# MULTI-HAZARD MITIGATION PLAN UPDATE 2014

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Prepared By:


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Resolution

# Chapter 1: Introduction

## 1.1 About the Plan 2014 Update

The City of Skiatook has developed a strategic planning update to the City's Multi-Hazard Mitigation Plan. It is designed to fulfill the Hazard Mitigation Grant Program requirements of the Federal Emergency Management Agency (FEMA), according to the Stafford Disaster Relief and Emergency Assistance Act. This act provides federal assistance to state and local governments to alleviate suffering and damage from disasters. It broadens existing relief programs to encourage disaster preparedness plans and programs, coordination and responsiveness, insurance coverage, and hazard mitigation measures.

This plan is developed in accordance with guidance from, and fulfills requirements for the Hazard Mitigation Grant Program (HMGP). The plan addresses natural hazards and hazardous materials events. In the future the City may initiate additional studies to address technological and man-made hazards, such as water quality emergencies, power failures, and terrorism. It was felt that due to the immediate need to complete the five year Multi-Hazard Mitigation Plan update the plan would be more manageable if it would continue to be limited for the time being to natural hazards and hazardous materials events and to retain a single jurisdiction format.

The original Multi-Hazard Mitigation Plan was approved by FEMA on January 7, 2008.

### 1.1.1 Purpose

The purpose of this plan is to:

1. Re-Assess ongoing hazard mitigation activities in the City of Skiatook (Chapter 1)
2. Continue to follow the 10-Step Planning Process used by the City of Skiatook in completing a Multi-Hazard Mitigation Plan (Chapter 2)
3. Identify and re- assess the hazards every five years that may pose a threat to citizens and property (Chapter 3)
4. Evaluate mitigation measures that should be undertaken to protect citizens and property (Chapter 4)
5. Outline a strategy for implementation of the updated mitigation projects (Chapter 5)
6. Plan Maintenance and Adoption (Chapter 6)

The objective of this plan is to provide guidance for community activities for the next five years. It will ensure that the City of Skiatook and other partners implement activities that are most effective and appropriate for mitigating natural hazards and hazardous materials incidents.

## 1.1.2 Scope

The scope of the Skiatook Multi-Hazard Mitigation Plan is community-wide. It addresses all natural hazards deemed to be a threat to citizens of Skiatook, as well as hazardous-materials events. Both short-term and long-term hazard mitigation opportunities are addressed beyond existing federal, state, and local funding programs.

## 1.1.3 Authority

Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act or the Act), 42 U.S.C. 5165, enacted under Sec. 104 the Disaster Mitigation Act of 2000, (DMA 2000) P.L. 106-390, and 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, including the requirement for communities to develop local hazard mitigation plans.

## 1.1.4 Funding

Funding for the Update to the Skiatook Multi-Hazard Mitigation Plan was provided by a grant from the Federal Emergency Management Agency (FEMA) and the Oklahoma Department of Emergency Management (ODEM). A 75% FEMA grant through the ODEM, with a 25% local share. The Hazard Mitigation Grant Program grant under FEMA-1876-DR-OK was $36,199.00. The local match was $12,167.00.

## 1.1.5 Goals

The goals for the Skiatook Multi-Hazard Mitigation Plan were developed by the staff and the Skiatook Emergency Management Advisory Committee (SEMAC), with input from interested citizens. The local goals were developed taking into account the hazard mitigation strategies and goals of the federal and state governments.

***National Mitigation Strategy and Goal***

FEMA has developed ten fundamental principles for the nation's mitigation strategy:

1. Risk reduction measures ensure long-term economic success for the community as a whole, rather than short-term benefits for special interests.
2. Risk reduction measures for one natural hazard must be compatible with risk reduction measures for other natural hazards.
3. Risk reduction measures must be evaluated to achieve the best mix for a given location.
4. Risk reduction measures for natural hazards must be compatible with risk reduction measures for technological hazards, and vice versa.
5. All mitigation is local.
6. Emphasizing proactive mitigation before emergency response can reduce disaster costs and the impacts of natural hazards. Both pre-disaster (preventive) and post-disaster (corrective) mitigation is needed.
7. Hazard identification and risk assessment are the cornerstones of mitigation.
8. Building new federal-state-local partnerships and public-private partnerships is the most effective means of implementing measures to reduce the impacts of natural hazards.
9. Those who knowingly choose to assume greater risk must accept responsibility for that choice.

10. Risk reduction measures for natural hazards must be compatible with the protection of natural and cultural resources.

FEMA’s goal is to:

1. Substantially increase public awareness of natural hazard risk so that the public insists on having safer communities in which to live and work
2. Significantly reduce the risk of loss of life, injuries, economic costs, and destruction of natural and cultural resources that result from natural hazards

*State of Oklahoma Mitigation Strategy and Goals*

The State of Oklahoma has developed a Strategic All-Hazards Mitigation Plan to guide all levels of government, business, and the public to reduce or eliminate the effects of natural, technological, and man-made disasters. The goals and objectives are:

- Improve government recovery capability.
- Provide pre- and post-disaster recovery guidance.
- Protect public health and safety.
- Reduce losses and damage to property and infrastructure.
- Preserve natural and cultural resources in vulnerable areas.
- Preserve the environment.
- Focus only 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 state and federal agencies and local governments to facilitate post-disaster recovery and pre- and post-disaster mitigation.
- Coordinate federal, state, local, and private resources to enhance the preparedness and mitigation process.
- Ensure consistency between federal and state regulations.
- Protect critical facilities from hazards.
- Support legislation that protects hazardous areas from being developed. Skiatook's Goal

***Skiatook’s Goal***

To improve the safety and well-being of the citizens residing and working in the City of Skiatook by reducing the potential of death, injury, property damage, environmental and other losses from natural and technological hazards

Goals for mitigation of each of the hazards are presented in Chapter 4

### 1.1.6 Definition of Terms

**Hazard Mitigation** as defined by FEMA as “any sustained action taken to reduce or eliminate long-term risk to human life and property from a hazard event.”

Glossaries of terms that are commonly used in hazard mitigation are included in Appendix A.

### 1.1.7 Point of Contact

The primary point of contact for information regarding this plan is:

Dan Yancey, Skiatook City Manager
Skiatook Municipal Offices
110 N. Broadway
Skiatook, OK 74070
(918)396-2797

The secondary point of contact is:

David Truelove, City Planner
Skiatook Municipal Offices
110 N. Broadway
Skiatook, OK 74070
(918) 396-2797

## 1.2 Community Description

Like most cities in the region, the City of Skiatook is faced with a variety of hazards, both natural and man-made. In recent history, winter storms, lightning, floods, and tornadoes have made the national headlines. Any part of the City may be impacted by high winds, drought, hail, fire, hazardous materials events, and other catastrophes. In some cases such as flooding, the area most at risk have been mapped and delineated. Figure 1-1 in Appendix 1 is a base map of the City of Skiatook, showing its major features and highways.

The City of Skiatook is located in northwest Tulsa County and southeast Osage County in the Bird Creek Basin. According to 2010 Census figures, Skiatook has a population of 7,397. It is located in the growth trend-line for the Tulsa Metropolitan Area, and has experienced a growth rate of 24.47% since 2000, with an annual average growth of approximately 2.45%.

### 1.2.1 Governance

The City of Skiatook functions under a Council-Manager form of government. The City Council has all powers of a statutory Council-Manager city, including the determination of matters of policy. The governing body consists of a seven-member City Council, which includes one Councilor from each of the City's wards and one Councilor at-large. The Mayor and Vice-Mayor are elected from within the Council.

The Council's duties and responsibilities include approving the City budget, passing laws of the City (called Ordinances), conducting public meetings, investigations, and hearings as they deem necessary. Through ordinances and resolutions, the Council provides for the licenses, permits, and certificates issued by City departments and agencies. Appeals by citizens of such actions are subject to review by Council.

Under the authority of the City Council, the City Manager directs the day-to-day operations of the City. The City's Administration consists of multiple departments including Administrative, Community Development, Police, Fire and Public Works.

## 1.2.2 Geography

**Latitude:** 36.22N **FIPS**: 040143
**Longitude:** 96.00W

Skiatook is located in northeast Oklahoma on State Highway 20 and is approximately 4 miles west of the intersection of State Highway 20 and US 75. Skiatook is 15 miles north of Tulsa and 118 miles northeast of Oklahoma City. Skiatook has an incorporated area of 12.7 square miles, and has 186 square miles within its fence line. The area is part hills and bluffs and part wide prairie, marking the dividing line between the ridges of the Ozarks in the East and the broad plains of the West. Skiatook is on the boundary of the Cherokee Nation and the Osage Reservation.

## 1.2.3 Climate

Skiatook lies at an elevation of 650 feet above sea level. Skiatook is far enough south to miss the extreme cold of winter. The climate is essentially continental characterized by rapid changes in temperature. The winter months are usually mild, with temperatures occasionally falling below zero, but only for a very short time. Temperatures of 100 degrees or higher are often experienced from late July to early September. January's average temperature is 35.1 degrees Fahrenheit and July's average is 82 degrees Fahrenheit. Skiatook will receive a wide variety of precipitation throughout any given year. It averages 40.91 inches of rainfall and 7 inches of snow each year.

April, May and June account for 55% of all severe weather during a typical year, with 77% of the severe weather occurring between the Months of March and July. June is the most active month of the year for hail, wind, floods and tornados.

## 1.2.4 History

Skiatook was founded by the late William C. Rogers, who was known as “The Merchant Prince of the Cherokee”. Rogers established a general store or trading post on the banks of Bird Creek about two miles north of the present City in about 1880. Col. Adair, a Cherokee, serving as a delegate of the Cherokee Nation in U.S. Congress, is credited with bringing the first official post office to the settlement in 1882. Rogers chose the name Ski-A-Took for the post office. The meaning of the name remains a puzzle after 100 years. In 1892, the name was changed to Skiatook.

On December 18, 1904, Skiatook was established on the present site when the Midland Valley Railroad laid a railroad at this site which was two miles south of Roger’s store. Rogers moved to the new City site and built a large brick store building. Immediately after this move building began. Skiatook was incorporated as a City in the summer of 1905. The first permanent school was built in 1908.

## 1.2.5 Population and Demographics

According to the US Census, the City of Skiatook has a 2010 population of 7,397 which is a significant population increase when compared to 2000, as shown in Figure 1-2 in Appendix 1. Approximately 1.23% of Tulsa County's population is located in Skiatook. Over the last twenty years, Tulsa County's population is growing increasingly older, with the median age increasing from 33.1 in 1990, to 35.4 in 2000 and to 35.2 in 2010, according to the U.S. Bureau of the Census. Older populations are more vulnerable to certain hazards, such as extreme heat and cold. A map, showing the age 65 and older areas, is shown in Figure 1-3 in Appendix 1. Low-income populations are also more vulnerable to extreme temperatures; low-income areas are shown in Figure 1-4 in Appendix 1. Manufactured housing is more vulnerable to tornadoes and high winds; parcels with mobile homes and mobile home parks are shown in Figure 1-5 in Appendix 1. Skiatook demographic data is shown in Table 1-1.

**Table 1-1:**
**City of Skiatook Demographic Data**
**Source: 2000 and 2010 Census**

| ***SUBJECT*** | ***2000 CENSUS*** | ***2010 CENSUS*** |
|---|---|---|
| Total Population | **5,396** | **7,397** |
| 65 Years and older | **719** | **845** |
| Poverty Status (individuals) | **716** | **510** |

According to the Tulsa County Assessor's Office and the Osage County Assessor's Office there are 9,338 properties with improvements within the City of Skiatook, with a total value, adjusted for fair market value of $ 584,872,223. Numbers of properties with improvements (buildings, garages, pools, storage, etc.) and improvement values, by type are shown in the table below.

**Table 1-2:**
**City of Skiatook Housing Property Types by Assessed Values**
**Source: Tulsa County/Osage County Assessor's Office**

| ***PROPERTY TYPE*** | ***NUMBER OF PROPERTIES*** | ***TOTAL VALUE*** |
|---|---|---|
| Residential | 5,701 | $ 481,739,612 |
| Commercial | 332 | $ 63,771,538 |
| Agricultural | 812 | $ 39,322,313 |
| other | 2,493 | $ 38,760 |
| **Total** | **9,338** | **$ 584,872,223** |

## 1.2.6 Local Utilities--Lifelines

Lifelines are defined as those infrastructure facilities that are essential to the function of the community and the well being of its residents. They generally include transportation and utility systems. Transportation systems include interstate, US, and state highways, rail, waterways, ports and harbors, and airports. Utility systems include electric power, gas and liquid fuels, telecommunications, water, and wastewater. The following table shows utilities and the companies or sources that supply each one for Skiatook.

**Table 1-3:**
**Utility Suppliers for Skiatook**

| ***UTILITY*** | ***SUPPLIER*** |
|---|---|
| **Electric** | City of Skiatook |
| **Water** | City of Skiatook |
| **Sewage Treatment** | City of Skiatook |
| **Natural Gas** | Oklahoma Natural Gas Company |
| **Telephone & Cable** | AT&T and Community Cablevision Company |

### 1.2.7 Economy

Of Skiatook's population over the age of 16, there are 4,008 people in the labor force and 5.7% are unemployed. Of the people employed, 76.8% are salary and private-wage workers, 13.3% are government workers, and 9.9% are self-employed in unincorporated businesses. The median household income in 1999 was $32,946, and the median family income was $37,879.

### 1.2.8 Industry

The top five employers in the Skiatook area are the Skiatook Public Schools with an estimated employment base of 278; the City of Skiatook with 119; Wal-Mart with 66; Super-H with 65 and Exchange Bank with 30 employees. Principle employment occupations include managerial, professional, sales, and office work, followed by production, transportation, construction, maintenance, and service occupations.

### 1.2.9 Future Development

The Tulsa Metropolitan Area is growing at 1.3%, the same as the national growth rate. Comparatively, the State of Oklahoma is growing at 1.0% annually. Tulsa County's annual growth rate is 2.007%, and Skiatook is experiencing an annual growth rate of 3% Growth, development and redevelopment in Skiatook continues at a brisk pace.

***Growth Trends***

INCOG estimates that Skiatook will continue to grow at 3% per year over the next twenty years. Development activity is concentrated in the western part of the City adjacent to State Highway 20.

## 1.3 Regulatory Framework

This section contains a summary of the current ordinances for land use, zoning, subdivision, and floodplain management in Skiatook. It also lists the current building codes and fire insurance rating.

### 1.3.1 Comprehensive Planning and Zoning

Skiatook has a comprehensive plan, zoning code, and subdivision regulations. The Skiatook Planning Commission oversees planning and zoning in Skiatook. The Skiatook1980-2000 Plan, adopted in 1981 looks to the future of the City and provides for the orderly and systematic growth of the community. The plan sets forth the City's goals and establishes objectives and policies that will accomplish these goals. This enables each future decision to be placed within larger context of the public need. Rather than a confusing and haphazard conglomeration of conflicting land uses.

See Figure 1-6 for Skiatook's Comprehensive Land Use Map. The comprehensive plan map is spatially important as a consideration for assessing vulnerability for floods, expansive soils, wildfires, and hazardous materials.

> **The Skiatook Comprehensive Plan**, was prepared for, and adopted by the City of Skiatook on March 3, 1981.

**Skiatook Zoning Ordinance**, originally adopted in 1974, is administered by the City Planner and City staff. The latest amending Ordinance (2013-23) was adopted November 12, 2013.

**City of Skiatook Subdivision Regulations** is administered by the Skiatook Planning Commission pursuant to the powers vested through Title 19, Oklahoma Statutes, Chapter 19.a, Sections 12 and 13, as amended to review, approve and disapprove plats for the subdivision of land within the City of Skiatook.

### 1.3.2 Floodplain Management

The City of Skiatook participates in the National Flood Insurance Program (NFIP). The City enforces floodplain management regulations beyond the national minimum criteria.

### 1.3.3 Building Codes

The City of Skiatook has adopted and uses the latest version (2006) of the International Building Codes as well as supplemental ordinances which cover areas where the International Codes are inadequate or vague. This information was used as a reference in preparing this Hazard Mitigation Plan.

### 1.3.4 ISO Fire Protection Rating

ISO's Public Protection Classification (PPC) program provides important information about municipal fire-protection services, which is used by insurance companies to establish fire insurance premiums. The program also helps communities plan for, budget, and justify improvements in order to mitigate the effects of the fire hazard. A uniform set of criteria, which incorporates nationally recognized standards developed by the National Fire Protection Association and the American Water Works Association, is used to evaluate a community's fire protection service and rate it on a scale from 1 to 10, where lower numbers indicate a better rating. The evaluation inventories and analyzes the following segments of fire protection resources:

- Fire Alarm and Communication Systems – including telephone systems and lines, staffing, and dispatching systems.
- The Fire Department – including equipment, staffing, training, and geographic distribution of fire companies.
- The Water Supply System – including condition and maintenance of hydrants, and a careful evaluation of the amount of available water compared with the amount needed to suppress fires

Skiatook has a combination paid and volunteer fire department, and an ISO fire rating of 6 and 9 in the rural area. Fire Department statistics and information were used in the preparation of this plan update and are discussed in more detail in Chapter 3: Wildfires.

## 1.4 Existing Hazard Mitigation Programs

To counter pertinent hazards, the City of Skiatook has identified plans and procedures for informing people about protection measures and warning the public of impending threats. The reviews of existing plans are important in the preparation of this hazard mitigation plan update.

### 1.4.1 Capital Improvements Plans

The City of Skiatook completed a Capital Improvement Plan in December, 2003. The CIP is the principle method of scheduling and financing future capital needs that address hazard mitigation actions. Major updates to the CIP occur periodically and the plan receives a minor review during the annual budgeting process for the City. Several items were found to have a positive impact upon the City's ability to mobilize and respond to hazard events. The CIP related items identified in the action plan will be incorporated in the next CIP update.

### 1.4.2 Emergency Operations Plans

The City of Skiatook has adopted an Emergency Operations Plan, updated in 2003. The EOP was used as a reference in preparing this Hazard Mitigation Plan. As part of the EOP, critical facilities were identified. These facilities include shelters, police and fire stations, schools, childcare centers, senior citizen centers, hospitals, disability centers, vehicle and equipment storage facilities, emergency operations centers, and City hall. The City of Skiatook's critical facilities are shown in Figure 1-7 in Appendix 1, and listed in Section 3.3. The vulnerability of Critical Facilities to various hazards is addressed in this study.

# Chapter 2:

# The Planning Process

## 2.1 Documentation of the Planning Process

The Skiatook Multi-Hazard Mitigation Plan is a community-wide effort to coordinate Skiatook's multi-hazard planning, development, and mitigation activities. The City of Skiatook contracted with Andy Armstrong Consulting, LLC, in 2011 to assist with the process of updating the plan. Andy Armstrong Consulting, LLC was responsible for overall coordination and management of the plan update, aided by the staff of the City of Skiatook.

Simply stated, a mitigation plan is the product of a rational thought process that reviews the hazards, measures their impacts on the community, identifies alternative mitigation measures, and selects and designs those that will work best for the community.

This plan, as updated, continues to address the following hazards:

- Floods
- Tornadoes
- High Winds
- Lightning
- Hailstorms
- Severe Winter Storms
- Extreme Heat
- Drought
- Expansive Soils
- Wildfires
- Earthquakes
- Dam Breaks
- Hazardous Materials Events

| **Mitigation Planning Process** |
|---|
| Step 1 |
| Organize |
| Step 2 |
| Involve the Public |
| (this step will continue throughout the process) |
| Step 3 |
| Coordinate with Agencies & Organizations |
| (this step will continue throughout the process) |
| Step 4 |
| Access the Hazard |
| Step 5 |
| Evaluate the Problem |
| Step 6 |
| Set Goals |
| Step 7 |
| Review Mitigation Strategies |
| Step 8 |
| Draft Action Plan |
| Step 9 |
| Adopt the Plan |
| Step 10 |
| Implement, Evaluate and Revise |

The approach to the multi-hazard plan update for Skiatook followed a ten-step process, based on the guidance and requirements of FEMA. The ten steps are described below

### 2.1.1 Step One: Organize to Prepare the Plan

*(January 2012 – May 2012)*

Citizens and community leaders; city, county, regional, state, and federal staff; and professionals active in disaster mitigation planning provided important input in the development of the plan update and recommended goals and objectives, mitigation measures, and priorities for actions.

The initial planning process was formally created in 2004 by action of the Board of Trustees of the City of Skiatook appointing the Skiatook Hazard Mitigation Advisory Committee (SHMAC) to oversee the initial planning effort. In April of 2012, the Skiatook City Board updated committee appointments by Resolution and the SHMAC, again acted in an advisory capacity during the plan update process.

The SHMAC membership is partially made up of representatives of departments who have roles in hazards planning, response, protection, and mitigation. Several additions to the SHMAC were made as part of the update process. The additions included representatives of the Skiatook School District and TCCL; financial institutions: the Skiatook Senior Citizens organization, local utility and pipeline companies; emergency service providers; non-profits and the general public. The SHMAC is supported by a team of City staff. Andy Armstrong Consulting, LLC and PEC worked as consultants with the committee through this plan update. The City staff and the consultant met several times during the planning process and attended all meetings of the SHMAC and meetings with elected officials.

The SHMAC met regularly, in a public setting, at the Skiatook Municipal Board Room during the plan update process to review progress, identify issues, receive task assignments, and advise the staff team dedicated to preparing the planning materials. All of these meetings were posted at the Municipal Offices and in other public places, including the City's Website, and covered in newspaper articles by the local newspaper. Neighboring jurisdictions, Federal and State agencies, businesses, universities, non-profit organizations and the public participated throughout the entire planning process. Local research and input was provided by committee members. The consultant team outlined the plan and prepared a draft. Committee members reviewed the original plan and its mitigation actions; reviewed and confirmed the hazards to investigate, provided specific local and updated information, conducted the public surveys, ranked mitigation activities, and selected the action plan projects. The consultant then prepared the final plan for review. Skiatook Hazard Mitigation Advisory Committee members are shown in Table 2-1. A list of SHMAC meetings, staff meetings, and meetings and dates with governing bodies is shown in Table 2-1. The agendas and minutes for these meetings are included in Appendix 2. The minutes record the meeting's attendance.

**Table 2–1:**
**Skiatook Emergency Management Advisory Committee Meetings and Activities**

| Committee Member | Position/Department |
|---|---|
| Martin Tucker | Skiatook City Administrator |
| Jim Dunlap | Skiatook City Planner |
| Bob Nail | Skiatook Fire Marshall |
| Dale Parrish | Skiatook Fire Chief |
| Josh Brown | Skiatook City Board of Trustee Member |
| Pat Dean | Skiatook Police Capitan |
| Rick Thomas | Skiatook Public Schools |

| | |
|---|---|
| Stephanie Upton | Skiatook Chamber of Commerce – Executive Director |
| Buddy Ingles | Tulsa City-County Library - Skiatook Branch Manager |
| Virgil Mayabb | Non-Profit - Citizen |
| Samantha Henry | American Red Cross - Disaster Relief Coordinator |
| Kim Hilton | Senior Citizens Coordinator |
| David Truelove | Skiatook Community Development Planner |
| Mike Pattison | Osage Co Emergency Management - Director |
| Scott Hilton | Osage County Commissioner |
| Brad White | Utility Representative –Public Works Director |
| Gary Bishop | USDA/NRCS Tulsa District Conservationist |
| Scott Neighbors | Church Representative –Assistant Pastor (Chairman of Committee) |
| Michael Fish | Osage Tribal Police - Sergeant |
| Sharon Griffin | Osage County Health Department – Administrative Director |
| Brenda Dale | Tulsa City County Health Dept. – Manager Emergency Prepredness |
| Jill Underwood | Citizen |

| ***Date*** | ***Activity*** |
|---|---|
| May 16, 2012 | SHMAC meeting at Community Center to discuss planning process and plan outline, discuss hazard Identification and assessment issues and begin review of Draft Plan. |
| June 27, 2012 | SHMAC meeting at Community Center to discuss public survey results, identify hazards, review mapping, discuss mitigation goals and objectives, and discuss mitigation activities and ranking process. |
| August 15, 2012 | SHMAC meeting at Community Center to review committee's initial mitigation activity rankings and select action plan activities. |
| September 12, 2012 | SHMAC meeting at Community Center to review committee's final mitigation activity rankings and select action plan activities, and discuss plan maintenance and adoption process. |
| Feb. 20,2014 | Public Hearing |

### 2.1.2 Step Two: Involve the Public

*(May 2012 – July 2012)*

In addition to the SHMAC, the staff team undertook additional projects to inform the public of this effort and to solicit their input. All meetings of the SHMAC were publicly posted as required by ordinances and rules of the jurisdiction. A public survey/questionnaire was developed and circulated by SHMAC members and by the City's website to solicit community input on hazard identification and assessment and possible mitigation measures. Feedback from these surveys was important to the development of the plan. Several comments led to consideration of new proposed priority mitigation items. Public comments were invited by public notice for the final committee meeting. A public hearing was held at the Skiatook City Board meeting to solicit public comments before plan approval. The public hearing notice, proof of publication, sign-in sheet, and hearing minutes are included in Appendix 2.

### 2.1.3 Step Three: Coordinate with Other Agencies and Organizations

*(May 2012 – July 2012)*

There are many public agencies, private organizations, and businesses that contend with natural hazards. The agencies identified below and in Table 2-2 were contacted directly and/or their websites were consulted to obtain critical hazard information and data that was utilized throughout the planning process. Throughout the planning process, consultant and staff team members reviewed and contacted available information sources to collect their data on the hazards. FEMA mapping, when combined with aerial data and historic data from the National Climatic Data Center proved to be crucial to hazard identification and impact. The following list of agencies was invited to comment on a draft of the plan prior to plan approval. A sample letter requesting such comments in included in Appendix 3.

***Federal***

US Army Corps of Engineers – Floodplain and Wetland Managers- Tulsa District Office

Natural Resource Conservation Service (NRCS) – Tulsa District Manager

US Fish and Wildlife Service – Oklahoma Ecological Services Field Office Manager

***Non-Profit***

American Red Cross – Eastern Oklahoma Region CEO

***State***

Oklahoma Department of Emergency Management – State Hazard Mitigation Officer

Oklahoma Water Resources Board – OWRB Director

Oklahoma Conservation Commission – Executive Director

Oklahoma Department of Wildlife Conservation - Director

Oklahoma Department of Environmental Quality – Executive Director

***Regional***

Indian Nation Council of Governments (INCOG) – Senior Engineer

***County***

Tulsa County Engineering Department – County Engineer

Osage County – Director, Osage County Emergency Management

Tulsa City County Library – Skatook Branch

***Communities***

City of Collinsville – Fire Chief

***Skiatook***

Public Works Department - Director

Police Department - Chief

Fire Department - Chief

***Business***

Skiatook Chamber of Commerce - President

***Academia***

Skiatook Public Schools - Superintendent

Coordination with other community planning efforts is critical to the success of the Multi-Hazard Mitigation Plan and future updates. The planning process utilized for the initial plan was again utilized for the 2014 update. The SHMAC used information included in the most current version of the City's Comprehensive Plan, Emergency Operations Plan, FIRM Maps, Building Codes and City Ordinances as part of the update process. The City Staff provided information in regard to the utilization of the initial Multi-Hazard Mitigation Plan as a resource for integrating Action Plan Activities and other plan information into other City planning activities. Through participation in the SHMAC the Skiatook School District and several other local organizations also provided valuable emergency management planning information to the plan update process. Hazard Mitigation plans and action plan examples from other jurisdictions and agencies were also utilized as a resource by the SHMAC in the update process.

## 2.1.4 Step Four: Assess the Hazard

*(May 2012 – July 2012)*

The staff team collected data on the hazards from available sources. Hazard assessment is included in Chapter 3, with the discussion of each hazard.

Table 2-2 lists the various hazards that affect the City of Skiatook, describes how they were identified, and why they were identified.

**Table 2–2: How and Why Hazards Were Identified**

| *Hazard* | *How Identified* | *Why Identified* |
|---|---|---|
| **Floods** | • Review of FEMA and City floodplain maps<br>• Buildings in the floodplains<br>• Historical floods and damages (detailed in Chapter 3) | • 156 structures in the City of Skiatook are located in the regulatory floodplain<br>• Over $ 9 million of property at risk |
| **Tornadoes** | • Review of recent disaster declarations<br>• Input from Emergency Manager<br>• Consensus of Emergency Management Advisory Committee<br>• Review of data from the National Climatic Data Center | • Skiatook is located in "Tornado Alley"<br>• An average of 52 tornados per year strike Oklahoma<br>• All citizens and buildings are at risk |
| **High Winds** | • National Weather Service data<br>• Loss information provided by national insurance companies | • 4 high wind-related events in Skiatook in the last 6 years. |
| **Lightning** | • National Climatic Data Center information and statistics | • Oklahoma ranks 15th in lighting related causalities<br>• 88 deaths and 243 injuries over 38 years due to lighting |
| **Hailstorms** | • National Climatic Data Center and State Disaster Declarations | • 4 hail damage events in Skiatook over the last 8 years |
| **Severe Winter Storms** | • Review of past Disaster Declarations<br>• Input from State Emergency Management Agency and Skiatook Emergency Management<br>• Input from area utility companies | • 11 winter storm events in Tulsa County in the last 6 years<br>• 3 winter storm-related Disaster Declaration in Tulsa or Osage County In the past 3 years. |
| **Extreme Heat** | • Review of number of heat-related deaths and injuries during hot Oklahoma summers<br>• Review of data from National Climatic Data Center and National Center for Disease Control | • Local community service organizations have made heat-related deaths a high priority |
| **Drought** | • Historical vulnerability to drought, the "Dust Bowl" era<br>• Drought and water shortages in adjacent communities in recent years | • Need to ensure adequate long-term water resources for the City of Skiatook |
| **Expansive Soils** | • Input from INCOG<br>• Review of NRSC data | • Damage to buildings from expansive soils can be mitigated with public information and building code provisions |

**Table 2–2: How and Why Hazards Were Identified (continued)**

| *Hazard* | *How Identified* | *Why Identified* |
|---|---|---|
| **Wildfires** | • Input from Skiatook Fire Department<br>• Input from State Fire Marshal | • Continuing loss of life and property due to fires<br>• Several miles of Skiatook's perimeter are exposed and vulnerable to wildfires |
| **Earthquakes** | • Historic records of area earthquakes<br>• Input from Oklahoma Geological Survey<br>• Input from USGS | • Skiatook has a history of mild earthquakes<br>• Skiatook has experienced one earthquake every 5 years |
| **Dam Break** | • Skiatook Reservoir is upstream of the City of Skiatook | • Buildings and facilities in the City would be flooded if the reservoir dam fails |
| **Hazardous Materials Events** | • Input from ODEQ<br>• Input from the State Fire Marshall | • Several hazardous materials sites are scattered throughout the community<br>• Major traffic ways expose Skiatook to potential traffic way hazardous materials incidents |

## 2.1.5 Step Five: Assess the Problem

*(July 2012 – August 2012)*

The hazard data was analyzed in light of what it means to public safety, health, buildings, transportation, infrastructure, critical facilities, and the economy. The consultant team and City staff prepared several analyses using a geographic information system utilizing data obtained from INCOG. The discussion of the problem assessment is addressed for each hazard in Chapter 3. A summary paragraph discussing the changes made as a result of the 2014 Update is included at the end of each subsection in Chapter 3. The only hazard determined to need revision and in-depth risk analysis was floods.

**DAMAGE ESTIMATION METHODOLOGY**

The following methodologies were used in the development of damage cost estimated for buildings and contents for flooding and tornado/high wind damage, used in the City of Skiatook's *Multi-Hazard Mitigation Plan Update 2014.*

**Tornado Damage:** Damage estimates for the tornado scenario were based on:
1. Structure value: Tulsa County Assessor's office.
2. Contents: FEMA's Contents Value, *Understanding Your Risks*.
3. Damage to structure: based on percent damage experienced during typical events, using the Fujita Scale, damage characteristics, Table 3-12.

Damage estimates were based on a "worst case" scenario, assuming about 25% of the buildings in the tornado path would experience substantial damage or total destruction;

**HAZUS Damage Estimation Model:** FEMA's HAZUS Damage Estimation Models to calculate damages from Flooding

**Depth of Damage**: Flooding damage estimates for building and contents are based on actual structures' estimated flood depth determined by aerial topographic mapping and field investigations. Maps of the floodplains are included in Chapter 3.
Flood damage curves, for structures (single-family, multi-family, office, commercial, industrial), and contents were estimated using "Damage Factors".
Flood depth of damage curve estimates were used for riverine flooding and dam failures in (Chapter 3).

**Structure Value**: Value of buildings within the City of Skiatook was obtained from the Tulsa County Assessor's offices.
For critical facilities, non-profit properties with structural improvements, such as churches, which are tax exempt and where no county assessor valuation was available, the buildings' footprints were measured using aerial photography, GIS, and field investigation to determine size, in square feet. The value of structure was obtained by calculating the square footage times the value per square foot obtained by using FEMA publication *State and Local Mitigation Planning: Understanding Your Risks: Identifying Hazards and Estimating Losses*, August 2001, "Average Building Replacement Value per square foot," see below, source: HAZUS

**Contents Value**: Value of contents for all buildings was estimated using "Contents Value as Percentage of Building Replacement Value" table found in *Understanding Your Risks*.
**The average replacement values** were adjusted by the Consumer Price Index (CPI) to represent 2000 dollar figures. The CPI is the ratio of the value of a basket of goods in the current year to the value of that same basket of goods in the previous year. It measures the average level of prices of the goods and services typically consumed by an urban American family. The http://woodrow.mpls.frb.fed.us/research/data/us/calc/hist1800.cfm
Website can be used to adjust historic dollar figures to current year dollar figures.

**Average Building Replacement Value per Square Foot**

| **Occupancy Class** | **Total $/sq. ft.** |
|---|---|
| Single Family Dwelling | 77 |
| Mobile Home | 52 |
| Multi-family Dwelling | 98 |
| Temporary Lodging | 102 |
| Institutional Dormitory | 98 |
| Nursing Home | 89 |
| Retail Trade | 67 |
| Wholesale Trade | 53 |
| Personal/Repair Services | 92 |
| Professional/Tech. Services | 87 |
| Banks | 151 |
| Hospital | 145 |
| Medical Office/Clinic | 112 |
| Entertainment & Recreation | 131 |
| Theaters | 98 |
| Parking | 30 |
| Heavy Industrial | 69 |
| Light Industrial | 69 |
| Food/Drugs/Chemicals | 69 |

| | |
|---|---|
| Metals/Minerals Processing | 69 |
| High Technology | 69 |
| Construction | 69 |
| Agriculture | 26 |
| Church/Non-Profit Offices | 113 |
| General Services | 88 |
| Emergency Response | 130 |
| Schools | 91 |
| Colleges/Universities | 115 |

Flood Contents Loss Estimation Table

| **Flood Depth** (feet) | **One Story No Basement** (% Contents Damage) | **Two Story No Basement** (% Contents damage) | **One or Two Story With Basement** (% Contents damage) | **Manufactured Home** (% Contents damage) |
|---|---|---|---|---|
| -2 | 0 | 0 | 6 | 0 |
| -1 | 0 | 0 | 12 | 0 |
| 0 | 13.5 | 7.5 | 16.5 | 12 |
| 1 | 21 | 13.5 | 22.5 | 66 |
| 2 | 33 | 19.5 | 30 | 90 |
| 3 | 40.5 | 27 | 34.5 | 90 |
| 4 | 43.5 | 30 | 42 | 90 |
| 5 | 45 | 33 | 49.5 | 90 |
| 6 | 60 | 36 | 57 | 90 |
| 7 | 64.5 | 39 | 66 | 90 |
| 8 | 66 | 43.5 | 73.5 | 90 |
| >8 | 67.5 | 49.5 | 76.5 | 90 |

*Source: FEMA Benefit-Cost Analysis Full Data Module*

### 2.1.6 Step Six: Set Goals

*(August 2012 – September 2012)*

Project and community hazard mitigation goals and objectives for Skiatook were developed by the SHMAC to guide the development of the plan. The hazard mitigation goals for the City are listed in Chapter 4.

### 2.1.7 Step Seven: Review Possible Activities

*(August 2012 – September 2012)*

A wide variety of measures that can affect hazards or the damage from hazards were examined. The mitigation activities were organized under the following six categories. A more detailed description of each category is located in "Chapter 4: Mitigation Strategies."

1. **Preventive activities**—zoning, building codes, City ordinances
2. **Structural Projects**—Levees, reservoirs, channel improvements
3. **Property protection**—Acquisition, retrofitting, insurance
4. **Emergency services**—Warning, sandbagging, evacuation
6. **Public information and education—**Outreach projects and technical assistance

## 2.1.8 Step Eight: Draft an Action Plan

*(September 2012 – October 2012)*

After all potential hazard mitigation activities were reviewed, the Skiatook Multi-Hazard Mitigation Plan was drafted. It identified the high-priority mitigation measures, identified the party responsible for implementing the tasks, estimated the cost of the projects, identified potential funding sources, and determined the target completion date for each task. Once the plan had been drafted, it was widely circulated to City staff and the general public for comment and review.

## 2.1.9 Step Nine: Adopt the Plan

*(March 2014)*

The SHMAC approved the final plan and submitted it to the Skiatook City Council for adoption.

## 2.1.10 Step Ten: Implement, Evaluate, and Revise

*(March 2012 - Ongoing)*

Adoption of the Multi-Hazard Mitigation Plan is only the beginning of this effort. Community offices, other agencies, and private partners will proceed with implementation. The SHMAC will monitor progress, evaluate the activities, and annually recommend revisions to the action items. This process will involve quarterly meetings in which the SHMAC will monitor progress on the Action Plan and review other mitigation actions for inclusion in the Action Plan for Years 2 through 5. This monitoring and review process will also be coordinated so as to provide input into other appropriate City planning efforts specifically updates to the City's Capital Improvement Plan and the Annual Budget.

# Chapter 3:

# Updated Risk Assessment and Vulnerability Analysis

## 3.1 Identifying Hazards

There were 13 hazards investigated by the SHMAC. These were considered to be all the relevant hazards, following the committee's hazard information search. Hazard identification was discussed at the initial hazard mitigation planning meeting, held on May 16, 2012, and reviewed at the hazard mitigation planning committee meeting held on June 27, 2012.

These hazards are listed in Table 2.2. The table lists each hazard, the items that were considered in how the hazard was identified, and why each hazard was identified. Hazard information was obtained from the public works, fire and police departments: the City Administrator; the Administrative Assistant; the regional planning agency (INCOG); review of FIRMs; state and federal agency websites, and public input.

Since July 15, 2006 six major disaster declarations have been issued by FEMA that affected Skiatook and Tulsa and Osage Counties in Oklahoma. These disaster declarations are listed as follows. DR-1985 (1/31/11 to 2/5/11) Severe Winter Storm and Snowstorm; DR-1876 (12/24/09 to 12/25/09) Severe Winter Storm; DR-1775 (6/3/08 to 6/20/08) Severe Storms and Flooding; DR-1735 (12/8/07 to 1/3/08) Severe Winter Storm; DR-1678 (1/12/07 to 1/26/07) Severe Winter Storm; DR-1623 (11/23/05 to 3/31/06) Severe Wildfire Threat. These events are also mentioned and/or further described under each hazard below.

## 3.2 Profiling Hazard Events

This section provides a profile of each hazard. In this section the letter "X", when included in a subsection identification label, refers to a specific hazard's subsection, as follows.

| | | |
|---|---|---|
| X-1 Flood Hazard | X=6 Winter Storm Hazard | X=11 Earthquake Hazard |
| X=2 Tornado Hazard | X=7 Heat Hazard | X=12 Hazardous Material Hazard |
| X=3 High Winds Hazard | X=8 Drought Hazard | X=13 Dam Break Hazard |
| X=4 Lightning Hazard | X=9 Expansive Soils Hazard | |
| X=5 Hail Storm Hazard | X=10 Wildfire Hazard | |

Subsection 3.2.X.1 describes each hazard, subsection 3.2.X.2 identifies the location of the hazard, subsection 3.2.X.3 identifies the extent (such as severity or magnitude) of the hazard, subsection 3.2.X.4 provides information on previous occurrences, and subsection 3.2.X.5 discusses the probability of future occurrences, and subsection 3.2.X.6 discusses vulnerability and impacts. Each hazard affects this bi-county area as a whole, except flood hazards, dam break hazards, expansive soil hazards, and hazardous material hazards.

### 3.2.1 Flood Hazard

**3.2.1.1 Description** Flooding is defined as the accumulation of water within a water body and the overflow of the excess water onto adjacent lands. The floodplains are the lands adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that is susceptible to flooding. Flooding can take many forms including river floods (riverine) and creeks and flash floods. The most likely event for serious flooding would be flash flooding due to storm water drainage backup caused by a large amount of rain from a thunderstorm. Flash floods occur with little or no warning and can reach peak flow within a few minutes. Waters from flash floods move with great force and velocity and can roll boulders, tear out trees, destroy buildings, and sweep away bridges. These walls of water can reach heights of 10 to 30 feet and generally carry large amounts of debris. Most flood deaths are due to flash floods.

**3.2.1.2 Location** The location of the flood hazard in the City of Skiatook is its regulatory floodplain, as defined by the City's Flood Insurance Rate Maps (FIRMs). The regulatory floodplain lies in the Hominy Creek and Bird Creek watersheds. The flood hazard is shown on Figure 3-1 in Appendix 1.

**3.2.1.3 Extent** The severity of a flood is determined by several factors; including, rainfall intensity, rainfall duration, rainfall location, size of watershed, topography of watershed, and ground cover imperviousness and degree of saturation. The magnitude of the flood hazard is the regulatory floodplain. The regulatory floodplain is defined as the area inundated by the runoff from the rainfall having a one-percent chance of occurring in any given year.

Although flooding is an identified hazard, the effects have been minimal except for a few locations in the City. The regulatory floodplain is identified in the City's Flood Insurance Rate Maps (FIRMs) as Zone A and Zone AE. The following chart describes the FIRM's flood zones.

| **Flood Zones** | | |
|---|---|---|
| **Zone A** | The 100-year or Base Floodplain. There are seven types of A zones: | |
| | **A** | The base floodplain mapped by approximate methods, i.e., BFEs are not determined. This is often called an unnumbered A zone or an approximate A zone. |
| | **A1-30** | These are known as numbered A zones (e.g., A7 or A14). This is the base floodplain where the firm shows a BFE (old format). |
| | **AE** | The base floodplain where base flood elevations are provided. AE zones are now used on new format FIRMs instead of A1-30 zones. |
| | **AO** | The base floodplain with sheet flow, ponding, or shallow flooding. Base flood depths (feet above ground) are provided. |
| | **AH** | Shallow flooding base floodplain. BFE's are provided. |
| | **A99** | Area to be protected from base flood by levees or Federal flood protection systems under construction. BFEs are not determined. |
| | **AR** | The base floodplain that results from the de-certification of a previously accredited flood protection system that is in the process of being restored to provide a 100-year or greater level of flood protection |
| **Zone V and VE** | **V** | The coastal area subject to velocity hazard (wave action) where BFEs are not determined on the FIRM. |
| | **VE** | The coastal area subject to velocity hazard (wave action) where BFEs are provided on the FIRM. |
| **Zone B and Zone X (shaded)** | Area of moderate flood hazard, usually the area between the limits of the 100-year and the 500-year floods. B zones are also used to designate base floodplains or lesser hazards, such as areas protected by levees from the 100-year flood, or shallow flooding areas with average depths of less than one foot or drainage areas less than 1 square mile. | |
| **Zone C and Zone X (unshaded)** | Area of minimal flood hazard, usually depiction FIRMs as exceeding the 500-year flood level. Zone C may have ponding and local drainage problems that do not warrant a detailed study or designation as base floodplain. Zone X is the area determined to be outside the 500-year flood. | |
| **Zone D** | Area of undetermined but possible flood hazards. | |

The City of Skiatook considers a rainfall of 1 inch per hour or a creek rise that stays within the creek bank or drainage channel to be a minor severity. A major severity to the City of Skiatook 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 creek rise that overflows the banks of the creek or drainage channel.

**3.2.1.4 Previous Occurrences** Historically, Skiatook has recognized flooding within the community as a major hazard. The City joined the National Flood Insurance Program (NFIP) in 1980, adopting the Flood Damage Prevention Ordinance, and requiring that all future development comply with the ordinance.

Since 1980, the National Climatic Data Center reported six flood events in and around the City of Skiatook, causing approximately $220,000.00 in property damages.

Appendix 6 summarizes the previous occurrences of this hazard.

**3.2.1.5 Probability of Future Events** The probability of future flooding from the regulatory floodplain is statistically a one-percent chance of occurring in any given year, the 100-year floodplain. The City requires all new development to mitigate any increase in runoff through measures such as on-site storm water detention. Therefore, new development will not cause an increase in the 100-year floodplain over its existing condition. So the probability of future events should not increase with future development. An estimate of future occurrences is shown in the Likelihood Rating field in the Hazard Summary Table in Appendix 6.

**3.2.1.6 Vulnerability and Impact** Flooding can take many forms including river floods (riverine) and creeks and flash floods. The most likely event for serious flooding would be flash flooding due to storm water drainage backup caused by a large amount of rain from a thunderstorm. Flash floods occur with little or no warning and can reach peak flow within a few minutes. Waters from flash floods move with great force and velocity and can roll boulders, tear out trees, destroy buildings, and sweep away bridges. These walls of water can reach heights of 10 to 30 feet and generally carry large amounts of debris. Most flood deaths are due to flash floods.

The low-lying areas in the flood plains would be more susceptible to flooding. Roadways in the area are vulnerable and have a history of having to be closed during flooding events. This can cause what is usually temporary interruptions to the highway and road system and has the potential to isolate a community for a period of time. The county has no structures that are classified as repetitive loss structures. Water Wells, houses, utility lines and sewer systems are damaged by flood waters. This causes the citizens to be without power, homes and in many cases people must be relocated to other areas.

**Table 3-1: Contributing Factors to Flash-flood Hazard and Vulnerability in Oklahoma**

| Factor | Effect |
|---|---|
| **Precipitation Rate** | The most obvious contributing factor. As the rate of precipitation increases, so too does its ability to outpace the ability of the watershed to absorb it. *This 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, flashier response to precipitation. |
| **Shape of Watershed** | Longer, narrower watersheds will tend to “meter out” runoff so that water arrives from down shed (nearer to the mouth of the stream) areas faster than from up shed 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. |
| Contributing factors to flash-flood hazard and vulnerability in Oklahoma. | |

It is estimated that 5% of the residential structures (106 residences) in the City of Skiatook are located in the 100 year floodplain. It is unknown the number of people that reside in these residences; these structures are valued at 4 million dollars. No structures are currently designated as repetitive loss structures.

## 3.2.2 Tornado Hazard

**3.2.2.1 Description** A tornado is a rapidly rotating vortex or funnel of air extending to the ground from a cumulonimbus cloud. When the lower tip of a vortex touches earth, the tornado becomes a force of destruction. The path width of a tornado is generally less than a half-mile, but the path length can vary from a few hundred yards to dozens of miles. A tornado moves at speeds from 30 to 125 mph, but can generate winds exceeding 300 mph.

**3.2.2.2 Location** The City of Skiatook is located north of Tulsa, Oklahoma. The following figure obtained from the FEMA web site shows central Oklahoma, along with the area around Fort Worth Texas, to be the area of highest number of recorded tornados per area in the country. Therefore, due to its location, the entire City of Skiatook is at risk from tornados.

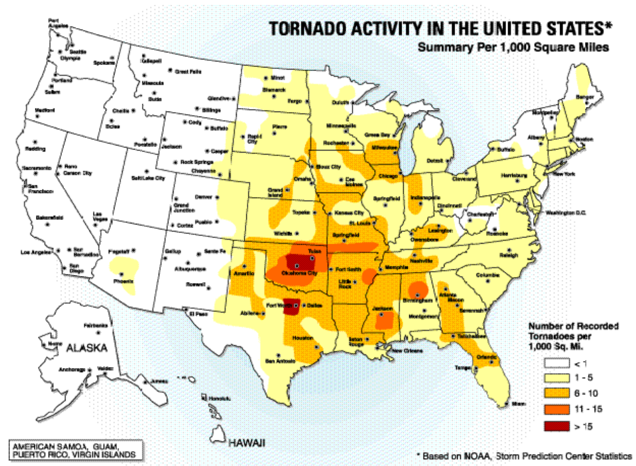



Figure I.1 The number of tornadoes recorded per 1,000 square miles

**3.2.2.3 Extent** The severity of tornados is measured on the Fujita Tornado Scale (see below). Almost 70% of all tornadoes are measured F0 and F1, causing light to moderate damage, with wind speeds between 40 and 112 miles per hour. F4 and F5 tornadoes are considerably less frequent, but are the big killers. Sixty-seven percent of all tornado deaths were caused by F4 and F5 storms, which represent only 1% of all tornadoes. Since 2006, Osage and Tulsa Counties have experienced 23 tornados up to an EF-2 magnitude tornado. Tornado size or rating is only part of the damage analysis used to estimate economic impact. The other factor is housing and building density. The most severe impact by a tornado would result from an F5 tornado moving through the City and hitting several neighborhoods.

**Table 3.1**
**Fujita Tornado Scale**

| *Category* | *Wind Speed (mph)* | *Damage* |
|---|---|---|
| F0 | Gale tornado (40-72) | **Light:** Damage to chimneys, tree branches, shallow-root trees, sign boards |
| F1 | Moderate tornado (73-112) | **Moderate:** Lower limit is beginning of hurricane wind speed—surfaces peeled off roofs, mobile homes pushed off foundations or overturned, cars pushed off roads |
| F2 | Significant tornado (113-157) | **Considerable:** 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) | **Severe:** Roofs and some walls torn off well-constructed houses, trains overturned, most trees in forest uprooted, cars lifted off the ground and thrown |
| F4 | Devastating tornado (207-260) | **Devastating:** Well-constructed houses leveled, structures with weak foundations blown off some distance, cars thrown and large missiles generated |
| F5 | Incredible tornado (261-318) | **Incredible:** Strong frame houses lifted off foundations and carried considerable distance to disintegrate, automobile-sized missiles fly through the air in excess of 100 yards, trees debarked |

On February 1, 2007, the Fujita scale was decommissioned in favor of the more accurate Enhanced Fujita Scale, which replaces it. None of the tornadoes recorded on or before January 31, 2007 will be re-categorized. Therefore maintaining the Fujita scale will be necessary when referring to previous events.

**Table 3-3: Enhanced Fujita Tornado Scale**

| 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. |
| source: http://en.wikipedia.org/wiki/Enhanced_Fujita_Scale | | |

The City of Skiatook considers any event of EF3 and above to be a major severity.

**3.2.2.4 Previous Occurrences** Figure 3-2 in Appendix 1 shows past tornado events in Osage and Tulsa Counties. 37 tornado events have been recorded in both counties from 2000 through February 28, 2013. According to the National Climatic Data Center information, since 2006, Osage County has experienced thirty tornados causing $653,000 in property damage. Tulsa County has experienced seven tornados causing $1,026,000 in property damage. During that same time frame, areas immediately adjacent to the City of Skiatook have experienced three tornados. Appendix 6 summarizes the previous occurrences of this hazard.

| **Episode Narrative** | |
|---|---|
| An F1 tornado touched down for a minute one mile southeast of Tulsa International airport or in the vicinity of the corner of Pine and Garnett. The tornado damaged some equipment at a farm implement dealership and threw a parked car on top of another parked car. Six to eight power poles were blown down as well. Property damage was estimated at 100K. | 02-25-2000 |
| An F0 tornado briefly touched down just north of Sperry. The only damage was to trees. | 03-07-2000 |
| A storm chaser reported a tornado northwest of Skiatook. The tornado touched down briefly and no damage was reported. | 06-04-2000 |
| An F1 tornado developed along the leading edge of a line of thunderstorms. The tornado severely damaged a hotel near the Tulsa International Airport injuring seven people, damaged | 04-01-2006 |

| | |
|---|---|
| covered parking at the airport, snapped trees, and turned over a sports utility vehicle at the airport. Seventy-five other cars were also damaged by the tornado. Property damage was estimated at 250K. | |
| An EF0 tornado destroyed a storage building on the west side of Rhema Bible College, damaged the roofs of a business and several homes, and blew down trees and power lines. Property damage was estimated at 75K. | 05-07-2008 |
| The EF1 tornado that developed near Kiefer in Creek County moved northeast across the north side of Skiatook before dissipating over Broken Arrow. In Tulsa County, the tornado damaged several homes, damaged a gas station canopy, uprooted several trees, snapped numerous large tree limbs, and blew down power poles. The estimated peak wind in the tornado based on this damage was 95 mph. Property damage was estimated at 100K. | 05-13-2010 |
| An EF1 tornado damaged two airplanes and the roof of a hangar at the Skiatook Municipal Airport. It also snapped and uprooted large hardwood trees. Maximum wind in the tornado based on this damage was 90 to 100 mph. | 04-15-2012 |

**3.2.2.5 Probability of Future Events** The probability of future tornado events in the City of Skiatook are the same as that of this part of Oklahoma; random throughout the area as shown on Figure 3-2. No area of the City is any more or less at risk from the tornado hazard. An estimate of future occurrences is shown in the Likelihood Rating field in the Hazard Summary Table in Appendix 6.

**3.2.2.6 Vulnerability and Impact** The City of Skiatook is located in what is considered an active part of tornado alley. Every structure in the City is vulnerable to tornadoes. Structures, automobiles and plant/ animal life can sustain damage from such event or be completely destroyed. Utility service outages can affect large segments of the population for long periods of time with no electric, gas or water service. Economic losses from homeowners and businesses alike can be devastating. Food spoilage with lack of refrigeration, gas pumps not operating, and daily life activities can all come to a halt. People displaced from homes that are damaged and destroyed also create a new set of challenges with the basics of food, shelter and clothing.

On the lower end, damage from an F0 tornado with winds from 40-72 mph can result in destruction of road signs, tall structures, trees, and possible damage to shingled roofs. Mid –range F2 and F3 tornadoes with winds from 113-206 mph will result in considerable damage. Roofs will be torn off structures, mobile homes completely demolished, most trees and plant life destroyed, objects as big as cars thrown small distances (as well as other light missiles being generated), and trains being blown over can result from these storms. The worst case is the F5 tornado with winds from 261-318 mph. Total destruction will occur in the path of the tornadoes, which have been up to ½ mile wide in the past. Homes, automobiles, appliances, outbuildings, and anything outdoors can be picked up and thrown long distances as large missiles. Most plant life including lawns, shrubs and trees are completely destroyed.

Utility infrastructure such as power lines, substations, water towers, and water wells, are vulnerable and can be severely damage or destroyed from a tornado. Emergency vehicles responding to the devastated areas can have trouble responding due to down power lines and debris in roadways. Livestock is vulnerable during tornado events and are often killed since there is little protection for the animals on the open range. People caught in the path of a tornado who don't take shelter have the potential of being injured or killed. Residents most vulnerable to tornadoes are those living in mobile homes.

Historically the tornado will move in a southwest to northeast direction, but can move in any direction. Consequently, vulnerability of humans and property is difficult to evaluate since the tornadoes form at different strengths, in random locations, and create narrow paths of destruction.

Advances in meteorology and the use of Doppler radar allow efficient prediction of tornado formation before they occur. A network of storm watchers attempt to identify funnel clouds and report to various networks to alert the population. . The City has developed and implemented a plan for improvements to the outdoor warning system coverage. This plan is illustrated in Figure3-3 in Appendix 1. Even though these advances have significantly improved the available response time, tornadoes can still occur unexpectedly and without warning.

Utilizing storm spotters and early warning systems, county residents can take appropriate precautions during these events. As a result, casualty rates are low. The increased popularity of mobile/manufactured housing has increased susceptibility of existing structures to tornadoes. The use of better building techniques, tie-down systems and the availability of storm shelters all help mitigate losses in the City of Skiatook and rural areas within the City's fenceline.

## 3.2.3 High Wind Hazard

**3.2.3.1. Description** Wind is defined as the motion of air relative to the earth's surface. Extreme windstorm events are associated with cyclones, severe thunderstorms, and accompanying phenomena such as tornadoes and downbursts. Winds vary from zero at ground level to 200 mph in the upper atmospheric jet steam at 6 to 8 miles above the earth's surface. The mean annual wind speed in the mainland United States is reported by FEMA to be 8 to 12 mph, with frequent speeds of 50 mph and occasional wind speeds of greater than 70 mph. Oklahoma wind speeds average 10 miles per hour.

**3.2.3.2 Location** The location of this hazard is uniform over the entire City area. No area of the City is more of less at risk from a high wind hazard than another.

**3.2.3.3 Extent** The recorded events vary widely in wind speed, which is measured in knots. During high wind events the City usually experiences high wind speeds between 52-65 knots. In addition, there have been total property damages in the City ranging from $2-42K, according to the NCDC. These damages resulted from trees being blown down on houses and cars, power lines being split in half, and shingles being blown off houses. The magnitude of the high wind hazard is categorized on various wind scales, such as the Beaufort, Saffir-Simpson, and the Fujita measurement scales. The tables below containing the Beaufort and Saffir-Simpson scales show that there is little consensus of opinion as to what wind speeds produce various damages. (The Fujita Scale is shown in the Table 3.1.)

**Table 3.2**
**Beaufort Scale of Wind Strength**

| *Force* | *Wind Speed (mph)* | *Damages* |
|---|---|---|
| **9** | 47-54 | **Strong gale:** Chimneys blown down, slate and tiles torn from roofs |
| **10** | 55-63 | **Whole gale:** Trees broken or uprooted |
| **11** | 64-75 | **Storm:** Trees Uprooted, cars overturned |
| **12** | 75+ | **Severe Storm:** Devastation is widespread, buildings destroyed |

**Table 3.3**
**Saffir-Simpson Scale**

| *Category* | *Wind Speed (mph)* | *Storm Surge (feet)* | *Damages* |
|---|---|---|---|
| **1** | 74-95 | 4- 5 | **Minimal:** Trees, shrubbery, unanchored mobile homes, and some signs damaged, no real damage to structures |
| **2** | 96-110 | 6-8 | **Moderate:** Some trees toppled, some roof coverings damaged, major damage to mobile homes |
| **3** | 111-130 | 9-12 | **Extensive:** Large trees are toppled, some structural damage to roofs, mobile homes destroyed, structural damage to small homes and utility buildings |
| **4** | 131-155 | 13-18 | **Extreme:** Extensive damage to roofs, windows, and doors, roof systems on small buildings completely fail, some curtain walls fall |

| | | | |
|---|---|---|---|
| **5** | 155+ | 18+ | **Catastrophic:** Roof damage is considerable and widespread, window and door damage is severe, extensive glass failure, entire buildings could fall |

The City of Skiatook 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.

**3.2.3.4 Previous Occurrences** According to the National Climatic Data Center, there have been 7 recorded events of property damage from high winds during the period of 2000 to 2012. The following table lists damage information from high winds in Skiatook and Tulsa and Osage Counties.

**Table 3.4**
**Fatalities and Property Damage Caused by High Winds**
**From 2000 to 2012**

| *Location* | *Events* | *Deaths* | *Damage* |
|---|---|---|---|
| **Skiatook** | 7 | 0 | $32,000 |
| **Tulsa County** | 7 | 0 | $32,000 |
| **Osage County** | 7 | 0 | $32,000 |

Appendix 6 summarizes the previous occurrence of this hazard.

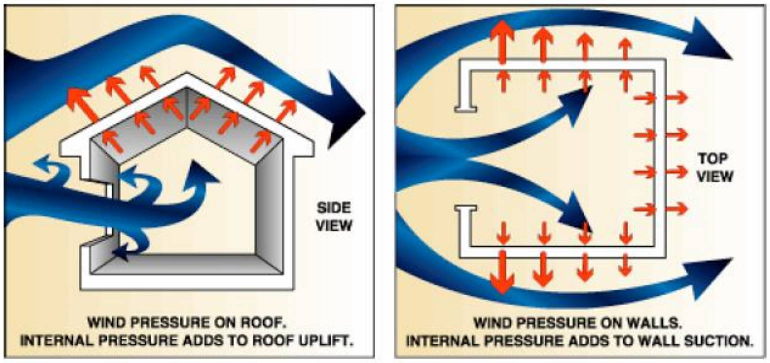
**3.2.3.5 Probability of Future Events** The majority of the United States is at some risk of high wind hazards, including the City of Skiatook. Meteorological conditions have not changed so future events should occur at the same probability as the previous events. An estimate of future occurrences is shown in the Likelihood Rating field in the Hazard Summary Table in Appendix 6.

**3.2.3.6 Vulnerability and Impact** Property damage and loss of life from windstorms are increasing due to a variety of factors. Use of manufacturing housing and mobile homes is on an upward trend, and this type of structure provides less resistance to wind than conventional construction. 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.

Winds are always part of severe storms such as tornadoes and blizzards, but do not have to accompany a storm to be dangerous. Down-slope windstorms, straight-line winds, and microbursts can all cause death, injury, and property damage. Very little available data exists separate from thunderstorms or tornado data. Any efforts made to mitigate for tornadoes or thunderstorm winds should address the hazard of high winds.

Extreme winds can cause several kinds of damage to a building. The diagram below shows how extreme winds affect a building and helps explain why these winds cause buildings to fail. Wind speeds, even in these extreme wind events, rapidly increase and decrease. An obstruction, such as a house, in the path of the wind causes the wind to change direction. This change in wind direction increases pressure on parts of the house. The combination of increased pressures and fluctuating wind speeds creates stress on the house that frequently causes connections between building components to fail. For example, the roof or siding can be pulled off or the windows can be pushed in.

Diagram of Windstorm Effects




Buildings that fail under the effects of extreme winds often appear to have exploded, giving rise to the misconception that the damage is caused by unequal wind pressures inside and outside the building. This misconception has led to the myth that during an extreme wind event, the windows and doors in a building should be opened to equalize the pressure. In fact, opening a window or door allows wind to enter a building and increases the risk of building failure.

Damage can also be caused by flying debris (referred to as windborne missiles). If wind speeds are high enough, missiles can be thrown at a building with enough force to penetrate windows, walls, or the roof. For example, an object such as a 2” x 4” wood stud weighing 15 pounds, when carried by a 250-mph wind, can have a horizontal speed of 100 mph and enough force to penetrate most common building materials used in houses today. Even a reinforced masonry wall will be penetrated unless it has been designed and constructed to resist debris impact during extreme winds. Because missiles can severely damage and even penetrate walls and roofs, they threaten not only buildings but the occupants as well.

In addition to structural issues, high winds can affect electrical and other utilities with service outages. Power lines can ground out or knocked down causing loss of electrical service. Travel can be disrupted with the loss of stop lights, street lights and dangerous cross winds making travel difficult. There could also be loss of water, sewer, and communications abilities.

## 3.2.4 Lightning Hazard

**3.2.4.1 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 in passing rapidly through the atmosphere causes thunder.

Within the thunderstorm clouds, rising and falling air causes turbulence which results in a buildup of a static charge. The negative charges concentrate in the base of the cloud. Since like charges repel, some of the negative charges on the ground are pushed down away from the surface, leaving a net positive charge on the surface. Opposite charges attract, so the positive and negative charges are pulled toward each other. This first, invisible stroke is called a stepped leader. As soon as the negative and positive parts of the stepped leader connect there is a conductive path from the cloud to the ground and the negative charges rush down it causing the visible stroke. Thunder is caused by extreme heat associated with the lightning flash. In less than a second, the air is heated to 15,000 to 60, 000 degrees. When the air is heated to this temperature, it rapidly expands. When lightning strikes very close by, the sound will be a loud bang, crack or snap. Thunder can typically be heard up to 10 miles away. During heavy rain and wind this distance will be less, but on quiet nights, when the storm is many miles away, thunder can be heard at longer distances.

**3.2.4.2 Location** The location of this hazard is uniform over the entire City area. No area of the City is more of less at risk from a lightning hazard than another.

**3.2.4.3 Extent** The type of lightning is a measure of the severity of the lightning hazard. Cloud-to-ground is the more sever type is terms of potential cause of damage to the community. The table below from the National Climatic Data Center shows the types and frequency categories of lightning. The more severe type of lightning, coupled with an increased frequency, pose a greater lightning hazard to the community. Although lighting is an identified hazard in the City, the effects have been minimal with no reported events occurring with-in the past several years.

**Table 3.5**
**Type and Frequency of Lightning**

| Type of Lightning | | |
|---|---|---|
| **Type** | **Contraction** | **Definition** |
| Cloud-ground | CG | Lightning occurring between cloud and ground. |
| In-cloud | IC | Lightning which takes place within the cloud. |
| Cloud-cloud | CC | Streaks of lightning reaching from one cloud to another. |
| Cloud-air | CA | Streaks of lightning which pass from a cloud to the air, but do not strike the ground. |
| Frequency of Lightning | | |
| **Frequency** | **Contraction** | **Definition** |
| Occasional | OCNL | Less than 1 flash per minute. |
| Frequent | FRQ | About 1 to 6 flashes per minute. |
| Continuous | CONS | More than 6 flashes per minute. |

The City of Skiatook 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 City of Skiatook considers any lightning strike that causes death or property damage to be a major severity.

**3.2.4.4 Previous Occurrences** For Tulsa County, the National Climatic Data Center (NCDC) received reports of only 2 lightning strikes during the six-year period from 2006 to 2012, producing no injuries and no deaths and $50,000 in property damage. There were no recorded events within Osage County. With the frequent wind and thunderstorm activity the area experiences, it is certain that many more lightning strikes were not reported. According to the Oklahoma State Fire Marshall's Office, lightning caused no structure fires in the City of Skiatook between 2000 and 2010.

**Table 3.6**
**Reported History of Lightning Events, Fatalities, and Damages**
**from 2006 to 2012**

| *Location* | *Number of Events* | *Number of Deaths* | *Amount of Damage* |
|---|---|---|---|
| **Skiatook** | 0 | 0 | $000 |
| **Tulsa County** | 7 | 1 | $2,100,000 |
| **Osage County** | 0 | 0 | $000 |

Appendix 6 summarizes the previous occurrences of this hazard.

Lightning strikes can also cause high-voltage power surges that have the ability to seriously damage equipment and valuable data if surge protection devices are not installed properly. Property damage from power surges and resulting fires can destroy not only the electronics in private homes, but also unprotected PBXs, telecommunications equipment, wireless systems, and radio base stations.

**3.2.4.5 Probability of Future Events** Meteorological conditions have not changed so future events should occur at the same probability as the previous events. An estimate of future occurrences is shown in the Likelihood Rating field in the Hazard Summary Table in Appendix 6.

**3.2.4.6 Vulnerability and Impact** The largest vulnerability to lightning is the potential loss of human life. Property damage can also occur to structures, electrical equipment, water wells, etc. Anyone outdoors during a thunderstorm is exposed and at risk of injury from lightning. Most people are injured or killed by lightning will participating in some form of recreation. Some of the area swimming pools and water parks are installing early warning devices for the danger of lightning strikes. Damage to trees and homes would generally be under $1,000 if a strike did occur.

## 3.2.5 Hail Storm Hazard

**3.2.5.1 Description** Hail is frozen water droplets formed inside a thunderstorm cloud. They are formed during the strong updrafts of warm air and downdrafts of cold air, when the water droplets are carried well above the freezing level to temperatures below 32 deg F, and then the frozen droplet begins to fall, carried by cold downdrafts, and may begin to thaw as it moves into warmer air toward the bottom of the thunderstorm. This movement up and down inside the cloud, through cold then warmer temperatures, causes the droplet to add layers of ice and can become quite large, sometimes round or oval shaped and sometimes irregularly shaped, before it finally falls to the ground as hail.

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 are in late spring and early summer.

**3.2.5.2 Location** The location of this hazard is uniform over the entire City area. No area of the City is more of less at risk from the hail storm hazard than another.

**3.2.5.3 Extent** The severity of a hail storm is dependent upon the size and number of the hailstones. The extent of the hazard can range from damage through destruction of structures and personal property to bodily injury, depending on the size of the hail. The National Climatic Data Center has reported hail up to 2 ¾ -inches in diameter. The City of Skiatook considers any hail of H4 or higher on the NOAA/TORRO hail scale, illustrated below, 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 | 0.80-1.2 | 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 hailstones | 3.5-40 | Grapefruit | Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open |

| | | | | |
|---|---|---|---|---|
| H10 | Super hailstones | 4+ | Softball and up | Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open |

The National Weather Service (NWS) issues Severe Thunderstorm Warnings whenever a thunderstorm is forecast to produce wind gusts of 58 miles per hour (50 knots) or greater and/or hail size one inch in diameter or larger. Prior to January 5, 2010 the criteria for hail was ¾ inch or larger.

**3.2.5.4 Previous Occurrences** According to the National Climatic Data Center, Tulsa County has experienced 327 hailstorm incidents with hail of at least 1-inch in diameter in the eight-year period from January 1, 1995 to December 31, 2003, as shown in the table below. Damage to buildings and crops totaled $24 million. Over this same time period, Skiatook has experienced 6 hailstorm incidents.

**Table 3-11: History of Significant Hail Events in Skiatook from 2000 to 2012**

| Date | Magnitude | Episode Narrative |
|---|---|---|
| 5-19-2003 | 1.00 | |
| 11-14-2005 | 1.75 | Golfball size hail broke windows in at least one home. |
| 4-06-2006 | 1.00 | |
| 4-08-2008 | 1.00 | Severe thunderstorms occurred across northeast Oklahoma during the late evening and early morning hours of the 7th and 8th. |
| 9-21-2009 | 1.50 | Severe thunderstorms occurred over a large part of eastern Oklahoma from the early afternoon hours into the evening hours of the 21st. The continued heavy rain across the area resulted in flash flooding. |
| 4-24-2011 | 1.75 | On the afternoon of the 24th, a stalled frontal boundary extended across northwestern Arkansas and far southeastern Oklahoma. This boundary began to lift to the north with widespread showers and thunderstorms initiating north of the boundary and affecting much of eastern Oklahoma. Recent heavy rains had saturated the ground and the additional heavy rainfall with this activity resulted in widespread flash flooding. Large hail was also observed with the stronger storms as well as two brief tornados. The activity continued into the early morning hours of the 25th |

Appendix 6 summarizes the previous occurrences of this hazard.

**3.2.5.5 Probability of Future Events** Meteorological conditions have not changed so future events should occur at the same probability as the previous events. An estimate of future occurrences is shown in the Likelihood Rating field in the Hazard Summary Table in Appendix 6.

**3.2.5.6 Vulnerability and Impact** Vulnerability is difficult to evaluate since hail occurs in random locations and creates relatively narrow paths of destruction. Hail is capable of causing considerable damage to crops, buildings, and vehicles, and occasionally death to farm animals. Hail can also strip leaves and small limbs from non-evergreen trees. While large hail poses a threat to people caught outside in a storm, it seldom causes loss of human life.

- Costs and losses to agricultural and livestock producers
- Reduced yields and crop loss
- Injuries or loss of livestock
- Damage to barns and other farm buildings
- Damage to trees resulting in increased susceptibility to disease
- Urban, residential, and commercial
- Damage to buildings, possibly Skiatook critical facilities
- Roofs
- Windows
- Damage to automobiles, trucks, trains, airplanes, etc.
- Disruptions to local utilities and services
- Power

- Communications
- Transportation

Past storms in the City of Skiatook and Osage and Tulsa Counties have showed crops losses from slight damage of less than 10% production loss to total devastation of the crop with 100% loss. Damage to vehicles can range from several hundred dollars to total loss of the vehicle. At times when large parking lots or dealerships get hit, losses can be in the millions of dollars. Loss from a major hailstorm damaging automobiles and structures in a larger city could total in the tens of millions of dollars.

## 3.2.6 Winter Storm and Ice Storm Hazard

**3.2.6.1 Description** All winter storms are accompanied by cold temperatures and blowing snow, which can severely reduce visibility. A 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. An ice storm occurs when freezing rain falls from clouds and freezes immediately on impact. All winter storms make driving and walking extremely hazardous. The aftermath of a winter storm can impact a community or region for days, weeks, and even months. Storm effects such as extreme cold, flooding, and snow accumulation can cause hazardous conditions and hidden problems for people in the affected area. People can become stranded on the road or trapped at home, without utilities or other services. Residents, travelers and livestock may become isolated or stranded without adequate food, water and fuel supplies. The conditions may overwhelm the capabilities of a local jurisdiction. 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; house fires occur more frequently in the winter due to lack of proper safety precautions.

**3.2.6.2 Location** The location of this hazard is uniform over the entire City area. No area of the City is more of less at risk from the winter storm hazard than another.

**3.2.6.3 Extent** A winter storm can range from moderate snow (2 to 4 inches over 12 to 24 hours) to blizzard conditions (4 to 6 inches over 12 to 24 hours) with high winds, freezing rain or sleet, heavy snowfall with blinding wind-driven snow and extremely cold temperatures that lasts several days. Some winter storms may be large enough to affect several states while others may affect only a single community. The table below gives a range of physical intensities from winter storms along with the potential effect. The City of Skiatook considers Level 3 and Level 4 as significant events but may experience a level anywhere on this chart.

**Table 3-12: The Balthrop Ice Scale**

| Level | Cause | Effect |
|---|---|---|
| Level 1; Nuisance Event, No Major Impact | Freezing rain and sleet, but little ice accumulation. Roads not hazardous. Ice forming on grass. | Little to no effect on the State of Oklahoma. |
| Level 2; Minor Event, Caution Advised | No measurable ice. Black ice on roads and bridges. Winter Weather Advisory. | Untreated roadways and bridges may become hazardous and slick. Livestock may need additional supplemental feed. |
| Level 3; Major Event, Isolated Emergency Conditions in the State of Oklahoma | Ice accumulations of ¼ to ½ inches. Reduced visibility. Winter Storm Warning. | Widespread hazardous road conditions. Travel discouraged. Isolated power outages because of down power lines from ice accumulations. Tree damage. Livestock loss potential increases. Supplemental feed necessary. |
| Level 4; Extreme Event, The State of Oklahoma Under Full State of Emergency | Crippling event. Winds over 35 mph. 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 ice. Communications |

| | | |
|---|---|---|
| | | infrastructure lost from ice accumulation. May be a long lasting event. |

The City of Skiatook has been exposed to almost all characteristics produced by a winter storm. The City has had heavy snow, ice, freezing drizzle, sleet, and freezing rain. Within recent years winter storms have produced little property damage within the City.

Historically, ice and snow have produced dangerous driving conditions in the City of Skiatook. Wrecks causing injuries are an indirect result of winter storms. The City has experienced winter storms of varied intensities that included snow and/or ice. Snow-blocked and ice covered roads not only make travel dangerous, but the removal and clearing of snow and ice can be costly. Downed electrical lines and the resulting loss of power to homes, businesses, and water systems not only increase hardships and hinder recovery, but can also increase potential dollar losses during and after winter storm events. Loss of power can cause diplacees, along with human exposure to extreme temperatures. Power failures, communications and transportation disruptions are common consequences of winter storms in the City. Heavy accumulations of ice or snow can also result in collapse of or structural damage to buildings. The damage may be caused directly by the excessive weight of the ice/snow accumulation, or by ice-laden trees or branches falling on structures.

**3.2.6.4 Previous Occurrences** According to the National Climatic Data Center, 11 winter storms were reported in Osage and Tulsa County from 2006-2012 with no reported property damage. The specific locations within the county were not reported, but probably affected large areas of the county. Specific data for the City was not available.

**Table 3.13**
**History of Severe Winter Storms and Ice Storms in Tulsa/Osage Counties from 2000 to 2012**

| Date | Episode Narrative (Excerpt) |
|---|---|
| 02/08/2011<br>02/09/2011 | A strong upper level disturbance moved from the northwestern United States southeastward into the Southern Plains on the 8th and 9th. Snow developed across the region during the evening hours of the 8th and continued through the 9th. Widespread light to moderate snow fell across eastern Oklahoma and bands of very heavy snow developed.<br><br>Much of northeastern Oklahoma received more than a foot of snow while portions of far northeastern Oklahoma picked up about two feet of snow. The NWS Cooperative Observer measured 27 inches of snow in about nineteen hours from this storm. This measurement breaks the state 24-hour snowfall record. Many roads were impassable as blowing and drifting snow resulted in two to four foot snow drifts.<br><br>Record cold followed this storm with temperatures falling well below zero degrees Fahrenheit on the morning of the 10th. The Oklahoma Mesonet station near Nowata measured -31 degrees Fahrenheit, a reading that breaks the all-time state minimum temperature record. Six to twelve inches of snow fell across Tulsa County. |
| 02/04/2011 | A strong upper level disturbance moved from southwest Texas to northern Texas into northern Arkansas on the 4th. Snow developed into the area during the morning hours and continued into the evening hours. Some of this snow was moderate to heavy and resulted in bands of locally heavy accumulations of up to five inches across eastern Oklahoma. Four to five inches of snow fell across Tulsa County |
| 02/01/2011 | A very strong storm system moved across the Southern Rockies into the Southern Plains on the 31st of January and 1st of February. Cold air had surged into the region ahead of this system on the 30th and 31st. Precipitation developed into eastern Oklahoma during the evening of the 31st, beginning as freezing rain and sleet. Most places transitioned to snow fairly quickly although some locations in northeastern Oklahoma and east-central Oklahoma received between one quarter and one half inch of sleet before the transition. Other locations received about one quarter of an inch of ice before changing over to snow. Heavy snow fell during most of the day resulting in more than four inch accumulations north of a Sallisaw to McAlester line. A large portion of northeastern Oklahoma received more than ten inches of |

| | |
|---|---|
| | snow and a swath of 20 inch snows were measured across Osage, northern Tulsa, Rogers, and Ottawa Counties.<br><br>Strong winds frequently gusting to more than 35 mph resulted in near zero visibilities and snow drifts up to about five feet across northeastern Oklahoma. The storm had a crippling impact on the region with interstate highways impassable and closed, the Tulsa International Airport closed, and many businesses shut down for a couple days during and following the storm.<br>The storm's effects on the area lasted days. Hundreds of traffic accidents occurred and numerous vehicles were stranded in the snow. This storm resulted in a disaster declaration. One half inch of sleet fell early in the event then twelve to sixteen inches of snow fell across Tulsa county. |
| 01/19/2011<br>01/20/2011 | An upper level disturbance approached the region from the northwest late on the 19th. Light freezing rain and sleet developed ahead of this system over northeastern Oklahoma late in the evening of the 19th. The precipitation changed over to snow around midnight on the 20th and continued to spread southward over time. Snow continued into the morning hours of the 20th before the system moved to the east of the region. Four to six inches of snow fell across a large portion of northeastern Oklahoma. |
| 03/20/2010<br>03.21.2010 | A strong upper level storm system moved from the Southern Rockies into the Southern Plains on the 20th and 21st while a cold front moved across the area on the 19th and 20th. Precipitation formed over the region late on the 19th. A mixture of rain, light freezing rain, and light sleet changed over to snow from north to south on the 20th. Periods of snow, some heavy at times, continued into the afternoon and evening hours of the 21st as the storm exited the region. Widespread four to six inch snows occurred over eastern Oklahoma with nearly a foot accumulating across portions of northeastern Oklahoma. Portions of Adair County received a foot of snow, ten inches of snow fell across portions of Latimer and Le Flore Counties, nine inches of snow fell across portions of Muskogee and Sequoyah Counties, and eight inches were reported across portions of Cherokee County. Roads were snow packed and very treacherous during and after the storm, resulting in numerous automobile accidents. Four to six inches of snow fell across Tulsa County. |
| 01/28/2010<br>01/29/2010 | A strong upper level low pressure system moved from Baja California into the Southern Rockies on the 28th and into the Southern Plains on the 29th. Rain changed to freezing rain and sleet during the morning and early afternoon of the 28th. The freezing rain resulted in 1/4 to 3/4 of an inch of glaze across much of northeast Oklahoma. Sleet amounts were up to an inch across portions of northeast Oklahoma. An estimated 5000 electric customers in northeastern Oklahoma were without power during the height of the storm. As the upper low neared the region on the 29th, the precipitation changed to snow with more than 4 inches falling generally north of a McAlester to Fort Smith line. Up to 8 inches of snow fell across portions of northeast Oklahoma by the evening of the 29th. Many automobile accidents occurred across the area as a result of the icy conditions, which resulted in numerous indirect injuries. One to three quarters of an inch of glaze occurred across Tulsa County along with five to eight inches of snow. |
| 12/24/2009<br>12/25/2009 | A strong upper level low pressure system moved from the Southern Rockies across the Southern Plains on the 24th. Widespread precipitation developed as this system approached. Arctic air gradually spread into the region behind a strong cold front changing the rain to sleet over much of northeastern Oklahoma during the morning hours and then to snow during the afternoon. Many locations received between one half and one and a half inches of sleet over the northeastern portion of the state. Periods of heavy snow followed resulting in at least four inches of snow along and north of I-40. Heavier bands of snow between eight and twelve inches fell along a Pawnee to Pawhuska line and along an Okmulgee to Vinita line. Many roads were snow covered and closed across the region, including interstate highways and turnpikes. Numerous automobile accidents occurred during this storm as roads became treacherous. These accidents resulted in three (indirect) fatalities and numerous injuries. The Tulsa International Airport was also closed during the storm with numerous flights into and out of the airport cancelled. Very strong wind with frequent gusts above 35 mph caused very |

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|---|---|
| | low visibility in blowing snow and near blizzard conditions. Snow drifts of several feet occurred across portions of northeastern Oklahoma.<br><br>A major disaster declaration was approved for 29 counties in Oklahoma to help with the $18 million spent in response and recovery efforts as a result of this storm. The declaration included the following counties in eastern Oklahoma: Nowata, Craig, Ottawa, Tulsa, Rogers, Delaware, Okfuskee, Okmulgee, Muskogee, and Sequoyah. Four to eight inches of sleet and snow fell across Tulsa County. |
| 03/28/2009 | A strong upper level low pressure system translated from northwestern Texas across southeastern Oklahoma into northeastern Arkansas. Rain associated with this system changed to snow during the morning of the 28th and continued into the evening. Some of this snow became very heavy with rapid accumulations reported. Widespread four to six inch snowfalls occurred across much of northeastern Oklahoma. A persistent band of convective snow developed over portions of Tulsa, Creek, Pawnee, Osage, Okmulgee, Wagoner, and Rogers Counties with up to ten inches of snow reported across northern Creek, southeastern Pawnee, and southeastern Osage Counties. |
| 01/26/2009<br>01/27/2009 | Upper level disturbances passing through the Southern Plains resulted in precipitation development north of a stationary arctic front located in North Texas. Freezing rain began across the area during the late morning hours of the 26th and became more widespread and heavy during the afternoon and evening hours. Freezing rain changed to sleet north of a Okemah-Wagoner-Colcord line during the morning of the 27th with heavy freezing rain continuing south of that line. The heaviest icing and most widespread power outages and tree damage occurred across portions of Cherokee, Sequoyah, Muskogee, and Adair Counties where one to one and a half inches of ice accumulated. More than 100,000 electric customers were without power during the height of the storm in eastern Oklahoma and some customers in remote rural areas continued to be without power for more than two weeks.<br>A 40 to 50 mile wide swath of heavy sleet occurred just to the west of the most significant ice with two to three inches accumulating along and near an Okemah-Wagoner-Grove line. Elsewhere up to an inch of sleet fell on top of the heavy ice. |
| 03/03/2008<br>03/04/2008 | A strong upper level storm system tracked across the Southern Plains resulting in widespread precipitation north of a cold front. The precipitation changed to snow over eastern Oklahoma during the evening of the 3rd. The snowfall was heavy at times and resulted in accumulations of four to eight inches over a number of counties before it ended. Four to six inches of snow fell across Tulsa County. |
| 12/08/2007<br>12/10/2007 | Arctic air spread into the region ahead of a strong storm system over the desert southwest. Several disturbances translated from the low pressure area across the Southern Plains, resulting in several periods of precipitation, including thunderstorms. Freezing rain was the dominant precipitation type during the event; the thunderstorms resulted in an increased rate of ice accumulation. One to two inches of ice accumulated on trees and power lines within a 40 mile wide band along a Bristow-Tulsa-Vinita-Miami line and one to one and a half inches of ice accumulated on exposed surfaces along a Welty-Coweta-Jay line.<br>Nearly one million people were estimated to be without power in eastern Oklahoma after this event, some of which remained without power for up to two weeks. Early estimates indicate that this storm could be the most costly weather-related disaster in Oklahoma history. A number of indirect related injuries and fatalities were attributed to this storm in eastern Oklahoma, including seven fatalities in automobile accidents on treacherous roads; one carbon monoxide fatality due to improper use of a heat source indoors; and six fatalities due to house fires that were started by temporary heat or light sources during the power outages. There were also three direct fatalities, including one in which a male was killed in Tulsa when a utility pole fell on his vehicle due to ice weighting; and two hypothermia deaths, one in Tulsa on the 15th and one in Skiatook on the 18th. Up to two inches of ice accumulated on trees, power lines, and other exposed surfaces in Tulsa County. |
| 01/12/2007<br>01/14/2007 | An arctic cold front moved into northeastern Oklahoma during the late evening hours of the 11th and had finally passed through the southeastern portion of the state by the evening of the 12th. A strong upper level low pressure system moved into the southern Rockies and several disturbances translated across the Southern Plains bringing periods of heavy sleet and freezing |

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| | rain to the region. The initial precipitation began around daybreak on the 12th and the final round occurred on the 14th. \|A devastating swath of one to three inch ice amounts fell in an estimated 60 to 80 mile wide band from roughly Atoka to McAlester to Muskogee to Grove. An estimated 120,000 electric customers were without power due to downed power poles and power lines within this swath, some of which were without power for more than two weeks. West of the heavy ice, one to three inches of sleet occurred with lesser amounts of freezing rain, generally between 1/4 to 1/2 inch. |
| 02/18/2006<br>02/20/2006 | Arctic air spread into the region on the 16th setting the stage for a period of wintry precipitation as several upper level disturbances moved through the area from the 17th through the 20th. Precipitation began during the late evening on the 17th as the first disturbance approached. A combination of freezing rain, sleet, and snow began accumulating during the late evening hours of the 17th and by daybreak on the 18th had resulted in significant impact across the region. The first round of wintry precipitation ended around midday on the 18th but another began during the evening hours of the 19th, which continued through the early morning hours of the 20th. |
| 12/03/2002<br>12/04/2002 | An upper level system moving out of the desert southwest into the southern plains interacted with cold air near the surface to produce freezing rain from the afternoon hours on December 3rd to the early morning hours on December 4th. The freezing rain resulted in ice on power lines and trees causing power outages. The power outages were the most widespread to the west and north of Tulsa in western Tulsa, northern Creek, Pawnee, Osage, Washington and Nowata counties. At one time 4,000 homes were without power in Sand Springs and 2,000 homes were without power in Bartlesville. The cities of Drumright, Skiatook and Nowata also experienced significant power outages. Isolated power outages occurred in the rural areas of Rogers, Craig, Mayes, Ottawa and Delaware counties. In addition to the power outages, many roads in the area became slick and hazardous. Several schools were closed on the 4th. |
| 12/25/2000<br>12/27/2000 | Summary of winter weather events for December 25-27 2000. A slow moving winter storm moved across the State Christmas day bringing heavy freezing rain and dangerous ice accumulations. While all of Eastern Oklahoma received significant ice accumulations, East Central and Southeast Oklahoma were hardest hit. One to two inches of ice accumulation were common in these areas with locally higher amounts. Over 500 power poles were downed during the event and over 200,000 Oklahomans were without power. The heavy ice accumulations also left thousands without telephone and water service. Some locations in Southeast Oklahoma were without utility services for more than a week. Numerous shelters and feeding sites were established across Southeast Oklahoma to provide water, food and a warm place to sleep. Thousands of trees were damaged across Southeast Oklahoma including 7 State parks where damage was estimated at over 1 million dollars. Numerous reports of trees downed on vehicles and homes were reported across Southeast Oklahoma. Some of the areas that experienced the most damage were in Pittsburg, Latimer and LeFlore counties. While damage estimates were not finalized as of late February, a preliminary total for the state was $168.9 million. |
| 12/11/2000 | A strong Arctic cold front moved south across Eastern Oklahoma on the morning of December 11, 2000. Freezing rain and freezing drizzle developed behind the boundary producing a thin layer of ice on pavement surfaces. Cold temperatures produced black ice across a large portion of Eastern Oklahoma. This thin layer of ice was responsible for numerous accidents during the morning commute across a large portion of Eastern Oklahoma. No widespread power outages were reported. Many area schools and some government offices were also closed due to the slick roads. |

Appendix 6 summarizes the previous occurrences of this hazard.

**3.2.6.5 Probability of Future Events** Meteorological conditions have not changed so future events should occur at the same probability as the previous events. An estimate of future occurrences is shown in the Likelihood Rating field in the Hazard Summary Table in Appendix 6.

**3.2.6.6 Vulnerability and Impact** The City of Skiatook and Osage and Tulsa Counties are affected periodically by heavy snow and ice that cause damage. Trees and power lines fall due to the weight of ice and snow causing damage to their surroundings as well as blocking streets and roads. Icy roads cause accident rates to increase and impair the ability for emergency vehicles to respond which can result in more injuries and a higher loss of life.

Winter storms can range from accumulating snow and/or ice over just a few hours to blizzard conditions with blinding wind-driven snow that can last several days. The aftermath from a damaging winter storm can continue to impact a region for weeks and even months. Economic losses can occur to livestock producers and any business in the affected areas. Water systems being shut down or frozen can disrupt social services, schools, homes, and businesses. Carbon monoxide poisoning is always a possibility as homeowners and businesses use alternative heat sources to keep warm. Personal health can be affected in a variety of ways including mental and physical stress, frostbite or related injuries and inability to travel for care.

Cold waves pose a variety of threats to individuals and communities. The list below summarizes some of the most common impacts of cold waves.

- Costs and losses to livestock producers
    - Loss of livestock due to exposure
    - Greater mortality due to Increased vulnerability to disease
    - Increased feed costs
    - Reduced milk production
    - Cost of supplemental water for livestock if onsite ponds and streams are frozen
    - Machinery and farm vehicles that will not operate in cold weather
- Urban, residential, and commercial impacts
    - Availability of water for municipal use due to frozen and burst water lines
    - Homes with alternative energy sources
    - House fires from overburdened chimneys
    - Carbon monoxide poisoning from exhaust produced by heaters and generators
    - Vehicles that will not operate in cold weather
    - Cost of keeping transportation lines clear of ice and snow
- Health
    - Mental and physical stress in the form of "cabin fever"
    - Frostbite and hypothermia
    - Disruption of services
    - Government offices and schools closed
    - Garbage collection halted
- General economic effects
    - Revenue loss from lost production in business and industry
    - Negative impact of economic multipliers
    - Higher energy costs
    - Damage to animal species
    - Loss of wildlife, particularly if cold wave is coupled with prolonged snow cover that makes sources of food unavailable
    - Greater mortality due to Increased vulnerability to disease
    - Loss of trees and woody shrubs that are not hardy enough to survive prolonged exposure to cold temperatures, especially when soil moisture is low
    - Pollution from increased energy production

A major winter storm can be lethal. Preparing for cold weather conditions and responding to them effectively can reduce the dangers caused by winter storms.

Mitigating ice storm damage must be a joint effort by City and County workers, private land owners, and corporate entities. City workers simply do not have the available resources to maintain all the wire systems in the City. Ordinances that require the maintenance of trees and shrubs surrounding the area of electric and telephone wires are a first step toward mitigating ice storm damage. Aggressive public education programs must be in place to alert people to the possible damages to their and other's property. Large corporations such as Cox Cable do not have the man-power or financial resources to maintain all their lines. Regular trimming by all levels of participants can substantially reduce the damage caused by future episodes.

## 3.2.7 Heat Hazard

**3.2.7.1 Description** Temperatures that hover 10 degrees or more above the average high temperature for the region 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.

**3.2.7.2 Location** The location of this hazard is uniform over the entire City area. No area of the City is more of less at risk from the heat hazard than another.

**3.2.7.3 Extent** The heat index is a measure of the severity of the heat hazard. This index is designed to indicate how the heat and humidity in the air combine to make individuals feel. It relates index ranges with specific heat disorders. The City of Skiatook can experience index reading into the heat stroke range. Higher humidity plus higher temperatures often combine to make us feel a superficial temperature that is higher than the actual air temperature. The City of Skiatook considers any reading 105 degrees and hotter to be a major severity.

**Table 3.14 Heat Index**

| 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 |

| HI | Possible Heat Disorder: |
|---|---|
| 80°F - 90°F | Fatigue possible with prolonged exposure and physical activity. |
| 90°F - 105°F | Sunstroke, heat cramps and heat exhaustion possible. |
| 105°F - 130°F | Sunstroke, heat cramps, and heat exhaustion likely, and heat stroke possible. |
| **130°F or greater** | **Heat stroke highly likely with continued exposure.** |

**3.2.7.4 Previous Occurrences** According to the National Climatic Data Center, 2 deaths resulted from 6 extreme heat episodes from 2000 to 2012 in Tulsa and Osage Counties. No structural damage is recorded for the heat hazard for neither the City of Skiatook nor Tulsa and Osage Counties.

Appendix 6 summarizes the previous occurrences of this hazard.

**3.2.7.5 Probability of Future Events** Meteorological conditions have not changed so future events should occur at the same probability as the previous events. An estimate of future occurrences is shown in the Likelihood Rating field in the Hazard Summary Table in Appendix 6.

**3.2.7.6 Vulnerability and Impact** In a normal year, approximately 175 Americans die from extreme heat. Between 1936 and 1975, nearly 20,000 people succumbed to the effects of heat and solar radiation. From 1979-1999, excessive heat exposure caused 8,015 deaths in the United States. On average approximately 400 people die each year from exposure to heat. In Oklahoma, July is generally the hottest month of the year, followed by August.

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.

Most heat disorders occur because the victim has been overexposed to heat or has over exercised for his or her age and physical condition. Other conditions that can induce heat-related illnesses include stagnant atmospheric conditions and poor air quality. 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. Excessively dry and hot conditions can provoke dust storms and low visibility. Drought occurs when a long period passes without substantial rainfall. A heat wave combined with a drought is a very dangerous situation.

Extreme heat can have a serious economic impact on a community. Increased demand for water and electricity may result in shortages of resources. Moreover, damage to food supplies may occur as the heat damages agricultural crops and livestock are susceptible to heat related injuries or death.

Young children, elderly people, and those who are sick or overweight are more likely to become victims to extreme heat. Other conditions that can limit the ability to regulate temperature include fever, dehydration, heart disease, mental illness, poor circulation, sunburn, prescription drug use, and alcohol use. Another segment of the population at risk is those whose jobs consist of strenuous labor outside. When temperatures reach 90 degrees and above, people and animals are more likely to suffer sunstroke, heat cramps, and heat exhaustion.

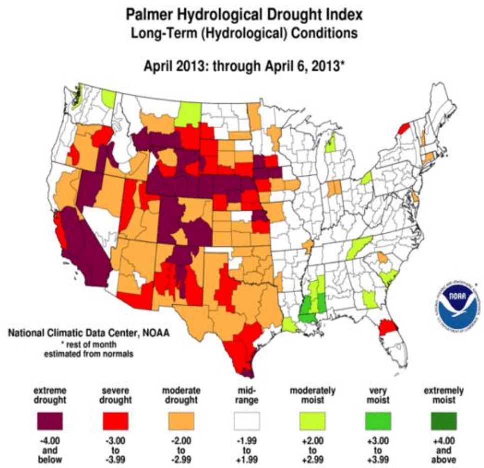
Another extreme heat hazard is air pollution. During summer months, consistent high temperatures and stagnant airflow patterns cause a build-up of hydrocarbons to form a dome-like ceiling over large cities. The abundance of factories, automobiles, lawn equipment, and other internal combustion machines emit high particulate matter that builds and worsens with the increase in temperature. The resulting stagnant, dirty, and toxic air does not move away until a weather front arrives to disperse it. When the particulate matter reaches a pre-determined level, an ozone alert is issued for the Tulsa area and implementation measures are undertaken to reduce the use of cars and the output of the offending chemicals. Ozone alerts usually include advisories for the elderly and those with breathing difficulties to stay indoors in air-conditioned environments.

## 3.2.8 Drought Hazard

**3.2.8.1 Description** A drought is a period of drier-than-normal conditions that results in water-related problems. Precipitation (rain or snow) falls in uneven patterns across the country. When no rain or only a small amount of rain falls, soils can dry out and plants can 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 fall, and the depth to water in wells decreases. 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. A period of below-normal rainfall does not necessarily result in drought conditions. Some areas of the United States are more likely to have droughts than other areas. In humid, or wet, regions, a drought of a few weeks is quickly reflected in a decrease in soil moisture and in declining flow in streams. In arid, or dry, regions, such as Oklahoma, people rely on ground water and water in reservoirs to supply their needs. They are protected from short-term droughts, but may have severe problems during long dry periods because they may have no other water source if wells or reservoirs go dry.

**3.2.8.2 Location** The location of this hazard is uniform over the entire City area. No area of the City is more of less at risk from the drought hazard than another.

**3.2.8.3 Extent** The Palmer Index was developed in the 1960s and uses temperature and rainfall information in a formula to determine dryness. It has become the semi-official drought severity index. The Palmer Index is most effective in determining long term drought; a matter of several months. It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, minus 2 is moderate drought, minus 3 is severe drought, and minus 4 is extreme drought. NOAA has used this index to classify the drought hazard through the continental United States. As of April 2013, the City of Skiatook and northeast Oklahoma was in the moderate range of the drought hazard's severity. The national map showing the April 2013 Palmer Drought Index is shown below.




Based on the intensity scale above the City of Skiatook considers a reading of -2 and above to be a minor severity and a reading of -3 and below to be a major severity.

3.2.8.4 One of the greatest natural disasters in U.S. history and the most severe and devastating to Oklahoma was the decade-long drought in the 1930s that has become known as the Dust Bowl. Reaching its peak from 1935 through 1938, high temperatures and low rainfall combined to destroy crops and livestock. High winds literally blew the land away, causing massive soil erosion. Hundreds of small rural communities were ruined and about 800,000 people were displaced. The total expenditure by the American Red Cross for drought relief in Oklahoma in 1930-1931 was the third largest ever in the nation.

In northeastern Oklahoma, an area referred to as "Green Country" for its plush forests and preponderance of lakes, streams and waterways, is not immune to the growing spread of drought. According to the National Climatic Data Center, there have been 16 events in Tulsa County from 2000 through 2012.

**Table 3-15: History of Drought Events in Tulsa and Osage Counties from 2000 to January 2013**

| Date | Episode Narrative (Event) |
|---|---|
| 11/1/2005<br>11/30/2005 | |
| 12/1/2005<br>12/31/2005 | The prolonged absence of significant rainfall through December resulted in the continuance of severe drought conditions (D2) across most of eastern Oklahoma with exceptional drought conditions (D4) developing into the southeastern portion of the state. During the month, some portions of northeastern Oklahoma received about 3/4 of an inch of precipitation while other areas received generally less than 1/2 inch. Precipitation was only 17 percent of normal in southeastern Oklahoma making it the driest October-December period since 1921. Northeastern Oklahoma fared slightly better during that 90 day period receiving about 27 percent of the normal precipitation for that period. Annual precipitation for eastern Oklahoma ranged from around 55 |

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| | percent of normal average precipitation in the southeastern portion of the state to about 75 percent of normal average annual precipitation in the northeastern portion of the state. Stream flow was well below normal for tributaries of the Red River and Arkansas River Basins. All of the major reservoirs across eastern Oklahoma were below 70 percent of their normal pools with Hugo, Eufaula, and Beaver Reservoirs below 60 percent of their normal pools. A burn ban remained in place across the entire state through December. |
| 1/1/2006<br>1/31/2006 | Several rainfall events during the month brought near normal to above normal precipitation to portions of southeastern Oklahoma while northeastern Oklahoma received another month of below normal precipitation for January. Rainfall amounts in some locations in southeastern Oklahoma reached three to four inches for the month. A widespread rainfall event on the 28th and 29th produced 24-hour rainfall amounts of one to two inches, which was the first time in about five months that more than an inch of rain was observed in southeastern Oklahoma. Despite this needed rainfall, northeastern Oklahoma remained in severe drought (D2) to extreme drought (D3) conditions and southeastern Oklahoma remained in exceptional drought (D4) conditions during the month due to the rainfall deficits that the area experienced in the long-term. Reservoirs in eastern Oklahoma remained below 70 percent of their normal pools during January. A burn ban that was issued for the region in mid November remained in effect through the month. |
| 5/1/2006<br>5/10/2006 | Long term drought conditions in eastern Oklahoma were in the severe drought (D2) category at the beginning of May 2006 but had improved into the moderate drought (D1) category by the 10th of the month as a result of several widespread, heavy rain events that occurred early in the month. Moderate drought (D1) conditions continued throughout the remainder of May 2006. Some of the heavier rainfall amounts recorded during the month included 7.79 inches in Antlers OK, 6.56 inches in Tahlequah OK, 5.92 inches in Westville OK, 5.47 inches at Spavinaw Dam OK, 5.33 inches in Jay OK, 5.31 inches in Scipio OK, and 5.04 inches in Wilburton OK. Normal precipitation for eastern Oklahoma for the month of May averages from about 4.4 inches in Washington County to about 6.4 inches in Le Flore County. By the end of the month, all major reservoirs were near their normal pools except Eufaula and Beaver, which were just below 80 percent of their normal pools. |
| 9/1/2006<br>9/30/2006 | Widespread heavy rainfall was again lacking across much of eastern Oklahoma during this month, especially the southern portion of the state and to the northwest of Tulsa. Normal precipitation for the month ranges from about four inches to about five and a half. Large sections of eastern Oklahoma received less than 50 percent of normal rainfall amounts. Areas of southeastern Oklahoma have received about 60 percent of normal precipitation over the past 12 months. Severe drought conditions (D2) remained in place during September to the south of the Arkansas River while extreme drought conditions (D3) remained generally south of the Canadian River. Severe drought conditions (D2) had also developed over Osage and Pawnee Counties. |
| 7/1/2011<br>7/31/2011 | A persistent subtropical ridge of high pressure over the south central United States during the month of July resulted in prolonged hot and dry weather across the region. There were a few days on which isolated to widely scattered thunderstorms occurred but these were far too few to have much effect. Much of eastern Oklahoma received precipitation amounts during the month that were well below average and some locations only received a few hundredths of an inch of rainfall during the entire month. As a result, severe to extreme drought conditions had redeveloped across the majority of the region by month's end. Monetary damages as a result of this drought were not available. |
| 8/1/2011<br>8/31/2011 | A persistent subtropical ridge of high pressure continued to dominate the weather across the south central United States during much of August, resulting in prolonged hot and dry weather across the region. As a result, drought conditions worsened during the early |

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| | half of the month across eastern Oklahoma with Okfuskee, Creek, and Pawnee Counties slipping into exceptional drought conditions while severe drought conditions developed across the remainder of the region with the exception of the far northeast part of the state. Some relief was felt by month's end across northeastern Oklahoma as several precipitation events that affected that region resulted in a lot of the area ultimately receiving near to slightly above normal precipitation amounts for the month. Being that August is typically one of the driest months of the year in this region of the country, the effects of the long-term drought were only subtly improved by this rainfall. Monetary damages as a result of the drought were not available. |
| 9/1/2011<br>9/30/2011 | A persistent subtropical ridge of high pressure continued to dominate the weather across the south central United States during September, resulting in prolonged hot and dry weather across the region. Most of eastern Oklahoma received below normal precipitation for the month. Large areas of Choctaw and Pushmataha Counties in the southeastern portion of the state received as little as 5 to 25 percent of the normal average precipitation for the month. As a result, exceptional drought conditions continued across Okfuskee, Creek, and Pawnee Counties and developed across Choctaw County. Extreme drought conditions persisted across much of the remainder of southeastern Oklahoma while severe drought conditions continued across the northeastern portion of the state during September. Monetary damage estimates resulting from the drought were not available. |
| 10/01/2011<br>10/31/2011 | Several precipitation events during the month produced beneficial rainfall across portions of east-central Oklahoma but given the long-term shortage of precipitation across the area, it had little impact on the long-term drought. The northeastern and southeastern portion of the state experienced another month of below normal precipitation with some areas receiving between 10 and 25 percent of normal precipitation, so drought conditions in those regions persisted or even worsened in some cases. Severe to extreme drought conditions continued across all of northeastern and east-central Oklahoma while southeastern Oklahoma continued to experience exceptional drought conditions in October. Monetary damage estimates resulting from the drought were not available. |
| 11/01/2011<br>11/30/2011 | Several precipitation events resulted in widespread, significant rainfall across much of eastern Oklahoma during the month with much of the region receiving between four and eight inches of precipitation. Rainfall totals for the month were from about 2.50 inches across portions of Osage and Pawnee Counties (about 75 percent of normal rainfall for the month) to 15 to 20 inches across southern Le Flore County (from 200 to 300 percent of normal rainfall for the month). As a result of this rainfall, drought conditions across much of eastern Oklahoma improved during the month with the exception of Osage, Pawnee, Washington, and Nowata Counties where severe drought conditions persisted. Monetary damage estimates resulting from the drought were not available. |
| 07/01/2012<br>07/30/2012 | Very hot temperatures combined with a lack of appreciable rainfall resulted in significantly worsening drought conditions across all of eastern Oklahoma during the month of July. Much of northeastern Oklahoma received less than 25 percent of average precipitation for the month while much of the southeastern portion of the state received less than 50 percent of average monthly precipitation amounts. By the end of the month, much of eastern Oklahoma was considered to be in extreme drought (D3). The USDA declared all counties in eastern Oklahoma disaster areas due to the drought. Monetary damage estimates resulting from the drought were not available. |
| 08/01/2012<br>08/31/2012 | Rainfall was typically sporadic for August across eastern Oklahoma. Much of the region received below average rainfall for the month with areas north of I-44 only receiving between 10 and 25 percent of normal rainfall. Given the prolonged period of unusually dry weather that the region has experienced, the precipitation that was received in August 2012 did little to improve the drought, which had slipped into the extreme (D3) |

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| | category across much of eastern Oklahoma early in the month. Much of the area north of I-40 had moved into the exceptional drought (D4) category by the middle of the month. Monetary damage estimates resulting from the drought were not available. |
| 09/01/2012<br>09/31/2012 | Rainfall was once again sporadic across eastern Oklahoma during September 2012 with hot and dry weather dominating the region throughout much of the month. A few cold frontal passages did yield some much needed rainfall but it was too spotty to make a real difference in the ongoing drought conditions across the area. Despite a few locations actually receiving slightly above normal precipitation during the month, the area as a whole received between 25 and 75 percent of normal. Much of Osage and Pawnee Counties received less than 25 percent of normal average rainfall for the month. Exceptional (D4) drought conditions persisted during the month across much of northeastern Oklahoma along and north of I-44 while extreme (D3) drought conditions persisted across the remainder of eastern Oklahoma. Monetary damage estimates resulting from the drought were not available. |
| 10/01/2012<br>10/31/2012 | Rainfall during October 2012 was once again below normal across much of eastern Oklahoma. The exception was across northern Tulsa County and much of Rogers County, where thunderstorms brought locally heavy rainfall to those areas during the middle of the month. Most of eastern Oklahoma received between 25 and 75 percent of normal rainfall for the month, while the east-central portion of the state received less than 25 percent of normal rainfall for that region. Severe (D2) to extreme (D3) drought conditions persisted across all of eastern Oklahoma during the month while exceptional (D4) drought conditions persisted across much of Pawnee, Osage, Washington, and Nowata Counties. Damage estimates resulting from the drought were not available. |
| 11/01/2012<br>11/30/2012 | November 2012 was extremely dry across all of eastern Oklahoma. In fact, the entire region received less than 50 percent of its normal average precipitation for the month with much of the region south of I-44 receiving less than 25 percent of normal precipitation. Portions of far southeastern Oklahoma only received about 5 percent of normal precipitation for the month. For the southeastern climate region of the state, November 2012 was the second driest on record and rainfall received during the Autumn months also went down as the second driest Autumn period on record. As a result of this continued dry weather, most of eastern Oklahoma remained in extreme (D3) drought conditions while exceptional (D4) drought conditions persisted across much of Pawnee, Osage, Washington, and Creek Counties. Monetary damage estimates resulting from the drought were not available. |
| 12/01/2012<br>12/31/2012 | Precipitation over eastern Oklahoma continued below normal during December 2012, ranging from 0.25 inches near the Kansas/Missouri border to nearly four inches locally in southeastern Oklahoma. Much of southeastern Oklahoma received between 75 and 90 percent of normal precipitation while much of northeastern Oklahoma north of I-44 only received between 10 and 25 percent of normal precipitation. As a result of this continued dry weather, most of eastern Oklahoma remained in extreme drought (D3) conditions while exceptional drought (D4) conditions continued across much of Osage, Pawnee, Washington, and Creek Counties. Monetary damage estimates resulting from the drought were not available. |
| 01/01/2013<br>01/31/2013 | Several storm systems brought generally light precipitation to eastern Oklahoma during early to mid-January 2013. Toward month's end, a strong storm system moved across the region producing one half to more than three inches of rain as widespread showers and thunderstorms tracked across the area. As a result of this rain event on the 29th, portions of northeastern Oklahoma ended up receiving near normal to well above normal monthly precipitation while much of southeastern Oklahoma received well below normal precipitation. Due to the persistent dry pattern the area had experienced for much of 2012, the rainfall during January 2013 generally resulted in only a very slight improvement in the overall drought conditions over eastern Oklahoma. Much of the |

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| | region remained in extreme drought (D3) conditions during the month while Osage, Pawnee, Washington, Creek, and Nowata Counties remained in exceptional drought (D4) conditions. Monetary damage estimates resulting from the drought were not available. |

Appendix 6 summarizes the previous occurrences of this hazard.

**3.2.8.5 Probability of Future Events** Meteorological conditions have not changed so future events should occur at the same probability as the previous events. An estimate of future occurrences is shown in the Likelihood Rating field in the Hazard Summary Table in Appendix 6.

**3.2.8.6 Vulnerability and Impact** Lack of fresh water is damaging to livestock and crops. During the summer months, temperatures in the City of Skiatook can easily reach over 100 degrees Fahrenheit. Often these high temperatures will persist for many days and possibly for weeks. When these high temperatures coincide with times of little or no rain, drought can occur.

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. A period of below-normal rainfall does not necessarily result in drought conditions. Some areas of the United States are more likely to have droughts than other areas. In humid, or wet, regions, a drought of a few weeks is quickly reflected in a decrease in soil moisture and in declining flow in streams. In arid, or dry, regions, such as Oklahoma, people rely on ground water and water in reservoirs to supply their needs. They are protected from short-term droughts, but may have severe problems during long dry periods because they may have no other water source if wells or reservoirs go dry. Drought conditions increase fire hazards and reduces water supply.

Heat and drought also effect local workforce capabilities. Workers exposed to these elements must be monitored for heat exhaustion and heat stroke. Another problem associated with drought is stale water. Areas of stale water are known to produce deadly bacteria.

Drought impacts in a number of ways, spanning all regions, and is capable of affecting the economy as well as the environment. Specific impacts can include

- reduced crop, rangeland;
- increased livestock and wildlife mortality rates;
- reduced income for farmers and agribusiness;
- increased fire hazard;
- reduced water supplies for municipal/industrial, agricultural and power uses;
- damage to fish and wildlife habitat;
- increased consumer prices for food;
- reduced tourism and recreational activities;
- unemployment;
- reduced tax revenues because of reduced expenditures; and
- foreclosures on bank loans to farmers and businesses.

The most direct impact of drought is economic rather than loss of life or immediate destruction of property. While drought impacts in Oklahoma are numerous and often dependent upon the timing and length of individual drought episodes, the greatest impacts of drought are usually experienced in the agricultural community. In addition to the obvious direct losses of both crop and livestock production due to a lack of surface and subsurface water, drought is frequently associated with increases in insect infestations, plant disease, and wind erosion.

Of course, one of the most significant potential impacts of drought relates to public water supply. In metropolitan areas, including the City of Skiatook, there may be a need to stop washing cars, cease watering the grass and take other water conservation steps. In smaller communities, reduced flow in rivers and streams can have a significant effect on the water amount allowed for municipal use. Hot weather during the summer increases demand and subsequent use of supplies, as well as evaporation. In turn, increased water demand can stress many smaller and/or antiquated delivery and treatment facilities to the point of collapse. Prolonged drought has a much greater impact on rural communities, which usually rely on relatively small watersheds and are especially vulnerable during such periods.

Water shortages can also affect firefighting capabilities in both urban and rural settings through reduced water flows and pressures. Most droughts dramatically increase the danger of fires on wild land. Although drought can have serious impact during winter months, it is most often associated with extreme heat. Wildlife, pets, livestock, crops, and humans are vulnerable to the high heat that can accompany drought.

## 3.2.9 Expansive Soils Hazard

**3.2.9.1Description** Soils and soft rock that tend to swell or shrink due to changes in moisture content are commonly known as expansive soils. 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 soils are most prevalent in regions of moderate to high precipitation, where prolonged periods of drought are followed by long periods of rainfall.

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.

Expansive soils can be recognized either by visual inspection in the field or by conducting laboratory analysis. Shales, clay shales, and residual soils containing smectite often have a characteristic "popcorn" texture, especially in semiarid areas.

**3.2.9.2 Location** The Natural Resources Conservation Service (NRCS) has identified the soils in Osage and Tulsa Counties. The expansive tendency of a soil is a function of its shrink-swell potential. The locations of these types of soils are shown on Figure 3-4 in Appendix 1.

The soil data for Tulsa County is from the Soil Survey Geographic (SSURGO) data base. The soil data for Osage County is from the State Soil Geographic (STATSGO) data base. Interpretation of soil properties are displayed differently for different soil geographic data bases.

The SSURGO data base provides the most detailed level of information, and is displayed with vector GIS data; each soil group is an individual feature with individual attribute data. The STATSGO data base is designed for multi-county resource planning, and is not detailed enough for interpretations at the county level. The soil maps for STATSGO are compiled by generalizing the more detailed SSURGO soil maps. These STATSGO data base is raster GIS data; each map unit is assigned an attribute value by sampling areas on more detailed maps and expanding the data statistically to characterize all map units. This is the reason for the change in soil appearance between Tulsa and Osage counties. Only Tulsa County will be used in any spatial analysis.

**3.2.9.3 Extent** The NRCS sorts this shrink-swell potential soil property into four categories; very low, low, moderate, high and very high. This is the range of magnitude of an expansive soils hazard. Shrink-swell potential categories are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The categories are very low, a change of less than 1%; low, 1 to 3%; moderate, 3 to 6%; high, 6 to 9%; and very high, greater than 9%. Map Number 8 in Appendix 1 illustrates the scattered areas within the community that have a high shrink-swell potential. Approximately 40% of the City falls into this category. . There is little risk of fatalities or injuries unless the soil situation caused a partial or full collapse of a building. The City of Skiatook considers moderate category to be a minor severity and the high and very high categories to be a major severity.

**3.2.9.4 Previous Occurrences** No information is available for the Skiatook area on how expansive soils have damaged structures.

**3.2.9.5 Probability of Future Events** The soils' properties obviously do not change so future occurrences of soils expanding and contracting will continue. An estimate of future occurrences is shown in the Likelihood Rating field in the Hazard Summary Table in Appendix 6.

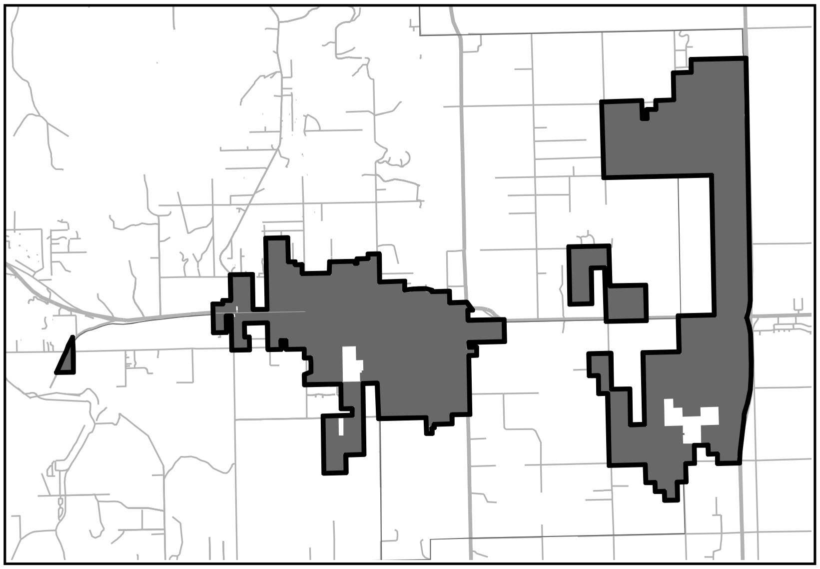
**3.2.9.6 Vulnerability and Impact** Vulnerabilities include structures with foundations such as homes and businesses, concrete slabs in driveways and sidewalks, and parking lots. Asphalt surfaces such as highways and runways could be affected. These structures are affected because expansive soils cause uneven settlement of the soil under the structures' foundations. This causes cracking and damage to the foundation and structure above the foundation, such as a building's wall and a road's pavement. Some areas in Skiatook are at higher risk to expansive soils than others as illustrated in Figure 3-4, but a dollar amount for damages is difficult to ascertain or assign to this particular hazard since very little incident record keeping is done. Although no records exist concerning damage to residential and commercial buildings from expansive soils, some damages due to this may have occurred.

## 3.2.10 Wildfire Hazard

**3.2.10.1 Description** Wildfires are defined as the uncontrolled burning of highly vegetated area, usually in forests and wooded areas. Wildfire has been a natural part of Skiatook and Northeast Oklahoma's ecosystem. Long before the Skiatook area was settled, wildfires ran across the prairies, replenishing nutrients to the soils and controlling invasive plant species. As suburban development has occurred, however, the interaction of wildfire and the environment has changed. Now, people and structures are at risk from flames spreading across the grasslands and wooded areas of Skiatook. Today, the developed areas of Skiatook lie alongside wild lands, creating an urban-wildland interface that is at risk of uncontrolled burns. Skiatook does not have any significant wooded areas, but grass fires in the undeveloped areas pose a problem every year.

Weather plays a major role in the birth, growth and death of a wildfire. Drought leads to extremely favorable conditions for wildfires, 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.

**3.2.10.2 Location** Skiatook is characterized by low residential densities and the presence of wildland-urban interface areas throughout the community. The Skiatook Fire Department has determined that all locations throughout the City area are susceptible to grass fires. The degree of susceptibility is dependent upon seasonal environmental factors such as current and antecedent weather (including wind velocity and humidity), fuel types, and both live and dead moisture. Changes in these factors raise or lower the fire danger rating throughout the community. The urban interface is where the main risk and vulnerability exits. To combat the wild land urban fires the Skiatook Fire Department implemented the Community Wild Fire Protection Program under the guidance of NFPA and the Oklahoma State Forestry Division. The Skiatook Fire/EMS is staffed with 18 fulltime firefighters that are also State licensed EMT's, supplemented with an additional reserve force of 25 volunteers. The following chart is a display of the urban interface location in black, around the four incorporated areas of the City which are shown in gray.



**Urban Interface**

**3.2.10.3 Extent** The City of Skiatook and surrounding Tulsa and Osage Counties 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, the Skiatook area 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 magnitude of the fire hazard in Skiatook is “Highly likely”, based upon the likelihood rating in Appendix 6. During 2011 in the Skiatook response area, there were 128 Wild Land urban interface fires. In excess of 6,000 acres were burned.

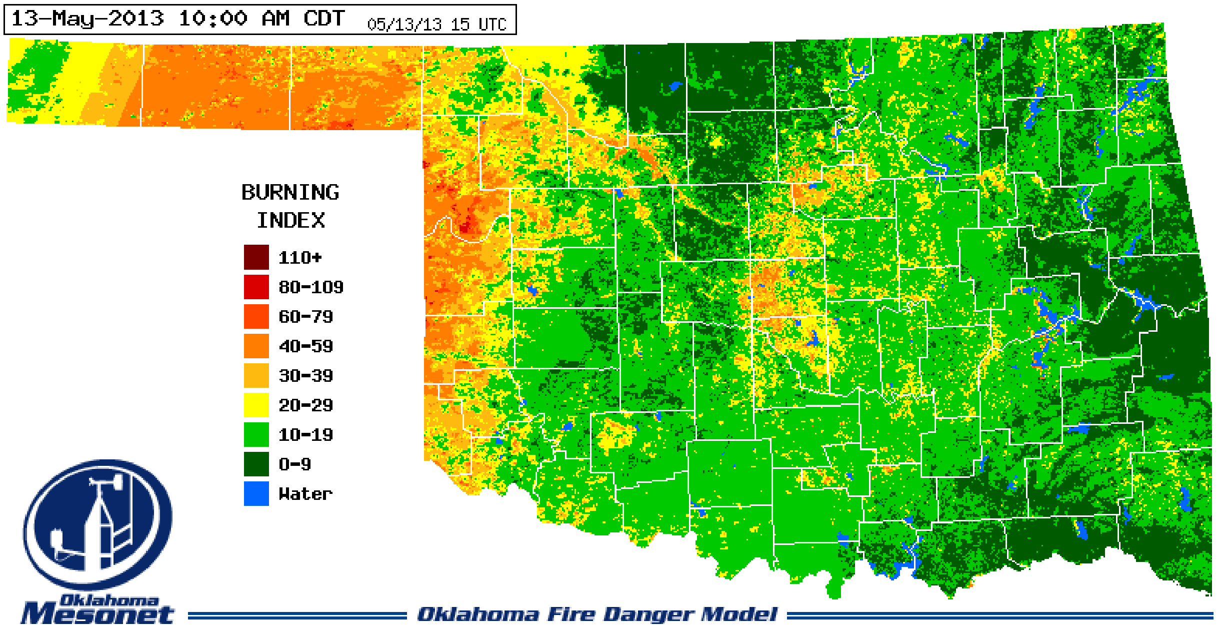
## The Keetch-Byram Drought Index (KBDI) *fire danger rating system*

| | |
|---|---|
| 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)<br>COLOR<br>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. |
| | | Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and |

| | | |
|---|---|---|
| CLASS 2: Moderate Danger (M)<br>COLOR CODE: B**lue** | fires start easily and spread at a moderate rate | 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)<br>COLOR<br>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)<br>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)<br>COLOR<br>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 2011-2012 when numerous wildfires broke out in Northeast Oklahoma, 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.




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 currently in much of Western Oklahoma suggests 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 Northeast 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 of Oklahoma. 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<br>(BI <40) | <100 | Fires can generally be attacked at the head or flanks by persons using hand tools.<br><br>Hand line should hold the fire. |
| 4-8<br>(BI=40-80) | 100-500 | Fires are too intense for direct attack on the head by persons using hand tools.<br><br>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<br>.<br>Control efforts at the fire head will probably be ineffective. |
| > 11 (BI > 110) | > 1,000 | Crowning, spotting, and major fire runs are probable<br>.<br>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). While many of these locations are in western Oklahoma, the Skiatook area also experiences times where wind speeds are higher and humidity is lower, contributing to more favorable burning conditions.

The City of Skiatook 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.

**3.2.10.4 Previous Occurrences** During 2011, the Skiatook Fire Department responded to 668 requests from 911 calls. Of those responses, 128 were for wild fires, 11 were for residential structures (50% or greater loss), 26 fires confined to area of origin (i.e., fire on stove, clothes dryer, home heat source producing smoke, etc.) and4 hazmat responses, two of which resulted in a fatality (driver of vehicle transport). A number of these responses were actually for multiple categories, such as car fires with hazardous material spills or for structure fires within a grass fire.

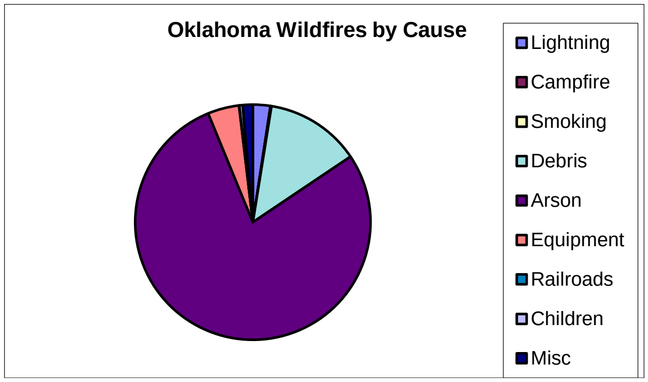
Appendix 6 summarizes the previous occurrences of this hazard.

**3.2.10.5 Probability of Future Events** The Skiatook Fire Department is continuing with its campaign to educating the public on the causes and effects of fires. However, all fires cannot be prevented so this hazard will continue. An estimate of future occurrences is shown in the Likelihood Rating field in the Hazard Summary Table in Appendix 6.

**3.2.10.6 Vulnerability and Impact** Periods of drought, dry conditions, high temperatures, and low humidity set the stage for wildfires. Areas along railroads and people whose homes are in woodland settings (especially cedar woodlands) in rural areas have an increased risk of wildfire. The sparsely populated tall grassed range lands, are capable of experiencing large sweeping fires. Ironically, fire suppression is capable of creating larger fire hazards, because live and dead vegetation is allowed to accumulate in areas where fire has been excluded. The especially large accumulations of deadfall throughout the Osage and Tulsa Counties resulting from the severe ice storm of 2007, is a concern to firefighters.

People start more than four out of every five wildfires, usually as debris burns, arson, or carelessness. Lightning strikes are another leading cause of wildfires. Other sources of ignition include railroads, catalytic converters on automobiles, and spontaneous ignition of hay bales. Wildfires that do not encounter a human population are difficult to calculate damages. Homes and businesses that are burned in naturally occurring fires are usually privately owned. When wild lands are destroyed by fire, the resulting erosion can cause heavy silting of streams, rivers, and reservoirs. Serious damage to aquatic life, irrigation, and power production then occurs.

This vulnerability to wildfire results in over 18,000 wildfires in the State each year. These fires 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 limited opportunity for mitigation through public awareness and education.




Arson is also a large proportion of the percentage of wildfires. Based on the above data, Oklahoma has a high probability of future hazard events. On average, fires kill nearly 5,500 Americans each year. Over 30,000 people are injured in fires annually. In the United States, someone dies in a fire every 40 minutes. Most often, victims are children or the elderly. Nearly 25 percent of the fires that kill young children are started by children playing with fire. Approximately 1,300 senior citizens die in fires annually. Approximately three-quarters of all fire fatalities occur in residential dwellings. Each year in the US, fire causes over $2 billion worth of damage to homes.

## 3.2.11 Earthquake Hazard

**3.2.11.1 Description** An earthquake is a sudden, rapid shaking of the Earth caused by the breaking and shifting of rock beneath the Earth's surface. For hundreds of millions of years, the forces of plate tectonics have shaped the Earth as the huge plates that form the Earth's surface move slowly over, under, and past each other. Sometimes the movement is gradual. At other times, the plates are locked together, unable to release the accumulating energy. When the accumulated energy grows strong enough, the plates break free causing the ground to shake. Most earthquakes occur at the boundaries where the plates meet; however, some earthquakes occur in the middle of plates. Earthquakes strike suddenly, without warning. Earthquakes can occur at any time of the year and at any time of the day or night. On a yearly basis, 70 to 75 damaging earthquakes occur throughout the world. Estimates of losses from a future earthquake in the United States approach $200 billion. There are 45 states and territories in the United States at moderate to very high risk from earthquakes, and they are located in every region of the country. California experiences the most frequent damaging earthquakes; however, Alaska experiences the greatest number of large earthquakes—most located in uninhabited areas. The largest earthquakes felt in the United States were along the New Madrid Fault in Missouri, where a three-month long series of quakes from 1811 to 1812 included three quakes larger than a magnitude of 8 on the Richter scale. These earthquakes were felt over the entire Eastern United States, with Missouri, Tennessee, Kentucky, Indiana, Illinois, Ohio, Alabama, Arkansas, and Mississippi experiencing the strongest ground shaking.

**3.2.11.2 Location** The faults most likely to affect Oklahoma are the New Madrid Fault, centered in the Missouri Bootheel region, and the Meers Fault, located in southwestern Oklahoma near Lawton. The area around the City of Skiatook is considered to be a part of the low intensity area of the New Madrid Fault in Missouri.

**3.2.11.3 Extent** The severity of an earthquake can be expressed in several ways. The magnitude of an earthquake, usually expressed by the *Richter Scale*, is a measure of the amplitude of the seismic waves. The Richter Scale, named after Dr. Charles F. Richter of the California Institute of Technology, is the best known scale for measuring the magnitude of earthquakes. The scale is logarithmic. An earthquake of magnitude 2 is the smallest quake normally felt by people. Earthquakes with a Richter value of 6 or more are commonly considered major; great earthquakes have magnitude of 8 or more on the Richter scale. A comparison of the Mercalli Scale and the Richter Scale is illustrated below.

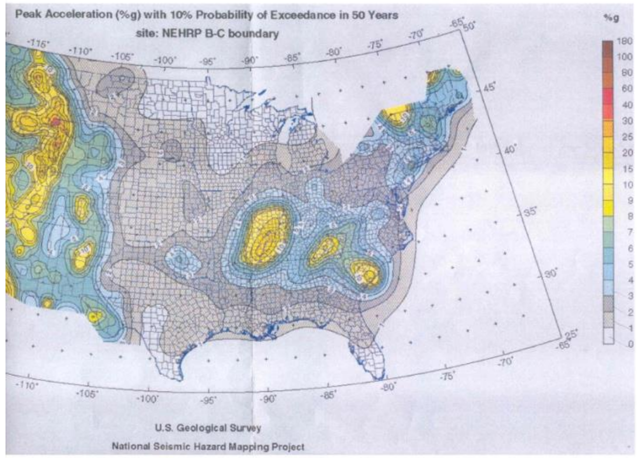
The City of Skiatook considers a reading of 5.4 and below on the Richter scale a minor severity and 5.5 and above to be a major severity.

**Table 3-17: Mercalli/Richter Earthquake Scale Comparison**

| Mercalli | Richter | 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 USGS National Seismic Hazard Mapping, shown below, shows Tulsa County in the 2%g (peak acceleration), 10% probability of exceedance in 50 years area. According to the FEMA 386-2, "Understanding Your Risks", Step 1; areas with 2%g peak acceleration or less have a relatively low seismic risk, and an earthquake risk assessment is not warranted. Earthquakes centered in the City of Skiatook area of Tulsa County are rare and the few events that have occurred in the County are largely unfelt. There has been no recorded damage caused by earthquakes in Tulsa County.




**3.2.11.4 Previous Occurrences** During the period of 1972-2008 approximately 2-6 earthquakes a year were recorded by the USGS National Earthquake Center in Oklahoma. Earthquake activity was generally scattered across the east-central part of Oklahoma. Beginning in 2008 through 2010 the rate of earthquakes began to climb with nearly 50 earthquakes recorded in 2009, with several big enough to be felt. This activity has continued with three significant earthquakes occurring in November 2011. The magnitude 4.7 and 5.6 earthquakes of November 5 and 6th and the 4.7 on November 8th, 2011, are the largest events recorded during this period of increased seismicity. Additionally, the magnitude 5.6 earthquake is the largest quake to hit Oklahoma in modern times. There is a possibility that these recent earthquakes occurred on the Wilzetta Fault, one of a series of small faults formed approximately 300 million years ago. The relationship between these recent earthquakes and this fault structure is still unknown and requires further investigation. The most likely major earthquake event that could impact the Skiatook area would probably originate in the New Madrid Fault Zone, which has been relatively quiet for 150 years. Seismologists estimate the probability of a 6 to 7 magnitude earthquake in the New Madrid area in the next 50 years to be higher than 90%. There have been no reported previous earthquake events, of significant magnitude, within the immediate vicinity of Skiatook.

**3.2.11.5 Probability of Future Events** The potential of future Earthquake events is a threat to Skiatook and most of Northeast Oklahoma is considered slight because of slow geological movement. However, since 2009, according to the Oklahoma Geological Survey, the frequency of earthquakes has temporarily increased in Oklahoma. These earthquakes do not appear to be inconsistent with what might be called normal seismicity for Oklahoma.

**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. Oklahoma is within the stable interior of the United States, averaging 58 minor earthquakes each year most of which are too small to be felt, that could change. Even small magnitude earthquakes can cause damage.

## 3.2.12 Hazardous Material Hazard

**3.2.12.1 Description** Hazardous materials are chemical substances that, if released or misused, can pose a threat to the environment or human health. These chemicals are used in industry, agriculture, medicine, research, and consumer goods. Hazardous materials come in the form of explosives, flammable and combustible substances, poisons, and radioactive materials. These substances are most often released as a result of transportation accidents or chemical accidents at plant sites.


**3.2.12.2 Location** The extent of the hazard is discussed on section 3.2.12.3. The location of Tier II facilities is shown in Map Number 8 in Appendix 1. The following table lists the Tier II facilities in and around the City of Skiatook.

**Table 3.10**
**SKIATOOK AREA TIER II FACILITIES**

| Name | Address |
|---|---|
| John Zink Co | 1501 John Zink Road |
| Air BP Skiatook Airport | S. Lombard Ln. |
| West Wild horse Tank Battery | NW/4 Sec 25 & SE/4 Section 24-T22N-R09E (East of Hominy, Ok) |
| Quarry Tank Battery | W/2 Section 19-T22N-R10E (East of Hominy) |
| Ferrellgas, D.B.A. Thermogas | 4605 W. Rogers |
| Synergy Gas of Tulsa--Skiatook | 14620 N. Peoria |

**3.2.12.3 Extent** The location and extent of the hazardous materials hazard in Skiatook are the fixed location sites (Tier II), include buildings or property where hazardous materials are manufactured or stored, and are regulated nationally under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) by the U.S. Environmental Protection Agency (EPA), and in Oklahoma by the Department of Environmental Quality. The City of Skiatook considers any hazardous material spill at a Tier II site or within any major transportation corridor to be a Major Severity.

**3.2.12.4 Previous Occurrences** The City Fire Department responded to 6 hazardous material spills and/or vapor releases in 2011, with 2 fatalities and an estimated damage in excess of $2,500,000. The City of Skiatook Fire Department developed its *Hazardous Materials Operations Level Plan.* The plan provides the Fire Department personnel with guidance and assistance in determining incident levels for response to hazardous materials incidents.

Appendix 6 summarizes the previous occurrences of this hazard.

**3.2.12.5 Probability of Future Events** Chemicals and hazardous materials are used throughout our society today, and will continue to be used in the future. And the City of Skiatook will continue to be exposed to this hazard. An estimate of future occurrences is shown in the Likelihood Rating field in the Hazard Summary Table in Appendix 6.

**3.2.12.6 Vulnerability and Impact** Many parts of the City are susceptible to hazardous materials events due to the high number of highly traveled roads and highways. Potential impacts include disruptions in transportation if highways are shut-down. Local businesses and residences can be affected by the roads being closed. Soils and waterways could become contaminated by spills, but are generally contained and cleaned up by professional response teams.

## 3.2.13 Dam Break Hazard

**3.2.13.1 Description** A dam is defined as a barrier constructed across a watercourse for the purpose of storage, control, or diversion of water. Dams typically are constructed of earth, rock, concrete, or mine tailings.

A dam failure is the collapse, breach, or other failure resulting in downstream flooding. Dam failures are primarily caused by hydrologic or structural deficiencies. A hydrologic deficiency is inadequate spillway capacity, caused by excessive runoff from heavy precipitation. Structural deficiencies include seepage, erosion, cracking, sliding, and overturning, mainly caused by the age of a dam and lack of maintenance.

The Oklahoma Water Resources Board coordinates the Oklahoma Dam Safety Program to ensure the safety of dams in the state. The program requires inspections every five years for low hazard structures and every three years for significant hazard structures. The program requires annual inspections for high hazard dams, so designated due to the presence of occupied dwellings immediately downstream. The dam on Skiatook Reservoir is designated as a low hazard structure by the OWRB.

**3.2.13.2 Location** The dam that could potentially impact the City of Skiatook is the dam on Skiatook Reservoir, located on Figure 3-5 in Appendix 1. The Skiatook Reservoir dam break inundation area was not available from the Corps of Engineers. The 500-year floodplain, downstream of the dam, was used to estimate the inundation area. The location of the 500-year floodplain through the City of Skiatook is also shown in Figure 3-6. A mitigation action to create a dam inundation area map will be recommended.

**3.2.13.3 Extent** The extent of the dam break hazard, the specific area of inundation from a failure of this dam is not available. For the purposes of this hazard's risk assessment, the 500-year floodplain downstream of this reservoir is the extent of this hazard and any form of dam break at the Skiatook Reservoir would be a major severity.

**3.2.13.4 Previous Occurrences** Skiatook has never been flooded by a failure of the Skiatook Reservoir dam. Its impact on the City would be similar to the flood hazard. Nationally, the most famous dam break event occurred at Johns City, PA. The South Fork Dam was built across Little Conemaugh River 14 miles upstream of Johns City. In 1889, South Fork Dam failed, and the resulting flood on the Little Conemaugh River caused over 2200 fatalities.

Skiatook Lake Dam: Source U.S. Army Corps of Engineers, Tulsa District

Appendix 6 summarizes the previous occurrences of this hazard.

**3.2.13.5 Probability of Future Events** Never say never, but continued dam inspection and proper maintenance should continue to keep this dam from failing. The Corps of Engineers is responsible inspection and maintenance of the dam. An estimate of future occurrences is shown in the Likelihood Rating field in the Hazard Summary Table in Appendix 6.

**3.2.13.6 Vulnerability and Impact** As long as dams exist so does the chance for failure. The Oklahoma Water Resources Board (OWRB) coordinates the Oklahoma Dam Safety Program to ensure the safety of more than 4,500 dams in the state that falls within its jurisdiction. 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 and flooding likely to occur if a dam were to fail.

Oklahoma has 184 high hazard dams and 87 significant hazard dams in the State that could possibly put people and structures at risk, but there is no recorded history of dam failure in the State of Oklahoma since 1950. Flooding potential exists if dam failure should occur at these high hazard dams. The dams in Osage County are high hazard due to the fact that they provide source water for public water systems. If a failure occurred, the potential exists to have thousands of people, pets, and livestock without water for a long period of time. Obviously the impact of this would be devastating and many people would have to relocate to carry on normal lives. Disruption to businesses and schools would be enormous. The economic impact of such an event would be impossible to predict.

The 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 be 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. To protect vulnerable populations the State of Oklahoma and the City of Skiatook, the following law is in place:

***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 Board.

# 3.3 Assessing Vulnerability: Identifying Assets

This section describes vulnerability in terms of the type and number of existing buildings and critical facilities in the hazard location. The vulnerability analysis utilizes FEMA publication 386-2, “Understanding Your Risks,” Step 3, in order to determine the building value and contents value to determine a total value per building at risk from each hazard.

The Tulsa County Assessor and Osage County Assessor classify properties into three (3) types; residential, commercial including office and industrial, and agricultural. A value for each property’s building was determined by the assessor, separate from the land value. The contents value was determined as a percentage of the building value, based on the Contents Value table in FEMA 386-2, Step 3.

The following table shows this information for all buildings in the City of Skiatook, and all the critical facilities. This table is referred to for all hazards that do not vary by location throughout the City.

**Table 3.11**
**TOTAL BUILDINGS IN COMMUNITY**

| Type | Number of Buildings/Improvements | Total Improvement Value ($) |
|---|---|---|
| Residential | 5,701 | $181,739,612 |
| Commercial | 332 | $ 63,771,538 |
| Agricultural | 812 | $ 39,322,313 |
| Critical Facilities | 26 | Exempt or No Data |
| Mobile Homes | 1 | $ 217,443 |

Flood hazards, dam break hazards, and hazards from expansive soils are the only three hazards that vary in magnitude in a pre-determined location. A hypothetical tornado was analyzed in the tornado hazard section. For these hazards, GIS models were used to determine the buildings at risk.

For each hazard, the assets (buildings) at risk from that hazard are tabularized in each hazard’s section, or referred to the above table. The total number of buildings at risk, the building type, the building value, its contents value, and the total value is shown. These tables follow the format in FEMA 386-2, worksheets 3a “Inventory Assets”.

This assessment also analyses the critical facilities at risk from each hazard. Where a hazard varies by location, these facilities’ locations are shown in relation to the hazard on a separate map. Information on mobile homes is not tracked by the Osage County Assessor; therefore, it is not included in the Skiatook vulnerability assessment.

Facilities that are classified as critical by the City of Skiatook are shown in the table below, and shown on Figure 1-7 in Appendix 1. These facilities are critical to the City in they provide public safety and emergency response services to a hazard event, they are necessary to preserve welfare and quality of life to the community, or in their propensity to gather groups of people.

**Table 3.12**
**SKIATOOK CRITICAL FACILITIES**

| TYPE | NAME |
|---|---|
| Government | Water Treatment Plant |
| Government | Wastewater Treatment Plant 1 |
| Government | Wastewater Treatment Plant 2 |
| Government | County Maintenance Facility |
| Government | Public Works |
| Government | Police Department |

| | |
|---|---|
| Government | Fire Department |
| Government | Post Office |
| Government | City Hall |
| School | Osage County Head Start |
| School | Intermediate and Elementary School |
| School | High School |
| School | K-1 School |
| School | Pre-School |
| Child Care | Cindy Care |
| Child Care | Essentially Kids, Inc |
| Child Care | Mart's Wee Care Daycare |
| Child Care | Sweet Things |
| Elderly | Senior Living Apartments |
| Elderly | Senior Citizen Housing |
| Elderly | Nursing Home |
| Church | Church of Christ |
| Church | First Assembly of God |
| Church | First Baptist Church |
| Church | Skiatook United Methodist Church |
| Church | Immanuel Baptist Church |

## 3.3.1 Flood Hazard

For the structures at risk from a flood hazard, those buildings on property intersecting the regulatory floodplain is summarized below.

**Table 3.13**
**TOTAL BUILDINGS IN REGULATORY FLOODPLAIN**

| **Type** | **Number of Properties** | **Total Improvement Value ($)** |
|---|---|---|
| Residential | 637 | $33,696,666 |
| Commercial | 62 | $ 5,116,234 |
| Agricultural | 408 | $17,458,072 |
| Critical Facilities | 4 | Exempt or No Data |
| Mobile Homes | 0 | $0 |

Figure 3-7 in Appendix 1 shows the location of critical facilities in relation to the flood hazard. Figure 3-8 shows the location of hazardous facilities in relation to the floodhazard.

Any future building in a flood hazard will be built in conformance with the City's Flood Damage Prevention Ordinance as part of Skiatook's membership in the NFIP; therefore, these buildings will not be considered by FEMA as at risk from the regulatory floodplain.

## 3.3.2 Tornado Hazard

Skiatook is fortunate to have never been hit by a tornado. However, to illustrate the damage a tornado could cause, a hypothetical tornado was located across the downCity area of Skiatook. This hypothetical tornado is one-mile long with a damage width of 600 feet. This hypothetical tornado is shown in Figure 3-9 in Appendix 1, and the locations of the critical facilities also are shown on this map. The total number of buildings within this tornado example, at risk from this example, is shown in the following table.

**Table 3.14**
**TOTAL BUILDINGS IN TORNADO SCENARIO**

| Type | Number of Properties | Total Improvement Value ($) |
|---|---|---|
| Residential | 100 | $ 6,053,248 |
| Commercial | 100 | $12,976,471 |
| Agricultural | 0 | $0 |
| Critical Facilities | 12 | Exempt or No Data |
| Mobile Homes | 0 | $0 |

### 3.3.3 High Wind Hazard

All areas, and all buildings, in Skiatook are at equal risk from this hazard. The total number of buildings, and value, in Skiatook is shown in the table at the beginning of this section.

### 3.3.4 Lightning Hazard

All areas, and all buildings, in Skiatook are at equal risk from this hazard. The total number of buildings, and value, in Skiatook is shown in the table at the beginning of this section.

### 3.3.5 Hail Storm Hazard

All areas, and all buildings, in Skiatook are at equal risk from this hazard. The total number of buildings, and value, in Skiatook is shown in the table at the beginning of this section.

### 3.3.6 Winter Storm Hazard

All areas, and all buildings, in Skiatook are at equal risk from this hazard. The total number of buildings, and value, in Skiatook is shown in the table at the beginning of this section.

### 3.3.7 Heat Hazard

All areas, and all buildings, in Skiatook are at equal risk from this hazard. The total number of buildings, and value, in Skiatook is shown in the table at the beginning of this section.

### 3.3.8 Drought Hazard

All areas, and all buildings, in Skiatook are at equal risk from this hazard. The total number of buildings, and value, in Skiatook is shown in the table at the beginning of this section.

### 3.3.9 Expansive Soils Hazard

The properties at risk from this expansive soils hazard are properties located on high and very high shrink-swell potential soil types. The locations of expansive soils are shown in Figure 3-4 in Appendix 1. A spatial analysis to determine the number of properties and buildings at risk from these high and very high shrink-swell potential soils in Tulsa County is shown in the following table. Expansive soils do not pose a risk to the contents of a building. Note that soils data for Osage County was in the STATSGO data base; its raster data type is not compatible for GIS spatial analysis. The number of critical facilities situated on high and very high expansive soils is also shown. There is no need to address expansive soils in this plan due to the lack of data related to damage and there is no justification for mitigating vulnerabilities. Vulnerabilities include structures with foundations such as homes and businesses, concrete slabs in driveways and sidewalks, and parking lots. Asphalt surfaces such as highways and runways could be affected.

**Table 3.15**
**TOTAL BUILDINGS IN SEVERE EXPANSIVE SOILS**

| Type | Number of Properties | Total Improvement Value ($) |
|---|---|---|
| Residential | 1,240 | $76,927,279 |
| Commercial | 772 | $10,402,324 |
| Agricultural | 329 | $14,204,141 |
| Critical Facilities | 12 | Exempt or No Data |
| Mobile Homes | 0 | $0 |

## 3.3.10 Wildfire Hazard

The Wildland Urban Interface (WUI) is defined as areas where homes are built near or among lands prone to wildland fire. It can be best described as a set of conditions. These conditions can include the amount, type, and distribution of vegetation; the flammability of structures in the area; and their proximity to fire-prone vegetation and to other combustible structures; weather patterns and general climate conditions; topography, hydrology, average lot size and road construction. Significant variations in these conditions, such as high winds and drought, and the general suburban/rural development pattern of Skiatook place virtually all areas and buildings in Skiatook at risk from this hazard. The total number of buildings, and value, in Skiatook is shown in the table at the beginning of this section. Fires can also destroy nonstructural assets such as agriculture, vegetation, and vehicles. Vulnerability of these non-structural assets, both in identifying these assets and estimating their damage potential was not quantified.

## 3.3.11 Earthquake Hazard

All areas, and all buildings, in Skiatook are at equal risk from this hazard. The total number of buildings, and value, in Skiatook is shown in the table at the beginning of this section. There is no need to address earthquakes in this plan because the infrequent events do not justify mitigating vulnerabilities. Vulnerabilities include all structures, homes, businesses and transportation infrastructure.

## 3.3.12 Hazardous Material Hazard

The public is most at risk from hazardous materials when they are being transported. The City has defined the major transportation routes and are shown in Figure 1-1 in Appendix 1.

## 3.3.13 Dam Break Hazard

For the structures at risk from a dam break hazard, those buildings on property intersecting the 500-year floodplain downstream of Skiatook Reservoir is summarized below.

**Table 3.16**
**TOTAL BUILDINGS IN DAM BREAK HAZARD**

| Type | Number of Properties | Total Improvement Value ($) |
|---|---|---|
| Residential | 376 | $18,315,986 |
| Commercial | 1 | $ 392,030 |
| Agricultural | 120 | $ 5,721,606 |
| Critical Facilities | 2 | Exempt or No Data |
| Mobile Homes | 0 | |

Figure 3-6 in Appendix 1 shows the location of the critical facilities in relation to the dam break hazard.

## 3.4 Assessing Vulnerability: Estimating Potential Losses

For each hazard, an analysis was done to determine the potential dollar losses to vulnerable buildings identified in Section 3.3. The analysis followed the methodology discussed in FEMA 386-2, step 4, and the format of FEMA 386-2 worksheet #4 "Estimate Losses".

The risk assessment in Section 3.3 for the flood hazard, dam break hazard, and the hypothetical tornado were the only three hazards of the 13 to identify buildings at risk by location. This vulnerability analysis estimates damages from only these three hazards.

### 3.4.1 Flood Hazard

For the flood hazard, for this planning exercise, all structures on property intersecting the regulatory floodplain are evaluated at one foot below the base flood elevation. (Actual first floor elevations were not surveyed and the best available topography has 10 foot contour intervals making windshield surveys plus and minus five feet.) Using FEMA 386-2, part 4, building damage with one foot of flood depth is estimated to be 14 percent of the building value, and content damage is estimated to be 21 percent of the building value.

### 3.4.2 Tornado Hazard

For the tornado hazard, a hypothetical tornado was located across the downCity area of Skiatook. This hypothetical tornado is one-mile long with a damage width of 600 feet. The FEMA 386-2 literature states there are no standard loss estimation models and tables for tornados. For damage estimation purposes, those structures within 100 feet to the tornado path were assigned to be completely damaged, those structures between 100 to 200 feet from the tornado path were assigned to be 50 percent damaged, and those structures between 200 and the outside edge of the damage buffer were assigned to be 25 percent damaged.

**Table 3.18**
**TOTAL BUILDINGS IN TORNADO SCENARIO**

| Type | Number of Properties | Total Improvement Value ($) |
|---|---|---|
| Residential | 100 | $ 6,053,248 |
| Commercial | 100 | $12,976,471 |
| Agricultural | 0 | $0 |
| Critical Facilities | 12 | Exempt or No Data |
| Mobile Homes | 0 | $0 |

**0 to 100 feet: COMPLETELY DESTROYED BUILDINGS**

| Type | Number of Properties | Total Improvement Value ($) |
|---|---|---|
| Residential | 100 | $ 6,053,248 |
| Commercial | 100 | $12,976,471 |
| Agricultural | 0 | $0 |
| Critical Facilities | 12 | Exempt or No Data |
| Mobile Homes | 0 | $0 |

**100 to 200 feet: 50% DAMAGED**

| Type | Number of Properties | Total Improvement Value ($) |
|---|---|---|
| Residential | 50 | $3,026,624 |
| Commercial | 50 | $6,488,236 |
| Agricultural | 0 | $0 |
| Critical Facilities | 6 | Exempt or No Data |
| Mobile Homes | 0 | $0 |

**200 to 300 feet: 25% DAMAGED**

| Type | Number of Properties | Total Improvement Value ($) |
|---|---|---|
| Residential | 25 | $1,513,312 |
| Commercial | 25 | $3,244,118 |
| Agricultural | 0 | $0 |
| Critical Facilities | 3 | Exempt or No Data |
| Mobile Homes | 0 | $0 |

## 3.4.3 Hazardous Material Hazard

The locations of the mobile homes in relation to the hazardous material locations can be determined by examining Figures 1-5 and 3-5 in Appendix 1. The locations of the elderly population in relation to the hazardous material locations can be determined by examining Figures 1-3 and 3-5 in Appendix 1. The locations of the low income population in relation to the hazardous material locations can be determined by examining Figures 1-4 and 3-5 in Appendix 1.

## 3.4.4 Expansive Soils

The potential damage to structures and infrastructure located on severe shrink-swell potential soils is dependent on the design of its foundation and quality of the construction of the foundation. Both factors were beyond the scope of this multi-hazard mitigation plan. Set damage estimates based on a percentage of the structure value were not used because of the wide variation of the factors involved in a foundation's stability. There is no need to address expansive soils in this plan due to the lack of data related to damage and there is no justification for mitigating vulnerabilities. Vulnerabilities include structures with foundations such as homes and businesses, concrete slabs in driveways and sidewalks, and parking lots. Asphalt surfaces such as highways and runways could be affected.

### 3.4.5 Dam Break Hazard

For the dam break hazard, for this planning exercise, all structures on property intersecting the hazard location were evaluated at two feet below the water elevation. (Actual first floor elevations were not surveyed and the best available topography has 10 foot contour intervals making windshield surveys plus and minus five feet.) This is one foot more than the vulnerability analysis for the flood hazard because the hazard from a dam break could occur as a surge of water rather than just rising water; therefore, it could cause more damage and that is accounted for in the greater damage estimate percentages for two feet deep. Using FEMA 386-2, part 4, building damage with two feet of flood depth is estimated to be 22 percent of the building value, and content damage is estimated to be 33 percent of the building value.

### 3.4.6 All Other Hazards

The magnitude of the damage to structures from all the other hazards does not vary by location. The total building and content value for all structures in Skiatook is totaled and shown in the table in the beginning of Section 3.3.

## 3.5 Assessing Vulnerability: Analyzing Development Trends

This section discusses the community's vulnerability in terms of a general description of land use and development trends so that mitigation options can be considered in future land use decisions. Three areas were analyzed. These are the types of existing and proposed land uses, development densities in the hazard areas, and anticipated changes in land use

3.5.1 The Osage County Assessor and Tulsa County Assessor both assigns three land use categories. These are residential, commercial including office and industrial, and agricultural. Land use changes can occur, and are initiated by the property owner, usually to accommodate a new development. The City's Board of Adjustment reviews each change request, and takes into account hazards and hazard prone areas in ruling on any land use change request.

3.5.2 There are 9,338 non right-of-way parcels of property in Skiatook. And of these 9,338 parcels, 1,111 parcels are in the regulatory floodplain; 637 residential, 62 commercial and 408 agriculture. Figure 3-1 in Appendix 1 shows this information. It must be noted that no new building development will be added to the flood hazard because any new building will conform to the City's Flood Damage Prevention Ordinance, which the City will continue to vigorously enforce. It will be recommended to all new construction to investigate the shrink-swell potential of its soils, and design and construct the foundation with the soils' properties as a consideration.

3.5.3 Anticipated changes in land use are along State Highway 20, west of Skiatook. This would be a mixture of commercial and residential development. These are the growth corridors of Skiatook. Neither of these areas is significantly situated in a flood hazard area.

# Chapter 4:
# Mitigation Strategies

This chapter identifies the hazard mitigation goals set by the City of Skiatook and discusses the mitigation projects, or measures, to be taken to achieve those goals.

## 4.1 Hazard Mitigation Goals

### 4.1.1 Mission Statement

To create a disaster-resistant community and improve the safety and well-being of the citizens of Skiatook by reducing deaths, injuries, property damage, environmental losses, and other losses from natural and technological hazards in a manner that advances community goals, quality of life, and results in a more livable, viable, and sustainable community.

The mission statement and goals were determined by the SHMAC at their initial meetings. Specific objectives were developed during the risk assessment phase and evaluated again as potential action steps were considered.

### 4.1.2 Specific Goals and Objectives

**Goal 1** **General**: To protect vulnerable populations and critical facilities from hazards.

**Objectives:**

1. Minimize loss of life and property and infrastructure damage from natural and man-made disasters.
2. Increase public awareness of risks from hazards and implement measures that can be taken to protect families and property from disasters.
3. Reduce the risk and effects of hazards and minimize community disruption.
4. Identify and protect vulnerable populations from natural and man-made hazards.
5. Identify and protect critical community facilities from hazards so that they can continue their missions in the event of a disaster.

**Goal 2** **Flood Hazard**: To reduce the risk of flood hazard in Skiatook

**Objectives:**

1. Identify at risk properties from the 100-year flood under existing and fully urbanized conditions.
2. Ensure that future urbanization and development does not increase flooding downstream or have off-site adverse impacts.
3. Identify and maximize the natural and beneficial uses of the floodplain.
4. Implement the best flood control measures to reduce vulnerability of flood-prone properties.

**Goal 3** **Tornado Hazard**: To reduce the risk from tornados in Skiatook

**Objectives:**

1. Encourage building of individual safe rooms and storm shelters.
2. Educate and encourage the building trades industry about construction standards that are adequate to withstand frequent high winds.

**Goal 4** **Hailstorm Hazard**: To reduce the risk from hailstorms in Skiatook.

**Objectives:**

1. Promote construction of hail resistant roofs.

**Goal 5** **Lightning Hazard**: To reduce the risk from lightning in Skiatook.

**Objectives:**

1. Reduce loss of life and property, and injury due to lightning by increased public awareness of measures to prevent and reduce damage, including warnings.

**Goal 6** **Winter Storm Hazard**: To reduce the hazards from winter storms in Skiatook.

**Objectives:**

1. Reduce property loss and community disruption due to severe winter cold and ice storms.

**Goal 7** **High Winds Hazard**: To reduce the risk from high winds in Skiatook.

**Objectives:**

1. Educate and encourage the building trades industry about construction standards that are adequate to withstand frequent high winds.

**Goal 8** **Drought Hazard**: Reduce the economic impact of drought hazards to Skiatook.

**Objectives:**

1. Reduce drought-related property and building foundation damage by improving building codes.

**Goal 9** **Wildfire Hazard**: To reduce the threat and financial impact of wildfire hazards in Skiatook.

**Objectives:**

1. Develop a City-wide fire response and support group to facilitate the provisioning of water to fires during large fires.

**Goal 10** **Expansive Soil Hazard**: Reduce structure's susceptibility to soil movement.

**Objectives:**

1. Reduce damage to property and building foundations due to expansive soils by improving building codes.

**Goal 11** **Earthquake Hazard**: To reduce the risk from earthquakes in Skiatook.

**Objectives:**

1. Educate and encourage the building trades industry about earthquake resistant construction.

**Goal 12** **Hazardous Materials Hazard**: To reduce the risk from hazardous material storage facilities around Skiatook.

**Objectives:**

1. Protect the public from exposure from hazardous materials events from sites within the community.

**Goal 13** **Extreme Heat**: To reduce the risk from extreme heat in Skiatook.

**Objectives:**

1. Reduce injury and potential loss of life to citizens during periods of extreme heat through education.

## 4.2 Mitigation Categories

There are several types of measures that communities and individuals can use to protect themselves from, or mitigate the impacts of, natural and man-made hazards. Mitigation measures, for purposes of this study, fall into the following categories:

- Preventive Measures
- Structural Projects
- Property Protection
- Emergency Services
- Public Information and Education

### 4.2.1 Preventive Measures

Preventive activities are designed to keep certain conditions from occurring or getting worse. The objective is to ensure that **new** development does not increase damages or loss of life and that new construction is protected from those hazards. Preventive measures are usually administered by building, zoning, planning, and code enforcement offices. They typically include planning, zoning, building codes, and floodplain development regulations and storm water management.

The first two measures, planning and zoning, work to keep damage-prone development out of the hazardous or sensitive areas. Skiatook's Comprehensive Plan identifies areas that are sensitive to urban development. Skiatook's Zoning Ordinance regulates development by dividing the community into zones or districts and setting development criteria for each zone or district. A zoning ordinance is considered the primary tool to implement the comprehensive plan's guidelines for how land should be developed.

The next two measures, floodplain development regulations and storm water management. Skiatook participates in the National Flood Insurance Program (NFIP). The NFIP sets minimum requirements for subdivision regulations and building codes. Storm water management regulations require developers to mitigate any increase in runoff due to their development. Building codes require a level of new construction standards for new building construction.

#### 4.2.1.1 Preventative Activities

- Planning and zoning help the City of Skiatook develop proactively so that the resulting infrastructure is laid out in a coherent and safe manner.
- Building codes for foundations, sprinkler systems, masonry, and structural elements such as roofs and the exterior building envelope are prime mitigation measures for occurrences of floods, tornadoes, high winds, extreme heat and cold, and earthquakes.
- Participation in the NFIP and using floodplain ordinances and subdivision regulations to regulate floodplain development is beneficial for Skiatook.
- Tree trimming adjacent to overhead power lines and placing new lines underground would help in preventing power outages during winter ice storms.
- Better information about hazardous materials in and being transported through the Skiatook community is desired for community safety and contingency planning.

## 4.2.2 Structural Projects

Structural projects are usually designed by engineers or architects, constructed by both the public and private sector, and maintained and managed by governmental entities. Structural projects traditionally include storm water detention reservoirs, levees and floodwalls, channel modifications, and drainage and storm sewer improvements.

### 4.2.2.1 Structural Activities

- Crossing and roadway drainage improvements must take into account additional detention or run-off reduction.
- Drainage and storm sewer improvements carry runoff from smaller, more frequent storms.
- Drainage system maintenance is an ongoing project of removing debris that decreases the effectiveness of detention ponds, channels, ditches, and culverts.

## 4.2.3 Property Protection Measures

Property protection measures are used to modify **existing** buildings or property subject to damage from various hazardous events. Property protection measures are normally implemented by the property owner. However, in some cases, technical and financial assistance can be provided by a governmental agency. Property protection measures from flooding typically include acquisition and relocation, flood-proofing, building elevation, and barriers. Property protection measures from other natural hazards include retrofitting, reinforced foundations, enhanced building codes with emphasis on the exterior building envelope, anchoring of roof and foundation, installation of safe rooms, hail resistant roofing, and insurance.

### 4.2.3.1 Property Protection Activities

**Floods**
- Dry floodproofing (making walls watertight so floodwaters cannot get inside)
- Wet floodproofing (letting the water in and removing everything that could be damaged by a flood)
- Installing drain plugs, standpipes or backflow valves to stop sewer backup

**Tornado**
- Constructing an underground shelter or in-building “safe room”
- Securing roofs, walls and foundations with adequate fasteners or tie downs
- Strengthening garage doors and other large openings

**High Winds**
- Installing storm shutters and storm windows
- Burying utility lines
- Installing/incorporating backup power
- supplies

**Hailstorms**
- Installing hail resistant roofing materials

**Lightning**

- Installing lightning rods and lightning surge interrupters
- Burying utility lines
- Installing/incorporating backup power supplies

**Winter Storms**

- Adding insulation
- Relocating water lines from outside walls to interior spaces
- Sealing windows
- Burying utility lines
- Installing/incorporating backup power supplies

**Extreme Heat and Drought**

- Adding insulation
- Installing water saver appliances, such as shower heads and toilets

**Wild Fires**

- Adding spark arrestors on chimneys
- Landscaping to keep bushes and trees away from structures
- Installing sprinkler systems
- Installing smoke alarms

**General Measures**

From the above lists, it can be seen that certain approaches can help protect from more than one hazard. These include:

- Strengthening roofs and walls to protect from wind and earthquake forces
- Bolting or tying walls to the foundation protect from wind and earthquake forces
- and the effects of buoyancy during a flood
- Adding insulation to protect for extreme heat and cold
- Anchoring water heaters and tanks to protect from ground shaking and flotation
- Burying utility lines to protect from wind, ice and snow
- Installing backup power systems for power losses during storms
- Installing roofing that is hail resistant and fireproof

Insurance has the advantage that, as long as the policy is in force, the property is protected and no human intervention is needed for the measure to work. Although most homeowner's insurance policies do not cover a property for flood damage, an owner can insure a building for damage by surface flooding through the National Flood Insurance Program (NFIP). Flood insurance coverage is provided for buildings and their contents damaged by a "general condition of surface flooding" in the area.

### 4.2.4 Emergency Service Measures

Emergency services measures protect people during and after a hazard event. Locally, these measures are coordinated by the emergency management agencies of the individual communities. Measures include preparedness, threat recognition, warning, response, critical facilities protection, and post-disaster recovery and mitigation.

Threat recognition is the key. The first step in responding to a flood, tornado, storm or other natural hazard is knowing that one is coming. Without a proper and timely threat recognition system, adequate warnings cannot be disseminated.

After the threat recognition system tells the Skiatook and/or the Osage and Tulsa County Emergency Management Agencies that a hazard is coming, the next step is to notify, **or warn**, the public and staff of other agencies and critical facilities. The following are the more common warning media:

- Outdoor warning sirens
- Sirens on public safety vehicles
- NOAA Weather Radio
- Commercial or public radio or TV stations
- Cable TV emergency news inserts
- Telephone trees
- Door-to-door contact
- Mobile public address systems

Just as important as issuing a warning is telling people what to do. A warning program should have a public information aspect. People need to know the difference between a tornado warning (when they should seek shelter in a basement) and a flood warning (when they should stay out of basements).

#### 4.2.4.1 Emergency Services Activities

The protection of life and property is the foremost important task of emergency responders. Concurrent with threat recognition and issuing warnings, a community should respond with actions that can prevent or reduce damage and injuries. Typical actions and responding parties include the following:

Response Activities

- Activating the emergency operations room (Emergency Management)
- Closing streets or bridges (Police or Public Works)
- Shutting off power to threatened areas (Skiatook Electric or ONG)
- Holding children at school/releasing children from school (School District)
- Passing out sand and sandbags (Public Works)
- Ordering an evacuation (Mayor)
- Opening evacuation shelters (Red Cross)
- Monitoring water levels (Public Works)
- Security and other protection measures (Police)

After a disaster, communities should undertake activities to protect public health and safety, facilitate recovery, and prepare people and property for the next disaster. This is commonly referred to as Post-Disaster Recovery and Mitigation.

Recovery Activities

- Patrolling evacuated areas to prevent looting
- Providing safe drinking water
- Monitoring for diseases
- Vaccinating residents for tetanus
- Clearing streets
- Cleaning up debris and garbage
- Regulating reconstruction to ensure that it meets all code requirements, including the NFIP's substantial damage regulations

Mitigation Activities

- Conducting a public information effort to advise residents about mitigation measures they can incorporate into their reconstruction work
- Evaluating damaged public facilities to identify mitigation measures that can be included during repairs
- Acquiring substantially or repeatedly damaged properties from willing sellers
- Planning for long term mitigation activities
- Applying for post-disaster mitigation funds

Overall Emergency Service Activities:

- Using solid, dependable threat recognition systems is first and foremost in emergency services.
- Following a threat recognition, multiple or redundant warning systems and instructions for action are most effective in protecting citizens.
- Good emergency response plans that are updated yearly ensure that well-trained and experienced people can quickly take the appropriate measures to protect citizens and property.
- To ensure effective emergency response, critical facilities protection must be part of the plan.
- Post-disaster recovery activities include providing neighborhood security, safe drinking water, appropriate vaccinations, and cleanup and regulated reconstruction.

## 4.2.5 Public Information and Education Measures

Successful public information and education measures involve both public and private sectors. Public information and education activities advise and educate citizens, property owners, renters, businesses, and local officials about hazards and ways to protect people and property from them. Public information activities are among the least expensive mitigation measures, and at the same time are often the most effective thing a community can do to save lives and property. All mitigation activities begin with public information and education.

Many benefits stem from providing map information to inquirers. Residents and businesses that are aware of the potential hazards can take steps to avoid problems and reduce their exposure to flooding, dam failure or releases, hazardous materials events, and other hazards that have a geographical distribution. These mapped hazards are included in this Hazard Mitigation study, and are discussed below. Flood Insurance Rate Maps (FIRMS) and Flood Hazard Boundary maps are available to show the flood zones for each property. Flood insurance is always recommended for those properties subject to flooding, especially for those in Flood Zone A.

Hazardous materials sites, listed in the Oklahoma Department of Environmental Quality's Tier II list, are shown on Figure 3-5 in Appendix 1, and are listed in Section 3.2.12. Transportation routes frequently used in the transport of hazardous materials include US 75, and SH 20. High-pressure pipeline locations have been suppressed by the Federal government since 9/11.

The Tulsa City-County Library Branch location in Skiatook is a place for residents to seek information on hazards, hazard protection, and protecting natural resources. Historically, libraries have been the first place people turn to when they want to research a topic. Interested property owners can read or check out handbooks or other publications that cover their situation. The libraries also have their own public information campaigns with displays, lectures, and other projects, which can augment the activities of the local government.

### 4.2.5.1 Public Information and Education Activities

- There are many ways that public information programs can be used so that people and businesses will be more aware of the hazards they face and how they can protect themselves.

- Most public information activities can be used to advise people about all hazards, not just floods.
- Other public information activities require coordination with other organizations, such as schools and real estate agents.
- There are several area organizations that can provide support for public information and educational programs.

## 4.3 Research, Review, and Prioritization

A wide range of literature searches and other sources were researched to identify mitigation measures for each hazard. Measures were identified to ascertain those that were most appropriate for the City of Skiatook. The public involvement process included the utilization of City's Website as part of a general hazard mitigation questionnaire solicitation effort. Several comments were received. A summary of the public's responses are included in Appendix 4. A list of potential mitigation measures was prepared by staff and presented to the SHMAC to stimulate debate and discussion prior to ranking priority mitigation measures. The complete listing of potential mitigation activities is included in Appendix 5.

The SHMAC reviewed the mitigation activities. The committee incorporated the criteria and principles of the STAPLE+E project evaluation method in their consideration of the mitigation activities. While not referred to by name at the time of the mitigation activity review, the intent of the method was used. An explanation of each STAPLE+E criteria item is as follows:

S: Social — Mitigations actions are acceptable to the community if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the community's social and cultural values.

T: Technical — Mitigation actions are technically most effective if they provide long-term reduction of losses and have minimal secondary adverse impacts.

A: Administrative — Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.

P: Political — Mitigation actions can truly be successful if all stakeholders have been offered an opportunity to participate in the planning process and if there is public support for the action.

L: Legal — It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.

E: Economic — Budget constraints can significantly deter the implementation of mitigation actions. It is important to evaluate whether an action is cost-effective before an action is implemented.

E: Environmental — Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with environmental regulations, and that are consistent with the community's environmental goals, have mitigation benefits while being environmentally sound.

A cost-benefit analysis was not done for each activity under consideration, but the SHMAC decided to have a formal cost-benefit evaluation done for any selected activity that would follow the requirements of the funding source where funds are being sought.

# Chapter 5:

# Action Plan

The City of Skiatook has reviewed and analyzed the risk assessment studies for the natural hazards and hazardous material events that may impact the Skiatook area. The SHMAC also reviewed the list of recommended actions included in the previous plan to determine if the actions should be deferred, cancelled or continued. The results of this review are included in Table 5-1 below.

**Table 5-1. Status of Mitigation Measures from Previous Plan**

| Action Plan # | 2008 Action Plan Measures | Progress 2008-2014 | Status in 2014 Plan Update |
|---|---|---|---|
| 1 | Develop a truck by-pass route around the City to reduce the possibility of a hazardous material incident along the main route (Highway 20) through the City. | No significant progress to date on this activity. | Included in Updated Plan as Action Item #11. |
| 2 | Build community partnerships involving local government leaders, civic, business and volunteer groups to work together for a safer community | Determined to be an ongoing issue. | Ongoing project restated and reassigned as Action Plan Item #4. |
| 3 | Teach City employees and community residents the symptoms of common life-threatening emergencies, for instance, the symptoms of heat disorders, and how to give CPR and first aid. | Considered to be a routine activity due to workforce turnover. | Continued as part of Action Item #14. |
| 4 | Supply NOAA Weather Radios to all local government buildings, schools and critical facilities | Activity has been started but is not complete. | Ongoing project redefined and reassigned as Action Plan Item #1. |
| 5 | Tree trimming needs around power lines to lessen the probability of tree branches causing power outages due to severe winter storms, ice and snow. | Significant activity in this area since 2003 continued maintenance is necessary, provided by City and other franchise utilities. | Considered to be a routine activity and has been dropped from Updated Action Plan. |
| 6 | Acquire floodplain properties where acquisition is the most cost effective mitigation measure. | No Activity. | Continued as part of Action Item #3. |
| 7 | Evaluate and upgrade the City warning systems, and upgrade the emergency communication network for Skiatook emergency operations. | Storm sirens, emergency radio equipment and back-up generators have been purchased and replaced. | Continued as part of Action Item #1. |
| 8 | Provide safe rooms in the police and fire stations to protect the community's first responders. | No significant progress to date on this activity. | Continued as Action Item # 8. |
| 9 | Develop a plan for Skiatook Police and Fire Department personnel to expand their knowledge and capabilities relative to hazardous | A Methamphetamine Ordinance has been adopted by the City of Skiatook and activity has | Dropped from Updated Action Plan. |

| | | | |
|---|---|---|---|
| | materials and events, including meth labs. | decreased. Completed Item- Delete from Action Plan | |
| 10 | Verify the accuracy of existing floodplain maps and review and update land use ordinances to avoid construction in flood-prone locations. | City Ongoing City Capital Improvement Activity. Now covered under City Development Ordinances. | Ongoing project, restated and reassigned as Action Plan Item #10 |
| 11 | Hazard Occurrence Data Collection. | Considered to be an ongoing activity due to updates in FEMA Flood Maps. | Continued as part of Action Item # 9. |
| 12 | Public Education for Mitigation | Determined to be an ongoing issue. | Continued as part of Action Item # 5. |
| 13 | Dam Break Inundation Map- Develop location listing, and or, map that identifies buildings and critical facilities within dam inundation zones vulnerable to flooding from dam failures. | To date the 500 year floodplain has been considered to be adequate for planning purposes. | Continued as part of Action Item # 9. |
| 14 | Window Laminates- Install protective Film on windows or replace with break resistant glass in all existing City buildings. | No significant progress to date on this activity. | Continued as part of Action Item # 18.. |
| 15 | Surge Protectors - Install lighting protection and suppression systems protecting radios, computers, and other essential equipment at critical facilities throughout the jurisdiction. | Activity completed. Delete from Action Plan. | Dropped from Updated Action Plan. |
| 16 | Increase the capacity of the Water Treatment Facility | Activity completed-Delete from Action Plan. | Dropped from Updated Action Plan. |
| 17 | Establish Fire Breaks in the Wildfire urban interface. | Activity completed-Delete from Action Plan. | Dropped from Updated Action Plan. |
| 18 | Safe rooms in schools. | No significant progress to date on this activity. | Continue to discuss with School |

As part of the plan update process, this chapter identifies and updates specific high priority actions to achieve the mitigation goals previously stated in the plan update, the lead agency for each action item, an anticipated time schedule, estimated cost, and identification of funding sources. Once funding is sought, a detailed benefit/cost analysis will be done and will follow the requirements of the funding source.

The following table identifies which mitigation type project is associated with each hazard.

| Hazard Type | Action Plan Activity Number |
|---|---|
| Floods | 1, 2, 3, 4, 5, 6, 9, 10, 14 |
| Tornados | 1, 2, 4, 5, 6, 7, 8, 10, 12, 14 |
| High Winds | 2, 4, 5, 6, 10, 12, 14, 17, 18 |
| Lightning | 2, 4, 5, 6, 10, 12, 13, 14 |
| Hailstorms | 2, 4, 5, 6, 10, 12, 14, 17, 18 |
| Severe Winter Storms | 2, 4, 5, 6, 10, 14 |

| | |
|---|---|
| Extreme Heat | 2, 4, 5, 6, 10, 14 17, 18, 19 |
| Expansive Soils | 4, 5, 6, 10, 17 |
| Drought | 4, 5, 6, 10, 15 |
| Wildfires | 2, 4 5, 6, 10, 14, 15, 20 |
| Earthquakes | 2, 4, 5, 6, 10, 14, 17 |
| Hazardous Materials Events | 2, 4, 5, 6, 10, 11, 14, 15, 16 |
| Dam Break | 1, 2, 3, 4, 5 6, 10, 14 |

## 2014 ACTION PLAN ITEMS:

**1. Upgrade the Skiatook outdoor warning system.**

Hazard Type: Tornados, Floods, Dam Break
Action Plan Project Type: Mitigation
Lead: City Fire Department
Time Schedule: FY 2014-18
Estimated Cost: $175,000 (includes developer participation)
Source of Funding: Local
Work Product/Expected Outcome: The work product is to update and implement an outdoor warning system location analysis (3-6 estimated locations within the community) and to require new developments to site future siren locations as part of the development process. The purpose of this activity is to maintain coverage as growth occurs and may include the implementation of a per acre development fee to cover this activity. The expected outcome is to provide an outdoor warning system that adequately covers all parts of the City.

**2. Explore the option to upgrade the City's mass emergency oriented warning system using digital communications and automation technology as part of a multi layered notification approach to cover city wide emergencies.**

Hazard Type: Floods, Tornados, High Winds, Lightning, Hail Storms, Severe Winter Storms, Extreme Heat, Wild Fires, Earthquakes, Hazardous Materials Events, Dam Break
Action Plan Project Type: Mitigation
Lead: City Fire Department
Time Schedule: FY 2014, and ongoing
Estimated Cost: Unknown at this time
Source of Funding: Local
Work Product/Expected Outcome: The work product is to support and participate in a digitally based notification system that can accomplish immediate city-wide emergency notification. The expected outcome is achieving better coverage through a multi-layered "all hazards" notification capability in the event of an emergency.

**3. Acquire floodplain properties where acquisition is the most cost effective mitigation measure.**

Hazard Type: Floods, Dam Break
Action Plan Project Type: Mitigation
Lead: City Community Development Department
Time Schedule: FY2014, and ongoing
Estimated Cost: Unknown at this time
Source of Funding: FEMA/Local (75% federal/25% local)
Work Product/Expected Outcome: The work product is to acquire and clear repetitive loss properties as an on-going activity when funds are available. The City has identified six (6) repetitive loss structures and has acquired twenty three (23) structures over the past several years The City will continue to work with property owners to acquire and remove these structures from the regulated floodplain. The expected outcome is to reduce the number of structures vulnerable to a flood hazard.

**4. Build community partnerships involving local government leaders, civic, business and volunteer groups to work together for a safer community.**

Hazard Type: Floods, Tornados, High Winds, Lightning, Hail Storms, Severe Winter Storms, Extreme Heat, Expansive Soils, Drought, Wild Fires, Earthquakes, Hazardous Materials Events, Dam Break

Action Plan Project Type: Education

Lead: City Manager, Fire Department/Community Development Department/Police Department/Public Works Department

Time Schedule: FY 2014 and ongoing

Estimated Cost: Unknown at this time

Source of Funding: Local / FEMA Grant

Work Product/Expected Outcome: The work product is to will be updating all mutual aid agreement as outlined in the City's EOP, develop a working group among partnership members so that the group is established before it is needed, identify a designated City representative to brief the media in the event of a hazard event, and build a hazard response information link on the City's website. The expected outcome will be to efficiently and effectively coordinate a response to a hazard event and to disseminate information to the public following a hazard event.

**5. Develop and implement public education/information programs, including an annual Safety Fair, designed to educate the public on a variety of hazard mitigation issues.**

Hazard Type: Floods, Tornados, High Winds, Lightning, Hail Storms, Severe Winter Storms, Extreme Heat, Expansive Soils, Drought, Wild Fires, Earthquakes, Hazardous Materials Events, Dam Break

Action Plan Project Type: Education

Lead: City Manager and Fire Department/Chamber of Commerce

Time Schedule: FY 2014 and ongoing

Estimated Cost: $5,000

Source of Funding: Local

Work Product/Expected Outcome: The work product will be to utilize the existing City website as an information resource, organize community events and provide education materials on specific mitigation activities to citizens within the community. The expected outcome will be more mitigation activities implemented by community residents.

**6. Promote certification of local emergency shelters within the community for use by the Red Cross in emergency situations requiring shelter. Support legislative initiatives that reduce liability in sheltering situations.**

Hazard Type: Floods, Tornados, High Winds, Lightning, Hail Storms, Severe Winter Storms, Extreme Heat, Expansive Soils, Drought, Wild Fires, Earthquakes, Hazardous Materials Events, Dam Break

Action Plan Project Type: Training

Lead: City Fire Department, Red Cross

Time Schedule: FY 2014, and ongoing

Estimated Cost: varies by location and scope of project due to certification

Source of Funding: Local

Work Product/Expected Outcome: The work product is to identify appropriate facilities that can become temporary shelters in the event of an emergency that causes evacuation or relocation of residents. The expected outcome is that sufficient certified shelters will be staffed by Red Cross staff during emergencies.

**7. Promote individual safe rooms within the community.**

Hazard Type: Tornado

Action Plan Project Type: Education

Lead: City Fire Department

Time Schedule: Ongoing

Estimated Cost: $5,000 (estimate for promotional materials)
Source of Funding: Local/Grants
Work Product/Expected Outcome: Develop public information program to foster 'shelter-in-place' practices and to promote participation in programs such as the SoonerSafe – Safe Room Rebate Program administered by the Oklahoma Department of Emergency Management. The expected outcome is to increase the number of residential safe rooms within the community by facilitating participation in FEMA and State rebate programs when they become available.

**8. Provide safe rooms in the police and fire stations to protect the community's first responders.**
Hazard Type: Tornado
Action Plan Project Type: Mitigation
Lead: City Police and Fire Departments
Time Schedule: Ongoing
Estimated Cost: Unknown at this time
Source of Funding: Local/Grants
Work Product/Expected Outcome: The work product is to construct safe rooms in existing police and fire facilities. The expected outcome is to provide increased protection of the community's first responders during tornado events.

**9. Develop a Dam Break Inundation Map which would include the location of critical facilities and other buildings vulnerable to flooding from a failure of the Skiatook Dam.**
Hazard Type: Flooding
Action Plan Project Type: Mitigation
Lead: City Community Development Department
Time Schedule: FY 2014 and ongoing
Estimated Cost: Unknown at this time
Source of Funding: Local / FEMA Grant
Work Product/Expected Outcome: The work product is to assess the potential impact of a dam break event at the Skiatook Lake Dam. The expected outcome is the identification of vulnerable structures and populations within the community and to facilitate planning efforts to identify response measures.

**10. Develop a coordinating network of Public Information staff, i.e., City, Schools, County, Tribal etc. by meeting on a regular basis to maintain lines of communication to effectively respond to emergency events.**
Hazard Type: Floods, Tornados, High Winds, Lightning, Hail Storms, Severe Winter Storms, Extreme Heat, Expansive Soils, Drought, Wild Fires, Earthquakes, Hazardous Materials Events, Dam Break
Action Plan Project Type: Education
Lead: City Manager and Fire Department
Time Schedule: FY 2014 and ongoing
Estimated Cost: Force account only
Source of Funding: Local
Work Product/Expected Outcome: The work product is to develop a localized network of agency representatives that are aware of operational changes in other agencies. The expected outcome is to have effective communication and situational awareness of other local agencies.

**11. Develop a truck by-pass around the City to reduce the possibility of a hazardous material incident along the primary arterial route (Highway 20) through the City.**
Hazard Type: Hazardous Materials
Action Plan Project Type: Mitigation
Lead: City Police and Fire Departments
Time Schedule: FY 2014-2017
Estimated Cost: Undetermined at this time.

Source of Funding: Local/Grants
Work Product/Expected Outcome: The work product will be the creation of a designated and enforceable truck by-pass route around the City. The expected outcome will be a reduction of hazardous material incidents in congested areas.

**12. Install electric utility lines underground in new development areas.**
Hazard Type: Tornado, High Winds, Severe Winter Storms
Action Plan Project Type: Mitigation
Lead: City Electric Department and City Community Development
Time Schedule: FY2014-2017
Estimated Cost: Unknown
Source of Funding: Local / Utility
Work Product/Expected Outcome: The work product will be the implementation of existing development regulations and planning for future developments within the community. The expected outcome will be an increased percentage of underground utility lines within the community.

**13. Purchase and install a THOR Guard lightning Detection systems for existing sports facilities within the community.**
Hazard Type: Lightning
Action Plan Project Type: Mitigation
Lead: City Fire Department
Time Schedule: FY2012-2017
Estimated Cost: Unknown at this time
Source of Funding: Local / Grants
Work Product/Expected Outcome: The work product is to develop a warning system to alert public that Lightning is occurring in the immediate area. The expected outcome is to increase public safety at community sports events.

**14. Develop a coordinated training strategy for teaching public employees and other community groups the symptoms of common, life threatening emergencies, heat disorders and how to give CPR and first aid by providing additional classes.**
Hazard Type: Floods, Tornados, High Winds, Lightning, Hail Storms, Severe Winter Storms, Extreme Heat, Wild Fires, Earthquakes, Hazardous Materials Events, Dam Break
Action Plan Project Type: Education
Lead: City Fire Department and Red Cross
Time Schedule: FY2014, and ongoing
Estimated Cost: $1,000 (estimated annually)
Source of Funding: Local
Work Product/Expected Outcome: The work product is to provide adequate training and response to life threatening emergencies by public employees and community groups. The expected outcome is a more effective response to emergency situations.

**15. Replace/continue replacing inadequately sized water lines.**
Hazard Type: Wildfires, Drought
Action Plan Project Type: Maintenance
Lead: City Community Development/Public Works Department
Time Schedule: FY2014-2017
Estimated Cost: undetermined at this time
Source of Funding: Local
Work Product/Expected Outcome: The work product will be to evaluate and increase water distribution capacity throughout the City. Also, new developments will be expected to provide adequately sized water lines as part of the development process. The expected outcome is to provide adequate volume and pressure to meet ISO standards throughout the community.

**16. Review and update contingency planning for transportation related hazardous materials incidents on State Highway 20.**
Hazard Type: Hazardous Materials
Action Plan Project Type: Preparedness
Lead: City Fire Department
Time Schedule: FY2014, and annually
Estimated Cost: City force account contribution
Source of Funding: Local
Work Product/Expected Outcome: Work product is the review and update of incident plans for emergency response personnel. The expected outcome is to allow City personnel and personnel who respond to City emergencies to properly identify potentially hazardous situations, assess the magnitude and monitor the event until hazardous material response contractors arrive. Also include a public information campaign to educate the general public on how to evacuate from the immediate incident area, if necessary.

**17. Adopt appropriate building codes for adequacy for tornados, high winds, hailstorms expansive soils and earthquakes.**
Hazard Type: Tornados, High Winds, Hailstorms, Expansive Soils. Earthquakes
Action Plan Project Type: Mitigation
Lead: City Community Development
Time Schedule: FY 2014, and annually
Estimated Cost: minimal (to include staff research time and publication costs)
Source of Funding: Local
Work Product/Expected Outcome: The work product is to develop a comparison summary between the current edition of the IBC and the next published edition, anticipated to be available in 2014 and to adopt the new IBC, if necessary. The expected outcome is to update the City's codes to include the latest technical updates that the City considers to be appropriate for the City of Skiatook.

**18. Window Laminates – Install protective film or break resistant glass on exposed windows in all existing City facilities.**
Hazard Type: High Wind, Extreme Heat, Hailstorms
Action Plan Project Type: Mitigation
Lead: City Manager and Community Development Department
Time Schedule: FY2014-2017
Estimated Cost: Undetermined at this time.
Source of Funding: Local/Grants
Work Product/Expected Outcome: The work product will be to increase protection and safety of personnel and property in existing City facilities. The expected outcome will be a reduction of risk for penetration from wind, rain and hail in City facilities.

**19. Establish cooling centers within the community for heat emergencies.**
Hazard Type: Extreme Heat
Action Plan Project Type: Mitigation
Lead: City Fire Department, Red Cross
Time Schedule: FY2014, and annually
Estimated Cost: Unknown at this time
Source of Funding: Local
Work Product/Expected Outcome: The work product is to identify and to develop working agreements for the use of public spaces for use in heat emergencies. The expected outcome is educating the public as to the availability and location of cooling centers.

**20. Continued participation in the Oklahoma Red Flag Fire Alert Program/OK-Fire Website.**
Hazard Type: Wildfires

Action Plan Project Type: Education
Lead: City Fire Department
Time Schedule: FY2012 and ongoing
Estimated Cost: City Public Information
Source of Funding: Local
Work Product/Expected Outcome: The work product is to utilize the City Website and other media resources to keep the public informed about wildfire conditions. The expected outcome is to reduce the incidence of wildfires within the community.

# Chapter 6:

# Plan Maintenance and Adoption

This chapter includes a discussion of the plan maintenance process and documentation of the adoption of the plan by the Skiatook Hazard Mitigation Advisory Committee and the Skiatook City Council. The plan update process reviewed City actions in regard to incorporation of mitigation strategies contained in the original plan into other planning mechanisms and determined that several actions had been taken including updating the Fire Department hazardous materials inventory; pro-active tree trimming programs by utility providers; surge protection for critical facilities; pre-disaster contingency planning; purchase and installation of storm sirens, emergency radio equipment and back-up generators; increasing the capacity of the Water Treatment Plant; adoption of the IBC Code; adoption of a Methamphetamine Ordinance; updating the city's Emergency Operations Plan; and working with OEM and FEMA on revisions to the city's FIRM Maps.

# 6.1 Monitoring, Evaluating, Updating the Plan

The Skiatook Multi-Hazard Mitigation Plan includes a range of action items to reduce losses from hazard events. Together, the action items provide a framework for activities that the City can choose to implement over the next five years. The effectiveness of the plan depends on the incorporation of the action items into existing City plans, policies, and programs.

The Skiatook City Manager, or his designee, and the Community Development Department will be jointly responsible for overseeing the plan's implementation and maintenance through existing City programs. The Director of Community Development or designated appointee will assume lead responsibility for facilitating plan implementation and maintenance meetings. The City of Skiatook will utilize a staff management team that will contribute to the monitoring, evaluations, and updates to the Multi-Hazard Mitigation Plan. The Skiatook Hazard Mitigation Advisory Committee (SHMAC) will continue to meet on, at least, an annual basis. This group will monitor the progress of the mitigation activities. Monitoring will include getting annual reports from the agencies and departments involved in the mitigation activities as to their progress. The GHMAC will make annual reports to the City Council summarizing the accomplishments of the mitigation activities.

The SHMAC will also evaluate the mitigation plan on an annual basis. The SHMAC evaluation shall include reviewing the goals and objectives of the mitigation plan for any changes. The SHMAC evaluation will also include a review of the hazards in the plan to determine if the risks or hazard locations have changed. The SHMAC will complete and provide an annual evaluation to the Skiatook City Council. In the action plan, the SHMAC will review the items identified to implement each action plan activity for their appropriateness, and report problems to the City Council. These implementation items include the responsible agency to oversee the mitigation activity, the time schedule, the funding source, and the funding source.

The GHMAC will make a comprehensive update to the Multi-Hazard Mitigation Plan within five years from the approval date, as per FEMA requirements, and will be resubmitted to OEM and FEMA for approval, as required.

# 6.2 Incorporating the Multi-Hazard Mitigation Plan

The Skiatook Multi-Hazard Mitigation Plan has been adopted by the Skiatook Planning Commission as an amendment to the Skiatook Comprehensive Plan. The Skiatook City Council has adopted the plan to guide City mitigation activities. Appropriate Action Plan activities will be incorporated into the planning process, and in the annual city budget. As stated in section 6.1, the SHMAC meets annually. This committee will monitor how mitigation activities are incorporated into other city plans. Skiatook currently has a comprehensive plan and a capital improvement plan to guide development and future improvements. These plans have mitigation strategies in them, and will incorporate the mitigation plan strategies into those plans when the particular plan is updated. The inspections department enforces the buildings codes in Skiatook. After adoption of the mitigation plan, the inspections department will continue to enforce the building codes on new construction. Selection of future CIP projects will include consideration of the goals and objectives of the mitigation plan. Note: All plans are updated as needed by the City of Skiatook.

# 6.3 Public Involvement

The City of Skiatook is committed to involving the public directly in updating and maintaining the Multi-Hazard Mitigation Plan. Copies of the Plan will be available at the local branch of the Tulsa City-County Library, Skiatook Municipal Offices, and City of Skiatook's website. This website address is www.cityofskiatook.com. Input from citizens will be solicited as to how the mitigation process can be more effective. Comments can be made directly to the City Manager and the City Planner, or can be e-mailed to the webmaster through the City's website.