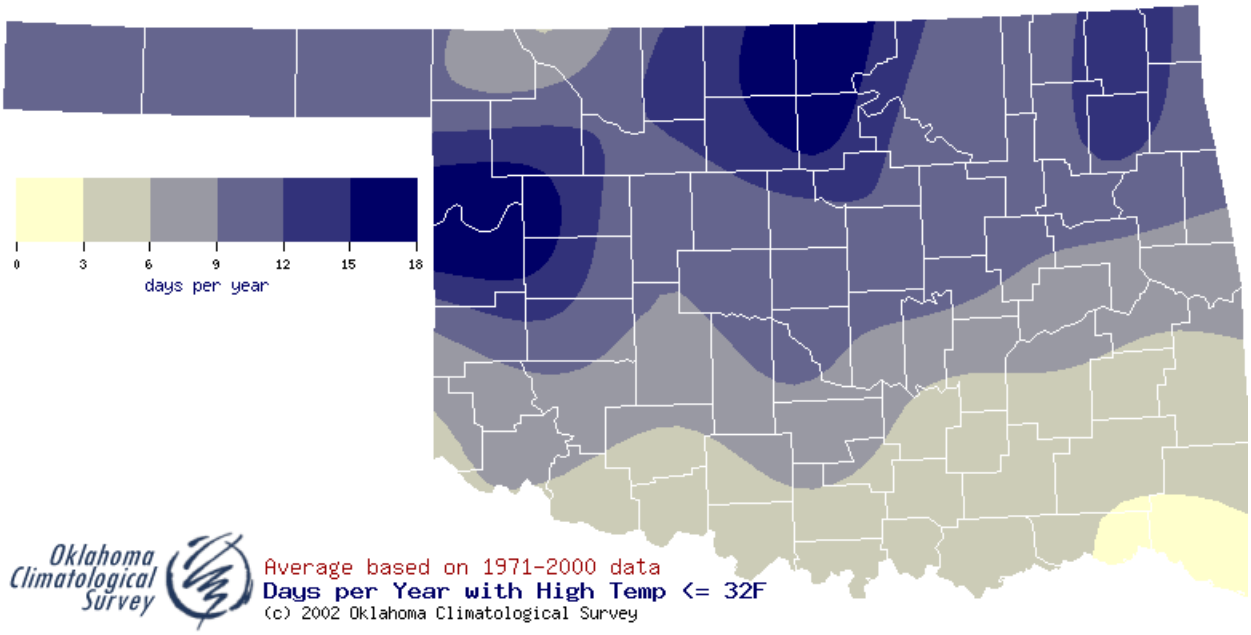
The highest temperature ever recorded in the state was 120 F. This reading was first observed during the brutally hot summer of 1936: at Alva on July 18, at Altus on July 19 and August 12, and at Poteau on August 10. Tishomingo observed 120 F on July 26, 1943. The Oklahoma Mesonet station near Tipton tied the mark on June 27, 1994.

Temperatures of 32 F or less occur, on average, about 60 days per year in the southeast. This value increases to about 110 days per year where the panhandle joins the rest of the state and further to 140

in the western panhandle. The lowest temperature on record is -27 F, set originally at Vinita on February 13, 1905, and tied at Watts on January 18, 1930.

Lowest Temperatures Recorded in Oklahoma			
Location	**County**	**Date**	**Temperature**
Vinita 2 N	Craig	1905\02\13	-27
Watts	Adair	1930\01\18	-27
Pawhuska	Osage	1930\01\22	-26
Vinita 2 N	Craig	1930\01\22	-26
Watts	Adair	1930\01\22	-26
Beaver	Beaver	1899\02\12	-25
Cleo	Major	1905\02\13	-25
White Eagle	Kay	1905\02\13	-25
Bartlesville Phillip	Osage	1930\01\22	-25
Miami	Ottawa	1930\01\22	-25
Spavinaw	Mayes	1930\01\22	-25
Gate	Beaver	1984\01\19	-25
Cleveland	Pawnee	1930\01\22	-24
Guthrie	Logan	1930\01\22	-24
Woodward	Woodward	1947\01\04	-24
Boise City 2 E	Cimarron	1959\01\04	-24

Temperatures below 32 degrees are common, but sustained periods of cold temperatures are rare. Bone-chilling temperatures in the single digits or lower are most likely to occur in the Panhandle or parts of northwestern Oklahoma. However, the dry winter days and abundant sunshine typically help afternoon temperatures moderate, such that northwestern Oklahoma averages only about ten days a year in which the high temperature does not break the freezing mark. Further to the south and east, across west-central and north-central Oklahoma, temperatures are more likely to remain below freezing during the day, as more cloud cover keeps temperatures lower.



Extreme cold temperatures in Oklahoma are more likely to occur when there is the combination of snow cover and terrain effects. Snow cover allows nighttime temperatures to drop rapidly in the presence of clear skies and calm winds. Cold air, which is heavier than warm air, 'pools' in relative low spots, such as valleys. For this reason, many of the all-time records in the state are from locations in eastern Oklahoma, where cold air can collect in valleys or the bottoms of hills, even though cold nights are more common in the west.

Other Risk Factors

Threatening conditions due to heat or cold often involve more than just the temperature. Moisture and wind speed have a great impact upon life-threatening weather conditions. Moisture in the summertime inhibits the ability of the body to cool itself, and winds in the wintertime whisk away heat from the body. However, combinations of high temperatures with high moisture or low temperatures with high wind speeds are relatively rare in Oklahoma. While temperatures nearly every year climb into triple-digits, heat index rarely reaches the most life-threatening proportions (values above 130 degrees). In wintertime, most of the coldest temperatures occur in the absence of strong winds, thus wind chill rarely poses an immediate threat to life.

Locations with most single-digit days annually		
Location	**County**	**# Days**
Cimarron	Kenton	14
Texas	Goodwell Research	13
Texas	Hooker	13
Beaver	Beaver	12
Cimarron	Boise City 2 E	12
Woods	Freedom	11
Ellis	Gage Airport	10
Alfalfa	Helena 1 SSE	9
Woodward	Fort Supply Dam	9
Ellis	Arnett	9
Harper	Buffalo	9

Heat Index

On average, about 175 people in America die from heat-related illnesses each year. As temperatures rise, the body tries to maintain a constant temperature through evaporation of sweat, which acts to cool the body. However, as humidity rises, the efficiency of evaporation declines rapidly. The effect on the body is equivalent to a higher

temperature with low humidity, commonly known as Apparent Temperature or Heat Index.

Heat Index	**Status**	Possible Heat Disorder:
80°F - 90°F	Elevated	Fatigue possible with prolonged exposure and physical activity.
90°F - 105°F	Moderate	Sunstroke, heat cramps and heat exhaustion possible.
105°F - 130°F	High	Sunstroke, heat cramps, and heat exhaustion likely, and heat stroke possible.
130°F or greater	**Extreme**	**Heat stroke highly likely with continued exposure.**

Temperature (F) versus Relative Humidity (%)						
°F	90%	80%	70%	60%	50%	40%
80	85	84	82	81	80	79
85	101	96	92	90	86	84
90	121	113	105	99	94	90
95		133	122	113	105	98
100			142	129	118	109
105				148	133	121
110						135

Source: National Weather Service http://www.crh.noaa.gov/pub/heat.htm

		Heat Index (average number of days per year)			
Location	**County**	**Maximum Observed**	**90 - 105**	**105-130**	**Greater than 130**
Webbers Falls	Muskogee	126	102	46	0
Broken Bow	McCurtain	135	106	44	0
Idabel	McCurtain	126	111	41	0
Antlers	Pushmataha	128	112	41	0
Burneyville	Love	125	112	40	0
Wilburton	Latimer	128	104	39	0
Centrahoma	Coal	125	104	39	0
Walters	Cotton	119	110	36	0
Claremore	Rogers	125	93	36	0
Okmulgee	Okmulgee	125	97	36	0

The effect of moisture is that even at what would not normally be considered dangerous temperatures, the inability of the body to dissipate heat can lead to life-threatening conditions. A humid afternoon, with relative humidity around 70%, can make a 90-degree temperature feel like a 105-degree temperature would on a 'dry' day, pushing the body to the point where heat stroke is possible. A temperature in the upper 90's with the same humidity makes heat stroke likely. Those working in direct sunshine may experience heat indices 10-20 degrees higher than ambient, shade temperatures.

Ten years of data from the Oklahoma Mesonet, 1994-2003, shows that most places in Oklahoma average at least several days with a heat index above 105 each year, but only a few instances of heat indices above 130 have been documented. In fact, the only locations in Oklahoma recording a maximum heat index of 130 or higher during the ten-year period were Broken Bow (McCurtain County; twice), Durant (Bryan County), Wister (LeFlore County), Red Rock (Noble County), Bowlegs (Seminole County), and Ketchum Ranch (Stephens County). The highest recorded heat index was 140 degrees, recorded at Red Rock. Heat index tends to be consistently higher in eastern portions of the state, where humidity is usually higher, Locations in eastern Oklahoma record 40 or more days each year, on average, of heat index in the high range. A full listing of heat indices and wind chills is listed at the end of this document.

Wind Chill

Like heat index, other weather factors can make it seem colder than it actually is. The reason is that wind helps the body dissipate heat, meaning that the body must produce heat more quickly in order to maintain its constant temperature. The combination of very cold temperatures and high wind speeds can cause flesh to freeze in as little as five minutes. Frostbite can occur in 15 minutes when the air temperature and wind speed combine to produce a wind chill of -18 degrees Fahrenheit.

Wind chill is an expression of the rate at which heat dissipates. This applies to any heat source – a person or animal, a car's engine, or water pipes. The bigger the difference between the object's actual temperature and the wind chill index, the faster the heat will be transported away from the object. This does not mean, however, that pipes will freeze if the actual temperature is above freezing and the wind chill is below freezing. The wind will help heat dissipate quickly to the ambient (outside) temperature, but it will not actually lower that temperature further.

Source: National Weather Service http://www.nws.noaa.gov/om/windchill/

In order to protect against the effects of wind, it is best to trap a layer of warm, insulated air close to the body, with a relatively impermeable shell. Loose-fitting, lightweight, warm clothing in several layers accomplishes this. Outer garments should be tightly-woven, water-repellant, and hooded in order to keep the warm air inside, much like a layer of insulation along the outside walls of a house.

Extreme wind chill temperatures in Oklahoma are exceedingly rare. Only about one quarter of the Oklahoma Mesonet sites, for the period 1994-2003, dropped into the frostbite risk categories (wind chill temperatures of -20 degrees or less), and even these were sporadic occurrences. Boise City, near the western edge of the Panhandle, had the greatest number of occurrences of wind chill values of -20 or lower, but those conditions occurred only four times over the past ten years. The lowest recorded wind chill by a Mesonet station occurred at Kenton, hitting -30. Nearly all stations that have dipped below -20 wind chill are in northern Oklahoma, and extend from the Panhandle to the Arkansas border.

Although cold temperatures do not pose a significant risk to many Oklahomans, those who have to spend more than 30 minutes at a time outdoors in the coldest weather may be at risk. Cold temperatures also pose other, more significant hazards, including winter precipitation such as snow or ice and frozen pipes bursting.

Location	County	Lowest Wind Chill
Kenton	Cimarron	-30
Boise City	Cimarron	-29
Kingfisher	Kingfisher	-28
Camargo	Dewey	-27
Hooker	Texas	-27
Goodwell	Texas	-26
Beaver	Beaver	-25
Jay	Delaware	-25
Marshall	Logan	-25
Pawnee	Pawnee	-25
Oilton	Creek	-24
Perkins	Payne	-23
Vinita	Craig	-23
Burbank	Osage	-22
Butler	Custer	-22
Cheyenne	Roger Mills	-22
Fairview	Major	-22
Guthrie	Logan	-22
Red Rock	Noble	-22
Slapout	Beaver	-22
Watonga	Blaine	-22
Alva	Woods	-21
Breckenridge	Garfield	-21
Copan	Washington	-21
El Reno	Canadian	-21
Lahoma	Major	-21
Miami	Ottawa	-21
Chandler	Lincoln	-20
Seiling	Woodward	-20

Wind Chill Chart

Wind (mph)	Temperature (°F)																	
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Temperature extremes and expected temperature ranges based on Cooperative Observer data, 1998-2003. Exceedance temperatures are the highest and lowest values occurring in 20 percent of years (i.e., two out of ten years would be expected to record a temperature of greater than / less than indicated value). Number of days is the average per year, and range is the annual average difference between the highest maximum and lowest minimum temperature recorded during the year.

			Temperature Extremes		Exceedance Temperatures		Number of Days		
County	Location	No. Years	Highest	Lowest	Max	Min	Min < 10	Max > 100	Range
Adair	Stilwell	40	108	-12	105	-6	5	2	101
Alfalfa	Cherokee	49	117	-16	110	-6	7	24	108
Alfalfa	Great Salt Plains Dam	42	114	-13	109	-5	6	21	107
Alfalfa	Helena 1 SSE	39	113	-15	108	-5	9	14	108
Beaver	Beaver	59	115	-25	110	-12	12	19	113
Beckham	Elk City	63	113	-12	108	-3	4	14	103
Beckham	Erick	61	115	-17	109	-4	5	16	105
Beckham	Sayre	35	114	-11	110	-2	4	23	104
Blaine	Canton Dam	30	113	-20	109	-5	5	17	106
Blaine	Geary	74	116	-12	108	-3	4	13	103
Blaine	Okeene	71	115	-18	110	-5	6	22	107
Blaine	Watonga	43	111	-15	107	-3	6	10	104
Bryan	Durant USDA	68	118	-11	108	3	2	14	98
Caddo	Anadarko	44	114	-17	109	-2	4	16	103
Caddo	Apache	58	116	-12	110	-1	3	21	103
Caddo	Carnegie 2 ENE	73	117	-14	110	-2	4	21	105
Canadian	El Reno 1 N	54	115	-15	108	-3	5	10	102
Carter	Ardmore	77	114	-8	109	3	1	14	96
Carter	Healdton	59	115	-14	110	-1	3	15	101
Cherokee	Tahlequah	62	118	-23	108	-5	5	8	103
Choctaw	Hugo	73	118	-8	108	4	1	12	95
Cimarron	Boise City 2 E	71	109	-24	105	-13	12	5	110
Cimarron	Kenton	79	109	-23	105	-15	14	6	112
Cleveland	Norman 3 S	47	116	-17	108	0	3	12	101
Comanche	Chattanooga 3 NE	79	116	-21	110	2	3	25	103
Comanche	Lawton	67	115	-11	110	1	2	21	100
Comanche	Wichita Mtn Wl Ref	68	112	-16	108	-2	5	13	104

			Temperature Extremes		Exceedance Temperatures		Number of Days		
County	Location	No. Years	Highest	Lowest	Max	Min	Min < 10	Max > 100	Range
Cotton	Walters	61	114	-17	110	2	2	21	100
Craig	Vinita 2 N	79	118	-27	108	-8	6	11	106
Creek	Bristow	56	115	-18	108	-3	5	13	103
Custer	Clinton	63	115	-14	111	-4	4	20	105
Custer	Weatherford	86	115	-14	110	-4	5	18	104
Dewey	Oakwood 3 SW	43	118	-20	109	-6	8	12	106
Dewey	Taloga	47	112	-21	109	-6	7	16	107
Ellis	Arnett	61	110	-18	107	-5	9	7	104
Ellis	Gage Airport	54	113	-20	108	-7	10	12	109
Garfield	Enid	84	118	-20	109	-3	5	16	105
Garfield	Waukomis	46	116	-18	111	-5	6	20	106
Garvin	Pauls Valley 4 WSW	77	114	-14	108	0	3	16	100
Grady	Chickasha	47	116	-11	110	-1	3	18	101
Grady	Chickasha Exp Station	43	112	-12	108	0	3	12	100
Grant	Jefferson	86	118	-23	110	-6	7	20	109
Greer	Mangum	60	117	-11	111	-2	4	29	105
Harmon	Hollis	61	117	-12	111	-1	3	34	105
Harper	Buffalo	71	115	-17	111	-9	9	24	111
Haskell	Mccurtain 1 SE	41	111	-9	108	-3	3	10	100
Hughes	Holdenville	84	118	-13	108	0	3	11	100
Jackson	Altus	71	120	-11	110	0	3	25	102
Jefferson	Waurika	82	116	-10	110	3	2	24	100
Johnston	Tishomingo Natl Wl Ref	49	120	-12	109	1	2	14	99
Kay	Blackwell 1 W	47	116	-20	109	-5	6	18	106
Kay	Blackwell 2 E	37	114	-12	109	-5	6	16	107
Kay	Newkirk	71	117	-22	109	-6	6	11	106
Kay	Ponca City	37	116	-11	110	-4	6	15	105
Kay	Ponca City Muni Airport	54	116	-12	109	-5	7	11	105
Kingfisher	Hennessey 4 ESE	67	116	-17	110	-4	4	20	106
Kingfisher	Kingfisher 2 Se	98	118	-20	110	-3	5	19	106
Kiowa	Altus Dam	40	114	-12	109	1	3	21	102

			Temperature Extremes		Exceedance Temperatures		Number of Days		
County	Location	No. Years	Highest	Lowest	Max	Min	Min < 10	Max > 100	Range
Kiowa	Hobart Municipal Airpt	86	117	-10	110	-2	4	20	103
Latimer	Wilburton	35	113	-16	108	0	2	13	99
Leflore	Poteau	51	120	-16	110	-1	2	14	100
Lincoln	Chandler 1	57	118	-20	109	-2	4	12	102
Lincoln	Meeker	77	119	-21	109	-4	5	14	104
Logan	Guthrie	87	116	-24	110	-5	5	16	105
Love	Marietta	56	112	-8	107	4	2	13	97
Marshall	Madill	58	111	-8	108	4	1	12	95
Mayes	Pryor	56	117	-21	108	-3	5	9	102
Mayes	Spavinaw	66	114	-25	106	-4	4	5	100
Mcclain	Blanchard 2 SSW	41	112	-11	109	0	3	12	100
Mcclain	Purcell	53	114	-13	108	0	4	11	102
Mccurtain	Idabel	60	114	-11	108	5	1	10	94
Mccurtain	Smithville	39	115	-22	107	0	3	6	99
Mcintosh	Eufaula 2 Sw	36	116	-18	108	0	3	12	99
Mcintosh	Hanna	40	109	-15	106	-1	3	7	99
Murray	Sulphur Platt Nl Park	55	114	-15	109	-2	3	12	101
Muskogee	Muskogee	83	118	-14	107	-2	3	9	99
Muskogee	Webbers Falls	73	115	-16	108	-1	3	12	100
Noble	Perry	68	117	-18	109	-3	5	12	103
Nowata	Nowata	47	118	-13	109	-5	6	9	105
Okfuskee	Okemah	82	115	-10	108	-1	3	12	100
Oklahoma	Oklahoma City Rogers	51	110	-8	106	-1	4	8	100
Okmulgee	Okmulgee Water Works	64	114	-18	107	-3	4	8	101
Osage	Barnsdall	38	115	-17	109	-10	7	11	107
Osage	Bartlesville Phillip	69	115	-25	108	-7	6	11	106
Osage	Pawhuska	83	116	-26	108	-9	7	10	106
Ottawa	Miami	64	116	-25	107	-7	6	7	103
Pawnee	Ralston	41	112	-15	108	-6	6	8	106
Payne	Cushing	54	117	-11	107	-3	6	9	102
Payne	Stillwater 2 W	96	115	-18	108	-4	6	9	103

			Temperature Extremes		Exceedance Temperatures		Number of Days		
County	**Location**	**No. Years**	**Highest**	**Lowest**	**Max**	**Min**	**Min < 10**	**Max > 100**	**Range**
Pittsburg	Mcalester	36	116	-10	109	1	3	15	100
Pittsburg	Mcalester Muni Airport	45	112	-14	107	-2	3	9	99
Pontotoc	Ada	83	116	-10	108	0	3	9	98
Pottawatomie	Shawnee	62	116	-14	108	-2	4	12	102
Pushmataha	Antlers	53	116	-10	107	3	2	11	96
Pushmataha	Tuskahoma	37	113	-13	108	-2	3	13	100
Roger Mills	Hammon 3 SSW	57	115	-18	110	-6	7	16	107
Roger Mills	Reydon	32	110	-16	107	-6	7	7	105
Rogers	Claremore 2 ENE	77	116	-21	107	-5	6	7	104
Seminole	Seminole	46	113	-12	108	0	3	12	100
Sequoyah	Sallisaw 2 NE	69	115	-19	107	-3	3	9	99
Stephens	Duncan	49	111	-8	108	1	2	12	98
Stephens	Marlow 1 WSW	72	114	-14	109	0	3	15	101
Texas	Goodwell Research	55	111	-22	107	-11	13	9	111
Texas	Hooker	74	112	-22	108	-13	13	15	112
Tillman	Frederick	69	117	-11	111	2	2	29	102
Tulsa	Bixby 2 E	35	112	-14	107	-3	4	8	102
Tulsa	Tulsa Intl Airport	59	112	-11	107	-2	5	9	101
Wagoner	Wagoner	71	119	-12	108	-2	4	9	101
Washita	Cloud Chief 2 SE	63	119	-14	111	-4	4	24	106
Washita	Cordell	38	115	-12	110	2	4	18	103
Woods	Alva	77	118	-16	112	-5	7	24	109
Woods	Freedom	39	114	-17	110	-9	11	18	112
Woods	Waynoka	53	114	-15	111	-8	8	19	109
Woodward	Fort Supply Dam	45	110	-18	108	-8	9	11	107
Woodward	Mutual	60	115	-19	111	-6	8	20	109
Woodward	Woodward	64	115	-24	110	-8	8	16	110

Extreme values of heat index and wind chill and total number of occurrences of heat index and wind chill thresholds for each Mesonet station, 1994-2003.

		Heat Index				Wind Chill			
County	Location	Maximum	Greater than 90	Greater than 105	Greater than 130	Minimum	Less than -20	Less than -40	Less than -60
Adair	Westville	120	793	133	0	-15	0	0	0
Alfalfa	Cherokee	116	912	255	0	-18	0	0	0
Atoka	Lane	120	1002	279	0	-7	0	0	0
Beaver	Beaver	115	863	85	0	-25	2	0	0
Beaver	Slapout	114	834	76	0	-22	1	0	0
Beckham	Erick	120	931	146	0	-14	0	0	0
Blaine	Watonga	118	864	139	0	-22	1	0	0
Bryan	Durant	134	1055	312	1	-5	0	0	0
Caddo	Apache	128	941	134	0	-17	0	0	0
Caddo	Fort Cobb	122	936	171	0	-15	0	0	0
Caddo	Hinton	123	904	162	0	-16	0	0	0
Canadian	El Reno	121	956	239	0	-21	1	0	0
Carter	Ardmore	120	1063	355	0	-6	0	0	0
Cherokee	Cookson	124	879	232	0	-9	0	0	0
Cherokee	Tahlequah	121	826	167	0	-19	0	0	0
Choctaw	Hugo	123	1033	311	0	-4	0	0	0
Cimarron	Boise City	103	548	0	0	-29	4	0	0
Cimarron	Kenton	103	486	0	0	-30	1	0	0
Cleveland	Norman	123	933	256	0	-15	0	0	0
Coal	Centrahoma	125	1044	388	0	-19	0	0	0
Comanche	Medicine Park	122	981	207	0	-17	0	0	0
Cotton	Walters	119	1100	362	0	-14	0	0	0
Craig	Vinita	117	837	225	0	-23	3	0	0
Creek	Bristow	122	959	337	0	-17	0	0	0
Creek	Oilton	122	917	277	0	-24	1	0	0
Custer	Butler	121	946	216	0	-22	1	0	0
Custer	Weatherford	122	897	131	0	-18	0	0	0
Delaware	Jay	120	792	148	0	-25	1	0	0
Dewey	Camargo	113	816	104	0	-27	1	0	0
Dewey	Putnam	119	886	141	0	-19	0	0	0

		Heat Index				Wind Chill			
County	Location	Maximum	Greater than 90	Greater than 105	Greater than 130	Minimum	Less than -20	Less than -40	Less than -60
Ellis	Arnett	110	814	45	0	-16	0	0	0
Garfield	Breckenridge	122	904	252	0	-21	1	0	0
Garvin	Byars	119	868	186	0	-14	0	0	0
Garvin	Pauls Valley	122	1047	332	0	-8	0	0	0
Grady	Acme	126	1022	249	0	-14	0	0	0
Grady	Chickasha	124	1038	331	0	-11	0	0	0
Grady	Minco	119	939	211	0	-17	0	0	0
Grady	Ninnekah	127	1015	343	0	-13	0	0	0
Grant	Medford	126	936	265	0	-17	0	0	0
Greer	Mangum	126	1037	259	0	-14	0	0	0
Harmon	Hollis	120	1081	288	0	-13	0	0	0
Harper	Buffalo	114	892	163	0	-17	0	0	0
Haskell	Stigler	120	977	295	0	-8	0	0	0
Hughes	Calvin	125	1019	349	0	-11	0	0	0
Jackson	Altus	126	1038	242	0	-13	0	0	0
Jefferson	Ringling	128	1039	297	0	-9	0	0	0
Jefferson	Waurika	119	1105	349	0	-8	0	0	0
Johnston	Tishomingo	121	1016	318	0	-11	0	0	0
Kay	Blackwell	129	912	282	0	-17	0	0	0
Kay	Newkirk	119	799	171	0	-19	0	0	0
Kingfisher	Kingfisher	127	980	282	0	-28	1	0	0
Kiowa	Hobart	125	934	125	0	-17	0	0	0
Latimer	Wilburton	128	1038	389	0	-5	0	0	0
LeFlore	Talihina	121	1012	299	0	-4	0	0	0
LeFlore	Wister	135	1024	339	1	-6	0	0	0
Lincoln	Chandler	122	870	200	0	-20	1	0	0
Logan	Guthrie	119	969	297	0	-22	1	0	0
Logan	Marshall	119	943	301	0	-25	2	0	0
Love	Burneyville	125	1116	405	0	-7	0	0	0
Major	Fairview	117	952	280	0	-22	1	0	0
Major	Lahoma	115	876	219	0	-21	1	0	0

		Heat Index				Wind Chill			
County	Location	Maximum	Greater than 90	Greater than 105	Greater than 130	Minimum	Less than -20	Less than -40	Less than -60
Marshall	Madill	123	1088	341	0	-3	0	0	0
Mayes	Pryor	124	909	286	0	-17	0	0	0
McClain	Washington	118	931	226	0	-13	0	0	0
McCurtain	Broken Bow	135	1064	445	2	3	0	0	0
McCurtain	Idabel	126	1112	413	0	-19	0	0	0
McCurtain	Mt Herman	123	932	151	0	0	0	0	0
McIntosh	Eufaula	123	969	309	0	-11	0	0	0
Murray	Sulphur	117	924	186	0	-12	0	0	0
Muskogee	Haskell	123	944	297	0	-15	0	0	0
Muskogee	Webbers Falls	126	1021	462	0	-12	0	0	0
Noble	Red Rock	140	911	274	1	-22	1	0	0
Nowata	Nowata	126	875	279	0	-18	0	0	0
Okfuskee	Okemah	121	946	292	0	-15	0	0	0
Oklahoma	Spencer	118	911	202	0	-14	0	0	0
Okmulgee	Hectorville	120	736	276	0	-9	0	0	0
Okmulgee	Okmulgee	125	972	356	0	-13	0	0	0
Osage	Burbank	119	816	226	0	-22	1	0	0
Osage	Foraker	121	805	191	0	-19	0	0	0
Osage	Skiatook	121	877	260	0	-15	0	0	0
Osage	Wynona	121	882	251	0	-17	0	0	0
Ottawa	Miami	115	773	148	0	-21	2	0	0
Pawnee	Pawnee	123	923	291	0	-25	1	0	0
Payne	Marena	117	900	235	0	-19	0	0	0
Payne	Perkins	116	900	238	0	-23	1	0	0
Payne	Stillwater	117	890	237	0	-15	0	0	0
Pittsburg	McAlester	128	987	283	0	-11	0	0	0
Pittsburg	Stuart	126	959	259	0	-13	0	0	0
Pontotoc	Ada	123	1006	318	0	-11	0	0	0
Pottawatomie	Shawnee	115	917	225	0	-15	0	0	0
Pushmataha	Antlers	128	1120	412	0	-6	0	0	0
Pushmataha	Clayton	127	981	294	0	-6	0	0	0

		Heat Index				Wind Chill			
County	Location	Maximum	Greater than 90	Greater than 105	Greater than 130	Minimum	Less than -20	Less than -40	Less than -60
Pushmataha	Cloudy	128	993	264	0	-3	0	0	0
Roger Mills	Cheyenne	114	793	48	0	-22	1	0	0
Rogers	Claremore	125	930	356	0	-18	0	0	0
Seminole	Bowlegs	132	980	325	1	-11	0	0	0
Sequoyah	Sallisaw	122	955	268	0	-7	0	0	0
Stephens	Ketchum Ranch	130	1001	209	1	-14	0	0	0
Texas	Goodwell	107	721	9	0	-26	2	0	0
Texas	Hooker	113	849	43	0	-27	3	0	0
Tillman	Grandfield	121	1071	332	0	-11	0	0	0
Tillman	Tipton	123	1075	287	0	-11	0	0	0
Tulsa	Bixby	124	934	304	0	-13	0	0	0
Wagoner	Tullahassee	119	918	306	0	-15	0	0	0
Washington	Copan	117	846	247	0	-21	1	0	0
Washita	Bessie	118	955	163	0	-18	0	0	0
Washita	Retrop	119	922	132	0	-17	0	0	0
Woods	Alva	117	907	231	0	-21	1	0	0
Woods	May Ranch	115	794	126	0	-19	0	0	0
Woodward	Freedom	120	923	229	0	-16	0	0	0
Woodward	Seiling	121	932	198	0	-20	1	0	0
Woodward	Woodward	125	864	136	0	-16	0	0	0

Floods and Flash Floods: Hazards in Oklahoma

Nationally, flooding and flash flooding is the number one killer of all storm-related natural disasters. About 140 people die each year in the United States due to flooding and flash flooding. In Oklahoma, flash flooding is a consistent threat to life.

This document will focus on flooding caused by excessive precipitation. Flooding as a result of large structural failures will be treated in a separate document.

Definitions: Flash Flooding versus River Flooding

Flooding occurs on continuous scales of time and area. Humans tend to group events into two categories: flash flooding and river flooding. Flash flooding refers to events that occur during or immediately after the life cycle of a thunderstorm. These events respond on the order of minutes to hours to heavy precipitation. River flooding refers to the response of larger streams to prolonged precipitation. Flooding on this scale may take days, or even weeks, to culminate.

Vulnerability to flash flooding and river flooding is a dichotomy, in that *flash flooding's primary threat is to human life and safety, while river flooding's primary threat is substantial economic damage*.

The size of a stream's watershed is the dominant factor in the time scale of its response to heavy precipitation. For example, very small creeks and branches of creeks can respond in minutes to heavy precipitation. Larger rivers, such as the Arkansas, may take days to crest after prolonged periods of rainfall.

Characteristic or Factor	Flash Flooding	River Flooding
Size of waterway	Small (from unnamed creeks to larger creeks)	Large creeks, minor rivers, major rivers
Area of watershed or catchment	Several hundred acres to tens of square miles	About a hundred to several thousand square miles
Associated precipitation	Convective storms, often slow-moving or "training" thunderstorms	Larger-scale precipitation patterns, often slow-moving fronts or remnants of tropical storms, or both
Duration of event	Minutes to hours	Hours to days
Time scale of response	Minutes to hours	Hours to days

Warning Lead Time	Short (no warning to several minutes)	Significant (several hours to about a day)
Location of flooding	Within or very near the footprint of heavy rainfall	Often downstream of heavy rainfall (increasingly so with larger watersheds)
Primary threat	Loss of life; human safety	Loss of property; economic disruption

Table A. Typical characteristics of, and factors related to, flash flooding and river flooding in Oklahoma.

Flash Flooding

Flash flooding occurs when the precipitation rate becomes so large that waterways cannot evacuate the runoff, streams swell and flash flooding occurs. It can occur as soon as minutes after a downpour has begun. The conditions that lead to flash flooding can happen anywhere in Oklahoma, during any season, and at any time of day.

Courtesy of NWS Southern Region HQ

Flash flooding is a real and significant hazard to life in Oklahoma because of two major factors:

1. The prevalence of convective precipitation. Thundershowers and thunderstorms can produce precipitation at very high rates. These events are certainly a large part of Oklahoma's rainfall climate. They are especially prevalent during the warm season.
2. Vehicular travel.

People often underestimate the power of water. This leads to many unfortunate and sometimes tragic encounters during seemingly minor flooding events. As little as six inches of water can cause a driver to lose control of a passenger vehicle.

From 1960-2002, there were 94 deaths due to flash flooding in Oklahoma. The vast majority of these deaths are vehicle-related. Since 1994, all flash flood deaths in Oklahoma have been vehicle-related.

A new campaign by the National Weather Service is urging people to think twice about driving into flooded areas. The campaign is simply called, "Turn Around Don't Drown" and this program reaches out to educate the public about flood safety and the dangers that come along with floods.

Factor	Effect
Precipitation Rate	The most obvious contributing factor. As the rate of precipitation increases, so does its ability to outpace the ability of the watershed to absorb it. T*his is the dominant factor in flash flooding events, and can overwhelm any or all of the following factors.*
Training Echoes	Storm cells that follow each other (much like box cars on a train) can repeatedly deposit large amounts of water on the same watershed, overwhelming its ability to handle runoff.
Slope of Watershed	Steeper topography (hills, canyons, etc.) will move runoff into waterways more quickly, resulting in a quicker response to precipitation.
Shape of Watershed	Longer, narrower watersheds will tend to "meter out" runoff so that water arrives from downshed (nearer to the mouth of the stream) areas faster than from upshed areas. In watersheds that are more square or circular than elongated, runoff tends to arrive in the main stem at the same time, intensifying the response. This factor becomes more significant with larger watersheds.
Saturation of Soils	Saturated or near-saturated soils can greatly reduce the rate at which water can soak into the ground. This can increase runoff dramatically.
Hardened Soils	Extremely dry soils can develop a pavement or "crust" that can be resistant to infiltration. This is especially true in areas of recent wildfire, where plant oils or resins may cause the soil to be even more water-resistant.
Urbanization	The urban environment usually intensifies the response to heavy precipitation. The two dominant urban factors are: 1) increased pavement coverage, which prevents infiltration and dramatically increases runoff; and 2) Urban systems are designed to remove water from streets and byways as quickly as possible. This accelerates the natural response to precipitation by placing runoff in waterways much more quickly.
Low-water crossings	The vast majority of flash-flood related deaths occur in vehicles. Many of these deaths occur at low-water crossings where the driver is unaware of the depth of the water or the consequences of driving into it.

Table B. Contributing factors to flash-flood hazard and vulnerability in Oklahoma.

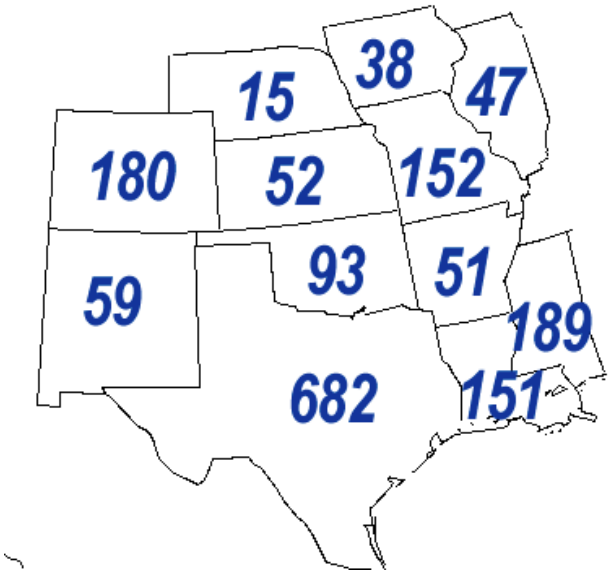


Figure 1. Flood and flash-flood related deaths in Oklahoma and nearby states, 1961-1999. Single events strongly influenced totals in Colorado (Big Thompson, 1976, 140 deaths), Louisiana (Hurricane Betsy, 1965, 50+ deaths), and Mississippi (Hurricane Camille, 1969, ~130 deaths).

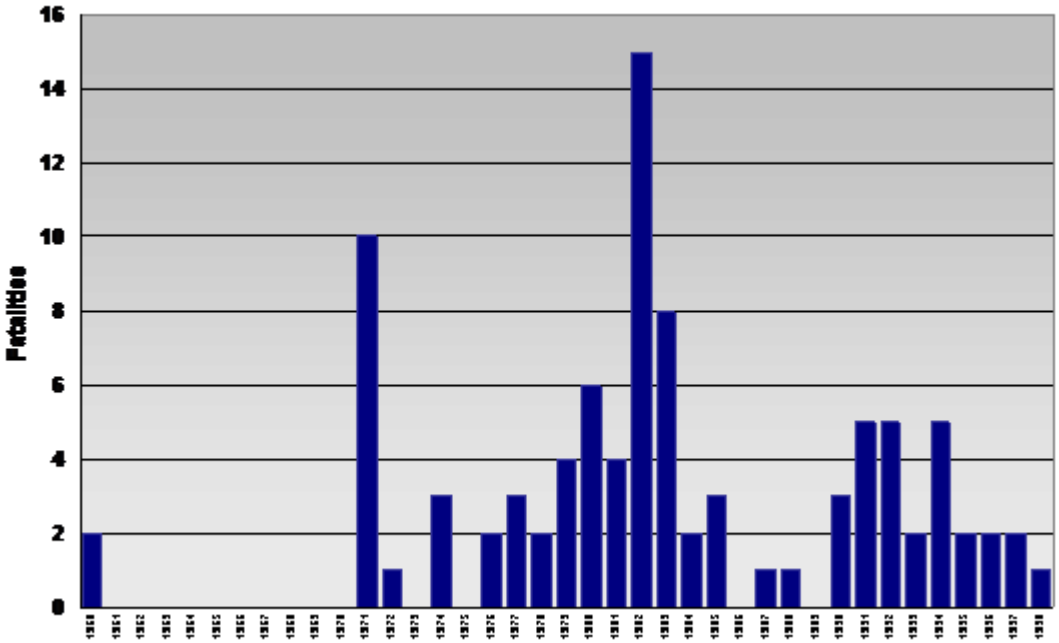


Figure 2. Flood-related deaths in Oklahoma by year since 1960. The vast majority of these deaths are flash flood deaths, and the vast majority of those are vehicle-related.

River Flooding

Flooding of larger streams and rivers typically requires many hours (a day or more) of intermittent or continuous heavy precipitation over a larger area. Typical scenarios for river flooding may involve a stalled or slow-moving front with persistent associated precipitation, the remnants of a land-falling tropical storm, or interaction between these two features.

River flooding occurs when heavy runoff from several tributaries converge in a larger stream's main channel. The stream level rises, crests and drops over the course of hours or days. As a general rule of thumb, the response to precipitation is slower for larger rivers. River flood damage occurs over a wide area, sometimes several square miles.

Oklahoma's vulnerability to river flooding changed dramatically during the last half of the 20th Century. Several factors combined to minimize the loss of life due to river flooding:

1. *Physical Floodwater Control* – Widespread damming of rivers and upstream tributaries has dramatically reduced the frequency and magnitude of river flooding in Oklahoma.
2. *More Accurate Forecasting* – Hydrological forecasting has improved, as has the timeliness and availability of rainfall observations. As a result, the forecast level of larger streams is much more predictable. River stage forecasting has matured to levels of accuracy that were impossible early in the century.
3. *Longer Warning Lead-Times* – Because river flooding typically occurs hours to days after rainfall ceases, warnings for river flooding often provide much more lead time than those for flash flooding.
4. *Floodplain Management* – The state, through the Oklahoma Water Resources Board, has aggressively pursued a policy of mitigation through incremental reclamation of flood-prone areas. This has gradually reduced the number of residences in harm's way.

As a result of these factors, the primary vulnerability to river flooding is economic in nature. Most major economic damage is confined to a few very large events. For example, flooding during the three years of 1957, 1984 and 1986 caused more damage than the remainder of the years between 1955-1999 (see Figure 3).

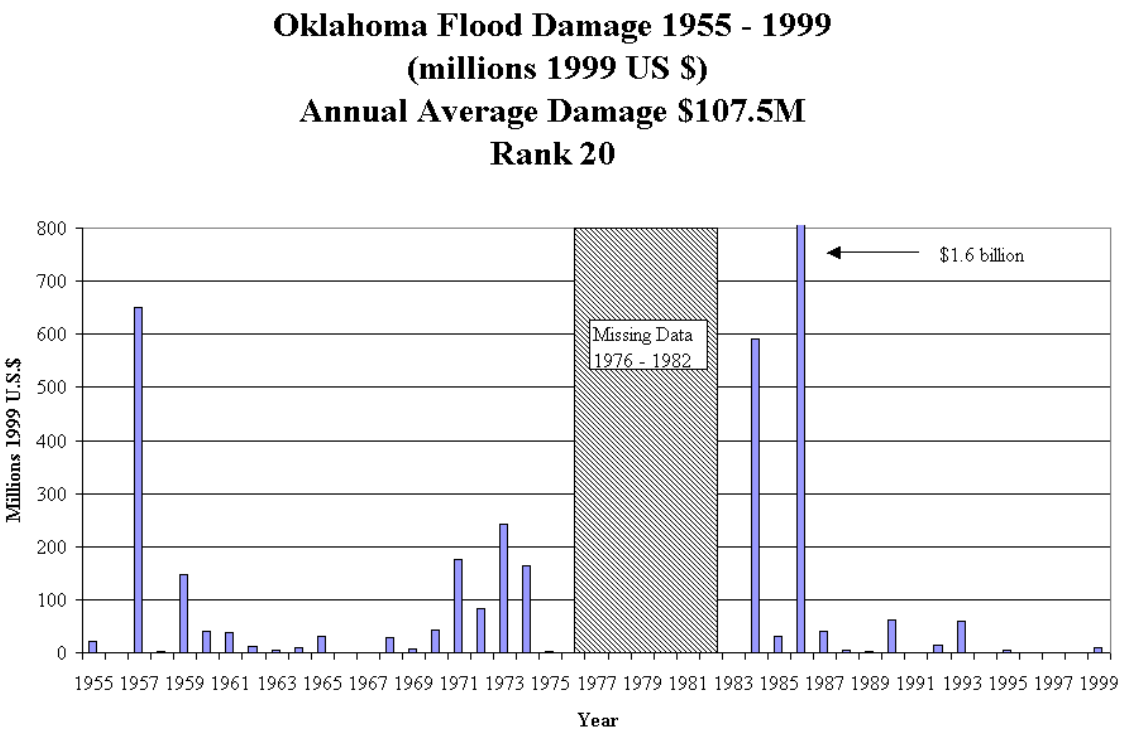


Figure 3. Economic damage due to flooding in Oklahoma: 1955-1999. River flooding events in 1957, 1984 and 1986 constitute the majority of dollars during the period. From Climatological Data National Summary, Annual Summary 27(13), 124; U.S. Army Corps of Engineers (1992) and (1999).

Seasonal Trends in River Flooding

Spring and fall are the preferred seasons for river flooding, because these are the seasons that provide the bulk of Oklahoma's rainfall. However, river flooding can occur during any month on the calendar.

Autumn months in Oklahoma provide an enhanced threat of wide-scale flooding because of the combination of several contributing factors. Late summer and autumn is the peak of the Gulf hurricane/tropical storm season. Large-scale weather patterns (fronts and upper-level storms) are also much more active in the autumn than in the summer. Moisture from land falling tropical storms can interact with slow-moving fronts to provide heavy rains for days at a time. In Oklahoma, these are the ingredients for river flooding. The moisture can be provided by tropical storms in the Gulf of Mexico, or even from the remnants of Pacific tropical storms (see Table C).

Year	Month	Tropical Storm	Source Region	Comments
1996	September	Fausto	Pacific	6+ inches rain; minor flooding along North Canadian.
1995	August	Dean	Gulf of Mexico	12-16 inches in parts of OK; interacted with weak, stalled cold front; major flooding along much of Salt Fork of the Arkansas River in Grant and Kay Counties; flooding also occurred on Cimarron, Washita and Arkansas Rivers.
1988	September	Gilbert	Gulf of Mexico	Interaction with slow-moving front; 4+ inch rains fell onto saturated soils; flooding on creeks and rivers.
1986	September-October	Paine	Pacific	Up to 20 inches in north-central OK; massive flooding on Cimarron. Flooding on the Arkansas River; ground was already saturated by rainfall associated with remnants of Pacific Hurricane Newton; estimated damages of $350 million; 52 counties declared disaster areas.
1983	October	Tico	Pacific	Up to 17 inches rain in southwest and central OK; Red River at Burkburnett and Terral rose to highest stage in 60 years; widespread flooding of smaller rivers and creeks.
1981	October	Norma	Pacific	Up to 24 inches of rain in south-central OK (Monthly total of 25.8” at Madill is greatest for any station during any month in OK history).
1961	September	Carla	Gulf of Mexico	

Table C. Selected Tropical-Storm-Related River Flooding in Oklahoma.

A Look at Recent Historical Flood Years

1993

A number of flooding problems were seen across Oklahoma in 1993. Numerous floods and flash floods occurred throughout the year, with May being the most damaging. In total, $126 million in property damage and $50 million in crop damage occurred. During the year, there were five fatalities and all of these deaths occurred on May 8. Of these five, four were in Oklahoma County and one was in Washita County. 13 events alone produced $5 million in damage and a more massive flood that affected central and eastern parts of the state produced $100 million in property and crop damage.

The fall months also saw its fair share of flooding, most notably on September 25 in northeast Oklahoma. Heavy rains fell during the evening of the 24th and early morning hours of the 25th which resulted in flash flooding. Rainfall amounts up to 8.5 inches fell in extreme northeast Oklahoma and sent many creeks in Nowata, Craig, and Ottawa Counties out of their banks. Approximately 150 people were evacuated in these counties during the early morning of the 25th as a result of the heavy rain.

1994-1999

After the extremely busy year of 1993, things quieted down much more over the next few years. Damaging floods were few and far between and only one fatality and one injury occurred during this time. Both the death and injury occurred on April 11, 1997 as heavy rains fell in north-central Oklahoma the day before, causing several rivers and streams, including the Chickaskia, to flood. The fatality, a 53-year-old woman, occurred when she drove around a barricade on the outskirts of Ponca City and attempted to drive through a flooded road. The flooded river took her car and washed it downstream. The injury occurred in a similar fashion, in that this man drove around a barricade as well on his way to Ponca City. After having his car washed off the road and into the river, the man was rescued and treated for hypothermia.

2000

2000 was the first major year of flooding for Oklahoma in seven years. Total damage for the year was $21 million, which most occurring from floods in May, June, and October. One death occurred in Tulsa County on May 6. A woman drove her car into a stream which had flooded the road and her car stalled. The woman got out of her car, but was swept away. The two injuries that occurred during 2000 were in Tillman County on October 22. As with most cases, they were due to driving into a flooded road. The car was swept off the road and into a creek and both occupants had to be rescued by boat and treated for injuries. One had a broken leg and the other received lacerations.

The most damaging flood event occurred during this same time period. From the evening hours on October 22 to the early morning hours on the 23rd, southern portions of Caddo County dealt with a flash flood. Nearly 200 people were left homeless after the heavy rains caused Box Elder and Cache Creek to overflow their banks. Much of downtown Anadarko was also flooded with a foot or more of water observed in some spots. A 35 mile wide band of rain from near Frederick to near Chandler was the cause for the heavy rains. Amounts in this band averaged four to eight inches, with Anadarko receiving 10 inches, which classifies as a 250-year rain event. Total damage from this flash flood accumulated to $6 million.

2001-2003

This three year period was relatively quiet, with a rather small $859 thousand in damage occurring to property and only $50 thousand to crops. Three people were injured during this time period. Two of the injured people were teenagers in Newalla that were rescued from a tree submerged in nearly eight feet of fast-flowing water on June 27, 2001. The other injury was in Elk City on May 4, 2001. On this day, several cars stalled in high water, and a young boy was swept into a drainage channel, but pulled to safety. The flash flood was a result of numerous thunderstorms that formed across southwest Oklahoma during the afternoon and spread northeastward.

2004

The most recent flood event with major damage occurred on March 4, 2004 in western portions of the state and much of north-central Oklahoma. The focus of the very heavy rainfall was along a 100-mile wide swatch along and northwest of Interstate 44 from southwestern through central and north-central Oklahoma. Rainfall amounts of 2.5 to five inches were common with locally heavier amounts of up to eight inches observed in Kingfisher and Blaine counties. Heavy runoff along Kingfisher Creek and its tributaries eventually produced flooding in the City of Kingfisher beginning at about 6:00 p.m. Two people were treated for injuries, including hypothermia, after being stranded in their car three miles west of Kingfisher. Three more people were treated for hypothermia and minor injuries after a Union Pacific train derailed because a small tributary of the Cimarron River had eroded some of the track. The injured Union Pacific employees were briefly stranded by the floodwaters two miles north of Kingfisher, and were eventually rescued.

Flood - Appendix A: Oklahoma Flash-Flood Warnings and Events, 1986-2003

The following list contains the total number of flash flood warnings and verified flash flood events for each of Oklahoma's 77 counties. Warnings indicate the number of times that meteorological conditions indicated an imminent threat of flash flooding. Verified events are the number of flash flood events that were confirmed by National Weather Service (NWS) personnel in follow-up investigations.

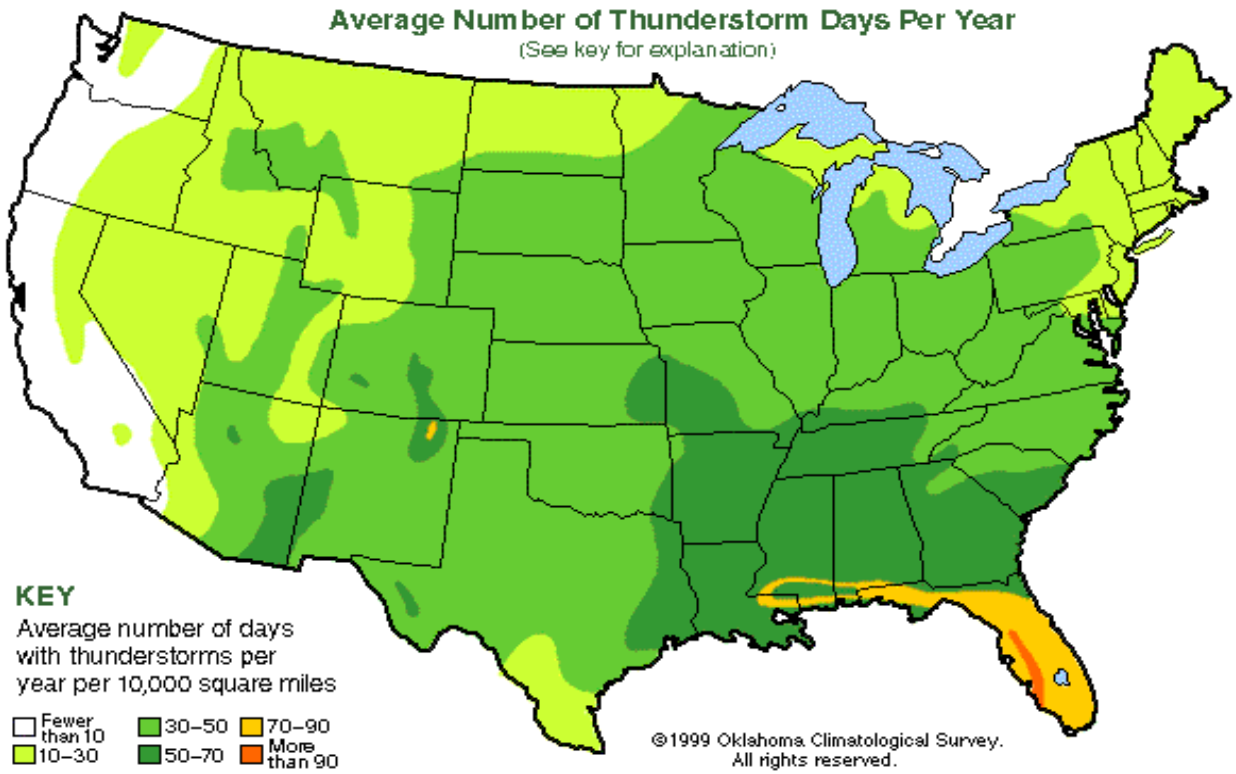
Discrepancies between the two sets of numbers are indicative that not all flash-flood events receive warnings, and not all warnings have subsequent flooding. Flash flood forecasting is difficult and limited somewhat by observational technology. Flash flood events in sparsely populated areas are more difficult to verify than those in urban areas. During times of widespread severe weather, flash flooding is only one of several hazards that threaten the public, and must "compete" with violent weather for the time and attention of NWS staff.

County	Warnings Issued	Verified Events	County	Warnings Issued	Verified Events	County	Warnings Issued	Verified Events	County	Warnings Issued	Verified Events
Adair	33	19	Custer	18	10	Latimer	45	32	Ottawa	23	18
Alfalfa	31	22	Delaware	21	18	Le Flore	71	36	Pawnee	37	21
Atoka	32	15	Dewey	13	6	Lincoln	26	18	Payne	20	12
Beaver	11	4	Ellis	16	7	Logan	4	21	Pittsburg	52	39
Beckham	18	5	Garfield	36	21	Love	26	6	Pontotoc	17	5
Blaine	21	10	Garvin	17	9	Major	17	10	Pottawatomie	22	13
Bryan	57	26	Grady	49	13	Marshall	33	13	Pushmataha	48	18
Caddo	40	19	Grant	41	26	Mayes	26	15	Roger Mills	11	4
Canadian	49	20	Greer	23	8	McClain	30	8	Rogers	44	38
Carter	32	14	Harmon	14	8	McCurtain	71	29	Seminole	16	11
Cherokee	46	34	Harper	7	3	McIntosh	28	21	Sequoyah	34	20
Choctaw	38	16	Haskell	31	24	Murray	26	16	Stephens	44	31
Cimarron	9	10	Hughes	12	5	Muskogee	48	33	Texas	13	8
Cleveland	37	25	Jackson	32	15	Noble	26	12	Tillman	30	14
Coal	17	5	Jefferson	29	13	Nowata	31	25	Tulsa	74	61
Comanche	44	30	Johnston	25	9	Okfuskee	20	17	Wagoner	38	27
Cotton	30	12	Kay	63	46	Oklahoma	65	49	Washington	29	27
Craig	27	20	Kingfisher	45	21	Okmulgee	38	32	Washita	19	11
Creek	49	42	Kiowa	37	16	Osage	71	54	Woods	14	11
									Woodward	14	8
									Statewide	**2495**	**1470**

Thunderstorms - Fury on the Oklahoma Plains

Oklahoma experiences a high number of thunderstorms each year, the majority of which occur in the warm months. The same can be said of most of the southern half of the country, although areas in the southeast and the high plains of Colorado and New Mexico are decidedly the most active areas within the United States. Given that Oklahoma has the highest incidence of significant tornadoes per square mile in the world, it follows that the state would experience a high number of severe thunderstorms. This can be seen from the graphic below.

The threats from thunderstorms are four-fold: winds (straight-line and tornadic), heavy rainfall (flash flooding), large hail, and lightning.



Severe Thunderstorm Parameters

For a thunderstorm to be considered severe there is a criteria that meteorologists go by. Severe thunderstorms are defined in the United States as having either tornadoes, wind gusts at least 58 mph, or hail at least 3/4 inch in diameter

What is a thunderstorm?

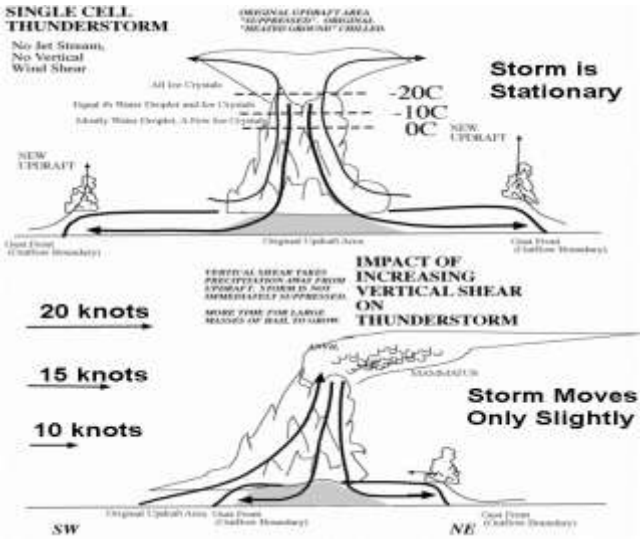
A thunderstorm is simple a storm with lightning and thunder, and is produced from what is called a cumulonimbus cloud. Thunderstorms can produce gusty winds, heavy rain and sometimes hail.

For a thunderstorm to form, certain conditions are needed. First and most important is moisture. Moisture is key because it forms clouds and rain that comprise the storm. Unstable air is important in the process as well. Relatively warm air that can rise rapidly provides the updrafts which strengthen the storm. Lastly, some means to lift the air is important. Without a lifting mechanism, the air can't be lifted as easily and often reduces chances of storms. Examples of lifting mechanisms are fronts, drylines, sea breezes, and even mountains just to name a few.

Thunderstorm Classifications

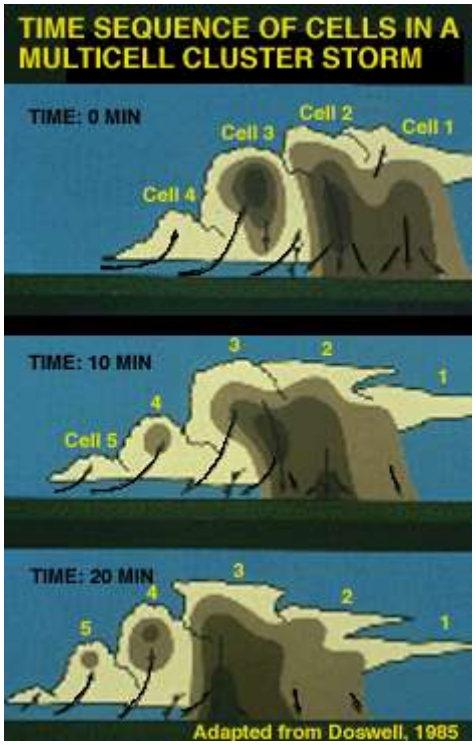
All thunderstorms are not created equal. The most important factor in determination of hazard risk is updraft strength. Weak thunderstorms, those generated from a weak updraft, are actually beneficial, as most of Oklahoma's precipitation is provided by garden-variety air mass thunderstorms during the warm season. A disproportionate amount of damage by thunderstorms is done by the less frequent severe thunderstorm, which has a strong updraft. Accordingly, the most damaging thunderstorms, those with violent updrafts, do an even more disproportionate share of the damage, given their rarity. These storms, termed "supercells," are always severe, whereas the other thunderstorm types can be considered either weak or severe.

The thunderstorm species can be split into three different cellular structures: single-cell, multi-cell, and supercell.



- **Single-cell** thunderstorms (also known as "pulse thunderstorms") typically do not produce severe weather and usually last for 20-30 minutes. These storms seem quite random in the production of brief severe events such as downbursts, hail, some heavy rainfall, and occasional weak tornadoes.

Photograph courtesy of NSSL

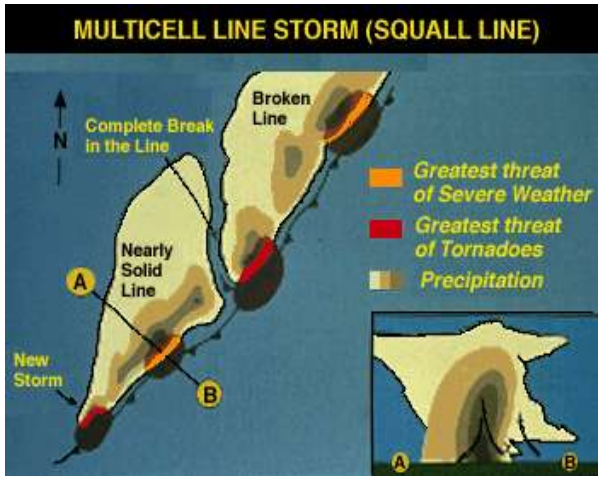


- **Multi-cell** thunderstorms can be broken down into two distinct families: multi-cell cluster storms and multi-cell line storms. Usually multi-cell storms are more severe than single-cell storms, but not nearly so as supercell storms. Multi-cell storms produce the most significant flash flood danger to the public due to their pulse-like nature.

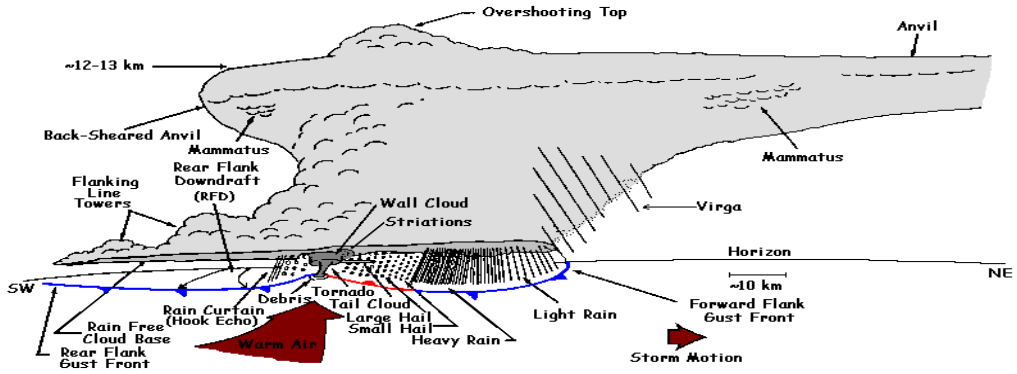
  - **Multi-cell cluster** thunderstorms are defined as a group of cells moving as a single unit, with each cell in a different stage of the thunderstorm life cycle. Multi-cell storms can produce moderate size hail, flash floods and weak tornadoes.

- **Multi-cell line** thunderstorms consist of a line of storms with a continuous, well developed gust front at the leading edge of the line. Also known as squall lines, these storms can produce small to moderate size hail, occasional flash floods and weak tornadoes. Quite different to multi-cell cluster storms due to structure, the main threat from multi-cell line storms is downburst winds.

Photographs courtesy of Chuck Doswell



- **Supercell** thunderstorms are defined by a rotating updraft. These storms can produce strong downbursts, large hail, occasional flash floods and weak to violent tornadoes. In fact, the major difference between supercell and multi-cell storms is the element of rotation in supercells. Even though it is the rarest of storm types, the supercell is the most dangerous because of the extreme weather generated.



from Houze and Hobbs

Photographs courtesy of Chuck Doswell

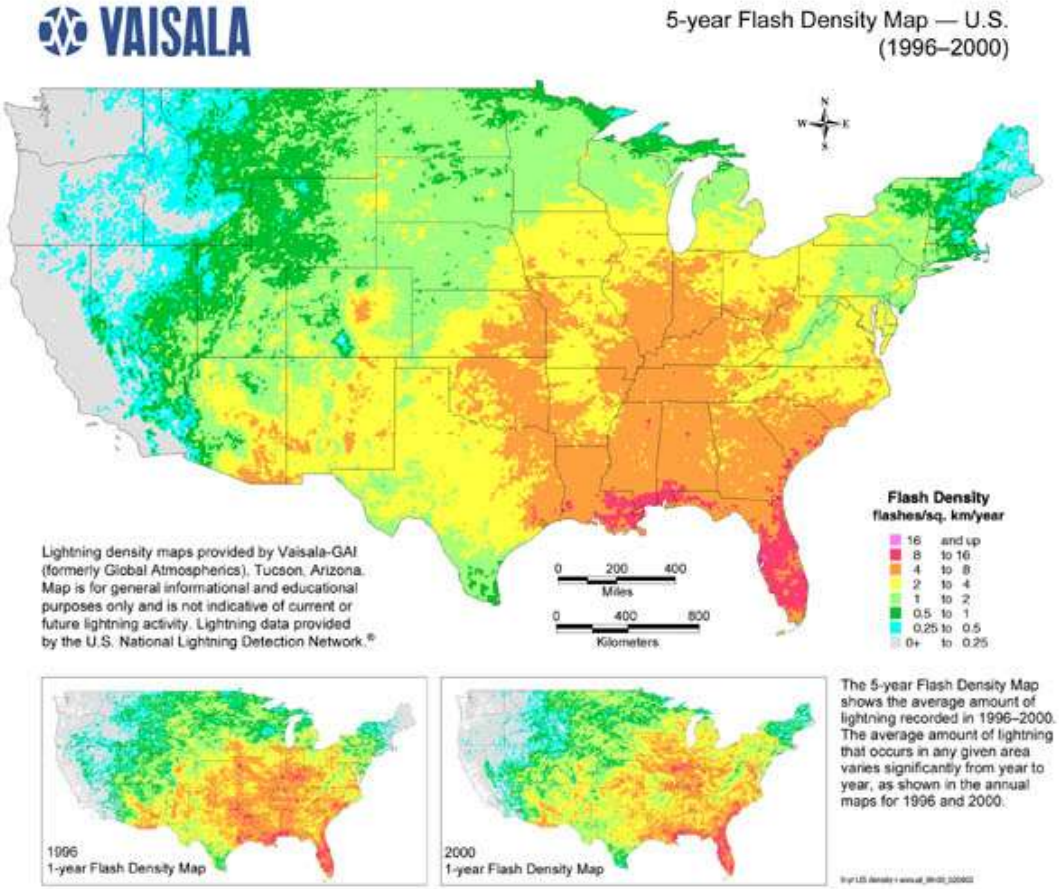
For all intents and purposes, thunderstorms should be broken down into two categories, given the propensity for supercell storms to dominate damage potential: supercells and ordinary.

Thunderstorm Hazards

As mentioned previously, the primary hazards associated with supercell thunderstorms are downburst winds, large hail, occasional flash floods, and weak to violent tornadoes, the latter two of which will be discussed in other documents. Another hazard which is endemic to all thunderstorm types is lightning.

Lightning

Lightning is a thunderstorm's number two killer each year (flooding remains number one). Each year, approximately 100 people die from lightning strikes, with another 1000 surviving strikes, but suffering some degree of injury. There is more than $2 billion damage annually in the USA from lightning. The worst lightning incident in the USA was in New Jersey, on July 10, 1926. A Navy ammunition arsenal was hit, killing 19 people and destroying property valued at $17 million (1986 dollars). Usually, single events caused by lightning are less dramatic than single events caused hurricanes, floods or tornadoes. Old data said successive flashes were on the order of 3-4 km apart.

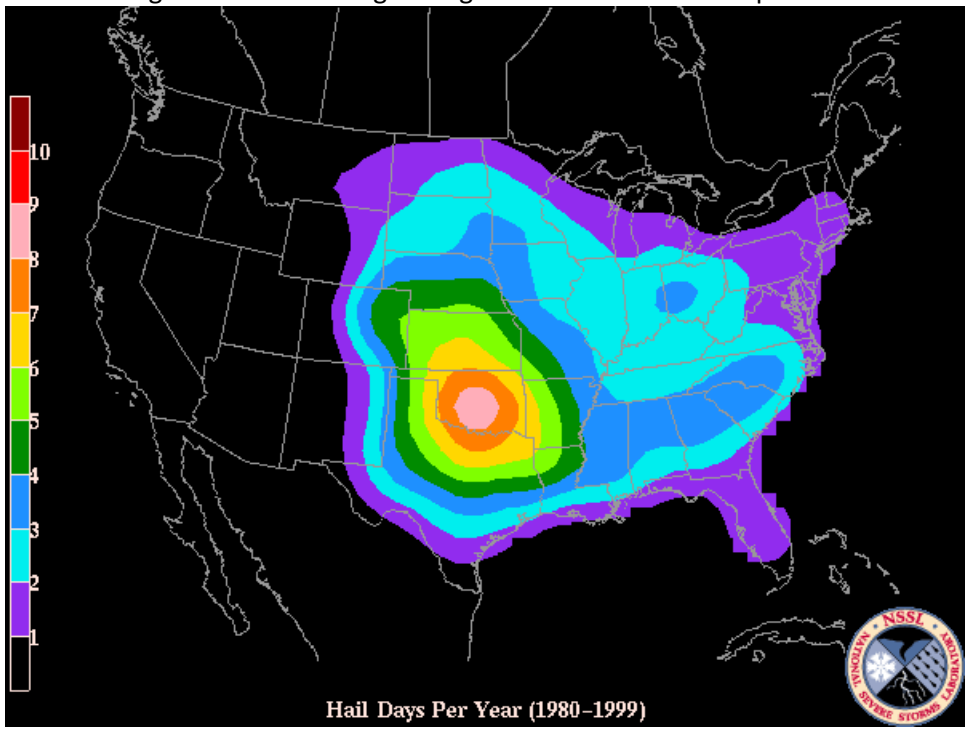


New data shows half the flashes are some 9 km apart. The National Severe Storms Laboratory report concludes with a recommendation that: "It appears the safety rules need to be modified to increase the distance from a previous flash which can be considered to be relatively safe, to at least 10 to 13 km (6 to 8 miles). In the past, 3 to 5 km (2-3 miles) was as used in lightning safety education."

According to statistics from the National Climatic Data Center (NCDC), 13 deaths and 73 injuries resulted from lightning strikes within Oklahoma since 1993. Included in that total is an incident where lightning struck the support pole of a tent on Fort Sill Army Base, injuring all 26 occupants. Nine of the marines were admitted to the hospital for the night, three into the Intensive Care Unit. Most injuries were cuts and bruises from the collapse of the tent; however, some of the men reported feeling "tingling sensations" through the next day.

Hail

While flooding is the most deadly severe thunderstorm hazard, hail is the most costly. In recent years, the annual loss from hail has been $1,900,000,000 - nearly two billion dollars - just in this country. Oklahoma crop losses due to hail average approximately $2.5 million per year in loss claims alone -- not including property/casualty claims. Hail damage to automobiles, roofs, windows and farm crops is staggering. Large hail is also a threat to small mammals and it kills many birds. Hail rarely kills people, but these were hollow words in China in May, 1986 when 100 people were killed, 9,000 injured, and 35,000 homes destroyed by an intense hailstorm. Large hail is generally one inch in diameter or larger and can cause a great deal of damage. Large hailstones can fall at speeds faster than 100 mph.



Courtesy of the Flagstaff NWS

Although not a significant threat to human life (there have been only a few hail-caused deaths in the United States since 1916), hail is massively damaging. This is exemplified by the "Mayfest" hail storm in 1995, the most expensive thunderstorm event in U.S. History (according to NCDC), where hail stones up to 4 inches in diameter contributed to over $2 billion in damage in Fort Worth, Texas, along with 109 hail related injuries.

That damage potential exists in Oklahoma as well. The table below lists the 12 most damaging Oklahoma hail events since 1993, as reported by NCDC. Other significant events exist prior to the official listing by NCDC as well, such as on Nov. 13, 1985, as baseball-sized hailstones driven by 60 mph winds battered parts of Tulsa County. Damages exceeded $37 million. There have been a few significant October hailstorms. Probably the most devastating of those occurred on October 5, 1951, when crops were destroyed along a 5-mile wide, 70-mile long swath across Harmon, Greer, and Kiowa counties. Accompanied by very strong winds, the hail destroyed 18,000 acres of cotton and sorghum. Total losses included $175,000 in crops and $70,000 to buildings and automobiles (at 1951 prices). A hailstorm pummeled central Oklahoma on April 20, 2004, associated with a supercell that rumbled through Yukon and Oklahoma City. Damage estimates have ranged from $75-$100 million from the hail that reached the size of baseballs. The slow-moving storm buried parts of the city in ice until it resembled a winter landscape. Low-lying areas had shelves of ice 2 feet thick as thousands of hailstones stuck together and became compacted. Cars had difficulty navigating streets covered in the thick ice sheets.

The 13 most destructive hail events in Oklahoma since 1993, ranked by damage amounts (data courtesy of NCDC and local media reports).

City	Date	Damage (millions)
Oklahoma City	04/21/2004	75.0-100.0
Tulsa	11/18/2003	20.0
Waurika	03/29/1993	5.0
Ada	04/02/1994	5.0
Bromide	04/26/1994	5.0
Altus	04/15/2000	2.6
Poteau	01/21/1999	2.6
Bartlesville	05/08/2000	2.0
Tulsa	03/26/2000	2.0
Bartlesville	05/20/2001	1.0
Hennessey	04/21/1999	1.0
Miami	05/04/2003	1.0
Tulsa	05/05/2000	1.0

A Brief Look at Destructive Hail Events Since 1993

Oklahoma City – April 21, 2004

The most damaging hail event in Oklahoma history racked up $75-100 in damage. Hailstones, some as big as baseballs, fell in Central Oklahoma and up to three inches of hail fell in parts of Oklahoma City. The immense amount of hail caused problems for many motorists in a scene that looked more like a snowstorm. Hundreds of people were without power as well, as a result of the storm. Thick sheets of ice covered the streets and flooding became an issue as the hail melted in nearby storm drains.

Tulsa – November 18, 2003

Hail the size of baseballs fell on Tulsa on this day, causing $20 million in damage. Enough hail feel that it looked like snow had accumulated. The storm that produced the hail moved through the city just before 10 a.m. and hail as large as 2.75 inches was reported in midtown Tulsa. As many as 2,500 customers in Tulsa were without power after the storms moved through. Major structural damage was reported in the city and surrounding areas.

Waurika – March 29, 1993

Just before 10 p.m., hail began to fall in Waurika from storms moving over the state line from Texas. Total cost of the damage in Waurika was $5 million and hail as large as 2.5 inches was reported.

Ada – April 2, 1994

Damage that occurred in Ada from this storm began around 6:45 p.m. and totaled $5 million. The largest hail reported was 2.5 inches. Funnel clouds were also reported three miles south of Ada at about 6:50 p.m.

Bromide – April 26, 1994

Just before 1 p.m., large hail began to pound Bromide and hail as large as baseballs contributed to the $5 million total in damages. Along with the structural damages, three people were also injured.

Altus – April 15, 2000

$2.6 million in damage occurred in Altus this day after hail as large as baseballs fell on the city. $2 million in damage occurred to homes and businesses and $600 thousand to vehicles. These severe thunderstorms affected a large part of western Oklahoma during the afternoon and evening hours of the 15th before weakening across central Oklahoma.

Poteau – January 21, 1999

In response to an advancing dryline and a powerful upper level jet, storms formed across southeast Oklahoma and went on to produce impressive hail damage. In Poteau, $2.6 million in damage occurred as a fairly small storm moved northeast through the city. Although small, the storm produced golf ball size hail and badly damaged many cars. Many cars had their windshields broken out, mirrors and antennas knocked off, and some even with paint knocked off.

Bartlesville – May 8, 2000

Baseball-size hail hit the city of Bartlesville on this day and resulted $2 million in damage. The hospital suffered severe roof damage as the storm moved through. Hail damaged hundreds of cars at several dealerships and smashed the windows of several Bartlesville police cars.

Tulsa – March 26, 2000

Around 4:30 in the afternoon, Tulsa was hit with a damaging hail storm that produced tennis ball size hail. Large hail fell from downtown through western and southern parts of the city. Many cars and roofs were damaged and many windows were broken by the wind driven hail. Damage from the storm accumulated to $2 million.

Bartlesville – May 20, 2001

On the afternoon of May 20, 2001, Bartlesville was hit with a hail storm that went on to produce $1 million in damage. The largest of the hail reports were 1.75 inches.

Hennessey – April 21, 1999

This day had a little bit of everything in the area around Hennessey. Tornadoes, strong straight line winds, and damaging hail were all reported. Large and destructive hail fell in many areas including Hennessey where an unusually large amount of golf ball to baseball-size hail fell several times, causing extensive damage to vehicles, homes, and wheat crop. Total damages from the storm in Hennessey total to $1 million.

Miami – May 4, 2003

Around 5 p.m., power lines and large trees were blown down, and some buildings had their roofs blown off by this damaging hail storm. Baseball-sized hail caused significant damage to about 160 cars at an automobile dealership, which contributed to the total cost of $1 million.

Tulsa – May 5, 2000

Shortly after 9:00 p.m. On May 5, 2000, Tulsa was hit with a variety of large hail. Quarter, golf ball, and baseball-size hail were all reported in the city. The damage from the hail storm totaled to $1 million.

Severe Winds

Tornadoes are not the only destructive winds associated with thunderstorms. Severe thunderstorm winds also cause widespread damage and occasional fatalities. Damaging wind from thunderstorms is much more common than damage from tornados. In fact, many confuse damage produced by "straight-line" winds and often erroneously attribute it to tornados. Wind speeds can reach up to 100 mph with a damage path extending hundreds of miles. Thunderstorm "straight-line" winds originate from rain-cooled air that descends with accompanying precipitation. Damaging thunderstorm winds termed *downbursts* are strong downdrafts which include an outburst of potentially damaging winds on or near the ground. As the air impacts the ground it is forced to spread out laterally causing the gusty and sometimes damaging winds associated with thunderstorms. Downbursts can be classified as either *macrobursts* (greater than 2.5 miles in diameter) or *microbursts* (less than 2.5 miles in diameter).

Squall lines and multicell storms occasionally develop the appearance of a "bow echo" on radar. This signature indicates an excellent chance that the strong mid-level currents have been directed to the ground in a downburst, forcing a portion of the squall line or multicell storm to accelerate forward. Macroburst and microburst winds are common with these storms, and 100+ MPH winds have been reported in extreme cases.

Courtesy of Rick Olivo of the Ashland Daily Press

The 10 highest winds speeds recorded by the Oklahoma Mesonet (1994-2004).		
Location	Wind Speed (MPH)	Date
Lahoma	113	08/17/1994
Bowlegs	102	11/09/1998
Grandfield	94	06/04/1995
Stigler	92	05/20/2001
Hobart	91	03/08/1994
Mangum	91	05/31/1999
Stigler	91	04/11/2001
Cloudy	90	03/02/2000
Hooker	90	05/15/2003
Chandler	88	08/07/1994

Oklahoma's proclivity for supercell thunderstorms guarantees a large number of encounters with damaging non-tornadic thunderstorm winds. According to NCDC statistics, the state has experienced severe winds which caused at least $50,000 in damage 350 times since 1993. Of those 350 events, 29 had damage estimates which exceeded $1 million. The most damaging non-tornadic thunderstorm, to the tune of $50 million, tore through central Oklahoma on July 25, 1995. The thunderstorm carried little or no hail, but winds were comparable to that of a small tornado or moderate hurricane, reaching nearly 100 mph. The strong winds lasted about half an hour, with the most intense winds occurring in a 10- to 15-minute period, and left some 75,000 residences and businesses without power for days.

While severe thunderstorm winds may be more common than tornadic winds, the ability of the tornadic winds to do catastrophic damage dwarfs that of the non-tornadic severe winds. Since 1993, fewer than 180 tornadoes have caused over $2 billion in damages, while the 350 instances of severe winds mentioned above have only resulted in $212 million in damage. Four people died in those 350 severe thunderstorm wind events, while 53 died as a result of the tornadic events.

The Oklahoma Mesonet has recorded 2832 instances of winds exceeding severe limits (58 mph) since its inception in 1994. Of those events, a majority were non-thunderstorm winds, associated with dryline and frontal passages mainly in western and northern Oklahoma. The strongest of those 2832 severe wind reports were associated with severe thunderstorms, however. The Mesonet recorded winds of 70 mph or above nearly 250 times. The strongest of those winds, 113 mph – which is the highest non-tornadic wind ever recorded in Oklahoma – occurred at Lahoma on August 17, 1994. That storm proceeded south through north central Oklahoma causing nearly $7 million in damages.

The 13 most destructive thunderstorm-related wind events in Oklahoma since 1993, ranked by damage amounts (data courtesy of NCDC).

City	Date	Damage (millions)
Moore/OKC	07/23/1995	50.0
Lawton	05/27/2001	11.0
Ft. Sill	05/27/2001	10.0
Kingston	02/09/2001	10.0
Beaver	09/12/1999	8.0
Lahoma	08/17/1994	7.0
Indiahoma	05/31/1999	5.0
Altus AFB	06/03/1995	5.0
Catoosa	04/24/1993	5.0
Healdton	05/08/1993	5.0
Prague	08/07/1994	5.0
Union City	06/03/1995	5.0
Waurika	03/29/1993	5.0

A Brief Look at Thunderstorm-Related Wind Events Since 1993

Moore/OKC – July 23, 1995

In the costliest wind-related event in Oklahoma history, power poles and trees were knocked down in several sections of Oklahoma City after hurricane-force winds moved through the city. At 12:37 a.m. On the 24th, a 97 mph wind gust was reported at Will Rogers World Airport. Periodic power outages were also reported and two injuries occurred.

Lawton/Ft. Sill – May 27, 2001

A very large severe line of thunderstorms formed during the late afternoon on May 27, 2001 in southwest Kansas and moved into Oklahoma during the evening. High winds from the line of thunderstorms resulted in $21 million in damages in Lawton and at Fort Sill. Late on that Sunday, a woman was killed during the event when a power pole fell on her while riding a motorcycle. Fort Sill's infrastructure was wrecked by the high winds and the Fort Sill Museum was hit hard as well. 1,800 people were still without power in Lawton the next day.

Kingston – February 9, 2001

Heavy damage was suffered on this day at Lake Texoma as eight boathouses were sunk, and forty boats were damaged at Catfish Bay Marina. One boat capsized and sank, killing a man on board. Severe thunderstorms developed across southern Oklahoma during the late evening on the 8th and early morning hours of the 9th, resulting in the extensive damage. The worst of the damage occurred on the western shore of Lake Texoma.

Beaver – September 12, 1999

Severe thunderstorms with high winds and large hail pounded the eastern parts of the central Oklahoma panhandle during the early morning hours of September 12, 1999. $6.5 million of the damage occurred to structures and $1.5 million to vehicles. 1400 homes in Beaver were damaged and two homes were completely destroyed. Fortunately, there were no injuries from the storm.

Lahoma – August 17, 1994

In an event that took many forecasters by surprise, the August 17, 1994 storm caused widespread damage in parts of Garfield, Alfalfa and Kingfisher counties. Baseball-size hail was reported along its destructive path. Lahoma was hardest hit by the storm. Several mobile homes were destroyed and the town suffered extensive damage. The Mesonet station recorded a wind speed of 113 mph at Lahoma as the storm moved through. Several injuries were reported, but none of them considered serious.

Indiahoma – May 31, 1999

Seven tornadoes were reported during the afternoon and evening of May 31st, and the early morning of June 1st. The tornadoes, however, were not the cause of the most extensive damage. A very large swath of straight-line winds developed on the west side of Tom Steed Lake and expanded in coverage as it moved through southern Kiowa County. The straight-line winds covered a width of 10-15 miles at times. Three injuries resulted as the damaging winds made their way into Comanche County and were estimated to be in the 80 to 100 mph range for most of the event.

Altus AFB – June 3, 1995

Most of the action on this night was from tornadoes; however, non-tornadic winds caused considerable damage at Altus AFB. On State Highway 6 in Altus, tennis ball-sized hail and 82 mph winds were reported at about 10 p.m., as a tornado lurked just to the west of the Air Force Base. Along with the damaging winds, more than three inches of rain fell in Altus between 9 p.m. and 10 p.m.

Catoosa – April 24, 1993

In an event that will be remembered more for the tornado threat, both high winds and a tornado hit the Tulsa suburb of Catoosa. 80 mph winds were recorded as the tornado made its way down Interstate 44. Out of the $100 million in total damage, $50 million was associated with high winds.

Healdton – May 8, 1993

No parts of Healdton were left untouched as damaging winds swept through the city around 6 p.m. Two tornadoes reportedly went through the city as well. Six injuries resulted from the high winds.

Prague – August 7, 1994

Winds estimated at 88 mph moved through Prague on this day causing considerable damage. Every barn in the western half of Prague was reportedly damaged or destroyed and extensive damage was suffered at Prague High School.

Union City – June 3, 1995

On the same day that Altus AFB suffered severe damage, Union City suffered the same fate from separate storms. The damaging winds hit between 8 p.m. and 9 p.m., and a tornado was moving toward the city at this time as well. Fortunately, no injuries occurred.

Waurika – March 29, 1993

Waurika suffered damage on this night as high winds swept through around 11 p.m. No injuries were reported.

Resources:

The National Weather Service: (http://www.nws.noaa.gov)
The Storm Prediction Center: (http://www.spc.noaa.gov)
National Climatic Data Center: (http://www.ncdc.noaa.gov)
Archives of "The Daily Oklahoman": (http://www.newsok.com)
The University of Illinois: "Severe Storms Online Meteorology Guide":
(http://ww2010.atmos.uiuc.edu/)

Tornado - Oklahoma's Most Famous Hazard

Oklahoma's distinction as the epicenter of Tornado Alley has become fairly well established, a result of the sheer number of tornadoes it has experienced. This dubious honor has been punctuated by the lost lives and damaged property from the violently rotating columns of air, seemingly so common in the state. In fact, Oklahoma has experienced 828 "significant" (F2-F5) tornadoes since 1950, the beginning-point of accurate tornado statistics.

The state's tornado statistics (1950-2003) are staggering:

- 2911 tornadoes
- An average of 54 tornadoes per year
- An average of 15 significant tornadoes per year
- 263 dead/4115 injured
- Over $2 billion in damage

Tornado Classifications:

- Weak: F0-F1
- Significant: F2-F5
  - Strong: F2-F3
  - Violent: F4-F5

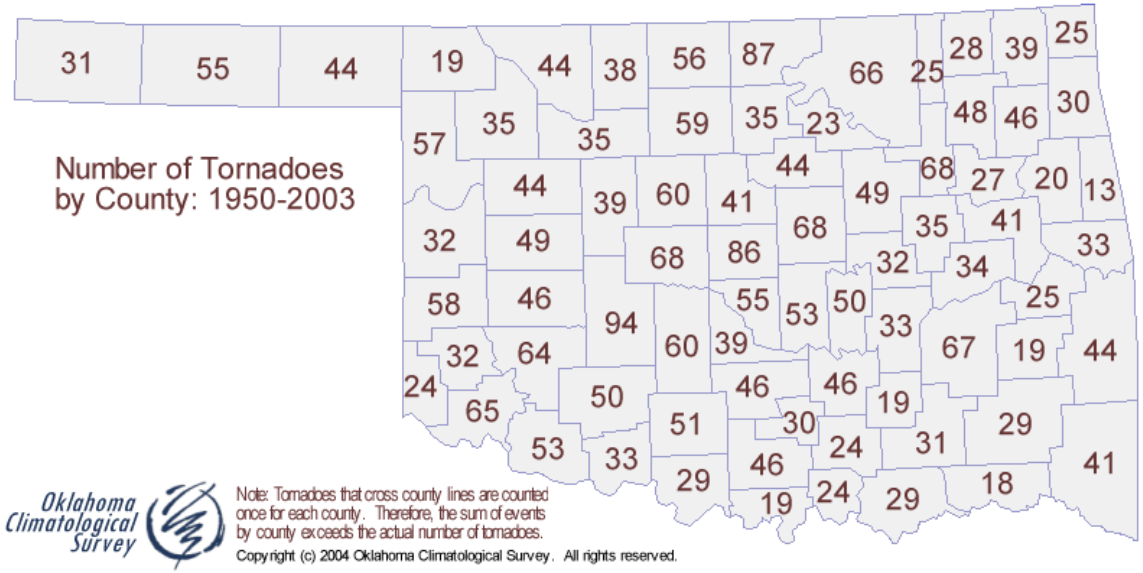
It is important to note that if these statistics were inclusive back to the region's first tornado records in 1893 (at that time, still a territory), the numbers would increase dramatically. However, the statistics that exist before 1950 are suspect, and are not included in the cumulative totals. Various singular events that are well-documented are discussed anecdotally in this document.

Since the latter parts of the 19th century, two mitigating factors have been working in opposition to determine the state's risk from tornadoes: the increases in both population and technology. Obviously, an increase in population enhances the hazards posed by tornadoes. As the population grows, the threat of a tornado striking populated areas similarly increases. The population growth is naturally accompanied by the necessary infrastructure and by-products of civilization, all of which increase the potential loss in the event of a tornado. The exodus of rural populations to urban areas is problematic as well. A tornado striking a larger population density significantly increases the chances for fatalities, as evidenced by the central Oklahoma outbreak of May 3, 1999, which caused more than $1 billion in damages and killed 40.

The hazard of population increase has been offset by the advancements in technology over the last half-century. Improvements in remote sensing, such as radars and satellites, coupled with improved communication systems, have increased the lead-time for warnings by an order of magnitude. Better construction practices have also worked to limit the damage potential from all but the most violent tornadoes. The residences and businesses of today are more apt to survive the damaging winds of weaker tornadoes than those structures built at the turn of the century. The inclusion of safe rooms, below-ground storm shelters, hurricane straps, and foundation anchor bolts in current construction plans has helped reduce the hazard to both life and property.

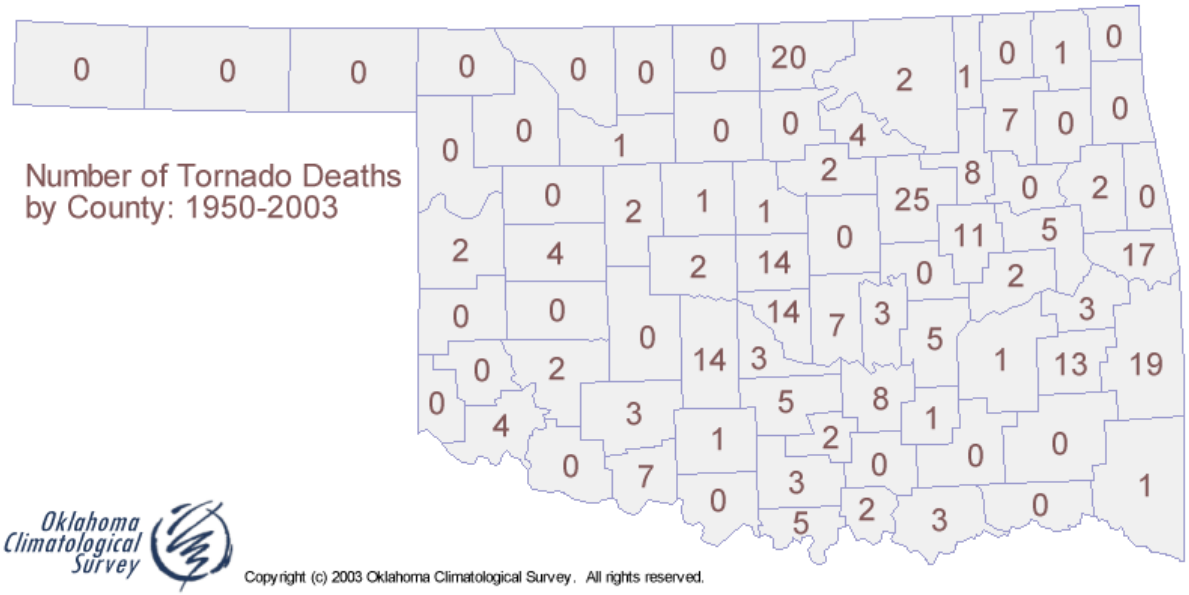
The Patterns

Tornado counts for a specific area, such as a county, are affected by several factors, including: size of the area, population base, and location. Some counties in Oklahoma have counts that reflect those factors quite well. Oklahoma and Tulsa counties both have high counts with 86 and 68 reported tornadoes, respectively. Caddo and Osage Counties, both very large areas, have high counts as well, at 94 (the state's highest) and 66, respectively. But a few anomalies do exist. Kay County, neither large nor overly populous, has the state's 2nd greatest total with 87 tornadoes.



Tornado deaths by county are dominated by singular events, and largely a result of significant tornadoes. The Kay County total of 20, for instance, is due entirely to the Blackwell F5 tornado, which struck on May 25, 1955. The same can be said of the 14 deaths each in Cleveland, Grady, and Oklahoma Counties. Those totals are reined by the May 3, 1999, central Oklahoma outbreak. Creek County's 25 tornado deaths are actually a combination of four separate significant events, yet over half (13) of that total came from an F4 tornado on June 8, 1974.

It is important to remember that while 69% of all tornadoes are considered weak, nearly 100% of all tornado deaths are due to significant tornadoes. Furthermore, nearly 70% of all tornado deaths are due to violent tornadoes (F4-F5), despite only 2% of all tornadoes falling into that category. A map of the tracks of violent Oklahoma tornadoes reveals a concentration of occurrence along and parallel to Interstate 44, from southwestern through northeastern Oklahoma. Particularly heavy clusters are indicated in Cleveland, Lincoln, Oklahoma, and Pottawatomie counties in central Oklahoma, and Creek, Osage, Pawnee, and Tulsa counties in the northeast.



Oklahoma Climatological Survey
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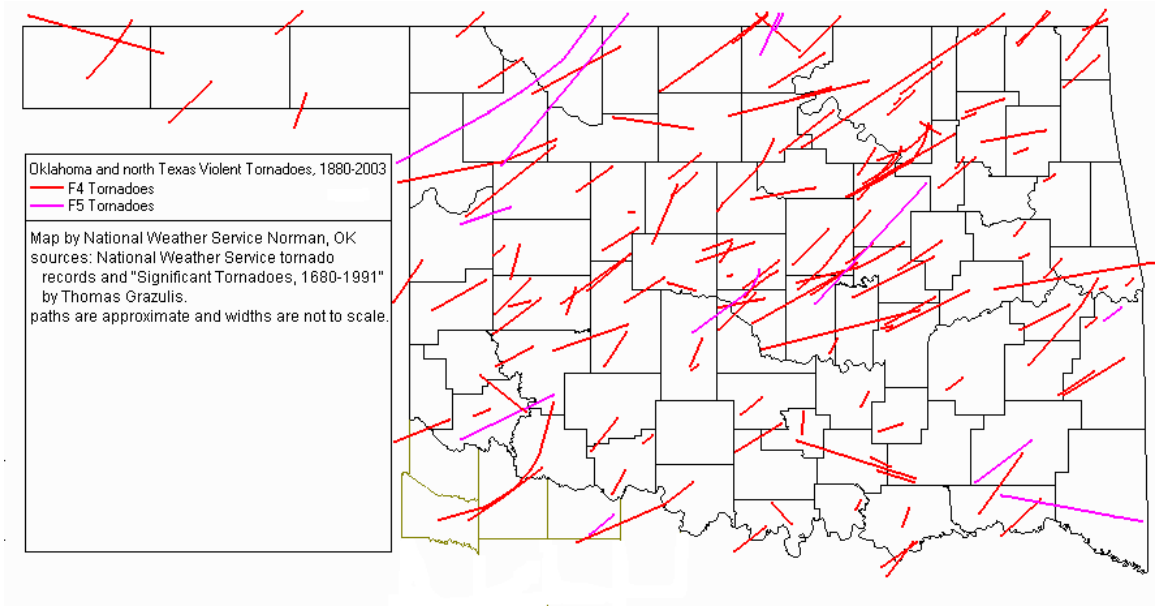
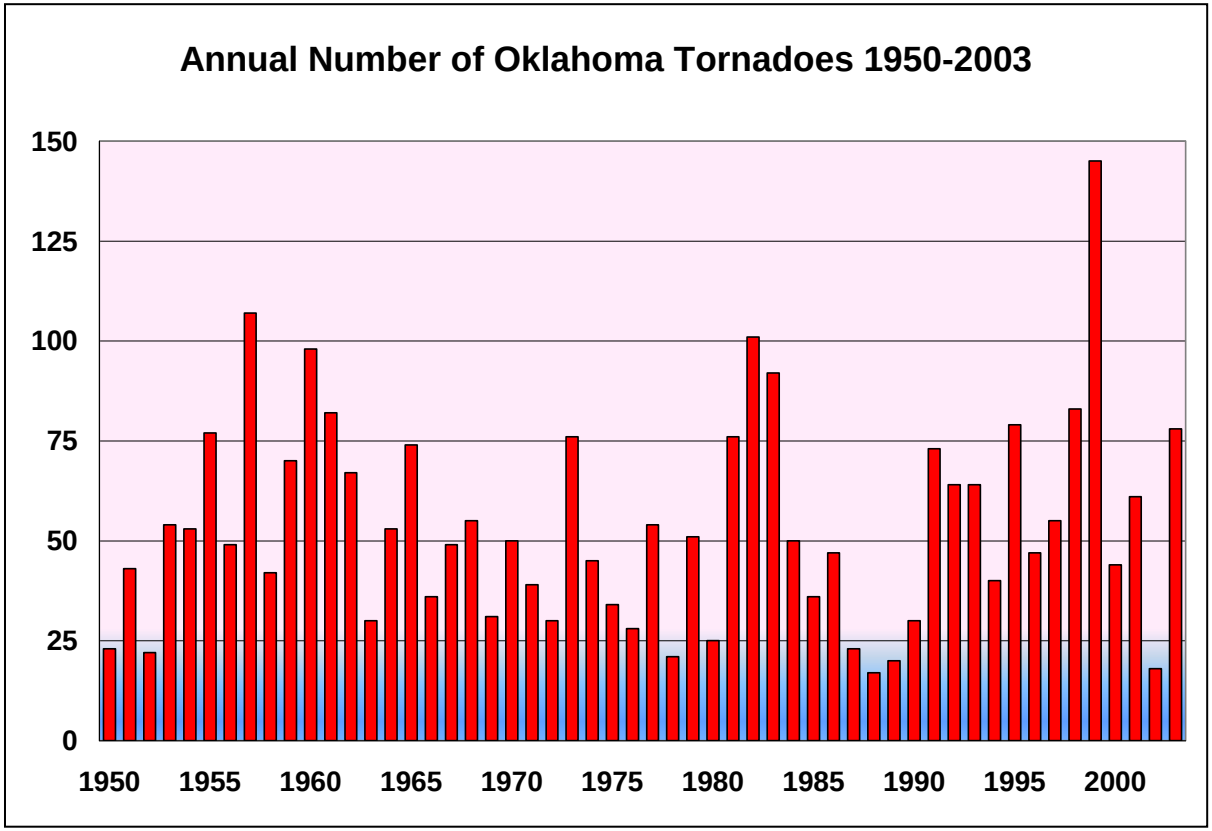
Trends

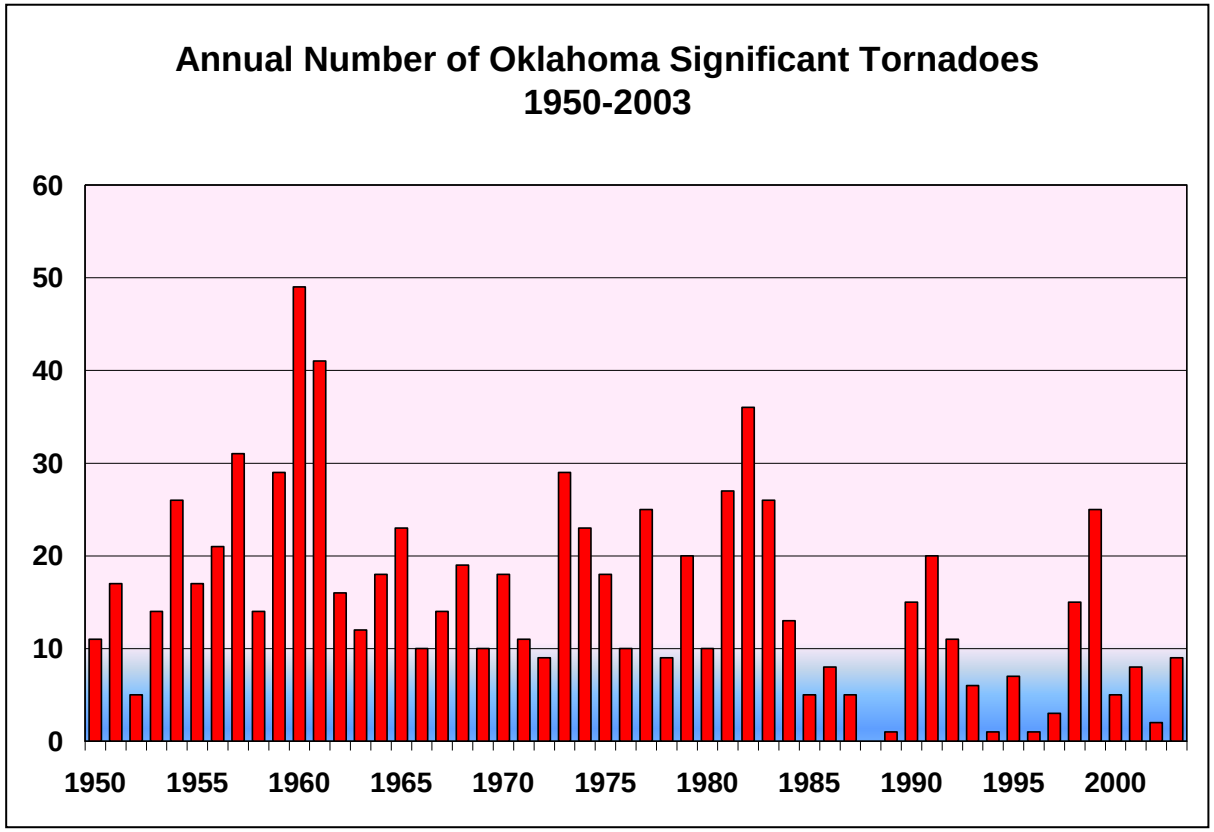


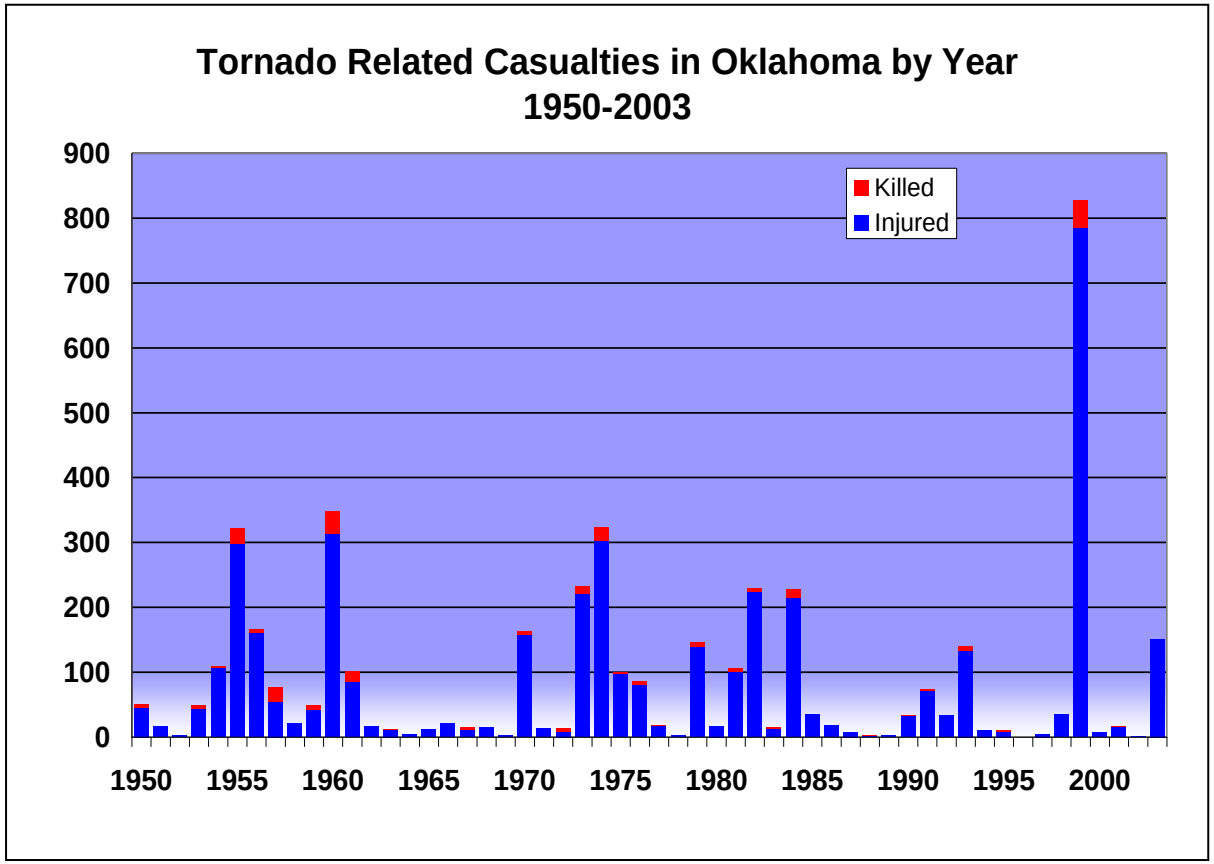
While the number of tornadoes per year has held fairly steady, the more important statistical trend, that of significant tornadoes, has been decidedly downward. The reason for this decrease is not necessarily due to a change in atmospheric conditions; it could be a by-product of the method used by National Weather Service (NWS) to determine a tornado's strength. The NWS did not implement the Fujita Scale as a classification scale until 1973, so classifications of tornadoes in the 1950s and 1960s after the fact required the use of fading recollections and accounts of tornadic damage. The tornado casualty trend shows, other than the extreme event of May 3, 1999, a reduction in tornado casualties in the last 20 years. The startling total of dead and injured in 1999 should punctuate the danger posed if a significant tornado should happen to strike a densely populated area.

Conclusion

The climatological records for Oklahoma indicate that the real danger faced by the state's citizens from tornadic activity, to both life and property, is overwhelmingly due to significant tornadoes. While the number of reported tornadoes has been increasing recently, the number of significant tornadoes reported has decreased. The state continues to face the risks associated with increasing population density in its large cities; Oklahoma City's population is expected to increase 12.6% between 2000 and 2010, some 90,000 people.


Annual Number of Oklahoma Tornadoes 1950-2003
150
125
100
75
50
25
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000


Annual Number of Oklahoma Significant Tornadoes
1950-2003
60
50
40
30
20
10
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000



Historical Perspective: Oklahoma Tornadoes

The state's most deadly tornado occurred before 1950, when an F5 tornado devastated the city of Woodward on April 9, 1947. That tornado began in Texas, where another twister slammed into the towns of Glazier and Higgins, before moving into Oklahoma. The tornadic storm left 69 dead in Texas. The tornado moved predominantly through rural areas after it crossed into Oklahoma, killing 8 and injuring another 42. The tornado, which was over a mile wide and moving at 50 mph, tore into Woodward at 8:42 p.m., leveling over 1000 homes and businesses. The storm left in its path 107 people killed and another 1000 injured. The cost of that tornado was massive in 1947-dollar amounts, yet even greater was the cost in human lives, as it left 116 dead in its wake as it crossed into Kansas. Nine of the ten deadliest tornadic events in Oklahoma occurred before 1950.

The 10 deadliest tornadoes in Oklahoma, ranked by fatalities (courtesy of the Norman NWS office).

Rank	City	Date	Killed
1	Woodward	April 9, 1947	116
2	Snyder	May 10, 1905	97
3	Peggs	May 2, 1920	71
4	Antlers	April 12, 1945	69
5	Pryor	April 27, 1942	52
6	Oklahoma City	May 3, 1999	40
7	Oklahoma City	June 12, 1942	35
8	Moore	April 25, 1893	31
9	Bethany	November 19, 1930	23
10	McAlester	May 8, 1882	21

Successive Significant Tornadoes

The occurrence of significant tornadoes in the same area in successive days, while rare, is not unheard of in Oklahoma. This scenario, when a localized area (within 50 miles) has been affected by significant tornadoes on consecutive days, has occurred 12 times since 1950.

Areas in Oklahoma which have been struck by significant tornadoes on successive days. To qualify, the tornadoes must have been within 50 miles of each other.

Dates	Counties affected – 1st day	Counties affected – 2nd day
June 17-18, 1955	Alfalfa, Wood	Woods
May 9-10, 1959	Hughes, Pontotoc	Seminole
May 4-5, 1960	Cleveland, Pontotoc, Pottawatomie, Seminole, Stephens	Cleveland, Creek, Garvin, Lincoln, Okfuskee, Pottawatomie
May 7-8, 1961	Wagoner	Mayes
May 24-25, 1962	Jackson	Washita
June 10-11, 1967	Ellis	Custer
June 22-23, 1969	Lincoln	Payne
May 19-20, 1977	Garvin	Oklahoma, Pottawatomie
April 10-11, 1970	Lincoln, Pottawatomie	McCurtain
May 12-13, 1983	Greer, Jackson	Harmon, Kiowa
April 26-27, 1991	Kay	Garfield, Noble, Osage
May 8-9, 2003	Cleveland, Grady, Lincoln, Oklahoma	Canadian, Oklahoma, Lincoln

Tornado - Appendix A: County-Level Tornado F-ratings and Casualties

County	killed	injured	F0/F?	F1	F2	F3	F4	F5	Total
Adair	0	1	3	6	2	2	0	0	13
Alfalfa	0	6	14	11	12	1	0	0	38
Atoka	0	12	9	11	10	0	1	0	31
Beaver	0	15	23	12	7	1	1	0	44
Beckham	0	3	30	20	4	4	0	0	58
Blaine	2	8	15	15	7	1	1	0	39
Bryan	3	12	6	7	12	3	1	0	29
Caddo	0	31	39	21	25	7	2	0	94
Canadian	2	7	25	21	16	3	3	0	68
Carter	3	30	15	18	6	6	1	0	46
Cherokee	2	5	6	8	3	3	0	0	20
Choctaw	0	40	5	6	2	3	1	1	18
Cimarron	0	3	19	8	3	0	1	0	31
Cleveland	14	375	18	15	17	2	2	1	55
Coal	1	2	7	4	7	1	0	0	19
Comanche	3	113	22	17	9	1	1	0	50
Cotton	7	15	16	7	4	4	2	0	33
Craig	1	24	8	14	12	4	1	0	39
Creek	25	302	16	13	9	6	4	1	49
Custer	4	17	23	14	7	4	1	0	49
Delaware	0	3	7	9	10	4	0	0	30
Dewey	0	7	19	16	8	1	0	0	44
Ellis	0	5	28	18	10	1	0	0	57
Garfield	0	22	26	15	10	6	2	0	59
Garvin	5	23	12	19	11	3	1	0	46
Grady	14	71	11	23	19	6	0	1	60
Grant	0	7	29	12	7	7	1	0	56
Greer	0	1	16	8	6	2	0	0	32

County	killed	injured	F0/F?	F1	F2	F3	F4	F5	Total
Harmon	0	6	9	12	3	0	0	0	24
Harper	0	7	7	8	3	1	0	0	19
Haskell	3	9	12	9	3	0	1	0	25
Hughes	5	41	10	5	15	1	2	0	33
Jackson	4	75	30	15	16	4	0	0	65
Jefferson	0	2	11	11	3	3	1	0	29
Johnston	0	8	9	7	6	1	1	0	24
Kay	20	294	42	17	20	4	2	2	87
Kingfisher	1	29	24	18	13	4	1	0	60
Kiowa	2	3	31	19	10	3	1	0	64
Latimer	13	105	3	9	5	0	2	0	19
Le Flore	19	152	11	13	13	4	2	1	44
County	killed	injured	F0/F?	F1	F2	F3	F4	F5	Total
Lincoln	0	143	18	26	14	7	2	1	68
Logan	1	51	14	12	11	3	1	0	41
Love	5	17	5	6	5	3	0	0	19
Major	1	17	11	13	8	2	1	0	35
Marshall	2	30	8	6	6	3	1	0	24
Mayes	0	17	14	16	11	5	0	0	46
McClain	3	44	15	11	11	1	0	1	39
McCurtain	1	36	6	16	16	2	0	1	41
McIntosh	2	11	15	6	11	2	0	0	34
Murray	2	8	8	12	8	1	1	0	30
Muskogee	5	36	20	8	10	2	1	0	41
Noble	0	18	14	13	5	1	2	0	35
Nowata	0	6	12	5	9	2	0	0	28
Okfuskee	0	6	12	7	7	3	2	1	32
Oklahoma	14	475	18	29	21	15	2	1	86
Okmulgee	11	115	11	13	6	4	1	0	35
Osage	2	61	28	17	14	3	4	0	66
Ottawa	0	69	6	8	7	3	1	0	25

County	killed	injured	F0/F?	F1	F2	F3	F4	F5	Total
Pawnee	4	64	12	5	3	0	3	0	23
Payne	2	41	10	18	10	4	2	0	44
Pittsburg	1	42	27	27	10	2	1	0	67
Pontotoc	8	79	14	11	15	5	1	0	46
Pottawatomie	7	111	15	14	14	5	4	1	53
Pushmataha	0	6	4	12	10	2	1	0	29
Roger Mills	2	11	10	11	9	1	1	0	32
Rogers	7	192	10	20	11	5	2	0	48
Seminole	3	44	11	10	18	8	3	0	50
Sequoyah	17	43	12	8	6	4	3	0	33
Stephens	1	23	16	16	12	7	0	0	51
Texas	0	1	32	14	7	2	0	0	55
Tillman	0	65	22	17	9	3	2	0	53
Tulsa	8	228	25	17	16	8	2	0	68
Wagoner	0	9	11	3	9	4	0	0	27
Washington	1	76	6	10	7	2	0	0	25
Washita	0	21	15	18	6	6	1	0	46
Woods	0	5	17	15	11	1	0	0	44
Woodward	0	3	22	8	2	3	0	0	35
Totals	263	4115	1192	989	730	245	85	13	3254

Oklahoma's Hazards: Wildfires

Wildfire is a natural part of Oklahoma's ecosystem. Long before the state was settled, wildfires ran across the prairies, replenishing nutrients to the soils and controlling invasive plant species. With settlement, however, the interaction of wildfire and the environment has changed. Now, people and structures are at-risk from flames spreading across the grasslands and forests of Oklahoma. Today, communities abut wildlands, creating an urban-wildland interface that is at risk of uncontrolled burns.

The development of such urban-wildland interfaces is part of a growing national problem. Fire losses and suppression costs have skyrocketed over the past decade, costing federal agencies alone $1.6 billion in 2002. Western states have been particularly hard-hit, as a prolonged, multi-year drought dried vegetation and forests, creating conditions ripe for raging infernos. As homes have edged up into canyons and forest lands, often far away from water sources that can be used to extinguish flames, costs of fire control have mounted.

Suppression Costs for Federal Agencies							
Year	Acres Burned	Bureau of Land Management	Bureau of Indian Affairs	Fish and Wildlife Service	National Park Service	USDA Forest Service	Totals
1994	4,724,014	$ 98,417,000	$ 49,202,000	$ 3,281,000	$ 16,362,000	$ 678,000,000	**$ 845,262,000**
1995	2,315,730	$ 56,600,000	$ 36,219,000	$ 1,675,000	$ 21,256,000	$ 224,300,000	**$ 340,050,000**
1996	6,701,390	$ 96,854,000	$ 40,779,000	$ 2,600	$ 19,832,000	$ 521,700,000	**$ 679,167,600**
1997	3,672,616	$ 62,470,000	$ 30,916,000	$ 2,000	$ 6,844,000	$ 155,768,000	**$ 256,000,000**
1998	2,329,709	$ 63,177,000	$ 27,366,000	$ 3,800,000	$ 19,183,000	$ 215,000,000	**$ 328,526,000**
1999	5,661,976	$ 85,724,000	$ 42,183,000	$ 4,500,000	$ 30,061,000	$ 361,000,000	**$ 523,468,000**
2000	8,422,237	$180,567,000	$ 93,042,000	$ 9,417,000	$ 53,341,000	$ 1,026,000,000	**$1,362,367,000**
2001	3,555,138	$192,115,00	$ 63,200,000	$ 7,160,000	$ 48,092,000	$ 607,233,000	**$ 917,800,000**
2002	6,937,584	$ 204,666,000	$109,035,000	$ 15,245,000	$ 66,094,000	$ 1,266,274,000	**$ 1,661,314,000**

Source: National Interagency Fire Center, http://www.nifc.gov/stats/wildlandfirestats.html

The U.S. Department of Agriculture Forest Service and Department of the Interior compiled a list of communities bordering federal lands that are considered at high risk of wildfire. The report, published as part of the Federal Register notice (Volume 66, No. 160, August 17, 2001, see http://www.fireplan.gov/reports/351-358-en.pdf), includes nearly every community in Oklahoma. Since 1996, the state has received fire management assistance from FEMA for fires in Cleveland, Creek, Comanche, Leflore, Logan, Murray, Osage, Payne, Stephens, and Woods counties. In 1996, more than 633,000 acres – nearly 1,000 square miles – were burned in Oklahoma, with FEMA assistance totaling $729,000, not including the cost of property and crop losses.

Oklahoma has some tools to help manage wildfire conditions. Since 1994, real-time weather information has been available from every county in Oklahoma, via the Oklahoma Mesonet. Data from the Mesonet are integrated with vegetation information in a Fire Danger Model (http://agweather.mesonet.org/models/fire/). These tools allow fire managers to see developing threats. Plans are being developed to integrate forecast information into the model, allowing fire managers to see potential conditions as much as 48 hours in advance.

Fire Indices

Fire intensity is controlled by both short-term weather conditions and longer-term vegetation conditions. During intense fires, understory vegetation, such as leaves, small branches, and other organic materials that accumulate on the ground, can become additional fuel for the fire. The most explosive conditions occur when dry, gusty winds blow across dry vegetation. In order to represent both processes, the Fire Danger Model uses two measures: The Burning Index (BI) and Keetch-Byram Drought Index (KDBI).

The Burning Index is a short-term response to meteorological factors. The burning index includes real-time observations of temperature, relative humidity, wind speed and solar radiation. It applies those factors to a vegetation model, which includes the "relative greenness" – a satellite-derived measure of the health of the vegetation – and fuel models for native vegetation, assigned on a 1-kilometer grid across the state. The model uses these inputs to produce four indices: Spread Component, Energy Release Component, Ignition Component, and Burning Index. Burning Index is a synthesis of the Spread and Energy Release components, and infers fireline intensity and flame length. The higher the number, the more difficult it is to fight a wildfire.

Flame Length (ft)	Fireline Intensity (Btu/ft/s)	Interpretations
<4 (BI <40)	<100	Fires can generally be attacked at the head or flanks by persons using hand tools. Hand line should hold the fire.
4-8 (BI=40-80)	100-500	Fires are too intense for direct attack on the head by persons using hand tools. Hand line cannot be relied on to hold fire. Equipment such as dozers, pumpers, and retardant aircraft can be effective.
8-11 (BI=80-110)	500-1,000	Fires may present serious control problems--torching out, crowning, and spotting. Control efforts at the fire head will probably be ineffective.
> 11 (BI > 110)	> 1,000	Crowning, spotting, and major fire runs are probable. Control efforts at head of fire are ineffective.

Fine fuels, such as small twigs and vegetation litter, respond quickly to changing weather conditions and can dry quickly following a rain. Locations with a higher average burning index most likely have experienced repeated episodes of high fire danger, although individual events can peak at locations that are not as prone to high fire danger. Nearly one in three of the 106 Oklahoma Mesonet stations, which have continuous records from July 1996 – December 2003, have peaked in the upper category of the Burning Index (BI >110). Almost all of these 36 locations are in western Oklahoma, where wind speeds are higher and humidity is lower, contributing to more favorable burning conditions.

County	Location	Average Burning Index July 1996 – December 2003
Harmon	Hollis	29
Harper	Buffalo	27
Beaver	Beaver	27
Texas	Goodwell	27
Cimarron	Boise City	25
Dewey	Camargo	25
Texas	Hooker	25
Washita	Bessie	25
Kiowa	Hobart	24
Washita	Retrop	24

A more slowly-responding model is the Keetch-Byram Drought index (KDBI). The KDBI relates to moisture levels in the subsurface layers. This is a better estimation of the potential for organic matter to contribute to fire intensity. For example, even if the burning index is low because the meteorological variables are not favorable for fire ignition, a high KDBI value may be indicative that should a fire start, it will likely be more intense.

County	Location	Percent KDBI Category 4
McCurtain	Idabel	13
Harper	Buffalo	12
LeFlore	Wister	12
Love	Burneyville	12
Pushmataha	Clayton	12
Tillman	Tipton	11
Alfalfa	Cherokee	10
Caddo	Hinton	10
Choctaw	Hugo	10
Cotton	Walters	10
Jackson	Altus	10
LeFlore	Talihina	10
Marshall	Madill	10
Texas	Goodwell	10

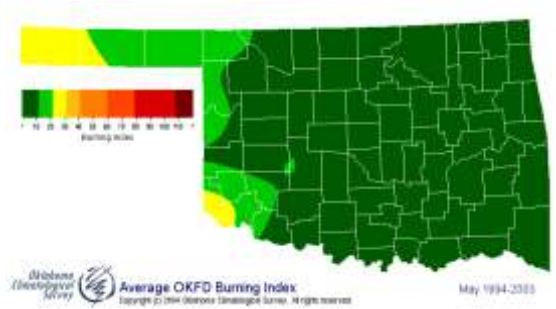
Like Burning Index, KDBI values are generally higher in western Oklahoma. However, unlike BI, peak KDBI values are more random. Every part of Oklahoma, with the exception of Kenton in Cimarron County, has recorded a maximum KDBI value in the upper category (600 to 800) since the Oklahoma Fire Danger Model was implemented in 1996. Fourteen counties have had KDBI values in the upper category for ten percent or more of the time since 1996, with no clear pattern to the distribution. This suggests that fires, once started, can be intense anywhere in the state.

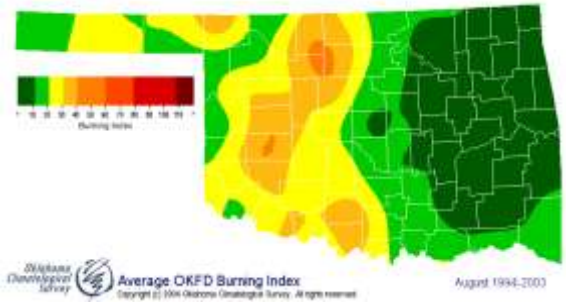
KBDI Value	Interpretations
0 - 200	Nearly all soil organic matter, duff, and litter are left intact after a burn. Once the fire passes, remaining embers extinguish quickly and, within a few minutes, the area is completely extinguished and smoke-free.
200 - 400	At these levels, litter and duff layers begin to contribute to fire intensity. Heavier fuel classes can become involved in the burn. Soil exposure is minimal. Smoke management can become a real hazard, especially if there are larger fuel classes available. Smoldering with resulting smoke can carry into the night.
400 - 600	These levels represent the upper range at which most understory type burning should be conducted. Most of the duff and organic layers will ignite and actively burn. The intensity can be expected to increase almost exponentially from the lower to upper ends of this range. Considerable soil exposure occurs. Complete consumption of all but the largest dead fuels can be expected, and larger fuels not consumed may smolder for several days, leading to smoke and possible fire control problems.
600 - 800	These levels represent the most severe drought conditions, and many states issue burning bans at these levels. Prescribed fires should not even be attempted at levels over 700. Fires that do occur will be intense and deep-burning. Live understory vegetation (2-3" range) should be considered part of the fuel complex due to its low fuel moisture. Most subsurface soil organic material will be consumed; great soil exposure will occur with great future erosion potential. Smoldering may occur for many days, with smoke and fire control problems.

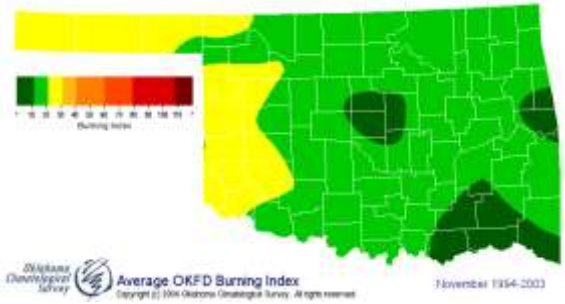
Frequency of high-fire conditions

Monthly and annual maps of average burning index values confirm the top-ten listing. Overall, burning index values are highest in the west and lowest in the east. On an annual average, burning index is not very high anywhere in the state. The highest average values range between 20 and 30, in the first category.

The highest burning index values show the variability of day-to-day burning index values. A broad swath of western Oklahoma has recorded burning index values in the highest category, in which major fire runs are possible, since 1996. Much of the area of highest BI values is actually lower than some other regions of the state with regards to overall annual average. Both averages and maxima show the lesser risk from short term weather conditions in eastern Oklahoma.

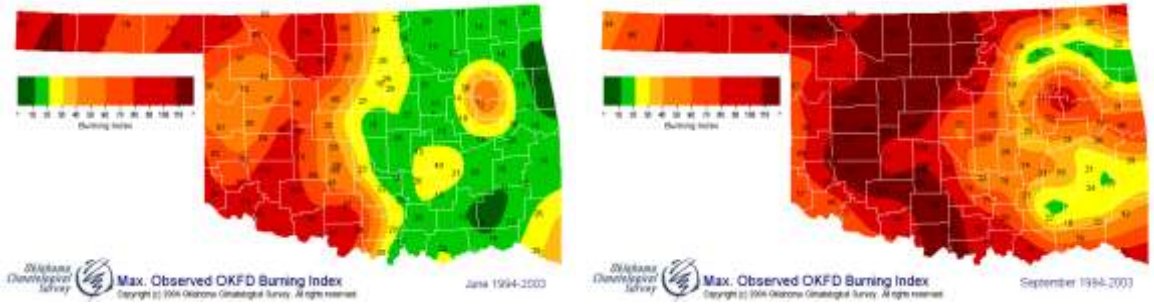




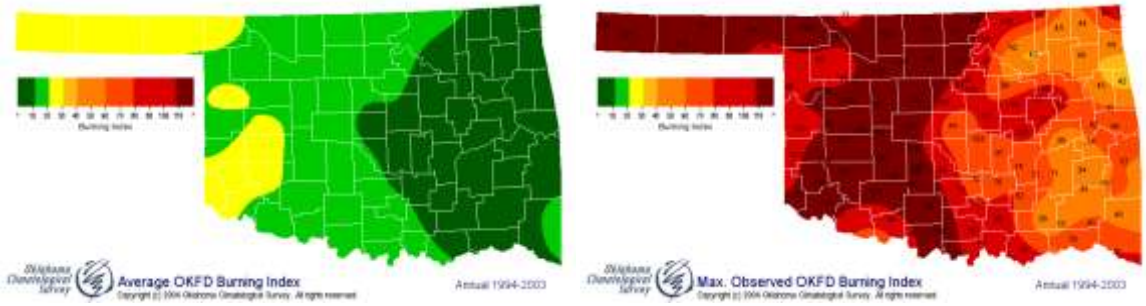


Average Monthly Burning Index for February, May, August and November (clockwise from upper left). The scale ranges from less than ten (dark green) to greater than 110 (dark red). Averages are from the Oklahoma Fire Danger Model for July 1996 – December 2003.

The burning index shows some seasonality across Oklahoma. On average, burning conditions are least favorable in May and June and most favorable from July through September, although the Panhandle also shows more favorable burning conditions in the winter months. Monthly maps of average burning index, for the period 1996-2003, reveal a minimum statewide in May and a maximum in August. Overall, July-September has the highest average burning index values across western Oklahoma, with the lesser values apparent in eastern Oklahoma.



Peak burning index for June and September, covering the period July 1996 – December 2003: The scale ranges from less than ten (dark green) to greater than 110 (dark red).



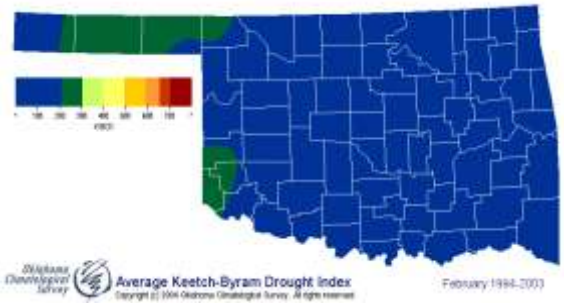
Burning Index can peak in the upper categories any month in Oklahoma, although high fire danger conditions in eastern Oklahoma are rare from May – August. By late August, however, much of eastern Oklahoma has begun to dry out and burning indices creep upward again for the fall. The Oklahoma Panhandle and a tier of counties along the Kansas border in western parts of the state have recorded high fire danger days throughout the winter months.

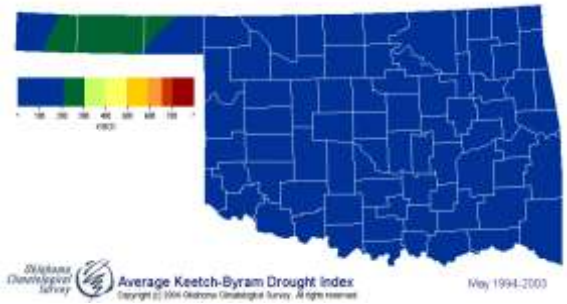
Average annual and maximum Keetch-Byram Drought Index. The scale ranges from less than 100 (blue) to greater than 700 (red). Data are from the Oklahoma Fire Danger Model, July 1996 – December 2003.

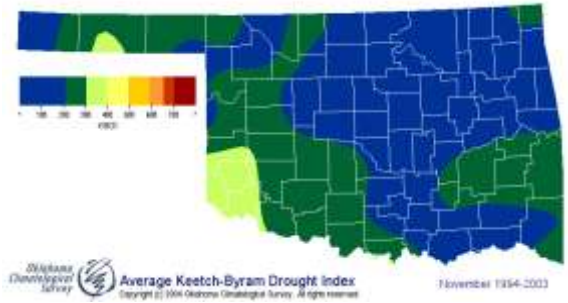
The Keetch-Byram Drought Index shows a remarkably abrupt increase during summertime. KDBI values statewide remain in the lowest category through June, and then increase dramatically in July (especially evident in southern Oklahoma). KDBI values, on average, peak in August – September, and then decline nearly as quickly as they rose. Maximum recorded KDBI values follow a similar trend, increasing statewide in July and declining in the fall.

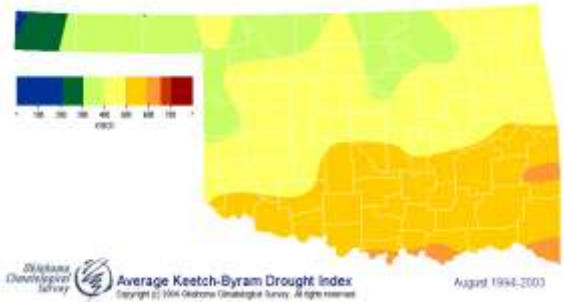
The combination of the two indices illustrates the highest potential for uncontrolled wildfires. A high burning index suggests that fires may start easily, such as from a discarded cigarette, and high KDBI values suggest plenty of organic material that will contribute to fire intensity. There is a relative maximum in both indices in the Panhandle during the winter months, and the both peak across southern and western Oklahoma in August.

Average Monthly KDBI for February, May, August and November (clockwise from upper left): The scale ranges from less than 100 (blue) to greater than 700 (red). Averages are from the Oklahoma Fire Danger Model for July 1996 – December 2003. (Below)









Wildfire Events in Oklahoma

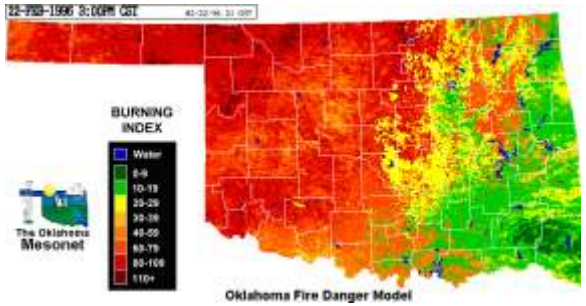
Since the summer of 1996, there have been 226 days in which burning index was in the upper two categories and KDBI was in the highest category at one or more Mesonet sites. There have been 100 days in which two or more stations have been in the highest 2 BI categories and highest KDBI categories and 22 days on which ten or more stations met those criteria. The most widespread conditions occurred on September 18-19, 2000, when 52 stations, or nearly half the state, met those criteria. All but 3 of the dates of widespread fire danger occurred during the

drought-stricken summer of 2000. February of 1996 also experienced widespread wildfire outbreaks, but data from the Fire Danger Model are not available to evaluate those conditions at this time.

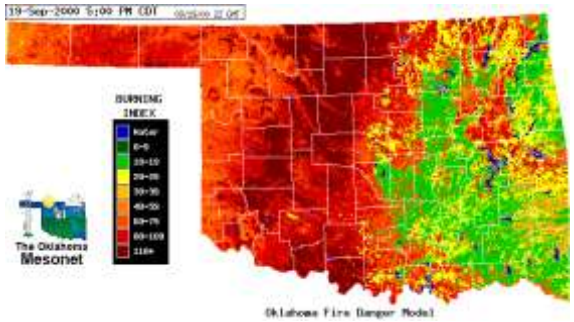
Dates with widespread risk of wildfires (Burning Index > 80; KDBI > 600)			
Year	**Month**	**Day**	**No. Of Sites**
2000	9	19	52
2000	9	18	37
2000	10	1	26
2000	9	20	22
2000	9	22	21
2000	9	17	20
2000	9	30	19
2000	10	10	19
2000	9	11	18
2000	9	14	18
2000	9	29	18
2000	9	21	17
2000	9	10	16
2000	10	12	16
2000	10	11	15
2000	9	15	14
2000	10	3	14
1998	9	25	13
1998	9	26	13
2000	9	5	11
2000	9	16	11
2001	8	21	10

During August and September of 2000, several large wildfires were reported in the state. The largest of these burned 11,500 acres in the Arbuckle Mountains, in Carter, Murray, and Garvin counties. It took firefighters nearly two weeks to extinguish the blaze. On September 19th, a large fire near Guthrie in Logan County destroyed 35 homes. Numerous other smaller fires were reported during the timeframe.

The FEMA website lists Fire Management Assistance being provided to Oklahoma for three separate fire complexes in Oklahoma on September 19-21, 2000. FEMA also provided Fire Management Assistance to Oklahoma for seven separate events in 1996. Wildfires needing assistance were spread across a large portion of northern and western Oklahoma, including Woods, Payne, Osage, Cleveland and Stephens Counties.



Burning Index on February 22, 1996



Burning Index on September 19, 2000

Mitigating Wildfire Risk

Weather conditions leading to wildfires can change rapidly. Thus, there are few measures, other than rapid-response, that can contain wildfires and limit their threat to property. However, longer-term mitigation measures are possible. The American Planning Association lists ten steps that communities can take to lessen wildfire danger (Source: http://www.planning.org/ newsreleases/1999/ftp0818.htm):

1. **Assess the site location and topography of proposed development and in areas with existing subdivisions and other buildings.**
   What types of fuels (including all vegetation) are in the surrounding area, and how stable is the soil? Mudslides and landslides can contribute to, or affect, wildfires.
2. **Evaluate how buildings are designed and constructed.**
   What materials have been used for existing buildings and how flammable are the materials overall? Evaluate overhang features for their potential to exacerbate fire damage by creating unnecessary updrafts.
3. **Maintain an adequate defensive zone, usually about 30 feet, between vegetation and buildings to retard the spread of wildfires to structures.**
   Planting trees next to houses or other buildings in wildfire hazard areas only increases the risks of an ensuing disaster.
4. **Install dry hydrants or other devices or structures to store rainwater for future fire-fighting needs.**
   Particularly in outlying areas that are more vulnerable to firestorms because of inadequate water storage and delivery systems.
5. **Develop a wildfire hazard map of your community.**
   Such a map should identify types of vegetation and their flammability, location of various roofing materials, topography and other factors using geographical information systems (GIS) data.

6. **Evaluate street widths, especially in fire-prone hillside and mountainous areas, for accessibility by fire vehicles or for speedy evacuation of residents.**
   Post-disaster reconstruction has shown time and time again that street widening is one of the most needed post-disaster safety improvements.
7. **Undertake pre-event planning for wildland fire recovery and reconstruction.**
   Such planning provides a systematic approach to develop what-if scenarios, address wildfire hazard mitigation issues as well as to prepare for possible post-disaster mitigation opportunities.
8. **Use an interdisciplinary approach when undertaking pre-disaster planning.**
   Take into account all factors including topography, layout and design of neighborhoods, population density, building intensity, intermixture of development with forested environments, flammability of vegetation, access and street widths, and water system capacity.
9. **Develop unique mitigation measures when standard practices aren't feasible.**
   Tailored mitigation measures should emphasize improved fire safety and lowered overall risk levels in areas where existing street and lot patterns do not lend themselves to standard measures, which require large building lots, dual access and setbacks from slopes.
10. **Adopt a post-disaster reconstruction plan for your community and apply it to on-going, routine planning activities.**
    Such a plan enables your community to identify opportunities and funds for hazard mitigation that time and circumstances seldom allow in the wake of a disaster. Local planners can help guide and coordinate the efforts of citizen groups, government agencies, community leaders and others involved in developing and approving a reconstruction plan.

Additional Resources

National Interagency Fire Center: http://www.nifc.gov/stats/wildlandfirestats.html

USDA Forest Service: http://www.fs.fed.us/fire/

FEMA: http://www.fema.gov/hazards/fires/wildfires.shtm

Oklahoma Fire Danger Model: http://agweather.mesonet.org/models/fire/default.html

Disasterhelp.gov: https://disasterhelp.gov/portal/jhtml/community.jhtml?community= Fire&index=0&id=3

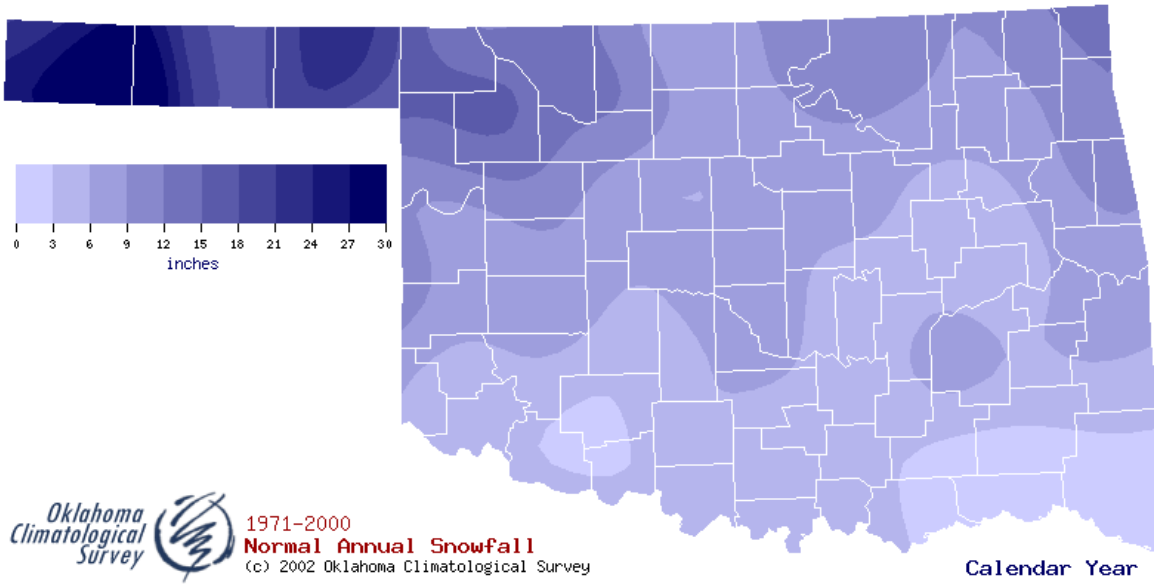
Wildland Fire Leadership Council: http://www.fireplan.gov/content/activity_in_your_state/ ?StateID=37&LanguageID=1

Icy Hazards in Oklahoma

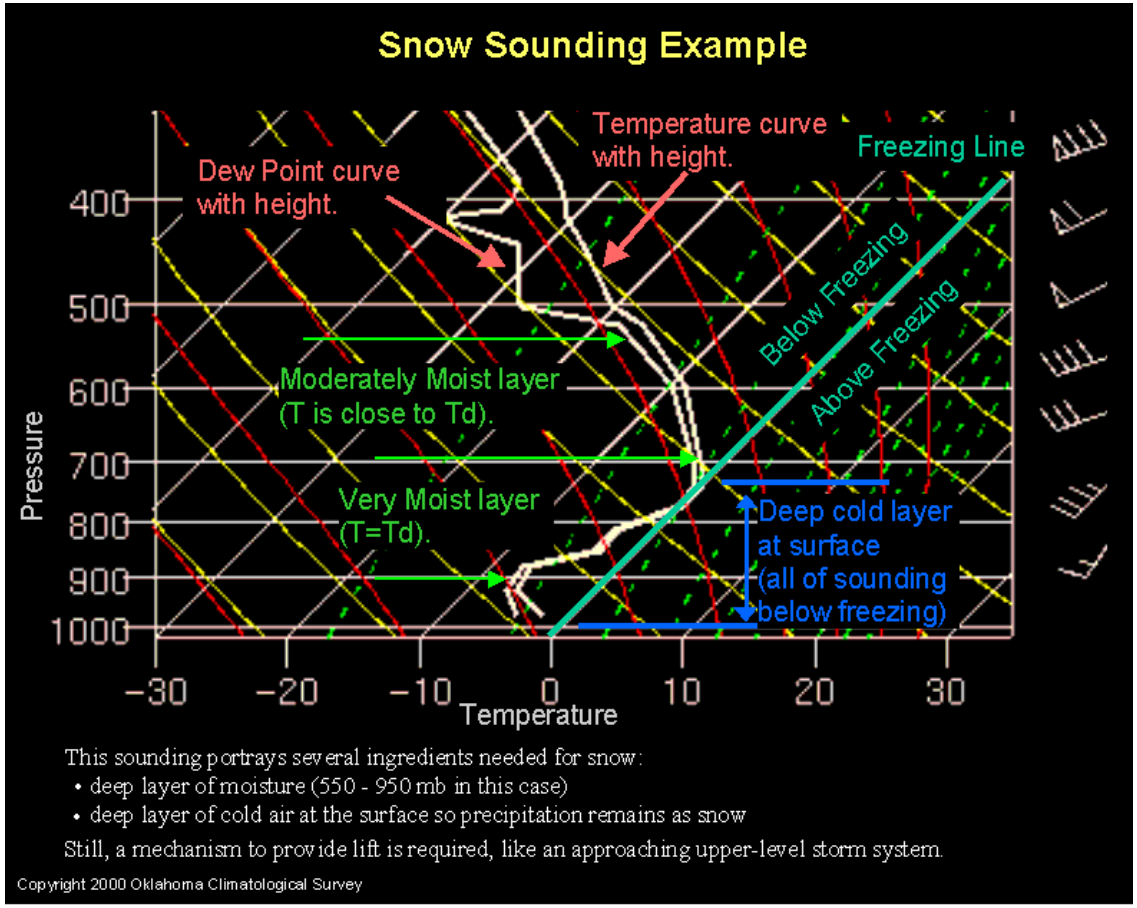
Oklahoma's experience with severe winter weather is generally confined to disruption of travel and damage to infrastructure due to excessive snow or ice. Luckily, those instances are uncommon, but the infrequency with which the state deals with severe winter weather tends to magnify its effects. Slight amounts of snow or ice often snarl traffic due to inexperienced drivers. Most of the fatalities associated with winter precipitation in Oklahoma are due to traffic accidents. Ice storms do the most damage, however, as they topple power lines and vegetation. Since 1993, the National Climatic Data Center (NCDC) lists 148 snow and ice events within Oklahoma, which caused nearly $400 million in damage.

Snow

The gradient of average annual snowfall is nearly opposite that of precipitation, in that it increases from less than two inches in the extreme southeast to nearly 30 inches in the western panhandle. The frequency of snow events also increases sharply along the same gradient. Locations in southeast Oklahoma have gone several years between events, while northwestern Oklahoma typically records several snow events in one winter. Blowing snow and blizzard conditions can pose significant problems for automobile travelers, but the effects of most snowstorms in the state are short-lived. Snowfall remaining on the ground more than a few days is an uncommon occurrence in northwestern Oklahoma, quite rare in central Oklahoma, and almost unheard of in the southeast. The greatest seasonal snowfall ever recorded in the state was 87.3 inches at Beaver during the winter of 1911-12. Buffalo observed the greatest monthly total of 36.0 inches in February 1971, including a daily snowfall record of 23 inches on the 21st day of that month.



SNOW FORMATION

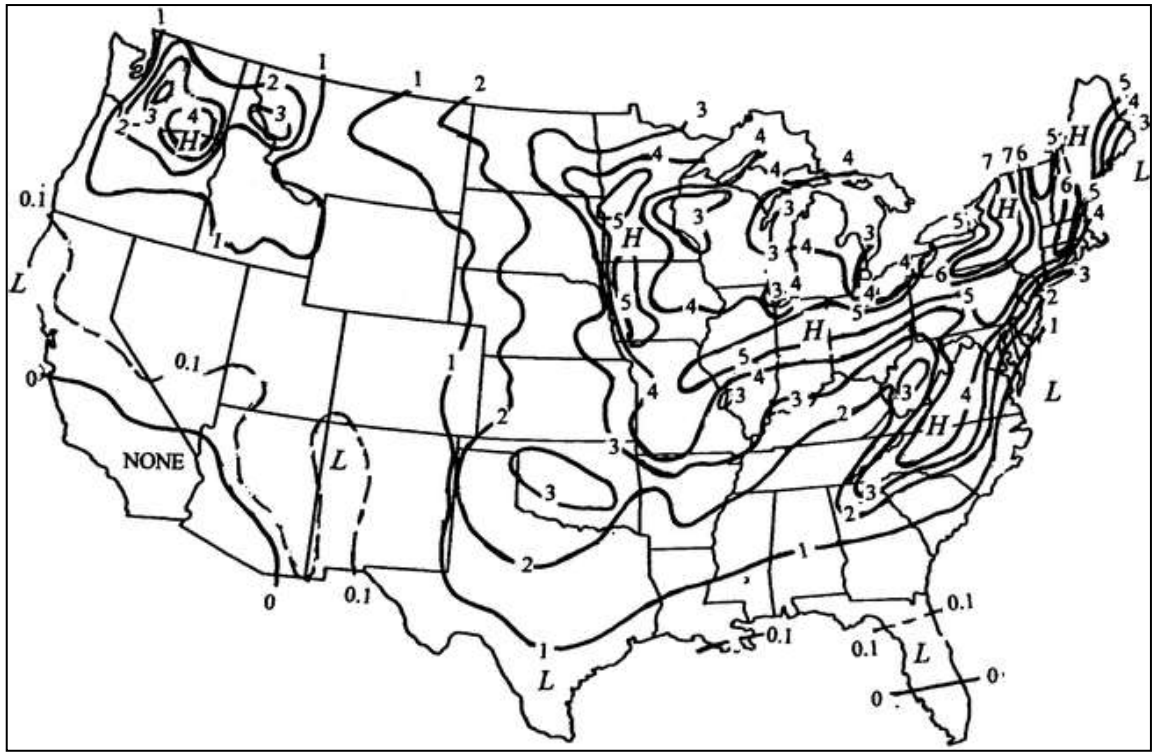


Snowflakes are simply aggregates of ice crystals that collect to each other as they fall toward the surface. The diagram below shows a typical vertical temperature profile for snow. Since the snowflakes do not pass through a layer of air warm enough to cause them to melt, they remain intact and reach the ground as snow. It is important that the temperature of the air does not rise above the freezing point between the mid-levels and the surface. This ensures that the ice crystals will stay intact in the form of snow, instead of melting and freezing once again to fall as sleet or ice pellets.

The intensity of the snow that does form is signified by visibility:

- "light" snow is when visibility is 5/8 statute mile or more
- "moderate" snow is when visibility is less than 5/8 but more than 5/16 statute mile
- "heavy" snow is when visibility is less than 5/16 statute mile

Freezing Rain



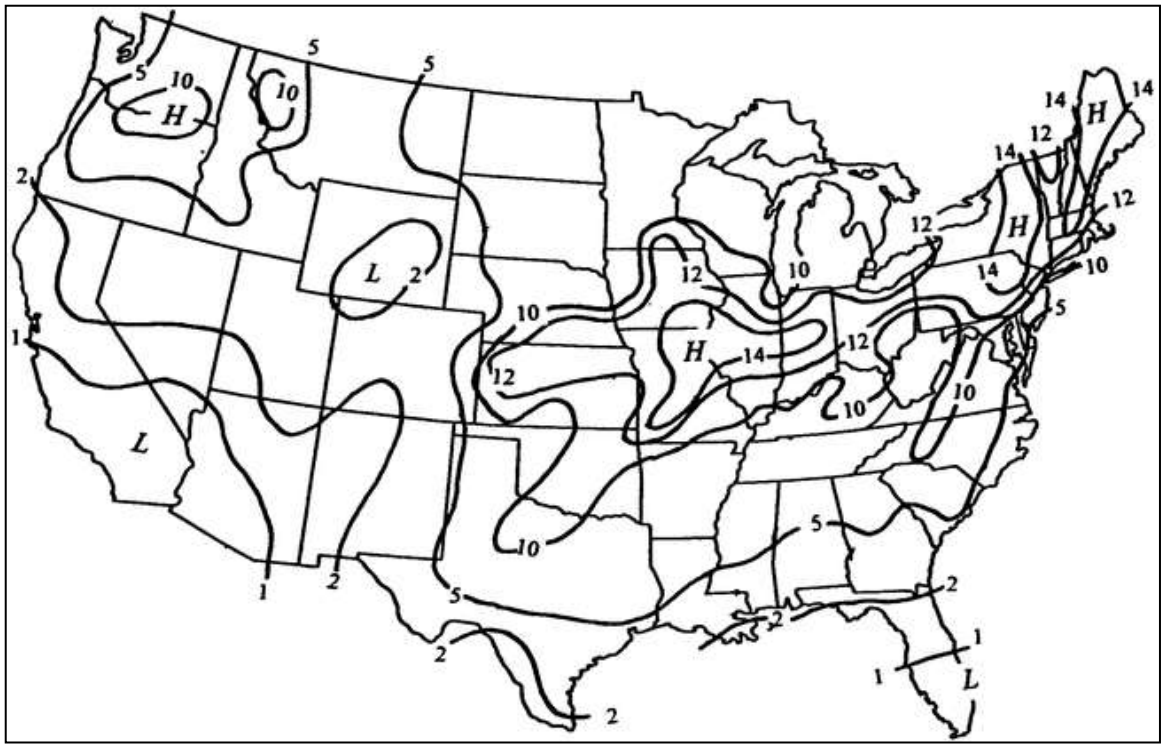
Freezing rain is a distinct wintertime hazard in Oklahoma. Ice storms are extended freezing rain events, lasting several hours to days at some locations, with heavy ice accumulations. The US National Weather Service considers an ice storm with greater than 0.25 inches (0.63 cm) of ice accumulation a significant episode that would trigger an *ice storm warning*. The resulting ice cover can down power lines and limbs, causing millions of dollars in damages and widespread power outages. These events make automobile travel very treacherous, especially on secondary roads, where the hazard can last several days. Significant icing events occur with nearly the same frequency as heavy snow events, especially in the southeastern half or so of the state. While ice accumulation is usually less than an inch, storms that deposit several inches can occur once or more per decade. The consecutive winters of 2000-01 and 2001-02 each featured a major ice storm that deposited more than three inches of ice in 24 hours across much of southeast and central Oklahoma. For the electric utility industry, an ice storm strikes in two waves: first from the initial ice accumulation and wind stress; then later from stresses caused by the rapid recoil of power lines when accumulated ice melts and falls.

The average annual number of days with freezing rain, based on 1948–2000 data (Changnon and Karl, 2003).

The pattern based on the maximum number of freezing-rain days recorded in any year between 1948 and 2000 (Changnon and Karl, 2003)

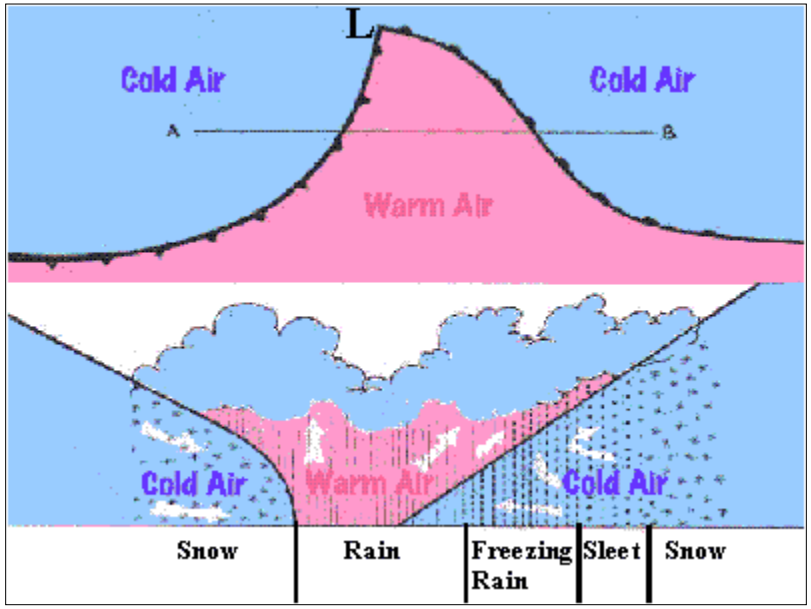
FREEZING RAIN FORMATION

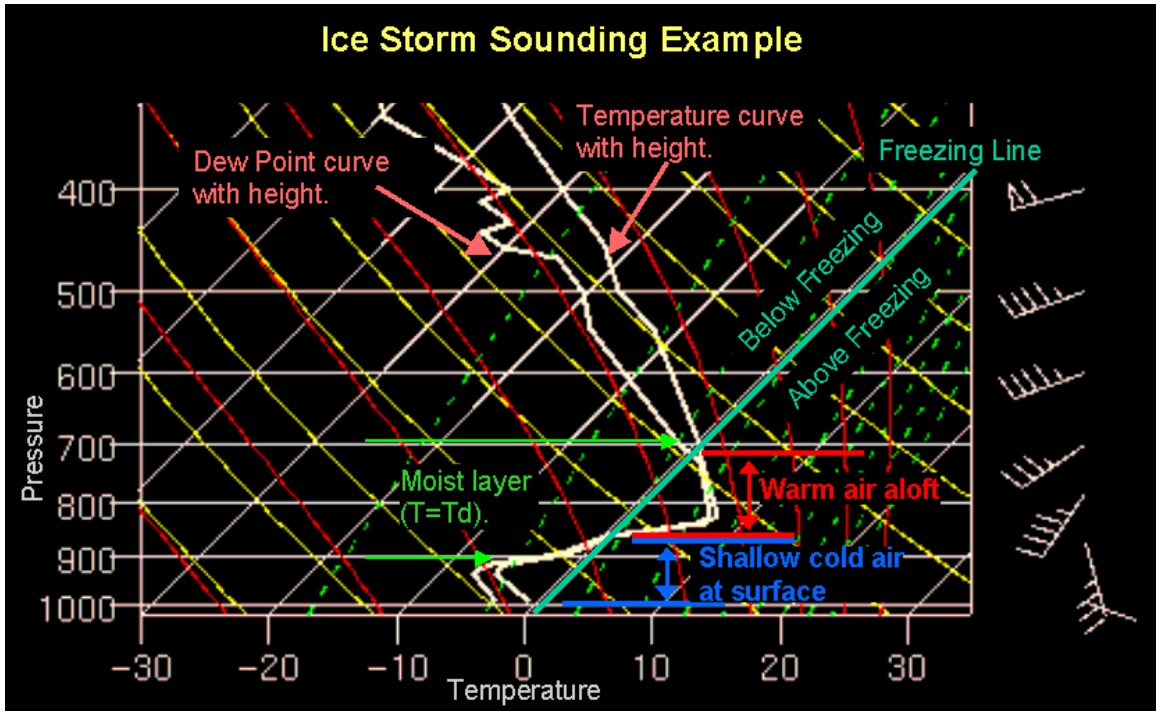
Freezing rain is most commonly found in a narrow band on the cold side of a warm front, where surface temperatures are at or just below freezing, as shown in the cross-section below (courtesy of:



http://www.islandnet.com/~see/weather/elements/icestorm.htm).

The diagram below shows a typical vertical temperature profile for freezing rain. Freezing rain develops as falling snow encounters a layer of warm air deep enough for the snow to completely melt and become rain. As the rain continues to fall, it passes through a thin layer of cold air just above the surface and cools to a temperature below freezing. However, the drops themselves do not freeze, a phenomena called supercooling (or forming "supercooled drops"). When the supercooled drops strike the frozen ground (power lines, or tree branches), they instantly freeze, forming a thin film of ice, hence freezing rain.





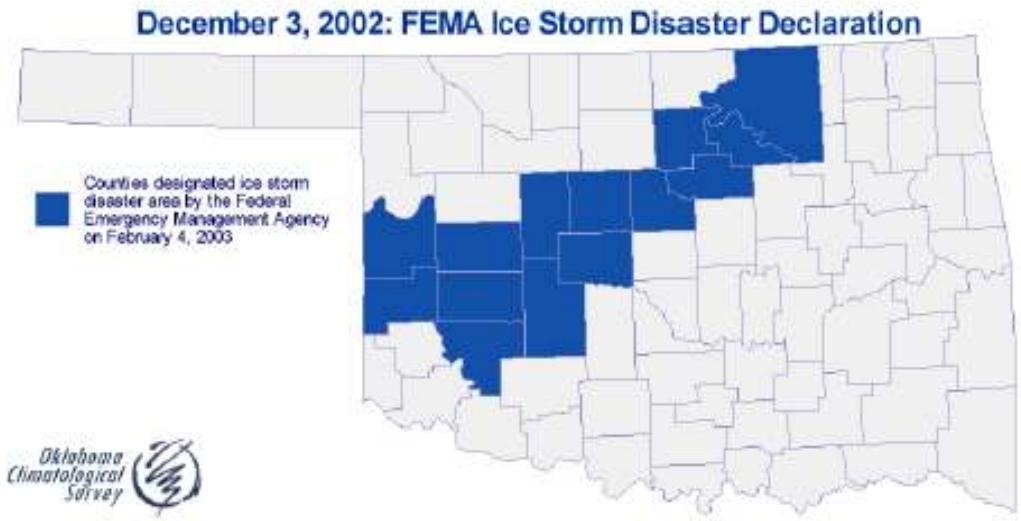
Whether freezing rain forms from the cold rain or not depends critically on the characteristics of the surface cold air layer. If the layer is too thick or too cold, it will refreeze the rain into ice pellets (sleet). If the cold layer is too warm or too shallow, the rain will continue to the ground as normal rain and will not freeze unless the temperature of the ground or some other surface it contacts is well below freezing. Often small temporal or spatial differences in air temperature and in droplet size result in freezing rain mixed with sleet, snow or non-freezing rain.

HISTORICAL OKLAHOMA WINTER STORMS

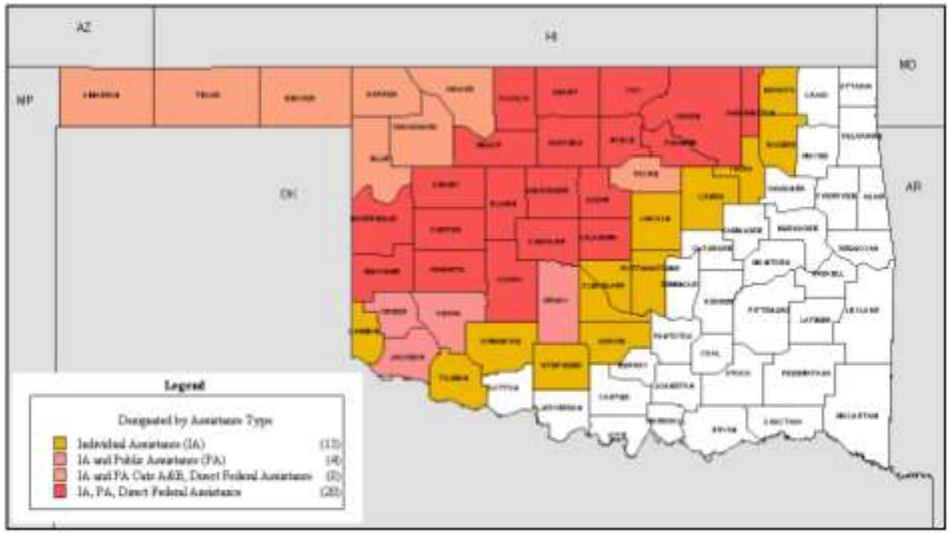
The top 10 Oklahoma snowstorms since 1951 (Table courtesy of the NWS).

Date	Highest Amount/Heavy Snowfall Event
Feb. 21-22, 1971	Highest Snowfall Total: 36 inches in Buffalo.
Nov. 25, 1992	22 inches in Laverne. Heavy snow was confined to a small portion of extreme northwestern Oklahoma.
Mar 16, 1970	20 inches in Bartlesville. Amounts of a foot or more were reported along the Kansas border
Mar. 13, 1999	19 inches in Medford.
Mar. 4-5, 1989	18 inches in Kansas, Oklahoma. Near-blizzard conditions occurred from south central through southeast Oklahoma.
Jan. 18-19, 1990	18 inches in Goodwell. Between 12 and 18 inches fell in the western two-thirds of the Oklahoma Panhandle.
Mar. 30-31, 1973	17 inches in Kenton. A foot or more in Cimarron County in the western Panhandle of Oklahoma.
Jan. 5-7, 1998	17 inches in Hennessey. Snow was reported over virtually the entire state.
Apr. 1-2, 1998	17 inches in Goodwell. Heavy snow was confined to the Oklahoma Panhandle.
Dec. 13-15, 1987	16 inches in Helena.

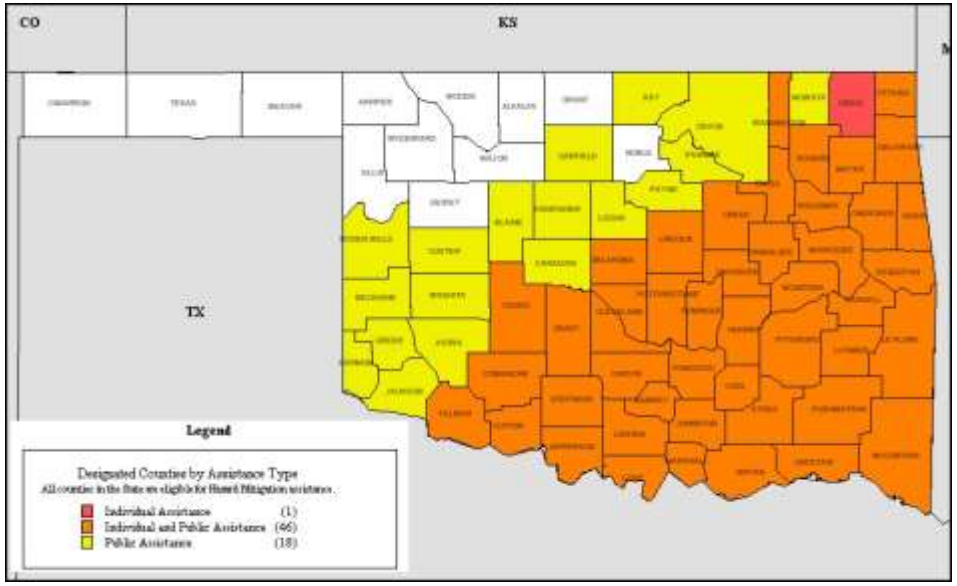
- **December 12, 2002:** The third significant ice storm in as many years, this icy blast left a damage footprint in a narrow band from west central to north central Oklahoma. Areas north of the icing region generally received 2-6 inches of snow, with some areas reporting more than eight inches. Moderate to heavy rainfall occurred to the south. The main impact of the ice storm was damage to electrical distribution systems. Because much of the area impacted by the storm is rural, the primary victims of the storms were members of rural electric cooperatives (RECs). About 30,000 REC customers were without power for some time during the storm. According to the Oklahoma Association of Electric Cooperatives, REC losses were about $4.5 million. Other power suppliers were impacted also. At the storm's peak, about 25,000 Oklahoma Gas & Electric (OG&E) customers lost power.



- **January 28-30, 2002:** This powerful winter storm wreaked havoc on the northwestern half of the state, and none suffered more than the state's power suppliers. The storm left over $100 million of damage in its wake, leaving some 255,000 residences and businesses without power. A week after the icy system exited the state, 39,000 Oklahoma residents were still in the dark as utility companies worked around the clock to replace snapped poles and downed power lines. Enid, a city of 47,000, was entirely without electricity for days. Power companies estimated that power could be lost for up to two months in some rural areas of northwestern Oklahoma. Southwestern Oklahoma State University in Weatherford closed its doors for only the 4th time in its 100-year history. The Oklahoma Association of Electric Cooperatives reported over 31,000 electrical poles destroyed due to the ice. With about 20 poles per mile on an average electrical supply line, that results in over 1,550 miles of destroyed power supply capabilities, enough to stretch from Oklahoma City to New York City. Electric power was not fully restored to all Oklahoma City residents until February 10th, 11 days after the brunt of the ice storm exited the region. Three weeks after the event, 2,320 customers remained without power. The most serious casualty in the wake of the ice storm, however, was the toll in human lives. Seven fatalities were directly attributable to the effects of the late-January storm. Four died in traffic accidents on the icy roadways, while two others died of asphyxiation while trying to get warm in enclosed spaces. Another resident died when a large tree branch crushed him as he tried to clear his residence of debris.



- **December 25-27, 2000:** Major snow and ice storms struck statewide, especially powerful in southeast quarter. Power was lost to at least 120,000 homes and businesses, including 90% of the residents of McIntosh, Latimer, and Pittsburg counties. Extended power outages also led to disruptions of local water supplies in several areas. At least 27 fatalities were attributable to the extreme weather conditions, which extended well into January 2001. Total property damage in the state was approximately $170 million.



- **October 25, 1997:** A very strong winter weather storm and blizzard moved across the central plains states through the day Saturday. A 74 year old female from Adams Oklahoma was returning home when her car became stuck in a snowdrift less than a mile from her home. She apparently died from hypothermia after trying to walk through the blizzard from her stranded car to her nearby home. She was found about noon the next day under about eighteen inches of snow in a milo field southeast of Hooker. Reports from the Oklahoma Mesonet sites in both Cimarron and Texas counties indicated wind gusts of 58 to 66 mph. Total snowfall accumulations across the Oklahoma Panhandle were from four to 12 inches across Cimarron and Texas counties and 2-6 inches across Beaver County. There was also an indirect death which occurred two weeks after the winter storm and blizzard. A man died from injuries sustained in a multi-car accident. The accident occurred on a closed road and those involved in the accident had gone around a barricade. Most roads in the Oklahoma Panhandle were closed during the winter storm and blizzard. There were numerous multi-car pile ups with many churches and gyms full of stranded

motorists. About 12,000 to 15,000 head of cattle were lost in this storm mainly in Texas County, but also Cimarron and Beaver counties. The high winds produced snow drifts of three to five feet.

- **January 1, 1993:** An upper-level storm system brought sleet and freezing rain to much of Oklahoma. Surface air temperatures were well below freezing so roads quickly became ice covered and dangerous. Roads remained ice covered until temperatures rose above freezing late in the morning on the 2nd. Numerous traffic accidents occurred and a few power outages were reported. In Oklahoma City, a 35-car pileup occurred around 2 a.m. On the 1st. A man was killed just west of Guymon when he lost control of his pickup and it collided with another vehicle. Near Durant, a woman lost her life when her vehicle slid off the road and hit a tree. Another woman lost her life in Oklahoma City when the car she was riding it hit a semi-trailer. The car was then hit by another vehicle and burst into flames. In Pontotoc County, a man died after his car slid off the road and hit a tree. The storm also caused problems for those flying as two 737s slid off icy runways at Will Rogers Airport. Many other flights were either delayed or canceled.

- **December 1987: A** large snow and ice storm caused more than $10 million in damages across the northwestern two-thirds of the state. About 114,000 customers were left without power and tree damage was severe. All flights to and from Will Rogers World Airport in Oklahoma City were cancelled, and several large broadcast antennas collapsed.

- **December 1937:** A significant ice storm struck southeastern and eastern Oklahoma, a mere 30 years after statehood in December of 1937. Considerable damage was done to trees, shrubs, and electric, telephone, and telegraph wires. Damages were totaled at a then-substantial $250,000. One elderly Muskogee resident claimed of the storm: "Seems like that one lasted a month."

SOURCES

1. Archived data from the Oklahoma Mesonet
2. Archived information from the Oklahoma Climatological Survey
3. The archives of The Daily Oklahoman, (1982-Current),
4. The archives of The Tulsa World (1989-Current)
5. The National Climate Data Center's (NCDC) Storm Events Database
6. The Federal Emergency Management Agency (FEMA)
7. The National Weather Service (NWS) Forecast Office in Norman, Oklahoma

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Changnon, S., and T. Karl, 2003: Temporal and Spatial Variations of Freezing Rain in the Contiguous United States: 1948–2000. J. *Appl. Meteo.,* 42, 1302–1315.

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