City of Tulsa Multi-Hazard Mitigation Plan Update – 2014

July 2014

R.D. Flanagan & Associates
Planning Consultants

ENGINEERING SERVICES

December 4, 2013

Mr. Bill Penka, State Hazard Mitigation Officer
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RE: City of Tulsa Multi-Hazard Mitigation Plan – 2014 Update

We are pleased to submit this *City of Tulsa Multi-Hazard Mitigation Plan-2014 Update*, as fulfillment of the requirements of the Hazard Mitigation Grant Program (HMGP-FEMA-1883-DR-OK-033).

This Multi-Hazard Mitigation Plan, prepared in accordance with State and Federal guidance, addresses floodplain management, dam and levee failures, tornadoes, high winds, hailstorms, lightning, winter storms, extreme heat, drought, expansive soils, wild fires, and earthquakes, hazardous materials sites, and transportation hazards.

We look forward to implementing this plan to enhance protection of the lives and property of our citizens from natural hazards and hazard materials incidents. If we can answer any questions or be of further assistance, please do not hesitate to contact me at 918-596-9475.

Sincerely,
CITY OF TULSA, ENGINEERING SERVICES

Bill Robison

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Acknowledgements

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Jack Henderson ..... City Council District 1
Jeannie Cue ..... City Council District 2
David Patrick ..... City Council District 3
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Karen Gilbert ..... City Council District 5
Byron "Skip" Steele ..... City Council District 6
Arianna Moore ..... City Council District 7
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Ann Patton, Vice Chair ..... Ann Patton Company, LLC
Bob Roberts, Secretary ..... Emergency Manager, Tulsa Public Schools
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Executive Summary

In the 1970's and early 1980s Tulsa was identified in a national study as one of the nation's most disaster-prone areas, having been declared a federal disaster area nine times in only fifteen years. Oklahoma's location at the intersection of the hot arid zone to the west, the temperate zone to the northeast, and the hot humid zone to the southeast makes it subject to a wide variety of potentially violent weather and natural hazards.

This City of Tulsa Multi-Hazard Mitigation Plan 2013 Update of the 2009 Mitigation Plan Update and the original 2003 Mitigation Plan is a strategic planning guide developed in fulfillment of the Hazard Mitigation Grant Program requirements of the Federal Emergency Management Agency (FEMA), according to the *Stafford Disaster Relief and Emergency Assistance Act*. This plan Update is developed in accordance with, and fulfills requirements for, the Pre-Disaster Mitigation Grant (PDM) and Hazard Mitigation Grant (HMGP). It also fulfills requirements for the Flood Mitigation Assistance Program (FMA), Severe Repetitive Loss Program (SRL), and the Community Rating System Plan (CRS) from the Federal Emergency Management Agency (FEMA).

In December 2005, the Multihazard Mitigation Council of the National Institute of Building Sciences completed a study to assess future savings from mitigation activities. Their findings reflected the fact that mitigation activities in general produced over $4 in savings for every $1 invested in mitigation actions, with the greatest savings in the areas of flood-related events (5:1) and wind-related events (3.9:1). In addition, the report concludes, *"Mitigation is most effective when carried out on a comprehensive, community-wide, and long-term basis. Single …activities can help, but carrying out a slate of coordinated mitigation activities over time is the best way to ensure that communities will be physically, socially, and economically resilient to future hazard impacts."*

Approval of this plan will qualify the City of Tulsa to apply for PDM funds, as well as HMGP funds following a federal disaster declaration, as required under Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 2000.

Background

Virtually every area of the city is vulnerable to natural and manmade hazards. The Tulsa Stormwater Drainage and Hazard Mitigation Advisory Committee (SDHMAB) and the Technical Advisory Committee (TAC) have identified 16 hazards affecting the City of Tulsa, including severe winter storms, high winds, tornadoes, lightning, hail, extreme heat, drought, urban fires, floods, dam failures, levee failures, earthquakes, expansive soils, wildfires, fixed-site hazardous materials, and transportation-hazardous materials.

Purpose

The purpose of this plan is to:

- Assess the progress on the previously identified mitigation measures;
- Assess the ongoing mitigation activities in the community;
- Identify and assess the hazards that pose a threat to citizens and property;

- Evaluate additional mitigation measures that should be undertaken;
- Outline a strategy for implementation of mitigation projects.

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

Stormwater Drainage and Hazard Mitigation Advisory Board

Citizens and professionals active in disasters provided important input in the development of the plan and recommended goals and objectives, mitigation measures, and priorities for actions. The members of the City of Tulsa Stormwater Drainage and Hazard Mitigation Advisory Board are listed above.

The Planning Process

Planning for the City of Tulsa Multi-Hazard Mitigation Plan followed a ten-step process, based on guidance and requirements of FEMA for the PDM grant program, HMGP, the Flood Mitigation Assistance (FMA) program, and the Community Rating System (CRS):

1. Organize to prepare the plan
2. Involve the public
3. Coordinate with other agencies and organizations
4. Assess the hazard
5. Assess the problem
6. Set goals
7. Review possible activities
8. Draft the action plan
9. Adopt the plan
10. Implement, evaluate, and revise

Plan Summary

The City of Tulsa Multi-Hazard Mitigation Plan provides guidance to help citizens protect life and property from natural and manmade hazards. The plan identifies the hazards that are most likely to strike each jurisdiction, provides a profile and risk assessment of each hazard, identifies mitigation measures for each hazard, and presents an action plan for the implementation of the mitigation measures.

Chapter 1- Introduction provides a profile of the City of Tulsa. This chapter includes a community description including demographics, lifelines, and critical facilities.

Chapter 2- Existing Mitigation Strategies provides an overview and discussion of existing resources and hazard mitigation programs.

Chapter 3- The Planning Process presents detailed information documenting the planning process including citizen and agency involvement, a table describing how and why each hazard was identified, and methodologies used in the plan for damage estimates and risk assessments.

Chapter 4- Natural and Manmade Hazards provides an assessment of 16 natural hazards. Each assessment includes a hazard profile, catalogs historical events, identifies the vulnerable populations, and presents a conclusion.

Chapter 5- Tulsa City Council Districts and Arkansas River Corridor Hazard Analysis sets disaster-specific goals and objectives and organizes proposed mitigation strategies under six mitigation categories: public information and education, preventive activities, structural projects, property protection, emergency services, and natural resource protection.

Chapter 6- Mitigation Goals and Objectives sets disaster-specific goals and objectives and organizes proposed mitigation strategies under six mitigation categories: public information and education, preventive activities, structural projects, property protection, emergency services, and natural resource protection.

Chapter 7- Action Plan outlines an action plan for the implementation of high priority mitigation projects, including a description of the project, the responsible party, anticipated cost, funding sources, and timelines for implementation.

Chapter 8- Plan Adoption and Maintenance provides a discussion of the plan documentation of the adoption resolutions, and the Plan maintenance process. Plan maintenance includes monitoring, evaluating, and updating the plan with involvement of the public.

Appendix A- Glossary provides a glossary of terms commonly used in disaster management and hazard mitigation.

Appendix B- Mitigation Strategies provides a more detailed discussion of possible Mitigation Measures outlined in Chapter 6, organized by category.

Appendix C- Mitigation Committee Meetings provides the agendas and sign-in sheets from the Citizens Advisory Committee and the Technical Advisory Committee meetings.

Appendix D- 2009 Mitigation Measures provides a report on the current status of all Mitigation Measures included in the 2009 plan – whether completed, in process, continuing in 2008 plan, or incomplete.

Appendix E- Tier II Facilities provides a complete list of all EHS and Non-EHS Tier II facilities in the City of Tulsa as reported to the Department of Environmental Quality

Mitigation Action Plan

The mitigation action plan includes strategies for implementing the mitigation measures, including information on the responsible agency, time frame, cost estimate, funding sources, and a statement of the measurable results.

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Chapter 1: Introduction

44 CFR Requirements met:

> ***Requirement §201.6(c)(2)(ii)(C):*** *[The plan **should** describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*
>
> ***Requirement §201.6(c)(3)(i):*** *[The hazard mitigation strategy **shall** include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.*

Included in this Chapter:

1.1 About the Plan
- 1.1.1 Purpose
- 1.1.2 Scope
- 1.1.3 Authority
- 1.1.4 Funding
- 1.1.5 Goals
- 1.1.6 Definition of Terms
- 1.1.7 Points of Contact

1.2 Community Description
- 1.2.1 Governance
- 1.2.2 Geography
- 1.2.3 Climate
- 1.2.4 History
- 1.2.5 Demographics
- 1.2.6 Lifelines
- 1.2.7 Economy
- 1.2.8 Development
- 1.2.9 Critical Facilities

1.1 About the Plan

This document is the Multi-Hazard Mitigation Plan 2014 Update for the City of Tulsa.

This strategic plan follows the provisions of the Hazard Mitigation Grant Program (HGMP) of the Federal Emergency Management Agency (FEMA) in accordance with the US *Stafford Disaster Relief and Emergency Assistance Act*, as amended as administered by the Oklahoma Department of Emergency Management (OEM). The Stafford Act provides the opportunity for federal assistance to state and local governments to alleviate suffering and damage from disasters. Amendments to the Act have broadened regulations to provide for programs that encourage strategies and measures to mitigate the impact of natural and man-made hazards, as well as for the continuation of long-standing programs for disaster preparedness, emergency operations plans and flood insurance coverage. The revisions to the Act make it clear that no federal assistance is available to an otherwise eligible jurisdiction if no Hazard Mitigation Plan has been adopted and is in effect.

This plan Update is developed in accordance with, and fulfills the requirements for, the Pre-Disaster Mitigation (PDM) and Hazard Mitigation Grant Program (HMGP). It also fulfills the requirements for the Flood Mitigation Assistance Program (FMA), Severe Repetitive Loss Program (SRL), and the Community Rating System Plan (CRS) from FEMA. The plan addresses 16 natural and manmade hazards that can affect people and property in the City of Tulsa.

1.1.1 Purpose

The purpose of this plan is to:

- Provide a description of the planning area (Chapter 1).
- Assess the ongoing mitigation activities in the City of Tulsa (Chapter 2).
- Describe the planning process used to develop the mitigation plan (Chapter 3).
- Identify and assess the hazards that pose a threat to citizens, businesses and property (Chapters 4 and 5).
- Establish Goals and Objectives for community mitigation measures (Chapter 6).
- Evaluate Mitigation Measures that should be undertaken to protect citizens, businesses and property (Chapter 7).
- Identify and recommend an Action Plan for implementation of mitigation projects (Chapter 8).
- Develop a strategy for the adoption, maintenance, upkeep, and revision of the City of *Tulsa Multi-Hazard Mitigation Plan* (Chapter 9).

In December 2005, the Multihazard Mitigation Council of the National Institute of Building Sciences completed a study to assess future savings from mitigation activities. Their findings reflect the fact that mitigation activities in general produced over $4 in savings for every $1 invested in mitigation actions, with the greatest savings in the areas of flood-related events (5:1) and wind-related events (3.9:1).

The objective of this plan is to provide guidance for mitigation activities for the next five years. It will ensure that the City of Tulsa implements hazard mitigation activities that are most effective and appropriate for the natural hazards that threaten the community.

1.1.2 Scope of the Plan

The scope of the *City of Tulsa Multi-Hazard Mitigation Plan Update* is citywide. It addresses 16 natural and manmade hazards deemed a threat to the citizens of Tulsa. Both short-term and long-term hazard mitigation opportunities are addressed beyond existing federal, state, and local funding programs.

1.1.3 Authority

The Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended, provides new and revitalized approaches to mitigation planning. In particular, Title 42 USC., Section 5165 includes as a primary requirement the development and submission for federal approval a plan that identifies the natural hazards, risks, and vulnerabilities of the respective jurisdictions and establishes specific mitigation measures and strategies. As stated above, revisions to the Act make it clear that no federal assistance is available to an otherwise eligible jurisdiction if no Hazard Mitigation Plan has been adopted and is in effect.

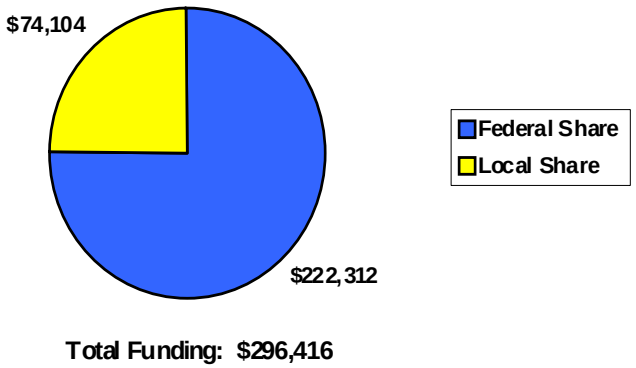
This requirement, in concert with other sections of the Act, provides a significant opportunity to reduce the City of Tulsa's disaster losses through mitigation planning.

1.1.4 Funding

Funding for the *City of Tulsa Multi-Hazard Mitigation Plan Update* was provided by a grant through the Hazard Mitigation Grant Program (HMGP) from the Federal Emergency Management Agency (FEMA) and the Oklahoma Department of Emergency Management (OEM), for a total of $296,416. Of the total grant amount, 75% is provided through the HMGP. The 25% local share may be provided

either through cash funding or through in-kind goods and services. Documented regular and active participation by local governmental agencies, businesses and local residents allowed the City of Tulsa to achieve its local share of the grant amount ($74,104).

Figure 1–1: City of Tulsa Multi-Hazard Mitigation Plan Funding



1.1.5 Goals

The Multi-Hazard Mitigation Council of the National Institute of Building Sciences has concluded, *"Mitigation is most effective when carried out on a comprehensive, community-wide, and long-term basis. Single activities can help, but carrying out a slate of coordinated mitigation activities over time is the best way to ensure that communities will be physically, socially, and economically resilient to future hazard impacts."*

The Tulsa Technical Advisory Committee (TTAC) and the Tulsa Citizens' Advisory Committee, the Storm Drainage and Hazard Mitigation Advisory Board (SDHMAB) developed the goals for the *City of Tulsa Multi-Hazard Mitigation Plan Update*, 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 benefit 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 goals are to:

1. Substantially increase public awareness of natural hazard risk so that the public demands safer communities in which to live and work, and
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 Standard Natural Hazards Mitigation Plan (updated 2011) to guide all levels of government, business, and the public in the reduction or elimination of the effects of natural disasters. The primary goals of the plan are to:

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

The key measures to implement these goals include:

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

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

City of Tulsa's Goal

To improve the safety and well-being of the citizens residing and working in the City of Tulsa by reducing the potential for deaths, injuries, property damage, environmental and other losses from natural hazards, and to do this in a manner that creates a disaster-resistant community, enhances economic development opportunities, and advances community goals and quality of life resulting in a more livable, viable, and sustainable community.

Goals for the mitigation of each of the hazards are presented in Chapter 6.

1.1.6 Definition of Terms

Hazard Mitigation is defined as: Sustained actions taken to reduce or eliminate long-term risk to human life and property from natural, man-made, and technological hazards and their effects. Note that this emphasis on "long-term" risk distinguishes mitigation from actions geared primarily to emergency preparedness and short-term recovery.

A glossary of additional terms commonly used in hazard mitigation is included in Appendix A.

1.1.7 Points of Contact

The primary points of contact for information regarding this plan are:

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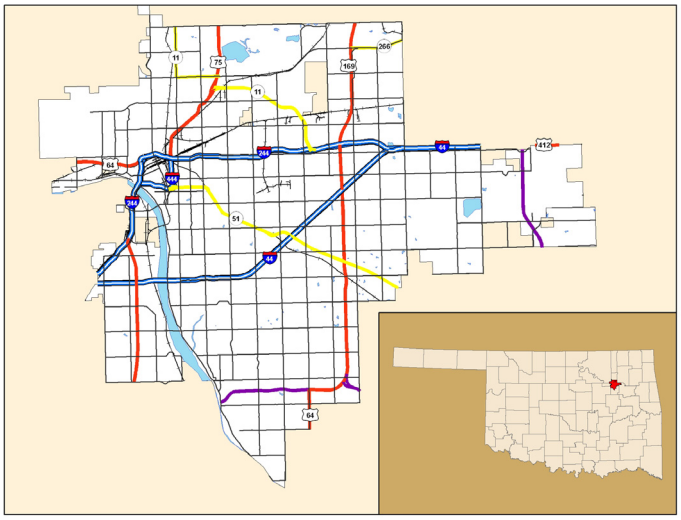
1.2 Community Description

The City of Tulsa is faced with a variety of hazards, both natural and man-made. While winter storms, dam releases, lightning, floods, and tornadoes have made national headlines in recent years, any part of a city can be impacted by these as well as high winds, drought, hail, fire, and other threats. In some cases, such as flooding and dam failure, the areas most at risk have been delineated and mapped. A basemap of the City of Tulsa, with its major features and highways, is shown in Figure 1–3.

Figure 1–2: City of Tulsa Locator Map



The City of Tulsa is primarily located in Tulsa County, in Northeast Oklahoma, 99 miles northeast of Oklahoma City, at the intersection of Interstate 44 and the Arkansas River. Tulsa has a total area of 200 square miles and had a 2010 Census population of 391,906.

1.2.1 Governance

The City of Tulsa was established as a town in 1898 under territorial law while Oklahoma was designated as Indian Territory. After Oklahoma became the 46th state in 1907, the City of Tulsa adopted its first city charter on July 3, 1908.

The City was governed by a Board of Commissioners comprised of a Mayor and four Commissioners - Police & Fire, Streets & Public Property, Waterworks & Sewerage, and Finance & Revenue. This form of government prevailed until May 8, 1990, when it changed to a Mayor and City Council form.

All legislative powers of the City of Tulsa, except for the rights of initiative and referendum reserved to the people of the City of Tulsa by the Constitution of Oklahoma, are exercised by a Council composed of nine Councilors elected by districts.

The executive and administrative powers of the City of Tulsa and any executive and administrative powers conferred on the city by the Constitution or the laws of Oklahoma are exercised by the Mayor.

1.2.2 Geography

Latitude: 36.15 N Longitude: 95.98 W FIPS Code: 040-75000

Tulsa is situated between the edge of the Great Plains and the foot of the Ozark Mountains in a generally forested region of rolling hills. The city touches the eastern extent of the Cross Timbers, an ecoregion of forest and prairie transitioning from the drier plains of the west to the wetter forests of the east. With a wetter climate than points westward, Tulsa serves as a gateway to "Green Country", a designation for northeast Oklahoma that stems from the region's green vegetation and relatively high amount of hills and lakes compared to central and western areas of Oklahoma, which lie largely in the drier Great Plains region of the Central United States.

Northeastern Oklahoma is the most topographically diverse part of the state, containing seven of Oklahoma's 11 ecoregions and more than half of its state parks. The region encompasses 30 lakes or reservoirs and borders the neighboring states of Kansas, Missouri, and Arkansas.

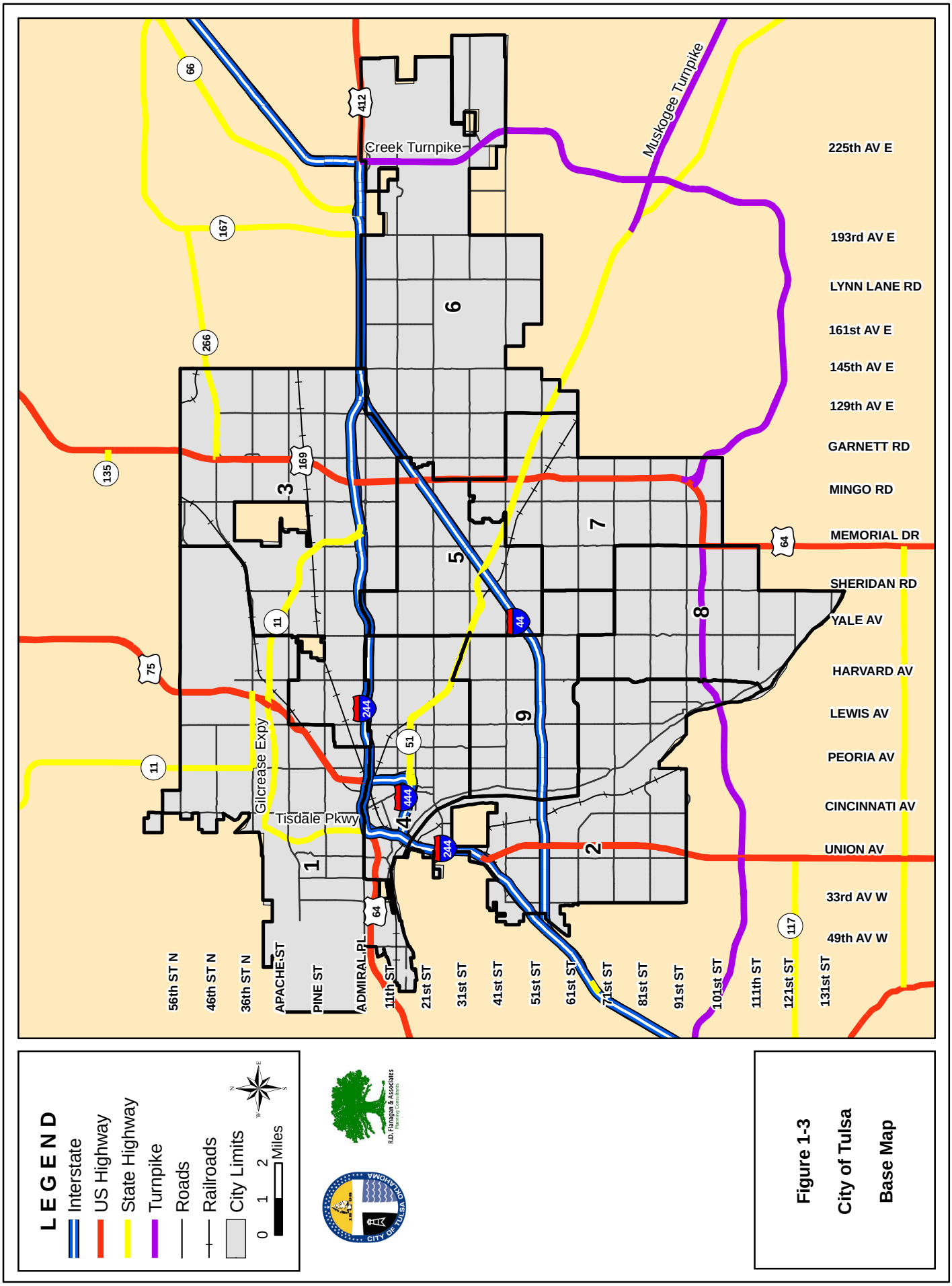


Figure 1-3
City of Tulsa
Base Map

The city is split by the prominent Arkansas River, which flows in a wide, sandy-bottomed channel. Its flow through the area is controlled by upstream flood control reservoirs, but its width and depth can vary widely throughout the year. However, a low-water dam maintains a full channel at all times in the area adjacent to downtown Tulsa. Heavily wooded and with abundant parks and water areas, the city holds several prominent hills, especially in its southern portions. While its central and northern sections are generally flat to gently undulating, the Osage Hills extension into the northwestern part of the city further varies the landscape. Holmes Peak in the northwest corner of the city is the tallest point in five counties at 1,030 ft.

1.2.3 Climate

Tulsa is situated near the heart of Tornado Alley and has a temperate climate with a yearly average temperature of 61°F and an average rainfall of 39 inches. Weather patterns vary by season with occasional extremes in temperature and rainfall.

Lightning over downtown Tulsa is common in the spring months

Primarily in the spring and early summer months, the city is vulnerable to severe thunderstorms containing large hail, damaging winds, or small tornadoes, providing the area with a disproportionate share of its annual rainfall. Severe weather is not limited, though, to this season. On December 5, 1975, Tulsa experienced a tornado. Due to its potential for major flooding events, the city has developed one of the most extensive flood control systems in the nation. A comprehensive flood management plan was developed in 1984 following a severe flood caused by a stalled weather front that dropped 15 inches of rain overnight, killing 14, injuring 288, and destroying 7,000 buildings totaling $180 million in damage. In the early 1990s and again in 2000, FEMA honored Tulsa as leading the nation in floodplain management.

Weather averages for Tulsa are listed in Table 1-1. Temperatures of 100° F or higher are often observed from July to early September, usually accompanied by high humidity brought in by southerly winds. Lack of air circulation, due to heat and humidity during the summer months, leads to higher concentrations of ozone, prompting the city to release “Ozone Alerts” that encourage all parties to do their part in complying with the Clean Air Act and E.P.A. standards. The autumn season is usually short, consisting of pleasant, sunny days followed by cool nights. Winter temperatures, while generally mild, occasionally experience extremes below 0° while annual snowfall averages about 9 inches.

Table 1–1: Weather averages for Tulsa, Oklahoma

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Avg hi °F	46.7	52.3	61.4	72.1	79.5	87.6	93.2	92.8	84.4	74.2	60.5	50	71.2
Avg low °F	26.3	30.7	38.8	49.7	59	67.7	72.4	70.8	62.3	50.8	38.8	29.9	50
Precip (inches)	1.5	1.8	3	3.9	5.7	4.9	3.4	3.1	4.3	3.7	2.6	2.0	39.8

Source: Weatherbase September 2012

1.2.4 History

The city now known as Tulsa was first settled by the Lockapoka Creek Indians between 1828 and 1836. Driven from their native Alabama by the forced removal of Indians from southeastern states, the Lockapokas established a new home at a site near Cheyenne and S. 18th Street. Under a large oak tree, they rekindled their ceremonial fire. This site was abandoned and destroyed during the Civil War, but afterwards the Lockapoka Creeks returned to their home along the Arkansas and relit the council fire.

In 1848, Lewis Perryman, a prominent Creek rancher, opened a cattle ranch and the first trading post near the Lockapoka settlement. His son George built a large white ranch house here, and in March 1878, a mail station was established at the Perryman store. The community served by the station was officially designated as "Tulsa."

The Oklahoma Jazz Hall of Fame (formerly the Union Train Depot) coexists in the shadow of modern downtown buildings

The big oil strike at Glenpool in 1905, just 15 miles south of Tulsa, made Oklahoma and Indian Territory the center of oil speculation and exploration. At the time of statehood in 1907, Tulsa's population was 7,298.

By 1920, Tulsa had grown to a city of 72,000, primarily due to oil discoveries. During the 1930s and 1940s, the US Army Corps of Engineers built levees along the Arkansas River, primarily to protect the critical oil refineries during the Second World War. During the war, Tulsa grew in importance as an aviation center, with the Spartan School of Aeronautics and the mile-long Douglas Aircraft plant, which produced bombers. Years later, McDonnell-Douglas and Rockwell International would contribute to the nation's space program and national defense.

The 1950s and 60s saw Tulsa grow to the south and east, and into the watersheds of Mingo and Joe Creeks. Flooding on the inland creeks and along the Arkansas River became increasing problems as the town continued to expand. The Corps of Engineers completed the Keystone Dam, on the Arkansas River in 1964. A more detailed discussion of Tulsa's flood history is presented in Chapter 4.

Tulsa enjoyed a period of economic prosperity during the 1970s and early 80s, but with the oil bust of the mid 1980s, Tulsa's economy took a downturn. City leaders searched for opportunities to diversify and to continue to improve the quality of life in one of America's most livable cities. In the year 2000, the focus of community leaders turned to inner-city redevelopment, sustainable growth, and safety from natural hazards. Additional information is in Section 1.2.7 – Economy.

Cultural and Historical Properties

Located in the former estate of oil pioneer Waite Phillips, Philbrook Museum is considered one of the top 50 fine art museums in the United States, and is one of five to offer a combination of historic home, gardens, and art collections. The collections of Thomas Gilcrease are housed at the Gilcrease Museum, which also holds the world's largest, most comprehensive collection of art and artifacts of the American West. The Sherwin Miller Museum of Jewish Art preserves the largest collection of Judaica in the Southwest United States.

Other museums, such as the Tulsa Air and Space Museum, the Oklahoma Jazz Hall of Fame, and the Tulsa Geosciences Center, document histories of the region, while the Greenwood Cultural Center

preserves the culture of the city's African American heritage. The Cultural Center houses a collection of artifacts and photography that document the history of the Greenwood area (known as The Black Wall Street) prior to the Tulsa Race Riot of 1921.

In addition, Cain's Ballroom, considered the birthplace of Western Swing, housed the performance headquarters of Bob Wills and the Texas Playboys during the 1930s. The centerpiece of the downtown Brady Arts District is the Brady Theater, the largest of the city's five operating performing arts venues and listed on the National Register of Historic Places.

The Tulsa Zoo and Living Museum doubles as a museum that documents the cultures and history of various climates in North America.

Tulsa has 55 buildings on the National Register of Historic Places as of September, 2012, including six Historic Districts. These are listed in Table 1-2 and shown in Figure 1-4. In 2011 the *Tulsa Hazard Mitigation Plan: Historic Preservation and Cultural Resources Annex* was adopted as an Annex to the *City of Tulsa Hazard Mitigation Plan*. The study was prepared in accordance with State and Federal guidance. It addresses districts and properties listed in the National Register of Historic Places, art deco buildings, and cultural resources, and their vulnerability to natural and man-made hazards. The plan discusses each historic property in detail, and can be found at web address: www.rdflanagan.com/Tulsa/Tulsa_HP_Plan-9-16-11.pdf.

Table 1–2: National Register of Historic Places - Tulsa, Oklahoma

	Name	Address
1	66 Motel	3660 Southwest Blvd.
2	Ambassador Hotel	1314 S. Main
3	Atlas Life Building	415 S. Boston Ave.
4	Boston Ave Methodist Episcopal Church	1301 S. Boston Ave.
5	Boulder-on-the-Park	1850 S. Boulder Ave.
6	Brady Heights Historic Dist	Bounded by Marshall and Easton, Denver & Cheyenne
7	Cain's Dancing Academy	423 N. Main
8	Circle Theater	10 S. Lewis Ave.
9	Cities Service Station #8	1648 Southwest Blvd.
10	City Veterinary Hospital	3550 South Peoria Ave.
11	Clinton-Hardy House	1322 S. Guthrie Ave.
12	Convention Hall	105 W. Brady St.
13	Cosden Building	409 S. Boston Ave.
14	Creek Council Tree Site	18th and Cheyenne Ave.
15	Dawson School	Jct. of East Ute Pl & N. Kingston Pl.
16	Carl K. Dresser House	235 W. 18th St.
17	Eleventh Street Arkansas River Bridge	US 66 over Arkansas R., from Tulsa to W. Tulsa
18	Gillette Historic District	Bounded by S. Yorktown & S. Lewis, E. 15th & E. 17th
19	Gillette-Tyrell Building	423 S. Boulder Ave.
20	Harwelden	2210 S. Main
21	Holy Family Cathedral, Rectory, & School	W. 8th and S. Boulder Ave.
22	Hooper Brothers Coffee Company Bldg	731--733 E. Admiral
23	Robert Lawton Jones House	1916 E. 47th St.
24	Maple Ridge Historic Residential Dist	Roughly bounded by Hazel, S. Peoria, 14th, & Railroad
25	Mayo Hotel	115 W. 5th St.
26	James McBirney House	1414 S. Galveston Ave.
27	McFarlin Building	11 E. 5th St.

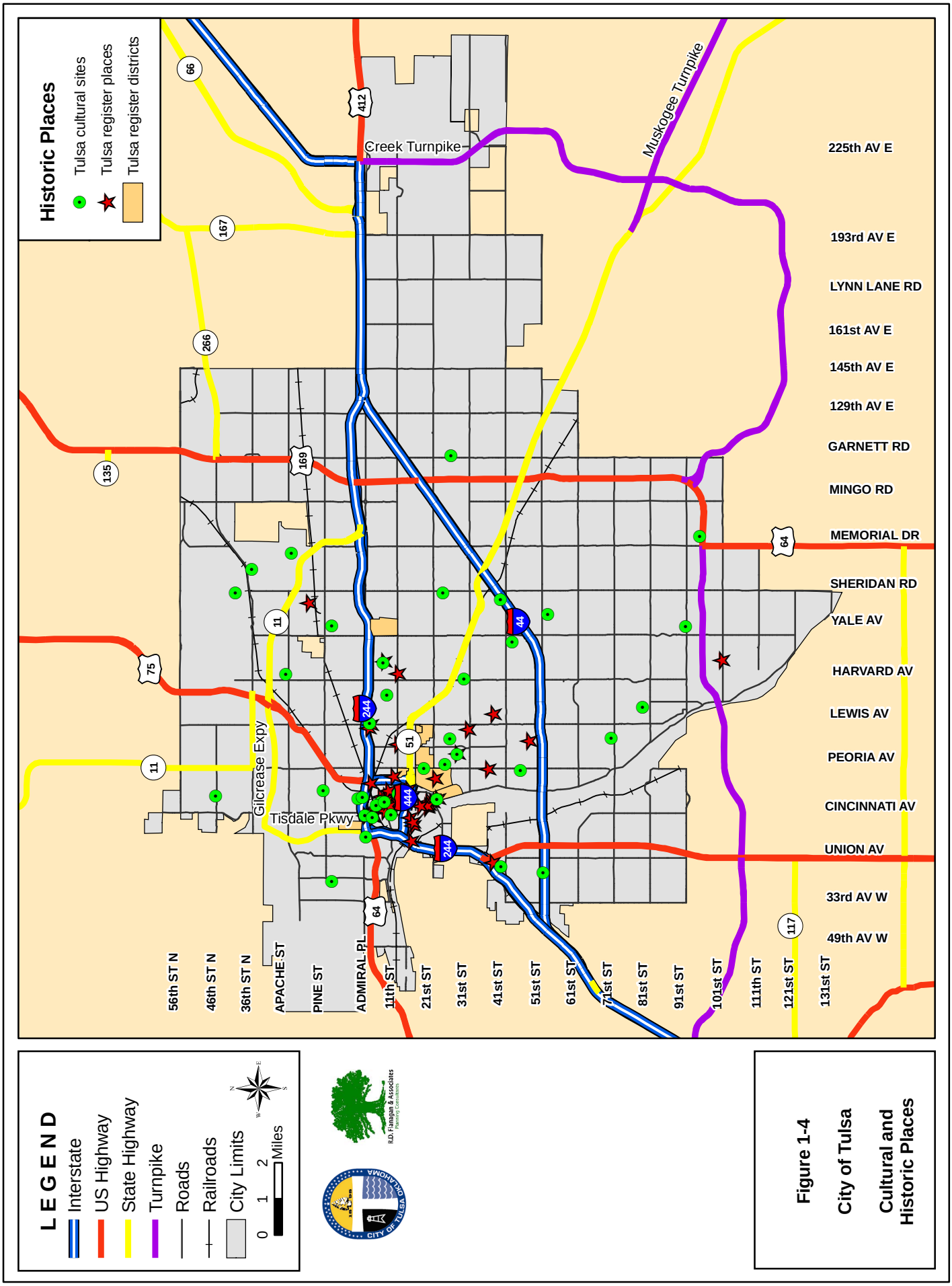


Figure 1-4
City of Tulsa
Cultural and Historic Places

	Name	Address
28	Robert M. McFarlin House	1610 Carson Ave.
29	Mincks-Adams Hotel	403 S. Cheyenne Ave.
30	Moore Manor	228 W. 17th Pl.
31	Mount Zion Baptist Church	419 North Elgin
32	Oklahoma Natural Gas Company Building	624 S. Boston Ave.
33	Foster B. Parriott House	2216 E. 30th St.
34	Petroleum Building	420 S. Boulder Ave.
35	Philcade Building	511 S. Boston Ave.
36	Phillips 66 Station #473	2224 E. Admiral
37	Waite Phillips Mansion (Philbrook)	2727 S. Rockford Ave.
38	Philtower	427 S. Boston Ave.
39	Pierce Block	301 E. 3rd St.
40	Public Service of Oklahoma Building	600 S. Main
41	Riverside Historic Residential District	Roughly bounded by Midland Rail Bike Trail, Riverside, S. Boston, E. 24th & E 21st
42	Riverside Studio	1381 Riverside Dr.
43	Sinclair Service Station	3501 E. 11th St.
44	William G. Skelly House	2101 S. Madison
45	Sophian Plaza	1500 S. Frisco Ave.
46	Southwestern Bell Main Dial Building	424 Detroit Ave.
47	St. John Vianney Training School for Girls	4001 E. 101st St.
48	Swan Lake Historic District	Roughly bounded by E. 15th, S. Utica, E. 21st & S. Peoria
49	Tracy Park Historic District	Roughly bounded by Norfolk, Peoria, 11th & 13th Sts.
50	Tribune Building	20 E. Archer St.
51	Tulsa Convention Hall	105 W. Brady St.
52	Tulsa Fire Alarm Building	1010 E 8th St.
53	Tulsa Monument Company Building	1735 E. 11th St.
54	Tulsa Municipal Building	124 E. 4th St.
55	United States Post Office & Courthouse	224 S. Boulder Ave.
56	James Alexander Veasey House	1802 S. Cheyenne Ave.
57	Vickery Phillips 66 Station	602 S. Elgin Ave.
58	Westhope	3704 S. Birmingham Ave.
59	Will Rogers High School	3909 E. 5th Pl.
60	White City Historic District	Roughly bounded by E. 2nd, S. Fulton /Frisco RR Tracks, E. 11th, & S. Yale
61	Yorktown Historic District	Bounded by 16th & 17th, Victor & Wheeling, 20th, & Lewis

1.2.5 Demographics

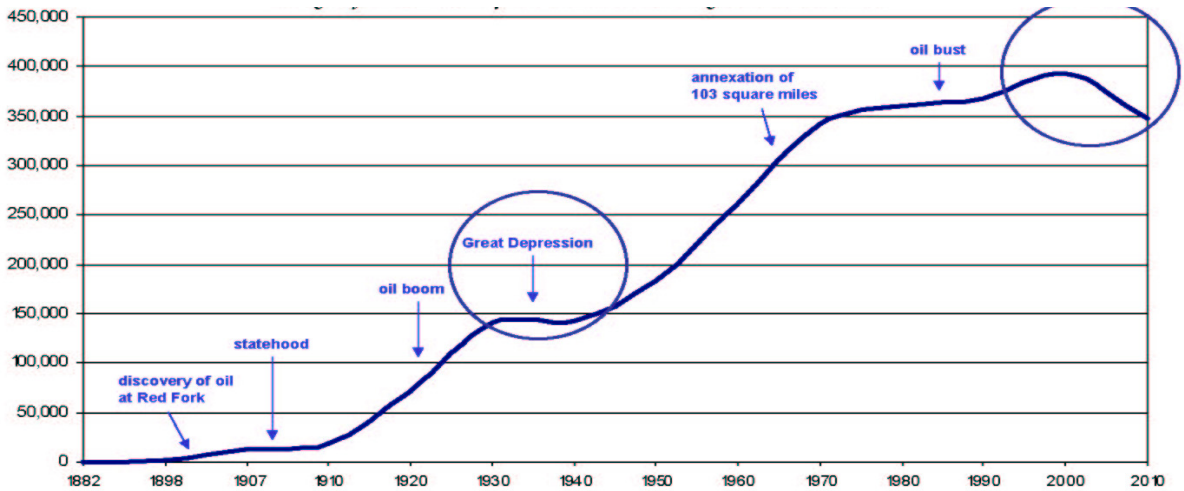
Demography is the use of population characteristics (e.g., age and income distribution and trends, mobility, educational attainment, home ownership and employment status) for purposes of social studies.

As was clearly demonstrated in Hurricane Katrina in 2005, the vulnerability of a segment of a community to disasters will often vary according to demographic factors such as income level, age, race, language, education, disability and home ownership. For example, individuals and families in low-income areas often have less extensive safety nets (transportation, savings, credit, food supplies, and extended family networks) than those in high-income districts. Similarly, aging populations are more vulnerable to extreme heat and cold and often have fewer financial resources for purchasing

supplies. Knowing the size and geographical location of potential at risk populations (such as small children, the elderly and the impoverished) are important to assessing the community's vulnerability.

Tulsa's population declined from 393,049, in 2000 to 391,906 in 2010. Over the last 10 years, the population of Tulsa has been declining for the first time since the Great Depression in the 1930s. East Tulsa is the only region of the City of Tulsa showing signs of growth, with an 18% population increase since 2000. For an overall view of the City of Tulsa population history since 1882, see Figure 1-5. All other things being equal, this decline is anticipated to continue for the next few years. A great deal of this is due to population movement to Tulsa suburbs and neighboring communities. During the 1990's, the growth rate for Tulsa County was twice that of the City of Tulsa and the movement to the communities of Bixby, Broken Arrow, Jenks, and other suburbs is continuing. One factor to consider is that while residential living is moving to the suburbs, many of these suburban residents continue to work in the City of Tulsa. For additional information on growth of nearby communities, see Table 1-3.

Figure 1–5: City of Tulsa Population History, 1882 - 2010



Source: Community Service Council Census Information Center

According to the Community Service Council, the fastest growing parts of Tulsa County are the suburban areas− primarily Jenks, Bixby, Owasso, Collinsville, Glenpool, and Broken Arrow—all of which experienced at least 30% growth during the decade. Table 1-3 was provided by the Community Service Council and updated using 2010 Census Data. The table shows the populations of select cities in Tulsa County for each Census report since 1970.

Table 1–3: Select Cities in Tulsa County Population Data

	Broken Arrow	Sand Springs	Owasso	Bixby	Glenpool	Jenks	Collinsville
1970	11,787	10,565	3,491	3,973	770	1,997	3,009
1980	35,761	13,121	6,149	6,969	2,706	5,876	3,556
1990	58,043	15,346	11,151	9,502	6,688	7,493	3,612
2000	74,859	17,451	18,502	13,336	8,123	9,557	4,077
2010	98,850	18,906	28,915	20,844	10,808	16,924	5,606

Source: Community Service Council/2010 US Census Data

The density of Tulsa in 2010 was 1,991.9 people per square mile, compared with the population density of Tulsa County at 1,058.1 per square mile. The population center of the city is 36th Street South and Pittsburg Ave, while the geographic center is 26th and Memorial, 2½ miles to the east-northeast.

Of Tulsa's population, 24.5% are under 18 years of age and 12.5% are over 65. About 66% of Tulsa's population is in the labor force (16 years of age and older). Tulsa's demographic data is summarized in Table 1-4. A map displaying the population density of the City of Tulsa is shown in Figure 1-6. Maps depicting the information listed in the table are included in Figures 1-7 through 1-14. Tulsans, on the average, are better educated than other Americans. Over 29 percent of Tulsans above the age of 25 have a bachelor's degree or better. Nine percent of the city's population over the age of 25 has a graduate or professional degree, which is higher than the national average.

Table 1–4: City of Tulsa Population Data

Subject	*Number (2000)*	*City % (2000)*	*State % (2000)*	*Number (2010)*	*City % (2010)*	*State % (2010)*
Total Population	393,049	100	11.4	391,906 ↓	100	8.7 ↑
Under 5 years old	28,318	7.2	6.8	29,392↑	7.5 ↑	7.0 ↑
Between 5-18 years old	69,022	17.6	19.1	96,017 ↑	24.5 ↑	24.8 ↑
65 years and older	50,508	12.9	13.2	48,988 ↓	12.5 ↓	13.5 ↑
White	275,488	70.1	76.2	245,333 ↓	62.6 ↓	72.2 ↓
African-American	60,794	15.5	7.6	62,313 ↑	15.9 ↑	7.4 ↓
Native American	18,551	4.7	7.9	20,771 ↑	5.3 ↑	8.6 ↑
Hispanic	28,111	7.2	5.2	55,258 ↑	14.1 ↑	8.9 ↑
Language other than English spoken at home (5 years and over)	36,209	9.9	7.4	53,691 ↑	13.7 ↑	8.8 ↑
Poverty Status * (Families)	10,840	13.8	11.2	15,144↑	15.9 ↑	11.9 ↑
Poverty Status * (Individuals)	54,121	20.2	14.7	75,637↑	19.3 ↓	16.2 ↑

Source: 2000, 2010 US Census Data/*American Community Survey

**The American Community Survey is a 5-year estimate for 2006 to 2009, released in 2010 prior to release of official 2010 statistics. These results are at variance with 100% 2010 Census figures.*

1.2.5.1 Vulnerable Populations

In any community, there are residents who may have greater vulnerability to the effects of disasters than does the general population. These groups may have little or nothing in common, and their needs may be very different. There is no "one size fits all" solution for handling populations with greater vulnerability. Some may need special consideration in warning, communication or evacuation, some may have special sheltering needs, whether medical or non-medical, and some may require other considerations in emergency planning and mitigation. Almost all have the ability to participate in a meaningful and active way in the planning, response, and mitigation activities of the community.

> *"The term "special needs" is widely used within the emergency management world. It generally refers to an extremely broad and heterogeneous population, including people with disabilities, minority groups, people who do not speak English, children and the elderly. Given this lack of specificity, it is conceivable that "special needs" could cover over 50 percent of the nation's population, rendering the term meaningless. These groups represent a large and complex variety of concerns and challenges. Many of these groups have little in common beyond the fact that they are often left out of emergency planning." (June Isaacson Kailes, Disability Policy Consultant. From the International Association of Emergency Managers Bulletin, Vol. 22, No. 4, April 2005.)*

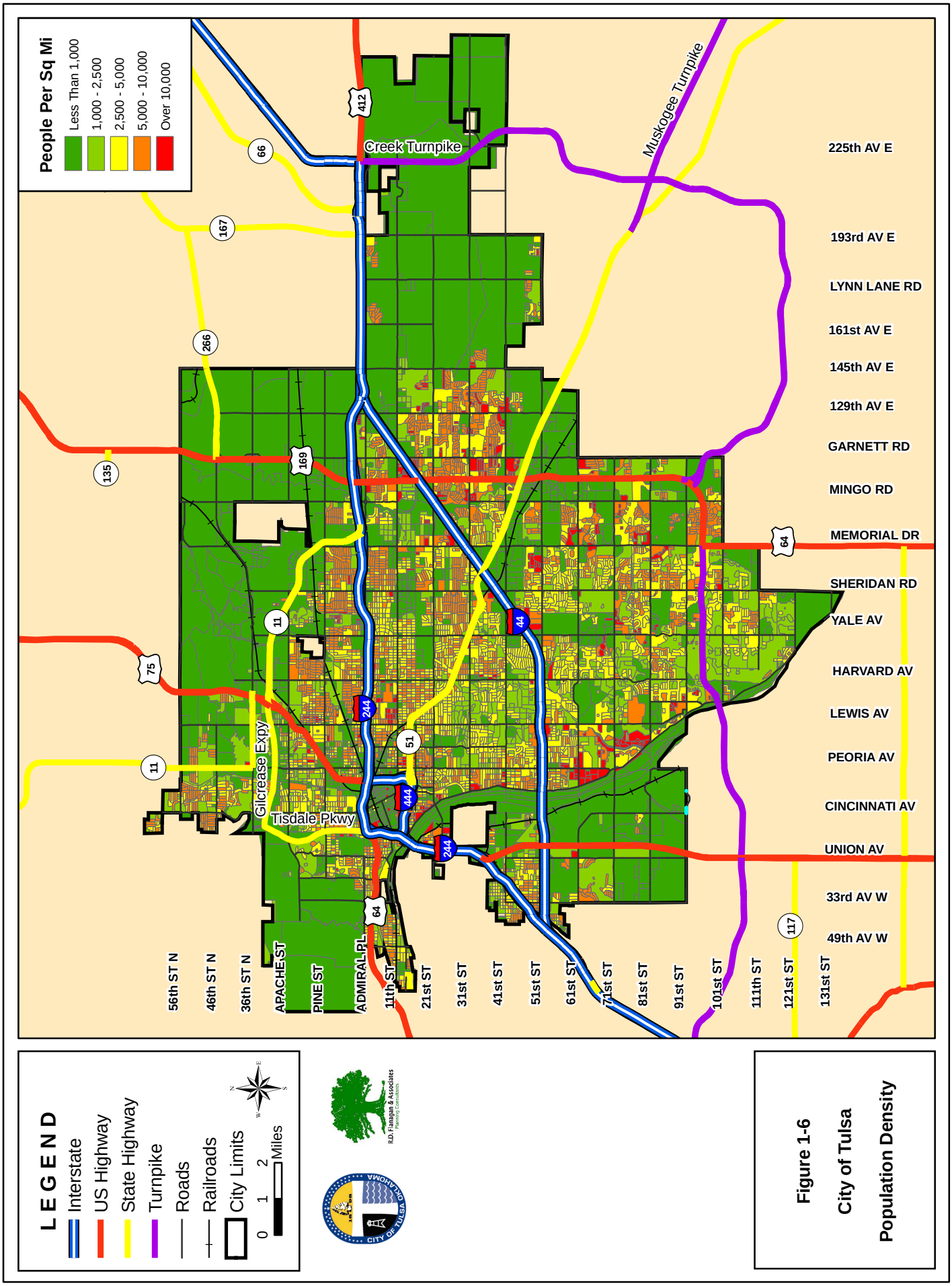


Figure 1-6
City of Tulsa
Population Density

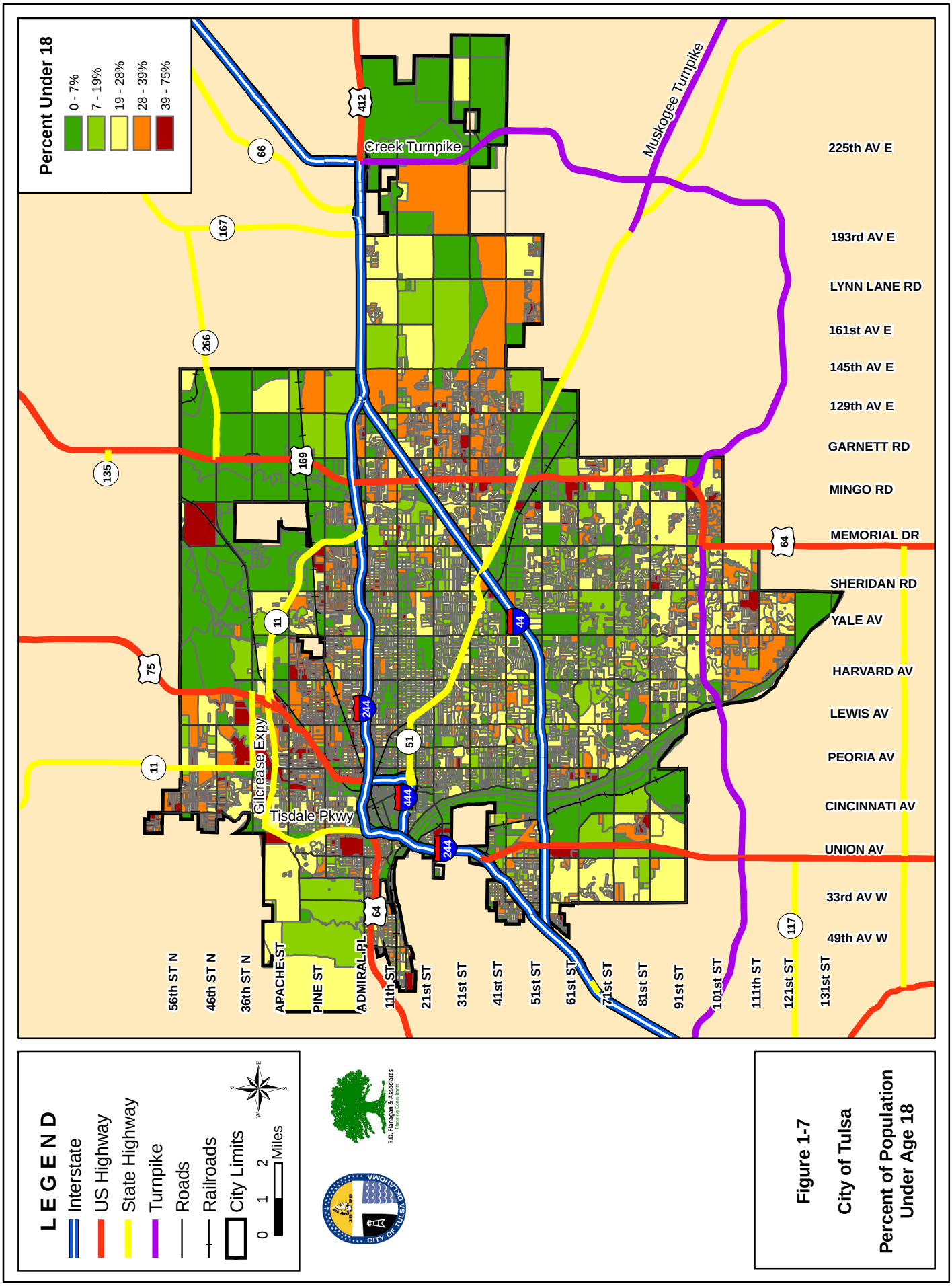
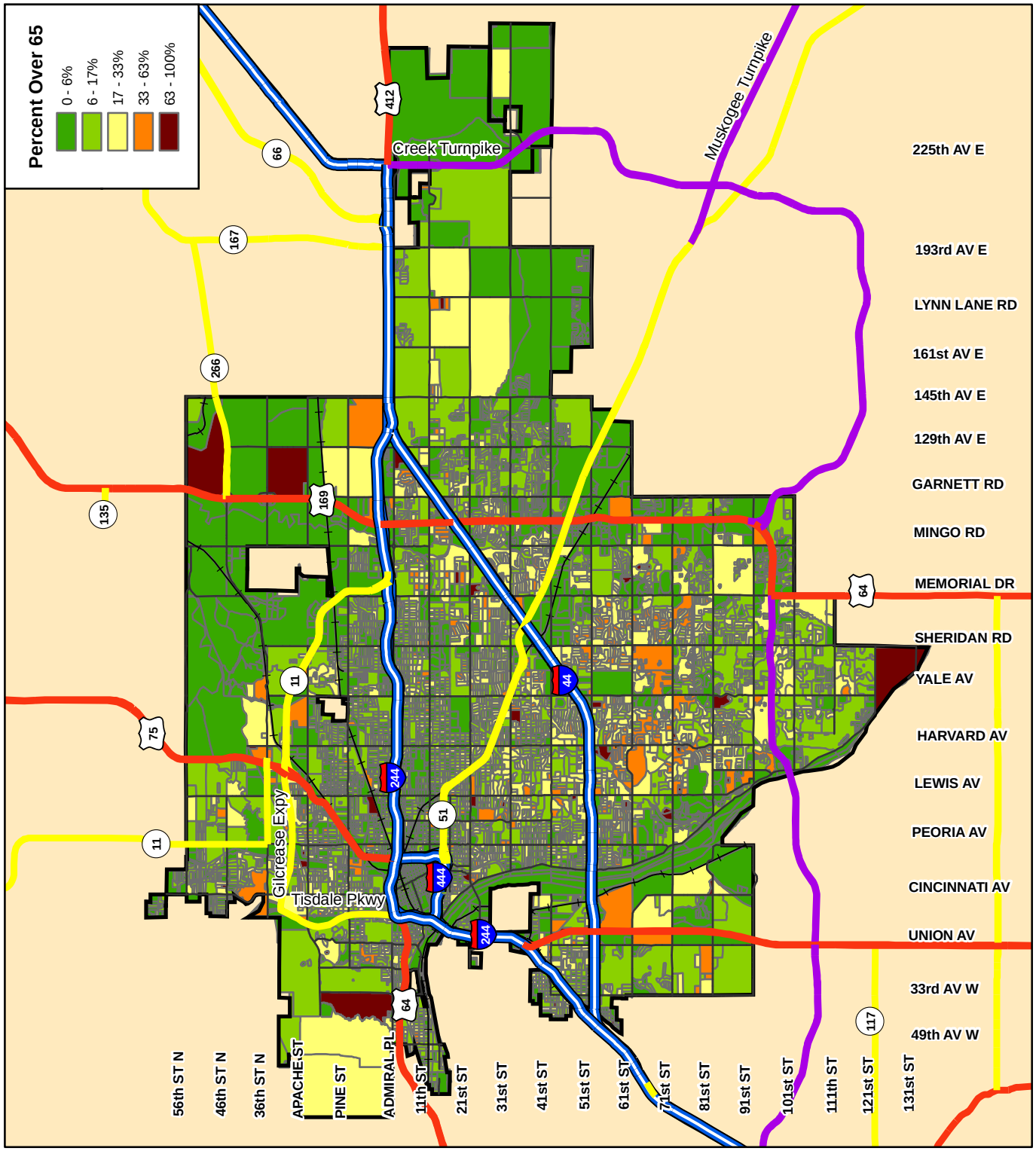


Figure 1-7
City of Tulsa
Percent of Population Under Age 18



LEGEND

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

0 1 2 Miles

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Figure 1-8
City of Tulsa
Percent of Population Age 65 and Older

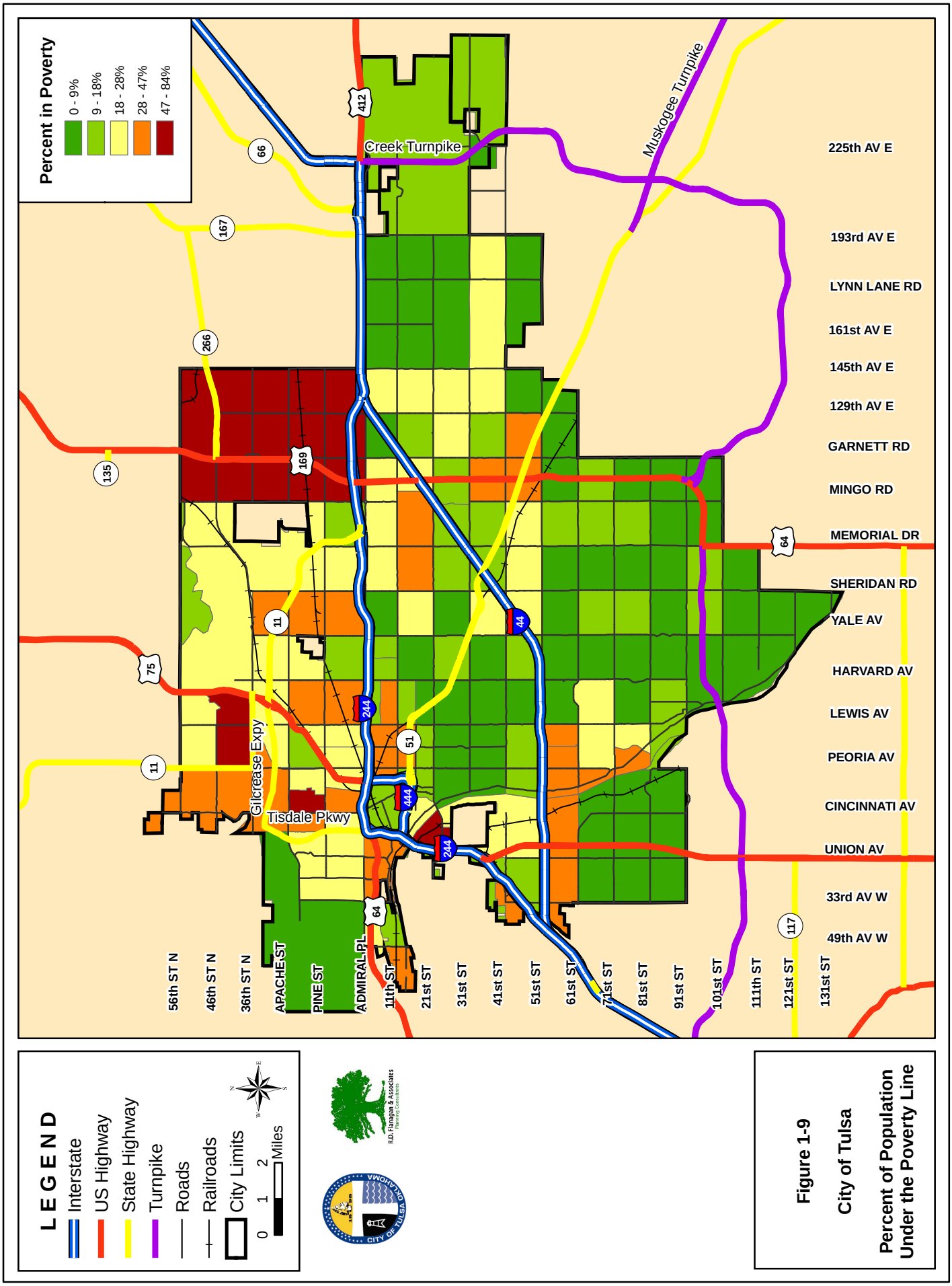


Figure 1-9
City of Tulsa
Percent of Population Under the Poverty Line

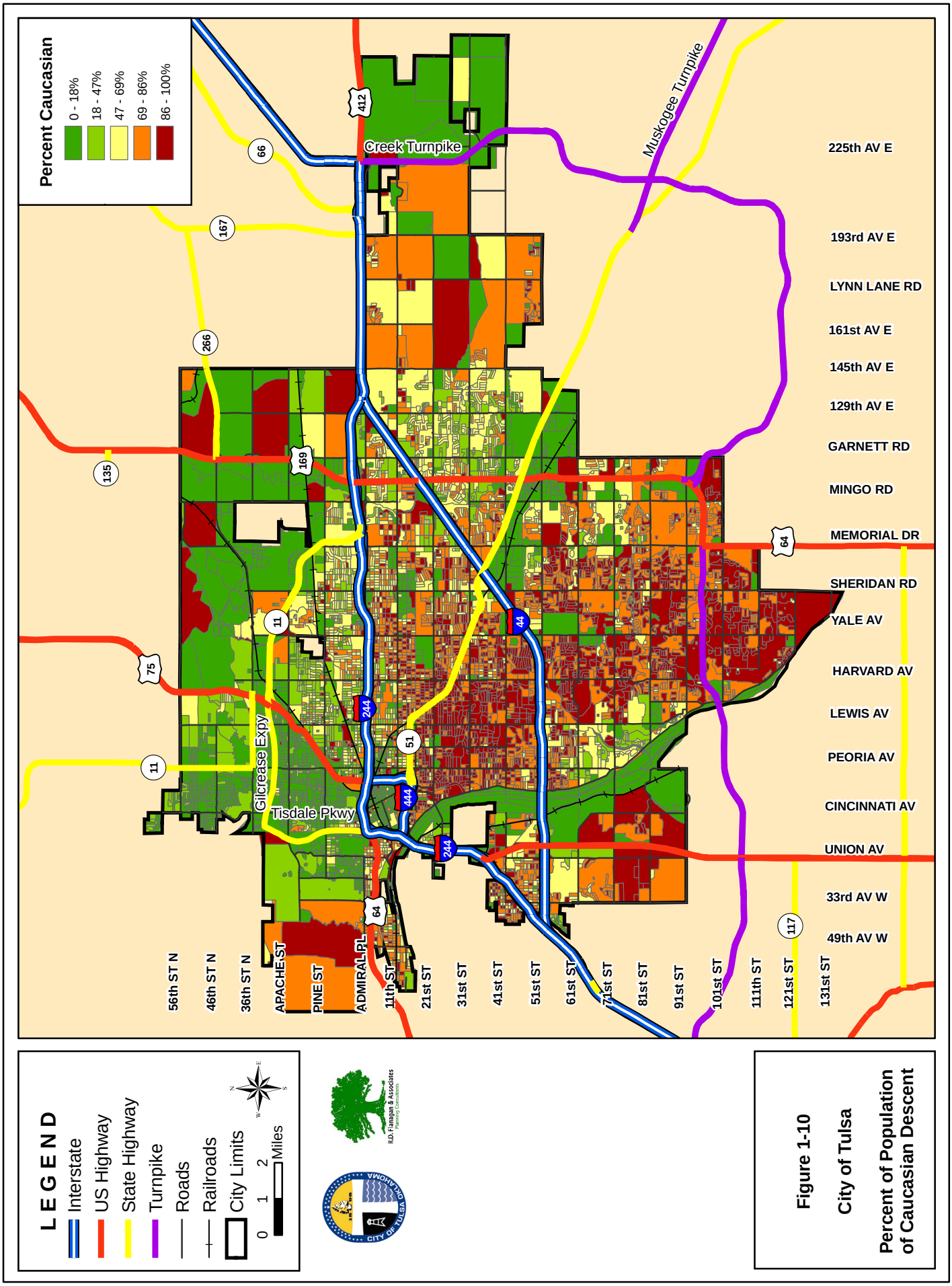


Figure 1-10
City of Tulsa
Percent of Population of Caucasian Descent

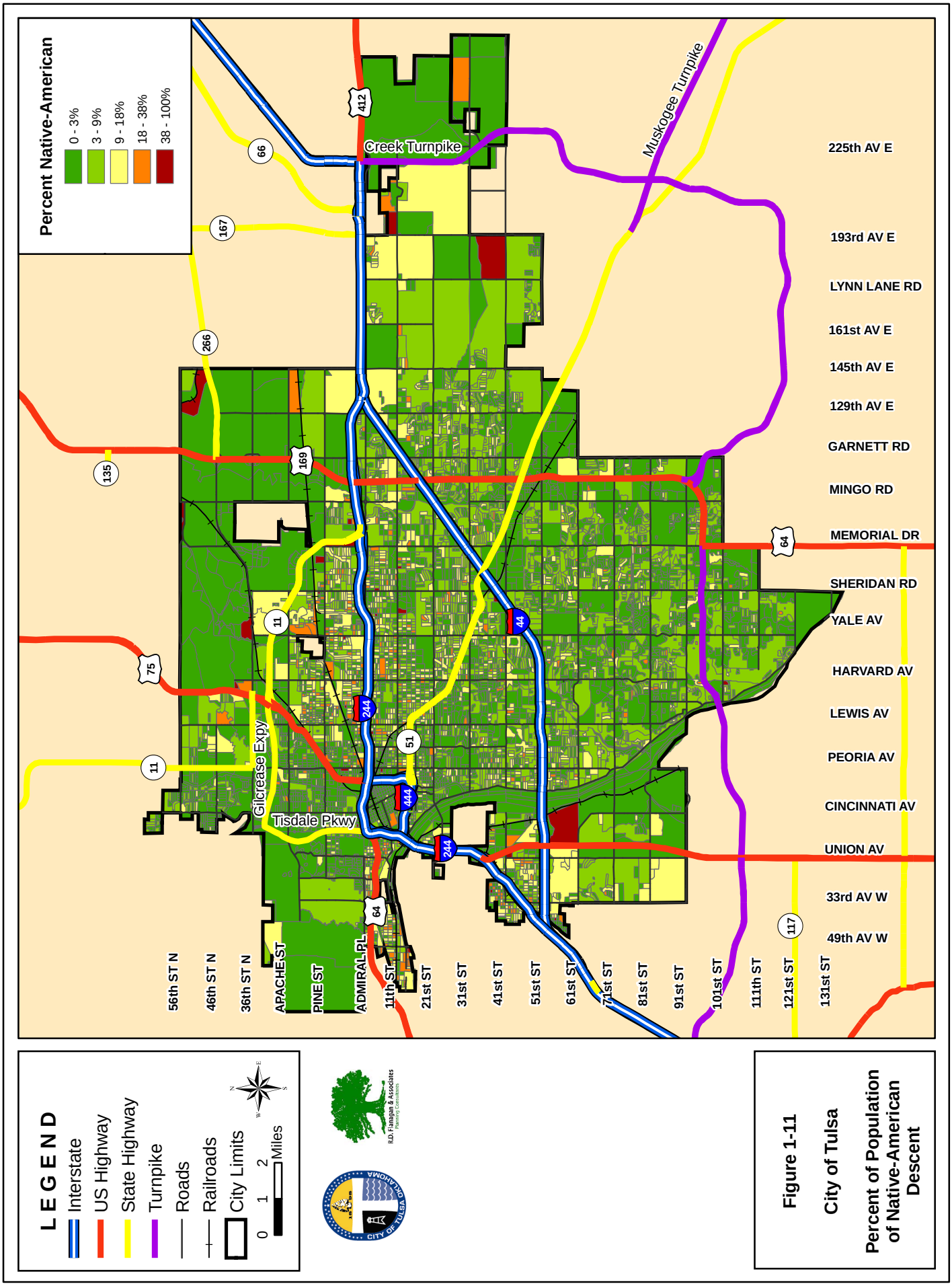


Figure 1-11
City of Tulsa
Percent of Population of Native-American Descent

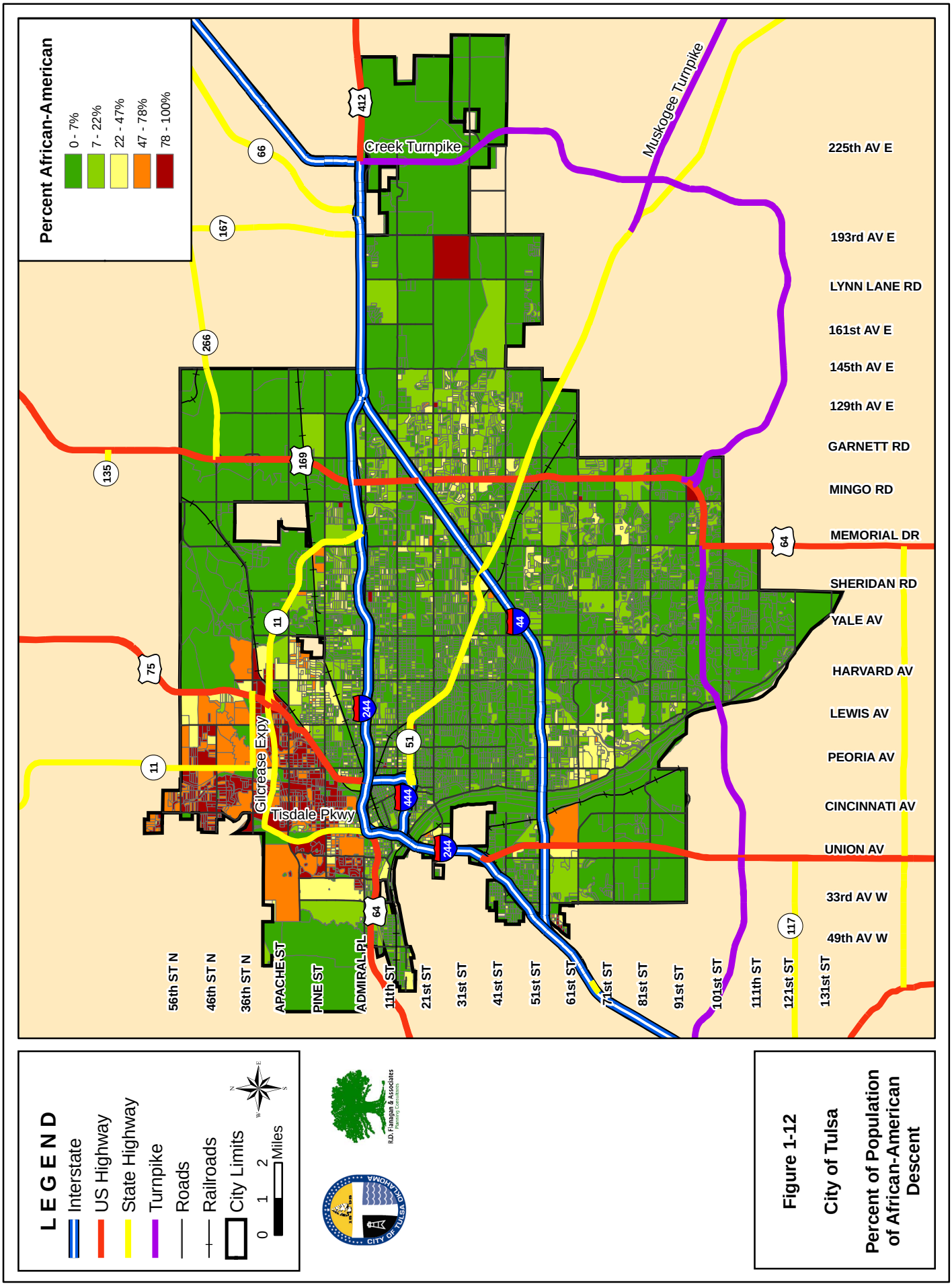


Figure 1-12
City of Tulsa
Percent of Population of African-American Descent

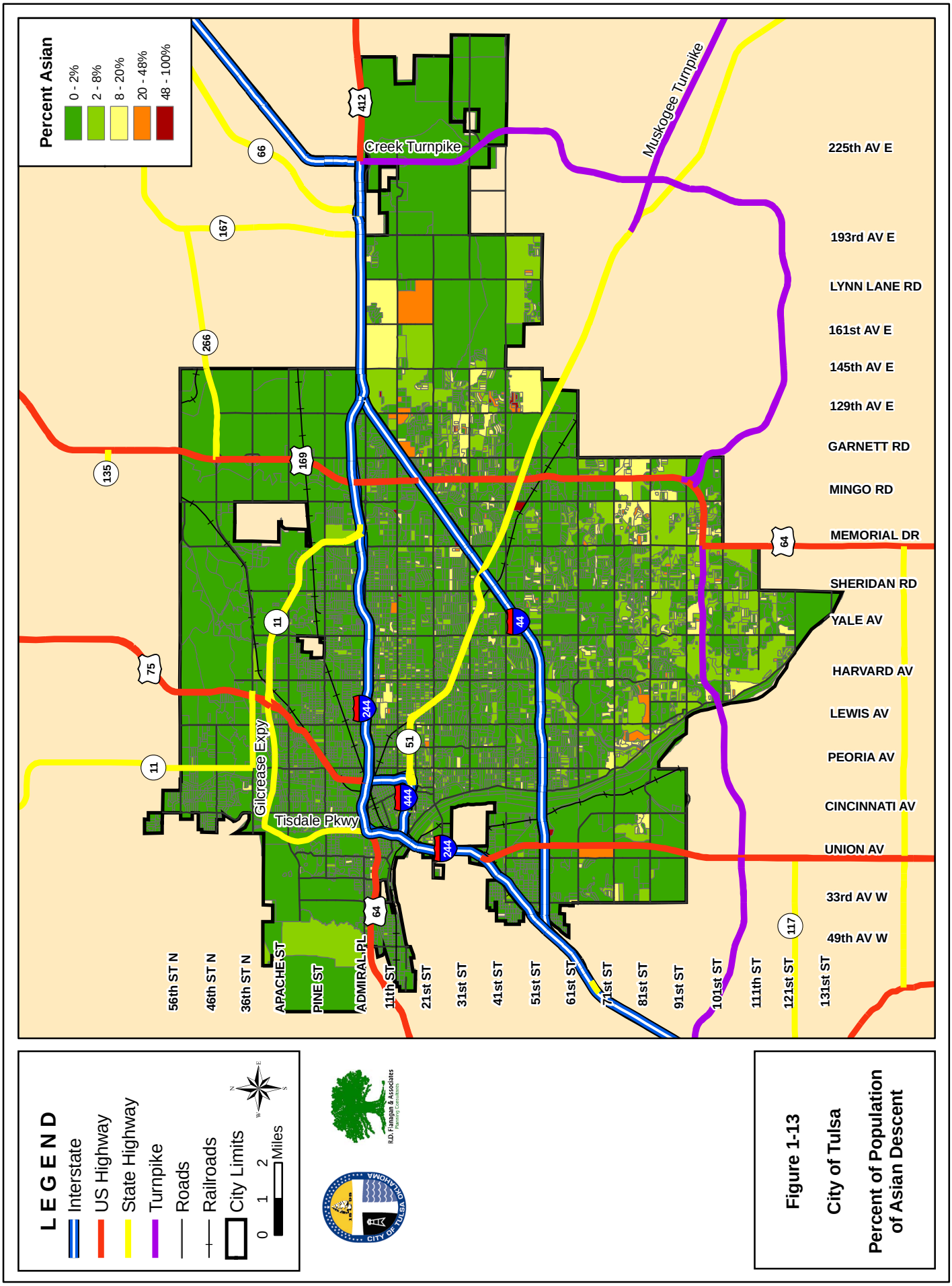


Figure 1-13
City of Tulsa
Percent of Population of Asian Descent

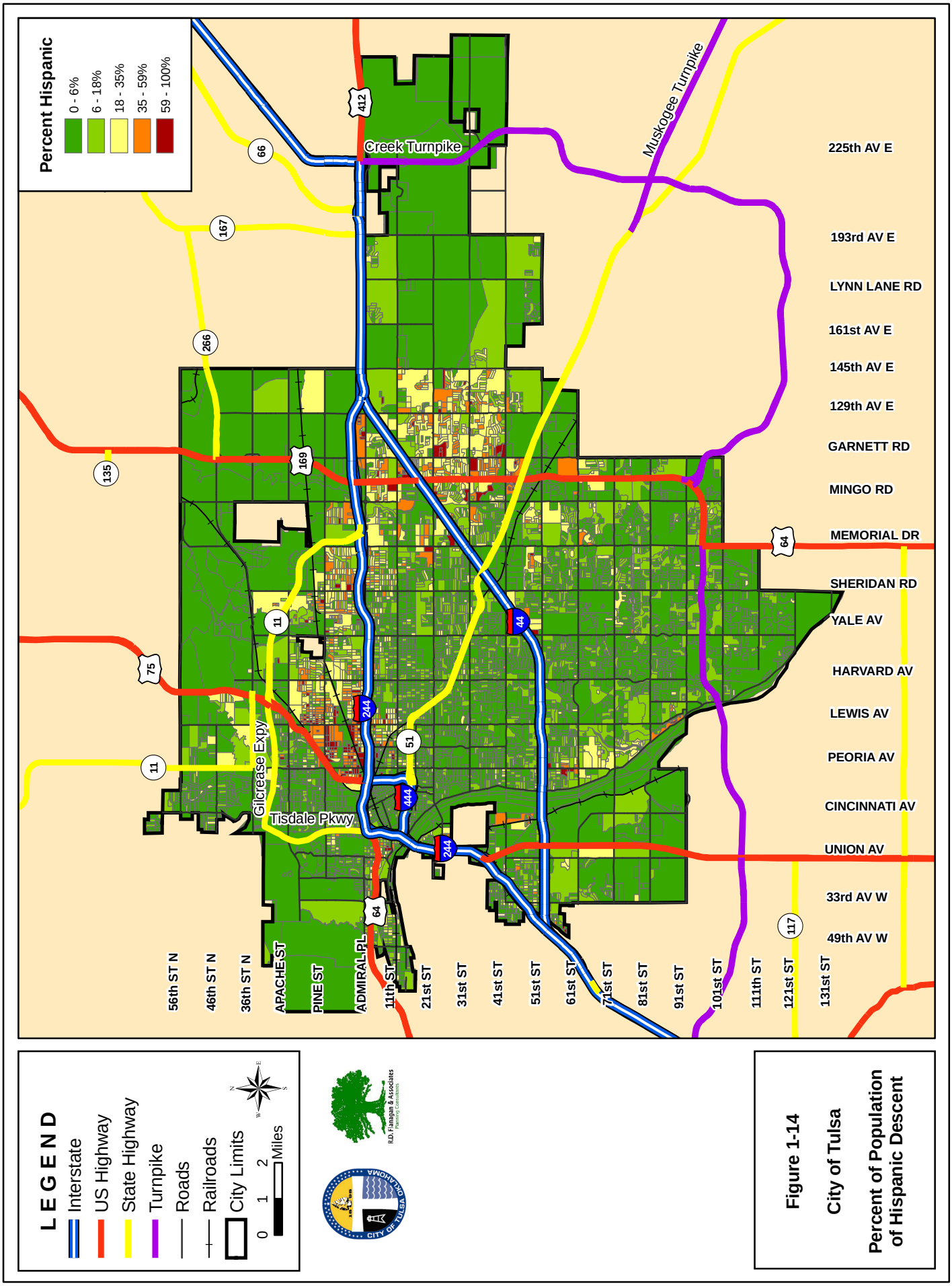


Figure 1-14
City of Tulsa
Percent of Population of Hispanic Descent

These vulnerable populations may include:

- The elderly;
- People in poverty;
- People who speak a language other than English;
- People with mobility, hearing, visual or other physical disabilities;
- People with developmental or other cognitive disabilities;
- People with no access to private transportation;
- People with medical needs or medical/life support devices;
- People with pets.

Note: Maps portraying areas of Tulsa with a high density of the elderly, persons living in poverty, and potentially non-English speaking populations may be found in figures 1-7 through 1-14.

1.2.6 Lifelines

Lifelines are defined as systems that are necessary for human life and urban function, especially during emergencies. Transportation and utility systems, as well as emergency service facilities are considered the lifelines of a community. Transportation systems include interstate, US and state highways, roadways, railways, waterways, ports, harbors, and airports. Utility systems consist of electric power, gas and liquid fuels, telecommunications, water, and wastewater. Emergency service facilities include Emergency Alert System (EAS) communication facilities, hospitals, and the police and fire departments. Emergency service facilities are dealt with in detail in Section 2.6.

Utility Systems

Water Service

Tulsa's raw water is brought from Spavinaw/Eucha and Oologah Lakes. Lake Hudson, located approximately 40 miles to the east of the city, has provided water in the past and remains available for future use.

The first Spavinaw flowline is 54 inches to 60 inches in diameter and is 53.9 miles long. The second flowline from Spavinaw ranges from 66 inches to 72 inches in diameter and is 52.2 miles long.

Yahola Lake and Mohawk Water Treatment Plant ***(Photo Courtesy of Google Earth, 2012)***

The first Oologah flowline is 42 inches in diameter and runs 16.7 miles to the 66-inch Bird Creek to Lynn Lane pipeline that is 7.9 miles long. The second Oologah flowline is 54 inches-72 inches in diameter and is 22.87 miles long.

Raw water is stored in Yahola Lake (2.0 billion gallon capacity) near Mohawk Water Treatment Plant and Lynn Lane Reservoir (1.1 billion gallon capacity) near A.B. Jewell Water Treatment Plant

The two plants treat between 90 and 190 million gallons of drinking water a day. The City of Tulsa supplies drinking water to more than

133,500 metered accounts in the City and more than 500,000 people in the metropolitan area. Treatment plants, distribution lines, and other infrastructure have been built and upgraded over the years to keep pace with Tulsa's growing need for high quality drinking water.

Until the summer of 2011, Tulsa had not been forced to restrict water use since the summer of 1981. Expansion of the A.B. Jewell Plant and construction of the new Mohawk Plant increased Tulsa's treatment capacity to 220 million gallons per day. In the summer of 2011, water use reached an all-time high of 207.6 MGD on August 1, as a result of less rain and higher temperatures, and fell slightly to 207.4 MGD the next day. The previous record of daily water volume was 190.9 MGD, set in 1999.

The Distribution Systems Section has more than 200 full-time equivalent employees who manage and maintain 2,010 miles of underground water lines, and thousands of valves, water meters, more than 14,000 hydrants, and 11 treated water storage reservoirs.

Wastewater Treatment

Tulsa has four wastewater treatment plants – Southside, Lower Bird Creek, Haikey Creek, and Northside – incorporating pumping and grit removal, aeration, sludge treatment, final clarifying and disinfection.

Information on each of the stations is in Table 1-5.

Table 1–5: City of Tulsa Wastewater Treatment Plants

Plant	Built	Upgraded	Lift Stations	Avg flow
Southside	1950	1972 1996	2 offsite 1 onsite	42 MGD
Northside	1958	1984 1995	2 offsite 1 onsite	42.6 MGD
Haikey Creek	1976	1983 1996	2 offsite	16 MGD
Lower Bird Creek	1996	--	2 offsite	2.0 MGD
TOTAL				**102.6 MGD**

In addition, the Northside Plant operates four flow-diversion facilities that are used to store excess flows as rainwater enters the joints of sewer pipes during extreme wet-weather periods. Collectively, they have a capacity of 83.2 million gallons. Following the period of significant rainfall, the stored wastewater is slowly released back into the sewer system and treated at a managed rate.

Electrical Service

Tulsa's electric power is provided by AEP/Public Service Company of Oklahoma (PSO). PSO, which is based in Tulsa, serves 532,000 customers in 232 communities across 30,000 square miles of eastern and southwestern Oklahoma, including approximately 285,000 customers in the Tulsa metropolitan area.

PSO owns 4,308 megawatts of electric generating capacity. It also has 690 megawatts of wind energy under long-term contracts, making it a leader in Oklahoma in promoting use of wind power and

Southside Wastewater Treatment Plant

supporting the state's wind industry. Today, approximately 14% of PSO's energy supplies are made up by wind power.

In addition to its headquarters, PSO's operations in Tulsa include two large service centers housing its transmission and distribution functions, a regional hub for material and supplies, and an energy dispatching center. The company also operates two power plants in the Tulsa area.

PSO is part of the American Electric Power (AEP), which is based in Columbus, OH. AEP is one of the largest electric utility systems in the United States, serving more than 5 million customers across 11 states. AEP also ranks among the nation's largest generators of electricity, owning more than 38,000 megawatts of generating capacity in the US, along with the nation's largest electric transmission system. The service territory of PSO is displayed on the map in Figure 1-15.

Electrical System Outages

The electrical grid infrastructure is vulnerable to a number of the natural disasters that will be addressed in this plan, primarily high winds, tornadoes, and severe winter storms. Table 1-6 displays the number of power outages with greater than 20,000 customers affected from 2003 through 2011 from the primary provider of electrical power in the City of Tulsa.

Figure 1–15: PSO Service Territory in Oklahoma (in Red)

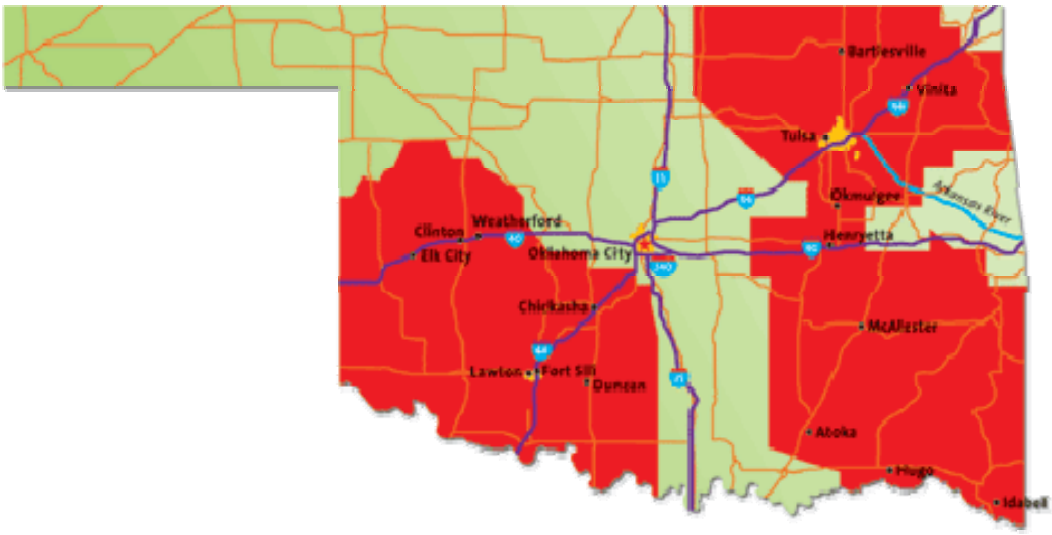


Table 1–6: PSO Outages with Greater Than 20,000 Customers Affected Jan 2003 – Dec 2011

Year	Interruption Start Date	Number of Interruptions	Total Accounts Affected	Total Customer Hours Interrupted	Average Customer Hours (Days) Interrupted	Primary Cause
2003	08/01/2003	349	45,572	332,004	7.29 (0.30)	High Winds
2004	05/13/2004	204	23,443	98,218	4.19 (0.17)	T Storms/High Winds
2004	06/02/2004	508	63,255	1,226,376	19.40 (0.81)	T Storms/High Winds
2005	06/04/2005	296	35,945	340,162	9.46 (0.39)	High Winds
2005	06/16/2005	384	36,729	227,710	6.2 (0.26)	High Winds
2005	11/27/2005	245	34,765	244,247	7.03 (0.29)	High Winds
2007	10/17/2007	324	29,404	182,168	6.2 (0.26)	High Winds
2007	12/09/2007	241	106,837	8,697,662	81.41 (3.39)	Ice Storm

Year	Interruption Start Date	Number of Interruptions	Total Accounts Affected	Total Customer Hours Interrupted	Average Customer Hours (Days) Interrupted	Primary Cause
2007	12/10/2007	579	219,646	16,444,032	74.87 (3.12)	Ice Storm
2007	12/11/2007	138	25,419	904,240	35.57 (1.48)	Ice Storm
2008	06/01/2008	N/A	66,843	983,646	14.72(0.613)	T Storms/High Winds
2009	4/22/2009	N/A	20,882	27,621	1.32(0.06)	Substation Equipment
2010	5/13/2010	N/A	30,318	315,707	10.41(0.43)	T Storms/High Winds
2011	8/10/2011	N/A	22,300	114,953	5.15(0.22)	T Storms/High Winds

It is apparent that, while the majority of these outages are caused by high winds and thunderstorms, the most severe are those from ice storms. This is primarily due to the extensive and widespread physical damage to lines and poles during a heavy ice storm.

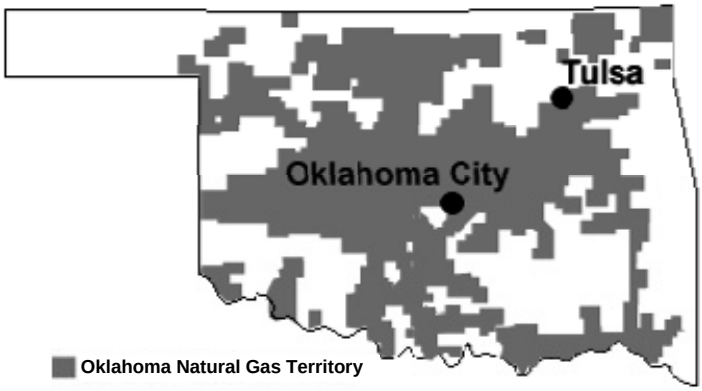
Loss of electrical power is perhaps more critical than the loss of other infrastructure services due to our dependence on power to support the other services – including water treatment plants, telecom services, fuel delivery, and so on. In addition, many people depend on electrically driven life-assistive devices such as breathing machines or dialysis equipment.

Power outages also create additional threats to life and health. Traffic signals may be disrupted, creating the potential for vehicle accidents. In the most recent major power outages in the City of Tulsa, a number of people were treated for carbon monoxide poisoning due to inappropriate use of alternative heating or generating devices. At least 40 were transported to local hospitals with CO related symptoms. Residential fires increased dramatically due to both electric lines coming into the home being damaged, and unsafe alternate sources of heat – charcoal grills, gas stoves and ovens, or combustion heaters. The uses of unattended candles were the cause of some of fires during the 2007 ice storms. Unsafe use of home generators can also put electric service personnel at risk due to "backfeeding" into service lines. For additional information on power outages and emergency generators, see Appendix B, Section B.2.11 and B.2.12.

Natural Gas Service

Tulsa's gas service is provided by Oklahoma Natural Gas (ONG), a subsidiary of its parent company, ONEOK. Founded in 1906, Oklahoma Natural Gas serves approximately 829,000 residential, commercial and industrial customers in Oklahoma. The territory of ONG is shown on the map in Figure 1-16. The company has affiliates that operate transmission and gathering operations in Oklahoma that include 2,348 miles of pipeline and five strategically-located underground storage facilities in the state.

Figure 1–16: ONG Territory Map

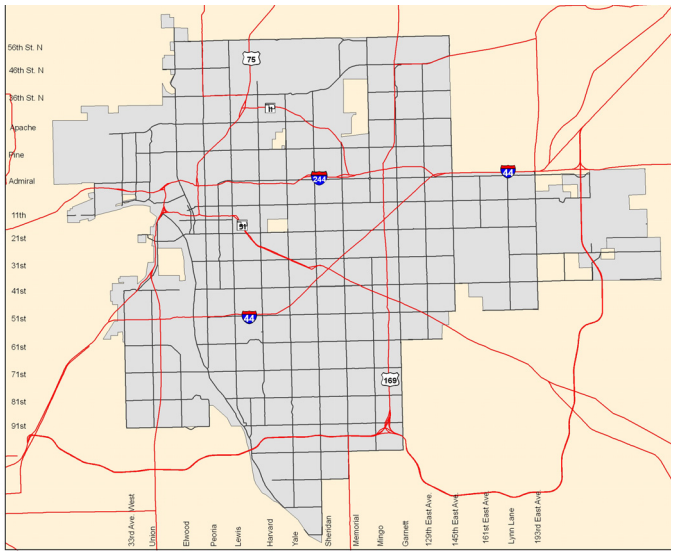


Transportation Systems

Major Highways and Roads

The City of Tulsa has a number of major highways, shown in Figure 1-17, including:

Figure 1–17: City of Tulsa Highways



- **Interstate 44**—runs SW-NE from Wichita Falls, TX to St. Louis, MO, a distance of 328 miles in Oklahoma. Most of I-44 is turnpike: the H.E. Bailey Turnpike from Texas to Oklahoma City, the Turner Turnpike from Oklahoma City to Tulsa, and the Will Rogers Turnpike from Tulsa to the Missouri border. Through Tulsa I-44 is also known as the Skelly Bypass and is routed for 3 miles of its length alongside S. 51st St. It is a heavily traveled highway, including tourist, business, and commercial truck traffic. Linking, as it does, several turnpikes and expressways, I-44 carries a high volume of hazardous material traffic, including chemical and petroleum products, and in some cases, radiological materials.
- **Interstate 244**—Loops from I-44 in the northeast around the northern and western sides of the city, and reconnects with I-44 immediately before the Turner Turnpike in western Tulsa. Through the city, I-244 ranges from four to six lanes and carries a substantial amount of traffic, both passenger and commercial.
- **US Hwy 64**—at 589 miles in length, US Hwy 64 is the longest US highway in Oklahoma. It runs from Clayton, NM through the Panhandle to Ft. Smith AR. In Tulsa, US Hwy 64 becomes the Broken Arrow Expressway before branching off to the south with the Mingo Valley Expressway and US Hwy 169 to Memorial Blvd. at S. 96th St., and then on to Bixby and Leonard. US Hwy 64 is heavily traveled by commercial and commuter traffic.
- **US Hwy 75**—runs from the Dallas-Ft. Worth area through Tulsa to the Canadian border. US Hwy 75 is a four-lane divided highway from I-40, at Henryetta, to the Kansas border, and provides excellent access to I-44, the Muskogee Turnpike, Cimarron Turnpike and the Indian Nation Turnpike. The rapid growth of Southwest Tulsa, particularly Jenks, Glenpool and Bixby, has increased traffic on the southern section of US 75, while the Wal-Mart Distribution Center in Bartlesville (approximately 40 miles to the north of Tulsa), and the highway's intersection with both I-44 and I-40 combine to make this a particularly heavily traveled four-lane highway.
- **OK Hwy 51**—is Oklahoma's third longest State highway at 330 miles in length. OK Hwy 51 is four lanes from I-35 to Stillwater and two lanes from there to Sand Springs, where it joins the Keystone Expressway. In downtown Tulsa, it branches off to the southeast, becoming the Broken Arrow Expressway. The highway carries a great deal of commuter and commercial traffic through Tulsa County.
- **US Hwy 169 (Mingo Valley Expressway)**—travels north-south from Collinsville in northeast Tulsa County to the Creek County Turnpike at about S. 96th and Garnett Rd. It is heavily traveled with both commercial and commuter traffic. The Mingo Valley Expressway

is also US Hwy 169, which runs from Tulsa to Minnesota. US Hwy 169 begins at the US Hwy 64 East interchange of the Creek Turnpike. US 169 is freeway grade north to Collinsville.

Traffic counts on these highways are presented in Table 1-7.

Table 1–7: Highway Traffic Counts

Highway	*Daily Traffic Counts*
Interstate 44 west Tulsa County (Creek County line)	46,100
Interstate 44 east Tulsa County (Rogers County line)	46,700
US Hwy 75 north Tulsa County (66th St. N)	33,800
US Hwy 75 south Tulsa County (Glenpool)	37,800
US Hwy 412 west Tulsa County (west Sand Springs)	25,700
US Hwy 412 east Tulsa County (225th E. Ave.)	39,400
US Hwy 64 west Tulsa County (Sand Springs)	50,700
US Hwy 64 southeast Tulsa County (Bixby)	26,000
OK Hwy 51 west Tulsa County	43,200
OK Hwy 51 east Tulsa County (209th E. Ave.)	78,000
Creek County Expy east Tulsa County (Mingo Rd.)	41,800
Mingo Valley Expy north Tulsa County (Apache Rd.)	56,914
Mingo Valley Expy south Tulsa County (S. 71st St.)	86,200
Broken Arrow Expy southeast Tulsa County (145th E. Ave.)	78,600

(Source: Oklahoma Department of Transportation, 2008)

Future transportation routes for the Tulsa area were mapped out in *Destination 2030*, a long-range transportation plan that contains elements on roadways, public transportation, bicycle and pedestrian ways, and freight movements. *Destination 2030* is a joint product of INCOG, ODOT and the Metropolitan Tulsa Transit Authority. Many of the corridors identified in the 2030 plan have been constructed or are in the planning stages. For major highways, the Plan included:

- Expansion of US Hwy 169 from Owasso to I-244 from four to six lanes;
- Expansion of I-44 from Sheridan Rd. to the Arkansas River from four to six lanes;
- Expansion of US Hwy 75 from I-44 to 151st St. South from four to six lanes;
- Extension of Gilcrease Expressway from Lewis Ave. to I-44.

The Plan encourages the development of bicycle-pedestrian trails, park-and-ride facilities and fuel-efficient automobiles. Regarding safety and congestion, the Plan supports the adoption of transportation incident management programs, the development of a regional Traffic Management Center, and the identification and abatement of high accident locations. Also recommended are infrastructure improvements at Tulsa International Airport (more air cargo facilities and better landside access) and the Port of Catoosa.

According to *Vision Tulsa 2012*, INCOG's *2032 Regional Transportation Plan Update* was adopted in December 2010. The plan improvises on the choices for roadways and maintenance. The 2032 plan also incorporates the vision for International Technology System (ITS) and incident management in the Tulsa metropolitan area in order to alleviate congestion. The plan calls for the detailed study of several high-

An MTTA's lift-equipped paratransit buses, part of the Lift Program

traffic and high-growth corridors and the implementation of commuter-choice options such as bus transit or a rail system utilizing existing rights-of-way.

Bus Lines and Taxi Service

The primary metropolitan bus service provider for the Tulsa area is the Metro Tulsa Transit Authority (MTTA), a public trust of the City of Tulsa established in 1968. In addition to regular bus service, MTTA operates the Lift Program, a curb-to-curb paratransit service for persons with disabilities who have been determined ADA Paratransit Eligible. The Lift Program offers service utilizing lift-equipped vans and taxis operating within the Tulsa City Limits.

Tulsa is also served by multiple nationwide or charter bus services, including the following:

- **Greyhound** – With a terminal at 317 S. Detroit. Greyhound is the largest provider of intercity bus transportation in the US.
- **Jefferson Lines** – Operates out of the Greyhound terminal, and provides service throughout the Midwestern states.
- **Kincaid Coach** – A charter bus service that operates out of multiple cities. In Tulsa, they maintain seven 54-passenger coaches, one 47-passenger coach, and one 40-passenger sleeper coach.
- **Pacesetter Coach** – provides limited charter bus service in the Tulsa area. Specific information on number of buses was unavailable.

The community is also serviced by over 20 taxicab, airport shuttle, and limousine companies that operate throughout the Tulsa metropolitan area.

Railway

The City of Tulsa is reviewing the feasibility of a light-rail transit system to support commuter traffic, but no action is anticipated for several years, and studies, at this point, do not indicate the major locations of potential routes.

Currently Tulsa is served by the Burlington Northern Santa Fe (BNSF) and the Union Pacific (UP) rail lines. Running north-south through Tulsa, the BNSF operates on tracks originally built by the St. Louis and San Francisco Railroad (Frisco). The trackage was absorbed into the BNSF's Texas Division when the Frisco was dissolved in 1981. The BNSF is one of the two largest railroads in the US, and is particularly strong in the Midwest and West.

The Cherokee Rail Yard in Tulsa supports a substantial amount of traffic, sometimes up to 22 trains a day with upwards of 100 cars each.

The Tulsa Cherokee Railroad yard in West Tulsa

Primary cargoes shipped through Tulsa are agricultural and mining products. Among the agricultural products are soybean meal, corn and corn syrup, nut and vegetable oil, cottonseed meal and oil, wheat and wheat bran, and malt. Mining products include coal, oil, propane, asphalt, gypsum, and limestone. In addition, hazardous materials, such as ammonia, fuel, or compressed natural gas is transported. The BNSF also carries crude oil from the Bakken fields in North Dakota to Tulsa and Sapulpa, where it is

then hauled to a terminal at Stroud, in Lincoln County, by the Stillwater Central Railroad. From Stroud it is transported by pipeline to the Cushing tank farm. The transportation schedule is expected to involve a maximum of 60,000 barrels of crude per day passing through Tulsa. Due to technological advances in recent years, the odds of a hazardous materials release from a railroad car, even in a significant derailment, is considered a very unlikely event.

Union Pacific, the largest railroad in North America, covers 23 states across the western two-thirds of the United States, and is a leading carrier of low-sulfur coal used in electrical power generation. It has broad coverage of the large chemical-producing areas along the Gulf Coast, and serves all six major gateways to Mexico. Union Pacific operates another north-south line in western Oklahoma that serves Enid, El Reno and Duncan, and connects Kansas wheat areas to the Texas ports. Union Pacific operates switchyards and related facilities at Muskogee, Tulsa, Oklahoma City, Chickasha, Enid and McAlester.

In addition, a study has been instituted to determine the feasibility of a mass transit commuter rail system between Tulsa and Broken Arrow, a major suburb to the southeast. This system could be several years in development.

Airports

The City of Tulsa is served by several airports, including:

Tulsa International Airport – Average of 167 aircraft based at the field and about 79 operations/day. This is Tulsa's primary commercial airport. TIA also houses the 138th Fighter Wing of the Air National Guard and is the global maintenance headquarters for American Airlines.

Richard Lloyd Jones Airport (Riverside) – Average of 543 aircraft based at the field and 926 operations/day. Riverside is primarily an airport for business-owned private aircraft.

In addition, there are heliport pads at all major Tulsa hospitals.

1.2.7 Economy

The aggregate population of the Tulsa MSA, which includes the City of Tulsa, is estimated to be 25 percent of the population of the state of Oklahoma. According to the Tulsa Area Chamber of Commerce's *2011 Economic Summary*, the Tulsa MSA produces $41.9 billion in goods and services, 30.9 percent of the Oklahoma economy. In 2012, the Brookings Institute named Tulsa one of the top 100 metros among the leading world economies. Tulsa accounts for nearly a quarter of the state's industrial employment, with 47,426 jobs and 1,117 manufacturers.

Though the oil industry has historically dominated Tulsa's economy, efforts in economic diversification have created a base in the sectors of aerospace, finance, technology, telecommunications, high tech, and manufacturing. The Tulsa International Airport (TUL) and the Tulsa Port of Catoosa, the nation's most inland seaport, connect the region with international trade and transportation. An American Airlines maintenance base at Tulsa International Airport is the city's third largest employer and the largest maintenance facility in the world, serving as the airline's global maintenance and engineering headquarters. Tulsa's Port of Catoosa and International Airport house extensive industrial parks.

During a national recession from 2001 to 2003, the city lost 28,000 jobs. In response, a development initiative, *Vision 2025*, was launched to encourage economic growth and recreate lost jobs. Projects spurred by the initiative promised urban revitalization, infrastructure improvement, tourism development, riverfront retail development, and further diversification of the economy. Between 2010 and 2015, the Tulsa area is projected to add 25,000 jobs. Employment and income data for Tulsa are presented in Table 1-8.

Table 1–8: City of Tulsa Employment and Income Data

Subject	*Number (2000)*	*%*	*Number (2010)*	*%*
Population 16 Years and Older	311,145	79.1%	303,985	76.4%
Population in Labor Force	202,164	66.0%	201,323	66.1%
Employed	190,954	62.3%	186,757	61.4%
Total Households	165,743	100%	164,888	
Household Income Below Poverty Level	10,840	10.9%	25,062	15.2%

Source: US Census Data 2000, 2010

In 2006, Forbes magazine rated Tulsa as second in the nation in income growth, and one of the best cities in which to do business in the country. Usually among the lowest in the nation in terms of cost of doing business, the Tulsa Metropolitan Area in 2011 was 15 percent below United States average and fifth lowest in the nation in that category. Tulsa stands out in many other national rankings, including fifteenth most affordable city in the nation (Forbes 2011) and one of the top 10 cities in which to retire (AARP 2011). In 2012, the *Fiscal Times* ranked Tulsa second among the top 10 cities for young people seeking jobs.

Major Employers

A number of large financial corporations are headquartered in Tulsa, the largest being the BOK Financial Corporation, the parent company to the Bank of Oklahoma, the Bank of Texas, the Bank of Arkansas, the Bank of Albuquerque, the Bank of Arizona, Colorado State Bank and Trust, and the Bank of Kansas City.

The semi-national convenience store chain QuikTrip, the national car rental companies of Vanguard and Dollar-Thrifty, and Mazzio's semi-national pizza chain, also call Tulsa home. Many international oil and gas-related companies have headquarters in Tulsa, including Williams Companies, SemGroup, Syntroleum, ONEOK, Samson and Excel Energy. Meanwhile, there are 37 companies in the Tulsa MSA that employ more than 1,000 people (listed in Table 1-9), although small businesses make up more than 80% of the city's companies.

Table 1–9: Tulsa MSA Largest Employers List, 1,000 or More Employees

Company	Sector
AAON Inc.	Heating Units
AEP/Public Service Company of Oklahoma	Electric Utility
American Airlines Maintenance Base	Aircraft Maintenance
AT&T (telephone and wireless employees)	Telecommunications
Baker Hughes	Manufactures Oil Field Machinery & Equipment
Bank of Oklahoma	Banking
Broken Arrow Public Schools	Public Schools
Cherokee Hard Rock Hotel and Casino	Hotel & Casino

Company	Sector
City of Tulsa	City Government
Direct TV	Customer Service
Hillcrest HealthCare System	Health Care
HP Enterprise Services	Systems engineering, computer support; data center
IC of Oklahoma, LLC	Manufactures Truck & Bus Bodies
Jenks Public Schools	Public Schools
Mazzio's	Restaurants
NORDAM Group	Aircraft Parts and Auxiliary Equipment
ONEOK	Natural Gas Transmission
OSU Medical Ceneter	Hospital
Owasso Public Schools	Public Schools
QuikTrip	Convenience Stores
Reasor's (all Tulsa locations)	Grocery Stores
River Spirit Casino	Casino
Saint Francis Healthcare System	Health Care
Spirit AeroSystems	Manufactures Aircraft Parts & Equipment
St. John Medical Center	Health Care
State Farm	Insurance
Tulsa Community College	Community College
Tulsa County	County Government
Tulsa Public Schools	Public Schools
Tulsa Technology Center	Vocational School
US Postal Service	Postal Services
Union Public Schools	Public Schools
University of Tulsa	University
Verizon Business	Communication Services
Wal-Mart/Sams Club	Retail
Whirlpool Corporation	Manufactures household electrical and gas ranges
Williams Companies	Oil & Gas

Source: Tulsa Metro Chamber

1.2.8 Development

According to the Tulsa County Assessor's Office and US Census Data, there are 136,553 properties with improvements within the City of Tulsa, with a total value, adjusted for fair market value $18,684,452,433. Numbers of properties with improvements (buildings, garages, pools, storage, and so forth) and improvement values, by type, are shown in the table below. No land values are included. Information from the County Assessor does not identify structures, only parcel types; the data from the Assessor only identifies 65 parcels in the City of Tulsa as being mobile homes. According to the US Census, 2010, there are 3,045 mobile homes in the City. Due to their vulnerability to natural hazards, the locations of mobile homes have been identified on the map in Figure 1–18.

No significant changes to development occurred in hazard areas.

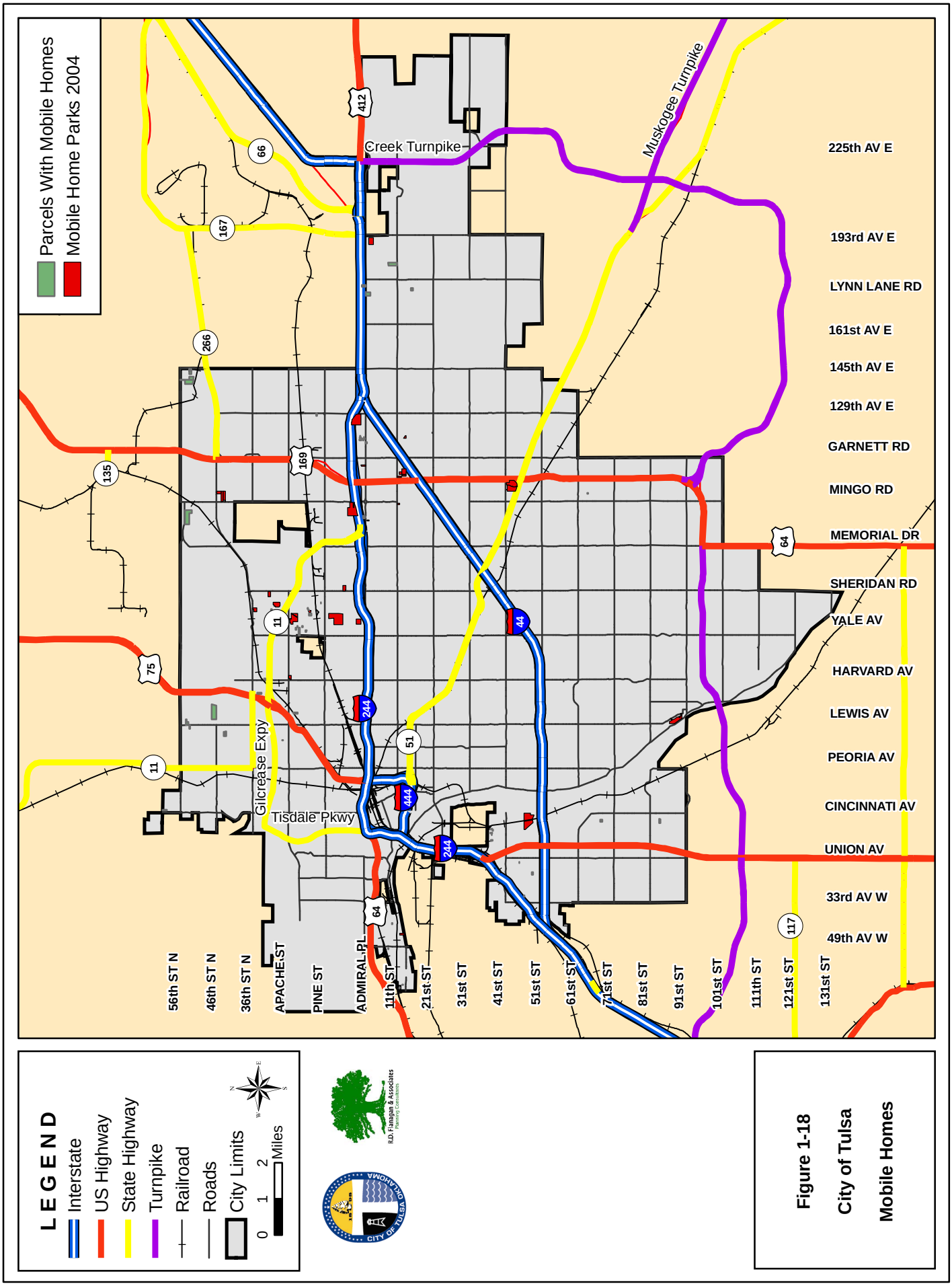


Figure 1-18
City of Tulsa
Mobile Homes

Table 1–10: City of Tulsa Improved Parcels by Value and Type

Improvement Type	*Number*	*Total Value*
Residential Single Family	122,030	$12,082,364,755
Residential Multi-Family	2,983	$937,075,152
Commercial	4,642	$3,455,938,156
Industrial	520	$404,686,254
Other	3,839	$1,805,822,029
Total	134,014	$18,685,886,346

Source: Tulsa County Assessor's Office, 2012

Future Development

Tulsa's population growth rate is 0.7 percent annually over the last 40 years, although it has declined within the city proper during the last few years. The Tulsa MSA is growing at a rate of 1.3 percent, the same as the national growth rate. Comparatively, the State of Oklahoma is growing at 1 percent annually. (For additional information, see Section 1.2.5 – Demographics.) According to the City of Tulsa *Vision Tulsa 2012* plan, the population of Tulsa is anticipated to be 459,660 by 2030. Information regarding future growth projections of populations in the City of Tulsa, Tulsa County, and the Tulsa Metropolitan Statistical Area are shown in Table 1-11.

Table 1–11: Tulsa Population Projections

YEAR	CITY	COUNTY	MSA[1]
1900	1,390	NA	NA
1907	7,298	21,693	121,878
1910	18,182	34,995	159,588
1920	72,075	109,023	321,213
1930	141,258	187,574	416,847
1940	142,157	193,363	400,584
1950	182,740	251,686	422,350
1960	261,685	346,038	503,090
1970	330,350	399,982	572,548
1980	360,919	470,593	711,652
1990	367,302	503,341	761,019
2000	393,049	563,299	859,530
2010	391,906	603,403	937,478
2015[2]	429,570	615,500	956,300
2020[2]	440,710	631,400	987,400
2025[2]	450,910	646,000	1,015,400
2030[2]	459,660	658,500	1,040,200

Source: Vision Tulsa 2012.[1]

Although the obvious direction of Tulsa's growth is south and east, there is great interest among city leaders in redeveloping Downtown Tulsa as the center of culture and the historical heart of the city.

[1]Tulsa MSA Represents Creek, Okmulgee, Osage, Pawnee, Rogers, and Wagoner counties

2 Forecasts are based on 2000 Census. Sources: Oklahoma State Data Center. Prepared by Research Wizard, Tulsa City-County Library.

Early in 2007, the City began the process of updating its 30-year old Comprehensive plan through a program called *PLANiTULSA*. *PLANiTULSA* was adopted by the Tulsa Metropolitan Area Planning Commission and approved by the Tulsa City Council in July 2010. It is now the official amendment to the City's Comprehensive plan.

The *Tulsa Comprehensive Plan* calls development in downtown a key component of creating a sustainable city, allowing for a more efficient use of land, and improved mobility. A vibrant downtown is important for maintaining a high quality of life for Tulsa residents and businesses.

The vision of Tulsa's future is already evident in such projects as the Brady District, the Blue Dome District (around Second Street and Detroit Avenue), the Sixth Street Project (which includes the Village at Central Park), the Tribune Lofts at Main and Archer streets, and the Renaissance Uptown Apartments at Tenth Street and Denver Avenue.

The completion of the BOK Center in downtown Tulsa has spurred development in the urban core area. The 18,041-seat venue is home to the Af2 Tulsa Talons and the CHL Tulsa Oilers. The BOK Center was designed to host major concerts, family shows, ice shows and other world-class entertainment. Located off Interstate 244, the BOK Center is diagonal from the Tulsa Convention Center, making it an entertainment and business complex.

One of the keys to the future development of Downtown Tulsa is making use of the structures already in place. In January 2002, Tulsa adopted the International Existing Building Code (IEBC), which makes it possible for entrepreneurs and property owners to use existing structures without being required to make major changes that would be prohibitively expensive. The *Tulsa Strategic Plan* suggests the creation of a viable redevelopment strategy to revive a significant number of vacant, underutilized, or poorly developed sites with mixed-use buildings in key areas of the City.

Growth Trends

The City of Tulsa has over 28,000 acres of buildable vacant land within its corporate area and about 20,000 acres vacant within its fenceline. A "fenceline" demarcates land around the perimeter of a community that has been identified for future growth and is to be protected from incorporation by other jurisdictions (See Figure 1-19). Tulsa's future growth areas are shown on the map in Figure 1-20.

The planning team examined Tulsa's existing city limits, fenceline, and capital improvements plans to determine areas of future growth and expansion. The team reviewed the *Tulsa Comprehensive Plan* and detailed small area plans to establish future land use, densities, and policies. Areas of vacant land for future growth (see Figure 1-20) include infill and urban redevelopment of the central and older section of the city, the northwest part of Tulsa in Osage County, east of 145th East Avenue between Admiral Boulevard and 51st Street, the recently annexed 13 square miles in Wagoner County, the Fair Oaks section of Wagoner County, and the southwest section of the city in the Mooser/Hager Creek basin.

Vacant available areas that are not expected to experience much growth pressure include north Tulsa County and the industrial area east of the Tulsa International Airport.

Southeast Osage County includes about 8 square miles of undeveloped annexed land, and another 12.85 square miles of undeveloped land within Tulsa's fenceline. The west loop of the Gilcrease Expressway is being extended to serve this area. The extension of other municipal utilities into the area, such as water and sanitary sewer, is expected to spur development. Due to the rugged nature of the terrain, development will most likely be residential with small-scale commercial developments.

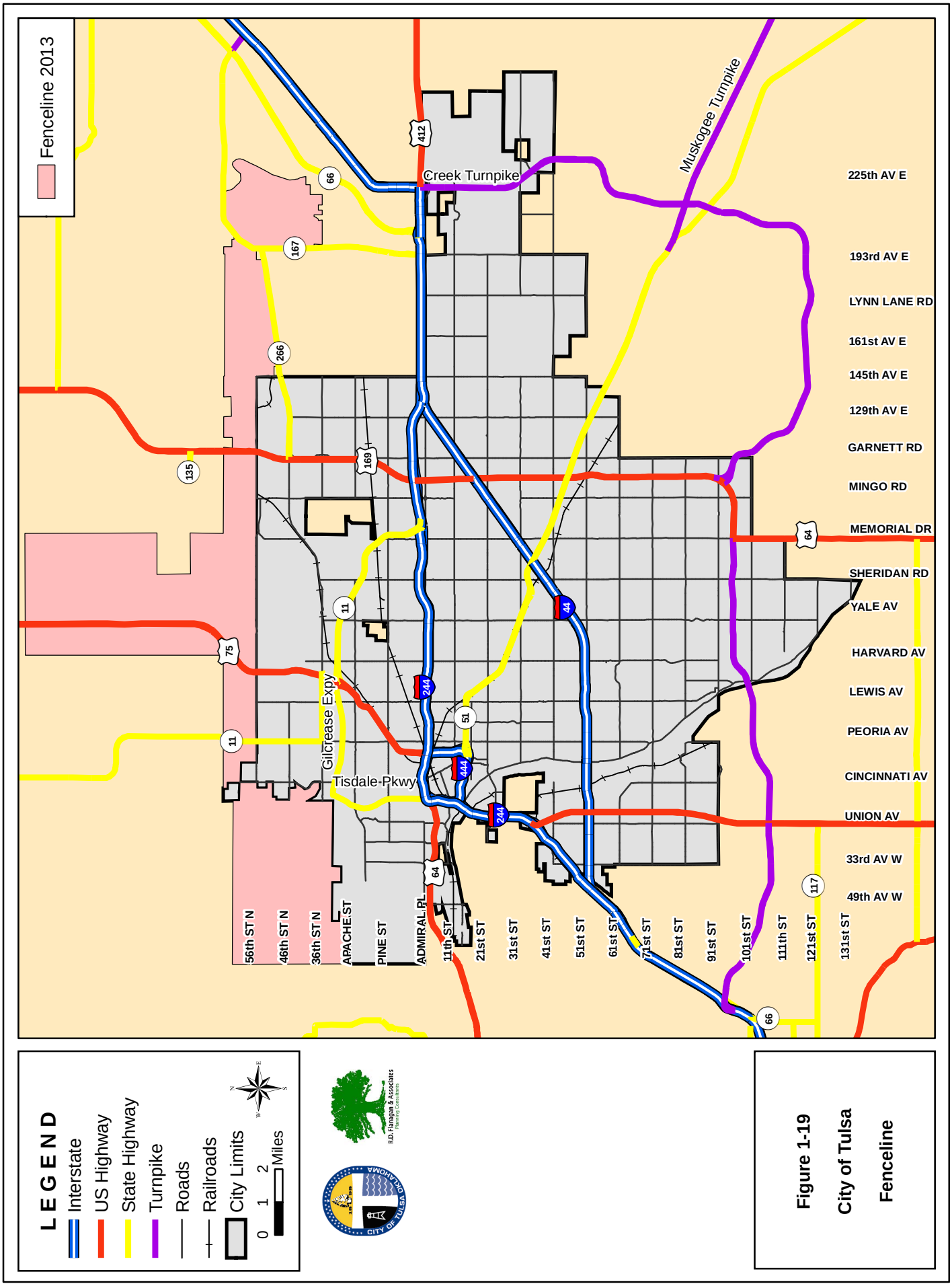


Figure 1-19
City of Tulsa
Fenceline

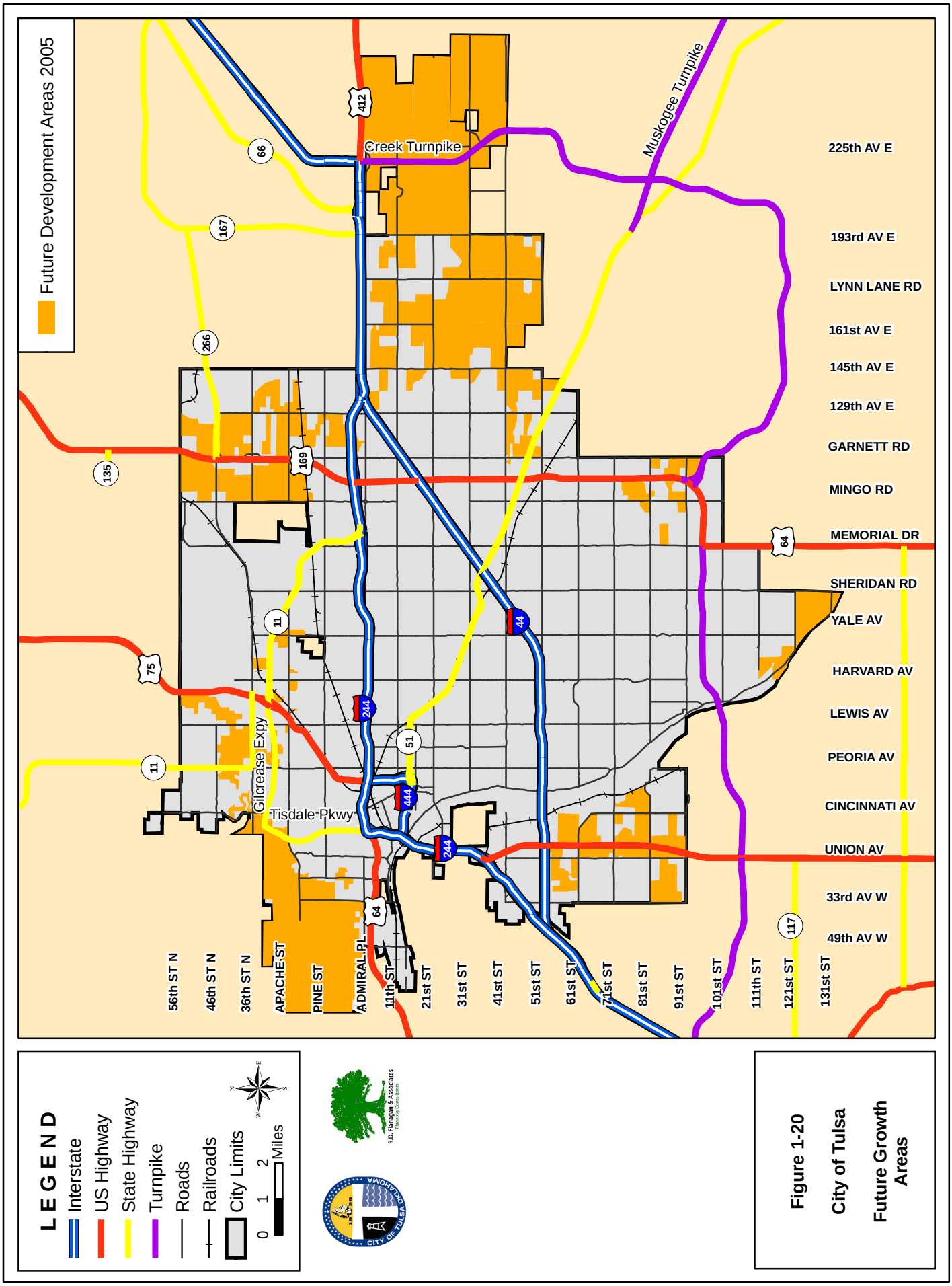


Figure 1-20
City of Tulsa
Future Growth Areas

North Tulsa County includes 32.15 square miles around which Tulsa has placed a fenceline. The Comprehensive Plan designates the area primarily as industrial and highway-oriented commercial. The wide expanses of the Bird Creek floodplain are set aside for open space.

Airport Industrial Area, from Tulsa International Airport east to the Rogers County line, encompasses some 6.38 square miles and is designated for industrial development. This area is served by US Highway 169, the Mingo Valley Expressway. Because it is underlain by massive limestone deposits, it has been difficult and expensive to develop.

East Tulsa, between 145th East Ave. and the Tulsa-Wagoner County line, and between Admiral Place and East 51st Street, includes approximately 10 square miles of land planned for mixed uses, primarily residential. The area has been slow to develop due to its limestone outcroppings

Wagoner County Area consists of 13 square miles of Fair Oaks. The area is designated for mixed uses, and is served by the recently completed East Creek Turnpike.

The Mooser/Hager Creek Basins, an area of future growth located in southwest Tulsa, include about 4 square miles of scenic, rugged woodland. The area is served by US Highway 75, and has been experiencing recent commercial and residential development. The highway corridor is expected to develop with commercial/business park and higher density residential uses, while the balance of the basin is expected to consist of mixed uses, primarily lower-density residential.

The floodplains of the future growth areas have been or are being identified and mapped, and new development will be regulated, although several areas that have had Master Drainage Plans developed in the past need to be updated and reviewed. The City's ordinances require structures be elevated at least 12 inches above the Base Flood Elevation (BFE) and that compensatory storage be provided for any fill placed in the floodplain. Stormwater detention requirements mandate that no adverse stormwater impacts result from new development. Tulsa's stringent stormwater and floodplain management ordinances and development regulations require that new development occurs outside of the 100-year floodplain, and not be damaged by, or result in damage to other properties due to flooding. In addition, any new critical facilities must be protected to the 500-year flood level. Roadways and bridges are required to pass the 100-year regulatory flood.

The growth areas will all continue to be subject to non-site specific natural hazards, such as tornadoes, lightning, hail, winter storms, extreme heat, drought, and earthquakes. Dam and levee failures are not a threat to these future growth areas. The multi-hazard mitigation measures identified and recommended in this plan should lessen the impacts of natural hazards on future development and population of the community.

1.2.9 Critical Facilities

Critical facilities are defined differently by different organizations and agencies, but are usually classified as those facilities vital to the health, safety, and welfare of the population and that are especially important following hazard events, or as those facilities that, if put out of operation by any cause, would have a broadly adverse impact on the community as a whole.

FEMA includes the following:

- Structures or facilities that produce, use or store highly volatile, flammable, explosive, toxic and/or water-reactive materials;
- Hospitals, nursing homes, and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a disaster;
- Police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers that are needed for disaster response activities before, during, and after an event;

- Public and private utility facilities that are vital to maintaining or restoring normal services to affected areas before, during and after an event.

This may also include buildings designated as emergency shelters, schools, childcare centers, senior citizen centers, major medical facilities, disability centers, and City Hall. Since 9/11, FEMA has also added banks and other major financial institutions to their critical facilities list. The City of Tulsa's critical facilities are mapped in Figures 1-21 through 1-30 and listed in Tables 1-12 through 1-21, below.

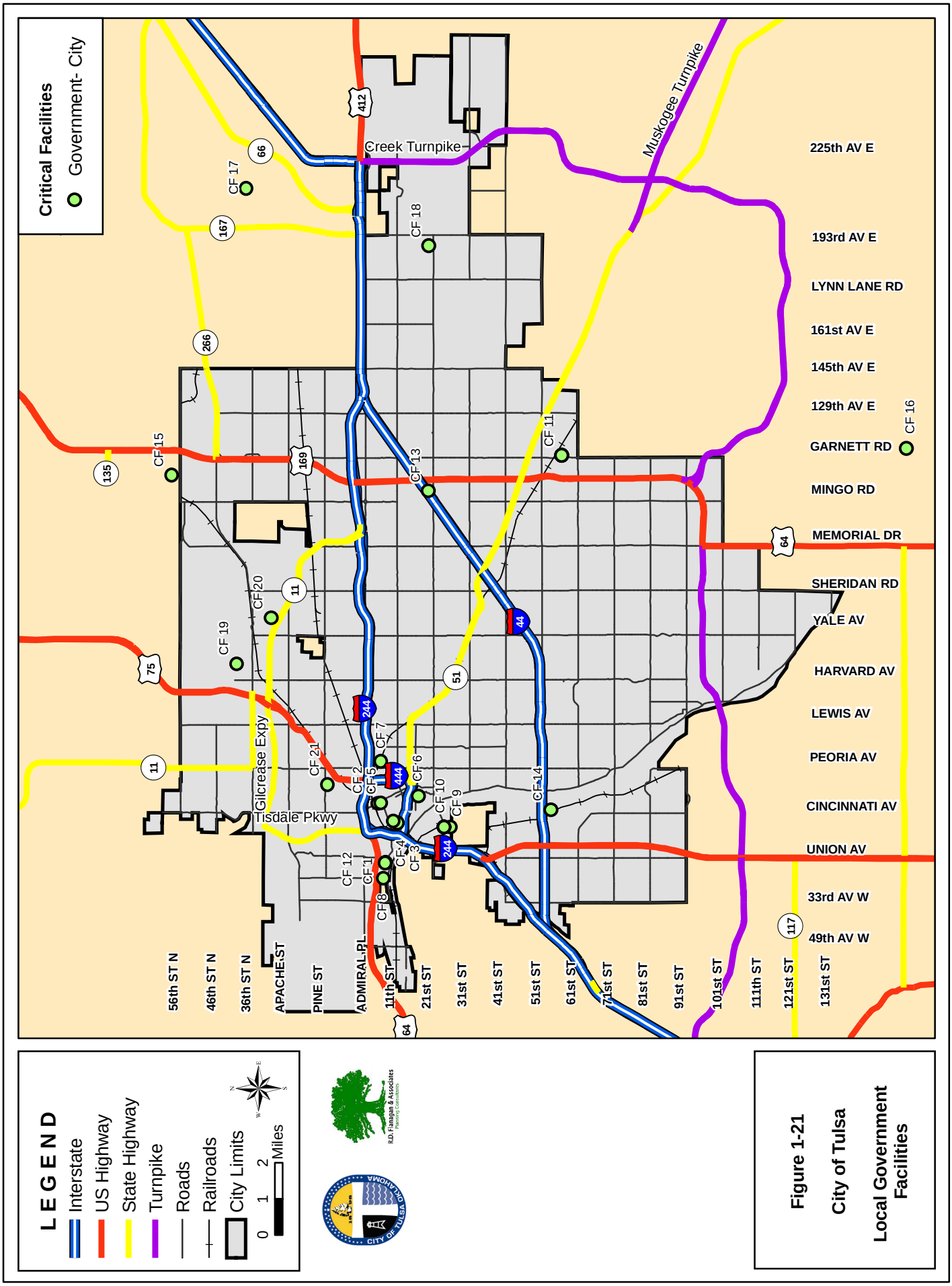

Critical Facilities
Government- City
Creek Turnpike
Muskogee Turnpike
Gilcrease Expy
Tisdale Pkwy
CF 1
CF 2
CF 3
CF 4
CF 5
CF 6
CF 7
CF 8
CF 9
CF 10
CF 11
CF 12
CF 13
CF 14
CF 15
CF 16
CF 17
CF 18
CF 19
CF 20
CF 21
225th AV E
193rd AV E
LYNN LANE RD
161st AV E
145th AV E
129th AV E
GARNETT RD
MINGO RD
MEMORIAL DR
SHERIDAN RD
YALE AV
HARVARD AV
LEWIS AV
PEORIA AV
CINCINNATI AV
UNION AV
33rd AV W
49th AV W
56th ST N
46th ST N
36th ST N
APACHE ST
PINE ST
ADMIRAL PL
11th ST
21st ST
31st ST
41st ST
51st ST
61st ST
71st ST
81st ST
91st ST
101st ST
111th ST
121st ST
131st ST
LEGEND
Interstate
US Highway
State Highway
Turnpike
Roads
Railroads
City Limits
0 1 2 Miles
R.D. Flanagan & Associates
CITY OF TULSA
Figure 1-21
City of Tulsa
Local Government Facilities

Table 1–12: City of Tulsa Government Facilities

Cat ID	Map ID	Name	Address
Government- City			
CF	1	City Garage	1720 W Newblock Park Dr
CF	2	City Of Tulsa (City Hall)	175 E 2nd St
CF	3	River Parks Authority	707 S Houston Ave, S 510
CF	4	Tulsa Convention Center	100 Civic Center
CF	5	Tulsa Performing Arts Center	110 E 2nd St
CF	6	Community Service Council - Tulsa	16 E 16th St
CF	7	Tulsa Transit	510 S Rockford Ave
CF	8	Juvenile Delinquency Project	315 S Gilcrease Museum Rd
CF	9	Field Customer Services	2445 S Jackson Ave
CF	10	Chemical Storage Building	2317 S Jackson Ave
CF	10	Fuel Facility	2317 S Jackson Ave
CF	10	Portable Building	2317 S Jackson Ave
CF	10	Storage Shed	2317 S Jackson Ave
CF	10	Surplus Facility	2317 S Jackson Ave
CF	10	Tire Shop	2317 S Jackson Ave
CF	10	W&M South Yard Storage Building	2317 S Jackson Ave
CF	10	W&M South Yard Office/stock Building	2317 S Jackson Ave
CF	10	Warehouse/Materials Stockroom	2317 S Jackson Ave
CF	11	Equipment Maintenance	5625 S Garnett Rd
CF	11	Street Dept Garage/Offices	5675 S Garnett Rd
CF	11	Water District Office/Warehouse	5605 S Garnett Rd
CF	12	Equipment Management	1720 Newblock Park Dr
CF	12	Structural Maintenance	1712 Charles Page Blvd
CF	13	Satellite Fuel Station	1747 S 101st E Ave
CF	14	Southside Water Treatment Plant	5300 S Elwood Ave
CF	15	Northside Water Treatment Plant	5628 N 105th E Ave
CF	16	Haikey Creek Wastewater Treatment Plant	11312 East 151st Street
CF	17	Lower BIrd Creek Wastewater Treatment Plant	21121 E 36th St N
CF	18	AB Jewell Water Treatment Plant	18707 E 21st St
CF	19	Mohawk Water Treatment Plant	3600 Mohawk Blvd
CF	20	Animal Shelter	3031 N. Erie
CF	21	Communications for the City of Tulsa	801 E Oklahoma St

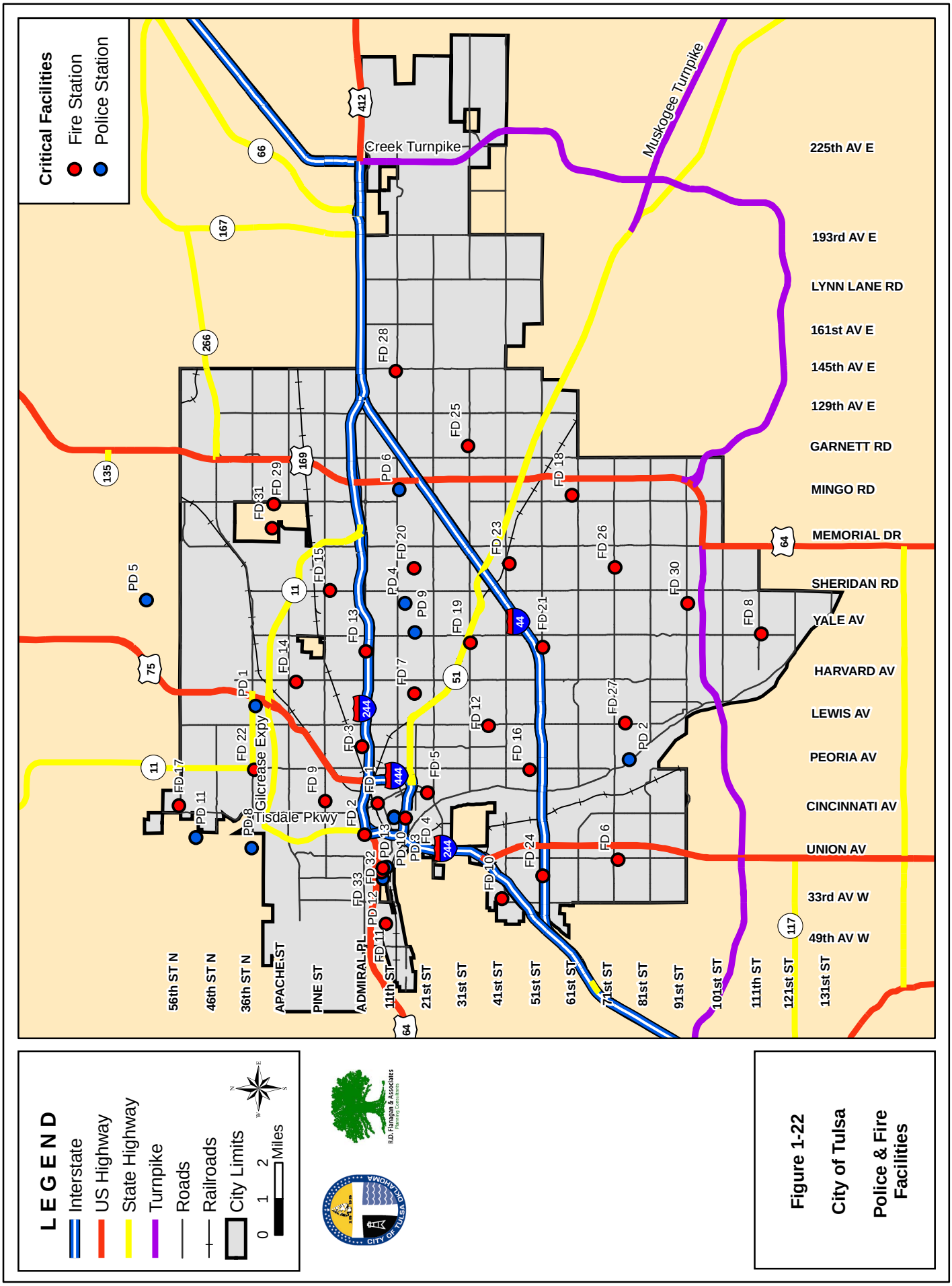


Figure 1-22
City of Tulsa
Police & Fire Facilities

Table 1–13: City of Tulsa Fire and Police Stations

Cat ID	Map ID	Name	Address
Police Stations			
PD	1	Tulsa Police Department (North Div)	3411 North Columbia
PD	2	Tulsa Police Station (Southwest Div)	7515 Riverside Pkwy
PD	3	Police Courts Building	600 Civic Center Plaza
PD	4	Tulsa Police Department (Support Div)	5963 E 13th
PD	5	Police Training Facility Building	6066 E 66th St North
PD	6	Tulsa Police Department (East Div)	10122 E 11th St
PD	8	Police Aviation-Hangar	1201 W 36th St N-
PD	9	Fire Station 11 transferred to Police	5009 E. 15th St.
PD	10	E-911 Building & PSRC Tower	911 Civic Center Plaza
PD	11	Youth Ranch	5136 N. Osage Drive
PD	12	Juvenile Detention Center	315 S Gilcrease Museum Rd
PD	13	Adult Detention Center	1700 Charles Page Blvd
Fire Stations			
FD	1	Tulsa Fire Department Hdqtrs	175 E 2nd St
FD	2	Tulsa Fire Department #2	524 W Edison
FD	3	Tulsa Fire Department #3	62 N Utica Ave
FD	4	Tulsa Fire Department #4	524 W 12th St
FD	5	Tulsa Fire Department #5	102 E 18th St
FD	6	Tulsa Fire Department #6/ Hazardous Materials	7212 S Union Ave
FD	7	Tulsa Fire Department #7	3005 E 15th St
FD	8	Tulsa Fire Department #9	11211 South Yale
FD	9	Tulsa Fire Department #10	508 E Pine St
FD	10	Tulsa Fire Department #12	3123 W 40th St
FD	11	Tulsa Fire Department #13	345 S 41st Av W
FD	12	Tulsa Fire Department #14	3602 S Lewis Ave
FD	13	Tulsa Fire Department #15	4162 E Admiral Pl
FD	14	Tulsa Fire Department #16	2412 N Harvard Ave
FD	15	Tulsa Fire Department #17	1351 N Sheridan Rd
FD	16	Tulsa Fire Department #18	4802 S Peoria Ave
FD	17	Tulsa Fire Department #19	509 E 56th St N
FD	18	Tulsa Fire Department #20	9827 E 59th St
FD	19	Tulsa Fire Department #21	4606 E 31st St
FD	20	Tulsa Fire Department #22	7303 E 15 St
FD	21	Tulsa Fire Department #23	4348 E 51st St
FD	22	Tulsa Fire Department #24	3520 N Peoria Ave
FD	23	Tulsa Fire Department #25	7419 E 42nd Pl
FD	24	Tulsa Fire Department #26	2404 W 51st St
FD	25	Tulsa Fire Department #27	11707 E 31st St
FD	26	Tulsa Fire Department #28	7310 E 71st Street

Cat ID	Map ID	Name	Address
FD	27	Tulsa Fire Department #29	7429 S Lewis Ave
FD	28	Tulsa Fire Department #30	14333 E 11th St
FD	29	Tulsa Fire Department #31	3002 N Mingo
FD	30	Tulsa Fire Department #32	6010 E 91st St
FD	31	Tulsa Fire Department #51 (Airport)	Taxiway Echo & Bravo
FD	32	Tulsa Fire Department Training	1760 Newblock Park Dr
FD	33	Tulsa Fire Department Supply	1790 Newblock Park Dr

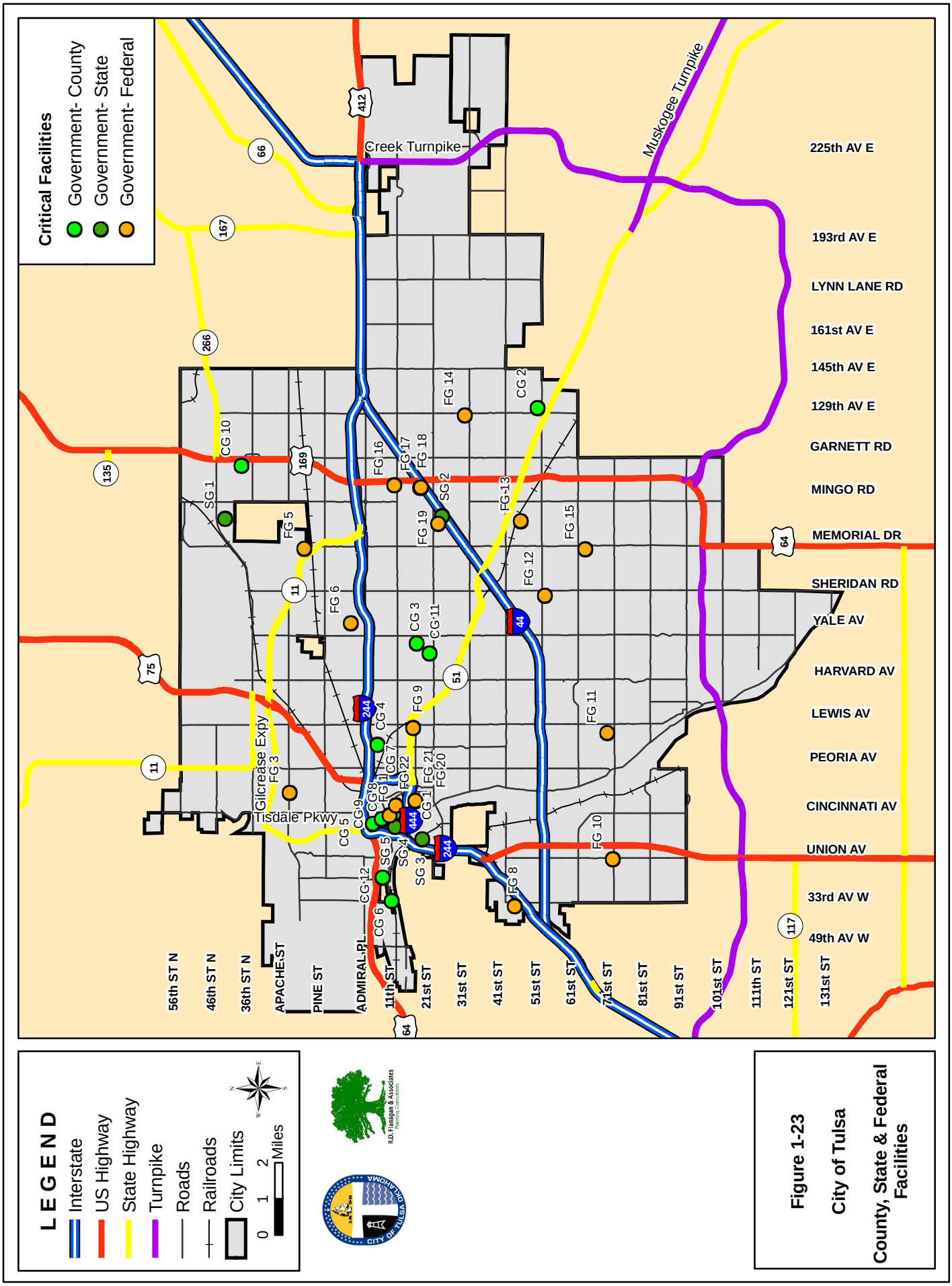


Figure 1-23
City of Tulsa
County, State & Federal Facilities

Table 1–14: County, State and Federal Government Facilities

Cat ID	Map ID	Name	Address
		Government-County	
CG	1	TAEMA Emergency Operations Center	600 Civic Center
CG	2	Tulsa City-County Health Dept, Main	5051 S. 129th East Ave.
CG	3	Tulsa City-County Health Department	4616 E. 15th St.
CG	4	Tulsa City-County Health Department	315 S. Utica
CG	5	Tulsa County Correctional Facility	300 N. Denver
CG	6	Tulsa County Deputy Sheriff	3240 Charles Page Blvd
CG	7	Tulsa County Offices	500 S. Denver Ave
CG	8	Tulsa County Sheriff	500 S. Denver Ave
CG	9	Tulsa County Sheriff Office	303 W. 1st St.
CG	10	OK Highway Dept Construction Division	4002 N. Mingo Expressway
CG	11	Tulsa Co Fairgrounds	4145 E21st St
CG	12	Tulsa County Juvenile Detention Center	315 S Gilcrease
		Government-State	
SG	1	Oklahoma Air National Guard - 138th Fighter Wing	9100 E 46th St
SG	2	Oklahoma Highway Patrol - Troop B HQ	9191 E Skelly Dr
SG	3	Medical Examiner	1115 W 17th St
SG	4	Dept. of Human Services	444 S Houston
SG	5	Ok. State Office Building	440 S Houston
		Government-Federal	
FG	1	USPS - Downtown Post Office	333 W 4th St
FG	3	USPS - Northside Post Office	626 E Apache
FG	5	USPS - Tulsa AMF Retail	2161 Cargo Rd
FG	6	USPS - Northeast Post Office	5313 E Independence
FG	8	USPS - Westside Post Office	3408 W 42nd Pl
FG	9	USPS - Donaldson Post Office	1423 Terrace Dr
FG	10	Post Office - CPU American Heritage Bank	7042 S Union
FG	11	USPS - Robert Jenkins Post Office	6910 S Yorktown
FG	12	USPS - Sheridan Tulsa Post Office	6110 E 51st St
FG	13	USPS - Southeast Tulsa Post Office	9023 E 46th St
FG	14	USPS - Eastside Tulsa	2920 S 129th E Ave
FG	15	FBI - Tulsa	8023 E63rd Pl
FG	16	NOAA - NWS	10159 E11th St
FG	17	USACE	1645 S101st E Ave
FG	18	Internal Revenue Service	1645 S101st E Ave
FG	19	USPS - Postage Handling Facility	2114 S91st E Ave
FG	20	ATF	125 W 15th St
FG	21	Secret Service	125 W 15th St
FG	22	US Attorney	110 W 7th St

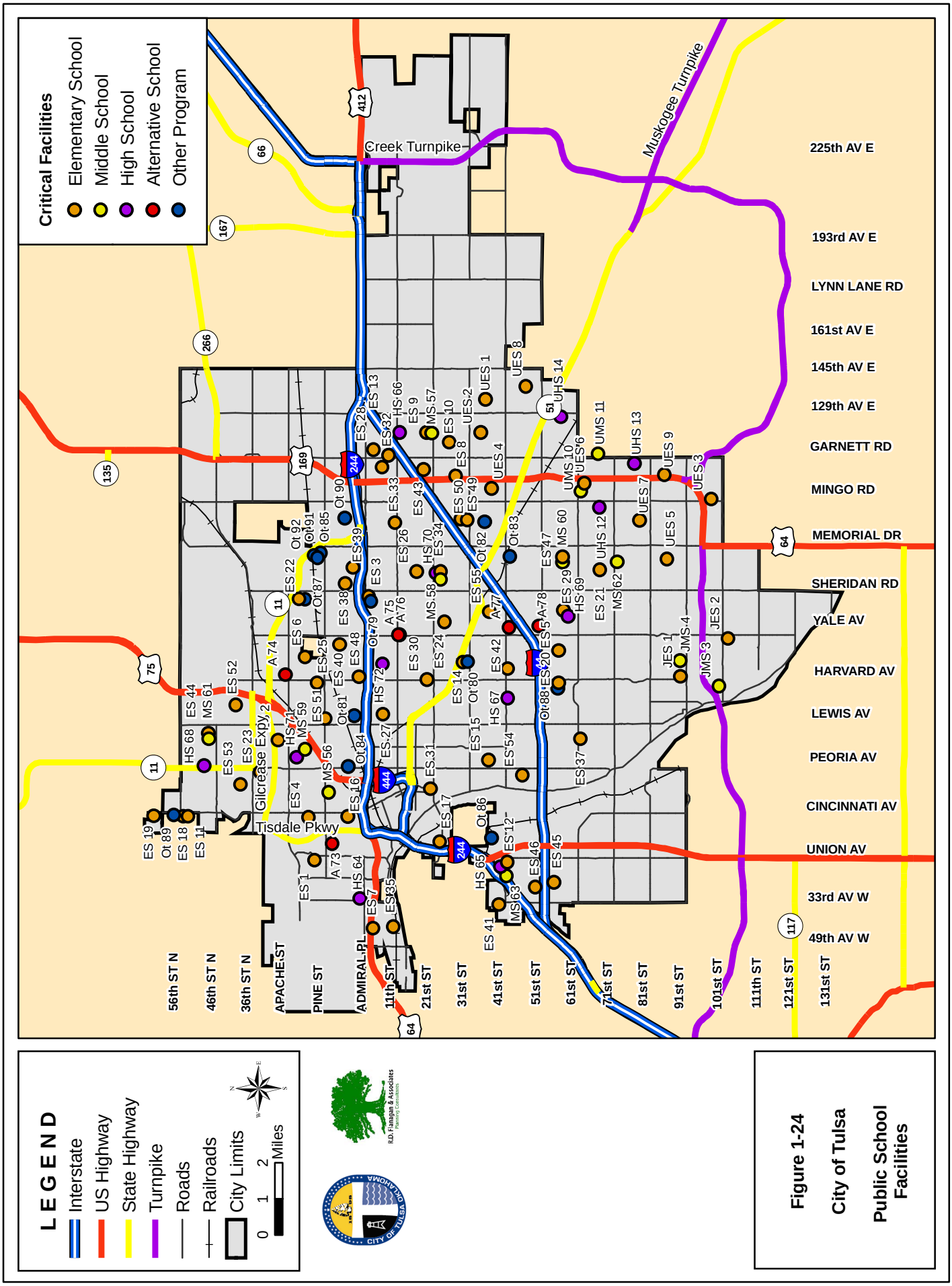


Figure 1-24
City of Tulsa
Public School Facilities

Table 1–15: City of Tulsa Public School Facilities

Cat ID	Map ID	Name	Address
		Tulsa Public Schools	
ES	1	Academy Central Elementary School	1789 W Seminole St.
ES	2	Anderson Elementary School	1921 E 29th St. N
ES	3	Bell Elementary School	6304 E Admiral Blvd.
ES	4	Burroughs Elementary School	1924 N Cincinnati Ave.
ES	5	Carnegie Elementary School	4309 E 56th St.
ES	6	Celia Clinton Elementary School	1740 N Harvard Ave.
ES	7	Choteau Elementary School	4132 W Cameron St.
ES	8	Columbus Elementary School	10620 E 27th St.
ES	9	Cooper Elementary School	1808 S 123 E Ave.
ES	10	Disney Elementary School	11702 E 25th St.
ES	11	ECDC Bunche	5402 N Cincinnati Ave.
ES	12	ECDC Porter	1740 W 41st St.
ES	13	ECDC Reed	10908 E 5th St.
ES	14	Eisenhower International School	2819 S New Haven Ave.
ES	15	Eliot Elementary School	1442 E 36th St.
ES	16	Emerson Elementary School	909 N Boston Ave.
ES	17	Eugene Field Elementary School	2249 S Phoenix Ave.
ES	18	Gilcrease Elementary School	5550 N Cincinnati Ave.
ES	19	Greeley Elementary School	105 E 63rd St. N
ES	20	Grimes Elementary School	3111 E 56th St.
ES	21	Grissom Elementary School	6646 S 73rd E Ave.
ES	22	Hamilton Elementary School	2316 N Norwood Pl.
ES	23	Hawthorne Elementary School	105 E 33rd St. N
ES	24	Hoover Elementary School	2327 S Darlington Ave.
ES	25	Jackson Elementary School	2137 N Pittsburg Ave.
ES	26	Jones Elementary School	1515 S 71st E Ave.
ES	27	Kendall-Whittier Elementary School	2601 E 5th Pl.
ES	28	Kerr Elementary School	202 S 117th E Ave.
ES	29	Key Elementary School	5840 S Hudson Ave.
ES	30	Lanier Elementary School	1727 S Harvard Ave.
ES	31	Lee Elementary School	1920 S Cincinnati Ave.
ES	32	Lewis and Clark Elementary School	737 S Garnett Rd.
ES	33	Lindbergh Elementary School	931 S 89th E Ave.
ES	34	MacArthur Elementary School	2182 S 73rd E Ave.
ES	35	Mark Twain Elementary School	541 S 43rd W Ave.
MS	36	Mayo Demonstration Academy	1127 S Columbia
ES	37	McClure Elementary School	1770 E 61st St.
ES	38	McKinley Elementary School	6703 E King St.

Cat ID	Map ID	Name	Address
ES	39	Mitchell Elementary School	733 N 73rd E Ave.
ES	40	Owen Elementary School	1132 N Vandalia Ave.
ES	41	Park Elementary School	3205 W 39th St.
ES	42	Patrick Henry Elementary School	3820 E 41st St.
ES	43	Peary Elementary School	10818 E 17 St.
ES	44	Penn Elementary School	2138 E 48th St. N
ES	45	Remington Elementary School	2524 W 53rd St.
ES	46	Robertson Elementary School	2721 W 50th St.
ES	47	Salk Elementary School	7625 E 58 St.
ES	48	Sequoyah Elementary School	3341 E Archer St.
ES	49	Skelly Elementary School	2940 S 90th E Ave.
ES	50	Skelly PreK- K	2714 S 90th E Ave.
ES	51	Springdale Elementary School	2510 E Pine St.
ES	52	Traice Academy/ Traice Middle School	2740 E 41st St. N
ES	53	Whitman Elementary School	3924 N Lansing St.
ES	54	Wright Elementary School	110 E 45th Pl.
ES	55	Zarrow International School	3613 S Hudson Ave.
MS	56	Carver Middle School	624 E Oklahoma Pl.
MS	57	East Central Junior High School	12121 E 21st St.
MS	58	Hale Junior High School	2177 S 67 E Ave.
MS	59	KIPP Tulsa Academy	1661 E Virgin St.
MS	60	Memorial Junior High School	7502 E 57 St.
MS	61	Monroe Demonstration Academy/Dual Language Immersion	2740 E 41st St. N
MS	62	Thoreau Demonstration Academy	7370 E 71st St.
MS	63	Webster Junior High School	2224 W 41st St.
HS	64	Central High School/ Junior High School	3101 W Edison St.
HS	65	Daniel Webster High School	1919 W 40th St.
HS	66	East Central High School	12150 E 11th St.
HS	67	Edison Preparatory High School/ Middle School	2906 E 41st St.
HS	68	McLain High School/ Junior High	4929 N Peoria Ave.
HS	69	Memorial High School	5840 S Hudson Ave.
HS	70	Nathan Hale High School	6960 E 21st St.
HS	71	Booker T. Washington High School	1514 E Zion St.
HS	72	Will Rogers High School/ Junior High	3909 E 5th Pl.
A	73	Continuation HS/ project Accept- Traice ES	1205 W Newton St.
A	74	Early College High School	3727 E Apache St.
A	75	Margaret Hudson School	1136 S Allegheny Ave.
A	76	Street School	1135 S Yale Ave.
A	77	Tulsa Learning Academy High School	4107 S Yale Ave., Ste 143
A	78	Tulsa School of Arts & Sciences	5155 E 51st St. #200

Cat ID	Map ID	Name	Address
Ot	79	Burbank / Indian Pupil Education	209 S Lakewood Ave.
Ot	80	Charles C. Mason Education Service Center	3027 S New Haven Ave.
Ot	81	Cleveland Middle School (Storage)	724 N Birmingham Ave.
Ot	82	Fulton Teaching and Learning Academy	8906 E 34th St.
Ot	83	Grant Transportation/ South Lot	7623 E 42nd Pl.
Ot	84	Helmzar Challenge Course	1006 N Quaker Ave.
Ot	85	Maintenance/ Plant Operations/ East Lot	1555 N 77th E Ave.
Ot	86	McBirney Transportation/ West Lot	10112 W 36th Pl.
Ot	87	Met Lombard/ Franklin MS/ HS	6201 E Virgin St.
Ot	88	Nimitz Middle School (Storage)	3111 E 56th St.
Ot	89	North Bus Lot	5720 N Cincinnati Ave.
Ot	90	Ross Child Nutrition	10908 E 5th St.
Ot	91	Transportation Administration Building	1555 N 77th E Ave.
Ot	92	Warehouse	1555 N 77th E Ave.
Union Public Schools			
UES	1	Union George F Boevers Elementary	3433 S 133rd E Ave.
UES	2	Union Briarglen Elementary	3303 S 121st E Ave.
UES	3	Union Cedar Ridge Elementary	9817 S Memorial Dr.
UES	4	Union Roy Clark Elementary	3656 S103rd E Ave.
UES	5	Union James Darnaby Elementary	7625 E87th St.
UES	6	Union Robert Grove Elementary	10202 E62nd St.
UES	7	Union Wesley Jarman Elementary	9015 E79th E Ave.
UES	8	Union Rosa Parks Elementary	13702 E 46th Pl. S
UES	9	Union Thomas Jefferson Elementary	8418 S 107th E Ave.
UMS	10	Union 6th - 7th Grade Center	1011 E 61st St.
UMS	11	Union 8th Grade Center	6501 S Garnett Rd.
UHS	12	Tulsa Union High School	6636 S Mingo Rd.
UHS	13	Union Intermediate High School	7616 S Garnett Rd.
UHS	14	Union Alternative School	5656 S 129th E Ave.
Jenks Public Schools			
JES	1	Jenks East Elementary School	8925 S Harvard Ave.
JES	2	Jenks Southeast Elementary School	10222 S Yale Ave.
JMS	3	Jenks Middle School	3019 E 101st St.
JMS	4	Jenks East Intermediate School	3933 E 91st St.

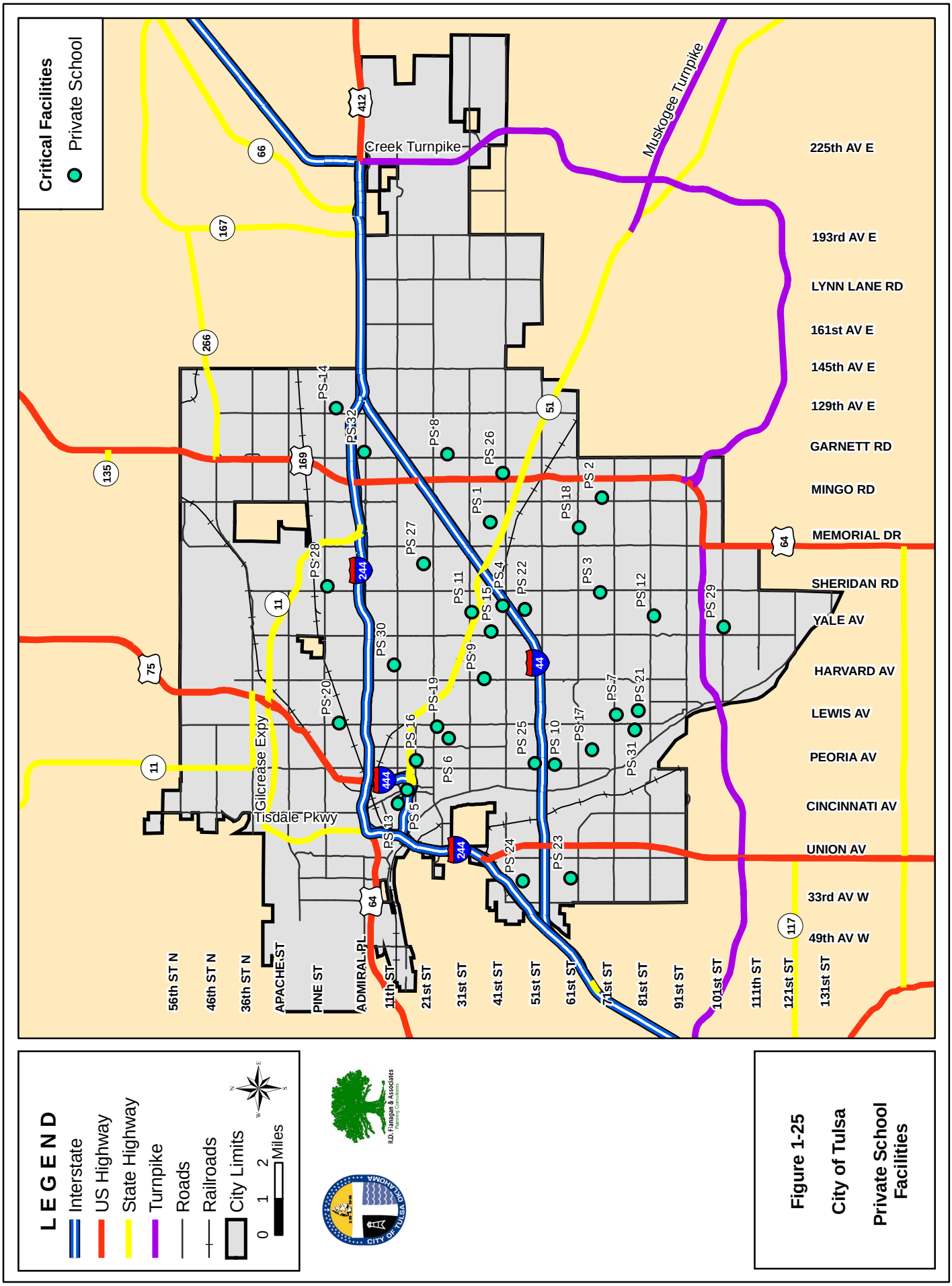


Figure 1-25
City of Tulsa
Private School Facilities

Table 1–16: City of Tulsa Private School Facilities

Cat ID	Map ID	Name	Address
PS	1	Aldersgate Learning Center	3702 S 90th E Ave.
PS	2	Asbury United Methodist Weekday Preschool	6767 S Mingo Rd.
PS	3	Bethany Christian School	6730 S Sheridan Rd.
PS	4	Bishop Kelly High School	3905 S. Hudson Ave.
PS	5	Boston Avenue Weekday School	1301 S Boston Ave.
PS	6	Cascia Hall Prepatory School	2520 S. Yorktown Ave.
PS	7	Christ the Redeemer Lutheran Church	2550 E 71st St.
PS	8	Christview Christian Church	2525 S Garnett Rd.
PS	9	Early Learning Center - Christ UMC	3515 S Harvard Ave.
PS	10	Evangelistic Temple School	1339 E 55th St.
PS	11	Happy Hands Educational Center	5717 E 32nd St.
PS	12	Holland Hall School	5666 E 81st St.
PS	13	Holy Family Cathedral School	820 S. Boulder Ave.
PS	14	Lincoln Christian School	1003 N 129th E Ave.
PS	15	Little Light House	5120 E. 36th St.
PS	16	Marquette Catholic School	1519 S. Quincy Ave.
PS	17	Metro Christian Academy	6363 S. Trenton Ave.
PS	18	Mingo Valley Christian School	8720 E. 61st St.
PS	19	Monte Cassino School	2206 S. Lewis Ave.
PS	20	Oklahoma Job Corps Academy	1133 N Lewis Ave.
PS	21	ORU Academy	7777 S Lewis Ave.
PS	22	Peace Academy	4620 S Irvington Ave.
PS	23	Riverfield Country Day School	2433 W 61st St.
PS	24	Saint Catherine Catholic School	2615 W 46th St.
PS	25	School of Saint Mary	1365 E 49th Pl
PS	26	Southpark Christian School	10811 E 41st St.
PS	27	St. Pius X Catholic School	1717 S 75th E Ave.
PS	28	Sts. Peter & Paul School	1428 N 67th E Ave.
PS	29	Town & Country School	5150 E 101st St.
PS	30	Tulsa Adventist Jr. Academy	900 S New Haven Ave.
PS	31	Victory Christian School	7700 S Lewis Ave.
PS	32	Wright Christian Academy	11391 E Admiral Pl.

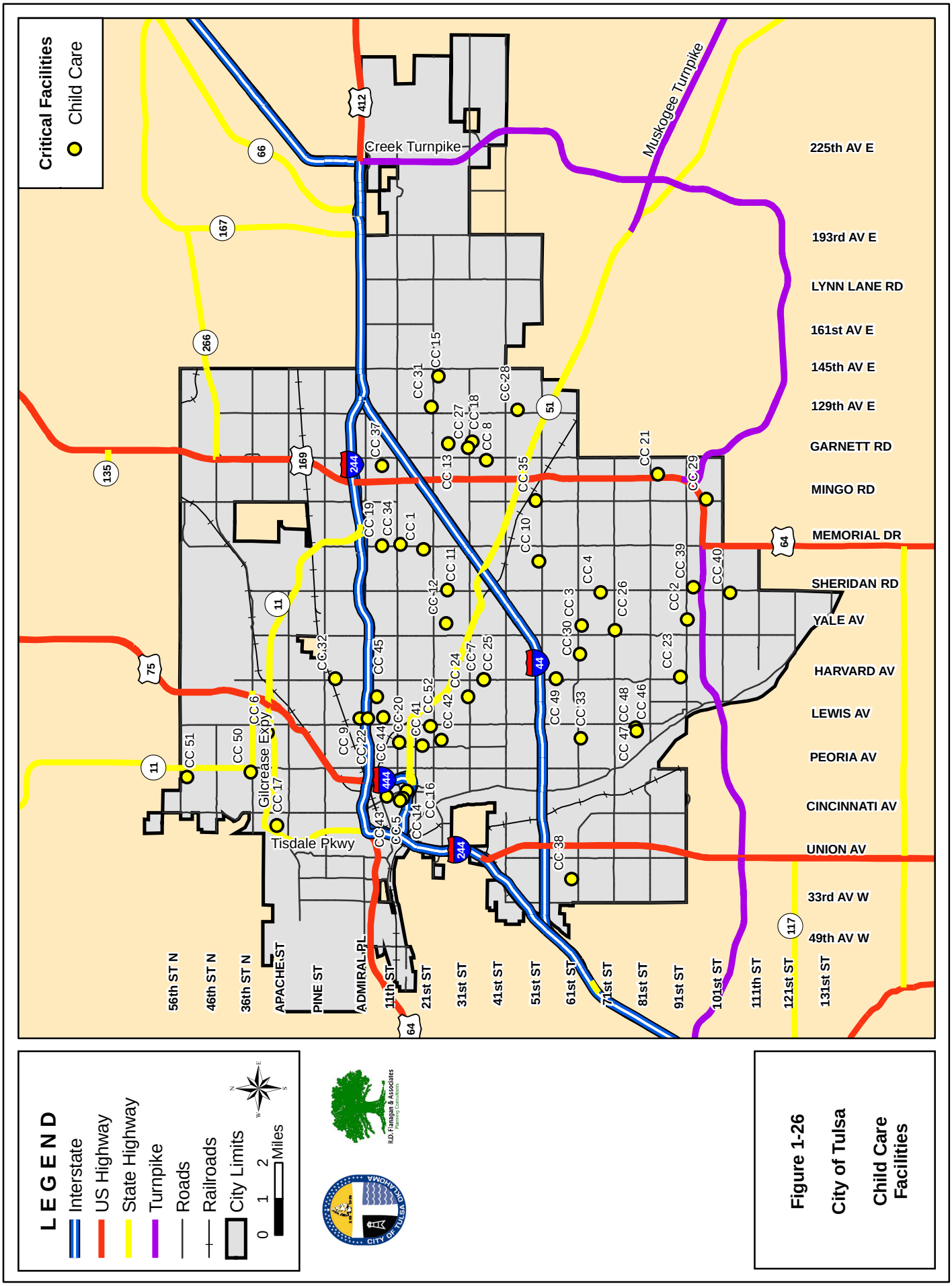


Figure 1-26
City of Tulsa
Child Care Facilities

Table 1–17: City of Tulsa Childcare Facilities

Cat ID	Map ID	Name	Address
CC	1	ABC Child Development Center	7915 E. 17th St.
CC	2	ABC Preschool - Fellowship Bible Church	5434 E. 91st St.
CC	3	Ave Maria House	6161 S. Yale Ave.
CC	4	Bethany Community School	6730 S. Sheridan Rd.
CC	5	Boston Avenue UM Weekday School	1301 S. Boston Ave.
CC	6	Bundles of Joy Child Care Center	2131 E. 31 Pl. N
CC	7	Christ Methodist ELC	3515 S. Harvard Ave.
CC	8	Cornerstone Child Development Center	3434 S. Garnett Rd.
CC	9	Crosstown Learning Center	2501 East Archer St.
CC	10	Day Schools #1	5085 S. 76th East Ave.
CC	11	Day Schools #11	2437 S. Sheridan Ave.
CC	12	Day Schools #9	2327 S. Darlington Ave.
CC	13	Disney Family Center CAP	11610 East 25th St.
CC	14	Early Learning Academy	1115 S. Boulder Ave.
CC	15	Eastgate Early Education Center	14002 E. 21st St., Ste. 300
CC	16	First Christian Child Development Center	913 S. Boulder Ave.
CC	17	Frost Head Start Early Childhood Center	203 West 28th St. N
CC	18	Garnett Learning Center	12000 E. 31st St.
CC	19	Happiness is One	455 S. Memorial Ave.
CC	20	Hillcrest CDC	1121 S. Victor Ave.
CC	21	Hope Worship Center	8304 S. 107th East Ave.
CC	22	Instituto Bilingue Guadalupano	2510 E Admiral Blvd.
CC	23	Jenks PS East Before & After Program	8925 S. Harvard Ave.
CC	24	John Knox Child Development Center	2929 E. 31st St.
CC	25	Kid's Connection Child Development Center	3515 S. Harvard Ave.
CC	26	KinderCare Learning Center	5110 East 71st St. S
CC	27	KinderCare Learning Center	11633 E. 31st St. S
CC	28	KinderCare Learning Center	12928 E. 43 Pl. S
CC	29	KinderCare Learning Center	9625 S. Mingo Rd.
CC	30	Kirk of The Hills Preschool	4102 E. 61st St.
CC	31	La Petite #7	1950 S. 131st E Ave.
CC	32	Mabee Red Shield Boys and Girls	1231 N. Harvard Ave.
CC	33	McClure Head Start	6150 S. Yorktown Ave.
CC	34	Memorial Village Early Learning Center	8119 East 12th St.
CC	35	Miss Helen's Private School	4849 S. Mingo Ave.
CC	36	NACT Headstart & Day Care	1470 W. 41st St.
CC	37	Reed Family Center	10940 E. 5th Ave.
CC	38	Riverfield Country Day School	2433 W. 61st St.
CC	39	Shining Through Learning Center	6605 E. 93rd St.

Cat ID	Map ID	Name	Address
CC	40	South Tulsa Baptist ELP	10310 S. Sheridan Ave.
CC	41	St. John Medical Center Chapman Learning Center	1710 E. 17th St.
CC	42	Temple Israel/ Day Schools Inc.	2004 E. 22nd Pl.
CC	43	Trinity Episcopal Day School	501 S. Cincinnati Ave.
CC	44	Tulsa Educare Inc.	2511 E. 5th Pl. S
CC	45	Tulsa University Child Development Center	2906 E. Third St.
CC	46	Victory Christian School	7700 S. Lewis Ave.
CC	47	Victory Kids Care	7700 S. Lewis Ave.
CC	48	Victory Mothers Day Out	7700 S Lewis Ave.
CC	49	WABC Learning Center, Inc.	5511 S. Harvard Ave.
CC	50	World Won Early Learning Center	PO Box 481018
CC	51	YWCA of Tulsa - North Center	5424 N. Madison Ave.
CC	52	YWCA Patti Johnson Wilson ELC	1910 S. Lewis Ave.

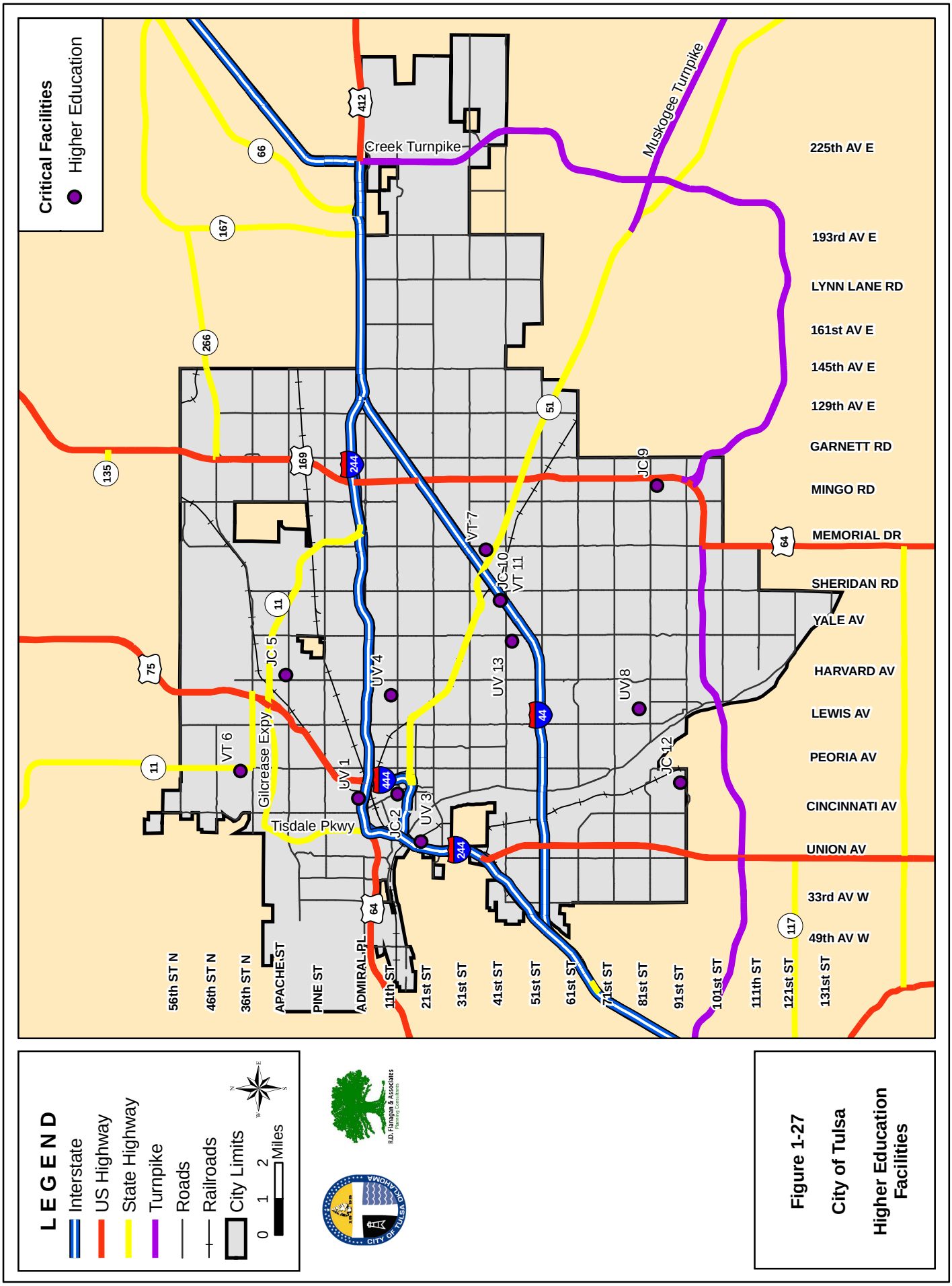


Figure 1-27
City of Tulsa
Higher Education Facilities

Table 1–18: City of Tulsa Higher Education Facilities

Cat ID	Map ID	Name	Address
UV	1	Oklahoma State University - Tulsa	700 N Greenwood Ave.
JC	2	Tulsa Community College - Metro Campus	909 S Boston Ave
UV	3	OSU College of Osteopathic Medicine	1111 W 17th St
UV	4	University of Tulsa	800 S Tucker Dr.
JC	5	Tulsa Community College - Northeast Campus	3727 E Apache St.
VT	6	Tulsa Technology Center - Peoria	3850 N Peoria Ave.
VT	7	Tulsa Technology Center - Lemley Campus	3420 S Memorial Dr.
UV	8	Oral Roberts University	7777 S Lewis Ave.
JC	9	Tulsa Community College - Southeastern Campus	10300 E 81st St.
JC	10	Tulsa Community College - Conference Center	6111 E Skelly Dr.
VT	11	Tulsa Technology Center - Skyline	6111 E Skelly Dr.
JC	12	Tulsa Community College - Riverside	801 E 91st St.
UV	13	University of Oklahoma – Schusterman Center	4502 E 41st St

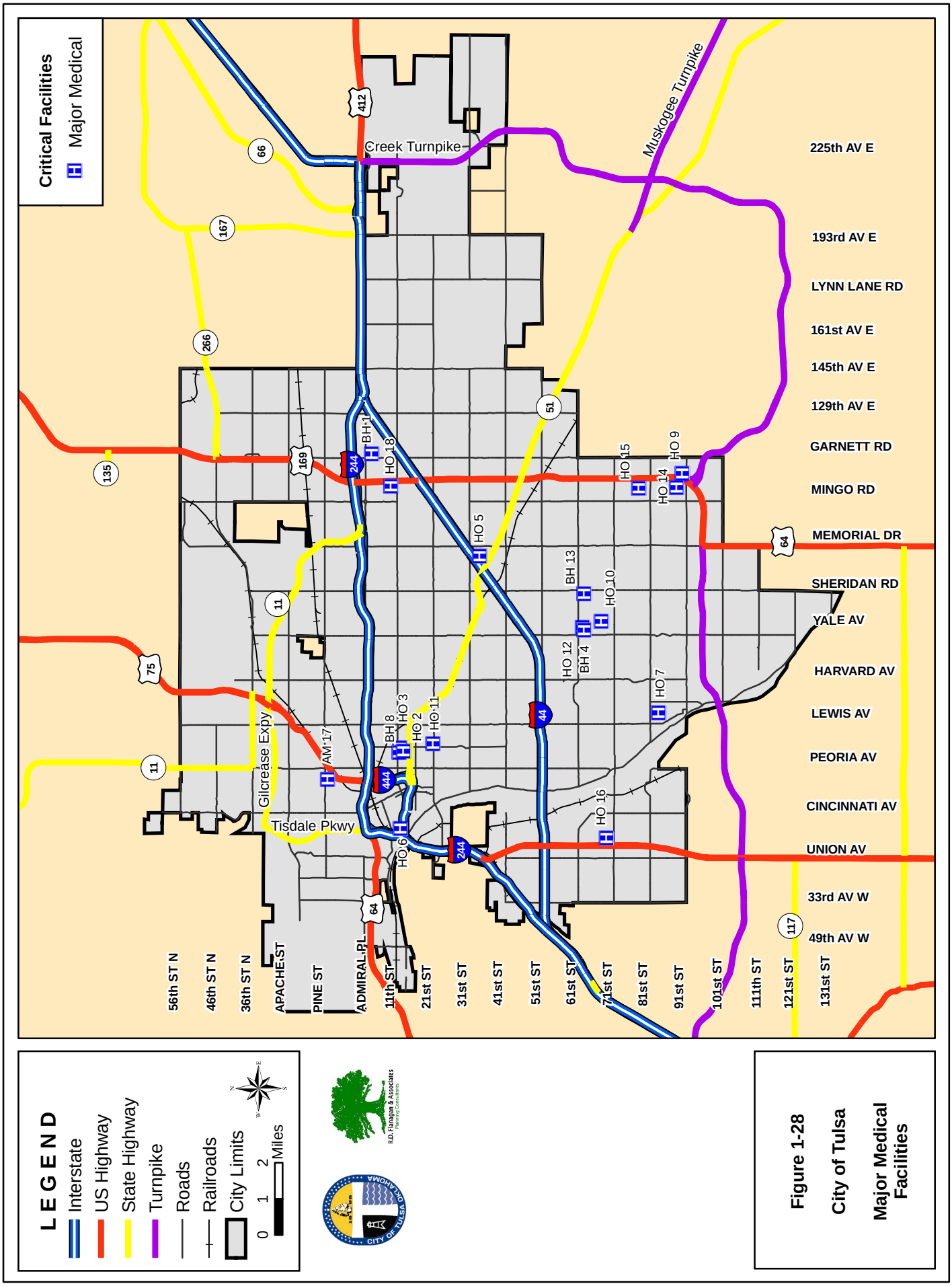


Figure 1-28
City of Tulsa
Major Medical Facilities

Table 1–19: City of Tulsa Major Medical Facilities

Cat ID	Map ID	Name	Address
BH	1	Brookhaven Hospital	201 S Garnett Rd
HO	2	Hillcrest Medical Center	1120 S Utica Ave
HO	3	Hillcrest Specialty Hospital	1125 S Trenton Ave
BH	4	Laureate Psychiatric Clinic & Hospital	6655 S Yale Ave
HO	5	Meadowbrook Specialty Hospital of Tulsa	3219 S 79th East Ave
HO	6	Oklahoma State University Medical Center	744 W 9th St
HO	7	Oklahoma Surgical Hospital	2408 E 81st St Ste 300
BH	8	Parkside Community Psychiatric Services & Hospital	1620 E 12th St
HO	9	Saint Francis Heart Hospital	10501 E 91st St
HO	10	Saint Francis Hospital	6161 S Yale Ave
HO	11	Saint John Medical Center	1923 S Utica Ave
HO	12	Select Specialty Hospital - Tulsa	6161 S Yale Ave, 5 South
BH	13	Shadow Mountain Behavioral Health System	6262 S Sheridan Rd
HO	14	SouthCrest Hospital	8801 S 101st East Ave
HO	15	Southwestern Regional Medical Center	10109 E 79th St
HO	16	Tulsa Spine & Speciality Hospital	6901 S Olympia
AM	17	EMSA	1417 N Lansing Ave
HO	18	American Red Cross	10151 E 11th St

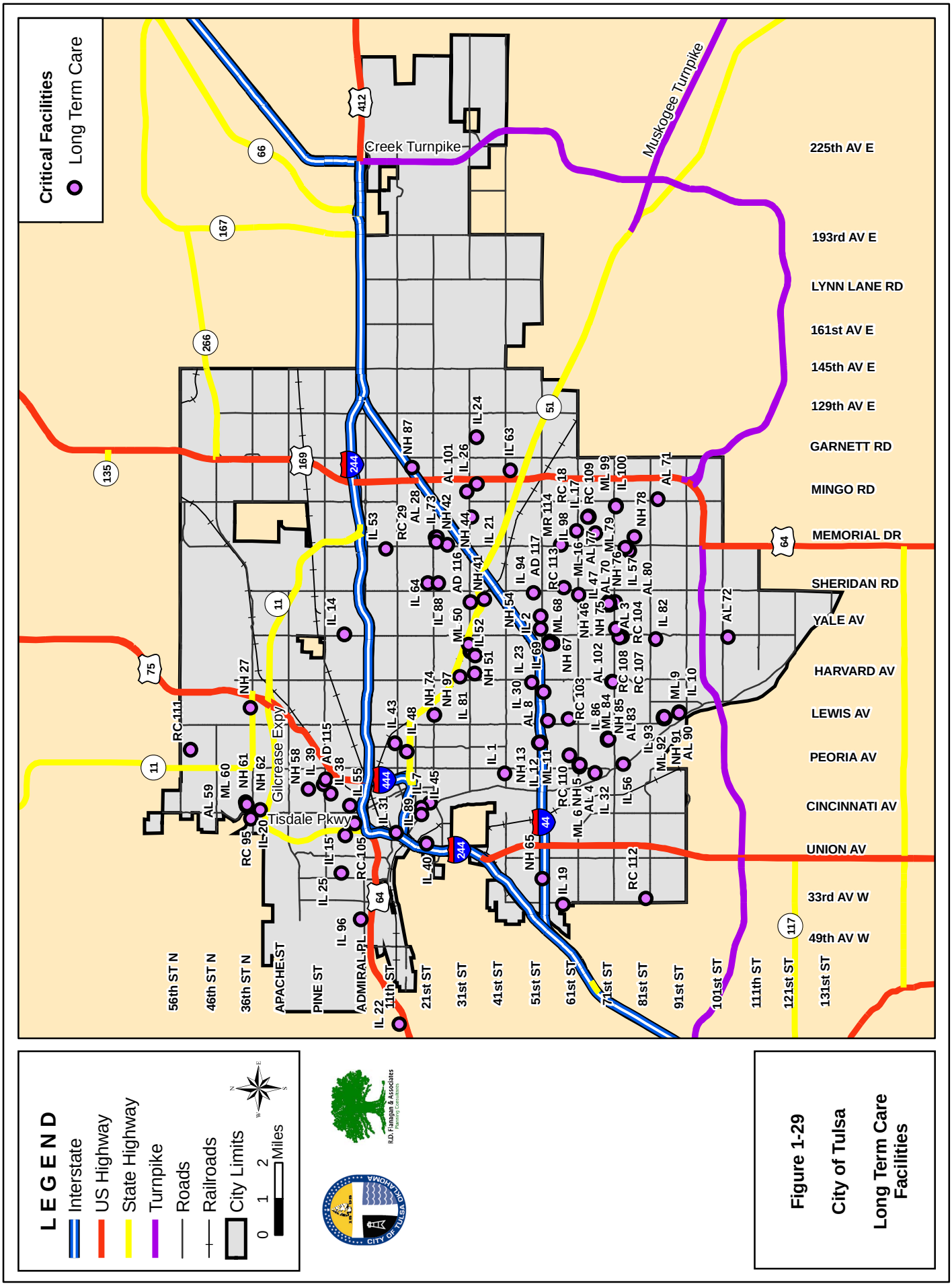


Figure 1-29
City of Tulsa
Long Term Care Facilities

Table 1–20: City of Tulsa Long Term Care Facilities

Cat ID	Map ID	Name	Address
IL	1	4100 Apartments	3933 S Norfolk Ave.
IL	2	5400 South Apartments	4700 E 54th St.
AL	3	Aberdeen Heights	7220 S Yale Ave.
AL	4	Ambassador's Courtyards	1380 E 61st St.
NH	5	Ambassador Manor Nursing & Rehab Center	1340 E 61st St.
ML	6	Ambassador Manor Nursing & Rehab Center	1340 E 61st St.
IL	7	Boulder Plaza	1840 S Boulder Ave.
AL	8	Brighton Gardens	5211 S Lewis Ave.
ML	9	Burgundy Place	8887 S Lewis Ave.
IL	10	Burgundy Place	8887 S Lewis Ave.
ML	11	Colonial Manor	5015 S Victor Ave.
IL	12	Colonial Manor	5015 S Victor Ave.
NH	13	Colonial Manor Nursing & Rehab Center	1815 E Skelly Dr.
IL	14	Cornerstone Village	1045 N Yale Ave.
IL	15	Country Club Gardens	959 Country Club Dr.
ML	16	Country Club of Woodland Hills	6333 S 91st E Ave.
IL	17	Country Club of Woodland Hills	6333 S 91st E Ave.
RC	18	Country Club of Woodland Hills Residential Care	6333 S 91st E Ave.
IL	19	Country Oaks	5648 S 33rd W Ave.
IL	20	Crestview Senior Duplexes	3535 N Cincinnati Ave.
IL	21	Disciples Village	9014 E 31st St.
IL	22	Edgewood at Gable Hills	7702 W Parkway Blvd.
IL	23	French Villa	4752 S Harvard Ave.
IL	24	Garnett Village	3254 S 120th East Pl.
IL	25	Gilcrease Estates	1143 N 24th W Ave.
IL	26	Glenwood Apartments	10221 E 34th St.
NH	27	Green Country Care Center	3601 N Columbia Ave.
AL	28	Heatheridge Assisted Living Community	2130 S 85th E Ave.
RC	29	Heatheridge Residential Care	2130 S 85th E Ave.
IL	30	Heatherwood Apartments	3006 E 51st St.
IL	31	Hewgley Terrace	420 S Lawton Ave.
IL	32	Inhofe Plaza	6565 S Newport Ave.
ML	33	Inverness Village	3800 W 71st St.
IL	34	Inverness Village	3800 W 71st St.
AL	35	Inverness Village - Alzheimer’s & Memory Support	3800 W 71st St.
NH	36	Inverness Village - Heather Hall	3800 W 71st St.
AL	37	Inverness Village - Redbud Court	3800 W 71st St.
IL	38	Jordan Plaza I & II	630 E Oklahoma St.
IL	39	Jordan Plaza III	775 E Pine St.

Cat ID	Map ID	Name	Address
IL	40	LaFortune Tower	1725 S Southwest Blvd.
NH	41	Lakewood Care Center	6201 E 36th St.
NH	42	Leisure Village	2154 S 85th E Ave.
IL	43	Luther Place on Troost	1304 S Troost Ave.
NH	44	ManorCare Health Services	2425 S Memorial Dr.
IL	45	Mansion House	1638 S Carson Ave.
NH	46	Maplewood Care Center	6202 E 61st St.
IL	47	Montereau in Warren Woods	6800 S Granite Ave.
IL	48	Murdock Villa	828 S Wheeling Ave.
AL	49	Oklahoma Methodist Manor	4134 E 31st St.
ML	50	Oklahoma Methodist Manor	4134 E 31st St.
NH	51	Oklahoma Methodist Manor	4134 E 31st St.
IL	52	Oklahoma Methodist Manor	4134 E 31st St.
IL	53	Park Village	650 S Memorial Dr.
NH	54	Parks Edge Nursing & Rehab Center	5115 E 51st St.
IL	55	Pioneer Plaza	901 N Elgin Ave.
IL	56	Prairie Rose	7401 Riverside Parkway
IL	57	Quail Creek Villa	7334 S Memorial Dr.
NH	58	Rest Haven	1944 N Iroquois Ave.
AL	59	Saint Simeon's Episcopal Home	3701 N Cincinnati Ave.
ML	60	Saint Simeon's Episcopal Home	3701 Cincinnati Ave.
NH	61	Saint Simeon's Health Care Center	3701 N Cincinnati Ave.
NH	62	Saint Simeon's Home Memory Center	3701 N Cincinnati Ave.
IL	63	Shadybrook Apartments	4203 S 109th East Ave.
IL	64	Sheridan Terrace	1937 S 68th East Ave.
NH	65	Sherwood Manor	2416 W 51st St.
IL	66	Southern Elms	4519 E 31st St.
NH	67	Southern Hills Rehab Center	5170 S Vandalia Ave.
ML	68	Southern Hills Retirement Community	5170 S Vandalia Ave.
IL	69	Southern Hills Retirement Community—The Villa	4515 E 53rd St.
AL	70	Sterling House of Tulsa	6022 E 71st St.
AL	71	Sterling House of Tulsa South	8231 S Mingo Rd.
AL	72	The Arbors	10201 S Yale Ave.
IL	73	The Broadmoor Retirement Community	8205 E 22nd St.
NH	74	The Cottage Extended Care	2552 E 21st St.
NH	75	The Health Care Centers at Montereau—Memory Support	6800 S Granite Ave.
NH	76	The Health Care Centers at Montereau—Skilled Nursing	6800 S Granite Ave.
AL	77	The Health Centers at Montereau—The Villa	6800 S Granite Ave.
NH	78	The Mayfair Nursing Center	7707 S Memorial Dr.
ML	79	The Montereau in Warren Woods	6800 S Granite Ave.

Cat ID	Map ID	Name	Address
AL	80	The Parke Senior Living	7821 E 76th St.
IL	81	The Scandia	3510 E 32nd St.
IL	82	Town Village	8222 S Yale Ave.
AL	83	Tulsa Jewish Retirement & Health Care Center	2025 E 71st St.
ML	84	Tulsa Jewish Retirement & Health Care Center	2025 E 71st St.
NH	85	Tulsa Jewish Retirement & Health Care Center	2025 E 71st St.
IL	86	Tulsa Jewish Retirement & Health Care Center	2025 E 71st St.
NH	87	Tulsa Nursing Center	10912 E 14th St.
IL	88	Tulsa Pythian Manor	6568 E 21st Pl.
IL	89	Tulsa Pythian Manor West	1700 Riverside Dr.
AL	90	University Village Retirement Community	8555 S Lewis Ave.
NH	91	University Village Retirement Community	8555 S Lewis Ave.
ML	92	University Village Retirement Community	8555 S Lewis Ave.
IL	93	University Village Retirement Community	8555 S Lewis Ave.
IL	94	Versailles Apartments	4816 S Sheridan Ave.
RC	95	Vintage Heights	1 W 36th St N
IL	96	West Edison Plaza	570 N 39th West Ave.
NH	97	Wildwood Care Center	3333 E 28th St.
IL	98	Woodland Manor	8641 E 61st St.
ML	99	Woodland Terrace	9524 E 71st St.
IL	100	Woodland Terrace	9524 E 71st St.
AL	101	Angel House Residential Assisted Living	10018 E 29th E Ave.
AL	102	Cypress Springs	7210 S Yale Ave.
CC	103	The Villages at Southern Hills	5721 S Lewis Ave.
RC	104	Comprehensive Community Rehabilitation Services, Inc	7112 S Canton Ave.
RC	105	Covenant House Residential Care Home	715 N Cheyenne Ave.
RC	106	Frankly Home	4006 W 45th Pl.
RC	107	Harvest Homes, Inc.	7028 S Harvard Ave.
RC	108	Harvest Residential Care Home II	3215 E 71st St.
RC	109	Hope of Angels	8516 E 65th St.
RC	110	Naquita's Niche, LLC	1521 E 59th St.
RC	111	Sarah's Residential Living Home	1571 E 53rd St. N
RC	112	St. Andrews Manor	3011 W 80th St.
RC	113	Trusted Care	5709 S 66th E Ave.
MR	114	Woodland Park Home, Inc.	5707 S Memorial Ave.
AD	115	Donald W Reynolds Adult Day Services-North	902 E Pine St.
AD	116	LIFE Senior Services, Inc.	5950 E 31st St.
AD	117	Oasis Adult Day Services	5525 E 51st St., Suite 400

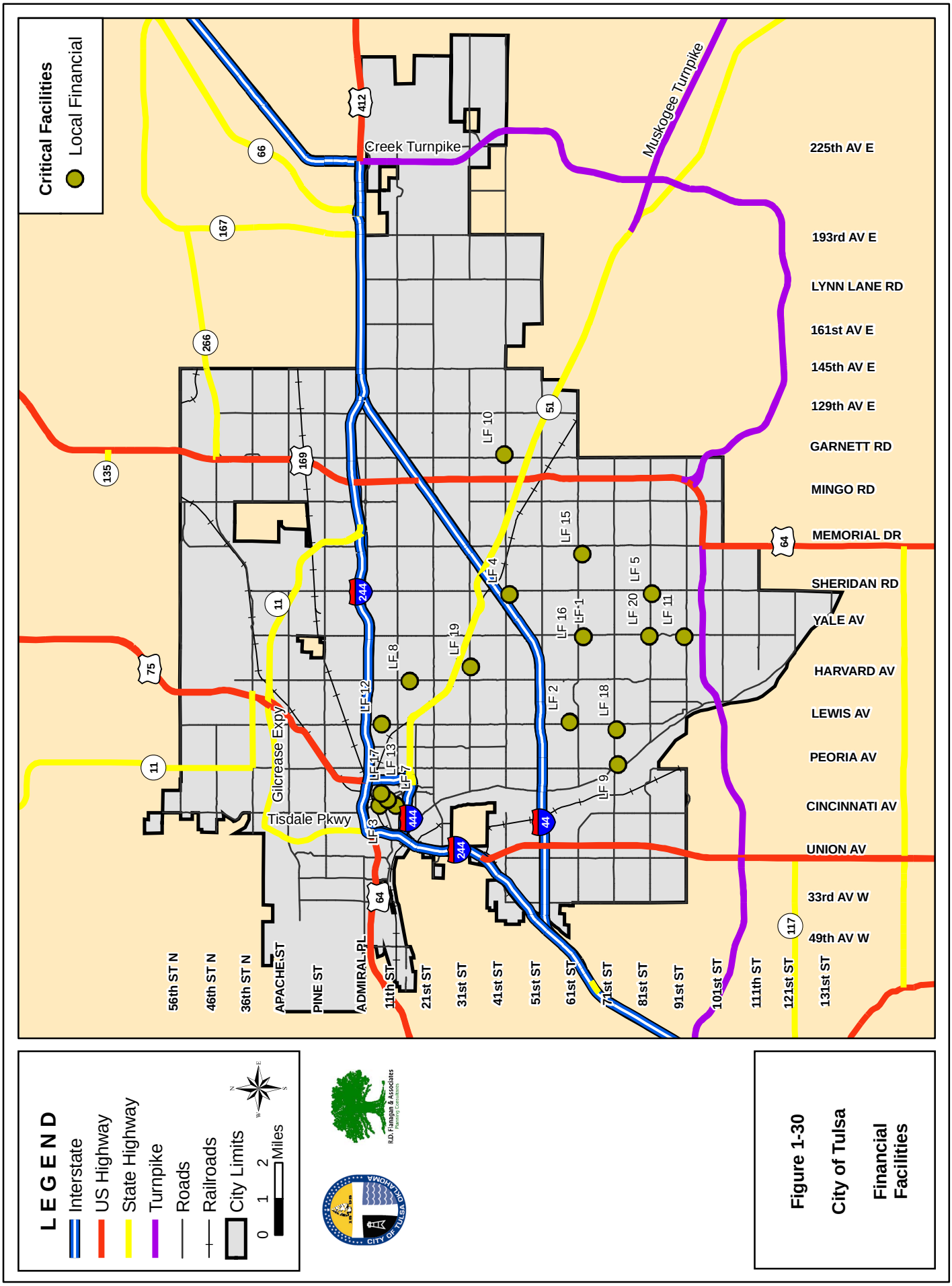


Figure 1-30
City of Tulsa
Financial Facilities

Table 1–21: City of Tulsa Financial Headquarters Facilities

Cat ID	Map ID	Name	Address
LF	1	American Bank & Trust Corp	6100 S Yale Ave
LF	2	American TrustCorp	5727 S Lewis Ave
LF	3	Bank of Oklahoma	1 Wiliams Ctr
LF	4	Bank of Oklahoma Tech. Center	6424 E 41st St
LF	5	Bank South of Tulsa	6130 E 81st St
LF	7	Energy One Federal Credit Union	220 W 7th
LF	8	F & M Bank Trust Co	1330 S Harvard Ave
LF	9	National Bank of Commerce	7127 Riverside
LF	10	Oklahoma Central Credit Union	11335 E 41st St
LF	11	ONB Bank & Trust Co.	8908 S Yale Ave
LF	12	Peoples State Bank Inc	445 S Lewis Ave
LF	13	Red Crown Federal Credit Union	509 S Boston
LF	15	Triad Bank NA	7666 E 61st St
LF	16	Trust Co of Oklahoma	6120 S Yale Ave
LF	17	Tulsa Federal Employees Credit Union	401 E 4th
LF	18	Tulsa National Bancshares	7120 S Lewis Ave
LF	19	Tulsa Teachers Credit Union	3720 E 31st St
LF	20	Oklahoma Central Credit Union	8080 S Yale Ave

Chapter 2: Existing Mitigation Strategies

44 CFR Requirements met:

Requirement §201.6(b): *In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process* ***shall*** *include:*

(1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;

(2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and

(3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

Requirement §201.6(c)(2)(ii): *[The risk assessment]* ***must*** *also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged by floods.*

Requirement: §201.6(c)(3)(ii): *[The mitigation strategy]* ***must*** *also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.*

Included in this Chapter:

2.1 About Hazard Mitigation Programs
2.2 Public Information and Education
2.3 Preventive Measures
2.4 Structural Projects
2.5 Property Protection
2.6 Emergency Services Procedures and Resources
2.7 Natural Resource Protection

2.1 About Hazard Mitigation Programs

Communities can do a number of things to prevent or mitigate the impacts of natural disasters. Such actions range from instituting regulatory measures (e.g., building and zoning codes) and establishing Emergency Operations Plans (EOP) and Emergency Operations Centers (EOC), to purchasing fire trucks and ambulances and constructing large and small infrastructure projects like levees and safe rooms. Most communities have already made considerable investments in these critical areas. The sections that follow in this Chapter survey the regulations, plans and infrastructure that the City of Tulsa has in place for avoiding or mitigating the impacts of natural hazards. This survey is based on FEMA's *State and Local Mitigation Planning How-to Guide* (FEMA 386-1, September 2002), and covers the following topics: Public Information and Education, Prevention, Structural Projects, Property Protection, Emergency Services, and Natural Resource Protection.

There are several national hazard mitigation programs developed by FEMA and other agencies that are designed to help communities organize their mitigation activities to achieve tangible results in specific areas, such as flood protection and fire hazard abatement. This section looks at Tulsa's participation and progress in these national programs.

The Planning Team reviewed relevant community studies, plans, reports, and technical documents in the inventory, evaluation and planning phases of the Multi-Hazard Mitigation Plan development. The Emergency Operations Plan was used to assess the current capabilities of the City of Tulsa. The Comprehensive Plan and Small Area Plans were used to determine community growth patterns and identify areas of future development. The Capital Improvements Plan was used to determine priorities of public infrastructure improvements, and timing of potential future development. These plans were

used to identify areas of future growth and development so that hazardous areas could be identified, evaluated, planned for, and appropriate mitigation measures taken.

2.1.1 National Flood Insurance Program (NFIP)

For decades, the national response to flood disasters was simply to provide disaster relief to flood victims. Funded by citizen tax dollars, this approach failed to reduce losses and didn't provide a way to cover the damage costs of all flood victims. To compound the problem, the public generally couldn't buy flood coverage from insurance companies, because private insurance companies see floods as too costly to insure.

In the face of mounting flood losses and escalating costs of disaster relief to U.S. taxpayers, Congress established the National Flood Insurance Program (NFIP). The goals of the program are to reduce future flood damage through floodplain management, and to provide people with flood insurance. Community participation in the NFIP is voluntary.

Tulsa joined the National Flood Insurance Program in 1971. All residents of Tulsa are eligible to purchase federal flood insurance. Tulsa's advances have earned its flood program one of the top ratings in the nation through the Community Rating System, which has allowed Tulsans to enjoy some of the lowest flood insurance rates in the nation. The City of Tulsa continues to maintain full compliance with the NFIP.

Community Rating System (CRS)

The CRS is a part of the National Flood Insurance Program that helps coordinate all flood-related activities of the City. Tulsa has participated in the National Flood Insurance Program (NFIP) since 1971 and in the CRS since 1991. The CRS is a voluntary program that seeks to reduce flood losses, facilitate accurate insurance rating, and promote awareness of flood insurance by creating incentives for a community to go beyond minimum floodplain management requirements. The incentives are in the form of insurance premium discounts. CRS ratings are on a 10-point scale (from 10 to 1), with residents of the community who live within FEMA's Special Flood Hazard Areas (SFHA) receiving a 5% reduction in flood insurance rates for every Class improvement in the community's CRS rating. The City takes part in the following CRS activities:

- Public information activities
- Mapping and regulatory activities
- Flood damage reduction activities
- Flood preparedness activities

Tulsa advanced from a Class 5 to a Class 3 community on October 1, 2000, and to a Class 2 community on October 1, 2003, making the City's flood insurance rates the lowest in the country. In October 2006, Roseville, CA gained the distinction of becoming a class 1 CRS community, which placed Tulsa as the second lowest flood insurance rates in the country. The Class 2 rating allows Tulsa's SFHA residents a forty percent reduction in their flood insurance premium rates. All rates are based on where the structure is located in FEMA's Flood Insurance Rate Maps (FIRMs). New Digital Maps (DFIRMs) became effective in August, 2009.

Tulsa has had 2,106 pre-FIRM flood insurance policy claims totaling $36,947,506 and 74 post-FIRM policy claims totaling $1,259,747 since 1978. A summary of City of Tulsa flood insurance policies, according to NFIP, as of June 30, 2013, is included in Table 2-1. Tulsa has 91 Repetitive Loss properties. Information about Repetitive Loss properties is included in Chapter 4.

Table 2–1: City of Tulsa Flood Insurance Policies

Flood Insurance	Amount
Flood Insurance Policies in Force	1,895
Value of Insurance in Force	$424,994,800
Premiums in Force	$1,221,165
Total Losses	2,578
Amount of Flood Losses Paid	$38,900,416

2.1.2 Firewise Community

The Firewise Community certification is a project of the National Wildfire Coordinating Group. It recognizes communities that have gone through a process to reduce the dangers of wildfires along what is referred to as the Wildland-Urban Interface. A specialist from Firewise Communities USA will work with the local community to assess wildfire dangers and create a plan that identifies agreed-upon achievable solutions to be implemented. For additional information on Firewise Communities, visit www.firewise.org/usa/. Tulsa does not participate in the Firewise Community program.

2.1.3 Fire Protection Rating

ISO's Public Protection Classification (PPC) program provides important information about municipal fire-protection services, which, in the past, was used by insurance companies to establish fire insurance premiums. Currently most fire insurance rates are determined by actual loss figures and history within specific zip codes. The PPC program does help communities plan for, budget, and justify improvements in order to mitigate the effects of the fire hazard.

A uniform set of criteria 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. These criteria incorporate nationally recognized standards developed by the National Fire Protection Association and the American Water Works Association. 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.

City of Tulsa Fire Protection Rating

Tulsa's fire protection rating has been a 3 since 2007.The rating is split in some areas, some areas of east Tulsa, not near a fire station, have a rating of 9.

2.1.4 StormReady Community

StormReady is a nationwide community preparedness program that began in Tulsa in 1999, and uses a grassroots approach to help communities develop plans to handle all types of severe weather—from tornadoes to tsunamis. The program encourages communities to take a new, proactive approach to improving local hazardous weather operations by providing emergency managers with clear-cut

guidelines on how to improve their hazardous weather operations. To be officially StormReady, a community must:

- Establish a 24-hour warning point and emergency operations center;
- Have more than one way to receive severe weather warnings and forecasts and to alert the public;
- Create a system that monitors weather conditions locally;
- Promote the importance of public readiness through community seminars;
- Develop a formal hazardous weather plan, which includes training severe weather spotters and holding emergency exercises.

Additional information can be found at http://www.stormready.noaa.gov/.

Tulsa has been certified as a StormReady Community since 1999.

2.1.5 Business Continuity Mitigation and Planning Programs

The shutdown or permanent loss of businesses can be particularly devastating to a community for a number of reasons.

1. Loss of a business can negatively affect the city's tax base and revenue. In 1993, a tornado struck in the area of Catoosa, Oklahoma, destroying a number of residences and a major truck stop on Interstate 44. The truck stop, and associated traffic and personnel it attracted, supported restaurants, clothing stores, motels, and numerous other businesses in the area. Overall, the loss of the one business cost the community almost 50% of its tax base until the truck stop was able to reopen.
2. Closing of a business may eliminate jobs, not only for the employees of that particular company, but also for vendors for and customers of the affected business. Following a severe tornado in Oklahoma City in 2002 that affected large parts of the community, including a General Motors plant, hundreds of workers were temporarily unemployed, putting a severe strain on the social service agencies for the area.

A great deal of the mitigation information in this document is applicable to residential, public, and commercial properties. When available, the plan will include business-specific information and strategies. For further discussion on business vulnerability and the importance of Business Continuity Planning (BCP), see Appendix B, Section B.1.10.

The City of Tulsa is served by the Disaster Resistant Business Council (DRBC), a coalition of a number of groups, including the Tulsa Metro Chamber, Red Cross, R.D. Flanagan & Associates, Family & Children's Services, the Oklahoma Department of Insurance, the Tulsa Health Department, State Farm Insurance, and others. The DRBC is a program of Tulsa Partners Inc., and has worked since 2006 to promote and support business continuity planning with small businesses, long term care facilities, hospitals, and non-profit agencies. For more information, see www.tulsapartners.org/DRBC.

2.1.6 Community Plans

City of Tulsa Area Plans

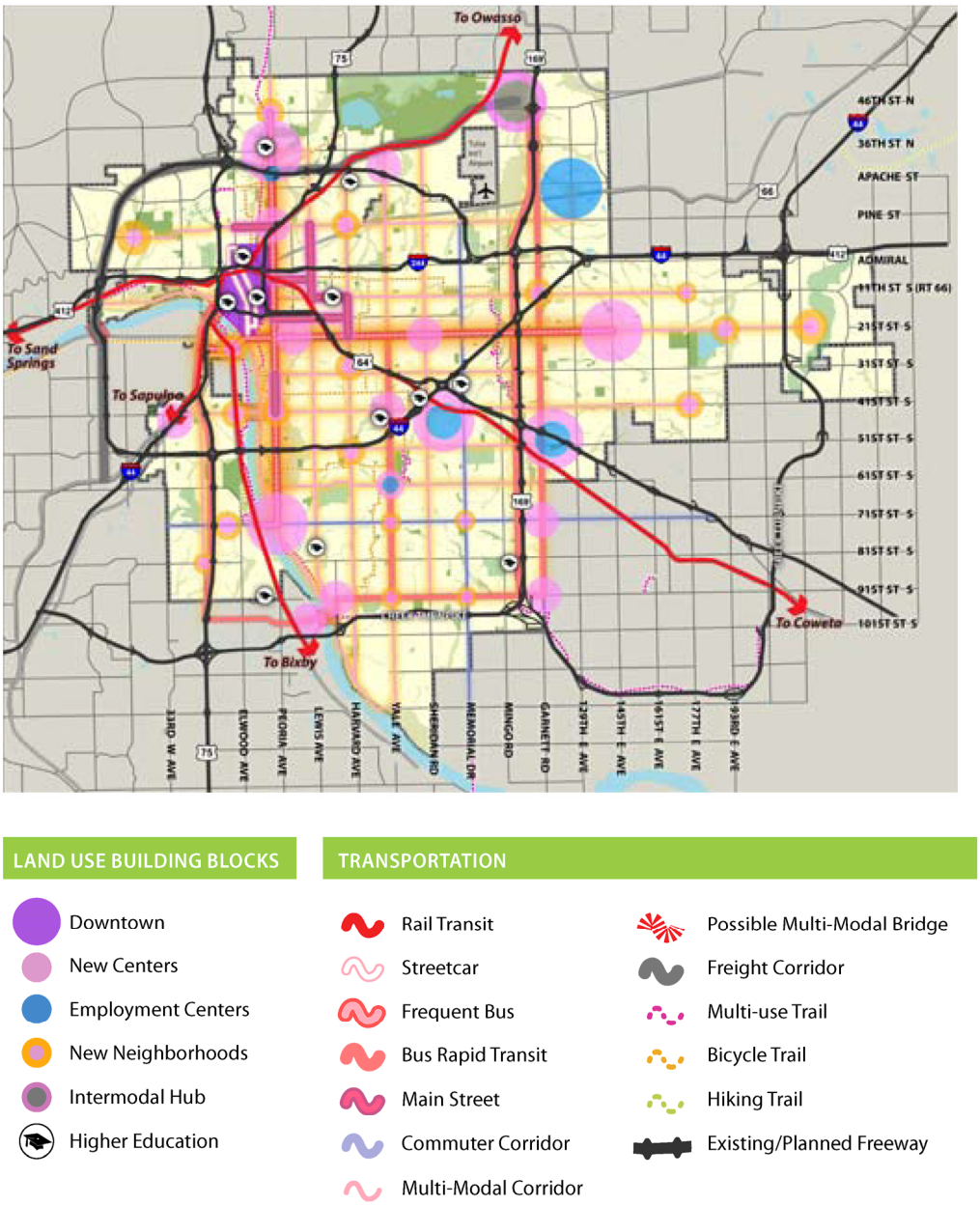
The City of Tulsa has a long and successful history of comprehensive land-use planning. Tulsa's first Comprehensive Plan, one of the first in the nation, was developed in 1923, and has undergone extensive updates in 1949, 1960, and the extensive Vision 2000 Comprehensive Plan process from 1972-1978.

PLANiTULSA 2010 Comprehensive Plan

Tulsa's most recent comprehensive planning process, PLANiTULSA, was completed in 2010, and is now undergoing the development of more detailed Small Area Plans at the neighborhood level. The PLANiTULSA Vision Plan map is shown below in Figure 2-1, and represents an overview of general land-use patterns.

The Comprehensive Plan guides the physical development of the city. Its policies will provide a framework within which individuals, businesses and public officials can make decisions that are consistent with the community's vision for the future. These guiding principles are vitally important. They will be used to guide development of a comprehensive plan, ensure that planning recommendations and strategies reflect and support the core values of Tulsa citizens, and serve as a guidepost for potential development scenarios and policy decisions.

Figure 2–1: PLANiTULSA 2010 Vision Map



Small Area Plans

The City of Tulsa has an extensive on-going small area and neighborhood planning process, primarily focused on addressing aging infrastructure, economic development and area revitalization. The small area planning process was established in the City of Tulsa's updated Comprehensive Plan, which was adopted in 2010. Small area plans are intended to focus resources where change is anticipated and desired and is dependent upon stakeholder consensus. The completed Tulsa Comprehensive Plan, updated through the two-year PLANiTULSA process, provided the solid foundation for new and ongoing neighborhood planning efforts. These community based efforts will continue to produce small area plans which are intended to be adopted as elements of the citywide comprehensive plan. These plans will guide implementation and revitalization efforts including projects, partnerships, programs, policies and procedures. These neighborhood and small area plans are summarized below, and shown on the map in Figure 2- 2.

1. Brady Arts District Plan & Brady Village Infill Development Guidelines-2010

The Brady Arts District of Downtown Tulsa (Brady Arts District Tax increment Finance District No. 1), adopted the "Brady Village Infill Development Design Guidelines," the "Brady Arts District – A Small Area Plan" and the "Brady Arts District Streetscape Summary Report."

2. Brookside Infill Plan

The Brookside Neighborhood encompasses about 1 ½ square miles, from E. 31st Street on the north, to E. 51st Street on the south, Riverside Drive on the west to S. Lewis Ave. on the east. The *Brookside Infill Neighborhood Detailed Implementation Plan* area is located along South Peoria Avenue, with Crow Creek on the north, and stretching south 2 miles to Interstate 44, Skelly Drive (East 51st Street).

Mayor Bartlett at the Hazard Mitigation Plan Information Table at *City Hall in the Neighborhood*

3. Charles Page Blvd. Plan- 1995

The *Charles Page Area Revitalization Plan* area is located in northwest Tulsa, bounded on the north by W. Edison Ave., the south by the Arkansas River, the west by 65th West Ave., the east by US Highway 244, and encompasses about 2 square miles.

4. Crutchfield Neighborhood Revitalization Plan- 1994

The Crutchfield study area encompasses about one square mile, and is located in the southwest area of the Springdale Plan. The Crutchfield Neighborhood Revitalization Plan was incorporated into the Springdale Plan as a supplement

5. East Tulsa Neighborhood Plan, Phase l -2006

The East Tulsa Neighborhood Plan, Phase I, consists of about five square miles, bounded generally by E. 11th Street on the north, S. 145th E. Ave. on the east, US 169 on the west, and E. 31st Street on the south.

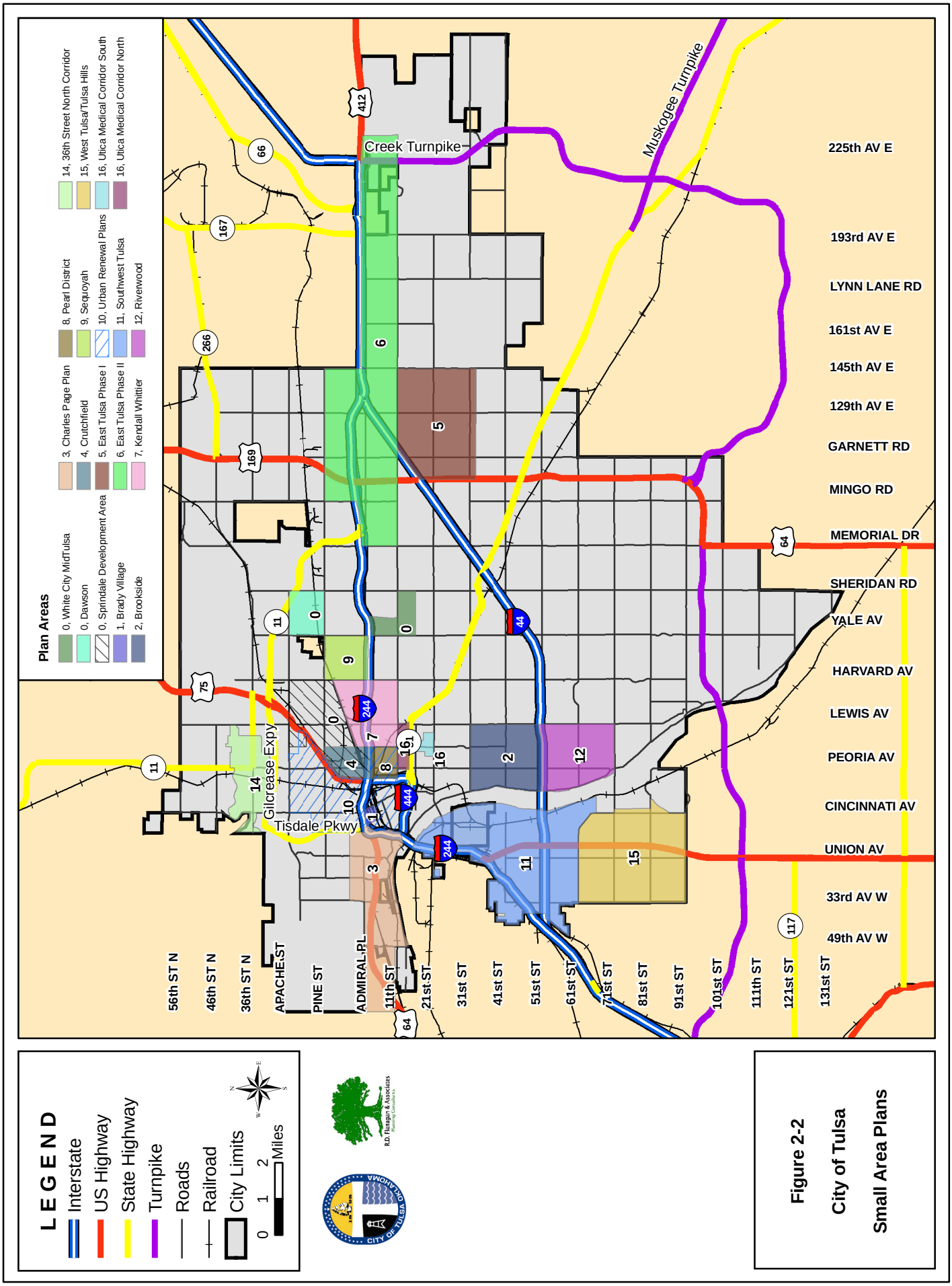


Figure 2-2
City of Tulsa
Small Area Plans

6. East Tulsa Neighborhood Plan, Phase II- 2004

The East Tulsa Neighborhood Plan, Phase II, encompasses about twelve square miles in East Tulsa, and is bounded generally by E. Pine Street and I-244 and I-44, US 412 on the north, S. Memorial Drive on the west, E. 11th Street on the south, and s. 225th E. Ave., in Waggoner County on the east.

7. Kendall-Whittier Square Plan

The Kendall-Whittier Square area consists of about two and a half square miles, bounded generally by the BNSF RR on the north, Utica Ave. on the west, E. 11th Street on the south, and Lewis Ave. on the east.

8. Pearl District Plan

The Pearl District contains about a square mile, and is bounded on the north by I-244, the west by the Inner Dispersal Loop, the south by E. 11th Street, and the east by S. Utica Ave,

9. Sequoyah

The Sequoyah Area Plan encompasses a square mile, bounded on the west by N. Harvard Ave., the east by N. Yale Ave., the north by E. Pine St., and the south by E. Admiral Place. The area is primarily residential, with industry located in the northwest area, adjacent to the railroad. Sequoyah and Owen schools are located within the planning area.

10. Downtown Area Plan- 2009

The Downtown Area covers about a square mile, and is bounded an all sides by the Inner Dispersal Loop expressway system, generally by 1-244 on the north, Maybelle Ave. on the west, 13th Street on the south, and E. Madison Ave. on the east. The City began development of an updated Downtown Tulsa Master Plan following the development of Vision 2025 downtown elements. The plan is intended to maximize existing downtown initiatives. The Downtown Plan is based on previous master plans, district plans and other studies. It is also based on emerging private and public development and redevelopment in the Central Business District area, near downtown neighborhoods, and connections to the Arkansas River.

11. Southwest Tulsa Plan

The Southwest Area consists of about seven square miles, located in West Tulsa, bounded on the north and east by the Arkansas River, the west by I-244, and the south by W. 61st Street.

12. Riverwood Neighborhood Plan- 1997

The Riverwood Neighborhood is located in south Tulsa, contains a little over two and a half square miles, and is bounded on the north by E. 51st Street and I-44, on the west by the Arkansas River, the south by E. 71st Street, and the east by S. Lewis Ave.

13. Eugene Field Neighborhood Revitalization Small Area Plan

The Eugene Field Neighborhood consists of about a square mile, is bounded generally on the north and east by the Arkansas River, the west by I-244, and the south by W. 25th Street.

14. 36th Street North Corridor Small Area Plan

The 36th Street North Corridor area is about three square miles in size, and is bounded generally on the north by Flat Rock Creek, on the west by N. Cincinnati Ave., the south by 31st St, North, and the east by N. Lewis Ave.

15. West Highlands/Tulsa Hills Small Area Plan

The West Highlands-Tulsa Hills area is located in southwest Tulsa, contains about six square miles, and is bounded on the north by W. 61st Street, the west by S. 33rd W. Ave., the south by W. 91st Street, and the east by S. Elwood Ave. There was, among citizen stakeholders, a large desire to

maintain the area's "rural" character. Among the names for each citizen design groups' visions were "Rural Preserve" and "Urban Country." Yet stakeholders also understood that growth and development is currently happening, and is likely to continue. There was consensus for the more-intense development to happen in the area's eastern parts.

16. Utica Midtown Corridor Small Area Plan

The Utica Midtown Corridor Plan area consists of two plan sub-areas: Utica Midtown North, bounded by the Broken Arrow Expressway on the south, E. 11th Street on the north, S. Peoria Ave. on the west, and S. Lewis Ave. on the east; and Utica Midtown South, bounder by the Broken Arrow Expressway on the north, E. 21st St. on ht south, roughly S. St. Louis Ave. on the west, and S. Yorktown Ave. on the east.

Incorporation of Hazard Mitigation into Community Planning Processes

The City of Tulsa Planning Department has actively participated in the Hazard Mitigation Plan Update process. Hazard Mitigation Planning staff and consultants have attended and made presentations at City Council, City Council District meetings, planning citizens meetings, and City Hall in the Neighborhood meetings. Typical of the incorporation of Hazard Mitigation Plan issues and Mitigation Measures is language in the Eugene Field Small Area Plan:

> *"To protect residents, employees, employers and neighborhood visitors against natural and man-made hazards a number of guidelines have been developed and are outlined below. These guidelines are designed to reduce or mitigate the impact of general hazards that are often the result of severe weather conditions or site specific hazards related to the geographic location of the neighborhood.*

- *Develop shelters / safe rooms throughout the community that include the provision of a back-up generator*
- *Encourage IBHS Fortified / Safe Homes Building Standards*
- *Incorporate the use of post-tension slabs when soil conditions indicate the need*
- *Encourage the use of whole house surge protection to prevent power surges*
- *Explore the use of lightning prediction systems for outdoor recreational areas*
- *Educate homeowners about impact-resistant roofing and potential home insurance discounts*
- *Implement a street tree program to decrease energy consumption, reduce air pollutants and greenhouse gases, improve water quality and provide human health and comfort benefits"*

2.2 Public Information and Education

Public information and education strategies are an important part of any successful program to mitigate the loss of life and property from natural and man-made hazards. Examples of such strategies include outreach projects, hazard information distribution, and school age and adult education programs. This section examines the existing communications infrastructure in and around Tulsa, and the programs and activities that the City currently has in place to serve this purpose. See Appendix B for discussion of potential activities and programs within this category.

2.2.1 Public Information Infrastructure

Television/Radio

Cable television is supplied by Cox Cable. Tulsa's government access Channel 23 is available to all Cox subscribers. Tulsa is served by the following TV stations:

Table 2–2: Tulsa Area Television Stations

Channel	Call sign	Network	Owner
2	KJRH-TV	NBC	E.W. Scripps Company
6	KOTV-TV	CBS	Griffin Communications
8	KTUL-TV	ABC	Allbritton Communications Company
11	KOED-TV	PBS	Oklahoma Educational Television Authority
19	KQCW-TV	The CW	Griffin Communications
23	KOKI-TV	FOX	Clear Channel
35	KRSC-TV	Educational	Rogers State University
41	KMYT-TV	MyNetworkTV	Clear Channel
44	KTPX-TV	ION Television	ION Media Networks
47	KWHB-TV	Religious	LeSea Broadcasting
51	KXAP-TV	Hispanic	Perez Broadcasting
53	KGEB-TV	Religious	Oral Roberts University

Tulsa is also served by 11 AM radio stations and 19 FM stations.**Telephone, Wireless and Cable Service**

Tulsa has an advanced telecommunications infrastructure comparable to most large metropolitan areas. The primary telecom provider is AT&T (formerly Southwestern Bell). In addition, there are a number of cellular and private telecom providers. Cox Cable also provides VOIP telephone service in the area.

AT&T offers digital DMS 100 central switch; fiber optic trunk line; 75,000 available line capacity; MCI and AT&T points of presence; and 99.9% redundancy.

Newspapers

Tulsa's morning and Sunday newspaper is the *Tulsa World.* In addition, an African American community newspaper, *The Oklahoma Eagle*, a Hispanic community newspaper, *Hispano de Tulsa*, and an American Indian newspaper, *Native American Times*, serve the area. Tulsa is also served by two business newspapers, several suburban and metro area weeklies, and the University of Tulsa *Collegian*.

2.2.2 Outreach Programs

Outreach Programs, as the name implies, are designed to inform the community about natural hazards and measures that can be taken to protect against them. Tulsa has outreach programs through the Tulsa Fire Department, City of Tulsa Public Works, American Red Cross, Tulsa Area Emergency Management and a number of other organizations. The City also maintains a comprehensive Internet web site that posts local ordinances and agency contact information, as well as City Commission agendas and meeting minutes. Tulsa videotapes its City Commission meetings and broadcasts them over its public access Channel 23 (T-GOV).

Tulsa City government has a close relationship with the local newspaper, the *Tulsa World*, which serves as a reliable outlet for municipal news releases on hazard related issues. The *Tulsa World* provides coverage of City Council and Planning Commission meetings, and makes itself available for in-depth presentations and discussions of matters of local importance. The *Tulsa World* makes their articles available to the public via the Internet, www.tulsaworld.com.

The City of Tulsa has an outreach program for informing citizens about natural hazards, how to prevent or mitigate their impacts, and what resources the community has to assist in damage prevention, mitigation and recovery. For example, in the past the *Tulsa World* has carried articles on family preparedness, tornado mitigation, lightning safety, house and wildfire mitigation, flooding, storm drainage, floodplain regulations, dam safety, the City's EOC, storm sirens, the Red Cross, amateur radio operators, storm spotters, and hazard mitigation planning.

Other local outreach efforts include:

- The Emergency Operations Center (EOC) and the National Weather Service Tulsa Forecasting Office offers presentations to groups interested in storm preparedness.
- The EOC has direct access to the cable television system and local radio stations to alert citizens in the event of an emergency.
- Tulsa's Mayor issues a declaration supporting September as being National Preparedness Month.
- The National Weather Service and local ham radio groups offer classes for future storm spotters.
- Tulsa Fire Department has an active Public Education Department. The Public Education Unit educates the general public in fire prevention, fire safety, and survival techniques. It provides Department information, sponsors the annual Fire Protection Week, is the TFD presence at the Tulsa State Fair, and representative to schools, neighborhood groups, and associations.
- The Tulsa Fire Department coordinates Project Life. Project Life is a free smoke detector installation program that targets neighborhoods with a history of fires. Some smoke detectors may be installed by TFD companies in a neighborhood immediately after a fatality fire, or detectors may be installed over a larger area usually over the weekend after residents have been notified by mail or flyers.
- The Tulsa Project is another free smoke detector installation program. When a fire company goes on any call to a home, the company officer is to determine the condition or lack of smoke alarm there. Upon determination that an alarm is absent or inoperable, the officer, with permission of the occupants, will install a detector or fresh batter to ensure that the home and family is protected.
- Tulsa Partners provides a number of outreach programs in the community including, but not limited to:
    - An annual conference on Emergency Preparedness for Long Term Care Facilities;

- The Disaster Resistant Business Council provides opportunities for businesses to develop business continuity plans;
- Children's workshops, developed in conjunction with the national organization Save the Children, are presented in elementary schools and childcare centers.

City of Tulsa Radio/TV Programs/Communications

Meetings of Tulsa's City Council are advertised on the Internet and broadcast over Channel 24 (T-Gov). Tulsa's Emergency Manager has direct access to the cable television system and local radio to alert citizens of emergencies. In addition, an overview of the Hazard Mitigation Plan is made available on the City of Tulsa's website.

2.3 Preventive Measures

Preventive measures are defined as government administrative or regulatory actions or processes that influence the way land and buildings are developed and built. This section contains a summary of the current ordinances and codes that relate to land use, zoning, subdivision, and stormwater management in the City of Tulsa. Land use planning, regulations, and ordinances are the primary tools for hazard mitigation at the community level. Management of environmental hazards relies on effective land use planning. The regulation of land use can reduce the exposure of residents to natural hazards, such as limiting the development of floodplains, and to technological hazards, such as chemical storage facilities. Tools outlined in this section of the plan have been, and will continue to be, used to reduce future flood and other hazard losses in the City of Tulsa. The following items are reviewed in this section: Comprehensive and land use planning; building codes adopted by the city of Tulsa; Tulsa zoning ordinances; and stormwater management regulations and the role they play in preventing future flood losses. Current standards in Tulsa plans and regulations are included in this section. Plans, codes, regulations, and ordinances, should be reviewed and revised as necessary to reflect changes during the five-year plan update process. See Chapter 7 and Appendix B for discussion of potential activities and programs within this category.

2.3.1 Planning and Zoning Ordinances

Tulsa's *Comprehensive Plan* defines policies for providing guidance and direction of the City's physical development. It covers ordinances for land use, zoning and subdivision, and the development of standards for transportation and public facilities. The original plan, adopted in 1924, contained Tulsa's first zoning ordinances. It was revised in 1960, and again in 1976, when a land use plan was added. Early in 2007, the City of Tulsa began a process to update its Comprehensive Plan; the plan was completed and became effective in July, 2010.

The *City of Tulsa Zoning Code* is a compilation of Title 42, Zoning and Property Restrictions of the City of Tulsa. The original document was adopted on July 1, 1970 and has been revised through July 27, 2011. The Zoning Code identifies 29 separate zoning districts to govern land use development within the City. The ordinances contain regulations for such things as building location and construction, mobile home location and protection, hazardous materials industries, and development in special flood hazard areas. The 1970 code was based on a low density, auto-oriented, suburban development pattern which was common in that era. The 2010 Comprehensive Plan strongly suggested the need for zoning modifications in response to changing community sentiment and current conditions. Work to revise the current City of Tulsa Zoning Code began in February 2012. A map of City zoning is presented in Figure 2-3.

The purpose of zoning is to:

1. Encourage the most appropriate uses of land according to the policies set forth in the Tulsa Comprehensive Plan;
2. Maintain and stabilize the value of property;
3. Secure safety from fire and other damages to public health and safety;
4. Provide adequate light and air;
5. Decrease traffic congestion and its accompanying hazards;
6. Prevent undue concentration of population;
7. Create a comprehensive and stable pattern of land use upon which to plan for water supply, transportation, sewers, schools, parks, public utilities, and other facilities.

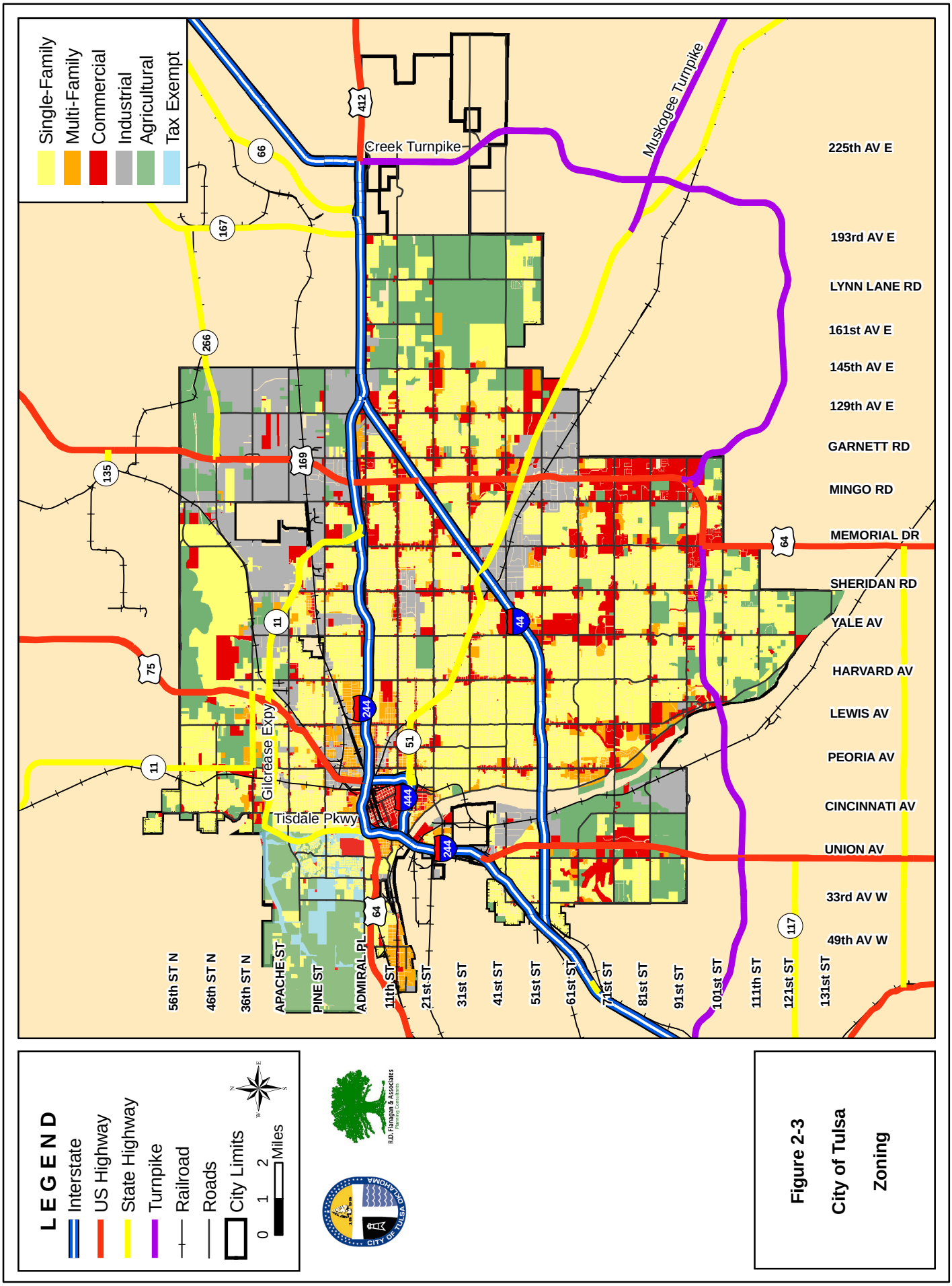
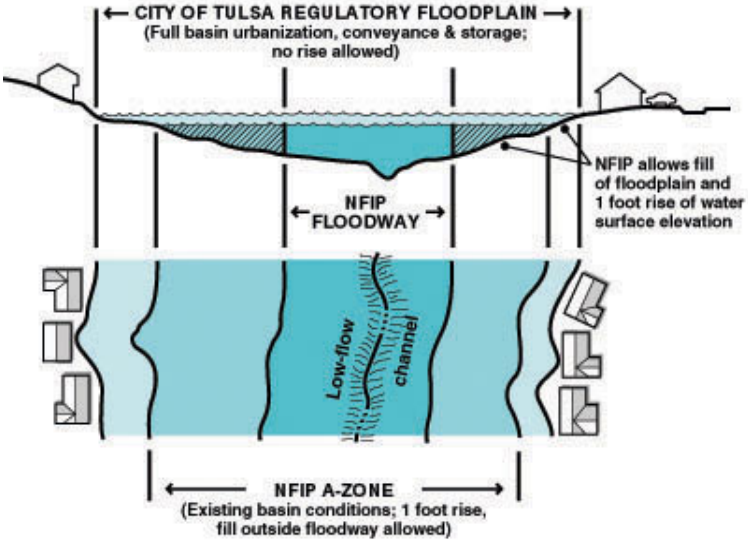


Figure 2-3
City of Tulsa
Zoning

Currently the city is zoned into residential, commercial, industrial, public, agriculture and university districts. These districts regulate such things as land use, lot sizes, setbacks, parking, and landscaping requirements. There are 29 zoning districts, supplemented by special overlay districts, which assign specific criteria to the underlying zoning. These special overlay districts include planned development districts, redevelopment districts, and the downtown district. Subdivision design standards can require elevation data collection during the platting process. Lots may be required to have buildable space above the base flood elevation.

2.3.2 Flood and Stormwater Management

Tulsa has grown up with flooding. The city was settled on a major river, in a weather convergence zone with violent spring and autumn storms, on a frontier where people believed they had a right to do what they wanted with their land. After many years of repeated floods, the community instituted improved floodplain management practices that constitute one of the most respected flood programs in the nation.



Tulsa welcomes growth, so long as it does not flood or cause flooding elsewhere

Unlike many communities, the City of Tulsa regulates to a higher standard in three categories of so-called "100-year" floodplain areas in order to reduce future flood losses:

- As a minimum standard, the FEMA Special Flood-Hazard Area is an area that has a 1% chance of flooding in any given year. FEMA SFHA floodplains are designated on FEMA's Flood Insurance Rate Maps (FIRM). The SFHA identifies the National Flood Insurance Program's (NFIP) minimum national standard, which reflects only existing development conditions at the time of the study.
- City of Tulsa regulatory floodplain areas, which are calculated by a different standard. They take into account "100-year" flooding that would occur when contributing watersheds are fully developed. Therefore, Tulsa regulatory floodplain areas may be wider than the FEMA floodplains and may extend farther up creeks and waterways.
- Floodways, generally the most dangerous center strip along a water course where water is apt to run faster and deeper. Tulsa applies more stringent regulations in floodways because of the higher risk there.
- Throughout this report, "floodplain" will mean specifically the City of Tulsa regulatory floodplain, unless otherwise noted.

Because the SFHA, the national minimum standard, deals with existing conditions and does not take the impacts of future urbanization into account in its modeling or floodplain map delineations, buildings that have been permitted and built in accordance with the National Flood Insurance Program's (NFIP) minimum standards may flood in the future as the basins develop. This is why the City of Tulsa regulates to a higher standard, requiring that no insurable structure will be built that has its first finished floor less than 1 foot above the Base Flood Elevation (BFE).

Without requirements for upstream detention of excess flows and compensatory storage (both also required by Tulsa), piping and paving for future urbanization and development can cause an increase in urban stormwater runoff and flood depths. In some instances, it could cause discharges to double and can widen the floodplain and cause increases in the Base Flood Elevation (BFE).

Between 1980 and 2000, the City of Tulsa created master drainage plans for each of its major waterways that serve as the framework for flood management planning and programs. For the dates when those were completed, see Table 2-3.

Over the past three decades, both the frequency and severity of flooding have been greatly reduced by improved management and land use practices, but Tulsa's climate ensures that larger than 100-year rains will continue to occur over the city's future, with periodic damages. In addition, the potential for larger-than-100-year rains will continue, with a perennial risk for catastrophic floods. The first citywide master drainage plan was the *Flood and Stormwater Management Plan 1990–2005*. This plan prioritizes and coordinates the flood protection projects that are detailed in the city's 29 master drainage plans. The last revision of the plan was September 7, 2001. (Refer to Table 2–3, Master Drainage Plans and Basins.) The plan summarizes the following:

- Capital Improvement Program (see next section)
- Non-Structural Mitigation/Acquisition Priority List

The City later developed the *Flood and Stormwater Management Plan 1999-2014*, published on September 10, 1998. It was developed in accordance with planning criteria from the Community Rating System (CRS), Flood Mitigation Assistance (FMA), and Hazard Mitigation Grant Program (HMGP). Although the 1999-2014 plan primarily dealt with flooding, it also addressed other natural hazards. The *Flood and Stormwater Management Plan* recommended stormwater capital improvements projects. Tulsa has established a stormwater management fee dedicated to stormwater mitigation projects.

Table 2–3: Master Drainage Plans and Basins

Plan Name	*Creeks Watersheds*	*Year Completed*	*Plan Name*	*Creeks Watersheds*	*Year Completed*
Bird	Bird	1993	Mingo Creek		
Cherry/Red Fork	Cherry	1982	Upper Mill/Jones	Upper Mill	1993
	Red Fork		(Update)	Upper Jones	
				Upper Audubon	
Coal	Coal	1987	Upper Mid Mingo	Audubon	1981
				Bell	
Crow	Crow	1989		Brookhollow	
	Swan			Fulton	
	Travis Park			SouthPark	
Dirty Butter	Dirty Butter	1987		Sugar	
Downtown	Central Bus. Dist.	1993	Upper Tup/Brook	Upper Tupelo	1994
			(Update)	Upper Brookhollow	
Elm	Elm / Update	1988/2008	Upper Mingo	Alsuma	1988
Flatrock	Flatrock	1987		Catfish	
	Valley View			Ford	
				Mainstem	
Fred	Fred	1988	Northwest	Bigheart	1989
Fry Ditch #2	Fry Ditch #2	1989		Harlow	
				Parkview	
Garden City	Garden City	1987		Oak	
				Lower Basin	
Haikey	Haikey	1989	Perryman	Perryman	1988
	Little Haikey		South Tulsa Basin	South Tulsa	1992
Joe Mainstem	Mainstem, Joe				

Plan Name	Creeks Watersheds	Year Completed	Plan Name	Creeks Watersheds	Year Completed
	No Study		Southwest	Mooser	1988
Joe, East & West	Upper Joe, E/W	1989		Nickel	
Little Joe	Little Joe (Upper)	1992		Hager	
			Spunky Adams	Adams	1989
South Fork Joe	Joe, South Fork	1982		Center	
				Pond	
Mingo Creek	Mainstem (USACE)	No MDP		Reservoir	
Cooley	Cooley	1980		Spunky	
Lower Mingo	Little	1991	Vensel	Vensel	1978
	Quarry		Vensel (Update)	Vensel	1994
	Eagle				
	Douglas				
Lower Mid Mingo	Tupelo	1980			
	Mill				
	Jones				

2.3.3 Building Codes

Tulsa has adopted the following Building Codes:

- International Building Code, 2009 Edition
- International Existing Building Code, 2009 Edition
- International Fire Code, 2009 Edition
- International Residential Code, 2011 Edition
- International Residential Code (Pools), 2011 Edition
- International Plumbing Code, 2009 Edition
- International Fuel Gas Code, 2009 Edition
- International Mechanical Code, 2009 Edition
- International Property Maintenance Code, 2006 Edition
- International Private Sewage Disposal Code, 2006 Edition
- National Electrical Code, 2011 Edition

2.3.4 Capability Assessment

Land Use Management

The most potent set of tools municipal governments have in their hazard mitigation arsenal are bundled in the term “land use management.” Zoning codes allow counties, cities and towns to develop in an orderly, reasonable and safe manner. In addition to zoning, communities may adopt subdivision regulations, building codes, electrical codes, plumbing codes, floodplain management regulations and more in order to assure continuity within the community, quality construction and safety for the citizens. Building inspections may be required and even occupancy permits may be required for commercial establishments – all for the sole purpose of the safety of the occupants of the structures or buildings.

Zoning and subdivision ordinances can regulate the type of development that occurs in hazard areas. They can also limit development densities where evacuation routes are tight, lifelines are fragile or soils are likely to shift (in the case of an earthquake or expansive soils). In wildfire zones, these ordinances can require that streets be wide enough to accommodate fire trucks. In addition, they can

require that access to an adequate water supply and fire hydrants exists and that landscaping be designed to avoid fueling a fire.

Land use management can be the first line of protection of the lives of the citizens of the community by adoption of building codes that require fortified construction that can withstand 130 mph winds, including windows, doors and safe rooms that meet or exceed 250 mph winds and flying debris protection, and roofs that are wind and hail resistant.

Additional Statutory, Regulatory and Policy Capabilities

The State of Oklahoma has directed that "local governments [be assisted] in carrying out their responsibilities to alleviate the suffering and damage that result from major disasters and emergencies by:

1. Providing State assistance programs for public losses and needs sustained in disasters;
2. Encouraging the development of comprehensive disaster preparedness and assistance plans, programs, capabilities, and organizations by the State and local governments;
3. Achieving greater coordination and responsiveness of disaster preparedness and relief programs;
4. Encouraging individuals and local governments to obtain insurance coverage and thereby reduce their dependence on governmental assistance; and
5. Encouraging hazard mitigation measures, such as development of land-use and construction regulations, floodplain management, protection of wetlands, and environmental planning, to reduce losses from disasters" (Oklahoma Administrative Code, Title 145, Chapter 10, Subchapter 1, §145:10-1-3).

City councils may use general revenues, voter-approved general obligation bonds, and voter-approved sales taxes in "carrying out their responsibilities" regarding hazard mitigation planning and action. In addition, municipal governments have the specific statutory authority to create public trusts for multiple purposes which have the authority to borrow money, issue revenue bonds, and/or accept grants, subject to dedicated sources of revenue. Municipal governments have the statutory authority to create joint operational entities by "inter-local agreement" and jointly fund such entities.

State Oklahoma boards of education are obligated by the State that "(t)he [school] site and building(s) shall ensure that the health and safety of those served are properly safeguarded. Where required, the facility shall have utility systems, plumbing systems, electrical systems, mechanical systems, emergency systems, building interiors and building envelope designed, built, and maintained to recognized standards, codes and/or other legal requirements" and to institute "appropriate programs pertaining to hazardous materials, hazardous waste, asbestos, underground storage tanks, lead contamination, and other applicable life, health, and/or safety matters" (Oklahoma Administrative Code, Title 210, Chapter 35, Subchapter 3, Part 19, Standard X: School Facilities, §210:35-3-186 (h) and (j)). Boards of education may use appropriated State funds, federal funds, and/or grants from other lawful sources to fund this obligation. Boards of education have specific statutory authority to present propositions to the registered voters of their respective districts for the authority to issue general obligation bonds for such purposes that advance compliance with the State mandate. This would include, but not be limited to new construction or renovation of existing facilities and acquisition of materials and equipment to meet hazard mitigation goals and objectives set by the individual boards of education.

2.3.5 Other Preventive Measures

All water distribution pump stations presently have backup generators. Water treatment plants currently do not have generators, but a plan is being developed by the City to have generators at the plants capable of treating and distributing a minimum of 10 MGD/plant.

All sanitary sewer pump stations either have back-up generators or are on redundant electrical feeds. During the recent major ice storm in December, 2007, during which some of the pump stations on redundant feeds temporarily lost power, there were no overflows as a result.

2.4 Structural Projects

Structural projects are usually designed by engineers and architects, constructed by the public sector, and maintained and managed by governmental entities. They typically include such projects as stormwater detention reservoirs, levees and floodwalls, channel modifications, drainage and storm sewer improvements, and community tornado safe-rooms. The following section includes measures that are already in place or included in current planning. See Chapter 6 and Appendix B for discussion of potential activities and programs within this category.

Some of Tulsa's most beautiful parks are multi-purpose flood control and stormwater detention facilities

2.4.1 City of Tulsa Capital Improvements Plans

The City of Tulsa's Capital Improvements Plan lists approved street, building, water, sewer, and stormwater capital improvement needs, their costs, priority, and 5-year funding schedule. Capital improvements projects identified for hazard mitigation purposes – such as flood, tornadoes, high winds, and drought – are listed in Appendix F.

Some of the more significant projects either ongoing or planned are:

- Ongoing stormwater and drainage projects funded by the City's stormwater utility assessment;
- Development of a new Emergency Operations Center; and
- Recent completion of a new Emergency Communications (9-1-1 dispatch) Center.

2.5 Property Protection

Property protection measures are used to modify buildings or property that are subject to damage from various hazardous events. The property owner normally implements property protection measures. However, in many cases technical and financial assistance can be provided by a governmental agency. Property protection measures typically include acquisition and relocation, flood-proofing, building elevation, barriers, retrofitting, safe rooms, hail resistant roofing, insurance, and the like. The following section includes examples of property protection measures which have already been implemented within the City of Tulsa or which are part of current projects. See Chapter 7 and Appendix B for discussion of potential activities and programs within this category.

2.5.1 City of Tulsa Property Protection

Expansive Soils: Expansive soils have been mapped for the City of Tulsa. Tulsa typically runs a soils report before beginning any City construction. Building elevation and meeting current 2008 IBC codes that highlight safety concerns are two other areas that are considered part of the normal business process.

Expansive Soils/Extreme Heat: For the last 30 years, water and sewer lines have been bedded in sand or gravel to reduce the risk from line breakage due to expansive soils and increased water usage during extreme heat. This is more of a problem with older pipelines, and breaks from increased demand are more common than breaks from soil movement.

Hail: Providing hail resistant roofing is considered when the project budget can accommodate the added cost. Flood proofing, SafeRooms and lightning protection are typically considered on a site-by-site basis based on the critical nature of the facility.

Lightning: Critical facilities such as telecommunications and water treatment plants have lightning protection. In addition, the airport and the Police Academy have lightning protection. All individual city of Tulsa computers have surge protection, but not robust enough to protect against a significant lightning strike, and lightning protection is not typically included in the design of new facilities unless there is considerable or sensitive electronics and computer equipment.

Tornados/High Winds: The 911 Center is divided into zones, with the operations area designed to withstand 250 mph winds, while the administrative office area is designed to withstand an F1 or F2 level tornado. The Emergency Operations Center (Tulsa Area Emergency Management Agency) is located underground, beneath the Police Station at the Civic Center.

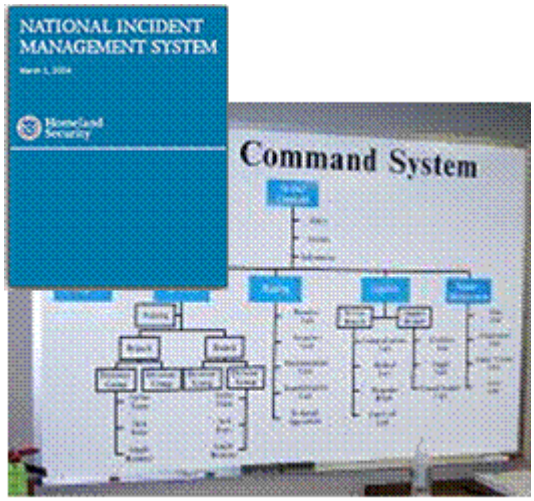
2.6 Emergency Services Procedures and Resources

In times of emergency, it is critical that a community have resources available to respond in an efficient manner to a hazard event. This section outlines Tulsa's current emergency services and response procedures, notification and warning systems, critical facility protection and available emergency response resources. See Chapter 7 and Appendix B for discussion of potential activities and programs within this category.

2.6.1 National Incident Management System (NIMS)

In 2004, Homeland Security Presidential Directive #5 (HSPD-5) was issued stating that, in order to be eligible for certain Federal disaster mitigation funding, state, local, and tribal jurisdictions must incorporate the use of the National Incident Management System (NIMS) into their protocols.

The NIMS incorporates a system currently used called Incident Command System (ICS), a management system developed by the fire service to provide a common language, common management protocols, and scalable incident response chains-of-command that can be applied to any emergency response, whether it be a single family fire to a major tornado event. ICS also allows for "unified command" for situations where multiple agencies may be in charge of various aspects of the operation



A typical Emergency Operations Center ICS Assignment Board

The NIMS enhances ICS by establishing a single, comprehensive system for incident management to help achieve greater cooperation among departments and agencies at all levels of government.

For further information on integrating NIMS/ICS into an Emergency Operations Plan, see the NIMS Integration Center at www.fema.gov/emergency/nims/nims.shtm. Available information includes *Local and Tribal Integration: Integrating the National Incident Management System into Local and Tribal Emergency Operations Plans and Standard Operating Procedures*, available at www.fema.gov/pdf/emergency/nims/eop-sop_local_online.pdf.

For a jurisdiction to be "NIMS Compliant," the following conditions must be met:

1. NIMS must be incorporated into existing training programs and exercises. Training will include, but not be limited to, completing FEMA course IS 700, *National Incident Management System, an Introduction.* The course is available on the FEMA website at training.fema.gov/EMIWeb/IS/is700.asp.
2. The jurisdiction must formally recognize NIMS and adopt NIMS principles and policies. State, territorial, tribal, and local entities should establish legislation, executive orders, resolutions or ordinances to formally adopt NIMS.
3. A baseline must be established by determining which NIMS requirements the jurisdiction already meets. As gaps in compliance with NIMS are identified, entities should use existing initiatives such as the Office for Domestic Preparedness (ODP) Homeland Security grant programs to develop strategies for addressing those gaps.

4. The concepts of NIMS must be incorporated into the Emergency Operations Plan (EOP).
5. A timeframe for fully implementing NIMS must be established.
6. As of FY 2007, Federal preparedness assistance became dependent upon the entity being fully NIMS compliant.

The City of Tulsa and Tulsa County have met all the preceding conditions and are both fully NIMS compliant.

2.6.2 Emergency Operation Plan

The *Tulsa Area Emergency Operations Plan*, updated in August 2013, was evaluated during the planning process to ensure that it adequately addressed the hazards identified in the Multi-Hazard Mitigation Plan, and that the Plan took the EOP into account during the planning process. The plan is written in accordance with existing federal, state, and local statutes. Please note, though Tulsa's Public Works Department, now Engineering Services, was split into several separate departments, it is still named as such throughout the EOP to describe the responsibilities of Engineering Services during disaster operations.

The City of Tulsa's emergency procedures are authorized by Title 8, "Civil Defense and Civil Emergencies," of the *City Ordinances*. The Tulsa Emergency Manager reports to both City and County jointly. The EM is responsible for developing written plans, and in an emergency shall enforce all emergency rules and regulations, and if necessary take control of transportation, communications, stocks of fuel, food, clothing, medicine, and public utilities for the purpose of protecting the civilian population.

In the event of a civil emergency, the mayor may proclaim a state of emergency in any part of the city affected. These emergency powers include the authority to impose curfew, limit assembly, restrict the transport of weapons and explosives, prohibit the dispensing or purchase of alcoholic beverages, and block the use of certain public streets or highways.

Tulsa's City/County *Emergency Operations Plan* (EOP) defines who does what, when, where, and how in order to mitigate, prepare for, respond to and recover from natural disasters, technological accidents, nuclear incidents, and other major incidents/hazards. The Plan is comprehensive in that it deals with mitigation and preparation activities, as well as response and recovery.

The EOP establishes the Emergency Operations Center (EOC), lays out emergency tasks and responsibilities, direction and control, continuity of government, and administration and logistics. The EOP is reviewed and tested at least once each year.

Emergency response is directed and executed by five operational groups:

- **Policy Group**, made up of the Mayor and four members of the community who, as a rule, are elected officials. This is the decision making group for all policy-level decisions. During an emergency, the Committee will advise and direct the activities of the entire response organization through the EOC emergency service coordinators.
- **Emergency Services Coordination Group** is comprised of the City department/agency heads and led by the Emergency Management Director, who acts as Chief of Operations. The Group includes the Police Chief, Fire Chief, Public Works Director, Health and Medical Coordinator, Shelter Coordinator, Resources Coordinator, and an EOC Staff Coordinator appointed by the Director.
- **Operations Staff** is composed of Officers-in-Charge of communications, damage assessment, public information, administration, transportation, warning/reporting, and shelter management/evacuation.

- **Emergency Service Coordinators**, made up of City department directors and volunteers with the functional expertise required to adequately respond to most emergencies, are responsible for the operation of their own departments and coordination with other departments and agencies.
- **EOC Support and Special Staff** is comprised of volunteers and employees with skills and training in areas essential to a total response to an emergency, assist the Emergency Service Coordinators, and perform other functions and critical tasks outside the scope of government departments.

The EOP contains procedures and responsibilities for the five operational groups, and includes report forms, contact lists and telephone numbers, damage assessment procedures, equipment sources, critical facilities, hazardous materials sites, shelter locations, volunteer groups, and other community resources, and references.

The Plan has general response procedures applicable to a wide range of natural and man-made disasters, as well as instructions for specific emergencies, such as HAZMAT events, bomb threats, and terrorism. Also included are instructions for setting up incident command posts, shelters, and staging areas and handling mass evacuations.

2.6.3 Emergency Operations Center

Tulsa Emergency Operations Center

The Emergency Operations Center (EOC), located in the basement of the Police/Municipal Courts Building in the City Hall complex, may be activated by any member of the Policy Group when it appears that any portion of Tulsa is, or may be, threatened with loss of life or extensive property damage.

During major emergencies, Tulsa's City government will be moved to the EOC. Tulsa's backup EOC is at Tulsa County Fairgrounds. The establishment and operation of the EOC is covered in detail in Tulsa's *Emergency Operations Plan*.

The Emergency Management Director (EMD) is responsible for coordinating all phases of the emergency management program, including emergency planning and training, education and warning, and communications. The EMD makes routine decisions and advises the Policy Group on alternatives when major decisions are required of that body. During emergencies, the EMD is responsible for the proper functioning of the EOC and its staff and acts as liaison with other local, county, state, and federal emergency management agencies.

The EOC has three stages of operation: Normal Peacetime Readiness, Increased Readiness, and Emergency Period.

- **Normal Peacetime Readiness.** Ensure the EOC is properly equipped and operationally ready; test warning system; review and revise *Emergency Operation Plan*; educate public as to warning signals; practice emergency operations with City officials and departments.
- **Increased Readiness.** Policy Group is advised of emergency measures; prepare EOC for activation; review EOC procedures and brief EOC staff; obtain necessary supplies; test internal and external communications; coordinate feeding of EOC staff.
- **Emergency Period.** Sound warning system; activate EOC; establish security; establish internal and external communications; move essential City functions to EOC.

The EOC is equipped with a communications center with all the necessary communications equipment. An emergency generator with fuel for a substantial period is available. During an emergency, the EOC operates on a two-shift, around the clock basis. An incident command post may

be set up to coordinate activities at the site of a disaster. When necessary, offices and equipment at City Hall are available to support emergency operations.

During an emergency, the EOC may effectively become the seat of City government for the duration of the crisis. Day-to-day functions that do not contribute directly to response actions may be suspended for the duration of the emergency.

The City of Tulsa and the EOC keep an index of citizen storm shelters, so that in the aftermath of a disaster that spreads debris over shelters, emergency rescue teams will know where to begin looking for survivors.

2.6.4 Emergency Notification and Warning Systems

Warning systems may be activated from any level of government by agencies having responsibility to notify the public of imminent danger. At the local level these warnings are channeled through the Emergency Management Director in order to assign responsibility and ensure control of the warning process.

Tulsa Emergency Notification and Warning Systems

Emergency Alert System (EAS) Communication

While the Emergency Alert System (EAS) was designed to give the president a means by which to address the American people in the case of a national emergency, it has been used since 1963 by local emergency management personnel for relay of local emergency broadcasts. EAS, which is controlled by the Federal Communications Commission (FCC), utilizes FM, AM, and TV broadcast stations, as well as cable and wireless cable providers to relay emergency messages.

Table 2–4: EAS stations in or near Tulsa

Facility	*Frequency*	*City*	*Facility*	*Frequency*	*City*
EAS FM radio stations					
KHJM	100.3	Tulsa	**KNYD**	90.5	Broken Arrow
KXOJ FM	100.9	Tulsa	**KIZS**	92.1	Broken Arrow
KTBT	101.5	Collinsville	**KBEZ**	92.9	Tulsa
KRTQ	102.3	Sand Springs	**KEMX**	94.5	Tulsa
KJSR	103.3	Tulsa	**KWEN**	95.5	Tulsa
KJMM	105.3	Bixby	**KRAV**	96.5	Tulsa
KQLL	106.1	Owasso	**KMOD**	97.5	Tulsa
KHTT	106.9	Muskogee	**KVOO FM**	98.5	Tulsa
KWGS	89.5	Tulsa	**KXBL**	99.5	Tulsa
EAS AM radio stations					
KGTO	1050	Tulsa	**KTBZ**	1430	Tulsa
KFAQ	1170	Tulsa	**KXOJ**	1550	Sapulpa
KAKC	1300	Tulsa	**KRMG**	740	Tulsa
KTFX	1340	Sand Springs	**KCFO**	970	Tulsa
KMUS	1380	Sperry			
TV broadcast stations					
KWBT	19	Tulsa	**KPAX**	44	Tulsa
KJRH	2 (NBC)	Tulsa	**KWHB**	47	Tulsa

Facility	Frequency	City	Facility	Frequency	City
KOKI	23 (FOX)	Tulsa	**KOPE**	51	Tulsa
K39CW	39	Tulsa	**KGEB**	53	Tulsa
KTFO	41	Tulsa	**KOTV**	6 (CBS)	Tulsa
KTPX	44	Tulsa	**KTUL**	8 (ABC)	Tulsa
Cable TV					
Cox Cable of Tulsa (Local television override is available)					

Emergency warnings are received and disseminated through the National Warning System (NAWAS). NAWAS is a protected, full time, voice communication system interconnecting the National Warning Center and numerous warning points in each state. Oklahoma has one primary state warning point, 2 alternate state warning points, and 30 secondary warning points. The primary point is at Oklahoma Highway Patrol headquarters in Oklahoma City. Alternates are located in the Oklahoma Department of Emergency Management EOC and the National Guard EOC. The 30 secondary points are located in OHP district headquarters, sheriff/police departments, fire departments, and local EOCs throughout the state. TAEMA is one of the in-state warning points for NAWAS. This system is answered in both the EOC and the Public Safety Response Center.

SkyWarn (Weather Spotters) is a national program designed to place personnel in the field to spot and track tornadoes. They are trained by NWS and instructed in what to report. Teams are made up of government employees and private citizens. During severe weather, storm spotters relay reports to their coordinator in the EOC. Confirmed tornado sightings are relayed to the NWS, which then disseminates appropriate warnings.

Notifications of severe weather or other serious hazard are relayed to the public through Tulsa's siren warning system, mobile teams, and TV/Cable override, as authorized by the Mayor, Policy Group, Emergency Manager or Police or Fire Department personnel. Instructions to activate the warning system are channeled through the Emergency Management Director, if time permits, to fix a single point of responsibility for the warnings and ensure control.

Tulsa's EOC has installed NOAA weather radios at all public buildings and schools. The EOC has the capability of overriding local radio and television stations, including cable channels. The emergency warning messages are generic, alerting the public of the danger and advising what to do or where to get further information.

Members of Tulsa's deaf and hard-of-hearing community are served by two state programs that can facilitate alerts and warnings:

- OK-WARN is the Oklahoma Weather Alert Remote Notification program for emergency weather/situation notification service via pagers and/or E-mail addresses. The hazardous weather pager program gives deaf and hard-of-hearing Oklahoman's better access to important severe weather information. The success of a pilot program in 2001 led to the creation of OK-WARN, which now provides life-saving messages about tornadoes, severe thunderstorms, winter storms, flash floods, river floods and high wind warnings from local National Weather Service offices to deaf and hard-of-hearing people who sign up for the service. There is no cost for qualified deaf and hard of hearing persons.
- The State Department of Rehabilitation Services can (a division of Oklahoma Department of Health) provide free NOAA weather radios specially adapted to the needs of the deaf and hard of hearing community with such accessories as strobes and bed shakers.

Flood Alert System

Tulsa installed a flood alert system in 1984, with the help of FEMA and the National Weather Service. The system monitors rainfall and stream levels to provide advance warning of potential flooding. (SNP, 09-04-05) The City updated the system so that emergency personnel can monitor the rainfall and stream gauges from remote locations via the internet. The new system, OneRain, includes a satellite modem so that it is still accessible if normal internet connections are lost. According to their website, "OneRain's complete systems approach to hydrological management includes nationwide 24/7-supported enterprise level software that collects, processes and delivers real-time sensor data from local hydro-meteorological networks and other external sources such as USGS, HADS, METAR, Tides, etc., for web-based dissemination, visualization, monitoring and alerting. Additional services include gauge-adjusted radar rainfall and historical analysis, rain and hydromet gauging, real-time satellite telemetry services and integration, storm properties analyses and professional consulting services. OneRain's products and services support critical decisions for emergency management, early flood warning, dam safety monitoring, reservoir and hydropower operations, stormwater/wastewater management, and forensic analyses." Funding through the Hazard Mitigation Grant Program was used to purchase the system. More information on OneRain can be found at the following web address: http://www.onerain.com/

Lightning Warning Systems

Tulsa Public Schools and the University of Tulsa use ThorGuard© to warn of lightning danger at outdoor recreation areas. A map showing ThorGuard© coverage areas in Tulsa is shown in Figure 2-4.

Mass Notification System

Tulsa has implemented a new Everbridge mass notification system. The Mass Notification system will be used for emergency and non emergency notifications to citizens of the City of Tulsa as well as internal messaging and staffing requirements. The system is capable of sending out approximately 50,000 calls per minute. Citizens can log on to the City website to set up their preferences such as different methods of notification such as home phone, cell phone, text messaging, email, etc. Citizens can also opt out of non-emergency notifications but cannot opt out of emergency notifications. The TAEMA Director is delegated responsibility for overall management of the Emergency Notification portion of the Mass Notification System and maintains the Standard Operational Guidelines under which emergency notifications will be conducted. The TAEMA Director receives and maintains emergency message reports and provides periodic updates, along with recommendations for improvement, to the stakeholders. Due to the nature of emergency response often involving multidisciplinary response, TPD, TFD, TAEMA, and PSRC/911 Center personnel will work together to insure accurate, timely, and complete information is communicated to the public.

Further information regarding the policies and procedures of the Tulsa Mass Notification System are outlined in the Tulsa Area Emergency Management Agency Mass Notification System Emergency Notification Guidelines, April 17, 2013.

Warning Sirens

At the time of this plan update there were 87 warning sirens located throughout the City of Tulsa; each audible for up to a mile. Sirens are audibly tested each Wednesday at noon and silently tested daily. Tests are typically one minute in length while actual warnings are three-minute signals. Sirens in Tulsa have three sounds, the three-minute "steady" tone warns of impending tornadoes. The only change in sound during the three-minute period may be an increase of decrease in volume that is caused by a change in wind direction or velocity. Sirens are only a part of Tulsa's warning systems and are intended to warn people who are out of doors about impending dangers. The location of the warning sirens is shown in Figure 2-5. Each of the City's warning sirens has been installed or existing

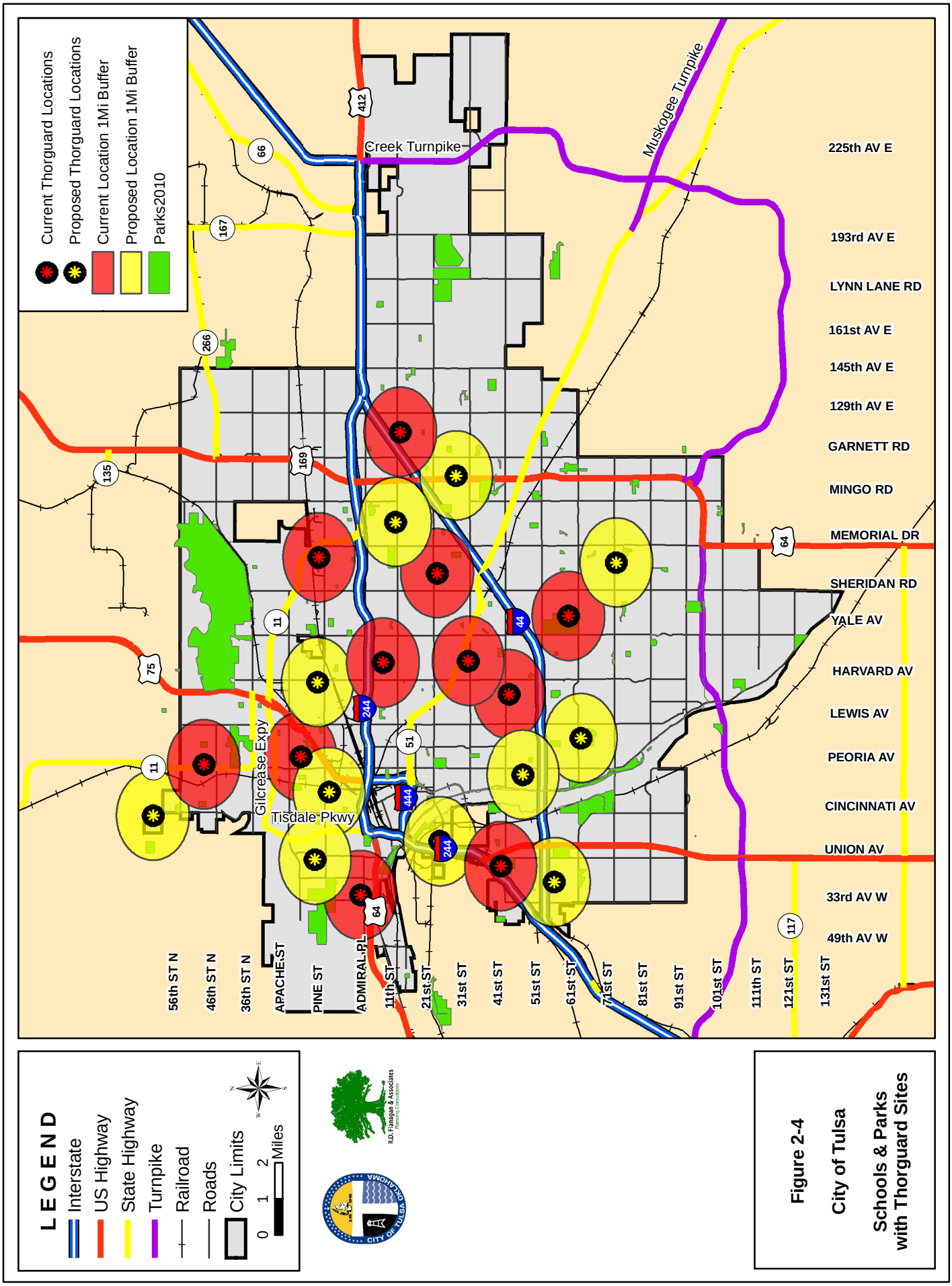


Figure 2-4
City of Tulsa
Schools & Parks with Thorguard Sites

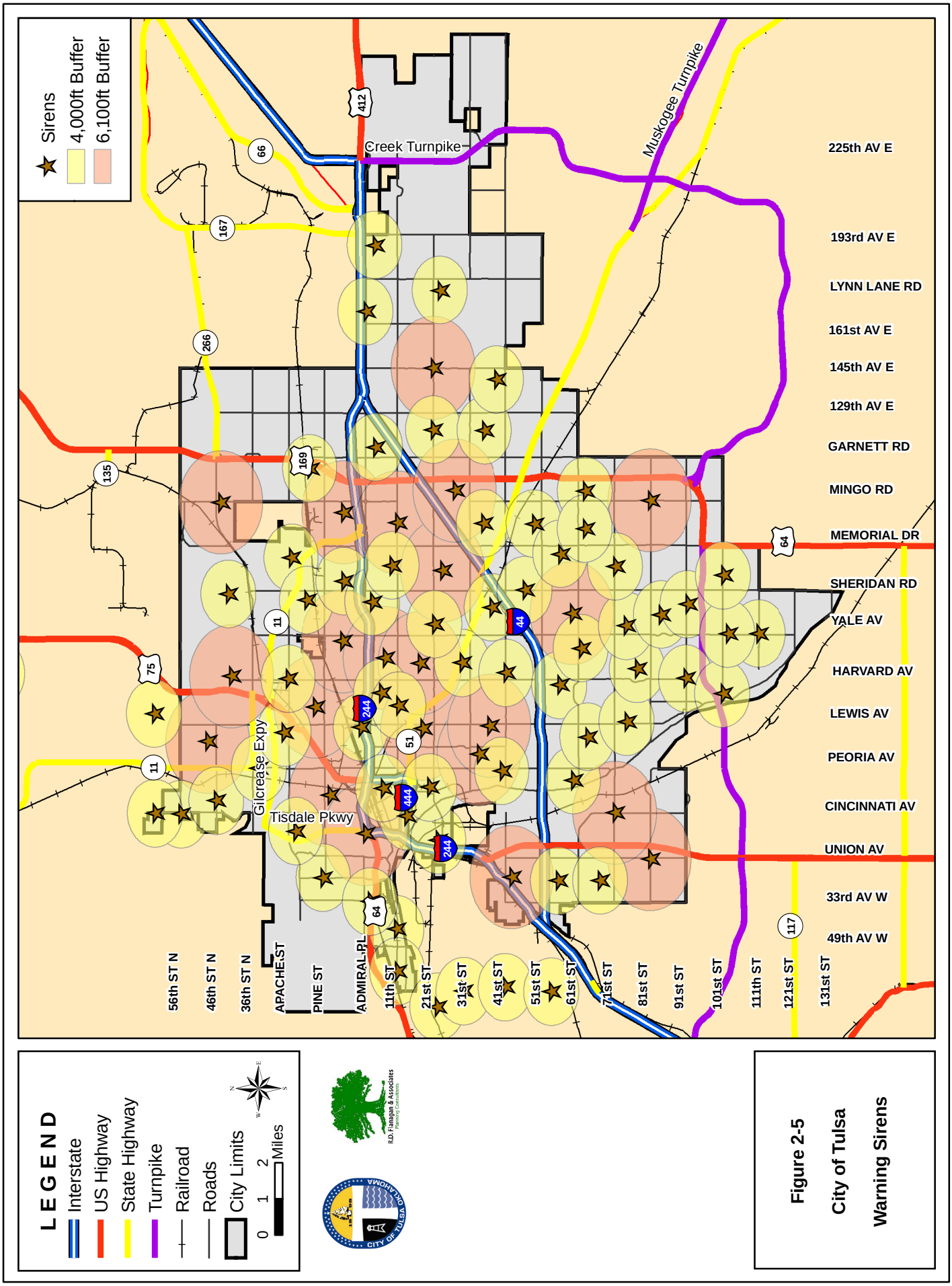


Figure 2-5
City of Tulsa
Warning Sirens

sirens upgraded since 1984. Since most sirens have a service life of approximately 20 years, a number of sirens will need to be replaced in the near future.

Each warning siren is radio controlled and operates off of two deep 3-cell wet cell batteries that are kept charged by a 110 VAC floating DC charger. Each siren has a two-way status, which allows it to communicate with the Tulsa EOC to report such things as loss of power, low battery voltage, or tampering.

The all clear is made over local radio stations and Cable Television and not over the warning sirens.

Tulsa Area Emergency Management Agency has primary responsibility for monitoring weather information and activating warning sirens. When the sirens are activated, TAEMA staff notifies the Public Safety Response Center (PSRC) as soon as practical. If the PSRC receives a tornado warning for Tulsa via the weather alert radio when TAEMA personnel are not available and/or the EOC is not staffed, the PSRC supervisor is authorized to sound the warning system and then notify the TAEMA director and/or EOC.

Table 2–5: Alert and Siren Signals

Type of Alert	*Hazard*	*Siren Signal*
Natural Disaster Alert	Tornado Warning	3-minute straight tone
Natural Disaster Alert	Flood Warning	3-minute slow high-low siren tone
Other Disaster Alerts	Nuclear Attack	3-minute wavering tone

2.6.5 Fire Safety Resources

Tulsa Fire Department and Resources

The Fire Department, with headquarters located in the One Technology Center, OTC, 175 E 2nd Street, 74103, employs 696 firefighters, including a Fire Chief. The City has 30 fire stations, including the airport station, staffed by a minimum of 3 firefighters per shift per Fire Company, on a 24-hour basis. All firefighters are trained at various levels as First Responders, Emergency Medical Technicians, or Paramedics. The Department provides primary fire control and suppression for the City of Tulsa and Tulsa International Airport.

The City of Tulsa *Emergency Operations Plan* lists the emergency functions of the Fire Department as follows:

- Fire suppression
- Fire investigation
- Fire prevention and education
- Rescue operations
- Medical First Response
- Hazardous material operations
- Supporting the operation of the warning system
- Hazardous material decontamination
- Assisting in damage assessment
- Communication system support

Fire Department resources for fulfilling emergency functions are listed in Table 2-6.

Table 2–6: Tulsa Fire Department Resources

Resource	*Quantity*	*Resource*	*Quantity*
No. of Fire Stations	30	No. Pick-up Trucks	9
No. of Base Station	38	No. Self Contained Air Masks	385
No. of Mobile Radios	123	No. Spare Air Bottles	1,100
No. Paid Firefighters	696	No. Generators (#KW)	29(3-5KW)
Pumping Engines in Res.	8	Mutual Aid Agreements (23)	Written
No. Pumping Engines	29		Spavinaw
No Pumping Eng.1500 GPM	35		Eucha
No. Ladder Trucks If aerial-give length	9-65' 4-80'		Berryhill
No. Elevated Platform	2-75' 1-95' 2-118'		Catoosa & Blackdog
No. Mini Pumpers	1	No. Boats	15 various
No. Grass Pumpers	7	No. Gasoline Trucks	1
Crash-Fire Rescue	4 (At TIA)	**Other Resources**	42 Pagers
No. Trained EMTs	451-B 30-I 109-P 78-EMR		2 HAZTRK
No. Sedans	48	No. Automatic External Defibrillators	46 and 5 Reserve

Tulsa Fire Department has mutual aid agreements with all area Departments, and frequently assists with response in areas outside the Tulsa City Limits.

The Tulsa Fire Department (TFD) along with EMSA provides pre-hospital emergency medical service to the City of Tulsa, with the number of emergency medical calls continuing to increase each year. All Department firefighters are cross-trained in rescue and emergency medical skills. The City's EMTs are licensed by the Oklahoma State Department of Health and certified by the National Registry of Emergency Medical Technicians.

2.6.6 Public Safety Resources

Tulsa Police Department and Resources

The Police Department, located at Civic Center Plaza downtown, has over 900 employees, including 817 commissioned police officers. The Department is comprised of three major divisions, including the Administration Bureau, the Investigations Bureau (with a Detective and a Special Investigations Division, and the Forensics Lab), and the Operations Bureau. Operations is comprised of three separate facilities – Uniform Divisions North, Southwest, and East – and the Special Operations Division. In addition, Uniform Support services include Air Support, Mounted Patrol, K9, Bike Patrol and Motorcycle Patrol.

The City of Tulsa's *Emergency Operations Plan* lists the emergency functions of the Police Department as follows:

- Maintain law and order
- Traffic control

- Access control of restricted areas
- Security of vital facilities
- Operation of the backup warning system
- Communication system support
- Liaison with other law enforcement agencies
- Search and rescue operation support

Tulsa County Sheriff's Department

The Tulsa County Sheriff's Department is located at 303 W. 1st St. in Tulsa. Under Tulsa's *Emergency Operations Plan*, the Sheriff's Department has the following responsibilities:

- Coordinate all law enforcement in the County
- Disseminate warnings throughout the County
- Coordinate relocation traffic control
- Coordinate mutual aid agreements
- Support emergency public safety activities
- Provide for security, protection and relocation of inmates in the County Jail.

The EOP lists law enforcement resources available for fulfilling emergency functions in the City of Tulsa, the resources are listed in Table 2-7.

Table 2–7: Law Enforcement Resources Available to Tulsa

Resource	Quantity	Resource	Quantity
K-9 Units	12	Deputies/Reserve/Aux	44
Squad Cars	730	Vehicles w/ Radio	730
Communications Van	4	Bull Horn	1
Radiological Inst.	14	Dispatchers	105
Mobile Crime Lab	1	Walkie-Talkie	1207
Bomb Disposal	6	OLETS Teletype Terminal	5
SCUBA Trained	10	Portable Generators	5
Total Officers	817	Bull Horns	1
Aircraft	2	K-9 Units	12, 4 Bomb, 2 Dope

2.6.7 Public Works Department Resources

Tulsa Public Works Department and Resources

Tulsa's Public Works Department is located at various locations around the City. Under Tulsa's *Emergency Operations Plan*, the Public Works Department has the following responsibilities:

- Debris clearance
- Maintaining roads and bridges
- Assisting with damage assessment of public property
- Assisting in decontamination operations

In addition, the Inspection Services section has the responsibility in Tulsa's Emergency Plan to provide damage assessment for the affected areas of Tulsa. They have 40 field inspectors that are very familiar with locating addresses throughout the City of Tulsa. They report the scope and severity of affected properties for emergency and FEMA attention. After the initial emergency response they then provide detailed damage assessment to verify what structures are habitable or uninhabitable and the amount of damage to each structure.

Tulsa's Public Works Department resources available for fulfilling emergency functions are listed in Table 2-8.

Table 2–8: Public Works Department Resources

Resource	*Quantity*	*Resource*	*Quantity*
Total Employees	585	Pickup Trucks	95
Office Staff	75	Bucket Trucks	10
Total Field Personnel	461	Tool trucks	162
Portable Radios	403	Dump trucks	121
Hand-held Radios	154	Bulldozers/earthmovers	30
4-Wheel Drive Vehicle	59	Portable Light systems	12
Passenger Vehicles	40	Portable generators	56
Frontend Loaders	4		

The Publics Work Department is also responsible for Hazard Mitigation in the City of Tulsa including the following:

- Identify vulnerabilities of existing public buildings, roads, bridges, water systems, and sanitary sewer systems to known hazards and take steps to reduce vulnerabilities.
- Reduce vulnerability of new public facilities to known hazards through proper design and site selection.
- Develop plans to protect facilities and equipment at risk from known hazards.
- Install emergency generators in key facilities and have portable generators available to meet expected needs.

2.6.8 Other City, County, State and Federal Response

Tulsa City Clerk is responsible for City administrative and fiscal duties.

Tulsa City Attorney is responsible for legal and emergency information services and serves as a member of an advisory committee.

Superintendent of Tulsa Schools is responsible for providing buses for transporting evacuees, and for MOUs with neighboring jurisdictions for use of buses for evacuation.

Tulsa Civil Air Patrol assists with search and rescue and crowd control.

Tulsa County office of the State Medical Examiner, when committed:

- Collects, identifies, and coordinates interment of deceased disaster victims
- Coordinates funeral home support activities

Tulsa Health Department, when committed:

- Investigates sanitation conditions and establishes safe standards for crisis location, emergency shelter, or disaster relief operations
- Coordinates medical support and epidemic control
- Inspects food and water supplies
- Provides public health education

Tulsa County Office Department of Human Services, when committed:

- Provides provisions and funds for emergency aid
- Coordinates with the Red Cross and other volunteer agencies

Oklahoma National Guard, when committed:

- Assists in radiological protection
- Assists in law enforcement and traffic control
- Assists in search and rescue operations
- Provides military engineer support and assistance in debris clearance
- Provides logistical support with supply, transportation, maintenance and food service
- Provides communication support
- Provides chemical, biological, and radiological detection services

Other State and Federal agencies, when committed, assist with:

- Public welfare
- Resources
- Law enforcement
- Health and medical support and supplies
- Debris clearance
- Public information and education

2.6.9 Health Care Facilities and Shelters

Tulsa is home to four major medical centers and numerous specialty hospitals and clinics.

Hillcrest Medical Center, located in mid-town Tulsa, is a 493-licensed-bed tertiary medical center. In addition to the primary care facility, Hillcrest has facilities in Women's Healthcare, Exercise and Lifestyle, a Chest Pain Center, emergency department and trauma, cardiology unit, and a premier burn care unit.

Hillcrest Medical Center

St. Francis Medical System is a not-for-profit Catholic healthcare organization made of Saint Francis Hospital, Saint Francis Hospital at Broken Arrow, Laureate Psychiatric Clinic and Hospital, Warren Clinic, The Children's Hospital at Saint Francis, and Saint Francis Heart Hospital. It has a staff of nearly 7,000 full and part-time employees.

St. John Health System is a not-for-profit Catholic healthcare system operates hospitals in Tulsa, Owasso, Sapulpa, and Bartlesville. Other subsidiaries of St. John Health System include OMNI Medical Group primary care physicians, St. John Physicians, Inc. multi-specialty group practice, St. John Urgent Care Centers, St. John Villas Senior Living Centers and medical complexes in South Tulsa and Claremore.

OSU Medical Center, located in downtown Tulsa, is the largest osteopathic teaching facility in the country, with 15 postgraduate programs that train 126 residents each year in both primary care and sub-specialty areas. OSU Medical Center provides numerous highly specialized services, including a telemedicine program serving 35 regional hospital and clinic partners in rural Oklahoma through the OSU Center for Health Sciences. Among the other services offered are cardiology care, adolescent, geriatric and psychiatric care, and comprehensive wound care.

For locations of major healthcare facilities in the community, see Figure 1-28.

2.6.10 Medical Response and Coordination

The Tulsa County Medical Coordinator is one of the Emergency Medical Services Authority (EMSA) Directors. He will operate in accordance with the Tulsa Metropolitan Medical Response System (MMRS).

The City/County Health Director is responsible for:

- Inspects food and water to ensure safe supplies of both.
- Investigates sanitary conditions of emergency shelters and disaster relief operations to protect the health and safety of occupants and workers.
- Controls insects and rodents and employs other environmental health measures to prevent epidemics and the spread of disease.
- Provides core public health services, such as immunization programs and other related medical services.
- Disseminates public health information concerning safety issues and hazards.
- Monitors the community health status and reports identified public health problems to appropriate agencies.
- Provides limited hazardous materials emergency response capability.
- Enforces laws and regulations to protect public health and ensure safety.

The Tulsa Health Department maintains its own Emergency Operations Communications Center in the basement of the Health Department headquarters at S. 129th E. Ave. and E. 51st Street in the City of Tulsa.

TULSA HEALTH DEPARTMENT
Director
5051 S. 129th East Avenue
Tulsa, OK 74134
(918) 582-9355
Web Site: http://www.tulsa-health.org/

In the event of a disaster, the Tulsa Area Chapter of the American Red Cross is responsible for identifying and managing public shelters, in cooperation with other appropriate agencies.

As of September, 2012 Tulsa is home to 117 long-term care facilities, 49 of which are licensed by the State of Oklahoma. Tulsa Housing Authority maintains three high-rise facilities designed for the elderly and people with disabilities:

- Hewgley Terrace, 420 S. Lawton
- LaFortune Tower, 1725 Southwest Blvd.
- Pioneer Plaza, 901 N. Elgin

During an emergency or disaster, medical service providers are responsible for emergency medical care for victims, health care, and crisis counseling.

In the case of a disaster requiring shelters, the Superintendent of Tulsa Public Schools will assist with providing buses for transportation during disaster relief operations. The Tulsa Area Chapter of the American Red Cross will assist with shelter operation and support activities, supported by the Salvation Army, the County office of the Department of Human Services, the Tulsa Medical Reserve Corps, and the Tulsa Human Response Coalition. Emergency shelters will be drawn from a mixture of public and private resources and utilized according to the following priority: public schools first, followed by churches, government buildings, colleges/universities, and private buildings.

Ambulance service is provided by the Emergency Medical Services Authority, with support from Tulsa Fire Department. EMSA operates 30 ambulance units in its Eastern division with one basic EMT and one paramedic each, operating 24 hours a day, seven days a week staffed as needed by on-duty or off-duty personnel.

2.6.11 Volunteer and Community Support Organizations

- The **Tulsa Area Chapter of the American Red Cross** provides reception, care, food, lodging, and welfare assistance throughout northeastern Oklahoma; coordinates relief and shelter activities; and provides first aid support and blood supply, counseling, and damage assessment of private property.
- **Salvation Army** helps people in need of food, clothing, utilities, cleaning supplies, and life sustaining prescriptions. It also assists in finding missing persons and offers disaster services.
- The **United Way** provides financial assistance to Tulsa non-profits for such things as emergency food, clothing, shelter, utility bill assistance, counseling, literacy, advocacy and legal assistance.
- **Tulsa Community Action Program** (CAP) provides homeless services, including both emergency and transitional housing. Emergency shelter is offered to those with no resources who are in immediate need of shelter.
- **The Tulsa Partners Language & Culture Bank** is a group of people with identified proficiencies in cultural and language skills. The L&CB will support emergency response agencies during a disaster, whether single-family or catastrophic, in working with members of various cultural groups. It includes such groups as the Hispanic Chamber of Commerce, the YWCA Multi-Cultural Center, the TCC Language Center, Communication Services for the Deaf, the Jewish Federation, the Russian Golothic Church, the Islamic Foundation, and others.
- The Tulsa Red Cross maintains the **Community Emergency Response Team** (CERT) program. CERT volunteers are available to assist first responders (police, firefighters and EMS) during emergencies. CERT teams also assist in mitigation activities, including public awareness programs and other non-structural community mitigation measures. Additional

information on CERT is included in Chapter 5, and is available on the Internet at www.citizencorps.gov/cert/.

- The **Tulsa Medical Reserve Corps** is a Citizen Corps program that provides licensed medical professionals (frequently retired) plus support staff for emergencies. The Tulsa group currently has over 1,000 volunteers, over 60% of who are licensed professionals. They are coordinated out of the Tulsa Health Department.
- The **Tulsa Human Response Coalition** is a collaboration of mental health and social service agencies, many of them faith based, culturally based, or otherwise "non-traditional" in the disaster realm, such as the National Guard Family Support Group. THRC can call upon its partners for a coordinated response to support other agencies in the area of mental health, social services, and cultural and religious support.
- The **Tulsa Amateur Radio Club** and **Tulsa Repeater Organization** provide emergency communications, storm spotting and damage assessments.
- **Tulsa Partners Inc**. is a Tulsa-based 501(c)3 organization that coordinates multiple programs, including the Disaster Resistant Business Council (see Section 2.1.5) and programs to provide preparedness and business continuity support to childcare centers, long term care facilities, and hospitals. They also assisted Tulsa Area Emergency Management Agency with developing an Emergency Operations Plan Annex for childcare facilities.

2.7 Natural Resource Protection

Natural resource protection activities are generally aimed at preserving and restoring the natural and beneficial uses of natural areas. In doing so, these activities enable the beneficial functions of floodplains and drainage ways to be better realized. This section reviews the natural resource protection activities that have already been implemented in the community or are already in the planning stages. See Chapter 6 and Appendix B for discussion of potential activities and programs within this category.

2.7.1 City of Tulsa Resource Protection

Tulsa's *Comprehensive Development Plan* states that the community seeks to conserve its natural resources through their protection and integration with compatible development. In particular, the City is committed to:

- Protecting stream corridors as wetlands, flood management and wildlife areas;
- Utilizing stream corridors, where appropriate, as linkages between activities and for recreation;
- Protecting scenic vistas;
- Protecting endangered wildlife nesting areas and preserves.

The Elm Creek Project in midtown Tulsa is an example of a flood control project existing in harmony with the natural world.

Since the last plan update period, projects have been implemented in the City of Tulsa to protect our most valuable natural resources. Some projects, as taken from the *Vision Tulsa 2012* plan, include the following:

- Improvements were made along the Arkansas River. A popular improvement was the rebuilding of sand bars by River Parks crews from sand washed downriver to enhance the nesting area for Least Terns, a bird on the endangered species list. They also built a light sand moat to help protect the eggs and birds from predators.
- Efforts to protect the river were made through a partnership between environmental officials and law enforcement to establish unwanted medication drop-off locations at each police and sheriffs station. The purpose of this partnership is to prevent the disposition of medicines in residential toilets. In the past, advice given for the disposition of medicine was to flush it in a toilet. This practice proved to have negative impacts as many streams near wastewater plants have unusually high levels of antibiotics and growth hormones, upsetting fish and frog populations. The program removed medicines from the system and promoted better water quality in the city.
- Education of Tulsans was also on the agenda of City of Tulsa workers. Residential customers were educated through a campaign called "Trap the Grease" to help prevent clogs in the pipes in both residential and commercial sides of the waste water system. They also

worked with local businesses in a voluntary, non-regulatory program for prevention called "Partners for a Clean Environment" (PACE). Participating businesses implemented practices such as saving water, cleaner chemical use, and installing new grease traps in waste water systems. City crews partnered with other organizations to offer special educational classes, booths, and sales of products on ways to build a compost bin or rain barrel.

- The biggest environmental story in local government was solid waste and recycling. Collection of refuse, recycling, and disposing contracts all ended in June of 2012. In 2011, curbside-recycling customers began collecting steel cans, cardboard, paperboard, and plastic bottles #3 through #7 for recycling. The city also partnered with the Metropolitan Environmental Trust and Public Service Co. of Oklahoma to collect unwanted freezers and refrigerators, free of charge, from households in a program called "Cool Cash." If the unit was still working, the electric utility would also send the donor a $25 check in thanks for helping lower demand on power systems. The summer saw record amounts of recycling in Tulsa. Plastic bottle recovery rates were up almost 20 percent over 2010 in part because of consumption of bottled water in a summer of record heat

Looking west from Urbana Bridge

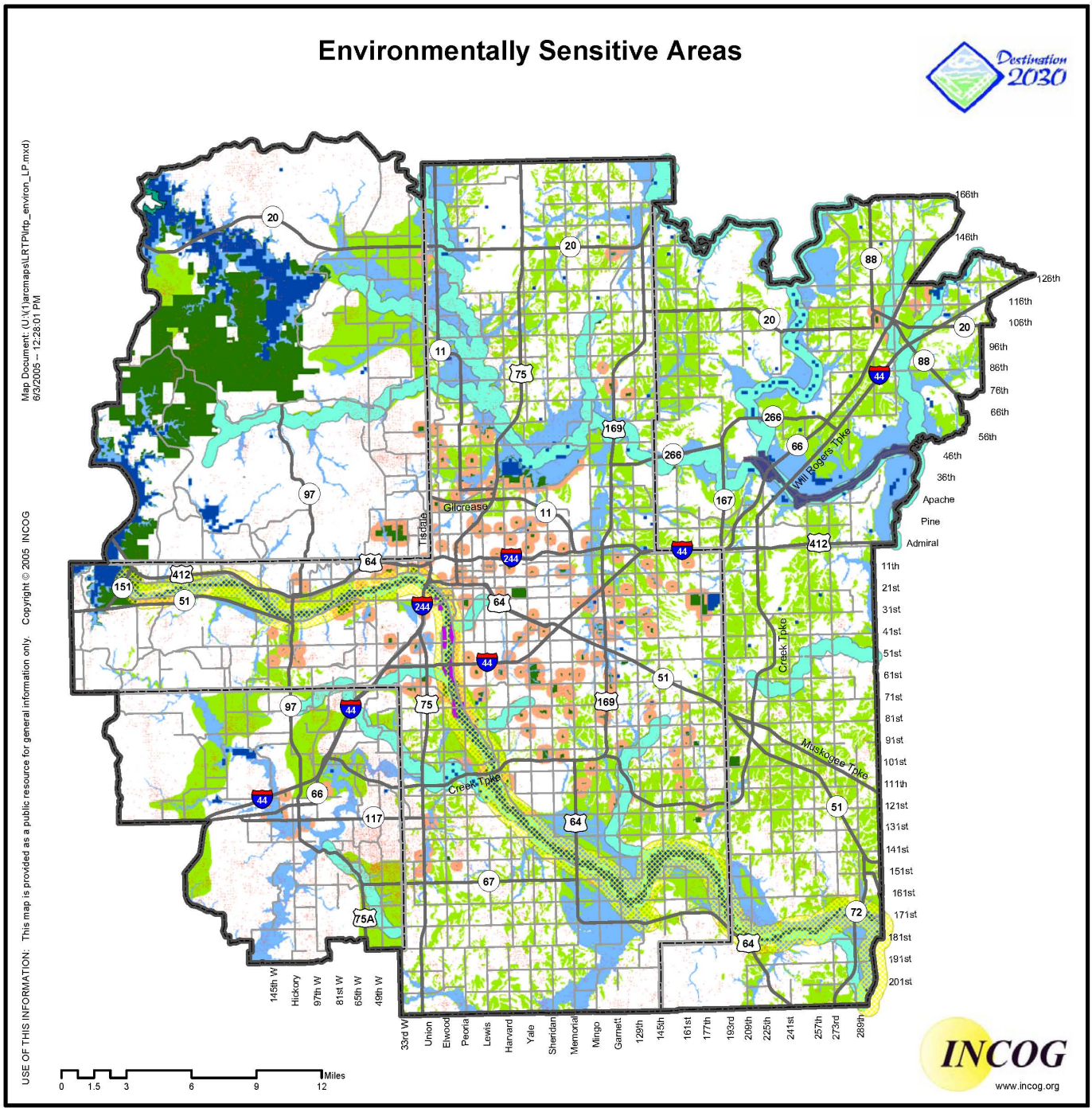
The City intends to preserve its major stream corridors as greenways, for use as community connectors and for flood management.

The City of Tulsa currently has no formal stream corridor preservation or watershed management programs. Section 9-21(b) of the *City Code* contains the City's Erosion and Sediment Control Policies. All development is required to provide appropriate erosion control facilities to minimize the amount of sediment leaving a site, under the guidelines of "no adverse impact."

The City does advocate, when possible, maintaining creeks and other small waterways in their natural state.

2.7.2 Environmentally Sensitive Areas

The following map, Figure 2-6, by the Indian Nations Council of Governments, and included in the City of Tulsa's Comprehensive Plan, *PlaniTulsa 2010*, identifies areas such as wildlife preserve or nesting areas, parkland, prime farmland, steep slopes in excess of 25% and other environmentally sensitive areas that should be included in the planning for development, as well as certain mitigation activities such as flood control projects or other structural projects.



Transportation Management Area
County Boundary
Highways
Arterials

Lake or Pond

Oil and Gas Wells
wells

Bald Eagle Habit and Nesting Area
1/2 Mile Buffer Zone

Impaired Streams
1/4 mile buffer zone

Other Sensitive Areas
Arkansas River Least Tern Preserve
Skiatook Wildlife Management Area
McClellan-Kerr Navigation System

Floodplains
100 year Floodplain

Parkland
Park
1/4 mile buffer

Prime Farmland
Prime Farmland

N
W E
S

Map Scale - 1:410,000

Location Map

Figure 2-6

Chapter 3: The Planning Process

44 CFR Requirements met:

Requirement §201.6(b): *An open public involvement process is essential to the development of an effective plan.*

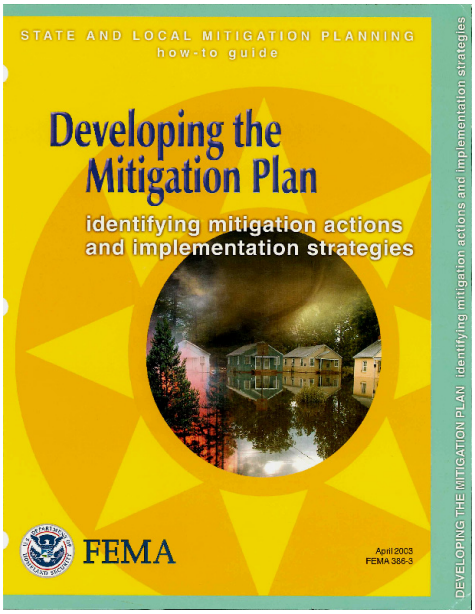
Requirement §201.6(b): *In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process* ***shall*** *include:*
(1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;
(2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and
(3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

Included in this Chapter:

3.1 Step One: Organize to Prepare the Plan
3.2 Step Two: Involve the Public
3.3 Step Three: Coordinate with Others
3.4 Step Four: Assess the Hazard
3.5 Step Five: Assess the Problem
3.6 Step Six: Set Goals
3.7 Step Seven: Review Possible Activities
3.8 Step Eight: Draft an Action Plan
3.9 Step Nine: Adopt the Plan
3.10 Step Ten: Implement, Evaluate, and Revise

Requirement §201.6(c)(1): *[The plan* ***shall*** *document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.*

Planning Process Introduction



The City of Tulsa Multi-Hazard Mitigation Plan Update is an effort to direct the multi-hazard planning, development, and mitigation activities of the City of Tulsa. The City of Tulsa is responsible for overall coordination and management of the study.

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.

The planning for the City of Tulsa followed a ten-step process, based on the guidance and requirements of FEMA. The ten steps are described on the following pages.

This plan addresses the following hazards:

General Hazards:

- Severe Winter Storms
- High Winds
- Tornadoes
- Lightning
- Hail
- Extreme Heat
- Drought
- Earthquakes
- Urban Fires

Site-Specific Hazards:

- Floods
- Dam Failures
- Levee Failures
- Expansive Soils
- Wildfires
- Fixed-Site Hazardous Materials
- Transportation-Hazardous Materials

3.1 Step One: Organize to Prepare the Plan

Citizens, community leaders, government staff personnel, and professionals active in disasters, met monthly to review draft chapters and provided important input into the development of the plan and recommended goals and objectives, mitigation measures, and priorities for actions.

The planning process was formally created by a resolution of the City Council of Tulsa. The resolution designated the Tulsa Stormwater Drainage and Hazard Mitigation Advisory Board (SDHMAB) to serve as the Tulsa Citizens' Advisory Committee to oversee the planning effort.

City of Tulsa Stormwater Drainage and Hazard Mitigation Advisory Board

The Stormwater Drainage and Hazard Mitigation Advisory Board (SDHMAB**)** consists of the following members:

Judith Finn, J.D., PhD

Chair, Tulsa Stormwater Drainage and Hazard Mitigation Advisory Board

Partner, Pinkerton & Finn, P.C., MS in Urban Studies, Focus on Systems Analysis. Chairman, Urban Study, US Corps of Engineers; Chairman of the Tulsa City-County Health Department. She has been involved with the Environmental Advisory Council 25 years and Citizen participation in flood plain mapping, zoning, and mitigation 30+ years

Ann Patton

Vice-Chair, Tulsa Stormwater Drainage & Hazard Mitigation Advisory Board

Owner, Ann Patton Company, LLC; A Tulsa-based writer and consultant with more than 35 years' experience in journalism and government, specializing in public policy, hazard management, partnership development, and grassroots community building. Recent clients include the Department of Homeland Security, the Dept. of Health and Human Services and the National Institute for Building Sciences.

She retired from the City of Tulsa in 2004, and continues to serve as a local and national volunteer: Board, Natural Hazards Mitigation Association.

Bob Roberts, CEM, CHS
Secretary, Stormwater Drainage & Hazard Mitigation Advisory Board

Emergency Manager, Tulsa Public Schools. Previously Sr. Coordinator for Planning & Preparedness with American Red Cross Disaster Services and President of Oklahoma Volunteer Organizations Active in Disaster. He has worked with communities, Tribes, and other government entities as a consultant in developing disaster mitigation plans and is a certified instructor for FEMA and the Department of Homeland Security. He has extensive experience in community disaster education and planning in disaster preparedness and mitigation, sustainability, homeland security, and business continuity.

Kyle Bierley
Member, Tulsa Stormwater Drainage & Hazard Mitigation Advisory Board

Executive Vice President, RotoRooter Plumbing BS in Management and Marketing Oklahoma State University. Certified in individual wastewater from Department of Environmental Quality. He has an OSHA Excavation Certificate of Competence. Kyle is certified as a State Of Oklahoma Master Plumbing Contractor

Brandon Perkins
Member, Tulsa Stormwater Drainage & Hazard Mitigation Advisory Board

President, Brandon Perkins Development; B.A. Finance, Northeastern State University; Member, Tulsa Metropolitan Area Planning Commission; Board of Directors, Home Builders Association of Greater Tulsa; Director, National Home Builders Association;

Supporting the SDHMAB is the City of Tulsa Staff and the Tulsa Technical Advisory Committee (TTAC), which includes representatives of departments that have roles in multi-hazard planning, response, protection, and mitigation. Most of the detail work was done by management teams consisting of the following:

City of Tulsa City Support Staff

City Support Staff consists of the following members:

Bill Robison
Mitigation Plan Project Coordinator; Sr. Special Projects Engineer, City of Tulsa

BS in Civil Engineering from Oklahoma State University. Bill is a member of American Public Works Association, and is 2012-13 President of the Oklahoma Floodplain Managers Association.

Contribution: Project management, guidance and administration; City of Tulsa engineering and floodplain management perspective.

Paul Zachary, P.E. CFM

Director, City of Tulsa (CoT) Engineering Services

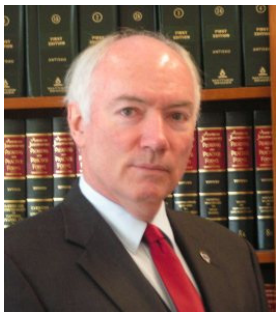
Contribution: Project oversight and management; liason with Mayor, administration and City Council; coordination with other City Departments and Engineering Services departments.

Mark Swiney, *J.D.*

Legal Counsel

BA in Liberal Arts, Notre Dame; MA in Humanities, University of Tulsa; J.D. University of Tulsa. Serves as legal counsel to Stormwater Drainage and Hazard Mitigation Advisory Board since 1988.

Contributions: Legal counsel, advice and services.



Matt Liechti, P.E.

Manager, CoT Engineering Services Project Coordination

Contributions: Project management and guidance, quality control; liason with Department heads. Coordination with Engineering Services: Water, Wastewater, Streets, Stormwater Management, Water Quality, Maintenance & Operations.

Deborah Stowers, P.E., CFM

Lead Engineer, CoT Stormwater Design

BS in Petroleum Engineering and BS in Civil Engineering from University of Oklahoma. Member of Oklahoma Floodplain Managers and American Society of Civil Engineers. Certified Floodplain Manager and Professional Engineer.

Contributions: Provides Property and Flood Protection Assistance to Property Owners and assists in prioritization of stormwater projects. Staff to the Stormwater Drainage and Hazard Mitigation Advisory Board (SDHMAB). Coordination and design of small stormwater projects.

Laguitia Tate

Administrative Assistant, Stormwater Design

Contributions: Administrative staff to Stormwater Design Section; administration for the Stormwater Drainage and Hazard Mitigation Advisory Board, including preparation and maintenance of meeting agendas, minutes, public notices.

City of Tulsa Technical Advisory Committee (TTAC)

Joan Arthur, P.E.

CoT Senior Special Project Engineer

BS in Chemical Engineering, ODEQ A Water Operator, Professional Engineer License in OK & FL

Contributions: Liaison with the Water Department, Utility Board; Presentations and information on water usage, treatment, storage, supply; drought and water conservation programs.

Paul Ator

Tulsa Fire Department (TFD) Coordinator, Hazardous Materials

Contributions: Coordination with the City of Tulsa Fire Department; lead for Hazardous Materials; Presentations and information Hazardous Materials training, manpower, capabilities, historic events, equipment, response.

Michael D. Baker

Director of Emergency Medical Services, Tulsa Fire Department

Oklahoma State University- BUS with focus on Fire and Emergency Management, Sociology, and Political Science. Tulsa Community College - AS Fire and Emergency Services, AAS Fire Protection Technology, AAS Emergency Medical Technology.

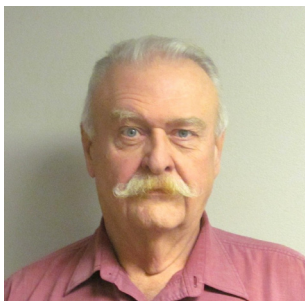
Contributions: Coordination, presentations and information on Emergency Medical Services activities, manpower, equipment, capabilities of the Tulsa Fire Department.

Dave Berry

Professional Real Estate Associate, McGraw Realtors

BA Coe College. Member, Tulsa CRS Public Outreach Committee; Hazard Mitigation Business Committee; Member, OK CERT Team; Volunteer, Tulsa Partners; Veteran US Air Force officer, Squadron Disaster Preparedness Officer, Red Cross liaison, Department of Defense Joint Duty Assignment.

Contributions: Stakeholder perspectives, representative of the Tulsa Real Estate industry.



Bob Bledsoe

CoT, Communications Department

BA Journalism, Oklahoma State University

Contributions: Participant and liaison with the City of Tulsa Communication Department. Assist in the development and implementation of Public Information and Education Strategies, surveys, brochures, press releases; liaison with the Mayor's office.

Graham Brannin

CoT, Public Works Planning & Intergovernmental Administrator

BS in Geology, BS in Petroleum Engineering, University of Tulsa. Experience as a Safety/Environmental Consultant with Sara Services and as a Reservoir Engineer with Conoco Petroleum; Board Member, Tulsa Partners; Chair, Tulsa Leadership Council, American Lung Association; member, CoT Sustainability Team.

Contributions: Stormwater quality and environmental concerns; analysis of environmental impacts of natural and man-made hazards and proposed mitigation measures.

Kelli Bruer

Director, Communications/Public Relations, Emergency Medical Services Agency (EMSA)

BS, BA Marketing, University of Tulsa; member, Tulsa Heat Coalition.

Contributions: Public information and education; information on types emergency services ambulance runs, areas, demographics, periods of year for various hazards.

Sara Kelly Combs

Mortgage Officer, Legend IPC

BS Agricultural Economics, Oklahoma State University; Member Board of Directors, Tulsa Partners; member, Association of Contingency Planners; member, Steering Committee, Millennium Center; former Business Continuity Officer, Spirit Bank.

Contributions: Stakeholder- A broad range of perspectives to the planning process, including mortgage banker, business continuity, volunteer agencies, public involvement.

Carl Craigo, P.E., CFM

CoT, Construction Manger

BS, Civil Engineering, West Virginia University

Contributions: Professional engineer; project manager, City of Tulsa Elm Creek Master Drainage Plan; design and development of the Centennial Park stormwater detention facility.

Contributions: Project manager, Pearl District, Elm Creek Master Drainage Plan.

J.K. Evicks

Environmental Manager, BAMA Companies, Inc.

BS in Biosystems Engineering, Oklahoma State University; Member of the Local Emergency Planning Committee (LEPC);

Contributions: Stakeholder- Private sector business perspective of one of the city's major corporations; business continuity planning; Hazardous materials management, Local Emergency Planning Committee.

Roy Foster

CoT, Water Quality Assurance Manager

BS Geology/Chemistry, Hardin Simmons University. Director, Tulsa County Conservation District. Director, Oklahoma Water Environment Association.

Class A Water Operator, Class A Water Laboratory Operator, Class A Wastewater Laboratory Operator, Class B Wastewater Operator, and NIMS/ICS 100-400.
Contributions: Ensures that water quality and environmental concerns are addressed in the analysis of hazards, hazardous materials events, and proposed mitigation measures.

Mike Gurley

State Farm Insurance

Loss Mitigation Team Manager

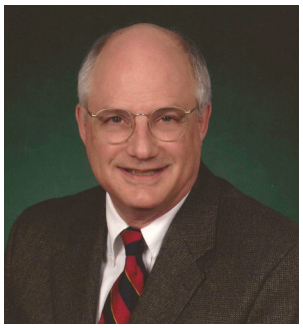
Contributions: Stakeholder- Mitigation manager for one of the largest national insurance companies; perspective, concerns, information about natural and man-made hazards, occurrences, costs, severity, demographics of impacted populations; mitigation measures, IBHS Safe Home building codes; incentives and discounts for hazards protection.

Richard Hall

Planner, City of Tulsa Fire Department

BA, Geography, University of Oklahoma;

Contributions: Planning perspectives, expertise, information, programs, liaison with the Tulsa Fire Department; Presentations to committees on fire-related issues, including Hazardous Materials, Fire data, Urban Fires, Wildfires.



Charles Hardt

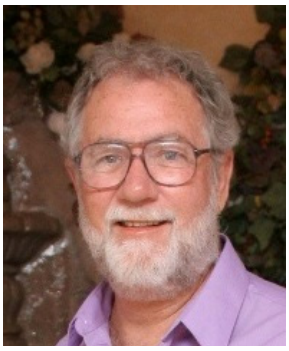
Retired Director, Public Works Department, City of Tulsa

Charles Hardt heads the Operations Division, which oversees Equipment Management and the Public Works Department activities including Engineering Services, Public Facilities & Property Management, Environmental Services and Policy Development.
Contributions: Experience as Director of Public Works, hydrologist, flooding, dam failure, administration, political considerations, funding, economics, and environmental considerations.

Laura Hendrix, CFM

City of Tulsa, Working in Neighborhoods

Specializing in floodplain management, hazard mitigation planning, and disaster preparedness training. AA Social Sciences, BA Geography & Land Use, MA Geography; Past Vice-Chair, Chair, Executive Director, Montana Floodplain Managers Assn.; Member Association of State Floodplain Managers, 2009 National Floodplain Manager of the Year.
Contributions: Hazard mitigation education and outreach to neighborhood leaders and civic associations, communicating flood hazard, mapping, regulations, and insurance issues to citizens, experience with FEMA grant funding and implementation of CRS compatible hazard mitigation plan mitigation measures.



Barry Hughes

Vice President and Creative Director of Impact Marketing & Advertising

Barry studied marketing and advertising at Allan Hancock College and the University of California at Santa Barbara; Marketing & Production Director for Osborn Ministries International headquartered in Tulsa; Website Manager, Marketing & Social Media Director for Rocky Mountain RV & Marine in Albuquerque, New Mexico; Oklahoma Floodplain Managers Association Volunteer.

Contributions: Public information, advertising, education perspective

Roger Jolliff

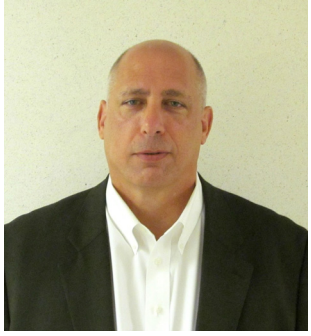
Director, Tulsa Area Emergency Management Agency

AAS, Police Science, Tulsa Junior College; BS Criminal Justice, Langston University; MPA, University of Oklahoma; Over 3,000 hours of EM training; Assisted in 15 Presidential Disasters; FEMA Master Exercise Practitioner; Past Deputy Commander OK-1 Disaster Medical Assistance Tram; Member Cherokee Nation, Member Oklahoma Emergency Management Association.
Contributions: Tulsa City-County Emergency Management Director; broad emergency management perspective; liaison with State, FEMA, other surrounding jurisdictions.

Todd Kilpatrick

Director, Levee District # 12

Contributions: Levee District administration, planning, operations, maintenance, funding, social, technical, political, historic, legal, economic, and environmental considerations and perspectives.



Keith Laub

Director, Tulsa Community College

BS, Communications, University of the State of New York; MS, Management, Southern Nazarene University; member Florida Emergency Planning Association, Louisiana Emergency Planning Association, National Emergency Managers Association, International Association of Emergency Managers; IS0026-IS410 Advanced Incident Commander's Course; Florida SERT Logistics Management Certification.
Contributions: Educator, many faceted Emergency Management experience and perspectives.

Brian Lewis

Senior Environmental Monitoring Technician, City of Tulsa

BS, Biology/Fish & Wildlife, Northeastern State University

Contributions: Environmental and water quality perspectives to the planning process.

Kim Meloy

Web Content/Social Media Manager, City of Tulsa

Contributions: Liaison with City Communications Department; perspectives and expertise on communication, public information and education; newsletters, utility bill information; website, twitter, facebook management.

Nicole McGavock

Meteorologist, Hydrologist, National Weather Service, Weather Forecast Office-Tulsa

BS Atmospheric Science/Geography, The Ohio State University
MS Atmospheric Science, University of Arizona
Member of the American Meteorological Society, National Weather Association, and American Geophysical Union
Contributions: Stakeholder- Presenter and expert resource to Advisory Committee on issues related to the National Weather Service, general weather topics, severe winter storms, lightning, hail, tornadoes, heat, drought.

Josh Miller

Financial Services Representative, State Farm Insurance

BS, Hospitality, Oklahoma State University; Insurance Loss Mitigation.

Contributions: Stakeholder-Liaison with insurance industry; identification of insurance industry perspectives, issues, capabilities, programs.

Steve Piltz

Meteorologist-in-Charge, National Weather Service, Weather Forecast Office-Tulsa, OK

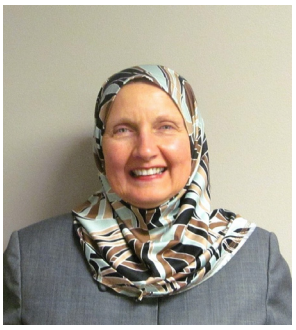
BS - St. Louis University
Member: American Meteorological Society, National Weather Association, Amateur Radio Relay League, Oklahoma Emergency Management Association, Arkansas Emergency Management Association
Contributions: Stakeholder- National Weather Service information and expertise; Presenter on Severe Winter Storms, developer of the Sperry-Piltz Ice Forecast model.

Alan Rowland

City of Tulsa Public Works Financial Planning Manager

BS, Accounting, University of Central OK.

Contributions: Economics, budget, finance issues and considerations for Hazard-related programs.



Sheryl Siddiqui

Language and Culture Bank

BS, Nursing, Salem State University; Co-Chair, Language and Culture Bank; Board Member, Oklahoma Center for Community Justice; Spokes person, Islamic Council of Oklahoma; Retired Emergency Room Nurse.

Contributions: Stakeholder- Liaison and contributor on linguistic and cultural issues and solutions, communications for diverse ethnic and cultural communities.

Jami Skimbo

CoT, Environmental Compliance Specialist

Contributions: Coordinator, liaison, contributor with the environmental requirements and Water and Wastewater Departments of the City.

James Spicer

Owner, Green Country Permaculture, LLC

Degree in Permaculture Design, Humboldt State University; Degree in Agroecology, Prescott College; Certification Stormwater Mitigation, Dryland Irrigation Strategy.

Contributions: Stakeholder- Presenter, resource on xeriscaping, low intensity development, use of local natural vegetation in landscaping.

David Steele P.E., CFM

Former Senior Engineer, Development Services, City of Tulsa

B.S.C.E., Civil Engineering, M.C.E., Civil Engineering, Oklahoma State University;

Contributions: Development, engineering and permitting perspectives on all aspects of Hazard Mitigation and measures to reduce the impacts of hazards on the community.

Chris Stevens

PIO/Special Event Coordinator/Paramedic, EMSA

Contributions: Information on emergency ambulance service, public information and education, types of emergencies, demographic and geographic data.

Tim Thornton

Parks Maintenance Supervisor, City of Tulsa

BS in Agriculture Education

Contributions: City of Tulsa Parks Department liaison; parks planning information, integration of Parks Plans into Hazard Mitigation Planning considerations, and HM Planning considerations into Park and Trails planning; Lightning Sensing and Warning cooperation and coordination with the Tulsa County Parks and Tulsa area schools systems.

Harold Tohlen

Development Services, Floodplain Administrator, City of Tulsa

B.S., M.S. Civil Engineering, Oklahoma State University; 2004-Present, Manager, CoT Permits, Stormwater, Water Mains, Floodplain Manager; `1964-2000 US Army Corps of Engineers; Water Resources Design, Hydrology, Operations & Maintenance; USACE HQ, Wash. D.C., Head of Navigation Program, Operations Branch Chief, Flood Control, Budget, Hydro Power.

Contributions: Coordination with City of Tulsa Development Permits Department.

Henry Townsend

TCLEPC Chair, President, Self-LosStop Consultants, Inc.

A.A. Liberal Arts, Miami Dade Community College; B.B.A., Economics, University of Miami; Chair, Tulsa County LEPC; member, Board of Certified Safety Professionals; Professional Member, Chair, Government Activities, Tulsa Chapter American Society of Safety Engineers; full member, American Industrial Hygiene Association.

Contributions: Hazardous Materials and Transportation Hazards expertise; liaison with the Tulsa City-County LEPC.

Theron Warlick

Planner III, City of Tulsa Planning Department

BA Urban Planning, University of Cincinnati; MS, Architectural Urban Science, University of Oklahoma. CoT Planning Manager, Elm Creek Master Drainage Plan; Centennial Park Stormwater Detention Facility; Tulsa Comprehensive Plan, Small Area Plans, Tulsa Hazard Mitigation Plan Update. Coordinator/Liason between the CoT Planning Department and Floodplain Management and Hazard Mitigation Planning Team; attended TAC and SDHMAB meetings, and community planning meetings; Reviewed draft sections of the Hazard Mitigation Plan.

Contributions: Coordination with Tulsa Planning Department plans and projects.

Other members of the Tulsa Technical Advisory Committee (TTAC) which have attended a minimum of two meetings, include: Gary Cheatham, Past Chair, SDHMAB; Josh Donaldson, CoT Planning Dept.; Curt Easter, City/County Emergency Management; Jacob Hagen, CoT Stormwater Quality; Philip Howery, CoT ; Jack Page, Chief, CoT Development Services; Tammy Pitts, CoT Finance Dept.; Sue Price, CoT Parks Dept.; Roy Teeters, CoT Stormwater Maintenance; Scott Van Loo, Chief, Stormwater Quality; Brian Young, Stormwater Maintenance; and Terry Young, Former Mayor, City of Tulsa.

The TTAC met monthly during the planning process. Members also attended meetings of the Stormwater Drainage & Hazards Mitigation Advisory Board (SDHMAB) and meetings with elected officials.

Consultant:

Ronald D. Flanagan, CFM
Principal Planner
R.D. Flanagan & Associates
Planning Consultants
3015 E. Skelly Dr., Suite 270
Tulsa OK 74105

Staff:

Annie Mack Vest, MA/BS, Manager
David Wakefield, IT
John D. Flanagan, MA/BA, Planner
Tyler Brooks, BA, GIS Specialist
Nancy Edwards, MA/BA, Admin

Mark Swift, P.E.

Swift Water Resources Engineering, LLC

BS Civil Engineering, OSU; Graduate study in Hydrology Engineering; P.E. Okla. No. 13733; Certified Floodplain Manager. SWRE is a Tulsa-based minority-owned firm specializing in urban hydrology, hydraulics and natural hazards mitigation. SWER has been responsible for work on 32 major projects for the City of Tulsa Engineering Services, seven projects for the Tulsa District, US Army Corps of Engineers, 41 projects as sub-consultant for other engineering firms, and over 60 projects for private individuals and corporations.

Angela Swift, CPA

CEO, Swift Water Resources Engineering, LLC

BS Business Administration, Accounting, OSU; CPA, Certificate #5153; 2006-Present, Executive Vice-President/Treasurer, Francis Oil & Gas, Inc., Vice-President Finance, Silverado Foods, Inc., Managing Director, Gilcrease Museum Association; Assistant to Finance VP, Tribune/Swab-Fox; Staff Auditor, Deloitte & Touche.

Tim Lovell

Executive Director of Tulsa Partners, Inc.

Master of Management, BA, Rhetoric/Writing; Executive director of Tulsa Partners, Inc. since 2004, overseeing a variety of initiatives related to mitigation, preparedness, response, recovery and sustainability. He assisted in the creation of Tulsa Partners, Inc., a 501(c) (3) non-profit agency designed to support the building of a safe and sustainable community. He also oversaw the process that created the Tulsa Citizen Corps umbrella of homeland security volunteer programs. Member of the Preserve America Technical Advisory Committee for 2008 "Preparing to Preserve: An Action Plan to Integrate Historic Preservation into Tribal, State, and Local Emergency Management Plans."

French Wetmore
French & Associates, Ltd.

French Wetmore is a national consultant with extensive experience in floodplain management, hazard mitigation planning, and the Community Rating System (CRS). He is former Chair of the National Association of Flood Plain Managers and has collaborated in previous Tulsa projects.

The SDHMAB and the TTAC met monthly at Engineering Services during the planning process to review progress, identify issues, receive task assignments, and advise the consultants. A list of SDHMAB, TTAC, and public meetings and dates is shown in Table 3-1, below. Refer to Appendix C for meeting agendas.

Table 3–1: Tulsa Hazard Mitigation Committee Meetings and Activities

Date	*Activity*
April 13, 2011	City of Tulsa (CoT) Storm Drainage & Hazard Mitigation Advisory Board: (SDHMAB) Discuss Tulsa HM Plan Update.
April 19, 2011	City of Tulsa (CoT) Storm Drainage & Hazard Mitigation Advisory Board:
Jan. 4, 2012	Technical Advisory Committee (TAC)
Jan. 10, 2012	City Council District 1, City Hall in the Neighborhood Meeting
Jan. 12, 2012	TAC Hazard Mitigation Committee Meeting
Jan. 13, 2012	Outreach Projects pursuant to a Public Information Program Strategy (OPS) Meeting.
Jan. 24, 2012	City Council District 5, City Hall in the Neighborhood Meeting
Feb. 1, 2012	TAC Hazard Mitigation/CRS Committee Meeting
Feb. 20, 2012	City Council District 2, City Hall in the Neighborhood Meeting
Feb. 28, 2012	Small Area Plans Meeting, Greenwood Cultural Center.
Mar. 5, 2012	City Council District 3, City Hall in the Neighborhood Meeting
Mar. 15, 2012	Tulsa Partners *A Day Without Business* Conference
Mar. 22, 2012	County Local Emergency Planning Committee (LEPC) briefing on CoT HMGP Plan.
Mar. 28, 2012	City Council District 7, City Hall in the Neighborhood Meeting.
April 12, 2012	CoT Hazard Mitigation Team Staff meeting
April 17, 2012	SDHMAB meeting.
April 19, 2012	Southwest Tulsa Chamber of Commerce meeting- Arkansas River.
April 24, 2012	City Council District 8, City Hall in the Neighborhood Meeting.
April 30, 2012	City Council District 9, City Hall in the Neighborhood Meeting.
May 10, 2012	CoT Hazard Mitigation Team (TAC) Staff Meeting, High Winds, Tornadoes, Safe Rooms
May 13, 2012	City Council District 6, City Hall in the Neighborhood Meeting.
May 15, 2012	SDHMAB Meeting: High Winds, Tornadoes, Safe Rooms
May 17, 2012	HM Plan/Process Televised Presentation to City Council Meeting.
May 30, 2012	Presentation of HM Plan & Process to City/County LEPC
June 1, 2012	SDHMAB Sub-Committee Meeting: Media Strategy
June 7, 2012	TAC Meeting, Extreme Heat & Drought.
June 19, 2012	CC Dist 3, Councilor Gilbert, Presentation on Hazard Mitigation Plan.
June 19, 2012	CoT SDHMAB Meeting, Extreme Heat, Drought.
July 5, 2012	TAC Meeting: Hazardous Materials, Transportation Hazards, LEPC.
July 10, 2012	CC Dist 6, Councilor Steele, Presentation on Hazard Mitigation Plan, High Winds, Tornadoes, Safe Rooms, IBHS Fortified Homes Building Codes.

Date	Activity
August 2, 2012	TAC Meeting: Earthquakes, Expansive Soils, IBHS Fortified Homes Building Codes
August 21, 2012	COT SDHMAB Meeting: Earthquakes, Expansive Soils, IBHS Fortified Homes Building Codes.
Sept. 6, 2012	TAC Meeting: Drought, Wildfires
Sept. 10, 2012	County Commission Levee & Emergency Operations Center Public Meeting.
Sept. 19, 2012	City Council Levee & Emergency Operations Center Public Meeting.
Sept. 25, 2012	COT SDHMAB Meeting: Community Rating Service, Floodplain Management, Public Participation & Involvement.
Oct. 4, 2012	TAC Meeting: Floods, Dam & Levee Failures.
Oct. 16, 2012	SDHMAB Meeting: Floods, Dam & Levee Failures.
Nov. 1, 2012	TAC Meeting: Severe Winter Storms, Back-up Emergency Generators.
Nov. 9, 2012	SDHMAB Sub-Committee Meeting: Arkansas River Levees.
Dec. 5, 2012	CoT Dev. Svcs. Meeting: Hilti Foundation to Floor Sill Fasteners
Dec. 6, 2012	TAC Meeting: Lightning, Hail, Lightning Sensing & Warning Systems.
Dec. 7, 2012	SDHMAB Sub-Committee Meeting: Arkansas River & Levees
Dec. 12, 2012	IBHS Fortified Homes Conference Call.
Dec. 14, 2012	SDHMAB Sub-Committee Meeting: Arkansas River
Dec. 18, 2012	SDHMAB Meeting: Lightning, Hail, Lightning Sensing & Warning Systems.
Jan. 3, 2013	TAC Meeting: Arkansas River Corridor
Jan. 8, 2013	Sub-Committee Meeting: Impact/Hail-Resistant Roofing meeting.
Jan. 11, 2013	Environmental Education Committee Meeting: HM Plan Briefing.
Jan. 15, 2013	SDHMAB Meeting: Arkansas River Corridor.
Feb. 7, 2013	TAC Meeting: Public Participation and Involvement.
Feb. 19, 2013	SDHMAB Meeting: Public Participation and Engagement.
Mar. 7, 2013	TAC Meeting: Hazards Review, Mitigation Measures Confirmation.
Mar. 19, 2013	SDHMAB Meeting: Hazards Review, Mitigation Measures Confirmation.
Apr. 11, 2013	State HM Meeting
Apr. 11, 2013	Tulsa TAC Meeting
Apr. 18, 2013	Day without Business
May 9, 2013	Tulsa HM TAC Meeting
May 10, 2013	Environmental Committee Meeting
May 14, 2013	USACE Table Top Exercise
May 21, 2013	Levee District Meeting
May 21, 2013	SDHMAB Meeting
May 22, 2013	LEPC – HM Presentation
May 23, 2013	City Council Presentation
May 28, 2013	Moore Tornado Tour

Date	Activity
Jun 6, 2013	Tulsa HM TAC Meeting
Jun 11, 2013	Global Alliance Tour
Jun 18, 2013	SDHMAB Meeting
Jun 19, 2013	FEMA OKC HM Plan Review
Jul 11, 2013	State Hazard Mitigation Team Meeting
Jul 30 – Aug 1, 2013	FEMA Local Plan Workshop, OKC
Aug 3, 2013	OKC Moore Rebuild Expo
Aug 20, 2013	SDHMAB Meeting
Sep 10, 2013	SDHMAB Meeting
Nov 19, 2013	Final review and Prioritize Mitigation Measures
	Public Meeting to Review Plan prior to Adoption

3.2 Step Two: Involve the Public

In addition to the Tulsa Citizens Advisory Committee (City of Tulsa Storm Drainage and Hazard Mitigation Advisory Board), the management team of Tulsa Technical Advisory Committee (TTAC) undertook projects to inform the public of this effort and to solicit their input. All meetings of the SDHMAB and TTAC were publicly posted as required by ordinance. The TTAC and TCAC made use of the 2012 *City Hall in the Neighborhood* meetings to reach out to the public. Meetings were held in the nine Council Districts. A booth was set up with information about the Hazard Mitigation Plan Update; staff was available to answer any questions related to the planning process.

Throughout the duration of the plan update process, a webpage was made available on the City of Tulsa website with information on the plan and a short survey for the public. *https://www.cityoftulsa.org/public-safety/hazard-mitigation.aspx* The website also included the location of upcoming mitigation meetings, past agendas, and a link to the 2009 Multi-Hazard Mitigation Plan. Completed surveys and public comments were used to draft the risk assessment, Chapter 4, and the Action Plan, Chapter 7.

A survey with information about Hazard Mitigation and the Hazard Mitigation Plan Update was included in the December 2012 Tulsa water bill. Informational meetings were held before the City Council and televised. Meetings were held in the City Council Districts, and presentations on the Hazard Mitigation Plan to District neighborhood leaders.

3.3 Step Three: Coordinate with Other Agencies and Organizations

Many public agencies, private organizations, and businesses contend with natural hazards. Management team members contacted them to collect their data on the hazards and determine how their programs can best support the Tulsa Multi-Hazard Mitigation planning program. Numerous plans and studies were reviewed in the preparation of this update to the plan. They are listed in Sections 2.1.6, 2.3.1, Table 2-3, and the “Sources “ section at the end of the discussion on the hazards in Chapter 4. A sample letter and a list of agencies contacted are included below.

A private website was created where the draft plan was maintained so participating agencies and organizations could review and provide feedback as the plan was developed.

The Emergency Operations Plan is administered under the Tulsa Area Emergency Management Agency. The Engineering Services and Planning Departments play key roles during most emergencies.

Table 3–2: Agency Coordination Contact List

Title	*Agency*
Federal	
Natural Hazards Program Specialist.	FEMA Region VI
Meteorologist-in-Charge	National Weather Service (NWS)
State Conservationist	Natural Resource Conservation Service (NRCS)
Dam Safety	US Army Corps of Engineers
Disaster Response	US Army Corps of Engineers
Floodplain Management Coordinator	US Army Corps of Engineers
Field Supervisor	US Fish and Wildlife Service
Director	US Geological Survey
Field Office Director	Housing & Urban Development
State	
Director	Oklahoma Biological Survey
Director	Oklahoma Climatological Survey
Executive Director	Oklahoma Conservation Commission
Commissioner of Agriculture	Oklahoma Department of Agricultural, Food & Forestry
Executive Director	Oklahoma Department of Commerce
State Superintendent	Oklahoma Department of Education
Director	Oklahoma Department of Emergency Management
Executive Director	Oklahoma Department of Environmental Quality
Hazardous Materials	Oklahoma Department of Environmental Quality
Commissioner	Oklahoma Department of Health
Director	Oklahoma Department of Transportation
Director	Oklahoma Department of Wildlife Conservation
Fire Marshal	Oklahoma Fire Marshal
Director	Oklahoma Geological Survey
Insurance Commissioner	Oklahoma Insurance Department
State NFIP Program Coordinator	Oklahoma Water Resources Board
Dam Safety	Oklahoma Water Resources Board

Title	Agency
County	
Commissioner District 1 Chairman	Tulsa County
Commissioner District 2	Tulsa County
Commissioner District 3	Tulsa County
Emergency Manager	Tulsa Area Emergency Management Agency
Director	Tulsa County Health Department
Assessor	Tulsa County
Sheriff	Tulsa County
Commissioner District 3 Chairman	Wagoner County
Emergency Manager	Wagoner County
Commissioner District 3 Chairman	Osage County
Emergency Manager	Osage County
Commissioner District 1 Chairman	Creek County
Emergency Manager	Creek County
Commissioner District 1 Chairman	Rogers County
Emergency Manager	Rogers County
City	
Mayor	City of Tulsa
Police Chief	City of Tulsa
Fire Chief	City of Tulsa
Councilor District 1	City of Tulsa
Councilor District 2	City of Tulsa
Councilor District 3	City of Tulsa
Councilor District 4	City of Tulsa
Councilor District 5	City of Tulsa
Councilor District 6	City of Tulsa
Councilor District 7	City of Tulsa
Councilor District 8	City of Tulsa
Councilor District 9	City of Tulsa
Mayor	City of Broken Arrow
Mayor	City of Jenks
Mayor	City of Sand Springs
Mayor	City of Bixby
Mayor	City of Glenpool

Title	Agency
Mayor	City of Catoosa
Emergency Management Coordinator	Tulsa Public Schools
Emergency Manager	Broken Arrow Emergency Management
Fire Chief	City of Collinsville
Emergency Manager	City of Owasso
Chief of Police	Sperry Emergency Management
Emergency Manager	Glenpool Emergency Management
City Manager	Jenks Emergency Management
Emergency Manager	Sand Springs Emergency Management
Director	Arkansas River Levee District
Chairman	Tulsa Area LEPC
Director	Metro Medical Response System
Urban Forester	City of Tulsa
Non Profit	
President & CEO	Tulsa Metro Chamber
Response Coordinator	Tulsa Repeater Organization
Executive Director	Tulsa Human Response Coalition
Executive Director	Arts & Humanities Council of Tulsa
Executive Director	Tulsa Historical Society
Director	2-1-1 Helpline
Executive Vice President	Home Builders Association of Greater Tulsa
Executive Director	AIA, Eastern Oklahoma
President	Tulsa Area United Way
Chairman of Board	Tulsa Area Chapter American Red Cross
Chief Operating Officer	Community Action Project of Tulsa County
Tulsa County Chairman	Indian Nations Council of Governments (INCOG)
Major	Salvation Army
Director	YWCA Multicultural Center
Academic	
President	Oral Roberts University
President	Oklahoma State University - Tulsa
President	The University of Tulsa
President	The University of Oklahoma - Tulsa
President	Tulsa Community College

Title	Agency
Businesses	
Port Director	Tulsa Port of Catoosa
Safety Coordinator	OSU Medical Center
Safety Coordinator	St. John Medical Center
Safety Coordinator	St. Francis Hospital
Safety Coordinator	Hillcrest Medical Center

3.4 Step Four: Assess the Hazard

The management team collected data on the hazards from available sources. Hazard assessment is included in Chapter 4, with the discussion of each hazard.

Table 3–3: How and Why Hazards Were Identified

Hazard	How Identified	Why Identified
Dam/Levee Failures	Input from US Army Corps of Engineers (USACE) Input from Oklahoma Water Resources Board, (OWRB), Dam Safety Division Input from Tulsa Department of Public Works Input from State Levee Coordinator	• Population and buildings below dam and behind levees are very vulnerable in event of major release or dam failure • Dam break/release contingency plan needs updating • Warning systems need to be updated and refined • City considering redevelopment options for areas behind levees
Drought	Historical vulnerability to drought, the "Dust Bowl" era Recent (2002) drought and water shortages in Bartlesville, just north of Tulsa Widespread Oklahoma drought of 2005-2006.	• Continuing mid-west and western drought and impacts on Oklahoma communities, including neighboring Bartlesville • Acute awareness of Oklahoma's population to the severe results of drought • Need to ensure adequate long-term-water resources for Tulsa's metropolitan area population
Earthquakes	Historic records of area earthquakes Input from Oklahoma Geological Survey Input from USGS HAZUS Surveys of potential damages	• Tulsa area has a history of mild earthquakes • Tulsa County has experienced nine earthquakes in the last 15 years • Failure of the New Madrid fault could have consequences for the City of Tulsa and Tulsa County
Expansive Soils	Review of Natural Resource Conservation Service data Input from City Building Inspections Department Input from Oklahoma Department of Transportation	• Expansive soils are prevalent in the City of Tulsa. • Damage to buildings and infrastructure from expansive soils can be mitigated with public information and building code provision

Hazard	*How Identified*	*Why Identified*
Extreme Heat	Review of number of heat-related deaths and injuries from EMSA and State/Local Health Departments Review of data from National Climatic Data Center and National Center for Disease Control & Prevention	• TAEMA and local community service organizations have made heat-related deaths a high priority • High percentage of outdoor workers at risk • High percentage of poor and elderly populations at risk • High Incidence in heat-related deaths and injuries in Oklahoma and Tulsa
Floods	Review of FEMA floodplain maps Buildings in the floodplains Historical floods and damages (detailed in Chapter 4)	• 10% of City land is located in floodplains • 1984 flood caused $180 million in damage • 1984 flood killed 14 people • Flood damage occurs every year • Over $1 billion of property at risk
Hailstorms	Review of data from National Climatic Data Center	• 242 hail damage events in the City of Tulsa over the last 15 years • Over $89.7 Million in property damage
High Winds	National Weather Service data Loss information provided by national insurance companies	• 91 thunderstorm and high wind-related events in the Tulsa area from 1995 through 2011, and almost $25 Mil in damage
Lightning	National Climatic Data Center information and statistics	• Oklahoma has had 295 incidents resulting in 8 deaths, 48 injuries, and $14.8 Mil over a 10-year period. • Seven lightning events in the City of Tulsa caused 2 injuries and 1 death from 1995 through 2011.
Severe Winter Storms	Review of past disaster declarations Input from Tulsa County Emergency Management Agency and Tulsa Emergency Management Input from Tulsa Department of Public Works Input from area utility companies	• Severe winter storms are an annual event in the Tulsa area and can produce both wide-spread economic disruption and massive public utility outages. • Tulsa has had 35 major winter storm events since 1995. • Four winter storm-related Federal Disaster Declarations in the past 7 years have required over $330 million in Federal assistance.

Hazard	How Identified	Why Identified
Tornadoes	Review of recent disaster declarations Input from Emergency Manager Review of data from the National Climatic Data Center	• Tulsa is located in "Tornado Alley" • An average of 52 tornadoes per year strike Oklahoma • Recent disaster events and damage • Oklahoma City tornado of 1999 killed 42 people and destroyed 899 buildings; the more recent 2013 tornado cause similar damages but less loss of life and injury. • All citizens and buildings are at risk • There have been 15 tornadoes in Tulsa County in the last 15 years. Two of those struck the City of Tulsa, causing $2,100,000 in reported damages.
Wildfires	Input from Tulsa Fire Department Input from surrounding county & community fire departments Input from State Fire Marshal Input from Oklahoma State University Rangeland Conservation	• Fires of the urban/rural interface threaten Tulsa properties • Several miles of Tulsa's perimeter and a number of identified critical facilities are exposed and vulnerable to wildfires • Six wildfires in 2005-2006 in Tulsa County caused 1 death, 11 injuries, and $2.05 Mil in reported damages. • 1,997 improved parcels are located in Wildfire Concern Areas.

3.5 Step Five: Assess the Problem

The hazard data was analyzed in light of what it means to public safety, health, buildings, transportation, infrastructure, critical facilities, and the economy. Some of the work for Steps 4 and 5 had been initiated by the Indian Nations Council of Governments. They prepared several analyses using their geographic information system. The discussion of the problem assessment is addressed for each hazard in Chapter 4.

Damage Estimation Methodology

Information from the Tulsa County Assessor's office was used to generate potential losses from the seven site-specific hazards identified in Chapter 4 and Chapter 5 of the Plan Update. Damage estimates for the nine general hazards were not specifically generated due to the fact that all structures in the City of Tulsa are at risk of impact. The following methodologies were used in the development of damage cost estimated for buildings and contents for flooding, including dam and levee impacts, used in the *City of Tulsa Multi-Hazard Mitigation Plan.*

Structure Value: Value of buildings within the City of Tulsa was obtained from the Tulsa County Assessor's office.

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," p. 3-10, source: HAZUS

Contents Value: Value of contents for all buildings was estimated using "Contents Value as Percentage of Building Replacement Value" table, page 3-11, *Understanding Your Risks*.

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 and engineering Master Drainage Plans for each drainage basin. Maps of the floodplains are included in Chapter 4.

Flood damage curves, for structures (single-family, multi-family, office, commercial, industrial), and contents were estimated using Table A-3, "Damage Factors," Economics Branch, Tulsa District, U.S. Army Corps of Engineers.

Flood depth of damage curve estimates were used for riverine flooding and dam failures (Chapter 4).

Estimation of the value of tax-exempt structures, for which no county assessor valuation is available, was done 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," p. 3-10.

3.6 Step Six: Set Goals

Project and community hazard mitigation goals and objectives for Tulsa were developed by the TCAC to guide the development of the plan. The hazard mitigation goals for the jurisdictions are listed in Chapter 5 and Appendix B.

3.7 Step Seven: Review Possible Activities

Wide varieties 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 5: Mitigation Strategies."

1. **Public Information and Education—**Outreach projects and technical assistance
2. **Preventive Activities**—Zoning, building codes, stormwater ordinances
3. **Structural Projects**—Levees, reservoirs, channel improvements
4. **Property Protection**—Acquisition, retrofitting, insurance
5. **Emergency Services**—Warning, sandbagging, evacuation
6. **Natural Resource Protection**—Wetlands and floodplain protection, natural and beneficial uses of the floodplain, and best management practices

The TTAC and the SDHMAB, after reviewing the potential mitigation activities, screened and selected the measures they felt were applicable, feasible, cost effective, and politically acceptable to their community. The measures specifically identified as potentially benefiting the community were combined into a new, more community-specific list for review.

To prioritize the list of possible mitigation measures, made up of over 192 identified mitigation measures, the SDHMAB members were given twenty votes each to select the individual measures they felt would best benefit the community's efforts to reduce or eliminate the adverse impacts of hazards on lives and property. The votes were tallied, and the Mitigation Measures were ranked in descending order. The Mitigation Measures selected and prioritized by this voting process best reflected the values and goals of the community, and the Mitigation priorities generally reflected the disaster and damage experience of the community.

The true challenge is to identify mitigation strategies and measures that represent the goals and political will of the community. Table 6-1, *Multi-Hazard Mitigation Measures, By Priority and Hazard* is the comprehensive list of Mitigation Measures receiving at least one vote from the 20-vote

selection process described above. After confirming the outcome with each advisory committee, the top ten priority measures became the focus for the next phase of the plan, the "Action Plan".

3.8 Step Eight: Draft an Action Plan

The top 69 high-priority Mitigation Measures constituted the Action Plan, and each Measure was further detailed to identify:

- A brief description of the Mitigation Measure (Action Plan Item)
- The lead agency responsible for implementation
- Anticipated time schedule for completion
- Estimated project cost
- Possible sources of funding
- The Work Product, or Expected outcome

The Action Plan items should be developed in enough specificity to respond to a Notice of Intent/Interest (NOI) from the State when HMGP Funds become available, or to provide basic information to begin to put together a Hazard Mitigation Grant Application.

3.9 Step Nine: Adopt the Plan

The Draft *City of Tulsa Multi-Hazard Mitigation Plan Update 2014* was submitted to the Oklahoma Department of Emergency Management and FEMA Region VI for review and approval. The SDHMAB approved the final plan, adopted it as an amendment to the *Comprehensive Plan*, and submitted it to, and was approved and adopted by the Tulsa City Council.

3.10 Step Ten: Implement, Evaluate, and Revise

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 SDHMAB and the TTAC will continue to meet on a regular basis to monitor progress, evaluate the activities, and periodically recommend revisions to the Plan and Action Items. The plan will be formally updated a minimum of every five years, as required by FEMA.

Chapter 4:
Natural and Manmade Hazards

Introduction

According to the Federal Emergency Management Agency (FEMA), a hazard is defined as an event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, or agricultural loss, among other types of loss or harm. Hazards are generally defined as one of two categories based on their source: natural hazards and man-made hazards. Each hazard has its own defining characteristics, such as time of year and geographic area of probable occurrence, severity, and risk level.

Natural phenomena, such as floods, tornadoes, severe drought, and wildfires, are natural hazards because they have the potential to destructively impact human settlements and activities. When damages from a natural hazard occur, the event is generally called a natural disaster.

Man-made hazards are broadly defined as a hazard that originates from accidental or intentional human activity. They can affect localized or widespread areas and are frequently unpredictable. This category of hazard includes such events as dam breaks and hazardous material events.

While Oklahoma communities can expect disaster-related losses, hazard assessments can be used to create proactive measures against likely events, and thereby significantly decrease or eliminate their impacts. Therefore, this chapter contains a risk identification and assessment for 16 hazards. The hazards addressed are those deemed most likely to impact the City of Tulsa. The hazards include both general hazards and site-specific hazards.

Included in this Chapter:

Introduction
Hazards Summary
Annual Average Damages
Hazards Analysis
Secondary Events
Vulnerability Assessment
4.1 Winter Storms
4.2 High Winds
4.3 Tornadoes
4.4 Lightning
4.5 Hailstorm
4.6 Extreme Heat
4.7 Drought
4.8 Earthquakes
4.9 Urban Fire
4.10 Floods
4.11 Dam Failures
4.12 Levee Failures
4.13 Expansive Soils
4.14 Wildfires
4.15 Hazardous Materials
4.16 Transportation Incidents
4.17 Hazard Composite

General Hazards

1. Severe Winter Storms
2. High Winds
3. Tornadoes
4. Lightning
5. Hail
6. Extreme Heat
7. Drought
8. Earthquakes
9. Urban Fires

Site-Specific Hazards

10. Floods
11. Dam Failures
12. Levee Failures
13. Expansive Soils
14. Wildfires
15. Fixed-Site Hazardous Materials
16. Transportation Hazardous Materials

Each hazard is covered in a separate section, which will include the following information:

Hazard Profile – Causes, effects, normal frequency (how often it is likely to occur at a particular location), and available scales or methods of measuring the severity of the events, if any; the geographical extent and impact of the hazards; and the identification of any topographic or geological conditions that would make a particular area prone to the hazard.

History/Previous Occurrences – Notable past occurrences of the hazard, including national, state, and local examples, if any. Where available, historic losses, in terms of lives and property, are detailed.

Vulnerability – The people, geographic locations, and types of property subject to the particular hazard are identified. For each hazard with a definable geographic location, such as floods and dam breaks, the number, types and value of buildings and contents that would likely be impacted are identified, along with the vulnerable populations. In addition, the potential effect on infrastructure, such as communications and utilities are reviewed.

Future Trends – Potential effects of the hazard in terms of future development areas of the community are reviewed in terms of population, structures, infrastructure, and critical facilities. When known, other factors such as emerging technological trends may be included in this analysis.

Conclusion – The information provided on each of the hazards is condensed into a brief summary/conclusion statement.

Hazards Summary

Severe Winter Storms	A severe winter storm is storm that drops four or more inches of snow during a 12-hour period, or six or more inches during a 24-hour period. Ice forming from freezing rain, freezing immediately upon contact with roads, homes, electric lines, trees and other structures adds to the dangers of winter storms. Winter storms are a significant hazard to the City of Tulsa, as they occur frequently and may affect the entire area.
High Winds	High wind events are typically associated the annual U.S. convective storm season, along with tornadoes and damage-causing hail. Extreme high wind events can be associated with either extreme intensity, or with large numbers of downbursts, or occasionally with both. Extremely intense high wind events can generate wind gusts in excess of 125 mph, with 100-125 mph occurring virtually every convective storm season. In derecho situations (straight-line winds), damaging winds exceeding 60-75 mph can occur over areas of hundreds of square miles, and any one location might experience such winds for 30 minutes or more. The greatest danger to people is a high wind event in areas where outdoor recreational or entertainment activities take place and those residing in mobile homes and/or deteriorating or poorly constructed homes.
Tornadoes	A rapidly rotating vortex of wind extending to the ground from a cumulonimbus cloud. When the lower tip of a vortex touches earth, it becomes a tornado and often a force of destruction.

Lightning	Lightning is generated by the buildup of charged ions in a thundercloud. When that buildup interacts with the best conducting object or surface on the ground, the result is a discharge of a lightning bolt. The air in the channel of a lightning strike reaches temperatures higher than 50,000˚ Fahrenheit. Oklahoma is vulnerable to frequent thunderstorms and convective weather patterns, and therefore its vulnerability to lightning is a constant and widespread threat during the thunderstorm season.
Hailstorm	A hailstorm is an outgrowth of a severe thunderstorm in which balls or irregularly shaped lumps of ice fall with rain. Extreme temperature differences from the ground upward into the jet stream produce strong updraft winds that cause hail formation. As of 2010, the National Weather Service has increased its size criteria for hail that defines a severe storm event to 1 inch from ¾ inch.
Extreme Heat	Extreme heat is characterized by a combination of very high temperatures and exceptionally humid conditions. A heat wave occurs when such conditions persist over time.
Drought	Drought is a climatic dryness severe enough to reduce soil moisture and water below the minimum necessary for sustaining plant, animal, and human life systems. Drought duration and severity are usually measured by deviation from norms of soil moisture, annual precipitation and stream flows. Droughts affect a large segment of the population, but are a minimal threat to property. Crop losses and mandatory water rationing are possible affects of severe drought.
Earthquakes	An earthquake is a sudden, rapid shaking of the ground caused by the fracture and movement of rock beneath the Earth's surface. Earthquakes occur in Oklahoma with some degree of regularity, although usually less than 3.0 on Richter Scale. The region's underlying geology exposes Oklahoma to some risk from a severe earthquake in the New Madrid Seismic Zone. However, almost all Oklahoma earthquakes are too small to be felt and rarely cause visible damage.
Urban Fires	An urban fire is one that burns a home or other improved structure. Fire generates a black, impenetrable smoke that blocks vision and stings the eyes, making it often impossible to navigate and evacuate
Floods	The accumulation of water within a body of water and the overflow of excess water onto adjacent lands. The floodplains are the lands adjoining the channel of a river, stream, ocean, lake, or other watercourse or body of water that is susceptible to flooding.
Dam Failures	The Federal Emergency Management Agency (FEMA) defines a dam as "a barrier constructed across a watercourse for the purpose of storage, control, or diversion of water." A dam failure is the collapse, breach, or other failure resulting in downstream flooding.
Levee Failure	A levee is defined as an earth embankment, floodwall, or structure along a water course whose purpose is flood damage reduction. A Levee failure is the collapse, breach, or other failure of the embankment or structure resulting in flooding of previously protected, low-lying areas.

Expansive Soils	Soils and soft rock that swell and shrink with changes in moisture content are commonly known as expansive soils. The effects from expansive soils develop gradually and are seldom a threat to the population, but can cause severe damage to improvements built upon or within them.
Fixed Site Hazardous Material Events	Hazardous materials are chemical substances that, if released or misused, can pose a threat to the environment or human health. Examples are explosives, flammable and combustible substances, poisons, and radioactive materials
Transportation-Hazardous Materials	Transportation is the physical movement of objects and materials through components of a system and its subsystems. Transportation includes the use of aviation, highway, railroad, pipeline, and marine systems for the movement of objects and people. This plan considers the potential of transportation related hazardous materials events and exposure to potential mass casualty transportation accidents.

Annual Average Damages

Data from the National Weather Service and the National Climatic Data Center (NCDC) was used to describe past damages associated with the hazards identified in this plan. Other sources include the Oklahoma Geological Survey, the National Response Center, and the Oklahoma State Fire Marshal. Available data is limited; information on total damage to property, injuries and loss of lives for a 15-year period from 1995 through 2011 is summarized in Table 4-1.

Table 4–1: Summary of Reported Damages, 1995-2011

Hazard	Events	Years	Events/ Year	Total Property Damage (Recorded)	Property Damage/ Event	Property Damage/ Year	Injuries	Injuries/ Event	Injuries/ Year	Deaths	Deaths/ Event	Deaths/ Year
Floods	38	15	2.53	$50,000.00	$1,315.79	$3,333.33	0	0	0	0	0	0
Tornadoes	15	15	1.00	$3,152,000.00	$210,133.33	$210,133.33	7	0.4666667	0.4666667	0	0	0
High Winds	91	15	6.07	$7,800,000.00	$85,714.29	$520,000.00	2	0.021978	0.1333333	1	0.010989011	0.066667
Lightning	7	15	0.47	$15,000.00	$2,142.86	$1,000.00	2	0.2857143	0.1333333	1	0.142857143	0.066667
Hail	242	15	16.13	$24,775,000.00	$102,376.03	$1,651,666.67	0	0	0	0	0	0
Winter Storms	35	15	2.33	$50,154,500.00	$1,432,985.71	$3,343,633.33	0	0	0	0	0	0
Extreme Heat	30	15	3.30	$0.00	$0.00	$0.00	212	0	0	13	0.433333333	0.866667
Drought	3	15	3.30	$0.00	$0.00	$0.00	0	0	0	0	0	0
Expansive Soils	*Data Unavailable*											
Urban Fires[1]	8460	11	769.0909	$137,844,342.00	$16,293.66	$12,531,303.82	1166	0.14	106	72	0.009	6.545455
Wildfires[1]	5571	10	557.1	$2,810,365.00	$504.46	$281,036.50	*Data Unavailable*					
Earthquakes[2]	9	15	0.6	$0.00	$0.00	$0.00	0	0	0	0	0	0
HazMat Events[3]	13,133	17	772.5294	*Data Unavailable*								
Dam Failures	0	15	0	*Data Unavailable*								
Transportation[4]	91	15	6.066667	*Data Unavailable*								

[1] Based on a 10- year time period from 2000-2010. Source: OK Fire Marshall's Office

[2] Source: Oklahoma Geological Survey Earthquake Catalog

[3] Source: Tulsa Fire Dept.

[4]. Source: National Response Center

From 1995 to 2012 there have been fifteen Presidential Declarations for a Major Disaster which included Tulsa County, and as a result, the City of Tulsa. The declarations, including the disaster number, incident, declaration date, and the type of assistance received, are summarized in Table 4-2. All disasters declared in Tulsa County result in the County and its communities being eligible for Hazard Mitigation Grant Program Funding.

Table 4–2: Federal Disaster Declarations in Tulsa County 1995 to 2012

Disaster Number	Incident	Declaration Date	Assistance Received
FEMA-DR-1985	Severe Winter Storm/Snow Storm	March 13, 2011	Public Assistance
FEMA-DR-1876	Severe Winter Storm	February 25, 2010	Public Assistance
FEMA-DR-1735	Severe Winter Storms	December 18, 2007	Public Assistance
FEMA-DR-1678	Severe Winter Storms	February 1, 2007	Public Assistance
FEMA-DR-1623	Severe Wildfire Threat	January 10, 2006	Individual/ Public Assistance(B)
FEMA-DR-1401	Ice Storm	February 1, 2002	Individual Assistance
FEMADR-1355	Severe Winter Storm	January 5, 2001	Individual/Public Assistance
FEMA-DR-1272	Tornadoes, Storms, and Flooding	May 3, 1999	Individual / Public Assistance

Hazards Risk Analysis: Probability and Vulnerability

A Hazard Analysis provides a quantitative method for assessing and evaluating hazards and standardized criteria for a rating and scoring system. Table 4-3 shows the results of the risk analysis for the City of Tulsa, which includes the numeric ranking of the historical and actual probability of occurrence, impact potential for each event, and the extent of existing mitigation activities and capabilities of local and area response agencies. Table 4-4 provides the description of each of the ranking criteria for each component.

Table 4–3: City of Tulsa Hazard Vulnerability Analysis

Type of Hazard	Occurrence		Vulnerability				Mitigation Activities	Resources		
	History	Probability	Human	Property	Infrastructure	Business		Internal	External	Total
Heat, Extreme	5	5	5	3	4	3	3	4	4	5.4
Tornadoes	5	5	3	4	3	3	2	3	3	5.3
Winter Storm/Ice Storm	5	5	1	3	2	5	2	2	3	5.0
Lightning	5	5	3	2	2	2	1	2	1	4.9
Flooding	5	5	3	4	3	2	3	4	4	4.8
Dam Failure	3	3	4	4	4	3	2	2	2	4.7
Hail	5	5	1	4	2	1	2	2	1	4.6
High Wind Events	5	5	1	4	2	1	2	2	1	4.6
Levee Failure	3	3	3	3	3	3	2	2	2	4.0
Expansive Soils	5	4	1	3	3	1	3	4	4	3.4
Urban (Structure) Fires	5	5	1	2	1	1	4	4	4	3.1
HazMat Incidents, Fixed Site	3	3	4	2	1	2	1	2	3	3.3
Drought	3	3	2	1	2	2	2	2	3	2.8
Transportation Incidents	3	4	4	1	1	1	2	3	4	2.8
Wildfires	2	3	1	2	1	1	2	3	3	1.6
Earthquake	1	1	1	1	1	1	3	4	4	0.3

Table 4–4: Summary of Hazard Vulnerability Ranking Criteria

Summary:	This tool looks at an organization's or community's vulnerability to the effects of various hazards. Using a scale of 0 to 5, the probability of occurrence and the impact potential are measured against mitigation activities and the resources available to respond to the hazard. The total is based on a formula that weighs risk heavily but provides credit for mitigation and response and recovery resources. The highest score possible is 7.8. The lower the total score, the lower the overall risk from the Hazard.	
Instructions:	Score each hazard based on a scale of 0 to 5 with 5 being the highest. Ratings values: 1 = Low : 2-3 = Moderate : 4-5 = High	
Historical Occurrence:	This is based on the number of occurrence in the last 20 years. Maximum is 5; if a new hazard, use 0.	
Probability:	Probability is the likelihood an event will occur. Score 0 if non-existent, 1 if less than 1%, 2 if less than 5%, 3 if less than 10%, 4 if less than 20%, and 5 if greater than 20%. Percents are based on the likelihood of an event occurring within a 15 year period of time. History and probability are similar, but hazards that are newly developing, hazards where the likelihood has increased or decreased based upon new developments or activities, or hazards that have a lack of historical information may need to be considered individually.	
Impact:	Based on “worst-case scenario” - greatest possible impact should worst-case event occur. Maximum threat is the worst-case scenario of a hazard. Its impact is expressed in terms of human casualties, property loss, and business interruption/loss of revenue issues. Secondary events need to be factored in where necessary. Assume maximum population when appropriate (for example, industrial park during peak work hours).	
Internal/ External Resources:	Based on the resources available to the community internally, or to Mutual Aid agreements or other understandings with neighboring jurisdictions. May also include private resources available, such as corporate firefighting/hazmat teams or medical resources.	
Analysis Results:	**Extreme Risk: Greater than 6.0**	**Moderate Risk: 2.5 to 4.0**
	High Risk: 4.0 to 6.0	**Low Risk: Less than 2.5**

Secondary Events

Many disasters set off other types of events in a cascade of effects that can result in highly complex and hazardous conditions. Severe thunderstorms, for example, may spawn high winds, lightning, hailstorms, tornadoes, and flooding. It is generally more useful to consider all secondary events as a part of the overall situation created by the primary event. These events are frequently referred to as "cascade" events. Table 4-5 identifies secondary events that are related to each of the 16 natural and manmade hazards studied in this report.

Table 4–5: Secondary (Cascade) Hazard Events

Primary Event	Dam Failure	Drought	Expansive Soils	Flood	Fixed-Site HazMat Event	Power Failure	Urban Fire	Transportation HazMat	Water Supply Failure	Wildfire
Winter Storm				X		X	X	X	X	
High Wind					X	X	X	X	X	X
Tornado					X	X	X	X	X	
Lightning					X	X	X	X		X
Hail						X				
Extreme Heat		X	X			X			X	
Drought			X						X	X
Earthquake	X				X	X	X	X	X	
Urban Fire					X	X				X
Flood	X				X	X	X	X	X	
Dam Failure				X	X	X		X	X	
Levee Failure				X	X	X	X	X	X	
Expansive Soil									X	
Wildfire					X	X	X	X	X	
Fixed-Site HazMat							X			X
Transportation HazMat					X	X	X			X

Vulnerability Assessment

An assessment (Table 4-6) indicates that the City of Tulsa is vulnerable to all hazards presented in this document.

Table 4–6: Hazard Vulnerability for the City of Tulsa

	General Hazards									Site-Specific Hazards						
	Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Hazardous Material Sites	Transportation-Hazard
City of Tulsa	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tulsa Council District 1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tulsa Council District 2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tulsa Council District 3	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
Tulsa Council District 4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tulsa Council District 5	X	X	X	X	X	X	X	X	X	X			X	X	X	X
Tulsa Council District 6	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
Tulsa Council District 7	X	X	X	X	X	X	X	X	X	X			X	X	X	X
Tulsa Council District 8	X	X	X	X	X	X	X	X	X	X	X		X		X	X
Tulsa Council District 9	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
Arkansas River Corridor	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Critical Facilities

As identified in Chapter 1 of this Plan Update, several types of facilities are critical to the functioning of the City of Tulsa after disasters and during the recovery process. The critical facilities have the same probability of being impacted by the general hazards identified in this Plan Update. The impact of these hazards on critical facilities in the City of Tulsa will be addressed in Sections 4.1 through Section 4.9, below.

The geographic location of each identified critical facility will determine the level of exposure to the site-specific hazards identified in this Plan Update. In order to provide a more meaningful analysis of vulnerable critical facilities to these hazards, they will be analyzed, addressed and mapped by their respective District location in Chapter 5.

4.1 Severe Winter Storms

4.1.1 Hazard Profile

A severe winter storm is one that drops more than two inches of snow or a quarter inch of ice. Winter weather is a tough forecast. If temperature stays 39 F or less in the atmosphere or above, snow tends to occur. If temperature anywhere in the column of sky above exceeds 39 F, the snow melts. Then this could be rain, sleet, or glaze depending on the temperature near the ground.

> ***"Severe winter storms may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation. Severe winter weather can down trees, cause widespread power outages, damage property, and cause fatalities and injuries"***
>
> *-Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards, FEMA, January 2013*

An ice storm occurs when freezing rain falls and freezes immediately upon contact. Ice storms often take shape overhead of the impacted area and come in waves. Thunderstorms that include thunder and lightning can be involved.

Ice accumulation depends on the temperature of the raindrops and the temperature of the object the rain is landing on. Other factors of ice accumulation include the "catch size" of the object, raindrop size, rainfall rate, and wind.

The National Weather Service (NWS) in Tulsa issues a Winter Weather Advisory when one to three inches of new snow or icing are expected which could make driving and walking hazardous. A Winter Storm Watch is issued when four or more inches of snow, ½ inch or more of sleet, or ¼ inch or more of glaze is expected. A Winter Storm Warning is issued when hazardous conditions are forecast to occur across the area, or when there is difficulty in determining the type of conditions which will predominate. A Blizzard Warning is issued when there is heavy snow and winds are greater than 35 mph. Definitions of winter weather terms, as provided by the NWS, are included in Table 4-7.

Table 4–7: National Weather Service Winter Weather Terms

Term	Definition
Blizzard Warning	Issued for sustained or gusty winds of 35 mph or more, and falling or blowing snow creating visibilities at or below ¼ mile; these conditions should persist for at least three hours.
Freezing Rain	Rain that falls onto a surface with a temperature below freezing. This causes it to freeze to surfaces such as trees, cars, and roads, forming a coating or glaze of ice. Even small accumulations of ice can cause a significant hazard.
Sleet	Rain drops that freeze into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects. However, it can accumulate like snow and cause a hazard to motorists.
Winter Storm Watch	Alerts the public to the possibility of a blizzard, heavy snow, heavy freezing rain, or heavy sleet. Winter Storm Watches are usually issued 12 to 48 hours before the beginning of a Winter Storm.
Winter Weather Advisory	Issued for accumulations of snow, freezing rain, freezing drizzle, and sleet which will cause significant inconveniences and, if caution is not exercised, could lead to life-threatening situations.
Winter Storm Warning	Issued when hazardous winter weather in the form of heavy snow, heavy freezing rain, or heavy sleet is imminent or occurring. Winter Storm Warnings are usually issued 12 to 24 hours before the event is expected to begin.

Location

The northeast corner of Oklahoma is situated in a prime location to experience the periodic collision of warm, moist Gulf air and arctic air from the Canadian Shield. Because of this climatic positioning, the City of Tulsa experiences winter weather ranging from extreme sub-zero temperatures, snow and freezing rain to mild, spring-like days. Therefore, Tulsa is considered vulnerable to the effects of a severe winter ice/snow event. The location of this hazard is uniform over the entire planning area.

Measurement

The *Wind Chill Index* is a measure of how cold the wind makes real air temperature feel to the human body. Created in 1870, the National Weather Service released a more scientifically accurate equation in 2001. The chart (Figure 4-1) is used to calculate wind chill. (The Chart is not applicable in calm winds or when the temperature is over 50°F.)

Figure 4–1: National Weather Service Wind Chill Index

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

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

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

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

Source: National Weather Service and NOAA

Table 4-8 displays Balthrop's Winter Storm Physical Intensities. This measure of the intensities and impacts of winter storms was developed by Charles Balthrop of the Oklahoma Department Emergency Management. From an historical standpoint, this chart is fully applicable to the City of Tulsa and an accurate predictor of future Severe Winter Storms. The table gives a range of physical intensities from winter storms along with the potential effect on the City of Tulsa.

Table 4–8: Balthrop's Winter Storm Physical Intensities

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

Source: State of Oklahoma Hazard Mitigation Plan

The Sperry-Piltz Ice Accumulation Index, shown in Table 4-9, is a tool used to predict the types of damage that may be incurred prior to a winter storm actually striking. The tool was developed at the office of the National Weather Service in Tulsa, OK. Mr. Sid Sperry, representing the Oklahoma Association of Electric Cooperatives, and Mr. Steve Piltz, meteorologist in charge of the NWS office in Tulsa monitored the effects and impacts of ice storms for more than ten years. They formed a research alliance with the Oklahoma Climatological Survey in Norman, OK to develop a guide using the various weather parameters involved in the formation of ice storms.

The Sperry-Piltz Ice Accumulation Index, or SPIA Index, can accurately predict the location, timing, and severity of ice storm impacts days in advance. The tool allows cooperatives and other entities to be better prepared for severe ice events.

Extent /Severity

The City of Tulsa considers a minor severity winter storm to be a Level 2 event or below (ice accumulation of less than ¼ inch—see Table 4-9), and a major severity event to be Level 3 and above (ice accumulation greater than ¼ inch) resulting in power outages and hazardous travel conditions.

Table 4–9: The Sperry-Piltz Ice Accumulation Index (SPIA Index)

The Sperry-Piltz Ice Accumulation Index, or "SPIA Index" – Copyright, February, 2009

ICE DAMAGE INDEX	* AVERAGE NWS ICE AMOUNT (in inches) *Revised-October, 2011	WIND (mph)	DAMAGE AND IMPACT DESCRIPTIONS
0	< 0.25	< 15	Minimal risk of damage to exposed utility systems; no alerts or advisories needed for crews, few outages.
1	0.10 – 0.25	15 - 25	Some isolated or localized utility interruptions are possible, typically lasting only a few hours. Roads and bridges may become slick and hazardous.
	0.25 – 0.50	> 15	
2	0.10 – 0.25	25 - 35	Scattered utility interruptions expected, typically lasting 12 to 24 hours. Roads and travel conditions may be extremely hazardous due to ice accumulation.
	0.25 – 0.50	15 - 25	
	0.50 – 0.75	< 15	
3	0.10 – 0.25	> = 35	Numerous utility interruptions with some damage to main feeder lines and equipment expected. Tree limb damage is excessive. Outages lasting 1 – 5 days.
	0.25 – 0.50	25 - 35	
	0.50 – 0.75	15 - 25	
	0.75 – 1.00	< 15	
4	0.25 – 0.50	> = 35	Prolonged & widespread utility interruptions with extensive damage to main distribution feeder lines & some high voltage transmission lines/structures. Outages lasting 5 – 10 days.
	0.50 – 0.75	25 - 35	
	0.75 – 1.00	15 - 25	
	1.00 – 1.50	< 15	
5	0.50 – 0.75	> = 35	Catastrophic damage to entire exposed utility systems, including both distribution and transmission networks. Outages could last several weeks in some areas. Shelters needed.
	0.75 – 1.00	> = 25	
	1.00 – 1.50	> = 15	
	> 1.50	Any	

(Categories of damage are based upon combinations of precipitation totals, temperatures and wind speeds/directions.)

Source: Oklahoma State Hazard Mitigation Plan

Frequency

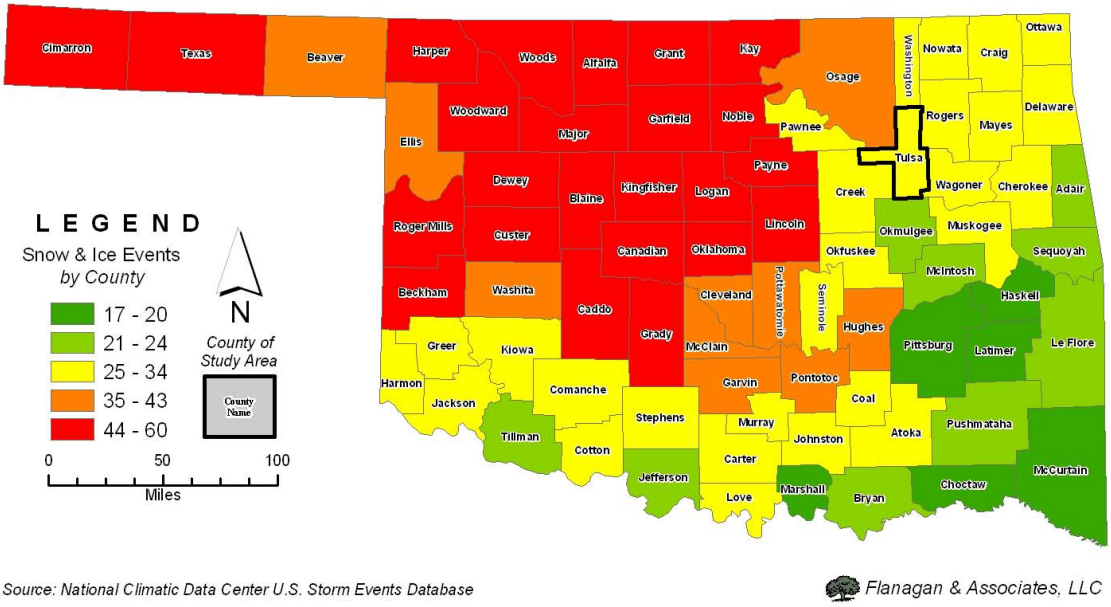
Oklahoma Climatological Survey reports 8.3 inches of snow as an annual average in Tulsa County. The average number of days with snow on the ground is seven. The greatest daily snowfall occurred in Tulsa on March 9, 1994, when snow accumulation was 12.9 inches. From 1995 to 2011 a total of 692 winter storm events occurred in Oklahoma, an average of about 43 winter storms each year. Tulsa County reported 35 severe winter storm events during this time period. The NCDC Storm Events Database includes reports of severe winter storm events on a regional basis. Severe winter storms are, by nature, not isolated events – therefore it could be stated that Winter Weather events affecting Tulsa County will also have some impact on the City of Tulsa. Based on information from the National Weather Service and NCDC, the City of Tulsa can expect to experience around two severe winter storm events per year, on average. A summary of these events compared with Oklahoma events during the reporting period is included in Table 4-10. A map of winter storm events in Oklahoma from 1990 to 2010 as reported by county is shown in Figure 4-2.

Table 4–10: Tulsa County Winter Storm Events from 1995-2011

Location	Events	Deaths	Injuries	Property Damages
Tulsa County	35	0	0	$50,154,500
Oklahoma	692	2	6	$753,354,500

Source: NCDC Storm Event Database

Figure 4–2: Oklahoma Snow and Ice events by County 1990-2010



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

Flanagan & Associates, LLC

Impact

The impact of severe winter storms can affect Tulsa for weeks and even months and cause great inconvenience, injuries and deaths. Everyone is affected by the loss of mobility. Streets and highways are slick and hazardous, even walking from house to car can be dangerous. Public transportation is often blocked. Residents, commuters, travelers and livestock may become isolated or stranded without adequate food, water and fuel supplies. People are often inconvenienced or at risk of physical harm from loss of power to their homes. Above-ground electrical and telephone lines and tree limbs are often coated in a heavy build-up of accumulating ice, which break when under the stress of sufficient weight. Falling trees also often bring down power lines. When electrical lines are damaged, other utilities, such as natural gas, can become inoperable. Snowmelt after a winter storm event can overburden the stormwater system and cause sewage to backup. Severe winter storms impact the business community automatically during power outages. Even when power is not lost, the business community will experience revenue and productivity losses due to poor travel conditions and extreme cold temperatures.

4.1.2 History/Previous Occurrences

Oklahoma experiences severe winter storms on an annual basis. The City of Tulsa has been impacted on multiple occasions by these frequent events. Tulsa County, including the City of Tulsa, has been included in four Presidential Disaster Declarations and one Emergency Disaster Declaration based on winter storm events since 1998. The most significant ice storm in Oklahoma history occurred in 2007—one that took a devastating toll on the City of Tulsa.

In the time since approval of the Tulsa Hazard Mitigation Plan Update 2009, one severe winter storm event occurred in the planning area. Narratives of this event and other significant winter storms that have impacted Tulsa in recent years are included in Table 4-11.

Table 4–11: City of Tulsa Winter Storm Event Narratives

Date	Event Narrative
December 2000	On Christmas Day, precipitation fell as freezing rain resulting in ice accumulations of around 1 inch. Thousands of homes and vehicles were damaged by falling trees and ice, and thousands of trees and utility poles were damaged or destroyed.
January 2002	A large part of northwest and central Oklahoma, including Tulsa, was hit by a severe winter ice and snow storm that cut off power to 255,000 customers and a resulted in over $100 million in damage and seven fatalities. This event resulted in a Presidential disaster declaration, FEMA-DR-1401-OK. Tulsa County was not included in this declaration but neighboring Osage County was.
January 12-14, 2007	A severe ice storm resulted in power outages to over 122,000 homes (some for up to 3 weeks) in the eastern third of Oklahoma, including Tulsa County. Damages were estimated at $50 million, with 32 deaths and 3,919 injuries. A devastating swath of 1 to 3 inches of ice fell in an estimated 60- to 80-mile wide band from roughly Atoka to McAlester to Muskogee to Grove. West of the heavy ice, 1 to 3 inches of sleet fell with lesser amounts of freezing rain. Prolonged power outages combined with extreme temperatures created water supply crises in some of the more rural, isolated communities.
December 8-11, 2007	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. 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. The governor declared a State of Emergency for all 77 Oklahoma counties. After a week more than 150,000 customers were still without electricity, including several city water and sewage plants. Fallen power lines created another hazard as the broken lines sparked structure fires. Fire departments responded to over 200 structure fires in the first week of the storm; at one point there were 13 fires. Other fires were caused by portable heating sources inside homes. Schools had to close for several days, due to the power outages. The Red Cross opened 34 shelters in Tulsa County with more than 1,800 people registering to spend the night. Nursing homes were encouraged to shelter in place; one had to be evacuated and caused the ice storm to impact multiple victims more than once. The storm cleanup was estimated to have cost at least $200 million statewide. In Tulsa alone, there were 2.7 million cubic yards of debris. Power outages impacted 226,500 homes in Tulsa; there were 29 deaths statewide, six of them in Tulsa (4 fire fatalities, 1 traffic fatality, 1 hypothermia fatality); Tulsa International Airport closed to incoming/departing flights for 24+ hours; three Tulsa hospitals were forced to rely on emergency generators. During the storm 4,007 trees were lost due to severe structural damage to the tree trunks. Over 5,349 additional trees were identified as being dangerous because of hangers (limbs that could potentially fall and cause injury), which then had to be trimmed for public safety. This event resulted in a Presidential disaster declaration in Tulsa County, FEMA-DR-1735-OK. The total countywide per capita impact for Tulsa County was $5.92 million.
January 31 – February 2, 2011	Oklahoma was hit by the “Groundhog Day Blizzard” that dumped a record 14 inches of snow on Tulsa, with more snow following on February 4th and 7th. Tulsa International Airport was closed, as was I-44 between Stroud and Miami, along with the Creek, Indian Nations and Muskogee Turnpikes. In the early phase of the “back-to-back blizzards”, temperatures dropped into the single digits and remained below freezing during the day. High winds dropped the wind-chill temperatures as low as 36° below zero in some parts of the state. Water mains broke. For the first time in 111 years, the *Tulsa World* cancelled its print editions for three days. Tulsa’s public schools were closed for eight days due to this series of winter storms. A Presidential disaster declaration was declared for Tulsa County, FEMA-DR-1985-OK.

Source: NCDC Storm Event Database

Probability of Future Events

Based on the geographic location of Tulsa, the number of storms reported between 1995 and 2011, and factoring in the weather patterns, the City of Tulsa can expect to experience two severe winter

weather events each year, and a severe winter snow/ice event every three years. The City of Tulsa is considered to have a HIGH probability of future severe winter storm events.

4.1.3 Vulnerability

This section summarizes the City of Tulsa's vulnerability to winter storms, including the impact on people, structures and buildings, critical facilities, and infrastructure. This information, as well as information provided by the City was used to determine the Vulnerability Criteria identified in Tables 4-3 and 4-4. The City of Tulsa was determined have a HIGH vulnerability to the Severe Winter Storm hazard.

Population

A broad spectrum of Tulsa's population is vulnerable to the effects of winter storms. People who travel in winter storms are at the most risk. The National Weather Service reports that 70 percent of winter storm-related deaths involve automobile accidents, more than the number of people caught out in the storm. Winter storms are deceptive killers because most deaths are indirectly related to the storm. While the majority of winter storm deaths are a result of traffic accidents, other risks include:

- Cold temperatures carry the threat of hypothermia, primarily in the elderly;
- Slips and falls due to slippery walkways;
- Back injuries or heart attacks may occur during snow removal or debris cleanup;
- House fires occur more frequently in winter due to lack of proper safety precautions when using alternate heating sources (i.e., unattended fires, improperly placed space heaters, etc.). Fires during winter storms present a great danger because frozen water supplies may impede firefighting efforts.
- Improper hookup of home generators may cause "back feed" into electrical transmission lines thought to be disconnected, threatening utility workers;
- Carbon monoxide from improperly located generators or other heating sources may threaten residents.

January 30, 2002, winter storm caused widespread damage in Tulsa

The elderly are at higher risk due to physical condition and frequent isolation. According to NOAA, 50% of hypothermia cases occur in people over the age of 60. In addition, more than 75% of all hypothermia victims were found to be male. Exhaustion and heart attacks caused by overexertion are also likely causes of winter storm-related deaths.

The City of Tulsa has four shelters providing refuge for the homeless population. During the December 2007 ice storm, all shelters were reporting operation at or above capacity. The homeless population is also a high-risk population to the effects of a severe winter weather event, which is especially true if they are unaware that public shelters are available, or unable to access them. Low income populations often cannot afford the high cost of heating their homes during the winter months.

Structures/Buildings

A direct threat to structures/buildings from a severe winter event is excessive snow/ice accumulation onto flat or low-grade sloped roofing surfaces. This is especially true of older structures that were not constructed to withstand this type of stress, such as the 48.5% of homes in the City of Tulsa constructed prior to 1970.

Commercial structures face the same impacts of winter weather as residential properties. As a result of the record snowfall in 2011, a portion of the roof of the Hard Rock Casino, located in the Tulsa metro area, collapsed. The damage was confined to an area that was the original structure, built in 1992. The cause of the collapse was attributed to the heavy weight of snow accumulation on the roof.

As witnessed during the 2007 ice storm, trees and vegetation are susceptible to complete loss in the aftermath of a severe ice event. According to the Department of Forestry, ice accumulation can increase the branch weight of trees by 30 times or more. Trees near buildings may break and damage exterior components or windows. Downed trees can also damage power lines and cause outages. This was a problem in Tulsa during the 2007 ice storm, when 80% of downed lines were damaged by trees.

More indirect threats to structures/buildings would be from power outages causing interruption to heating and refrigeration (loss of supplies, food, sensitive equipment), frozen water pipes (excessive flooding causing damage to interior and sensitive electronic equipment if pipes break), and fires (caused by power lines being torn away from structure or power surges as lost power is restored). At the peak period of the December 2007 Ice Storm, Tulsa Fire Department responded to more than 200 structure fires in 5 days.

Critical Facilities

All critical facilities in the City of Tulsa are susceptible to the potential impacts of a winter storm event. Among other things, power outages interrupt vital services, and snow/ice accumulation or debris from damaged trees result in inaccessibility due to road closures or blockages.

During the December 2007 ice storm, three of Tulsa hospitals were dependent on generator power for an extended time. Of the six tertiary care hospitals, all but one lost power, and a nursing home facility in Collinsville was forced to evacuate its 90 residents due to the prolonged power outage. Additionally, only one Tulsa Police Substation had an operational fuel station. Tulsa Fire Department reported that 13 of their stations were without power (some without heat) and they were running low on oxygen bottles.

There are 111 long term care facilities in the City of Tulsa, all of which are vulnerable to the impacts of a winter storm event. It would be difficult and dangerous to evacuate nursing homes and rehabilitation centers during a winter storm. In the 2007 ice storm event, nursing homes were strongly encouraged to shelter in place, rather than evacuate, if at all possible. One nursing home decided to evacuate and caused the ice storm to affect victims multiple times instead of just once. Residents were sent to several different locations, some had to be moved more than twice. It is important for nursing home facilities to have a shelter-in-place safety plan in the event of a winter storm. Nursing homes, and all critical facilities that house special populations, should be equipped with back-up generators or generator pad and transfer switches so that a mobile generator can be hooked-up and power remain on.

Infrastructure

Water Treatment – The most significant effect during a winter event would be from loss of electrical power, delays to chemical deliveries (road inaccessibility), personnel and staffing issues. Both of Tulsa's water treatment plants are vulnerable to these risks. During the 2007 ice storm, the Mohawk Water Treatment Plant was offline for a period of approximately four days. Due to the

severity of the storm, electrical power from both feeds to the plant was interrupted. The A.B. Jewell plant was able to provide water during the storm and to meet the City's baseline needs. Due to the widespread power outages, Tulsa's overall water demand was significantly reduced.

Wastewater Treatment – The most significant threat to the operation of Tulsa's four wastewater treatment plants during a winter storm would be power outages. All four plants and lift stations have either double feeds or generators. In the December 2007 ice storm no outages were reported at any of the four stations.

Utilities: Damage to utilities infrastructure can result in losses of up to $2 billion per winter storm event. The primary utility providers for Tulsa's jurisdiction are AEP/PSO (electricity) and ONG (natural gas). The service stations and substations for both of these providers are vulnerable to the risks from a severe winter event.

Electricity - During a winter storm, providers of electrical service could experience any combination of the following challenges in meeting the needs of the Tulsa jurisdiction: Destruction of distribution and transmission poles, downed broken power lines, staffing issues due to the inclement weather (some workers may not be able to get out of their homes), danger to workers from downed power lines, hazardous road conditions and fallen debris from trees, and insufficient field and/or office staff to effectively handle the workload.

As a result of the December 2007 ice storm, AEP/PSO reported 226,500 customers without power (78% of their Tulsa customer base), over 1,000 distribution poles and approximately 150 transmission poles broken, approximately 9,000 meter enclosures damaged and approximately 1,000,000 miles of power lines repaired/replaced (not all in Tulsa). Additionally, 4,600 restoration workers were utilized (as opposed to 600 in normal operations) working 73,600 man-hours per day (4,600 workers putting in 16-hour days), with support staff handling more than 512,600 calls pertaining to the event. A summary of power outage data and the rate of restoration during the 2007 ice event are shown in Table 4-12.

Table 4–12: Summary of Tulsa Area Event – December 2007

Date	Daily High	Daily Low	Customers Without Power	% increase / decrease restoration
11-Dec	36	32	225,769	--
12-Dec	*35*	*32*	178,507	-20.93%
13-Dec	*34*	*31*	169,724	-4.92%
14-Dec	*41*	*30*	81,000	-52.28%
15-Dec	*38*	*25*	62,454	-22.90%
16-Dec	*44*	*20*	42,145	-32.52%
17-Dec	*55*	*25*	30,205	-28.33%
18-Dec	*56*	*35*	8,344	-72.38%
19-Dec	*62*	*27*	2,000	-76.03%

Date	Daily High	Daily Low	Customers Without Power	% increase / decrease restoration
20-Dec	*61*	*36*	1,000	-50.00%
21-Dec	*65*	*31*	--	-100.00%

Gas – During a winter event, Oklahoma Natural Gas (ONG) could experience a variety of challenges in meeting the needs of the Tulsa jurisdiction, including: damage to gas meters from ice accumulation, falling power lines or tree debris, inaccessibility to underground gas meters from falling debris, danger to field employees related to road conditions, downed power lines, extreme temperatures, and insufficient field and/or office staff to effectively handle workload generated by such an event.

During the December 2007 ice storm, ONG reported approximately 50 above-ground gas meters damaged due to power lines and falling tree debris, several underground meters inaccessible due to debris, and several instances where field employees had to practice extra caution while working in areas affected by downed electric lines and tree limbs. Fortunately, ONG reported that during this event there were no customer outages related to the storm.

Transportation Systems (Highways, Public Transportation, Railway, Airports) – All manner of transportation would be at risk during a winter event in the Tulsa jurisdiction. Road closures due to ice/snow accumulation can result in loss of retail trade, wages and tax revenue. Such closures often exceed $10 million/day in the eastern part of the country. The inability of public transportation (taxis, buses) to function after a winter event can also contribute to increased risk to the population if it hampers access to necessary medical care or safe shelter. Fortunately, Tulsa's public bus system (MTTA) experienced only minor disruptions in operations during the December 2007 ice storm, and was able to provide essential services to the local Emergency Operations staff during the event. During the blizzard of 2011, heavy snow accumulation crippled the transportation system in Tulsa. EMSA vehicles had to be towed out of high snow banks. Fire Trucks were able to get around the City using tire chains, but even this measure failed when chains broke.

Severe winter weather could result in the interruption of normal operations at Tulsa's International Airport and the city's private business airports. Major ice or snow accumulations can impact runway safety and result in cancellation or major delays in regular flight schedules. The December 2007 storm resulted in flights being cancelled by all airlines servicing TIA for over 24 hours. In addition to delaying the transportation of goods and materials on courier flights, passengers were stranded with no real timeline for resumption of services. The impassability of roads in the area pretty much isolated many stranded fliers at the airport for this time period.

As a result of the 2007 ice storm and 2011 blizzard, the City of Tulsa has focused on ways to get the city quickly back up and running after a severe winter storm. As of November 2012 the City has more than 14,500 tons of salt, 62 truck-mounted salt/sand spreaders, 45 truck-mountable snow plows and four motor graders that can be turned into snow plows. The spreaders are assigned to 36 specific routes totaling 1,768 lane-miles. Spreading and plowing routes are based on traffic counts. Once main streets are cleared and conditions permit, selected residential streets are treated, based upon traffic and steepness of grade.

Emergency Services- Fire, Police and Medical Services would all be vulnerable to the same potential affects of a Winter Storm event. Staffing issues due to the inclement weather (some workers may not be able to get out of their homes), danger to workers derived from downed power lines, hazardous road conditions and fallen debris from trees, and insufficient field and/or office staff to effectively handle the workload can be expected in all areas.

Additionally, the fallen debris or impassable roads could potentially hamper effective response times for emergency calls, and hazardous road conditions add to the risk of accidents for responders, potentially reducing both fleet resources and manpower (injuries). During the December 2007 ice storm, Tulsa Police Department reported that 11 cars were damaged during the event.

4.1.4 Future Trends

For information regarding future development in the City of Tulsa, see Section 1.2.8.

Population

Increasing energy prices combined with the rise in cost of basic necessities will continue to put a strain on those in the jurisdiction already struggling to take care of their most basic needs. A steadily increasing population relying on fixed incomes could very easily translate into a greater number of people unable to provide heat for their homes in times of severe winter weather.

Additionally, more and more elderly are choosing to remain in their homes rather than move into assisted/progressive living situations – many of whom will have some type of special need that may be exacerbated during such an event. Any populations with functional and access needs will require additional planning considerations.

Structures/Buildings

All residential, commercial and industrial buildings added to the city's inventory should include certain planning precautions. For all new construction, attention to the placement of trees and large shrubs is necessary to reduce the risk of power line interference. Burying electrical power lines, when possible, is the most favorable strategy. Commercial and industrial projects should include adequate backup power systems to protect critical equipment and data storage.

Critical Facilities

All considerations for Structures/Buildings above apply equally, if not more, to critical facilities. Several mitigation measures included in this plan address the issue of power outages at City of Tulsa fueling stations and water/wastewater plants. In addition, due to the extremely widespread power outages in December of 2007, this plan includes a mitigation measure addressing the development of a Comprehensive Master Generator Plan, which reviews the capabilities of all City facilities, their necessity in the response and recovery process, their current capabilities to remain up and running during an extended power outage, and the costs of retrofitting them to a workable level.

Infrastructure

Since many new residential subdivisions are including buried power lines as part of their planning, it is expected that this mitigation measure will produce a measurable effect on future winter storms in currently undeveloped areas.

4.1.5 Conclusions

Due to the rich, moist atmosphere present in Tulsa, the entire jurisdiction should expect to be repeatedly affected by winter events. The degree of severity is dependant greatly on the temperature fluctuation between daytime and nighttime, and the duration of any extreme temperature conditions. The City of Tulsa is considered to have a HIGH vulnerability to and HIGH probability of Severe Winter Storms.

Data Limitations

Data kept by the National Climatic Data Center cannot separate out geographically the effects of winter storms that often encompass extremely wide areas. With that in mind, casualties, damages, and

the effects of historic events are frequently aggregate numbers for storms that extend outside the geographical boundaries of the designated area.

4.1.6 Sources

Northeast States Consortium at www.nesec.org/hazards/winter_storms.cfm

National Weather Forecast Office at www.wrh.noaa.gov/otx/safety/winter.php

NOAA Economics (The Economics and Social Benefits of NOAA Data & Products – Research paper by Adams et al., 2004 on Economic Costs of Snowfall in U.S.

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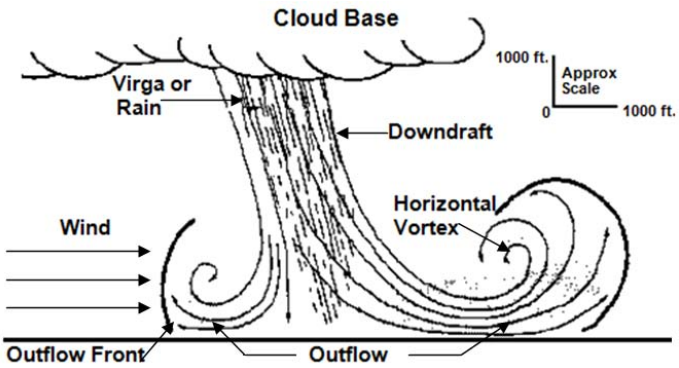
Richard J. Hauer, Mary C. Hruska, and Jeffrey O. Dawson. 1994. *Trees and ice storms: The development of ice storm–resistant urban tree populations.* Special Publication 94-1, Department of Forestry, University of Illinois at Urbana- Champaign. Urbana, IL 61801. http://web.aces.uiuc.edu/vista/pdf_pubs/icestorm.pdf

4.2 High Winds

4.2.1 Hazard Profile

Figure 4–3: High Winds Diagram



A Microburst is a particularly violent type of downburst that can generate winds up to 168 mph

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, see Figure 4-3. Winds vary from zero at ground level to 200 mph in the upper atmospheric jet stream 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.

Location

The risk of this hazard is uniform over the planning area, the City of Tulsa. Winds are always part of severe storms but do not have to accompany a storm to be dangerous. Down-slope windstorms, straight-line winds, derechoes (a widespread and long-lived, violent straight-line windstorm associated with a fast-moving band of severe thunderstorms), and microbursts (a very localized column of sinking air, producing damaging straight-line winds that are similar to but distinguishable from tornadoes) can all cause death, injury, and property and crop damage.

Measurement

While there are several scales that measure wind speeds the most appropriate for the purposes of Oklahoma plans is the Beaufort Scale of Wind Strength.

The Beaufort Scale of Wind Strength is a scale of wind velocity used by the National Weather Service. The Scale measures wind at a 36-foot elevation and is presented in Table 4-13. The City of Tulsa may experience a wind force of 9 to 12, as measured on the Beaufort Scale.

Extent /Severity

The City of Tulsa considers a wind force of 9 or below on the Beaufort Scale to be of minor severity and a wind force of 10 and above to be of major severity. As a rule, damage increases significantly when wind speeds reach 60 mph, and damage is almost certain with wind velocities above 70 mph.

High winds generated by Oklahoma's spring and autumn storms can be devastating to older homes and mobile homes

Table 4–13: Beaufort Scale of Wind Strength

Beaufort number	Wind Speed (mph)	Seaman's term		Effects on Land
0	Under 1	Calm		Calm; smoke rises vertically.
1	1-3	Light Air		Smoke drift indicates wind direction; vanes do not move.
2	4-7	Light Breeze		Wind felt on face; leaves rustle; vanes begin to move.
3	8-12	Gentle Breeze		Leaves, small twigs in constant motion; light flags extended.
4	13-18	Moderate Breeze		Dust, leaves and loose paper raised up; small branches move.
5	19-24	Fresh Breeze		Small trees begin to sway.
6	25-31	Strong Breeze		Large branches of trees in motion; whistling heard in wires.
7	32-38	Moderate Gale		Whole trees in motion; resistance felt in walking against the wind.
8	39-46	Fresh Gale		Twigs and small branches broken off trees.
9	47-54	Strong Gale		Slight structural damage occurs; slate blown from roofs.
10	55-63	Whole Gale		Seldom experienced on land; trees broken; structural damage occurs.
11	64-72	Storm		Very rarely experienced on land; usually with widespread damage.
12	73 or higher	Hurricane Force		Violence and destruction.

Source: Huler, Scott (2004). Defining the Wind: The Beaufort Scale

Frequency

According to the NCDC Storm Events Database, during the 16 year reporting period 1995 to 2011, the City of Tulsa experienced 91 thunderstorm/high wind events (after duplicate reports were removed), summarized in Table 4-14; event wind speeds ranged between 60-95 mph. Given this frequency, the City of Tulsa can expect about six damaging high wind events per year. A map showing Oklahoma high wind events by County is included in Figure 4-4.

Table 4–14: City of Tulsa High Wind Events from 1995-2011

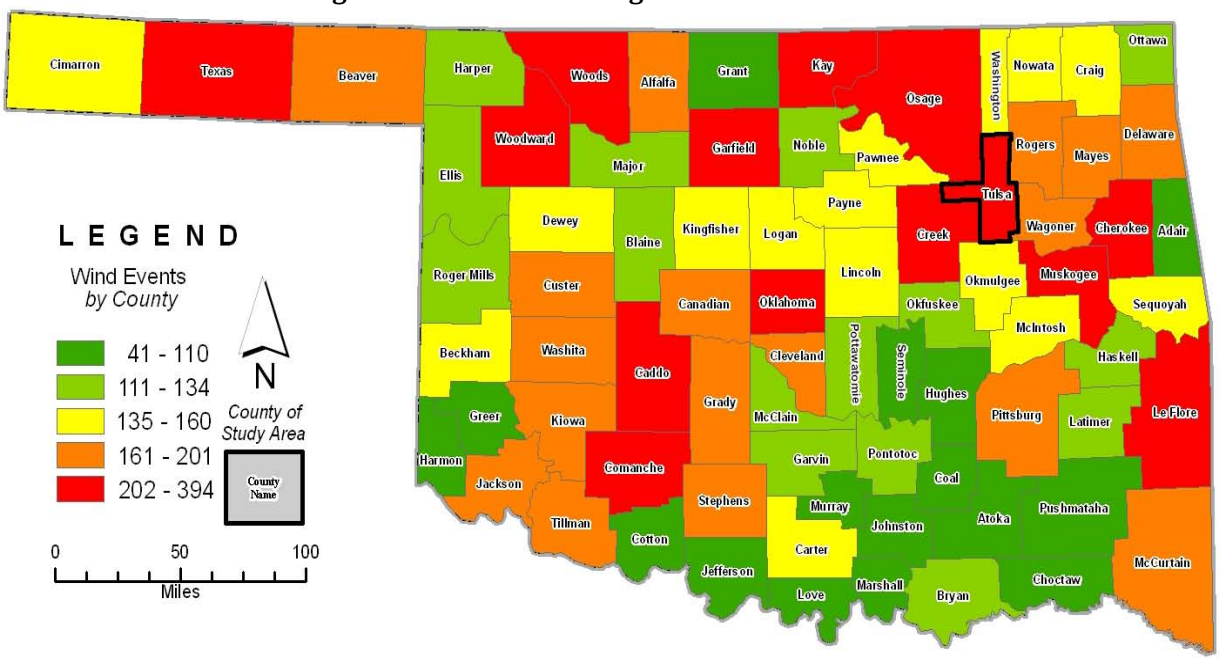
Location	Events	Fatalities	Injuries	Damages
City of Tulsa	91	1	2	$7.8 Million
Oklahoma	9,260	8	196	$959,980,200,

Source: NCDC Storm Events Database

Impact

The impact of this hazard can result in damage to homes, businesses and citizens, and can cause loss of income for both families and communities. Wind is the fourth-leading cause of property damage. In Oklahoma, wind events are generally associated with the huge convective thunderstorms that move through the region in the spring and fall months generating tornadoes, downbursts and high winds. It is not unusual for winds produced by these storms to reach speeds of 80 to 100 mph, with winds of 50 to 70 mph being commonplace. Downbursts, like the one that struck Tulsa on June 6, 2006, can topple trees, damage houses and power lines, and break up sidewalks and streets. During the 16-year period 1995 thru 2011, high winds caused $7.8 million dollars in damages in the City of Tulsa.

Figure 4–4: Oklahoma High Wind Events 1990-2010



Source: National Climatic Data Center U.S. Storm Events Database
Events include NCDC categories of high winds, thunderstorm winds and storm winds.

Flanagan & Associates, LLC

4.2.2 History/Previous Occurrences

The NCDC Storm Events Database includes reports of 93 thunderstorm/high wind events in the City of Tulsa Since 1993. Event wind speeds ranged between 85 to 100 mph. Summaries of the more notable past wind events are included in Table 4-15.

Table 4–15: City of Tulsa High Wind Event Narratives

Date	Event Narrative
June 2, 2004	Thunderstorm winds of nearly 80 mph blew glass windows out of the Adams Mark Hotel in downtown Tulsa, and caused structural damage to the NE façade of the nearby Wiltel (now called One Technology Center) building. One person was injured by the breaking glass. AEP estimated approximately 70,000 customers were without power at the peak of the outage, with the company estimating repairs in the Tulsa area to cost several million dollars. NCDC reports show property damages estimated at $4 Million.
June 6, 2006-	A microburst with winds estimated at 85 mph occurred. The Tulsa County Fairgrounds received an estimated $2.5 Million in damages – most notably the destruction of an 80-year old Ferris Wheel, and major damage to the roofs at the Trade Center and the Exchange Center. Two nearby churches experienced substantial roof damage, an estimated 1,420 homes experienced varying degrees of damage, primarily to roofs/roofing material, and trees were uprooted destroying sidewalks/driveways. 13,000 customers were without power at the peak of the event; four people were transported to the hospital for treatment of minor injuries.

Date	Event Narrative
October 17, 2007	Straight-line winds clocked in excess of 80 mph accompanying an energetic upper-level system caused 2 large and several smaller tents to collapse at the local Oktoberfest celebration. More than 7,000 people were in attendance at the time of the storm – a light attendance as it was the preview "corporate night". EMS crews arriving on scene treated 29 people and transported 24 to local hospitals – 3 in critical condition. Authorities estimate that an additional 20-30 people self-transported to medical facilities seeking treatment. Damages were estimated at $100,000.
June 1, 2008-	Tulsa NWS confirmed that a downburst packing winds of 70 mph hit the TownWest Shopping Center located in West Tulsa. The shopping center sustained damage to a sizable section of the roof, and several cars in the parking lot were damaged. AEP reported damage to 24 power poles in the area, and power outages to approximately 6,200 customers. Gas leaks were also suspected around the shopping center. In addition, 20 windows on the south side of downtown BOk Tower and six glass panes on the west side of the 15-story One Technology Center were damaged. Some of the glass from the BOK tower fell into nearby Second Street.
May 13, 2010	Thunderstorms produced a tornado and exceptionally strong winds that formed a bow echo. The worst-hit areas of the city were from S. 36th to 101st Street and from Yale Ave. to Riverside Dr. High winds caused damage to homes and businesses, peaking at 120 mph. About 50 power poles were blown down, and 18 schools and 40,000 AEP customers were without power.
July 14, 2012	A thunderstorm hit South Tulsa generating high winds that knocked down power lines between 71st and 81st streets, and Lewis and Riverside. The storm tore off part of the roof at an apartment complex. There was also damage to The Plaza Shopping Center on 81st and Lewis. River Spirit Casino was forced to close after high winds and lightning damaged their air conditioning system. Tulsa Police Department was forced to block off South Lewis from 71st to 83rd, and Delaware from 81st to Riverside. As a result of the storm, 1,400 PSO customers were without power for several hours.
July 24, 2013	Winds as high as 76 mph were recorded at Tulsa International Airport, the highest speed ever recorded at the site. Around 11:30 pm, the storm began in the Tulsa area and lasted a half--hour to an hour. The event caused power outages to nearly 100,000 PSO customers; outages lasted several days. Debris covered the city, calling for implementation of the City's Debris Clean-up Plan. Tulsa County Social Services, Tulsa County Juvenile Courts and detention Center, Tulsa County Parks Administration Office, and Tulsa County Carol Crowson Annex, lost power during the storm. The storm was classified as a derecho due to consistent reports of wind damage or measured wind gusts of 58 mph for over 250 mph. *(*Tulsa World/Channel 6 News)*

Source: NCDC Storm Events Database/*Local News Media

Probability of Future Events

With 91 high wind events recorded within the City of Tulsa in a 16-year period, it is clear that high winds are a frequent event. The City of Tulsa can expect on the order of five to six events a year, with multiple events potentially producing economic loss. Deaths and injuries are more likely in tornadoes, the most severe wind events, but as casualties have occurred during high wind events, deaths and injuries remain a possibility. The City of Tulsa has a HIGH probability of future High Wind events.

4.2.3 Vulnerability

This section summarizes the City of Tulsa's vulnerability to the High Wind hazard, including the impact on people, structures and buildings, critical facilities, and infrastructure. This information, as well as information provided by the City, was used to determine the Vulnerability Criteria identified in Tables 4-3 and 4-4. The City of Tulsa, including all future development areas, was determined to have a HIGH vulnerability to the High Wind hazard.

Population

The people most vulnerable to high wind-related deaths, injuries, and property damage are those residing in mobile homes and deteriorating or poorly constructed homes. However, as demonstrated by the October 17, 2007 Oktoberfest event, those participating in outdoor activities in high-risk weather conditions are particularly at risk from wind-driven debris and falling or collapsing structures. Also at increased risk are those operating motor vehicles, particularly those with high profiles. RV's, full-sized vans, truck-trailers, etc., can be blown over by high winds, and smaller, lower-profile vehicles can be moved from their designated lane of travel. It should be noted that anyone operating a vehicle at highway speeds during a sudden burst of high wind could lose control of their vehicle.

Structures/Buildings

Property damage from windstorms is increasing due to a variety of factors. Manufactured housing provides less resistance to wind than conventional construction. Not all states have uniform building codes for wind-resistant construction. Inferior construction practices result in buildings being more vulnerable to high winds. In particular, certain types of buildings, such as glass-clad office buildings, present increased vulnerability, as reported in *Performance of Glass Cladding of High Rise Buildings in Hurricane Katrina.*

The glass-clad Bank One Tower, Fort Worth TX, following the March 2000 storms. (Photo by Doug Smith, AAWE)

The deteriorating condition of older homes and the expanding use of aluminum-clad mobile homes increase the likelihood of high wind events impacting the community. The general design and construction of buildings in many high wind zones do not fully consider wind resistance and its importance to survival. Structures impacted by high winds face potential damages to the roof, windows, walls, wall coverings, and doors of the building. Near-surface winds and associated pressure effects exert pressure on structure walls, doors, windows, and roofs, which can cause the structural components to fail.

Roofing systems are the most vulnerable structural component to high wind events. According to the Insurance Institute for Business and Home Safety (IBHS), roof damage is present in 85 percent to 95 percent of wind-related insured property losses each year. Wind can cause roofing components to become free-flying missiles, damaging windows of nearby buildings. Glass windows, doors, and skylights are also vulnerable, and shattered glass can injure those nearby.

Critical Facilities

Due to the unpredictability of this hazard, all critical facilities within the City of Tulsa are considered vulnerable and at risk of damage as a result of high wind events. For high wind events, it is not possible to isolate specific critical facilities that would be more or less vulnerable to damage. Structural integrity may be compromised if a facility is in the direct path of the storm, in addition to

any secondary issues presenting, such as power disruption, water damage from accompanying rain, injury to workers/residents, etc.

Infrastructure

Water Treatment – The most significant effect during a high wind event would be from loss of electrical power. Each of the City's two water treatment plants have dual electrical feeds which supply power from independent substations. Additionally, these two plants are located in two different geographic areas of the city, which reduces the likelihood that both would be affected by the same storm.

Wastewater Treatment – The most significant threat to the operation of Tulsa's four wastewater treatment plants during a high wind event would be power outages. All four plants and lift stations have either double feeds or generators.

Utilities: An extreme high wind event will almost certainly cause utility service disruptions for utility providers.

- **Electricity:** During a high wind event, AEP/PSO (PSO) could experience any combination of the following challenges in meeting the needs of the Tulsa jurisdiction: Destruction of distribution and transmission poles, downed or broken power lines, danger to workers derived from downed lines, fallen debris from trees, and insufficient field and/or office staff to effectively handle the workload. Power outages may affect individual homeowners or entire businesses. As indicated by outage data provided by PSO, high wind accounts for the majority of extended power outages that have impacted more than 20,000 customers in the City of Tulsa from 2003 through 2011, as shown in Table 4-16.

Table 4–16: PSO Outages with Greater than 20,000 Customers Affected (High Winds)

Year	Interruption Start Date	Number of Interruptions	Total Accounts Affected	Total Customer Hours Interrupted	Average Customer Hours (Days) Interrupted	Primary Cause
2003	08/01/2003	349	45,572	332,004	7.29 (0.30)	High Winds
2004	05/13/2004	204	23,443	98,218	4.19 (0.17)	T Storms/High Winds
2004	06/02/2004	508	63,255	1,226,376	19.40 (0.81)	T Storms/High Winds
2005	06/04/2005	296	35,945	340,162	9.46 (0.39)	High Winds
2005	06/16/2005	384	36,729	227,710	6.2 (0.26)	High Winds
2005	11/27/2005	245	34,765	244,247	7.03 (0.29)	High Winds
2007	10/17/2007	324	29,404	182,168	6.2 (0.26)	High Winds
2008	06/01/2008	N/A	66,843	983,646	14.72(0.613)	T Storms/High Winds
2010	5/13/2010	N/A	30,318	315,707	10.41(0.43)	T Storms/High Winds
2011	8/10/2011	N/A	22,300	114,953	5.15(0.22)	T Storms/High Winds

Source: PSO

- **Gas:** During a high wind event, Oklahoma Natural Gas (ONG) could experience a variety of challenges in meeting the needs of the Tulsa jurisdiction, including falling power lines or tree debris, inaccessibility to gas meters from falling debris, downed power lines, extreme temperatures, and insufficient field and/or office staff to effectively handle workload generated by such an event.

Transportation Systems (Highways, Public Transportation, Railway, Airports) – High wind conditions could result in the interruption of normal operations at Tulsa's International Airport and

the private business airports. At least eight fatal aircraft incidents since 1975 have been attributed to microbursts. Debris from wind events can cause roads to be impassible.

Emergency Services- Fire, Police and Medical Services would all be similarly at risk to the secondary effects of a high wind event. Downed power lines or debris blocking city streets could limit or eliminate access to affected areas, as experienced after the June 2006 downburst. Medical Services (including treatment facilities) could be strained in responding to large numbers of injuries, such as occurred after the October 2007 high winds at Oktoberfest.

4.2.4 Future Trends

For information regarding future development in the City of Tulsa, see Section 1.2.8. As development within the City of Tulsa continues, it can be anticipated that the population and number of structures (both critical and non-critical) will increase. All future development areas for the City are equally at risk from high-wind events, with the following considerations.

Population

With rising interest in development along the River Parks area for public use, an increase in people participating in activities in these new facilities can be anticipated. A rise in outdoor activities would increase the number of people exposed to the dangers of high wind events, such as the October 2007 *Oktoberfest*, or the more recent *Rocklahoma* Concert (July 13, 2008) in Pryor, OK, where two tents were blown down and one person suffered a broken arm after slipping in the mud while running to safety.

Structures/Buildings

Though the City of Tulsa has adopted a residential building code that protects structures from winds of at least 90 mph, the jurisdiction continues to see wind events that exceed this level of intensity. As land within the city is developed for residential purposes, effort should be made to inform homebuilders and the general public of materials and techniques for building to higher wind standards, such as those recommended by the Insurance Institute for Business and Home Safety (IBHS). Building to a higher wind standard may protect residents from harm while, at the same time, lessening the economic impact of high wind events in the City of Tulsa. Further information about wind-resistant construction can be found in Chapter 7 and Appendix B.

In the continuing development and revitalization of Tulsa's downtown and currently undeveloped areas, districts experiencing a large amount of construction should be considered at high risk for wind-strewn debris during a high-wind event. Although most builders routinely do this, construction companies and crews should be cautioned to exercise great care in securing apparatus and supplies that might otherwise become wind-borne during a wind event. Following Hurricane Alicia, a group of glass distributors determined that more than 80% of glass breakage had been caused by wind-borne debris. Sources of debris included roof gravel, construction debris, broken glass and insufficiently secured rooftop appurtenances.

According to a report on "Performance of building cladding in urban environments under extreme winds", close observation often reveals large areas of pits, nicks, and scratches indicative of the impact of wind-borne debris. Although some abraded windows remain completely intact, they are eventually replaced as it is very likely that their decreased glass strength would lead to poor performance in future storms.

Critical Facilities

As the threat from the effects of high wind events themselves cannot be eliminated, any critical facilities undergoing expansion, renovation or rebuilding should consider following updated construction techniques for such projects. The addition of reinforced exterior materials, such as

windows, doors, siding, etc., can do much to improve the safety of these facilities. Additionally, all efforts to guard against potential secondary effects should also be implemented. These secondary effects may include, but not be limited to, compromise of structural integrity, broken windows/doors from wind-strewn debris, water damage from accompanying rains, power interruptions/surges, and communication interruption from lightning or wind damage.

Infrastructure

Ensuring a minimized effect on the delivery of utility service requires forethought and planning while in the development stage. Any plans for areas currently under development or being considered for development should include the provision for underground utility supply when possible, well trimmed vegetation (to limit creation of falling debris) and multiple access routes for emergency services vehicles.

4.2.5 Conclusions

Due to the nature of Tulsa's climate, severe thunderstorms and the high winds they frequently produce will remain a very real threat to this community. The probability and accompanying risk of high wind events occurring is high. Recent events, both in Tulsa and in the surrounding areas, serve as proof that while sporadic, high winds continue to produce life- and property-threatening conditions. Improved building technologies, advances in public communication capabilities, and opportunities for collaboration among community agencies should remain prominent in the planning and response communities' endeavors. The City of Tulsa is considered to have a HIGH probability of and a HIGH vulnerability to the High Wind hazard.

Data Limitations

In many cases, tornadoes and high wind events occur during the same storm incident. For example, a 2006 storm event produced damage at Tulsa International Airport from both a downburst and a tornado. In some cases, unless there is direct observation, it may never be known whether the damage was produced by a tornado or a downburst. This Section should be read and analyzed in conjunction with the Tornado section.

4.2.6 Sources

NCDC Storm Event Database, at Web address: http://www.ncdc.noaa.gov/stormevents/. National Climatic Data Center.

National Weather Service: Office of Climate, Water, and Weather Services, at Web address: http://www.nws.noaa.gov/om/hazstats.shtml.

Mighty Thunderstorm hits town (6/7/06) Tulsa World at www.tulsaworld.com

"Performance of building cladding in urban environments under extreme winds" by Tiphaine Williams and Ahsan Kareem of NatHaz Modeling Lab, University of Notre Dame

Bashor, Rachel and Kareem, Alisan. *Performance of Glass Cladding of High Rise Buildings in Hurricane Katrina.* Newsletter of American Association for Wind Engineering, December 2006. Also on Website: www.aawe.org.

FORTIFIED and FORTIFIED Home. See Institute for Business and Home Safety web site at http://www.disastersafety.org/fortified/ and http://www.disastersafety.org/fortified/home/

4.3 Tornadoes

4.3.1 Hazard Profile

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. Severe thunderstorms produce about 1,000 tornadoes each year in the United States. FEMA reports that 176 federal disaster declarations since the year 2000 have included tornado damage.

> ***"Typically, tornadoes cause the greatest damage to structures of light construction, including residential dwellings and particularly manufactured homes. The destruction caused by tornadoes ranges from light to catastrophic depending on the intensity, size, and duration of the storm. Tornadoes are more likely to occur during the months of March through May and tend to form in the late afternoon and early evening"***
>
> *-Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards, FEMA, January 2013*

Location

Oklahoma is located in "Tornado Alley," the most tornado-prone area of the nation. Tornadoes can occur any time of day, on any day of the year. The entire jurisdiction of the City of Tulsa is considered to be vulnerable to the effects of tornadoes.

Measurements

Almost 70% of all tornadoes are measured EF0 and EF1 on the Enhanced Fujita Scale, causing light to moderate damage, with wind speeds between 40 and 112 miles per hour. EF4 and EF5 tornadoes are considerably less frequent, but cause the most devastating impact including loss of life and property. Sixty-seven percent of all tornado deaths were caused by EF4 and EF5 storms, which represent only 1% of all tornadoes.

The Enhanced Fujita Scale was adopted in early 2007, although the layperson frequently refers to the earlier F-scale. The new scale is based on a broader set of degrees of damage to a wider variety of structures. The average tornado length (miles) and width (yards) is listed by EF classification in Table 4-17. A description of the Fujita Scale and comparison to the recently adopted Enhanced Fujita Scale (EF) are included in Table 4-18.

Table 4–17: Mean Tornado Length and Width by EF class

Class	Length (mi)	Width (yds)
EF0	.87	31.06
EF1	2.92	69.99
EF2	6.65	137.69
EF3	13.98	288.28
EF4	27.09	503.83
EF5	33.93	607.5

Source: Benefit-Cost Analysis – Tornado Methodology

On February 1, 2007, the original Fujita Scale was decommissioned and replaced with the more accurate Enhanced Fujita Scale. None of the tornadoes recorded on or before January 31, 2007 will be re-categorized however, which means the original Fujita Scale will remain applicable to events prior to February 2007. Information on the Enhanced Fujita Scale is at: http://www.spc.noaa.gov/efscale

Table 4–18: Fujita Scale and Enhanced Fujita Scale

Fujita Scale			EF Scale	
Category	**Wind Speed (mph)**	**Current Damage Indicators**	**Category**	**3 Second Gust (mph)**
F0	Gale (40-72)	***Light***: Damage to chimneys, tree branches, shallow-root trees, sign boards	EF0	65-85
F1	Moderate (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	EF1	86-110
F2	Significant (113-157)	***Considerable***: Roofs torn off frame houses, mobile homes demolished, boxcars pushed over, large trees snapped or uprooted, light-object missiles generated	EF2	111-135
F3	Severe (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	EF3	136-165
F4	Devastating (207-260)	***Devastating***: Well-constructed houses leveled, structures with weak foundations blown off some distance, cars thrown and large missiles generated	EF4	166-200
F5	Incredible (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	EF5	Over 200

IMPORTANT NOTE ABOUT ENHANCED F-SCALE WINDS: *The Enhanced F-scale still is a set of wind estimates (not measurements) based on damage.* It uses three-second wind gusts estimated at the point of damage based on a judgment of 8 levels of damage to the 28 indicators listed below. These estimates vary with height and exposure. **Important**: The "3 second gust" is not the same wind as in standard surface observations. Standard measurements are taken by weather stations in open exposures, using a directly measured, and "one minute mile" speed.

Structures Used as Damage Indicators in the Enhanced Fujita Scale			
1	Small barns, farm outbuildings	15	School - 1-story elementary (interior or exterior halls)
2	One- or two-family residences	16	School – middle or senior high school
3	Single-wide mobile home (MHSW)	17	Low-rise (1-4 story) building
4	Double-wide mobile home	18	Mid-rise (5-20 story) bldg.
5	Apartment, condo, townhouse (3 stories or less)	19	High-rise (over 20 stories)
6	Motel	20	Institutional building (hospital, government or university)
7	Masonry apartment or motel	21	Metal building system
8	Small retail building (fast food)	22	Service station canopy
9	Small professional (doctor office, branch bank)	23	Warehouse (tilt-up walls or heavy timber)
10	Strip mall	24	Transmission line tower
11	Large shopping mall	25	Free-standing tower
12	Large, isolated ("big box") retail building	26	Free standing pole (light, flag, luminary)
13	Automobile showroom	27	Tree - hardwood
14	Automotive service building	28	Tree - softwood

Extent /Severity

A typical tornado path is reported to be approximately 600 feet in width, and 2.5 miles in length. In Oklahoma, the tornado path generally runs from southwest to northeast, with the area of destruction being about 181 acres per event. Approximately 16 square miles of Oklahoma's 69,919 square miles are impacted by tornadoes each year.

Damage from an average tornado can include the destruction of roof surfaces, mobile homes being pushed off their foundations, and automobiles being blown off roadways. More severe tornadoes can lift 300-ton objects and toss homes more than 300 feet. The entire planning area may experience a

tornado ranging from EF0 to EF5 on the Enhanced Fujita Scale shown in Table 4-18. The City of Tulsa considers a minor severity tornado to be an EF0 or lower on the Enhanced Fujita Scale and a major severity to be an EF1 or higher.

Frequency

The annual chance of a tornado of any magnitude hitting any location is roughly 1 in 5,000. Bigger and more devastating tornadoes can and do occur, as evidenced by the May 3, 1999 Moore/Oklahoma City tornado, which stayed on the ground for 38 miles and the May 20, 2013 tornado that caused over $2 billion in damages. However, these events are rare. The chance of an EF4 or EF5 striking an area is only about 1 in 417,000 per year.

NCDC included reports of 15 tornado events in Tulsa County from 1995 thru 2011; with only one event occurring during the plan update period. Given the frequency of past events, the City of Tulsa can expect a tornado event to occur in or around its jurisdictional area once every year. A summary of NCDC tornado events from 1995 through 2011 is included in Table 4-19. A map of Oklahoma Tornado Events by County is included in Figure 4-5.

Table 4–19: Tornadoes in Oklahoma and Tulsa County from 1995 - 2011

Location	Events	Deaths	Injuries	Property Damages
Tulsa County – F0	9	0	0	$34,500
Tulsa County – F1	5	0	7	$2,550,000
Tulsa County – F2	1	0	0	$500,000
Tulsa County–F3	0	0	0	0
Tulsa County – F4	0	0	0	0
Tulsa County – F5	0	0	0	0
TOTAL: Tulsa	15	0	7	$3,152,000
Oklahoma – F0	708	0	14	$3,877,450
Oklahoma – F1	365	0	48	$52,960,500
Oklahoma – F2	117	6	169	$103,868,000
Oklahoma – F3	42	11	282	$403,211,000
Oklahoma – F4	13	32	730	$650,500,000
Oklahoma – F5	4	30	444	$540,000,000
TOTAL: Oklahoma	1,248	79	1,687	$1,754,416,950

Source: NCDC Storm Events Database

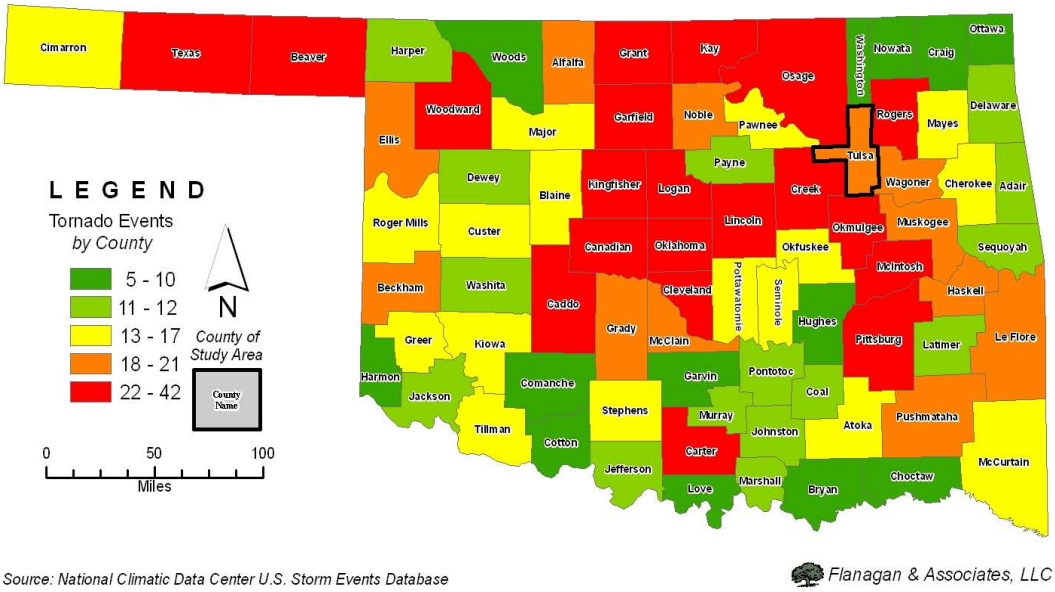
Impact

Storms that generate tornadoes have the ability to cause lightning, hail, high winds, and flooding damage. This can result in the direct loss of homes, businesses, and lives and indirectly cause the loss of income, medical care, and the ability for the government to respond to the disaster. Historically, tornadoes have proved to be costly events in the City of Tulsa. In a ranking of the Top Ten Costliest Oklahoma Tornadoes (1950 – 2012), the April 19, 1981 Tulsa tornado event is listed as the 6th most costly with damages estimated at $75-$100 Million. From 1995 thru 2011 tornadoes caused over $3,000,000 damage in the City of Tulsa and Tulsa County.

4.3.2 History/Previous Occurrences

Since modern tornado reporting began in 1950, Oklahoma, Tulsa County and the City of Tulsa have recorded accounts of numerous tornado events. From 1950 thru 2011, the NCDC Storm Event Database reported 4,652 tornadoes for Oklahoma, 66 of which occurred in Tulsa County. Tornado

Figure 4–5: Oklahoma Tornado Events by County 1990-2010



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

Flanagan & Associates, LLC

season of 2012 was fairly mild in Oklahoma; unfortunately this trend did not occur into 2013. From May 18, 2013 through the early morning hours of May 31st, 56 tornadoes were reported in Oklahoma. On May 20th, an EF5 tornado ravaged the city of Moore, Oklahoma for the third time in a little less than 15 years. The destruction of the storm was unfathomable, and once again renewed interest in tornado preparedness in Oklahoma. Just over a week later, on May 31, 2013, a long track tornado again tore through Central Oklahoma. At 2.6 miles wide, the El Reno tornado was the widest tornado ever recorded; wind speeds of this event were reported at 295 mph. Both the May 20th and May 31st historic tornadoes were headed from the southwest to the northeast, up the I-44 corridor. Though Tulsa was not impacted by the storms, history shows that tornadoes have impacted the city in the past and will impact the city in the future. Summaries of tornadoes that have impacted the Tulsa Metro Area are included in Table 4-20. A map showing tornado paths in the City of Tulsa from 1950 thru 2010 is included in Figure 4-6.

Table 4–20: City of Tulsa Historic Tornado Event Narratives

Date	Event Narrative
June 8, 1974	Two super cell storms moved through Tulsa between 7 and 8 pm. Two F3 rated tornadoes were produced by the storm systems. Three people were killed and 122 others injured. An estimated $30 million dollars in damage was accrued. An estimated 300 homes were severely damaged as well as several businesses. Over 1500 Tulsa residents were left homeless. The tornadoes caused considerable damage near 51st and Union, in the Brookside area near 41st and Peoria, and at 21st and Garnett on the northeast side of the city.
April 19, 1981	An F3 tornado struck southeastern Tulsa and its suburbs. At least four people were killed; two adults and two children. Dozens of homes were destroyed. A mobile home park was directly impacted during the event, multiple mobile homes were destroyed and pickup trucks were overturned. The tornado tore down utility lines and caused power failures in several areas. Seven people were injured when the tornado struck a church in Bixby. Debris was scattered over a mile-long area. With damages estimated at between $75 to $100 million, this tornado remains 6th on NWS list of Top Ten Costliest Oklahoma Tornadoes (1950-Present)

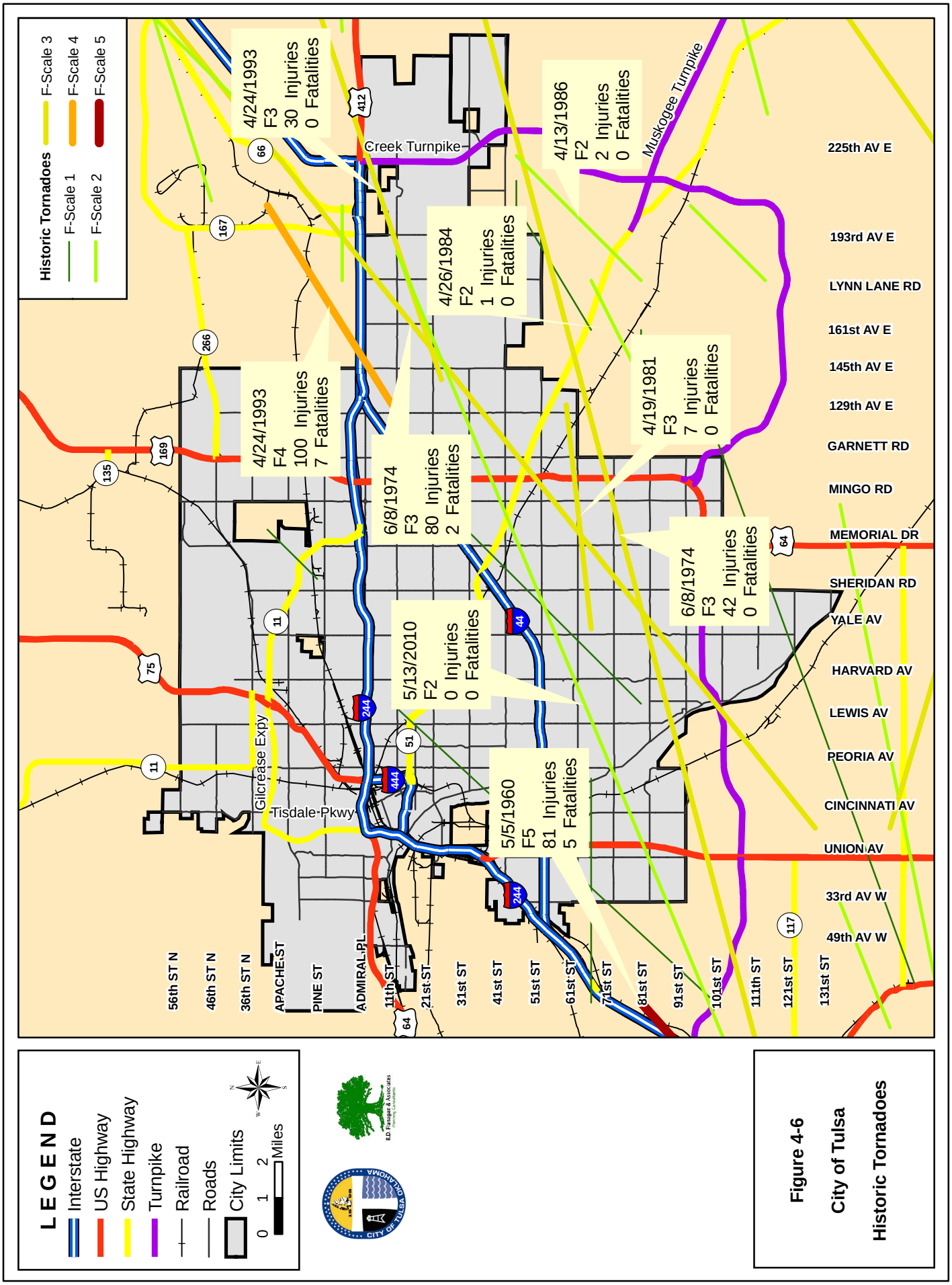


Figure 4-6
City of Tulsa
Historic Tornadoes

Date	Event Narrative
May 15, 1990	Widespread severe weather, including six tornadoes, struck northern and central Oklahoma. The worst of the tornadoes (F0) developed just west of Tulsa, and then moved through northern parts of the city. The storm heavily damaged two apartment complexes, and severely damaged or destroyed 83 homes. One person died and 12 were injured. Damage was estimated at $2.5 million.
May 3, 1999	One of the worst storms in Oklahoma history generated a total of 58 tornadoes over the western and central portions of the state. Tornado B20 of this massive tornado outbreak damaged a church and a school in West Tulsa before lifting up. This series of tornadoes was on the ground for over 100 miles. If it had continued on its track for an additional 5 miles, it would have impacted two of Tulsa's major hospitals.
April 1, 2006	National Weather Service officials reported that an F1 tornado touched down briefly just south of the Tulsa International Airport. Even though it was on the ground for just seconds, it was able to accomplish quite a bit of damage. The nearby Radisson Hotel sustained significant damage. The roof was ripped from several rooms displacing as many as 200 guests. Amazingly, there were no fatalities and only 7 injuries reported for the entire event. Preliminary damages were listed at $250 thousand.
May 13, 2010	A tornado developed as a result of intensified thunderstorms that moved into eastern Oklahoma in the morning hours. The EF2 tornado developed on the west side of Sapulpa in Creek County and moved northeast across the City of Tulsa. The most intense damage was noted just west of Highway 75, where a number of homes were severely damaged. As the tornado moved through Tulsa, numerous homes and businesses were damaged. The tornado snapped and uprooted numerous trees and blew down power poles. The estimated wind peak of the tornado was 120 mph.
May 30, 2013	A tornado touched town in Broken Arrow Thursday evening. Though Tulsa was not directly impacted, warning sirens did sound in the metro area. The storm continued northeast to the Creek Turnpike and Highway 51 before heading east to the 8800 block of South 241st Street. Several buildings were significantly damaged; a few homes also received structural damage. Street signs were knocked down and trees split in half. There were no injuries as a result of the storm.

Source: NCDC Storm Database

Probability of Future Events

The City of Tulsa is vulnerable to frequent thunderstorms and convective weather patterns, and therefore its vulnerability to tornadoes is a constant and widespread threat especially during the spring months. Tornadoes can, and do appear in nearly all months of the year at all hours of the day, so it is important that even in "light activity" years, education and preparations continue. The probability of a tornado occurring in the City of Tulsa, including future development areas, is considered HIGH.

4.3.3 Vulnerability

This section summarizes the City of Tulsa's vulnerability to the Tornado hazard, including the impact on people, structures and buildings, critical facilities, and infrastructure. This information, as well as information provided by the City, was used to determine the Vulnerability Criteria identified in Tables 4-3 and 4-4. The City of Tulsa, including all future development areas, was determined to have a HIGH vulnerability to the Tornado hazard.

Population

All populations within the City of Tulsa are considered vulnerable to the impact of tornadoes. Factors that can increase the level of vulnerability include:

Functional Needs

Persons at higher risk to the impact of tornado events include functional needs populations. Children under 5 years old, persons 65 years of age

and older, persons with mental or physical disabilities, and persons who are not English speaking are particularly vulnerable to tornadoes. These populations may not have the means to effectively respond when tornadoes threaten the area. Also at risk are homeless and low-income populations who may not have full access to advance warning capabilities (access to television, social media, NOAA weather radio). While much progress has been made in expanding communication resources for these individuals, there are still a large number of residents facing these challenges who are unable to receive vital warnings in a timely manner.

Sheltering Options

Residents of Tulsa unable to seek adequate shelter, such as safe rooms, when tornadoes threaten are vulnerable to loss of life and injury as a result. Also vulnerable are those populations that have access to a safe room or shelter but choose to ignore the advance warning until it is too late. Safe rooms are reinforced small rooms built within the interior of a home, which are fortified by concrete and/or steel to offer extra protection against tornadoes and severe windstorms. Safe rooms built to FEMA 320 or 361 criteria can withstand wind speeds of at least 250 mph. People without individual safe rooms in their homes will often seek out community shelters, thus exposing themselves to the residual risks associated with oncoming tornadoes, such as flying debris, before making it to safety. These populations would often be better off remaining in a safe place within their home than trying to seek shelter elsewhere.

Evidence of what a tornado can do to a high school hallway, a common place for sheltering students. **Photo courtesy of FEMA*

The City of Tulsa/Tulsa County *Emergency Operations Plan*, updated April 2010, advises citizens to plan and prepare for shelters in or near their homes. Local government facilities should not be relied upon for shelter because of liability issues, obtaining access after normal business hours, and travel time to the facility.

Multi-purpose community safe rooms can be installed in schools to protect students, faculty, and staff from tornado wind events. Schools that do not have a tornado safe room that meets or exceeds the requirements of FEMA Publication 361: *Design and Construction Guidance for Community Safe Rooms*, that provides near-absolute protection to occupants, remain at risk of tornado impacts. Without a tornado safe room, school students, faculty, and staff must shelter in reinforced but still vulnerable places within the school, such as hallways, restrooms, basements (if available), and interior classrooms with no windows or exterior walls.

Schools using hallways as a safe sheltering option are vulnerable to loss of life and/or injury during a tornado event. As shown in past events, such as Enterprise, AL and Joplin, MO, school hallways can be turned into wind tunnels during tornadoes (*Bernoulli Effect*), scattering large debris from one end of the corridor to the other. As a result, entire generations or young people are at risk of loss of life or injury if a tornado were to occur during school hours.

Advanced Warning

The time of day at which a tornado strikes a community is also a factor in vulnerability. Persons without NOAA weather radios in their homes or who live in areas without warning sirens are less likely to learn of oncoming severe weather, especially during evening and nighttime hours, and therefore may not have time to seek shelter. Inadequate warning is a key factor contributing to loss of life during a tornado, particularly for those in homes without safe rooms or shelters.

At the time of this plan update there were 89 sirens located throughout the City of Tulsa. Each siren is audible for up to a mile. Sirens are tested silently daily and audibly every Wednesday at noon. Tests are typically one minute in length, while actual warnings last for three minutes. Sirens in Tulsa have three sounds, with the three-minute "steady" tone warning of impending tornadoes. The only change in sound during the three-minute period may be an increase or decrease in volume that is caused by a change in wind direction or velocity. Sirens are only a part of Tulsa's warning systems and are intended to warn people who are out of doors about impending dangers.

Multi-Family Residential Properties

Persons living in multi-family residential properties like apartments and condominiums are particularly vulnerable during severe weather events such as tornadoes. Most of these structures are at least two stories high. Persons residing in units above the first floor are at greater risk to loss of life or injury, especially if unable to seek shelter on the lowest floor during the onset of a tornado event. Few multi-family residential properties have safe rooms on site for use by their tenants. Unlike homeowners, apartment dwellers are unable to purchase and install tornado safe rooms in their respective units.

Residents of Mobile Homes

Most at risk of fatality from a tornado are those living in mobile homes. As an example, Table 4-21 shows the numbers of tornado-related fatalities in the United States for each year from 1997 to 2011, and where the deaths occurred. It illustrates that, in any given year, those living in mobile homes are more vulnerable to the effects of a tornado than any other identifiable population. Though the total number of deaths in homes compared to mobile homes seems to be relatively close during this time period, 2011 includes the 161 fatalities in Joplin. Because of the intensity of this tornado, those in its path were equally vulnerable unless in a safe room.

In 2008, over 45% of all tornado deaths occurred in mobile homes. Mobile homes account for 1.2% of the housing stock in the City of Tulsa. No mobile home parks are listed to have tornado safe rooms or shelters. Effort should be made to continue to educate residents of mobile homes of their vulnerability to tornadoes.

Table 4–21: Tornado Fatalities in the United States

Year	Home	Mobile Home	Vehicle	Business	Outside Open	Other	Total for Year
1997	38	16	3	3	8	0	68
1998	46	64	16	1	3	0	130
1999	39	36	6	3	10	0	94
2000	7	28	4	0	2	0	41
2001	15	17	3	3	2	0	40
2002	15	32	4	1	3	0	55
2003	24	25	0	1	3	1	54
2004	21	11	2	2	0	0	36
2005	3	34	1	1	0	0	39

Year	Home	Mobile Home	Vehicle	Business	Outside Open	Other	Total for Year
2006	31	27	7	2	0	0	67
2007	16	52	2	10	1	0	81
2008	42	56	14	10	3	0	125
2009	7	12	1	1	0	0	21
2010	11	20	7	1	6	0	45
2011*	204	118	35	85	8	96	546
Totals	*519*	*548*	*105*	*124*	*49*	*97*	*1,442*

Source: National Weather Service Storm Prediction Center
***-2011 information is as of 9/27/11**

Operators and Passengers of Motor Vehicles

Those traveling in cars and trucks are at increased risk during a tornado event. Motor vehicles are extremely dangerous places to be if a tornado is imminent. Tornadoes can overturn or carry even the heaviest of vehicles. In addition, peak tornado activity is historically in late afternoon and evening, which coincides with heavier traffic due to drivers travelling to and from schools and commuters leaving the workplace. The May 31, 2013 tornado in Oklahoma presented a clear picture of the issues that arise when people are on the road during a tornado event. Residents attempted to evacuate the Oklahoma City Metro area that day, with no rhyme or reason to where they might go. This behavior created an unorganized contra flow situation and bumper to bumper traffic on I-35, directly in the path of the tornado. As a result, 21 fatalities occurred: eight were caused by the tornado, the others occurred due to flash flooding because they left their homes, that were otherwise untouched, and sought shelter elsewhere. In order to avoid situations such as this in the future, it is critical that residents are aware of the risks associated with traveling during tornado events. If evacuation is the only option, it must be done prior to a tornado warning being issued.

Structures/Buildings

Tornado damage is a factor of severity, and location and structure type, both on a landscape scale – rural/urban areas – and on a structure-by-structure scale. An EF4/EF5 tornado in an urban area will create phenomenal damage, but damage to structures will vary depending on how they are constructed.

Mobile Homes

As stated above, mobile homes are particularly susceptible to damage from tornadic winds. According to the 2010 Census, mobile homes account for an estimated 1.2% of total housing units in the City of Tulsa. This is low compared to the 10% national average estimate. Tornado wind speeds have been known to completely demolish mobile homes. Such was the case in the tornado that ripped through Hideaway Mobile Home Villa in Woodward, OK on April 15, 2012 killing 6 people. The vulnerability of mobile home construction is an example of how tornado damage in the same area can vary greatly, for example, a flimsy, unanchored mobile home may be obliterated while all surrounding objects suffer little or no damage.

Residential Property

Damages to residential properties depend on the tornado’s wind-speed and the level of wind resistance the property has been constructed to withstand. Houses with crawl spaces are more susceptible to lift. In addition, the manner in which foundations and roofs are constructed can affect a structure’s ability to withstand wind pressure.

Homes constructed to be more wind resistant, meeting high wind design requirements, such as the Insurance Institute for Business and Home Safety's (IBHS) fortified home construction recommendations, are less vulnerable to tornado damage. Homes constructed to this structural capacity can withstand winds up to 130 mph, which is 95% of tornadoes. According to the Federal Alliance for Safe Homes, 80% of residential tornado damage starts with wind entry through garage doors.

Older homes are especially vulnerable to tornado events. About 13% of homes in the City of Tulsa were built prior to 1969. These older homes in the jurisdiction are generally more vulnerable to tornado damage than more recently built homes constructed to higher standards.

Commercial Property

Commercial structures, whether office buildings or major retail facilities, are often built to achieve architectural or stylistic effects. Structures utilizing more modern-looking building materials, such as reflective glass facades, open breezeways between wings, etc., should be considered more vulnerable to damage from a tornado. Wind-driven debris (wood, metal and other items picked up by larger funnels) can cause catastrophic damage to buildings.

Critical Facilities

All critical facilities within the City of Tulsa should be considered vulnerable to the effects of a tornado event. Structural integrity may be compromised if in the direct path of the storm, in addition to any secondary issues, such as power disruption, water damage from accompanying rain, injury to workers/residents, etc.

Infrastructure

Water Treatment – The most significant impact from a tornado, other than the destruction or significant damage to the plant itself, would be the loss of electrical power. Both of the City of Tulsa's water treatment plants are vulnerable to these risks. Each of the City's two water treatment plants features dual electrical feeds, which supply power from independent substations. Additionally, these two plants are located in two different geographic areas of the city, which reduces the likelihood of both plants being damaged by the same storm.

Wastewater Treatment –The greatest threat to Tulsa's four wastewater treatment plants during a tornado (other than damage or destruction from a direct hit) would be power outages. All four plants and lift stations have either double feeds or backup generators.

Utilities-

- **Electricity:** During a tornado, AEP/PSO could experience any combination of the following challenges in meeting the needs of the Tulsa jurisdiction: destruction of distribution and transmission poles, downed broken power lines, danger to workers derived from downed power lines and fallen tree debris, and insufficient field and/or office staff to effectively handle the workload.
- **Gas:** During a tornado, ONG could experience a variety of challenges in meeting the needs of the Tulsa jurisdiction: danger to workers and inaccessibility of gas meters from fallen power lines or tree debris, extreme temperatures, and insufficient field and/or office staff to effectively handle workload generated by such an event. Broken gas lines can cause fires to erupt in areas that are potentially inaccessible by emergency vehicles

Transportation Systems (Highways, Public Transportation, Railway, Airports) –. Tornado conditions could result in the interruption of normal operations at Tulsa's International Airport and the private business airports. Debris in the roadways can result in the inability to access damaged areas until debris removal equipment arrives on site.

Emergency Services – Fire, Police and Medical Services would all be similarly at risk to secondary effects of a tornado. Downed power lines or debris blocking city streets could limit or eliminate access to affected areas, as experienced after the June 2006 downburst. Excessive debris in the streets could lead to damage to emergency vehicles, potentially reducing the number of vehicles available for response. Medical Services (including treatment facilities) could be strained in responding to large numbers of injuries.

4.3.4 Future Trends

For information regarding future development in the City of Tulsa, see Section 1.2.8. As development within the City of Tulsa continues, it can be anticipated that the population and number of structures (both critical and non-critical) will increase. All future development areas for the City are equally at risk from tornado events, with the following considerations.

Population

As the "baby-boomer" population moves into retirement, it can be anticipated that the number of people pursuing outdoor sports and/or social activities will also increase. Attention should be given to the task of continuing to educate the community about the dangers associated with tornadoes. Also adding to this increase in out-of-doors activity could be the rising cost of fuel. With more families looking for activities closer to home, parks and other outdoor recreation areas may become more attractive. These facilities, and the persons frequenting them, should be considered especially vulnerable to the effects of tornado events.

Residents of Tulsa will continue to be vulnerable to tornado events. There are things that can be done now in order to prevent loss of life and/or injury later. The most important of these is public education, if the community does not know how to react during a tornado warning or where to go, lives may be lost. Public education can inform residents the steps they can take to reduce their risks, such as having their own emergency plan for their household. City officials can take the time now to prepare residents for things they would not have thought of until after the disaster has occurred. Residents should be made aware of their sheltering options, installation of individual safe rooms should continue in the City.

Since the May 3, 1999 tornado outbreak in Oklahoma, effort has been made to educate the public on the life safety function of tornado safe rooms built to meet or exceed the criteria of FEMA Publications 320/361. Individual residential safe rooms have been installed state-wide, including various locations throughout the City of Tulsa. A list of residential safe rooms and their location is kept in the Tulsa County/City Emergency Operations Center. Persons who choose not to register their safe room remain vulnerable if they become trapped after a tornado event. Effort should be made to inform the public of the importance of safe room registration and the list of safe room locations in the City of Tulsa should be regularly updated.

Satellite radio and MP3 devices are making it possible for drivers to enjoy non-local network radio programming, which creates a "disconnect" from public radio broadcasts concerning severe weather conditions. Additionally, devices allowing the interface of personal MP3 devices with automobile radios are becoming more affordable, which in turn allows more drivers to listen to their own selection of music while traveling – again, decreasing the amount of localized and vital information that may be transmitted over the airwaves. These "disconnection" trends are offset, somewhat, by FEMA's program that sends emergency messages directly to telephones and cell phones in expected impact areas.

Structures/Buildings

As uninhabited areas continue to be developed and existing structures are renovated to accommodate new purposes in their use, actions to lessen the potential effects of tornado events should be

considered. The inclusion of Safe Rooms, reinforced exterior materials (windows, doors, etc.), reinforced skeletal structure of new buildings able to withstand the effects of high winds accompanying the strongest of storms, etc., should be considered an integral part of this development. Voluntary implementation of better design and construction practices, such as IBHS Fortified codes, could mitigate damages. Additionally, as part of any new development plans, the location of existing outdoor warning systems (sirens) should be noted and the installation of additional sirens considered.

Critical Facilities

As the threat from the effects of tornado events themselves cannot be eliminated, any critical facilities undergoing expansion, renovation or rebuilding should consider following updated techniques for such projects. The addition of Safe Rooms that meet or exceed the criteria of FEMA 361 Publication, reinforced exterior materials such as windows, doors, siding, etc., can do much to improve the safety of these facilities. Further, all efforts to guard against potential secondary effects should be implemented. These secondary effects may include, but not be limited to, compromise of structural integrity, broken windows/doors from wind-strewn debris, water damage from accompanying rains, power interruptions/surges, and communication interruption from lightning or wind damage.

Infrastructure

Ensuring local government facilities are well-protected against the potential effects of tornado events is an ongoing endeavor. Investigating and implementing new technology as it is made available will help ensure continuity of operations at all levels of the jurisdiction. Uninterrupted communications and protection of the ever-growing mountain of electronic data gathered in day-to-day operations should be considered priorities in any plans for future development.

4.3.5 Conclusions

Due to the nature of Tulsa's climate, severe thunderstorms and the tornadoes they frequently produce will remain a very real threat to the community, and vulnerability should be considered High. The absence of recent, reported "direct hits" should not be considered an indication of a reduction in this threat, but as opportunity for educating, preparing for and fortifying against such an event in the future. Improved building technologies, advances in public communication capabilities, and opportunities for collaboration among community agencies should remain prominent in the planning and response communities' endeavors. The City of Tulsa is considered to have a HIGH probability of and HIGH vulnerability to the Tornado hazard.

Data Limitations

There are many "intangibles" in tornado spotting. Low-hanging "scud" clouds may be mistaken for a lowering funnel. Tornadoes are frequently reported more often near inhabited areas and major highways, due to the greater likelihood of people being present when a tornado appears that causes little or no damage. In addition, there is frequently disagreement on whether visible damage was caused by a tornado, severe straight-line winds, or a downdraft. Consequently, fully accurate reports of number of tornadoes and tornado damage can be difficult to achieve.

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National Weather Service, Tulsa, OK at web address: http://www.srh.noaa.gov/oun/?n=tornadodata-ok-costliest

4.4 Lightning

4.4.1 Hazard Profile

Lightning is generated by the buildup of charged ions in a thundercloud. When the buildup interacts with prime conductive objects or surfaces on the ground, the result is a discharge of a lightning bolt. Thunder is the sound of the shock wave produced by the rapid heating and cooling of the air near the lightning bolt. The air in the channel of a lightning strike can reach temperatures higher than 50,000° Fahrenheit. Lightning is the most constant and widespread threat to people and property during the thunderstorm season.

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. Property damage from power surges and resulting fires can destroy not only the electronics in private homes, but also unprotected equipment located in the business sector and critical facilities in a community. Some 30% of all power outages annually are lightning-related, on average, with total costs approaching $1 billion dollars. *(Source: Ralph Bernstein, EPRI; Diels, et al (1997))*

"Lightning is a discharge of electrical energy that results from the buildup of positive and negative charges in a thunderstorm, which creates a "bolt" when the buildup of charges becomes strong enough. On average, 55 people are killed and hundreds are injured each year by lightning strikes in the United States. Lightning can strike communications equipment (e.g. radio or cell towers, antennae, satellite dishes, etc.) and hamper communication and emergency response. Lightning strikes can also cause significant damage to buildings, critical facilities, and infrastructure, largely by igniting a fire. Lightning can also ignite a wildfire."

-Mitigation Ideas, a Resource for Reducing Risk to Natural Hazards, FEMA, Jan 2013

Location

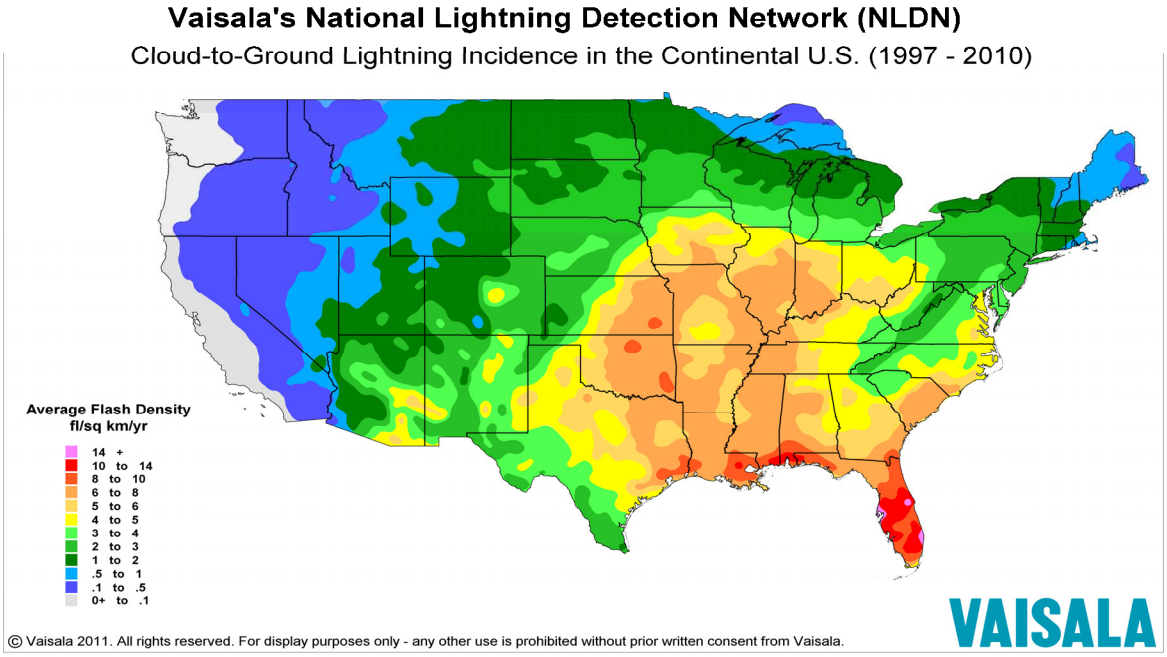
Lightning can occur between a cloud and the ground (Cloud-to Ground Lightning), between two clouds (Intercloud Lightning), or within the same cloud (Intracloud Lightning). Lightning can strike 10 miles out from the rain column, and lightning deaths often occur under a clear sky ahead of the storm. This is largely because people wait until the last minute to seek shelter – not fully comprehending the behavior and true danger of lightning. As lightning is a by-product of thunderstorms, the entire jurisdiction of the City of Tulsa is subject to the exposure and effects of lightning events.

Measurement

Lightning can be measured in a variety of ways: lightning flash frequency, flash intensity, and lightning impacts. One method is VAISALA's free lightning explorer map, described below (http://www.lightningstorm.com/explorer.html), which uses information from the National Lightning Detection Network. The U.S. National Lightning Detection Network is comprised of about 105 antennae connected to a central processor that records the time, polarity, signal strength, and number

of strokes of each cloud-to-ground lightning flash detected over the United States. A combination of time of arrival and direction finding technology is used to locate the flash. Depending on the location within the network, GAI claims a location accuracy of a few km, with a detection probability greater than 60%. The flash time is accurate to better than 2 milliseconds. The Vaisala Flash Density Map is shown in Figure 4-7.

Figure 4–7: Vaisala Cloud-to-Ground Lightning Incidence (Flash Density) Map



Extent/Severity

According to information provided by staff at the National Weather Service in Tulsa, cloud-to-ground (CG) lightning is classified as either negative or positive. Positive CG flashes make up approximately 5-10% of the total CG lightning. Positive CG flashes typically originate in the upper portion of thunderstorms. This increases the distance between the charge region within the cloud and the earth. Stronger charge is needed to overcome the electric potential of this distance compared to negative CG flashes, which originate lower in the cloud. The result is positive CG flashes with higher peak current compared to negative CG flashes (positive CG flashes may have a peak current 10x that of a negative CG flash).

The National Weather Service explained that positive CG flashes are often observed away (as far as 10 miles or more) from the main precipitation area of a thunderstorm due to the location of the upper charge region. This poses an extra fire danger and can catch people who are outdoors off guard. For example, if a positive CG flash ignites a wildfire, there may not be any rain to help extinguish the fire. Once in contact with an object on the ground, a CG flash can have multiple return strokes (this looks like the flash is flickering), a continuous current (this looks like the flash remains illuminated for a length of time and does not flicker), or a combination of these two.

Continuous current is more destructive and leads to a greater chance of fire. This is because the electricity remains in contact with an object for a longer period of time, allowing for greater heat to build up. Positive CG flashes usually have continuous currents. Positive CG flashes are more likely to cause damage than negative CG flashes due to the likelihood of continuous current and high peak current. It is important to remember that all lightning can cause damage.

Based on information provided by the National Weather Service, the city of Tulsa considers a negative cloud-to-ground flash with multiple return strokes, that causes no loss of life or injury and less than $1,000 in property damage, to be a minor severity lightning event; and a positive cloud-to-ground flash with a continuous or high peak current, that causes loss of life and/or injury and more than $1,000 property damage, to be a major severity lightning event.

Frequency

National Geographic reports that lightning strikes the surface of the earth approximately 100 times every second. According to the National Lightning Detection Network, researchers define a flash as all cloud-to-ground discharges which occur within 3 miles of each other within a one-second interval. Oklahoma averages 15.1 CG flashes per square mile per year. This gives Oklahoma the 6th highest flash density rating out of the 48 contiguous states (from Vaisala and based on data from 1997-2011). For further information, see: http://www.lightningsafety.noaa.gov/stats/Table-Flashes_by_State_1997-2011.pdf.

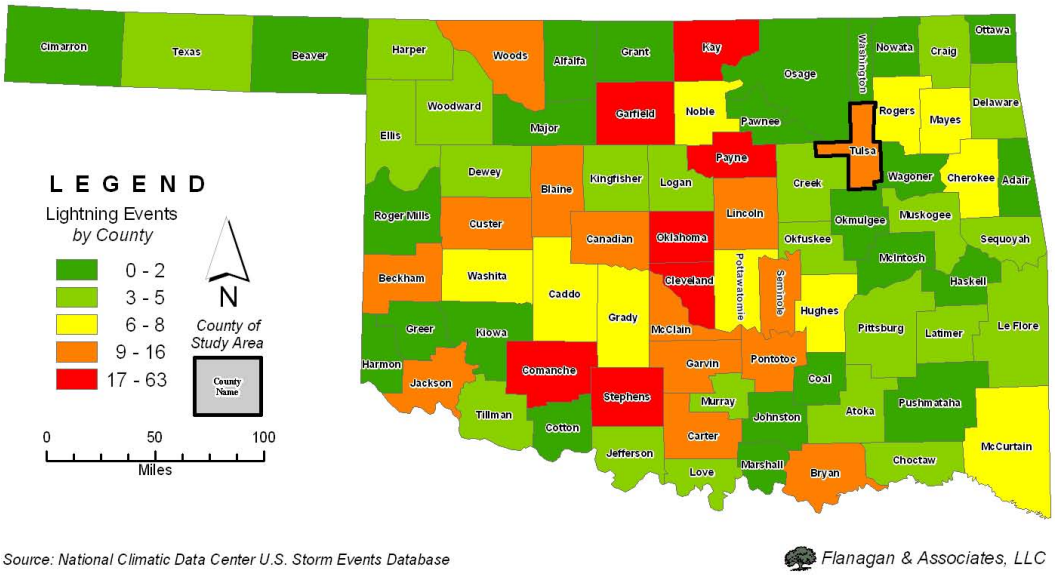
The Vaisala Flash Density Map indicates that the City of Tulsa may experience between 6 and 8 lightning flashes per sq km per year, or between 3,108 to 4,144 lightning flashes within the jurisdiction each year (6 to 8 flashes x 518 sq. km/yr). According to the NCDC Storm Events Database, the City of Tulsa experienced seven damaging lightning events from 1995 to 2011; a frequency of one lightning event about every two years during the 16 year reporting period. A summary of these events is included in Table 4-22. A map comparing the number of lightning events in Oklahoma by County from 1990 to 2010 is included in Figure 4-8.

Table 4–22: City of Tulsa Lightning Events from 1995-2011

Location	Events	Deaths	Injuries	Property Damages
City of Tulsa	7	1	2	$735,100
Oklahoma	381	11	76	$26,077,000

Source: NCDC Storm Events Database

Figure 4–8: Oklahoma Lightning Events by County 1990-2010



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

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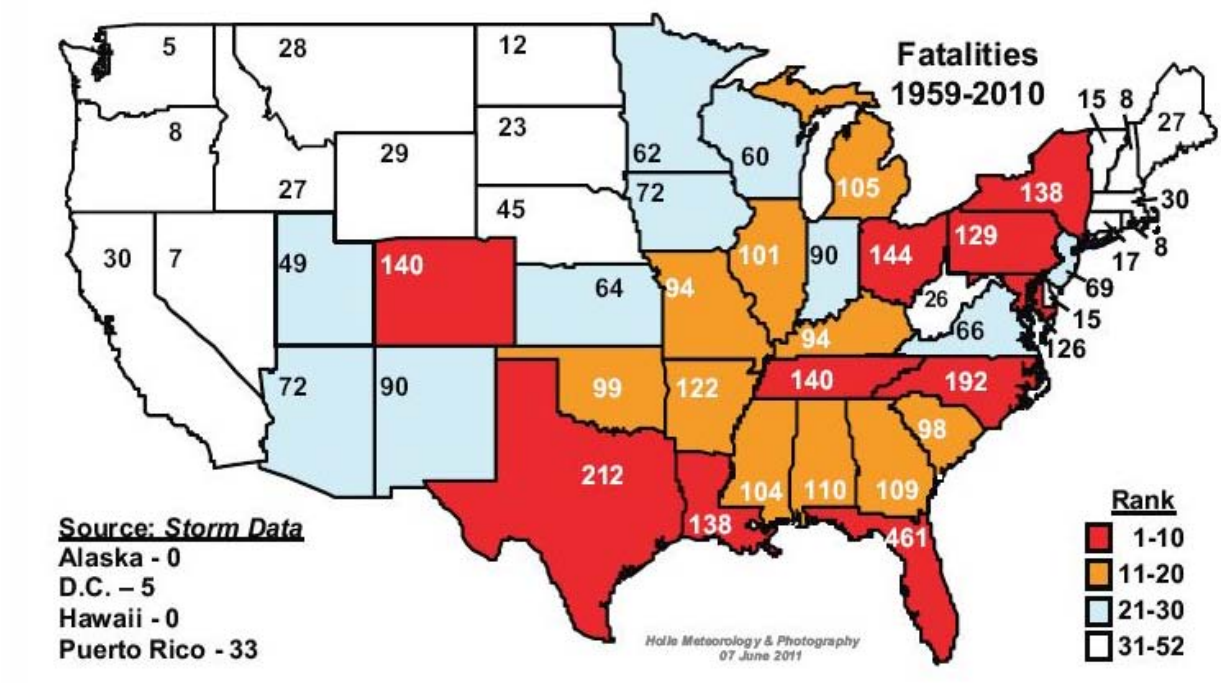
Impact

Lightning casualties and damages increase gradually through the spring when the thunderstorm season begins for most of the country, and peak during the summer months. In the period 1959-2010, lightning related events caused 99 deaths in Oklahoma (see Figure 4-9). The months most notorious for lightning incidents are June (21%), July (30%) and August (22%). The most injurious lightning strikes have been shown to occur on Sundays, Wednesdays and Saturdays between the hours of 12:00 noon and 6:00 pm.

Figure 4–9: Lightning Deaths by State 1959-2010



Source: http://www.lightningsafety.noaa.gov/stats/59-10_fatalities_rates.pdf

The impact of this hazard could include people displaced from their homes, businesses being closed, and financial loss due to urban fire, wildfire, power outages, and damaged electronic equipment. Between 1995 and 2010, 711 people were killed by lightning in the US; an average of 47 people per year. Lightning damages totaled $736.98 million to property and crops during those years, yet the National Lightning Safety Institute estimates that *when the impact of lightning includes wildfires, communications systems, power lines and electrical systems, lightning damages are more likely in the range of $4-$5 billion annually*.

4.4.2 History/Previous Occurrences

The NCDC Storm Events Database contains reports of 554 lightning events in the State of Oklahoma since 1993 (no events are recorded prior to 1993); with 13 deaths, 87 injuries, and $34.8 million in property damages. The database contains reports of 58 events in Tulsa County. While the most significant of these events did not occur within the city limits of Tulsa, they were located in nearby communities that rely on the City of Tulsa for mutual aid in times of disaster. Narratives of some Tulsa area lightning events are included in Table 4-23.

Table 4–23: City of Tulsa Historic Lightning Events

Date	Event Narrative
August 30, 1993	A lightning strike in South Tulsa caused $500,000 in damage. No event details were recorded.
April 22, 1995	Lightning struck a home in Tulsa causing a fire and $50,000 in damage.
May 17, 1999	A house near 111th Street between Yale & Sheridan was struck by lightning, sparking structural fire. The entire roof of home was destroyed. Estimated damage was $150K. No injuries, no deaths.
May 17, 1999	Broken Arrow, OK – A house in the 800 block of East Mason Drive was struck by lightning sparking structural fire. Fire destroyed the entire second level of the home. Estimated damage was $50K. No injuries, no deaths.
September 7, 1999	Tulsa County – Lightning ignited a fire at Mid-Continent Pipeline, located 7 miles east of Cushing in Tulsa County, where two tank batteries were damaged.
May 9, 2000	Tulsa County – One mile to the east of Tulsa, lightning strikes burned out 2 power pole phases causing power outages to approximately 550 residents.
June 10, 2003	A 17-year-old boy was struck by lightning while outside in a residential area. He was transported to local hospital for treatment of injuries.
July 23, 2005	Broken Arrow, OK – Two teenagers were struck by lightning while playing under a tree. Both went into cardiac arrest, but were revived on the scene and transported to a nearby hospital. One teenager later died from his injuries. The other was eventually released from the hospital, but required lengthy rehabilitation as a result of his injuries.
June 12, 2006	Glenpool, OK – A fuel tank containing 5 million gallons of fuel was struck by lightning igniting a fire. 800,000 gallons of fuel burned with much of the rest being pumped out. Five homes were voluntarily evacuated, and Highway 75 was rerouted for a time. No deaths, no injuries. Estimated damages - $2 million
February 26, 2010	Lightning struck a night club in Tulsa causing a fire that damaged the building. Estimated damages- $25,000.
March 20, 2012	Computer records indicate a single “super bolt” struck in the heart of South Tulsa just after 3:30 AM. It woke Tulsans and set off car alarms. Many thought it was an earthquake. A super bolt is a positively charged cloud-to-ground stroke of lightning. No damage from the super bolt was reported (source: KRMG Tulsa)

Source: NCDC Storm Database

Probability of Future Events

Oklahoma is vulnerable to frequent thunderstorms and convective weather patterns, and therefore its vulnerability to lightning is a constant and widespread threat during the thunderstorm season. The City of Tulsa and nearby jurisdictions are no exception, as demonstrated by the deadly and damaging lightning strikes in 2005 (death of one teenager and lingering disability of another) and 2006 (a victim of a lightning-caused petroleum tank farm fire). The City of Tulsa is considered to have a HIGH probability of a future lightning event occurring.

4.4.3 Vulnerability

This section summarizes the City of Tulsa’s vulnerability to lightning, including the impact on people, structures and buildings, critical facilities, and infrastructure. This information, as well as information provided by the City, was used to determine the Vulnerability Criteria identified in Tables 4-3 and 4-4. The City of Tulsa was determined to have a HIGH vulnerability to the Lightning hazard.

Population

All populations in Tulsa are vulnerable to lightning events. Anyone out-of-doors during a thunderstorm is exposed to and at risk from lightning. More people are killed by lightning strikes while participating in some form of recreation than any other activity. The next largest group of fatalities involves people located under trees, then those in proximity to bodies of water. Other common incidents are related to agricultural activity, telephone users, and people in proximity to radios and antennas. The types of injuries the populations in Tulsa are exposed to include:

- **Mild lightning injury** includes superficial burns having little or no damaging effects; confusion and amnesia; loss of consciousness; and, numerous other symptoms.
- **Moderate lightning injury** includes the onset of sleep disorders, seizures, cardiac standstill, and irritability. Superficial burns are much more common.
- **Severe lightning injury** includes cardiopulmonary arrest. Persons impacted by this type of lightning injury do not often survive unless a bystander begins CPR immediately.

Table 4–24: Locations of Injurious Lightning Strikes

Location	Percent
Not reported	40
Open fields and recreation areas (not golf courses)	27
Under trees (not golf courses)	14
Water related (boating, fishing, swimming)	8
Golfing and on a golf course under trees	5
Heavy equipment and machinery related	3
Telephone related	2.4
Radio, transmitter and antenna related	0.6

On average, only 20% of lightning strike victims die from their injuries. However, injuries to survivors often lead to permanent disabilities. Seventy percent of lightning strike victims suffer from serious long-term effects, which include memory loss, attention deficits, sleep disturbance, numbness, dizziness, and stiffness in joints, irritability, fatigue, weakness, muscle spasms, depression, and an inability to sit for long periods.

Structures/Buildings

All structures and buildings within the City of Tulsa are vulnerable to the impact of a lightning event. As indicated throughout this section, lightning events are random and have an equal chance of occurring anywhere in the planning area. A bolt of lightning can explode walls of brick and concrete and cause fires to ignite within facilities. More information regarding urban fires, including those caused by lightning, is described in Section 4.9.

Vegetation throughout Tulsa is also susceptible to lightning damage. Trees are particularly vulnerable, acting as natural conductors. Buildings are vulnerable to “side flashes” if a lightning strike jumps from a tree to a facility, damaging both.

Critical Facilities

All critical facilities within the jurisdiction of the City of Tulsa should be considered vulnerable to the effects of a lightning event. Power disruption and potential destruction of electronic equipment (computers, vital medical equipment, communication equipment, data storage, etc.) should be considered a primary threat to critical facilities. Electrical equipment is vulnerable to the effects of a lightning strike, particularly computers and data files. Any facilities not equipped with whole building

surge protection are especially at risk to loss of equipment, data, and work productivity. A list of the Critical Facilities in the City of Tulsa can be found in Tables 1-12 through 1-21.

Infrastructure

Lightning-caused problems are one of the most common faced by American business today. A Carnegie-Mellon study showed that 33% of US businesses are affected by lightning – and that more businesses are affected by lightning storms than by floods, fires, explosions, hurricanes, earthquakes, and violence.

Electronic equipment from computers to enterprise-level communications systems can be seriously damaged by power surges from lightning. Surge protection should be included in any electronic system to minimize the risk of damage from lightning. In addition, lightning warning/detection systems (such as ThorGuard© which is utilized by Tulsa Public Schools) should be included in protection plans for critical components of the City of Tulsa's infrastructure. For additional information about lightning detection/alert systems in the City of Tulsa, see Chapter 6 and Appendix B, Section B.2.10 and B.4.8.

Water Treatment – The most significant impact from a lightning event would be loss of electrical power and damage to electrical equipment. Tulsa's water plants experience power outages related to lightning and thunderstorms on a regular basis. Outages are usually short in duration and affect only a portion of the facility. Both of the City's water treatment plants have sustained equipment damage in the past that required repair or replacement, and are at continued risk from this type of event.

Wastewater Treatment – The most significant threat to the operation of Tulsa's four wastewater treatment plants during a lightning event would be from power outages. All four plants and lift stations have double feeds and backup generators.

Utilities- The primary utility providers for Tulsa's jurisdiction are AEP/PSO (electricity) and ONG (natural gas). The service stations and substations for both of these providers would be vulnerable to the risks from a lightning event.

> **Electricity:** During a lightning event, AEP/PSO could experience any combination of the following challenges in meeting the needs of its Tulsa customers: damage to transformers or other transmission components, downed broken power lines, danger to workers from downed power lines and fallen debris from trees, and insufficient field and/or office staff to effectively handle the workload.
>
> **Gas:** During a lightning, ONG could experience a variety of challenges in meeting the needs of its customers in Tulsa: falling power lines or tree debris, inaccessibility to underground gas meters from fallen debris and power lines, and insufficient field and/or office staff to effectively handle workload generated by such an event.

Transportation Systems (Highways, Public Transportation, Railway, Airports) – Transportation systems would experience the same vulnerability to lightning events as other city facilities, including local electrical blackouts, traffic signal outages over wide areas, communication outages, etc.

Emergency Services- Fire, Police and Medical Services would all be similarly at risk to the secondary effects of a lightning event. Downed power lines or debris blocking city streets could limit or eliminate access to affected areas. A significant secondary effect on these services would be the interruption of communication capabilities due to a lightning strike.

4.4.4 Future Trends

Population

As the “baby-boomer” population moves into retirement, it can be anticipated that the number of people pursuing outdoor sports and/or social activities may also increase. Priority should be given to continuing the process of educating the community about the dangers associated with lightning. Also adding to this increase in out-of-doors activity could be the rising cost of fuel: with more families looking for activities closer to home, parks and other outdoor recreation areas may become more attractive.

With any future development comes construction. An increase in new construction and renovation projects will also increase the number of outdoor workers in a wide variety of functions. These groups should also be included in the public education efforts concerning the lightning hazard.

Structures/Buildings

As uninhabited areas are developed and existing structures renovated, actions to lessen the potential effects of lightning strikes should be considered. Installation of surge protectors for electricity and phone lines should be actively encouraged, as well as encouraging utility companies to relocate above-ground utility lines to underground.

Critical Facilities

As technology continues to advance, the need to protect power sources supporting new technology should advance as well. Working with local utility companies to coordinate the relocation of above-ground utilities (phone, electricity, etc.) to underground should be considered a top priority in the construction of new critical facilities, or the renovation of existing ones.

Infrastructure

Ensuring local government facilities are well protected against the potential effects of lightning strikes is an on-going endeavor. Investigating and implementing new technology as it is made available will help ensure the continuity of operations at all levels. Uninterrupted communications and protection of the ever-growing mountain of electronic data gathered in day-to-day operations should be considered priorities in any plans for future development.

4.4.5 Conclusions

Lightning is one of the most deadly and consistent hazards in the United States. People out of doors can have a false sense of security, thinking that they are safe because a storm front has not yet reached their location. In fact, lightning can strike ten miles out from the rain column, putting people that are still in clear weather at risk. The general rule of safety is that anyone outside during a thunderstorm should take cover.

Electronic equipment, from personal computers to enterprise-level communications systems, can be seriously damaged by power surges from lightning. Surge protection should be included in any electronic system to minimize the risk of damage from lightning.

In recent years, new technology has provided ample opportunities for communities and individuals to provide increased warning and alerts, enhanced surge protection, and improved building strike protection. The City of Tulsa is considered to have a HIGH vulnerability to and HIGH probability of the Lightning hazard.

Data Limitations

Accurate data on the effects of lightning events is difficult to obtain for multiple reasons. *Regarding injuries* – many survivors do not seek immediate medical care and only come to the attention of

medical personnel when they seek care for effects of the shock that have not resolved in the days after their injury. In addition, many lightning deaths and injuries are attributable to nervous system disruption with no visible signs of injury, so in some cases, injuries or deaths may be misdiagnosed as heart attacks, burns, electrocution or other ailments.

Regarding property damages – home and business owners often choose not to submit insurance claims in connection with their damages. Typically, the events that are documented are the more widespread occurrences affecting several business/residential locations.

Regarding data collection – much of the data utilized is taken from newspaper accounts, so if people/structures affected by lightning do not make the news, they are not included in the larger pool of statistics.

4.4.6 Sources

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4.5 Hailstorm

4.5.1 Hazard Profile

A hailstorm is an outgrowth of a severe thunderstorm in which balls or irregularly shaped lumps of ice fall with rain. Hail is formed in thunderstorms when the updraft is strong enough to hold freezing masses of water above the freezing level. Extreme temperature changes from the ground upward into the jet stream produce strong updraft winds that cause hail formation. Strong winds aloft promote the formation of larger stones which increase in size until they are heavy enough to fall out of updraft to the ground. Rotating thunderstorms, known as supercells, make the largest hail. Hailstorms are usually considered "severe" when hail is larger than one inch in diameter and accompanied by winds greater than 58 miles per hour.

> ***"Hailstorms are a potentially damaging outgrowth of severe thunderstorms. Hailstorms frequently accompany thunderstorms, so their locations and spatial extents overlap. Hail can cause substantial damage to vehicles, roofs, landscaping, and other areas of the built environment. U.S. agriculture is typically the area most affected by hail storms, which cause severe crop damage even during minor events."***
>
> *-Mitigation Ideas, a Resource for Reducing Risk to Natural Hazards, FEMA, Jan 2013*

Location

Hail can occur in any strong thunderstorm, which means that hail is a threat everywhere in Oklahoma. Hail is one of the most destructive hazards to agricultural crops and animals, and the major natural cause of automobile damage. Oklahoma experiences an average of 602 hailstorms each year with hailstones measuring at least one inch in diameter. All structures, vehicles, and populations in the City of Tulsa are at risk to the onset and impact of hail events.

Measurement

Hailstones are typically measured by their diameter. Common sizes and descriptions of hail are listed in Table 4-25. The damages expected from a hail event are a function of the diameter of the hailstones and wind speed, or velocity. Hailstorms are usually considered "destructive" when hail reaches 1.75 inches in diameter and is accompanied by high winds. When hailstones reach such dimensions, they can be extremely dangerous to property, agriculture and people caught outside, without shelter. Beginning January 5, 2010, the National Weather Service changed the criteria for a severe thunderstorm alert from predicted winds in excess of 58 mph and hail in excess of 0.75 inch to hail larger than one inch in size.

Table 4–25: Common Sizes and Descriptions of Hail

Hail Size	Description	Hail Size	Description
0.25 inch	Pea Size	1.75 inch	Golf Ball Size
0.50 inch	Mothball Size	2.00 inch	Hen Egg Size
0.75 inch	Dime/Penny Size	2.50 inch	Tennis Ball Size
0.88 inch	Nickel Size	2.75 inch	Baseball Size
1.00 inch (Severe)	Quarter Size	3.00 inch	Teacup Size
1.25 inch	Half Dollar Size	4.00 inch	Grapefruit Size
1.50 inch	Walnut/Ping Pong Ball Size	4.50 inch	Softball Size

Extent/Severity

The damages expected from a hail event are a function of the diameter of the hailstones and the wind speed, or hailstone velocity. As shown in the Combined NOAA/TORRO Hailstorm Intensity Scale, Table 4-26, hail is considered "destructive" when it reaches 1.6 inches in diameter, or golf ball size.

Table 4–26: 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	0.33-0.60	Marble or Mothball	Slight damage to plants, crops
H2	Potentially	0.60-0.80	Dime or grape	Significant damage to fruit, crops, vegetation
H3	Severe	0.80-1.20	Nickel to Quarter	Severe damage to fruit & crops, damage to glass & plastic structures, paint & wood scored
H4	Severe	1.2-1.6	Half Dollar to Ping Pong	Widespread glass damage, vehicle bodywork
H5	Destructive	1.6-2.0	Silver dollar to Golf Ball	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	2.0-2.4	Lime or Egg	Aircraft bodywork dented, brick walls pitted
H7	Very destructive	2.4-3.0	Tennis ball	Severe roof damage, risk of serious injuries
H8	Very destructive	3.0-3.5	Baseball to Orange	Severe damage to aircraft bodywork
H9	Super Hailstorms	3.5-4.0	Grapefruit	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
H10	Super Hailstorms	4+	Softball & up	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

The size of hailstones is a direct function of the severity and size of a storm. High velocity updraft winds keep hail in suspension in thunderclouds. The greater the intensity of heating at the Earth's surface, the stronger the updraft will be. Higher temperatures relative to elevation result in increased suspension time, allowing hailstones to grow in size. As a general rule, hail damage increases sharply when stones reach 1.75 inches in diameter and larger.

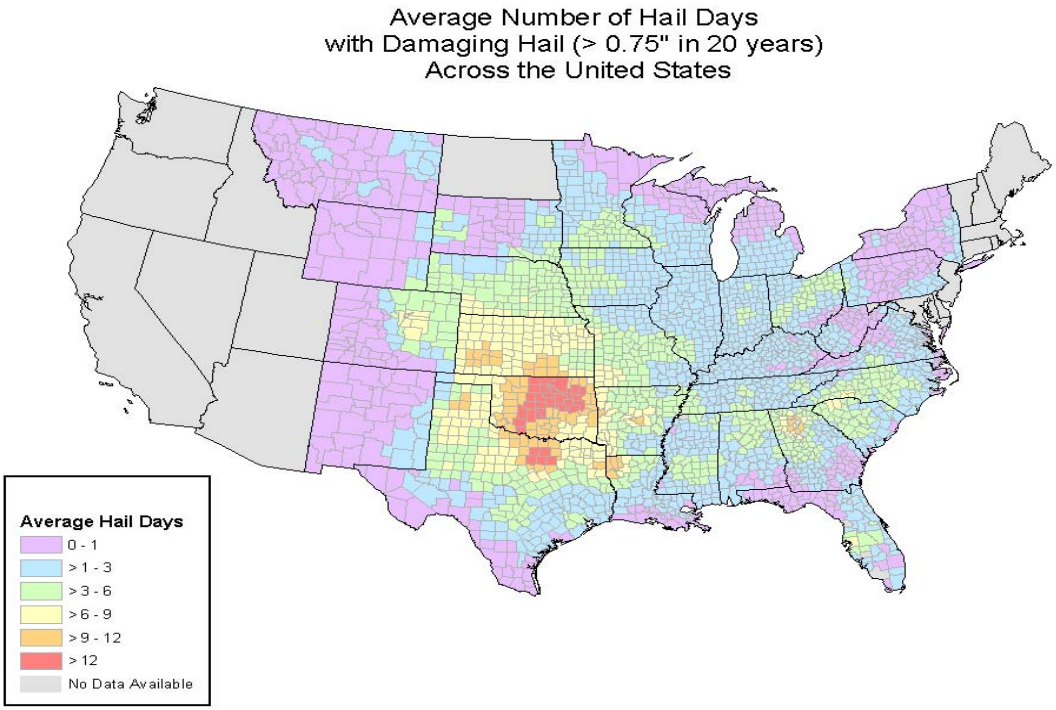
The City of Tulsa considers a minor severity hail event to be an H2 or lower on the Combined NOAA/TORRO Hailstorm Intensity Scales, and a major severity hail event to be an H3 or higher.

Frequency

The Great Plains, particularly the states of Oklahoma, Kansas, and Texas, are known for hailstorms. Hail has been reported in every month, with the highest frequency during the transitional months in the spring. The peak time of year falls right in the middle of that transition period, from mid-April to mid-May. Another small peak occurs in November, as the weather pattern transitions back into winter.

The National Weather Service, Tulsa Office, indicates hail 0.75 inches or larger occurs most often between March and June in Eastern Oklahoma and between the hours of 4:00 pm and 10:00 pm. Tulsa has an average of three days per year with 1.25 inch hail or larger. As indicated in Figure 4-10, Oklahoma, including Tulsa County, averaged greater than 12 hail days annually with damaging hail over a 20-year period.

Figure 4–10: Average Number of Hail Days



Source: National Weather Service

According to the NCDC Storm Events Database, the City of Tulsa reported 242 hail events from 1995 to 2011, summarized in Table 4-27. Given this data, the City of Tulsa can expect around 15 hail events to occur each year. Figure 4-11 displays a comparative map of hail events occurring in Oklahoma by county from 1990-2010.

Table 4–27: City of Tulsa Hail Events from 1995 -2011

Location	Events	Deaths	Injuries	Property Damage
City of Tulsa	242	0	0	$24,775,000
Oklahoma	6,899	0	2	$156,064,000

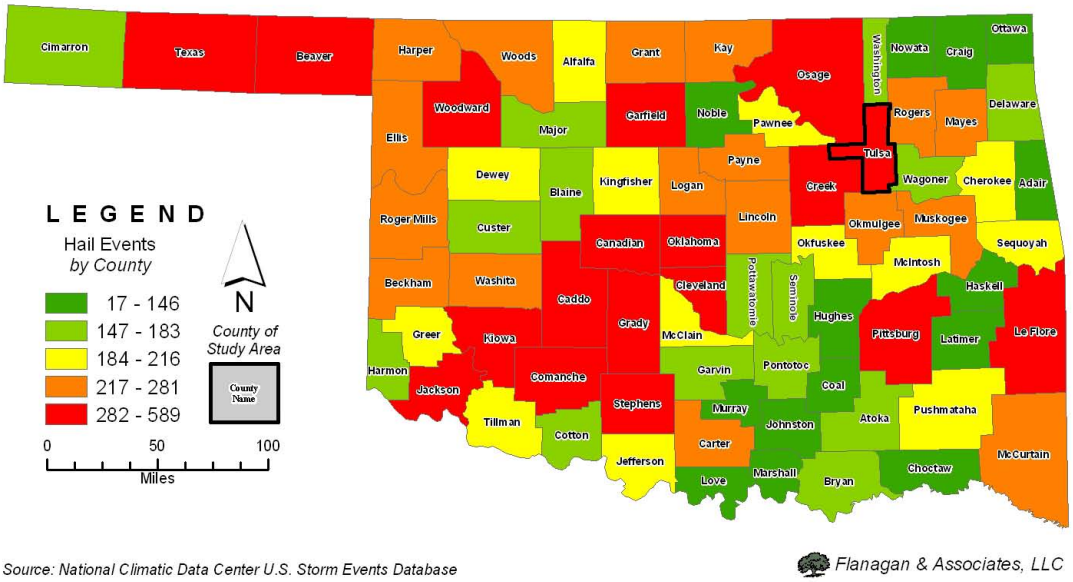
Source: NCDC Storm Events Database

Impact

When hail hits, it can damage cars, break windows, shred roof coverings, and lead to water-damaged ceilings, walls, floors, appliances, and personal possessions. Large hailstones can also cause serious bodily injury. Multiple impacts of concurrent severe thunderstorm effects (high winds, tornadoes and hail) are very likely within the Great Plains region. About 2% of United States' crop production is damaged by hail each year, and in the Great Plains states damages have sometimes reached 20%.

In total, hail causes nearly $1 billion in property and crop damage each year. In 2005, there were more than 13,000 hail storms in the United States. According to Swiss Re, four out of the top 20 most costly insurance losses of 2005 were hail-related. However the impact of this hazard remains mainly financial, involving repairs to cars, roofs, walls and windows. Hail caused over $24 million in damages to the City of Tulsa between 1995 and 2011.

Figure 4–11: Oklahoma Hail Events by County 1990-2010



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

Flanagan & Associates, LLC

4.5.2 History/Previous Occurrences

In the state of Oklahoma there have been over 20,000 reported hail events since 1956. The largest reported hailstone was 6 inches in diameter (grapefruit- to softball-size) falling 2 miles north of Gotebo, OK. In more recent years, hail has caused tremendous damage throughout Oklahoma. Property damage from hail in 2009 was $925,000. In 2008, a record year for hail damage, Oklahoma reported 1,204 hail events and property damage of $43 million. Almost all of the losses were from two hailstorms, one in Norman on November 5, 2008 ($40 million), and the other in Tulsa on April 8, 2008 ($1 million).

Tulsa County has experienced 1,993 reported hail events since 1960. According to NCDC the City of Tulsa reported 244 hail events since 1993; specific locations impacted in the County were not available for earlier years. Hail stones in Tulsa County ranged from 0.75 to 4.5-inches in diameter. Hail at Tulsa has usually been in the 0.75-2.5-inch range. Narratives of some events that have affected the City of Tulsa are included in Table 4-28.

Table 4–28: City of Tulsa Hail Event Narratives

Date	Event Narrative
May 5, 2000	Shortly after 9:00 p.m. Tulsa was hit with a variety of large hail. Quarter, golf ball, and baseball size hail were all reported in the city. The damage totaled $1 million.
November 11, 2003	Hail up to the size of baseballs fell on Tulsa, causing $20 million in damage. The storm moved through the city around 10 a.m. producing hail as large as 2.75 inches in diameter in midtown Tulsa. Major structural damage was reported in the city and surrounding areas.
April 5, 2005	A supercell thunderstorm moved north-northeast across the central portion of Tulsa County producing a several-mile-wide swath of large, damaging hail. Reports of golf ball or larger hail were common in a densely populated area of the county from Jenks to Tulsa. The largest hailstones reported were 3 inches in diameter. Many automobiles, homes, and businesses were damaged by the hailstorm.
April 8, 2008	Golf ball size hail fell near the intersection of Mingo Road and 91st Street South. Extensive damage to homes, businesses, and automobiles occurred; damages were estimated at $1 million.

Date	Event Narrative
June 1, 2008 -	A large storm system moved across the state, dropping large hail in several locations. The most damaging hail fell at Mannford, just west of Tulsa in Creek County, where City Officials estimated that every house in the community (approximately 1,100 homes) had sustained some damage from hail, which ranged in size from golf balls to tennis balls. Approximately 600 homes had windows broken out and every home suffered roof damage – with hailstones actually tearing through some of the roofs and landing inside the home. Additionally, between 1,000 and 1,500 vehicles sustained heavy damage. Two hail-related injuries were reported.
April 22-23, 2011	On Friday, April 22, 2011, hailstones from golf ball (1.75") to nearly tennis ball size (2.50") fell in south Tulsa County. Residents of Glenpool, Jenks, Bixby, south Tulsa and Broken Arrow were impacted. Hail fell for 10-20 minutes. The next night, thunderstorms ahead of the front in eastern Oklahoma carried hail up to tennis ball size, damaging wind gusts, and five brief tornadoes. Hail 2.50 inches in diameter resulted in $50,000 damages in Tulsa.

Source: NCDC Storm Database

Probability of Future Events

As hail is a direct by-product of thunderstorm activity, and Oklahoma has a climatic environment most suitable for this weather activity, the City of Tulsa will continue to experience thunderstorms of varying severity with hail present in many of these events. Based on history and previous occurrences from the past 16 years, the City of Tulsa has a HIGH probability of hail storms and can expect to experience an average of 15 hail events each year.

4.5.3 Vulnerability

This section summarizes information about The City of Tulsa's vulnerability to hail, including the impact on people, structures and buildings, critical facilities, and infrastructure. This information, as well as information provided by the City, was used to determine the Vulnerability Criteria identified in Tables 4-3 and 4-4 The City of Tulsa was determined have a HIGH vulnerability to the Hailstorm hazard.

Population

Given the climatic environment in this jurisdiction, all demographic groups located within the Tulsa jurisdiction are vulnerable to the effects and potential damages of hailstorm events. Although not as common as structure and vehicle damage, personal injury can be caused by large hail driven by high winds. Baseball size hail falls at 100 mph. Those engaging in outdoor recreational activities, such as jogging, walking and camping, may find themselves in a situation where sufficient shelter is unavailable and be seriously injured.

Hailstones can cause widespread damage to crops and automobiles and serious bodily injury

Structures/Buildings

Severe hailstorms can cause considerable damage to buildings and automobiles. Structures without hail-resistant roofs are especially vulnerable to hail damage. Hail can cause bruises, punctures and leaks on roofing systems. The amount of damage depends on the size of the hail, and the age, material, and surface temperature at the time of the event. Substantial hail damage may result in the need for a completely new roofing system. Large hail driven by high winds can break through windows, doors and skylights that are not impact resistant, allowing rain water to enter buildings. Large commercial buildings are vulnerable to potential million

dollar damage as a result of the impact of hail. Vegetation is vulnerable to damages from hail, and trees and shrubs can suffer long-term damage. The interior of facilities are also at risk, as mentioned above, from broken windows, glass doors, and skylights that allow rain to enter the buildings. Interior furniture, computer equipment and flooring can be damaged and may need to be replaced.

Hail events do not usually receive the depth of reports and information sharing seen with other natural hazards. Many homeowners do not report minor claims to their insurance companies, and detailed reports are generally unavailable from insurance carriers as a result of proprietary information concerns. These factors create an obstacle to accurately analyzing the cost and true economic impacts of such a widespread, sporadic and uneven event as severe hail.

The City of Tulsa has significant exposure to hailstorms, and virtually all buildings in a storm's path are at risk. The entirety of the jurisdiction is vulnerable to the damaging effects of hail.

Critical Facilities

Since all buildings are vulnerable to damage, all critical facilities fall into this category (for a complete list of City of Tulsa critical facilities, see Tables 1-12 through 1-21). Hail is unlikely to render a building non-operational. This is not the case with City of Tulsa vehicles, which are vulnerable severe windshield damage from hail if covered parking is not available. Many of these vehicles are needed to perform critical functions within the City.

Infrastructure

Water Treatment – It is not anticipated that a hail event would cause a major disruption in the normal operation of the water treatment systems for the City of Tulsa.

Wastewater Treatment – It is not anticipated that a hail event would cause a major disruption in the normal operation of the wastewater treatment systems for the City of Tulsa.

Utilities – It is not anticipated that electric power, gas service, or the local municipal authorities would suffer a major disruption from hail.

Transportation Systems (Highways, Public Transportation, Railway, Airports) – During a hail event, public transportation vehicles may sustain damage. If severe enough (such as the hail event on June 1, 2008 in Mannford, OK) there could be some risk of loss of use of these vehicles, possibly disrupting normal operation of city routes. During a major storm that is producing hail, it is reasonable to assume that flights leaving and arriving at Tulsa International Airport could be delayed. Aircrafts on the runway during a significant event could potentially experience some damage if the hailstones were of a substantial size, the velocity of the stones high, and the event prolonged.

Emergency Services – Fire, Police and Medical Services would all be similarly at risk to the secondary effects of a hail event. Response vehicles in the open during a hail event would all face the same risk of damage, most likely to windows and/or windshields. A secondary effect could be an increased call volume related to traffic accidents, should the hail event occur during a period of heavy traffic flow.

If a major hail event were to occur between 7:30 – 8:30 a.m. or 5 – 6 p.m. on any weekday, the risk of commuters being caught in the event is substantially higher. The daytime population of Tulsa increases by over 74,000 due to the inflow of commuters from neighboring communities. Additionally, the majority of workers in the city have a commute time of 15-20 minutes, resulting in a high volume of traffic on the city streets in these time periods.

4.5.4 Future Trends

For information regarding future development areas in the City of Tulsa, refer to Section 1.2.8.

Population

Since deaths or injuries from hail events are extremely rare, and since all areas of the city are equally exposed to hailstorms, the vulnerability of populations in newly developed areas will be low, and will be similar or equal to the vulnerability of already established populations.

Structures/Buildings

In all areas being considered for future development, the construction of any new structures/buildings should include plans to utilize impact-resistant materials and components, when available. When buildings are being considered for renovation or conversion from one purpose to another, strong emphasis should be placed on utilizing these same materials whenever possible. The two primary areas of concern would be roofing and window systems.

Critical Facilities

Any future development and renovation of critical facilities should include the improvement of these facilities to help ensure the community's sustainability. Hail-resistant materials should become standard in this class of facility and made part of all future plans, along with the use of protective screens for external equipment (i.e., air filtration/conditioning systems, backup generators, communication terminals, etc.) to help protect them from damaging weather events.

Infrastructure

As research and development of alternative fuel sources evolves, it is anticipated that "bio-fuels" will begin to play a much larger role in energy resources. Strong consideration should be given to the way bio-fuels supporting this technology are produced. Since crops are potentially quite vulnerable to hail damage, large, wind-driven hail could produce a high economic impact. It is not anticipated that future infrastructure in Tulsa would have a higher vulnerability to hail damage than the infrastructure already in place.

4.5.5 Conclusions

The states in the middle of the Great Plains, and particularly Oklahoma, are the most likely to have severe thunderstorms and therefore have the most hail events. The peak season for hail is in the late spring and early summer. Oklahoma experiences an average of 869 hailstorms each year with hailstones measuring at least 0.75" in diameter, while Tulsa has about 15 hail events each year with stones ranging from 0.75 to 2.5-inches in diameter, but occasionally as large as 4.5 inches. All buildings and crops in the City and County are at risk. Due to the number of hail events experienced in the past, and damages incurred, the City of Tulsa has HIGH probability of and a HIGH vulnerability to hailstorms.

Data Limitations

The property losses due to hail are not well defined and conflicting information exists. For example, in 1992 the Property Claims Service declared, "Hailstorms across the country (in 1992) ran up a bill of $1.57 billion." Yet, their data on all weather catastrophes shows that hail plus other conditions caused $3.9 billion in insured losses in 1992, and only one storm was a hail-only event, and it caused losses listed at $275 million. This is but one example of the lack of good data on the property losses due to hail. In addition, since a hailstorm is seldom a nationally declared disaster, there may be no agency gathering aggregate data across a region on losses.

4.5.6 Sources

The Weather Channel Storm Encyclopedia at Website:
www.weather.com/encyclopedia/thunder/hail.html

National Weather Service Forecast Office – Tulsa, OK at www.srh.noaa.gov/tsa/climate/tulhail.html

"Trends in Hail in the United States" by Stanley Changnon, Chief Emeritus & Principle Scientist at Illinois State Water Survey – Mahomet, IL at
http://sciencepolicy.colorado.edu/socasp/weather1/changnon.html

National Climatic Data Center at www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms

Tulsa World (Vol. 103, No 262) at www.tulsaworld.com

Tulsa City Data at web address: www.city-data.com/city/tulsa-oklahoma.html

4.6 Extreme Heat

4.6.1 Hazard Profile

> ***"Extreme heat is typically recognized as the condition where temperatures consistently stay ten degrees or more above a region's average high temperature for an extended period. Fatalities can result from extreme temperatures, as they can push the body beyond its limits."***
>
> *-Mitigation Ideas, a Resource for Reducing Risk to Natural Hazards, FEMA, Jan 2013*

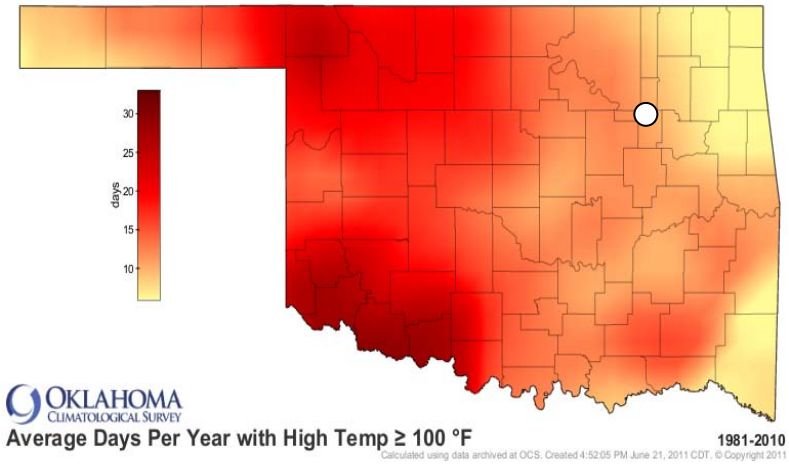
Extreme summer weather is characterized by a combination of very high temperatures and exceptionally humid conditions. Temperatures that hover 10 degrees or more above the average high temperature for the region are defined as extreme heat. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when a "dome" of high atmospheric pressure traps hazy, damp air near the ground. Excessively dry and hot conditions can provoke dust storms and low visibility. Droughts occur when a long period passes without substantial rainfall. A heat wave combined with a drought is a very dangerous situation. A heat wave occurs when such conditions persist over long periods. A lack of nighttime cooling can exacerbate the conditions when urban structures fail to release ambient heat absorbed during the day.

Although heat can damage buildings and facilities, it presents a more significant threat to the safety and welfare of citizens. According to the National Weather Service, extreme heat was the cause of 119 deaths on average from 2002 to 2011. There is a consensus that most deaths due to extreme heat are preventable if precautions are taken. Extreme summer temperatures can result in water shortages, increase fire hazards, and prompt excessive demands for energy.

Location

The City of Tulsa is located in an area known for its hot, humid summers, with temperatures often reaching above 100ºF for extended periods. Due to its location, sustained high temperature is a hazard that impacts the entire planning area, particularly the aged, the poor, the obese, those with heart problems, and people who work out of doors. Figure 4-12 shows the average number of days per year in Oklahoma with temperatures exceeding 100°F from 1981-2010. According to Oklahoma Climatological Survey, during this time period, the City of Tulsa averaged between 10 and 15 days per year with temperatures exceeding 100°F.

Figure 4–12: Days with Temperatures above 100ºF



Source: Oklahoma Climatological Survey

Measurement

The Heat Index and Heat Disorders table (Table 4-29) relates index ranges with specific disorders, particularly for people in the higher risk

risk groups. The heat index illustrates how the human body experiences the combined effects of high temperature and humidity. It more accurately reflects what the body experiences than simply measuring the air temperature. For example, when the air temperature is 98° Fahrenheit and the relative humidity is 50%, the human body experiences the discomfort and stress equivalent to 113° Fahrenheit with no humidity

Table 4–29: Heat Index and Heat Disorders Table

Relative Humidity (%)

Air Temperature (°F)	40	45	50	55	60	65	70	75	80	85	90	95	100
110	136												
108	130	137											
106	124	130	137										
104	119	124	131	137									
102	114	119	124	130	137								
100	109	114	118	124	129	136							
98	105	109	113	117	123	128	134						
96	101	104	108	112	116	121	126	132					
94	97	100	102	106	110	114	119	124	129	136			
92	94	96	99	101	105	108	112	116	121	126	131		
90	91	93	95	97	100	103	106	109	113	117	122	127	132
88	88	89	91	93	95	98	100	103	106	110	113	117	121
86	85	87	88	89	91	93	95	97	100	102	105	108	112
84	83	84	85	86	88	89	90	92	94	96	98	100	103
82	81	82	83	84	84	85	86	88	89	90	91	93	95
80	80	80	81	81	82	82	83	84	84	85	86	86	87

Heat Index
(Apparent Temperature)

With Prolonged Exposure and/or Physical Activity

Extreme Danger	Heat stroke or sunstroke highly likely
Danger	Sunstroke, muscle cramps, and/or heat exhaustion likely
Extreme Caution	Sunstroke, muscle cramps, and/or heat exhaustion possible
Caution	Fatigue possible

Source: NOAA/National Weather Service

The Heat Index and Disorders Table displays varying degrees of caution depending on the relative humidity combined with the temperature.

The shaded zones on the chart indicate varying symptoms or disorders that could occur depending on the magnitude or intensity of the event. “Caution” is the first level of intensity where fatigue due to heat exposure is possible. “Extreme Caution” indicates that sunstroke, muscle cramps or heat exhaustion are a possibility, whereas a “Danger” level means that these symptoms are likely. “Extreme Danger” indicates that heat stroke or sunstroke is highly likely.

The National Weather Service has a system in place to initiate advisories or warnings when the Heat Index is expected to have a significant impact on public safety. The severity of the anticipated heat event determines whether advisories or warnings are issued.

Extent/Severity

The City of Tulsa considers an event of minor severity to be a heat index of 95 or less on the Heat Index, and an event of major severity to be a heat index greater than 95.

Frequency

Over the past 10 years, the average high temperature for July and August in the City of Tulsa area has been 93.5º F, with an average humidity of 56%, putting the area in the “Extreme Caution” category on the National Weather Service (NWS) Heat Index scale. When temperature and humidity rise higher, as they often do in July and August, conditions can reach the “Danger” and even “Extreme Danger” categories.

According to the NCDC Storm Events Database, 30 separate extreme heat events were reported for the City of Tulsa in the 16 year reporting period 1995 through 2011, a frequency of about two

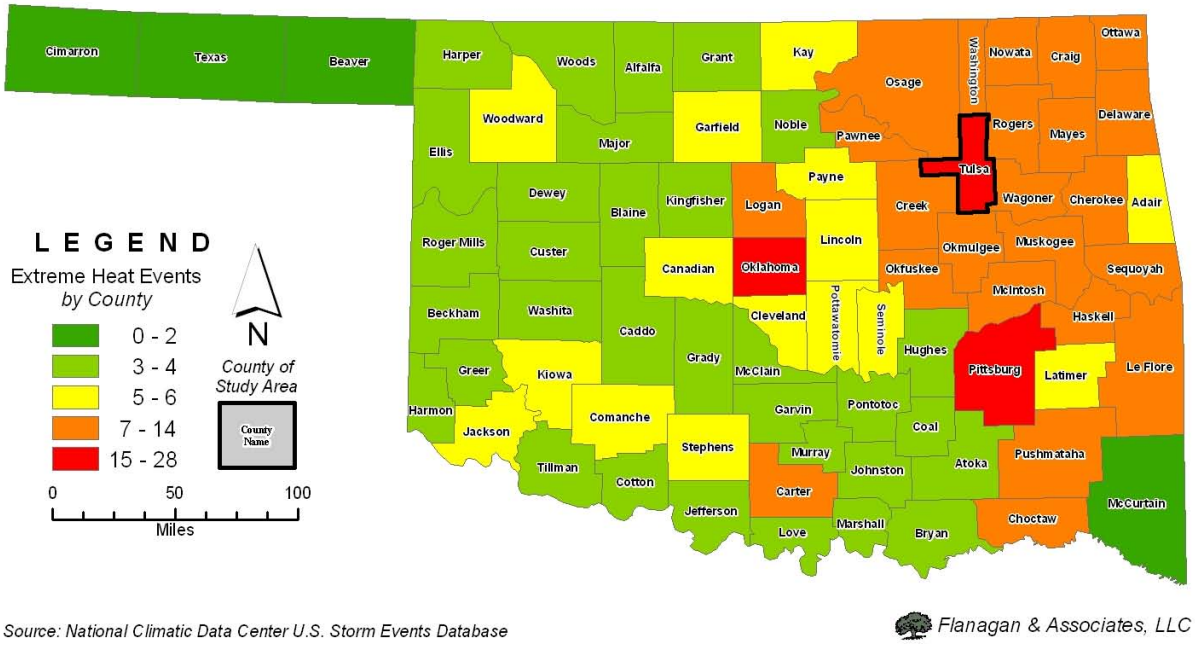
extreme heat events every year. A summary of these events is included in Table 4-30. Oklahoma extreme heat events by county from 1990-2010 are compared in Figure 4-13.

Table 4–30: City of Tulsa and Oklahoma Extreme Heat Events 1995-2011

Location	Events	Deaths	Injuries	Property Damages
City of Tulsa	30	13	212	$0
Oklahoma	47	91	157	$10,000

Source: NOAA National Climatic Data Center

Figure 4–13: Oklahoma Extreme Heat Events by County 1990-2010



Impact

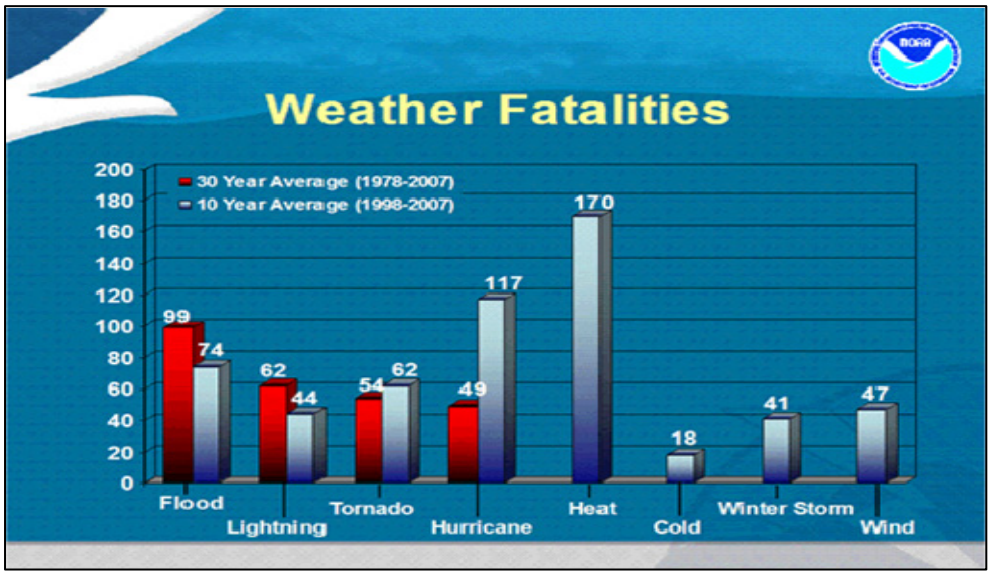
The impact of extreme heat is primarily a danger to people, resulting in muscle cramps, nausea, heat exhaustion, heat stroke, and death. Heat has consistently caused a higher number of fatalities than other hazards. Figure 4-14 compares weather fatalities by hazard over a 10-year average (1998-2007) and a 30-year average (1978-2007).

Extreme heat increases the risk of and impacts from wildfire and drought and is hazardous to agricultural crops and livestock. The demands on water supplies can result in shortages, rationing, and increased vulnerability to urban fire. Roads, bridges and railroads are susceptible to damage from extreme heat. When high temperatures are combined with drought and high winds, the threat of wildfire can become severe. The impact of the extreme heat hazard can be mitigated by notifications and warnings to vulnerable populations, the establishment of cooling rooms, utility cost assistance programs, backup electric generation for critical facilities, and similar measures.

Another hazard associated with extreme heat is air pollution. During the summer months, consistently 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 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, Tulsa issues ozone alerts and implements measures 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.

Figure 4–14: Average Number of Weather Fatalities by Hazard



Source: NOAA/National Weather Service

4.6.2 History/Previous Occurrences

In Oklahoma, July is generally the hottest month of the year, closely followed by August. The NWS compiled a 106-year record of monthly and annual average temperatures in Oklahoma, and the Dust Bowl years of 1921, 1931 and 1936 show the highest average temperatures across a 12-month period—until the scorching summer of 2011. Oklahoma experienced its hottest summer on record in 2011, with 42 days of temperatures above 100º F and three consecutive days with 110º F. Nationally, too, the summer of 2011 was the hottest since the Dust Bowl.

Historically, the City of Tulsa has experienced extreme heat events on multiple occasions. The National Weather Service has compiled the top 25 consecutive days with a temperature greater than or equal to 100°F for the City of Tulsa from January 1905 to September 2011 (Table 4-31).

According to the Oklahoma Climatological Survey, from 1971 to 2000, the City of Tulsa had an average of five days with highs above 100º F in July, and six days above the century mark in August. There have been a little over a dozen years since 1993 when summer temperatures in Tulsa have exceeded these averages: 1993, 1994, 1996, 1998, 1999, 2001, 2006, 2007, 2008, 2009, 2010, 2011, and 2012. Extreme heat events have been reported in the City of Tulsa every year since the approval of the previous update. Narratives of some recent events that have affected the City of Tulsa are included in Table 4-32.

Table 4–31: Top 25 Consecutive Days of Temperature in Tulsa Greater than or Equal to 100°F 1905 -2011

Rank	Number of Days	End Date
1	22	8/28/1936
1	22	8/22/1918
3	21	7/21/1980

Rank	Number of Days	End Date
4	20	8/16/1980
5	19	7/26/1934
6	17	9/4/2000
6	17	7/25/1954
8	16	8/18/1956
8	16	8/12/1934
10	14	8/8/2011
10	14	8/17/1913
12	12	8/9/1970
12	12	7/20/1936
12	12	7/5/1931
12	12	9/9/1925
12	12	7/6/1911
17	11	7/24/2011
17	11	7/15/1966
17	11	8/11/1937
17	11	8/7/1919
21	10	8/22/1993
21	10	8/30/1983
21	10	7/18/1969
21	10	7/6/1925
21	10	8/7/1923

Table 4–32: City of Tulsa Extreme Heat Event Narratives

Date	Event Narrative
July 6, 2001	An extended period of excessive heat affected all of western and central Oklahoma in July. Most areas regularly experienced high temperatures at or above 100º F, particularly western and north central Oklahoma. Eight fatalities resulted from the heat. A 78-year-old male died July 6th in Tulsa while loading equipment at a storage facility.
July-August, 2006	Temperatures reached above 100º F starting in mid-July and continued through the middle of August. Many locations at times reached 105º or greater with higher heat index values. The heat caused 10 fatalities across the area during this time period.
August, 2007	Humidity as a result of the spring rains continued well into the summer and increased the danger from the temperatures. The combination of heat and high humidity resulted in daytime heat index values from 105º to 113º across much of eastern Oklahoma. Two men died in Tulsa as a direct result of the heat. Two hundred other people were treated by EMS in Tulsa for heat related illnesses. Many of those victims were attending the PGA Championship.
July 2010	Temperatures were above normal with daytime readings reaching the mid 90s to near 100º and overnight temperatures only falling into the mid to upper 70s. Very humid conditions as a result of the excessive rainfall that occurred earlier in the month and subsequent highly saturated soils resulted in afternoon heat index values between 105 and 115º. At least 28 people were treated for heat-related illness in the Tulsa area during this period. One heat-related death occurred in Skiatook on the 22nd. At least 11 people were treated for heat-related illness on the 30th and 31st in the Tulsa area.

Date	Event Narrative
August 2010	Exceptionally hot weather occurred in Tulsa with above normal daytime temperatures of 101 to 106º, which combined with high humidity, resulted in 110 to 115º heat index values. Little relief was felt at night as temperatures only fell to near 80º F during the nighttime hours. The overnight low temperature recorded at the Tulsa International Airport was 85 and 83 degrees, respectively, which are both unusually warm even for northeastern Oklahoma in the summertime. At least 51 people were treated for heat-related illness in Tulsa during this period.
June-August 2011	Hottest summer on record for the State of Oklahoma and the U.S., temperatures were the highest since the Dust Bowl. Excessive heat began in late June and remained elevated through mid August. Temperatures climbed to above 100 degrees on all but two days from July 9-31 at the Tulsa International Airport. It was 2nd warmest July on record for the area since records began in 1905. August was the 5th hottest August on record since 1905. The record breaking summer caused 4 fatalities and 296 injuries in Tulsa County.
Summer 2012	Extreme temperatures plagued the City of Tulsa for the third consecutive summer during 2012. The thermometer rose to 100º F or more for multiple days, and several Tulsans were treated for heat-related illnesses. By mid July, Tulsa had experienced 15 days above 100º. Three Tulsa cooling stations were open for the summer, providing relief to those without access to air conditioning. The extreme temperatures impacted outdoor workers, forcing many construction companies to change their schedules to avoid the hottest part of the day. Local firefighters succumbed to heat related illness while fighting area fires.

Source: NCDC Storm Events Database

Probability of Future Events

Extreme heat will continue to be a probability for the City of Tulsa. Due to aggressive heat plans in the City/County of *Tulsa Emergency Operations Plan*, the impact of these heat waves has been greatly reduced. The impact of future events will be directly related to the continuation of this aggressive program, and other mitigation measures that may be implemented to reduce the effect of the urban heat island, particularly in central Tulsa. The City of Tulsa is considered to have a HIGH probability of extreme heat events occurring in the future.

4.6.3 Vulnerability

This section summarizes the City of Tulsa's vulnerability to the Extreme Heat hazard, including the impact on people, structures and buildings, critical facilities, and infrastructure. This information, as well as that provided by the City, was used to determine the Vulnerability Criteria identified in Tables 4-3 and 4-4. The City of Tulsa was determined have a HIGH vulnerability to the Extreme Heat hazard. The City of Tulsa Heat Action Plan, described in Chapter 2, helps lessen the impact of Extreme Heat events on the City of Tulsa.

Population

Extreme heat can take its toll on the all populations of the City of Tulsa, and even the most physically fit individuals can succumb to heat effects. However, certain segments of the population are at higher risk. These populations include the following:

- Individuals 65 years and older
- Infants
- Socially isolated individuals
- Mentally & mobility challenged individuals
- Obese individuals
- Individuals under the influence of alcohol or medications
- Individuals and families living below the poverty line
- Outdoor workers

Of particular interest are individuals over the age of 65 AND below the poverty line. These are at the greatest risk of loss of life due to extreme heat conditions.

The commonality among all heat related disorders is twofold: the individual has been exposed to high temperatures too long, or has exercised beyond the ability for his or her age and physical condition. Heat-related illnesses can include the following:

- **Heat Cramps**: muscular pains and spasms due to heavy exertion. They usually involve the abdominal muscles or legs. It is generally thought that the loss of water from heavy sweating causes the cramps.
- **Heat Exhaustion**: typically occurs when people exercise heavily or work in a warm humid place where body fluids are lost through heavy sweating. Blood flow to the skin increases, causing blood flow to decrease to the vital organs. This results in a form of mild shock. The skin will be cool and moist, and can appear to be either pale or flushed. The victim may have a headache and/or be suffering from nausea. There may also be some dizziness.
- **Heat Stroke**: the most serious heat emergency. It is life threatening. The victim's temperature control system, which produces sweating to cool the body, stops working. The body temperature can rise so high that brain damage and death may result if the body is not cooled quickly.

Elderly Populations: In the City of Tulsa, men aged 45 to 65 years of age account for the highest number of EMSA transports due to heat related illness each year. Though this demographic accounts for a high number of transports, many are able to walk away unscathed after treatment. Elderly populations account for less EMSA transport but are less likely to recover once they have succumbed to the impact of extreme heat. Often times, elderly populations are socially isolated and not frequently checked on. At the same time, many may not mentally comprehend the need to go to a cooling center. Research shows that heatstroke occurs 12 to 13 times more frequently in elderly persons. Factors increasing the vulnerability of elderly persons to heat include:

- Inability to cool their body and adjust to sudden temperature changes.
- Pre-existing chronic medical conditions, such as lung disease and diabetes, which change normal body responses to heat.
- Heat-sensitive prescription medicines that weaken the body's ability to control its temperature or inhibit perspiration.
- Mental ability to recognize interior and exterior temperatures and failure to take precautionary measures to prevent heat stroke.

According to the NCDC annual storm event summaries, of the 3,322 heat-related deaths in the United States from 1995 to 2011, 61.52% involved persons over the age of 60 (Table 4-33). In the City of Tulsa, persons 65 years of age and older constitute 12.5% of the total population. Elderly persons living alone are at higher risk to extreme temperatures and should be regularly checked on by friends or neighbors. Effort should be made to educate elderly populations and their caretakers on preventative measures and the signs and symptoms of heat-related illness.

Table 4–33: Deaths from Extreme Heat

Year	Oklahoma	United States	Over 60, US
1995	0	1,021	73%
1996	10	36	84%
1997	0	81	65%
1998	24	173	68%
1999	10	502	67%
2000	5	158	68%
2001	9	166	62%

Year	Oklahoma	United States	Over 60, US
2002	0	167	52%
2003	3	36	61%
2004	0	6	50%
2005	1	158	56%
2006	24	253	58%
2007	3	105	52%
2008	3	71	62%
2009	1	45	49%
2010	1	138	56%
2011	8	206	63%
Totals	**102**	**3,322**	**61.52%**

Source: NOAA National Climatic Data Center Annual Summaries

Infants and Children (aged five years and younger): According to the 2010 US Census, children under the age of 5 years account for 7.5% of Tulsa's population. Infants and children are at higher risk to heat-related illness than adults. In the summer months, children are more likely to spend long periods of time outside. Children adjust slower to changes in environmental heat and produce more heat with activity than adults do and, at the same time, produce less sweat.

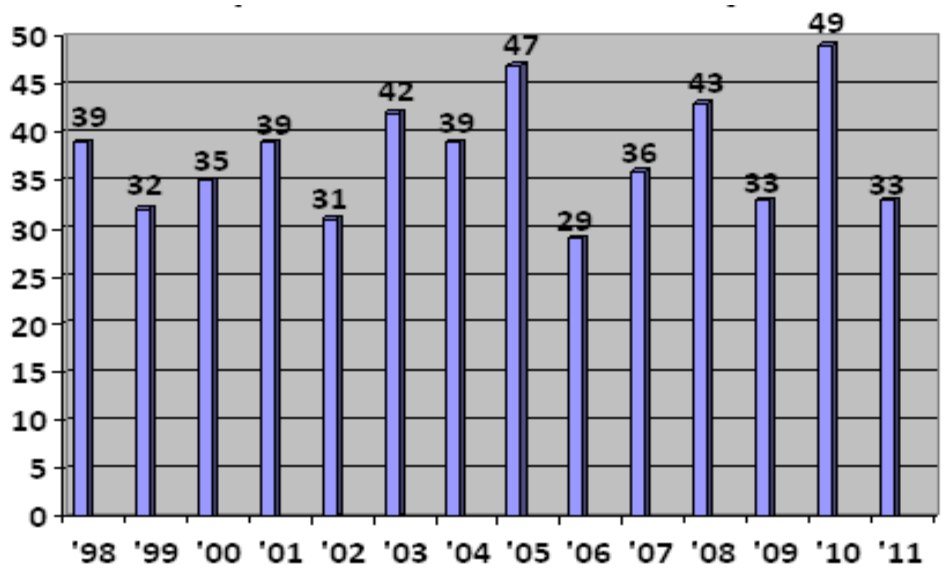
A factor increasing the risk of infants and children is the number left unattended in vehicles or trapped in vehicles while playing. Even in mild temperatures, vehicles can reach life-threatening temperatures at a rapid pace, such as 109º F in 15 minutes. Children left in vehicles easily succumb to hyperthermia, which occurs when the body absorbs more heat than it can dissipate. Hyperthermia is a dangerous medical emergency, and if not immediately treated leads to disability or death. Figure 4-15 summarizes the number of hyperthermia related deaths (children in vehicles) from 1998 through 2011.

Low-Income Households and the Homeless: Low-income and homeless populations are considerably vulnerable to extreme heat than the general population. In the City of Tulsa, 15.1% of the population is living in poverty. Persons living below the poverty line may not be able to afford air conditioning because of high cost, have limited or no access to air conditioned facilities, or have limited access to healthcare.

Even if cooling centers are set up, these populations may not be notified of their locations or have transportation to access them. This is of especial concern when heat waves continue for many days and when low-income populations consist of young children and elderly adults. Of the 19.3% population living in poverty in the City of Tulsa, 35.5% have children under the age of five and 9.0% involve adults aged 65 and older.

Figure 4–15: Number of Child Vehicular Deaths (Hyperthermia) 1998-2011
Source: National Weather Service

Outdoor Workers: According to the Occupational Safety and Health Administration (OSHA),



workers exposed to hot and humid conditions are at risk of heat illness, particularly those doing heavy work tasks or using bulky protective clothing and equipment. During the summer of 2012, many outdoor workers were forced to alter their work schedules to account for the extreme temperatures. Others, however, were not at liberty to make such changes. Workers new to the job may be at greater risk than those who have acclimated. Employers should include heat illness prevention steps in worksite training and plans.

Athletes: According to the Centers for Disease Control and Prevention (CDC), heat illness during athletic practices or competitions is a leading cause of death and disability among U.S. high school athletes and the third most common cause among athletes in general. In the City of Tulsa, most school athletic practices begin August 1st, the beginning of the hottest summer month. High school athletes train sometimes twice a day in triple digit temperatures. Athletes with a higher Body Mass Index (BMI) categorizing them as obese are at higher risk to extreme heat than a more physically fit individual; though, as previously stated, even the most physically fit can succumb to extreme heat. Coaches, athletes, trainers, and parents unaware of heat risk factors and protocols are vulnerable to loss of life or injury from this hazard.

Structures/Buildings

Structures and buildings are vulnerable to extreme heat in a limited way, such as in damage from expansive soils (see Section 4.13, *Expansive Soils*). Temperatures typically rise from the outer edges of the city and peak in the center. This phenomenon, referred to as the "Urban Heat Island" (UHI), can have a significant health impacts in urbanized areas. According to the Environmental Protection Agency, heat islands occur on the surface and in the atmosphere. On sunny days during the summer, sunlight can heat dry and exposed urban surfaces, such as pavements and buildings, causing urban regions to become much warmer than their rural surroundings. As a result an "island" of higher temperatures is formed in the landscape. A sketch of an Urban Heat-Island profile is included in Figure 4-16.

A range of factors varies between rural and urban areas and contributes to the UHI – for example:

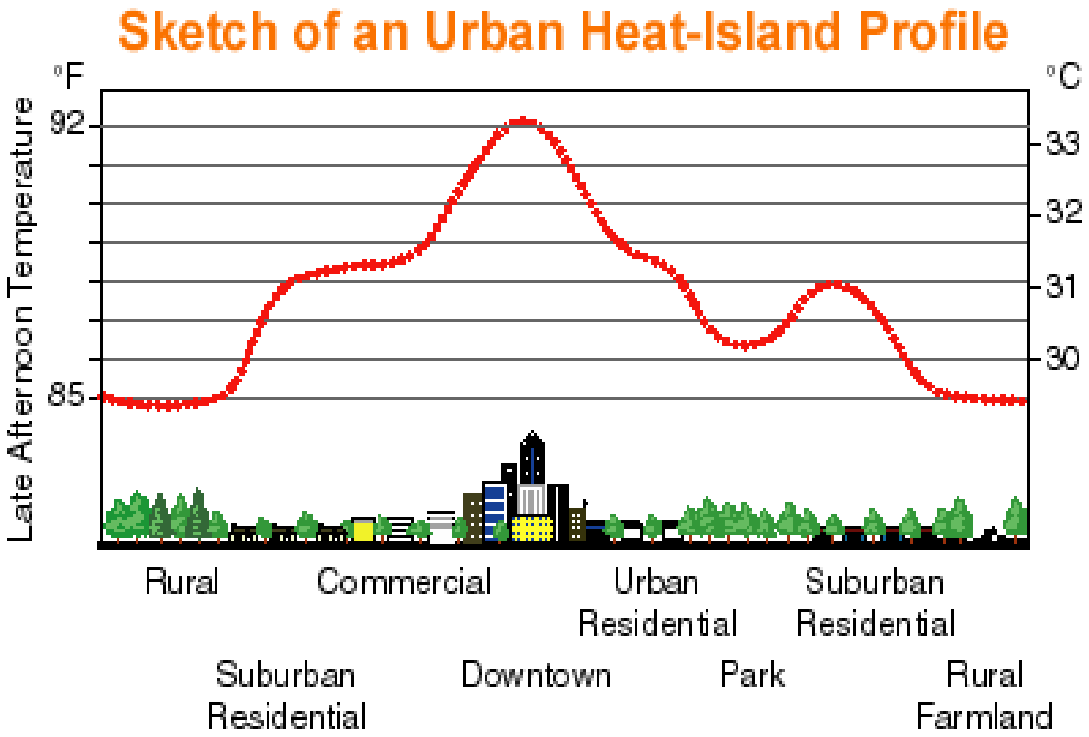
- **Thermal properties** of building and road materials, the height and spacing of buildings and air pollution levels. These factors result in more of the sun's energy being captured, absorbed

and stored in urban surfaces compared to rural surfaces during the day and a slower loss of this energy at night, thus resulting in comparatively higher air temperatures.

- **Less evaporation and shading**, with the consequent reduction in associated cooling, takes place in the typically drier urban areas as there is less vegetation.
- **Greater inputs of heat** as a result of the high density of energy use in cities. All this energy, for example from buildings and transport, ultimately ends up as heat.

Strategic planning which takes account of the above factors, particularly in the context of climate change, is required. Planting trees and vegetation and the creation of green spaces to enhance evaporation and shading are other options, as temperatures in and around green spaces can be several degrees lower than their surroundings.

Figure 4–16: Urban Heat Island Effect



Source: LLBL Heat Island Group

Critical Facilities

Critical Facilities face the same issues as other structures and buildings above. In addition, a great many city facilities, such as City of Tulsa recreation centers, may be designated as cooling centers for vulnerable neighborhoods. As such, these facilities need to include this ability in their plans.

Of especially high vulnerability are the medical care and long-term care facilities. During an extreme heat event, power outages are not uncommon. While the larger medical treatment facilities in the City are supplied with dependable, redundant generator backup systems, an alarming number of long-term care and nursing home facilities are not. In July 2006, a Grove area nursing home was forced to evacuate 84 patients when power at the facility failed. Temperatures in parts of the state ranged from 101 – 109 at that time.

Infrastructure

Water Treatment – Water demand during periods of extreme heat increases significantly. If prolonged, demand could possibly exceed treatment capacity. City Ordinances are in place to restrict outdoor and non-essential water use during drought or in times of emergency.

Given that extreme heat conditions also increase the demand for electricity, power outages could be a potential secondary effect. However, the water treatment plants are a high priority customer and would not be impacted by planned rolling outages.

Wastewater Treatment – The most significant threat to the operation of Tulsa's four wastewater treatment plants during an extreme heat would be power outages. All four plants and lift stations have either double feeds or generators, so it is not anticipated that this would pose a threat to wastewater systems.

Utilities: The primary utility providers for Tulsa's jurisdiction are AEP/PSO (electricity) and ONG (natural gas).

> **Electricity -** During extreme heat, AEP/PSO could experience any combination of the following challenges in meeting the needs of the Tulsa jurisdiction: Failure of vital delivery components due to exposure to high heat and/or excessive/ simultaneous demand of supply, or insufficient field and/or office staff to effectively handle the workload. By the end of June, 2012 a PSO spokesperson said the demand for electricity in the City of Tulsa was already reaching high thresholds.
>
> During typical work week demand for electrical power spikes in the hours between 4 and 7 p.m., as workers are returning to their homes and adjusting thermostats up or down, depending upon the season. This simultaneous demand placed on power station and transformer components sometimes results in power outages across the jurisdiction.
>
> **Gas** – No significant vulnerabilities in the delivery of natural gas supply during extreme heat events have been reported.

Transportation Systems (Highways, Public Transportation, Railway, Airports) – Extreme heat may cause engines of vehicles to overheat and tires to blowout more quickly. Heat is also the number one factor behind car battery failure. Such events lead to stranded drivers in already scorching temperatures. Increase in passengers utilizing the City's public transportation system (MTTA) as a method of staying out of the heat during peak heat danger hours is expected as part of the City's heat alert process. Long periods of high temperatures may cause flight delays and cancellations and/or cargo restrictions at airports. Asphalt roads could possibly rut or crack, and railway lines buckle from extreme heat.

Emergency Services- Fire, Police and Medical Services would all be similarly at risk to the effects of an Extreme Heat event. Fire and Medical Services typically receive a higher volume of heat-related call requests, therefore taxing the response capabilities of both services. Fire and Police services could be considered at risk to secondary effects, due to the added physical stress of working (often with heavy gear) under conditions of extreme heat. While not an immediate threat to delivery of these services, the demand for additional personnel to achieve an effective response could potentially increase the cost for these resources.

4.6.4 Future Trends

For information regarding future development in the City of Tulsa, see Section 1.2.8.

Population

With the rising cost of fuel and related travel expenses, more people are opting for vacations and/or recreation at local venues, such as public parks, close to home. As the number of people using local outdoor venues increases, vulnerability also increases.

Statistics show that the average age of the population is increasing, producing a higher percentage of elderly, a population particularly vulnerable to extreme temperatures. It is also probable that an increasing number of people in the more vulnerable population (elderly, fixed income, compromised health situations) will be less able to afford the cost of cooling their homes—due to economic conditions and the relative increase in the number of elderly in the population

Renewed development in Tulsa's downtown and surrounding areas will likely increase the number of outdoor workers exposed to extreme heat. Care should be exercised to ensure that this outdoor workforce is informed about how to avoid heat illnesses.

Structures/Buildings

While structures and buildings are only vulnerable in a limited way, such as in damage from expansive soils, development/redevelopment within City of Tulsa should take into account the potential adverse health impacts of the urban heat island effect. In addition, buildings and paving materials act as "storage units" for the energy, and radiate heat at night, keeping the ambient temperature from reducing to a level which could provide relief from the harmful effects of extreme heat.

The City of Tulsa's 2010 *Comprehensive Plan* includes a subsection, "Nature in the City." The section notes that natural areas should not just be found in the outlying areas. Tulsa's urban spaces are to be threaded with trails and green spaces that can provide shade and respite. These amenities will reduce the Urban Heat Island effect. (*Tulsa Comprehensive Plan*, PA-9)

Critical Facilities

Any future development or renovation of existing critical facilities should include plans for dependable backup systems for delivery of critical power.

Infrastructure

As certain developed areas of the city continue to age, the pipelines delivering water to these sections will also continue to deteriorate, increasing the likelihood of line ruptures during peak usage periods, including extreme heat events. Any development/redevelopment in these areas should be closely monitored to ensure existing water lines are capable of handling the additional load – and replaced as necessary.

Sporadic power outages are increasingly commonplace events in any community during prolonged periods of high temperatures. With an average of more than six hundred new residential building permits issued each year, the burden on power delivery systems will continue to grow. Developers working in previously undeveloped areas should remain in constant contact with utility companies to ensure that local power stations do not become overloaded.

4.6.5 Conclusions

Oklahoma can expect to experience an extreme heat event every summer. The severity of the hazard depends upon a combination of temperature, humidity and access to air conditioning. With July's average high temperature being 93.5° F, and average afternoon humidity around 56%, Tulsa has an average heat index of 105° F, and is considered to have a High vulnerability to the Extreme Heat hazard.

The most effective way to mitigate casualties from extreme heat is through public information and education, although other community programs, like cooling stations and air conditioner loan programs can also produce an impact. While Tulsa has appeared to have reduced the number of documented deaths and medical transports because of its aggressive actions implementing its Extreme Heat Action Plan, scorching summer temperatures will continue to be a threat to the City and its residents. The City of Tulsa is considered to have a HIGH probability of and HIGH vulnerability to the Extreme Heat hazard.

Data Limitations

The Oklahoma State Medical Examiner's Office and the Oklahoma State Health Department have no standardized protocols for defining a "heat-related" death, relying on the judgment of the individual physician attending. This could lead to substantially lower mortality/morbidity figures. In addition, death by other causes, such as cardiac arrest with heat as a "contributing factor", can further skew the final statistics for heat-related deaths and injuries.

4.6.6 Sources

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4.7 Drought

4.7.1 Hazard Profile

Drought is a normal, recurrent feature of climate. It occurs in virtually all climatic zones, but its characteristics vary significantly from one region to another. Drought is generally defined as "climatic dryness severe enough to reduce soil moisture and water below the minimum necessary for sustaining plant, animal, and human life systems." Drought is caused by a deficiency of precipitation, which can be aggravated by high temperatures, high winds, and low relative humidity. Duration and severity are usually measured by deviation from norms of annual precipitation and stream flows.

> ***"A drought is a period of unusually constant dry weather that persists long enough to cause deficiencies in water supply (surface or underground). Droughts are slow-onset hazards, but, over time, they can severely affect crops, municipal water supplies, recreational resources, and wildlife. If drought conditions persist over a number of years, the direct and indirect economic impacts can be significant. High temperatures, high winds, and low humidity can worsen drought conditions and also make areas more susceptible to wildfire. In addition, human actions and demands for water resources can accelerate drought-related impacts. "***
>
> *-Mitigation Ideas, a Resource for Reducing Risk to Natural Hazards, FEMA, Jan 2013*

Drought is "creeping" hazard of nature, and it is often difficult to recognize its onset before being in the middle of one. Drought analysis is more subjective than that for floods, because droughts do not occur spontaneously. They evolve over time as certain conditions are met and are spread over a large geographical area. Drought severity depends on its duration, intensity, geographic extent, and the regional water supply demands made by human activities and vegetation. This multi-dimensional nature makes it difficult to define a drought and to perform comprehensive risk assessments. This leads to the lack of accurate, reliable, and timely estimates of drought severity and effects, and ultimately slows the development of drought contingency plans. According to the National Drought Mitigation Center at the University of Nebraska-Lincoln, there are four kinds of drought, which occur at different stages, illustrated by Figure 4-17.

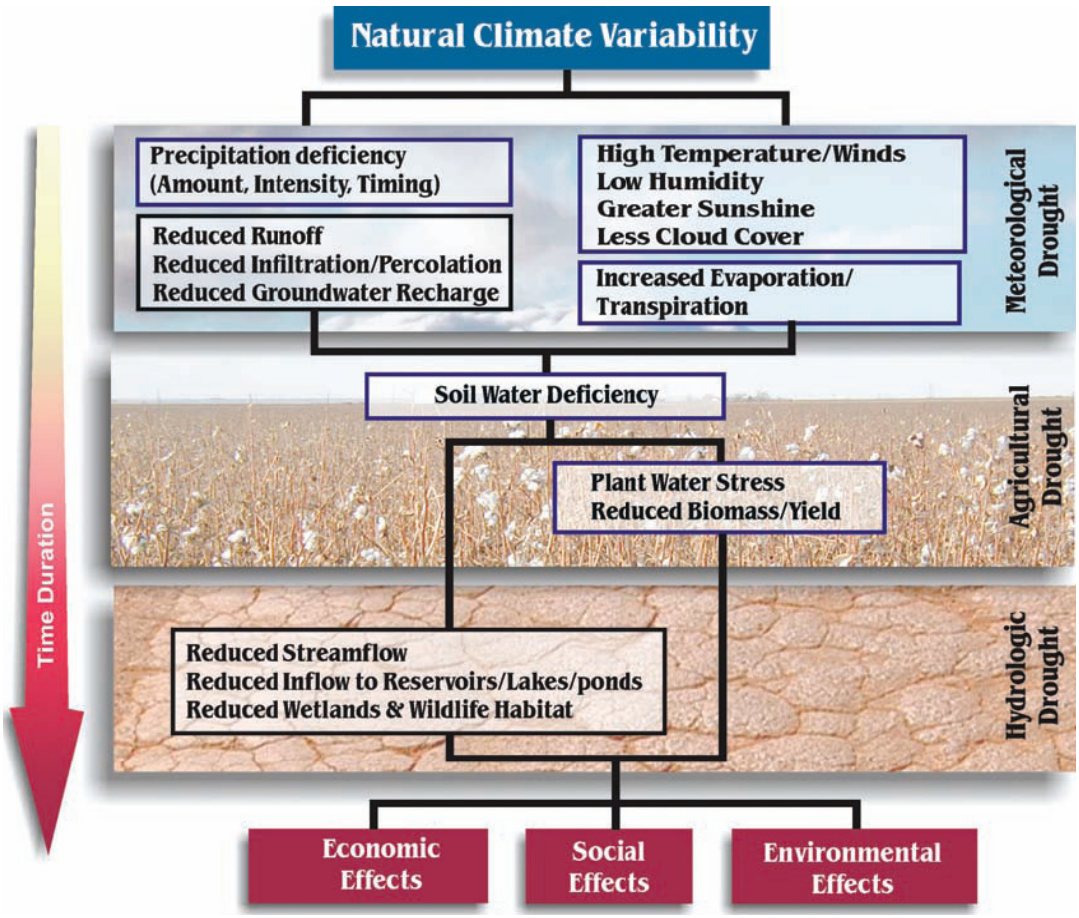
Meteorological drought is usually an expression of precipitation's departure from normal over some period of time. These definitions are usually region-specific, and based on a thorough understanding of regional climatology.

Agricultural drought occurs when there isn't enough soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought happens after meteorological drought but before hydrological drought. Agriculture is usually the first economic sector to be affected by drought.

Hydrological drought refers to deficiencies in surface and subsurface water supplies. It is measured as streamflow and as lake, reservoir, and groundwater levels. There is a time lag between lack of rain and less water in streams, rivers, lakes, and reservoirs, so hydrological measurements are not the earliest indicators of drought. When precipitation is reduced or deficient over an extended period of time, this shortage will be reflected in declining surface and subsurface water levels.

Socioeconomic drought occurs when physical water shortage starts to affect people, individually and collectively. Or, in more abstract terms, most socioeconomic definitions of drought associate it with the supply and demand of an economic good.

Figure 4–17: The Four Kinds of Drought



Location

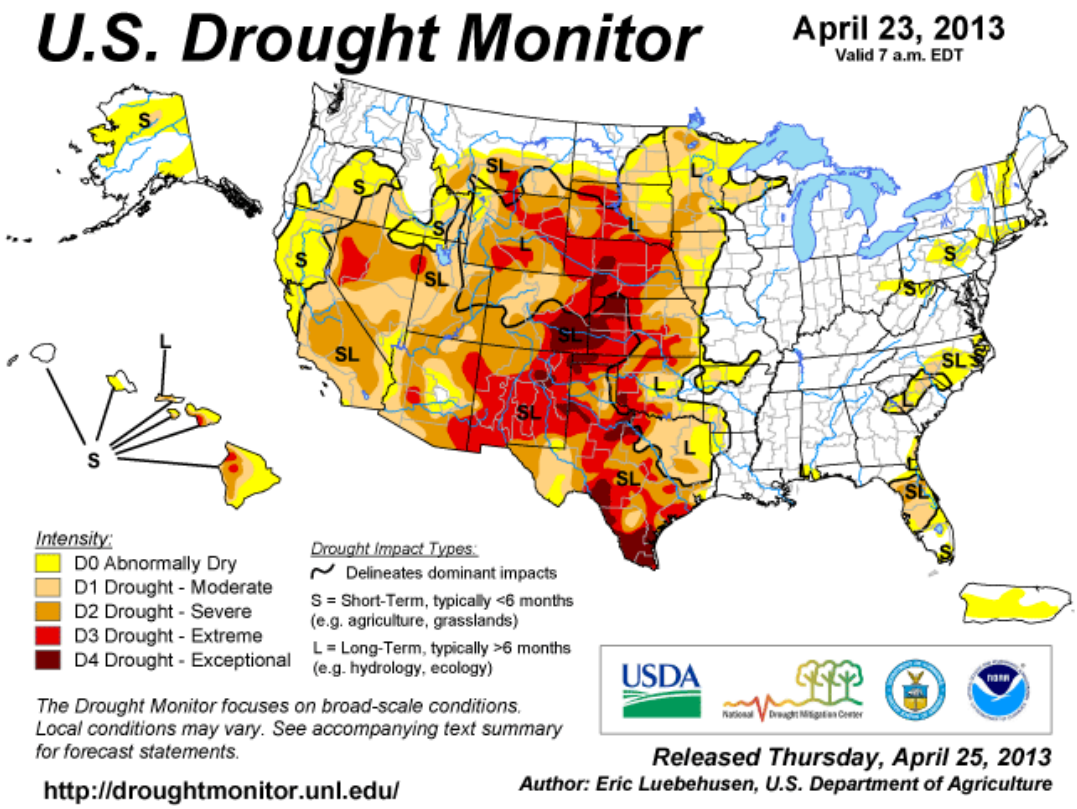
Drought is a widespread phenomenon that occurs over broad regions encompassing not only multiple communities, but frequently multiple states. The National Weather Service's drought monitor map illustrates the pervasive nature and degrees of dryness and prolonged droughts in several areas of the country. Figure 4-18 is the Drought Monitor map for the US, which is updated weekly. The City of Tulsa is as likely to experience Drought as any other geographic location in Oklahoma.

Measurements

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

The Palmer Index, the most familiar and widely used, measures the departure from normal precipitation. This index employs a range from 4 (extremely wet) to –4 (extremely dry). It incorporates temperature, precipitation, evaporation, runoff, and soil moisture when designating the degree of drought. Hydrologic Indices of drought (such as groundwater levels, reservoir volumes, or water levels) may be used to determine surface water supplies.

Figure 4–18: U.S. Drought Monitor Map for April 23, 2013



Palmer Drought Severity Index (PDSI): In 1965, meteorologist Wayne Palmer developed an index to "measure the departure of the moisture supply". Palmer based his index on the supply-and-demand concept of the water balance equation, taking into account more than only the precipitation deficit at specific locations. The objective of the Palmer Drought Severity Index (PDSI), as this index is now called, was to provide a measurement of moisture conditions that were "standardized" so that comparisons using the index could be made between locations and between months.

The Palmer Drought Index is based on precipitation and temperature. The Palmer Iindex can therefore be applied to any site for which sufficient precipitation and temperature data is available. The Palmer Index varies roughly between -4.0 and +4.0. Weekly Palmer Index values are calculated for the Climate Divisions during every growing season and are on the World Wide Web from the Climate Prediction Center. The Palmer Index is included in the following table.

Table 4–34: PDSI Classifications for Wet and Dry Periods

Rating	Condition
4.00 or more	Extremely wet
3.00 to 3.99	Very wet
2.00 to 2.99	Moderately wet
1.00 to 1.99	Slightly wet
0.50 to 0.99	Incipient wet spell
0.49 to -0.49	Near normal
-0.50 to -0.99	Incipient dry spell

Rating	Condition
-1.00 to -1.99	Mild drought
-2.00 to -2.99	Moderate drought
-3.00 to -3.99	Severe drought
-4.00 or less	Extreme drought

Fire: Keetch-Byram Drought Index, Fire Danger Rating System: The Keetch-Byram Drought Index (KBDI) is a mathematical system for relating current and recent weather conditions to potential or expected fire behavior. This system was originally developed for the southeastern United States and is based on recent rainfall patterns. The KBDI is the most widely used drought index system by fire managers in the South. It is also one of the only drought index systems specifically developed to equate the effects of drought with potential fire activities. The result of this system is a drought index number ranging from 0 to 800 that accurately describes the amount of moisture that is **missing**. A rating of zero defines the point where there is no moisture deficiency and 800 is the maximum drought possible.

Table 4–35: The Keetch-Byram Drought Index (KBDI)

Rating	Description
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 through the night and heavier fuels will actively burn and contribute to fire intensity.

Source: Oklahoma Hazard Mitigation Plan

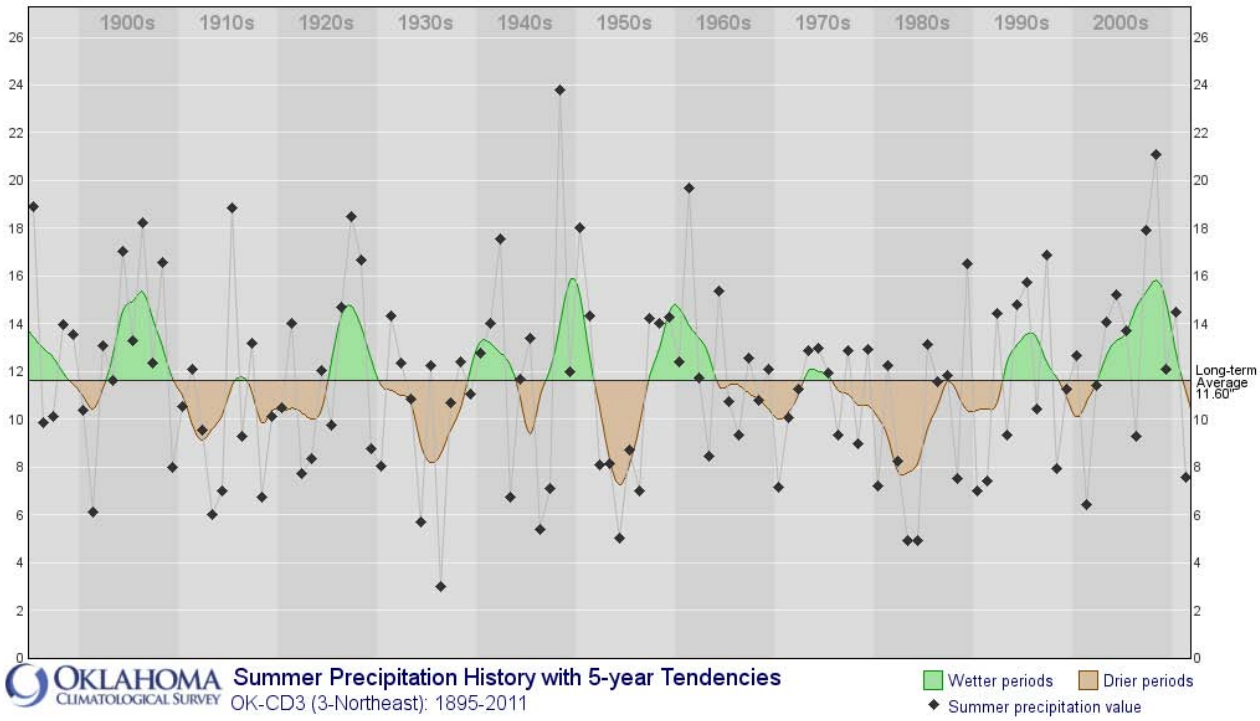
Extent (Magnitude/Severity)

Because of the gradual nature of drought's onset, and its uneven impacts, it is often difficult to determine the beginning and end of a drought event. Based on the Palmer Drought Index, Tulsa drought conditions can range from 4 to –4. This value is adjusted weekly through the Climate Prediction Center. The City of Tulsa considers a drought event of minor severity to be a -2 to 0 on the Palmer Drought Index and a drought event of major severity to be -2 to -4.

Frequency

Long-term forecasts of droughts are difficult and inexact. There is no commonly accepted way of determining the probability that is equivalent to the 100-year or 1-percent-annual flood chance. The US Army Corps of Engineers (USACE) has developed the *National Drought Atlas* to provide information on the magnitude and frequency of minimum precipitation and stream flow for the contiguous United States. On average, the July-to-January period is the lowest six-month period of stream flow throughout the U.S. and is used to characterize drought. The mean monthly flow from July to January has a once-in-20-years chance of falling below a level that would classify it as a drought. In other words, the average occurrence of drought is once every 20 years. Figure 4-19 displays the summer precipitation history in Northeast Oklahoma from 1895 through 2011.

Figure 4–19: Summer Precipitation History, with 5-year Tendencies



Source: Oklahoma Climatological Survey

Drought is a normal part of virtually all climates. However, an ample water supply is critical to the economic well being of the City of Tulsa. Tulsa County and the City of Tulsa experienced severe drought three times from 1995 through 2011, summarized in Table 4-36. Given this frequency, one may conclude that the City of Tulsa can expect a drought once every 5 years. There is no commonly accepted way of determining the probability that is analogous to the 100-year or 1-percent-annual flood chance. A map comparing Oklahoma drought events by county is shown in Figure 4-20.

Table 4–36: City of Tulsa Drought Events 1995- 2011

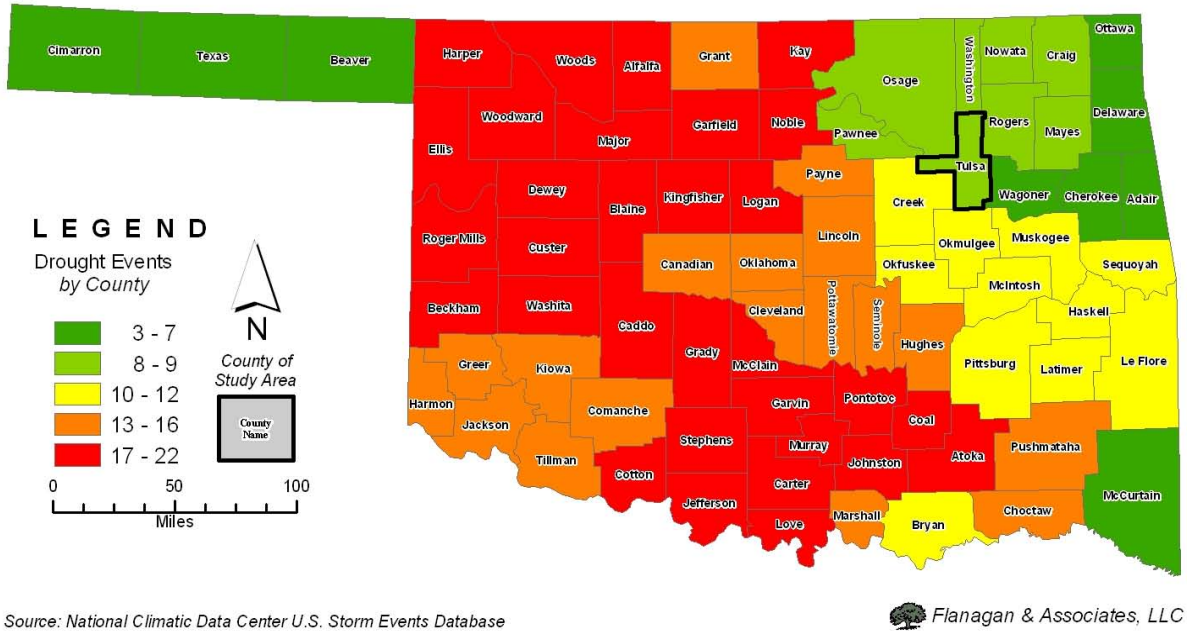
Location	Events	Deaths	Injuries	Property Damages
City of Tulsa	3	0	0	Unknown
Oklahoma	79	0	0	$10,096,284,000

Source: NOAA /National Climatic Data Center

Impact

The most direct impact of drought is economic rather than loss of life or immediate destruction of property. In the City of Tulsa, drought has an impact on the raw water supply. Drought can also impact the quality of the water in water supply lakes and reservoirs due to higher sediment levels. Drought results in an increase in water demands in Tulsa, especially for residential and commercial irrigation. Water shortages can affect fire-fighting capabilities through reduced water flows and pressures. Drought also affects power production, since when water levels drop; electric companies cannot produce enough inexpensive hydropower to meet demand and are forced to buy electricity from other, usually more costly, sources. Infrastructure failure is also an impact of drought, i.e. line breaks due to high demands, pressure differentials, and expansive soils.

Figure 4–20: Oklahoma Drought Events by County 1990-2010



4.7.2 History/Previous Occurrences

Oklahoma began the new century with drought conditions. In early August 2000, an extended period of unusually dry weather lasted for two months. Many parts of the state did not receive rain in August, and portions of southern and south central Oklahoma remained dry for almost 90 days, starting in June. Total agricultural losses were estimated between $600 million and $1 billion statewide. Reservoir levels across southwest and south central Oklahoma averaged 50 percent of normal. Oklahoma experienced record breaking heat and some of the driest conditions since 1921.

According to NCDC, Tulsa County and the City of Tulsa have experienced severe drought during three separate periods in the last decade: an extended period of drought in 2005-2006, followed by droughts in 2011 and 2012. Narratives of these droughts are included in Table 4-37.

Table 4–37: City of Tulsa Drought Event Narratives

Date	Event Narrative
December 2005-April 2006	A sustained period of dry weather and high temperatures spread drought across much of Oklahoma, especially the east central and southeast portions of the state. The winter of 2005-2006 was the second driest since records began being kept in 1895. High winds, combined with dry soil conditions, helped spread the worst series of wildfire outbreaks in Oklahoma history. (See 3.11 Wildfire, below) By April 2006, the severe drought had become “extreme drought” in some areas. Over 40 cities in Oklahoma had to impose some form of water rationing or restrictions on water use. In Tulsa, only 1.59 inches of precipitation fell during the months of December, January and February. The winter of 2005-2006 was the driest ever in Tulsa. On average 5.36” of precipitation falls during the winter months in Tulsa County.
January 2011-November 2011	July 2011 was officially the hottest month on record locally and nationally. High temperatures were over 100° F for almost the entire month. Rainfall totals, especially for in western and southern Oklahoma were little more than a trace. The dry vegetation contributed to several grass fires. The City of Tulsa restricted water use for the first time since the 1980’s during this summer due to the high demand for water.

Date	Event Narrative
Summer 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, while much of the southeastern portion of the state received less than 50 percent of normal. 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. The City of Tulsa initiated voluntary water restrictions in the summer of 2012.

Source: NCDC Storm Events Database

Probability of Future Events

As drought is a direct by-product of normal climatological activity, it is accepted that the City of Tulsa will continue to be vulnerable to droughts of varying severity. Based on drought occurrences over the past 50 years, the City of Tulsa has a MODERATE probability of drought and can expect to experience the effects of a drought cycle about every 5 to 10 years.

4.7.3 Vulnerability

This section summarizes the City of Tulsa's vulnerability to Drought, including the impact on people, structures and buildings, critical facilities, and infrastructure. This information was used to determine the Vulnerability Criteria identified in Tables 4-3 and 4-4. Because of its abundant water supply, the City of Tulsa was determined to have a MODERATE vulnerability to the Drought hazard. (See Tables 4-3, Hazard Risk Analysis, and Table 4-4, Summary of Hazard Risk Analysis Ranking Criteria for an explanation of how the rankings were derived.)

Drought and Water Conditions the City of Tulsa

Tulsa is served by two water treatment plants: Mohawk Water Treatment Plant, originally constructed in 1922, was rebuilt in 1998, with a capacity of 100 MGD; and AB Jewell Water Treatment Plant, built in 1972; with a current treatment capacity of 120 MGD. Raw water is stored in Yahola Lake (2.0 billion gallon capacity) near the Mohawk Plant and the Lynn Lane Reservoir (1.1 billion gallon capacity) near the A.B. Jewell Plant. Tulsa draws its raw water from Lake Spavinaw/Lake Eucha and Lake Oologah. The City of Tulsa has a contract to draw water from Lake Hudson for emergency use, up to enough to replace the water supply of either Mohawk or AB Jewell. Lake Hudson has provided water in the past and is available for future use. Water from Lake Spavinaw flows by gravity to the Mohawk Plant, while water from Lake Oologah is pumped to the AB Jewell Plant.

Since the last plan update, drought conditions for the City of Tulsa have worsened. During summers with average temperatures and rainfall amounts, the City of Tulsa water supply maxes out at about 175 MGD per day. In the summer of 2011, an executive order was issued to begin water restrictions after the use reached an all-time high of 207.6 MGD on August 1, as a result of less rain and higher temperatures, and fell slightly to 207.4 MGD the next day. The previous record of daily water volume was 190.9 MGD, set in 1999. In the summer of 2012, voluntary water restrictions were implemented. The City of Tulsa has four stages of water restrictions as outlined in Title-C, Chapter 13, entitled restricted use of water in times of shortages:

- **Stage 1 - Voluntary Restrictions:** The condition for Stage 1 shall exist when water usage reaches 94% of deliverability each day for 2 consecutive days. Stage 1 would be implemented when demand is 206 MGD for 2 consecutive days. Under Stage 1 conditions, customers will be asked to conserve water voluntarily by limiting outside watering to the hours between midnight and noon every other day based on odd-even house numbering
- **Stage 2 - Mandatory Restriction of Outside Watering to Every Other Day:** The conditions for Stage 2 shall exist when water usage reaches 97% of deliverability each day for 2 consecutive

days, or 213 MGD. Under Stage 2 conditions, the Mayor can order the mandatory restriction of outside watering to the hours between midnight and noon every other day.

- **Stage 3 - Mandatory Restrictions of Outside Watering to Every Other Day with a Hand-Held Hose:** The conditions of Stage 3 shall exist when water usage reaches 100% of deliverability each day for 2 consecutive days, or 220 MGD. Under Stage 3 conditions, the Mayor can order the mandatory restriction of outside watering to the hours between midnight and noon every other day by hand-held hose only.
- **Stage 4 - Mandatory Curtailment of Outside Watering:** The conditions of Stage 4 shall exist when water usage exceeds deliverability each day for 2 consecutive days. Under Stage 4 conditions, the Mayor may prohibit all outside watering.

Water restrictions in the City of Tulsa are targeted at reducing residential irrigation which, as shown in Table 4-38, accounts for nearly 50% of water demand in the City.

Table 4–38: Tulsa Water Demand Components

Entity	FY '10 -'11 Average Demand (MGD)	FY '10 -'11 Average Demand (%)	*Demand Changes Based on Tulsa Population?*	*Tulsa Population Based Demand (%)*
Single Family	31.1	31.59%	*Yes*	*31.59%*
Multi-Family	9.64	9.80%	*Yes*	*9.80%*
Commercial	15.92	16.17%	*Yes*	*16.17%*
Industrial	5.08	5.17%	*No (a)*	
Large Industrial	11.25	11.43%	*No (a)*	
Park/Cemetery/Golf	0.5	0.51%	*Yes*	*0.51%*
Night Watering	0.36	0.37%	*Yes*	*0.37%*
Master Meter Customers	15.51	15.76%	*No (b)*	
WTP Process	0.52	0.53%	*Yes*	*0.53%*
Constructions Meters	0.45	0.46%	*Yes*	*0.46%*
Flushing, Line Breaks, Fire Flow (Unmetered)	8.11	8.23%	*Yes*	*8.23%*
Total Water Consumed	98.45	100.00%		*68%*

(a) Growth Computed at Rate of 1.0 %
(b) Growth Based on Customer Population

Source: City of Tulsa Comprehensive Water Usage Plan

Population

Depending on their severity, drought can affect the health and safety of the affected area. According to the National Drought Mitigation Center, some of these impacts include: anxiety or depression about economic losses caused by drought; health problems related to low water flows and poor water quality; health problems related to dust; loss of human life; threat to public safety from an increased number of forest and range fires; reduced incomes; and changes in lifestyle. Water rationing may be required in order to adjust to low water levels. Information about drought and the need for water rationing in the City of Tulsa should be available to the public. According to the University of Nevada's Drought Monitor, the primary impact currently to the Tulsa area is the effect on wheat production, although other factors listed above may come into play for individual homeowners and businesses.

Structures/Buildings

Drought's primary threat to structures within the City of Tulsa is from its contribution to the shrinkage of expansive soils. More information on this hazard is available in Section 4.13, below.

Critical Facilities

Critical facilities in the City of Tulsa have no special vulnerability to the Drought hazard—other than from expansive soils.

Infrastructure

The effect on infrastructure is, for the most part, similar to the effect on structures, in that the primary danger is drought's effect on expansive soils. In many communities, drought can have impacts on the community's ability for firefighting, with both wildland and structure fires. The City of Tulsa's water supply is sufficiently robust that the Tulsa Fire Department does not consider this an issue at the time of this Plan Update.

Water Treatment – Drought increases the demand for water and at the same time may impact the availability of raw water. The City of Tulsa monitors and regulates its lake levels to mitigate the impacts of drought and conserve water. In addition, the City's primary water supply lakes (Eucha, Spavinaw and Oolagah) are located in different water sheds. Due to differences in local weather patterns, one area may be impacted to a lesser degree than another. The City of Tulsa also has an emergency contract in place to purchase water from Lake Hudson.

Wastewater Treatment – Water shortages during periods of drought can reduce the capacity of wastewater systems. Shrinking soils can cause wastewater pipeline breaks and groundwater contamination

Utilities- No vulnerabilities outside those experienced by other City services/facilities.

Transportation Systems (Highways, Public Transportation, Railway, Airports) – Roadways could potentially face secondary effects (cracking) if located in areas of expansive soils.

Emergency Services- Fire services could potentially be affected if a severe drought reduces availability of water for fire suppression. Police and medical services would not face any vulnerability outside those experienced by other City services/facilities.

4.7.4 Future Trends

For information regarding future development in the City of Tulsa, see Section 1.2.8.

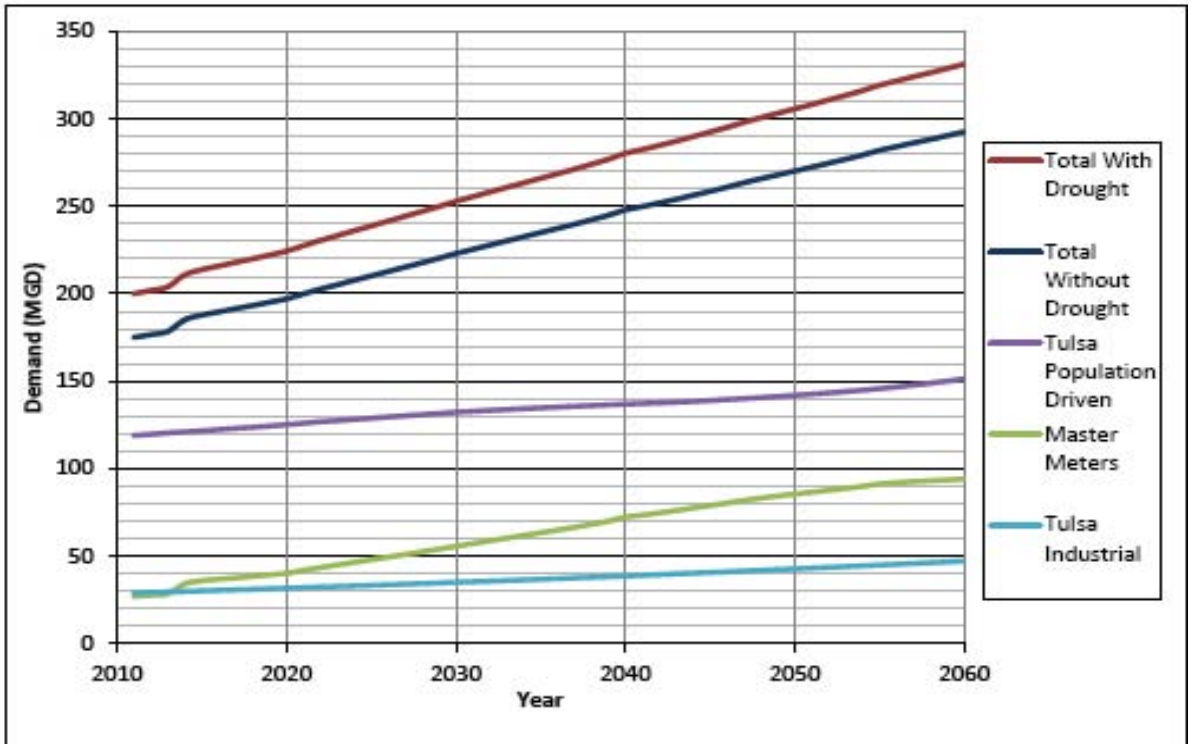
Population

The City of Tulsa Comprehensive Water Plan has projected water demands in the City with drought and without drought to determine the need for an expansion of water treatment and capacity as the population grows. Projected maximum day water demands in Tulsa from 2010 to 2060 are displayed in Figure 4-21.

As drought is primarily an agricultural threat in nature, and Tulsa is a largely urban jurisdiction, the population vulnerable to this threat would remain basically unchanged—other than a possible increase in numbers. The only additional note might be that should the area surrounding Tulsa become affected by a drought severe enough to have an impact on local agricultural businesses, those Tulsa residents dependent on outdoor labor or recreational opportunities for income could be affected by this event.

In order to conserve water in the City during periods of drought, efforts should be made to educate the public on what actions it can take to conserve water, such as: EPA Water Sense, rain gardens, and the cultivation of native plants to reduce the need for irrigation during dry summer periods.

Figure 4–21: Projected Max Day Water Demands



Source: City of Tulsa Comprehensive Water Plan

Structures/Buildings

The primary threat to structures within the City of Tulsa lies in the effect of drought on expansive soils and wildfire. Any future development/renovations undertaken by the City involving structures/buildings should consider measures to limit the likelihood of damage from these two hazards. Though wildland fires are not a threat to the urban center of Tulsa, potential impacts should be considered as urban development moves into agricultural areas. More information on these hazards is available in Section 4.13, *Expansive Soils* and Section 4.14, *Wildfire.*

Critical Facilities

As with other structures/buildings in Tulsa, the most severe threat to critical facilities lies in the secondary effects of expansive soils and wildfires triggered by a severe drought. Critical facilities that have been identified as being located on shrink/swell soils should monitor the integrity of their facilities and plan for that potential. For a discussion of critical facilities in potential expansive soil problem areas, see Section 4.13.

Likewise, these facilities should plan for the possibility of water shortages during drought events, as this would have a severe impact on daycares, nursing homes and other medical clinic/hospital facilities.

Infrastructure

The effect on infrastructure, whether discussing current or future vulnerability, is for the most part similar to drought's impact on structures: the primary danger is from expansive soils and wildfire. As development within the city continues (both new and existing projects), certain considerations should be kept in mind: The capacity, age and condition of the water delivery systems for the city should be reviewed on a regular basis to ensure they can meet the demand of increased and/or relocated populations; location and composition of roadways must be reviewed to ensure appropriate

techniques and materials are utilized to allow for the shrinking and swelling of soils in the event of a major drought; the City's main water supply sources should be monitored during severe heat events to ensure that the trigger points for water emergencies are accurate and sufficient. The recent drought events in western Oklahoma should serve as stimulant to review and develop appropriate emergency plans should the trend for more frequent and severe droughts continue.

4.7.5 Conclusions

Oklahoma and Tulsa County have experienced three short-term droughts in the last decade, in 2005-2006, 2011 and 2012. The severe, long-term drought of the 1930s led to the construction of Oklahoma's numerous hydroelectric dams and reservoirs. More recent drought response and recovery activities, however, have not been as ambitious or far-sighted. The City of Tulsa has a robust and plentiful water supply that is drawn from two separate watersheds, and—until 2011 and 2012—has not had to impose water rationing since the 1980s. The City of Tulsa is considered to have a MODERATE probability of and a MODERATE vulnerability to the Drought hazard.

Data Limitations

There are signs that drought is becoming an increasing problem in the United States, including in Oklahoma. However, it is difficult to predict drought probabilities for the near future due to the nature and complexity of the hazard.

4.7.6 Sources

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City of Tulsa Comprehensive Water Usage Plan, 2012

4.8 Earthquakes

4.8.1 Hazard Profile

An earthquake is a sudden, rapid shaking of the ground caused by the fracture and movement of rock beneath the Earth's surface. Most severe earthquakes take place where the huge tectonic plates that form the Earth's surface collide and slide slowly over, under, and past each other. They can also occur along any of the multitude of fault and fracture lines within the plates themselves.

The faults most likely to affect Oklahoma, and perhaps the City of Tulsa, are the New Madrid Fault, centered in the Missouri Bootheel region, the Meers Fault, located in southwestern Oklahoma near Lawton, and the Nemaha Fault, running north from Oklahoma up through Topeka KS.

As the Earth's crust moves and bends, stresses are built up, sometimes for hundreds of years, before suddenly breaking or slipping. This abrupt release of accumulated tension can be devastating to human communities on the surface. The destructiveness of an earthquake depends upon a number of factors, including the magnitude of the tremor, direction of the fault, distance from the epicenter, regional geology, local soils, and the design characteristics of buildings and infrastructure, such as roads, bridges, and pipelines.

> ***"An earthquake is a sudden release of energy that creates a movement in the earth's crust. Most earthquake-related property damage and deaths are caused by the failure and collapse of structures due to ground shaking. The level of damage depends upon the extent and duration of the shaking. "***
>
> *-Mitigation Ideas, a Resource for Reducing Risk to Natural Hazards, FEMA, Jan 2013*

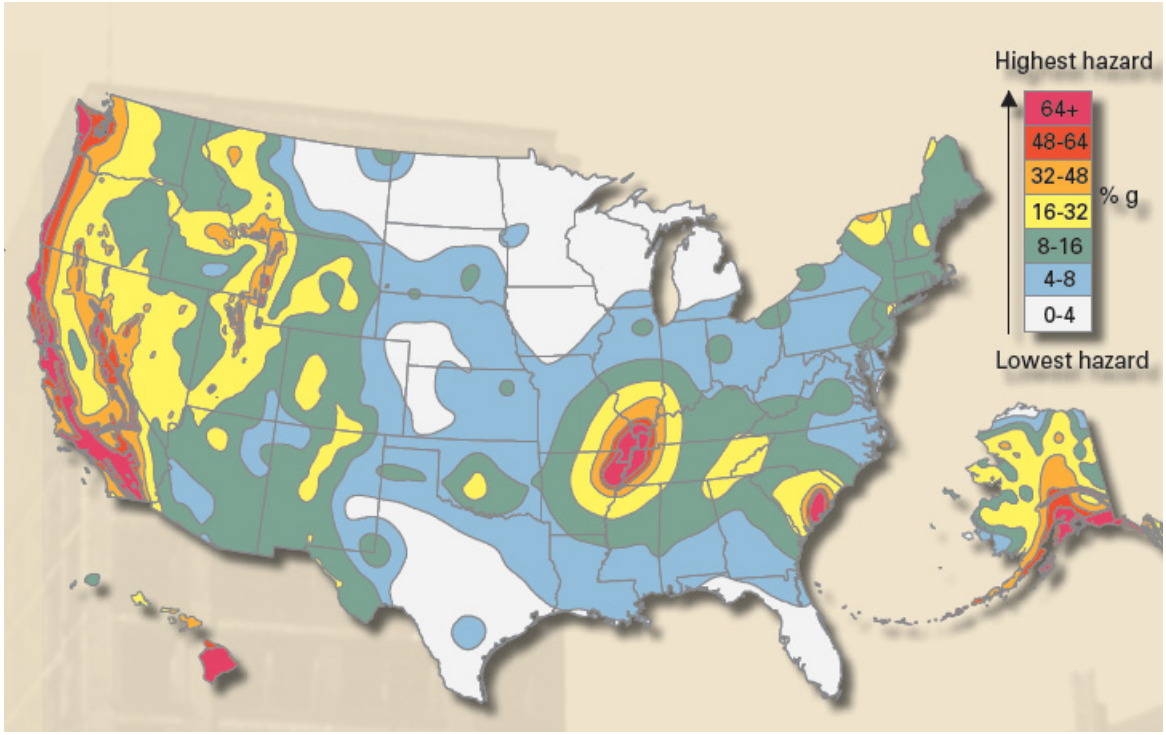
Earthquake intensity can be significantly affected by the stability of underlying soils. For example, during the Northridge, California earthquake, three times as much damage was done to single-family homes and buried utilities in ground failure zones than in nearby areas where the footing was more solid. In addition, the intensity of West Coast tremors is dissipated by the relative "warmth" of the region's geology. By contrast, the thick Pennsylvanian sandstone and limestone strata of the central United States are much more efficient conductors of tremors. Consequently, a 6.8-magnitude earthquake in the New Madrid Fault would have a much wider impact than a comparable event on the California coast.

Location

As shown in Figure 4-22, the majority of Oklahoma earthquakes are concentrated in Garvin, Grady, and McClain counties in south central Oklahoma where the Ouachita, Arbuckle and Wichita mountains converge. All of Tulsa County is equally susceptible to an earthquake as they are not limited to one specific geographic area.

An earthquake occurring in an entirely different state could affect Tulsa County, and consequently the City of Tulsa. Such was the case in 2011 when tremors from a 5.6 magnitude earthquake in Lincoln County, rattled locations across Oklahoma and as far away as Kansas, Missouri, Nebraska, Arkansas, and Texas. In Tulsa, for example, the rattling and shaking from the November 5, 2011 Wilzetta earthquake in Lincoln County went on for about 15 seconds. From a geologic location standpoint, the boundaries of the City of Tulsa create the possibility of damage from an earthquake of sufficient magnitude along the well-known Wilzetta or New Madrid faults. Figure 4-23 displays the geologic rock patterns and fault lines in Tulsa.

Figure 4–22: U.S. National Seismic Hazards Map



Colors on this map show the levels of horizontal shaking that have a 2-in-100 chance of being exceeded in a 50-year period. Shaking is expressed as a percentage of g (g is the acceleration of a falling object due to gravity.) – (Source: USGS, 2008 US Nat'l Seismic Hazard Maps)

Measurement

Modern seismological technology has greatly enhanced the capability of scientists to sense earthquakes. Before the development of today's delicate sensors, only "felt" earthquakes were captured in the historical record.

Two standard measures are used to classify an earthquake's extent: *magnitude* and *intensity*. These measures are sometimes referred to as the Richter Scale (magnitude) and the Modified Mercalli (intensity).

Magnitude is an Arabic number representing the total amount of energy released by the earthquake source. It is based on the amplitude of the earthquake waves recorded on seismographs that have a common calibration. The magnitude of an earthquake is thus represented by a single, instrumentally determined value.

Intensity, expressed as a Roman numeral, is based on the earthquake's observed effects on people, buildings and natural features. It varies depending on the location of the observer with respect to the earthquake's epicenter. In general, the intensity decreases with distance from the fault, but other factors such as rupture direction and soil type also influence the amount of shaking and damage. The Modified Mercalli and Richter Scales are compared in Table 4-39.

Extent/Severity

The City of Tulsa considers an earthquake with a reading of 4.8 and below on the Richter Scale to be an event of minor severity and an earthquake with a reading of 4.9 and above to be an event of major severity.

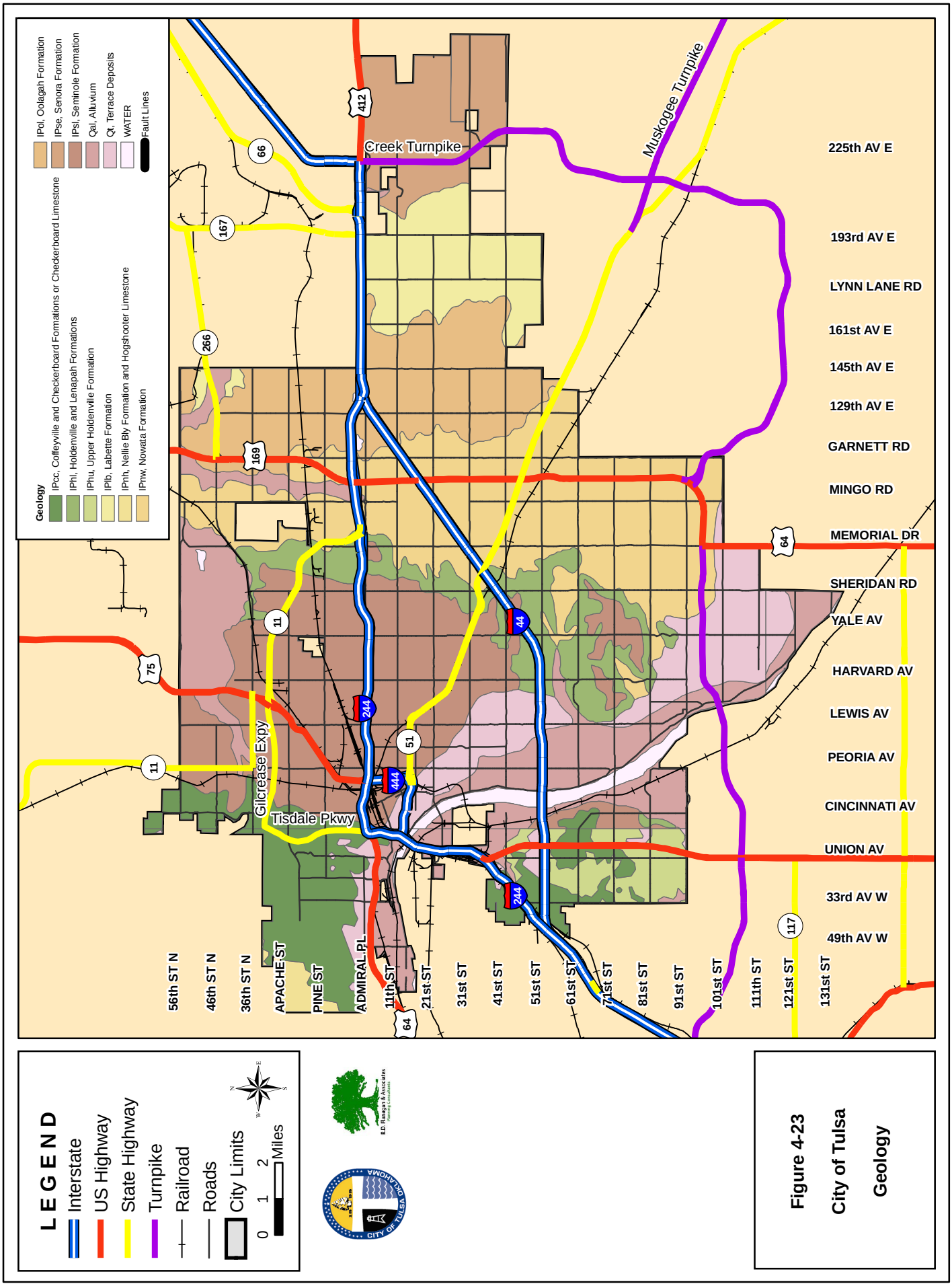


Figure 4-23
City of Tulsa
Geology

Table 4–39: Comparison of Mercalli and Richter Scales

Mercalli	Richter	Description
I	0-4.3	Vibrations are recorded by instruments. People do not feel any Earth movement.
II		A few people might notice movement if they are at rest and/or on upper floors of tall buildings.
III		Shaking felt indoors; hanging objects swing. People outdoors might not realize that an earthquake is occurring.
IV	4.3-4.8	Dishes rattle; standing cars rock; trees might shake. Most people indoors feel movement. Hanging objects swing. Dishes, windows, and doors rattle. A few people outdoors may feel movement.
V		Doors swing; liquid spills from glasses; sleepers awake. Almost everyone feels movement. Dishes are broken. Pictures on the wall move. Small objects move or are turned over. Trees shake.
VI	4.8-6.2	People walk unsteadily; windows break; pictures fall off walls. Everyone feels movement. Objects fall off shelves. Furniture moves. Plaster in walls may crack. Trees and bushes shake. Damage is slight in poorly built buildings. No structural damage.
VII		Difficult to stand; plaster, bricks, and tiles fall; large bells ring. Drivers feel their cars shaking. Some furniture breaks. Loose bricks fall from buildings. Damage is slight to moderate in well-built buildings; considerable in poorly built buildings.
VIII	6.2-7.3	Chimneys fall; branches break; cracks in wet ground. Drivers have trouble steering. Houses that are not bolted down might shift on their foundations. Tall structures such as towers and chimneys might twist and fall. Well-built buildings suffer slight damage. Poorly built structures suffer severe damage. Water levels in wells might change.
IX		General panic; damage to foundations; sand and mud bubble from ground. Well-built buildings suffer considerable damage. Houses that are not bolted down move off their foundations. Some underground pipes are broken. The ground cracks. Reservoirs suffer serious damage.
X		Most buildings destroyed; large landslides; water thrown out of rivers and lakes. Some bridges are destroyed. Dams are seriously damaged. The ground cracks in large areas. Railroad tracks are bent slightly.
XI	7.3-8.9	Roads break up; large cracks appear in ground; rocks fall. Most buildings collapse. Some bridges destroyed. Underground pipelines destroyed. Railroad tracks badly bent.
XII		Total destruction; "waves" seen on ground surface; river courses altered; vision distorted. Almost everything is destroyed. Objects are thrown into the air. Large amounts of rock may move.

Frequency

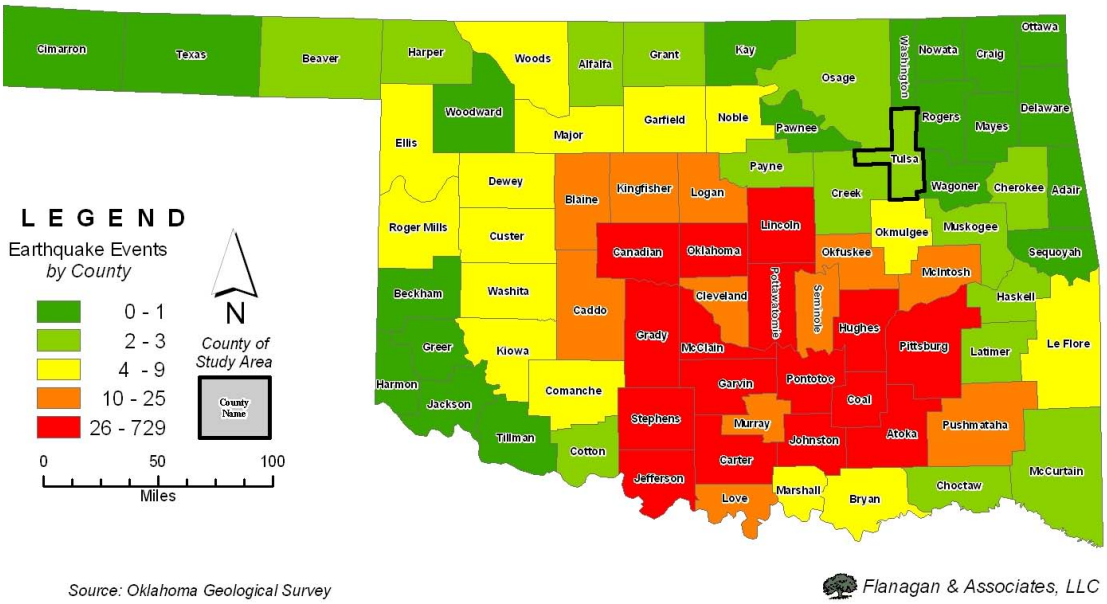
The frequency of earthquakes in Oklahoma has increased annually since 2009. In 2010 there were more than 200 earthquakes recorded in Oklahoma from January through April; 60 of these events were “felt.” According to the Oklahoma Geological Survey, Tulsa County experienced nine earthquakes centered within its boundaries from 1995 through 2011, or about one event every two years. A summary of these events is included in Table 4-40. The events ranged from 1.8 to 2.3 on the Richter Scale. None of the events were centered in the City of Tulsa. A map comparing earthquake frequency in Oklahoma by County from 1990 to 2010 is shown in Figure 4-24.

Table 4–40: Earthquake Events in Tulsa County and Oklahoma from 1995 -2011

Location	Events	Deaths	Injuries	Property Damages
Tulsa County	9	0	0	Unknown
Oklahoma	2,819	0	0	Unknown

Source: USGS/Oklahoma Geological Survey

Figure 4–24: Oklahoma Earthquake Events by County 1990-2010



Impact

The impact of this hazard depends on the intensity of the earthquake. In a GIS environment, a 5.6 Richter event centered near Sparks, OK in Lincoln County was simulated using FEMA-HAZUS-US software. Such as event would not adversely affect any structures, critical facilities or infrastructure in the City of Tulsa, or result in injuries or fatalities.

According to Randy Keller of the Oklahoma Geological Survey, a major quake in the New Madrid area would cause some minor damage in the eastern part of the state. Oklahoma would, however, likely become involved in aiding the victims of a serious New Madrid earthquake, since the State is one of nine associate members of the Central United States Earthquake Consortium.

4.8.2 History/Previous Occurrences

Until recently, the largest earthquake on record in the state—a VII-intensity event that registered 5.5 on the Richter scale—happened near El Reno on April 9, 1952. The 5.6 magnitude earthquake centered in Lincoln County on November 5, 2011 broke this record.

According to Oklahoma Geological Survey, there have been 10 earthquakes centered in Tulsa County since 1983. Five of these events were near the limestone quarries south of Owasso, four were in southwest Tulsa, near Mounds and Glenpool, one was east of Sperry, and one about 400 yards east of Booker T. Washington High School in Tulsa. The quake near Washington High School was a 1.7-magnitude event. (A “felt” quake is normally about 3.5 magnitude and higher.) All of the events were less than 2.5 magnitude. Narratives of some of the more notable earthquake events in Oklahoma are included in Table 4-41. Figure 4-25 show the Historic Earthquakes for the City of Tulsa.

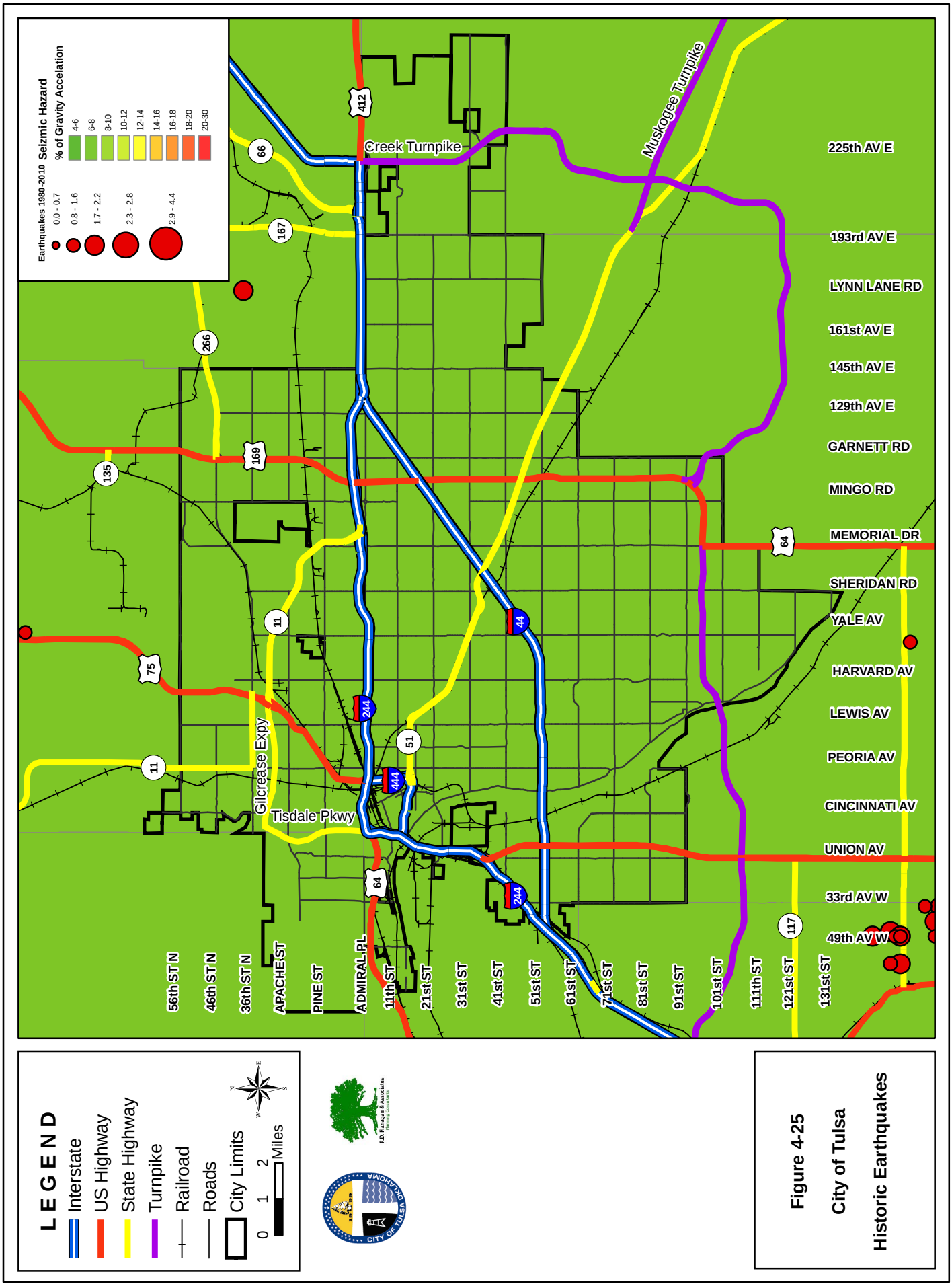


Figure 4-25
City of Tulsa
Historic Earthquakes

Table 4–41: Oklahoma Historic Earthquake Event Narratives

Date	Event Narrative
April 9, 1952	Until November 5, 2011, the largest earthquake on record in the state – a VII-intensity event that registered 5.5 on the Richter Scale – happened near El Reno. It was apparently caused by slippage along the Nemaha Fault. The tremor toppled chimneys and smokestacks, cracked bricks on buildings, broke windows and dishes, and was felt as far away as Austin, Texas, and Des Moines, Iowa.
April 28, 1998	One of the largest earthquakes recorded in Oklahoma, measuring 4.2 on the Richter Scale, occurred near Lawton, at Richard's Spur, in Comanche County. The quake rattled dishes and caused a 14-foot crack to appear in the second floor of the Comanche County courthouse building.
February 8, 2002	A 3.8 magnitude earthquake was detected 5.6 miles north of Lawton. The quake passed from northeast to southwest and lasted about 1.5 seconds. The tremor was described as moderate, lifting and dropping houses with a kind of rolling sensation rather than hard shaking. Pictures were knocked over on dressers.
October-November 2010	A series of four unfelt earthquakes from 2.2 to 2.5 magnitudes occurred in the vicinity of 46th St. N. and 141st E. Ave., south of Owasso, near the limestone quarries, generally between the Mingo Valley Expressway and the Rogers County line.
November 5, 2011	The earthquake activity began with a 4.7 magnitude earthquake which occurred at 2:15 a.m. Saturday November 5, with the epicenter located near Prague. A record-breaking 5.6 magnitude earthquake followed Saturday night around 11 p.m. near Sparks. The quake was felt as far away as Texas, Missouri, Kansas, Tennessee and Wisconsin. More than 40 aftershocks occurred in the Sparks, Prague, Meeker area. The largest aftershock was a magnitude 4.0 reported at 3:39 a.m. Sunday, November 6, according to the U.S. Geological Survey. The Oklahoma State Department of Health reports two minor injuries related to the Saturday night earthquake. Lincoln County Emergency Management reports that 12 homes sustained minor to moderate damage, most involving cracks in sheetrock and brick facade damage. Some roofs and chimneys were also damaged. The event rattled homes in Tulsa for 10 to 15 seconds.

Source: USGS/Oklahoma Geological Survey

Probability of Future Events

The City of Tulsa and its future development areas are at low risk from earthquakes. Any earthquake risk would most likely come from proximity to the New Madrid and Meers faults. According to Dr. James Lawson, chief geophysicist of the Oklahoma Geological Survey's Seismic Observatory at Leonard, the risk of an earthquake in the New Madrid Fault Zone should not be over emphasized. He believes a major seismic event there would have no greater impact on Tulsa than a locally generated earthquake. An 8-magnitude event in New Madrid would likely produce only VI-intensity tremors in Oklahoma, and would not be as severe as the Ft. Gibson quake of 1882. Based on the nine earthquakes centered near Tulsa from 1995 through 2011, the City can expect to experience about one event every two years. The City of Tulsa is considered to have a LOW probability of future earthquake events.

4.8.3 Vulnerability

This section summarizes the City of Tulsa's vulnerability to earthquakes, including the impact on people, structures and buildings, critical facilities, and infrastructure. This information was used to determine the Vulnerability Criteria identified in Tables 4-3 and 4-4. HAZUS modeling was used to help generate the data. The City of Tulsa was determined to have a LOW vulnerability to the Earthquake hazard. (See Tables 4-3, Hazard Risk Analysis, and Table 4-4, Summary of Hazard Risk Analysis Ranking Criteria for an explanation of how the rankings were derived.)

Population

Most earthquake injuries and fatalities occur within buildings from collapsing walls and roofs, flying glass, and falling objects. As a result, the extent of a community's risk depends not just upon its location relative to a known fault, and its underlying geology and soils, but also on the design of its structures. Those populations who do not know how to respond when an earthquake occurs remain vulnerable to potential earthquakes. All populations in the City of Tulsa should be made aware of what actions to take during an earthquake event.

Structures/Buildings

Buildings constructed to earlier seismic standards (or to no standard) can pose major threats to life and the continued functioning of key public services during an earthquake disaster. Un-reinforced masonry structures are the most vulnerable, while wood frame structures typically perform well.

Although located in the relatively quiet Central Plains Province, nearness to the New Madrid, Missouri, fault exposes some Oklahoma communities to VI intensity tremors

Unless secured and braced properly earthquakes can cause mobile homes to topple off their foundations. Earthquakes can cause damages to foundations and ceilings. Glass windows and doors, not made with shatter proof glass, can break and produce shards of glass as a result of seismic forces. Structures made of brick materials and not retrofitted to resist seismic forces are vulnerable to falling brickwork and causing injuries as a result. Based on the HAZUS earthquake scenario, buildings in the City of Tulsa have a low vulnerability to earthquakes. It is not likely an earthquake would cause major structural damage to any City of Tulsa facilities, although there were claims that the historic November 6th, 2011 event in Lincoln County caused some damage to the Excalibur building in downtown Tulsa.

Critical Facilities

Critical facilities face the same potential impacts to earthquakes as other structures/buildings in the City of Tulsa. Of special concern are the design and construction of critical facilities, such as hospitals and transportation facilities, oil and gas pipelines, electrical power and communication facilities, and water supply and sewage treatment facilities and lines.

Infrastructure

It is not likely the City of Tulsa's infrastructure will be impacted by an earthquake, as the city is located in an area of low seismicity.

4.8.4 Future Trends

For information regarding future development in the City of Tulsa, see Section 1.2.8.

Based on a HAZUS analysis that a worst-case scenario would create zero damage to life, health, and structural integrity for the City of Tulsa, there is no reason to believe that any future development will be impacted to any degree greater than existing development. Future structures and buildings constructed to withstand high wind speeds (as discussed in Tornadoes Section 4.3) would also be protected from potential seismic forces.

4.8.5 Conclusion

Tulsa County experienced nine earthquakes between 1995 and 2011, or about one earthquake every two years, none of which were "felt" events. None of the earthquakes was centered in the City of Tulsa. Given this information, Tulsa is considered to have a LOW probability of and a LOW vulnerability to the Earthquake hazard. As calculated using HAZUS software, a 5.6 magnitude earthquake similar to the 2011 event in Lincoln County would cause an estimated $0 in damage. Almost all Oklahoma earthquakes, however, are too small to be felt and cause no visible damage.

Data Limitations

While the HAZUS software is very comprehensive, structural integrity and Code requirements for a jurisdiction can greatly affect the actual damage taken by structures. Earthquake resistant construction is not something routinely considered in Oklahoma, so estimated damages are not as accurate as they might be in a jurisdiction such as California, where earthquake-resistant construction and earthquake events are routinely more closely studied.

4.8.6 Sources

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4.9 Urban Fires

4.9.1 Hazard Profile

Fire Fighters responding to a house fire, one of thousands that occur every year across the state

An urban (structure) fire is one that burns a home or other improved structure. Fire generates a black, impenetrable smoke that blocks vision and stings the eyes, making it often impossible to navigate through or evacuate a building on fire. Structure fire is the fifth leading unintentional cause of injury and death in the United States, behind motor vehicle crashes, falls, poisoning by solids or liquids, and drowning.

Fire kills more Americans than all natural disasters combined. It also ranks as the leading cause of death for children under the age of 15 at home. Approximately 80% of all fire deaths occur where people sleep, such as in homes, dormitories, barracks, or hotels. The majority of fatal fires occur when people are less likely to be alert, such as nighttime sleeping hours. Nearly all home and other building fires are preventable, even arsons. According to the US Fire Administration, in 2009 Oklahoma ranked fifth in number of per capita fire deaths with 21.2 deaths per million residents.

Location

While all Tulsa facilities are at risk from urban structure fire, there are some factors that affect the risk of a fire occurring in a given location. Average age of structures, type of construction, and location relative to fire stations and open woods or grassland can all influence the likelihood or extent of damage of structure fires. Structure fires that occurred in the City of Tulsa in 2011 were mapped by location, displayed in Figure 4-26. The map shows a high concentration of fires in the northwest corner of the City for that year. According to a representative from the Tulsa Fire Department, this map is typical for the city of Tulsa in other years.

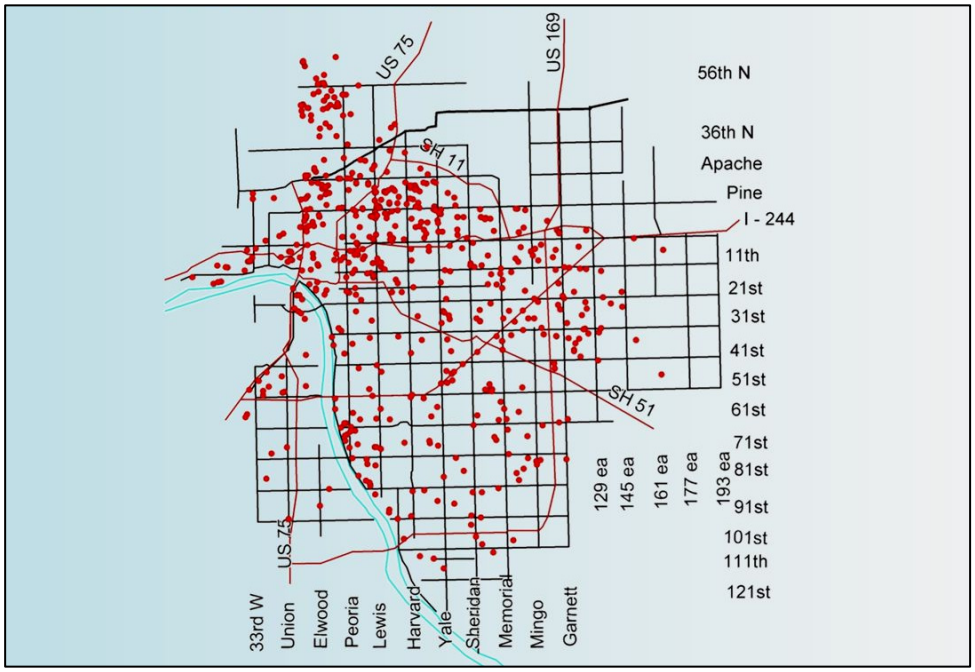
Measurement

Reports on fires are submitted by local fire departments to the State Fire Marshall's Office. This information is organized to show community, county and state summaries. This allows the number of fires that a community has to be measured against state and national averages.

Extent /Severity

The City of Tulsa considers an urban fire event of minor severity to be $5,000 or less in damage and no loss of life or injury and an urban fire event of major severity to be more than $5,000 in damage or loss of life or injury.

Figure 4–26: Tulsa Structure Fires by Location 2011



Source: Tulsa Fire Department

Frequency

According to reports from the State Fire Marshal and Tulsa Fire Department, during the years 2000 to 2011 the City of Tulsa experienced a total of 6,761 structural fires, 1,166 injuries, 72 deaths, and over $138 million in fire damage, including fires in critical facilities. Given this limited data, the City of Tulsa can expect 751 structure fires per year that do about $15 million in damage annually.

Impact

The impact of urban fire can be death and injury to civilians or emergency personnel, the loss of homes and businesses, and the loss of employment and local revenue streams. The loss of homes, businesses, jobs can be devastating to families and communities. According to the National Fire Protection Association, various factors can determine the extent of an urban fire. The contents and age of a structure influence the extent of an urban fire, as do the local weather conditions. Damages from urban fire can range from minor to substantial with damages far exceeding the value of the structure.

In recent years, the impact of urban fire has been greatly reduced due to the improvements in firefighting technology and training of local fire management officials. Improvements in building codes and technology have also enhanced a jurisdiction's ability to contain and mitigate the damage caused by urban fire. Although the extent of an urban fire cannot be qualitatively measured until the fire has occurred and damage assessed, the likely impact of an urban fire can be affected by public information about common fire hazards, notification techniques and procedures, fire department response speed, structure type and age, density of development, presence of flammable substances, water pressure and availability, and the use of smoke alarms.

4.9.2 History/Previous Occurrences

This section contains the best available information about past occurrences of urban fire events in the City of Tulsa. Information regarding the history of urban fire events in was made available through the city of Tulsa Fire Department and the Oklahoma Fire Marshal. Fire Marshal reports are based on information from fire departments state wide. The reports contain quantitative data relating to the

number of fire runs per structure type and the amount of damages (loss of life and property) from 2000 to 2011. Narratives of events in the data are not provided. Tables 4-42 and 4-43 detail the type and number of fires, along with damages related to non-critical facilities fire. Critical facilities that deserve special attention include nursing and retirement homes, hospitals and clinics, child care centers, correctional institutions, schools and colleges. A summary of Urban Fire events at critical facilities in the City of Tulsa from 2000 to 2009 is included in Table 4-44.

Table 4–42: City of Tulsa Urban Fire Damages to Residential Structures 2000-2011

Year	Private Dwellings, 1-2 family		Apartments, 3 or more families		Hotels and Motels		All Other Residential		Total Residential Fires	
	#	Dmg	#	Dmg	#	Dmg	#	Dmg	#	Dmg
2000	419	$9,315,005	136	$2,007,235	12	$140,580	2	$9,000	569	$11,471,820
2001	425	$4,570,621	169	$1,529,416	4	$12,005	20	$161,104	618	$6,273,146
2002	382	$5,234,222	146	$3,167,970	4	$14,000	23	$148,682	555	$8,564,874
2003	408	$5,474,632	158	$1,487,852	4	$10,102	25	$191,204	595	$7,163,790
2004	360	$4,338,608	153	$1,332,757	6	$18,205	40	$1,088,073	559	$6,777,643
2005	412	$6,196,756	156	$1,025,162	4	$1,111	26	$591,675	598	$7,814,704
2006	421	$6,568,098	200	$2,268,223	5	$221,010	31	$436,058	657	$9,493,389
2007	455	$7,822,264	198	$3,155,074	6	$15,200	49	$592,485	708	$11,585,023
2008	398	$5,348,508	175	$4,455,212	13	$188,904	34	$450,113	620	$10,442,737
2009	355	$4,499,651	171	$2,588,642	4	$61,500	22	$467,042	552	$7,616,835
2010	375	$6,247,607	207	$3,470,244	6	$81,075	36	$659,518	624	$10,458,444
2011	475	$8,673,157	211	$5,658,815	8	$75,200	48	$2,910,908	742	$17,318,080
Totals	4885	$74,289,129	2080	$32,146,602	76	$838,892	356	$7,705,862	7397	$114,980,485

Source: Tulsa Fire Department, 2012

Table 4–43: Tulsa Urban Fire Damages in Other Structures 2000-2011

Year	Stores and Offices		Industry,Utility,Defense, Labs,Mfg.		Storage in Structures		Other Structures		Total Structure Fires	
	#	Dmg	#	Dmg	#	Dmg	#	Dmg	#	Dmg
2000	34	$570,935	17	$531,600	25	$954,950	22	$571,400	98	$2,628,885
2001	38	$525,046	9	$29,056	30	$89,353	22	$3,077,272	99	$3,720,727
2002	42	$585,199	10	$127,451	33	$78,301	11	$131,503	96	$922,454
2003	33	$447,169	3	$6,300	37	$315,420	15	$56,209	88	$825,098
2004	29	$317,252	11	$547,003	19	$43,803	11	$38,203	70	$946,261
2005	30	$514,856	12	$116,006	35	$413,003	20	$17,368	97	$1,061,233
2006	29	$1,618,712	15	$598,552	25	$113,153	11	$9,604	80	$2,340,021
2007	31	$764,704	15	$ 268,206	21	$87,202	19	$9,762	86	$1,129,874
2008	36	$861,313	16	$865,001	30	$283,800	15	$2,609	97	$2,012,723
2009	24	$250,074	7	$67,000	24	$2,135,260	18	$31,831	73	$2,484,165
2010	30	$515,501	9	$76,101	16	$355,100	13	$333,713	68	$1,280,415
2011	33	$876,853	15	$271,753	41	$2,199,118	22	$164,277	111	$3,512,001
Totals	389	$7,847,614	139	$3,504,029	336	$7,068,463	199	$4,443,751	1063	$22,863,857

Source: Tulsa Fire Department, 2012

Table 4–44: Tulsa Urban Fire Damages in Critical Facilities 2000-2009

Year	Nursing		Childcare		Hospitals		Correctional		School/ University		Public Assembly		Total	
	#	Dmg	#	Dmg	#	Dmg	#	Dmg	#	Dmg	#	Dmg	#	Dmg
2000	5	$18,600	0	$0	0	$0	0	$0	13	$1,860,975	21	$1,600,400	39	$3,479,975
2001	3	$8.060	0	$0	1	$2	0	$0	14	$274,313	10	$34,611	28	$308,934.06
2002	2	$3,200	0	$0	3	$5,062	0	$0	7	$6,162	19	$753,539	31	$3,788,909
2003	1	$2,001	0	$0	0	$0	0	$0	4	$706	18	$69,320	23	$72,027
2004	4	$203,706	1	$101	1	$2001	0	$0	7	$14,474	26	$574,861	39	$795,143
2005	6	$27,506	1	$2,000	0	$0	0	$0	12	$4,639	20	$759,407	39	$867,170
2006	0	$0	0	$0	3	$155,200	1	$21	6	$3,910	13	$2,050,734	23	$2,209,865
2007	2	$15,501	0	$0	3	$2,600	0	$0	5	$609,006	27	$479,709	37	$1,106,816
2008	2	$8,002	1	$65,000	2	$4,501	0	$0	6	$139,807	16	842,603	27	$3,316,681
2009	0	$0	0	$0	2	$161	1	$501	7	$156,805	15	$1,777,415	25	$1,934,882
Totals	25	$278,524	3	$67,101	15	$169,527	2	$522	81	$3,070,797	185	$8,942,599	311	$12,529,070

Source: OK Fire Marshall Reports 2000-2010

Tulsa School of Arts and Sciences Urban Fire Event

On September 5, 2012 the Tulsa School of Arts and Sciences, also known as the historic Barnard School Building, went up in flames around 5 a.m. The director of the Tulsa School of Arts and Sciences said that the day before the fire, its contractor had been installing a ventilation pipe from the ceiling of the schools chemistry lab to the roof. He said it is standard for chemistry labs to have special ventilation to help remove odors and gases.

Tulsa Firefighters work to contain TSAS Fire

As firefighters got to the scene, the building exploded. Investigators said the fire migrated north under the hallway floor into the classroom, and the crawl space below where it vented from the classroom window. The fire had been smoldering in the crawl space above the school chemistry lab ceiling for hours. When the eight firefighters entered the lab, explosions or "backdraft" occurred as a result of increased oxygen to fuel the fire. Eight firefighters were hospitalized with burn injuries to their faces, hands, and legs after a total of two major explosions occurred just four seconds apart.

The fire was ruled to be accidental. The historic former Barnard Elementary was built in the 1920s, before smoke detectors or sprinklers were required. It had been two years since the building had been inspected by the fire marshal; the building was due for another inspection soon. The school was not equipped with a sprinkler system. The facility was up to code, even without sprinklers, had a built-in

firewall and three monitored smoke detectors, but the nature of the fire was not sufficient to activate the alarms. The buildings metal roof made it harder for the fire to be put out by the fire fighters. Officials say sprinklers could have saved the building.

Probability of Future Events

Based on the number of fire events and level of damages in the City of Tulsa from 2000 to 2011, the City of Tulsa is considered to have a HIGH probability of Urban Fire events.

4.9.3 Vulnerability

This section summarizes the City of Tulsa's vulnerability to urban fires, including the impact on people, structures and buildings, critical facilities, and infrastructure. This information was used to determine the Vulnerability Criteria identified in Tables 4-3 and 4-4. HAZUS modeling was used to help generate these data. The City of Tulsa was determined to have a MODERATE vulnerability to the Urban Fire hazard. (See Tables 4-3, Hazard Risk Analysis, and Table 4-4, Summary of Hazard Risk Analysis Ranking Criteria for an explanation of how the rankings were derived.)

Tulsa Fire Department Resources

As of November 2012, the following resources were available to the Tulsa Fire Department.

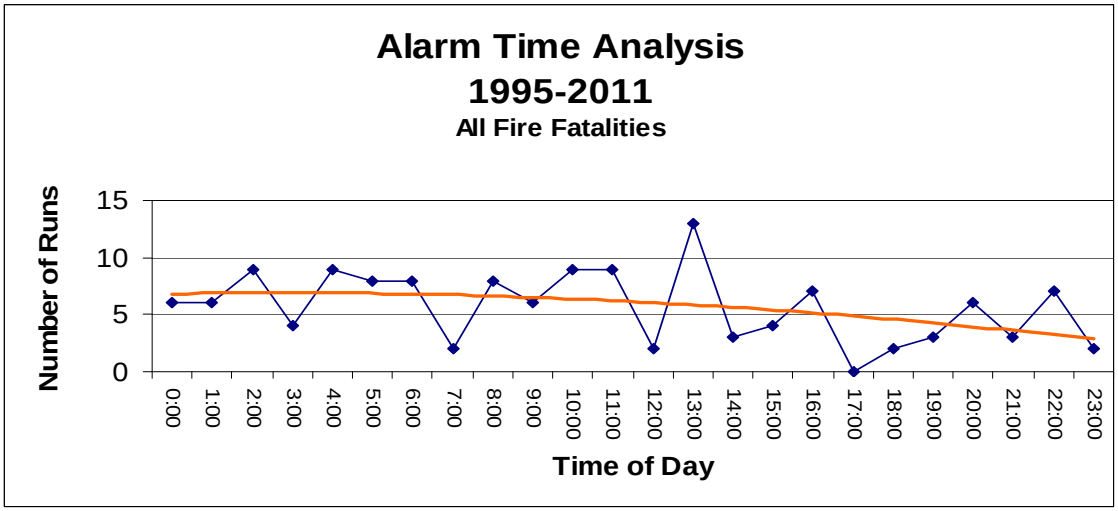
- Five Districts
- Three Platoons
- 208 Emergency Responders daily authorized strength
- 30 Stations (one at Tulsa International Airport)
- 26 Engines
- 12 Ladders
- Four Squads
- Seven Grass Rigs
- HazMat
- Rescue

Population

According to the Tulsa Fire Department, urban fires caused 72 deaths and 1,166 injuries in the jurisdiction from 2000 to 2011. In residences, the majority of fatal fires occur when people are less alert or sleeping. According to FEMA, heat and smoke from fire can be more dangerous than the flames. Inhalation of super-hot air can sear the lungs, and the fire's poisonous gases can cause disorientation and drowsiness. Instead of being awakened by a fire, the gases may cause a person to fall into a deeper sleep. Asphyxiation is the leading cause of fire deaths, exceeding burns by a three-to-one ratio.

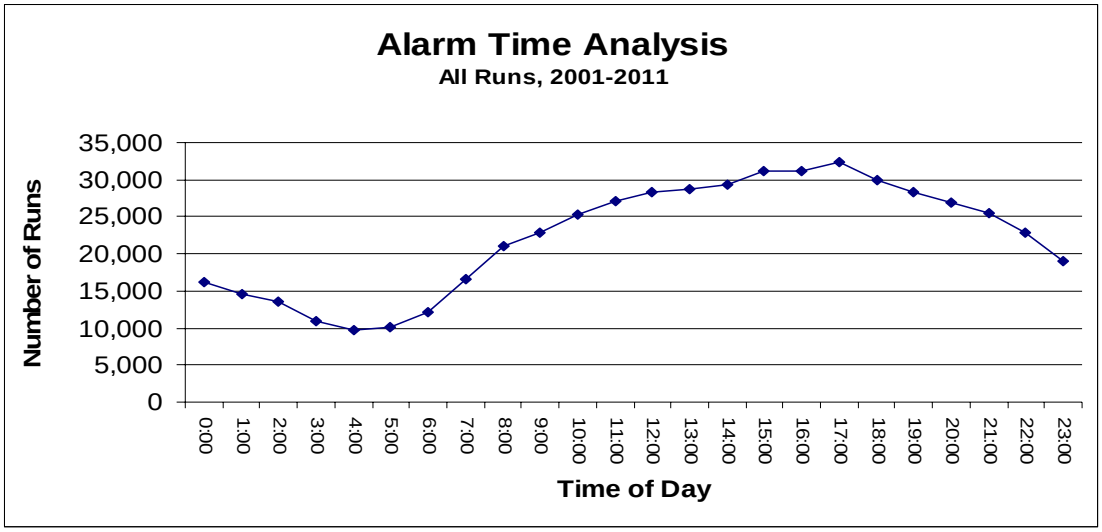
The Tulsa Fire Department provided an Alarm Time Analysis of all fire fatalities from 1995 to 2011, shown in Table 4-45, and all runs in the city of Tulsa from 2000 to 2011, shown in Table 4-46. The data shows that fatal fires in Tulsa do not follow the pattern of total calls. Total calls peak at 5:00 p.m., while fatal fires fall to zero at that time. On the other hand, fatal fires occur when people are least able to react. The 1:00 p.m. spike in fatal fires is an interesting anomaly. In the all-response time analysis, if the response is a measure of human activity, the all-run response curve should make sense, peaking at a time of maximum human activity.

Table 4–45: Tulsa Fire Department Alarm Time Analysis, All Fire Fatalities



Source: Tulsa Fire Department

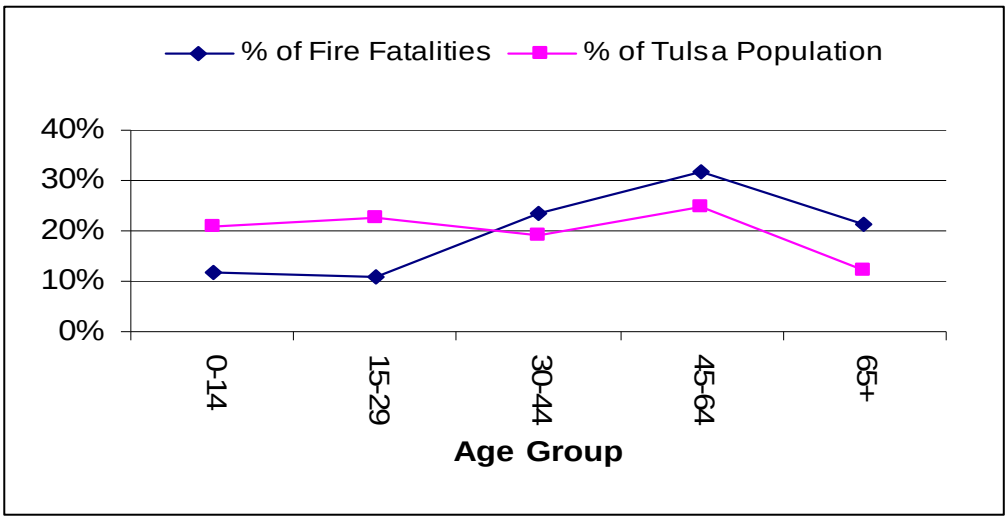
Table 4–46: Tulsa Fire Department Alarm Time Analysis, All Runs



Source: Tulsa Fire Department

In the City of Tulsa, fire victims are typically in one of three cohorts: 30 to 44, 45 to 64, and 65+. The Tulsa Fire Department provided a graph, displayed in Table 4-47, displaying the total number of fire fatalities by age group compared with the total population in Tulsa. The graph indicates fewer fatalities in for the cohorts 0 to 14 and 15 to 29. This could be a reflection of more training and ability to react in lower age groups, resulting in a decreased number of fatalities. Effort should be made in Tulsa to educate populations of all ages, especially aged 30 above, of urban fire dangers. As reported to the United States Fire Administration through the National Incident Reporting System, cooking is the leading cause of residential fires, and home heating is the second leading cause. The Center for Disease Control and Prevention (CDC) reports that most victims of urban fires die from smoke or toxic gases and not from burns as one might expect. The same report indicated that smoking is the leading cause of fire-related deaths.

Table 4–47: Tulsa Fatal Fires by Age of Victim 1995-2011 vs. % of Tulsa Population



Source: Tulsa Fire Department

Some of the vulnerabilities specific to Tulsa are related to flooding, lightning events, and winter storms that result in power outages. These can trigger urban fires, or create conditions that lead to fire, such as the use of alternative heating sources in homes.

Structures/Buildings

Structural fires have a number of different causes. As stated above, according to the CDC the leading cause of urban fire in 2010 was cooking incidents. In many cases, communities with aging infrastructures may be more susceptible to urban fire due to the flammability of materials used in construction and number of structures built before current fire safety, plumbing and electrical codes were implemented. The National Association of Home Builders (NAHB) makes the statement in their *Housing Economics* publication:

> "An overarching cause of residential fire deaths is the age of the dwelling. Both known studies that have looked at this question have found that older structures burn much more frequently than newer ones."

Consequently, while any building is vulnerable to fire, particular attention should be paid to lower-income neighborhoods with older residences and aging commercial structures. Per 2010 Census Data, 48.6% of Tulsa's residential structures were built before 1969, these structures have a significant exposure to urban fire damage.

Historic Barnard Elementary School, September 2012

Critical Facilities

Critical Facilities are prone to the same vulnerabilities described under Structures/Buildings above. Many critical facilities, from retirement homes to Emergency Operations

Centers, are located in older buildings with their intrinsic greater fire susceptibility. City of Tulsa critical facilities are listed in Tables 1-12 through 1-21, and are mapped in Figures 1–21 through 1-30.

All critical facilities within Tulsa should be considered vulnerable to the effects of an urban fire event. Structural integrity may be compromised with even a small fire, rendering the structure unusable.

Infrastructure

Water Treatment – The most significant effect during an urban fire event (other than a fire at one of the water treatment plants, themselves) would be from loss of electrical power.

Wastewater Treatment – The most significant threat to the operation of Tulsa's wastewater treatment facilities during an urban fire event (other than a fire at one of the treatment facilities) would be from power outages.

Utilities –

> **Electricity:** During an urban fire event, AEP/PSO could experience any combination of the following challenges in meeting the needs of the City of Tulsa: Destruction of distribution and transmission poles, downed broken power lines, and danger to workers derived from downed power lines.
>
> **Gas:** During an urban fire event, ONG could experience a variety of challenges in meeting the needs of the City of Tulsa: downed power lines, inaccessibility to gas meters, and extreme temperatures.

Transportation Systems (Highways, Railway, Airports) – Highways and main thoroughfares in the City of Tulsa could be vulnerable to secondary effects from an urban fire event. Smoke blowing across the highway could create limited visibility and result in traffic accidents or the closure of roads and highways. Depending on location of the event, an increased presence of emergency vehicles could slow or inhibit traffic flow on main thoroughfares into and out of the city.

Emergency Services- Fire, Police and Medical services would all be similarly at risk to the secondary effects of an urban fire event. Emergency personnel on scene would be vulnerable to the cumulative affects of heat and toxic smoke generated by the fire itself. Call volume to all emergency service agencies could increase dramatically if it is a large scale event. Likewise, medical services in the area could become taxed should the fire event encompass several units / buildings and include multiple injuries.

4.9.4 Future Trends

For information regarding future development in the City of Tulsa, see Section 1.2.8.

Population

All future populations are vulnerable to urban fires in the City of Tulsa. Seniors are frequently at higher risk from fire injury or death due to decreased mobility skills. With the aging of the population, educational programs that target seniors and senior living centers may become increasingly significant.

With a more challenging economy comes the increased inability to afford adequate daycare resources and an increase in the number of children left to care for themselves during daytime or evening hours while parents are at work. Younger children left on their own, or caring for younger siblings, are at a higher risk from accidental fires. Populations in the City of Tulsa should be encouraged to identify exit routes in their homes, schools, and work places.

Education and outreach should continue to inform all Tulsa populations of urban fire dangers. Public awareness should include education of special populations about the dangers of urban fires. Fire evacuation plans should be promoted in all future development areas.

Structures/Buildings

All new and refurbished structures are vulnerable to the potential effects of an urban fire event. Ensuring that all future commercial and residential development includes appropriate fire detection/protection devices is of considerable importance. The need for fire/smoke detector systems (hardwired with battery backup), sprinkler systems (where appropriate) and fire extinguishers should be considered for all new construction projects.

Properties being refurbished should be evaluated for their resistance to fire, and their compliance to current codes. Preventative measures should be taken in the future to identify and protect structures especially vulnerable to urban fires. More stringent building codes that mandate fire-resistant roofing materials and other measures should be considered in all future development.

Critical Facilities

Regarding the urban fire hazard, critical facilities need to be especially cognizant of “code plus” fire safety requirements that go beyond the minimum fire code. Sprinkler systems, alarm systems, fire resistant roofing and building materials, fire resistant landscaping, and other features are especially important for facilities that cannot afford to be put out of commission.

Infrastructure

Ensuring a minimized effect on the delivery of firefighting service requires forethought and planning in the development stage. Areas currently under development or being considered for development should include the provision for adequate water supplies for firefighting over and above residential or business usage. Adequate streets design to support the arrival, deployment, and departure of firefighting units should also be taken into account.

4.9.5 Conclusion

Fires occur year-round, but the rate of residential fires during the US holiday season and in January is twice that of the summer months. The probability of an urban fire event occurring in the jurisdictions of City of Tulsa is HIGH. As the most common type of disaster, public information should be a strong mitigation response and other possible mitigation measures should be reviewed.

Data Limitations

Local fire department data is sometimes turned over to the State Fire Marshal’s office a year after the year in which events occurred, and it takes time for it to be entered into the state database. Consequently, complete data is frequently two or more years behind. In addition, the Fire Marshal’s office does not list actual number of events, but number of “fire department runs.” Additionally, the data does not distinguish between fire run within the district and outside. For example, the fire department may send a unit for “smoke in a building” at a retirement home, but the unit will return to station quickly, and no damage will occur. Because of this, the number of “structure fires” in the above tables may be higher or lower than the number of runs listed.

4.9.6 Sources

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4.10 Floods

4.10.1 Hazard Profile

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

> ***"A flood is the partial or complete inundation of normally dry land. The various types of flooding include riverine flooding, coastal flooding, and shallow flooding. Common impacts of flooding include damage to personal property, buildings, and infrastructure; bridge and road closures; service disruptions; and injuries or even fatalities."***
>
> *-Mitigation Ideas, a Resource for Reducing Risk to Natural Hazards, FEMA, Jan 2013*

Most flood dangers and deaths are caused by flash floods. Flash floods result from intense storms dropping large amounts of rain within a brief period. The two key elements are rainfall intensity and duration, but topography, soil conditions and ground cover also play important roles.

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.

There are three common types of flooding in Tulsa: riverine flooding, flash flooding, and urban flooding.

Riverine flooding occurs from excessive rainfall in upstream areas that forces rivers and streams to rise and overflow their banks, inundating the adjacent floodplains. Riverine flooding is usually a gradual process, with several hours to several days of warning time for downstream communities. This type of event usually remains in flood for a longer period than flash or urban flooding, and often causes more damage due to the length of time structures are inundated, the velocity and depth of water, and floating debris.

Flash flooding is associated with the large convective thunderstorms that frequent the region that can drop between 1 and 5 inches of rain in the space of an hour. When the soil is already saturated, rainfall from such storms can converge in creeks and streams suddenly, with little warning. Flash floods can reach peak flows within a few minutes. Waters from flash floods move with great force and velocity and can tear out trees, carry away houses and outbuildings, and destroy roads and bridges. These walls of water often carry large amounts of debris, sewage and pollutants. Although potentially hazardous to life and destructive of property, flash flooding usually lasts only a matter of hours.

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

Location

This section contains the locations of Tulsa's creeks and floodplains. Locations of lakes and impoundments, and more detailed information about the Arkansas River, are contained in the sections on dams, levees, and the Arkansas River Corridor.

Floods can lead to "cascading" events increasing the damage – including power outages, health issues, and hazardous materials releases, as illustrated in the above photo where the flood breached an oil refinery

Creeks, rivers, watercourses, and floodplains are laced throughout the City of Tulsa. The jurisdiction's 213 square miles contain 56 creeks and watersheds, which directly or ultimately drain into either the Arkansas River or into Bird Creek, a tributary to the Verdigris River. A major ridgeline runs diagonally through Tulsa, from northwest to southeast. Watersheds to the southwest of the ridge generally flow to the Arkansas River, and those to the north and east into Bird Creek. Figure 4-27 shows the 56 drainage basins that lie partly or entirely within Tulsa. A list of streams and their total drainage area is included in Table 4-48.

FEMA and Tulsa have identified those areas within the watersheds of Tulsa's streams that have a one-percent chance of flooding in any given year. Figure 4-28 is a generalized map showing floodplains that have been identified along the major waterways and rivers. The flooding issues and Critical Facilities for each watershed are covered more closely in Chapter 5, organized by Tulsa City Council Districts 1 through 9, with a special section on the Arkansas River Corridor, which spans many districts.

Table 4–48: City of Tulsa Streams and Drainage Basins

Stream	Total Drainage Area (Acres)	SFHA Area (Acres)	City Regulatory Floodplain Area (Acres)	Tulsa Council District Location
Adams Creek	1,094.40	0.99	67.88	6
Alsuma Creek	563.20	26.23	11.65	7
Arkansas River Local Drainage	4,076.80	411.75	0.79	1,2,4
Arkansas River Mainstem	2,118.40	2,074.13	1.41	2,4,8,9
Audubon Creek	1,798.40	22.75	90.60	5,7
Bell Creek	1,344.00	55.15	152.89	5,7
Bigheart Creek	787.20	0.00	0.00	1
Bird Creek	8,230.40	3,826.66	107.69	1,3
Brookhollow Creek	3,129.60	162.75	67.53	5,6,7
Catfish Creek	825.60	60.13	23.37	7

Stream	Total Drainage Area (Acres)	SFHA Area (Acres)	City Regulatory Floodplain Area (Acres)	Tulsa Council District Location
Center Creek	2,476.80	101.02	116.61	6
Cherry/Redfork Creek	2,233.60	65.06	71.91	2
Coal Creek	6,220.80	348.57	605.85	1,3,4,5
Cooley Creek	3,526.40	234.14	177.69	3,6
Crow Creek	2,080.00	49.95	189.27	4,9
Dickinson Creek	326.40	1.73	0.00	5,6
Dirty Butter Creek	5,478.40	274.34	248.79	1,3
Douglas Creek	2,374.40	160.81	55.01	3,5
Downtown Creek	1,094.40	8.55	0.00	4
Eagle Creek	1,376.00	159.27	94.92	3
Elm Creek	2,297.60	0.12	176.80	1,3,4
Flat Rock Creek	1,548.80	749.89	218.00	1,3
Ford Creek	1,644.80	83.75	40.22	6,7
Fred Creek	2,572.80	99.86	43.72	2,8,9
Fry Ditch No. 1	550.40	0.00	0.00	7,8
Fry Ditch No. 2	2,995.20	145.63	56.64	7;8
Fulton Creek	793.60	41.71	32.19	5,7
Garden City Creek	243.20	70.68	0.00	2
Hager Creek	1,561.60	156.18	66.62	2
Haikey Creek	5,363.20	257.64	141.27	7,8
Harlow Creek	4,448.00	314.21	196.06	1,
Joe Creek	2,464.00	105.99	23.19	2,8,9
Jones Creek	1,164.80	39.31	18.81	5
Jones Tributary Creek	864.00	2.19	25.99	
Left Basin Creek #4	1,145.60	57.07	75.38	3
Little Haikey Creek	332.80	9.66	0.00	6,7
Little Joe Creek	2,796.80	74.09	67.70	5,7,8,9
Little Mingo Creek	1,030.40	101.27	74.18	3
Lower Basin Creek	1,062.40	229.01	324.49	1
Lower Mingo Creek	1,145.60	79.42	85.88	3
Mingo Creek Mainstem	3,641.60	1,215.97	3.63	5,6,8
Mingo Creek Mainstem-LM	1,702.40	98.36	16.91	3
Mingo Creek Mainstem-MU	2,054.40	258.18	26.30	7
Mingo Creek Mainstem-MUM	2,726.40	115.63	117.36	7
Mooser Creek	1,676.80	41.40	127.29	2
Nickel Creek	793.60	0.00	52.94	2

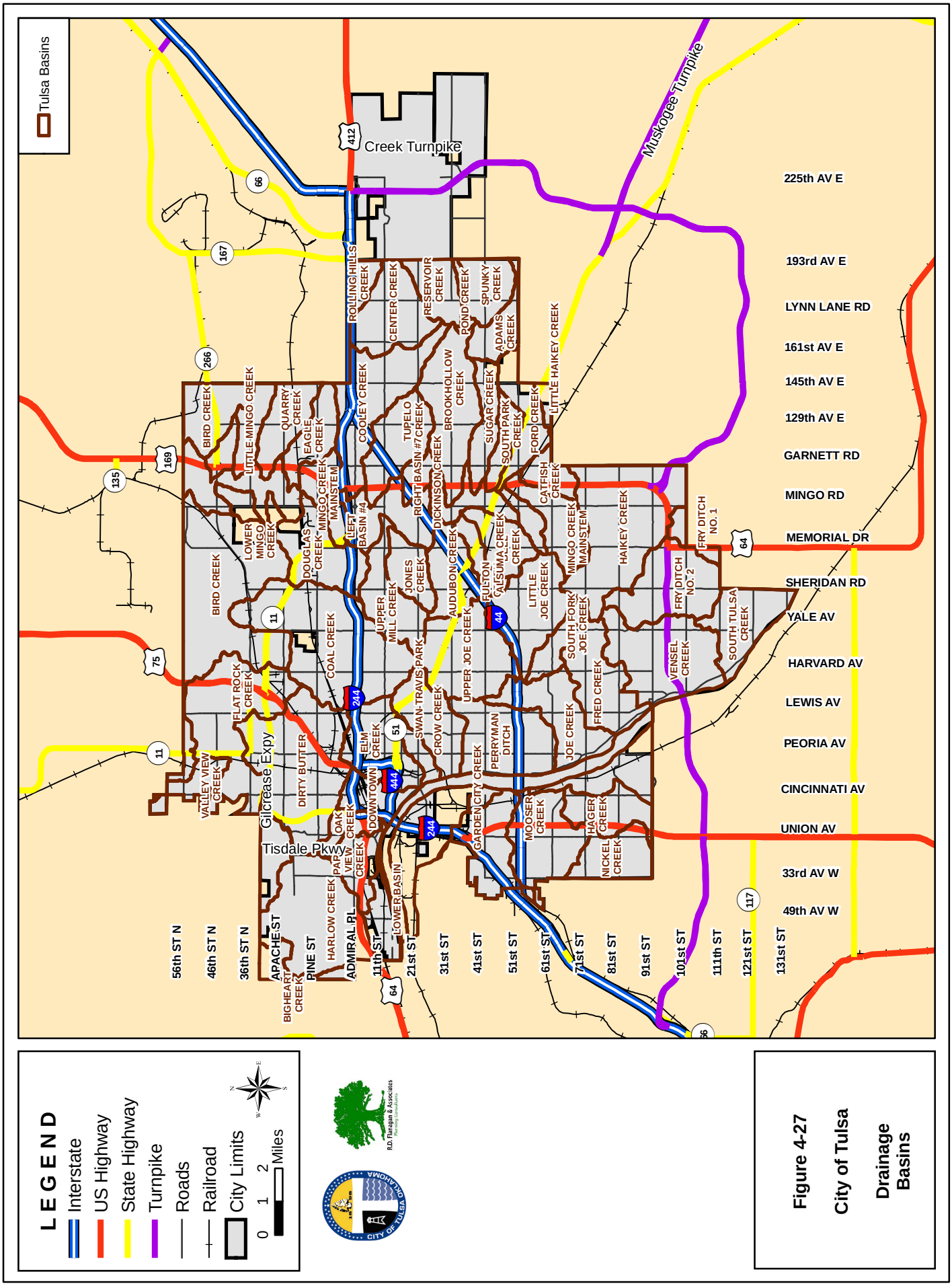
Stream	Total Drainage Area (Acres)	SFHA Area (Acres)	City Regulatory Floodplain Area (Acres)	Tulsa Council District Location
Oak Creek	1,248.00	3.88	255.01	1,4
Park View Creek	3,040.00	16.47	424.22	1,4
Perryman Ditch	332.80	10.36	41.03	4,9
Pond Creek	1,606.40	236.76	42.20	6
Quarry Creek	1,292.80	4.17	62.70	3
Reservoir Creek	576.00	8.44	47.85	6
Right Basin Creek #7	633.60	16.09	15.03	5,6
Rolling Hills Creek	864.00	4.27	0.00	6
South Fork Joe Creek	857.60	52.56	9.38	8,9
South Park Creek	2,144.00	268.34	240.24	6,7
South Tulsa Creek	1,414.40	44.91	123.96	8
Spunky Creek	1,331.20	55.06	27.38	6
Sugar Creek	640.00	2.74	56.27	6,7
Swan-Travis Park Creek	2,163.20	165.45	77.57	4
Tupelo Creek	3,251.20	138.69	204.87	3,5,6
Upper Joe Creek	1,945.60	123.25	0.08	4,5,9
Upper Mill Creek	902.40	55.69	27.10	3,4
Valley View Creek	3,840.00	248.18	107.96	1
Vensel Creek	1,094.40	0.99	67.88	2,8
Total	127,859.20	13,846.52	5,858.26	

Measurement

Floodplain Management is based on what is termed "100-year floods," which is the flood that has a one percent (1%) chance of occurring in any given year. FEMA has established the Special Flood Hazard Area (SFHA), more commonly referred to as the 100-year flood level, as the base flood elevation (BFE) for planning and development along waterways. As a part of its regulatory function the National Flood Insurance Program (NFIP) has established zones which are used in Flood Insurance Rate Maps (FIRM) and have a direct bearing on the flood insurance rates paid by the owner of a structure in the respective zones *(if the owner chooses to purchase flood insurance)*. Flood Insurance Rate Maps change from time-to-time based upon changing conditions within a community that affect the 100-year floodplain. Table 4-49 lists zones identified for use in regulating construction in the floodplain, and for determining insurance rates for properties located in the floodplain. For information on Tulsa's existing floodplain management program, see Section 2.3.2.

The City of Tulsa has identified three key goals for the floodplain and stormwater program:

- Prevent new problems;
- Correct existing problems;
- Enhance the community's safety, environment, and quality of life.


Tulsa Basins
Creek Turnpike
Muskogee Turnpike
Gilcrease Expy
Tisdale Pkwy
225th AV E
193rd AV E
LYNN LANE RD
161st AV E
145th AV E
129th AV E
GARNETT RD
MINGO RD
MEMORIAL DR
SHERIDAN RD
YALE AV
HARVARD AV
LEWIS AV
PEORIA AV
CINCINNATI AV
UNION AV
33rd AV W
49th AV W
56th ST N
46th ST N
36th ST N
APACHE ST
PINE ST
11th ST
21st ST
31st ST
41st ST
51st ST
61st ST
71st ST
81st ST
91st ST
101st ST
111th ST
121st ST
131st ST
BIRD CREEK
LITTLE MINGO CREEK
QUARRY CREEK
EAGLE CREEK
MINGO CREEK MAINSTEM
LOWER MINGO CREEK
DOUGLAS CREEK
COOLEY CREEK
ROLLING HILLS CREEK
CENTER CREEK
RESERVOIR CREEK
POND CREEK
SPUNKY CREEK
ADAMS CREEK
LITTLE HAIKEY CREEK
TUPELO CREEK
BROOKHOLLOW CREEK
SUGAR CREEK
SOUTH PARK CREEK
FORD CREEK
CATFISH CREEK
LEFT BASIN #4
RIGHT BASIN #7
DICKINSON CREEK
MINGO CREEK MAINSTEM
HAIKEY CREEK
FRY DITCH NO. 1
FRY DITCH NO. 2
JONES CREEK
UPPER MILL CREEK
AUDUBON CREEK
FULTON
CALUMA CREEK
LITTLE JOE CREEK
SOUTH FORK JOE CREEK
VENSEL CREEK
SOUTH TULSA CREEK
COAL CREEK
FLAT ROCK CREEK
VALLEY VIEW CREEK
DIRTY BUTTER
SWAN-TRAVIS PARK
UPPER JOE CREEK
CROW CREEK
ELM CREEK
DOWNTOWN
PERRYMAN DITCH
JOE CREEK
FRED CREEK
GARDEN CITY CREEK
MOOSER CREEK
HAGER CREEK
NICKEL CREEK
OAK CREEK
PARK VIEW CREEK
HARLOW CREEK
ADMIRAL PL
LOWER BASIN
BIGHEART CREEK
Figure 4-27
City of Tulsa
Drainage Basins
LEGEND
Interstate
US Highway
State Highway
Turnpike
Roads
Railroad
City Limits
0 1 2 Miles
R.D. Flanagan & Associates
CITY OF TULSA
OKLAHOMA

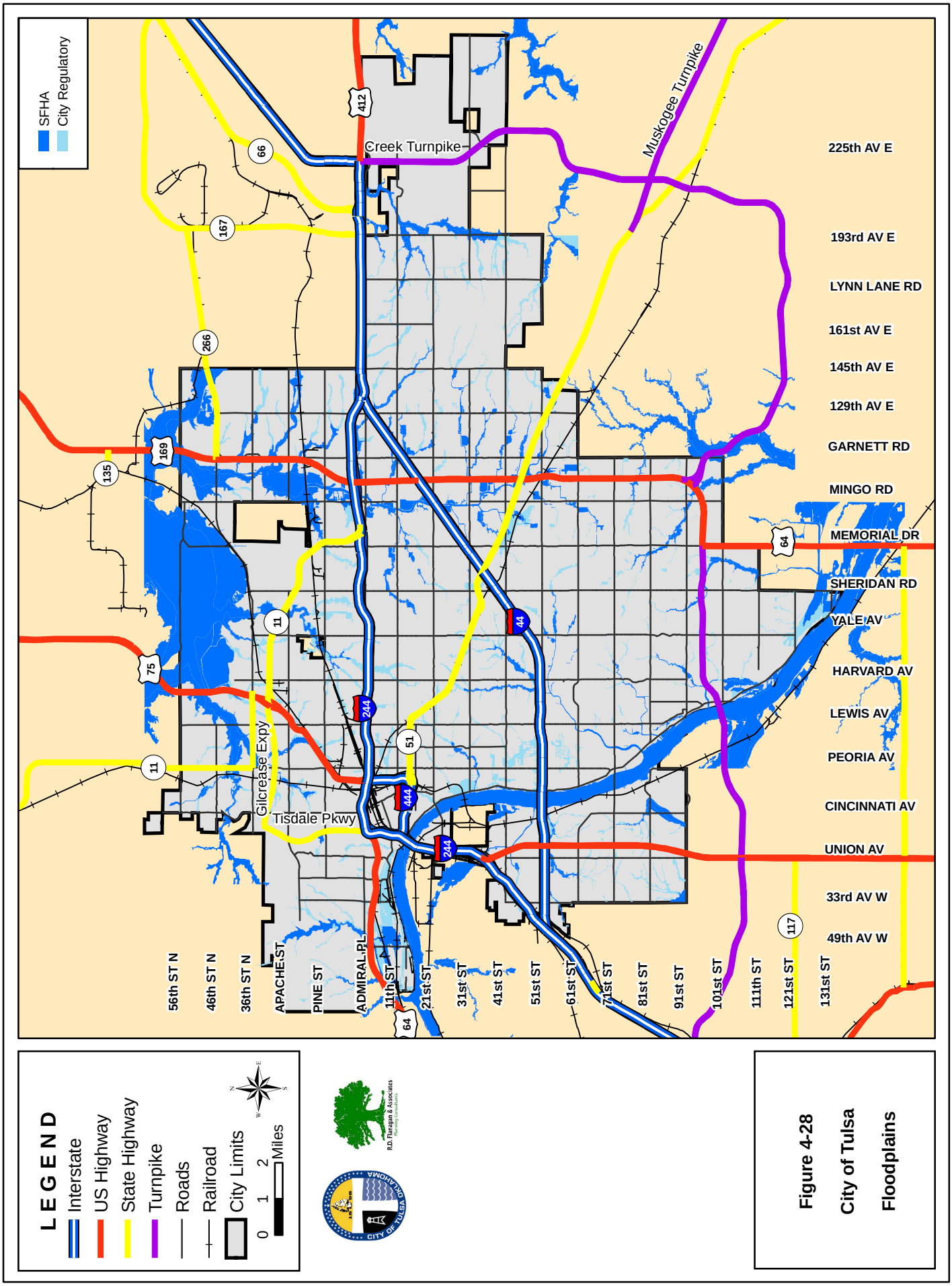


Figure 4-28
City of Tulsa
Floodplains

Table 4–49: FEMA Flood Insurance Rate Map Flood Zones

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

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

Experience has shown that the National Flood Insurance Program's minimum standard is insufficient for Tulsa. Therefore, the city's regulations exceed NFIP's standard in several important ways, as listed in the *City of Tulsa Stormwater Management Plan* and highlighted below.

Ultimate watershed urbanization. Runoff generally becomes deeper and faster, and floods become more frequent, as watersheds develop. Water that once lingered in hollows, meandered around oxbows, and soaked into the ground now speeds downhill, shoots through pipes, and sheets off rooftops and paving.

Insurance purposes require the NFIP floodplain maps to be based on existing watershed development. But unless plans and regulations are based on future watershed urbanization, development permitted today may well flood tomorrow as uphill urbanization increases runoff. Tulsa enforces the NFIP minimum regulations and maps, to retain eligibility for federal flood insurance. In addition, the City

enforces its own more extensive maps and regulations, which are based on ultimate watershed urbanization as forecast in the comprehensive plan.

Watershed-wide regulation. Floodplains are only part of flood-management considerations. Water gathers and drains throughout entire watersheds, from uplands to lowlands. Each watershed is an interactive element of the whole. A change at one place can cause changes elsewhere, whether planned or inadvertent.

Stormwater detention. One way to avoid increased flooding downstream from new development is to provide stormwater detention basins throughout watersheds. New or substantially improved developments must detain the excess stormwater on site - unless they are exempted in master plans or allowed to pay a fee in lieu of on-site detention. Water from detention basins is released slowly downstream. In-lieu fees are allocated for regional detention facilities. In most instances, the City has found regional detention basins to function more satisfactorily than smaller, scattered on-site facilities.

Valley storage. Flood water cannot be compressed. It requires space. Encroachments into a channel or floodplain can dam, divert, or displace flood waters. So Tulsa requires compensatory excavation if a development - including a flood control project - would reduce valley storage. Preserving or recreating floodplain valley storage is a keystone of the City's program.

Freeboard. NFIP regulations require finished floors of new development to be at or above the base flood elevation, based on existing watershed conditions. Tulsa includes freeboard as another margin of safety, requiring finished floors to be at least 1 foot above the regulatory flood elevation, based on ultimate watershed urbanization.

Erosion and sedimentation. Erosion and sedimentation rob hillsides of valuable topsoil, dam lowlands, clog streams, and pollute rivers. Builders must control site erosion from new development.

Permits and performance standards. Tulsa requires a watershed development permit to be issued before developing, redeveloping, building, excavating, grading, regrading, paving, landfilling, berming, or diking of any property within the city. There are five types of watershed development permits: floodway, floodplain, stormwater drainage, stormwater connection, and earth change permits. Individual residential lots outside the floodplain are exempted.

Tulsa's regulations are based on adopted floodplain maps (both Tulsa and NFIP), watershed-wide master drainage plans, and development permits based on specific performance standards.

Source: *City of Tulsa Stormwater Management Plan*

Extent/Severity

Rainfall in the City of Tulsa averages 39 inches per year, but thunderstorms can, and have, dumped more than half that amount on the city in a few hours, causing widespread flooding and devastating flash floods.

Tulsa flood problems are widely dispersed and could be divided into several categories:

- Floods along major waterways with very large drainage basins, such as the Arkansas River and Bird Creek;
- Flash floods along tributary creeks and water ways that ultimately drain into the Arkansas River or Bird Creek;
- Floods that impact streets and transportation systems;
- Localized drainage and nuisance flooding problems.

Arkansas River flood issues are complex for Tulsa. The construction of Keystone Dam and Kaw Reservoir on the Arkansas upstream from Tulsa has greatly reduced the frequency of seasonal

riverine flooding. These flood control dams have not, however, eliminated the potential for catastrophic flooding on the river, as witnessed by the 1986 floods that were caused by forced emergency releases from Keystone Dam due to torrential rains. Additional information about the Arkansas River Corridor is contained in the Arkansas River Corridor section, Chapter 5.10.

Along tributary creeks and waterways, the frequency and magnitude of flooding have been greatly reduced, but not eliminated, by significant advances in Tulsa's floodplain management. The city is still prone, however, to frequent nuisance, street, and localized flooding, remains vulnerable to larger floods along rivers and creeks, and continues to be at risk of catastrophic flooding along the Arkansas River.

There has been little change along Bird Creek in recent years. Bird Creek continues to flood almost annually. Its floodplain is sparsely developed but includes important assets such as the Mohawk Zoo.

Plans to build low-water dams on the Arkansas River at Tulsa, Sand Springs, and Jenks are expected to spur development along the river, but they will also present management and development challenges, based on the river's flooding potential.

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

Frequency

The NCDC Storm Database includes reports of 38 flood or flash flood events specifically naming the City of Tulsa from 1995 through 2011. Recent history has shown Tulsa experiences an average of two or three flood events each year. A summary of these events is included in Table 4-50. A map comparing the frequency of Oklahoma flood events by county from 1990 to 2010 is show in Figure 4-29.

Table 4–50: Floods in Oklahoma and the City of Tulsa from 1995-2011

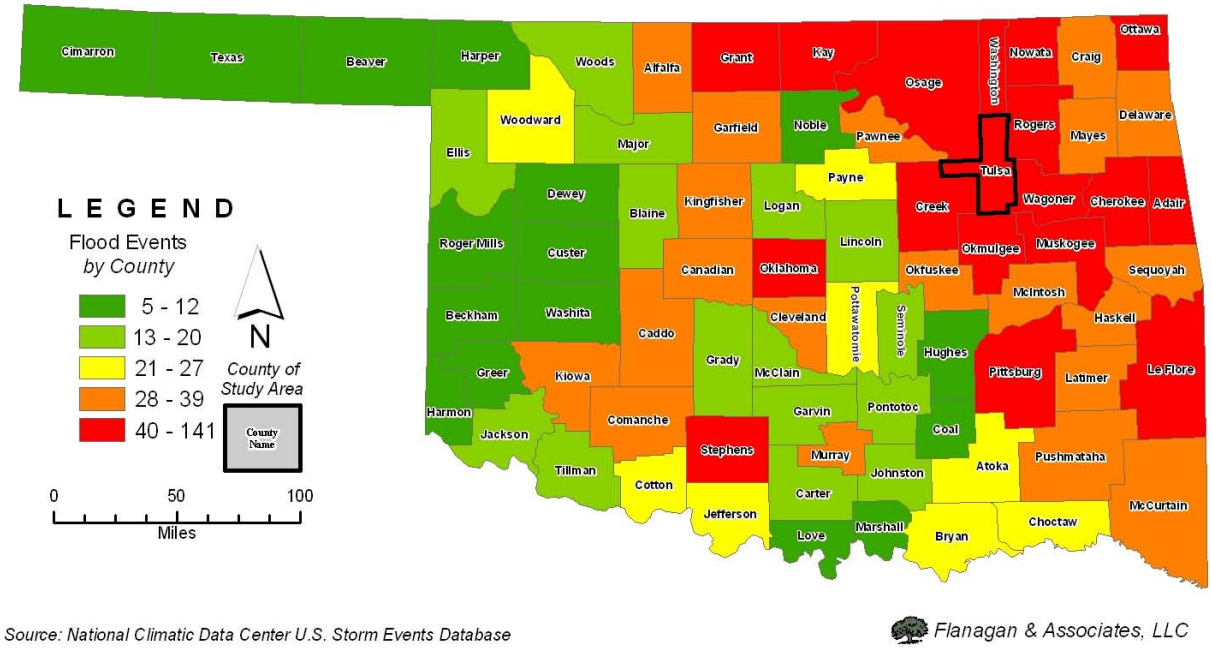
Location	Events	Deaths	Injuries	Property Damage
City of Tulsa	38	1	0	$50,000
Oklahoma	2,049	28	175	$86.4 Million

Source: NCDC Storm Events Database

Impact

The impact of this hazard occurs during and after periods of heavy rainfall, when streams and rivers overrun their banks. Roads and railroads can become impassable. Blocked roads inhibit emergency responders' ability to reach residents in flooded areas, and homes and businesses become inaccessible. Roads closed by floodwaters can create a financial and travel/access hardship to residents, businesses and government entities. According to NCDC, flooding events in the City of Tulsa from 1995 to 2011 caused no deaths or injuries and $50,000 in damages.

Figure 4–29: Oklahoma Flooding Events by County 1990 to 2010



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

Flanagan & Associates, LLC

4.10.2 History/Previous Occurrences

Over the years flooding has been one of Tulsa's most frequent, disruptive, and damaging disasters. Early settlers lived on a high bluff overlooking the Arkansas River, but later development spilled into lowland floodplains. Over the first 100 years of its life, Tulsa experienced some damaging flooding every few years along the Arkansas River, Bird Creek, and their tributary streams. Arkansas River flooding became less frequent after partial levees were built during World War II, and after Keystone Dam was completed in 1964.

In Tulsa, and throughout Oklahoma, floods have accounted for many of the most frequent and most costly weather disasters. In the 15 years between 1970 and 1985, Tulsa County experienced nine major floods, serious enough to be declared federal disasters – the most federal flood disasters on record for any community in the nation to that time.

Flood events have continued to impact Tulsa in recent years. The NCDC Storm Events Database includes reports of 13 flood events in the City of Tulsa since approval of the previous plan. Narratives of some previous flood events in the jurisdiction are included in Table 4-51.

Table 4–51: City of Tulsa Flood Event Narratives

Date	Event Narrative
May 10, 1970.	The Mother's Day Flood in Tulsa caused $163,000 in damages on rapidly developing Mingo and Joe Creeks.
April, May and September 1974	April and May floods left $744,000 in damages on Bird Creek. Violent storms and tornadoes June 8 caused widespread flooding on Joe, Fry, Haikey and Mingo Creeks in Tulsa County, with more than $18 million in damage. On September 19, Mingo Creek flooded again.
May 31, 1976.	On Memorial Day, a 3-hour, 10-inch deluge centered over the headwaters of Mingo, Joe and Haikey Creeks in Tulsa caused a flood that killed three and caused $40 million in damage to more than 3,000 buildings.

Date	Event Narrative
May 26-27, 1984	**The 1984 Memorial Day Flood,** the worst in the city's history, was Tulsa's watershed point. After a muggy Sunday afternoon, a stalled cool front produced some 15 inches of midnight rain, centered over Mingo Creek but also extending across most of the city. The results were disastrous. The 1984 Memorial Day Flood killed 14, injured 288, damaged or destroyed nearly 7,000 buildings, and left $180 million in damage ($257 million in 1994 dollars). Mingo Creek alone accounted for $125 million of the damage. The newly elected mayor and street commissioner had been in office for only 19 days, but both knew the issues well. In the darkest hours of the city's worst disaster, they pledged to ensure that such a disaster would never be repeated. Before daylight, they had assembled the City's first Flood Hazard Mitigation Team to develop the community's strategy. Within days, a new approach to Tulsa flood mitigation, response and recovery was developed. As ultimately implemented, the program included the relocation of 300 flooded homes and a 228-pad mobile home park, $10.5 million in flood control works, and $2.1 million in master drainage plans. The total capital program topped $30 million, mostly from local capital sources, flood insurance claim checks, and federal funds.
October 1986	**The 1986 Arkansas River Flood** was a first test of the new stormwater management program. It also served as a reminder of the finite protection of Keystone Dam. Between September and October 1986, Keystone Reservoir filled to capacity, forcing the Corps to release water at the rate of 310,000 cubic feet per second. Downstream flooding was inevitable. At Tulsa, a private westbank levee failed, causing $1.3 million in damage to 64 buildings. The city fielded its hazard-mitigation team and cleared 13 substantially damaged structures.
May 29,1994	Heavy rainfall resulted in flash flooding in the west and south parts of Tulsa. Hager Creek overflowed its banks, and some homes were evacuated. Some structures near 81st Street South and Elwood Avenue had 2 to 4 feet of water in them, and houses were also flooded near 71st Street South and Harvard Avenue. A total of 8 to 12 homes were flooded in the city. Numerous roads were closed due to the flooding, including Interstate 44 from 33rd West Avenue to Union Avenue. Water was waist deep on the access road to I-44, and 1 foot deep on the interstate itself.
October 5, 1998	Major street flooding in Tulsa included the areas of 31st and Yale, 96th and Sheridan, and two feet of water over the road at 28th and 129th East Avenue. The basement of the Southwestern Bell telephone building in downtown Tulsa took on water, causing the loss of phone service across much of the city for several hours and temporarily disabling 911 emergency services. Cell phones, pagers, and 911 emergency services across much of eastern Oklahoma were also affected. One woman had to be rescued on a bridge near 101st and Garnett when her car stalled in four feet of water. Two other women had to be rescued when they tried to cross a swollen creek on foot at 81st Street near the Oak Creek subdivision. Damages were estimated at $30,000, not including the economic impact of the phone service interruption.
August 26, 1999	More than 20 streets in Tulsa had to be closed. Tulsa police responded to 39 vehicles that were stalled in high water. Lower Mingo Creek overflowed, flooding undeveloped areas near 36th Street North. Lower Haikey Creek at 101st Street also escaped its banks. Northern Tulsa County had flooding along the Bird Creek. Damages for the countywide event were estimated at $40,000.
May 6, 2000	Over 6 inches of rain fell over Tulsa County, causing widespread flooding. Flood damage was reported in Jenks, Bixby, Glenpool, south Tulsa and Broken Arrow. Numerous roads and intersections were flooded. Damage to roads, bridges and infrastructure was estimated at $200,000, while countywide it was about $3 million. One fatality occurred when a woman attempted to cross a street flooded by a nearby stream. Her car stalled, and with the water rising so quickly, she got out of the vehicle and was swept away.
September 8, 2007.	Heavy rain caused widespread severe street flooding across the city. Numerous vehicles were stranded in the floodwaters. The worst reports of flooding were on Sheridan Avenue between South 42nd and 46th Streets, where water was three to four feet deep. Damage was estimated at $30,000.
April 24, 2008	Heavy rain caused flooding in Mohawk Park, which required Mohawk Zoo to be closed. No damages were reported

Date	Event Narrative
June 4, 2010	Thunderstorms dumped heavy rain in northeast Oklahoma. A number of streets were closed for several hours in Tulsa because of flash flooding, including 46th and Sheridan, 76th and Riverside Drive, 81st and Elwood and the 1300 block of North Louisville. A few reports were received of vehicles stranded in high water.
March 19, 2012	Severe thunderstorms developed along a cold front that pushed into the region during the midday hours of the 19th. The thunderstorms evolved into a line as they pushed eastward and produced damaging wind, large hail and a brief tornado over eastern Oklahoma. The slow moving nature of the complex also resulted in widespread flash flooding across the region. Vehicles we reported stranded in high water near W 81st Street South and S Elwood Avenue in Jenks.

Source: NCDC Storm Events Database/City of Tulsa Records (*dollar amounts are not adjusted for inflation)

Probability of Future Events

Current flood planning is based on what are termed "100-year floods" or "500-year floods." That terminology is somewhat misleading and is changing to floods being referred to as having a 1% chance of occurring in any given year.

Depending on the extent of the rainfall, such larger storms could be expected to inundate floodplain lands and the roads, bridges, buildings, and other structures thereon. The frequency and magnitude of floods that could threaten people or property depends, in large part, on the magnitude and location of the rain and the condition of the receiving systems. For example, on-the-ground conditions such as debris in creeks could exacerbate flooding problems.

No probability has been assigned for other potential causes of Tulsa flooding, such as waterline breaks or snowmelt, because those flooding causes cannot be predicted statistically or are infrequent within the jurisdiction. Flooding hazards from dam or levee breaks and flooding lake releases are discussed in the report section for those hazards.

Based on the 38 flood events that occurred from 1995 through 2011, the City of Tulsa is considered to have a HIGH probability of future flood events. The City should expect an average of two or three flood events each year.

4.10.3 Vulnerability

This section summarizes the City of Tulsa's vulnerability to the Flood hazard including the impact on people, structures and buildings, critical facilities, and infrastructure. This information was used to determine the Vulnerability Criteria identified in Tables 4-3 and 4-4. HAZUS modeling was used to help generate these data. The City of Tulsa was determined to have a HIGH vulnerability to the Flood hazard. (See Table 4-3, Hazard Risk Analysis, and Table 4-4, Summary of Hazard Risk Analysis Ranking Criteria for an explanation of how the rankings were derived.)

Population

In the City of Tulsa, 7,250 residential single family structures and 244 residential multi-family structures are touched by the regulatory floodplains. In a citywide 100-year flood, over 31,000 individuals could be displaced by flooding within or near the inundation areas.

Those at greatest risk include persons living in residences located in repetitive flood areas for the larger events. Also at risk are those traveling by car and on foot in areas that are known to experience flooding during heavy rains. Motorists continue to ignore barricades and warnings against driving on flooded roads and run the risk of becoming stranded in their vehicles. Just two feet of water moving at 10 mph will float virtually any car, SUV or pickup. Too often the rate of the water's rise is not appreciated and people become trapped in the vehicle – as reported in May 2000 when a woman was

traveling on Sheridan Avenue between 71st and 81st Streets and crossed a road that was flooded by a nearby creek. The vehicle stalled in the rapidly rising water forced the woman to flee the car, where she was swept away and drowned. A map showing streets commonly barricaded during flood events is shown in Figure 4-30; frequently flooded intersections are shown in Figure 4-31.

Flood events can, and in Tulsa's history have, become so severe that evacuation of homes and businesses is necessary. Those who are directed to evacuate an area due to rising water but are without appropriate transportation could be at greater risk. Likewise those being directed to evacuate, but are not willing to leave their homes for fear of looting, or not willing to leave pets behind, may resist such instruction, thereby placing themselves at risk. Additionally, for persons for whom English is not their first language, risk could be higher as they may not understand the true nature of the hazard and fail to take necessary precautions.

Floodwaters also put the public at risk due to mold. Residents whose homes have been inundated by floodwaters face the risk of serious health problems due to mold; especially if their exposure to mold is for an extended period of time.

Structures/Buildings

In Tulsa, 8,702 existing structures of all types are touched by the floodplains of its rivers and streams, listed in Table 4-52. Structural values used in this assessment were from the Tulsa County Assessor's Office. It is estimated that the average structure will experience 2 feet of flooding, which will result in 25% damage to the structure and 25% damage to contents. As previously mentioned, damaged structures face the additional risk of mold growth. Mold growth and moisture have the ability to ruin building contents and eventually may compromise the integrity of the damaged structure.

Table 4–52: Structures Touched by 100-year Floodplain

Improvement Type	*Number*	*Est. Market Value*
Residential Single-Family	7,250	$542,952,240
Residential Multi-Family	244	$74,385,423
Commercial	371	$190,452,245
Industrial	89	$61,441,911
Other	748	$96,451,852
Total	8,702	$966,035,933

Source: Tulsa County Assessor's Office, 2012

Flood Insurance Policies

According to *FEMA Flood Insurance Policy and Claims Statistics*, as of December 31, 2013, in the City of Tulsa there were 1,825 flood insurance policies in-force, with a total value of $415,014,800, and 2,578 total losses paid, in the amount of $38,909,317.

Repetitive Losses

FEMA defines Repetitive Loss (RL) properties for which two or more National Flood Insurance Program losses of at least $1,000 each have been paid within any rolling 10-year period. The term "rolling 10-year period" means that a claim of $1,000 can be made in 1991 and another claim for $2,500 in 2000; or one claim in 2001 and another in 2007, as long as both qualifying claims happen within 10 years of each other.

During the 5-year update mitigation was completed, resulting in the removal of 39 properties from the FEMA RL list. Tulsa currently has 93 properties on its FEMA Repetitive Loss list, listed in Table 4-53: 48 Residential, 18 Multi-Family, 21 Commercial, and 6 Industrial. Of the 93 properties,

23 are located in the SFHA, 16 in the City Regulatory Floodplain, and 54 are outside the 100-year floodplain.

Table 4–53: City of Tulsa Repetitive Loss Property Count and Claims

Type	SFHA		City Regulatory		No Floodplain		Totals	
	#	Claims	#	Claims	#	Claims	#	Claims
Residential Single-Family	16	$359,927.11	10	$143,102.15	22	$604,337.91	48	$1,107,367.16
Residential Multi-Family	0	$0.00	0	$0.00	18	$264,401.88	18	$264,401.88
Commercial	5	$453,844.75	5	$178,223.94	11	$582,856.67	21	$1,214,925.36
Industrial	2	$421,588.11	1	$30,572.11	3	$35,495.85	6	$487,656.07
Totals	23	$1,235,359.97	16	$351,898.20	54	$1,487,092.30	93	$3,074,350.47

Tulsa has developed a Repetitive Loss Plan that recommends the measures needed to solve the flooding problem of each repetitive loss property. Tulsa's strategies include:

- Construction of flood protection projects, such as channel improvements and stormwater detention ponds;
- Construction of small local projects, such as storm sewers, culvert replacements, and drainage ditches;
- Acquisition of the property and removal and demolition of the building.

The Federal Privacy Act of 1974 (5 U.S.C.553a) stipulates no personal identifier in any information released to the public can be used by communities when describing RL properties. A map showing the locations of Tulsa's repetitive loss properties is included in Figure 4-32.

Not all properties that sustain repetitive flooding are considered to be an RL property. It is important to consider the area, rather than a collection or cluster, of properties when examining repetitive flooding problems. All properties at risk should be captured, not just the ones that have made the RL list. A Repetitive Loss Area Analysis (RLAA) is a careful examination and mitigation assessment for an area with a high number of RL properties.

As a condition of its participation in the CRS program, Tulsa must discuss its RL properties and Floodplain Management Planning. The Tulsa Floodplain Management Plan was last updated in 2008 as part of the three year CRS verification. At the time 130 RL properties and 20 RLAs were identified; 18 RL properties were insured. In 2008, an RLAA was conducted on the 20 RLAs identified. Included in each RLAA are property identifiers, claim information, structure type and description, and photographs. The cause of flooding is also included in each RLAA. The City of Tulsa Floodplain Management Plan is in the process of being updated. The update will be submitted as part of the CRS review and included in the 5-year update of the Hazard Mitigation Plan.

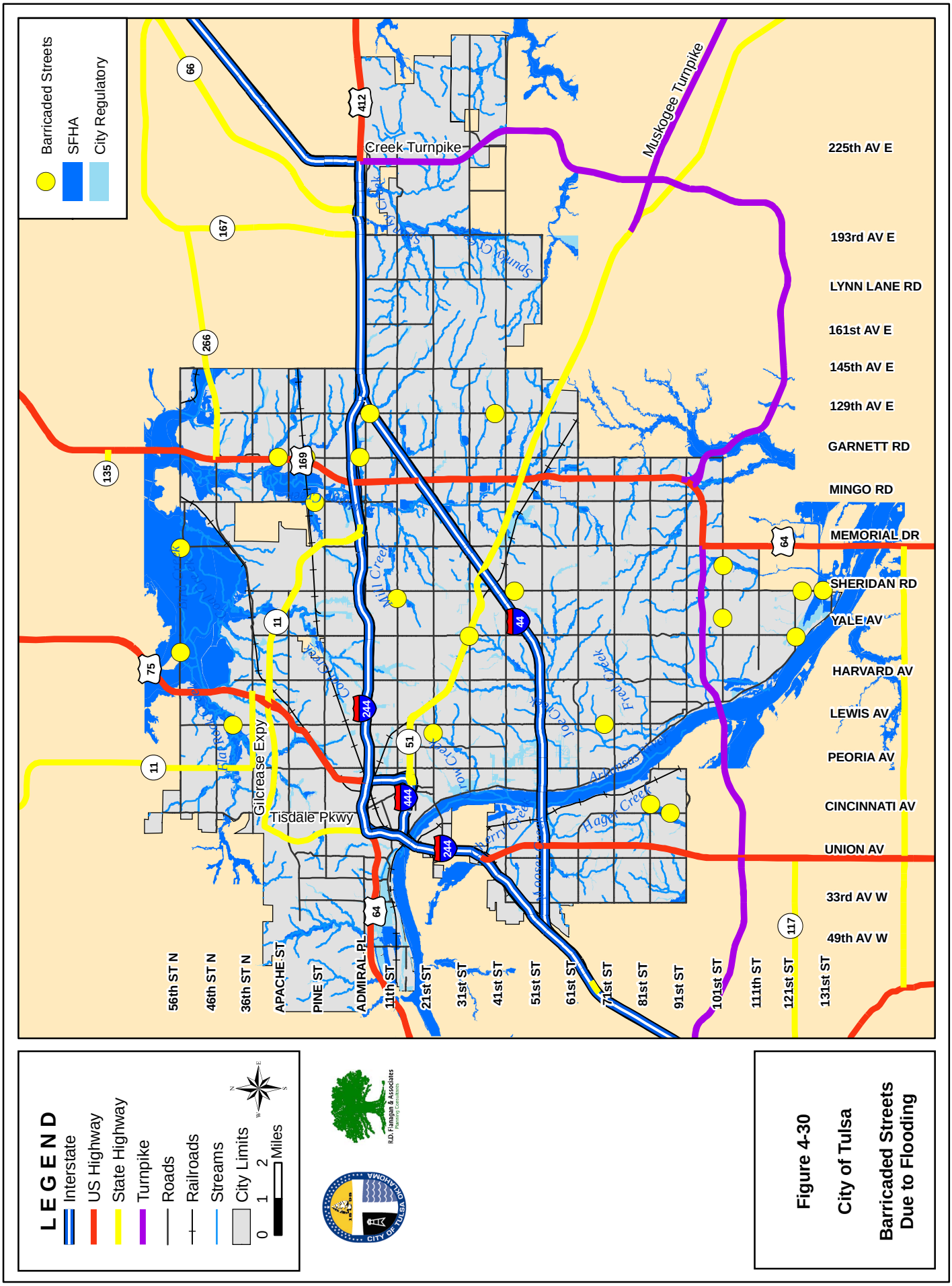


Figure 4-30
City of Tulsa
Barricaded Streets Due to Flooding

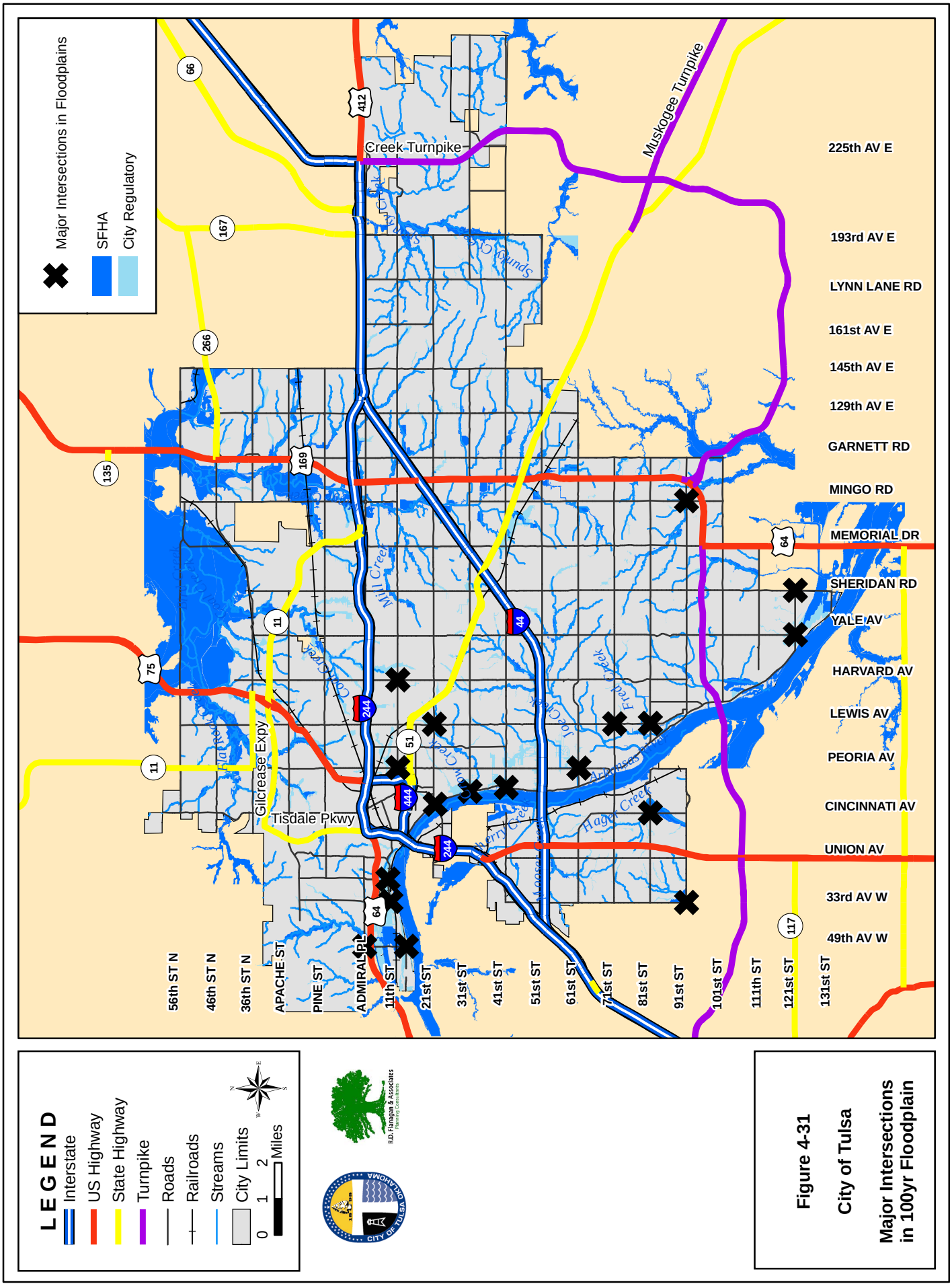


Figure 4-31
City of Tulsa
Major Intersections in 100yr Floodplain

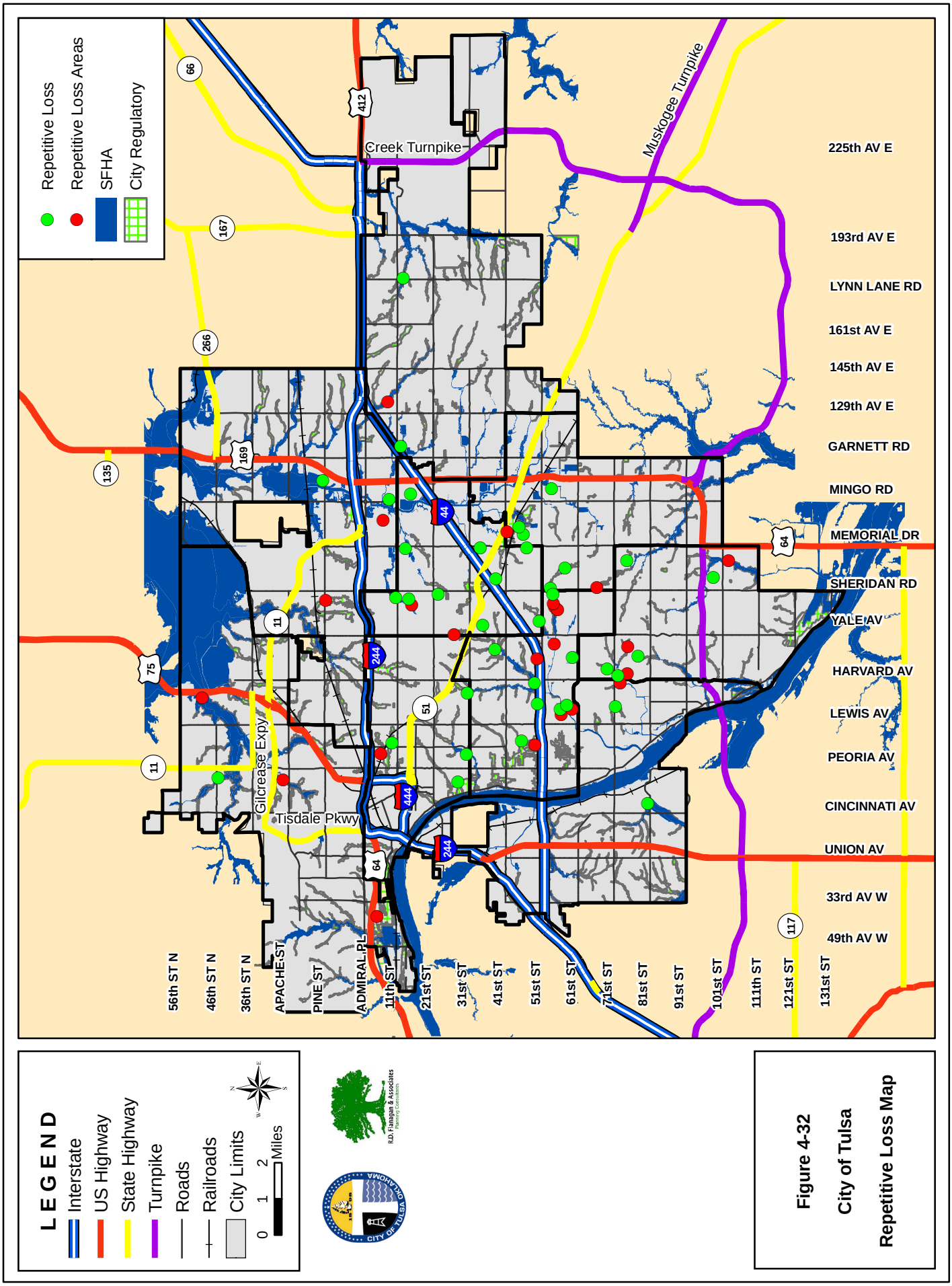


Figure 4-32
City of Tulsa
Repetitive Loss Map

Critical Facilities

Tulsa has 26 critical facilities touched by or adjacent to the city's floodplains. Critical facilities located in the floodplains pose a problem for the community since, in the event of a flood, the impacts reach beyond the flooding of the facility. For example, if child care centers cannot open, parents cannot go to work to provide important community services. First responder services are hampered if flooded police and fire stations cannot operate effectively. During the 1984 flood, hundreds of police cars parked in the floodplain were flooded and unavailable for use in responding to the City's worst flood disaster in modern times. Critical facilities located in the floodplain are listed and mapped in Chapter 5.

Infrastructure

Water Treatment – Most significant impact to Tulsa's water treatment facilities during most major flood events would be from loss of electrical power. Flooding in the watershed could impact water quality in the lakes that supply the city's water system. The impacts could range from minor to significant, depending on the nature of the flooding, pollutants released to the watershed and their location, and the impact on the City's intakes. Deposition of sediments, nutrients and other contaminants by flooding can have a long-term effect on the City's water supply lakes.

Wastewater Treatment – Most significant effect during most major events would be from loss of electrical power. Additionally, localized flooding at or near the access road to the Apache lift station could prevent access to that facility during an emergency. The Southside Treatment plant, just north of the I-44 Bridge, although above the 100-year floodplain, is within the 500-year flood zone and could possibly be inundated by a peak flood event, releasing raw and treated wastewater into the Arkansas River.

Utilities – The primary utility providers for Tulsa's jurisdiction is AEP/PSO (electricity) and ONG (natural gas). **Electricity**: The largest threat to the delivery of electrical service would be the destruction/damage of power poles/lines. The PSO electric plant that supplies the city is located on the west bank of the Arkansas River and is protected by a levee from the 100- and 500-year flood. It is at some possible risk from a peak flow event on the river. (See Dam and Levee Failure, below).

Transportation Systems (Highways, Public Transportation, Railway, Airports) – Inaccessibility of major roadways is the primary threat posed to the transportation system during a Flood event. Several intersections within the City's jurisdiction face repeated flooding during heavy rain events, as illustrated in Figure 4-31, above. Most situations are short-lived, but do create potential life safety issues due to stranded motorists and inaccessibility to safety vehicles. Additionally, bridges in typical high water areas could be compromised in their integrity, especially if of older construction. Figure 4-33 displays the locations of bridges in high water areas that may overtop when floodwaters rise.

Emergency Services- Fire, Police and Medical Services would all be similarly at risk to effects of a Flood event. Flood/Flashflood events create a larger call load for all emergency response agencies, presenting various challenges to the agencies, in addition to the posed hazards to emergency personnel performing these services. During many of the events resulting in street flooding, law enforcement and fire personnel are stationed at intersections to ensure the safety of motorists who may try to enter these barricaded areas. This could potentially affect response time if the event is widespread enough to require a large number of the City's resources.

4.10.4 Future Trends

For information regarding future development in the City of Tulsa, see Section 1.2.8.

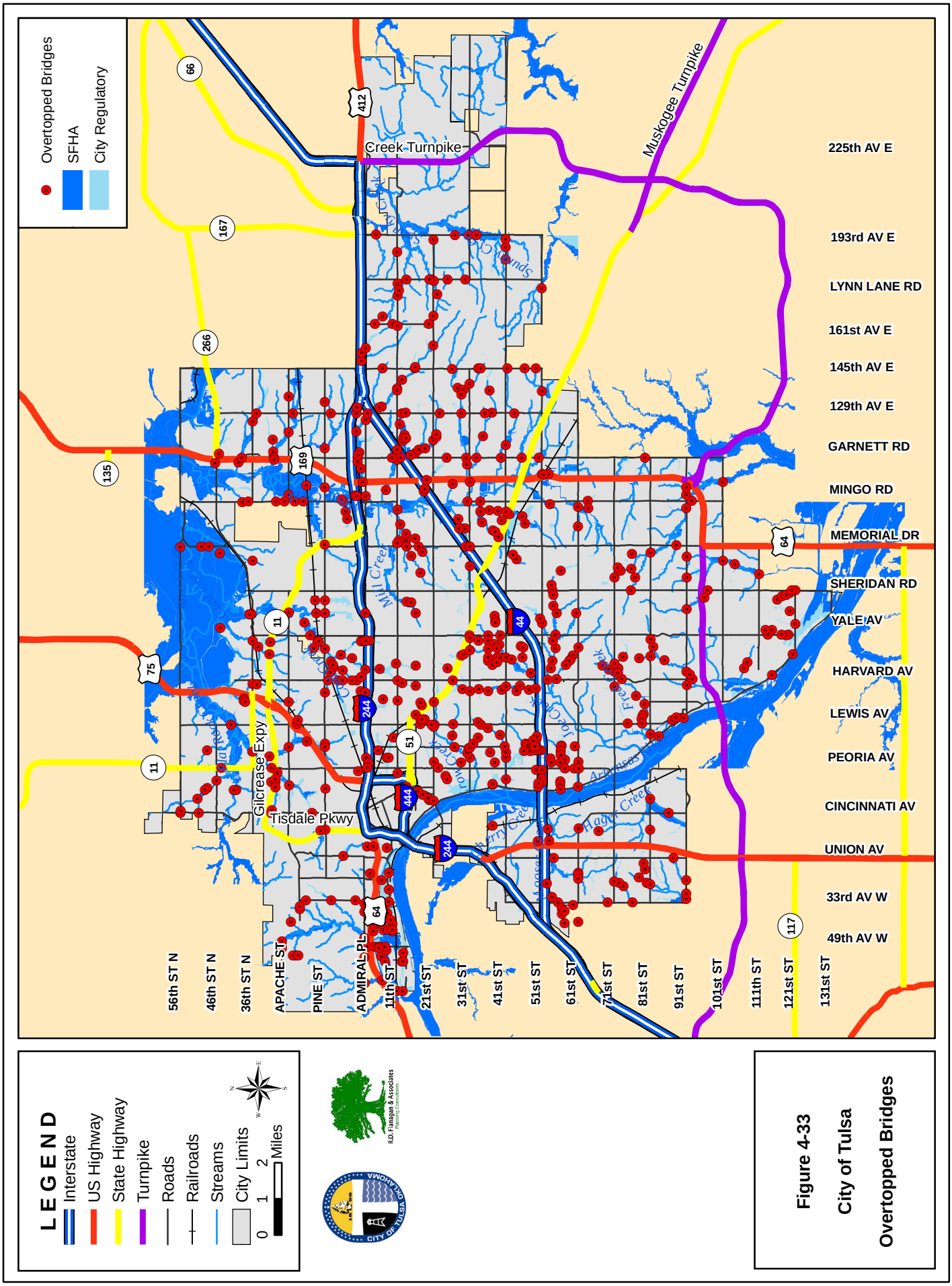


Figure 4-33
City of Tulsa
Overtopped Bridges

Population

With more recreational opportunities being developed along the banks of the Arkansas River (RiverParks area and future low-water dams) – there will naturally be an increase in population taking advantage of those areas. Many times, people who are unfamiliar with waterway recreational areas are unaware of the dangers of swiftly moving waters. In times of heavy rains and flood conditions in the jurisdiction, the Arkansas River flows at a much deeper level, producing a swifter and stronger current, even along the banks. A combination of all these factors equates to an increase in the number of those vulnerable to the secondary flood risk of wading into or getting too close to swift moving waters.

News reports have proven that even with an aggressive campaign designed to alert people to the dangers of flash floods, there are those that continue to defy the odds and attempt to drive through standing water on roadways. Without stronger penalties for the disregard of road barriers and warning signs, this is a trend that will most likely continue – therefore putting that group of drivers and their passengers at increased risk of harm during times of flash flood conditions.

Structures/Buildings

As development in new areas and revitalization of existing ones continue, locations and building techniques should be closely examined. The reduction of the earthen footprint in the community can potentially create water run-off to another area that was previously at low to no risk for flooding. This has been demonstrated in the Broken Arrow area that has experienced a phenomenal rate of growth. The NW portion of Wagoner County (which includes areas east of Broken Arrow) has reported more than 5,000 homes built over the last 5 years. These areas previously experienced heavy rains that pooled and caused no damage – because no homes were there at the time. These tracts are now dotted with new homes, and more huge housing additions are currently under construction. The Wagoner County Planning Director stated that “The more impervious the area, it’s that much less absorption you’re going to have. The more concrete poured the less open land for some of that water to run off to.”

Additionally, development in areas along the outer perimeters of the City’s boundaries that have been identified as potential flood risk areas could have a substantial impact on the integrity and capacity of drainage systems already in place. Existing systems are frequently overwhelmed during storms that produce slow-moving, heavy rainfall, because of the volume of the runoff or the presence of debris in the storm drains. An aggressive and ongoing public awareness program should be maintained to ensure new and existing developments comply with the ordinances and policies that are designed to address this issue.

Critical Facilities

With Tulsa’s strong commitment to maintaining current flood plain zoning guidelines, it is not anticipated that any new critical facility development will occur within flood-prone areas of the jurisdiction. Any renovations or improvements made to existing critical facilities in the 100-year floodplain should be evaluated to ensure the prescribed improvements will help mitigate potential damage from a future flood event.

Infrastructure

Transportation Systems (Highways, Public Transportation, Railway, Airports) – Currently, the City of Tulsa’s most likely ongoing threat from flooding would be a flash flood event. During a storm event that is producing a large amount of rainfall over a short period of time, it is highly likely that several roadway intersections will become inundated and impassable. With this in mind, plans being developed or implemented for street and/or roadway improvements within the jurisdiction should consider mitigation measures to reduce flooding of these roads and intersections.

4.10.5 Conclusions

Over recent years, progress has been made in protecting the lives and property of Tulsa's citizens from flooding, but much work remains to be done to make Tulsa flood-safe. It is important that Tulsans avoid being lulled into a false sense of security that could make them vulnerable to unexpected tragedy.

Because of the number of streams that run through the city, the seasonal thunderstorms that dump massive amounts of rainfall in brief time-spans, the presence of aging levees, a high hazard dam on the Arkansas River above the jurisdiction, and the community's history of flooding, Tulsa remains vulnerable to frequent moderate flooding and the potential for infrequent catastrophic flooding. The City of Tulsa is considered to have a HIGH vulnerability to and HIGH probability of the Flood hazard.

To protect citizens, property, and the community from flooding, this study has identified several flood mitigation measures to be implemented, which are discussed in the chapter on mitigation strategies and Appendix B.

Data Limitations

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

4.10.6 Sources

City of Tulsa Stormwater Management Plan. https://www.cityoftulsa.org/city-services/flood-control/stormwater-management-plan.aspx

Extreme Weather and Climate Events at National Climatic Data Center website: www.ncdc.noaa.gov/oa/climate/severeweather/extremes.html

FEMA Flood Insurance Statistics at Website: www.fema.gov/nfip/10110309.shtm

FEMA Flood Insurance Study, Tulsa, Oklahoma, Tulsa County. FEMA, Revised May 4, 1998.

National Flood Insurance Program. http://www.floodsmart.gov/floodsmart/

Parcels (Value and Type), Tulsa County Assessor's Office, 2012

4.11 Dam Failure

4.11.1 Hazard Profile

The Federal Emergency Management Agency (FEMA) defines a dam as "an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material for the purpose of storage or control of water." Dams typically are constructed of earth, rock, concrete, or tailings (chaff) from mining operations. A dam failure is the collapse, breach, or other failure resulting in downstream flooding. The amount of water impounded in the reservoir behind a dam is measured in acre-feet. As a function of upstream topography, even a very small dam may impound or detain many acre-feet or millions of gallons of water.

A break in a dam produces an extremely dangerous flood situation because of the high velocities and large volumes of water. In the event of a dam failure, the potential energy of the water stored behind even a small dam can cause great property damage, as well as loss of life if there are people downstream from the dam. The extent of this inundation may be minimal to uninhabited farmland or catastrophic in an urban environment.

Storm events are not always the cause of dam failure or partial dam failure. According to the *Living with Dams: Know Your Risks* brochure (April 2012), most dam failures fall into one or more of the following categories:

- **Structural Failures**: Foundation defects, including settlement and slope inability or damage caused by earthquakes, have caused about 30% of all U.S. dam failures.
- **Mechanical Failures**: Malfunctioning gates, conduits, or valves can cause dam failure or flooding both upstream and downstream.
- **Hydraulic Failures:** Overtopping of a dam is often a precursor of dam failure. National statistics show that overtopping due to inadequate spillway design, debris blockage of spillways, or settlement of the dam crest account for approximately 34% of all U.S. Dam failures. *(http://www.livingneardams.org/brochure)*

There can be varying levels of dam failure. Partial dam failures include inadequate spillway capacity that causes excess flow to overtop the dam; and internal erosion through the dam or foundation. Complete failure occurs if internal erosion or overtopping results in a total structural breach, releasing a high-velocity wall of debris-laden water rushing downstream, damaging or destroying everything in its path.

Flooding can occur downstream from a dam without the structure being breached. Sometimes, to prevent overtopping and catastrophic failure, dams are forced to make emergency releases of large amounts of water, which can cause downstream flooding.

Dam Safety Programs

The National Dam Safety Act requires the Director of FEMA and the National Dam Safety Review Board to establish and maintain a coordinated national dam safety program. The OWRB coordinates

the Oklahoma Dam Safety Program to ensure the safety of more than 4,600 dams in the state. The program requires inspections every five years for low hazard structures and three years for significant hazard structures. Dam owners for each of the 318 high hazard dams are required to have an annual inspection. In addition, owners of dams classified as "high hazard" are required to have an Emergency Action Plan (EAP) in place approved by the Water Resources Board and with copies of the plan provided to local law enforcement agencies and emergency management officials. OWRB staff requires submittal and subsequent approval of plans and specifications prior to dam construction or modifications.

Location

There are 12 dams either within the City of Tulsa or of concern to Tulsans. These structures are described in Tables 4-54 and 4-55, below and shown on the map in Figure 4-34. Keystone and five other high hazard dams would have a direct impact on the City of Tulsa if a failure were to occur. These six high hazard dams are included in the following table, along with other dams whose failure would impact the City. Each of these dam failure areas is discussed more fully in the Chapter 5 Council District Section(s) in which it would have impacts.

Tulsa Bridle Trails Detention Facility dam became classified as a high hazard dam in 2012, since its failure could overtop 101st Street nearby. Since then, the roadway was raised during an improvement project and, in 2014, it was recommended that the dam no longer be considered high hazard.

OWRB recognizes a final high hazard dam in Tulsa County, the Carousel Concourse Detention Pond. This dam is outside of the city limits of Tulsa and its failure would not impact the city.

Table 4–54: City of Tulsa High Hazard Dams

Keystone Dam	**Council Districts 1, 2, 4, 8, 9**
Location	On Arkansas River, 10 miles west of Tulsa
Source	Arkansas River
Drainage basin	22,351 sq. miles
Owner/operator	U.S. Army Corps of Engineers
Year built	1964 (with an estimated useful life of 50 years)
Length/ Height	4,600 feet long, 121 feet high
Surface area	23,610 acres
Construction material	Masonry and earth-fill
Use of Dam	Water storage, flood control, hydroelectric, and recreation
Capacity	431,922 acre-feet (normal), 1,560,564 (maximum)
Flood damage history	Keystone has not failed, but high releases in 1986 caused significant downstream damage
Results of failure	Inundation of Sand Springs, Tulsa, Jenks, Broken Arrow, Bixby
Emer. Action Plan (EAP)	Yes
Yahola Dam	**Council District 1, City Water**
Location	North of Tulsa on Lake Yahola
Source	Pumped storage
Owner/operator	City of Tulsa
Year built	1948
Length/ Height	17,500 feet long, 35 feet high
Surface area	431 acres
Construction material	Concrete and earth-fill
Use of Dam	Water supply for Tulsa
Capacity	6,445 acre-feet (normal)
Flood damage history	None to date
Results of failure	Inundation of areas in North Tulsa
EAP	Yes

Skiatook Lake Dam	**Council District 1, 3**
Location	18 miles north-northwest of Tulsa
Source	Hominy Creek
Drainage basin	354 sq. miles
Owner/operator	US Army Corps of Engineers
Year built	1984
Length/ Height	3,590 feet long, 143 feet high
Surface area	10,502 acres
Construction material	Concrete and earth-fill
Use of Dam	Flood control, water supply, fish and wildlife, recreation
Capacity	321,408 acre-feet (normal), 499,102 acre-feet (maximum)
Flood damage history	None
Results of failure	Inundation of low-lying homes and infrastructure below dam, including Mohawk Park and other areas on Bird Creek in District 1
EAP	Yes
Oologah Lake Dam	**Council District 6, 3, City Water**
Location	27 miles northeast of Tulsa
Source	Verdigris River
Drainage basin	4,339 sq. miles
Owner/operator	US Army Corps of Engineers
Year built	1974
Length/ Height	4,000 feet long, 137 feet high
Surface area	29,500 acres
Construction material	Earth-fill and concrete
Use of Dam	Flood control, water supply, navigation, fish and wildlife, recreation
Capacity	549,209 acre-feet (normal), 1,509,721 acre-feet (maximum)
Flood damage history	None
Results of failure	Inundation of low-lying homes and infrastructure below dam, including areas along Bird and Spunky Creeks
EAP	Yes
Lynn Lane Reservoir	**Council District 6, City Water**
Location	E. 21st St. and 193rd E. Ave.
Source	Pumped storage
Owner/operator	City of Tulsa
Year built	1950
Length/ Height	13,300 feet long, 15 feet high
Surface area	420 acres
Construction material	Concrete and earth-fill
Use of Dam	Raw water storage
Capacity	325 acre-feet
Flood damage history	None
Results of failure	Inundation of areas of East Tulsa and A.B Jewell Dam
EAP	Yes

Warrenton Lake Dam	**Council District 7**
Location	Near E. 67th St. and S. Kingston Ave.
Source	Tributary to Joe Creek
Owner/operator	Warren Medical Center
Year built	1936
Length/ Height	400 feet/ 37 feet
Surface area	4 acres
Construction material	Earth-fill
Use of Dam	Recreation
Capacity	41 acre-feet, 50 acre-feet maximum storage
Flood damage history	None
Results of failure	Downstream property inundation
EAP	Yes
Tulsa Bridle Trails Detention Facility	
Location	Near Memorial DR and E. 101st St. South
Source	
Owner/operator	City of Tulsa
Year built	1968
Length/ Height	600.0 ft long, 17 ft high
Surface area	0.0
Construction material	
Use of Dam	Stormwater Detention Pond
Capacity	230 acre-ft
Flood damage history	None
Results of failure	None (see text)
EAP	
Other high-hazard dams of interest to Tulsans:	
Spavinaw Lake Dam	**Council District 1**
Location	50 miles east-northeast of Tulsa
Source	Spavinaw Creek
Drainage basin	73.8 sq. miles (including Eucha, 392.4 sq. miles)
Owner/operator	City of Tulsa
Year built	1922
Length/ Height	3,500 ft. long, 75 ft. high
Surface area	1,637 acres
Construction material	Concrete and earth-fill
Use of Dam	Water Supply for Tulsa, Recreation, Flood control
Capacity	31,686 acre-feet (normal), 72,400 acre-feet (maximum),
Flood damage history	None
Results of failure	Inundation Spavinaw town
EAP	Yes

Lake Eucha Dam	**City Water**
Location	60 miles east-northeast of Tulsa
Source	Spavinaw Creek
Drainage basin	318.6 sq. miles
Owner/operator	City of Tulsa
Year built	1952
Length/ Height	2,100 ft. long, 95 ft. high
Surface Area	2,880 acres
Construction material	Concrete and earth-fill
Use of Dam	Water Supply for Tulsa and Jay OK, Recreation
Capacity	79,600 acre-feet (normal), 119,931 acre-feet (maximum)
Flood damage history	None
Results of failure	Overtopping Spavinaw Dam, inundation of Spavinaw town
EAP	Yes
Lake Hudson Dam (Markham Ferry)	**City Water**
Location	2 miles northwest of Locust Grove, 37 miles east of Tulsa
Source	Grand River
Drainage basin	11,553 sq. miles
Owner/operator	Grand River Dam Authority
Year built	1964
Length/ Height	5,100 feet long, 90 feet high
Surface area	12,000 acres
Construction material	Concrete and earth-fill
Use of Dam	Hydroelectric power, flood control
Capacity	200,300 acre-feet (normal), 444,510 acre-feet (maximum)
Flood damage history	None
Results of failure	Inundation of low-lying homes and infrastructure below dam
EAP	Yes

Table 4–55: City of Tulsa Low or Significant Hazard Dams.

Page Belcher Golf Course	**Council District 2**
Location	W. 71st St. S. and S. Union Ave.
Source	Tributary Nickel Creek
Year Completed	1950
Length/ Height	410 ft. long, 30 ft. high
Hazard	Significant
Surface Area	3 acres
Recreation Lake Dam	**Council District 1**
Location	Mohawk Blvd. and N. 81st E. Ave.
Source	Tributary Bird Creek
Year Completed	1950
Length/ Height	4000 ft. long, 15 ft. high
Hazard	Significant
Surface Area	80 acres

Mill Creek Pond	**Council District 8**
Location.....	E 97th and Sheridan Rd.
Source.....	Tributary Arkansas River
Year Completed	1970
Length/ Height.....	1450 ft. long, 28 ft. high
Hazard.....	Low
Surface Area	10 acres
Minshall Park 2nd	**Council District 8**
Location.....	E. 75th and S. Kingston Ave.
Source.....	Tributary Haikey Creek
Year Completed	1960
Length/ Height.....	400 ft. long, 28 ft. high
Hazard.....	Low
Surface Area	4 acres
OKNONAME 143013	**Council District 8**
Location.....	E 97th and S. Oswego Ave.
Source.....	Tributary Arkansas River
Year Completed	1960
Length/ Height.....	300 ft. long, 30 ft. high
Hazard.....	Low
Surface Area	2 acres
OKNONAME 143014	**Council District 8**
Location.....	E. 96th and S. Quebec Ave.
Source.....	Tributary Arkansas River
Year Completed	1950
Length/ Height.....	280 ft. long, 25 ft. high
Hazard.....	Low
Surface Area	4 acres
Southern Hills C.C.	**Council District 2**
Location.....	E. 65th and S. Evanston Ave.
Source.....	Tributary Joe Creek
Year Completed	1970
Length/ Height.....	350. ft. long, 35 ft. high
Hazard.....	Low
Surface Area	1 acre

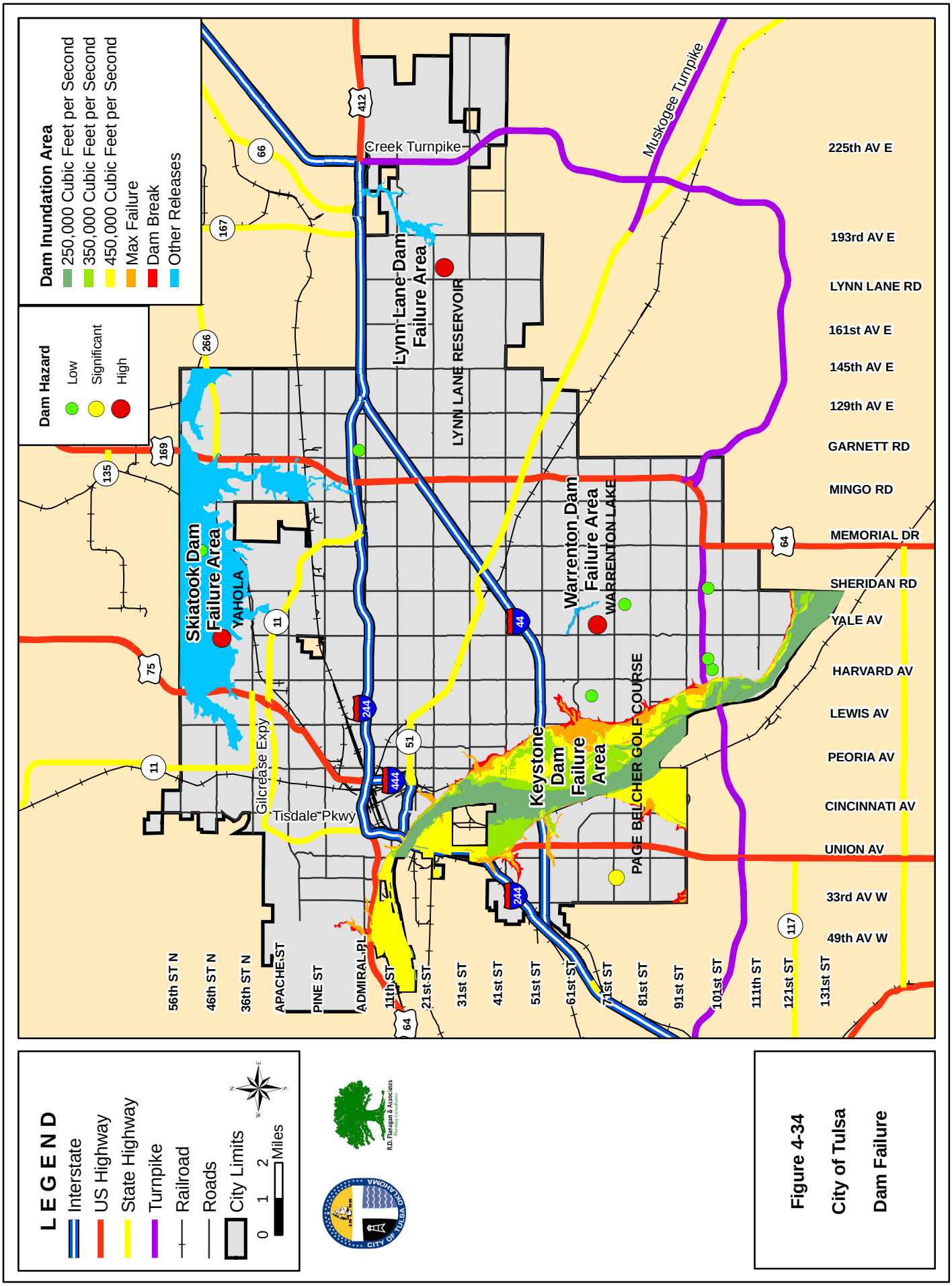


Figure 4-34
City of Tulsa
Dam Failure

Arkansas River Corridor

Of particular concern for Tulsa are Keystone Dam and three levees, all built by the Corps of Engineers on the Arkansas River upstream from and west of downtown Tulsa. (A fourth levee, at Garden City, was built by private funds.) These structures have prevented millions of dollars in flood damages since they were built, but they present inherent risk for catastrophic disaster. Because of the unique hazard presented by these structures, this plan focuses on the dams and levees and the Arkansas River valley corridor through Tulsa.

The Arkansas River is one of the longest tributaries of the Mississippi River. At Keystone Dam just above Tulsa, the Arkansas joins with a major tributary, the Cimarron River, which drains portions of New Mexico, Texas, and Oklahoma. Over the years, the Corps of Engineers has estimated bank-full channel capacity at between 90,000 and 110,000 cubic feet per second. This section of the plan focuses specifically on the impacts a Dam failure would have on Tulsa. Information on the four levees that could have an adverse impact on Tulsa can be found in Section 4.12, *Levee Failure.*

Keystone Dam

The Corps of Engineers completed Keystone Dam, about 15 miles west of downtown Tulsa, in 1964. Authorized purposes include flood control, hydropower, water supply, water quality, navigation, irrigation, recreation, and fish and wildlife management. Keystone Dam is 4,600 feet long, 121 feet high, and composed of masonry and earth fill. The dam has a 720’ concrete spillway and 18 tainter gates. It is inspected on a 5-year frequency and operated by the United States Army Corps of Engineers (USACE).

It is also relevant for Tulsa that, in 1976, the Corps completed Kaw Dam 115 river miles upstream (northwest) of Keystone. The Kaw flood pool contains 919,400 acre-feet of water, according to the Corps. The Corps estimates that, together, Keystone and Kaw dams provide an estimated 15-year level of flood control storage.

Arkansas River Regulation

It is important to note that the City of Tulsa regulates land use within the Arkansas River corridor only to the standard of the National Flood Insurance Program – a 100-year floodplain based on existing watershed development. It is arguable that this standard is justified because of the size of the Arkansas watershed, but it is less stringent than the City’s regulation over floodplains in the balance of Tulsa. On the other hand, the Arkansas offers far greater potential for catastrophic flooding than other Tulsa floodplains. City staff has proposed adjusting the regulatory standard so the Arkansas River regulations in Tulsa would be based on the 1986 flood, the flood of record since Keystone Dam was built.

Because the Arkansas River is the most dominant feature of Tulsa, and the River Corridor is of great interest to the development community, the vulnerability of the Arkansas River Corridor to the Dam Failure hazard is assessed in a separate section of Chapter 5.

Measurement

The amount of water impounded in the reservoir behind a dam is measured in acre-feet. An acre-foot is the volume of water that covers an acre of land to a depth of one foot, or approximately 325,000 gallons. An acre-foot is equal to 43,560 cubic feet. Even a very small dam may contain many acre-feet or millions of gallons of water. Water discharge is measured in cubic feet per second (cfs). A cubic foot contains about 7.5 gallons of water. One cubic foot per second equals about 450 gallons per minute.

Any artificial water barrier that has a height of 25 feet or more from the natural streambed, and 50 acre-feet or more of storage capacity, qualifies as a dam and is under the jurisdiction of the Oklahoma

Water Resources Board (OWRB). The OWRB classifies dams as high-hazard, significant-hazard, and low-hazard, depending on the amount of water stored and downstream populations and infrastructure. Of the 16 dams in or around the City of Tulsa, the OWRB has classified eight as High Hazard, one as Significant Hazard, and seven as Low Hazard. Not all of these dams would impact the city directly—such as Hudson, Spavinaw and Eucha, which are many miles distant from the jurisdiction. But a failure of these dams would have a significant impact on Tulsa's water supply, a crucial element of the City's economy and regional stature. Information about the Federal hazard potential classification for dams is located in Table 4-56.

Table 4–56: Federal Hazard Potential Classification for Dams

Classification	Description
Low Hazard Potential	Dams assigned the low hazard potential classification are those where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.
Significant Hazard Potential	Dams assigned to the significant hazard potential classification are those where failure or mis-operation results in probably no loss of human life, but can cause economic loss, environmental damage, and disruption of lifeline facilities or other vital functions. Significant hazard dams are often located in predominantly rural or agricultural areas, but might also be small to moderate dams located in areas with population and significant infrastructure.
High Hazard Potential	Dams assigned the high hazard potential classification are those where failure or mis-operation will probably cause loss of human life.

Source: Federal Guidelines for Dam Safety, April 2004

Dams are classified based on the potential damages to downstream development. If a high-hazard dam fails, there likely will be loss of life and extensive damage to development – communal, industrial, or agricultural. Failure of a dam classified as significant would likely cause no loss of life but appreciable agricultural, industrial, or structural damage. Failure of a low hazard dam would cause no loss of life and minimal economic loss. The classification scheme in no way suggests that a dam is in need of repair – it could be in excellent condition or in poor condition. It simply reflects a dam's potential for doing damage downstream if it were to fail. Areas likely to be impacted by a dam break are delineated using dam breach analyses that consider both "sunny day" failures and failures under flood conditions.

Extent/Severity

The failure of a major Tulsa dam could cause catastrophic damage. In the words of the Corps of Engineers, failure of Keystone Dam "would be catastrophic in terms of property damage, potential for loss of life, and environmental destruction."

The City of Tulsa considers a minor severity dam event to be an extraordinary release that results in less than three feet depth of flooding on a one story building, and a major severity dam event to be a breach or failure that exceeds the capacity of the Dam's downstream riverbed immediately downstream from the dam and/or equates to (or exceeds) a 100- or 500-year flood and results in a depth of three feet of flooding or more on a one story building.

Frequency

In the area of chief concern for Tulsa, the Arkansas River corridor, the frequency of flooding has been dramatically reduced by Keystone and Kaw dams and the Arkansas River levees. Only one significant flood event (1986) has occurred along the Arkansas at Tulsa since these dams were completed.

Impact

Dam failures can cause catastrophic floods, releasing sudden walls of water that can sweep across land thought to be protected by the structure. Thus, dams may create a false sense of security,

increasing the amount of property at risk of flooding as people and businesses locate downstream, believing they are totally safe. In addition, dams, and other structural measures are extremely costly and can disrupt or destroy the natural environment. In the event of a dam failure, the potential energy of the water stored behind even a small dam can cause great property damage and, if there are people downstream, loss of life. The following factors influence the impact of a dam failure:

- level of failure (partial or complete);
- rapidity of failure (sudden or gradual);
- amount of water released;
- nature of the development and infrastructure located downstream.

A break in a dam produces an extremely dangerous flood situation because of the high velocities and large volumes of water. The severity of impact on areas downstream and the height to which waters will rise are largely functions of valley topography and the volume of water released.

Besides dam failures, there are hazardous actions that have to be taken to prevent dam failures, such as sudden releases of water when the dam is threatened with overtopping. In this case, a dam may have failed in its purpose to protect downstream people and property, without physically failing. The impact of this hazard can affect downstream homes, business, agriculture, and infrastructure. Dam failure can occur over a prolonged period of time, giving people time to prepare for the imminent failure, or can be sudden with little or no warning.

As noted above, the Corps estimates that Keystone and Kaw together provide about a 15-year level of flood control storage. According to the Corps' analysis, the Tulsa levees could be overtopped at 450,000 cfs. Events that may exceed these projects' levels of protection are still probable and will be discussed in later paragraphs.

4.11.2 History/Previous Occurrences

In Oklahoma, there have been three significant documented dam failures, each after sudden and heavy rainfall events. The City of Tulsa has not been impacted by a Dam break or failure (other than the 1986 forced-release event) in the past. Narratives of historic dam failures in Oklahoma are included in Table 4-57.

Table 4–57: Oklahoma Dam Event Narratives

Date	Event Narrative
October 3, 1923	Heavy rain caused a dam failure at Lake Overholser, which displaced 15,000 residents.
September 4, 1940	Cleveland, in Pawnee County, suffered losses in the half-million dollar range when the town was inundated by the Cleveland Dam break.
April 13-14 1945	After 14.6 inches of rain fell in the Wewoka area the night of April 13-14, 1945, heavy flows on Coon Creek overtopped and breached the Wewoka Dam, sending a wall of water into Wewoka Creek. Eight people in the path of the deluge were killed and the town of Wewoka was under 4 feet of water. Eighty people were forced from their homes.

Probability of Future Events

The Corps believes there is a LOW probability that Keystone Dam would fail, because it is operated by the Corps and inspected at least once each year. The age of Keystone Dam is another issue of concern for Tulsa. When Keystone was built in 1964, the Corps estimated it would have a 50-year useful life. In addition, a great deal of silt has collected upstream from the dam, including in the flood pool. The Keystone flood pool filled completely in 1974 and 1986.

Even though a dam break is unlikely, there is a high probability that the Corps will be forced to make flooding releases from the dam. Even without a breach of the dam, forced releases of flooding waters

from Keystone Dam, such as occurred in 1986, could cause extensive property damage and disruption, as well as safety risks. The Corps has studied and mapped the areas that would be inundated from 250,000 cubic feet per second, 350,000 cfs, and 450,000 cfs releases from the Keystone reservoir. (Keystone Dam's maximum discharge could be as much as 940,000 cfs. A "100-year" discharge is estimated at 200,000 cfs.)

4.11.3 Vulnerability

This section summarizes the City of Tulsa's vulnerability to dam failure, including the impact on people, structures and buildings, critical facilities, and infrastructure. This information was used to determine the Vulnerability Criteria identified in Tables 4-3 and 4-4. The City of Tulsa was determined to have a HIGH vulnerability to the Dam Failure hazard. (See Tables 4-3, Hazard Risk Analysis, and Table 4-4, Summary of Hazard Risk Analysis Ranking Criteria for an explanation of how the rankings were derived.)

Population

People, property, critical facilities, and infrastructure downstream of dams could be subject to devastating danger and damage in the event of failure. The number of fatalities or injuries resulting from dam failures is strongly influenced by the number of people occupying the inundation area, the amount of warning they are provided, and the amount of pre-event public education and planning. People who might be at risk include those who are living, working, at school or play, or traveling through vulnerable areas.

The estimated numbers of inhabitants below the four high-hazard dams are:

Keystone Dam: The Corps of Engineers has projected the effects if there should be a failure of Keystone Dam. A dam break would send a 20-foot-high wall of water rushing down the Arkansas River valley, destroying or damaging almost everything in its path in the river's floodplain. The flood surge would reach Tulsa in a very short time. The average building in the flood zone would have from 10 to 20 feet of water in the structure. Based on US Census information, a Keystone Dam break or major release could impact an estimated 47,793 people and 9,579 parcels with improvements. The number of people vulnerable to a maximum failure of the dam is not available for public dissemination; it is accessible in the USACE *Keystone Dam Consequence Assessment Report*, September 2011.

Lynn Lane Reservoir: Lynn Lane Reservoir is a terminal storage reservoir and does not receive surface water runoff. It was therefore analyzed for sunny day failure only. A breach or break of the Lynn Lane Reservoir could potentially impact an estimated 46 households in Tulsa. Areas subject to inundation from the reservoir are mainly rural with scattered residents and several businesses. The impacted roadways would be about 1 mile of S. 193rd Street, and 0.5 miles of E 11th Street and about 0.5 miles of E. Admiral Place. The flooded water would approach, but unlikely impact Interstate 44. Some low lying roadway crossings along the Spunky Creek may be affected. Most of the area downstream of the Reservoir is occupied single-family houses on large lots and there are two large baseball / softball complexes sit adjacent to the reservoir. Therefore, the risk associated with this dam breach or break is highly dependent on the time of which it occurs. If the breach were

Lynn Lane Reservoir

to occur on a weeknight or on a weekend, the extent to which life could be lost would be higher, due to the nature of the land use and activities near the dam. The A.B. Jewell water treatment plant also sits directly, 400 ft., below the reservoir. Any breach or break of the dam would adversely affect the water supply and distribution of the City of Tulsa due to lost treatment capacity.

Yahola Dam: Yahola is a terminal storage reservoir and does not receive surface water runoff; therefore it was analyzed for sunny day failure only. Areas subject to inundation from a breach are predominately in Mohawk Park, Mohawk Golf Course, and nearby open field and wooded areas. The risk associated with a failure of Yahola Reservoir is highly dependent on the time of which it occurs. Normally, there would be more people in the golf course and park exposed to a failure during a weekend day in the spring, summer or fall. If the breach were to occur in the middle of the night or in the winter, the potential damage would be less, since fewer citizens would be using the park and associated facilities. There are no permanently habitable structures downstream of the Yahola Dam. However, there are approximately 12 structures associated with the golf course and Mohawk Park, which could potentially be destroyed or inundated with water. Flood waters would approach but not likely affect the Tulsa Zoo in Mohawk Park. Water surface elevations of Bird Creek could increase temporarily downstream extending to, but not beyond the Mingo Valley Expressway (Hwy 169). Some low lying roadway crossings of Bird Creek may be affected, but likely only in the upper reaches nearest the reservoir.

Warrenton Dam: A breach or break of the Warrenton dam could potentially impact an extremely limited number of citizens of Tulsa. Most of the area downstream of Warrenton Dam is occupied by high-rise office buildings. Therefore, the risk associated with this dam breach or break is highly dependent on the time of which it occurs. There would normally be more traffic on Yale Ave. during a week day and more residents working in the high-rise office buildings. If the breach were to occur in the middle of the night or on a weekend the risk would be less.

In addition to vulnerable populations, there are a number of hazardous materials Tier II sites in the areas beneath each of the high-hazard dams. Major damage to some of the industrial enterprises could trigger cascading disasters, such as chemical releases and explosions.

Structures/Buildings

County Assessor data was used to identify the number of improved parcels located in the inundation area of High-Hazard dams in the Tulsa area. There are no improved parcels affected by Yahola Dam.

Keystone Dam: There are 9,396 buildings below Keystone Dam that could be affected by a failure or major release, including 8,696 residential single-family dwellings, 221 residential multi-family structures, and 320 commercial and industrial buildings. A summary of improved parcels located in the Keystone Dam inundation area, by type and fair-market value, is included in Table 4-58.

Table 4–58: Improved Parcels Impacted by Keystone Dam Break

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	8,696	$825,111,045
Residential Multi-Family	221	$74,287,432
Commercial	304	$138,592,587
Industrial	16	$4,681,541
Other	159	$29,846,377
Total	9,396	$1,072,518,982

Source: Tulsa County Assessor's Office, 2012

As with population data, the number of structures vulnerable to a maximum failure of Keystone Dam is not available for public dissemination, but can be accessed on a need-to-know basis in the USACE *Keystone Dam Consequence Assessment Report*, September 2011.

Skiatook Dam: There are 116 buildings, within Tulsa city limits, below Skiatook Dam that could be affected by a failure or release. A summary of improved parcels located in the Skiatook Dam inundation area, by type and fair-market value, is included in Table 4-59.

Table 4–59: Improved Parcels Impacted by Skiatook Dam Break

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	71	$3,623,086
Residential Multi-Family	0	$0
Commercial	6	$479,000
Industrial	11	$10,240,815
Other	28	$5,445,249
Total	116	$19,788,150

Source: Tulsa County Assessor's Office, 2012

Warrenton Dam: There are 65 buildings below Warrenton Dam that could be affected by a failure or release. A summary of improved parcels located in the Warrenton Dam inundation area, by type and fair-market value, is included in Table 4-60.

Table 4–60: Improved Parcels Impacted by Warrenton Dam Break

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	65	$8,132,600
Residential Multi-Family	0	$0
Commercial	0	$0
Industrial	0	$0
Other	0	$0
Total	65	$8,132,600

Source: Tulsa County Assessor's Office, 2012

Lynne Lane Reservoir: There are two buildings below Lynne Lane Reservoir that could be affected by a failure. A summary of improved parcels located in the Lynne Lane Reservoir inundation area, by type and fair-market value, is shown in Table 4-61.

Table 4–61: Improved Parcels Impacted by Lynn Lane Reservoir Break

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	2	$80,020
Residential Multi-Family	0	$0
Commercial	0	$0
Industrial	0	$0
Other	0	$0
Total	2	$80,020

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Critical facilities located in dam failure inundation areas are listed and mapped for each Council District in Chapter 5.

Infrastructure

Water Treatment – Most significant impact to Tulsa's water treatment facilities during a dam break or failure would be from loss of access to the facilities and loss of electrical power. Flooding in the watershed could impact water quality in the lakes that supply the city's water system. The impacts could range from minor to significant, depending on the nature of the flooding, pollutants released to the watershed and their location, and the impact on the City's intakes. Deposition of sediments, nutrients and other contaminants by flooding can have a long-term effect on the City's water supply lakes.

Wastewater Treatment – Wastewater treatment plants along the Arkansas River would be inundated by a dam failure event; potentially releasing raw and treated wastewater into the Arkansas River.

Utilities – The primary utility providers for Tulsa's jurisdiction is AEP/PSO (electricity) and ONG (natural gas). **Electricity**: Although the PSO electric plant that supplies the city is located on the west bank of the Arkansas River, the plant has a mitigation plan in place in the event of river flooding. According to a PSO/AEP representative, the loss of the plant is unlikely to affect overall system reliability because of the redundancy and generating capacity reserves that are planned for on a system wide basis. The largest threat to the delivery of electrical service would be the destruction/damage of power poles/lines in the inundated areas. **Gas-** Transmission pipelines could be breached both through trees being uprooted, affecting the lines, and ground being washed out, exposing the pipelines to damage.

Transportation Systems (Highways, Public Transportation, Railway, Airports) – A Keystone Dam Failure would affect Interstate 244, a major interstate highway, and the 21st Street Bridge, a major crossing over the Arkansas River, connecting West Tulsa to the rest of the city. The Cherokee Yard, a major intermodal regional transportation hub for the BNSF Corporation, and the railroad bridge at 11th Street would also be impacted by the failure. Failure of Skiatook Dam would inundate parts of US 75 and US 169 and State Highway 266. Failure of the Lynne Lane Reservoir would approach, but would be unlikely to impact Interstate 44.

Emergency Services- Fire, Police and Medical Services would all be similarly at risk to effects of a dam failure event. Emergency responders would be extremely taxed. With loss of vital utilities, emergency services would be heavily impacted. As with flooding, a dam failure would create a larger call load for all emergency response agencies, presenting various challenges to the agencies, in addition to the posed hazards to emergency personnel performing these services.

4.11.4 Future Trends

Many Tulsans have said the riverbanks and even the river itself should be developed to provide an economic base in Central Tulsa. On the other hand, many people have said they want to retain the existing and evolving River Parks to provide a beautiful band of green that is extensively and enthusiastically used by thousands of Tulsans, and is generally prized as one of the city's best features. Others see the river as a treasure-trove of natural resources that should be preserved at all costs.

Given the inherent dangers along a river that drains nearly 75,000 square miles of land area, the future hazards along the Arkansas River will be determined by the balance of development and management that the community chooses. Various planning exercises offer possibilities for redefining local commitment to economic development, resource preservation, and hazard management along the river.

This analysis of future trends rests on several development plans:

- The Arkansas River Corridor Plan developed by the Indian Nations Council of Governments;

- The City of Tulsa Comprehensive Plan;
- Adopted Master Drainage Plans;
- Tulsa County Vision 2025 plans and proposals (which include river-development projects such as low-water dams);
- Infrastructure plans and projects, including the Gilcrease Expressway and a proposal for light rail in central Tulsa.

The riverfront future may hinge on how Tulsa defines the term "development" along the river. The future may be very different if "development" is defined as building parks and recreation areas, rather than lowland homes and businesses.

No additional control structures are currently planned that would improve the river's flood potential and recent Corps' analyses have concluded that no significant control structures (such as raising the height of the levees) would be feasible for the river. Therefore, the future depends in large measure on how people decide to manage and use the floodplain lands throughout Tulsa's segment of the Arkansas Valley.

Maps showing potential future development areas in the Arkansas River Corridor are included in Chapter 5, Figures 5.10-16 through 5.10-18.

Population

Virtually all of the current proposals would be expected to increase the number of people at risk in the Arkansas River lowlands. For this plan, it is assumed that management decisions will be based on FEMA's 100-year floodplain standard. Therefore, the numbers of people in all categories – living, working, going to school, traveling through, with functional and access needs, etc. – will increase, exposing more people to risk from larger events (such as the 1986 flood).

Structures/Buildings

Similarly, all of the current proposals would be expected to increase the number of buildings at risk in the Arkansas River lowlands. For this plan, it is assumed that building decisions will be based on the FEMA 100-year floodplain standard. Therefore, the numbers of buildings will increase, exposing more structures to risk from larger events such as the 1986 flood. If the 100-year floodplain standard were to be revised, the number of new structures at risk could be substantially reduced.

Critical Facilities

Current riverfront development proposals do not focus on critical facilities, so it is anticipated that the number of critical facilities would not increase in the river lowlands in the future. This assumption may hinge on whether leaders consider hazard management in expansion decisions for schools, detention facilities, social service agencies, health clinics, and other critical facilities. Again, it is anticipated that these decisions will be based on only the FEMA 100-year floodplain standard.

Infrastructure

Generally, all the current plans would increase the investment in infrastructure in the river lowlands. For example, proposals being considered all include new roads, the Gilcrease Expressway, new low-water dams and bridges, utilities, parks and walking trails. If higher standards than the FEMA SFHA are used, and if infrastructure impacts on the floodplain are carefully considered, infrastructure decisions might decrease future risks to valley properties and populations.

4.11.5 Conclusion

Tulsa is exposed to risk of flooding from failure of five high-hazard upstream dams. These dams are Keystone, Yahola, Warrenton, Skiatook and Lynn Lane (A.B. Jewell). The dam posing the greatest

threat to Tulsa is Keystone. However, the Corps of Engineers believes that the potential for failure is low because Keystone is operated by the Corps and is inspected at least once each year.

Forced releases of large amounts of water can be a significant flood hazard. This was exemplified by the 1986 Keystone Reservoir water releases that caused downstream flooding.

People, property, critical facilities, and infrastructure downstream of dams and behind levees could be subject to devastating danger and damage in the event of failure. The most important factor for public safety is the timeliness, the effectiveness of warning given to vulnerable populations, and the amount of pre-event public education and planning. Dams and levees often convey a false sense of security, allowing people to think they will always be protected, so dam and levee safety is not usually high in the public consciousness. The recent failures of the New Orleans and the Mississippi River levees may serve to focus more attention on these risks.

A related threat to Tulsa is posed by the Arkansas River levees, built in 1945 and protecting 2,271 residences, 149 commercial properties and 106 industrial parcels ($147,453,020 in property). Failure of the levees along the Arkansas River would have a devastating impact upon the City of Tulsa and Tulsa County.

The worst-case event, a failure of Keystone Dam and the Arkansas River levees, could impact 16,431 parcels with improvements within the city limits of Tulsa, create a severe risk for an estimated 93,836 people, cause an estimated $1,885,741,675 in damage to buildings, including 73 critical facilities. In addition, it could produce widespread power outages, and release of hazardous chemicals.

Tulsa is considered to have a HIGH vulnerability to a LOW probability Dam Failure event.

Data Limitations

Census figures are insufficient to identify the number of people with disabilities or with limited knowledge of English, who would be extremely vulnerable in an event that would have a short warning time.

4.11.6 Sources

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Rooftop to River: Tulsa's Approach to Floodplain and Stormwater Management, "Setting and History: Learning the Hard Way," p. 1–7 and at Web address: www.smartcommunities.ncat.org/articles/rooftop/index.shtml. City of Tulsa, 1994.

Water Management Analysis Report, Flood of September – October 1986, Northeastern Oklahoma and Southeastern Kansas. US Army Corps of Engineers Tulsa District, August 1987.

4.12 Levee Failure

4.12.1 Hazard Profile

According to the Federal Emergency Management Agency, a levee is "a man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding." Levees are considered structural flood control projects, and are generally constructed to protect floodplain development. Until the late 1960s, structural measures such as levees were the dominant approach to riverine floodplain management. Currently, however, under the National Flood Insurance Program (NFIP) regulations, levees are not recognized as acceptable measures for protecting new, substantially improved, or substantially damaged structures.

Levee B Area, 1984 Flood

Levee failures or damages behind levees can be caused by several occurrences:

- Overtopping due to flood heights exceeding the levee design-protection elevation;
- Flooding from upstream sources internal to the levee;
- Erosion caused by embankment leaking or "piping" or excessive saturation of a sand levee. "Piping" is internal erosion caused by seepage, and can occur around pipes, through animal burrows, around roots of trees, and other weaknesses.
- Improper operation and maintenance, including failure to inspect and repair seepage problems or manage vegetation.

The failures of levees along the Mississippi River in 1993 and in New Orleans after Hurricane Katrina in 2005 have focused new attention on the inherent hazards of levees.

Levee failures can cause catastrophic floods, releasing sudden walls of water that can sweep across lands thought to be protected by the structure. Thus, levees may create a false sense of security, increasing the amount of property at risk of flooding as people and businesses locate behind levees and floodwalls, believing they are totally safe. In addition, levees, dams, and other structural measures are extremely costly and can disrupt or destroy the natural environment.

Location

The levees of most concern for Tulsa are west of downtown on the north, south, and west sides of the Arkansas River, protecting the refineries and some adjacent neighborhoods. The levees of concern to the City of Tulsa are shown in Figure 4-35.

In Tulsa, after disastrous floods in 1941 and 1943, residents appealed to the County Commission and the U.S. Department of War (now Corps of Engineers) to build levees to protect floodplain

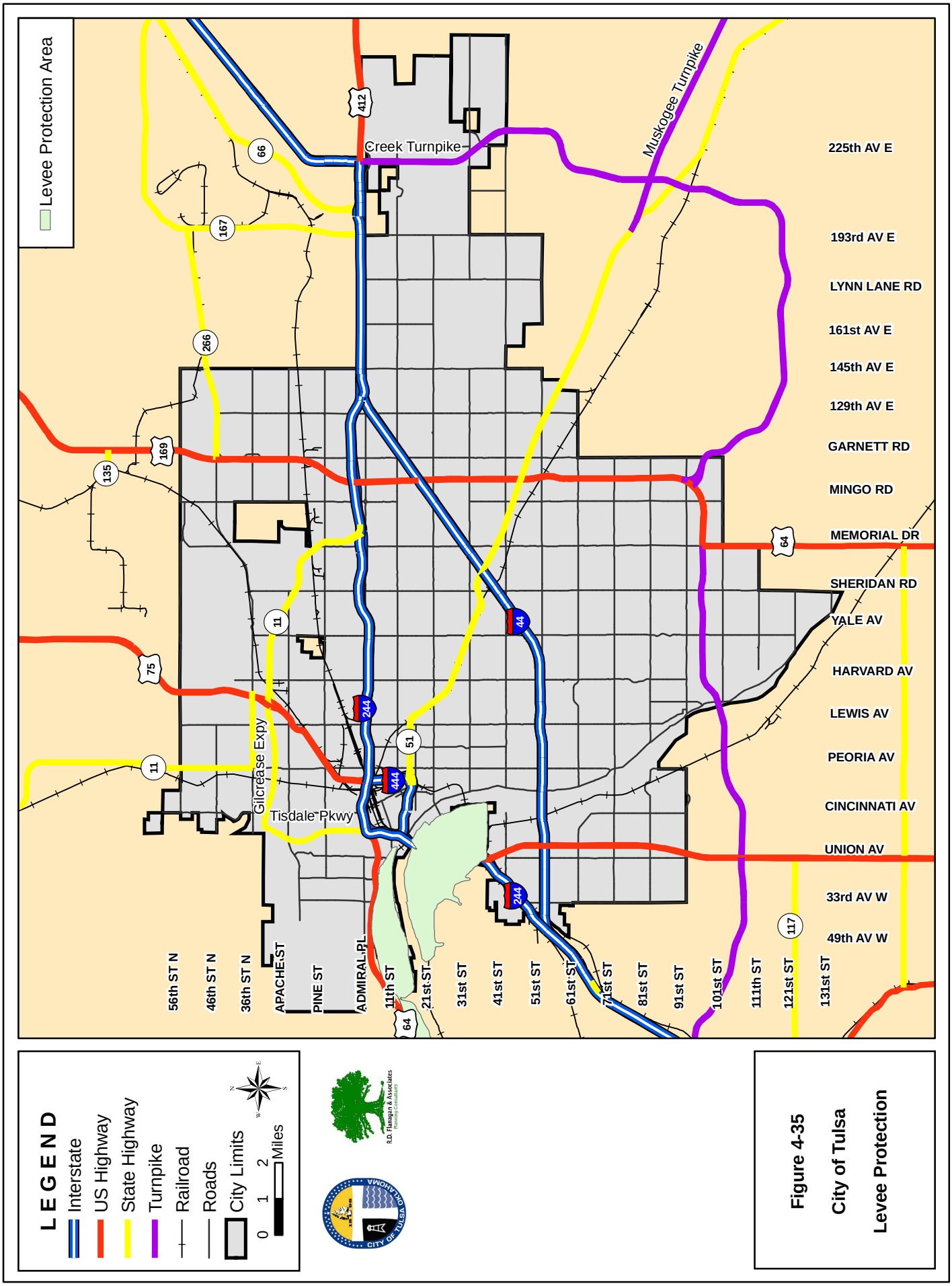


Figure 4-35
City of Tulsa
Levee Protection

development and vital war industries, such as the refineries in West Tulsa. The levees were finished in 1945.

Garden City, an area of low-income homes, was left unprotected downstream from the Corps' refinery levee. Garden City residents subsequently built their own non-engineered private dirt levee on the west side of the Arkansas River between 21st and 51st streets to protect their homes.

On the left bank of the Arkansas River near Tulsa, the levee extends from river mile 531.0 near Sand Springs, Oklahoma, downstream to river mile 521.4 at Tulsa. On the right bank, the levee extends from near river mile 526.7 downstream to river mile 521.3 and is adjacent to the major portion of the business and residential districts in West Tulsa and Tulsa County. Together, the three Corps earthen, grass-covered levees are about 20 miles long. The average height is 8 feet tall, with an average crest width of 8 feet.

The Corps designates these levees as:

- **Levee A,** the upstream left bank levee (the western levee, located north of the river in Sand Springs and Tulsa County);
- **Levee B,** the downstream left bank levee (the eastern levee, located north of the river, primarily within the jurisdiction of the City of Tulsa);
- **Levee C**, the right bank levee (the West Tulsa levee, within the Tulsa city limits, but also containing large unincorporated areas. These unincorporated areas, located in Tulsa County, contain oil refineries, oil tank storage farms, and railroad switching yards.)

The three levees are not connected, although the left bank levees tie into a floodway structure and operate as a system. The levee project also includes seven pumping stations, four stop-log structures, wing levees, diversion channels, and a floodway structure to pass flows from three tributaries north of the river.

The Corps of Engineers designed the levees to contain and withstand a Keystone dam release of 350,000 cfs, with a minimum of 3 feet of freeboard.

By agreement between the Corps and Tulsa County, they are maintained by Tulsa County Drainage District 12, a legal entity that is funded by assessments on properties behind the levees. A 2008 Corps of Engineers inspection report was critical of current maintenance.

Measurement

FEMA establishes mapping standards and risk determination zones and is responsible for reflecting these determinations on flood maps. A levee that FEMA shows on a FIRM as providing protection from the 1-percent annual chance or greater flood is considered to be an "Accredited Levee." The area protected by such a levee will be shown as Zone X on the FIRM.

Levee certification must be completed for the levee to be eligible for accreditation by FEMA. The certification process deals specifically with the design and physical condition of the levee. According to FEMA, it is the responsibility of the levee owner or community in charge of the levee's operations and maintenance to complete the requirements for levee certification. FEMA requires the community or levee owner to work with a licensed engineer or Federal agency responsible for the levee to develop and certify documentation that the levee meets design and construction standards for at least the 1-percent-annual-chance flood. Once the certification process is complete, the levee may become accredited.

A levee that has been previously accredited with providing 1-percent annual-chance flood protection on an effective FIRM can be designated as Provisionally Accredited Levee (PAL). This is done for levees that FEMA is awaiting data and/or documentation that show the levee's compliance with NFIP regulations. The documentation must be returned within a certain time period, and FEMA requires

signature from the community or levee owner that it agrees to provide documentation within the specified timeframe.

Levees reduce but do not eliminate the risk of flooding. Over time, risk reduction provided by a levee can change. Levees built many years ago many no longer provide the minimum level of risk reduction from a flood and may need improvements. Levees that are found to no longer meet Federal standards for risk reduction are mapped as being not providing such protection, or are de-accredited when new flood maps are issued to a community. The areas behind a de-accredited levee are mapped as high risk, or Special Flood Hazard Areas (SFHA). When the newly issued maps go into effect, property owners in the high-risk areas are subject to the Federal flood insurance requirement. Those property owners with mortgages from federally regulated or insured lenders will be required to purchase flood insurance.

Extent/Severity

The City of Tulsa considers a minor severity Levee event to be one that results in less than three feet depth of flooding on a one story building, and a major severity dam event to be one that exceeds the capacity of the downstream riverbed immediately downstream from the Levee and/or equates to (or exceeds) a 100- or 500-year flood and results in a depth of three feet of flooding or more on a one story building.

Frequency

In the area of chief concern for Tulsa, the Arkansas River corridor, the frequency of flooding has been dramatically reduced by Keystone and Kaw dams and the Arkansas River levees. Only one significant flood event (1986) has occurred along the Arkansas at Tulsa since the dams and levees were completed, other flood events have occurred, such as in 1957 and 1959, but the levees largely held.

Impact

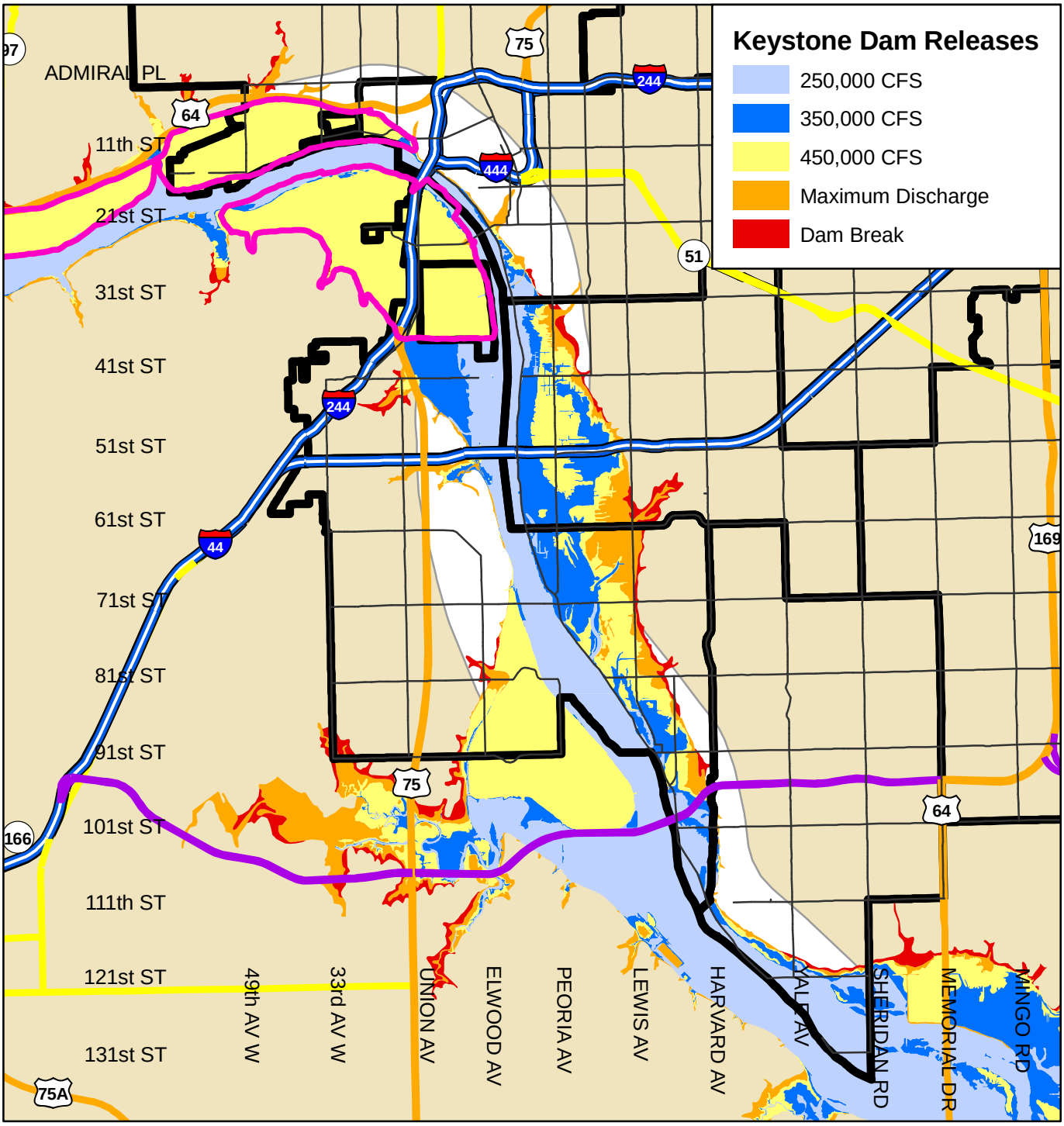
Levee failure flooding occurs with little or no warning and is often rapid, forceful, and extremely damaging.

The failure of a major Tulsa levee could cause catastrophic damage. In the words of the Corps of Engineers, failure of Keystone Dam or the Arkansas River Tulsa levees “would be catastrophic in terms of property damage, potential for loss of life, and environmental destruction.”

The Corps predicts Tulsa’s Arkansas River levees would overtop if Keystone Dam release rates reach 450,000 cfs. Some experts believe that a sustained flow of 300,000 cfs or greater could cause the levees to fail. Figure 4–36 shows the anticipated inundation area if the Tulsa levees fail during a 450,000 cfs release.

4.12.2 History/Previous Occurrences

Although the Corps’ Tulsa levees have not suffered major failure, properties protected by the levees have suffered flood damages from internal flooding in 1984, and Corps’ levees were threatened with failure and overtopping in 1986 and 1993. In 1986, the remnants of Hurricane Paine dumped nearly 2 feet of rain northwest of Tulsa, causing the Arkansas, Caney, and Neosho Rivers to flood. To prevent the Arkansas River from overtopping Keystone Dam, the Corps of Engineers opened floodgates and released 310,000 cfs of water through Sand Springs, Tulsa, Jenks and Bixby. No one knew if the sand levees would hold, and a catastrophic failure of the levee system was widely feared. In fact, the Sand Springs levee was breached, but volunteers quickly plugged it with sandbags. On the west bank, the private levees failed during the 1986 Arkansas River flood, and the river swamped a number of Garden City houses up to the rooftops, causing $1.3 million in damages to 64 buildings. The disaster was complicated by pollution from old, underground refining and chemical storage and dumps.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- Levee Protection Area
- River Corridor

0 1 2 Miles

N W E S

R.D. Flanagan & Associates
Planning Consultants

Figure 4-36

Arkansas River Corridor

Probable Inundation from a 450,000 CFS Failure

In all, more than 1,800 homes and businesses were flooded in Tulsa County, and 1986 damages were estimated at $63.5 million (in 1986 dollars)

Probability of Future Events

Although flooding has been significantly reduced along the Arkansas mainstem in Tulsa as a result of the construction of Keystone and Kaw dams, it has not been eliminated—as shown by the October 1986 peak flow event. Often these are due to hurricanes in the Gulf of Mexico or Gulf of California that stall over the Arkansas basin. The dams and levees that protect Tulsa can regulate these peak events, but cannot prevent them. Flows coming into Keystone Lake from the Arkansas and Cimarron Rivers in 1986 were around 400,000 cfs, which forced the Corps to release over 300,000 cfs to prepare to receive this surge. The Corps estimates that similar high flows will occur on the river about every 25 years. Tulsa is considered to have a MODERATE probability of the Levee Failure hazard.

4.12.3 Vulnerability

This section summarizes the City of Tulsa's vulnerability to Levee Failure, including the impact on people, structures and buildings, critical facilities, and infrastructure. This information was used to determine the Vulnerability Criteria identified in Tables 4-3 and 4-4. The City of Tulsa was determined to have a HIGH vulnerability to the Levee Failure hazard. (See Tables 4-3, Hazard Risk Analysis, and Table 4-4, Summary of Hazard Risk Analysis Ranking Criteria for an explanation of how the rankings were derived.)

Population

People, property, critical facilities, and infrastructure behind the levees could be subject to danger and significant damage in the event of failure. The number of fatalities or injuries resulting from levee failures is highly influenced by the number of people occupying the inundation area, the amount of warning they are provided, and the amount of pre-event public education and planning. People who might be at risk include those who are living, working, at school or play, or traveling through vulnerable areas. An estimated 8,194 people occupy the areas behind the Arkansas River Levees.

Structures/Buildings

If the levee system were to fail to protect properties due to (1) planned releases from Keystone Dam in excess of the levee design protection, (2) from Keystone Dam failure, or (3) from flooding from internal sources, such as Harlow, Parkview, or Oak creeks, the damage to the City and County would be catastrophic. The numbers of improved parcels located behind the Arkansas River Levees, at Tulsa, and their estimated market values are included in Table 4-62.

Table 4–62: Improved Parcels Levee Failure Inundation Area

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	2,186	$71,759,920
Residential Multi-Family	15	$14,859,400
Commercial	98	$11,445,565
Industrial	23	$9,538,400
Other	739	$14,994,650
Total	3,061	$122,597,935

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

There are 27 critical facilities located in the inundation areas of the Arkansas River Levees. Critical facilities located in the Levee inundation areas are listed and mapped in each District section of

Chapter 5. The Sun Oil Refinery, which could also be considered a critical facility, but is not included in this list, is also located behind the levees on the west side of the Arkansas River.

Infrastructure

A failure of the Arkansas River Levees would have impacts more similar to a dam failure rather than riverine flooding. As witnessed in Hurricane Katrina, levee failures have catastrophic results. Tulsa infrastructure would be devastated by a failure of the Levees. Inundation of I-244 and the 21st Street Bridge would limit the ability to cross the Arkansas River.

4.12.4 Future Trends

For information regarding future development in the City of Tulsa, see Section 1.2.8.

Population

Virtually all of the current development proposals for the Arkansas River corridor would be expected to increase the number of people at risk in the lowlands and floodplains. For this plan, it is assumed that management decisions will be based on FEMA's 100-year floodplain standard. Therefore, the numbers of people in all categories – living, working, going to school, traveling through, with functional and access needs, etc. – will increase, exposing more people to risk from larger events (such as the 1986 flood).

Structures / Buildings

Similarly, all of the current development proposals would be expected to increase the number of buildings at risk in the Arkansas River lowlands. If building decisions are based on the FEMA 100-year floodplain standard, the number of buildings exposed to flooding from levee failure will increase, exposing more structures to risk from events like the 1986 flood. If the 100-year floodplain standard were to be revised, the number of new structures at risk could be substantially reduced.

Critical Facilities

Current riverfront development proposals do not focus on critical facilities, so it is anticipated that their number would not increase in the river lowlands in the future. The probability of future damage may hinge on whether leaders consider hazard management in expansion decisions for schools, detention facilities, social service agencies, health clinics, and other critical facilities. Again, it is anticipated that these decisions will be based on only the FEMA 100-year floodplain standard.

Infrastructure

Generally, all current development plans would increase the investment in infrastructure in the river lowlands. For example, all proposals include new roads, the Gilcrease Expressway, new low-water dams and bridges, utilities, parks and walking trails. If higher standards than the FEMA 100-year floodplain are used, and if impacts to infrastructure in the floodplain are carefully considered, planning decisions might decrease future risks to valley properties and populations.

4.12.5 Conclusions

People, property, critical facilities, and infrastructure downstream of dams and behind levees could be subject to injury, death and significant damage in the event of their failure. The most important factor for public safety is the timeliness and effectiveness of warning given to vulnerable populations, and the amount of pre-event public education and planning. Levees often convey a false sense of security, since they allow people to think they will always be protected. As a consequence, levee safety is not usually high in the public consciousness. The failures of the New Orleans and the Mississippi River levees may serve to focus more attention on these risks. Failure of the levees along the Arkansas River would have a devastating impact upon the City of Tulsa and Tulsa County. The City of Tulsa is

considered to have a HIGH vulnerability to and a MODERATE probability of the Levee Failure hazard.

Data Limitations

Data are limited for Tulsa-specific hazard risk, vulnerability, impacts, preventive measures, costs, and benefits for damage to buildings, critical facilities, and infrastructure due to a lack of specific record keeping, as referenced in Section 4.9.5.

4.12.6 Sources

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4.13 Expansive Soils

4.13.1 Hazard Profile

Soils and soft rock that tend to swell or shrink due to changes in moisture content are commonly known as expansive soils. Expansive soils are often referred to as swelling clays because clay materials attract and absorb water. Dry clays will increase in volume as water is absorbed and, conversely, decrease as they dry. These movements lead to cracking and buckling of the infrastructure built on or in expansive soils and result in billions of dollars of damage annually.

Location

Based on surveys of underlying soils, Figure 4–37 shows a generalized map of the areas of Tulsa where soils have low to very high expansive qualities. (For information on expansive soils in individual Council Districts, see Chapter 5)

Generally, many Tulsa lowlands along the river and waterways have low shrink-swell soils. Many higher elevations have moderate to high potential, including large areas of central and east Tulsa. Localized sites with very highly expansive soils have been identified in North Tulsa between 36th and 56th St. N., from Harvard Ave. to Mingo Rd., and between Garnett and 145th E. Ave., from 56th St. N. south to S. 41st St. Another pocket of very high shrink-swell soils is between S. 31st and 41st St. along Lynn Lane. Moderate to high shrink/swell soils predominate in future growth areas to the east and southeast, with low to moderate expansive soils in the south, on both sides of the Arkansas River.

Soils with high to very high shrink/swell potential cover 30.84 percent of the City of Tulsa's land area. Soils classified as Moderate cover 24.45 percent. Soils with low shrink/swell potential are the most common, covering 42.28 percent of the City's total land area. Information regarding expansive solids in the City of Tulsa is included in Table 4-63.

Table 4–63: City of Tulsa Expansive Soils

Expansion Potential	Area (sq mi)	Percent of Total City Limits
Very High	7.45	3.72%
High	54.25	27.12%
Moderate	48.91	24.45%
Low	84.57	42.28%
Water	4.83	2.41%
Total	200.01	100.00%

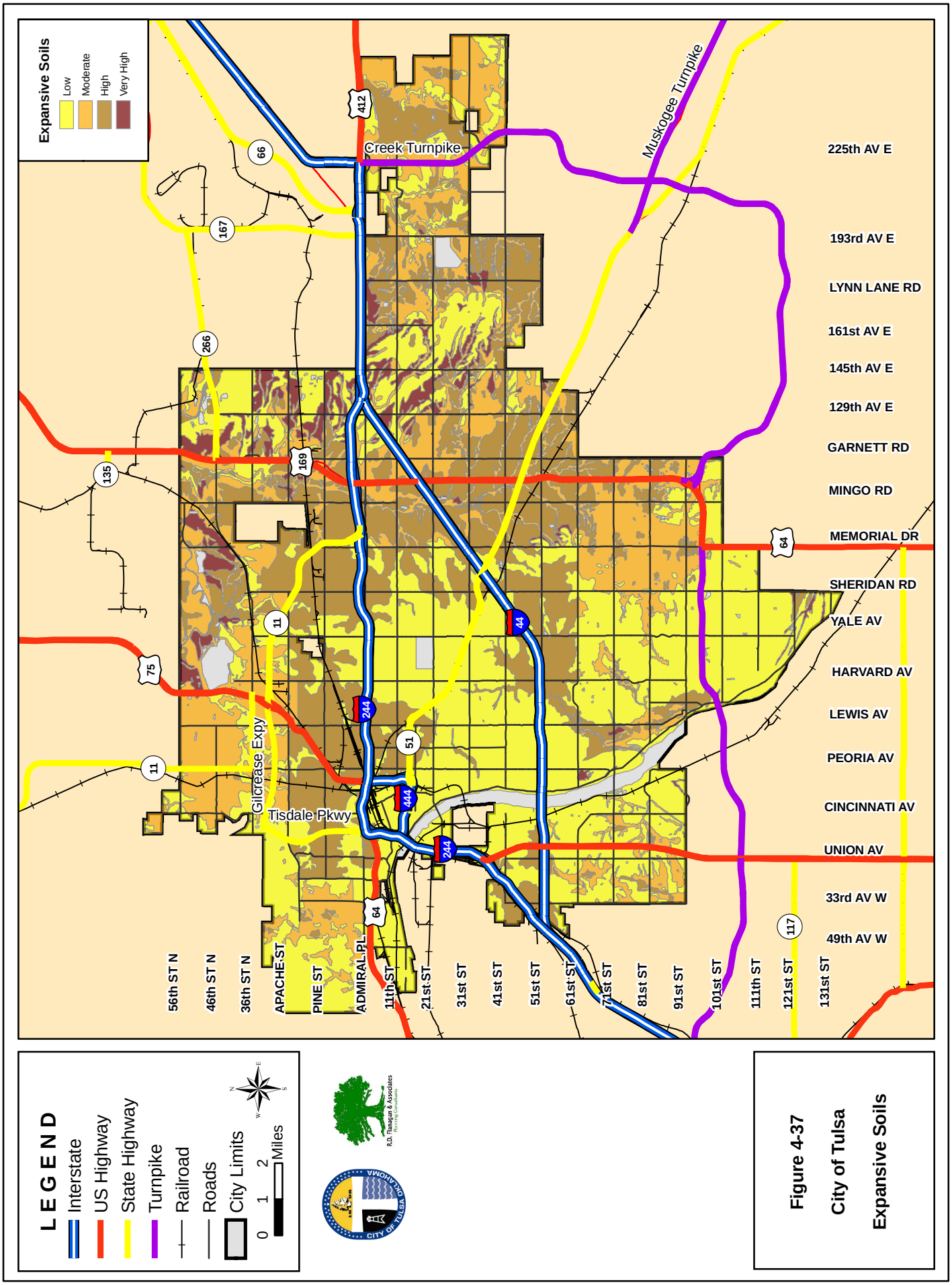


Figure 4-37
City of Tulsa
Expansive Soils

Measurement

The risk associated with expansive soil is related to shrink/swell potential in a qualitative manner: very high, high, moderate and low. As shown in Table 4-64, the shrink-swell potential is low if the soil has a linear extensibility of less than 3 percent; moderate if 3 to 6 percent; high if 6 to 9 percent; and very high if more than 9 percent. If the linear extensibility is more than 3, shrinking and swelling can cause damage to buildings, roads, and other structures and to plant roots. Under such conditions, special designs or soil treatment are commonly needed.

Table 4–64: Expansive Soils Linear Extensibility Percent

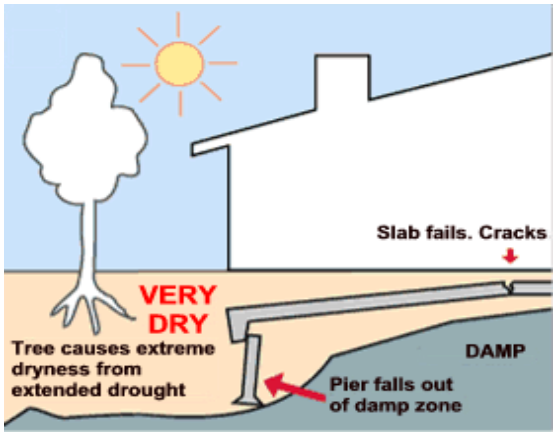
Expansion Potential	Linear Extensibility Percent
Very High	> 9%
High	6% - 9%
Moderate	3% - 6%
Low	< 3%
Water	0%

The National Resource Conservation Service (NRCS), in its Soil Survey Geographic Database (SSURGO), identified expansive soils for the City of Tulsa as shown in Figure 4–37. SSURGO map units were classified from low to very high based on the linear extensibility percent (LEP) for the soils within the identified map units to depths up to 60 inches, the depth at which damage to improvements from expansive soils is most likely to occur. Soil samples are dehydrated through air- or oven-drying for a predetermined length of time under a constant temperature. Linear extensibility percent is the linear expression of the volume difference of natural soil fabric at 1/3 bar or 1/10 bar water content and oven dryness. The volume change is reported as percent change for the whole soil. In addition, the Oklahoma Department of Transportation has a program to evaluate the expansive tendencies of soils and shale formations in the state.

Extent/Severity

With 30.87% of the City of Tulsa having soils with High to Very High shrink/swell potential, the jurisdiction could suffer damage from expansive soils. This being said, the extent of expansive soils property damage can vary greatly, based on the long-term weather conditions, the type and quality of construction, materials used in construction, and, most importantly, the soils the structures are built upon. For example, aging gas and water pipelines, especially when originally constructed in wet soil, can crack and rupture during periods of extended drought. Damage from expansive soils can be reduced by mapping the soils in the jurisdiction and by informing property owners and prospective buyers and builders of potential soil hazards and the techniques that can be used to limit their impacts.

Figure 4–38: Effects of Expansive Soils



The City of Tulsa considers soils with Low to Moderate expansion potentials that result in cracks in walls to be of minor severity, but soils with High to Very High expansion potentials that result in water-main breaks and leaks from hazardous materials pipelines to be of major severity.

Frequency

Local frequency analyses have not been prepared because of the nature of this hazard, which is consistent with other geologic hazards that occur rarely or slowly over time and are either not documented or are treated as routine maintenance.

Impact

The impact of this hazard occurs over time and affects structures and infrastructure. If the shrink-swell potential is rated moderate to very high it can damage buildings, roads, and other structures. The high degree of shrinkage associated with high and very high shrink-swell potentials can damage plant roots.

Cracks in exterior walls caused by soil expansion

Many researchers show that expansive soil is one of the most costly hazards in the United States, in terms of property damage from shifting soils. For example, out of the 250,000 homes built each year on expansive soils, 10% sustain significant damage during their useful lives, some are damaged beyond repair, and 60% sustain minor damage. For all types of building construction, annual losses of $740 million are estimated. The total annual cost of expansive soil-related damage and preventive design of moderate- to high-risk structures throughout the United States has been conservatively estimated at between $2.5 billion and $10 billion (in 1995 dollars).

Despite its costly effects, expansive soil is a silent hazard. Because the damage develops gradually and seldom presents a threat to life, expansive soils have received limited attention. Many problems are not recognized as being related to expansive soils or may be considered only nuisances and therefore are never repaired.

4.13.2 History/Previous Occurrences

In Oklahoma, numerous foundation failures and pipeline breaks have resulted from soil shrinkage during the unusually hot and dry summers of 1998 and 2005-2006, 2011, and 2012. For example, a combination of extreme heat and soil movement caused above average numbers of water line breaks in Tulsa during the summers of 2011 and 2012.

The only City of Tulsa structure with recorded damage from expansive soils is the Motorcycle Shop at 1720 W. Newblock. Damage was significant enough that retrofitting under the building was required. Since the City does not routinely list damage as having been caused by expansive soils, it is likely there has been other damage of this nature.

Probability of Future Events

Analyses of future probability have not been prepared because of the nature of this hazard, which is consistent with other geologic events that occur rarely or slowly over time. It could be assumed that shrink-swell soils in Tulsa will continue to cause localized problems in areas of high to very high expansive soils, similar to those experienced in the past. The City of Tulsa is considered to have a HIGH probability of experiencing the Expansive Soils hazard.

4.13.3 Vulnerability

This section summarizes information about the City of Tulsa's vulnerability to Expansive Soils, including the impact on people, structures and buildings, critical facilities, and infrastructure. This

information was used to determine the Vulnerability Criteria identified in Tables 4-3 and 4-4. The City of Tulsa was determined to have a MODERATE vulnerability to the Expansive Soils hazard. (See Tables 4-3, Hazard Risk Analysis, and Table 4-4, Summary of Hazard Risk Analysis Ranking Criteria for an explanation of how the rankings were derived.) It should be emphasized that the City of Tulsa does not, as a rule, document damage from expansive soils as being the result of a natural hazard, but rather treats it as a routine maintenance issue.

Population

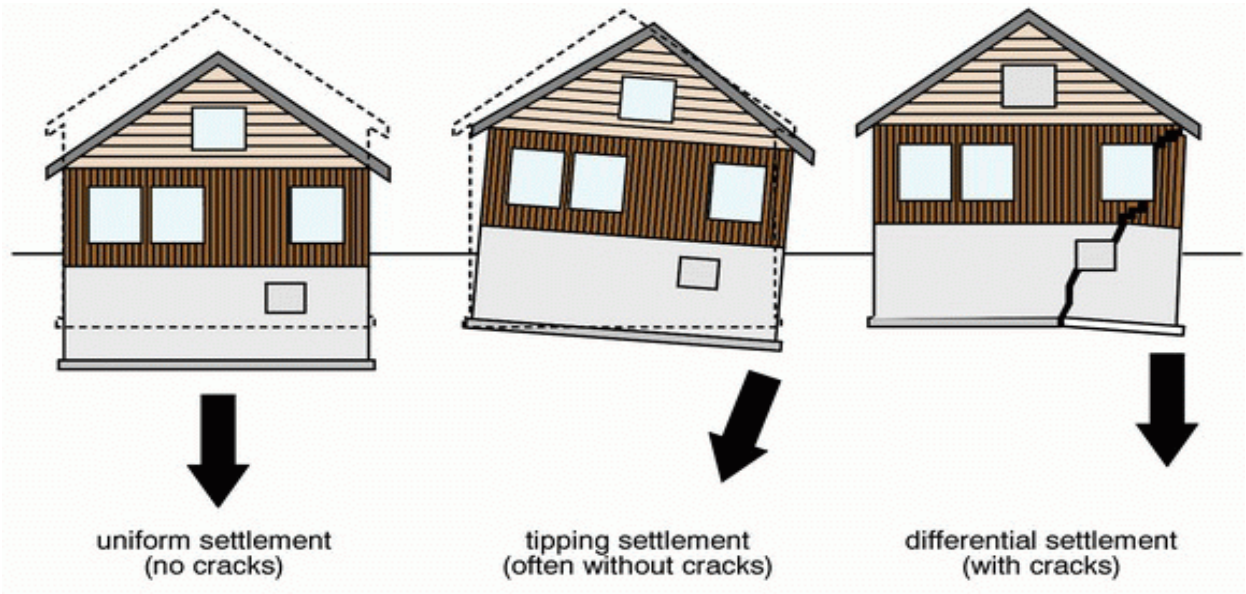
Direct threats to life or personal injury have not generally been documented for expansive soils, due to the nature of the hazard. Indirect threats to populations in Tulsa include economic damages in residential structures. Public health concerns arise from this hazard when the shrinking and swelling of soils cause water or sewer lines to break, which often occur in critical times such as periods of extreme heat and drought.

Structures/Buildings

The increase in soil volume can cause damage to foundations. The most obvious manifestations of damage to buildings are sticking doors, uneven floors, and cracked foundations, floors, walls, ceilings, and windows. If damage is severe, the cost of repair may exceed the value of the building. It does not take much movement to damage buildings. As little as a differential movement of 0.25 inches between adjacent columns can cause cracking in load-bearing walls of a 2-foot-wide bay.

Houses and one-story commercial buildings are more likely to be damaged by the expansion of swelling clays than are multi-story buildings, which are usually heavy enough to counter swelling pressures. However, if constructed on wet clay, multi-story buildings may be damaged by shrinkage of the clay if moisture levels are substantially reduced, such as by evapotranspiration or by evaporation from beneath heated buildings. Typical damages to houses caused by expansive soils are shown in Figure 4-39.

Figure 4–39: Types of Expansive Soil Damage



The greatest damage occurs when small buildings are constructed when clays are dry, such as during a drought, and then subsequent soaking rains swell the clay. Other cases of damage involve increases of moisture volume from broken or leaking water and sewer lines, over-watering of lawns and landscape, and modifications of the surface that produce ponding.

A total of 52,062 improved parcels are underlain by soils with High to Very High shrink/swell potential in the City of Tulsa. A breakdown of vulnerable parcels by value, adjusted for fair market, and type is shown in Table 4-65.

Table 4–65: City of Tulsa Expansive Soils

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	46,089	$3,376,611,563
Residential Multi-Family	1,530	$446,669,191
Commercial	2,166	$1,584,675,284
Industrial	335	$299,298,551
Other	1,942	$978,972,829
Total	52,062	$6,686,227,418

Critical Facilities

Of the facilities identified as critical by the city of Tulsa, 166 are built upon soils classified as having "high" or "very high" shrink/swell potential. The remainder of Tulsa's critical facilities are on "low" or "moderate" shrink/swell soils. Critical facilities vulnerable to the Expansive Soils hazard are listed and mapped by Council District in Chapter 5.

Infrastructure

Damage to the built environment results from differential vertical movement that occurs as clay moisture content adjusts to the changed environment. In a highway pavement, differential movement of 0.4 inches within a horizontal distance of 20 feet is enough to pose an engineering problem if high standards for fast travel are to be maintained.

4.13.4 Future Trends

Soils in Tulsa's identified future-development areas are primarily classed as "low" and "moderate", but soils with a "high" shrink-swell potential are also present, along with a few areas that are "very high." Of particular concern, more than 23% of the land in areas zoned for future industrial development in the north and northeast quadrants of the city are classed as "very high." With 30.84% of the soils within the city limits being categorized as having "high" to "very high" shrink/swell potential, the City of Tulsa will continue to have Moderate vulnerability to the damaging effects of expansive soils. Expansive Soils in the Future Growth Areas are shown in Figure 4-40.

Structures / Buildings

Damage to structures in Tulsa can be expected during and following any period of extended drought. This is especially true of structures built during a period of a drought followed by soaking rains that cause swelling of clays. Because the level of structural damage that is often incurred as a result of building on soils with High to Very High shrink/swell potential, it is imperative for builders to identify soil types at proposed sites before they are developed.

Critical Facilities

As Tulsa is developed, expansive soils could cause considerable damage to new critical facilities if these are built without structural mitigation strategies in mind. While structures on expansive soils would not have an immediate impact on the City, they could have a shortened effective lifespan, thereby requiring expenditures in the future to replace them. In addition, long-term structural damage to buildings housing vulnerable populations – schools, long-term care facilities, childcare centers –

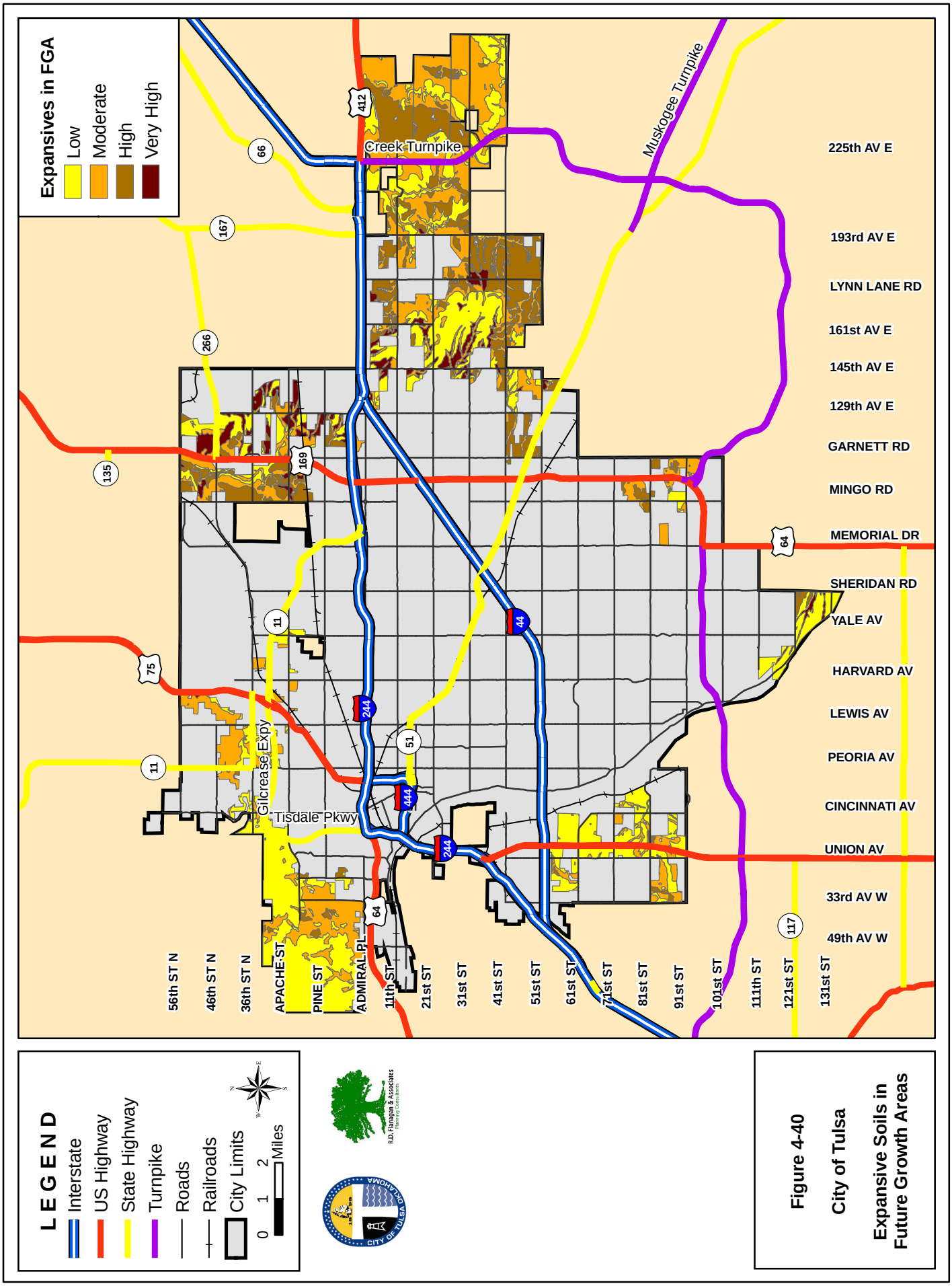


Figure 4-40
City of Tulsa
Expansive Soils in Future Growth Areas

could place the residents at risk should the buildings be exposed to other natural hazard events in a sub-standard condition—such as tornadoes, high winds and earthquakes.

Infrastructure

Long referred to as the "unknown hazard," expansive soils may be a hazard with more of a future than a past. As Tulsa's infrastructure continues to age – particularly water and sewer lines built at the beginning of the last century with materials and techniques that would not meet today's codes – a prolonged period of drought could significantly speed and intensify infrastructure deterioration. For example, aging gas, sewer and water pipelines, especially when originally constructed in wet soil, can rupture during periods of extended drought. The rehabilitation of roads and aging central business districts will likely include the replacement of much of the city's infrastructure that lies underground, especially if located in areas with expansive soils. The use of the more flexible PVC or HDPE piping could reduce the impact of expansive soils.

4.13.5 Conclusions

The history of Tulsa's expansive soil hazard is difficult to track. Neither the City nor insurance companies monitor damage to structures from expansive soils as the impact of a specific natural hazard. The City treats all such damage as a maintenance issue. According to City Engineers, the expansive soil hazard is routinely taken into account in engineering studies and construction practices for infrastructure projects, but not specifically documented.

Expansive soils develop gradually and are seldom a threat to the population, but can cause severe damage to improvements built upon them. With 27.12% of the soils within the city limits classified as having high shrink/swell potential and less than 4% in the "very high" category, the City of Tulsa has a MOEDRATE vulnerability to the damaging effects of expansive soils. Increased damage to structures could be expected during and following a period of extended drought, particularly for structures built during a drought that have been subsequently subjected to soaking rains.

Data Limitations

Data are limited for Tulsa-specific expansive soils hazard risk, vulnerability, impacts, preventive measures, costs, and benefits for damage to buildings, critical facilities, and infrastructure due to a lack of specific record keeping, as referenced in Section 4.13.3.

4.13.6 Sources

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

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4.14 Wildfires

4.14.1 Hazard Profile

As more people make their homes in wild land settings in close proximity to large tracts of grasslands or forests, the number of citizens and structural improvements at risk to the impacts of wildfire increases. Wildfires often begin unnoticed and spread quickly, igniting grass, brush, trees, and homes.

> ***"A wildfire is any outdoor fire that is not controlled, supervised, or arranged. Wildfire probability depends on local weather conditions; outdoor activities such as camping, debris burning, and construction; and the degree of public cooperation with fire prevention measures. Wildfires can result in widespread damage to property and loss of life.***
>
> *-Mitigation Ideas, a Resource for Reducing Risk to Natural Hazards, FEMA, Jan 2013*

Wildfires can move on three different levels. A *surface fire* is the most common type and burns along the surface of grasslands or forests, usually moving quickly through an area. A *ground fire* is usually started by lightning and burns on or below the forest floor in the humus layer down to the mineral soil, mostly by smoldering combustion. A *crown fire* has ascended from the ground into the forest canopy, spreads rapidly by wind and moves by jumping along the tops of trees.

Fire suppression is now recognized to have created a larger fire hazard, because live and dead vegetation accumulates in areas where fire has been excluded. In addition, the absence of fire has altered or disrupted the cycle of natural plant succession and wildlife habitat in many areas. Consequently, United States land management agencies are committed to finding ways of reintroducing fire into natural ecosystems (such as prescribed burning) while recognizing that fire fighting and some types of fire suppression are still important.

According to FEMA, as stated in the report *Multi-Hazard Identification and Risk Assessment*, there are four categories of wildfires experienced throughout the United States. The categories are described in Table 4-66.

Table 4–66: Wildfire Categories

Title	Description
Interface or intermix fires	Fires that are fueled by both wild land vegetation and the built-environment
Firestorms	Events of such extreme intensity that effective suppression is virtually impossible. They occur during extremely dry weather and generally burn until conditions change or available fuel is exhausted.
Prescribed fires	Fires intentionally set or selected natural fires that are allowed to burn for beneficial purposes.
Wild land fires	Fires fueled by natural vegetation and typically occur in national forests and parks.

Location

Vulnerable Wildfire Level of Concern areas for the City of Tulsa are shown on the map in Figure 4-41. Within the Tulsa City/County jurisdiction, development in more remote and wooded areas, also referred to as the Wildland Urban Interface (WUI), continues to take place. Because more people are choosing to build expensive homes on acreage in rural settings, surrounded by grasslands and forest, the WUI has increased enormously. This is particularly true of Tulsa, with its growing

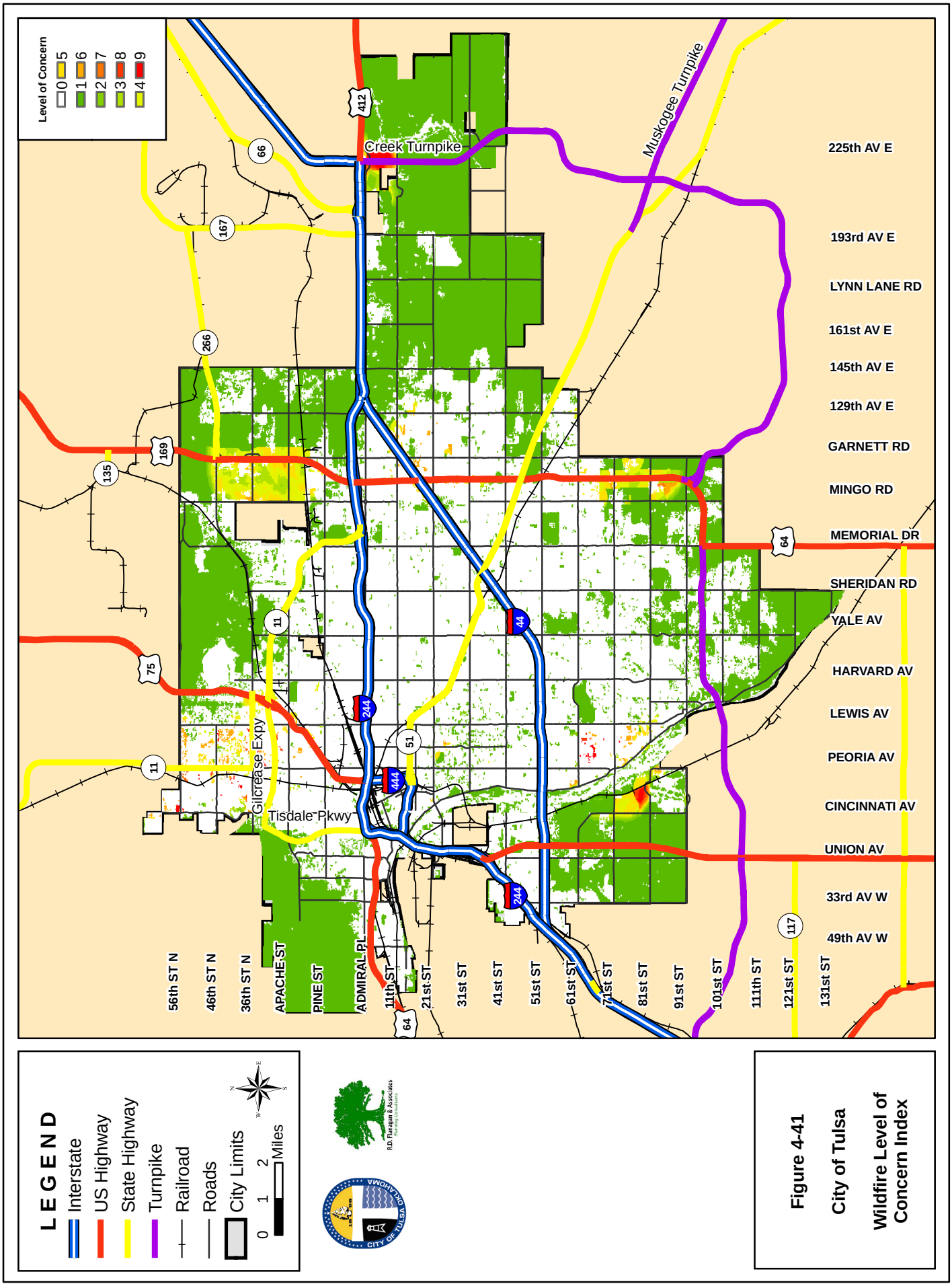

Figure 4-41
City of Tulsa
Wildfire Level of Concern Index

suburban population and upscale economy. While most grasslands of the U.S. have a fuel load of 1,000 to 2,000 lb. per acre, around Tulsa it is between 6,000 and 10,000 lbs. per acre.

Residential and business structures developed in close proximity to grassy and woody fuels will be natural risks for this hazard event. In addition, wildland/grassland fires are a strong threat to agricultural areas such as farms and/or ranches, especially during the high risk fire season.

A worker tries to help Tulsa firefighters put out a grass fire at 56th St. North and U.S. 169 northeast of Tulsa International Airport.

(Source: Tulsa World, 10/25/06)

Measurement

Wildfire danger is measured using indexes that relate longer-term soil and vegetation conditions to shorter-term weather patterns. The most explosive conditions occur when dry, gusty winds blow across dry vegetation. These factors are contained in the Keetch-Byram Drought Index (KDBI), the Fire Danger Rating System, and the Burning Index (BI). The **Keetch-Byram Index** relates weather conditions to potential or expected fire behavior, using numbers from 0 to 800 to represent the amount of moisture that is present in soil and vegetation; it is described in detail in Section 4.7, *Drought*. The **Fire Danger Rating System**, Table 4-67, combines the combustibility of vegetation and weather conditions to derive the easily understood Green-Blue-Yellow-Orange-Red fire danger alerts.

Table 4–67: Fire Danger Rating System

Rating	Basic Description	Detailed Description
CLASS 1: Low Danger (L) COLOR CODE: Green	Fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
CLASS 2: Moderate Danger (M) COLOR CODE: Blue	Fires start easily and spread at a moderate rate	Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
CLASS 3: High Danger (H) COLOR CODE: Yellow	Fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.
CLASS 4: Very High Danger (VH) COLOR CODE: Orange	Fires start very easily and spread at a vary 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.

Rating	Basic Description	Detailed Description
CLASS 5: Extreme (E) COLOR CODE: Red	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: Oklahoma Hazard Mitigation Plan (http://www.wfas.net/content/view/34/51/)

The **Burning Index**, Table 4-68, relates temperature, relative humidity, wind speed and solar radiation to the "relative greenness" of vegetation (taken from satellite measurements) and fuel models for native vegetation (assigned on a 1-kilometer grid across the State). These factors are used to derive four indices: Spread Component, Energy Release Component, Ignition Component, and Burning Index. The Burning Index is a synthesis of the Spread and Energy Release components, and is used to predict fire line intensity and flame length. The higher the number, the more difficult the wildfire is to fight.

Table 4–68: Burning Index

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

Extent /Severity

Wildfires have been increasing in number and causing a greater economic impact nation-wide, largely due to the rapid spread of rural estates on the peripheries of most American cities. The structures and critical facilities located in the wildland/urban interface and surrounded by dry grass and trees are clearly the most vulnerable.

Since wildfire risk can be dramatically reduced by landscaping and debris clearance, a detailed wildfire risk assessment should be made of any critical facilities located in the wildland/urban fringe. The City of Tulsa considers a reading of moderate and below on the Fire Danger Rating system (Table 4-67) to be a minor severity level and a rating of high and above to be of major severity.

Frequency

Tulsa has three wildland fire seasons. The worst is February through April, when grass fuels are dead, the humidity low, temperatures elevated, and winds are as high as 50-70 mph. A moderate wildfire season occurs in July or August, when some grasses are dormant or dead from the mid-summer heat. The third wildfire season, also moderate, is in the fall, after frost has killed the annual grasses.

According to the Oklahoma State Fire Marshal, from 2000 to 2009, City of Tulsa and Tulsa County fire departments made 5,571 grass and crop fire runs that burned a total of 5,077 square miles and caused $2,810,365 in damages; summarized in Table 4-69, below. Based on this limited data, the City of Tulsa Fire Department can expect to make about 507 wildfire runs each year.

Table 4–69: City of Tulsa Grass and Crop Fires, 2000-2010

Year	Runs	Acres Burned	Damages
2000	684	0	$209,715
2001	436	1,031	$628,691
2002	412	86	$27,163
2003	437	264	$16,961
2004	387	178	$10,377
2005	585	751	$37,716
2006	750	2,109	$93,944
2007	337	24	12,379
2008	563	189	32,587
2009	980	445	1,740,732
2010	*Data not available*		
Total	**5,571**	**5,077**	**2,810,265**
Average	**557**	**507**	**281,026**

Source: Oklahoma State Fire Marshal

Impact

The impact of the wildfire hazard can increase during times of drought, high wind and extreme heat. Wildfire can cause loss of life, loss of homes, loss of business, and devastating economic impacts to individual homeowners. The Fire Departments in the City of Tulsa are confident in their ability to respond quickly and effectively enough to limit damage from wildfires in or adjacent to their jurisdiction. Large wildfire events can call for the evacuation of one, and sometimes multiple, communities. A worst-case scenario, in Tulsa's view, would be the destruction of four structures and the injury or death of one person, either civilian or firefighter.

After a wildfire, vegetation may be destroyed and the organic material in the soils may be burned away or decompose into water repellent substances that prevent water from absorbing into the soil. In effect, normal rainfall after a wildfire may result in unusual erosion or flooding from burned areas; depending on the topography of the burned area, heavy rain can also produce destructive debris flows. Wildfires also have an affect on water supplies. The loss of ground-surface cover, such as pine needles and small branches, and the chemical transformation of burned soils make watersheds more susceptible to erosion from rainstorms and load runoff with soils and pollutants.

4.14.2 History/Previous Occurrences

According to the National Interagency Fire Center, Oklahoma reported 2,486 wildland fires destroying 293,381 acres in 2011. Narratives of Wildfire events reported to have impacted the City of Tulsa, including Tulsa County and its neighboring jurisdictions, are included in Table 4-70.

Table 4–70: Wildfire Event Narratives

Date	Event Narrative
November 2005-April 2006	As of January 2006, nearly 2,800 fires had left more than 550,000 acres scorched across the state; leaving 869 homes damaged, 300 of those destroyed. The wildfires of 2005-2006 impacted areas in and around Tulsa County and the City of Tulsa. In neighboring Creek County, the Depew Fire Complex burned for than a thousand acres and threatened 1,450 homes in Bristow. The Wainwright Fire Complex in nearby Muskogee County burned more than 4,000 acres and threatened nearly 12,000 homes in the Town of Muskogee. The Shamrock Fire Complex in Creek County threatened more than 300 homes in Drumright and Shamrock, OK. More than 6,500 homes near Kellyville were threatened as a result of the Sapulpa Fire Complex in Creek County, which burned over 800 acres. The Prague Fire Complex in Lincoln and Okfuskee Counties burned more than 640 acres and threatened 2,650 homes in eight communities.
Spring-Summer 2011	Extreme or exceptional drought conditions, combined with very warm temperatures, dry air and gusty winds, created rapid fire growth potential in early spring through the summer of 2011. According to the Oklahoma Forestry Service, a total of 132,103 acres were burned across eastern Oklahoma. Fifteen people were reported injured in wildfires on March 11, 2011; 54 wildfires burned statewide that day. On April 3, the State EOC was aware of more than 100 fires burning in Oklahoma. From June to August, there were numerous wildfires, with 15 resulting in Fire Management Assistance Grants (FMAGs), according to OEM
August 2011-Turley	On August 2, 2011, very dry, hot, and breezy conditions, along with extremely dry fuels as a result of long-term drought, promoted the rapid spread of wildfire just outside of Tulsa city limits near Turley, OK. The fire burned from 56th St. N. to 66th St. N., and from Lewis Ave. to Peoria Ave. Losses from the fire were assessed at $491,200.00. The total included five total loss homes, eight damaged homes, loss of three mobile homes, eleven storage sheds, two barns, one plane hanger, 10 vehicles, one dump truck and $37,000 in miscellaneous losses.
Summer 2012	In July and August 2012, wildfires devastated Oklahoma, including communities surrounding the City of Tulsa. Oklahoma Forestry Service reported nearly 114,000 acres burned from July 28th to August 9th, including 58,500 acres in Creek County. As a result of the fires, Creek County was approved for FMAGs to help reimburse local governments, volunteer fire departments and other first responders for costs associated with responding to the fires. In nearby Payne County, 63 homes were damaged as a result of wildfires during the same incident period, including 53 destroyed, 59 of which were uninsured. In Oklahoma County, 38 homes were damaged, including 33 destroyed, 31 of which were uninsured. And, in Cleveland County, 154 homes were damaged, including 141 destroyed, 127 of which were uninsured. Federal assistance was denied for Payne County, Oklahoma County, and Cleveland County.

Source: State of Oklahoma Hazard Mitigation Plan/Oklahoma Forestry Service/Tulsa Fire Department

Probability of Future Events

Suburban growth in the wildland interface will be a significant factor in the potential increase in number of wildfires occurring. The City of Tulsa is considered to have a MODERATE probability of future wildfire events.

4.14.3 Vulnerability

This section summarizes the City of Tulsa's vulnerability to wildfires, including the impact on people, structures and buildings, critical facilities, and infrastructure. This information was used to determine the Vulnerability Criteria identified in Tables 4-3 and 4-4. The City of Tulsa was determined to be at LOW vulnerability to Wildfire hazard. (See Table 4-3 Hazard Risk Analysis, and Table 4-4, Summary of Hazard risk Analysis Ranking Criteria for an explanation of how the rankings were derived.)

Population

As evidenced by the 2005-2006 and 2012 wildfire outbreaks, the rural and urban/wildland interface areas of Tulsa are vulnerable to wildfires. Deaths and injuries with wildfires have been very low in the state, and largely confined to firefighters. According to assessor data 1,740 residential single-

family structures, 44 residential multi-family structures, and six mobile homes are located in areas of Moderate to High wildfire LOC. Persons residing in these structures face the most exposure to loss of life and/or property as a result of a wildfire. Best practices, such as public education on Firewise practices, hazard-reducing landscaping techniques, and evacuation procedures should be implemented, especially in newly developed areas within Tulsa's fence line.

Structures/Buildings

Any structures/buildings constructed within the Wildland Urban Interface area or on ranches/farms situated in grassy/wooded areas should be considered at risk to the effects of a wildfire event. According to the Insurance Institute for Business and Home Safety, embers from wildfires can reach buildings from a mile or more away and cause it to ignite. Wildfires have the ability to completely destroy a structure and its contents. The intense heat of wildfires can cause glass windows and doors to break and consequently expose the interior of the home to flames. Damage to structures can be mitigated through the implementation of Firewise practices such as landscaping, fire-resistant construction, community regulations, community education, fire audits, and access routes.

According to 2012 Tulsa County Assessor data there are 1,997 improved parcels in the City of Tulsa located in areas of Moderate to High Wildfire Concern. The parcels have a total improvement value of $589,296,001, adjusted for fair market. This represents 3.15 percent of the total assessed value for Tulsa. A summary of parcels by fair-market value and type is included in Table 4-71.

Table 4–71: City of Tulsa Wildfire Structural Vulnerability

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	1,740	$140,882,483
Residential Multi-Family	44	$61,823,806
Commercial	112	$188,068,741
Industrial	11	$35,191,181
Other	90	$163,329,790
Total	1,997	$589,296,001

Source: Tulsa County Assessor Data, 2012

Critical Facilities

Wildfires have the ability to destroy critical facilities located in areas of concern. Critical facilities such as medical care facilities, resident care homes, daycare facilities, and utility out-stations located in these high-risk areas should be considered vulnerable to the effects of wildfires. Critical facilities vulnerable to the Wildfire hazard are listed and mapped for each Council District in Chapter 5.

Infrastructure

Water Treatment – Most significant effect during most major events would be from loss of electrical power. Additional threat from wildfire is not currently documented for facilities of this nature.

Wastewater Treatment – Most significant effect during most major events would be from loss of electrical power. Additional threat from wildfire is not currently documented for facilities of this nature.

Utilities- The primary utility providers for Tulsa's jurisdiction are AEP/PSO (electricity) and ONG (natural gas).

> **Electricity**: The largest threat to the delivery of electrical service would be the destruction/damage of power poles/lines with resulting power outages.

Gas: As most gas lines are buried, there is little opportunity for wildfire to damage them. However, when wildfire spreads to homes and other structures that use gas for heating and cooking, or to homes that have propane gas cylinders, explosions and gas fires can occur.

Transportation Systems (Highways, Public Transportation, Railway, Airports) –During a wildfire located near a major highway, a section of the highway may be closed or traffic diverted to other routes. Roads and bridges in the more rural portions of the City's jurisdiction would be at greater risk during a widespread event as they are located in closer proximity to fields/grasslands that could become involved in a wildfire.

Emergency Services- Fire, Police and Medical Services would all be similarly at risk to effects of a Wildfire event. During a severe wildfire, roads may become impassable and portions of the community isolated or cut off from vital emergency services and supplies. While an event affecting the entire city would be improbable, Tulsa's outlying areas, and the most distant from emergency services, are likely to experience wildfires. These small pockets of residential developments in the more rural settings of the city, along with any businesses/utilities supporting them in the immediate area, are especially at risk in the event of a large wildfire event.

4.14.4 Future Trends

For information regarding future development in the City of Tulsa, see Section 1.2.8.

Population

With many locations of planned development lying within the urban/rural interface to the west, south and east of the city, future development areas will be at higher risk to wildfires. It is not anticipated that deaths and injuries would increase.

Structures/Buildings

As development in areas identified as "at risk" within the Wildland Urban Interface progresses, any structures and/or buildings constructed as a part of that development would be at risk during a wildfire event. Effort should be made to educate residents in wildfire areas of concern about steps they can take to reduce the vulnerability of their homes to wildfire events. New development in these areas should consider fortified construction methods.

Critical Facilities

Special care should be exercised to ensure that any new critical facilities, such as medical care facilities, day care centers, utility outstations etc., are appropriately located and are constructed or retrofitted utilizing proper fire resistant building and landscaping practices.

Infrastructure

As the WUI area continues to be developed, roadways, utility access, emergency services and other support businesses will also be at risk from a wildfire event and should be planned appropriately.

4.14.5 Conclusions

As shown during the rash of wildfire in the winter of 2005-2006, areas of the City of Tulsa that are in the WUI are at moderate to high risk of wildfires, and at severe risk during times of high wind and drought. This being said, these vulnerable areas are a relatively low percentage of the total community. The City of Tulsa's overall vulnerability to the Wildfire Hazard is considered to be LOW.

Data Limitations

Data to the State Fire Marshal's office is frequently turned in by localities over a year after the year in which events occurred. Once submitted, it takes time to enter the information into the state database. Consequently, complete data is frequently one to two, or more, years behind. In addition, the Fire Marshal's office does not list the actual number of wildfire events, but number of "fire department runs." The Tulsa Fire Department may send a unit for a small grassfire in a center median, which does not show up as a grassfire in the NCDC database. Also, for a larger wildfire complex, many runs to separate locations may be reported for one event. Because of data inconsistencies, accurate numbers for wildfire events and damages are often difficult to obtain.

4.14.6 Sources

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4.15 Fixed Site Hazardous Materials

4.15.1 Hazard Profile

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 often released as a result of chemical accidents at plant sites, from structure fires, or transportation accidents.

In recent years, the increased usage of chemically dependent products and the introduction of new chemicals, materials and substances into commerce have resulted in a corresponding increase in the number of accidents and spills involving toxic and hazardous materials.

Hazardous materials sites, for regulatory purposes, are divided into two general categories: fixed sites, and transportation facilities. Fixed 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 federal government has established detailed systems for keeping track of Tier II hazardous materials sites. The Emergency Planning and Community Right to Know Act of 1986 defines a Tier II site as any location that has, for any 24 hour period, either 1) specified threshold amounts of defined Extremely Hazardous Substances, or 2) any other substance requiring a Material Safety Data Sheet (MSDS) for amounts greater than 10,000 pounds.

Transportation of hazardous materials is regulated by the U.S. Department of Transportation (DOT), under the Hazardous Materials Transportation Act, 49 CFR 119 for natural and other gases transported by pipeline, and 49 CFR 195 for liquids transported by pipeline. For intrastate commerce, the transportation of hazardous materials is regulated by the Oklahoma Corporation Commission. In this plan, transportation facilities are covered under Transportation, Section 4.16, below.

The United States Environmental Protection Agency sorts hazardous materials into six categories:

1. Toxic Agents (irritants, asphyxiates, narcotics)
2. Other Toxic Agents (hepatoxic, nephratoxic)
3. Hazardous Wastes
4. Hazardous Substances
5. Toxic Pollutants
6. Extremely Hazardous Substances

Extremely Hazardous Substances (EHSs) are chemicals defined and listed in Appendices A and B of Title 40 CFR Part 355 (rules promulgated under EPCRA). There are currently 362 listed EHSs. Some of the EHSs are also CERCLA hazardous substances. Sections 302, 303, and 304 of EPCRA require reporting of storage or use of EHSs. Facilities that maintain EHSs on-site in quantities greater than corresponding Threshold Planning Quantities (TPQs) must cooperate in emergency plan preparation.

According to the U.S. Environmental Protection Agency, the extremely hazardous substances list and its threshold planning quantities are intended to help communities focus on the substances and facilities of most immediate concern for emergency planning and response. However, while the list includes many of the chemicals which may pose an immediate hazard to a community upon release, it does not include all substances which are hazardous enough to require community emergency response planning.

Location

The City of Tulsa and Tulsa County have inventoried local businesses and industry to identify dangerous chemicals that are being manufactured and/or stored in the community. There are 298 hazardous materials sites located generally with the City of Tulsa.

Due to the sensitivity of this information, a detailed list of Tier II facilities is not provided in this section of the plan. A list of Tulsa's Tier II facilities and the number of people living or working within ¼ mile of each facility is included in Appendix E, and is available on a *need to know* basis

Figure 4-42 illustrates the Tier II facilities assessed by this plan. There are 139 critical facilities within the ¼-mile buffer zone of one or more of these Tier II sites; a complete inventory of vulnerable facilities, separated by Council District, can be found in Chapter 5.

Measurement

Reports on hazardous materials events are submitted by the responsible party to the County Local Emergency Planning Committee (LEPC), the Oklahoma Department of Environmental Quality, and the National Response Center (NRC). Reports are sorted to show community, county and state summaries. This allows the number of hazardous materials events that occur in a community during a specific time frame to be measured against state and national averages.

Extent/Severity

The City of Tulsa considers a minor severity event to be a chemical spill that is unlikely to cause severe casualties, or which meets the Emergency Response Guidebook definition of a "small spill," and a major severity event to be the release of a toxic chemical which has the likelihood of producing serious injury or death, or which meets the definition of a "large spill" for a particular chemical according to the most current edition of the Emergency Response Guidebook.

Frequency

Two sources were used to account for the number of Hazardous Materials incidents in Tulsa from 1995-2011; locally, Tulsa Fire Department responses to 13,133 hazmat incidents during this time period. Tulsa Fire Department does not breakdown the hazmat incidents by type. In order to assess the number of Fixed-Site incidents, data from the National Response Center was used. The NRC includes reports of 298 fixed-site hazardous materials events in the City of Tulsa from 1995 through 2012 (once duplicate entries have been accounted for), an average of about 17.5 events per year during this 17-year period. It should be emphasized that the overwhelming majority of these incidents were harmless (but reportable) releases of materials used in manufacturing, such as nitrogen oxide, hydrogen sulfide, anhydrous ammonia, sulfur dioxide and sulfuric acid. Of these 298 releases, 120 were the result of equipment failure, 23 due to operator error, 22 to dumping, 16 to natural phenomena (e.g., storms, lightning and electrical outages), 68 to "other" causes (accident, maintenance, etc.), and 49 were for "unknown" reasons. The vast majority (196) occurred in the oil and gas transportation, processing and refining industry, primarily located in West Tulsa. Based on information from Tulsa Fire Department and the NRC, Tulsa should expect multiple fixed-site incidents on an annual basis.

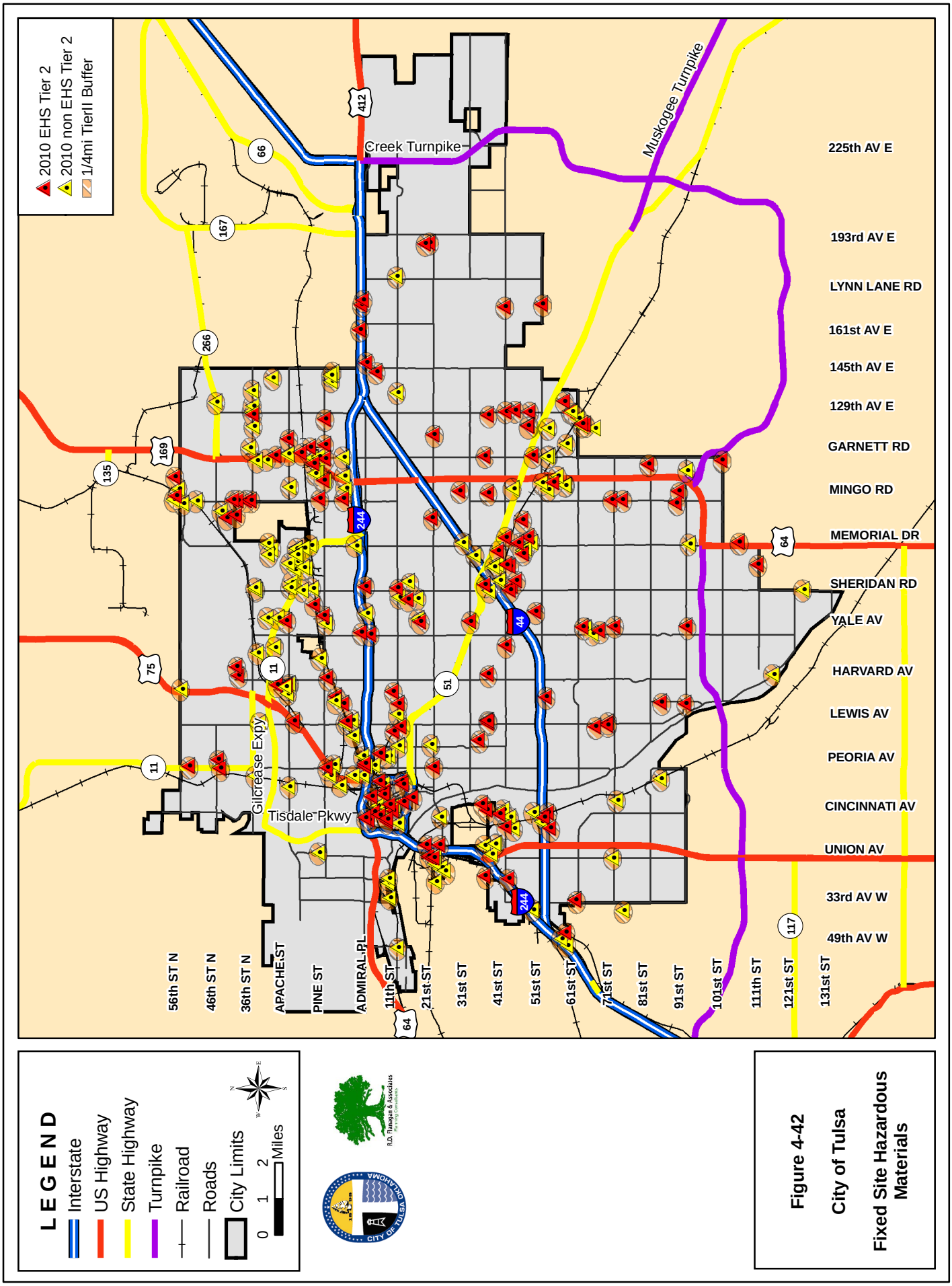

Figure 4-42
City of Tulsa
Fixed Site Hazardous Materials

Impact

Hazardous materials affect people through inhalation, ingestion, or direct contact with skin. They can cause death, serious injury, long-lasting health problems, and damage to buildings, homes and other property. The impact of this hazard can interrupt business operations, disrupt transportation systems, disable emergency response capability, and cause injury, or loss of life. Hazardous material events can range from relatively harmless to catastrophic with numerous long-term health and environmental effects.

The extent of this hazard is predominately influenced by the amount of the chemical involved, local weather conditions, response team training and equipment, enforcement of community regulations and codes, identification of hazardous material storage sites and pipelines, and advanced warning systems (e.g., warning sirens with voice capability, Reverse 911, etc.)

4.15.2 History/Previous Occurrences

From January 1, 1995 to December 31, 2012, there were 298 fixed-site hazardous materials incidents in the City of Tulsa and Tulsa County reported to the National Response Center. Of those 298 events, 228 were at sites that had multiple incidents. Companies that reported multiple incidents are listed in Table 4-72.

Table 4–72: Tulsa County Companies with Multiple Fixed-site Incidents

Company	Address	Events
Sinclair Oil	902 W. 25th St.	110
Sun Refinery	1700 S. Union Ave.	60
PSO	2128 E. 26th St., 3600 S. Elwood Ave.	15
HollyFrontier Refinery	902 West 25th St	10
Williams Pipeline	2120 S. 33rd West Ave.	7
Bama Pie	2745 E. 11th St.	8
American Airlines	3800 N. Mingo Rd.	4
Electronic Chemicals	5201 W. 21st St.	3
Koch Industries	11920 E. Apache	3
PermaFix Treatment	2700 S 25th West Ave	3
City of Tulsa Wastewater	5628 North 105th East Ave	3
American Cold Storage	505 W. 2nd Street	2
	Total	**228**

Source: National Response Center

Almost all of these were harmless, but reportable, releases of petrochemical processing gasses that would normally be flared (or burned). Common causes of releases to air were unplanned power outages, compressor failures and high winds. Causes of releases to soil and streams included heavy rains that resulted in containment basins being overtopped. A summary of typical and more significant hazardous materials releases is presented in Table 4-73, below.

Table 4–73: Hazardous Materials Release Event Narratives

Date	Event Narrative
March 19, 1988	The Sonoco refinery accidentally released 375 lbs. of hydrofluoric acid which vaporized into heavier than air acid gas that drifted five miles through downtown Tulsa. The release resulted in 36 people seeking medical treatment, many of them policemen and fire fighters responding to the incident.

Date	Event Narrative
July 10, 2001	A valve on an arsine gas cylinder blew off and released 50 to 60 pounds of gas at the Solkatronic Chemical loading dock at the Port of Catoosa. About 143 people from Solkatronic and Air-X-Changers complaining of nausea and breathing problems were taken to area hospitals in ambulances, city buses and private cars. Arsine gas destroys red blood cells and can lead to kidney failure; breathing even small amounts can be harmful. All patients were released after decontamination, tests and observation. Tulsa Fire Department's HazMat unit responded to the event, along with emergency response crews from Sonoco and Boeing.
August 18, 2003	An explosion and fire at the Airgas Mid South facility in Tulsa occurred when gas vented from a liquefied propylene cylinder ignited. At 4:35 p.m. firefighters arrived at the scene. The fire was volatile and thick black smoke and fireballs exploded into the sky and ignited nearby structures and vehicles. The explosion blew gas cylinders hundreds of feet in the air. About 500 PSO customers lost power. I-244 was shut down and surrounding buildings were evacuated. There were no reported injuries from the accident. Four nearby facilities, 64 vehicles, and 5,000 company cylinders were damaged or destroyed.
December 15, 2006	Sinclair refinery was found guilty of discharging 1.1 million gallons of treated wastewater per day into the Arkansas River in such a way as to manipulate the results of Oklahoma EPA monitoring. Sinclair management had directed employees to shunt wastes with high concentrations of oil and grease to holding impoundments while monitoring was in progress. The refinery was fined $5 million in criminal penalties and $500,000 in community service payments.
July 5, 2009	A chemical vapor cloud released from a hazardous waste management company resulted in at least one resident and several emergency responders being treated for eye and nose irritation. About 12:15 a.m. Tulsa firefighters responded to a report of smoke at Envirosolve on Southwest Blvd., where vapors were found to be coming from an 85-gallon drum of Sodium Percarbonate, a chemical used in portable toilets and septic tanks. An increase in humidity caused a reaction with the chemical and released the vapor, which traveled in a southeast direction, staying close to the ground. HazMat crews wearing chemical protective clothing and company officials worked inside the structure moving drums to gain access and stop the production of vapors. One nearby resident was transported to a hospital by paramedics for irritation to the eyes and nose and several firefighters and police officers were evaluated for similar symptoms. One firefighter was treated for heat-related illness.
April 22, 2011	A fire burned a ring around the top of Tank 13 at HollyFrontier's Tulsa West, when a bad valve allowed hydrocarbons to pass into the sour water system, or the slop tank, which holds refinery product and water. There were no injuries.
August 2, 2012	A fire and explosion occurred at about 3:00 a.m. at the HollyFrontier refinery in West Tulsa. The fire started in the diesel hydrotreater unit. The Tulsa Fire Department responded, but the fire was brought under control by the refinery's fire crews and emergency response teams. This event resulted in legal action against the refinery by the EPA and OSHA for unsafe processes and working conditions.
September 5, 2012	A fire destroyed the Tulsa School of Arts and Crafts (formerly Barnard Elementary) at 17th and S. Lewis Ave. The fire may have started in a science lab where various chemicals were stored. Hazardous material crews were called. At about 5:15 a.m., as firefighters were battling what seemed a small fire, an explosion—presumably from chemicals stored in the science lab—rocked the building, injuring eight firefighters. Several firemen had 2nd and 3rd degree burns on their hands and faces.

Source: National Response Center and Local News Media

4.15.3 Vulnerability

This section summarizes the City of Tulsa's vulnerability to Fixed-Site Hazardous Materials events, including their impact on people, structures and buildings, critical facilities, and infrastructure. This information was used to determine the Vulnerability Criteria identified in Tables 4-3 and 4-4. Tulsa was determined to be at MODERATE vulnerability to the Fixed-Site Hazardous Materials hazard. (See Table 4-3 Hazard Risk Analysis, and Table 4-4, Summary of Hazard risk Analysis Ranking Criteria.)

Population

Since approximately 75-80% of all hazardous materials releases occur at fixed-site facilities, the greatest danger is to the populations working and living in the areas near Tier II facilities. According to a Marplot analysis, which uses US Census data, 54,131 residents of Tulsa live or work within ¼ mile of a Tier II facility. Persons at heightened risk include those with mobility or severe health issues that would limit their ability to evacuate quickly, and people who speak a language other than English, limiting their ability to receive warning messages. Those outside during an event could fall ill from breathing in chemicals. Sheltering in place or evacuation may be required depending on the level and type of event.

Structures/Buildings

Structures and buildings are, as a rule, not vulnerable to hazardous material spills except in the case of flammable and explosive materials, like natural gas and some petroleum products. An explosion at any Tier II facility may create collateral off-site damage. Adjacent structures and properties are most vulnerable. Explosions may increase vulnerability if they lead to a release of gaseous or liquid hazardous materials. According to Tulsa County Assessor data, 20,787 improved parcels are located within ¼ mile of Tulsa's Tier II sites with a total value, estimated for fair market price, of $4,340,750,764, as summarized in Table 4-74.

Table 4–74: Improved Parcels, ¼ Mile Tier II Site

Improvement Type	*Number*	*Est. Market Value*
Residential Single-Family	15,864	$1,254,436,361
Residential Multi-Family	799	$231,103,972
Commercial	1,617	$1,571,648,493
Industrial	390	$337,031,517
Other	2,117	$946,530,421
Total	20,787	$4,340,750,764

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

There are 139 critical facilities located within ¼-mile of a Tier II site in the City of Tulsa. These facilities are listed and discussed in greater detail by City Council District in Chapter 5.

Infrastructure

Water Treatment – Water treatment plants use large amounts of liquid chlorine for purifying drinking water. A liquid chlorine spill at a water treatment plant could force the evacuation of the facility and a temporary stop of operations.

Wastewater Treatment – Wastewater treatment plants not only process contaminated waste, but also use hazardous chemicals. A hazardous substance spill at a plant could force the shutdown of the facility. In addition, a malfunction at the plant could cause the spill of contaminated wastes into rivers and streams.

Utilities:

> **Electricity –** There are no immediate vulnerabilities to the supply of electricity because of a hazardous materials spill. Although electrical substations contain hazardous materials, such as battery acids and PCBs, these do not pose a danger to local citizens, as substations are usually fenced and bermed. However, a fire at a substation could result in the release of toxic materials into the smoke plume and require evacuation or sheltering in place of nearby populations.

Gas – No significant vulnerabilities to a fixed-site toxic materials release are likely to interfere with the delivery of natural gas. Natural gas is itself, a hazardous material. Leaks from ruptured pipes can result in fires, explosions, the temporary shut off of gas delivery through the affected lines, and loss of life and/or injury.

Transportation Systems (Highways, Railway, Airports) – Evacuation of contaminated areas can clog roadways or block traffic until the event has dissipated.

Emergency Services- Fire, Police and Medical services could be impacted by having to evacuate facilities. Fire, Police and Medical services could have a surge of demand as the result of a Tier II event. While not an immediate threat to delivery of these services, the demand for additional personnel to provide an effective response could potentially increase the cost for these resources.

4.15.4 Future Trends

For information regarding future development in the city of Tulsa, see Section 1.2.8.

Population

Development in the City of Tulsa will continue to expose the general population to hazardous material spills if located within a Tier II buffer zone or around another type of facility that stores Hazardous Materials. Tier II reporting is done on an annual basis. As the city continues to grow and businesses change, there is always opportunity for a new Tier II site to be reported. The City should continue to work with the LEPC to ensure safety and preparation of residents living or working within ¼ mile of a Tier II facility.

Structures/Buildings

Structures and buildings will remain vulnerable to releases of flammable and explosive materials, like natural gas and some petroleum products. No developments are planned near facilities utilizing or transporting flammable and explosive materials.

Critical Facilities

There are no plans to locate critical facilities in close proximity to existing hazardous materials sites.

Infrastructure

Infrastructure vulnerabilities to hazardous materials will continue to exist. Care should be given in future planning to ensure that both infrastructure and workers are not exposed to hazardous materials releases.

4.15.5 Conclusion

Varying quantities of hazardous materials are manufactured, used, or stored at an estimated 4.5 million facilities in the United States, from major industrial plants and water treatment facilities to local dry cleaning establishments and gardening supply stores. The estimated annual damage from hazardous materials events in the United States is $22.4 million. Most victims of chemical accidents are injured at home. These incidents usually result from ignorance or carelessness in using flammable or combustible materials.

Tulsa has for over a century grown and prospered with the petroleum industry. By its nature, petroleum refining is a volatile industry and involves hazardous materials. The industry also produces and discharges hazardous wastes, and can leave contaminated “brownfields” behind when refining and manufacturing plants close down. Tulsa has for decades worked to clean up the Arkansas River, control wastes from refining and other industries, and has recently embarked upon an aggressive program to transform several of its brownfields into development-ready properties. These efforts should continue in the future.

Based on the City of Tulsa's hazardous materials information, including the workers, nearby populations and critical facilities at risk, the jurisdiction is considered to have a MODERATE probability of and a MODERATE vulnerability to Hazardous Materials/Fixed Site incidents.

4.15.6 Sources

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4.16 Transportation-Hazardous Materials

4.16.1 Hazard Profile

Transportation is defined as the physical movement of an object through components of a system and its subsystems. Transportation includes the use of aviation, highway, railroad, pipeline, and marine systems to convey movement of objects and people. In 1967, the Department of Transportation (DOT) was created in order to administer and protect the nation's transportation systems. The National Transportation Safety Board (NTSB) was established within the DOT as an independent agency responsible for investigating transportation incidents and promoting transportation safety.

When in transport, hazardous materials are characterized by nine separate classes of hazards: 1) explosives, 2) gases, 3) flammable liquids, 4) flammable solids, 5) oxidizers and organic peroxides, 6) toxics, 7) radioactive materials, 8) corrosive materials, and 9) miscellaneous dangerous goods. By far the greatest percentage of any hazard shipment (72%) falls under the flammable liquids category. Gases and corrosive materials are next with 8.8% and 8.7% respectively. Radioactive materials are shipped the least and account for only 0.6% of all hazardous material transport. Gasoline comprises 40.9% of hazmat shipments.

Location

The City of Tulsa is crossed by highways and railroads, and has one international airport, all of which carry hazardous materials. Each element is summarized below and shown on the map in Figure 4-43.

Highways: Hazardous materials make up between four and eight percent of all truck shipments. Trucks carrying hazardous materials have an accident rate of 0.32 per million vehicle miles as compared to 0.73 accidents per million vehicle miles of non-hazardous material shipments. Due to the volume of transport activity, non-hazardous material truck accidents rates are more than twice the hazardous material accident rates.

The City of Tulsa is crossed by 487 miles of US and state highways: I-44, I-244, US Hwy 64, US Hwy 75, US Hwy 169 (Mingo Valley Expy), and OK Hwy 51 (Broken Arrow Expy). There are 30,840 improved parcels within ¼-mile of these corridors, valued at $4,720,118,256.

- **Interstate 44** runs SW-NE from Wichita Falls, TX to St. Louis, MO, a distance of 328 miles in Oklahoma. Most of I-44 is turnpike: the H.E. Bailey Turnpike from Texas to Oklahoma City, the Turner Turnpike from Oklahoma City to Tulsa, and the Will Rogers Turnpike from Tulsa to the Missouri border. Through Tulsa I-44 is also known as the Skelly Bypass and is routed for several miles alongside S. 51st St. It is a heavily traveled highway, including tourist, business, and commercial truck traffic. Linking, as it does, several turnpikes and expressways, I-44 carries a high volume of hazardous material traffic, including chemical and petroleum products, and in some cases, radiological materials.
- **Interstate 244** loops from I-44 in the southwest around the northern and western sides of the city, and reconnects with I-44 immediately before the Turner Turnpike in western Tulsa. Through

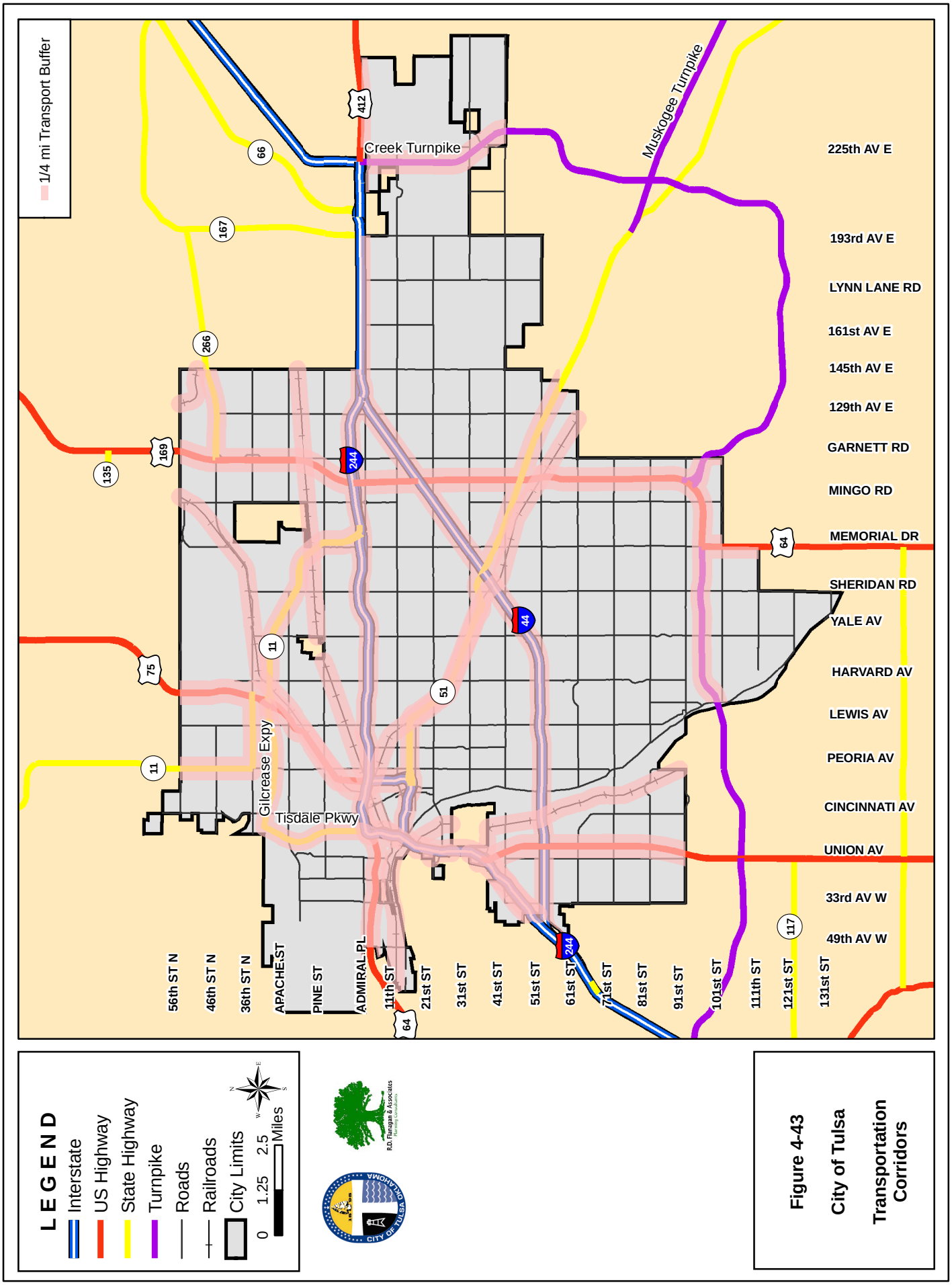

Figure 4-43
City of Tulsa
Transportation Corridors

the city, I-244 ranges from four to six lanes and carries a substantial amount of traffic, both passenger and commercial.

- **US Hwy 64** At 589 miles in length, US Hwy 64 is the longest U.S. highway in Oklahoma. It runs from Clayton, NM through the Panhandle to Ft. Smith AR. In Tulsa, US Hwy 64 becomes the Broken Arrow Expressway before branching off to the south with the Mingo Valley Expressway and US Hwy 169 to Memorial Blvd. at S. 96th St., and then on to Bixby and Leonard. US Hwy 64 is heavily traveled by commercial and commuter traffic.
- **US Hwy 75** runs from the Dallas-Ft. Worth area through Tulsa to the Canadian border. US Hwy 75 is a four-lane divided highway from I-40, at Henryetta, to the Kansas border, and provides excellent access to I-44, the Muskogee Turnpike, Cimarron Turnpike and the Indian Nation Turnpike. The rapid growth of Southwest Tulsa, particularly Jenks, Glenpool and Bixby, has increased traffic on the southern section of US 75, while the Wal-Mart Distribution Center in Bartlesville (approximately 40 miles to the north of Tulsa), the recently developed Tulsa Hills Shopping Center, and the highway's intersection with both I-44 and I-40 combine to make this a particularly heavily traveled four-lane highway.
- **OK Hwy 51** is Oklahoma's third longest State highway at 330 miles in length. OK Hwy 51 is four lanes from I-35 to Stillwater and two lanes from there to Sand Springs, where it joins the Keystone Expressway. In downtown Tulsa, it branches off to the southeast, becoming the Broken Arrow Expressway. The highway carries a great deal of commuter and commercial traffic through Tulsa County.
- **Mingo Valley Expressway** travels north-south from Collinsville in northeast Tulsa County to the Creek County Turnpike at about S. 96th and Garnett Rd. It is heavily traveled with both commercial and commuter traffic. The Mingo Valley Expressway is also US Hwy 169, which runs from Tulsa to Minnesota. US Hwy 169 begins at the U.S. Hwy 64 East interchange of the Creek Turnpike. U.S. 169 is freeway grade north to Collinsville.

Traffic counts on these highways are presented in the Table 4-75.

Table 4–75: Highway Traffic Counts

Highway	Daily Traffic Counts
Interstate 44 west Tulsa County (Creek County line)	46,100
Interstate 44 east Tulsa County (Rogers County line)	46,700
US Hwy 75 north Tulsa County (66th St. N)	33,800
US Hwy 75 south Tulsa County (Glenpool)	37,800
US Hwy 412 west Tulsa County (west Sand Springs)	25,700
US Hwy 412 east Tulsa County (225th E. Ave.)	39,400
US Hwy 64 west Tulsa County (Sand Springs)	50,700
US Hwy 64 southeast Tulsa County (Bixby)	26,000
OK Hwy 51 west Tulsa County	43,200
OK Hwy 51 east Tulsa County (209th E. Ave.)	78,000
Creek County Expy east Tulsa County (Mingo Rd.)	41,800
Mingo Valley Expy north Tulsa County (Apache Rd.)	56,914
Mingo Valley Expy south Tulsa County (S. 71st St.)	86,200
Broken Arrow Expy southeast Tulsa County (145th E. Ave.)	78,600

Source: Oklahoma Department of Transportation

Railroads: Millions of passengers are transported annually on the nation's heavy and light rail public systems and over 1.52 million carloads of hazardous material move by rail each year. Collisions and

derailments are the most common accidents for rail transport. Tulsa has 13,314 improved parcels within its railroad corridors, valued at $1,568,121,710.

Currently Tulsa is served by the Burlington Northern Santa Fe (BNSF) and the Union Pacific (UP) rail lines. Running north-south through Tulsa, the BNSF operates on tracks originally built by the St. Louis and San Francisco Railroad. The BNSF's Cherokee Rail Yard in Tulsa supports a substantial amount of traffic, sometimes up to 22 trains a day with upwards of 100 cars each.

The primary cargoes shipped through Tulsa are agricultural and mining products. In addition, hazardous materials such as ammonia, fuel, or compressed natural gas are transported. Due to technological advances in recent years, the odds of a hazardous materials release from a railroad car, even in a significant derailment, are considered low.

Union Pacific, has broad coverage of the large chemical-producing areas along the Gulf Coast, and operates a north-south line in western Oklahoma that serves Enid, El Reno and Duncan. Union Pacific has switchyards and related facilities at Muskogee, Tulsa, Oklahoma City, Chickasha, Enid and McAlester.

A study has been instituted to determine the feasibility of a mass transit commuter rail system between Tulsa and Broken Arrow, a major suburb to the southeast. This system could be several years in development.

Although Oklahoma did not receive 2010 stimulus funding for high-speed rail between Tulsa and Oklahoma City, the City and the state are continuing to seek money for planning and environmental studies for rail links to the Dallas-Ft. Worth area, and to Kansas City and St. Louis. If such projects are funded and built, they would significantly increase passenger rail traffic through Tulsa.

Airports: Accidents involving aircrafts can range from human error to meteorological causes. Fog, ice, thunderstorms and wind shear are conditions that can lead to difficulties in properly controlling aircraft. Weather delays are common in air transportation and are instituted to help prevent accidents. Airport runway pavement is also a concern. When deteriorated, runway pavement can cause damage to aircraft turbines, propellers, and landing gear and may result in runway closure.

The City of Tulsa is served by several airports, including:

- **Tulsa International Airport** – Average of 167 aircrafts based at field with 79 operations/day. This is Tulsa's primary commercial airport. TIA also houses the 138th Fighter Wing of the Air National Guard and is the global maintenance headquarters for American Airlines.
- **Richard Lloyd Jones Airport (Riverside)** – Average of 543 aircraft based at field with 926 operations/day. Riverside is primarily an airport for business-owned private aircraft.
- **Harvey Young Airport (1H6)** – Average of 87 aircraft based at the field, with 68 operations/day. Harvey Young is an east-side airport for privately owned aircraft.

  In addition, there are nine heliport pads in Tulsa, including at the Tulsa Civic Center and all major Tulsa hospitals.

Measurement

The National Transportation Safety Board (NTSB) investigates significant accidents in all forms of transportation including all civil aviation accidents, selected highway accidents, railroad accidents, major marine accidents, pipeline accidents, hazardous material releases from any form of transportation, and other transportation problems that have a recurring nature. The Freedom of Information Act allows accident reports, safety studies, numerous databases, and historical archives to be accessible online through the NTSB.

Extent Severity

The City of Tulsa considers a minor severity transportation event to be an incident where response lasts no longer than an hour, hazardous materials are contained within a quarter mile, and there is no loss of life or major injuries. A major severity incident would include facility shutdowns exceeding one hour, hazardous materials releases exceeding a quarter mile, and/or loss of life and/or major injuries.

Frequency

According to the National Response Center, the City of Tulsa had 91 reported transportation events (mobile, rail, air) in the 16 years from 1995 through 2011. Given this information the City of Tulsa can expect about six transportation events to occur, within its jurisdictional area, each year.

I-40 Bridge collapse at Webbers Falls on the McClellan-Kerr Navigation System of the Arkansas River on May 26, 2002.

Impact

The impact of transportation events may include business disruptions, injuries, psychological trauma, and sometimes even loss of life. Transportation accidents are frequently a "cascade" disaster, occurring more frequently during storms. Storms, especially winter storms, cause streets to become slick, which increases the risk of transportation accidents. Excessive speed, exhaustion and other causes also increase the risk.

A worst-case railroad chlorine or anhydrous ammonia tank explosion could result in dozens of deaths, severe injuries, and hospitalizations. The extent of a transportation event can be lessened by, among other measures, well-trained and equipped Hazmat Teams, mass notifications of people in the impact area, planned and practiced notification and evacuation procedures, and by relocating hazardous material transportation routes away from populated areas and critical facilities.

4.16.2 History/Previous Occurrences

According to the National Response Center, during the period from 1995 through 2011, there were 91 reported incidents of mobile, rail, or air events in the City of Tulsa. Some of these events are summarized in Table 4-76.

Table 4–76: Tulsa Transportation Incidents

Date	Description of Incident	Location	Suspected Responsible Party	Material
Truck/Highway Transport Spills				
1/26/2001	Driver made an emergency hard breaking move which caused the cargo to shift and three drums to be punctured. The truck was traveling eastbound on Hwy 412.	On Hwy 412 near the junction of 65th West Avenue	Advanced Chemical Co	Perchloroethylene

Date	Description of Incident	Location	Suspected Responsible Party	Material
12/13/2007	Crane over turned and spilled hydraulic fluid onto the street and into a storm drain, probably due to an ice storm.	9406 E 46th Street N.	Public Service Company of Oklahoma	Hydraulic Oil
12/14/2011	A trailer containing hydrochloric acid had a leaking valve. Nearby residents were evacuated and a potion of the OK Turnpike was closed.	MM 215/West Bound Route 44 on OK Turnpike	LT Harnett	Hydrochloric Acid
Railroad Release				
12/03/2001	Report of a collision of two freight trains with a derailment of four cars and a spill from the road switcher locomotive.	Tulsa Yard	BNSF Railroad	Oil: Diesel
07/13/2002	Brake rigging broke causing five cars to derail on a hop at rail yard. All five cars were carrying lube oil. No material release was reported.	Rail yard, 1631 West 33rd Place	BNSF Railroad	
11/01/2005	Report of 15 rail car derailment. Four flatcars were empty and 11 tank cars were loaded with lube oil. Unknown if cars derailed upright. No report of leaking tank cars. Three grade crossings were blocked.	Tulsa subdivision mile marker 278.25	Union Pacific Railroad	
07/02/2011	Nine cars derailed which included seven cars on their sides, all cars carrying anhydrous ammonia.	Milepost 424 NONE	N/A	Ammonia, Anhydrous
Aircraft Incident				
03/23/2000	Unknown aircraft/valve did not disengage	Gate 30 Airport Division 7777, East Apache Street	Delta Airline	Jet Fuel
8/17/2000	An airline company leaking chemical disinfectant material from airplane toilets on to the land outside the airplane.	3400 North Mingo	American Airlines	Chemical Toilet Disinfectant
08/27/2008	Report that aircrafts from the nearby airport releases chemical smells into the air when they fly over callers house. Caller reported headaches from the strong smell in the air from aircrafts.	1357 E 64th Street	Jones Riverside Airport	Unknown Material
09/10/11	Report of a spill of jet fuel from an airplane of between 30 and 100 gallons.	Tulsa International Airport, 7777 E Apache.	Delta Airlines	Jet Fuel

Source: National Response Center

Probability of Future Events

With 91 events occurring in a 16-year period, it can be anticipated that about six hazardous materials Transportation events a year will occur in the City. The Tulsa Fire Department states that an average of one to two incidents each year will require some level of evacuation of a neighborhood or facility. The City of Tulsa has a HIGH probability of an event involving the transportation of hazardous materials.

4.16.3 Vulnerability

This section summarizes the City of Tulsa's vulnerability to the Transportation-Hazardous Materials hazard, including the impact on people, structures and buildings, critical facilities, and infrastructure. This information was used to determine the Vulnerability Criteria identified in Tables 4-3 and 4-4. Tulsa was determined to be at MODERATE vulnerability to the Transportation-Hazardous Materials hazard. (See Table 4-3 Hazard Risk Analysis, and Table 4-4, Summary of Hazard risk Analysis Ranking Criteria for an explanation of how the rankings were derived.)

Population

A ¼ mile buffer was placed around highways, interstates, and railways in Tulsa to identify vulnerable populations. Approximately 115,799 residents of Tulsa live within ¼ mile of the transportation corridors. In addition, the transportation corridors (highways, railroads) cover a total of approximately 65.68 square miles – or 32.83% - of the total City of Tulsa land area. Population numbers of each Tulsa Council District vulnerable to the transportation-hazardous materials hazard are included in Chapter 5.

The occurrence of a transportation incident involving hazardous materials in Tulsa would be devastating and leave a lasting impact. The complexity of this hazard has much to do with the location of an event and materials involved. The mixing of chemical materials during an event can intensify the threat of loss of life and or injury. Contamination of the air and/or water can cause a major public health concern.

A rail or truck tank rupture would be a worse case scenario if large quantities of hazardous materials are released in a short amount of time, especially one involving release of anhydrous ammonia, which would have toxic effects on residents that breathed the vapor. Depending on the amount of material spilled, and the time it takes to contain the incident, populations more than ¼ mile downwind of a release could be impacted. Effort should be made to educate all residents in Tulsa about shelter in place and evacuation procedures.

Structures/Buildings

While there are 44,154 improved parcels located within the transportation corridors, structure damage, although possible, is unusual as a result of a transportation event. Consequently, this was not considered a significant vulnerability. The improved parcels located within ¼ mile of a major highway or interstate are summarized, by estimated market value and type, in Table 4-77. Improved parcels located within ¼ mile of a railway are summarized in Table 4-78.

Table 4–77: Improved Parcels ¼ Mile Highway Corridor

Improvement Type	Number	Est. Market Value
Residential Single-Family	27,425	2,094,408,275
Residential Multi-Family	895	259,891,864
Commercial	1,878	1,372,877,930
Industrial	210	186,574,230
Other	1,712	857,445,737
Total	32,120	4,771,198,036

Source: Tulsa County Assessor's Office, 2012

Table 4–78: Improved Parcels ¼ Mile Railroad Corridor

Improvement Type	*Number*	*Est. Market Value*
Residential Single-Family	10,358	$528,185,331
Residential Multi-Family	387	$68,599,982
Commercial	894	$429,033,158
Industrial	283	$224,179,764
Other	1,392	$3,176,836,099
Total	13,314	$1,568,121,710

Source: Tulsa County Assessor's Office, 2012

Infrastructure

Water Treatment – Loss of access or function due to its proximity to a transportation incident involving the release of hazardous materials (e.g., chlorine gas), is the primary vulnerability of Tulsa's Water Treatment facilities.

Wastewater Treatment – As with water treatment facilities, loss of access to or function of Tulsa's Wastewater Treatment facilities would be the primary impact from a transportation event

Utilities:

Electricity – The service stations and substations for electrical service would be vulnerable to the risks from a transportation event, although since the majority of the substations are unmanned, the effect of loss of access would be low unless there were additional issues. Above ground electric lines could be downed depending on the type and severity of the event, causing power loss to areas of the community.

Gas – No significant vulnerabilities to a transportation release are likely to interfere with the delivery of natural gas. Natural gas is itself a hazardous material. Leaks from ruptured pipes can result in fires, explosions, the temporary shut off of gas delivery through the affected lines, and loss of life and/or injury.

Transportation Systems (Highways, Railway, Airports) – Evacuation of contaminated areas can clog roadways or block traffic until the event has dissipated.

Emergency Services- Fire, Police and Medical services could be impacted by having to evacuate facilities. Fire, Police and Medical services could have a surge of demand as the result of a transportation event. While not an immediate threat to delivery of these services, the demand for additional personnel to provide an effective response could potentially increase the cost for these resources.

Critical Facilities

There are 173 critical facilities located within ¼ mile of one or more transportation corridors in Tulsa. Loss of access to, or complete loss of function of any one of these facilities, could cause negative social and economic impacts on the City, and potentially impact the ability of City government facilities in the buffer area to remain operational after an event. Critical facilities located within a City of Tulsa transportation corridor are listed and mapped in each District section of Chapter 5.

4.16.4 Future Trends

For information regarding future development areas in the City of Tulsa, see Section 1.2.8.

Population

Tulsa will continue to be at MODERATE vulnerability to and a HIGH probability of the Transportation-Hazardous Materials hazard. As no community is immune to a transportation accident involving hazardous materials, nor can they be avoided, public information and education is crucial in reducing loss of life and/or injury. Education and drills reinforcing procedures for sheltering in place vs. evacuating in the event of a hazardous materials incident, particularly for those in identified risk areas, should occur. Creation of identification methods targeting those with disabilities that inhibit them from evacuating on their own should be considered. Knowledge of the hazard and proper response procedures, prior to an event, could help lessen the amount of psychological stress on the public if an incident were to occur.

Structures/Buildings

In the past, the ability to effectively and quickly evacuate commercial and educational buildings has often been an afterthought of the designers. It was often geared more toward an internal structure fire than to an external threat. With the development of new protocols and parameters for the effective, emergency movement of building occupants, new structures need to have this included in their design parameters from the project's inception. In addition, all facilities need to have effective shelter-in-place plans, especially if the structure is in one of the greater at-risk areas.

Critical Facilities

As the threat of transportation events themselves cannot be eliminated, any critical facilities undergoing expansion, renovation or rebuilding should consider the occupants' ability to either shelter in place or evacuate quickly in the event of a transport-related hazardous materials incident.

Infrastructure

Ensuring a minimized effect on the delivery of utility service requires forethought and planning while in the development stage. Any plans for areas currently under development or consideration of development should include the provision for effective emergency access and staging for emergency vehicles and personnel.

4.16.5 Conclusions

The United States has the most productive transportation systems in the world. These operating systems include roads, air, rail, water, and pipelines. These systems make possible a high level of personal mobility and freight activity for the nation's residents and businesses. Although the source and location of transportation accidents can vary, the effects are typically the same. Accidents often involve human injury or death and/or the release of hazardous materials. Over the past 16 years, there have been 91 transportation incidents involving hazardous materials in the City of Tulsa reported to the NRC. This history, coupled with a large number of reporting sites, gives the City of Tulsa a HIGH probability of and a MODERATE Vulnerability to the Transportation-Hazardous Materials hazard.

Data Limitations

In the National Response Center database, many reports come from a caller who only supplies preliminary information. Follow-up information, unless the event is significant, is usually not pursued, so data is frequently incomplete. A caller, for instance, may call in "unknown sheen" on a body of water in a community. If the material on the water's surface is gone before investigators arrive, the material may never be known. Location may be similarly vague if the caller is not familiar with the area and cannot give precise location of what they are reporting.

4.16.6 Sources

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4.17 Hazard Summary and Composite

Most natural hazards- tornadoes, high winds, lightning, hail storms, winter storms, extreme heat, drought, and earthquakes- are not geographic area specific, and can impact the entire community equally and randomly.

Other natural hazards, such as floods, dam and levee failures, wildfires, and expansive soils, are geographic area specific, and the vulnerable areas of the community can be identified.

Of the site-specific hazards identified in this plan, flooding has caused the most damage in Tulsa. Mitigation over the years as lessened, but not eliminated, the amount of damages caused by flooding events in Tulsa. Though much has been done to lessen the impact of flooding in Tulsa, 8,702 improved parcels with a value, estimated for fair market, of $966,035,933, remain at risk. The identified flood zones cover 15.05%, or 30.10 square miles of land, in the City of Tulsa. Two hazards closely associated with flooding, dam and levee failures, have potential impacts that extend far beyond the flood zone. Tulsa is exposed to risk of flooding from failure of five high-hazard upstream dams. The dam posing the greatest threat to Tulsa is Keystone. People, property, critical facilities, and infrastructure downstream of dams and behind levees could be subject to devastating danger and damage in the event of failure. Dam inundation areas in Tulsa cover 15.12% of the land area, or 30.25 square miles, and would potentially impact 47,793 people. In total, 9,579 improved parcels are located in the dam inundation area of at least one high hazard dam in Tulsa, with a value, estimated for fair market, of $1,100,519,752. A related threat to Tulsa is posed by the Arkansas River levees, built in 1945 and protecting 2,271 residences, 149 commercial properties and 106 industrial parcels ($147,453,020 in property). Failure of the levees along the Arkansas River would have a devastating impact upon the City of Tulsa and Tulsa County.

In addition to flooding, dam failure, and levee failure, Tulsa has a heightened exposure to Fixed-Site Hazardous Materials and Transportation-Hazardous Materials. Approximately 54,131 people live within ¼ mile of a Tier II facility in Tulsa; 83,518 people live within ½ mile of a major highway/interstate system, and 32,281 people live within ¼ mile of the railway. An incident involving hazardous materials would potentially, depending on the severity of the event and the chemical, call for evacuation of impacted areas. Hazardous material events become an even greater concern if they contaminate the water supply, causing a major public health concern. Impacts of these hazards are primarily related to the populations and infrastructure at risk; the built environment is less likely to be impacted.

The remaining site-specific hazards addressed in this chapter, Wildfire and Expansive Soils, vary in their associated risks: Expansive soils do not directly cause loss of life, but the property and infrastructure can be damaged over time. Approximately 53,441 improved parcels with a value, estimated for fair market, of $6,796,078,847 are exposed to the risks of expansive soils. Wildfires impact both the general population and the built environment. The Wildland Urban Interface areas of Tulsa are those most likely to be impacted by wildfires. Brush or grass fires within the city limits of Tulsa would not necessarily be considered wildfires by definition. Regardless, it is important for the city to continue to maintain areas considered to have a high Wildfire Level of Concern and to encourage residents to do the same.

The Hazard Composite map in Figure 4-44 identifies the areas of the City of Tulsa that are vulnerable to geographic specific hazards.

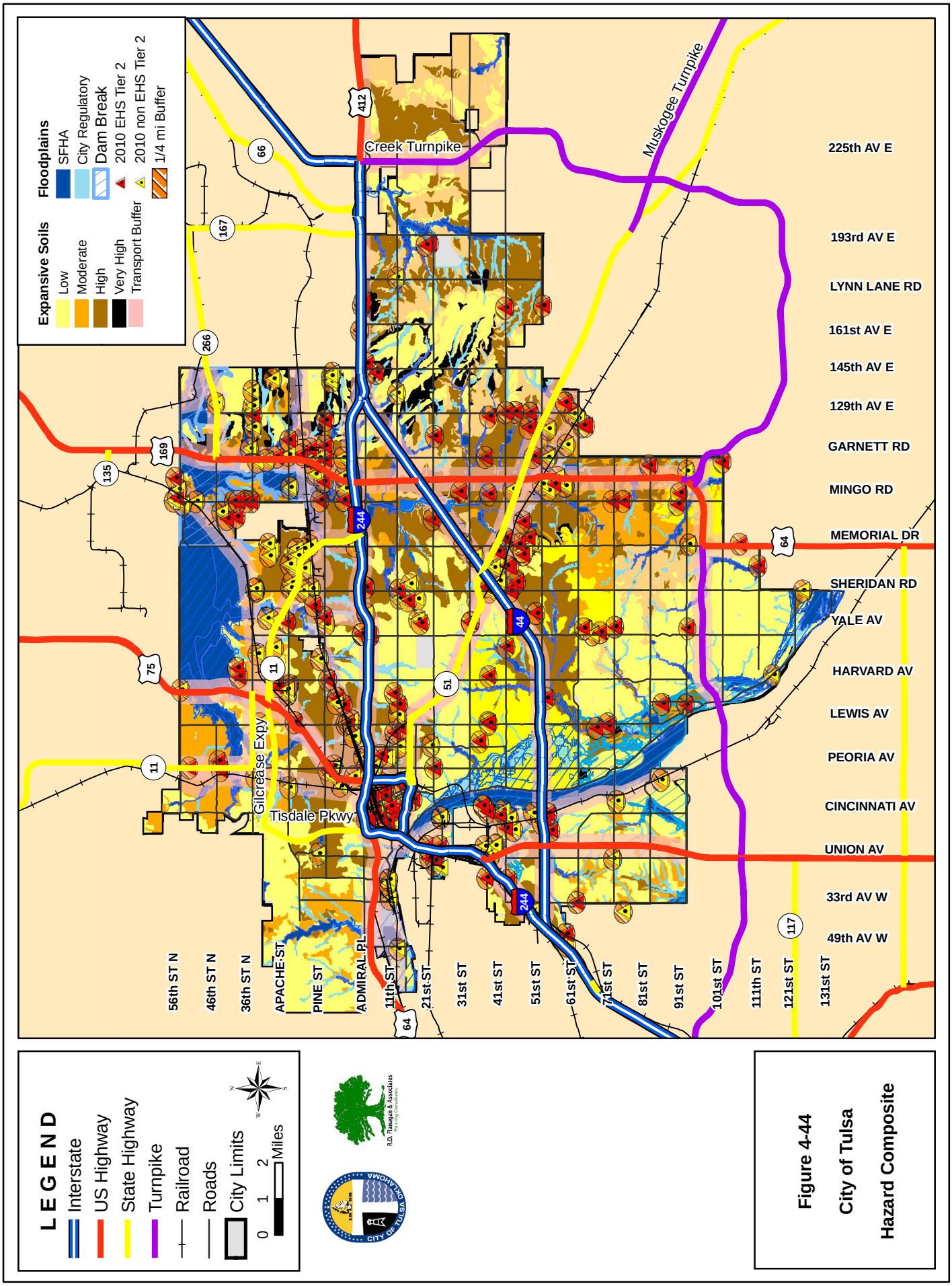


Figure 4-44
City of Tulsa
Hazard Composite

Chapter 5: Tulsa City Council Districts

Overview

Table 5-1 lists the City of Tulsa's City Council Districts and provides basic information about each.

Table 5–1: Tulsa City Council District Overview

District	Councilor	Population (2010)	Sq. Mi.	Latitude	Longitude
District 1	Councilor Jack Henderson	44,873	34.54	36.18	-95.99
District 2	Councilor Jeanie Cue	45,525	23.80	36.07	-96.00
District 3	Councilor David Patrick	43,820	32.78	36.18	-95.90
District 4	Councilor Blake Ewing	43,972	12.65	36.14	-95.98
District 5	Councilor Karen Gilbert	43,168	12.90	36.13	-95.90
District 6	Councilor Byron "Skip" Steele	47,887	37.88	36.13	-95.81
District 7	Councilor Arianna Moore	44,367	16.79	36.08	-95.87
District 8	Councilor Phil Lakin, Jr.	43,066	16.00	36.03	-95.92
District 9	Councilor G.T. Bynum	43,080	13.12	36.10	-95.96

About the Tulsa City Council

On Valentines Day in 1989, Tulsa voters approved the most sweeping changes in city government since the original 1908 charter. A new system was chosen to replace an outdated City Commission. The change came about after a 35-year debate on how City government could better represent the citizens of Tulsa. This new Charter provided for a Mayor-Council form of government with fewer City departments, more centralization, and greater operational efficiency.

The Tulsa City Council functions as the legislative and policy development body of the city. The Council passes local laws, reviews and approves the City's annual budget, monitors the efficiency and effectiveness of City operations, conducts investigations, and Councilors listen to concerns and suggestions from the residents of their districts. The current Chairman of the Tulsa City Council is David Patrick (District 3), and the Vice Chairman is Karen Gilbert (District 5). All councilors currently serve in staggered three-year terms. In November, Tulsans voted to change the charter so councilors would serve two-year terms in non-partisan elections. The change goes into effect in 2014. The last Council election was in December 2012.

Today, the Tulsa City Council continues to work with Tulsa's Mayor, City Auditor, and all City departments to find ways to make government function more efficiently and effectively so that all areas of the community are better served by City government. Tulsa's reputation as one of America's most livable cities is well-deserved, and the goal of the Tulsa City Council is to help Tulsa maintain that reputation. *(Source: http://www.tulsacouncil.org/)*

An overall map of the City of Tulsa displaying the Tulsa City Council District Boundary lines is shown in Figure 5-1.

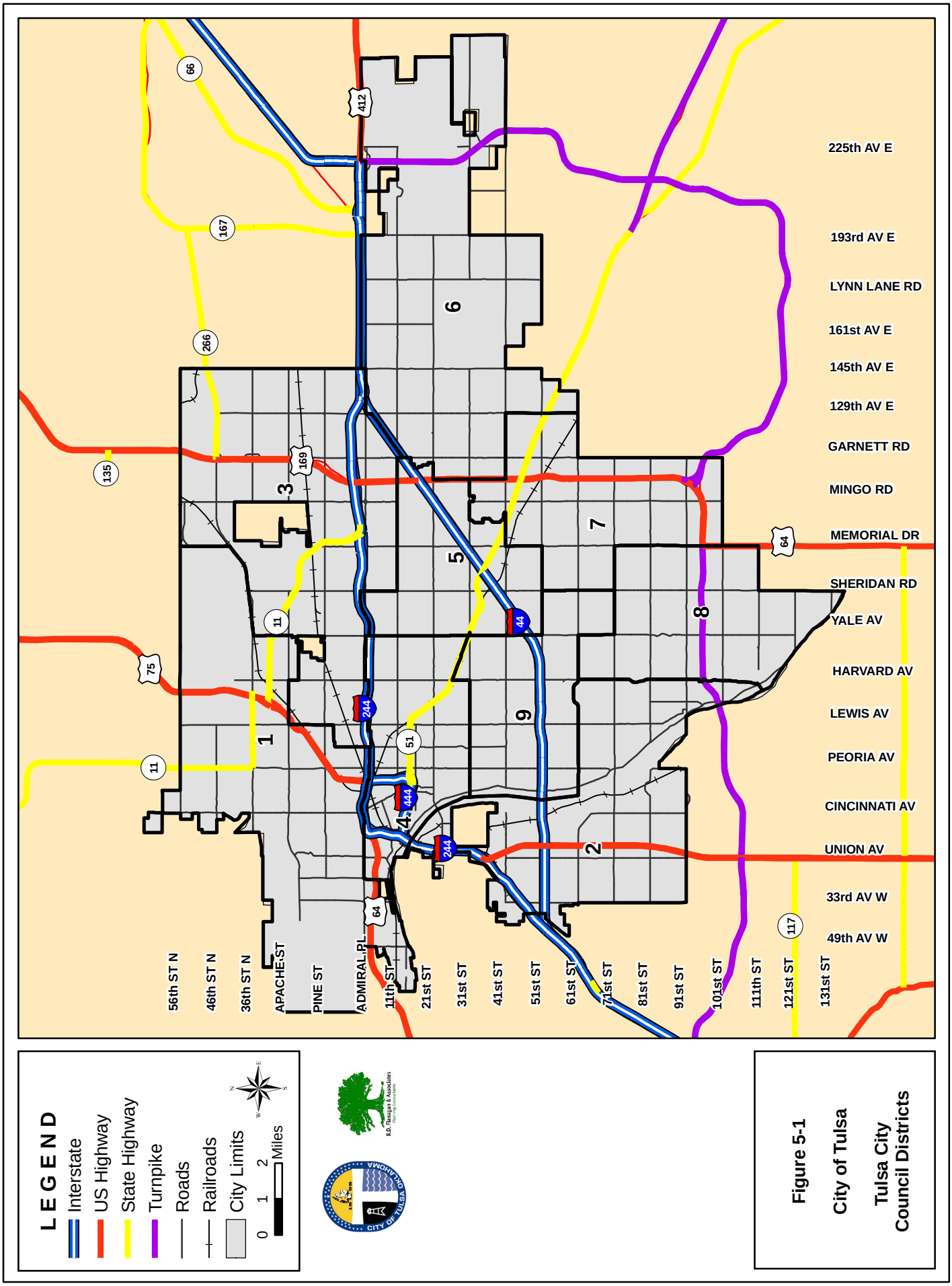


Figure 5-1
City of Tulsa
Tulsa City Council Districts

City of Tulsa Multi-Hazard Mitigation Plan Update

Tulsa City Council District 1

R.D. Flanagan & Associates

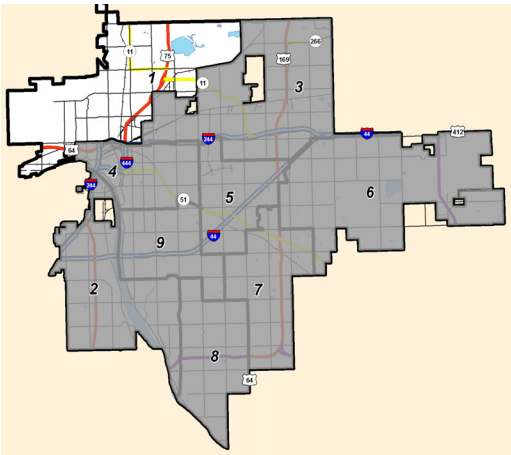
Planning Consultants

5.1 Tulsa City Council District 1

5.1.1 Introduction

5.1.1.1 Location

Figure 5.1–1: Tulsa Locator Map – District 1



Council District 1 is located in northwest Tulsa, in Tulsa and southeast Osage Counties, shown in the Locator Map. Total land area within District 1 is approximately 36 sq mi., as shown in the District 1 Base Map in Figure 5.1-2. The district is bounded generally on the north by 56th Street North, the east by N. Memorial Drive, the south by I-244 and the Arkansas River, and the west by 73rd West Avenue.

5.1.1.2 Jack Henderson-Councilor District 1

Councilor Jack Henderson was re-elected in 2011. He was sworn into office for another term on Monday, December 5, 2011. Jack Henderson is retired from AT&T, where he worked for 37 years. He is now serving his fourth term as District 1, Tulsa City Councilor. Henderson, a lifelong Tulsan, said it is his love for the city and his desire to make it better that has kept him so involved. He has worked with Housing and Urban Development projects, the Northside YWCA and the city's policy oversight committee for Community Development Block Grant funding. He also has taken leadership roles with the local chapters of the National Association for the Advancement of Colored People and 100 Black Men of America. He also was involved in changing Tulsa's commission form of government to the Mayor-City Council, which was enacted in 1990. *(Source: http://www.tulsacouncil.org/)*

Councilor Jack Henderson

5.1.1.3 History

Cultural and Historic Properties

Tulsa Council District 1 is home to seven cultural sites including: The Gilcrease Museum, Greenwood Cultural Center, Oklahoma State University-Tulsa, Rudisil Regional Library, Suburban Acres Library, Tulsa Community College-Northeast, and Tulsa Zoo and Living Museum, as shown on the map in Figure 5.1-3. There are no buildings listed on the National Register of Historic Places in Tulsa Council District 1.

5.1.1.4 Demographics

Council District 1 had a 2010 Census population of 44,873. A map displaying the population density of District 1 is shown in Figure 5.1-4. Table 5.1-1 includes the demographic makeup of Council District 1. Maps presenting the demographic information listed in Table 5.1-1 are included in Figures 5.1-5 through 5.1-12.

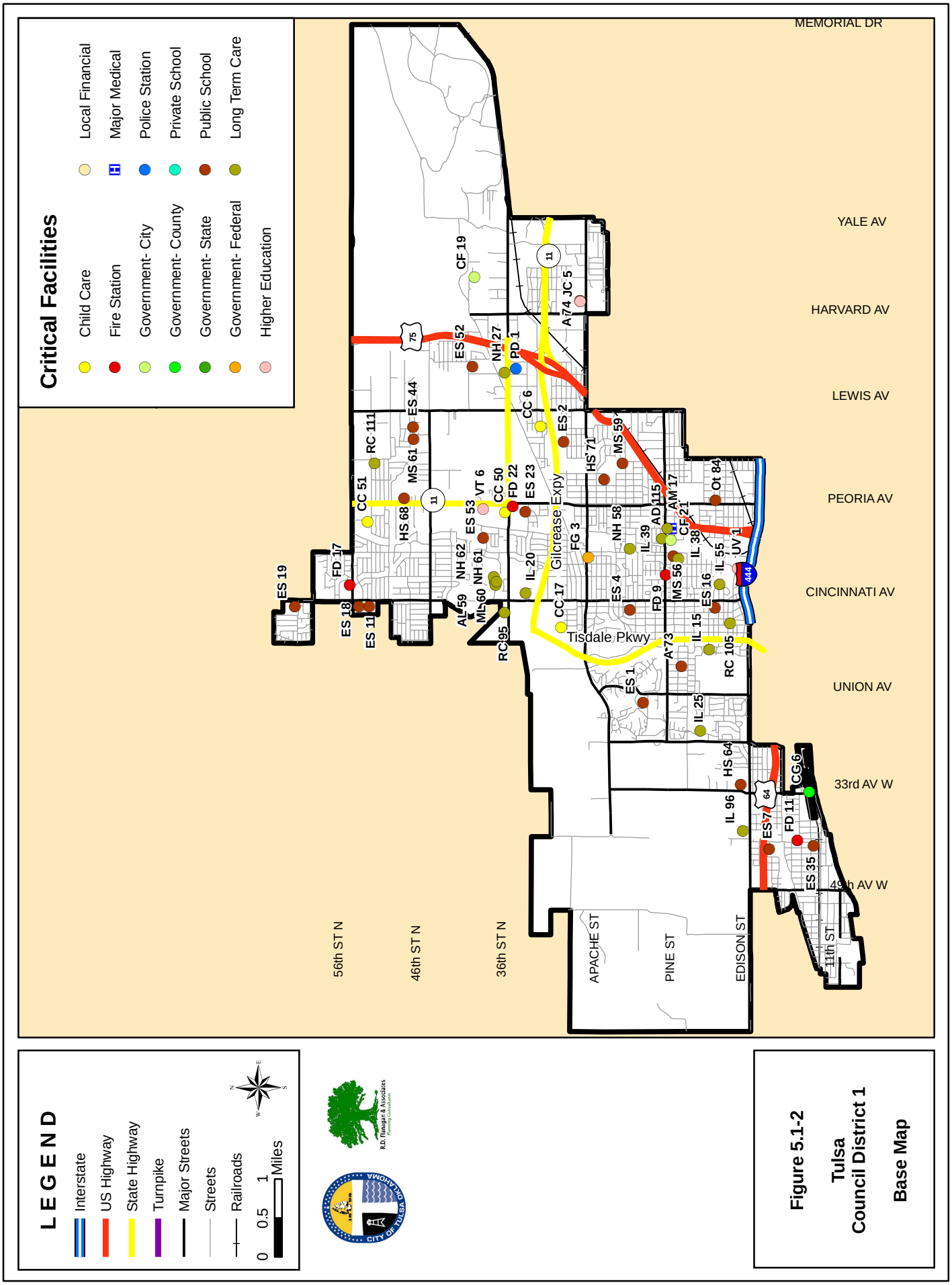


Figure 5.1-2
Tulsa Council District 1
Base Map

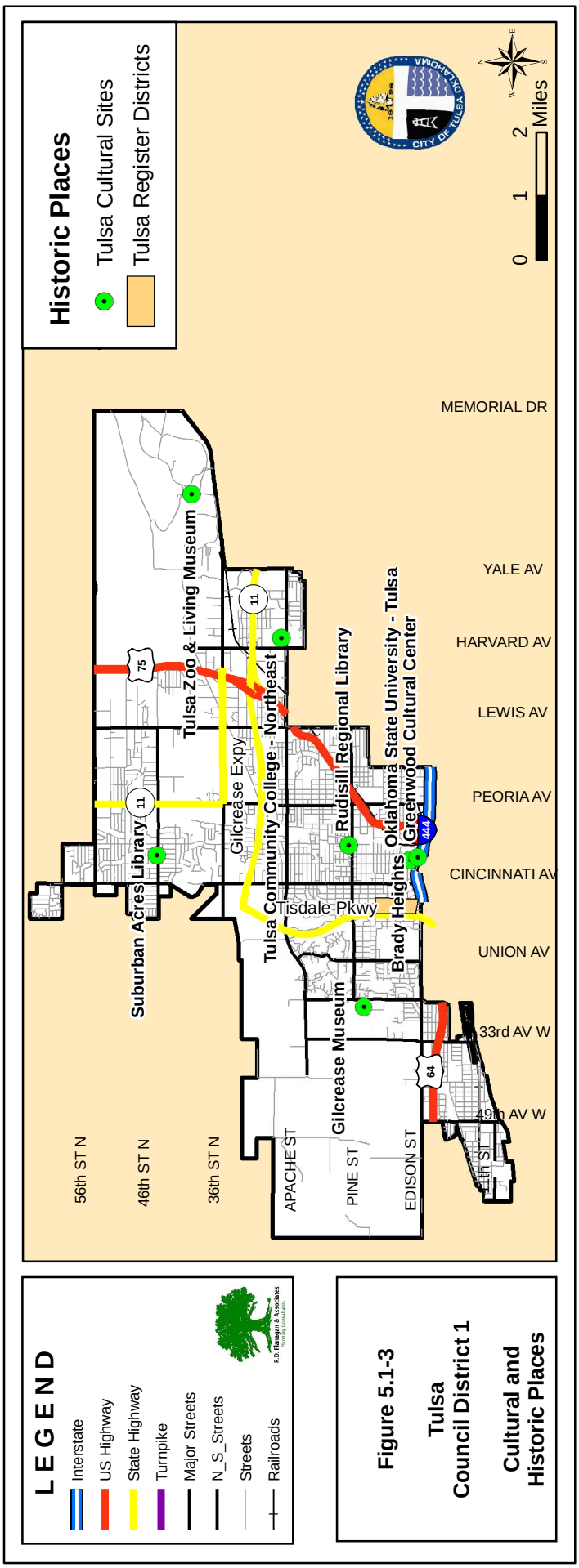


Figure 5.1-3
Tulsa
Council District 1
Cultural and Historic Places

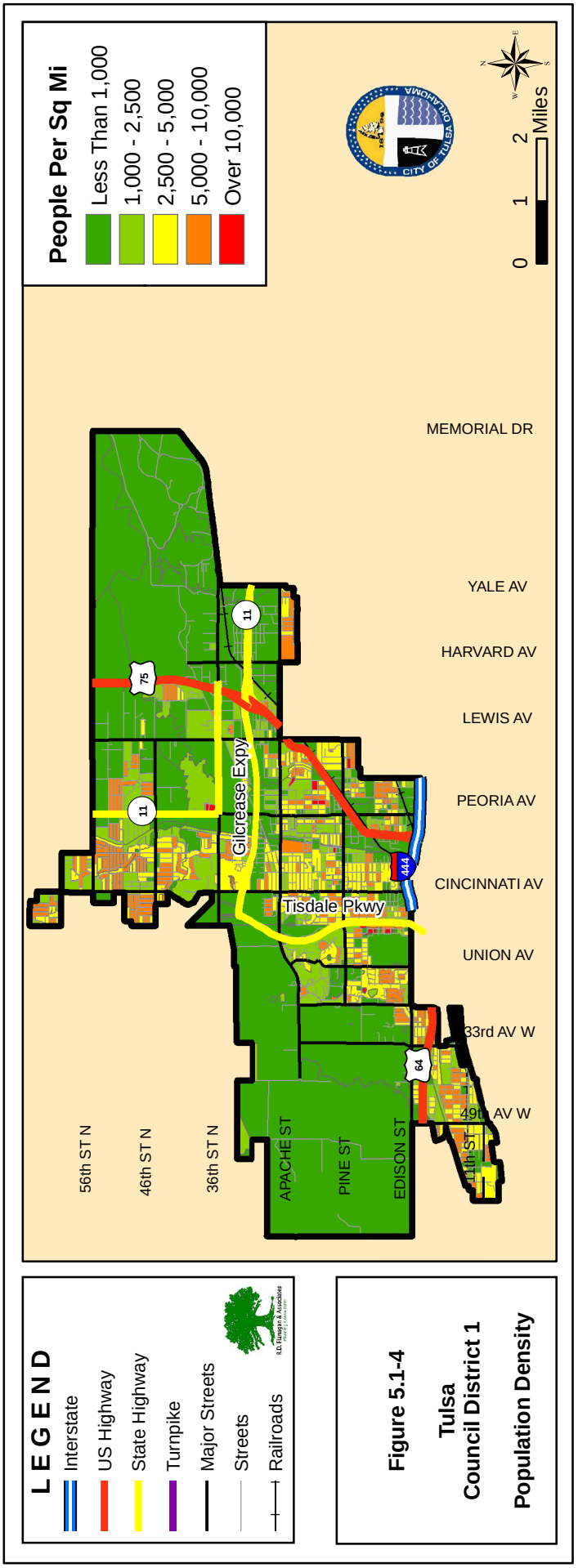


Figure 5.1-4
Tulsa
Council District 1
Population Density

Table 5.1–1: Tulsa Council District 1 Demographic Information

Category	District	Tulsa
Persons under 5 years of age	9.05%	7.53%
Persons under age 18	30.41%	24.44%
Persons age 65 and older	7.73%	12.46%
Poverty Status in 2010 (individuals)	32.29%	19.36%
White	23.86%	62.81%
Native-American	4.25%	5.35%
African American	60.87%	15.67%
Asian	0.23%	2.39%
Hispanic	7.76%	13.93%
Total Population	44,873	401,265

Source: US Census Data, 2010

5.1.1.5 Infrastructure

Tulsa Council District 1 is dependent upon the lifelines of the City of Tulsa as identified in Section 1.2.6 of this Plan Update. Any unique vulnerability of Tulsa Council District 1 in relation to the seven site-specific hazards identified in this plan will be addressed in Section 5.1.4, below.

5.1.1.6 Economy

The 2010 Census identified an income level of approximately $18,000 as the average poverty threshold for a family of four, including two children. Approximately 14,491 individuals or 32.3 percent of all persons in District 1 were living at or below the poverty line in 2010. A map showing areas of poverty in District 1 is presented in Figure 5.1-7.

5.1.1.7 Development

According to the Tulsa County Assessor's Office, there are 17,533 properties with improvements in District 1 with an estimated value, adjusted for fair market price, of $801,333,464.00. The numbers of properties with improvements, and improvement values, by type, are shown in Table 5.1-2. No land, contents or tax exempt values are included. Tulsa Council District 1 is made up of 45 homeowner associations, displayed in Figure 5.1-13. There are no neighborhoods zoned for Historic Preservation in District 1.

Table 5.1–2: Tulsa Council District 1 Property Types by Assessed Values

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	16,599	$506,121,553.00
Residential Multi-Family	117	$9,335,400.00
Commercial	382	$62,504,615.00
Industrial	52	$24,606,346.00
Other	383	$198,765,550.00
Total	17,533	$801,333,464.00

Source: Tulsa County Assessor's Office, 2012

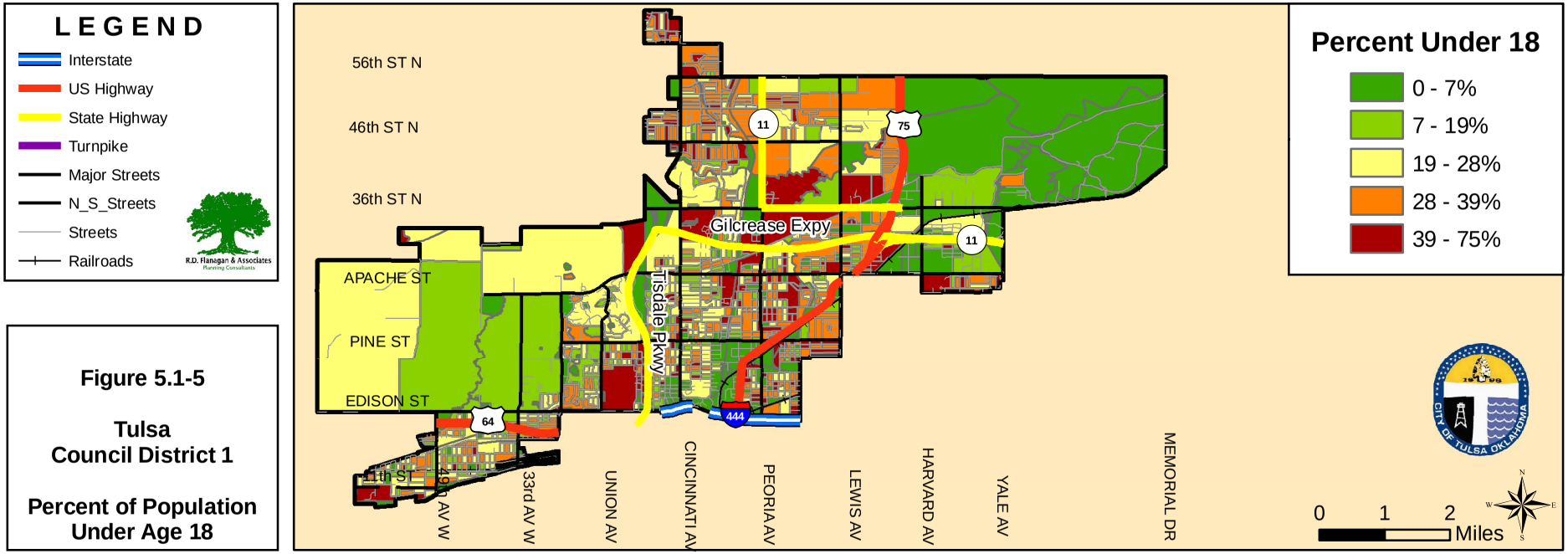


Figure 5.1-5

Tulsa
Council District 1

Percent of Population Under Age 18

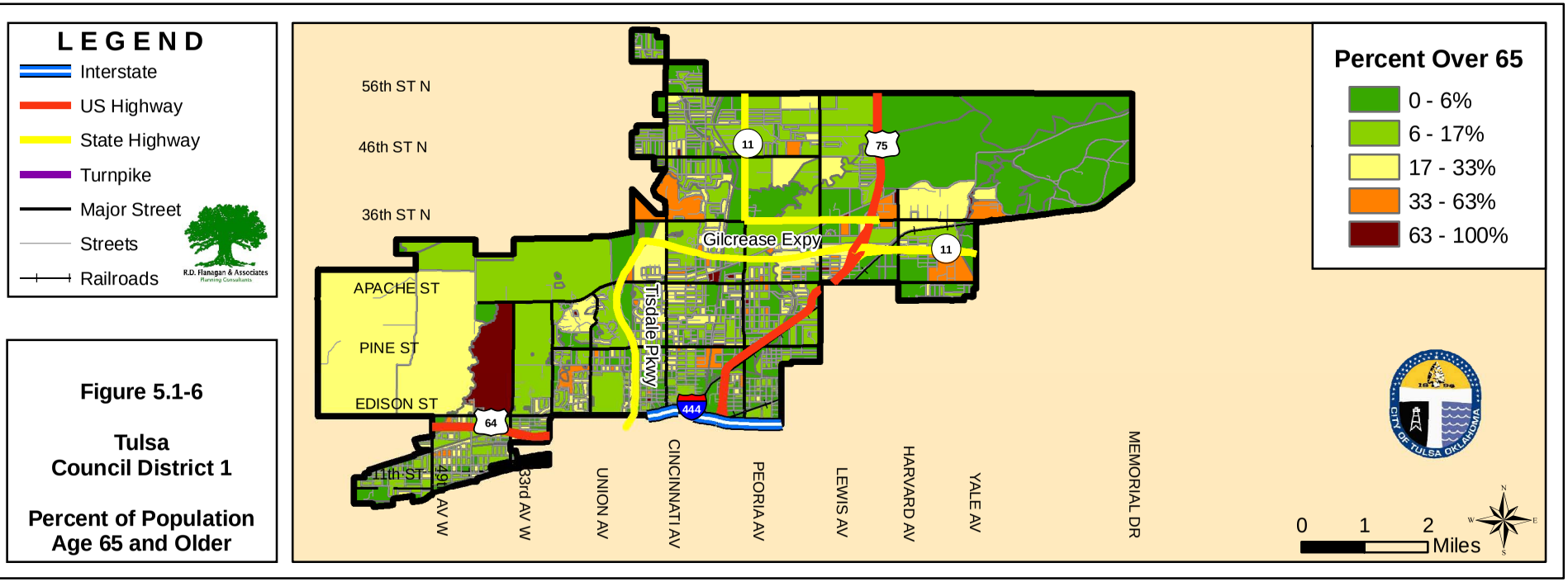


Figure 5.1-6

Tulsa
Council District 1

Percent of Population Age 65 and Older

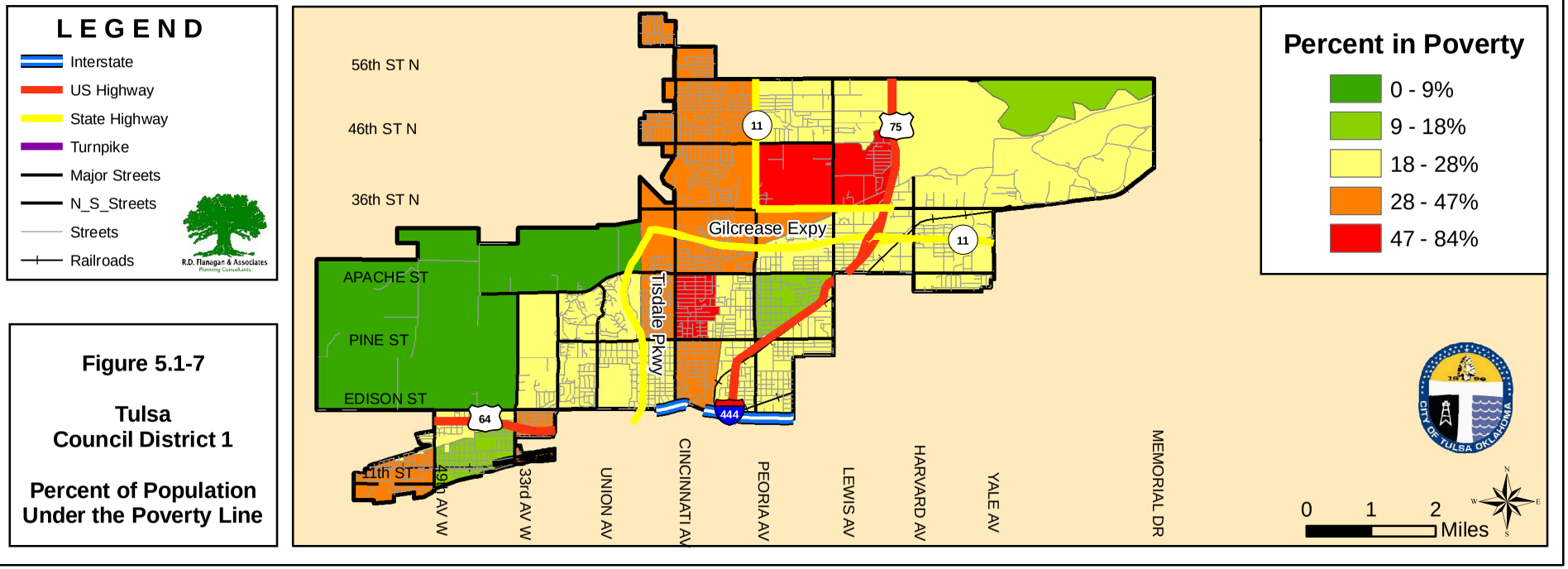


Figure 5.1-7

Tulsa
Council District 1

Percent of Population Under the Poverty Line

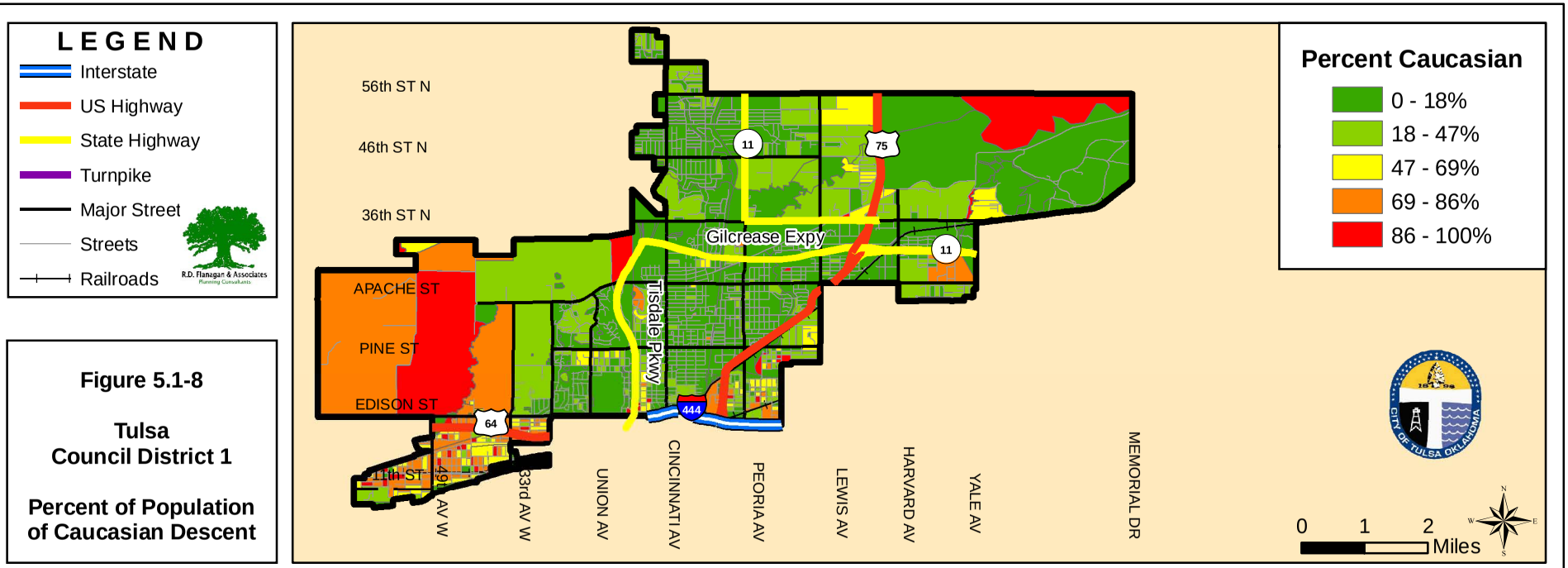


Figure 5.1-8

Tulsa
Council District 1

Percent of Population of Caucasian Descent

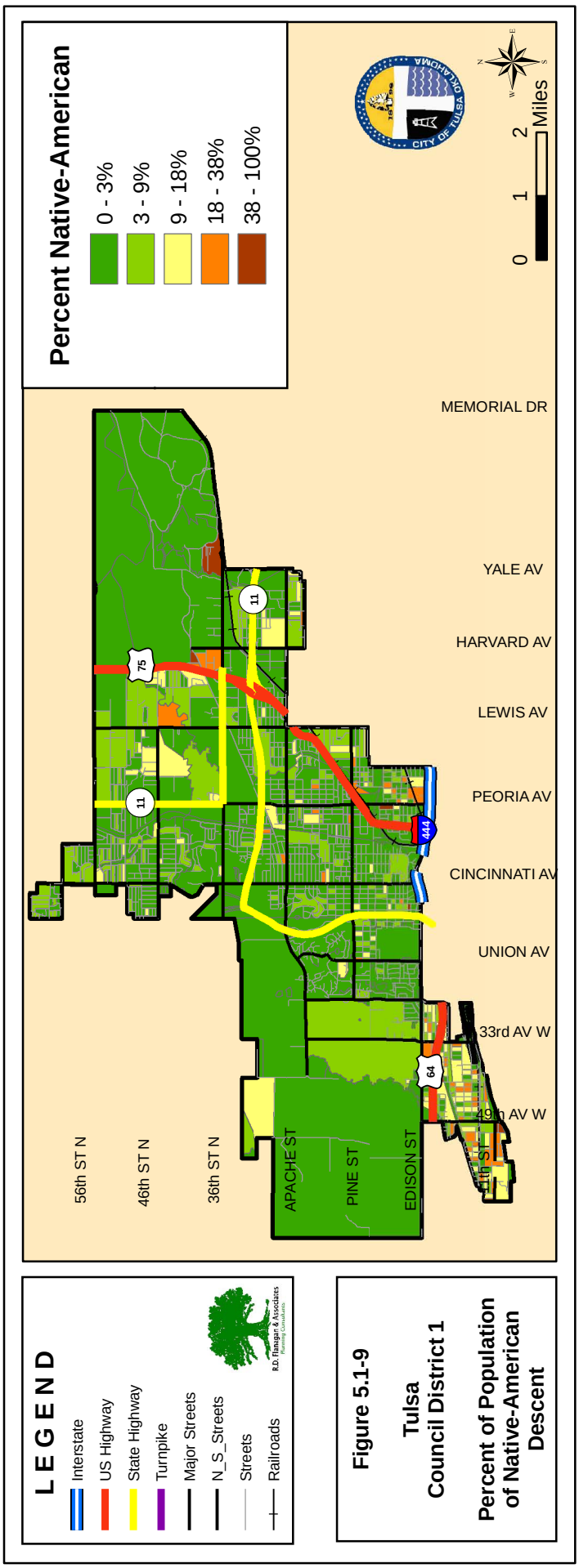


Figure 5.1-9
Tulsa Council District 1
Percent of Population of Native-American Descent

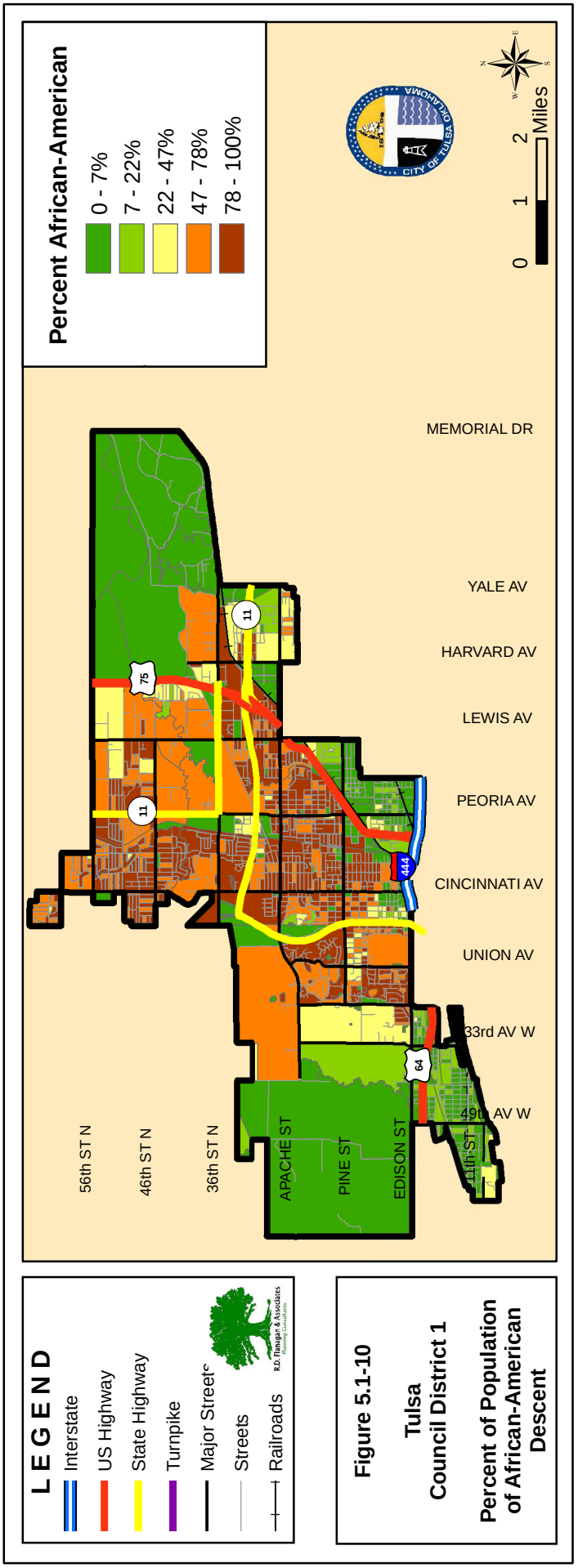


Figure 5.1-10
Tulsa Council District 1
Percent of Population of African-American Descent

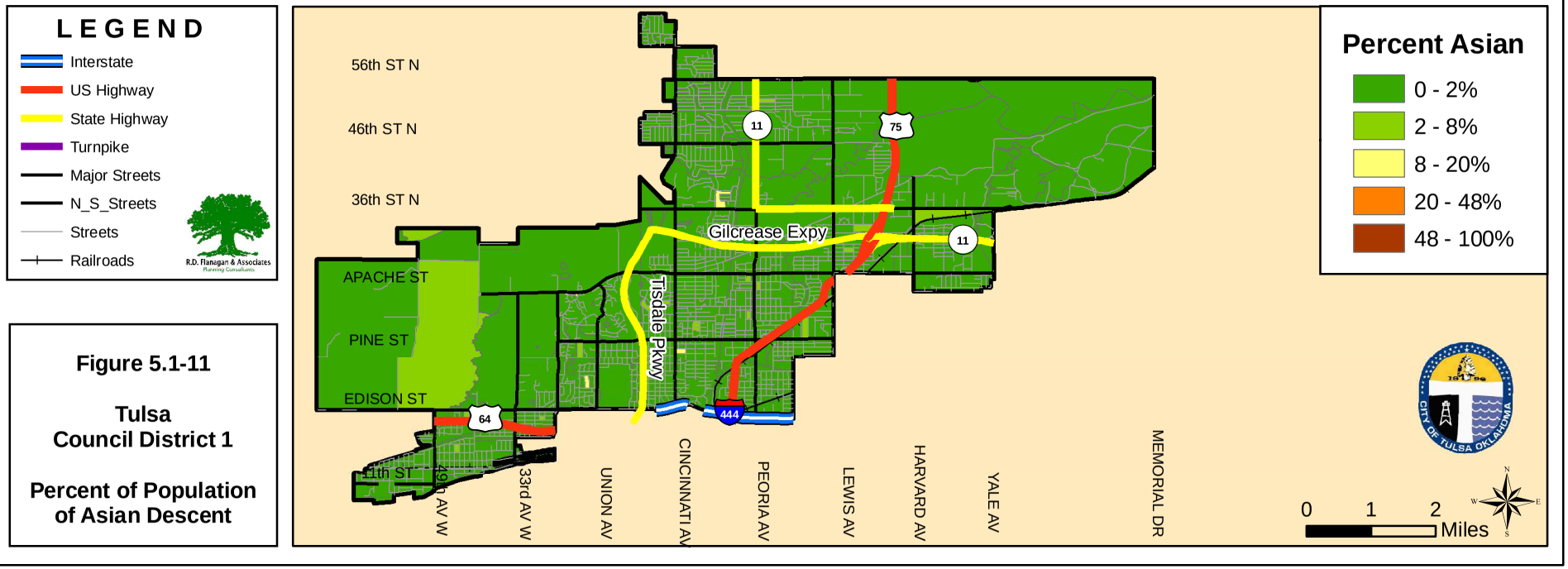


Figure 5.1-11

Tulsa
Council District 1

Percent of Population of Asian Descent

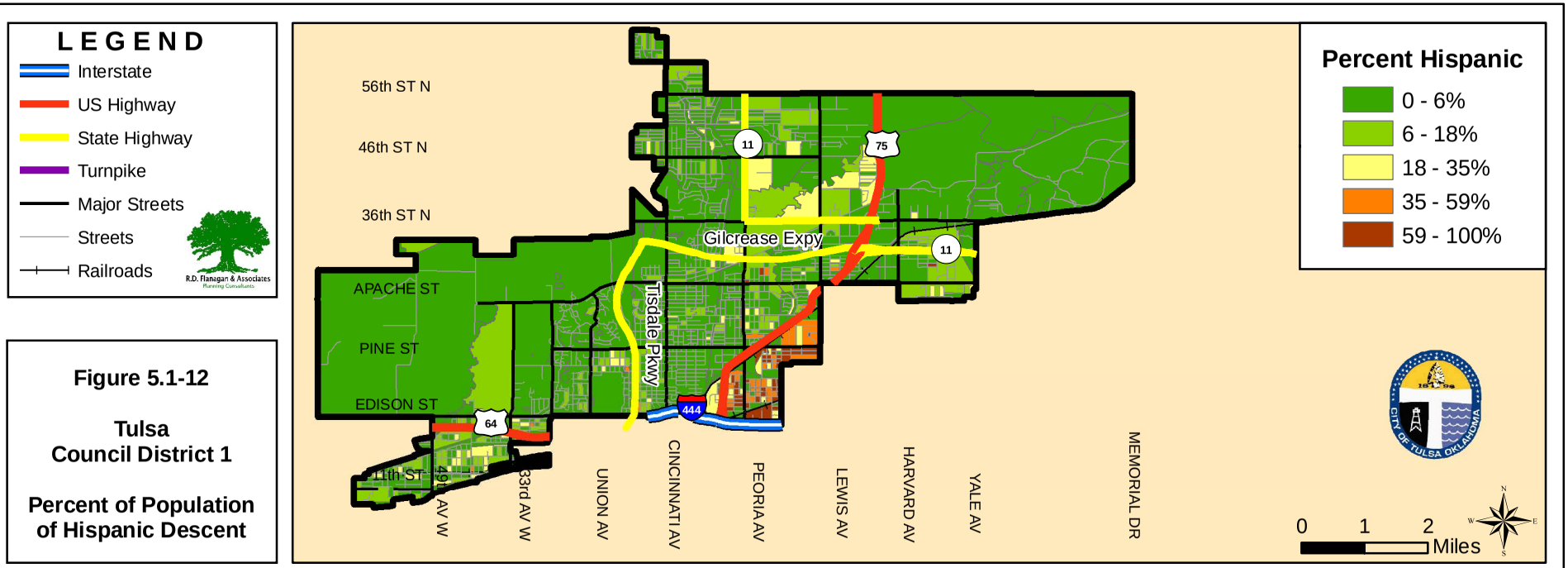


Figure 5.1-12

Tulsa
Council District 1

Percent of Population of Hispanic Descent

Zoning

For the purpose of this plan, five of the 29 zoning districts—Agricultural, Single- Family Residential, Multi-Family Residential, Commercial, and Industrial—were used to show zoning within District 1. Tulsa Council District 1 is primarily zoned for agricultural and single-family residential uses with commercial, multi-family, tax exempt, and industrial distributed throughout. A map of zoning areas in Council District 1 is shown in Figure 5.1-14.

Future Development

The City of Tulsa will continue to improve District 1's service infrastructures, such as flood control, water, sanitary sewer, and streets as conditions and funding allow. For information regarding future development plans in the City of Tulsa, see Section 1.2.8.

5.1.1.8 Critical Facilities

Table 5.1-3 lists the locations of District 1's Critical Facilities, which are shown in Figure 5.1-2.

Table 5.1–3: Tulsa Council District 1 Critical Facilities

ID	Map ID	Facility Name	Address
		Government-City	
CF	19	Mohawk Water Treatment Plant	3600 Mohawk Blvd
CF	21	Communications for the City of Tulsa	801 E Oklahoma St
		Police Stations	
PD	1	Tulsa Police Department (North Division)	3411 North Columbia
		Fire Stations	
FD	9	Tulsa Fire Department #10	508 E Pine St
FD	11	Tulsa Fire Department #13	345 S 41st Av W
FD	17	Tulsa Fire Department #19	509 E 56th St N
FD	22	Tulsa Fire Department #24	3520 N Peoria Ave
		Government- County	
CG	6	Tulsa County Deputy Sheriff	3240 Charles Page Blvd
		Government- Federal	
FG	3	USPS - Northside Post Office	626 E Apache
		Tulsa Public Schools	
ES	1	Academy Central Elementary School	1789 W Seminole St
ES	2	Anderson Elementary School	1921 E 29th St N
ES	4	Burroughs Elementary School	1924 N Cincinnati Ave
ES	7	Choteau Elementary School	4132 W Cameron St
ES	11	ECDC Bunche	5402 N Cincinnati Ave
ES	16	Emerson Elementary School	909 N Boston Ave
ES	18	Gilcrease Elementary School	5550 N Cincinnati Ave
ES	19	Greeley Elementary School	105 E 63rd St N
ES	23	Hawthorne Elementary School	105 E 33rd St N
ES	35	Mark Twain Elementary School	541 S 43rd W Ave
ES	44	Penn Elementary School	2138 E 48th St N
ES	52	Traice Academy/ Traice Middle School	2740 E 41st St N

ID	Map ID	Facility Name	Address
ES	53	Whitman Elementary School	3924 N Lansing
MS	56	Carver Middle School	624 E Oklahoma Pl
MS	59	KIPP Tulsa Academy	1661 E Virgin St
MS	61	Monroe Demonstration Academy/ Dual Language Immersion	2740 E 41st St N
HS	64	Central High School/ Junior High School	3101 W Edison St
HS	68	McLain High School/ Junior High	4929 N Peoria Ave
HS	71	Washington High School	1514 E Zion St
A	73	Continuation High School/ Project Accept/ Traice Elementary School	1205 W Newton
A	74	Early College High School	3727 E Apache
Ot	84	Helmzar Challenge Course	1006 N Quaker
Child Care			
CC	6	Bundles of Joy Child Care Center	2131 E. 31 Pl. N.
CC	17	Frost Head Start Early Start	203 West 28th Street North
CC	50	World Won Early Learning Center	PO BOX 481018
CC	51	YWCA of Tulsa - North Center	5424 N. Madison Ave.
Higher Education			
UV	1	Oklahoma State University - Tulsa	700 N Greenwood
JC	5	Tulsa Community College - Northeast Campus	3727 E Apache St
VT	6	Tulsa Technology Center - Peoria	3850 N Peoria Ave
Major Medical			
AM	17	EMSA	1417 N Lansing Ave
Long Term Care			
IL	15	Country Club Gardens	959 Country Club Dr
IL	20	Crestview Senior Duplexes	3535 N Cincinnati Ave
IL	25	Gilcrease Estates	1143 N 24th West Ave
NH	27	Green Country Care Center	3601 N Columbia Ave
IL	38	Jordan Plaza I & II	630 E Oklahoma St
IL	39	Jordan Plaza III	775 E Pine St
IL	55	Pioneer Plaza	901 N Elgin Ave
NH	58	Rest Haven	1944 N Iroquois Ave
AL	59	Saint Simeon's Episcopal Home	3701 N Cincinnati Ave
ML	60	Saint Simeon's Episcopal Home	3701 Cincinnati Ave
NH	61	Saint Simeon's Health Care Center	3701 N Cincinnati Ave
NH	62	Saint Simeon's Home Memory Center	3701 N Cincinnati Ave
RC	95	Vintage Heights	1 W 36th St North
IL	96	West Edison Plaza	570 N 39th West Ave
RC	105	Covenant House Residential Care Home	715 N Cheyenne
RC	111	Sarah's Residential Living Home	1571 E 53rd St N
AD	115	Donald Reynolds Adult Day Services-North	902 E Pine

5.1.2 Existing Mitigation Strategies

Existing mitigation measures currently being implemented throughout the City of Tulsa are detailed in Chapter 2, *Existing Mitigation Strategies*. The information that follows in this section surveys the infrastructure in place for avoiding or mitigating the impacts of natural hazards, that can be looked at from the District level.

5.1.2.1 Council District 1 Warning Systems

Warning Sirens

At the time of this plan update there were 15 warning sirens located in Tulsa Council District 1 and six located outside of, but with partial coverage within, the District. Locations of sirens in the District are mapped in Figure 5.1-15. Each warning siren is audible for up to a mile. Information regarding the testing of warning sirens in the City of Tulsa is included in Chapter 2. As the District continues to develop to the west and northwest, new sirens should be included to provide coverage for newly developed areas.

Lightning Sensing and Warning

The City of Tulsa is home to multiple outdoor recreation areas for public use. There are 18 parks in District 1, shown in Figure 5.1-16. The District is home to Tulsa Country Club, Mohawk Park, and multiple urban parks. Parks promote neighborhood revitalization and development; they also promote youth development. As discussed in Chapter 4, it is important that outdoor recreation areas be equipped with lightning sensing and warning systems.

Tulsa Public Schools and the University of Tulsa use ThorGuard© to warn of lightning danger at outdoor recreation areas. A map showing ThorGuard© coverage areas in Tulsa is shown in Chapter 2, Figure 2-3. Public school districts in the surrounding Tulsa Metro Area should be encouraged to purchase and install lightening warning systems. Private schools in the area should also be informed of their options and encouraged to install lightening warning systems for coverage of outdoor recreation areas.

5.1.3 Planning Process

The CAC/TAC met monthly during the planning process to review progress, identify issues, receive task assignments, and advise the consultants. Refer to Appendix C for meeting agendas.

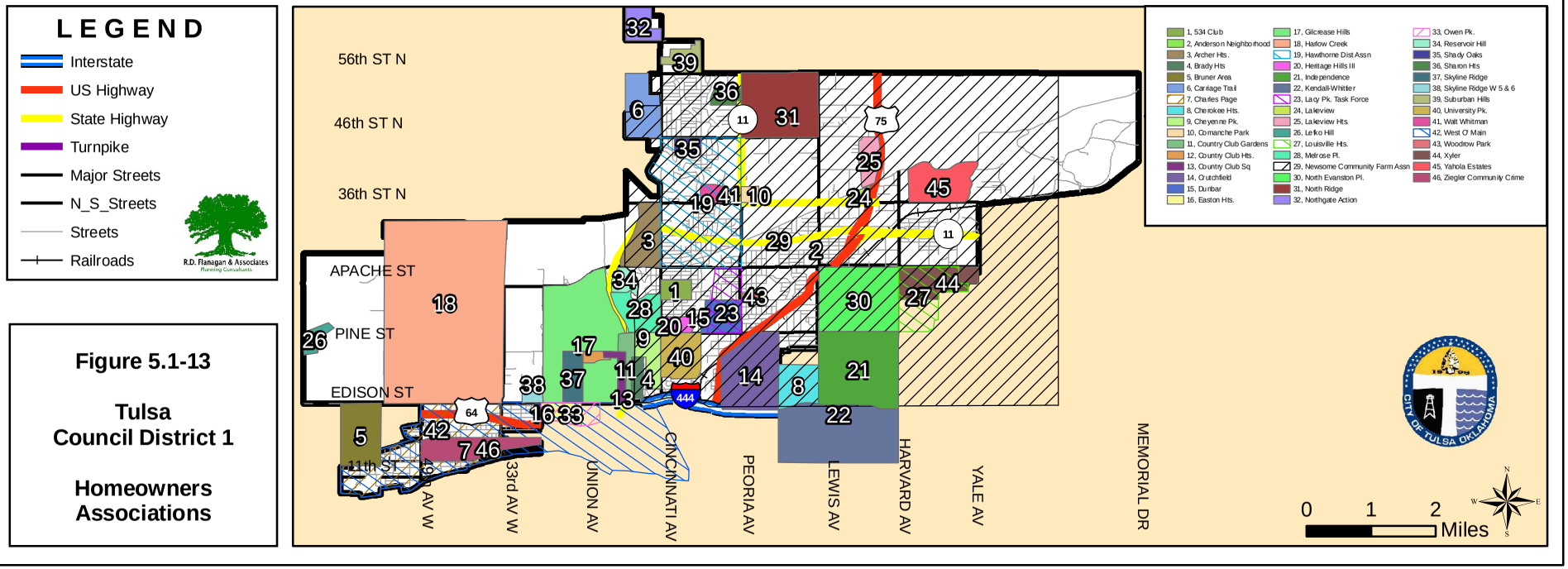


Figure 5.1-13

Tulsa Council District 1

Homeowners Associations

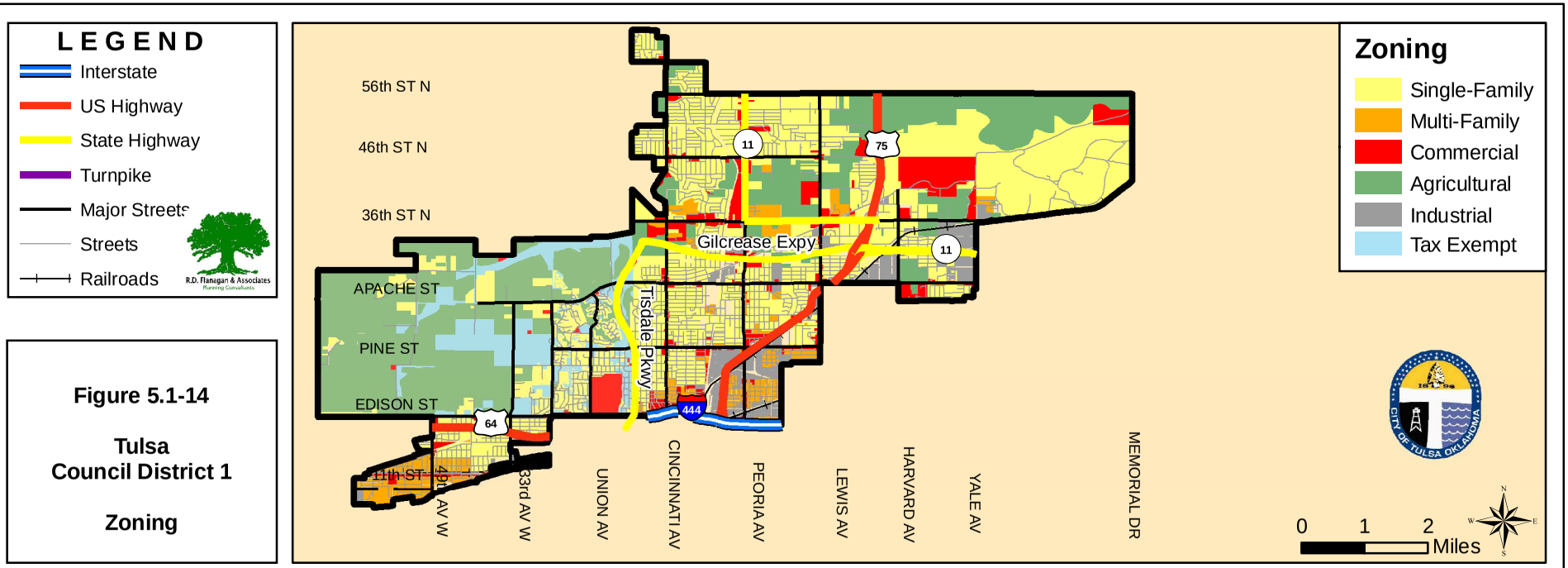
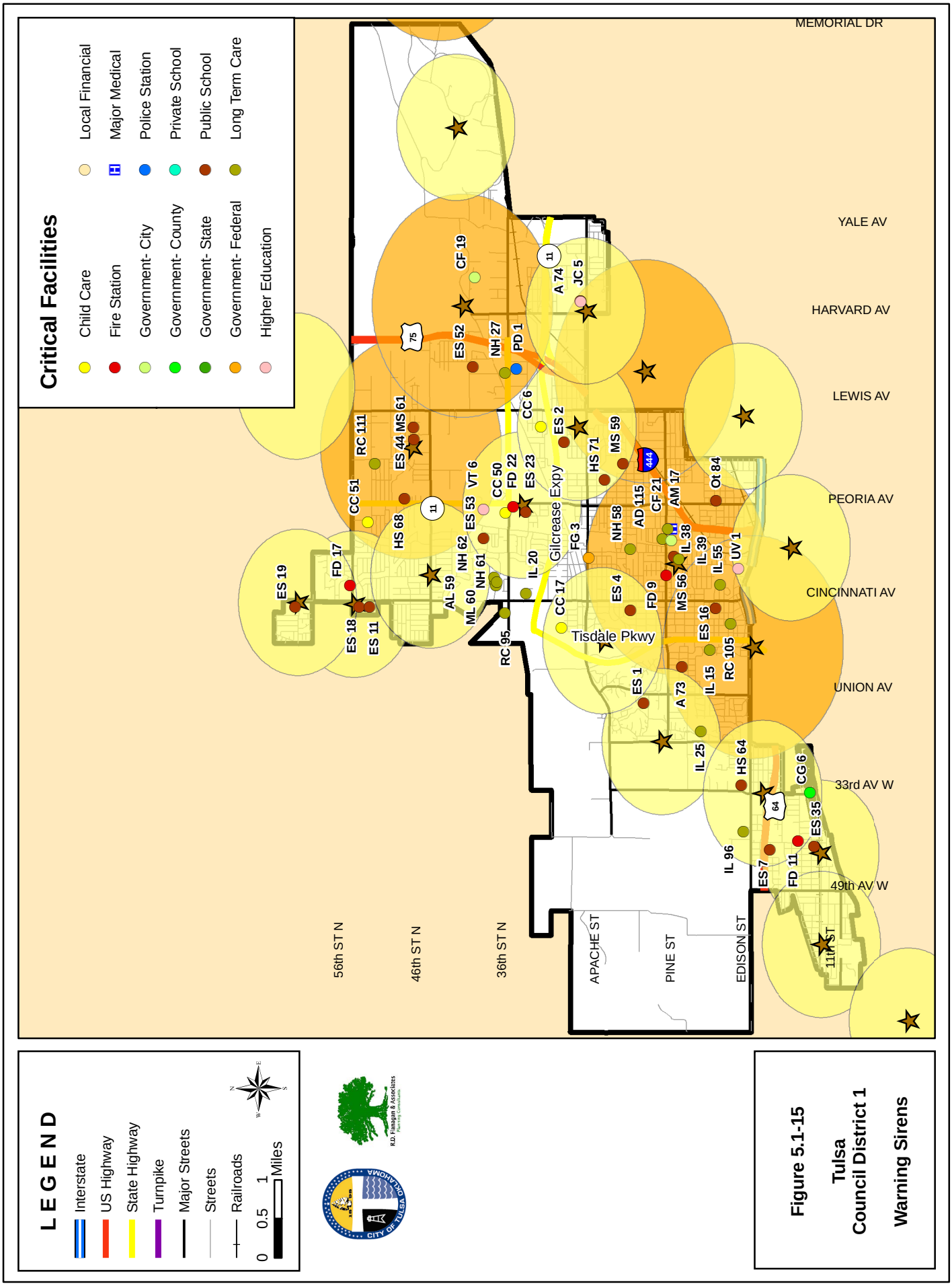


Figure 5.1-14

Tulsa Council District 1

Zoning



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroads

0 0.5 1 Miles

R.D. Flanagan & Associates Planning Consultants

CITY OF TULSA

Figure 5.1-15
Tulsa Council District 1
Warning Sirens

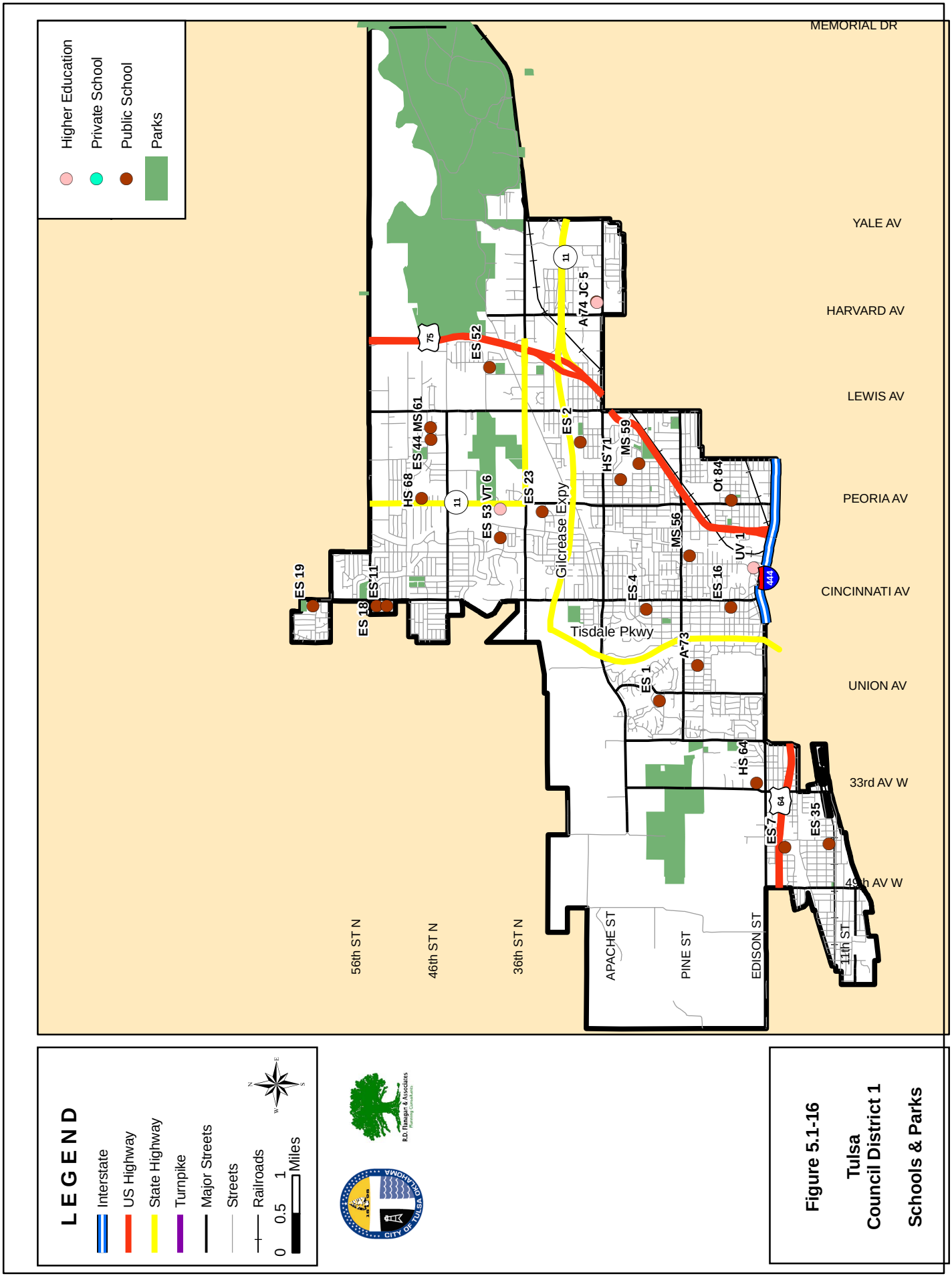


Figure 5.1-16
Tulsa Council District 1
Schools & Parks

5.1.4 Natural and Manmade Hazards

Hazards

General natural hazards, such as Severe Winter Storms, High Wind, Tornado, Lightning, Hailstorm, Extreme Heat, Drought, Earthquake, and Urban Fires affect all areas in the City of Tulsa randomly and equally, and are addressed in Chapter 4.

Site specific hazards, such as Flooding, Dam Failures, Levee Failures, Expansive Soils, Wildfires, Fixed-Site Hazardous Materials and Transportation-Hazardous Materials are addressed for District 1 in subsections 5.1.4.1 through 5.1.4.7, summarized in subsection 5.1.4.8 and shown on the map in Figure 5.1-25. Table 5.1-4 identifies the seven site-specific hazards that can impact Tulsa Council District 1.

Table 5.1–4: Tulsa Council District 1 Site-Specific Hazard Impacts

Hazard	Area (sq. mi)	Improved Parcels	Est. Market Value	Percent of Area Impacted	Impacted Population
Floods	8.8	2,271	$94,117,401	25.48%	5,260
Dam Failure	7.66	2,150	$75,417,498	22.18%	5,169
Levee Failure	1.47	2,582	$74,533,815	4.26%	4,753
Highly Expansive Soils	7.57	6,304	$349,581,475	21.92%	14,705
Wildfire	0.87	352	$14,686,944	2.52%	5,651
Fixed-Site HazMat, ¼ Mi.	4.64	2,289	$149,262,382	13.43%	4,861
Transportation HazMat Highway	9.09	4,594	$215,981,515	26.32%	11,460
Transportation HazMat Railroad	7.59	6,176	$266,042,658	21.97%	13,804

Source: Tulsa County Assessor's Office, 2012/US Census Data 2010

Tulsa Council District 1 has identified certain facilities as critical to the health, safety and welfare of its citizens, business and economy. Table 5.1-5 indicates, generally, the exposure of critical facilities to the seven site-specific hazards covered by this Plan Update.

Table 5.1–5: Tulsa Council District 1 Hazard Impacts on Critical Facilities

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Fixed Site Hazmat	Transportation-HazMat
CF	19	Mohawk Water Treatment Plant	X	X	X	X	X	X	X	X	X						X	
CF	21	Communications for the City of Tulsa	X	X	X	X	X	X	X	X	X				X		X	X
PD	1	Tulsa Police Department (North Div)	X	X	X	X	X	X	X	X	X							X
FD	9	Tulsa Fire Department #10	X	X	X	X	X	X	X	X	X				X			
FD	11	Tulsa Fire Department #13	X	X	X	X	X	X	X	X	X	X	X	X				
FD	17	Tulsa Fire Department #19	X	X	X	X	X	X	X	X	X					X		
FD	22	Tulsa Fire Department #24	X	X	X	X	X	X	X	X	X						X	X
CG	6	Tulsa County Deputy Sheriff	X	X	X	X	X	X	X	X	X	X	X	X			X	X

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Fixed Site Hazmat	Transportation-HazMat
FG	3	USPS - Northside Post Office	X	X	X	X	X	X	X	X	X				X		X	
ES	1	Academy Central Elementary School	X	X	X	X	X	X	X	X	X				X		X	
ES	2	Anderson Elementary School	X	X	X	X	X	X	X	X	X					X		X
ES	4	Burroughs Elementary School	X	X	X	X	X	X	X	X	X				X			
ES	7	Choteau Elementary School	X	X	X	X	X	X	X	X	X		X	X				X
ES	11	ECDC Bunche	X	X	X	X	X	X	X	X	X							
ES	16	Emerson Elementary School	X	X	X	X	X	X	X	X	X							
ES	18	Gilcrease Elementary School	X	X	X	X	X	X	X	X	X							
ES	19	Greeley Elementary School	X	X	X	X	X	X	X	X	X							
ES	23	Hawthorne Elementary School	X	X	X	X	X	X	X	X	X						X	X
ES	35	Mark Twain Elementary School	X	X	X	X	X	X	X	X	X		X	X				X
ES	44	Penn Elementary School	X	X	X	X	X	X	X	X	X							
ES	52	Traice Academy/ Traice Middle School	X	X	X	X	X	X	X	X	X							X
ES	53	Whitman Elementary School	X	X	X	X	X	X	X	X	X							
MS	56	Carver Middle School	X	X	X	X	X	X	X	X	X				X			
MS	59	KIPP Tulsa Academy	X	X	X	X	X	X	X	X	X							X
MS	61	Monroe Demonstration Academy/ Dual Language Immersion	X	X	X	X	X	X	X	X	X							
HS	64	CentralHigh School/ Junior High School	X	X	X	X	X	X	X	X	X							
HS	68	McLain High School/ Junior High	X	X	X	X	X	X	X	X	X							X
HS	71	Washington High School	X	X	X	X	X	X	X	X	X							
A	73	Continuation HS/ project Accept-Traice ES	X	X	X	X	X	X	X	X	X				X			
A	74	Early College HS	X	X	X	X	X	X	X	X	X							
Ot	84	Helmzar Challenge Course	X	X	X	X	X	X	X	X	X				X			
CC	6	Bundles of Joy Child Care Ctr	X	X	X	X	X	X	X	X	X							X
CC	17	Frost Head Start Early Start	X	X	X	X	X	X	X	X	X							X
CC	50	World Won Early Learning Ctr	X	X	X	X	X	X	X	X	X						X	X
CC	51	YWCA of Tulsa - North Ctr	X	X	X	X	X	X	X	X	X						X	X
UV	1	Oklahoma State Univeristy - Tulsa	X	X	X	X	X	X	X	X	X				X			X
JC	5	Tulsa Community College - Northeast Campus	X	X	X	X	X	X	X	X	X							
VT	6	Tulsa Technology Center - Peoria	X	X	X	X	X	X	X	X	X							X
AM	17	EMSA	X	X	X	X	X	X	X	X	X				X		X	X
IL	15	Country Club Gardens	X	X	X	X	X	X	X	X	X							X
IL	20	Crestview Senior Duplexes	X	X	X	X	X	X	X	X	X							X

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Fixed Site Hazmat	Transportation-HazMat
IL	25	Gilcrease Estates	X	X	X	X	X	X	X	X	X				X			
NH	27	Green Country Care Center	X	X	X	X	X	X	X	X	X							X
IL	38	Jordan Plaza I & II	X	X	X	X	X	X	X	X	X				X			
IL	39	Jordan Plaza III	X	X	X	X	X	X	X	X	X				X		X	
IL	55	Pioneer Plaza	X	X	X	X	X	X	X	X	X							
NH	58	Rest Haven	X	X	X	X	X	X	X	X	X				X			
AL	59	Saint Simeons Episcopal Home	X	X	X	X	X	X	X	X	X							
ML	60	Saint Simeons Episcopal Home	X	X	X	X	X	X	X	X	X							
NH	61	Saint Simeons Health Care Center	X	X	X	X	X	X	X	X	X							
NH	62	Saint Simeons Home Memory Center	X	X	X	X	X	X	X	X	X					X		
RC	95	Vintage Heights	X	X	X	X	X	X	X	X	X							
IL	96	West Edison Plaza	X	X	X	X	X	X	X	X	X							X
RC	105	Covenant House Residential Care Home	X	X	X	X	X	X	X	X	X							X
RC	111	Sarahs Residential Living Home	X	X	X	X	X	X	X	X	X							
AD	115	Donald W Reynolds Adult Day Services-North	X	X	X	X	X	X	X	X	X				X		X	X

5.1.4.1 Flood

Location

District 1 is affected by both the City Regulatory Floodplains and the Special Flood Hazard Area (SFHA). The SFHA makes up a large portion of the north-east corner of the District. The combined floodplains comprise 8.8 sq. mi., or 25.48 percent of the land within the Council limits. Streams in Council District 1 and their total drainage area are listed in Table 5.1-6. A map of District 1 drainage basins and 100-year Floodplains are displayed in Figure 5.1-17.

Table 5.1–6: Tulsa Council District 1 Streams and Drainage Areas

Basin	Total Drainage Area (sq. mi.)
VALLEY VIEW CREEK	0.18
DIRTY BUTTER	7.35
HARLOW CREEK	6.17
BIGHEART CREEK	0.75
DOWNTOWN	0.28
ELM CREEK	0.46
OAK CREEK	0.67

Basin	Total Drainage Area (sq. mi.)
ARKANSAS RIVER MAINSTEM	0.01
ARKANSAS RIVER LOCAL DRAINAGE	1.25
PARK VIEW CREEK	1.20
BIRD CREEK	0.02
BIRD CREEK	6.93
VALLEY VIEW CREEK	1.12
FLAT ROCK CREEK	7.69
COAL CREEK	0.37
Total	34.45

Impact/Vulnerability

In total, 1,998 residential single family structures, 15 residential multi-family structures, six mobile homes, 58 commercial buildings, 12 industrial facilities and 188 structures classified as *other* are located in the 100-year floodplains of Council District 1. The 2,271 improved parcels have an adjusted value, estimated for fair market, of $94,117,401. District 1 improved parcels touched by the 100-year floodplain are listed, by value and type, in Table 5.1-7.

Table 5.1–7: Tulsa Council District 1 Parcels in 100 year Floodplain

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	1,998	$72,768,510
Residential Multi-Family	15	$379,000
Commercial	58	$9,373,156
Industrial	12	$2,453,090
Other	188	$9,143,645.00
Total	2,271	$94,117,401

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Two critical facilities in District 1 are located in or adjacent to the 100-year floodplain. Vulnerable critical facilities are identified in Table 5.1-2 and shown in Figure 5.1-17. Flood damage at any of the identified facilities could require them to close for a period of time if repairs are necessary.

Repetitive Loss

Out of the 93 repetitive loss properties located in Tulsa, nine are located in Council District 1: six residential and three commercial.

Flood Control Projects

Tulsa's floodplain and stormwater program includes comprehensive watershed management, dedicated funds for maintenance and operation, and a $200 million capital improvements program. In Council District 1, many projects have been completed for flood control issues. Figure 5.1-18 displays flood control projects in Council District 1, identified in the 2004 Capital Improvements Plan. Projects included in the 2008-2012 Capital Expenditures Plan that have impacted District 1 are listed in Table 5.1-8.

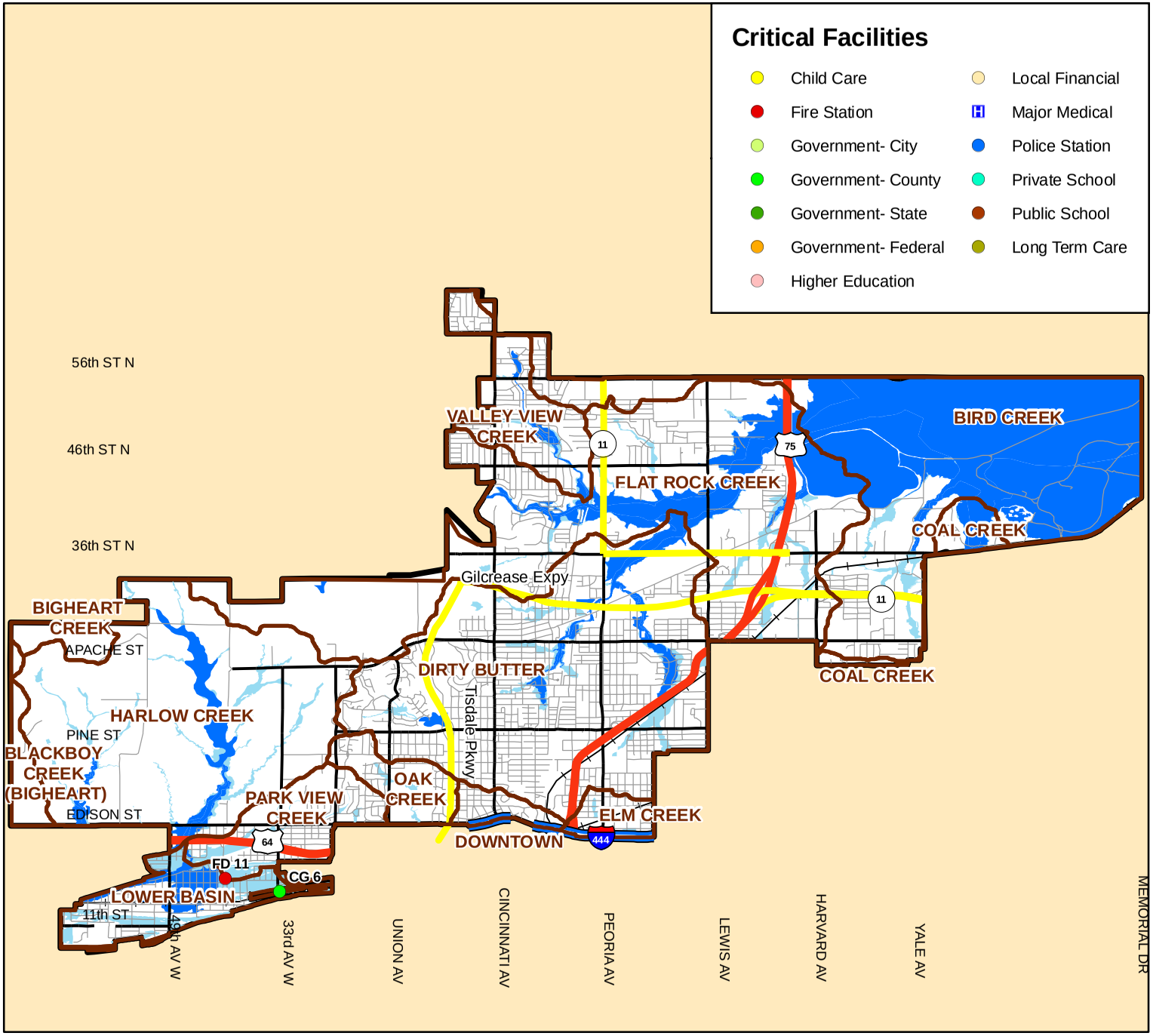
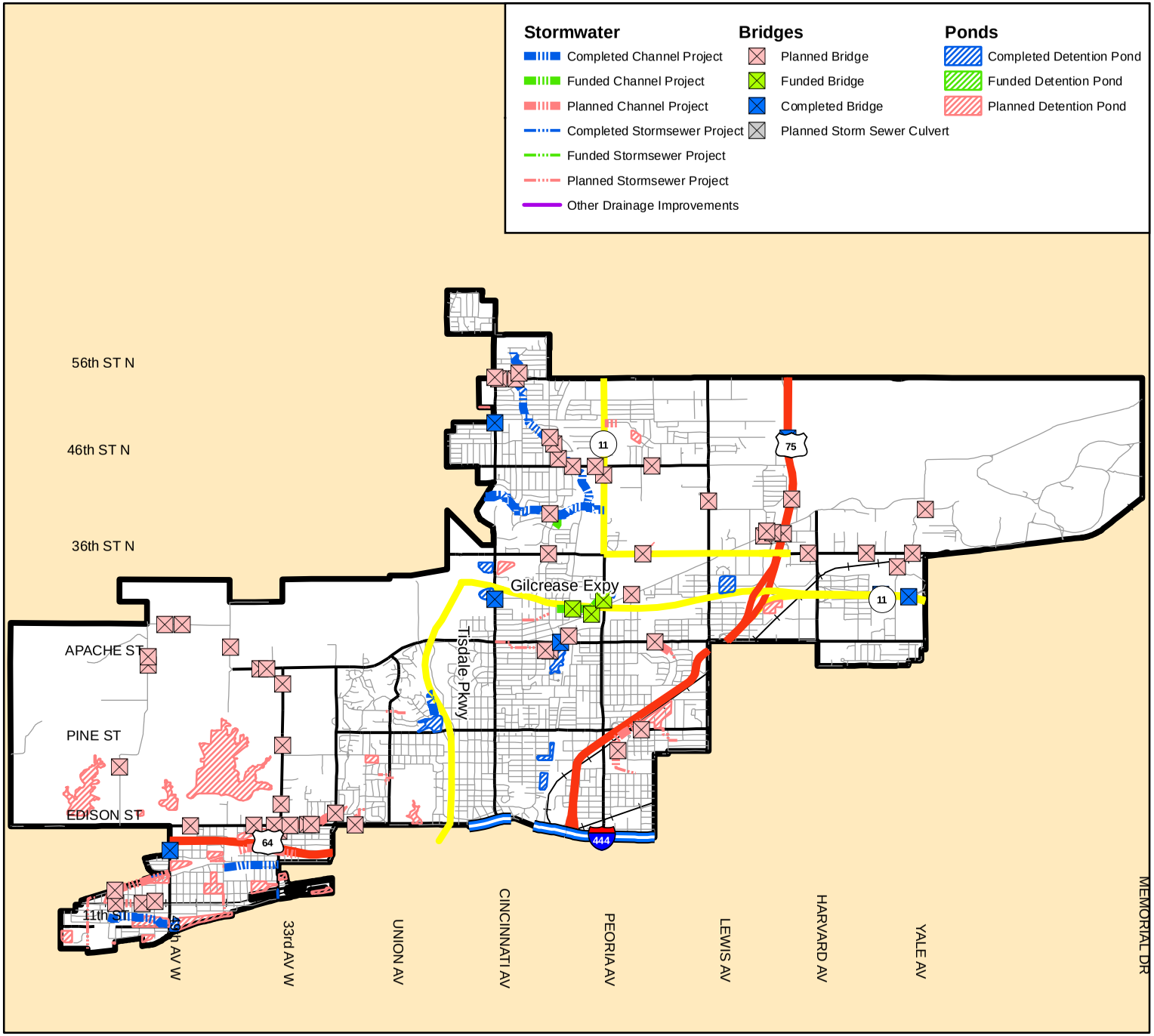


Figure 5.1-17

Tulsa
Council District 1

Drainage Basins & Floodplains



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroads

0 0.5 1 Miles

For more detailed information refer to the Citywide Master Drainage Plan.

Figure 5.1-18

Tulsa Council District 1

Flood Control

Table 5.1–8: Tulsa Council District 1 Flood Control Projects 2008-2012

Project ID	Project Basin and Description	Budget
1	Arkansas River Lower Basin - Storm Sewer & Detention Basin Improvements	$50,620,000
30	Dirty Butter Creek – Channel and Railroad Crossing	$850,000
39	Flat Rock Creek - 3900 N. Lansing Pl. Channel	$1,200,000
40	Flat Rock Creek – 48th Place N. and Hartford Channel & Culvert Improvements	$3,030,000
41	Flat Rock Creek – McLain Detention, 46th Street N. Crossing & Channel	$1,410,000
42	Flat Rock Creek Tributary – 32nd Street N. and Harvard Ave. Drainage Improvements	$660,000
52	Harlow Creek – Levees and Culvert Improvements	$2,760,000
53	Harlow Creek - Culverts and Detention	$13,760,000
75	Oak Creek - Union Avenue Storm Sewers and Channel	$370,000
76	Oak Creek - Roosevelt and Edison St. Detention	$6,220,000
77	Parkview Creek - Central High School Channel	$300,000
79	Parkview Creek - Expressway Storage	$930,000
80	Parkview Creek – Fairway Concrete Channel	$480,000
92	Valley View Creek – Erosion Control and Access	$2,510,000

Source: PLANiTulsa Capital Expenditures Plan 2008-2012

Conclusion

***Tulsa Council District 1 has a HIGH probability of and a HIGH vulnerability to the Flood hazard*.**

5.1.4.2 Dam Failure

Location

District 1 is located downstream of Keystone Lake Dam, Skiatook Lake Dam and the Yahola Reservoir Dam. Approximately 22.18 percent of land in the district is vulnerable to the Dam Failure hazard. A map of the dam inundation areas in District 1 is included in Figure 5.1-19.

Impact/Vulnerability

According to Tulsa and Osage County Assessor Data, there are 2,150 improved parcels located in the dam failure inundation areas of District 1. A summary of the parcels impacted by a break of Keystone Dam, by estimated fair market value and type, is included in Table 5.1-9.

A summary of the parcels impacted a break of Skiatook Dam, with estimated fair market value and type, is included in Table 5.1-10. No improved parcels in District 1 would be impacted by a failure of Yahola Reservoir Dam.

The greatest impact from a dam failure would be from loss of life or serious injury of those in the inundation area, devastating property loss and infrastructure damage and interruption. Affected roadways are likely to be N. Harvard, N. Yale, and N. Memorial, north of East 36th Street N.; US Highway 75 north of E 46th Street N; and US Highway 64 from S 49th W. Avenue to east of N. 33rd Avenue W.

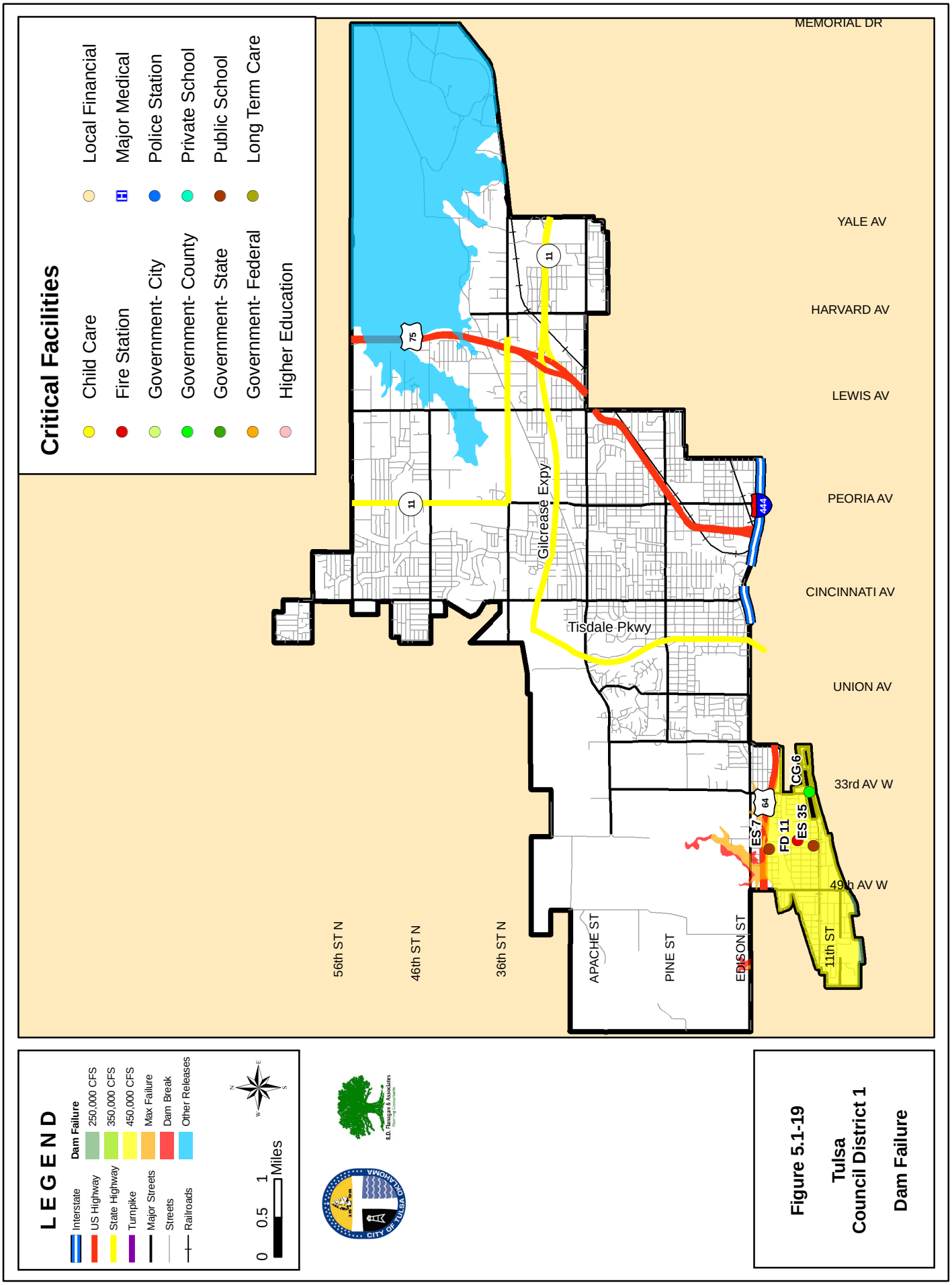

Critical Facilities
Child Care
Fire Station
Government- City
Government- County
Government- State
Government- Federal
Higher Education
Local Financial
Major Medical
Police Station
Private School
Public School
Long Term Care
MEMORIAL DR
YALE AV
HARVARD AV
LEWIS AV
PEORIA AV
CINCINNATI AV
UNION AV
33rd AV W
49th AV W
11th ST
56th ST N
46th ST N
36th ST N
APACHE ST
PINE ST
EDISON ST
Gilcrease Expy
Tisdale Pkwy
11
75
444
64
ES 7
FD 11
ES 35
CG 6
LEGEND
Interstate
US Highway
State Highway
Turnpike
Major Streets
Streets
Railroads
Dam Failure
250,000 CFS
350,000 CFS
450,000 CFS
Max Failure
Dam Break
Other Releases
0
0.5
1
Miles
N
W
E
S
R.D. Flanagan & Associates
Planning Consultants
CITY OF TULSA
Figure 5.1-19
Tulsa
Council District 1
Dam Failure

Table 5.1–9: Tulsa Council District 1 Improved Parcels Keystone Dam Inundation Area

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	1,944	$61,669,835
Residential Multi-Family	7	$179,200
Commercial	60	$3,985,992
Industrial	15	$4,405,800
Other	56	$2,852,641
Total	2,082	$73,093,468

Source: Tulsa and Osage County Assessor Data, 2012

Table 5.1–10: Tulsa Council District 1 Improved Parcels Skiatook Dam Inundation Area

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	63	$2,155,400
Residential Multi-Family	0	$0
Commercial	3	$5,500
Industrial	0	$0
Other	2	$163,130
Total	68	$2,324,030

Source: Tulsa County Assessor Data, 2012

Critical Facilities

Four critical facilities in District 1 are located in the inundation area of Skiatook Dam and Keystone Dam, as indicated in Table 5.1-5 and shown on the map in Figure 5.1-19. Two elementary schools are among the vulnerable facilities; Mohawk Water Treatment Plant is also at risk of impact. Effort should me made to ensure the staff and students are aware of evacuation plans in the event of an extraordinary release from, or failure of, Keystone Dam. Pre-planning is essential at all facilities in the Dam inundation area.

Conclusion

Tulsa Council District 1 has a HIGH vulnerability to and LOW probability of the Dam Failure hazard.

5.1.4.3 Levee Failure

Location

District 1 is located north of the Arkansas River and protected by Levee B. Approximately 4.26 percent of land in the District is vulnerable to failure or overtopping of Levee B. For an in-depth discussion of Levee Failure on the Arkansas River, see Chapter 4 and Section 5.10, Arkansas River Corridor. A map displaying the inundation area of Levee B in Council District 1 is shown in Figure 5.1-20.

Impact/Vulnerability

A failure of Levee B would pose a threat to District 1. Of the total land area in the District, 1.47 square miles is vulnerable to Levee failure. The area of District 1 protected by Levee District 12 includes 2,582 parcels with improvements and 30 critical facilities. The improved parcels at risk have

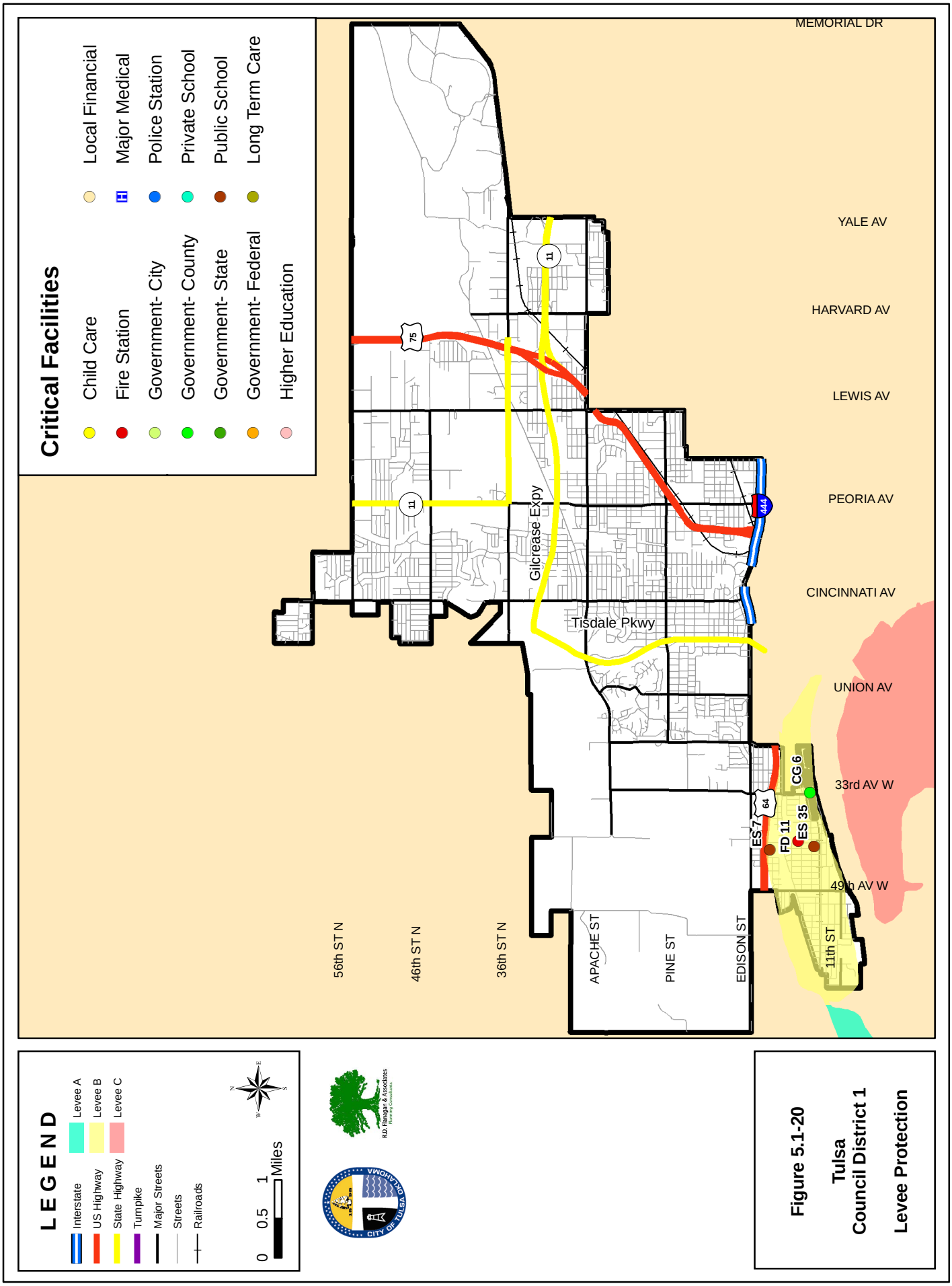


Figure 5.1-20
Tulsa Council District 1
Levee Protection

an estimated value of $74,533,815. The number and values of parcels in the Levee inundation areas are summarized in Table 5.1-11.

Table 5.1–11: Tulsa Council District 1 Improved Parcels in Levee B Inundation Area

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	1,909	$59,246,720
Residential Multi-Family	8 (24 Units)	$214,200
Mobile Home	9	$84,810
Commercial	66	$4,119,612
Industrial	17	$6,500,400
Other	582	$4,452,883
Total	2,582	$74,533,815

Source: Tulsa County Assessor's Office, 2012

The impact of this hazard would be catastrophic to Tulsa Council District 1 due to its close proximity to the Arkansas River, the number of residents living or working in the Levee inundation area, and the value of the built environment in the District. Approximately 10.5 percent of the Districts 44,873 residents are considered to be at risk. Although much depends upon the amount of warning given to residents, people living in the inundation areas of District 1 would have little time to react and evacuate the area, and almost even less opportunity to remove valuable household items and other property. Inundation would likely be six to nine feet in some residential areas.

Critical Facilities

The four critical facilities located in the levee inundation area of District 1 include a Tulsa County Deputy Sheriffs office, a fire department, and two elementary schools. It is especially important to make sure these facilities have evacuation plans in place. Occupants of these facilities at the time of Levee failure are highly exposed to the hazard impacts described in Chapter 4. This is especially true of those unable to evacuate such as functional needs populations in the area. Also of considerable importance are the many storage facilities containing hazardous materials, chemicals and fuels. Pre-planning is essential at all facilities at risk of impact. Table 5.1-5 indicates which critical facilities that would be impacted by the Levee Failure hazard. The facilities are shown in Figure 5.1-20.

Conclusion

Tulsa Council District 1 has a HIGH vulnerability to and a MODERATE probability of the Levee Failure hazard.

5.1.4.4 Expansive Soils

Location

Council District 1 is underlain predominantly by soils with Low to Moderate shrink/swell potential. Highly expansive soils make up about 19 percent of the District. In the south central part of the district, soils with a High shrink/swell potential are primarily between Gilcrease Museum Dr. and N Lewis Avenue, and between E Apache Street to E Admiral Blvd. Highly expansive soils are also common in the northeast, east of US Hwy 75 and Lake Yahola, and north of 36th St. North. Very High expansive soils underlie 2.78 percent of the District, almost all of this in the northeast, east of Lake Yahola in the Bird Creek basin. Table 5.1-12 shows the breakdown of soil types for Council District 1. A map showing the location of the District's expansive soils is presented in Figure 5.1-21.

Table 5.1–12: Tulsa Council District 1 Expansive Soils

Expansion Potential	Area (sq mi)	Percent of Total District Boundaries
Very High	0.96	2.78%
High	6.61	19.14%
Moderate	12.79	37.03%
Low	13.12	37.98%
Water	1.06	3.07%
Total	34.54	100.00%

Impact/Vulnerability

According to data from the Tulsa County Assessors Office, as shown in Table 5.1-13, there are 5,897 Residential Single Family parcels with improvements located on soils with High to Very High shrink/swell potential. The parcels have a value, adjusted for fair market, of $349,581,475.00.

Table 5.1–13: Tulsa Council District 1 Improved Parcels on Highly Expansive Soils

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	5,897	$283,905,642
Residential Multi-Family	88	$3,525,600
Commercial	123	$32,607,019
Industrial	19	$8,172,946
Other	177	$21,370,268
Total	6,304	$349,581,475

Source: Tulsa and Osage County Assessor's Office, 2012

Critical Facilities

There are 15 Critical facilities located on High to Very High expansive soils in District 1. Although it is likely the structures were engineered to account for the soils on which they are built, effort should be made to monitor the facilities for damages and report/repair as necessary. Table 5.1-5 indicates which critical facilities are located on soils with High to Very High shrink/well potential in District 1; a map of these facilities is included in Figure 5.1-21.

Conclusion

Tulsa Council District 1 has a HIGH vulnerability to and HIGH probability of the Expansive Soils hazard.

5.1.4.5 Wildfire

Location

The undeveloped area of the District 1, west of Cincinnati Avenue, south of E 36th Street, and north of E Admiral Avenue; is located in an area of Low Wildfire Level of Concern (LOC). The central area of the District is for the most part urbanized; however, there are areas with Moderate and High Wildfire LOC. In the eastern area of the District, areas of Low Wildfire LOC surround Lake Yahola and Mohawk Park. Approximately 2.52 percent of land, or 0.87 square miles, in District 1 has an 8 or 9 LOC, all of it on small scattered parcels between N. Lewis and N. Cincinnati (east to west), and from E 56th St. N. south to Apache Street. A map displaying the Wildfire LOC of District 1 is shown in Figure 5.1-22.

Impact/Vulnerability

The Wildfire LOC Index indicates the areas of District 1 most vulnerable to the Wildfire hazard to be located throughout the north-central area of the District, with areas of greatest concern located primarily north to south from E 56th St North to E Apache Street, and east to west from N Lewis Avenue to N Cincinnati Avenue. The area of the District north of E 56th Street towards Turley, OK is partially covered by Moderate and High Wildfire LOC. This part of the District was narrowly missed by the August 2011 urban fringe fire in Turley, which burned all the way up to the District boundary line at E 56th Street N. and N. Peoria Avenue.

Additionally, District 1 has a heightened exposure to the wildfire hazard due to the large area of unoccupied land that meets with developed areas on the urban fringe, also known as the Wildland Urban Interface (WUI). Though not indicated as having a high wildfire susceptibility on the map, as explained in Chapter 4, WUI areas are prone to wildfires, especially vulnerable during periods of extreme heat and drought. According to Tulsa County Assessors data, 352 parcels with improvements are located in areas of Moderate to Very High Wildfire LOC. These are summarized in Table 5.1-14, along with their fair market value and type.

Table 5.1–14: Tulsa Council District 1 Wildfire Level of Concern

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	313	$9,275,381
Residential Multi-Family	2	$1,643,400
Commercial	21	$1,581,300
Industrial	0	$0
Other	16	$2,186,863
Total	352	$14,686,944

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Three critical facilities in Council District 1 are located in areas with Moderate to High Wildfire LOC. Though a wildfire is not likely to impact the urban areas of Tulsa, grasses and low lying shrubs around the facilities should be well maintained. For a list of critical facilities located in areas of Moderate to High Wildfire LOC, see Table 5.1-5.

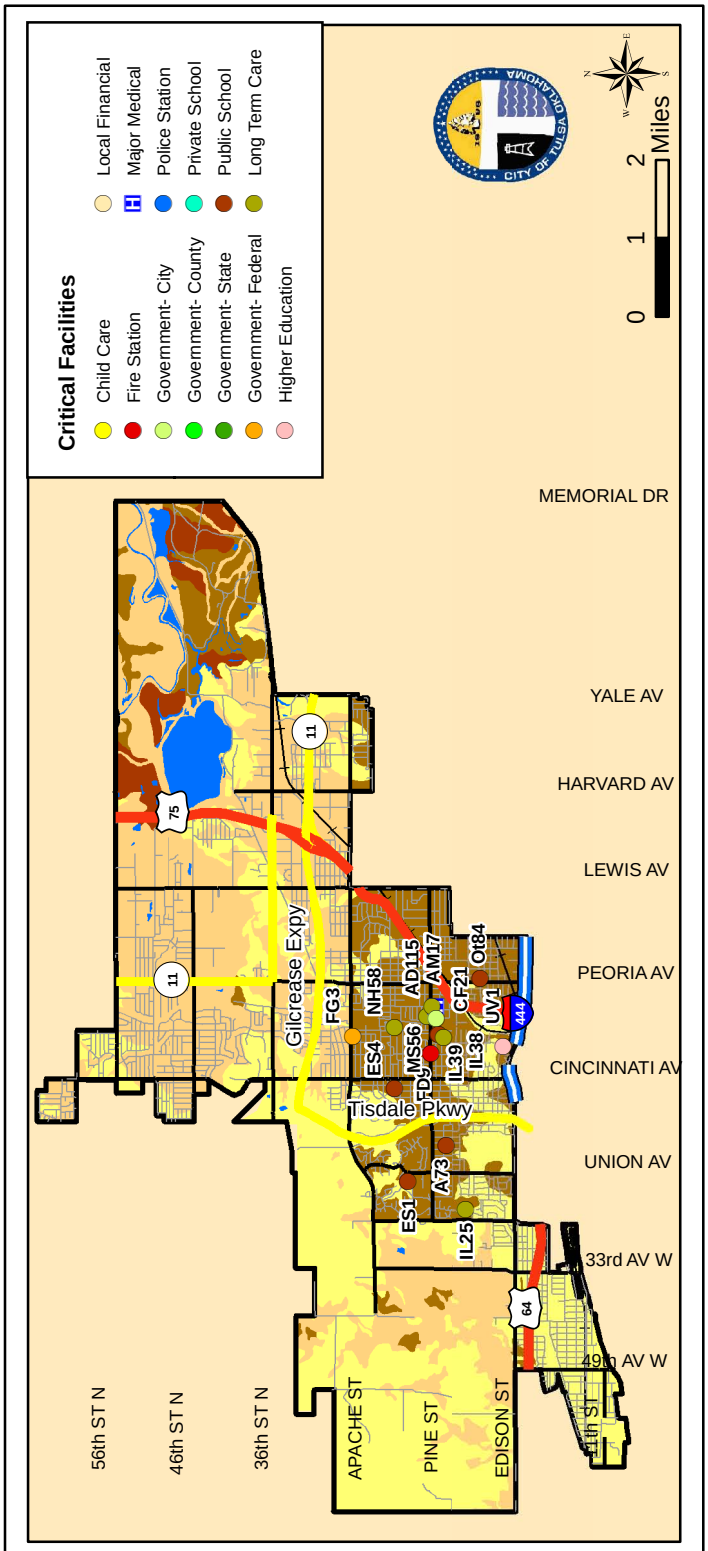
Conclusion

Tulsa Council District 1 is considered to have a MODERATE vulnerability to and MODERATE probability of the Wildfire hazard.

5.1.4.6 Fixed-Site Hazardous Materials

Location

There are 33 Tier II facilities within the boundaries of Tulsa Council District 1. Of the 33 sites, 12 contain Extremely Hazardous Substances (EHS). Due to the sensitive nature of this material, Tier II facilities in the District are mapped in Figure 5.1-23 to show only the approximate location of the sites. A listing of EHS and Non-EHS Tier II facilities in Council District 1 can be found in Appendix E, and is available on a need-to-know basis.



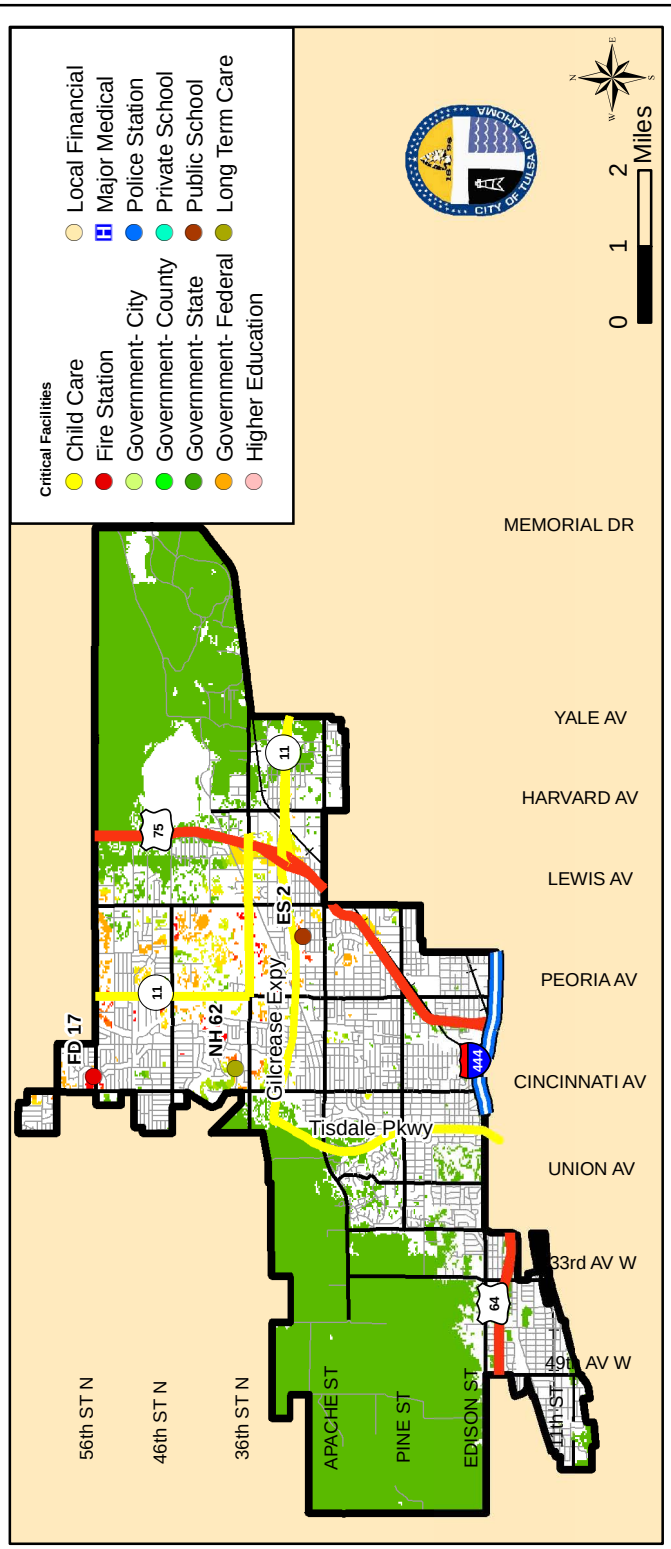
LEGEND

Interstate
US Highway
State Highway
Turnpike
Major Streets
N_S_Streets
Streets
Railroads

Expansive Soils
Low
Moderate
High
Very High
Water

R.D. Flanagan & Associates

Figure 5.1-21
Tulsa
Council District 1
Expansive Soils



LEGEND

Interstate
US Highway
State Highway
Turnpike
Major Streets
Streets
Railroads

Level of Concern
0
1
2
3
4
5
6
7
8
9

R.D. Flanagan & Associates

Figure 5.1-22
Tulsa
Council District 1
Wildfire Level of Concern Index

Impact/Vulnerability

According to the Marplot analysis, which uses 2010 US Census data, 4,861 people living or working in Council District 1 are vulnerable to the impacts of this hazard, as described in Chapter 4. Information regarding the number and type of improved parcels located within ¼ mile of a Tier II facility, along with their fair market value, is included in Table 5.1-15.

Table 5.1–15: Tulsa Council District 1 Buildings Located within ¼ Mile Tier II Site

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	1,915	$80,027,910
Residential Multi-Family	24	$1,660,500
Commercial	126	$22,463,584
Industrial	43	$21,963,246
Other	181	$23,147,142
Total	2,289	$149,262,382

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

12 critical facilities in Council District 1 are located within ¼ mile of a Tier II facility. Though structures are not likely to be impacted themselves, populations at the facilities are at high risk of being impacted if a hazardous materials event were to occur. Of high concern are the childcare, school, and long term care facilities in ¼ mile buffer of Council District 1's fixed-sites. Pre-planning is critical at these facilities. Effort should be made to ensure proper evacuation or shelter in place procedures are in place. A list of District 1 critical facilities located within ¼ mile of a Tier II facility is provided in Table 5.1-5.

Conclusion

Tulsa Council District 1 is considered to have a HIGH vulnerability to and MODERATE probability of a fixed-site hazardous materials release.

5.1.4.7 Transportation-Hazardous Materials

Location

Five significant transportation corridors cross Council District 1: Interstate 244, which runs briefly along the south-central boundary line of the District; US Highway 75, which passes roughly north to south west through the center of the district; US Highway 64, which travels east to west through the far southwest corner of the district; and State Highway 11 which briefly connects with US Highway 75 before heading eastward. Two railroads pass through District 1, entering at the south-central edge of the district and running northeast to exit at 36th Street N and Yale Ave. A map showing the transportation corridors in District 1 is included in Figure 5.1-24.

Impact/Vulnerability

A ¼-mile transportation buffer for the five transportation corridors encompasses 30.49 percent of Council District 1 (or 10.53 sq. mi.). According to 2010 US Census data, 6,915 residents live within ¼ mile of the Highway corridor, and 4,536 reside within ¼ mile of the Railroad. There are 3,314 parcels in District 1 located within ¼ mile of a major highway or interstate, with a total assessed value, adjusted for fair market price, of $164,901,735, summarized in Table 5.1-16.

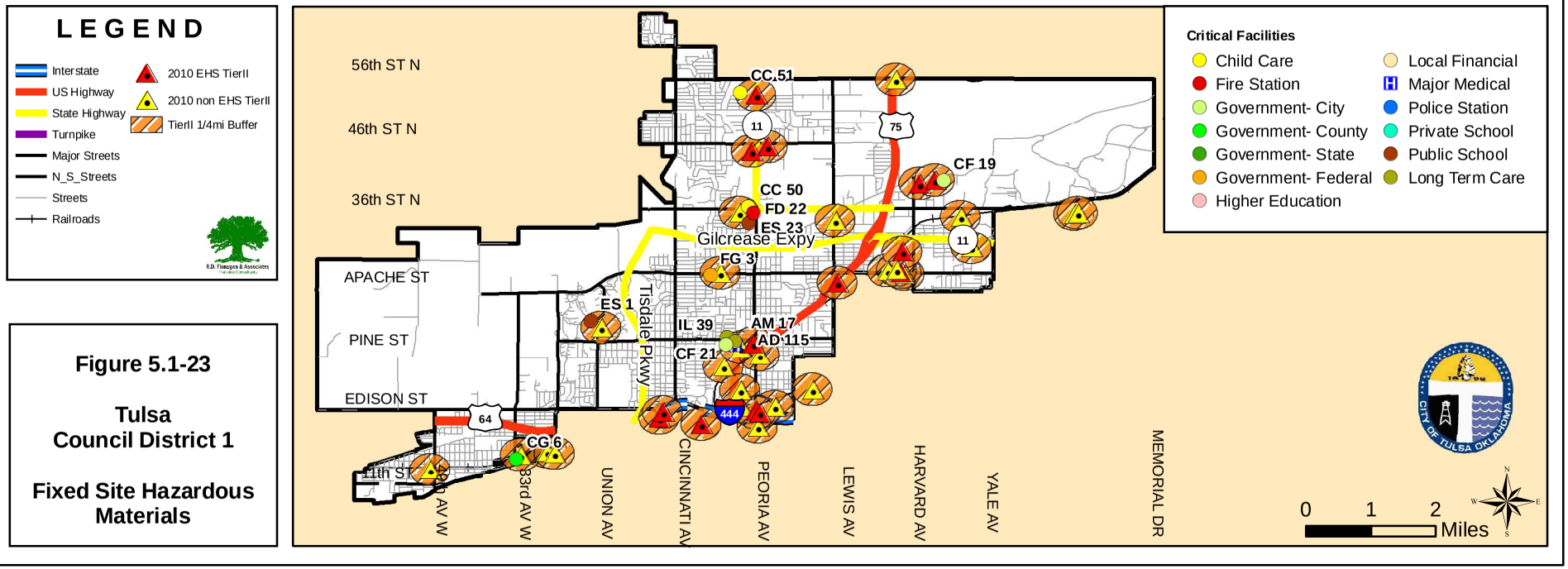


Figure 5.1-23

Tulsa Council District 1

Fixed Site Hazardous Materials

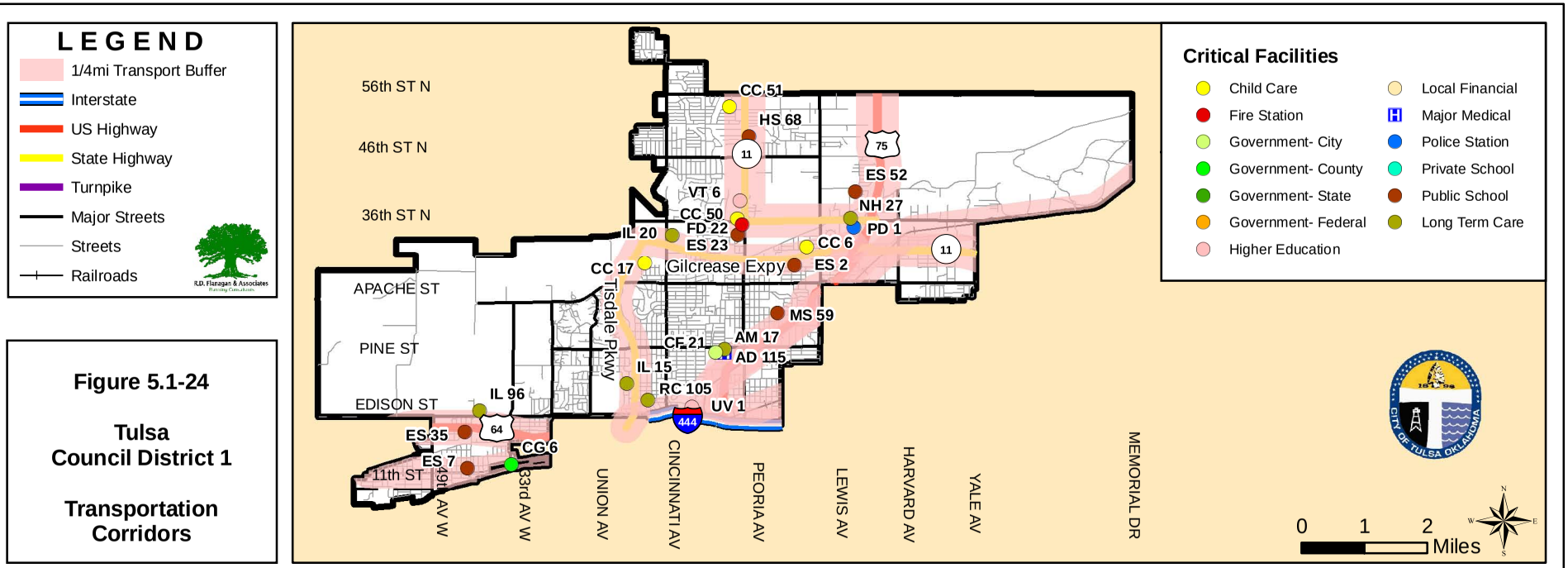


Figure 5.1-24

Tulsa Council District 1

Transportation Corridors

Table 5.1–16: Tulsa Council District 1 Parcels Touched by ¼ mile Highway Corridor

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	4,139	$133,586,933
Residential Multi-Family	51	$5,180,000
Commercial	198	$36,934,697
Industrial	32	$13,086,346
Other	174	$27,193,539
Total	4,594	$215,981,515

Source: Tulsa County Assessor's Office, 2012

There are 2,481 parcels in District 1 located within ¼ mile of a rail line, with a total assessed value, adjusted for fair market price, of $117,032,365. These are summarized by type and value in Table 5.1-17.

Table 5.1–17: Tulsa Council District 1 Parcels Touched by ¼ mile Railroad Corridor

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	2,128	$59,377,257
Residential Multi-Family	25	$695,300
Commercial	116	$16,994,652
Industrial	42	$18,371,746
Other	170	$21,593,410
Total	2,481	$117,032,365

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

24 critical facilities in Council District 1 are located within ¼-mile of a transportation corridor. Although the structures themselves are not likely to be directly impacted by this hazard, persons living or working within these facilities do have a heightened vulnerability. Of particular concern are those facilities that house functional needs populations, such as education facilities, long-term care facilities, and eldercare facilities. A transportation incident involving hazardous materials would likely require that people living or working in these facilities either shelter in place or evacuate. A list of critical facilities vulnerable to the Transportation hazard is included in Table 5.1-5 and mapped in Figure 5.1-24.

Conclusion

Tulsa Council District 1 has a HIGH vulnerability to and MODERATE probability of the Transportation hazard.

5.1.4.8 Hazards Summary

Site-specific hazards, unique to District 1, identified and mapped in this section, include Floods, Dam Failures, Levee Failures, Expansive Soils, Wildfires, Fixed-Site Hazardous Materials, and Transportation-Hazardous Materials. In total, the site-specific hazards impact 34.54 square miles of Tulsa Council District 1. The Hazards Composite Map, shown in Figure 5.1-25, summarizes the areas of the district potentially impacted by these site-specific hazards.

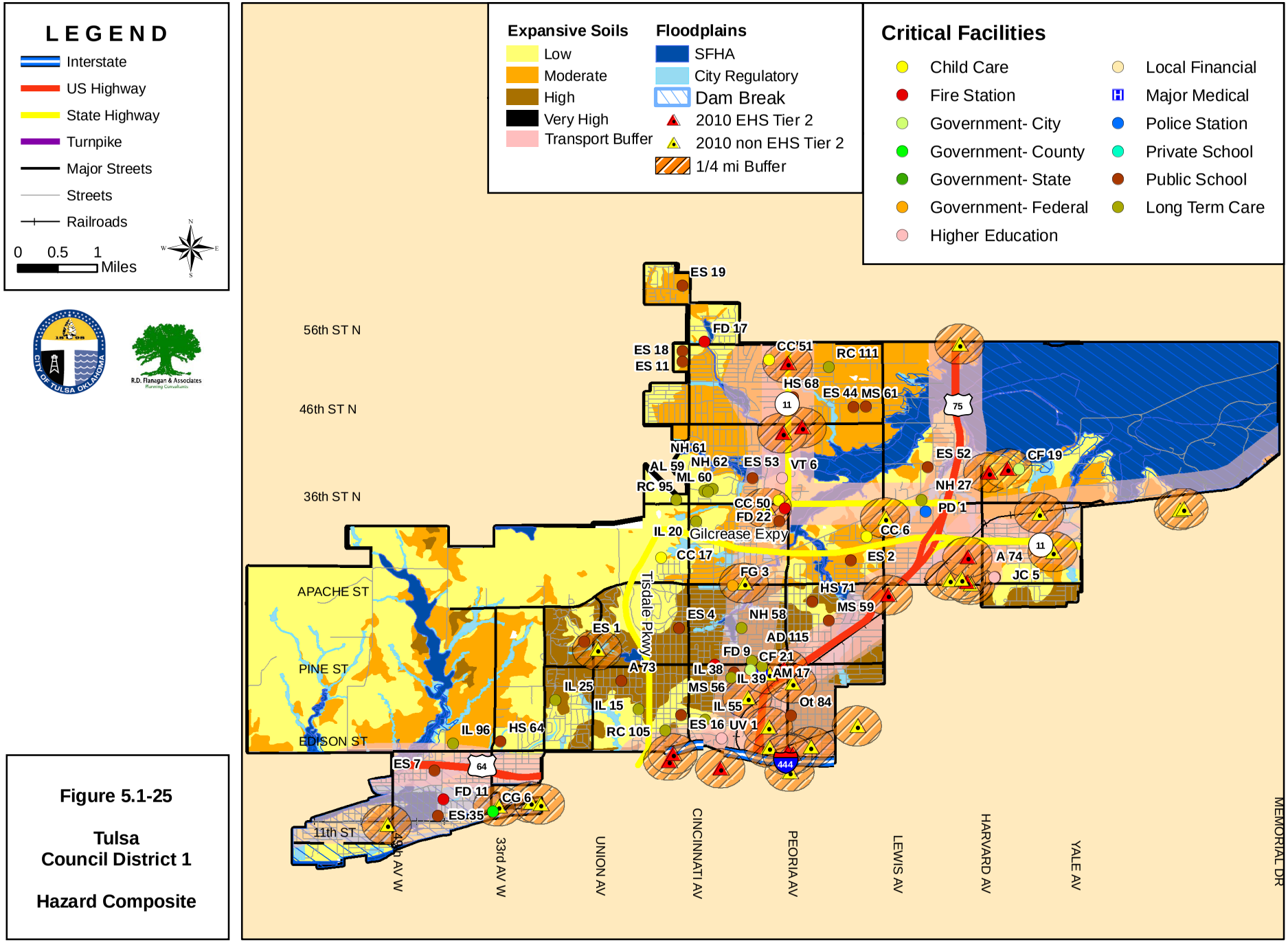


Figure 5.1-25

Tulsa Council District 1

Hazard Composite

City of Tulsa Multi-Hazard Mitigation Plan Update

Tulsa City Council District 2

R.D. Flanagan & Associates

Planning Consultants

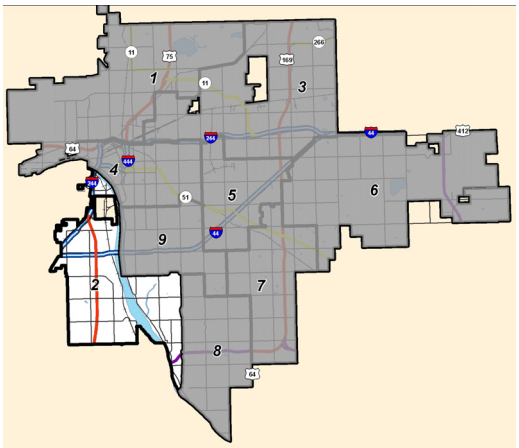
5.2 Tulsa City Council District 2

5.2.1 Introduction

5.2.1.1 Location

Council District 2 is located in southwest Tulsa, shown in the Locator Map, Figure 5.2-1. Total land area within District 2 consists of approximately 23.41 sq mi., as shown in the District 2 Base Map in Figure 5.2-2. The district is bounded generally on the north where I-244 crosses the Arkansas River, the east by Riverside Drive and S Harvard Avenue, the south by W 91st Street, and the west by S 33rd Avenue West.

Figure 5.2–1: Tulsa Locator Map – District 2



5.2.1.2 Jeannie Cue-Councilor District 2

Councilor Jeannie Cue is a third generation Tulsan. She was born in Tulsa in 1954 and grew up in southwest area of the city. Councilor Cue attended Webster High School and Tulsa Community College, where she earned her nursing degree. She has worked around the country at many hospitals, but retired after 19 years at Hillcrest Medical Center and American Airlines. Councilor Cue has been involved in her community for the last 40 years in various activities and organizations. This started with being extensively involved with PTA while her sons were in Tulsa Public Schools. She is currently a member at Trinity Baptist Church and participates in several metro and community organizations.
(Source: http://www.tulsacouncil.org/)

Councilor Jeannie Cue

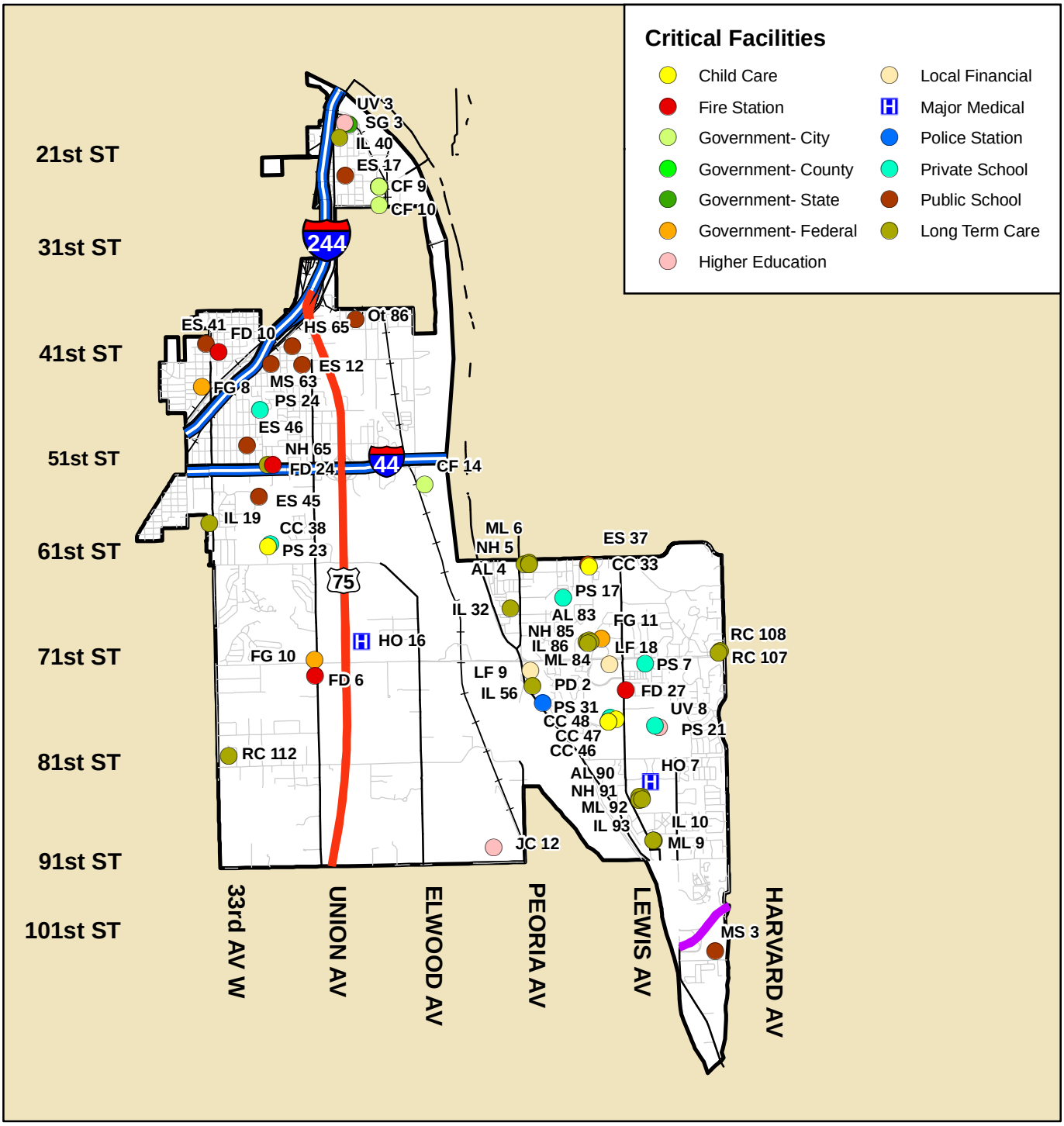
5.2.1.3 History

Cultural and Historic Properties

Tulsa Council District 2 is home to four cultural sites including: Oral Roberts University, Sherwin Miller Museum of Jewish Art, Webster High School, and Zarrow Regional Library; all of which are shown on the map in Figure 5.2-3. There was formerly one historic structure located in District 2; the 66 Motel at 3660 Southwest Boulevard. The motel was demolished on June 26, 2001. It was listed in the National Register of Historic Places on December 13, 1996, under the Register's Criteria A and C, and its NRIS is 96001487.

5.2.1.4 Demographics

Council District 2 had a 2010 US Census population of 11,028. A map displaying population density of District 2 is shown in Figure 5.2-4. Table 5.2-1 includes the demographic makeup of the District. Maps presenting the demographic information listed in Table 5.2-1 are included in Figures 5.2-5 through 5.2-12.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad

0 1 2 Miles

N W E S

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Figure 5.2-2

Tulsa Council District 2

Basemap

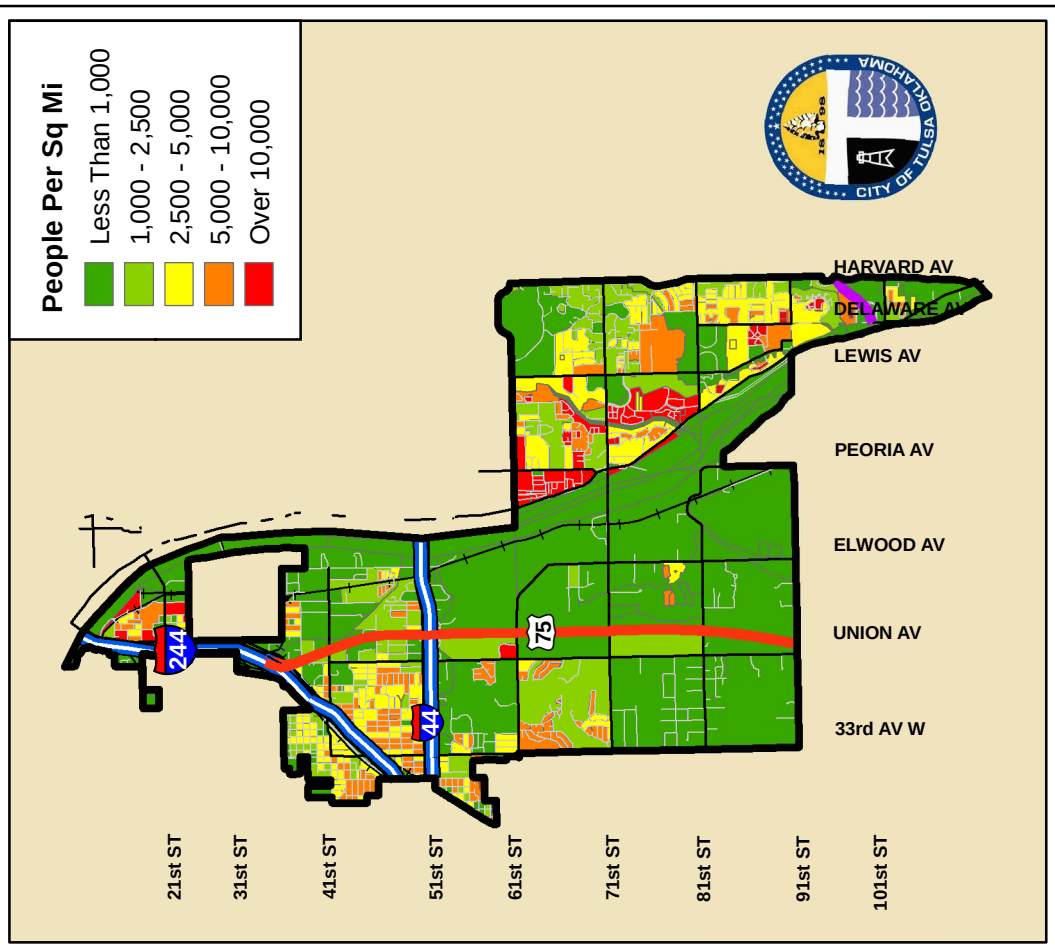
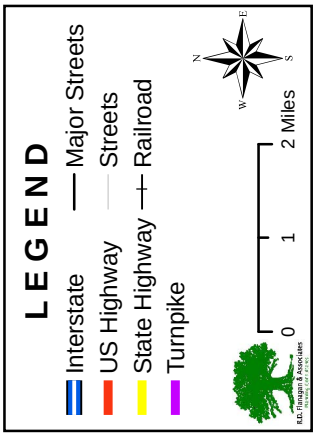


Figure 5.2-4

Tulsa Council District 2

Population Density



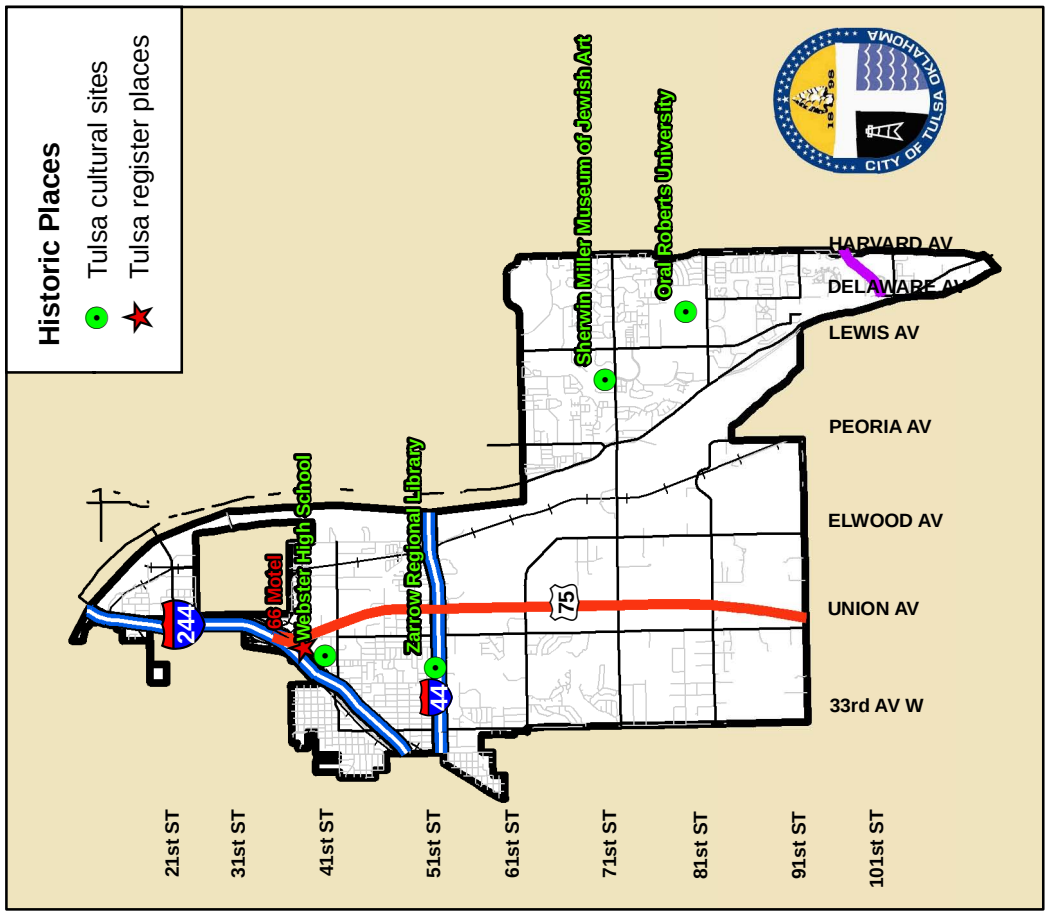


Figure 5.2-3

Tulsa Council District 2

Cultural and Historic Places

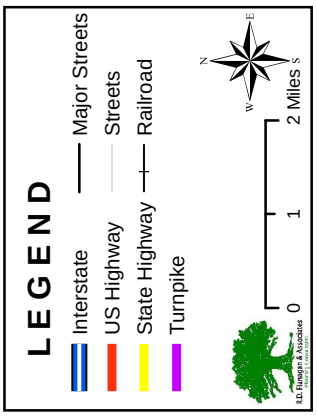


Table 5.2–1: Tulsa Council District 2 Demographic Information

Category	District	Tulsa
Persons under 5 years of age	8.05%	7.53%
Persons under age 18	23.73%	24.44%
Persons age 65 and older	11.55%	12.46%
Poverty Status in 2010 (individuals)	22.35%	19.36%
White	64.40%	62.81%
Native-American	6.21%	5.35%
African American	14.44%	15.67%
Asian	3.26%	2.39%
Hispanic	10.18%	13.93%
Total Population	45,525	401,265

Source: US Census, 2010

5.2.1.5 Infrastructure

Tulsa Council District 2 is dependent upon the lifelines of the City of Tulsa identified in Section 1.2.6 of this Plan Update. Any unique vulnerabilities of Tulsa Council District 2 in relation to the six site-specific hazards identified in this plan are addressed in 5.2.4, below.

5.2.1.6 Economy

The 2010 Census identified an income level of approximately $22,133 as the average poverty threshold for a family of four, including two children. Approximately 10,176 individuals, or 22.4% of all persons in District 2, were living below the poverty line in 2010.

5.2.1.7 Development

According to the Tulsa County Assessor's Office, there are 11,028 properties with improvements within District 2, with a total assessed value, adjusted for fair market value, of $1,735,119,146. The numbers of properties with improvements (buildings, garages, pools, storage, etc.) and improvement values, by type, are shown in Table 5.2-2. No land, contents or tax-exempt values are included. There are 38 homeowners associations located in District 2, as shown in Figure 5.2-13. There are no neighborhoods zoned for Historic Preservation in District 2.

Table 5.2–2: Tulsa Council District 2 Property Types by Assessed Values

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	10,052	$1,010,796,051
Residential Multi-Family	259	$148,089,334
Commercial	463	$442,397,759
Industrial	50	$39,141,093
Other	204	$94,694,909.00
Total	11,028	$1,735,119,146

Source: Tulsa County Assessor's Office, 2012

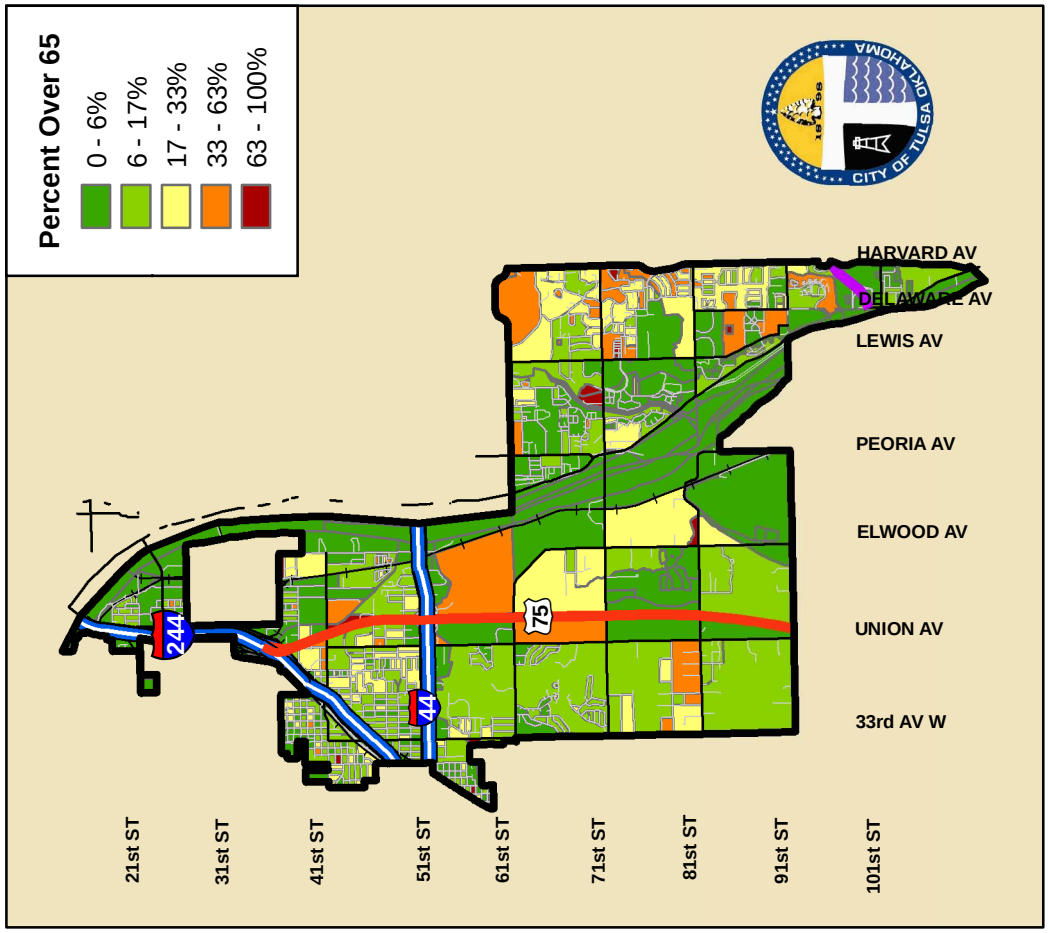
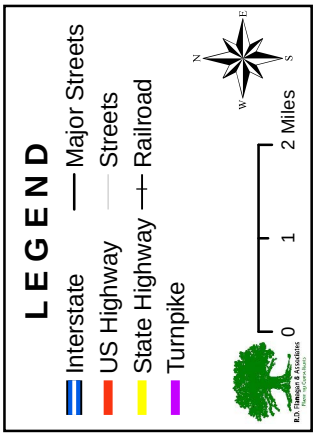


Figure 5.2-6

Tulsa Council District 2

Percent of Population Age 65 and Older



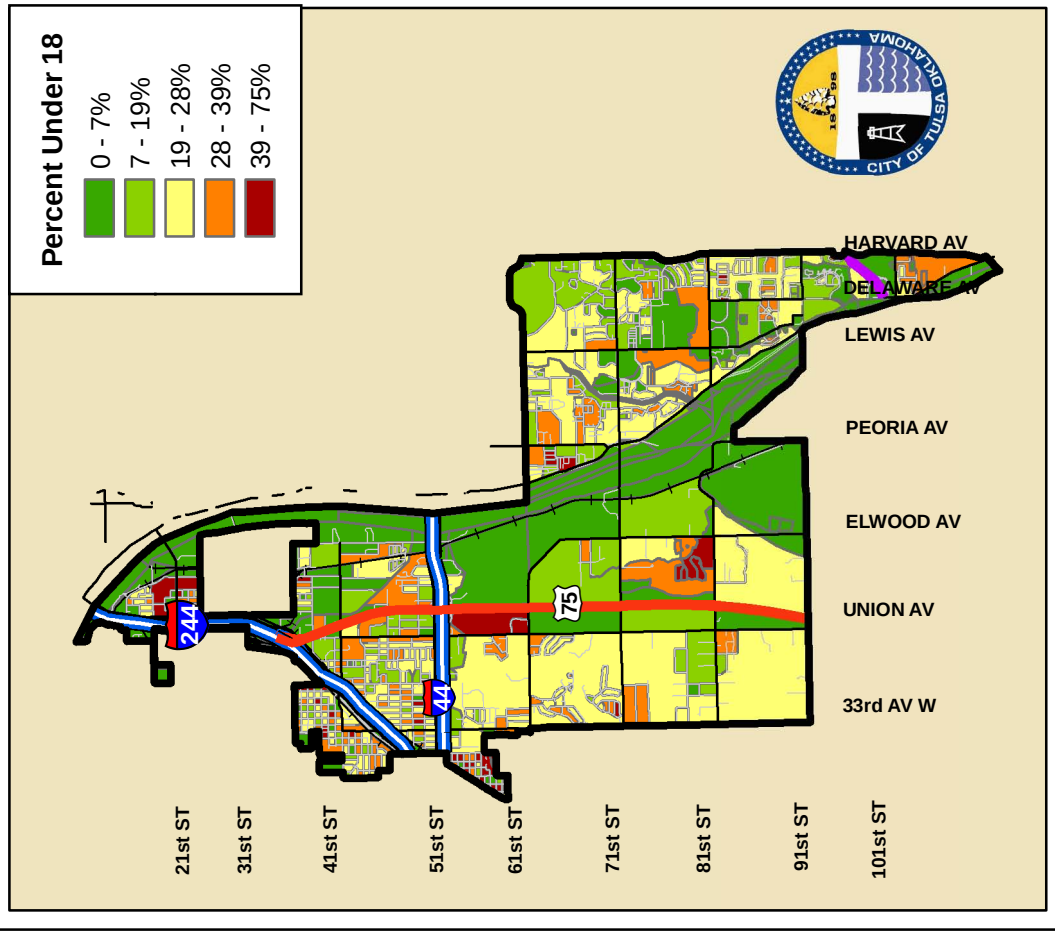
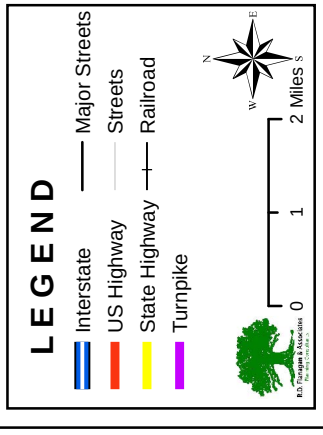


Figure 5.2-5

Tulsa Council District 2

Percent of Population Under Age 18



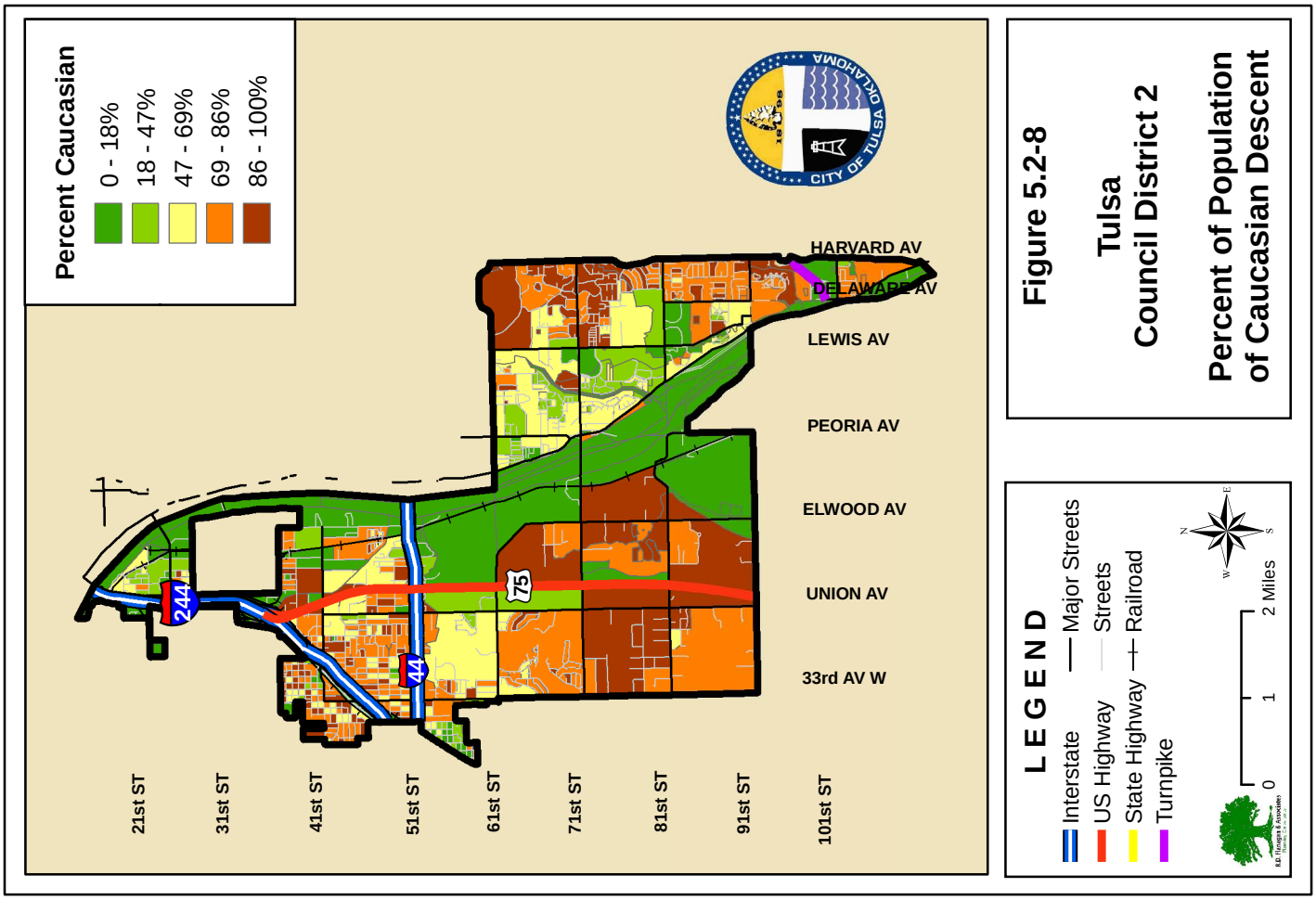


Figure 5.2-8

Tulsa Council District 2

Percent of Population of Caucasian Descent

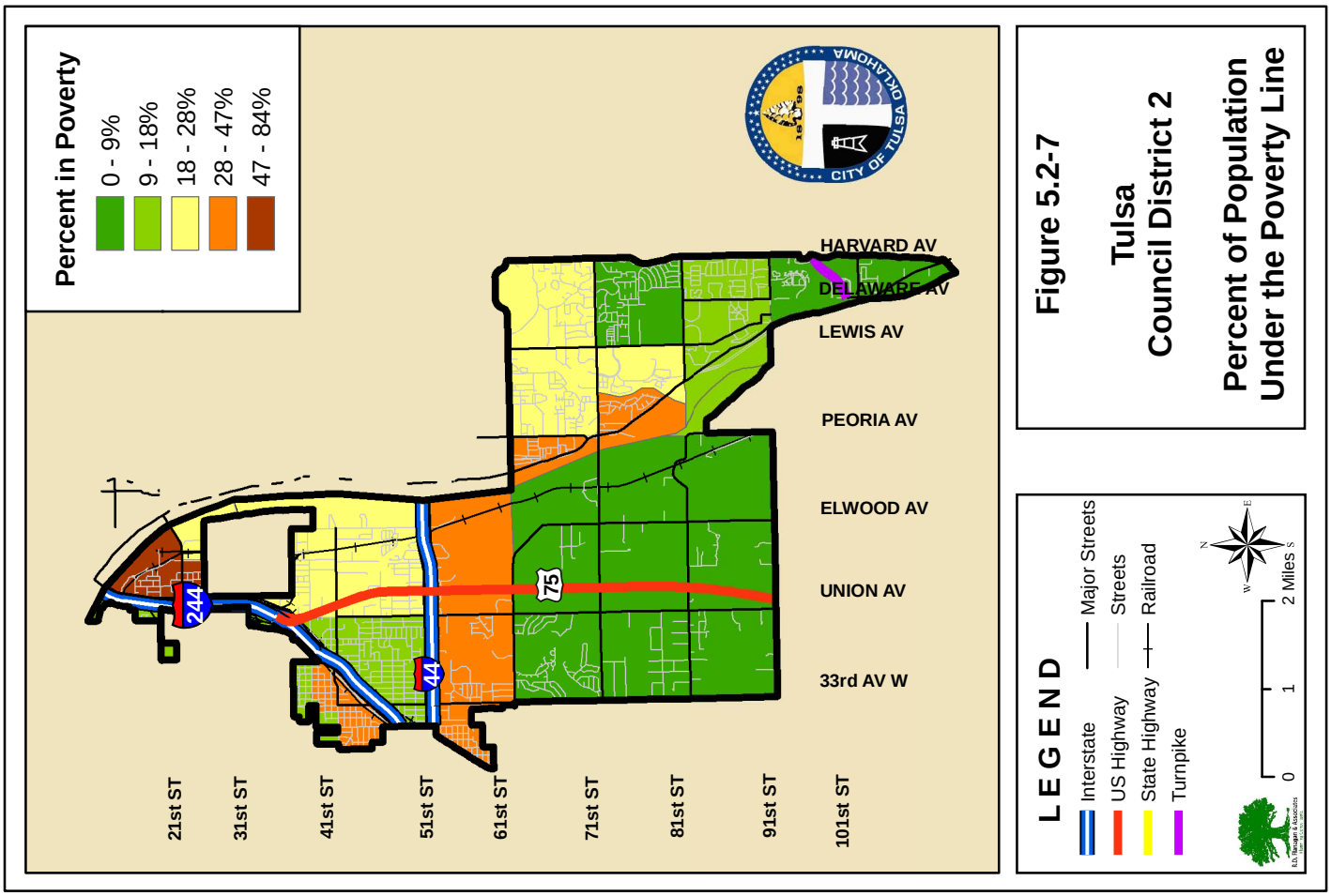


Figure 5.2-7

Tulsa Council District 2

Percent of Population Under the Poverty Line

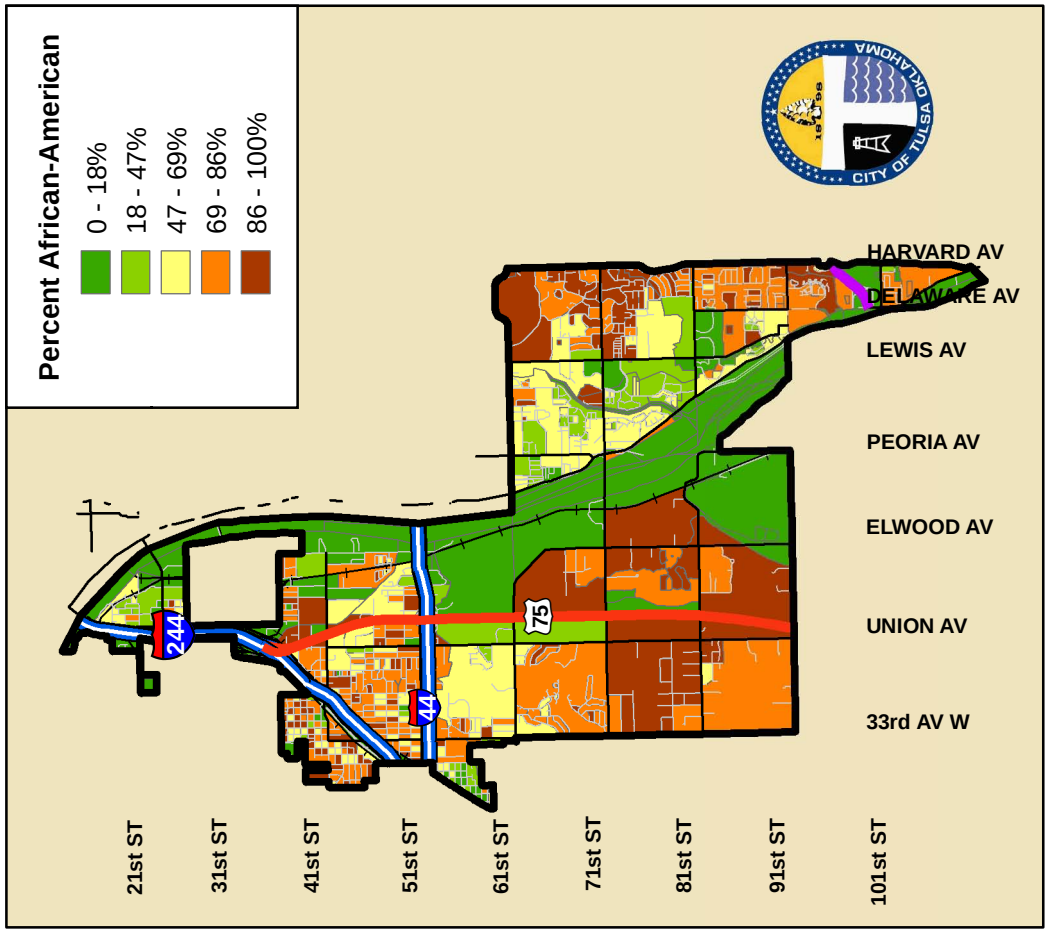


Figure 5.2-10

Tulsa Council District 2

Percent of Population of African-American Descent

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad

0 1 2 Miles

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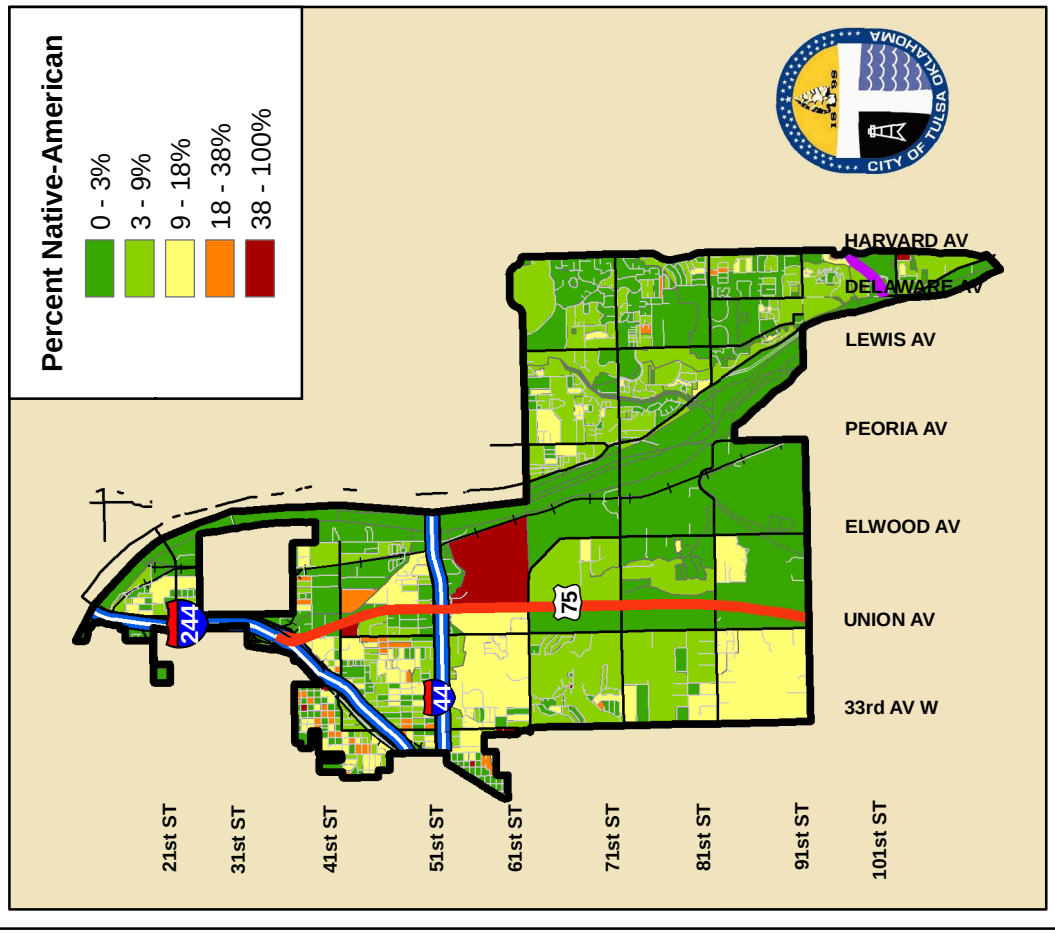

Figure 5.2-9

Tulsa Council District 2

Percent of Population of Native-American Descent

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad

0 1 2 Miles

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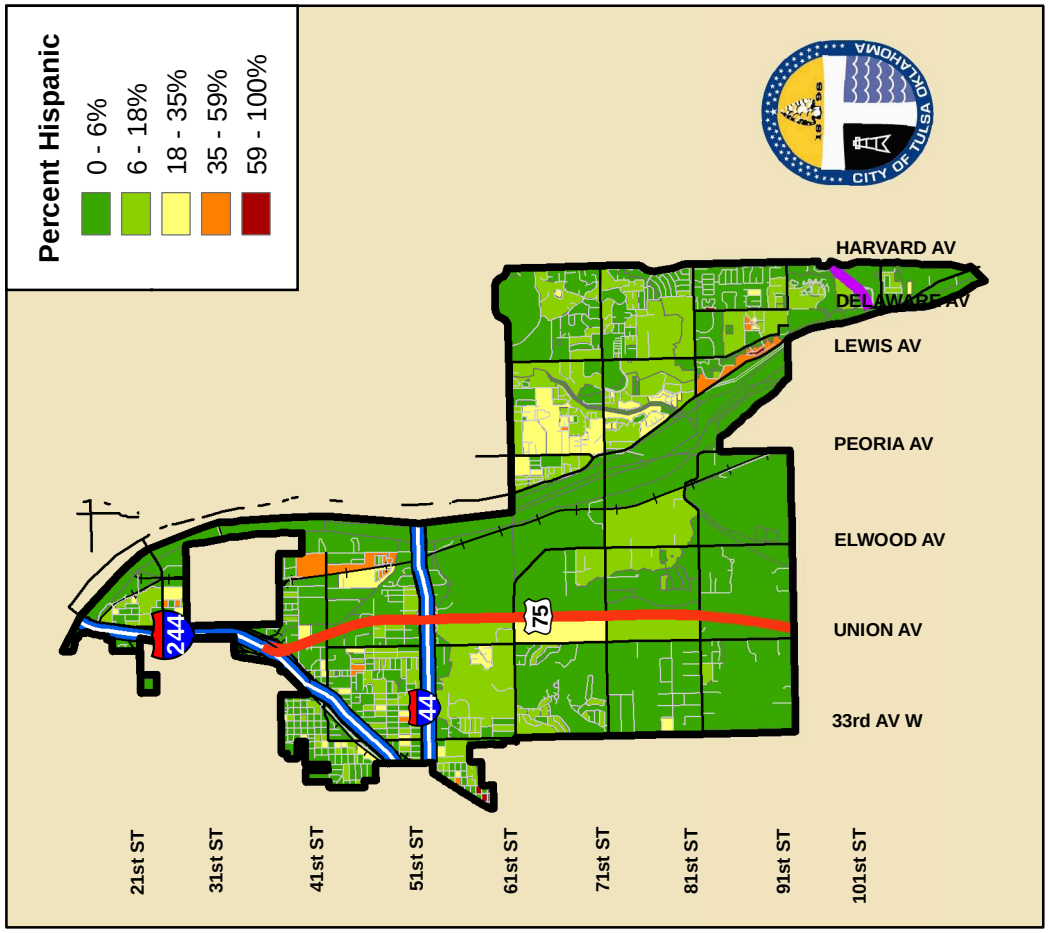

Figure 5.2-12

Tulsa Council District 2

Percent of Population of Hispanic Descent

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad

0 1 2 Miles

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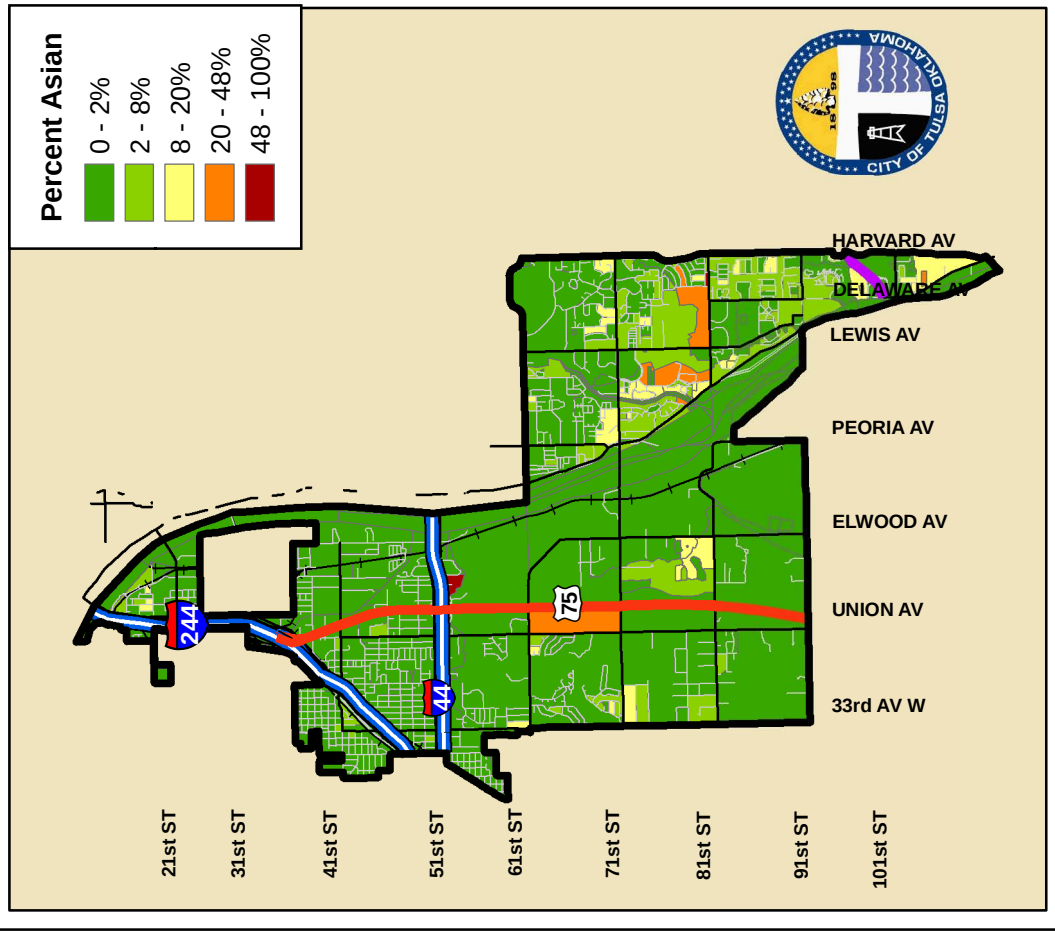

Figure 5.2-11

Tulsa Council District 2

Percent of Population of Asian Descent

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad

0 1 2 Miles

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Zoning

For the purpose of this plan, five of the 29 zoning districts—Agricultural, Single- Family Residential, Multi-Family Residential, Commercial, and Industrial—were used to show zoning within District 2. Much of the land area in District 2 is zoned for residential usage. The few areas zoned for commercial are located mostly in the western area of the District. Industrial zoning is predominately located around the northern edge of the District. Zoning in Council District 2 is displayed in Figure 5.2-14.

Future Development

The *PLANiTULSA 2010 Tulsa Vision Plan* lists the area centered near the intersection of Southwest Boulevard and West 41st Street, on the west side of the Arkansas River as an area of future development. This area includes Red Fork Main Street, Tulsa's first participant in the national Main Street program. The community is rich in local history and was the focus of planning and revitalization efforts before the PLANiTulsa process. The focus of this area will be to accommodate new development and some infill housing while maintaining the character of the neighborhood. Under the Vision, this neighborhood will evolve around its historic main street along the northern stretch of Southwest Boulevard and West 41st Street.

The City of Tulsa will continue to improve District 2's service infrastructures, such as flood control, water, sanitary sewer, and streets.

5.2.1.8 Critical Facilities

Table 5.2-3 lists the locations of District 2's Critical Facilities, which are shown in Figure 5.2-2.

Table 5.2–3: Tulsa Council District 2 Critical Facilities

ID	Map ID	Facility Name	Address
		Government-City	
CF	9	Field Customer Services	2445 S Jackson Ave
CF	10	Chemical Storage Building	2317 S Jackson Ave
CF	10	Fuel Facility	2317 S Jackson Ave
CF	10	Portable Building	2317 S Jackson Ave
CF	10	Storage Shed	2317 S Jackson Ave
CF	10	Surplus Facility	2317 S Jackson Ave
CF	10	Tire Shop	2317 S Jackson Ave
CF	10	W&M South Yard Storage Building	2317 S Jackson Ave
CF	10	W&M South Yard Office/stock Building	2317 S Jackson Ave
CF	10	Warehouse/Materials Stockroom	2317 S Jackson Ave
CF	14	Southside Water Treatment Plant	5300 S Elwood Ave
		Police Station	
PD	2	Tulsa Police Station (Southwest Div)	7515 Riverside Pkwy
		Fire Station	
FD	6	Tulsa Fire Department #6/ Hazardous Materials	7212 S Union Ave.
FD	10	Tulsa Fire Department #12	3123 W 40th St
FD	24	Tulsa Fire Department #26	2404 W 51st St
FD	27	Tulsa Fire Department #29	7429 S Lewis Ave.
		Government- State	
SG	3	Medical Examiner	1115 W 17th St.

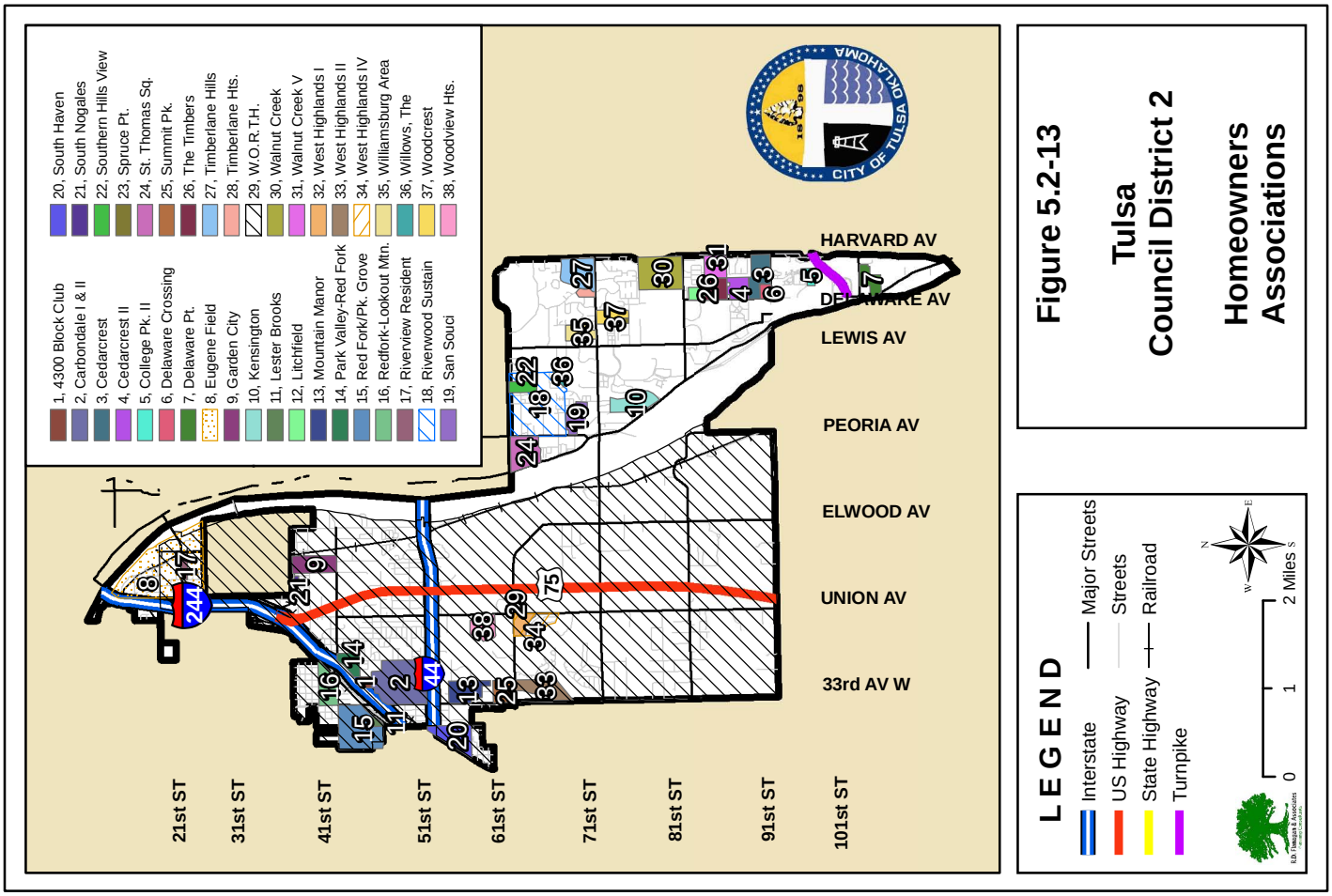


Figure 5.2-13
Tulsa Council District 2
Homeowners Associations

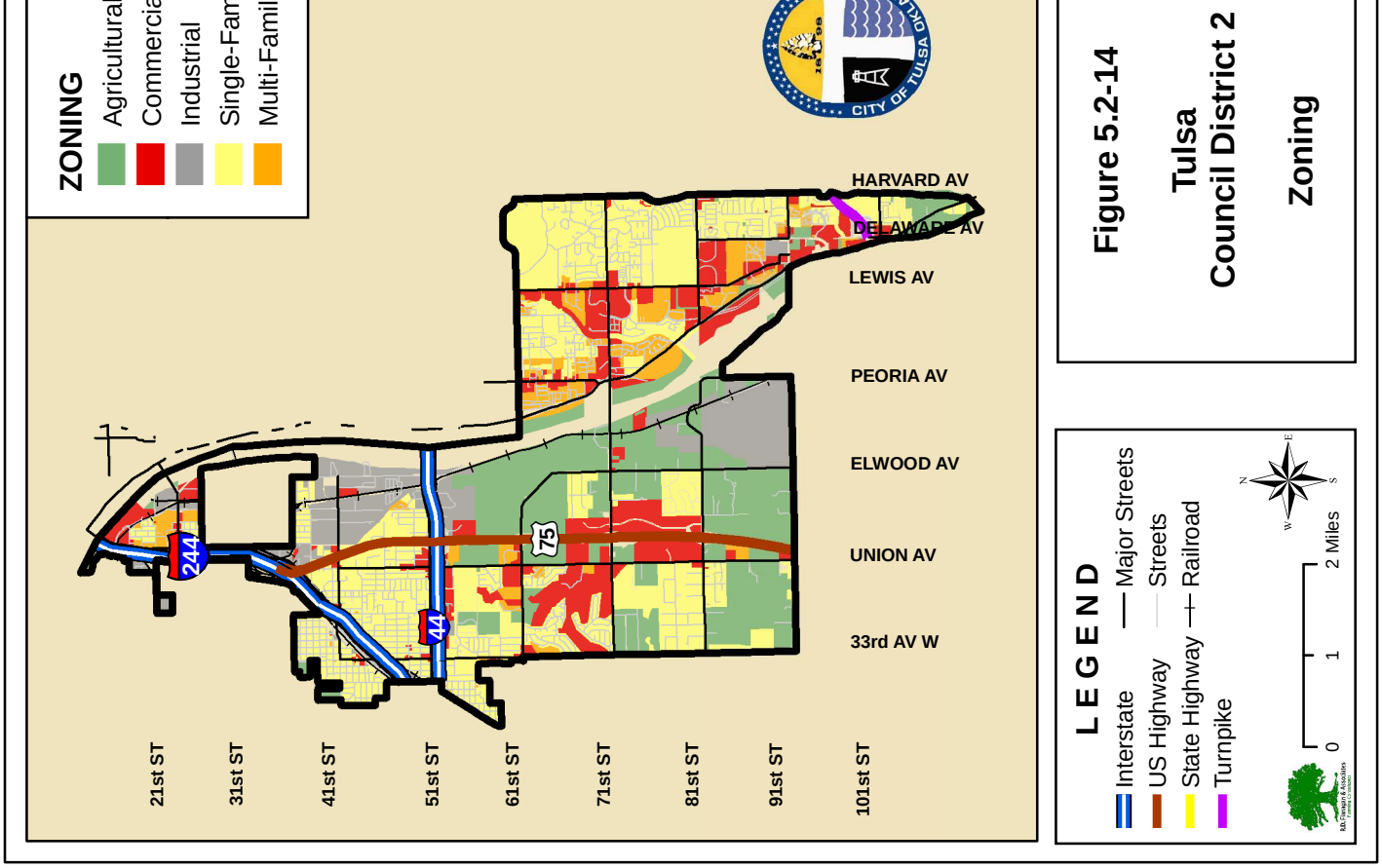


Figure 5.2-14
Tulsa Council District 2
Zoning

ID	Map ID	Facility Name	Address
Government- Federal			
FG	8	USPS - Westside Post Office	3408 W 42nd Pl.
FG	10	Post Office - CPU American Heritage Bank	7042 S Union Ave.
FG	11	USPS - Robert Jenkins Post Office	6910 S Yorktown Ave.
Tulsa Public Schools			
ES	12	ECDC Porter	1740 W 41st St
ES	17	Eugene Field Elementary School	2249 S Phoenix Ave
ES	37	McClure Elementary School	1770 E 61st St
ES	41	Park Elementary School	3205 W 39th St
ES	45	Remington Elementary School	2524 W 53rd St
ES	46	Robertson Elementary School	2721 W 50th St
MS	63	Webster Jr High School	2224 W 41st St
HS	65	Daniel Webster High School	1919 W 40th St
Ot	86	McBirney Transportation/ West Lot	10112 W 36th Pl
Jenks Public Schools			
JMS	3	Jenks Middle School	3019 E 101st St.
Private School			
PS	7	Christ the Redeemer Lutheran Church	2550 E 71st St.
PS	17	Metro Christian Academy	6363 S. Trenton Ave.
PS	21	ORU Academy	7777 S Lewis Ave.
PS	23	Riverfield Country Day School	2433 W 61st St.
PS	24	Saint Catherine Catholic School	2615 W 46th St.
PS	31	Victory Christian School	7700 S Lewis Ave.
Child Care			
CC	33	McClure Head Start	6150 S. Yorktown Ave.
CC	38	Riverfield Country Day School	2433 W. 61st St.
CC	46	Victory Christian School	7700 S. Lewis Ave.
CC	47	Victory Kids Care	7700 S. Lewis Ave.
CC	48	Victory Mothers Day Out	7700 S Lewis Ave.
Higher Education			
UV	3	OSU College of Osteopathic Medicine	1111 W 17th St.
UV	8	Oral Roberts University	7777 S Lewis Ave.
JC	12	Tulsa Community College - Riverside	801 E 91st St.
Major Medical			
HO	7	Oklahoma Surgical Hospital	2408 E 81st St Ste 300
HO	16	Tulsa Spine & Specialty Hospital	6901 S Olympia Ave.
Long Term Care			
AL	4	Ambassador's Courtyards	1380 E 61st St.
NH	5	Ambassador Manor Nursing & Rehab Center	1340 E 61st St.
ML	6	Ambassador Manor Nursing & Rehab Center	1340 E 61st St.
ML	9	Burgundy Place	8887 S Lewis Ave.
IL	10	Burgundy Place	8887 S Lewis Ave.
IL	19	Country Oaks	5648 S 33rd West Ave.
IL	32	Inhofe Plaza	6565 S Newport Ave.

ID	Map ID	Facility Name	Address
Long Term Care (continued)			
IL	40	LaFortune Tower	1725 S Southwest Blvd.
IL	56	Prairie Rose	7401 Riverside Pkwy.
NH	65	Sherwood Manor	2416 W 51st St.
AL	83	Tulsa Jewish Retirement & Health Care Center	2025 E 71st St.
ML	84	Tulsa Jewish Retirement & Health Care Center	2025 E 71st St.
NH	85	Tulsa Jewish Retirement & Health Care Center	2025 E 71st St.
IL	86	Tulsa Jewish Retirement & Health Care Center	2025 E 71st St.
AL	90	University Village Retirement Community	8555 S Lewis Ave.
NH	91	University Village Retirement Community	8555 S Lewis Ave.
ML	92	University Village Retirement Community	8555 S Lewis Ave.
IL	93	University Village Retirement Community	8555 S Lewis Ave.
RC	107	Harvest Homes, Inc	7028 S Harvard Ave.
RC	108	Harvest Residential Care Home II	3215 E 71st St.
RC	112	St. Andrews Manor	3011 W 80th St.
Local Financial			
LF	9	National Bank of Commerce	7127 Riverside Pkwy.
LF	18	Tulsa National Bancshares	7120 S Lewis Ave.

5.2.2 Existing Mitigation Strategies

Existing mitigation measures currently being implemented throughout the City of Tulsa are detailed in Chapter 2, *Existing Mitigation Strategies*. The information that follows in this section surveys the infrastructure in place for avoiding or mitigating the impacts of natural hazards, that can be looked at from the District level.

5.2.2.1 Council District 2 Warning Systems

Warning Sirens

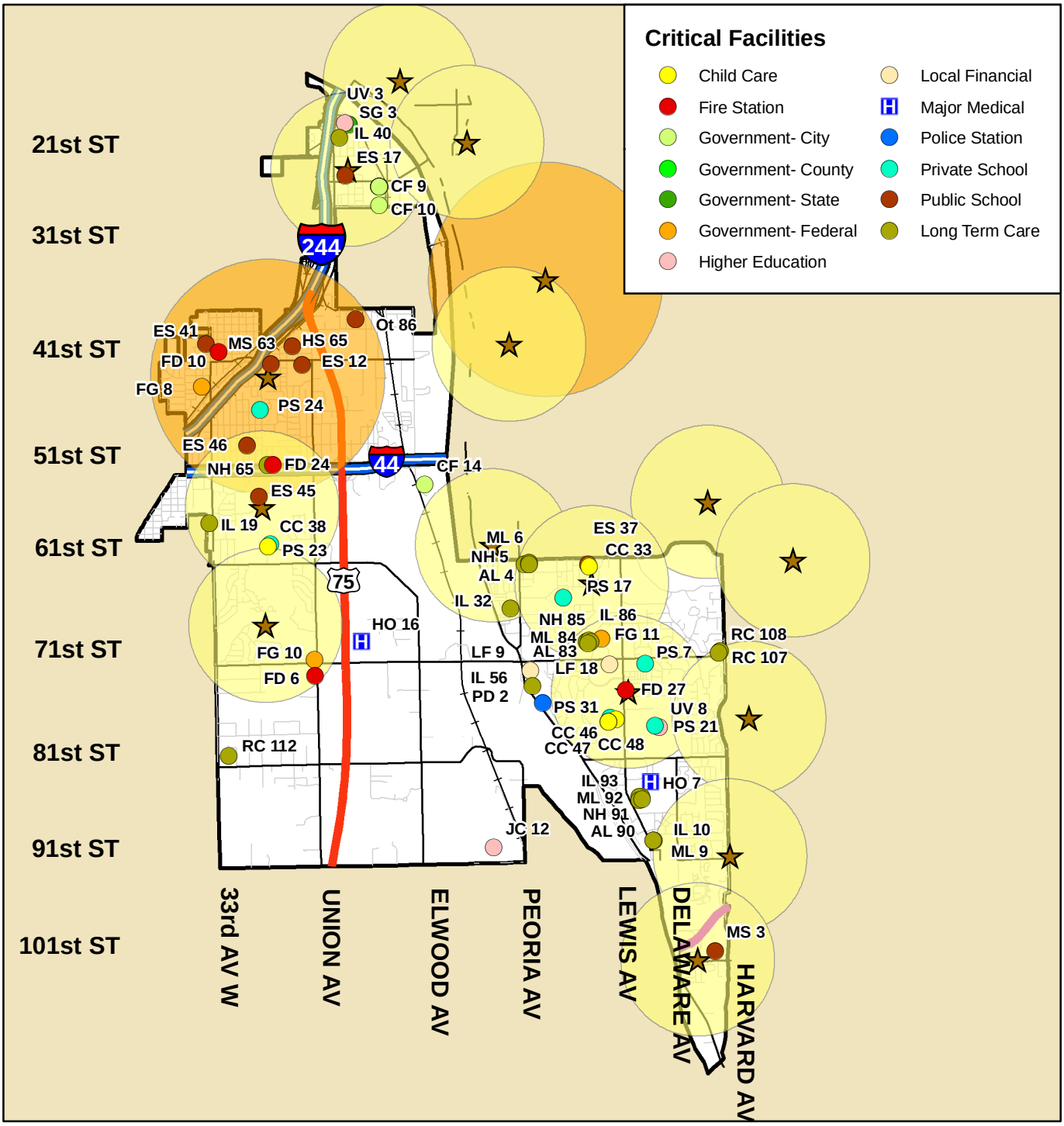
Of the 87 warning sirens in the City of Tulsa, eight are located within Tulsa Council District 2; seven others, although not physically within the District, provide partial coverage to some areas, as shown in Figure 5.2-15.

Lightning Sensing and Warning Systems

Tulsa Council District 2 has 13 parks, mapped in Figure 5.2-16. The District is home to Riverparks, Turkey Mountain, Southern Hills Country Club, Page Belcher Golf Course, and multiple urban parks. Parks promote neighborhood revitalization and development, as well as youth development. As discussed in Chapter 4, it is important for outdoor recreation areas to be equipped with lightning sensing and warning systems. Tulsa Public Schools and the University of Tulsa use ThorGuard© to warn of lightning danger at their outdoor recreation areas. A map showing ThorGuard© coverage areas in Tulsa is presented in Chapter 2, Figure 2-2. Public school districts in the surrounding Tulsa Metro Area should be encouraged to purchase and install lightning warning systems. Private schools, too, should also be informed of their options and encouraged to install warning systems for coverage at outdoor recreation areas.

5.2.3 Planning Process

The CAC/TAC met monthly during the planning process to review progress, identify issues, receive task assignments, and advise the consultants. A list of CAC, TAC, and public meetings and dates is shown in Table 3-1. Refer to Appendix C for meeting agendas.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad
- Sirens
- 4,000ft Buffer
- 6,100ft Buffer

0 1 2 Miles

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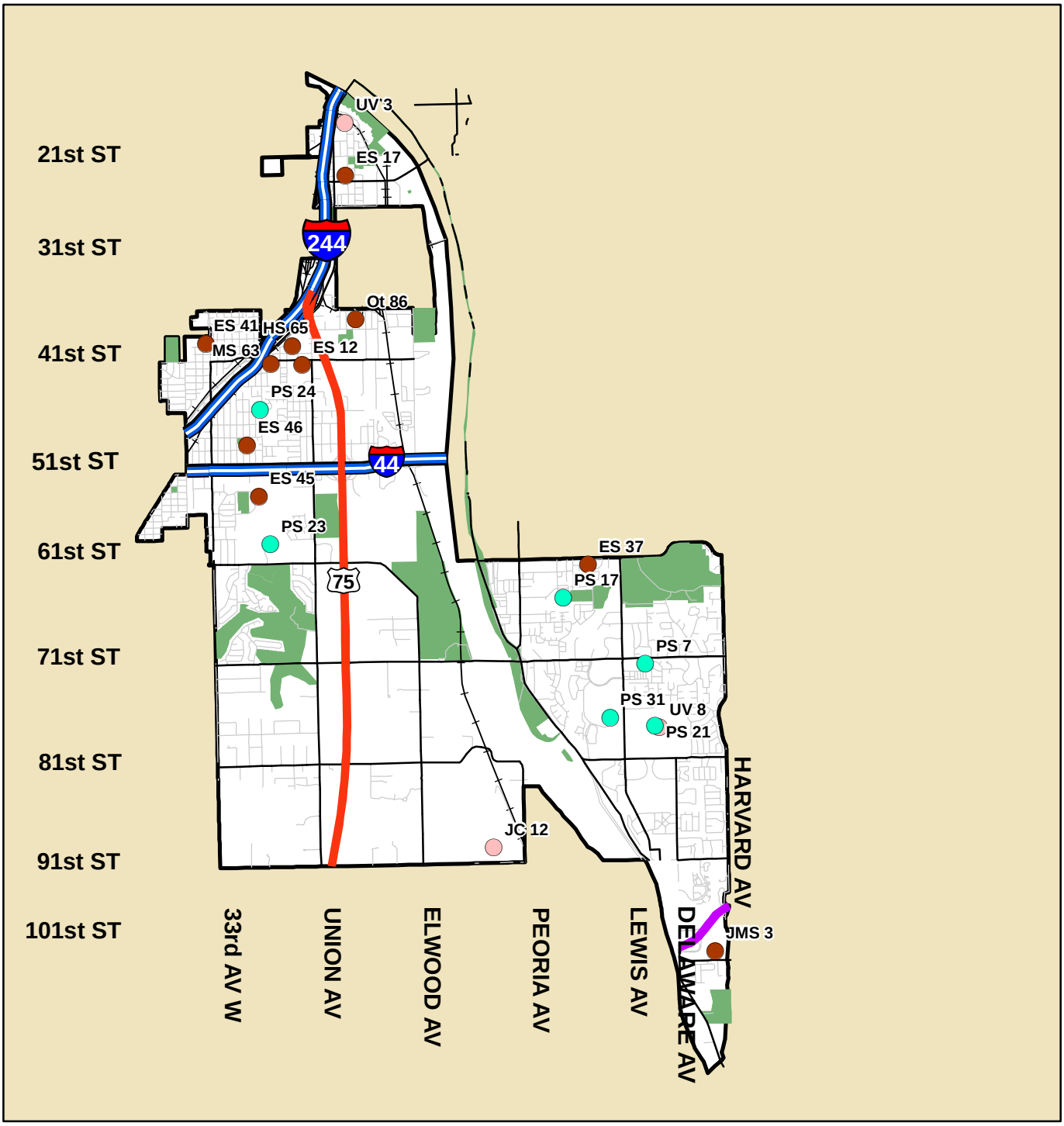
Figure 5.2-15

Tulsa Council District 2

Warning Sirens



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad
- Higher Education
- Private School
- Public School
- Parks

0 1 2 Miles

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Planning Consultants

Figure 5.2-16

Tulsa Council District 2

Schools & parks

5.2.4 Natural and Manmade Hazards

Hazards

General natural hazards, such as Severe Winter Storms, High Wind, Tornado, Lightning, Hailstorm, Extreme Heat, Drought, Earthquake, and Urban Fires affect all areas in the City of Tulsa randomly and more or less equally, and are addressed in Chapter 4.

Site specific hazards, such as Flooding, Dam Failure, Levee Failures, Expansive Soils, Wildfires, Fixed-Site Hazardous Materials and Transportation-Hazardous Materials are addressed for Council District 2 in subsections 5.2.4.1 through 5.2.4.8, summarized in subsection 5.2.4.9 and shown on the composite map in Figure 5.2-25. Table 5.2-4 identifies the seven site-specific hazards that can particularly impact Tulsa's Council District 2.

Table 5.2–4: Tulsa Council District 2 Site-Specific Hazard Impacts

Hazard	Area (sq. mi)	Improved Parcels	Est. Market Value	Percent of Area Impacted	Impacted Population
Floods	3.99	305	$57,372,353	16.76%	2,201
Dam Failure	10.82	3,667	$746,955,605	45.46%	22,946
Levee Failure	1.05	456	$46,679,520	4.41	3,084
Highly Expansive Soils	3.46	4,380	$561,512,926	14.54%	11,222
Wildfire	0.74	295	$89,589,031	3.11%	1,764
Fixed-Site HazMat, ¼ Mi.	5.69	2,486	$403,475,543	23.91%	6,953
Transportation HazMat Highway	5.93	2,738	$399,013,313	24.92	6,961
Transportation HazMat Railroad	4.33	1,857	$172,738,754	18.19%	6,450

Source: Tulsa County Assessor's Office, 2012

Tulsa Council District 2 has identified certain facilities as critical to the health, safety and welfare of its citizens, business and economy. Table 5.2-5 indicates, generally, the exposure of critical facilities to the seven site-specific hazards covered by this Plan Update.

Table 5.2–5: Tulsa Council District 2 Hazard Impacts on Critical Facilities

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Fixed Site HazMat	Transportation-Hazard
CF	9	Field Customer Services	X	X	X	X	X	X	X	X	X		X	X				X
CF	10	Chemical Storage Building	X	X	X	X	X	X	X	X	X		X	X			X	X
CF	10	Fuel Facility	X	X	X	X	X	X	X	X	X		X	X			X	X
CF	10	Portable Building	X	X	X	X	X	X	X	X	X		X	X			X	X
CF	10	Storage Shed	X	X	X	X	X	X	X	X	X		X	X			X	X
CF	10	Surplus Facility	X	X	X	X	X	X	X	X	X		X	X			X	X
CF	10	Tire Shop	X	X	X	X	X	X	X	X	X		X	X			X	X
CF	10	W&M South Yard Storage Building	X	X	X	X	X	X	X	X	X		X	X			X	X
CF	10	W&M South Yard Office/stock Building	X	X	X	X	X	X	X	X	X		X	X			X	X

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Fixed Site HazMat	Transportation-Hazard
CF	10	Warehouse/Materials Stockroom	X	X	X	X	X	X	X	X	X		X	X			X	X
CF	14	Southside Water Treatment Plant	X	X	X	X	X	X	X	X	X		X				X	X
PD	2	Tulsa Police Station (Southwest Div)	X	X	X	X	X	X	X	X	X		X					
FD	6	Tulsa Fire Department #6/ Hazardous Materials	X	X	X	X	X	X	X	X	X						X	
FD	10	Tulsa Fire Department #12	X	X	X	X	X	X	X	X	X				X			X
FD	24	Tulsa Fire Department #26	X	X	X	X	X	X	X	X	X				X			X
FD	27	Tulsa Fire Department #29	X	X	X	X	X	X	X	X	X		X					
SG	3	Medical Examiner	X	X	X	X	X	X	X	X	X		X	X			X	X
FG	8	USPS - Westside Post Office	X	X	X	X	X	X	X	X	X				X			X
FG	10	Post Office - CPU American Heritage Bank	X	X	X	X	X	X	X	X	X						X	
FG	11	USPS - Robert Jenkins Post Office	X	X	X	X	X	X	X	X	X		X		X		X	
ES	12	ECDC Porter	X	X	X	X	X	X	X	X	X		X		X			X
ES	17	Eugene Field Elementary School	X	X	X	X	X	X	X	X	X		X	X			X	X
ES	37	McClure Elementary School	X	X	X	X	X	X	X	X	X		X			X		
ES	41	Park Elementary School	X	X	X	X	X	X	X	X	X							
ES	45	Remington Elementary School	X	X	X	X	X	X	X	X	X							X
ES	46	Robertson Elementary School	X	X	X	X	X	X	X	X	X				X			X
MS	63	Webster Jr High School	X	X	X	X	X	X	X	X	X						X	X
HS	65	Daniel Webster High School	X	X	X	X	X	X	X	X	X				X			X
Ot	86	McBirney Transportation/ West Lot	X	X	X	X	X	X	X	X	X		X				X	X
JMS	3	Jenks Middle School	X	X	X	X	X	X	X	X	X		X					X
PS	7	Christ the Redeemer Lutheran Church	X	X	X	X	X	X	X	X	X							
PS	17	Metro Christian Academy	X	X	X	X	X	X	X	X	X		X		X			
PS	21	ORU eAcademy	X	X	X	X	X	X	X	X	X							
PS	23	Riverfield Country Day School	X	X	X	X	X	X	X	X	X							
PS	24	Saint Catherine Catholic School	X	X	X	X	X	X	X	X	X				X			
PS	31	Victory Christian School	X	X	X	X	X	X	X	X	X		X		X	X		
CC	33	McClure Head Start	X	X	X	X	X	X	X	X	X		X			X		
CC	38	Riverfield Country Day School	X	X	X	X	X	X	X	X	X							
CC	46	Victory Christian School	X	X	X	X	X	X	X	X	X		X		X			
CC	47	Victory Kids Care	X	X	X	X	X	X	X	X	X		X		X			
CC	48	Victory Mothers Day Out	X	X	X	X	X	X	X	X	X		X		X			
UV	3	OSU College of Osteopathic Medicine	X	X	X	X	X	X	X	X	X		X	X			X	X
UV	8	Oral Roberts University	X	X	X	X	X	X	X	X	X							
JC	12	Tulsa Community College - Riverside	X	X	X	X	X	X	X	X	X		X					
HO	7	Oklahoma Surgical Hospital	X	X	X	X	X	X	X	X	X		X		X		X	
HO	16	Tulsa Spine & Speciality Hospital	X	X	X	X	X	X	X	X	X							X

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Fixed Site HazMat	Transportation-Hazard
AL	4	Ambassador's Courtyards	X	X	X	X	X	X	X	X	X	X	X					
NH	5	Ambassador Manor Nursing & Rehab Center	X	X	X	X	X	X	X	X	X	X	X					
ML	6	Ambassador Manor Nursing & Rehab Center	X	X	X	X	X	X	X	X	X	X	X					
ML	9	Burgundy Place	X	X	X	X	X	X	X	X	X		X				X	
IL	10	Burgundy Place	X	X	X	X	X	X	X	X	X		X				X	
IL	19	Country Oaks	X	X	X	X	X	X	X	X	X							
IL	32	Inhofe Plaza	X	X	X	X	X	X	X	X	X		X					
IL	40	LaFortune Tower	X	X	X	X	X	X	X	X	X		X	X			X	X
IL	56	Prairie Rose	X	X	X	X	X	X	X	X	X		X			X		
NH	65	Sherwood Manor	X	X	X	X	X	X	X	X	X				X			X
AL	83	Tulsa Jewish Retirement & Health Care Center	X	X	X	X	X	X	X	X	X		X		X			
ML	84	Tulsa Jewish Retirement & Health Care Center	X	X	X	X	X	X	X	X	X		X		X			
NH	85	Tulsa Jewish Retirement & Health Care Center	X	X	X	X	X	X	X	X	X		X		X		X	
IL	86	Tulsa Jewish Retirement & Health Care Center	X	X	X	X	X	X	X	X	X		X		X			
AL	90	University Village Retirement Community	X	X	X	X	X	X	X	X	X		X		X			
NH	91	University Village Retirement Community	X	X	X	X	X	X	X	X	X		X		X			
ML	92	University Village Retirement Community	X	X	X	X	X	X	X	X	X		X		X			
IL	93	University Village Retirement Community	X	X	X	X	X	X	X	X	X		X		X			
RC	107	Harvest Homes, Inc	X	X	X	X	X	X	X	X	X							
RC	108	Harvest Residential Care Home II	X	X	X	X	X	X	X	X	X							
RC	112	St Andrews Manor	X	X	X	X	X	X	X	X	X							
LF	9	National Bank of Commerce	X	X	X	X	X	X	X	X	X		X					
LF	18	Tulsa National Bancshares	X	X	X	X	X	X	X	X	X		X		X			

5.2.4.1 Flood

Location

District 2 is impacted by local drainage of the Arkansas River, City Regulatory Floodplains and the Special Flood Hazard Area (SFHA). Together, the floodplains cover 3.99 square land miles, or 16.76 percent of District 2. Streams and drainage basins in the District are listed in Table 5.2-6, and a map of the drainage basins and floodplains is shown in Figure 5.2-17.

Table 5.2–6: Tulsa Council District 2 Streams and Drainage Areas

Basin	Total Drainage Area (sq. mi.)
POLECAT CREEK	0.07
CHERRY/REDFORK	0.09
NICKEL CREEK	2.44

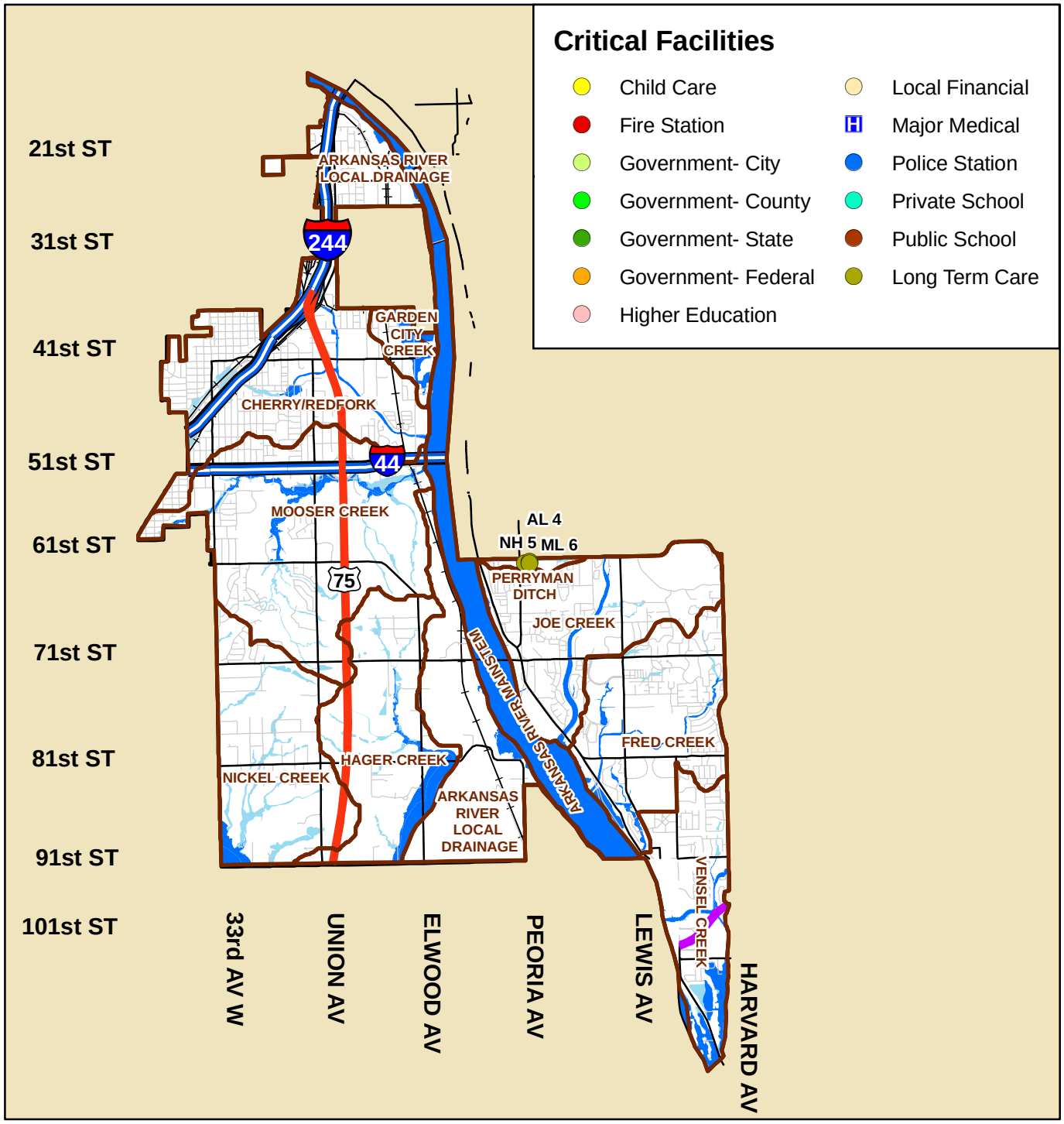
Basin	Total Drainage Area (sq. mi.)
VENSEL CREEK	1.58
SOUTH FORK JOE CREEK	0.01
HAGER CREEK	2.29
MOOSER CREEK	4.39
CHERRY/REDFORK	2.99
GARDEN CITY	0.34
ARKANSAS RIVER LOCAL DRAINAGE	0.93
ARKANSAS RIVER LOCAL DRAINAGE	1.87
JOE CREEK	2.46
PERRYMAN DITCH	0.11
FRED CREEK	2.39
ARKANSAS RIVER MAINSTEM	1.84
Total	23.80

District 2 has several areas that are prone to flooding after heavy rains. Most of these are related to creeks overflowing their banks, and some to local drainage problems. The dominant drainage in District 2 is the Arkansas River, which flows 8 miles from north to south, dividing the jurisdiction almost in half. In the northwest part of District 2, on the west bank of the Arkansas, is Garden City, which suffered catastrophic flooding as a result of the October 1986 emergency release of 305,000 cfs from Keystone Dam and the subsequent failure of the community's private levee. The streams which have flooded most in the past 10 years are Mooser, Hager and Nickel Creeks, which are all west bank streams, and Joe, Fred and Vensel Creeks, which are on the east side, south of 61st St. All are tributaries to the Arkansas River. The other major west-bank stream in District 2, Cherry Creek, has been channelized through most of its course, and has not been a cause of flooding in recent years.

The most flood prone areas in the District are along Joe Creek between 61st and 71st Streets, on Vensel Creek at its junction with the Arkansas River, between 101st and 115th Streets, and in the low-lying area north of Cherry Creek (essentially Garden City), between the Midland Valley Railroad tracks and the River.

Impact/Vulnerability

A total of 305 structures are touched by the 100-year floodplains in District 2, with an assessed value, adjusted for fair market, of $57,372,353. A summary of buildings touched by the 100-year floodplain, by type and value, is included in Table 5.2-7.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad
- Basins
- SFHA
- City Regulatory

0 0.5 1 Miles

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Figure 5.2-17

Tulsa Council District 2

Drainage Basins & Floodplains

Table 5.2–7: Tulsa Council District 2 Buildings Touched by 100 year Floodplain

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	247	$29,581,084
Residential Multi-Family	8	$807,500
Commercial	20	$7,801,022
Industrial	6	$8,824,044
Other	24	$10,358,703
Total	305	$57,372,353

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Three critical facilities in District 2 are located in or adjacent to the 100-year floodplain. These are identified in Table 5.2-5 and shown in Figure 5.2-17.

Repetitive Loss Properties

There are three Repetitive Loss Properties within Council District 2: two residential and 1 commercial.

Flood Control Projects

Tulsa's floodplain and stormwater program includes comprehensive watershed management, dedicated funds for maintenance and operation, and a $200 million capital improvements program. In the wake of the October 1986 flood, the City strengthened the levee at Garden City, purchased 13 parcels and cleared seven homes.

Figure 5.2-18 identifies flood control projects in the District that were included in the 2004 Capital Improvements Plan. Projects funded for the 2008-2012 period are listed in Table 5.2-8. In addition, the City has budgeted $10 million for flood control projects in the District for the 2014 to 2018 period.

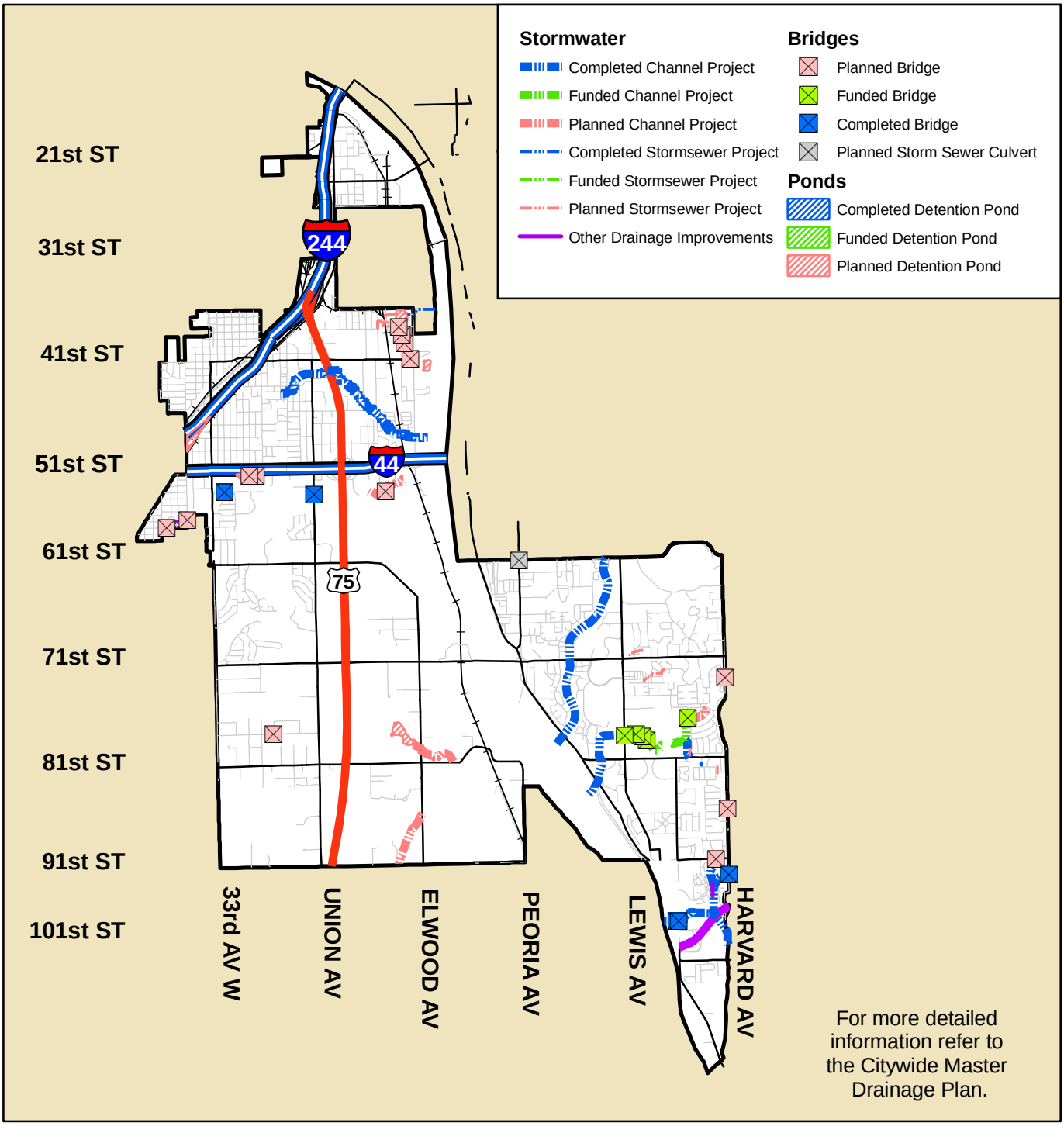
Table 5.2–8: Tulsa Council District 2 Flood Control Projects 2008-2012

City ID	Project Basin and Description	Budget
6	Cherry Creek/Red Fork Creek – Detention Basin	$3,360,000
49	Garden City - Drainage Improvements (Phase 2)	$7,300,000
54	Harlow Creek - Stormwater Storage Facilities	$1,700,000
71	Mooser Creek - Channel & I-44 Culvert	$3,200,000
72	Mooser Creek - South Haven Floodwall & Culvert Improvements	$1,610,000
73	Mooser Creek - Steel Companies Channel Improvements	$4,470,000
78	Parkview Creek - Edison Street Culvert	$140,000
Total Expenditures		**$21,780,000**

Source: PLANiTulsa Capital Expenditures Plan 2008-2012

Conclusion

Tulsa Council District 2 has a HIGH probability of and a HIGH vulnerability to the Flood hazard.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad

0 1 2 Miles

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Figure 5.2-18

Tulsa Council District 2

Flood Control

5.2.4.2 Dam Failure

Location

District 2 is located on the east and west sides of the Arkansas River in the southwest quadrant of the city, about 10 miles downstream from Keystone Dam. For an in-depth discussion of Dam Failure on the Arkansas River, see Chapter 5.10, Arkansas River Corridor. A map of the dam inundation areas in District 2 is included in Figure 5.2-19.

Impact/Vulnerability

A failure of Keystone Lake Dam would pose a very significant hazard to District 2, depending largely on the amount of the discharges. Of the total land area in District 2, 10.82 square miles is vulnerable to dam failure. The number of parcels with improvements in the Dam inundation area is summarized in Table 5.2-9. A list of critical facilities that would be impacted is included in Table 5.2-5. The impact of this hazard would be catastrophic to Tulsa Council District 2, given that the Arkansas River passes directly through it, the number of residents living or working in the Dam inundation area, and the value of the built environment that would be at risk. Nearly 50 percent of the District's 45,525 residents could be impacted by a failure of the dam. Depending on warning time, persons living in District 2 would have minimal time to react and evacuate the area to avoid loss of life. Property loss in this area, as a result of a Dam breach or failure, would be unavoidable.

District 2 has experienced one significant emergency release from Keystone Dam, in October 1986, with catastrophic results for Garden City, which is located within the District. River water entered the small community from a breach in a private levee, causing $1.3 million damage to 14 homes, 11 industrial buildings, and 39 mobile homes. Some of the houses flooded up to the rafters. The City eventually purchased 13 parcels, cleared seven homes, and rebuilt the damaged levee to provide at least limited protection to the extensive west bank industrial areas. This 1986 emergency release event is discussed more fully in Chapter 4 and Chapter 5.10, below. In addition, if the refineries and industries located on the west bank—in Tulsa County, outside Tulsa's corporate area—are flooded, large amounts of toxic industrial waste could be released into the river.

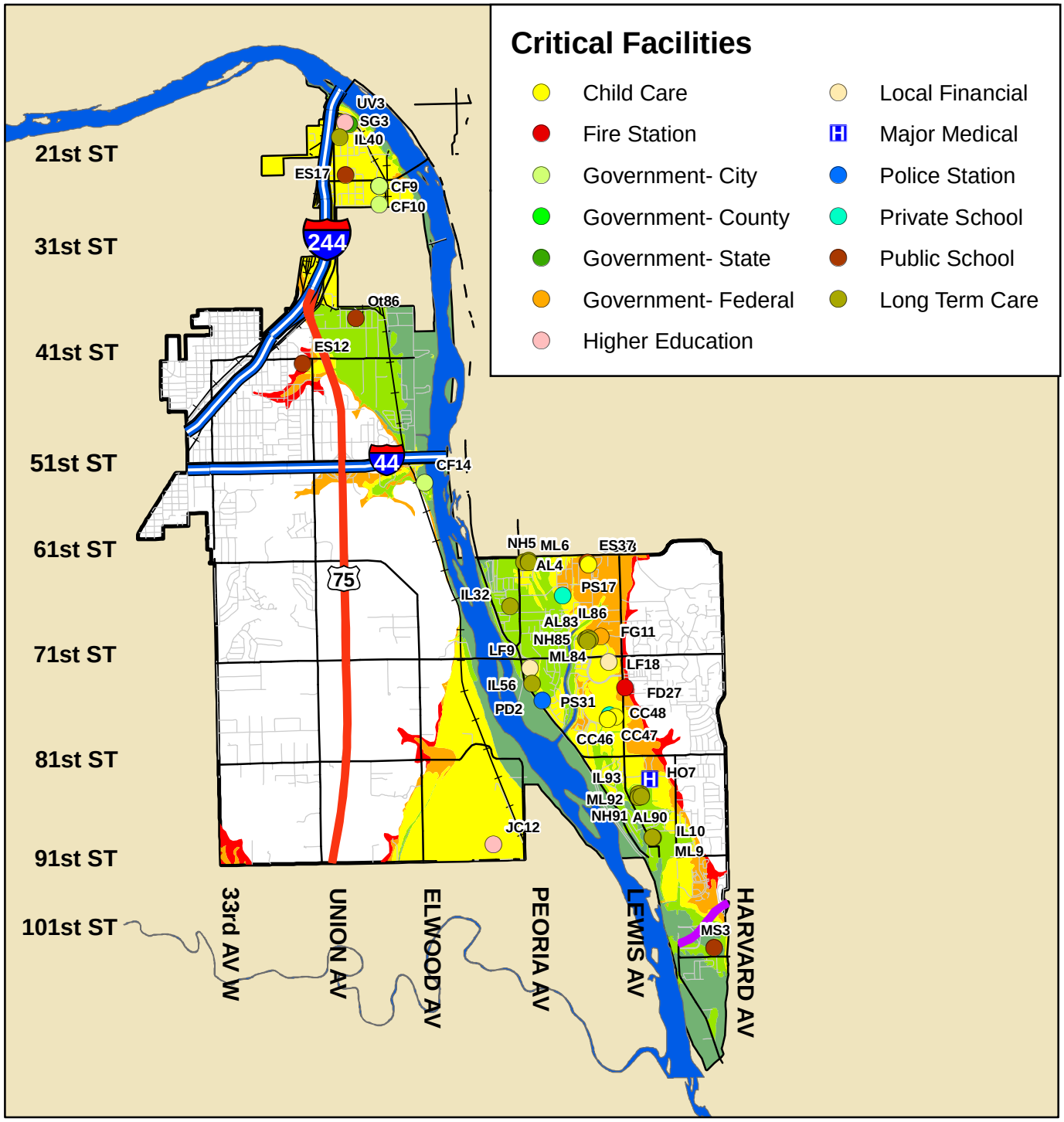
Table 5.2–9: Tulsa Council District 2 Improved Parcels in Keystone Dam Inundation Area

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	3054	$229,085,673
Residential Multi-Family	179	$130,213,634
Commercial	268	$300,433,605
Industrial	34	$35,987,693
Other	132	$51,235,000
Total	3,667	$746,955,605

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Almost all critical facilities in the District would be impacted by a failure or breach of Keystone Dam. Many of the facilities house a high number of functional needs populations, including: seven public/private school facilities; four child care facilities; one major medical facility; and 16 long-term care facilities. Populations occupying these facilities at the time of a dam breach or failure are highly exposed to the hazard impact. This is especially true of those unable to evacuate due to mental or physical disabilities. Pre-planning for a dam failure is essential for these facilities. Also at risk in District 2 is the Southside Wastewater Treatment Plant. Damage to the plant could result in untreated sewage being released into local waterways—a major public health concern.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad

Dam Failure

- 250,000 CFS
- 350,000 CFS
- 450,000 CFS
- Max Failure
- Dam Break
- Arkansas River

0 1 2 Miles

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Figure 5.2-19

Tulsa Council District 2

Dam Failure

Conclusion

Tulsa Council District 2 has a High vulnerability to and a Moderate probability of a Dam Failure.

5.2.4.3 Levee Failure

Location

District 2 is located on the east and west sides of the Arkansas River in Tulsa's southwestern quadrant. The Arkansas River passes from north to south for about 8 miles through the center of the District. The northern part of the District, on the west side of the Arkansas, is protected by Levee C and by a private levee around Garden City, a small, older development between the Okmulgee Expressway and the river, from about 35th St. to 41st St. For an in-depth discussion of Levee Failure on the Arkansas River, see Chapter 4 and Section 5.10, Arkansas River Corridor. A map displaying the inundation area of Levee C in Council District 2 is shown in Figure 5.2-20.

Impact/Vulnerability

Of the total land area in District 2, 1.05 square miles is vulnerable to an Arkansas River levee failure. A failure of Levee C and the private levee at Garden City would pose a hazard to District 2. The area of District 2 protected by levees is among the most impoverished in the City of Tulsa. According to parcel information from the Tulsa County Assessor's Office, 456 parcels with improvements would be impacted by a levee failure. The estimated value of the vulnerable facilities is $46, 679, 520. This estimate does not include the Holly Oil Refinery, which is in Tulsa County, outside the City's corporate limits. The number of parcels in the levee inundation areas is summarized in Table 5.2-10.

The impact of this hazard would be catastrophic to Tulsa Council District 2 on the west side of the river because of the number of residents living or working in the levee inundation area, and the value of the built environment in the District that would be impacted. Depending on warning time, persons living in District 2 would have minimal opportunity to react and evacuate the area to avoid loss of life. Property loss in this area, as a result of a Levee failure, would be unavoidable. Because of the number of industrial facilities in the inundation area that work with hazardous chemicals and produce toxic wastes, a levee failure could release pollutants into the river, as happened in 1986.

The private levee protecting Garden City, on the west bank of the Arkansas River failed catastrophically during the flood of October 4-5, 1986, when the US Army Corps of Engineers released 305,000 cfs from Keystone Dam. The surge of water broke through Garden City's levee and inundated most of the area between the Midland Valley Railroad tracks and the river. In some places the water was up to the rafters of homes. The flooding extended south to a mobile home park on the north side of Cherry Creek. As stated above, the levee failure caused $1.3 million damage to 14 homes, 11 industrial buildings, and 39 mobile homes. The City eventually purchased 13 parcels, cleared seven homes, and rebuilt the damaged levee.

Table 5.2–10: Tulsa Council District 2 Improved Parcels in Levee C Inundation Area

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	263	$12,034,400
Residential Multi-Family	7	$14,645,200
Commercial	28	$7,295,753
Industrial	6	$3,038,000
Other	152	$9,666,167
Total	456	$46,679,520

Source: Tulsa County Assessor's Office, 2012

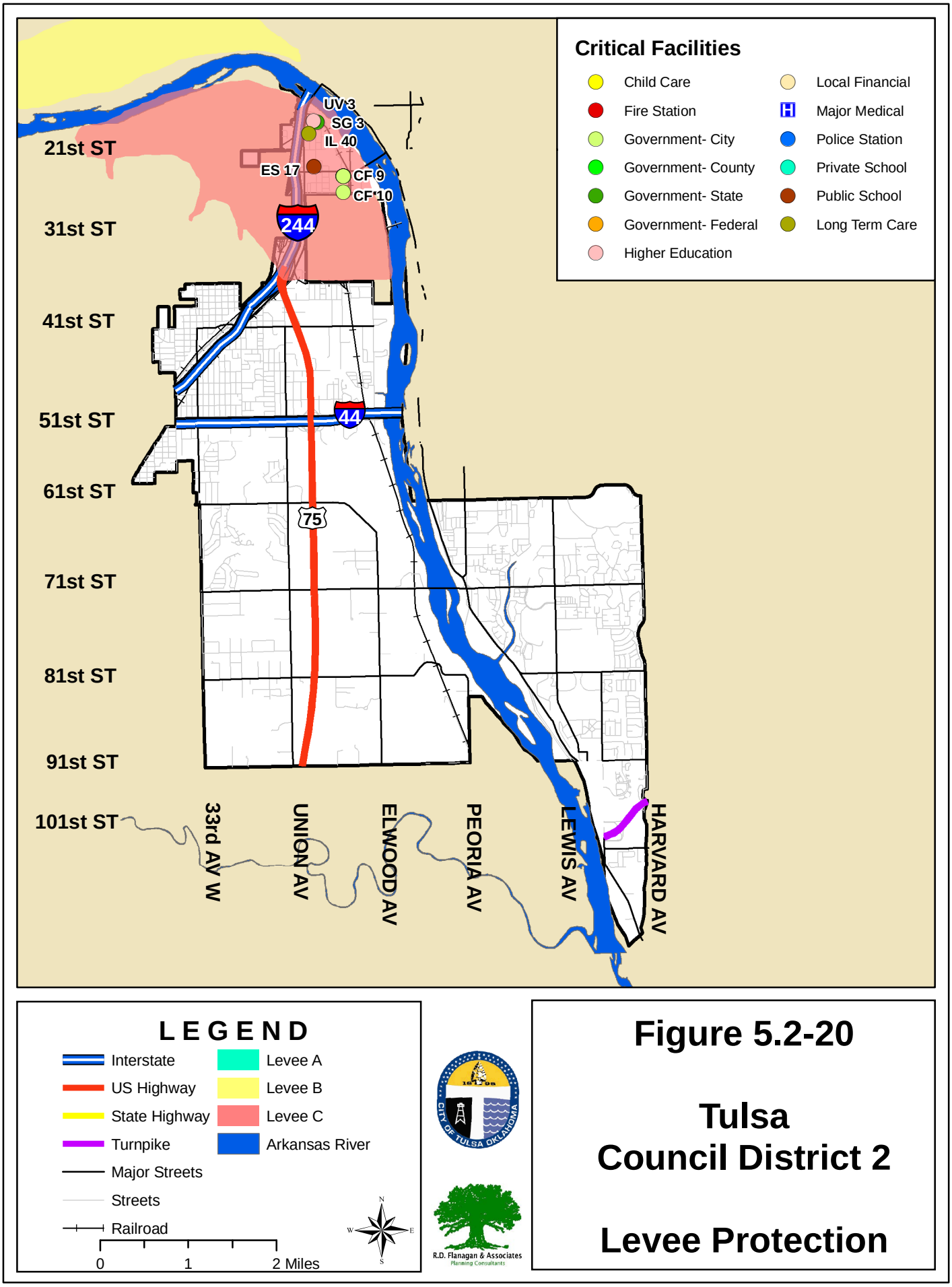


Figure 5.2-20

Tulsa Council District 2

Levee Protection

Critical Facilities

Fourteen critical facilities are located in the inundation area of Levee C. Two facilities of particular concern include Eugene Field Elementary School and LaFortune Tower; both of which house functional needs populations. People occupying these facilities at the time of a levee failure are highly exposed to the hazard impact. This is especially true of those unable to evacuate due to mental or physical disabilities. Pre-planning is essential at these facilities. Critical facilities located in the Levee inundation area are listed in Table 5.2-5 and shown on the map in Figure 5.2-20.

Conclusion

Tulsa Council District 2 has a HIGH vulnerability to and a MODERATE probability of the Levee Failure hazard.

5.2.4.4 Expansive Soils

Location

As indicated in Table 5.2-11, Council District 2 is underlain predominantly by soils with a Low shrink/swell potential, with Moderate and High expansive soils beneath 26.82 percent of the District and Very High beneath less than one percent. A map showing the location of the Districts expansive soils is presented in Figure 5.2-21.

Table 5.2–11: Tulsa Council District 2 Expansive Soils

Expansion Potential	Area (sq mi)	Percent of Total District Boundaries
Very High	0.17	0.73%
High	3.29	14.05%
Moderate	2.99	12.77%
Low	15.06	64.33%
Water	1.9	8.12%
Total	23.41	100.00%

Impact/Vulnerability

According to Tulsa County Assessor data, 4,380 parcels, or about 39.80 percent of the total parcels in District 2, are underlain by soils with High to Very High shrink/swell potential. These have an assessed value, adjusted for fair market, of $561,512,926. The majority of parcels located on High to Very High expansive soils are residential single family structures. A summary of District 2 parcels located on High to Very High expansive soils is included in Table 5.2-12.

Table 5.2–12: Tulsa Council District 2 Parcels on High to Very High Expansive Soils

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	3,915	$233,494,785
Residential Multi-Family	138	$68,531,710
Commercial	237	$239,829,802
Industrial	17	$3,717,999
Other	73	$15,938,630
Total	4,380	$561,512,926

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

There are 24 Critical facilities located on High to Very High expansive soils in District 2, listed in Table 5.2-5 and shown in Figure 5.2-21. Although it is likely the structures were engineered to account for the soils on which they were built, the facilities should be monitored for damages and reported/repaired as necessary.

Conclusion

Tulsa Council District 2 has a HIGH vulnerability to and HIGH probability of the Expansive Soils hazard.

5.2.4.5 Wildfire

Location

Council District 2 is vulnerable to the Wildfire hazard. Of the land area that makes up the District, 0.74 square miles have a High to Very High Wildfire Level of Concern (LOC). A map displaying the Wildfire LOC of District 2 is shown in Figure 5-2-22. It should be noted that the green areas in the map represent undeveloped grass and forest land that is interspersed with residences and comprises a classic Wildland/Urban Interface area.

Impact/Vulnerability

There are 295 improved parcels located in areas of Moderate to Very High Wildfire LOC, broken down by value, estimated for fair market, and improvement type in Table 5.2-13. The area between W 71st Street and W 81st Street, and slightly west of S Elwood Avenue to S Peoria Avenue, on the west side of the railroad, has the highest level of concern. In addition, as mentioned above, District 2 has a heightened exposure to the Wildfire hazard due to the large area of unoccupied land that meets with developed areas on the urban fringe, also known as the Wildland/Urban Interface (WUI). Though not indicated as having high wildfire susceptibility on the map, as explained in Chapter 4, WUI areas are prone to wildfires, and are especially vulnerable during periods of extreme heat and drought. Drought conditions, extreme heat and high winds returned with a vengeance in early August 2012. Wildfires destroyed 376 houses near Mannford, west of Tulsa. Nearly 60,000 acres burned across a 56-mile perimeter, stopping just short of Mannford itself. Although the fires were 18 miles west of the District, the landscape is much the same as in the undeveloped westernmost part of the jurisdiction, and illustrates the vulnerability of the area to wildfire under conditions of drought, extreme heat and high winds.

Table 5.2–13: Tulsa Council District 2 Parcels Touched by Wildfire Level of Concern

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	255	$16,417,225
Residential Multi-Family	16	$43,011,506
Commercial	13	$12,863,600
Industrial	2	$1,630,200
Other	9	$15,666,500
Total	295	$89,589,031

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Four of the Districts critical facilities are located in areas of Moderate to Very High Wildfire LOC, identified in Table 5.2-5. A map displaying the Wildfire LOC of District 2 is shown in Figure 5-2-22. According to the Wildfire LOC Index, the facility most at risk to the Wildfire hazard is McClure

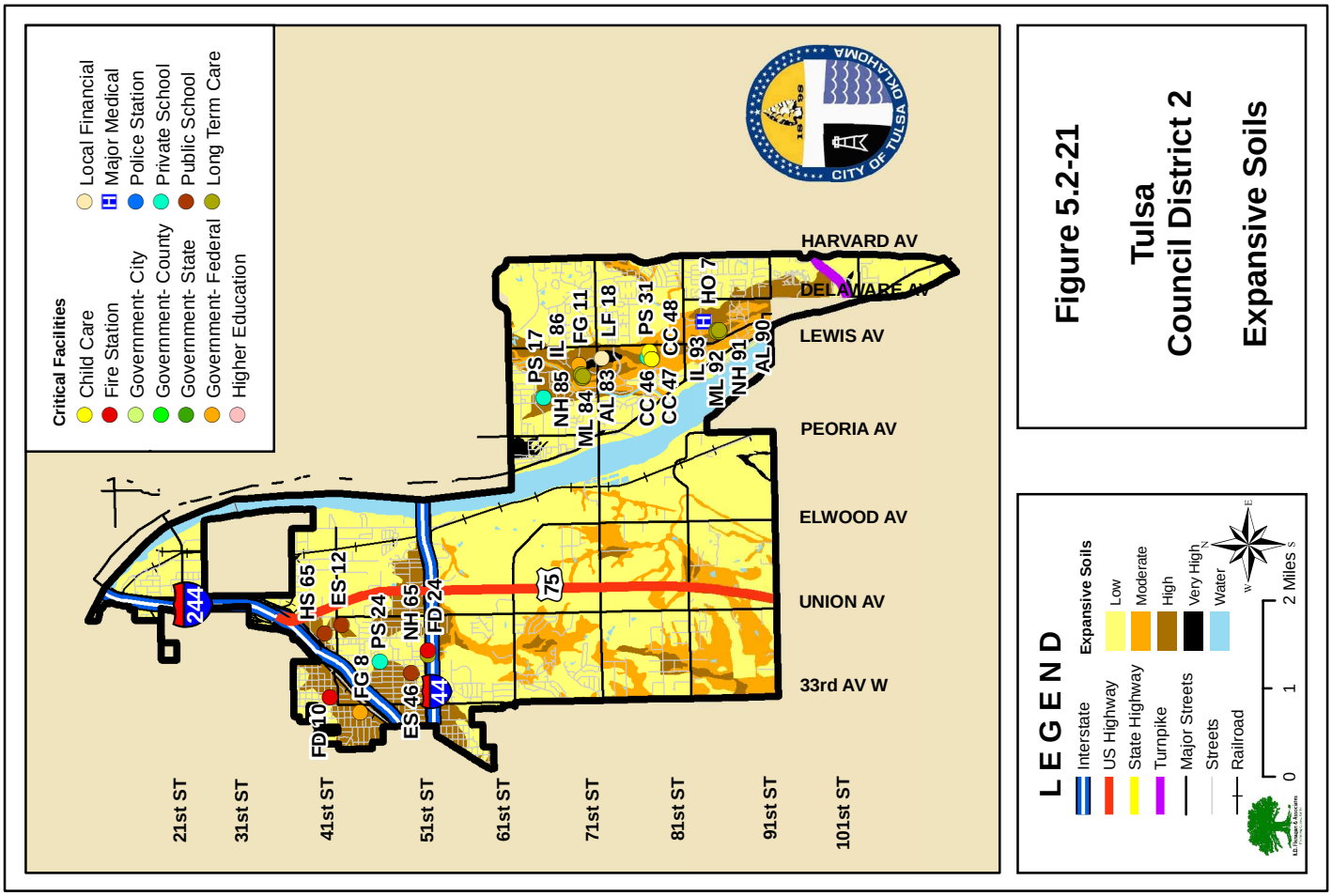


Figure 5.2-21

Tulsa Council District 2

Expansive Soils

Figure 5.2-22

Tulsa Council District 2

Wildfire Level of Concern Index

Elementary School. Though located in an area of High LOC, the school is surrounded by paved roads and residential neighborhoods. The plot of land just south of the school campus is well maintained open area.

As mentioned in Chapter 4, it would not be likely for a wildfire to occur in the urban areas of Tulsa; nevertheless effort should be made to continue to keep the grasses in the area around the school trimmed.

Conclusion

Tulsa Council District 2 is considered to have a LOW vulnerability to and LOW probability of the Wildfire hazard, except in the north western quadrant, which contains a classic Wildland/Urban interface area, and has a MODERATE vulnerability and MODERATE probability rating.

5.2.4.6 Fixed-Site Hazardous Materials

Location

There are 44 Tier II facilities within the boundaries of Tulsa Council District 2. Of these, 21 contain Extremely Hazardous Substances (EHS). Due to the sensitive nature of the material in this section of the Plan, Tier II facilities in the District are mapped in Figure 5.2-23 to show only their approximate location. A list of Tier II facilities in Council District 2 can be found in Appendix F, and is available on a need-to-know basis.

Impact/Vulnerability

District 2, particularly in its northwest quadrant, has a high number of Tier II facilities. More significantly, within the boundary of the District, but not part of the City of Tulsa, is one of Holly Frontier's two refineries (Tulsa East), with the second plant (Tulsa West) just outside the District's west boundary. According to GIS and Tulsa County Assessor Data, there are 2,486 improved parcels located within a ¼ mile radius of Tier II facilities in Council District 2. A summary of the parcels, by assessed value, adjusted for fair market price and type, is included in Table 5.2-14.

Table 5.2–14: Tulsa Council District 2 Parcels in ¼ Mile Tier II Buffer

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	2,160	$133,718,650
Residential Multi-Family	31	$40,995,258
Commercial	160	$169,947,571
Industrial	37	$30,405,693
Other	98	$15,666,500
Total	2,486	$403,475,543

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

In District 2, 23 critical facilities are located within ¼ mile of a Tier II facility, identified in Table 5.2-5 and mapped in Figure 5.2-23. Though structures are not likely to be impacted themselves, populations at the facilities are at high risk of being impacted if a hazardous materials event were to occur. Of high concern are the three Tulsa Public School facilities and 4 long term care facilities in ¼ mile buffer of the District's fixed-sites. Due to a high number of functional needs populations in these facilities, pre-planning is critical. Effort should be made to ensure proper evacuation or shelter-in-place procedures are in place.

Conclusion

Tulsa Council District 2 is considered to have a HIGH vulnerability to and HIGH probability of a fixed-site hazardous materials release.

5.2.4.7 Transportation-Hazardous Materials

Location

Five significant transportation corridors pass through Council District 2: Interstate 244, runs roughly from northeast to southwest along the northwest boundary of the district; Interstate 44, runs east to west, generally along S. 51st St. in the west central part of the district; U.S. Highway 75 runs roughly south to north through the center of the district, before merging with I-244 and turning northward at the Downtown Inner Dispersal Loop; the Creek Turnpike runs briefly through District 2 in the southern most corner of the district, essentially running from E 101st Street to Harvard before leaving the district.

Two railroad lines pass through District 2: one follows the west bank of the Arkansas River (Midland Valley), and the other (BNSF) follows I-244 from downtown Tulsa to the Cherokee Yard and on to Sapulpa and Oklahoma City. There are no airports in District 2, although the Jones Riverside Airport is located just south of the District, in Jenks. A map of the transportation corridors in District 2 is shown in Figure 5.2-24.

Impact/Vulnerability

A quarter mile transportation buffer for the five transportation corridors encompasses 43.11 percent of Council District 2 (or 10.26 square. miles), 4,595 improved parcels, and 13,411 residents (based on the 2010 US Census Data).

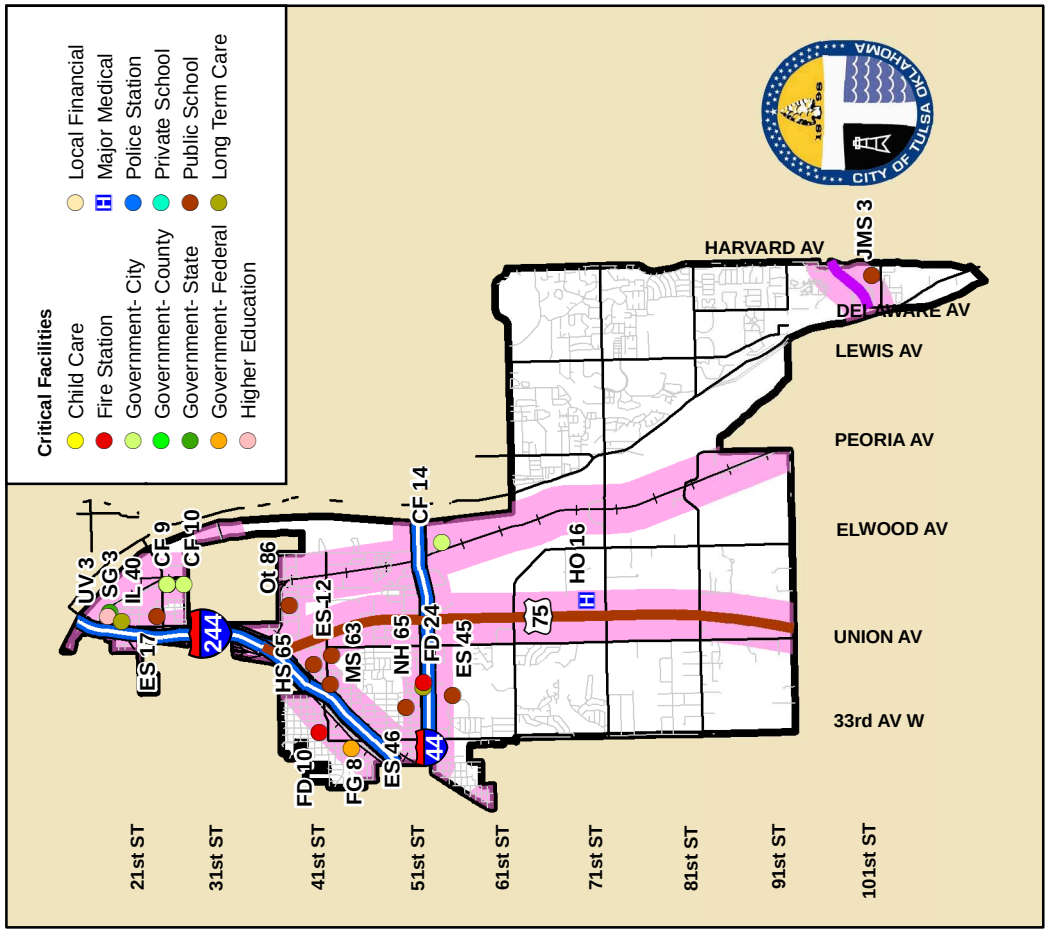
According to the Tulsa County Assessor, 2,738 improved parcels in District 2 are touched by the ¼ mile buffer of a Highway or Interstate in the District, with a total value, assessed for fair market, of $399,013,313. The numbers of parcels, by type, touched by the Highway corridors are summarized in Table 5.2-15.

Table 5.2–15: Tulsa Council District 2 Parcels Touched by ¼ mile Highway Corridor

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	2,380	$144,399,996
Residential Multi-Family	25	$8,208,553
Commercial	192	$174,409,931
Industrial	30	$13,860,100
Other	111	$58,134,733
Total	2,738	$399,013,313

Source: Tulsa County Assessor's Office, 2012

In total, 1,857 parcels in District 2 are located with ¼ mile of a rail line, with a total assessed value, adjusted for fair market price, of $172,738,754. The numbers of parcels within the railroad corridors, by type, are summarized in Table 5.2-16.



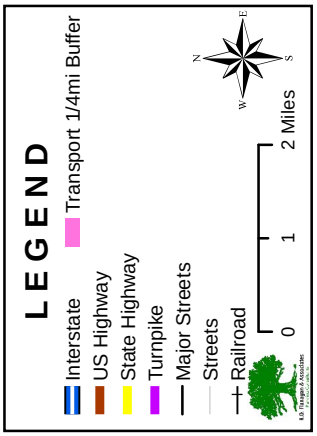
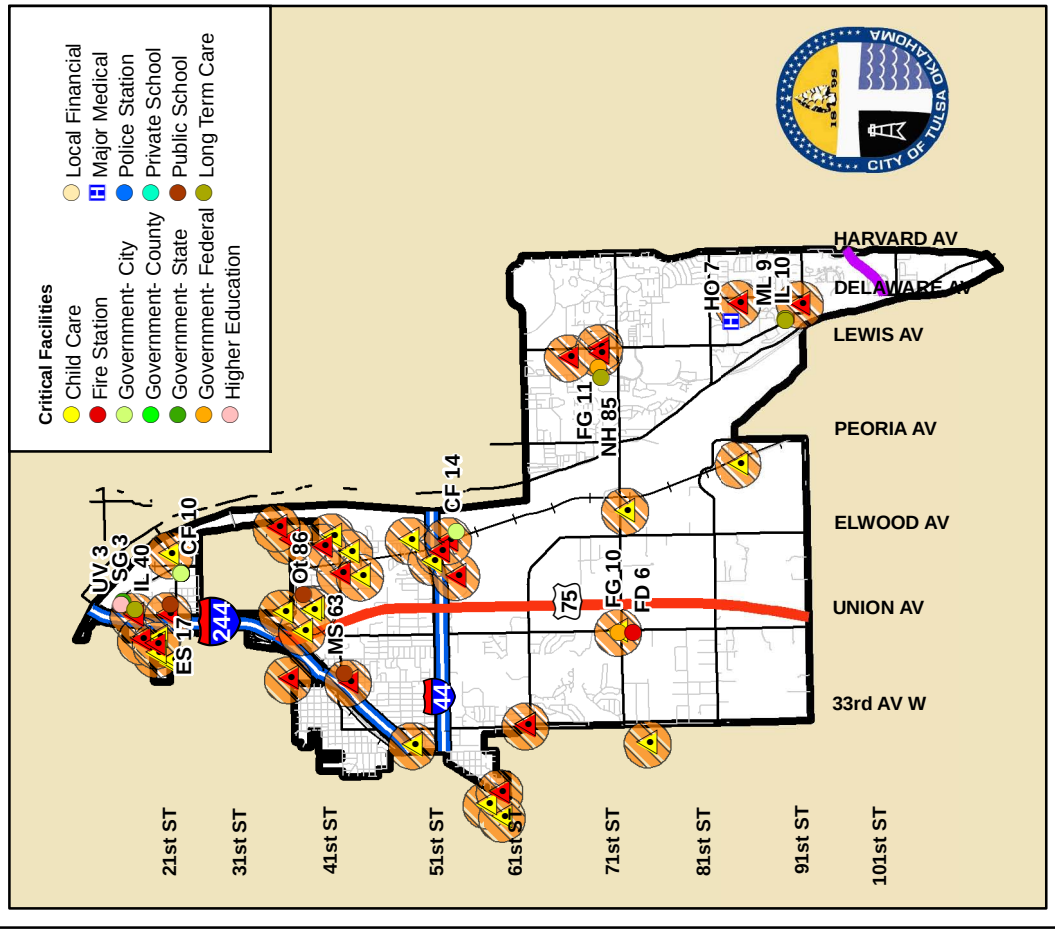


Figure 5.2-24

Tulsa Council District 2

Transportation Corridors



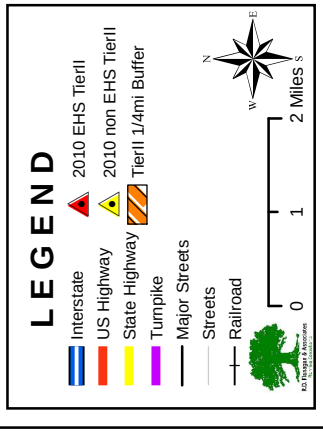


Figure 5.2-23

Tulsa Council District 2

Fixed Site Hazardous Materials

Table 5.2–16: Tulsa Council District 2 Parcels Touched by ¼ mile Railroad Corridor

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	1,585	$68,426,099
Residential Multi-Family	22	$15,478,553
Commercial	117	$34,035,056
Industrial	39	$32,339,394
Other	94	$22,459,652
Total	1,857	$172,738,754

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

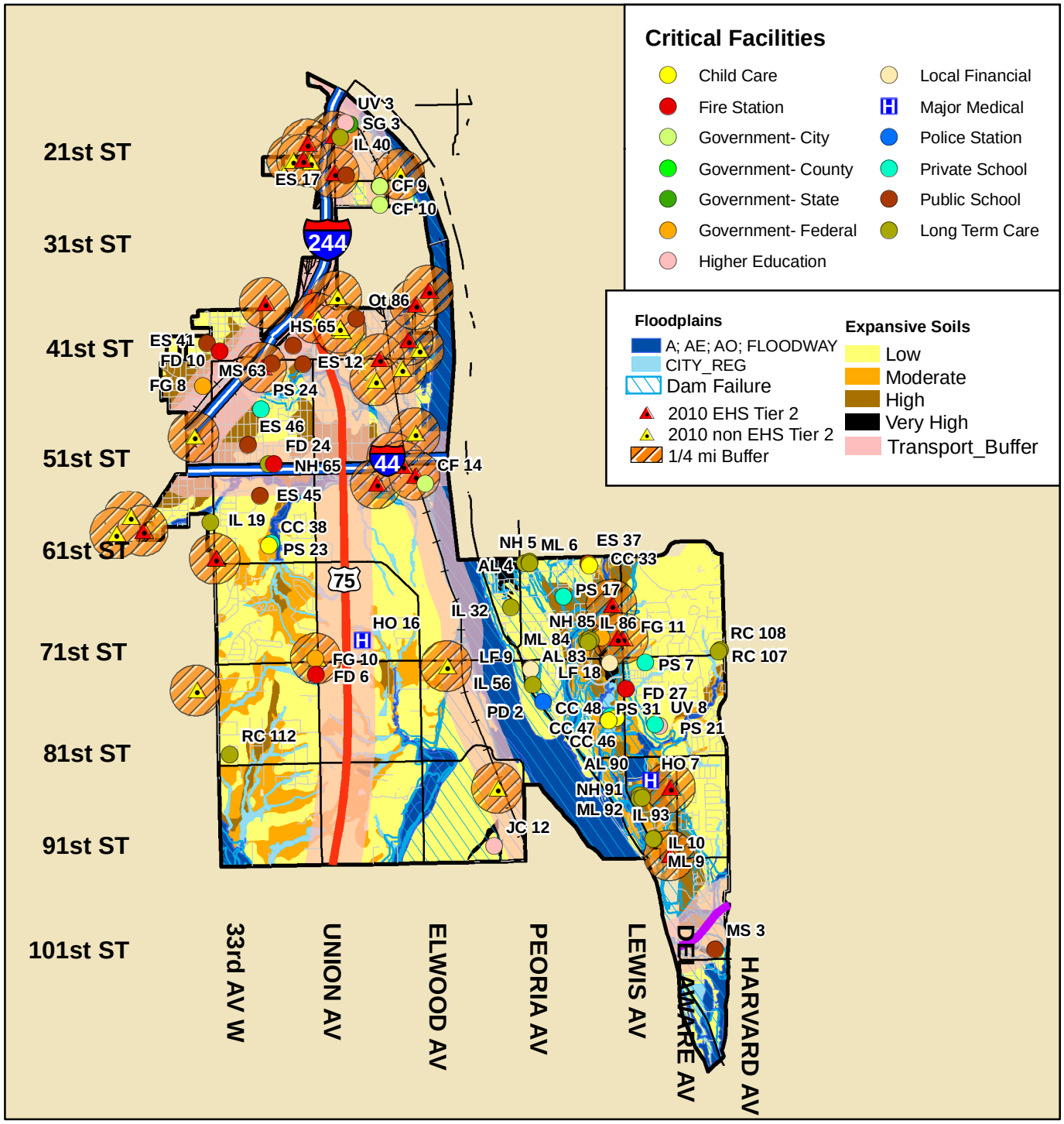
There are 27 critical facilities in Council District 2, located within ¼-mile of a transportation corridor. Critical facilities vulnerable to the Transportation hazard are listed in Table 5.2-5. Though structures themselves are not likely to be directly impacted by this hazard, populations living or working in these facilities are at high risk to the hazard. Of great concern are functional needs populations, such as children at the schools and residents of long term care facilities. As residents of these facilities are likely to need assistance evacuating or sheltering in place if a transportation incident were to occur, pre-planning is important at these facilities.

Conclusion

Tulsa Council District 2 has a HIGH vulnerability to and HIGH probability of the Transportation-Hazardous Materials event.

5.2.4.8 Hazards Summary

Site-specific hazards, unique to Tulsa Council District 2, identified and mapped in this section include Floods, Dam Failure, Levee Failure, Expansive Soils, Wildfires, Fixed-Site Hazardous Materials, and Transportation-Hazardous Materials. The Hazards Composite Map, shown in Figure 5.2-25, summarizes the areas of the district potentially impacted by these site-specific hazards.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad

0 1 2 Miles

R.D. Flanagan & Associates
Planning Consultants

Figure 5.2-25

Tulsa Council District 2

Hazard Composite

City of Tulsa Multi-Hazard Mitigation Plan Update

Tulsa City Council District 3

R.D. Flanagan & Associates

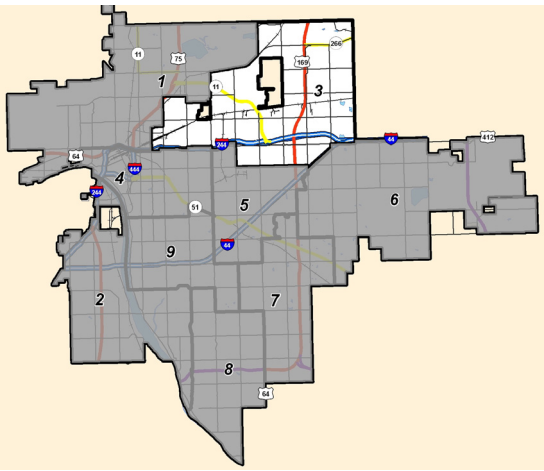
Planning Consultants

5.3 Tulsa City Council District 3

5.3.1 Introduction

5.3.1.1 Location

Figure 5.3–1: Tulsa Locator Map – District 3



Council District 3 is located in northeast Tulsa, shown in the Locator Map. Total land area within the District consists of approximately 32.76 sq mi., as shown in the Base Map in Figure 5.3-2. The District is bounded generally on the north by E 56th Street North, the west by N. Lewis Avenue, the south by East 11th Street and on the east by N. 145th East Ave.

5.3.1.2 David Patrick- Councilor District 3

Councilor David Patrick has called Tulsa home for 60 years. He was elected in 2011 for the fifth time as City Councilor of District 3. Growing up Councilor Patrick attended Tulsa Public Schools. After graduating from Will Rogers High School, he went on to receive multiple automotive certifications. Councilor Patrick now runs his family's business, Patrick Auto Service, which has been at the same location in District 3 since 1950. He and his brother bought the business from their parents in 1975. He owns a management company, Patrick Enterprises, which owns a number of commercial and residential properties. Councilor Patrick also owns a wheat farm in Colorado. Patrick's interest in community stemmed from his involvement on the Maxwell Community Council in the 1980s. He is currently a member of the Dawson Neighborhood Association. *(Source: http://www.tulsacouncil.org/)*

Councilor David Patrick

5.3.1.3 History

Cultural and Historic Properties

Tulsa Council District 3 is home to three cultural sites including: Maxwell Park Library, the Tulsa Air and Space Museum, and Tulsa International Airport, all of which are displayed on the map in Figure 5.3.3. There is one historic structure located in District 3; Dawson School, at the NE corner of East Ute Place and North Kingston Place. Dawson School is a sandstone, Romanesque style, two-room building. It is an excellent example of a schoolhouse built after the post-statehood school building boom. Dawson School was listed in the National Register of Historic places on December 7, 2001 under Criteria A and C, its NRIS number is 01001357.

5.3.1.4 Demographics

Council District 3 had a 2010 Census population of 43,820. A map displaying population density of District 3 is shown in Figure 5.3-4. Table 5.3-1 summarizes the demographic makeup of the District. Maps presenting the demographic information listed in the table are included in Figures 5.3-5 through 5.3-12.

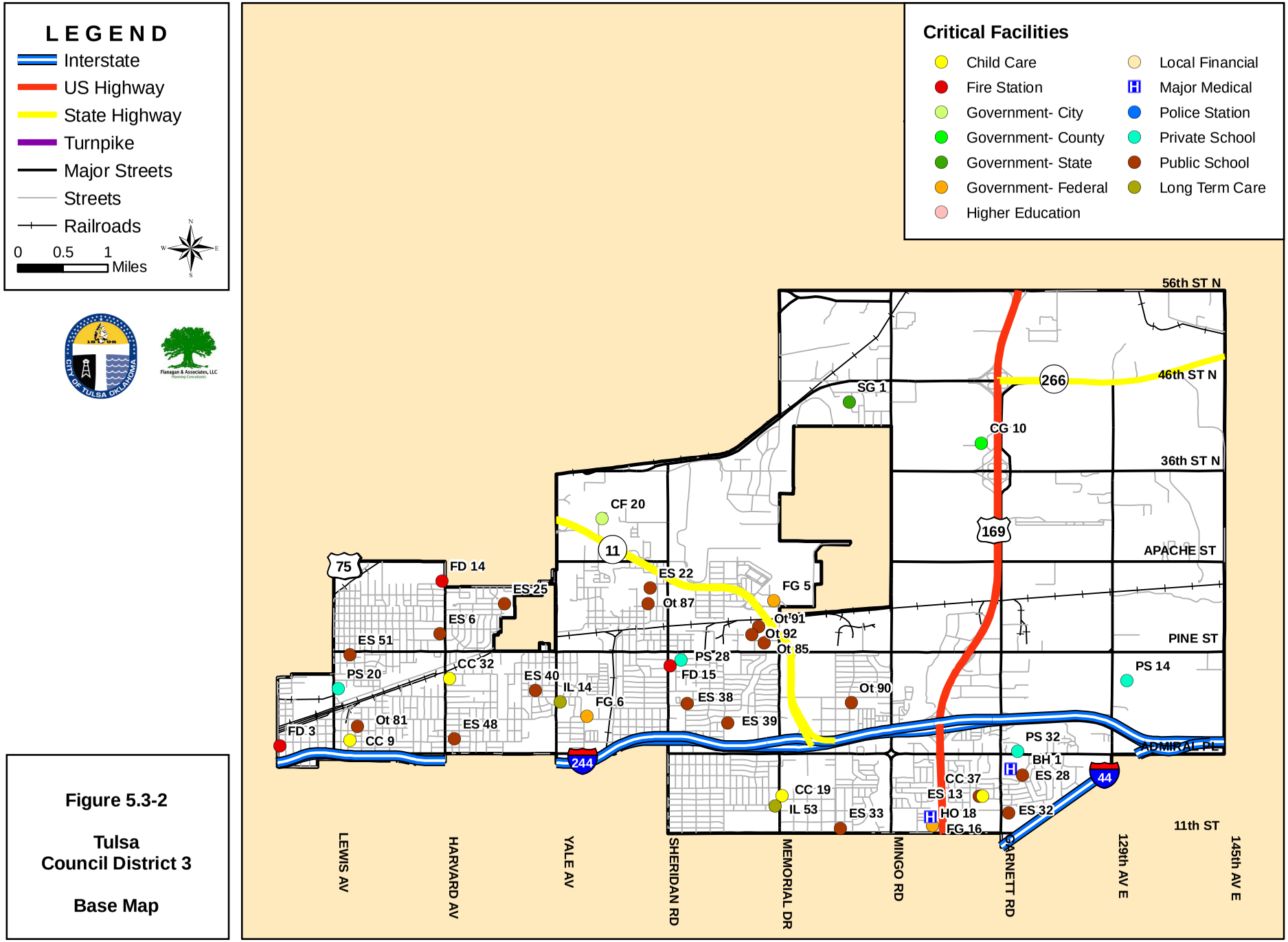


Figure 5.3-2

Tulsa Council District 3

Base Map

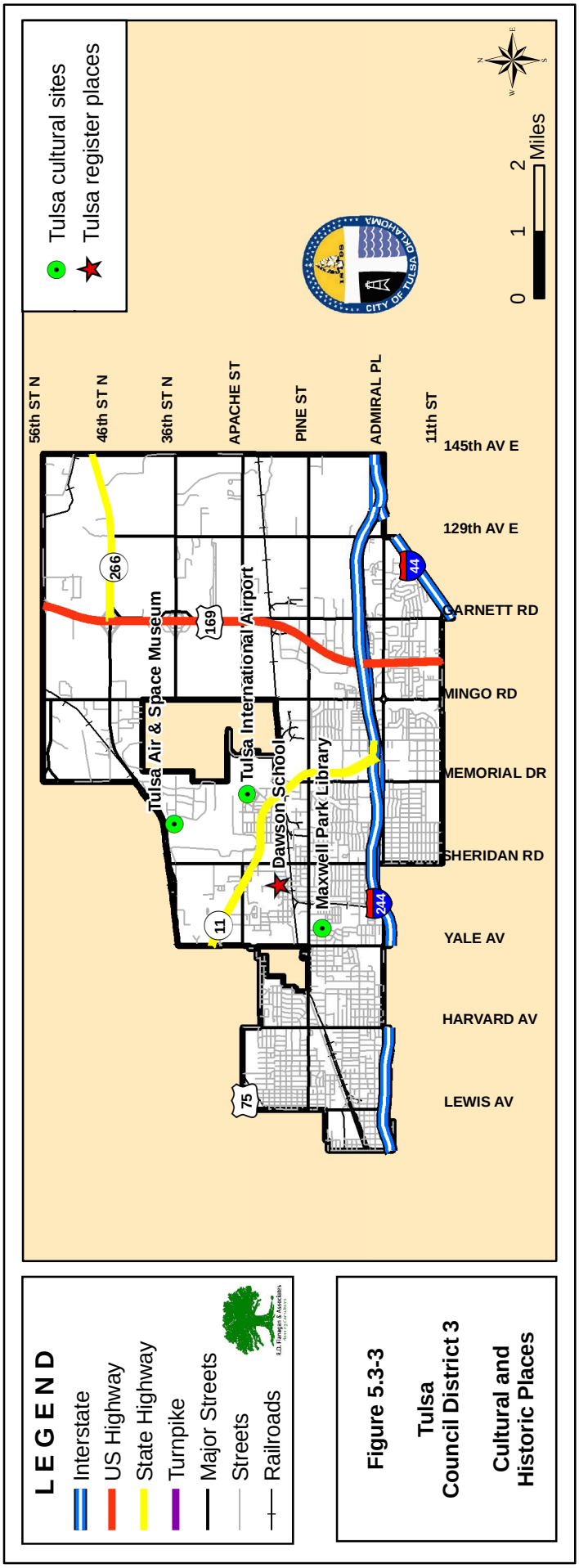


Figure 5.3-3
Tulsa Council District 3
Cultural and Historic Places

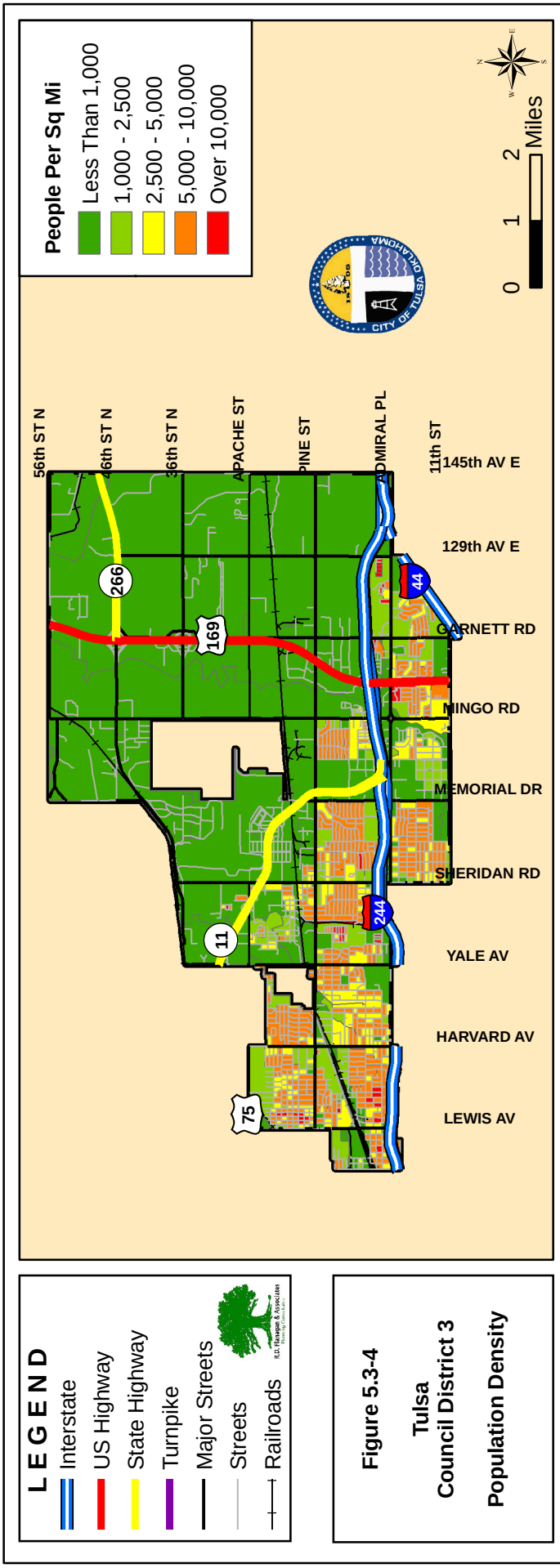


Figure 5.3-4
Tulsa Council District 3
Population Density

Table 5.3–1: Tulsa Council District 3 Demographic Information

Category	District	Tulsa
Persons under 5 years of age	9.71%	7.53%
Persons under age 18	30.32%	24.44%
Persons age 65 and older	9.64%	12.46%
Poverty Status in 2010 (individuals)	29.64%	19.36%
White	52.68%	62.81%
Native-American	8.09%	5.35%
African American	13.17%	15.67%
Asian	0.46%	2.39%
Hispanic	28.66%	13.93%
Total Population	43,820	401,265

Source: US Census, 2010

5.3.1.5 Infrastructure

Tulsa Council District 3 is dependent upon the lifelines of the City of Tulsa as identified in Section 1.2.6 of this Plan Update. Any unique vulnerability of Tulsa Council District 3 in relation to the seven site-specific hazards identified in this plan will be addressed in Section 5.3.4, below.

5.3.1.6 Economy

The 2010 Census identified an income level of approximately $22,133 as the average poverty threshold for a family of four, including two children. Approximately 12,989 individuals, or 29.64% of all persons in District 3, were living below the poverty line in 2010. The number of individuals living below the poverty line in 2010 was higher in District 3 than any other district in the City. A map showing areas of poverty in the District is presented in Figure 5.3-7.

5.3.1.7 Development

According to the Tulsa County Assessor's Office, there are 16,466 properties with improvements within District 3, with a total assessed value, adjusted for fair market price, of $1,101,556,412. The numbers of properties with improvements, and improvement values, by type, are shown in Table 5.3-2. No land, contents or tax exempt values are included. Tulsa Council District 3 is made up of 23 homeowners associations, displayed in Figure 5.3-13.

Table 5.3–2: Tulsa Council District 3 Property Types by Assessed Values

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	14,729	$597,429,290
Residential Multi-Family	292	$24,872,371
Commercial	561	$150,654,833
Industrial	124	$145,292,479.
Other	760	$183,307,439.00
Total	16,466	$1,101,556,412.

Source: Tulsa County Assessor's Office, 2012

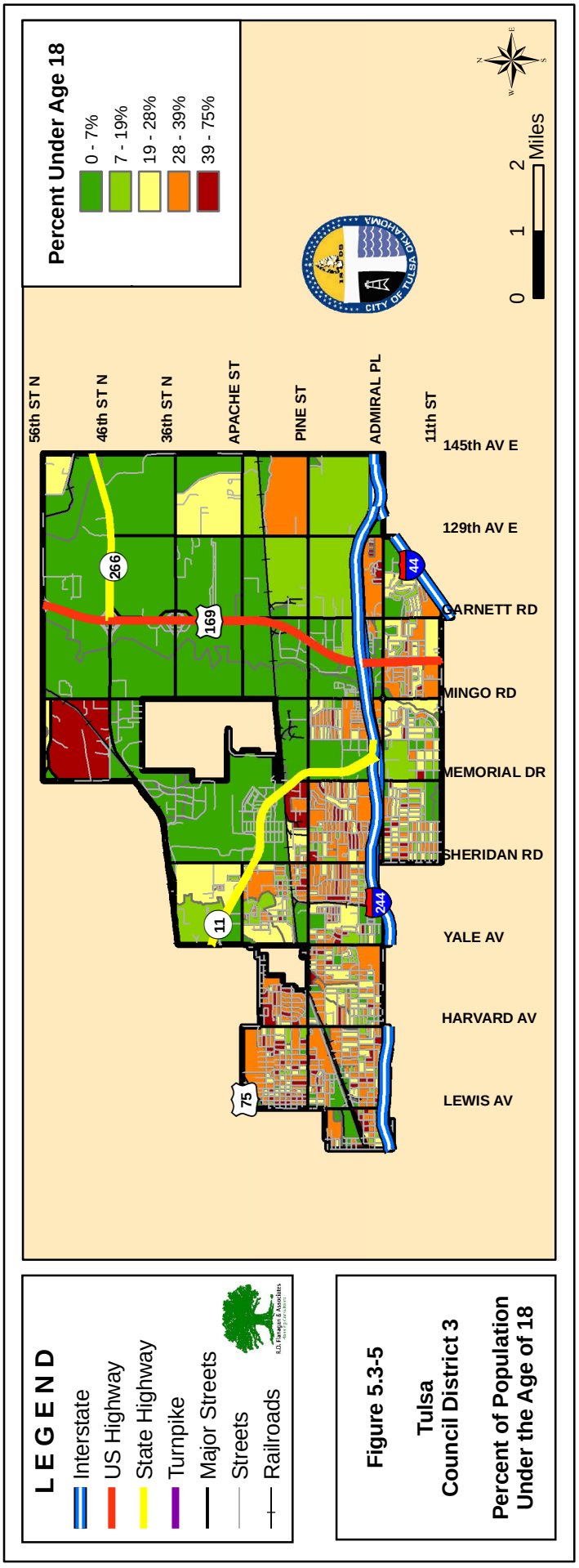


Figure 5.3-5
Tulsa
Council District 3
Percent of Population Under the Age of 18

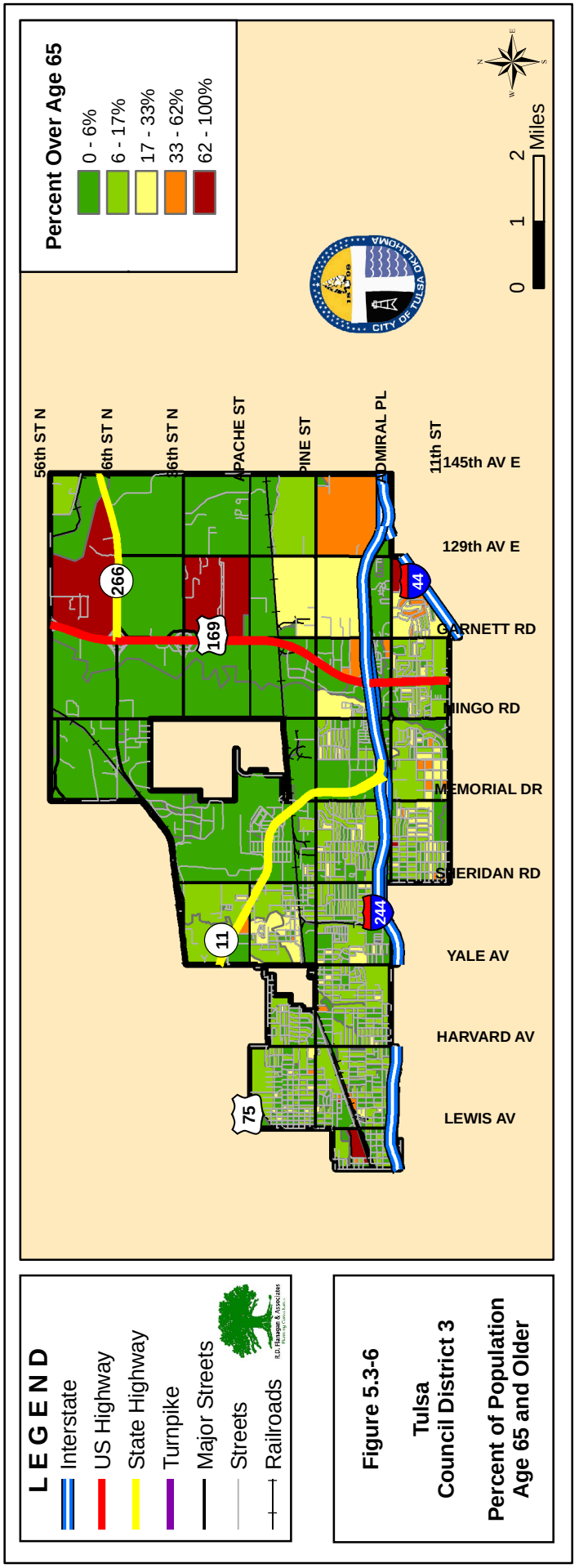


Figure 5.3-6
Tulsa
Council District 3
Percent of Population Age 65 and Older

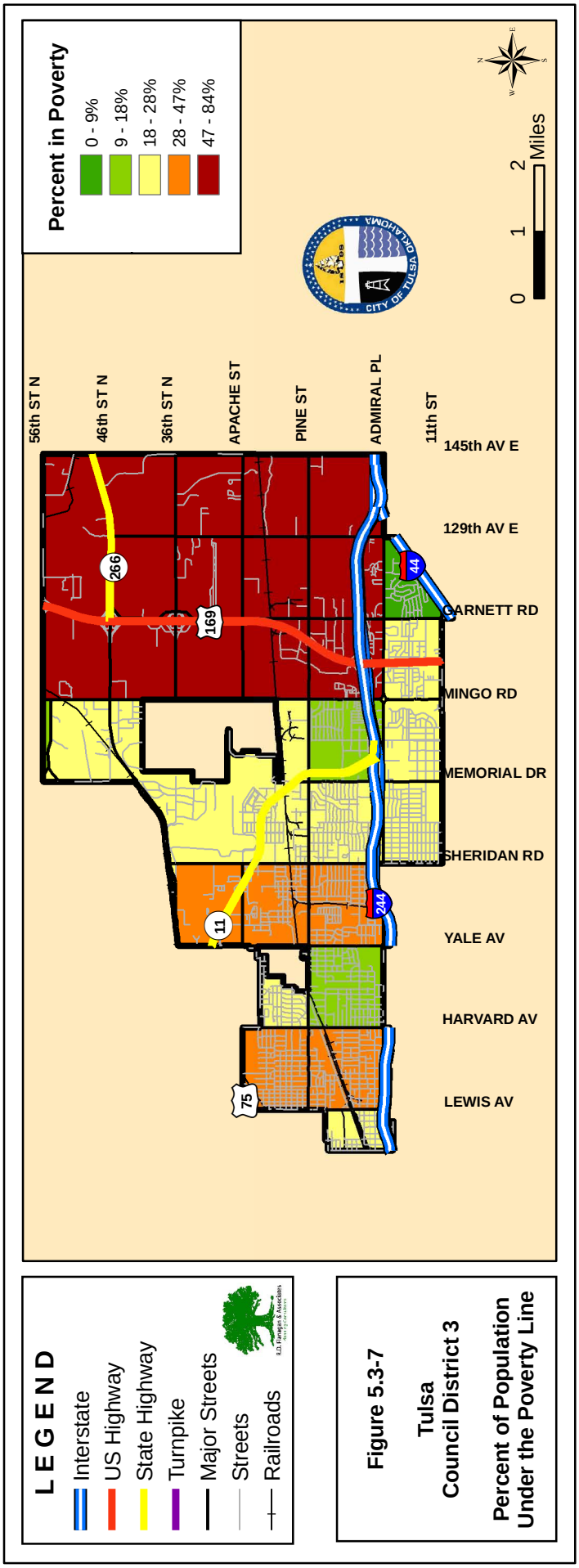


Figure 5.3-7
Tulsa
Council District 3
Percent of Population Under the Poverty Line

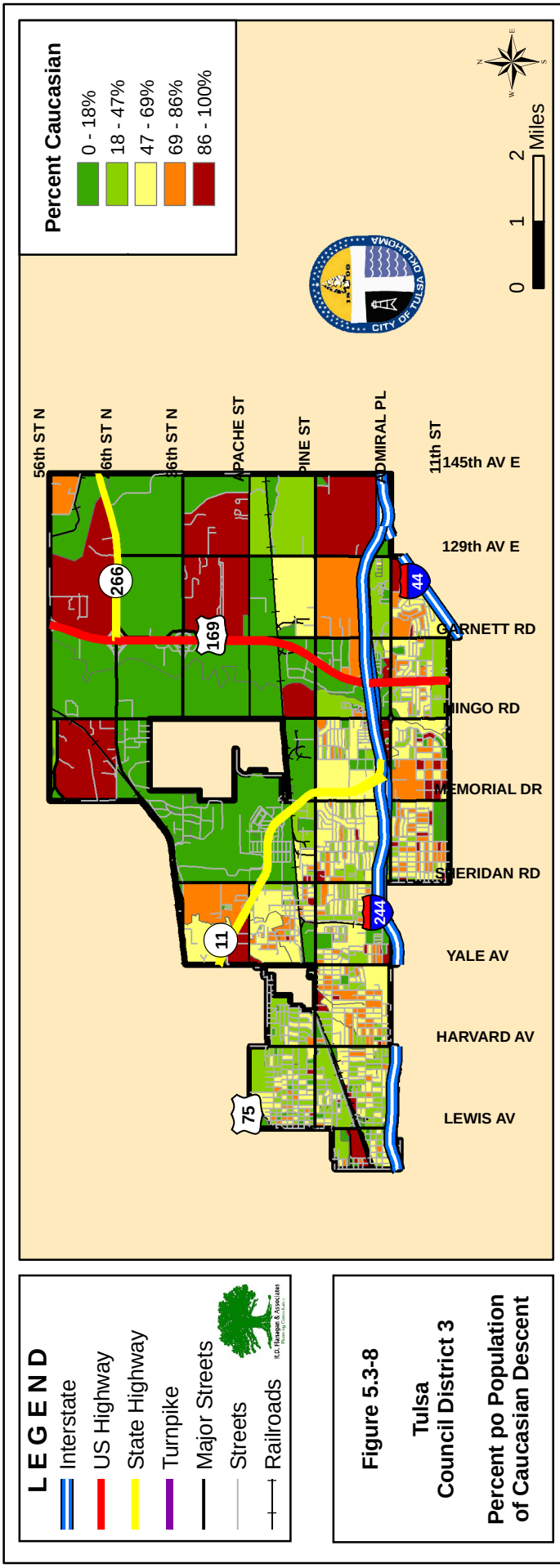


Figure 5.3-8
Tulsa
Council District 3
Percent po Population of Caucasian Descent

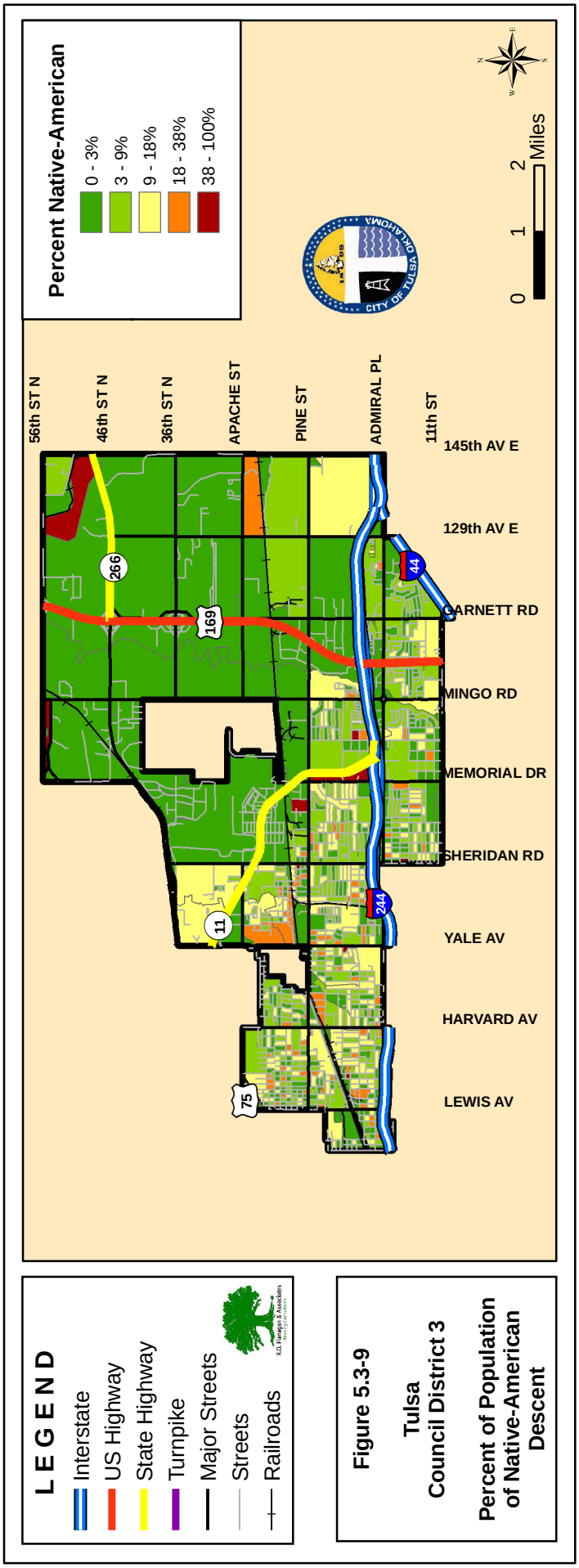


Figure 5.3-9
Tulsa Council District 3
Percent of Population of Native-American Descent

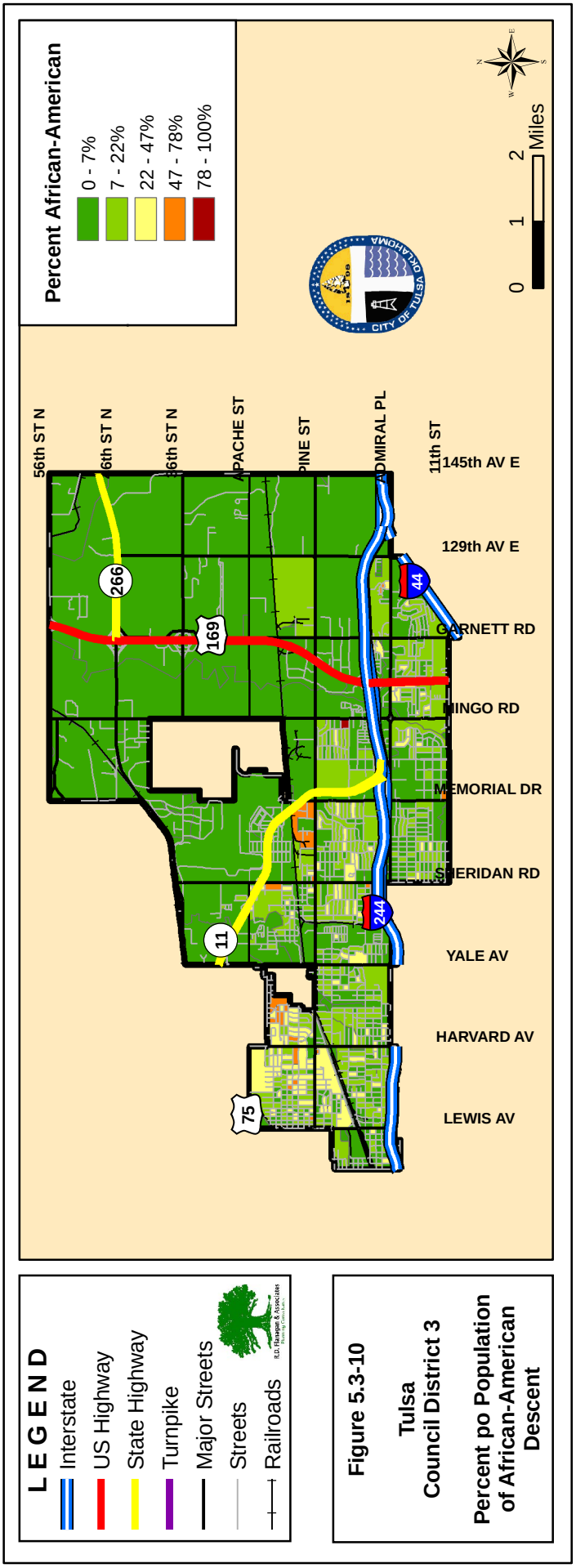


Figure 5.3-10
Tulsa Council District 3
Percent po Population of African-American Descent

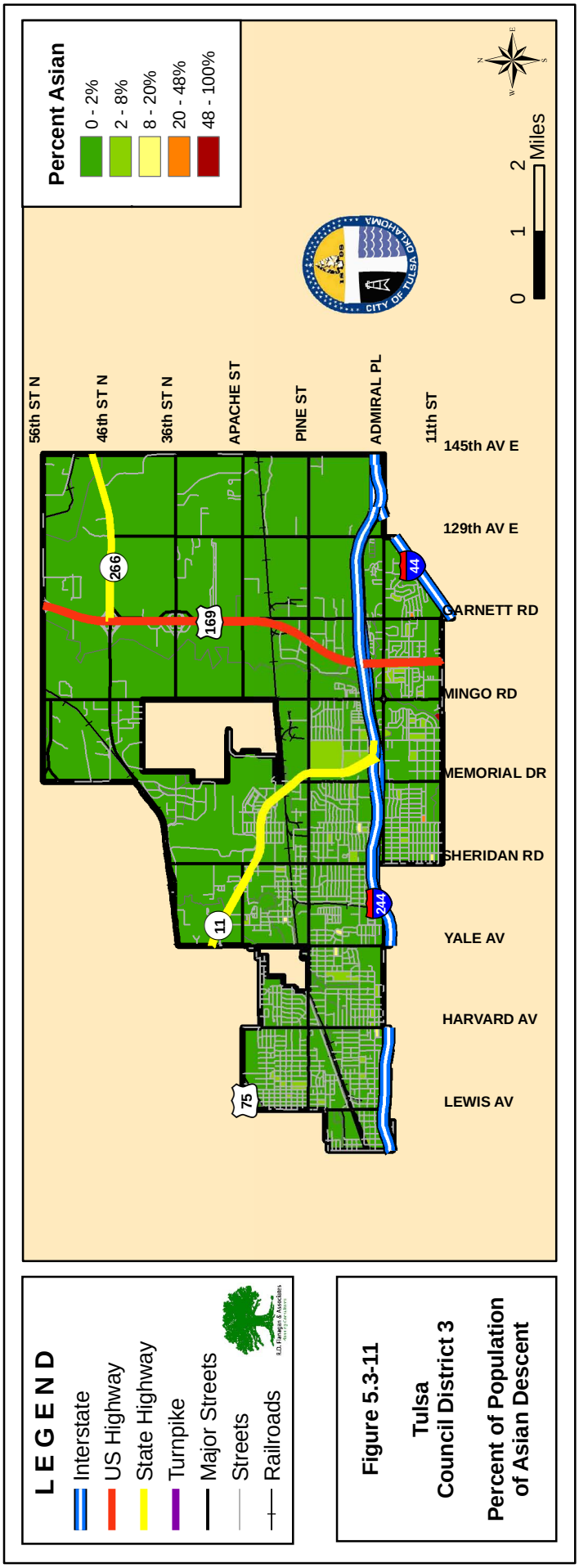


Figure 5.3-11
Tulsa
Council District 3
Percent of Population of Asian Descent

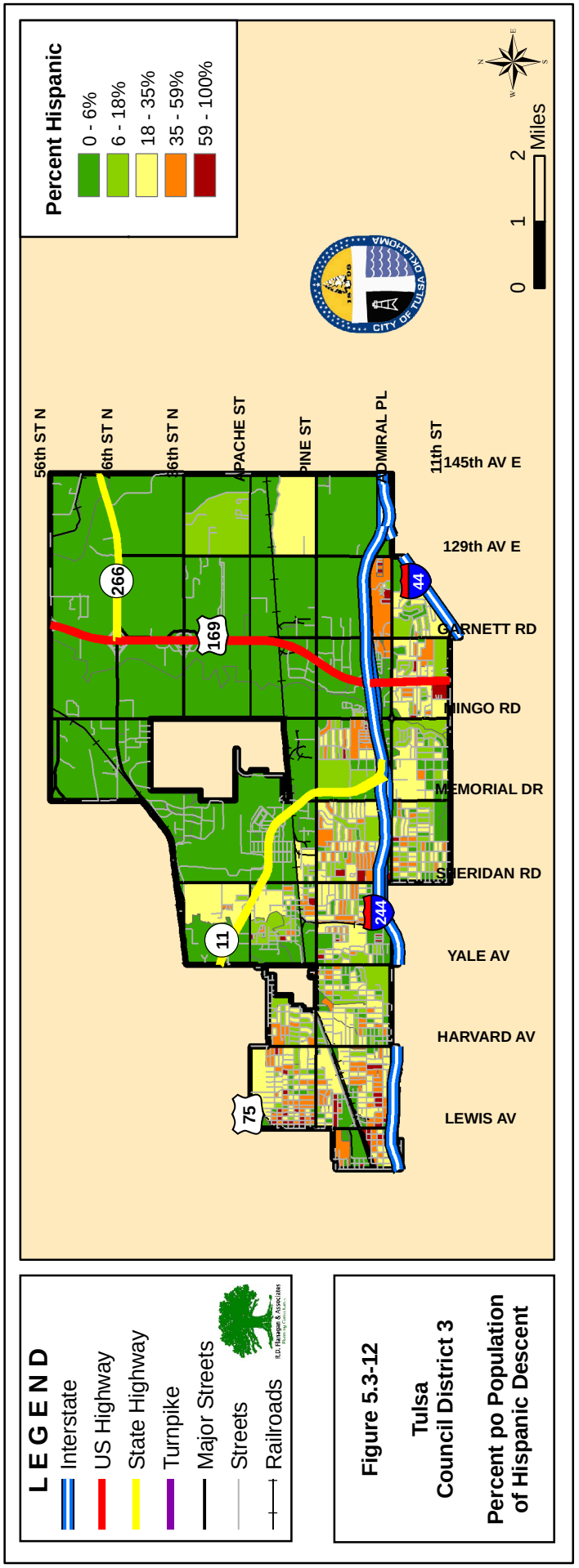


Figure 5.3-12
Tulsa
Council District 3
Percent po Population of Hispanic Descent

Zoning

For the purpose of this plan, four of the 29 zoning districts: Agricultural, Residential, Commercial, and Industrial were used to show zoning within District 3. Much of the land area in District 3 is zoned for single-family residential usage, followed by commercial usage. The areas zoned for industrial usage are spread throughout the District. Few areas are zoned for multi-family use in District 3. A map of zoning areas in Council District 3 is displayed in Figure 5.3-14.

Future Development

The City of Tulsa will continue to improve the service infrastructures of District 3, such as flood control, water, sanitary sewer, and streets, as budgets and funding allow. For information regarding future development plans in the City of Tulsa, see Section 1.2.8.

5.3.1.8 Critical Facilities

Table 5.3-3 lists the Critical Facilities in District 3, which are shown in Figure 5.3-2.

Table 5.3–3: Tulsa Council District 3 Critical Facilities

ID	Map ID	Facility Name	Address
Government-City			
CF	20	Animal Shelter	3031 N. Erie
Fire Station			
FD	3	Tulsa Fire Department #3	62 N Utica Ave
FD	14	Tulsa Fire Department #16	2412 N Harvard Ave
FD	15	Tulsa Fire Department #17	1351 N Sheridan Rd
Government- County			
CG	10	OK Highway Dept Construction Division	4002 N. Mingo Expressway
Government- State			
SG	1	Oklahoma Air National Guard - 138th Fighter Wing	9100 E 46th St
Government- Federal			
FG	5	USPS - Tulsa AMF Retail	2161 Cargo Rd
FG	6	USPS - Northeast Post Office	5313 E Independence
FG	16	NOAA - NWS	10159 E11th St
Tulsa Public Schools			
ES	6	Celia Clinton Elementary School	1740 N Harvard Ave
ES	13	ECDC Reed	10908 E 5th St
ES	22	Hamilton Elementary School	2316 N Norwood Pl
ES	25	Jackson Elementary School	2137 N Pittsburg Ave
ES	28	Kerr Elementary School	202 S 117th E Ave
ES	32	Lewis and Clark Elementary School	737 S Garnett Rd
ES	33	Lindbergh Elementary School	931 S 89th E Ave
ES	38	McKinley Elementary School	6703 E King St
ES	39	Mitchell Elementary School	733 N 73rd E Ave
ES	40	Owen Elementary School	1132 N Vandalia Ave
ES	48	Sequoyah Elementary School	3341 E Archer St
ES	51	Springdale Elementary School	2510 E Pine St

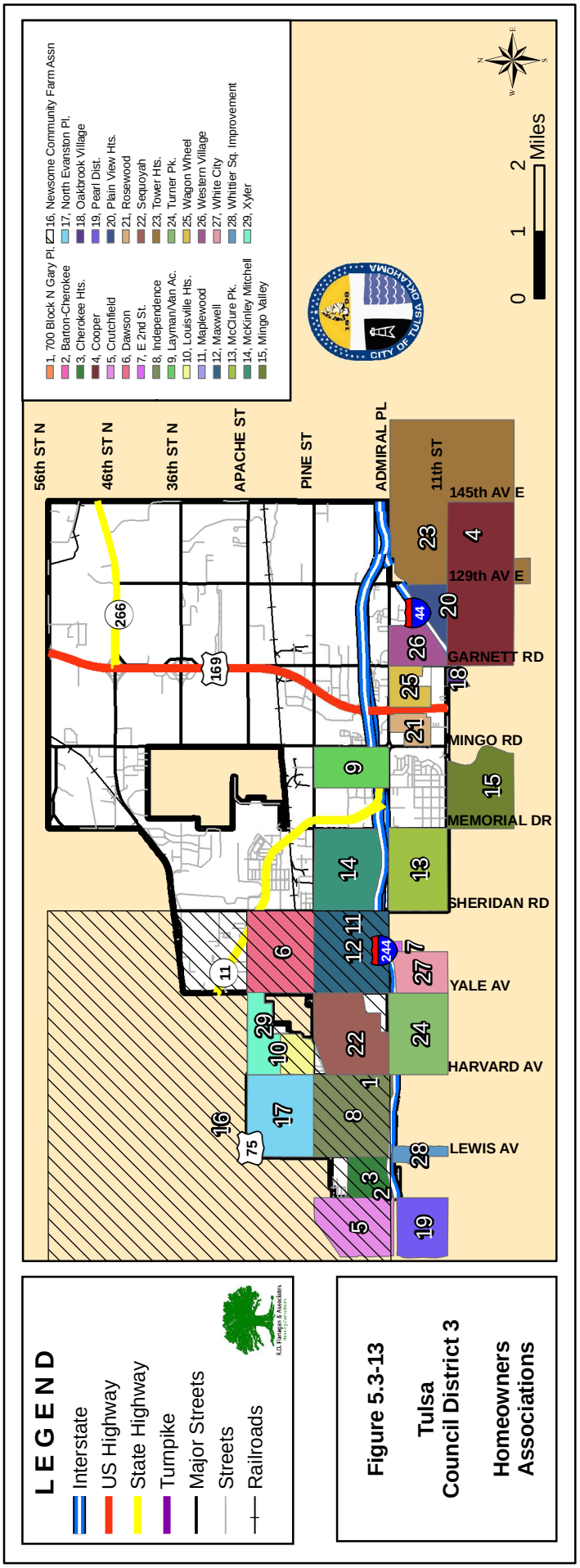


Figure 5.3-13
Tulsa Council District 3
Homeowners Associations

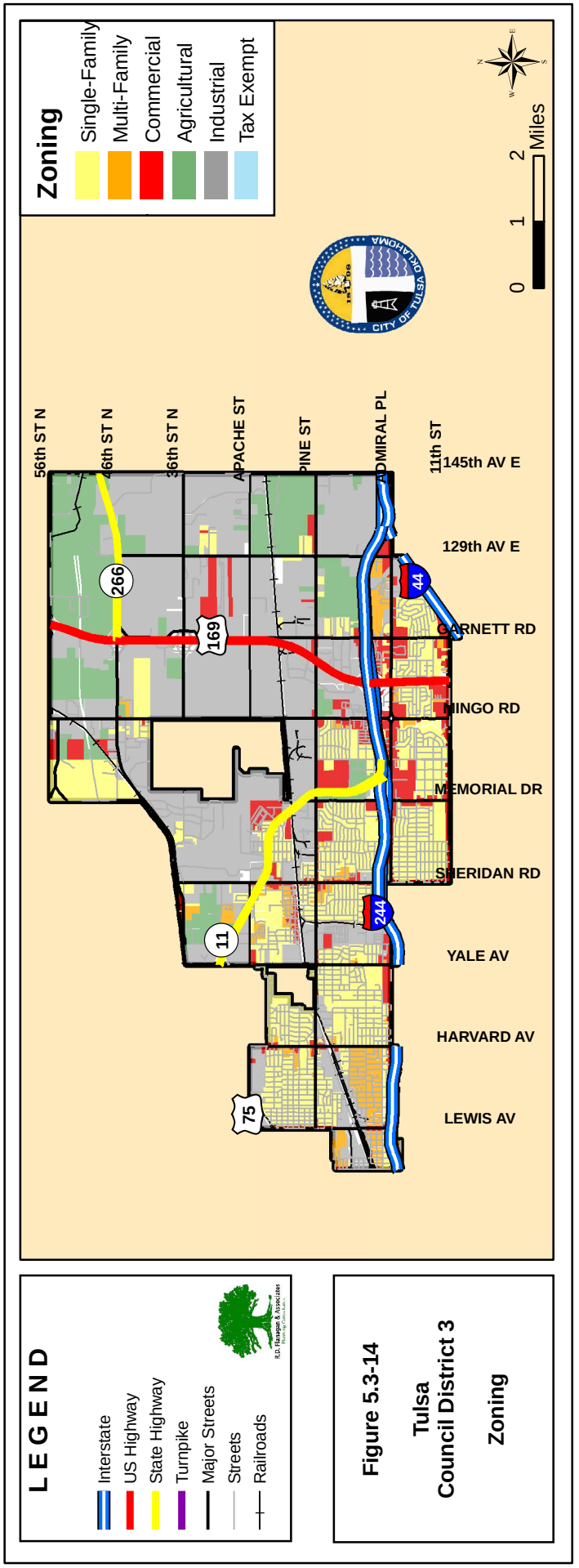


Figure 5.3-14
Tulsa Council District 3
Zoning

ID	Map ID	Facility Name	Address
Ot	81	Cleveland Middle School (Storage)	724 N Birmingham
Ot	85	Maintenance/ Plant Operations/ East Lot	1555 N 77th E Ave
Ot	87	Met Lombard/ Franklin MS/ HS	6201 E Virgin St
Ot	90	Ross Child Nutrition	10908 E 5th St
Ot	91	Transportation Administration Building	1555 N 77th E Ave
Ot	92	Warehouse	1555 N 77th E Ave
Private School			
PS	14	Lincoln Christian School	1003 N 129th East Ave
PS	20	Oklahoma Job Corps Academy	1133 N Lewis
PS	28	Sts. Peter & Paul School	1428 N 67th East Ave
PS	32	Wright Christian Academy	11391 E Admiral Pl
Child Care			
CC	9	Crosstown Learning Center	2501 East Archer
CC	19	Happiness is One	455 S. Memorial
CC	32	Mabee Red Shield Boys and Girls	1231 N. Harvard
CC	37	Reed Family Center	10940 E. 5th Ave.
Major Medical			
BH	1	Brookhaven Hospital	201 S Garnett Rd
HO	18	American Red Cross	10151 E 11th St
Long Term Care			
IL	14	Cornerstone Village	1045 N Yale Ave
IL	53	Park Village	650 S Memorial Dr

5.3.2 Existing Mitigation Strategies

Existing mitigation measures currently being implemented throughout the City of Tulsa are detailed in Chapter 2, *Existing Mitigation Strategies*. The information that follows in this section surveys the infrastructure in place for avoiding or mitigating the impacts of natural hazards, that can be looked at from the District level.

5.3.2.1 Council District 3 Warning Systems

Warning Sirens

Of the 87 warning sirens in the City of Tulsa, 10 are located within the boundary of District 3. Located outside the boundary, but providing partial coverage of some parts of the District are six additional City of Tulsa sirens. There are several areas of District 3 which are outside the range of the existing warning sirens: east of Garnett Rd. generally; north of Apache between Yale Ave. and Memorial Dr.; and between Mingo Rd. and Garnett Rd. and Apache and 36th St. North. Refer to Figure 5.3-15 for the locations and range of warning sirens in District 3.

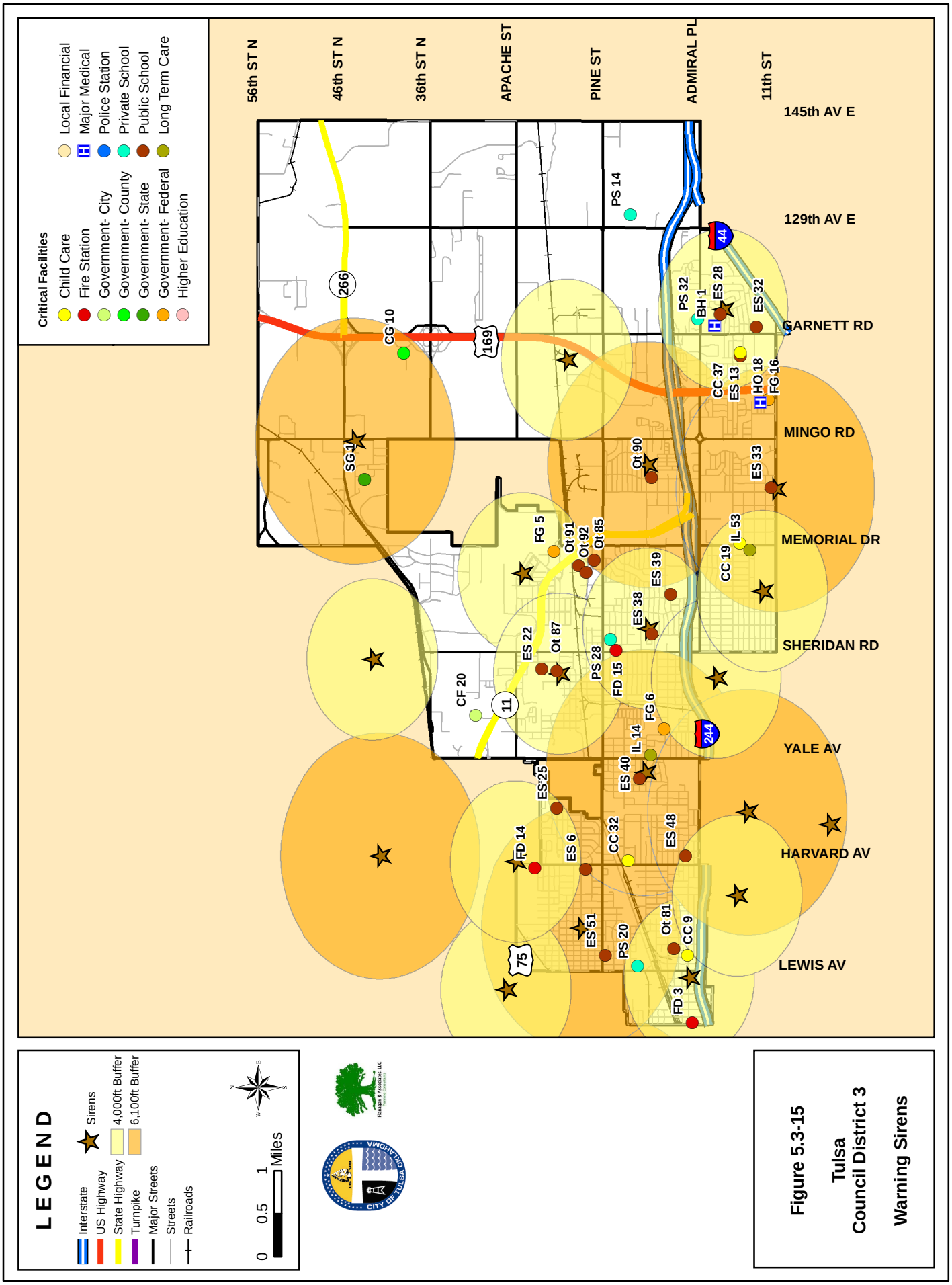


Figure 5.3-15
Tulsa Council District 3
Warning Sirens

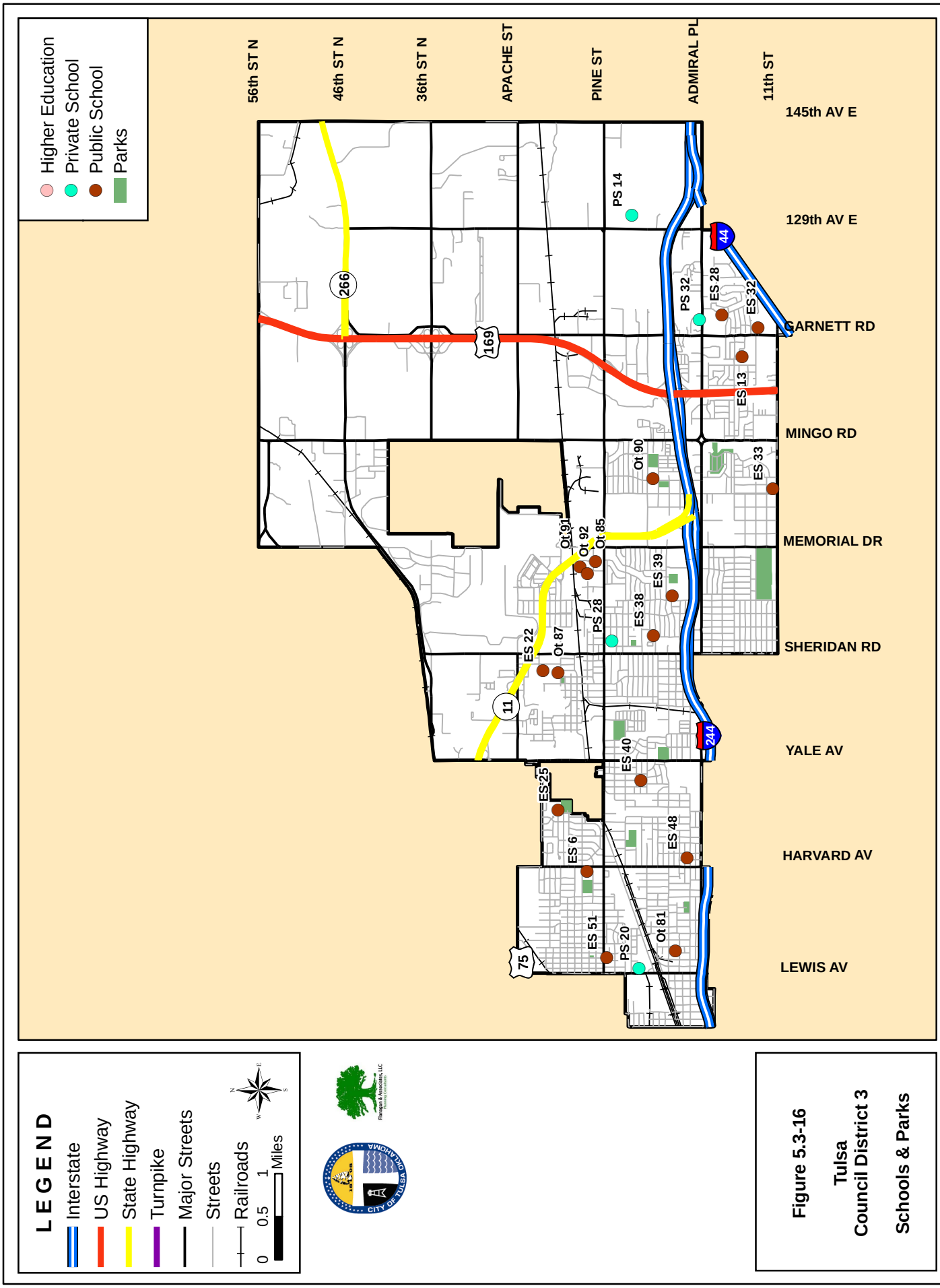


Figure 5.3-16
Tulsa Council District 3
Schools & Parks

Lightning Sensing and Warning

The City of Tulsa is home to many outdoor recreation areas for public use. There are 14 public parks in District 3, as shown in Figure 5.3-16. The District is at the eastern edge of Mohawk Park.

As discussed in Chapter 4, outdoor recreation areas should be equipped with lightning sensing and warning systems. Tulsa Public Schools and the University of Tulsa use ThorGuard© to warn of lightning danger at outdoor recreation sites. A map showing ThorGuard© coverage areas in Tulsa is shown in Chapter 2, Figure 2-3. Public school districts in the surrounding Tulsa Metro Area should be encouraged to purchase and install lightning warning systems. Private schools should also be informed of this option and encouraged to use them at outdoor recreation areas.

5.3.3 Planning Process

The CAC/TAC met monthly during the planning process to review progress, identify issues, receive task assignments, and advise the consultants. Refer to Appendix C for District 3 meeting agendas.

5.3.4 Natural and Manmade Hazards

Hazards

General natural hazards, such as Severe Winter Storms, High Wind, Tornado, Lightning, Hailstorm, Extreme Heat, Drought, Earthquake, and Urban Fires affect all Council Districts in the City of Tulsa randomly and more or less equally, and are addressed collectively in Chapter 4.

Site-specific hazards, such as Flooding, Dam and Levee Failures, Expansive Soils, Wildfires, Fixed-Site Hazardous Materials and Transportation-Hazardous Materials are addressed for District 3 in subsections 5.3.4.1 through 5.3.4.7, summarized in subsection 5.3.4.8 and are shown on the map in Figure 5.3-24. Table 5.3-4 identifies the site-specific hazards the can impact Tulsa Council District 3.

Table 5.3–4: Tulsa Council District 3 Site-Specific Hazard Impacts

Hazard	Area (Sq. mi)	Improved Parcels	Est. Market Value	Percent of Area Impacted	Impacted Population
Floods	6.95	1,433	$117,503,007	20.10%	3,893
Dam Failures	4.58	48	$17,464,120	13.97%	16
Levee Failure	0	0	0	0	0
Expansive Soils	16.64	11,963	$792,888,226	50.78%	29,898
Wildfire	1.74	62	$74,930,965	5.31%	160
Fixed-Site HazMat, ¼ Mi.	10.73	3,215	$401,106,108	32.73%	6,699
Transportation HazMat Highway	10.05	4,270	$461,146,344	30.66%	12,341
Transportation HazMat Railroad	7.66	3,548	$284,779,516	23.37%	7,361

Source: Tulsa County Assessor's Office, 2012/US Census Data 2010

Tulsa Council District 3 has identified certain facilities as critical to the health, safety and welfare of its citizens, business and economy. Table 5.3-5 indicates, generally, the exposure of these critical facilities to the seven site-specific hazards covered by this Plan Update.

Table 5.3–5: Tulsa Council District 3 Hazard Impacts on Critical Facilities

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Fixed Site HazMat	Transportation-Hazard
CF	20	Animal Shelter	X	X	X	X	X	X	X	X	X						X	X
FD	3	Tulsa Fire Department #3	X	X	X	X	X	X	X	X	X				X		X	X
FD	14	Tulsa Fire Department #16	X	X	X	X	X	X	X	X	X						X	
FD	15	Tulsa Fire Department #17	X	X	X	X	X	X	X	X	X				X			
CG	10	OK Highway Dept Construction Division	X	X	X	X	X	X	X	X	X							X
SG	1	Oklahoma Air National Guard - 138th Fighter Wing	X	X	X	X	X	X	X	X	X				X		X	
FG	5	USPS - Tulsa AMF Retail	X	X	X	X	X	X	X	X	X				X		X	X
FG	6	USPS - Northeast Post Office	X	X	X	X	X	X	X	X	X				X			
FG	16	NOAA - NWS	X	X	X	X	X	X	X	X	X				X			X
ES	6	Celia Clinton Elementary School	X	X	X	X	X	X	X	X	X							
ES	13	ECDC Reed	X	X	X	X	X	X	X	X	X				X			
ES	22	Hamilton Elementary School	X	X	X	X	X	X	X	X	X				X		X	X
ES	25	Jackson Elementary School	X	X	X	X	X	X	X	X	X	X			X			
ES	28	Kerr Elementary School	X	X	X	X	X	X	X	X	X				X			
ES	32	Lewis and Clark Elementary School	X	X	X	X	X	X	X	X	X				X			X
ES	33	Lindbergh Elementary School	X	X	X	X	X	X	X	X	X				X			
ES	38	McKinley Elementary School	X	X	X	X	X	X	X	X	X				X			
ES	39	Mitchell Elementary School	X	X	X	X	X	X	X	X	X	X			X			X
ES	40	Owen Elementary School	X	X	X	X	X	X	X	X	X							
ES	48	Sequoyah Elementary School	X	X	X	X	X	X	X	X	X							X
ES	51	Springdale Elementary School	X	X	X	X	X	X	X	X	X				X			
Ot	81	Cleveland Middle School (Storage)	X	X	X	X	X	X	X	X	X				X		X	
Ot	85	Maintenance/ Plant Operations/ East Lot	X	X	X	X	X	X	X	X	X				X			X
Ot	87	Met Lombard/ Franklin MS/ HS	X	X	X	X	X	X	X	X	X				X		X	
Ot	90	Ross Child Nutrition	X	X	X	X	X	X	X	X	X				X			
Ot	91	Transportation Administration Building	X	X	X	X	X	X	X	X	X				X		X	X
Ot	92	Warehouse	X	X	X	X	X	X	X	X	X				X			X
PS	14	Lincoln Christian School	X	X	X	X	X	X	X	X	X							
PS	20	Oklahoma Job Corps Academy	X	X	X	X	X	X	X	X	X				X		X	X

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Fixed Site HazMat	Transportation-Hazard
PS	28	Sts. Peter & Paul School	X	X	X	X	X	X	X	X	X				X			
PS	32	Wright Christian Academy	X	X	X	X	X	X	X	X	X							
CC	9	Crosstown Learning Ctr	X	X	X	X	X	X	X	X	X				X		X	X
CC	19	Happiness is One	X	X	X	X	X	X	X	X	X							
CC	32	Mabee Red Shield Boys and Girls	X	X	X	X	X	X	X	X	X				X		X	X
CC	37	Reed Family Ctr	X	X	X	X	X	X	X	X	X				X			
BH	1	Brookhaven Hospital	X	X	X	X	X	X	X	X	X				X			
HO	18	American Red Cross	X	X	X	X	X	X	X	X	X							X
IL	14	Cornerstone Village	X	X	X	X	X	X	X	X	X							
IL	53	Park Village	X	X	X	X	X	X	X	X	X				X			

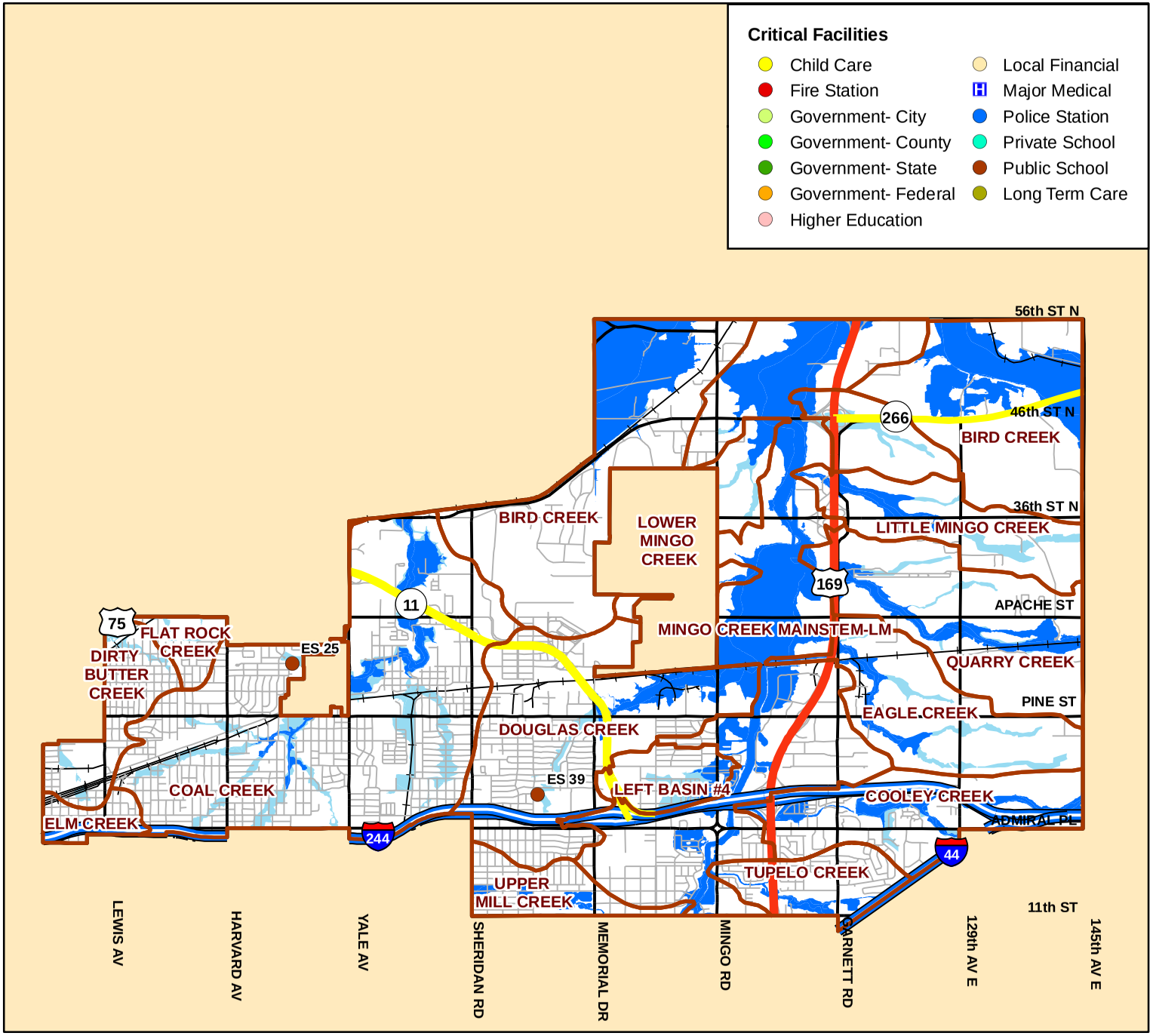
5.3.4.1 Flood

Location

District 3 is affected by the City Regulatory Floodplain and the Special Flood Hazard Area (SFHA). The combined floodplains comprise 6.95 sq. mi., or 20.10 percent of the land within District 3. The drainage basins, 100-year floodplains, City Regulatory Floodplains and the SHFA are all shown on the map in Figure 5.3-17. Streams in Council District 3 and their total drainage area are listed in Table 5.3-6. District 3 has three of the most flood-prone streams in Tulsa: Lower Mingo Creek running from south to north, generally between Mingo and Garnett Rd; Bird Creek running from west to east, generally north of E. 46th St. N.; and Coal Creek, another north-flowing stream, its many tributaries reaching from Lewis Ave. to Sheridan Rd., and from Admiral Blvd. to E. 36th St. N. Almost in the center of the District, and straddling the Mingo Creek and Bird Creek basins, is the Tulsa International Airport, which is outside of the corporate area. This reach of Mingo Creek was one of the most flooded in the City, and has been the site of some of Tulsa's worst disasters—those of 1976 and 1984.

Table 5.3–6: Tulsa Council District 3 Streams and Drainage Areas

Basin	Total Drainage Area (sq. mi.)
DIRTY BUTTER CREEK	0.89
EAGLE CREEK	1.83
QUARRY CREEK	2.46
LITTLE MINGO CREEK	1.39
LEFT BASIN #4	0.58
COOLEY CREEK	1.79
TUPELO CREEK	0.81



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroads
- Basins
- SFHA
- City Regulatory

0 0.5 1 Miles

Figure 5.3-17

Tulsa Council District 3

Basins & Floodplains

Basin	Total Drainage Area (sq. mi.)
BIRD CREEK	2.53
LOWER MINGO CREEK	0.72
DOUGLAS CREEK	3.21
UPPER MILL CREEK	0.67
LOWER MINGO CREEK	0.53
ELM CREEK	0.32
BIRD CREEK	3.01
MINGO CREEK MAINSTEM-LM	5.69
FLAT ROCK CREEK	0.33
COAL CREEK	6.02
Total	32.78

Impact/Vulnerability

In total 1,135 residential single family structures, 55 residential multi-family structures, 45 commercial buildings, 11 mobile homes, 28 industrial buildings, and 159 buildings classified as *other* are touched by the 100-year floodplains of Council District 3. The 1,433 improved parcels have an adjusted value, estimated for fair market, of $117,503,007. District 3 improved parcels touched by the 100-year floodplain are listed, by value and type, in Table 5.3-7.

Table 5.3–7: Tulsa Council District 3 Buildings Touched by 100 year Floodplain

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	1,135	$44,722,079
Residential Multi-Family	55	$6,094,400
Commercial	45	$17,749,708
Industrial	28	$32,292,950
Other	170	$16,643,870
Total	1,433	$117,503,007

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Two critical facilities in District 3 are located in or adjacent to the 100-year floodplain. Vulnerable critical facilities are identified in Table 5.3-3 and shown in Figure 5.3-17. Flood damage at any of the identified facilities could require them to close for a period of time if repairs are necessary.

Repetitive Loss Properties

Out of the 93 repetitive loss properties in the City of Tulsa, five are located in Council District 3: one residential and four commercial.

Flood Control Projects

Tulsa's floodplain and stormwater program includes comprehensive watershed management, dedicated funds for maintenance and operation, and a $200 million capital improvements program. In Council District 3, many projects have been completed for flood control issues.

Figure 5-3-18 displays flood control projects in Council District 3, identified in the 2004 Capital Improvements Plan. District 3 flood control projects budgeted in the 2008-2012 Capital Improvements Plan, are listed in Table 5.3-8.

Table 5.3–8: Tulsa Council District 3 Flood Control Projects 2008-2012

Project ID	Project Basin and Description	Budget
17	Coal Creek - Burlington Detention & Crossing Improvements	$3,700,000
18	Coal Creek - Celia Clinton Detention & Storm Sewer	$2,200,000
19	Coal Creek - Maxwell Park Storm Sewer	$18,360,000
20	Coal Creek - Pine and Fulton Drainage Improvements	$350,000
31	Dirty Butter Creek – Wheeling Latimer Detention, Crossing & Channel	$3,880,000
42	Flat Rock Creek Trib. - 32nd St. N. & Harvard Ave. Drainage Improvements	$660,000
67	Mill Creek - 11th & Sheridan Storm Sewer Rehabilitation	$15,500,000
70	Mingo Creek (Lower) – Carriage Village Mobile Home Park	$5,130,000

Source: PLANiTulsa Capital Expenditures Plan 2008-2012

Conclusion

Tulsa Council District 3 has a HIGH probability of and a HIGH vulnerability to the Flood hazard.

5.3.4.2 Dam Failure

Location

District 3 is located east of the Arkansas River in the northeast quadrant of the City of Tulsa, downstream from Skiatook Dam. The District is vulnerable to a failure of Skiatook Dam, which would release a flood surge into Bird Creek and, given other conditions, would cause backup along Coal Creek and Mingo Creek. A map of the dam break inundation areas in District 3 is shown in Figure 5.3-19. The dam inundation area in District 3 covers approximately 4.58 square miles of land, or 13.97 percent of the District. For an in-depth discussion of Dam Failure in the City of Tulsa, see Chapter 4, Dam Failure.

Impact/Vulnerability

About 4.58 sq mi of the land area in District 3 is vulnerable to dam failure. According to data from the Tulsa County Assessor, approximately 48 parcels with a total assessed value, adjusted for fair market, of $17,464,120 would be impacted by a failure of the Skiatook Dam. The number of parcels in the Skiatook Dam inundation areas is summarized in Table 5.3-9.

Table 5.3–9: Tulsa Council District 3 Parcels Touched by Skiatook Dam Inundation Area

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	8	$1,467,686
Residential Multi-Family	0	$0
Commercial	3	$473,500
Industrial	11	$10,240,815
Other	26	$5,282,119
Total	48	$17,464,120

Source: Tulsa County Assessor's Office, 2012

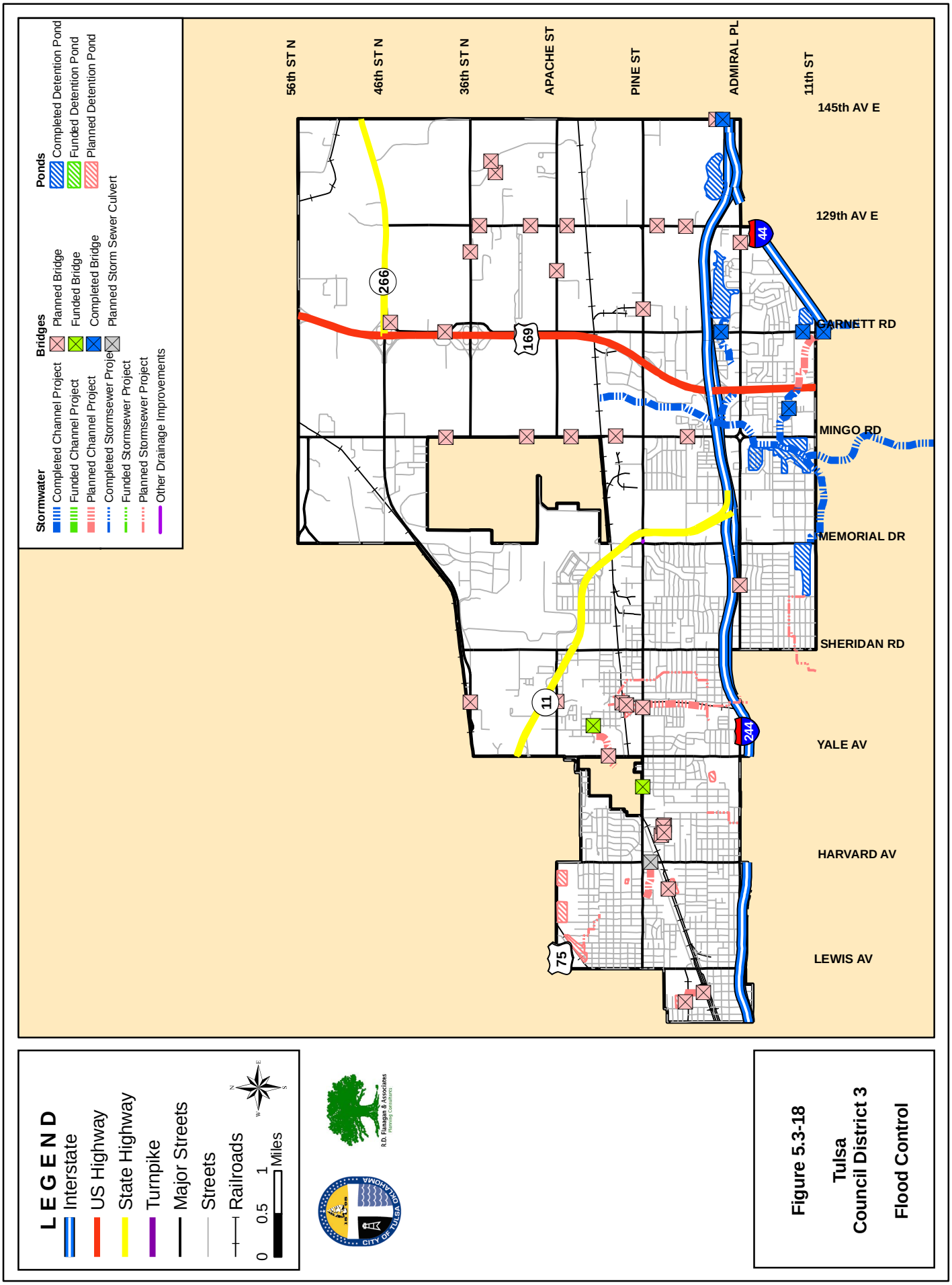


Figure 5.3-18
Tulsa
Council District 3
Flood Control

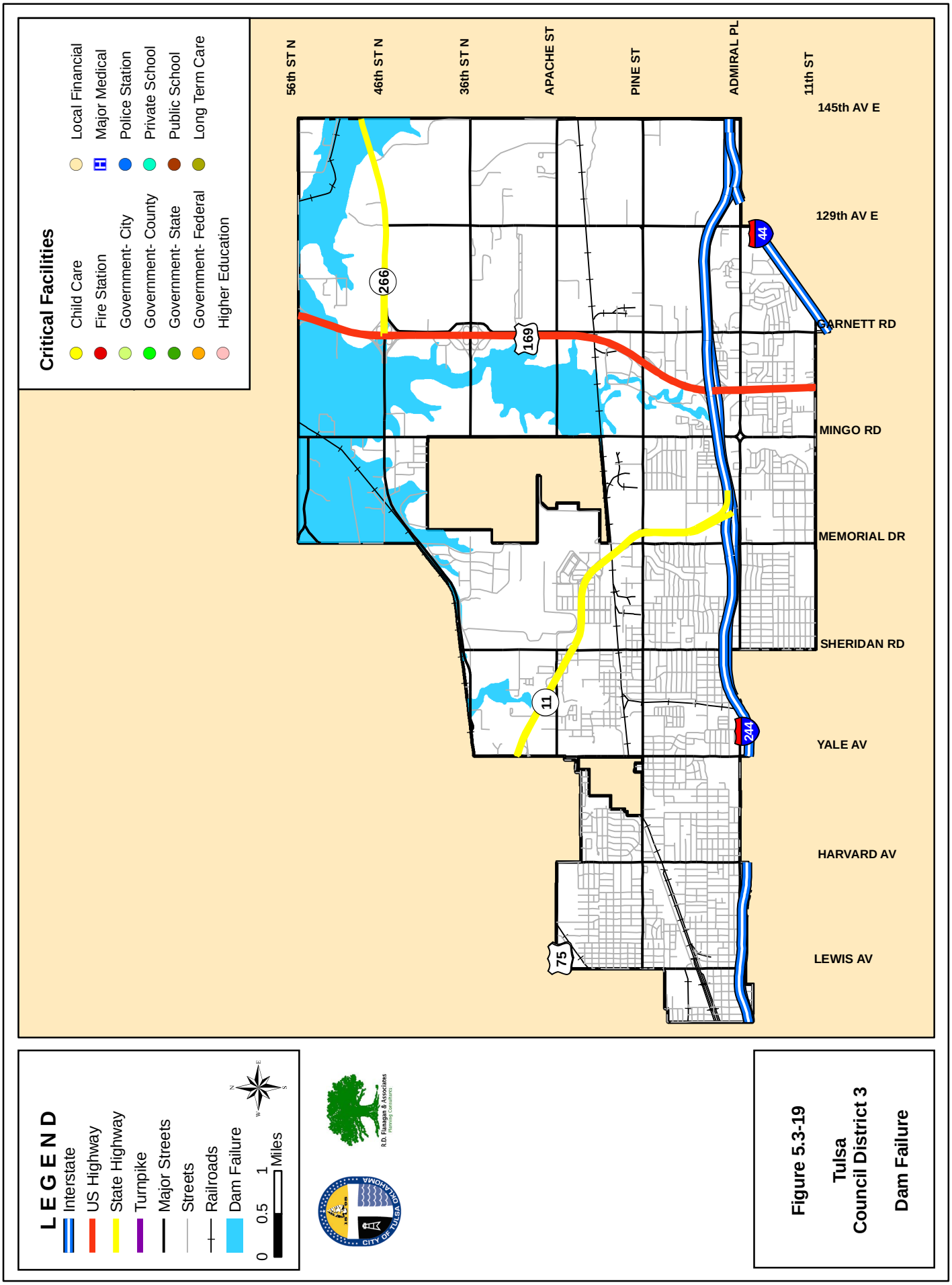


Figure 5.3-19
Tulsa
Council District 3
Dam Failure

Critical Facilities

One critical facility in District 3, the Northside Wastewater Treatment Plant, between 105th E. Ave. and the Mingo Valley Expressway, and north of E. 56th St. North, would be impacted by the breach or failure of Skiatook Dam. The plant is technically outside of the Tulsa Corporate Area, the boundary of which is E. 56th St. North. The treatment plant is designed for an average flow of 42.6 mg, although the plant's original load allocation was 36.8 mgd. Wastewater enters the treatment plant through a 36 inch and a 42 inch force main from the Northside Interceptor Lift Station and a 36 inch and a 42 inch force main from the Apache Lift Station. Additional influent is pumped from the Airport Lift Station through a 16 inch force main.

Conclusion

Tulsa Council District 3 has a MODERATE vulnerability to and a LOW probability of the Dam Failure hazard.

5.3.4.3 Levee Failure

Location

District 3 has one levee along Mingo Creek, north of Pine St. This private levee protects the Wolf Creek Industrial Park.

Impact/Vulnerability

The private levee on Mingo Creek that protects the Wolf Creek Industrial Park is not certified, and as of this writing is in need of maintenance and repair.

Critical Facilities

There are no critical facilities in area protected by the Wolf Creek Industrial Park levee.

Conclusion

Tulsa Council District 3 has a LOW vulnerability to and a MODERATE probability of the Levee Failure hazard.

5.3.4.4 Expansive Soils

Location

Council District 3 is underlain predominantly by soils with High shrink/swell potential, with High to Very High expansive soils beneath about 50.78 percent of the District and Low to Moderate soils beneath about 48.10 percent. The expansion potentials of District 3 soils are summarized in Table 5.3-10. A map showing the location of the Districts expansive soils is presented in Figure 5.3-20.

Table 5.3–10: Tulsa Council District 3 Expansive Soils

Expansion Potential	Area (sq mi)	Percent of Total District Boundaries
Very High	3.13	9.54%
High	13.51	41.24%
Moderate	7.12	21.73%
Low	8.71	26.58%
Water	0.30	0.91%
Total	32.76	100.00%

Impact/Vulnerability

According to Tulsa County Assessor data, 11,963 parcels of various types with a total value, assessed for fair market, of $792,888,226 are underlain by soils with High to Very High shrink/swell potential. The majority of the parcels are residential-single family structures. As mentioned in Chapter 4, this structure type has the highest exposure to expansive soils. Residents should be made aware of the expansive soil hazard so they may record and repair them as necessary. A summary of District 3 parcels located on highly expansive soils is included in Table 5.3-11.

Table 5.3–11: Tulsa Council District 3 Parcels on High to Very High Expansive Soils

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	10,761	$415,818,040.00
Residential Multi-Family	250	$18,135,280.00
Commercial	363	$105,196,675.00
Industrial	89	$126,475,642.00
Other	500	$127,262,589
Total	11,963	$792,888,226.00

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Critical Infrastructure in District 3 has the potential to be impacted by this hazard, especially during periods of extreme heat and drought. All major transportation routes in the District are underlain at some point by soils with High shrink/swell potential. The highways and interstates should be monitored for damages in these areas. The City should continue to monitor roads and pipelines in areas with highly expansive soils for cracks and other damages, especially during periods of extreme heat and drought. There are 28 Critical facilities located on High or Very High expansive soils in District 3. Although it is likely the structures were engineered to account for the soils on which they are built, effort should be made to monitor the facilities for damages and report/repair as necessary. A complete inventory of critical facilities located on soils with High to Very High expansion potential is included in Table 5.3-5.

Conclusion

Tulsa Council District 3 has a HIGH vulnerability to and HIGH probability of the Expansive Soils hazard.

5.3.4.5 Wildfire

Location

Council District 3 is vulnerable to the Wildfire hazard. Of the land area that makes up the District, 14.12 square miles, or 43.08 percent of the District, has a High to Very High Wildfire Level of Concern (LOC). A map displaying the Wildfire LOC in the District is shown in Figure 5.3-21.

Impact/Vulnerability

There are 62 parcels with improvements located in areas of Moderate to Very High Wildfire LOC, summarized in Table 5.3-12. The area of the District with the greatest LOC is located to the east of Tulsa International Airport, from N Mingo Road to just east of N Garnett Road and south from just north of E 46th Street North to the St. Louis and San Francisco (Frisco) railroad tracks between E Apache Street and E Pine Streets. The large area east of the Mingo Valley Expressway to the

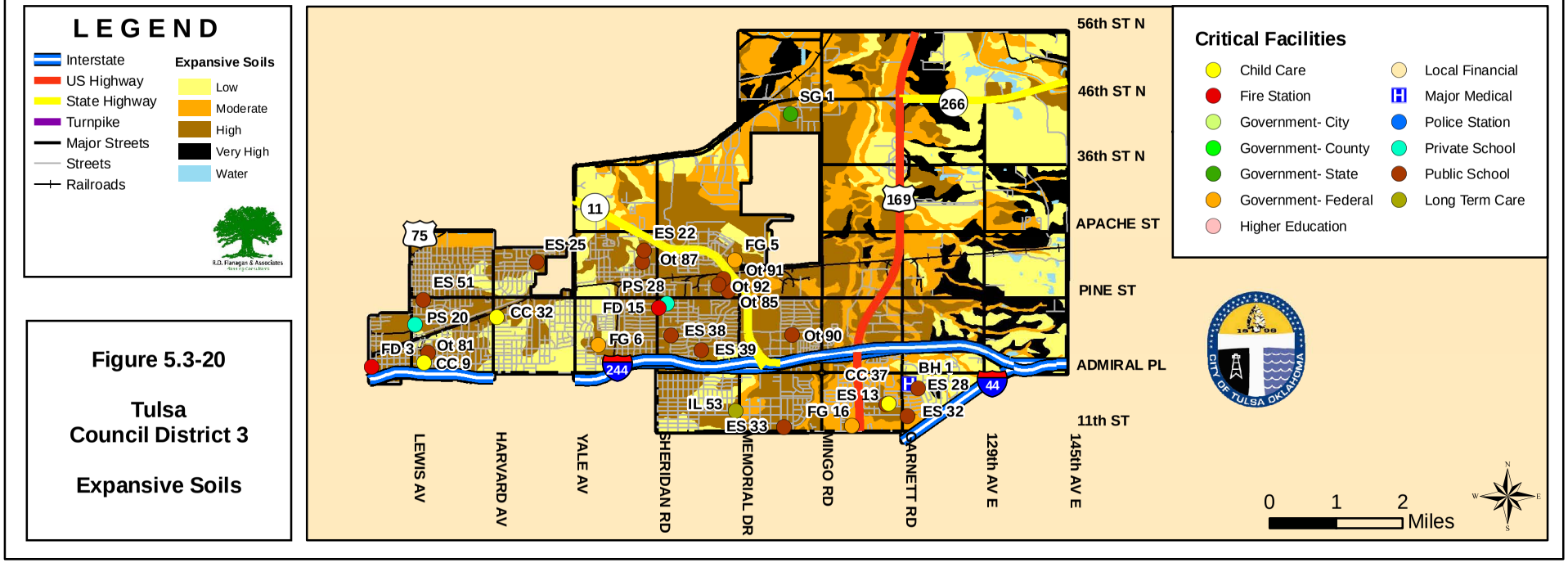


Figure 5.3-20

Tulsa Council District 3

Expansive Soils

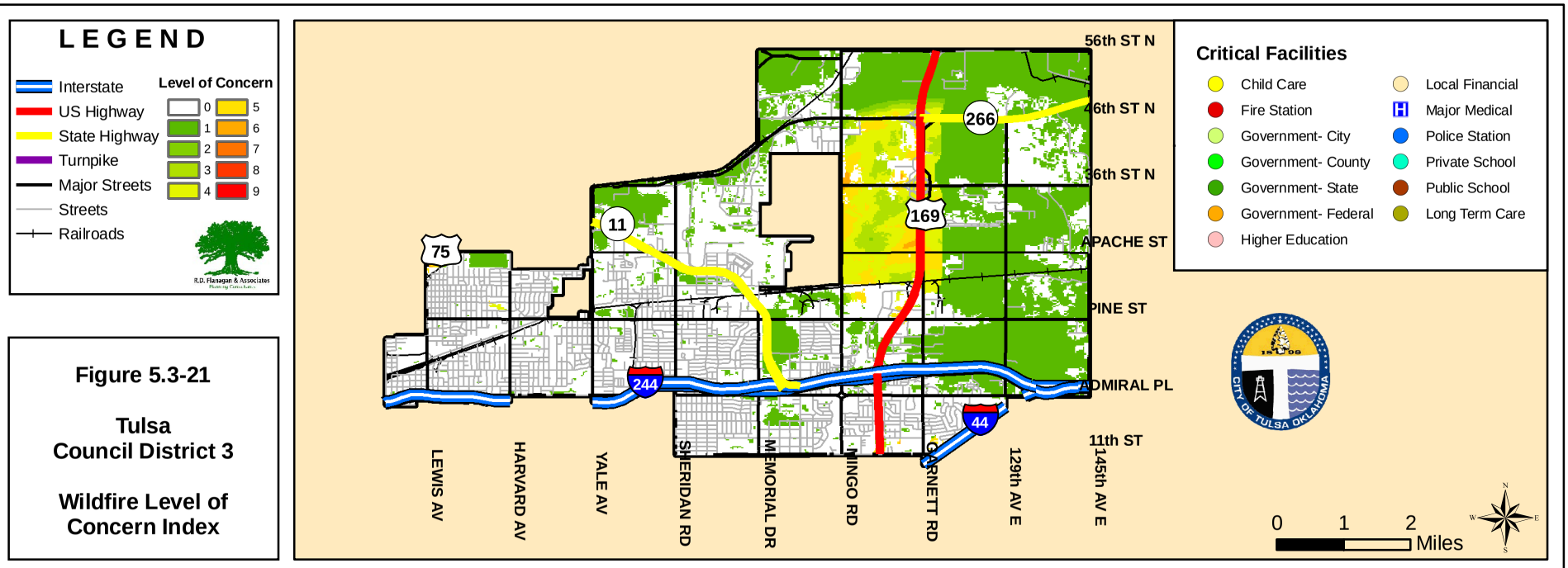


Figure 5.3-21

Tulsa Council District 3

Wildfire Level of Concern Index

corporate boundary, north of I-244 is largely given over to industry, including extensive limestone quarries. District 3 has a heightened exposure to the wildfire hazard due to the large areas of unoccupied land that adjoin developed areas on the urban fringe—an area known as the Wildland Urban Interface (WUI). Although not indicated as having a high wildfire susceptibility on the map, as explained in Chapter 4, WUI areas are prone to wildfires. Lightning, a cigarette thrown from a car window, or sparks from a motor vehicle or train, can ignite wildfire fuels, especially during times of extreme heat and drought.

Table 5.3–12: Tulsa Council District 3 Parcels Touched by Wildfire Level of Concern

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	19	$1,830,485
Residential Multi-Family	0	$0
Commercial	9	$19,925,600
Industrial	8	$32,030,100
Other	26	$21,144,780
Total	62	$74,930,965

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

No critical facility in District 3 is located in an area with wildfire concern.

Conclusion

Tulsa Council District 3 is considered to have a MODERATE vulnerability to and LOW probability of the Wildfire hazard.

5.3.4.6 Fixed-Site Hazardous Materials

Location

There are 90 Tier II facilities located in Tulsa Council District 3. Of the Tier II sites in the District, 30 contain an Extremely Hazardous Substance (EHS). Due to the sensitive nature of this material, Tier II facilities in the District are mapped in Figure 5.3-22 to show only approximate location of the sites. A listing of EHS and Non-EHS Tier II facilities in Council District 3 can be found in Appendix E, and is available on a need-to-know basis.

Impact/Vulnerability

According to the Marplot analysis, which uses 2010 US Census data, 6,699 people living or working in Council District 3 are vulnerable to the impacts of this hazard, as described in Chapter 4. Information regarding the number and type of improved parcels located within ¼ mile of a Tier II facility, along with their fair market value, is included in Table 5.3-13.

Table 5.3–13: Tulsa Council District 3 Parcels in ¼ Mile Tier II Buffer

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	2,462	$83,975,166
Residential Multi-Family	69	$2,425,700
Commercial	220	$62,255,057
Industrial	92	$124,932,879
Other	372	$127,517,306
Total	3,215	$401,106,108

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

12 critical facilities in Council District 3 are located within ¼ mile of a Tier II facility. Although structures are not likely to be impacted, populations at the facilities are at high risk if a hazardous materials release were to occur. Of high concern are the childcare and public school facilities in ¼ mile buffer of these Tier II sites. Pre-planning is critical at these facilities. Effort should be made to ensure proper evacuation or shelter in place procedures are posted and practiced. A list of District 3 critical facilities located within ¼ mile of a Tier II facility is provided in Table 5.3-5.

Conclusion

Tulsa Council District 3 is considered to have a HIGH vulnerability to and MODERATE probability of a fixed-site hazardous materials release.

5.3.4.7 Transportation-Hazardous Materials

Location

There are seven significant transportation corridors in Council District 3, shown on the map in Figure 5.3-23: Interstate 244 runs roughly east to west through the southernmost part of the District just north of E Admiral Pl.; Interstate 44 runs briefly southwest to northeast along the District's southeast boundary line before merging with Interstate 244; US Hwy 169 (Mingo Valley Expressway) runs roughly north to south through the center of the District; OK Hwy 11 (Gilcrease Expressway) runs northwest to southeast from just north of E Apache at Yale Ave. to Interstate 244 east of Memorial Blvd.; OK Hwy 266 begins at a cloverleaf interchange with US Hwy 169 at E. 46th St. N. and heads east to the Port of Catoosa and the town of Verdigris; US. Hwy 75 follows the northwest boundary of the District then crosses the District between Memorial and Mingo. The St. Louis and San Francisco Railroad (Frisco) passes generally east to west through the center of the District, from about N. Utica Ave. and E. Haskell St. in the west to 145th E. Ave. and Apache in the east. The Atchison Topeka & Santa Fe rail line runs from the southwest to northeast in the northwest quadrant of District 3, following US Hwy 75 to its junction with the Gilcrease Expressway, crossing the District between Memorial Blvd. and Mingo Rd. north of E. 46th St. N. Tulsa International Airport is surrounded by District 3, but is not within Tulsa's corporate area.

Impact/Vulnerability

A ¼-mile transportation buffer on each side of a corridor would encompass 54.06% of Council District 3 (or 17.71 sq. mi.), 9,362 improved parcels, 35,276 residents, and 16 of the District's critical facilities. According to Tulsa County Assessor data, 4,270 parcels in District 3 are touched by the ¼ mile buffer of a Highway or Interstate, with a total value, assessed for fair market, of $461,146,352. In total, 2,804 parcels in District 3 are located within ¼ mile of a rail line, with a total assessed value, of $238,685,125. The numbers of District 3 improved parcels touched by the transportation corridors are summarized, by value and type, in Tables 5.3-14 and 5.3-15.

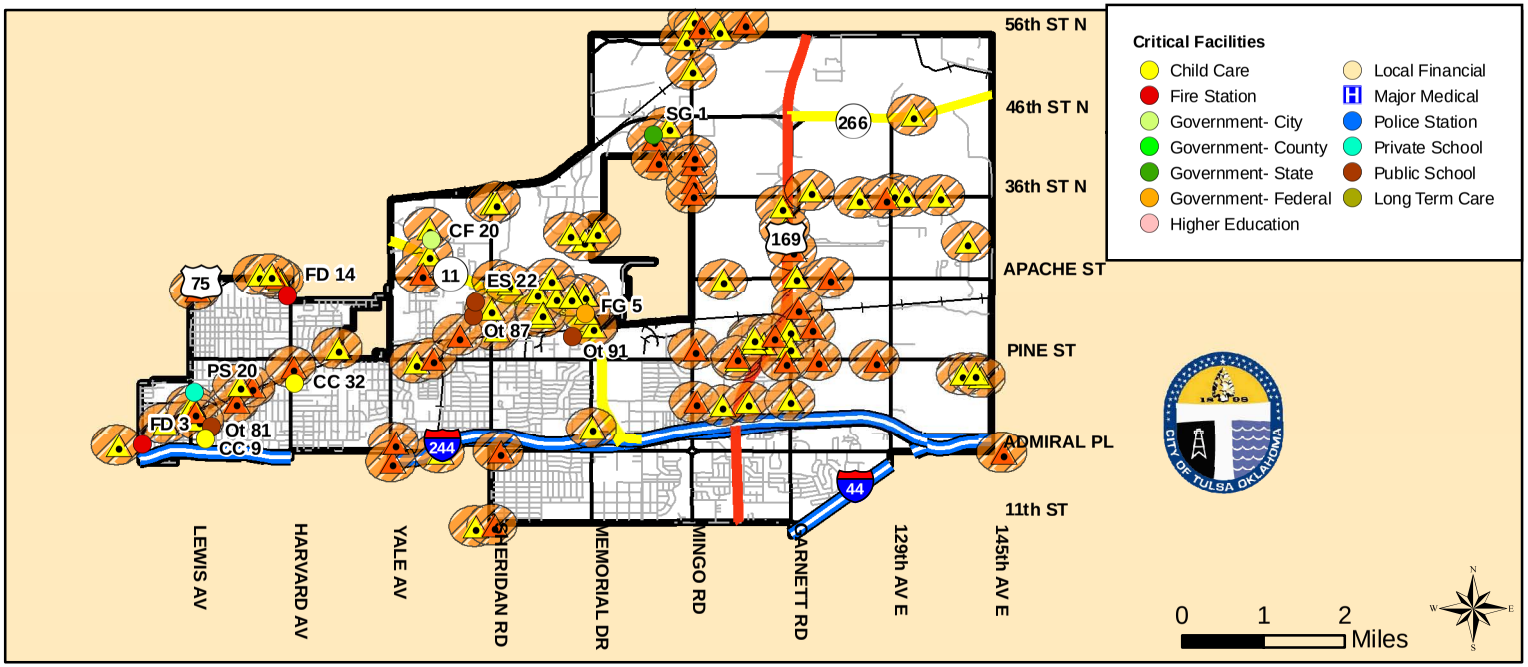


Figure 5.3-22

Tulsa Council District 3

Fixed Site Hazardous Materials

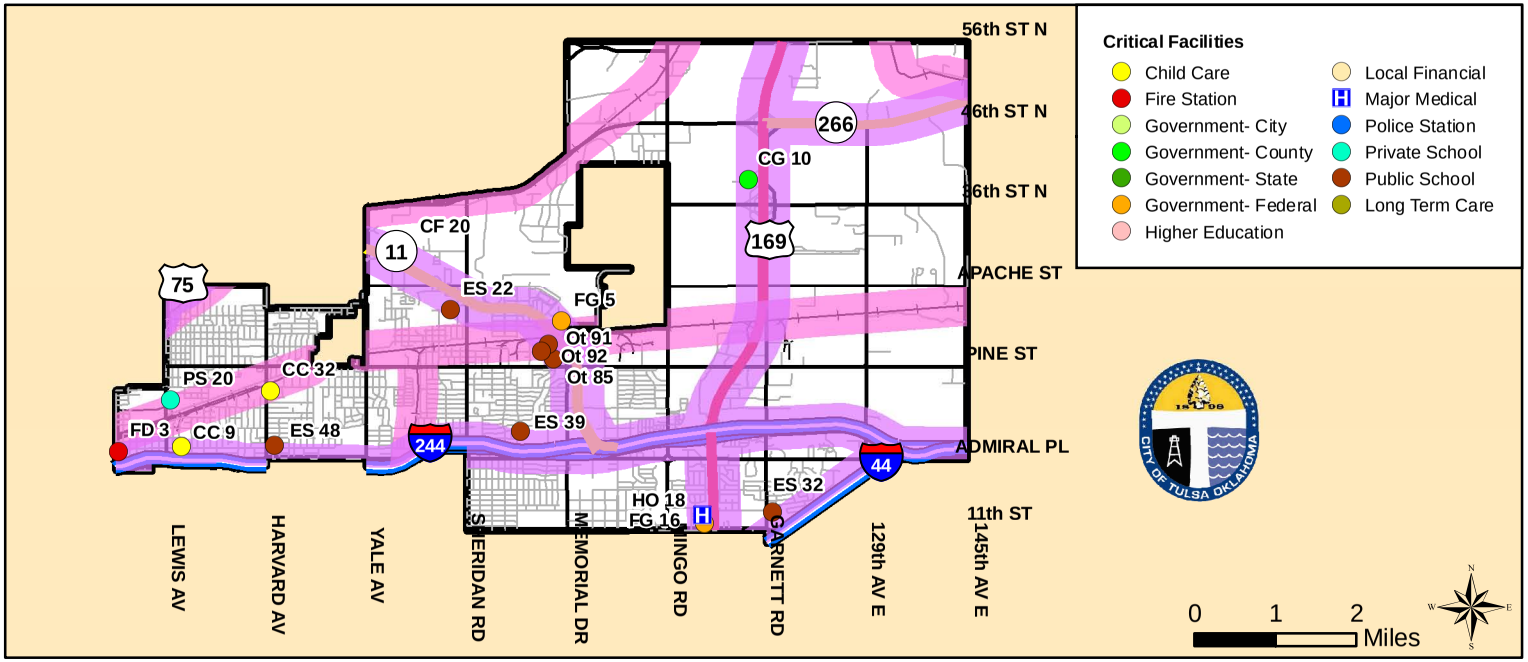


Figure 5.3-23

Tulsa Council District 3

Transportation Corridors

Table 5.3–14: Tulsa Council District 3 Parcels Touched by ¼ mile Highway Corridor

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	3,484	$154,104,352
Residential Multi-Family	118	$10,959,391
Commercial	299	$104,572,940
Industrial	55	$83,456,632
Other	314	$108,053,029
Total	4,270	$461,146,344

Source: Tulsa County Assessor's Office, 2012

Table 5.3–15: Tulsa Council District 3 Parcels Touched by ¼ mile Railroad Corridor

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	2,275	$71,566,652
Residential Multi-Family	95	$3,832,200
Commercial	104	$13,331,253
Industrial	65	$90,340,744
Other	265	$59,614,276
Total	2,804	$238,685,125

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Sixteen critical facilities in District 3 are located within a transportation corridor. These are comprised of one police station, a fire station, one animal shelter, one USPS facility and seven Tulsa Public Schools facilities, including four elementary schools and one Junior High/High School. Critical facilities vulnerable to the Transportation hazard are listed in Table 5.3-5 and shown in Figure 5.3-23. Over half of the facilities in close proximity to a major transportation route are childcare centers, elementary or middle schools. The large majority of persons in these facilities during the hours of 7:30 AM and 4:00 PM are children. As mentioned in Chapter 4, children are at heightened risk of being impacted by hazards. Pre-planning at these facilities is important to preventing loss of life should a transportation-related explosion or release of toxic material occur near one of the District's critical facilities and require the evacuation or sheltering in place procedures to be implemented.

Conclusion

Tulsa Council District 3 has a HIGH vulnerability to and HIGH probability of the Transportation hazard.

5.3.4.8 Hazards Summary

Site-specific hazards, unique to Tulsa Council District 3, identified and mapped in this section, include Floods, Dam Failures, Levee Failure, Expansive Soils, Wildfires, Hazardous Materials, and Transportation-related hazardous material releases. The Hazards Composite Map, shown in Figure 5.3-24, summarizes the areas of the district potentially impacted by these site-specific hazards.

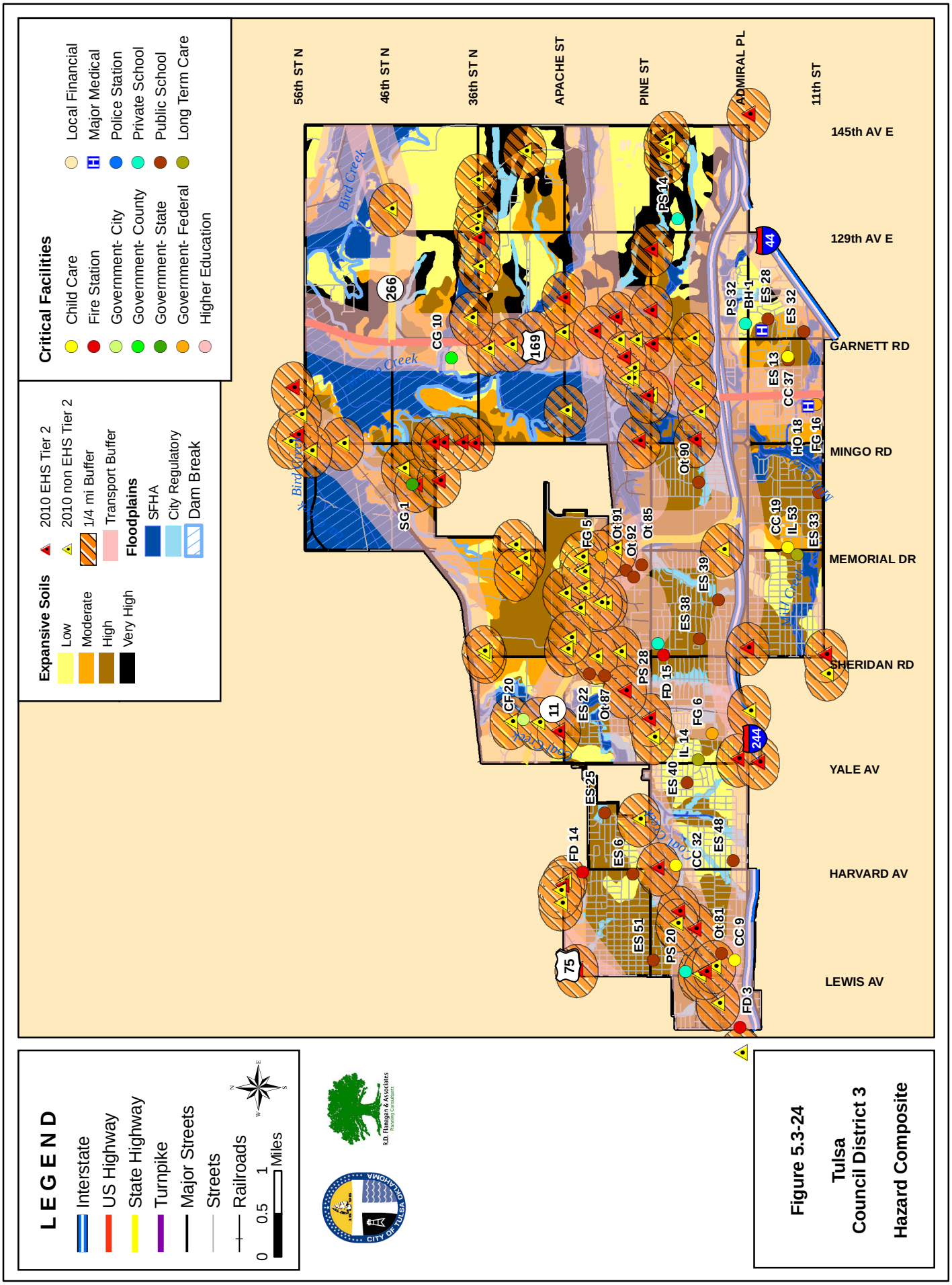


Figure 5.3-24
Tulsa Council District 3
Hazard Composite

City of Tulsa Multi-Hazard Mitigation Plan Update

Tulsa City Council District 4

R.D. Flanagan & Associates

Planning Consultants

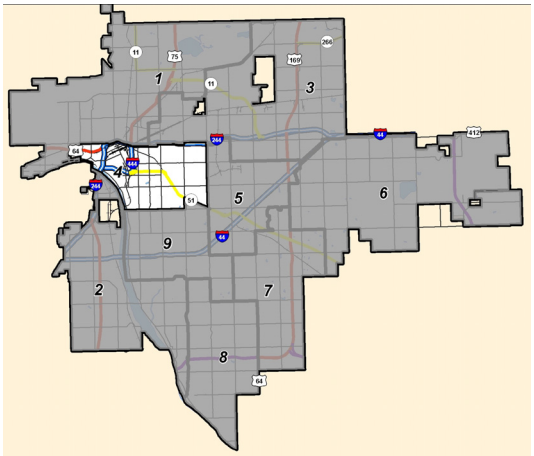
5.4 Tulsa City Council District 4

5.4.1 Introduction

5.4.1.1 Location

Council District 4 is located in west-central Tulsa, shown in the Locator Map. It includes almost all of the original urban city center. Total land area within District 4 consists of approximately 12.65 sq mi., as shown in the District 4 Base Map in Figure 5.4-2. The district is bounded generally on the north by I-244, the east by S. Yale Avenue, the south by E 31st Street, and the west by Riverside Drive and the Arkansas River.

Figure 5.4–1: Tulsa Locator Map – District 4



5.4.1.2 Blake Ewing-Councilor District 4

Councilor Blake Ewing joined the City Council in December of 2011. Councilor Ewing has lived in Tulsa for 21 years. He attended Wilson Middle School and Nathan Hale High School. After attending John Brown University in Arkansas and doing some traveling, Ewing returned to Tulsa to become a well known downtown entrepreneur and restaurateur. At age 25, he established Joe Momma's Pizza at 61st and Highway 169. He subsequently opened a Joe Momma's downtown, as well as the Max Retropub, Boomtown Tees, Back Alley Blues & BBQ, the Phoenix Café and Archer Market.

Councilor Blake Ewing

Councilor Ewing sits on Oklahoma Restaurant Association's Board of Directors. He is a two-time "Tulsey" award winner, as "Entrepreneur of the Year" and "Restaurateur of the Year." *Tulsa Business Journal* named him one of Tulsa's "40 Under 40."

Ewing is the founder and first president of the Blue Dome Association. He sits on the Nathan Hale High School Magnet Program Advisory Board. He participated in the Refuse and Recycling Task Force. Councilor Ewing was also the founding Chair of the Shop Tulsa Task Force. *(Source: http://www.tulsacouncil.org/)*

5.4.1.3 History

Cultural and Historic Properties

Because it includes almost all of the original city center, Tulsa Council District 4 is the home of more cultural and historic sites than any other District. Among these are Cains Ballroom, the Oklahoma Jazz Hall of Fame, the Brady Theatre, the Philbrook Museum, and the Mayo Hotel. The locations of Council District 4's historic places are displayed in Figure 5.4-3.

5.4.1.4 Demographics

Tulsa Council District 4 had a 2010 US Census population of 43,972. A map displaying population density of the District is shown in Figure 5.4-4. Table 5.4-1 presents the District's demographic makeup. Maps illustrating the demographic information are shown in Figures 5.4-5 through 5.4-12.

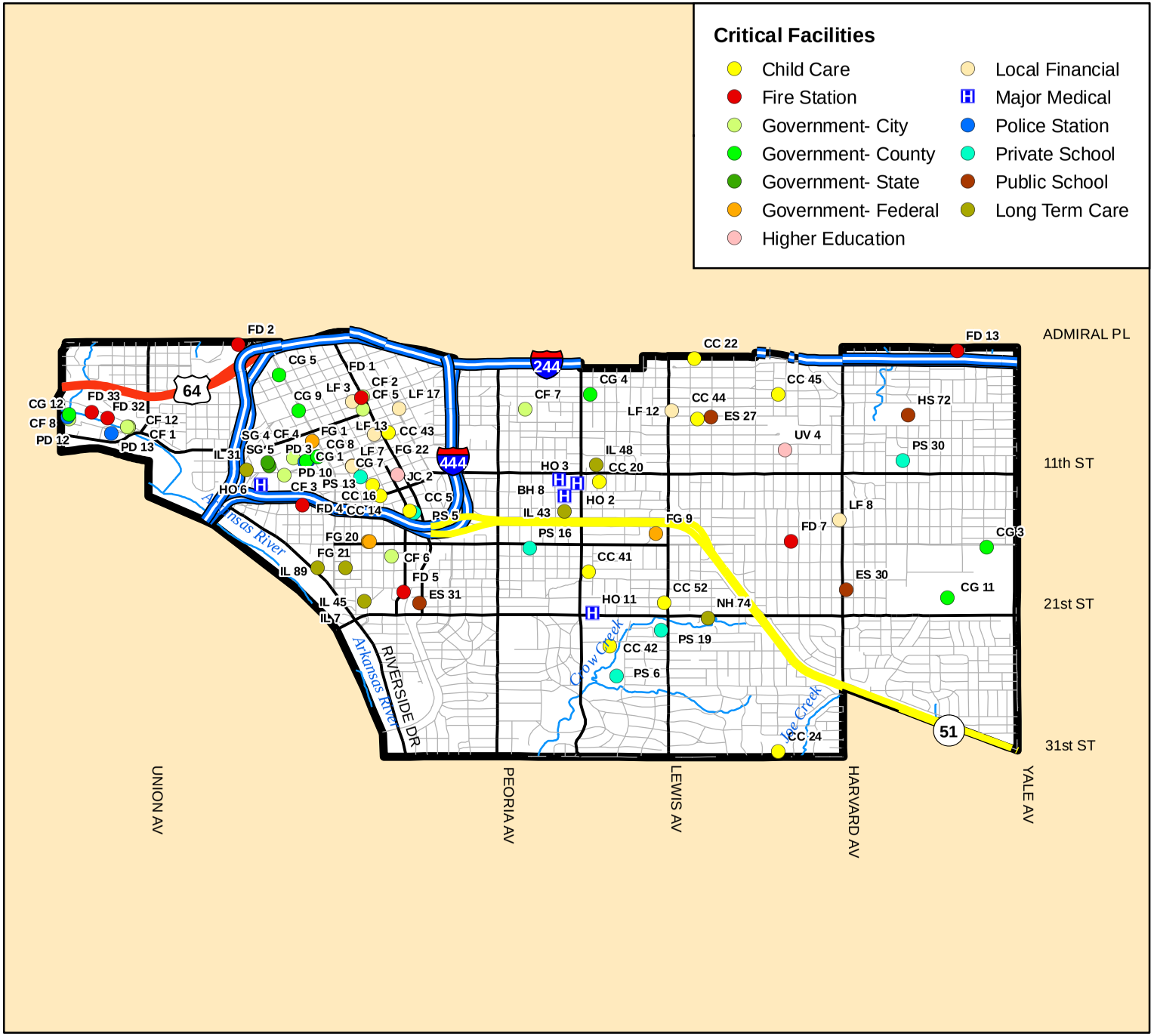


Figure 5.4-2

Tulsa
Council District 4

Basemap

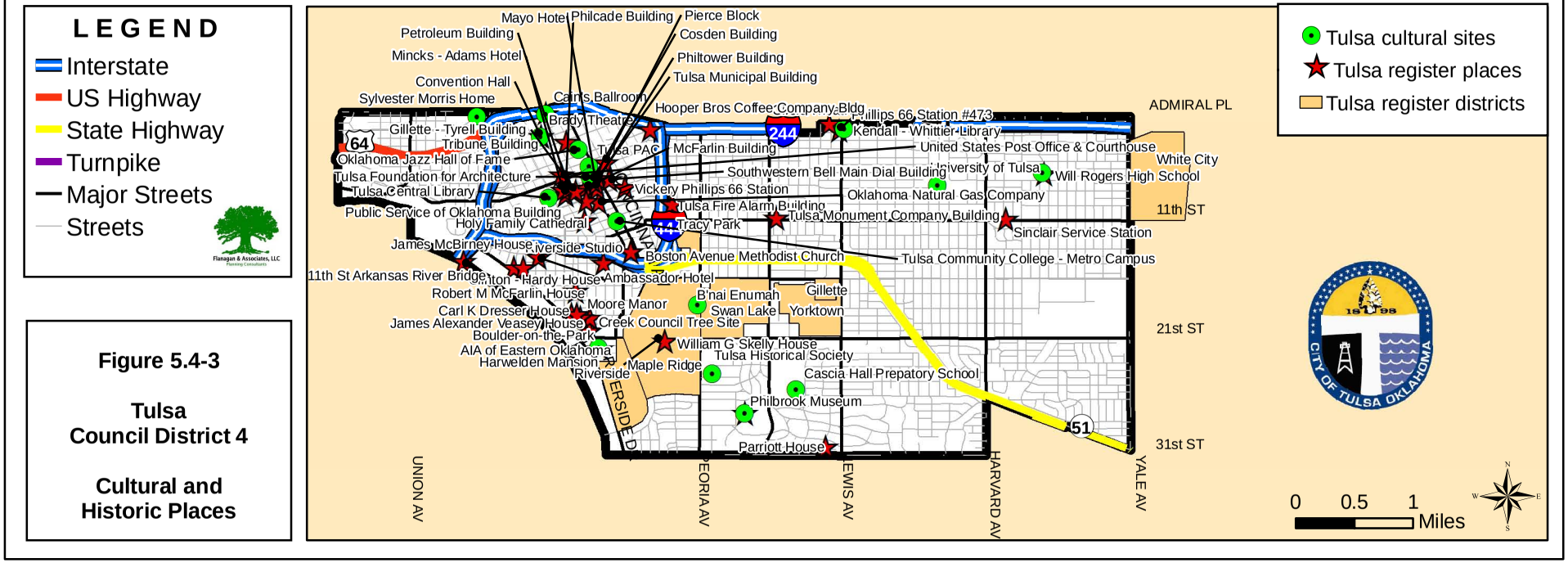


Figure 5.4-3

Tulsa Council District 4

Cultural and Historic Places

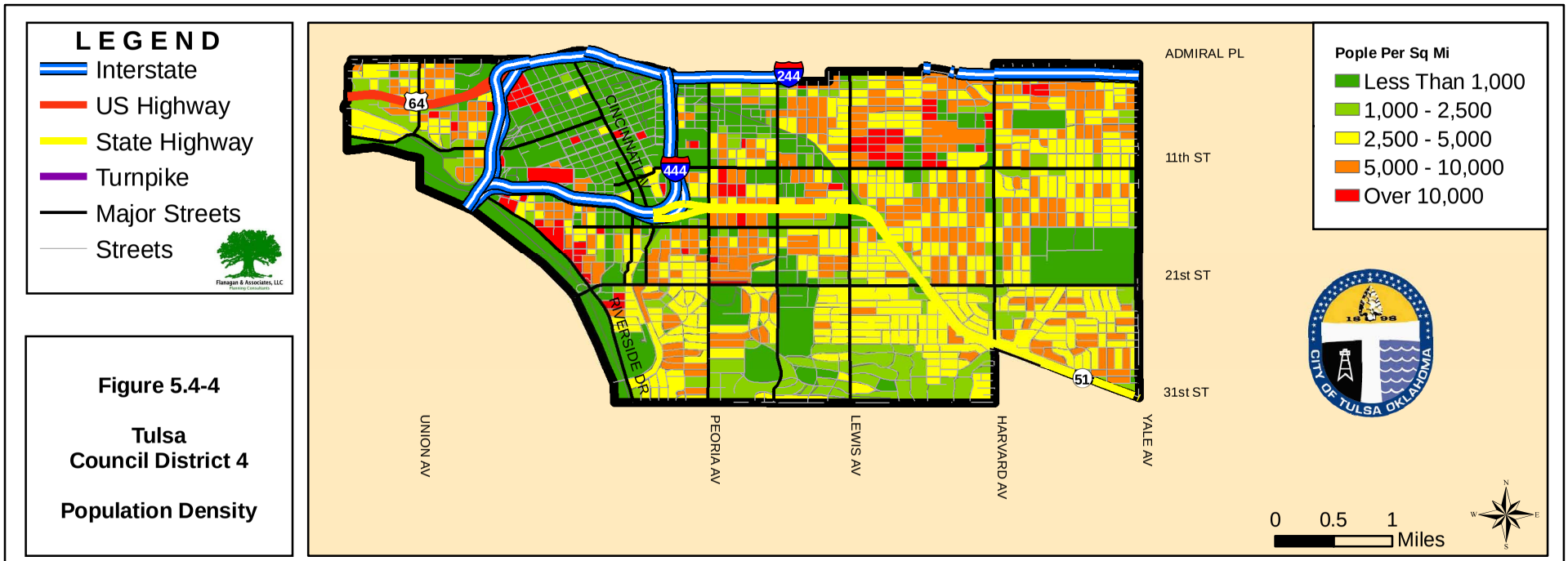


Figure 5.4-4

Tulsa Council District 4

Population Density

Table 5.4–1: Tulsa Council District 4 Demographic Information

Category	District	Tulsa
Persons under 5 years of age	5.33%	7.53%
Persons under age 18	16.09%	24.44%
Persons age 65 and older	10.12%	12.46%
Poverty Status in 2010 (individuals)	18.14%	19.36%
White	75.80%	62.81%
Native-American	5.93%	5.35%
African American	7.14%	15.67%
Asian	1.64%	2.39%
Hispanic	8.88%	13.93%
Total Population	43,972	401,265

Source: US Census Data, 2010

5.4.1.5 Infrastructure

Tulsa Council District 4 is dependent upon the lifelines of the City of Tulsa as identified in Section 1.2.6 of this Plan Update. Any unique vulnerability of Tulsa Council District 4 in relation to the seven site-specific hazards identified in this plan will be addressed in Section 5.4.4, below.

5.4.1.6 Economy

The 2010 US Census identified an income level of approximately $22,133 as the average poverty threshold for a family of four, including two children. Approximately 7,976 individuals, or 18.14 percent of individuals in District 4, were living below the poverty line in 2010. A map showing poverty distribution in the District is shown in Figure 5.4-7.

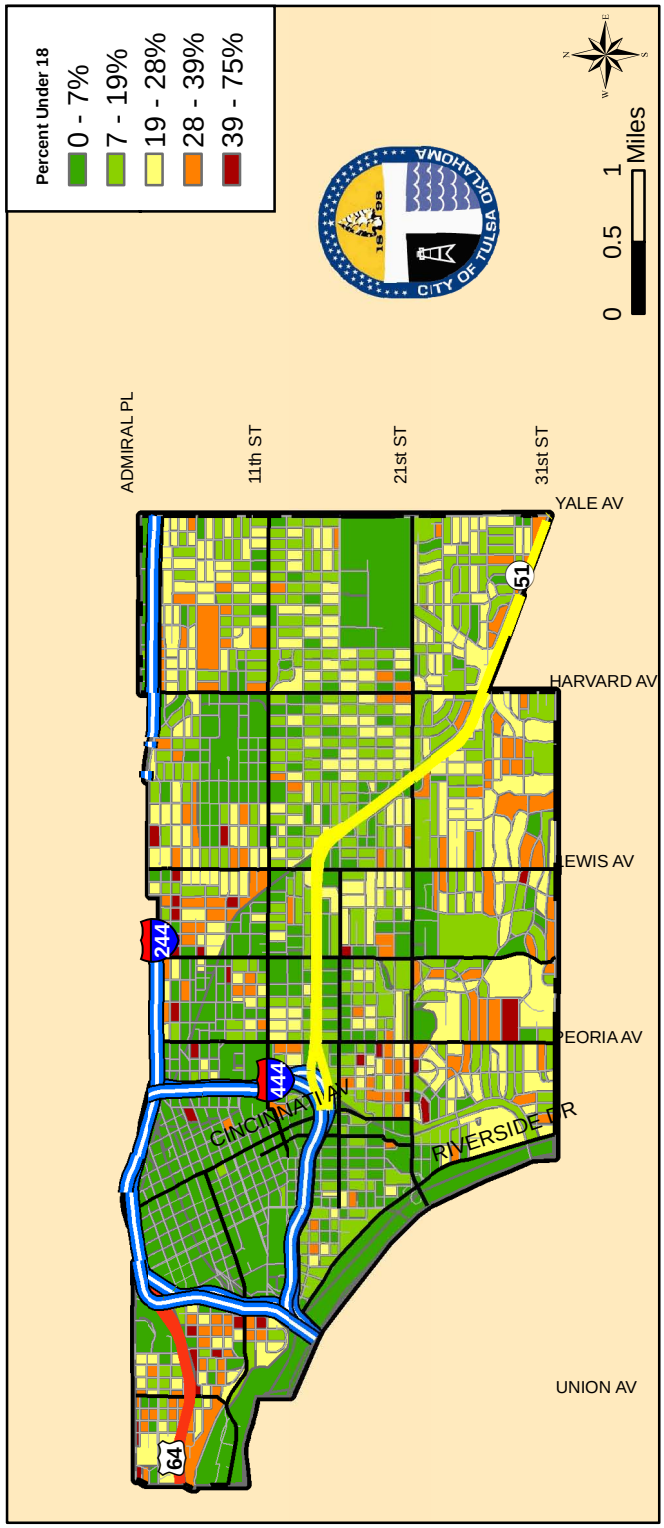
5.4.1.7 Development

According to the Tulsa County Assessor's Office, there are 18,628 properties with improvements within District 4, with a total assessed value, adjusted for fair market price, of $3,086,206,259. The numbers of properties with improvements and improvement values, by type, are shown in Table 5.4-2. No land, contents or tax exempt values are included. Tulsa Council District 3 is made up of 56 homeowners associations, displayed in Figure 5.4-13

Table 5.4–2: Tulsa Council District 4 Property Types by Assessed Values

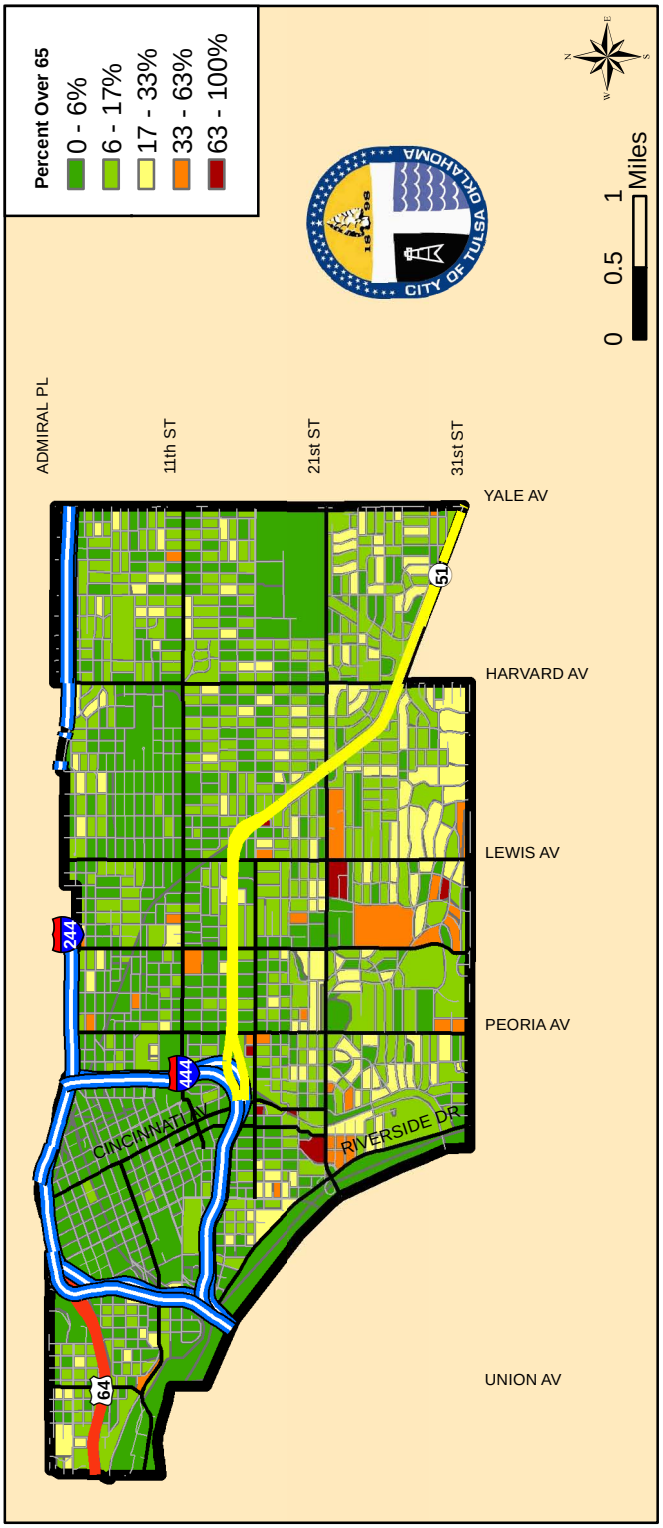
Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	15,709	$1,856,374,454.00
Residential Multi-Family	777	$116,535,714.00
Commercial	963	$708,437,450.00
Industrial	47	$16,600,377.00
Other	1,132	$388,258,264.00
Total	18,628	$3,086,206,259.00

Source: Tulsa County Assessor's Office, 2012



LEGEND
- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets

Figure 5.4-5
Tulsa Council District 4
Percent of Population Under Age 18



LEGEND
- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets

Figure 5.4-6
Tulsa Council District 4
Percent of Population Age 65 and older

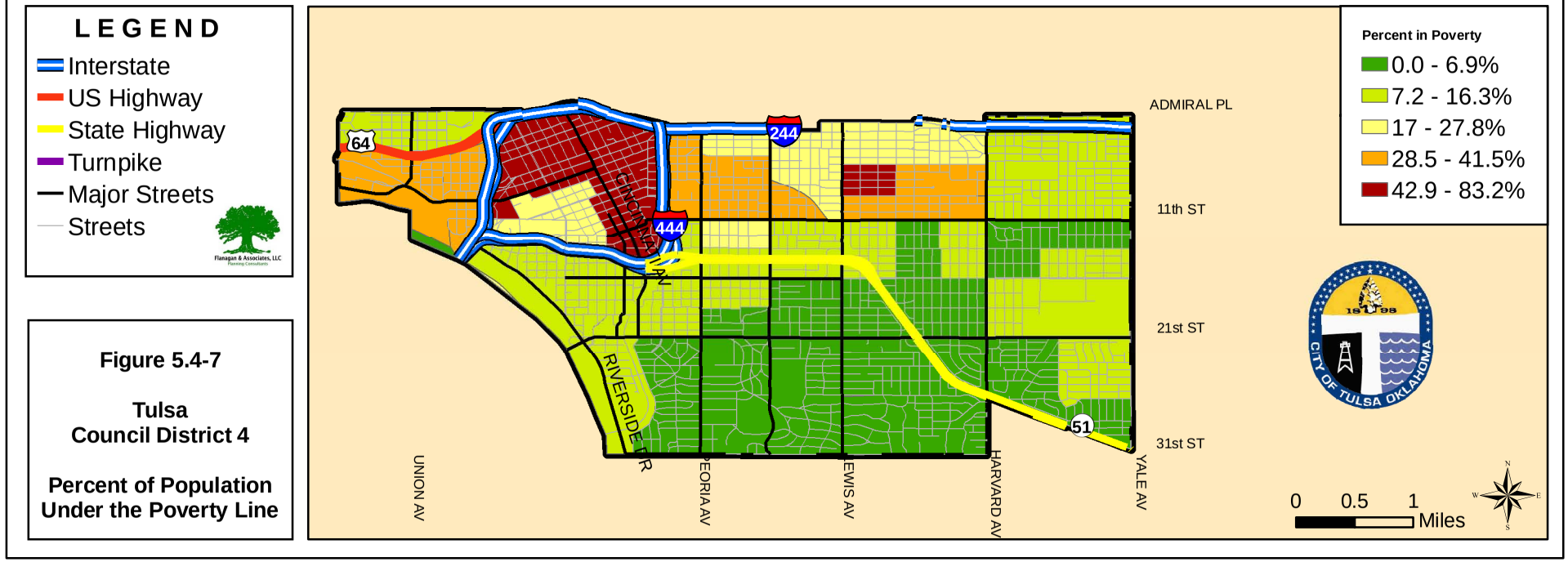


Figure 5.4-7

Tulsa
Council District 4

Percent of Population Under the Poverty Line

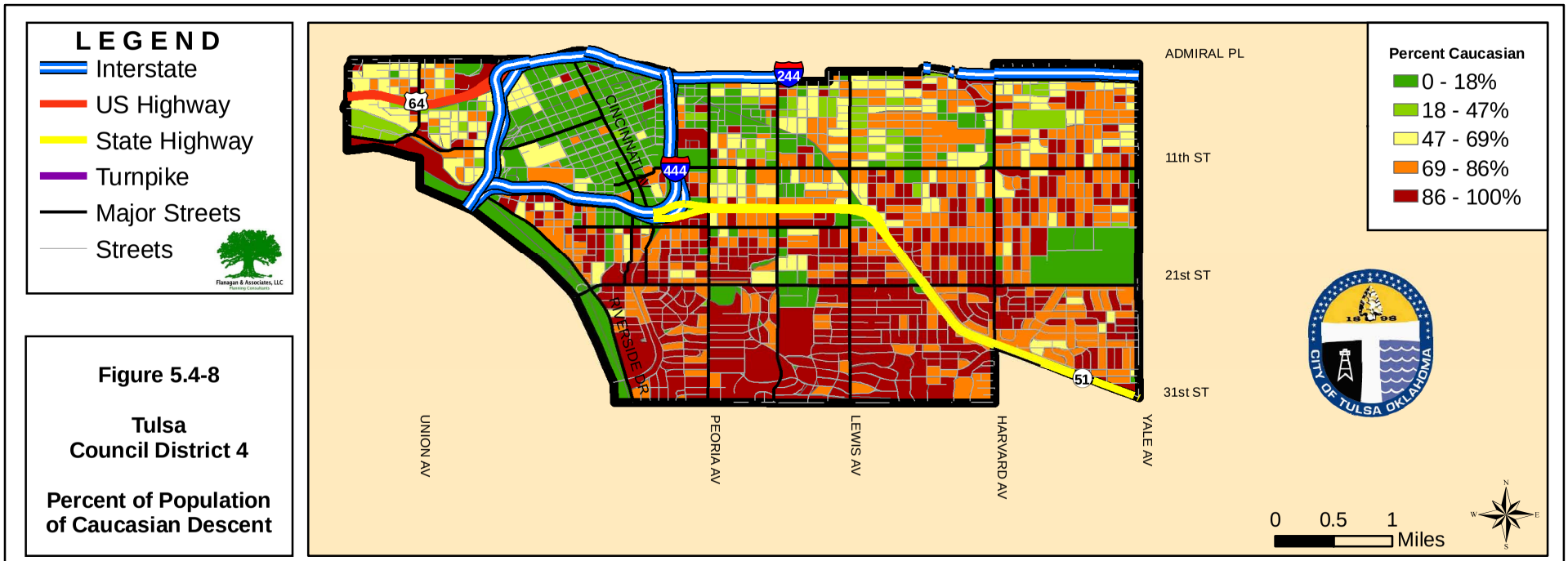
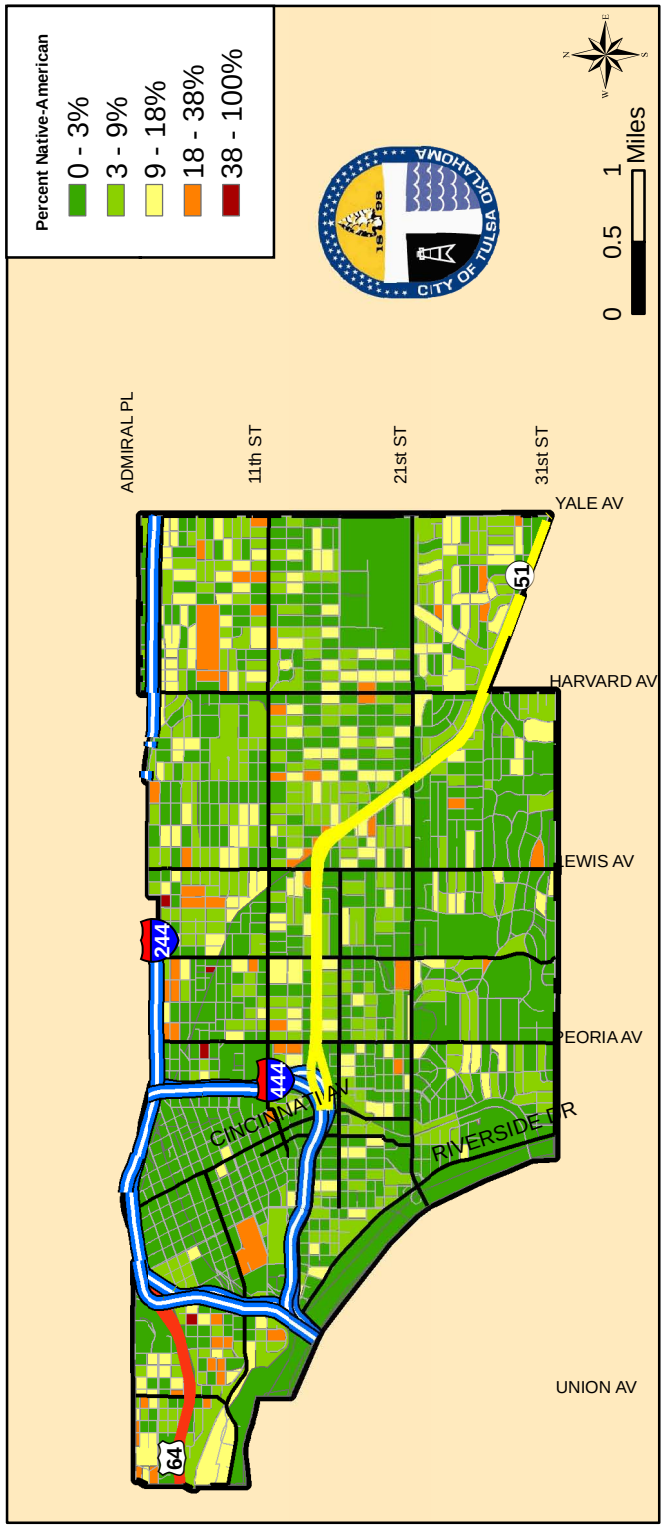


Figure 5.4-8

Tulsa
Council District 4

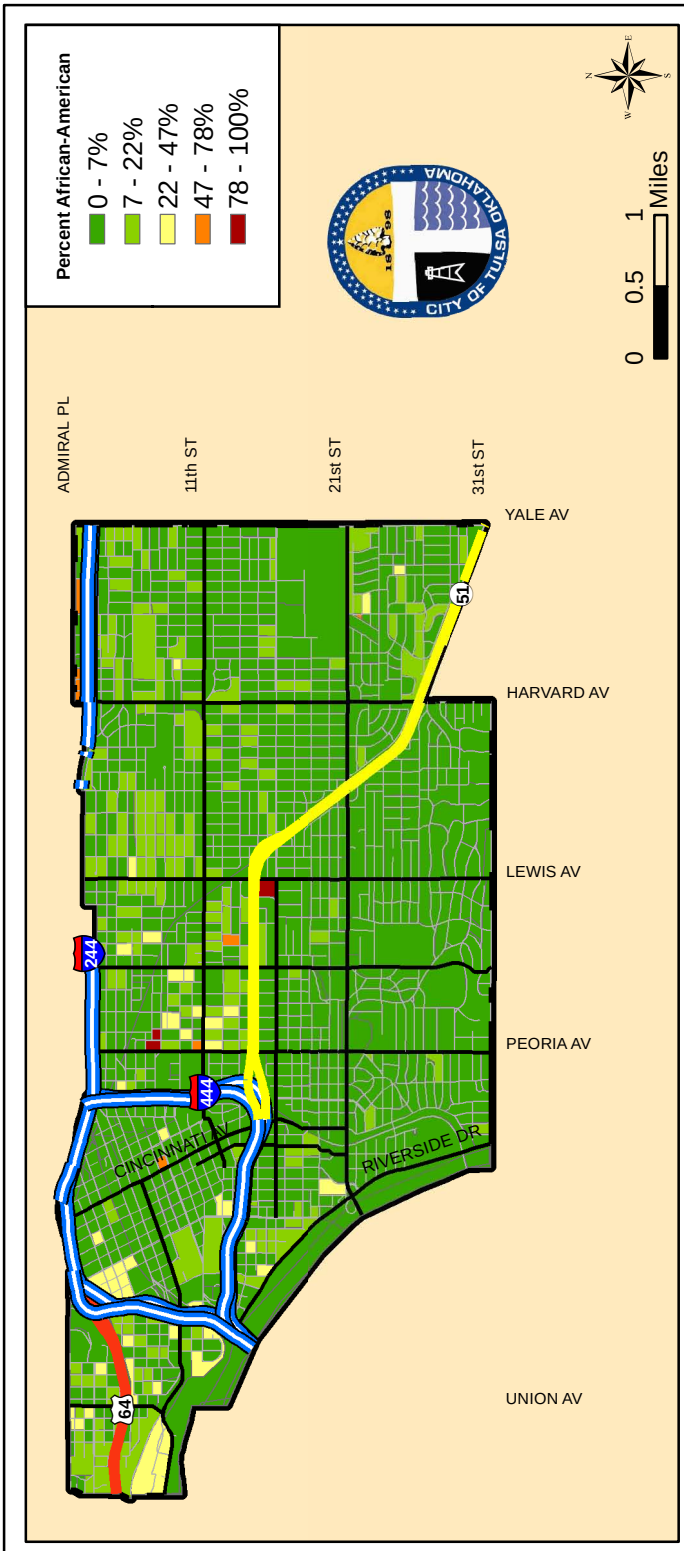
Percent of Population of Caucasian Descent



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets

Figure 5.4-9
Tulsa Council District 4
Percent of Population of Native-American Descent



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets

Figure 5.4-10
Tulsa Council District 4
Percent of Population of African-American Descent

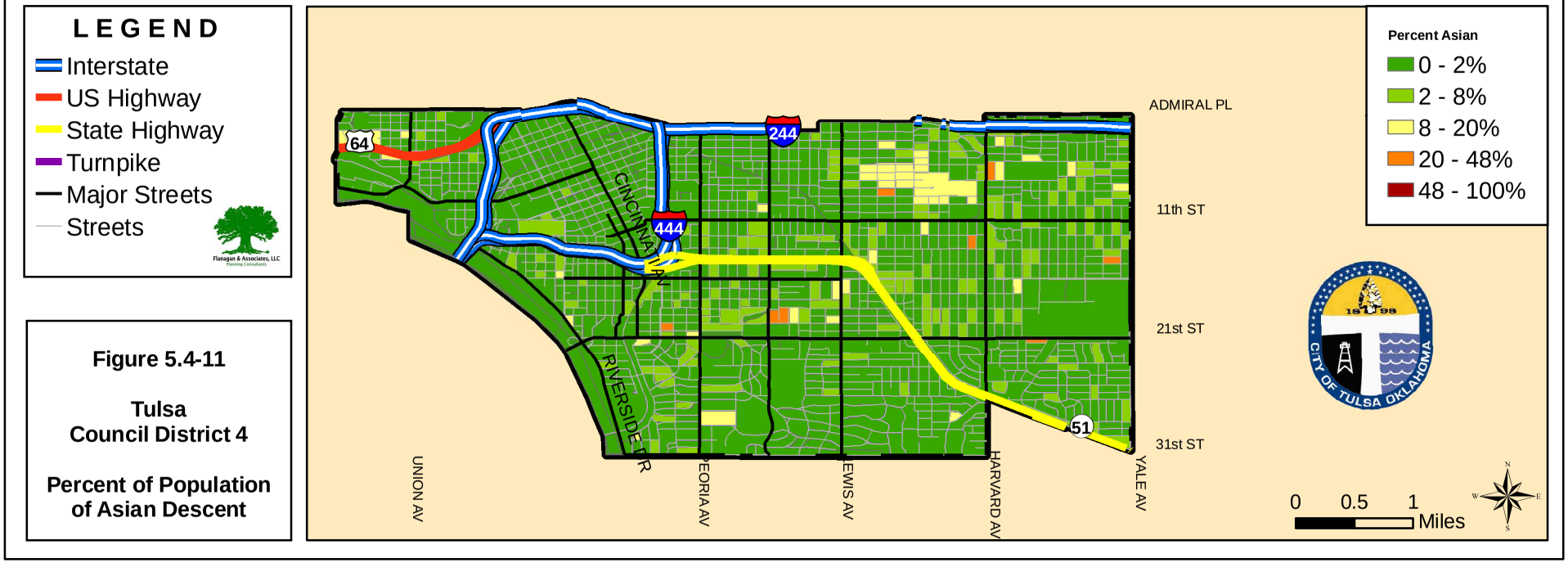


Figure 5.4-11

Tulsa Council District 4

Percent of Population of Asian Descent

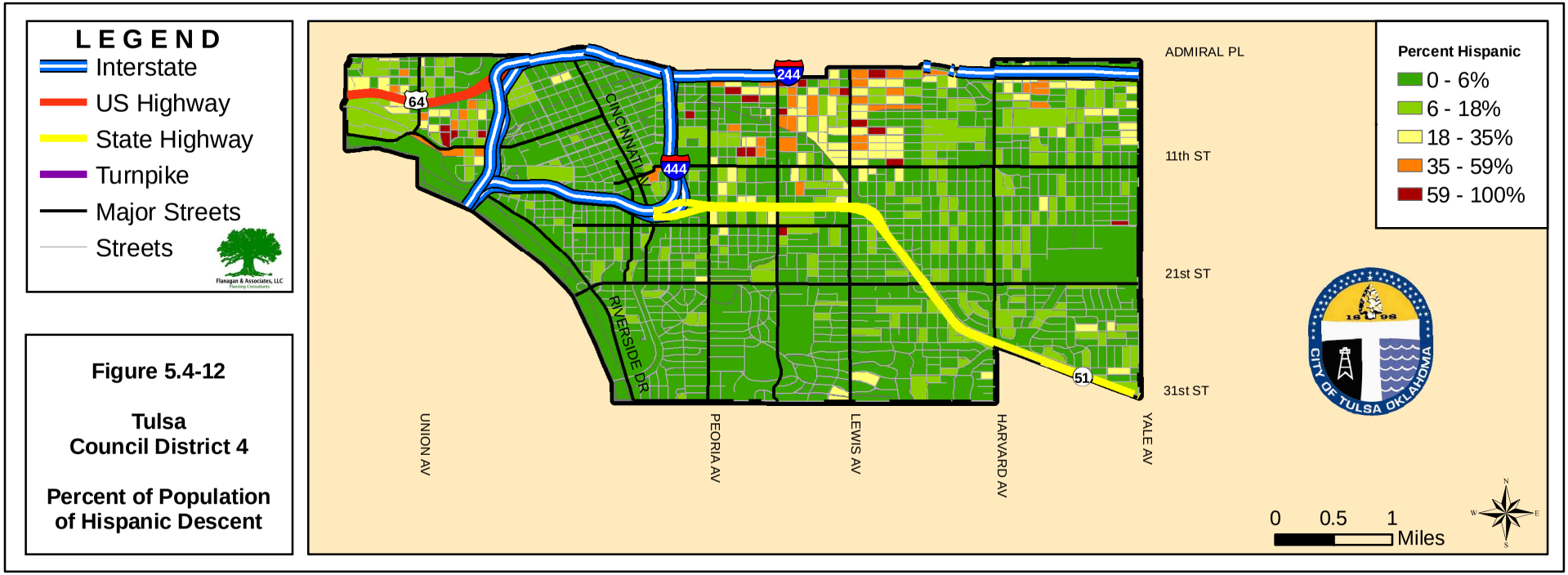


Figure 5.4-12

Tulsa Council District 4

Percent of Population of Hispanic Descent

Zoning

For the purpose of this plan, five of the 29 zoning districts: Agricultural, Single-Family Residential, Multi-Family Residential, Commercial, and Industrial were used to show zoning patterns within District 4. The land area within the District is primarily zoned for Single-Family Residential usage. Downtown Tulsa, located in the Inner Dispersal Loup, is primarily zoned for Commercial and Public facilities (the latter not mapped). Multi-Family Residential and Industrial use areas are dispersed throughout the District. A map of zoning areas in Council District 4 is displayed in Figure 5.4-14.

Future Development

The City of Tulsa will continue to improve the service infrastructure of District 4, such as flood control, water, sanitary sewer, and streets as funding and budgets allow. For information regarding future development plans in the City of Tulsa, see Section 1.2.8.

5.4.1.8 Critical Facilities

Table 5.4-3 lists the locations of District 4's Critical Facilities, which are shown in Figure 5.4-2.

Table 5.4–3: Tulsa Council District 4 Critical Facilities

ID	Map ID	Facility Name	Address
Government- City			
CF	1	City Garage	1720 W Newblock Park Dr
CF	2	City Of Tulsa (City Hall)	175 E. 2nd St.
CF	3	River Parks Authority	707 S Houston Ave, S 510
CF	4	Tulsa Convention Center	100 Civic Center
CF	5	Tulsa Performing Arts Center	110 E 2nd St
CF	6	Community Service Council - Tulsa	16 E 16th St
CF	7	Tulsa Transit	510 S Rockford Ave
CF	8	Juvenile Delinquency Project	315 S Gilcrease Museum Rd
CF	12	Equipment Management	1720 Newblock Park Dr
CF	12	Structural Maintenance	1712 Charles Page Blvd
Police Station			
PD	3	Police Courts Building	600 Civic Center Plaza
PD	10	E-911 Building & PSRC Tower	911 Civic Center Plaza
PD	12	Juvenile Detention Center	315 S Gilcrease Museum Rd
PD	13	Adult Detention Center	1700 Charles Page Blvd
Fire Station			
FD	1	Tulsa Fire Department Headquarters	411 S Frankfort
FD	2	Tulsa Fire Department #2	524 W Edison
FD	4	Tulsa Fire Department #4	524 W 12th St
FD	5	Tulsa Fire Department #5	102 E 18th St
FD	7	Tulsa Fire Department #7	3005 E 15th St
FD	13	Tulsa Fire Department #15	4162 E Admiral Pl
FD	32	Tulsa Fire Department Training	1760 Newblock Park Dr
FD	33	Tulsa Fire Department Supply	1790 Newblock Park Dr
Government- County			
CG	1	TAEMA Emergency Operations Center	600 Civic Center

ID	Map ID	Facility Name	Address
CG	3	Tulsa City-County Health Department	4616 E. 15th St.
CG	4	Tulsa City-County Health Department	315 S. Utica
CG	5	Tulsa County Correctional Facility	300 N. Denver
CG	7	Tulsa County Offices	500 S. Denver Ave
CG	8	Tulsa County Sheriff	500 S. Denver Ave
CG	9	Tulsa County Sheriff Office	303 W. 1st St.
CG	11	Tulsa Co Fairgrounds	4145 E21st St
CG	12	Tulsa County Juvenile Detention Center	315 S Gilcrease
Government- State			
SG	4	Dept. of Human Services	444 S Houston
SG	5	OK State Office Building	440 S Houston
Government- Federal			
FG	1	USPS - Downtown Post Office	333 W 4th St
FG	9	USPS - Donaldson Post Office	1423 Terrace Dr
FG	20	ATF	125 W 15th St
FG	21	Secret Service	125 W 15th St
FG	22	US Attorney	110 W 7th St
Tulsa Public Schools			
ES	27	Kendall-Whittier Elementary School	2601 E 5th Pl
ES	30	Lanier Elementary School	1727 S Harvard Av
ES	31	Lee Elementary School	1920 S Cincinnati Ave
HS	72	Will Rogers High School/ Junior High	3909 E 5th Pl
Private School			
PS	5	Boston Avenue Weekday School	1301 S Boston Ave
PS	6	Cascia Hall Preparatory School	2520 S. Yorktown Ave.
PS	13	Holy Family Cathedral School	820 S. Boulder
PS	16	Marquette Catholic School	1519 S. Quincy
PS	19	Monte Cassino School	2206 S. Lewis
PS	30	Tulsa Adventist Jr. Academy	900 S New Haven
Child Care			
CC	5	Boston Avenue UM Weekday School	1301 S. Boston Ave
CC	14	Early Learning Academy	1115 S. Boulder
CC	16	First Christian Child Development Center	913 S. Boulder
CC	20	Hillcrest CDC	1121 S. Victor
CC	22	Instituto Biling Guadalupano	2510 E Admiral Blvd
CC	24	John Knox Child Development Center	2929 E. 31st St.
CC	41	St. John Medical Center Chapman Learning Center	1710 E. 17th St.
CC	42	Temple Israel/ Day Schools Inc.	2004 E. 22nd Pl.
CC	43	Trinity Episcopal Day School	501 S. Cincinnati Ave.
CC	44	Tulsa Educare Inc.	2511 E. 5th Pl. S
CC	45	Tulsa University Child Development Center	2906 E. Third
CC	52	YWCA Patti Johnson Wilson ELC	1910 S. Lewis

ID	Map ID	Facility Name	Address
Higher Education			
JC	2	Tulsa Community College - Metro Campus	909 S Boston Ave
UV	4	University of Tulsa	800 S Tucker
Major Medical			
HO	2	Hillcrest Medical Center	1120 S Utica Ave
HO	3	Hillcrest Specialty Hospital	1125 S Trenton Ave
HO	6	Oklahoma State University Medical Center	744 W 9th St
BH	8	Parkside Comm. Psychiatric Services & Hospital	1620 E 12th St
HO	11	Saint John Medical Center	1923 S Utica Ave
Long Term Care			
IL	7	Boulder Plaza	1840 S Boulder
IL	31	Hewgley Terrace	420 S Lawton Ave
IL	43	Luther Place on Troost	1304 S Troost
IL	45	Mansion House	1638 S Carson
IL	48	Murdock Villa	828 S Wheeling
NH	74	The Cottage Extended Care	2552 E 21st St
IL	89	Tulsa Pythian Manor West	1700 Riverside Dr
Local Financial			
LF	3	Bank of Oklahoma	1 Wiliams Center
LF	7	Energy One Federal Credit Union	220 W 7th
LF	8	F & M Bank Trust Co	1330 S Harvard Ave
LF	12	Peoples State Bank Inc	445 S Lewis Ave
LF	13	Red Crown Federal Credit Union	509 S Boston
LF	17	Tulsa Federal Employees Credit Union	401 E 4th

5.4.2 Existing Mitigation Strategies

Existing mitigation measures currently being implemented throughout the City of Tulsa are detailed in Chapter 2, *Existing Mitigation Strategies*. The information that follows in this section surveys the infrastructure in place for avoiding or mitigating the impacts of natural hazards, that can be looked at from the District level.

5.4.2.1 Council District 4 Warning Systems

Warning Sirens

As shown in Figure 5.4-15, there are nine warning sirens located within District 4. An additional nine sirens located outside of the boundary lines of the District provide partial coverage. Each warning siren is audible for up to a mile. Information regarding the testing of warning sirens in the City of Tulsa is included in Chapter 2.

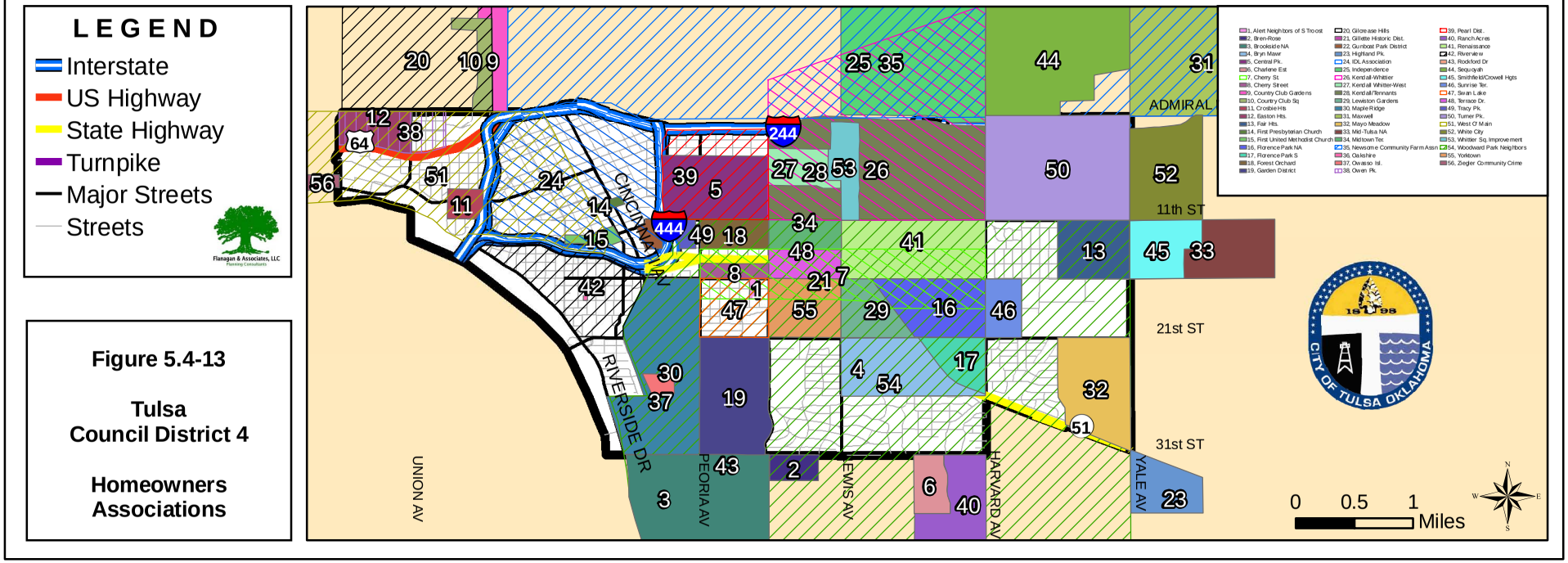


Figure 5.4-13

Tulsa Council District 4

Homeowners Associations

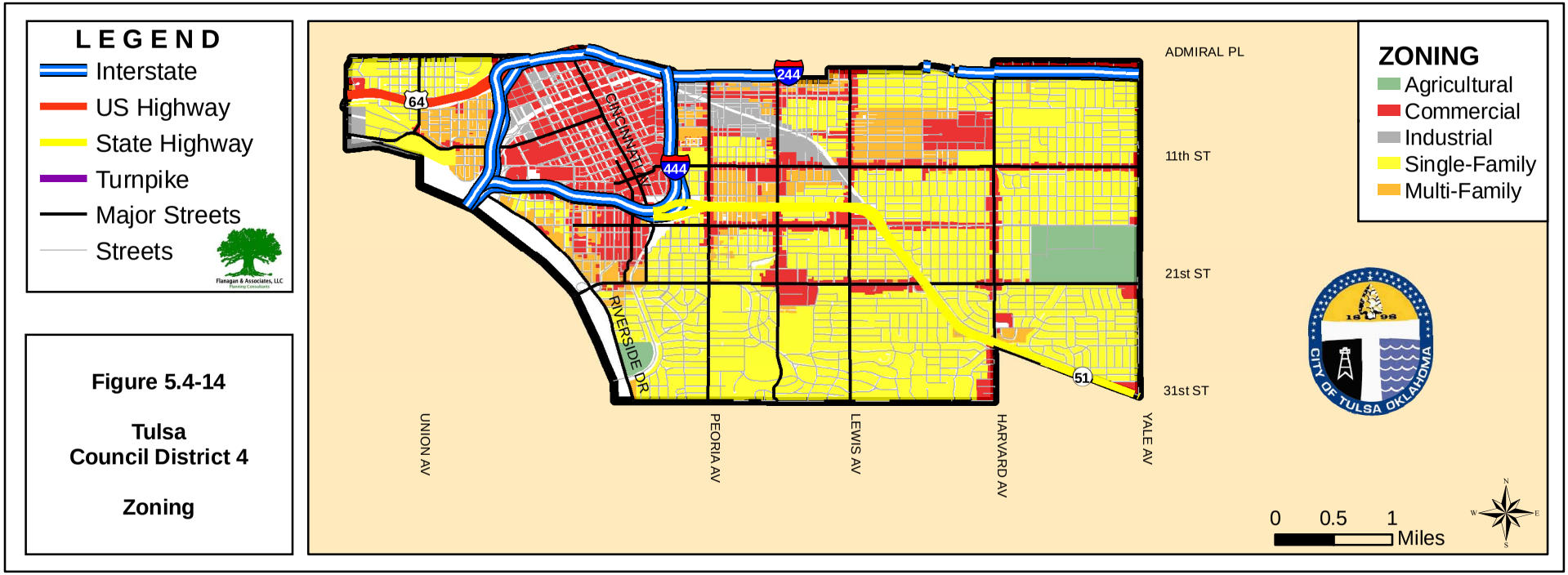


Figure 5.4-14

Tulsa Council District 4

Zoning

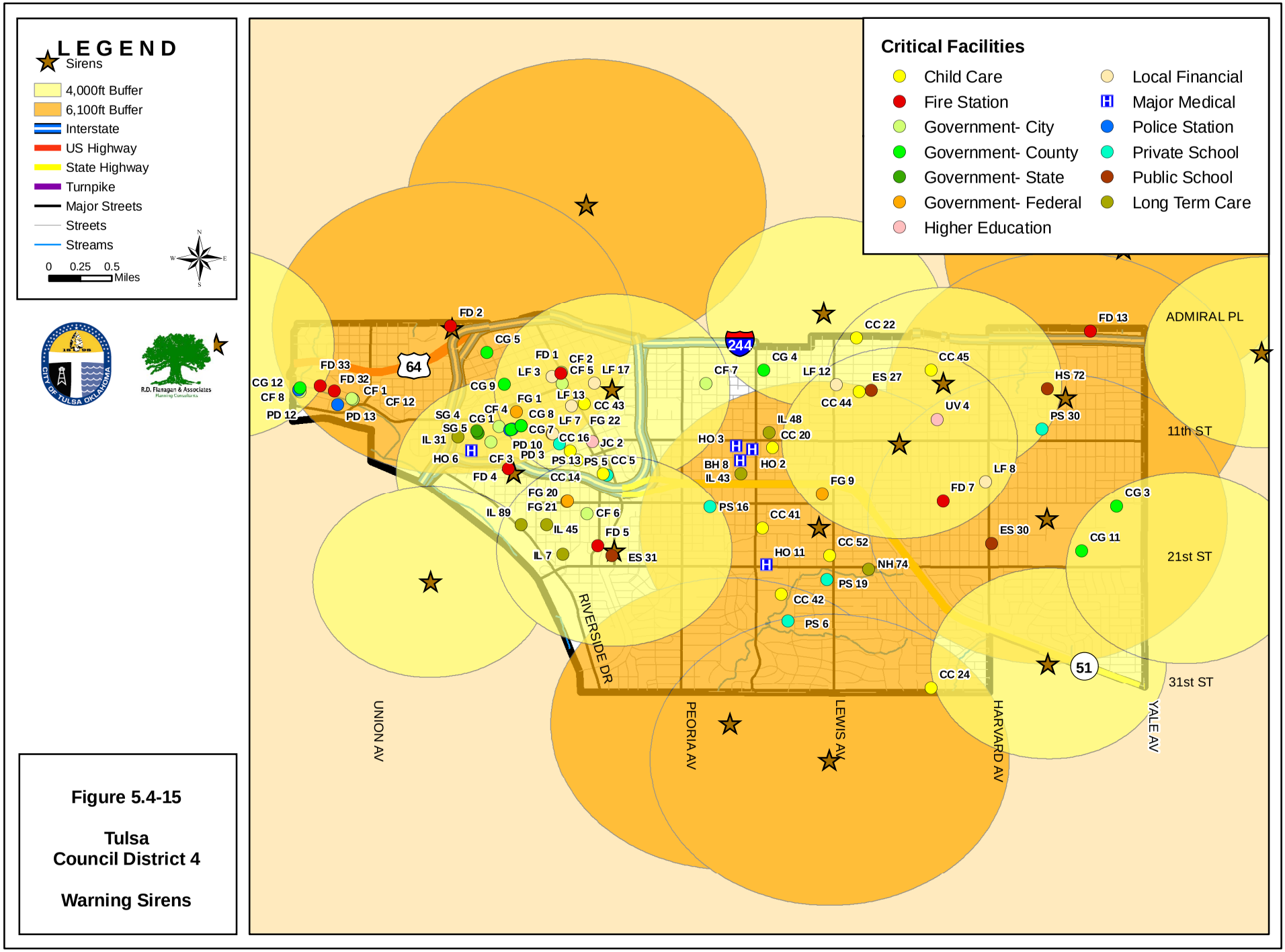


Figure 5.4-15

Tulsa
Council District 4

Warning Sirens

Lightning Sensing and Warning

There are 17 outdoor recreation parks in District 4. These are mapped in Figure 5.4-16. These include Riverparks, Guthrie Green, Centennial Park, Tulsa University athletic facilities, and a number of urban parks. Parks promote neighborhood revitalization and development, they also promote youth development. As discussed in Chapter 4, it is important for outdoor recreation areas be equipped with lightning sensing and warning systems. Tulsa Public Schools and the University of Tulsa use ThorGuard© to warn of lightning danger at their outdoor recreation areas. A map showing ThorGuard© coverage areas in Tulsa is shown in Chapter 2, Figure 2-3. Public school districts in the surrounding Tulsa Metro Area should be encouraged to purchase and install lightning warning systems. Private schools in the area school also be informed of their options and encouraged to install such systems for coverage at their outdoor recreation areas.

5.4.3 Planning Process

The CAC/TAC met monthly during the planning process to review progress, identify issues, receive task assignments, and advise the consultants. Refer to Appendix C for meeting agendas.

5.4.4 Natural and Manmade Hazards

Hazards

General natural hazards, such as Severe Winter Storms, High Wind, Tornado, Lightning, Hailstorm, Extreme Heat, Drought, Earthquake, and Urban Fires affect all areas in the City of Tulsa randomly and more or less equally, and are addressed in Chapter 4.

Site specific hazards, such as Flooding, Dam and Levee Failures, Expansive Soils, Wildfires, Fixed-Site Hazardous Materials and Transportation-Hazardous Materials are addressed for Council District 4 in subsections 5.4.4.1 through 5.4.4.7, summarized in subsection 5.4.4.8 and shown on the map in Figure 5.4-25. Table 5.4-4 identifies the site-specific hazards the can particularly impact Tulsa Council District 4.

Table 5.4–4: Tulsa Council District 4 Site-Specific Hazard Impacts

Hazard	Area (Sq. mi)	Improved Parcels	Est. Market Value	Percent of Area Impacted	Impacted Population
Floods	1.44	1,355	$164,087,920	11.38%	3,022
Dam Failure	0.97	563	$105,978,875	7.67%	1,298
Levee Failure	.20	23	$1,384,600	2.53%	357
Highly Expansive Soils	2.83	4,579	$694,602,710	22.37%	12,335
Wildfire	0.17	279	$46,040,734.00	1.34%	397
Fixed-Site HazMat, ¼ Mi.	3.37	4,244	$1,201,166,251	26.64%	11,113
Transportation HazMat Highway	5.10	7,931	$1,022,802,866	40.32%	17,267
Transportation HazMat Railroad	2.85	3,719	$531,497,501	22.53%	8,789

Tulsa Council District 4 has identified certain facilities as critical to the health, safety and welfare of its citizens, business and economy. Table 5.4-5 indicates, generally, the exposure of critical facilities to the seven site-specific hazards covered by this Plan Update.

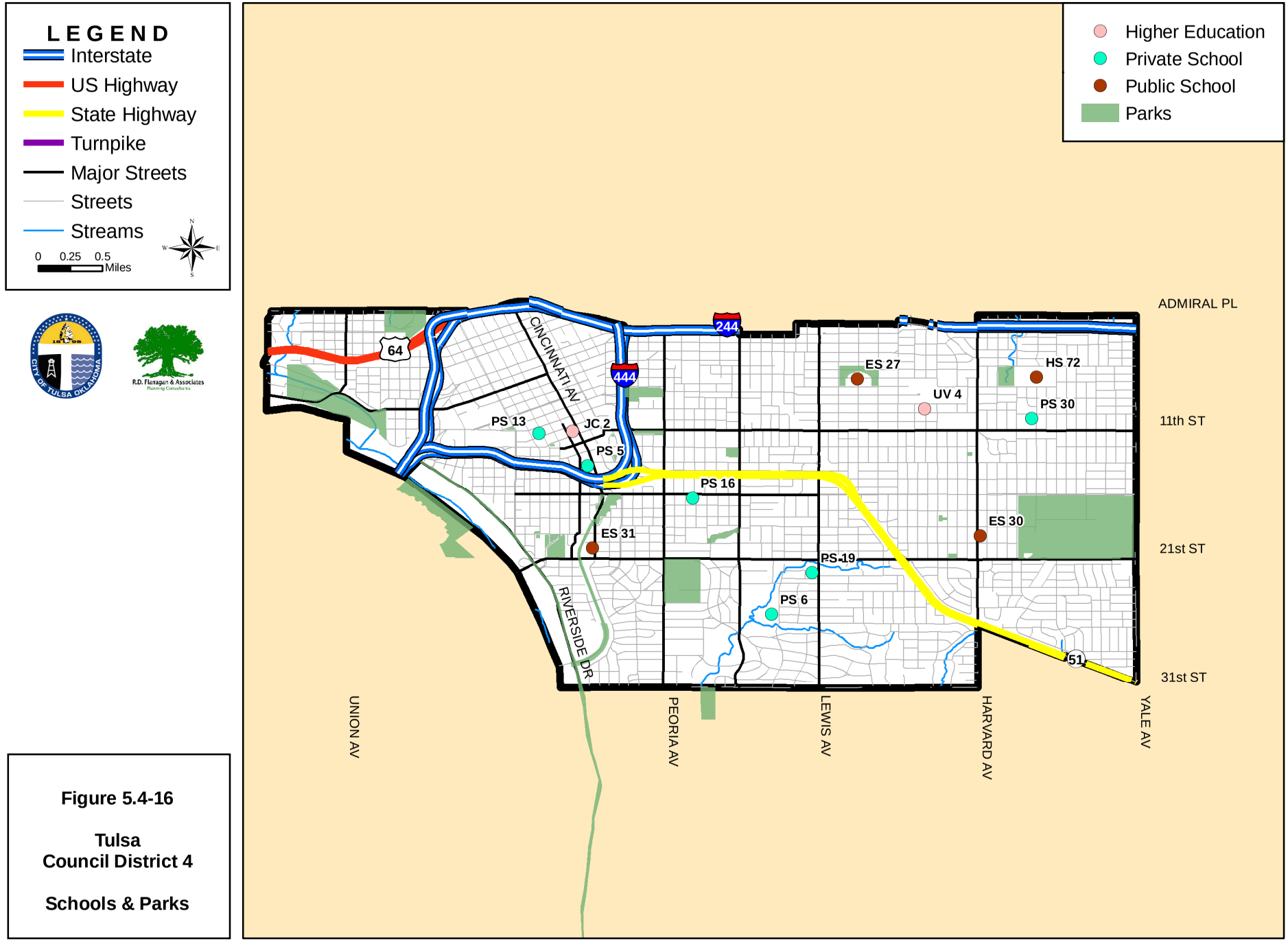


Figure 5.4-16

Tulsa
Council District 4

Schools & Parks

Table 5.4–5: Tulsa Council District 4 Hazard Impacts on Critical Facilities

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storms	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Fixed Site HazMat	Transportation-HazMat
CF	1	City Garage	X	X	X	X	X	X	X	X	X	X	X	X				X
CF	2	City Of Tulsa (City Hall)	X	X	X	X	X	X	X	X	X						X	X
CF	3	River Parks Authority	X	X	X	X	X	X	X	X	X						X	X
CF	4	Tulsa Convention Center	X	X	X	X	X	X	X	X	X						X	X
CF	5	Tulsa Performing Arts Center	X	X	X	X	X	X	X	X	X						X	X
CF	6	Community Service Council - Tulsa	X	X	X	X	X	X	X	X	X						X	X
CF	7	Tulsa Transit	X	X	X	X	X	X	X	X	X						X	X
CF	8	Juvenile Delinquency Project	X	X	X	X	X	X	X	X	X	X	X	X			X	X
CF	12	Equipment Management	X	X	X	X	X	X	X	X	X	X	X	X				X
CF	12	Structural Maintenance	X	X	X	X	X	X	X	X	X	X	X	X				X
PD	3	Police Courts Building	X	X	X	X	X	X	X	X	X						X	X
PD	10	E-911 Building & PSRC Tower	X	X	X	X	X	X	X	X	X						X	X
PD	12	Juvenile Detention Center	X	X	X	X	X	X	X	X	X	X	X	X			X	X
PD	13	Adult Detention Center	X	X	X	X	X	X	X	X	X	X	X	X				X
FD	1	Tulsa Fire Department Hdqtrs	X	X	X	X	X	X	X	X	X						X	X
FD	2	Tulsa Fire Department #2	X	X	X	X	X	X	X	X	X							X
FD	4	Tulsa Fire Department #4	X	X	X	X	X	X	X	X	X							X
FD	5	Tulsa Fire Department #5	X	X	X	X	X	X	X	X	X							
FD	7	Tulsa Fire Department #7	X	X	X	X	X	X	X	X	X							
FD	13	Tulsa Fire Department #15	X	X	X	X	X	X	X	X	X							X
FD	32	Tulsa Fire Department Training	X	X	X	X	X	X	X	X	X	X	X	X				X
FD	33	Tulsa Fire Department Supply	X	X	X	X	X	X	X	X	X	X	X	X			X	X
CG	1	TAEMA Emergency Operations Center	X	X	X	X	X	X	X	X	X						X	X
CG	3	Tulsa City-County Health Department	X	X	X	X	X	X	X	X	X							
CG	4	Tulsa City-County Health Department	X	X	X	X	X	X	X	X	X				X		X	X
CG	5	Tulsa County Correctional Facility	X	X	X	X	X	X	X	X	X				X		X	X
CG	7	Tulsa County Offices	X	X	X	X	X	X	X	X	X						X	
CG	8	Tulsa County Sheriff	X	X	X	X	X	X	X	X	X						X	
CG	9	Tulsa County Sheriff Office	X	X	X	X	X	X	X	X	X						X	X
CG	11	Tulsa Co Fairgrounds	X	X	X	X	X	X	X	X	X							
CG	12	Tulsa County Juvenile Detention Center	X	X	X	X	X	X	X	X	X	X	X	X			X	X
SG	4	Dept. of Human Services	X	X	X	X	X	X	X	X	X						X	X
SG	5	Ok. State Office Building	X	X	X	X	X	X	X	X	X						X	X

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storms	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Fixed Site HazMat	Transportation-HazMat
FG	1	USPS - Downtown Post Office	X	X	X	X	X	X	X	X	X						X	
FG	9	USPS - Donaldson Post Office	X	X	X	X	X	X	X	X	X							X
FG	20	ATF	X	X	X	X	X	X	X	X	X						X	X
FG	21	Secret Service	X	X	X	X	X	X	X	X	X						X	X
FG	22	US Attorney	X	X	X	X	X	X	X	X	X						X	
ES	27	Kendall-Whittier Elementary School	X	X	X	X	X	X	X	X	X				X			
ES	30	Lanier Elementary School	X	X	X	X	X	X	X	X	X							
ES	31	Lee Elementary School	X	X	X	X	X	X	X	X	X							
HS	72	Will Rogers High School/ Junior High	X	X	X	X	X	X	X	X	X							
PS	5	Boston Avenue Weekday School	X	X	X	X	X	X	X	X	X						X	X
PS	6	Cascia Hall Prepatory School	X	X	X	X	X	X	X	X	X							
PS	13	Holy Family Cathedral School	X	X	X	X	X	X	X	X	X						X	X
PS	16	Marquette Catholic School	X	X	X	X	X	X	X	X	X				X			X
PS	19	Monte Cassino School	X	X	X	X	X	X	X	X	X							
PS	30	Tulsa Adventist Jr. Academy	X	X	X	X	X	X	X	X	X	X						
CC	5	Boston Avenue UM Weekday School	X	X	X	X	X	X	X	X	X					X	X	X
CC	14	Early Learning Academy	X	X	X	X	X	X	X	X	X						X	X
CC	16	First Christian Child Development Ctr	X	X	X	X	X	X	X	X	X						X	X
CC	20	Hillcrest CDC	X	X	X	X	X	X	X	X	X				X		X	
CC	22	Instituto Biling Guadalupano	X	X	X	X	X	X	X	X	X				X			X
CC	24	John Knox Child Development Ctr	X	X	X	X	X	X	X	X	X							
CC	41	St. John Medical Ctr Chapman Learning Ctr	X	X	X	X	X	X	X	X	X	X			X		X	
CC	42	Temple Israel/ Day Schools Inc.	X	X	X	X	X	X	X	X	X							
CC	43	Trinity Episcopal Day School	X	X	X	X	X	X	X	X	X						X	
CC	44	Tulsa Educare Inc.	X	X	X	X	X	X	X	X	X				X			
CC	45	Tulsa University Child Development Ctr	X	X	X	X	X	X	X	X	X							X
CC	52	YWCA Patti Johnson Wilson ELC	X	X	X	X	X	X	X	X	X				X			
JC	2	Tulsa Community College - Metro Campus	X	X	X	X	X	X	X	X	X						X	
UV	4	University of Tulsa	X	X	X	X	X	X	X	X	X						X	
HO	2	Hillcrest Medical Center	X	X	X	X	X	X	X	X	X				X		X	X
HO	3	Hillcrest Specialty Hospital	X	X	X	X	X	X	X	X	X				X		X	
HO	6	Oklahoma State University Medical Center	X	X	X	X	X	X	X	X	X						X	X

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storms	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Fixed Site HazMat	Transportation-HazMat
BH	8	Parkside Community Psychiatric Services & Hospital	X	X	X	X	X	X	X	X	X				X		X	X
HO	11	Saint John Medical Center	X	X	X	X	X	X	X	X	X						X	
IL	7	Boulder Plaza	X	X	X	X	X	X	X	X	X							
IL	31	Hewgley Terrace	X	X	X	X	X	X	X	X	X						X	X
IL	43	Luther Place on Troost	X	X	X	X	X	X	X	X	X				X		X	X
IL	45	Mansion House	X	X	X	X	X	X	X	X	X							
IL	48	Murdock Villa	X	X	X	X	X	X	X	X	X				X		X	X
NH	74	The Cottage Extended Care	X	X	X	X	X	X	X	X	X							X
IL	89	Tulsa Pythian Manor West	X	X	X	X	X	X	X	X	X		X					
LF	3	Bank of Oklahoma	X	X	X	X	X	X	X	X	X						X	X
LF	7	Energy One Federal Credit Union	X	X	X	X	X	X	X	X	X						X	
LF	8	F & M Bank Trust Co	X	X	X	X	X	X	X	X	X							
LF	12	Peoples State Bank Inc	X	X	X	X	X	X	X	X	X				X			
LF	13	Red Crown Federal Credit Union	X	X	X	X	X	X	X	X	X						X	
LF	17	Tulsa Federal Employees Credit Union	X	X	X	X	X	X	X	X	X						X	

5.4.4.1 Flood

Location

District 4 is affected by the City Regulatory floodplain and the Special Flood Hazard Area (SFHA). The Arkansas River passes on the western edge of the District. The combined floodplains comprise 1.44 sq. mi., or 11.38 percent of land within District 4. A list of District 4 streams and drainage areas is included in Table 5.4-6. Maps of the 100-year floodplain and District 4 drainage basins are shown in Figure 5.4-17.

Table 5.4–6: Tulsa Council District 4 Streams and Drainage Areas

Basin	Total Drainage Area (sq. mi.)
DIRTY BUTTER	0.00
UPPER JOE CREEK	0.93
UPPER MILL CREEK	0.35
DOWNTOWN	1.28
ELM CREEK	2.87
OAK CREEK	0.42
CROW CREEK	2.50

Basin	Total Drainage Area (sq. mi.)
PERRYMAN DITCH	0.09
SAN-TRAVIS PARK	0.89
ARKANSAS RIVER-MAINSTEM	0.32
ARKANSAS RIVER LOCAL DRAINAGE	0.01
PARK VIEW CREEK	0.46
COAL CREEK	2.52
Total	12.64

Impact/Vulnerability

In total, 1,017 single-family residential structures, 70 multi-family residential structures, 91 commercial buildings, 15 industrial buildings, and 162 buildings classified as *other*, are touched by the 100-year floodplains of District 4. These have a total assessed value, adjusted for fair market price, of $164,087,920. The buildings impacted by the 100-year floodplain are listed, by type, in Table 5.4-7.

Table 5.4–7: Tulsa Council District 4 Buildings Touched by 100 year Floodplain

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	1,017	$109,185,276
Residential Multi-Family	70	$8,977,945
Commercial	91	$24,607,464
Industrial	15	$1,340,250
Other	162	$19,976,985
Total	1,355	$164,087,920

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

There are 11 critical facilities located in the 100-year floodplains of District 4. Flood damage at any of these facilities could require them to close for a period of time, if repairs are necessary. Critical facilities impacted by the 100 year floodplain are identified in Table 5.4-5 and shown in Figure 5.4-17.

Repetitive Loss Properties

Out of the 93 repetitive loss properties in the City of Tulsa, seven are located in Council District 4: three residential and four commercial.

Flood Control Projects

In Council District 4, many projects have been completed for flood control issues. Figure 5.4-18 displays flood control projects in the District identified in the 2004 Capital Improvements Plan. The flood control projects budgeted in the 2008-2012 CIP for District 4 are listed in Table 5.4-8. The projects, which focus on Coal Creek, Crow Creek, Elm Creek, Mill Creek, Oak Creek, Parkview Creek and Upper Joe Creek, as well as the Arkansas River and downtown storm drainage, total $117,090,000.

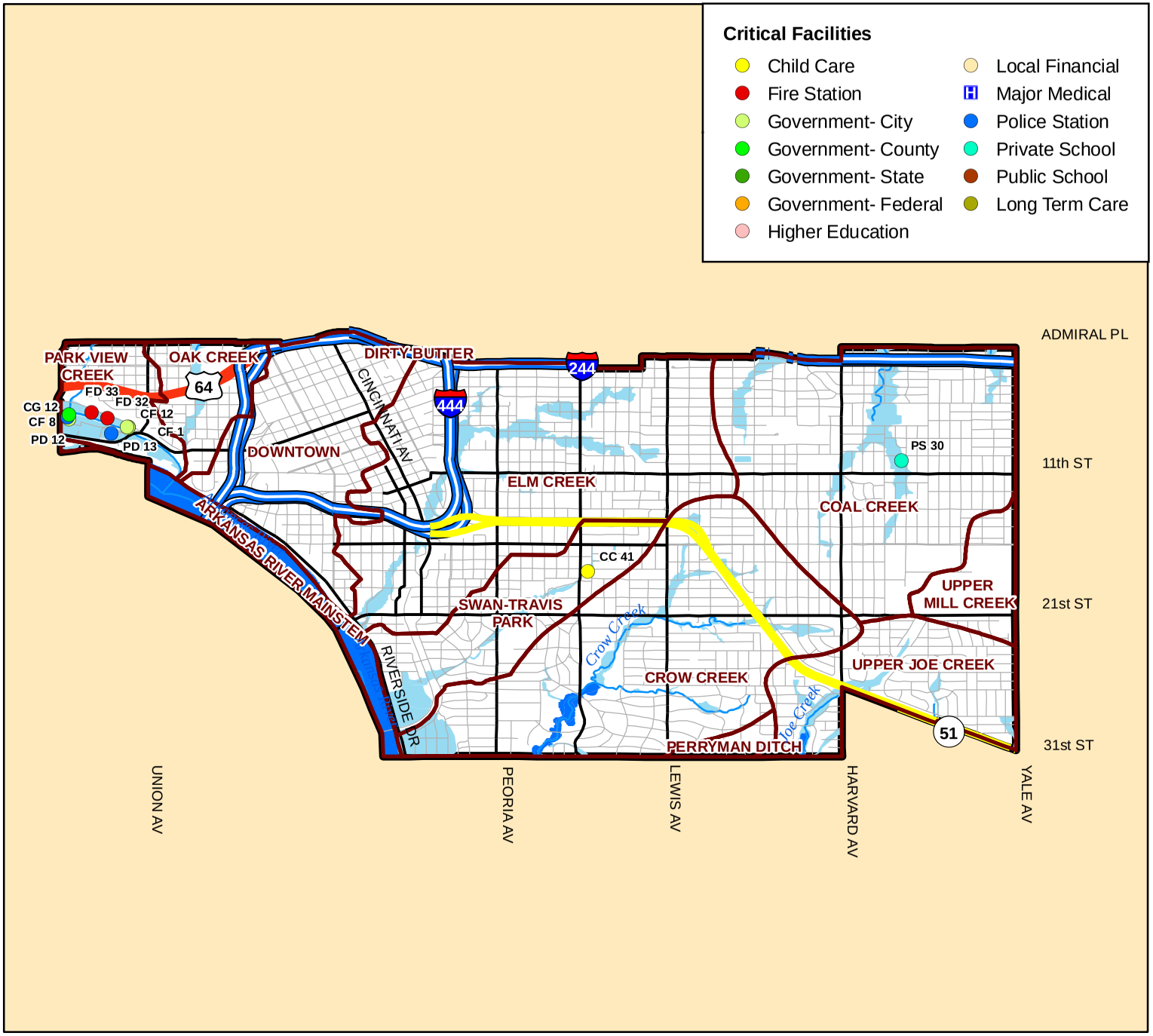


Figure 5.4-17

Tulsa
Council District 4

Drainage Basins & Floodplains

Table 5.4–8: Tulsa Council District 4 Flood Control Projects 2008-2012

Project ID	Project Basin and Description	Budget
1	Arkansas River Lower Basin - Storm Sewer & Detention Basin Improvements	$50,620,000
21	Coal Creek – Urbana Storage	$1,820,000
22	Crow Creek - 15th St. and BA Expressway Detention Basin &Storm Sewer Improvements	$4,210,000
29	Crow Creek - Yorktown Apartments Channel & Berm	$690,000
32	Downtown Storm Drainage System Reconstruction	$15,780,000
33	Elm Creek – 7th Street Canal Conveyance System	$5,680,000
34	Elm Creek – 15th Street Storm Sewer Connector	$110,000
35	Elm Creek – Central Park Detention Pond	$500,000
36	Elm Creek - Central Park South Detention Facility	$7,120,000
37	Elm Creek – NBR Detention Pond	$4,420,000
38	Elm Creek – Rockford Storm Sewer	$1,490,000
68	Mill Creek - 15th & Fulton Storm Sewer and Drainage Channel	$5,000,000
69	Mill Creek - Storm Sewer and Bridges (west of McClure Park)	$11,000,000
76	Oak Creek - Roosevelt and Edison St. Detention	$6,220,000
79	Parkview Creek - Expressway Storage	$930,000
89	Upper Joe Creek - 26th and Louisville Detention	$1,500,000
	Total	$117,090,000

Source: PLANiTulsa Capital Expenditures Plan 2008-2012

Conclusion

Tulsa Council District 4 has a HIGH probability of and a HIGH vulnerability to the Flood hazard.

5.4.4.2 Dam Failure

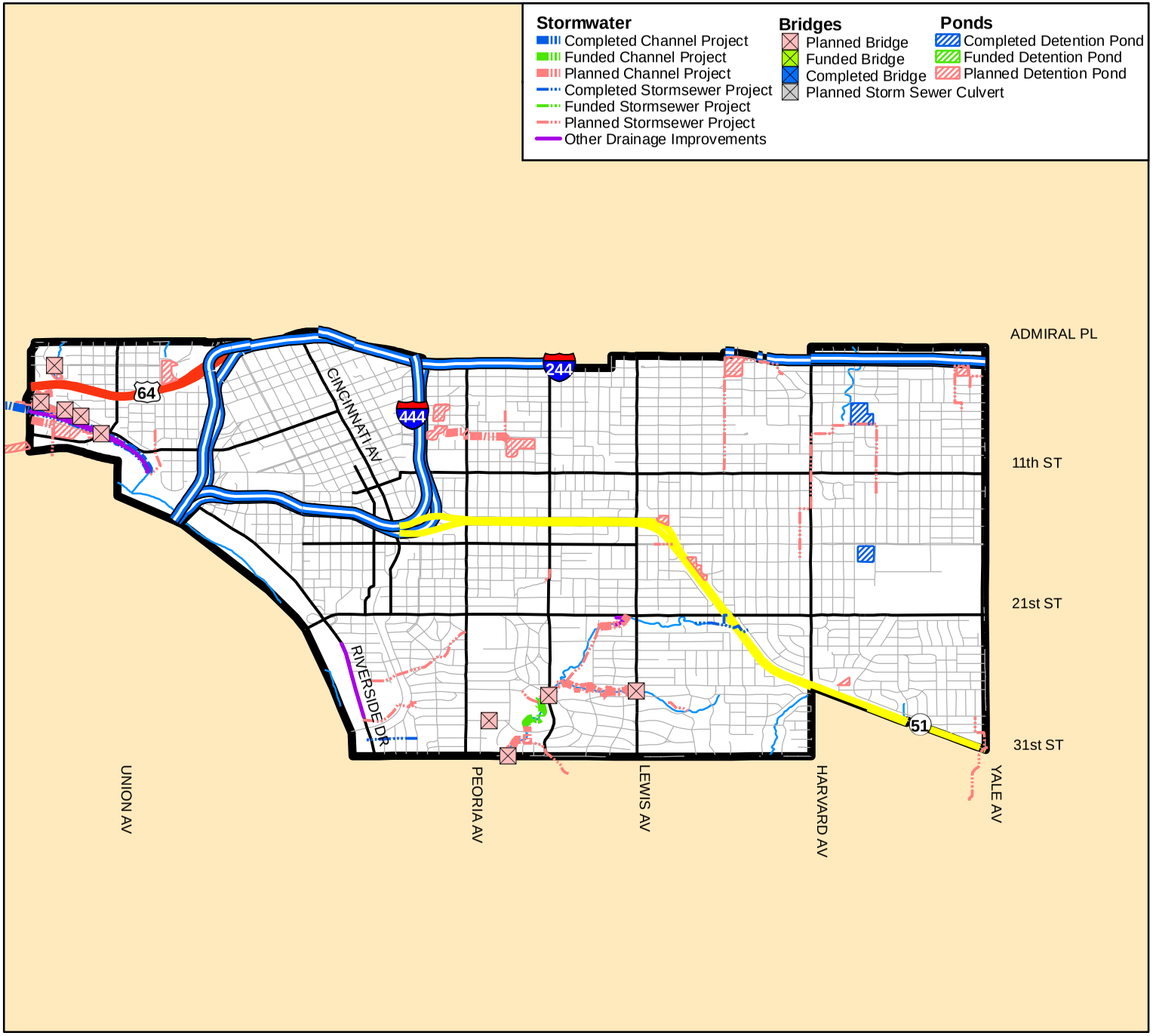
Location

District 4 is located on the east side of the Arkansas River on the west-central edge of the City of Tulsa, downstream from Keystone Dam. About 7.67 percent, or 0.97 square miles, of the land area in District 4 is vulnerable the impacts if Keystone Lake Dam were to fail or be breached, or if the USACE were forced to make an emergency release of over 350,000 cfs. For an in-depth discussion of Dam Failure on the Arkansas River, see Chapter 4 and Section 5.10, Arkansas River Corridor. A map of the dam inundation areas in District 4 is included in Figure 5.4-19.

Impact/Vulnerability

A failure of Keystone Lake Dam is a significant threat to District 4, depending largely on the size of the release discharges. The area just north and east of the Arkansas River within the District, from N. 33rd West Ave. south to E. 31st St. is likely to be impacted. Areas of particular vulnerability are the Perryman Ditch, from the river to Charles Page Blvd., and from N. 33rd West Ave. to Quanah Ave., currently protected by Levee B; and along Riverside Drive from E. 26th St. south to 31st St., and from the river to as far east as Madison Ave. This area is essentially between Swan Creek and Crow Creek.

The numbers of improved parcels in the Keystone Dam inundation area are summarized by type and assessed value, adjusted for fair market price, in Table 5.4-9.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Streams

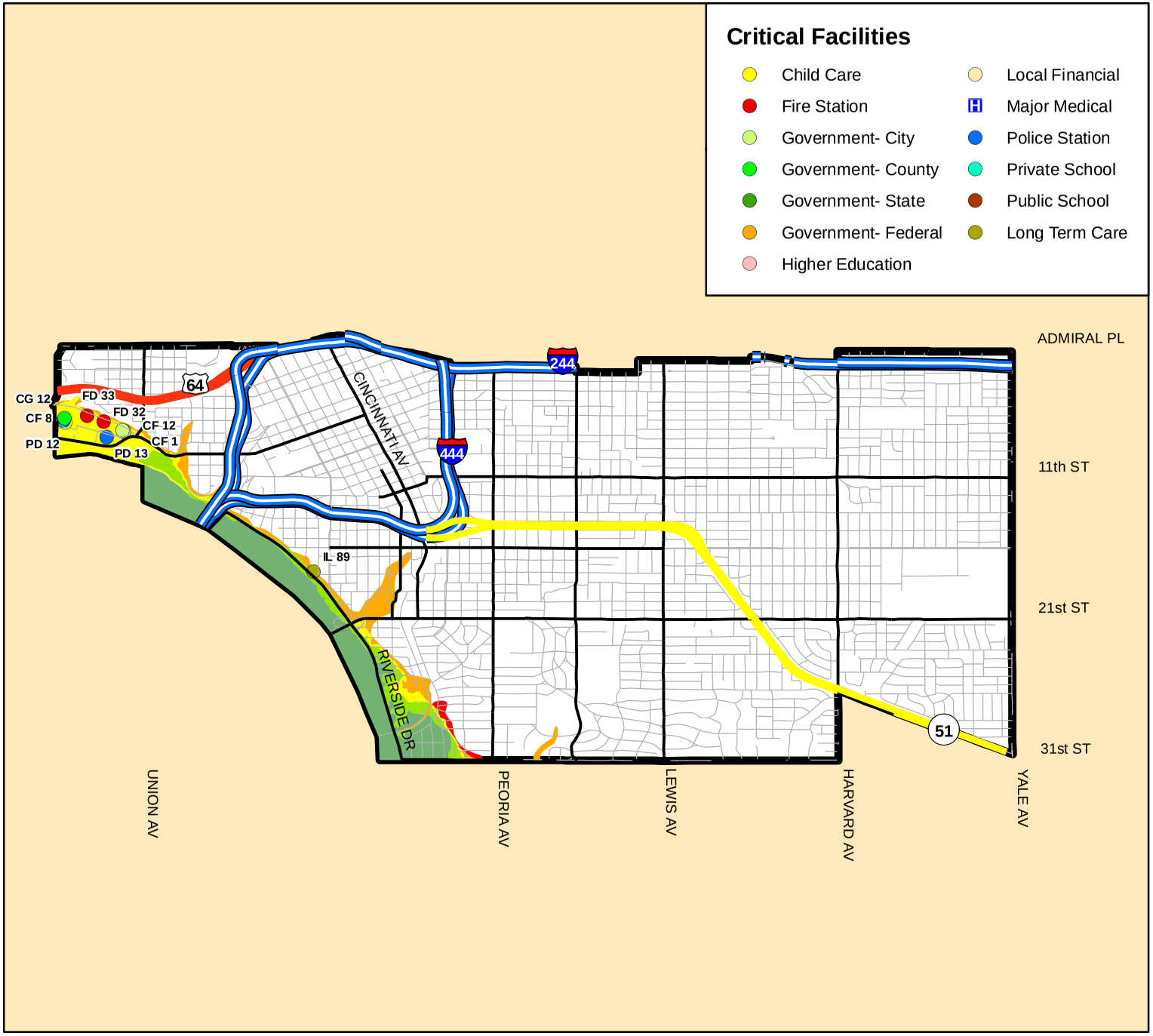
0 0.25 0.5 Miles

For more detailed information refer to the Citywide Master Drainage Plan.

Figure 5.4-18

Tulsa
Council District 4

Flood Control



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets

Dam Break

- 250,000 CFS
- 350,000 CFS
- 450,000 CFS
- Max Failure
- Dam Break
- Other Releases

0 0.25 0.5 Miles

N W E S

Figure 5.4-19

Tulsa
Council District 4

Dam Failure

Table 5.4–9: Tulsa Council District 4 Parcels in Keystone Dam Break Inundation Area

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	477	$81,367,200
Residential Multi-Family	25	$8,221,500
Commercial	28	$11,877,263
Industrial	0	$0
Other	33	$4,512,912
Total	563	$105,978,875

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Ten critical facilities in District 4 are located in the inundation area of Keystone Dam, as indicated in Table 5.4-5 and shown on the map in Figure 5.4-19. Effort should be made to ensure occupants are aware of evacuation plans in the event of an extraordinary release from, or failure of, Keystone Dam, particularly one that threatened the Arkansas River left bank Levee B. Pre-planning is essential at all facilities in the Dam inundation area.

Conclusion

Tulsa Council District 4 has a HIGH vulnerability to and a LOW probability of the Dam Failure hazard.

5.4.4.3 Levee Failure

Location

District 4 is located on the north and east sides of the Arkansas River, in the west-central part of the City of Tulsa. The area north of and adjacent to the Arkansas River, from N. 33rd W. Ave. to the 11th St. Bridge/I-244, is protected by Levee B. Of the total land area in District 4, 0.20 square miles of land is vulnerable to Levee failure. For an in-depth discussion of Levee Failure on the Arkansas River, see Chapter 4 and Section 5.10, Arkansas River Corridor.

Impact/Vulnerability

A failure of Levee B would pose a hazard to District 4. According to parcel information provided by the Tulsa County Assessor's Office, 23 improved parcels with a total value, estimated for fair market price, of $1,384,600 would be impacted by failure or overtopping of the levee. The number of parcels in the levee inundation area is summarized in Table 5.4-10. A map displaying the inundation area of Levee B in Council District 4 is shown in Figure 5.4-20.

Table 5.4–10: Tulsa Council District 4 Improved Parcels in Levee B Inundation Area

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	14	$478,800
Residential Multi-Family	0	$0
Commercial	4	$30,200
Industrial	0	$0
Other	5	$875,600
Total	23	$1,384,600

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Nine critical facilities in District 4 are located within the inundation area of Levee B. Occupants of these facilities at the time of a levee failure are highly exposed to the hazard impacts described in Chapter 4. This is especially true of those unable to evacuate, such as functional needs populations, and, of course, those in the detention facilities. Also of considerable importance are the many storage facilities containing hazardous materials, chemicals and fuels. Pre-planning is essential at all facilities at risk of impact. Table 5.4-5 identifies the critical facilities that would be impacted by the Levee Failure hazard. The facilities are shown in Figure 5.4-20.

Conclusion

Tulsa Council District 4 has a HIGH vulnerability to and a LOW probability of the Levee Failure hazard.

5.4.4.4 Expansive Soils

Location

Council District 4 is underlain predominantly by soils with a Low shrink/swell potential, with Highly expansive soils beneath about 22.32 percent of the District. Highly expansive soils underlie the area, generally, between I-244 south to 21st St. and from Peoria Ave. east to Delaware Ave. Another patch of highly expansive soils is in the northwest quadrant of the District, from Archer St. north to Edison St., and between N. 29th W. Ave. east to N. Denver Ave. Table 5.4-11, includes breakdown of soil types for Council District 4. A map showing the location of the District's expansive soils is presented in Figure 5.4-21.

Table 5.4–11: Tulsa Council District 4 Expansive Soils

Expansion Potential	Area (sq mi)	Percent of Total District Boundaries
Very High	0.0	0%
High	2.74	22.32%
Moderate	0.0	0%
Low	9.26	75.28%
Water	0.30	2.40%
Total	12.30	100.00%

Impact/Vulnerability

According to 2012 Tulsa County Assessor data, 4,579 improved parcels, or about 24.58 percent of the total parcels in District 4, are underlain by soils with High shrink/swell potential, with an assessed value, adjusted for fair market price, of $694,602,710. A summary of District 4 parcels located on High expansive soils is included in Table 5.4-12.

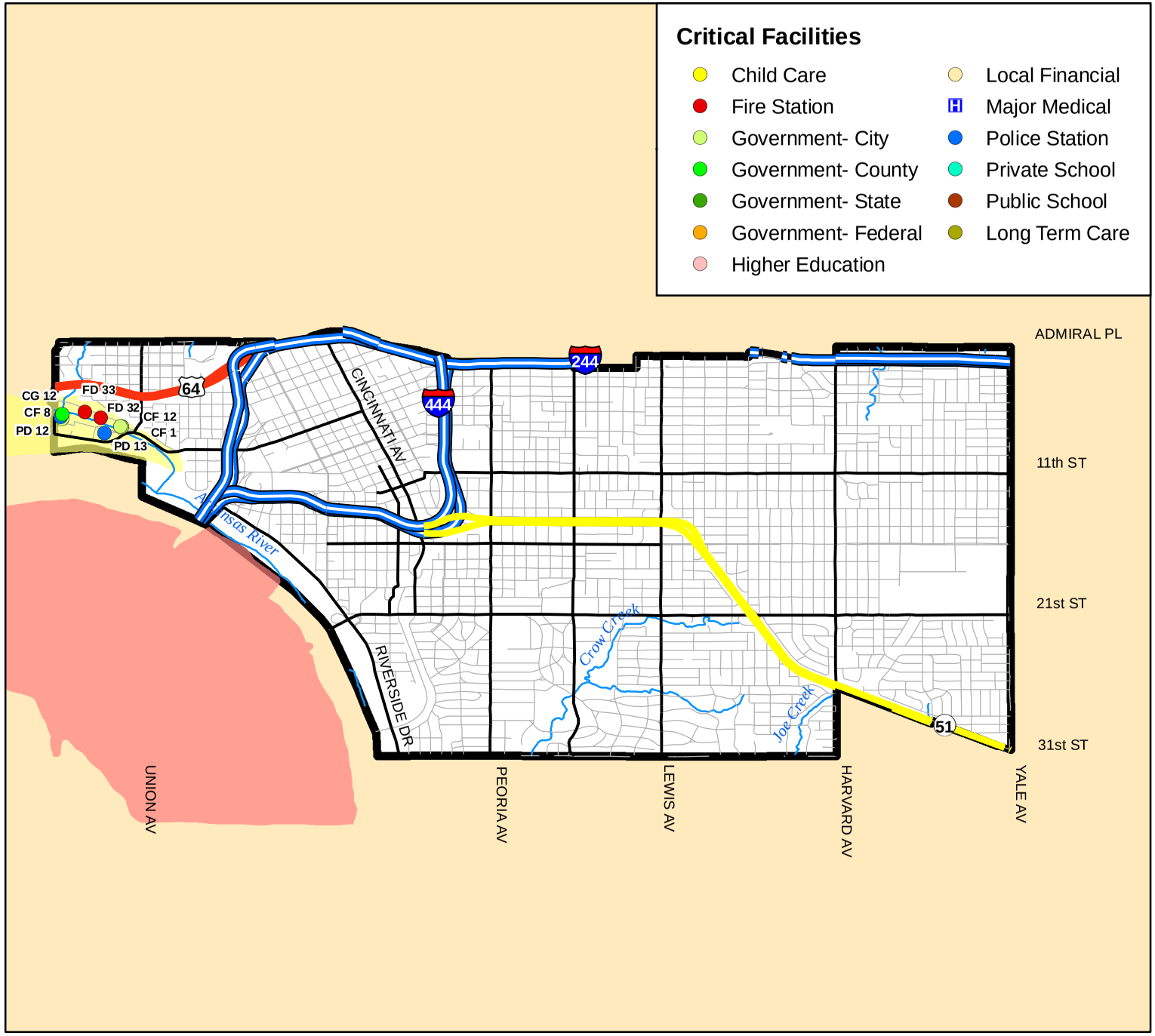


Figure 5.4-20

Tulsa
Council District 4

Levee Protection

Table 5.4–12: Tulsa Council District 4 Parcels on High to Very High Expansive Soils

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	3,434	$282,367,105.00
Residential Multi-Family	387	$38,641,715.00
Commercial	345	$93,068,114.00
Industrial	25	$8,124,746.00
Other	388	$272,401,030.00
Total	4,579	$694,602,710.00

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

There are 15 Critical facilities located on Highly expansive soils in the District. These are listed in Table 5.4-5, and shown in the map in Figure 5.4-21. Although it is likely the structures were engineered to account for the soils on which they are built, effort should be made to monitor the facilities for damages and report/repair as necessary.

Conclusion

Tulsa Council District 4 has a HIGH vulnerability to and HIGH probability of the Expansive Soils hazard.

5.4.4.5 Wildfire

Location

Council District 4 is located in an urbanized and developed area of Tulsa. The Wildfire LOC in District 4 is minimal, as shown in Figure 5.4-22.

Impact/Vulnerability

In total, 279 improved parcels are located in areas of Moderate to Very High Wildfire LOC in Council District 4. A breakdown of improved parcels by assessed value, adjusted for fair market price and type is included in Table 5.4-13. The area of District 4 shown to have the greatest LOC is located between I-444 and State Highway 51 (Broken Arrow Expressway) on the southeast corner of the Inner Dispersal Loop. This area has a rating of 9 on the Wildfire LOC Index. It is not likely a wildfire would spread into the urban center of Tulsa, as it is largely concrete streets and sidewalks, and the few open areas that exist are small and generally well maintained, and pose little danger to surrounding buildings.

Table 5.4–13: Tulsa Council District 4 Parcels Touched by Wildfire Level of Concern

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	239	$33,225,334.00
Residential Multi-Family	20	$6,369,100.00
Commercial	10	$6,317,750.00
Industrial	0	$0.00
Other	10	$128,550.00
Total	279	$46,040,734.00

Source: Tulsa County Assessor's Office, 2012

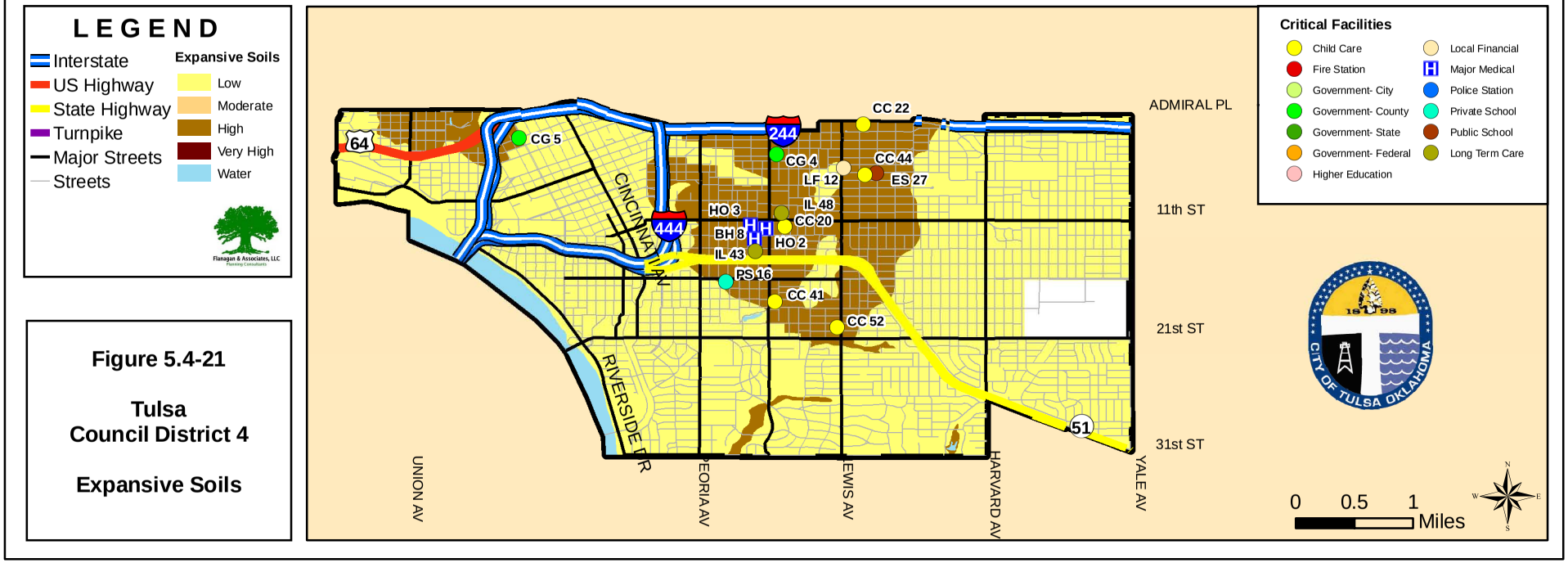


Figure 5.4-21

Tulsa Council District 4

Expansive Soils

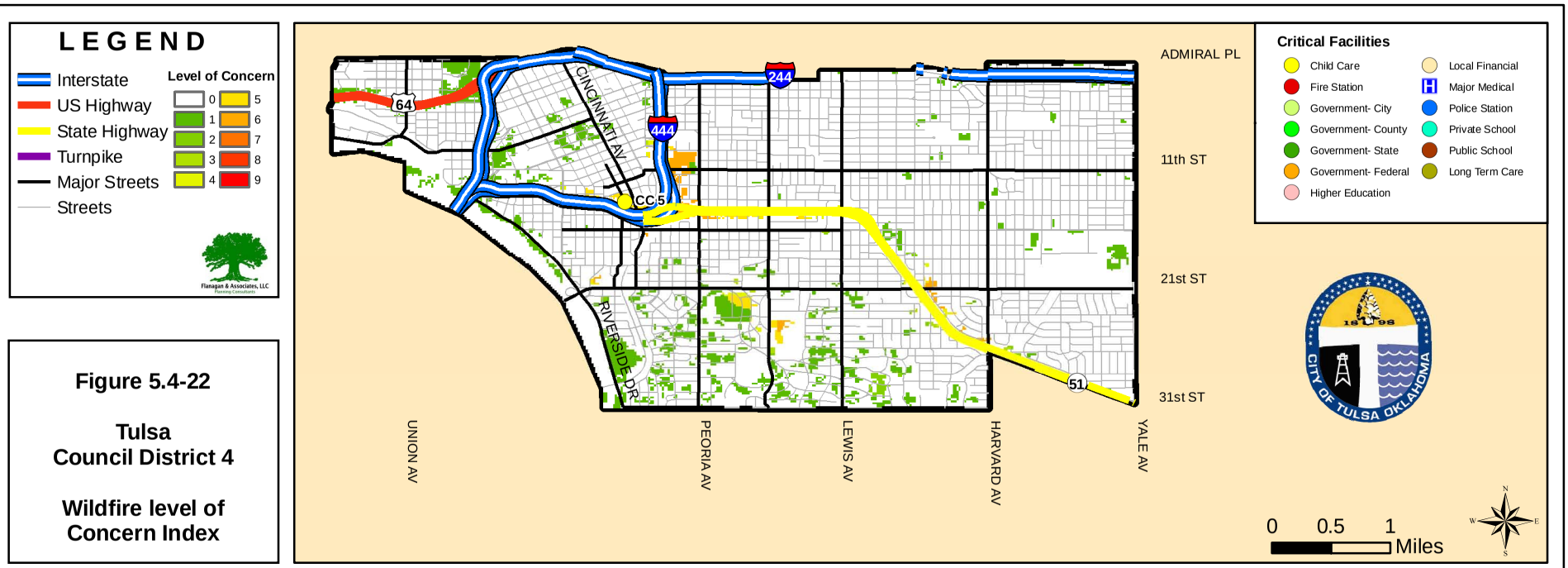


Figure 5.4-22

Tulsa Council District 4

Wildfire level of Concern Index

Critical Facilities

There is one critical facility in the District that is considered to be at risk of the wildfire hazard.

Conclusion

Tulsa Council District 4 is considered to have a LOW vulnerability to and LOW probability of the Wildfire hazard.

5.4.4.6 Fixed Site Hazardous Materials

Location

There are 34 Tier II facilities located within the boundaries of Tulsa Council District 4, of which 21 contain an Extremely Hazardous Substance. Although not within the District, the Holly Frontier refineries are near enough to pose a threat to the western part of District 4 should a large-scale release occur, as happened in March 1988 at the former Sonoco refinery (see Chapter 4). Due to the sensitive nature of this material, Tier II facilities in the District are mapped in Figure 5.4-23 to show only approximate location of the sites. A listing of EHS and Non-EHS Tier II facilities in Council District 4 can be found in Appendix E, and is available on a need-to-know basis.

Impact/Vulnerability

There are 11,113 people living or working in District 4 boundaries that are within a ¼-mile radius of the sites, according to the Marplot analysis, which uses 2010 US Census data. Also at risk would be people participating in activities in Tulsa's downtown area, including street fairs and River Parks activities. It should be emphasized that in most cases the hazardous materials in these facilities (for example, batteries containing acids) would only become a serious risk to local populations or emergency responders in the event of a structural fire, the smoke from which could possibly carry toxic materials. A summary of the number of parcels located within ¼ mile of one the 34 Tier II facilities in District 4, is included in Table 5.4-14.

Table 5.4–14: Tulsa Council District 4 Parcels in ¼ Mile Tier II Buffer

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	2,627	$230,057,146
Residential Multi-Family	295	$51,549,283
Commercial	437	$547,311,636
Industrial	46	$16,441,477
Other	839	$355,806,709
Total	4,244	$1,201,166,251

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Forty-seven critical facilities in Council District 4 are located within ¼ mile of a Tier II facility. Although structures are not likely to be damaged by a toxic release, populations at the facilities are at high risk of being impacted if a hazardous materials event were to occur. Of considerable concern are the six childcare facilities, two private schools, and three long term care facilities that are within the ¼ mile buffer zone of District 4's Tier II sites. Pre-planning is critical at these facilities. Effort should be made to ensure that proper evacuation or shelter in place procedures are posted and practiced. A list of District 4 critical facilities located within ¼ mile of a Tier II facility is provided in Table 5.4-5.

Conclusion

Tulsa Council District 4 is considered to have a HIGH vulnerability to and LOW probability of a fixed-site hazardous materials release.

5.4.4.7 Transportation-Hazardous Materials

Location

There are four significant highway transportation corridors in District 4, mapped in Figure 5.4-24: Interstate 244, runs roughly from north to south across the northwest quadrant of the District, before turning east along its northern boundary; Interstate 444, also known as the Cherokee Expressway and US Hwy 75, forms a half square of the Inner Dispersal Loop around the south and east sides of the urban core, with both ends at Interstate 244; US. Highway 64 enters the District from Sand Springs at in the northwest corner and travels east to duplex with I-244; OK Hwy 51, also known as the Broken Arrow Expressway, enters the District at its extreme southeast corner and merges with I-444 Inner Dispersal Loop, the Cherokee Expressway and US Hwy 75. All of these multi-lane expressways carry hazardous materials through the District. The Burlington Northern Santa Fe (BNSF) Railroad has its Cherokee Yard in West Tulsa, across the Arkansas River from District 4. Four railroads operate on trackage that pass through the District: the BNSF operates a line from the Cherokee Yard over the 11th St. bridge and across the northern boundary to the Port of Catoosa, Claremore and cities to the east; the Union Pacific operates on tracks that branch off from the BNSF line near the intersection of I-444 and I-244 and head east southeast to join the Broken Arrow Expressway at about 14th and S. Atlanta Ave., then follow the BA to OK Hwy 51 at Broken Arrow and on east to Muskogee; the Southern Kansas and Oklahoma Railroad (SKOL) operates a rail line from the northern boundary of District 4 north to Collinsville, with a branch line to the Port of Catoosa; and, finally, the Sand Springs Railroad (SS), a 10-mile short line, operates over tracks from the BNSF line at the 11th St. bridge west to Sand Springs, roughly parallel with Charles Page Blvd. All four railroads carry hazardous materials through the District.

Impact/Vulnerability

A ¼-mile transportation buffer for the five transportation corridors would encompass 62.85 percent of Council District 4 (or 7.95 sq. mi.), 26,056 residents (based on the 2010 US Census number of people per square mile), and 46 of the Districts critical facilities. According to Tulsa County Assessor Data, 7,931 improved parcels in District 4 are touched by the ¼ mile buffer of a Highway or Interstate in the District, with a total value, assessed for fair market, of $1,022,802,866. The numbers of parcels, by type, touched by the Highway corridors are summarized in Table 5.4-15. A total of 3,719 parcels in District 4 are located with ¼ mile of a rail line, with an assessed value, adjusted for fair market price, of $1,126,620,463. The numbers of parcels, by type, located within the Railroad transportation corridors are summarized in Table 5.4-16.

Table 5.4–15: Tulsa Council District 4 Parcels Touched by ¼ mile Highway Corridor

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	6,431	$514,171,479
Residential Multi-Family	409	$51,593,009
Commercial	444	$206,155,279
Industrial	32	$7,533,258
Other	615	$243,349,841
Total	7,931	$1,022,802,866

Source: Tulsa County Assessor's Office, 2012

LEGEND

- 2010 EHS TierII
- 2010 non EHS TierII
- TierII 1/4Mi Buffer
- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets

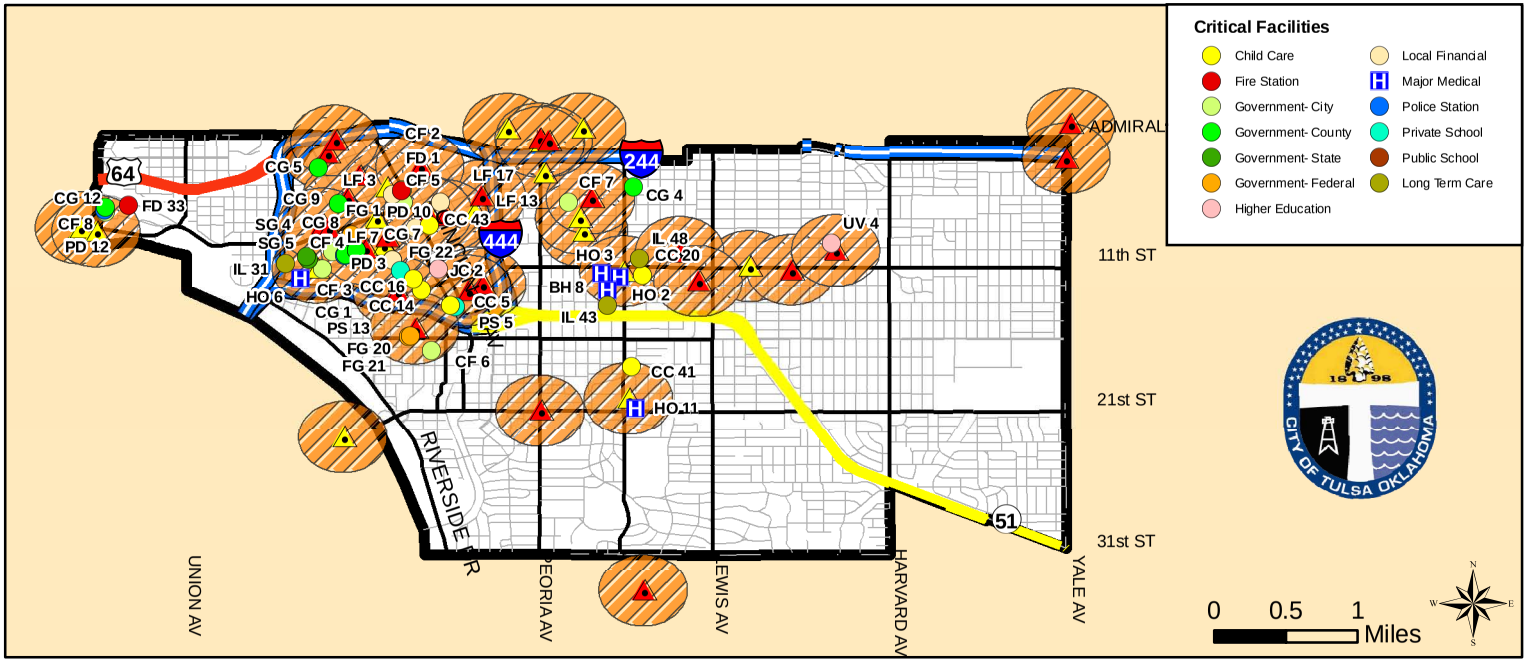


Figure 5.4-23

Tulsa Council District 4

Fixed Site Hazardous Materials

LEGEND

- Transportation Buffer
- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets

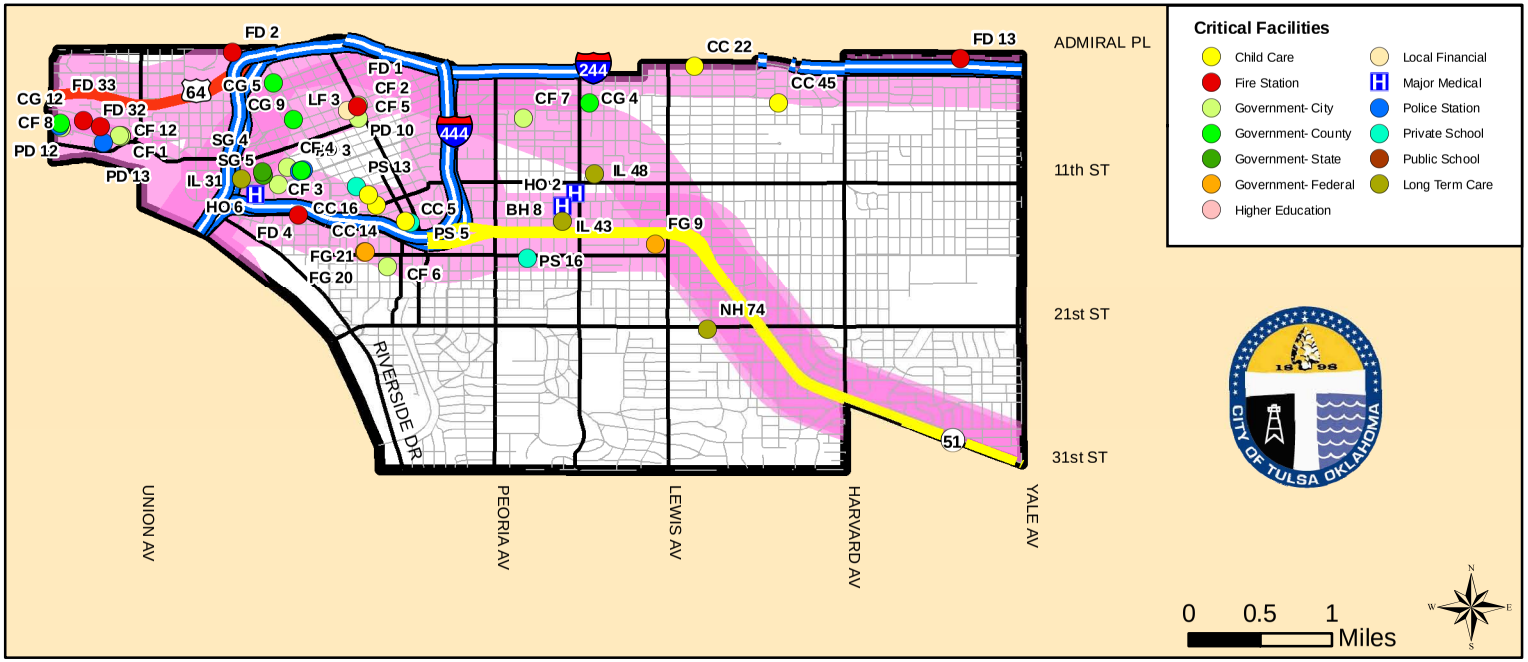


Figure 5.4-24

Tulsa Council District 4

Transporation Corridors

Table 5.4–16: Tulsa Council District 4 parcels Touched by ¼ mile Railroad Corridor

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	2,746	$219,622,564
Residential Multi-Family	160	$23,540,246
Commercial	291	$223,527,500
Industrial	43	$11,958,577
Other	479	$52,848,614
Total	3,719	$531,497,501

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

There are 46 critical facilities in District 4, located within ¼ miles of a transportation corridor. Although the structures themselves are not likely to be directly impacted by this hazard, persons living or working within these facilities do have a heightened vulnerability. Of particular concern are those that house functional needs populations, such as education facilities, long-term care facilities, and eldercare facilities. A transportation incident involving hazardous materials would likely require that people living or working in these facilities either shelter in place or evacuate. A list of critical facilities vulnerable to the Transportation hazard is included in Table 5.4-5 and mapped in Figure 5.4-24.

Conclusion

Tulsa Council District 4 has a HIGH vulnerability to and HIGH probability of the Transportation hazard.

5.4.4.8 Hazards Summary

Site-specific hazards, unique to Tulsa Council District 4, identified and mapped in this section, include Floods, Dam Failures, Expansive Soils, Wildfires, Hazardous Materials, and Transportation. The Hazards Composite Map, shown in Figure 5.4-25, summarizes the areas of the district potentially impacted by these site-specific hazards.

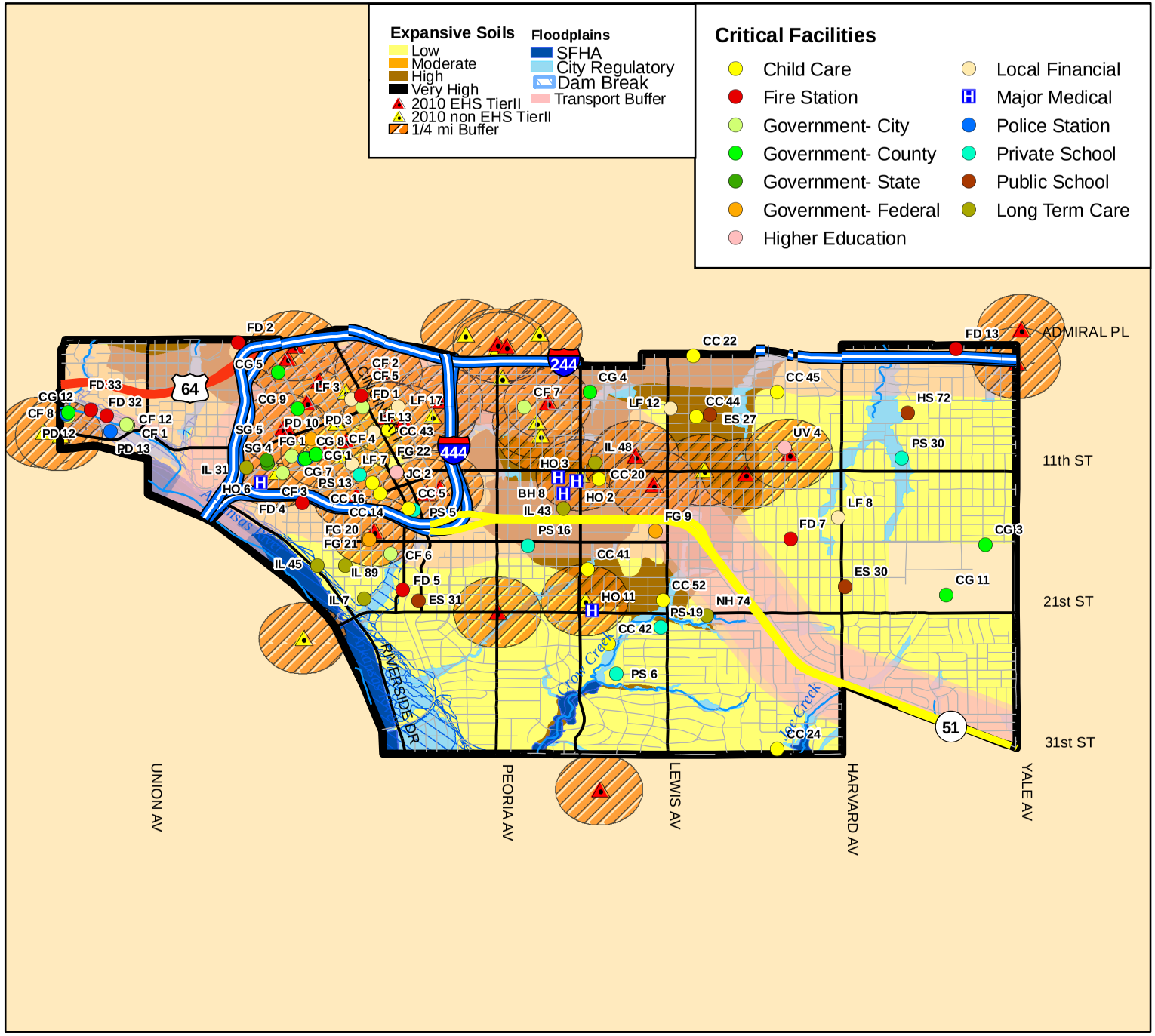


Figure 5.4-25

Tulsa
Council District 4

Hazard Composite

City of Tulsa Multi-Hazard Mitigation Plan Update

Tulsa City Council District 5

R.D. Flanagan & Associates

Planning Consultants

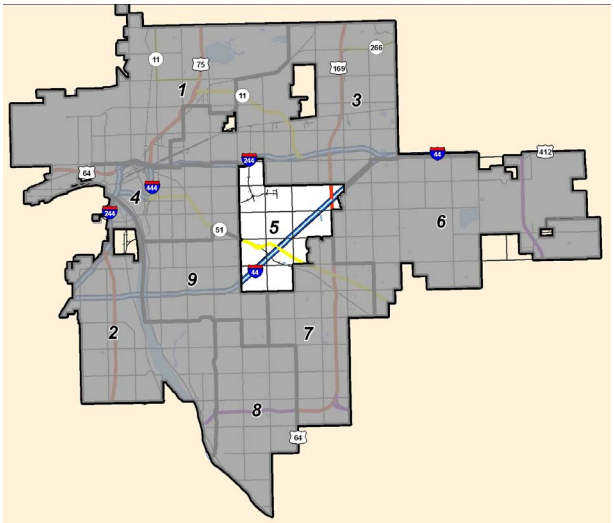
5.5 Tulsa City Council District 5

5.5.1 Introduction

5.5.1.1 Location

Council District 5 is located in the central area of Tulsa, shown in the Locator Map Figure 5.5-1. Total land area within District 5 consists of approximately 12.90 sq mi., as shown in the District 5 Base Map in Figure 5.5-2. The district is bounded generally on the north by E 11th Street, on the west by S. Yale Ave., on the south by E. 51st St., and on the east by S. Memorial Dr. in the south to S. Garnett Rd. in the north.

Figure 5.5–1: Tulsa Locator Map – District 5



5.5.1.2 Karen Gilbert-Councilor District 5

Councilor Karen Gilbert, a native Tulsan, has been a proud District 5 resident for the nearly 15 years. Gilbert has been employed with Tulsa Public Schools (TPS) for the past twelve years, working in both administrative and lead teaching capacities in early education settings. She was a finalist of the Tulsa Public School's Support Employee of the Year, chosen out of 3,000 candidates.

Councilor Gilbert is very involved in her community, particularly with TPS. Over the years, she has served in numerous leadership positions in the Parent Teacher Association, including: Memorial High School PTA president, vice president for TCPTA, Key Elementary PTA president, and Byrd Middle School PTA president. She also served on the advisory council for "Project Schoolhouse," where she organized and moderated Community Town Hall Forums during the planning and implementation of school closures. She served on a Bullying Task Force, which initiated a bullying policy for the school district. Gilbert also created and implemented a mentoring program between Key Elementary and Memorial High School called "Chargers in Charge" which involved high school students engaging elementary students in leadership and athletic activities.

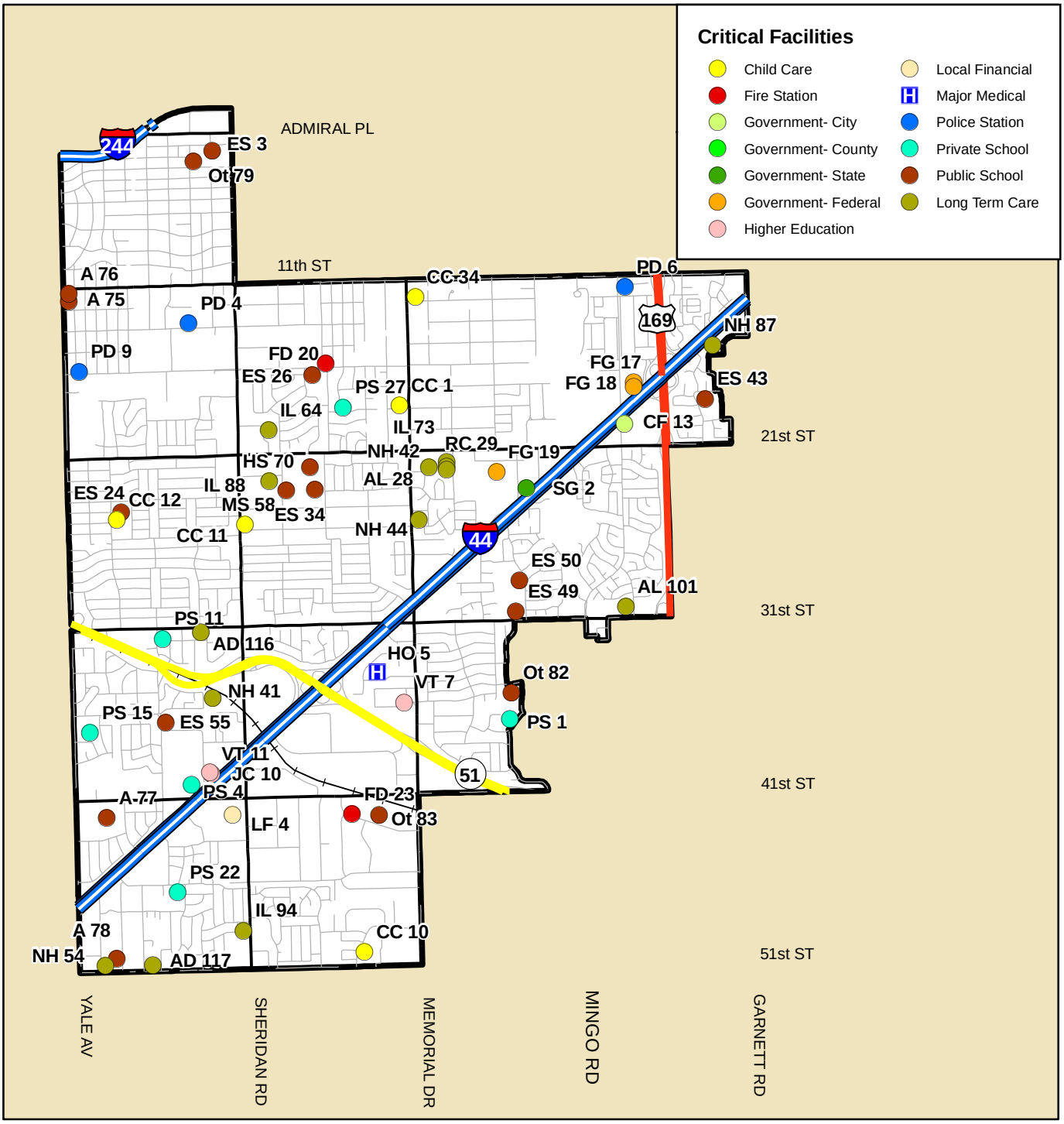
Councilor Karen Gilbert

Gilbert has accomplishments outside of TPS, too. She was a 2011 Honoree of the Festival of Hope, which was chaired by Governor Mary Fallin. She also is a graduate of Leadership Tulsa, class 49. *(Source: http://www.tulsacouncil.org/)*

5.5.1.3 History

Cultural and Historic Properties

Tulsa Council District 5 is home to two cultural sites, Nathan Hale Library and Tulsa Community College-Skyline, both of which are displayed on the map in Figure 5.5-3.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad

0 0.5 1 Miles

Figure 5.5-2

Tulsa Council District 5

Basemap

5.5.1.4 Demographics

Council District 5 had a 2010 US Census population of 43,168. A map displaying population density of the District is shown in Figure 5.5-4. The District's demographic characteristics are summarized in Table 5.5-1 and displayed in Figures 5.5-5 through 5.5-12.

Table 5.5–1: Tulsa Council District 5 Demographic Information

Category	District	Tulsa
Persons under 5 years of age	8.09%	7.53%
Persons under age 18	23.20%	24.44%
Persons age 65 and older	14.77%	12.46%
Poverty Status in 2010 (individuals)	19.82%	19.36%
White	63.34%	62.81%
Native-American	5.50%	5.35%
African American	11.73%	15.67%
Asian	1.90%	2.39%
Hispanic	18.49%	13.93%
Total Population	43,168	401,265

Source: US Census, 2010

5.5.1.5 Infrastructure

Tulsa Council District 5 is dependent upon the lifelines of the City of Tulsa as identified in Section 1.2.6 of this Plan Update. Any unique vulnerability of District 5 to the seven site-specific hazards identified in this plan will be addressed in Section 5.5.4, below.

5.5.1.6 Economy

The 2010 US Census identified an income level of approximately $22,133 as the average poverty threshold for a family of four, including two children. Approximately 8,558 persons or 19.82 percent of all individuals in District 5 were living below the poverty line in 2010. The percentage of people who have low-income and are classified as living in poverty in District 5 is mapped in Figure 5.5-7.

5.5.1.7 Development

According to the Tulsa County Assessor's Office, there are 13,574 parcels with improvements within District 5, with a total assessed value, adjusted for fair market price, of $1,820,576,856. The numbers of properties with improvements and improvement values, by type, are shown in Table 5.5-2. No land, contents or tax exempt values are included. Tulsa Council District 5 is made up of 24 homeowners associations, some of which are displayed in Figure 5.5-13.

Table 5.5–2: Tulsa Council District 5 Property Types by Assessed Values

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	11,878	$939,788,795
Residential Multi-Family	514	$127,223,494
Commercial	655	$494,356,674
Industrial	119	$53,110,266
Other	408	$206,097,627
Total	13,574	$1,820,576,856

Source: Tulsa County Assessor's Office, 2012

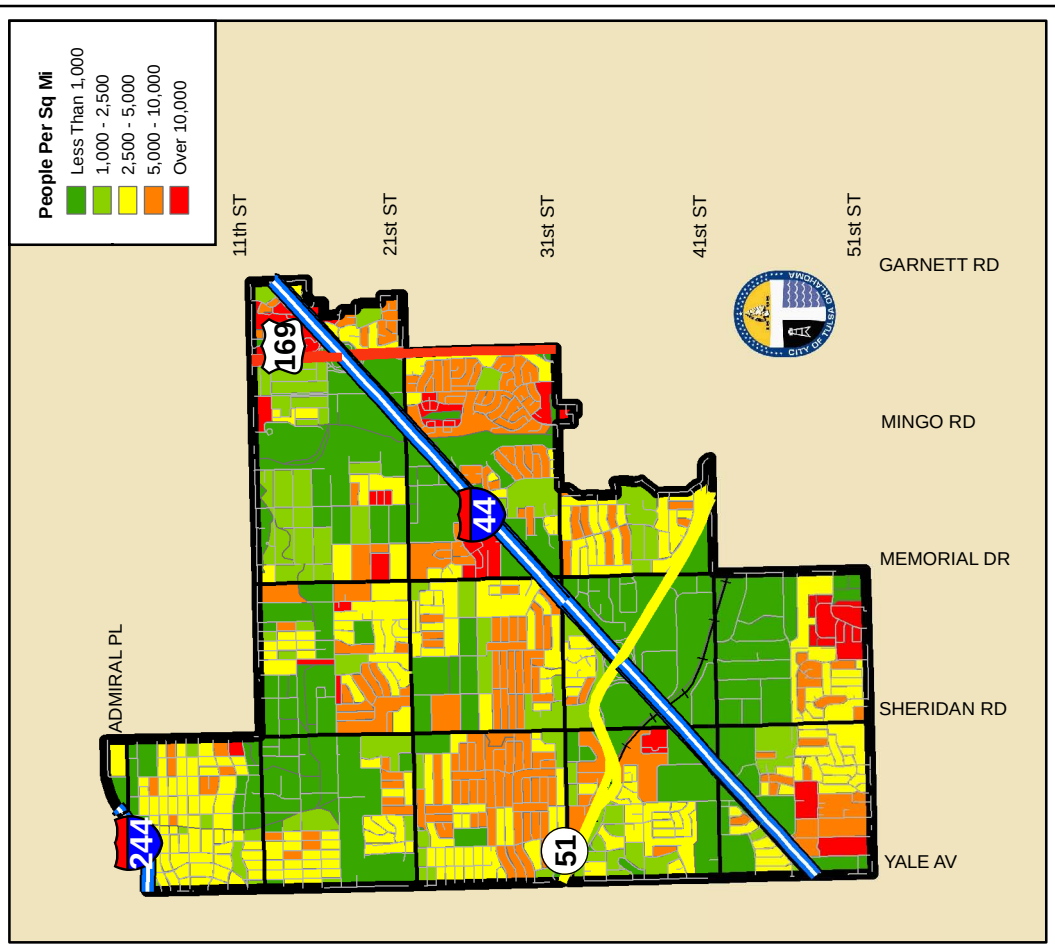


Figure 5.5-4

Tulsa Council District 5

Population Density

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad

0 0.5 1 Miles

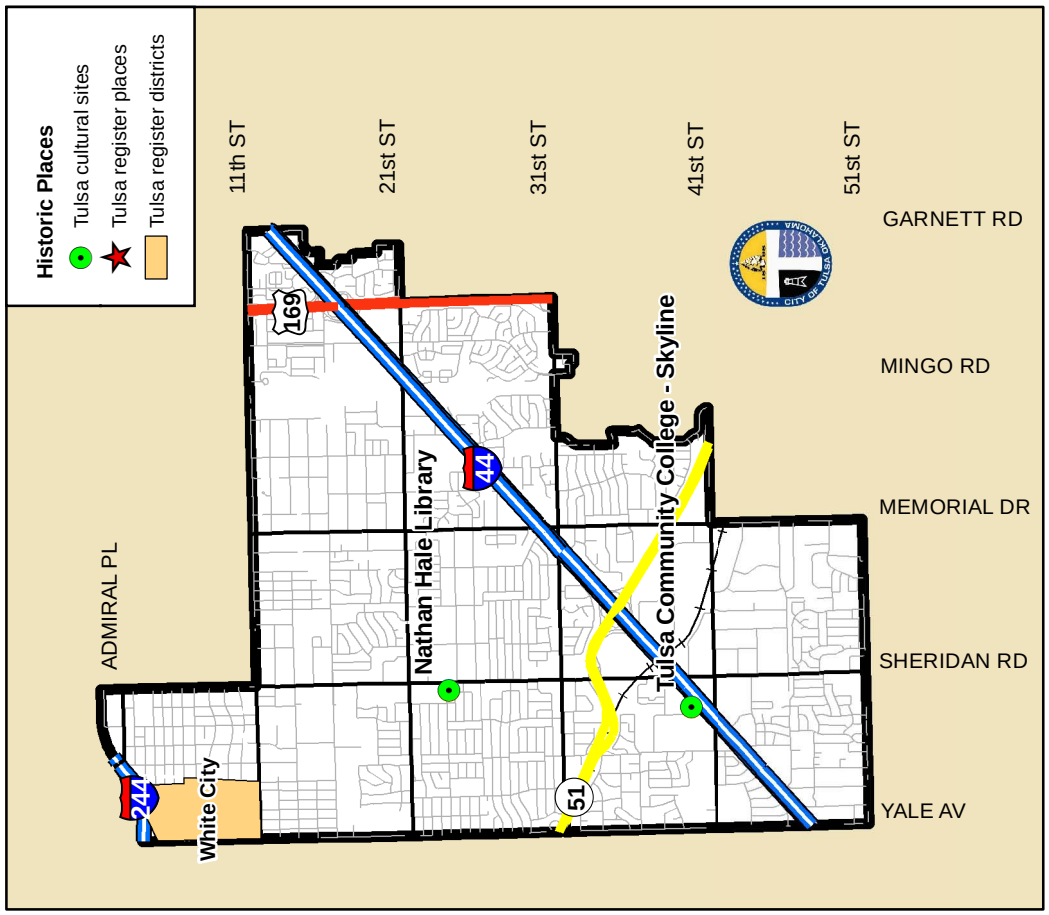


Figure 5.5-3

Tulsa Council District 5

Cultural and Historic Places

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad

0 0.5 1 Miles

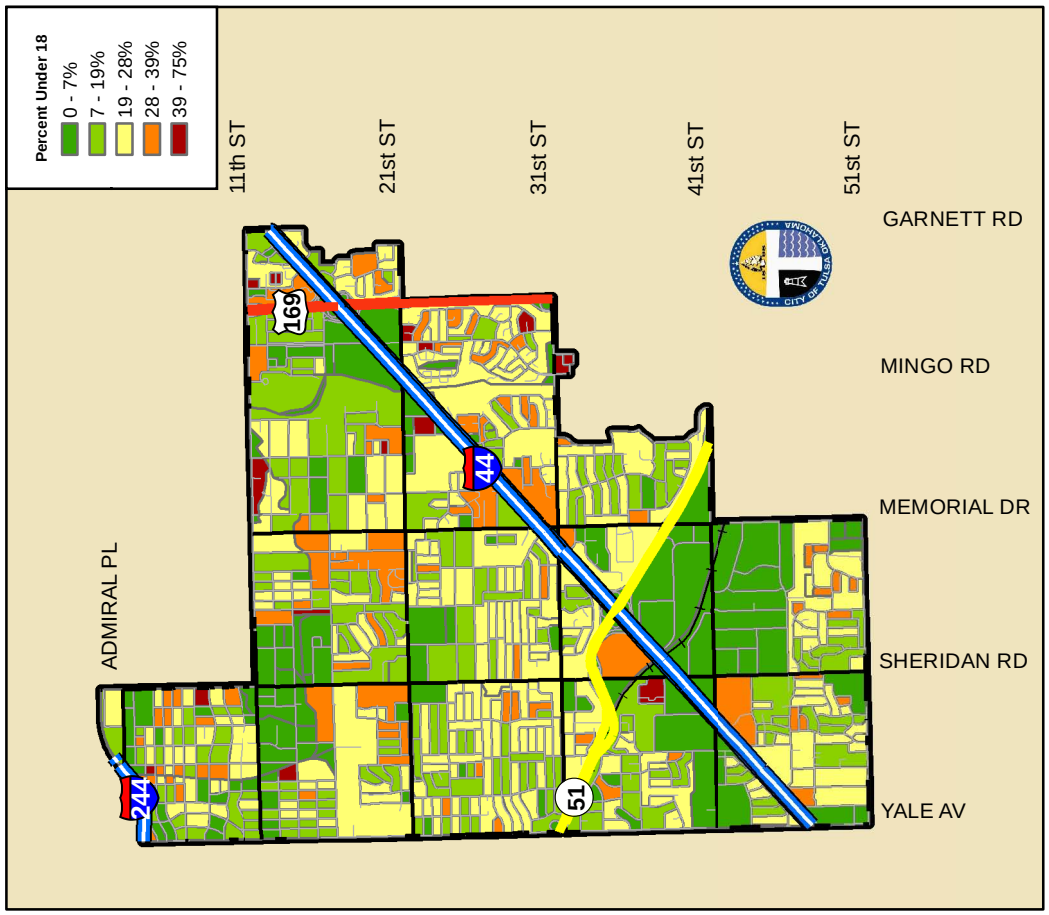


Figure 5.5-5

Tulsa Council District 5

Percent of Population Under Age 18

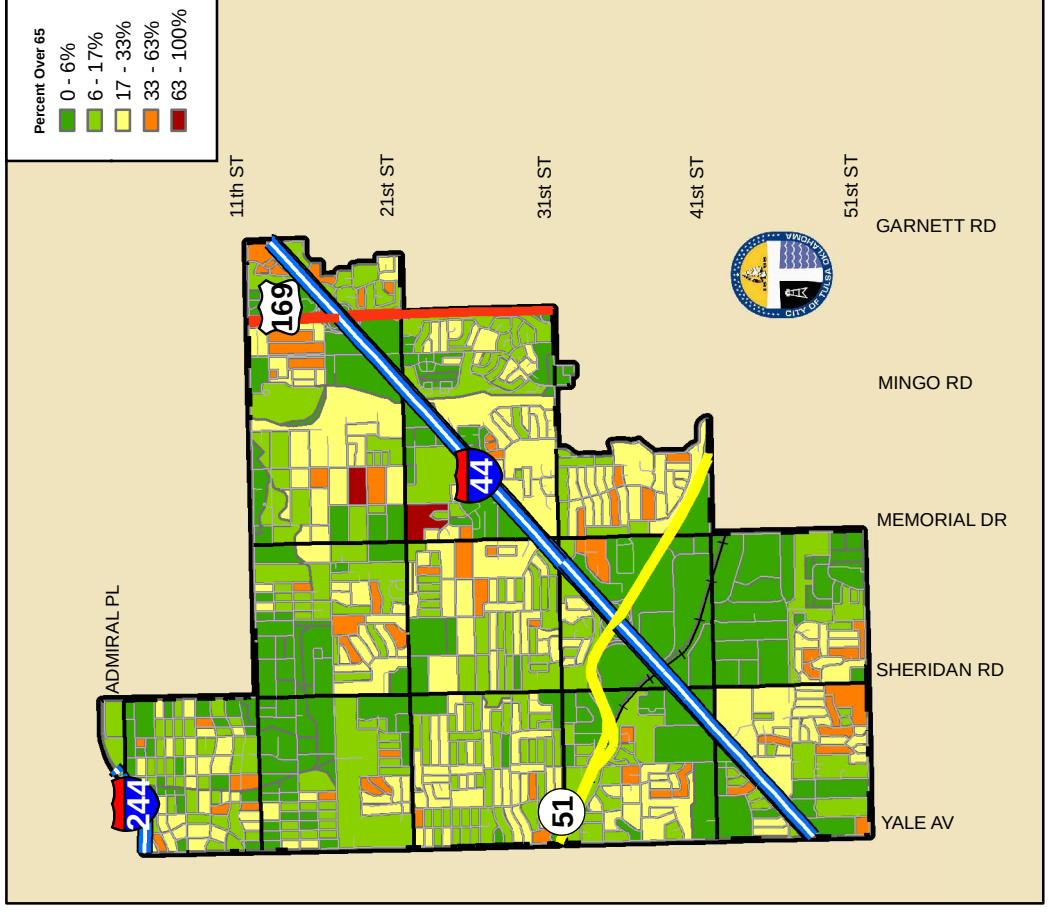


Figure 5.5-6

Tulsa Council District 5

Percent of Population Age 65 and Older

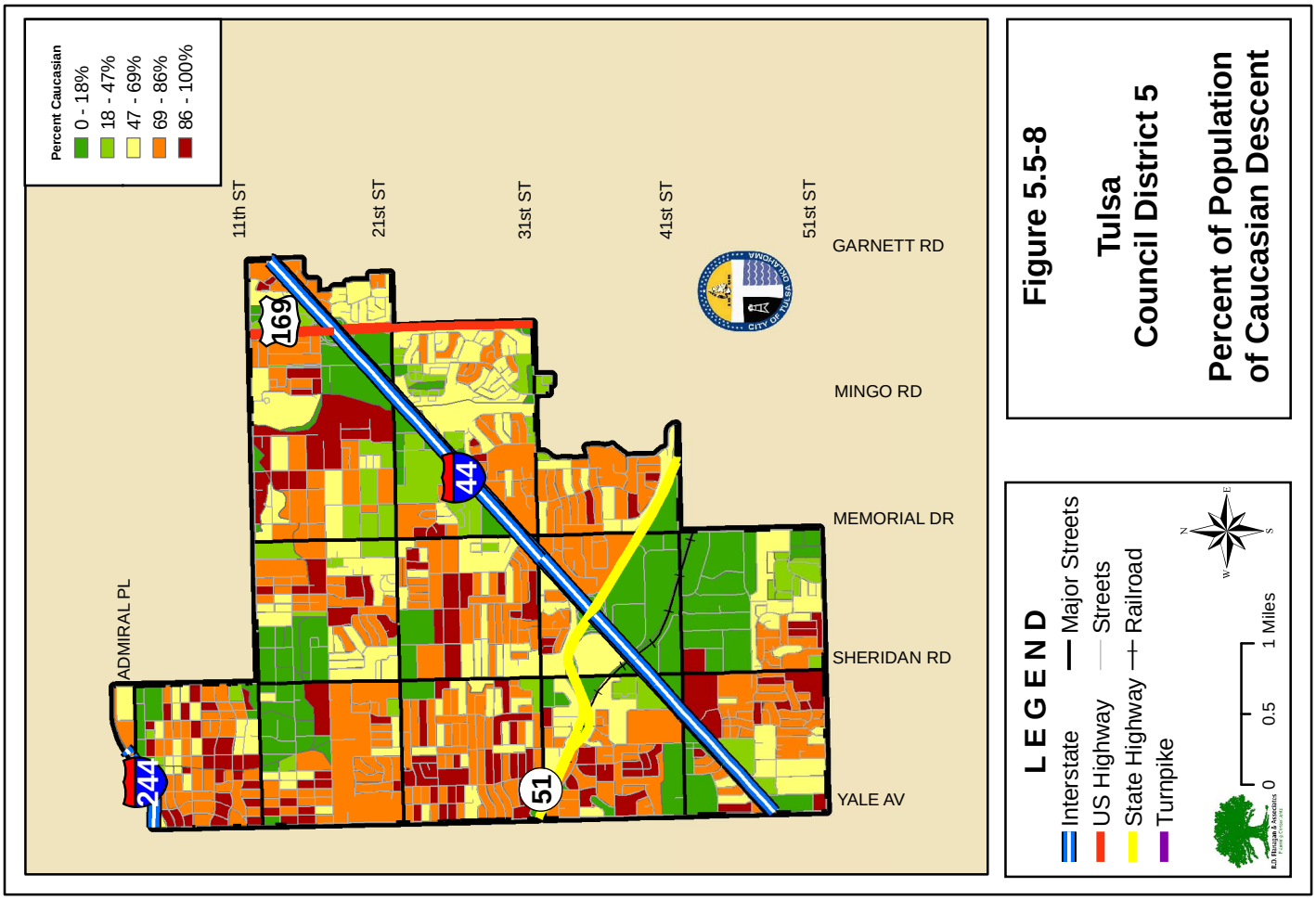


Figure 5.5-8

Tulsa Council District 5

Percent of Population of Caucasian Descent

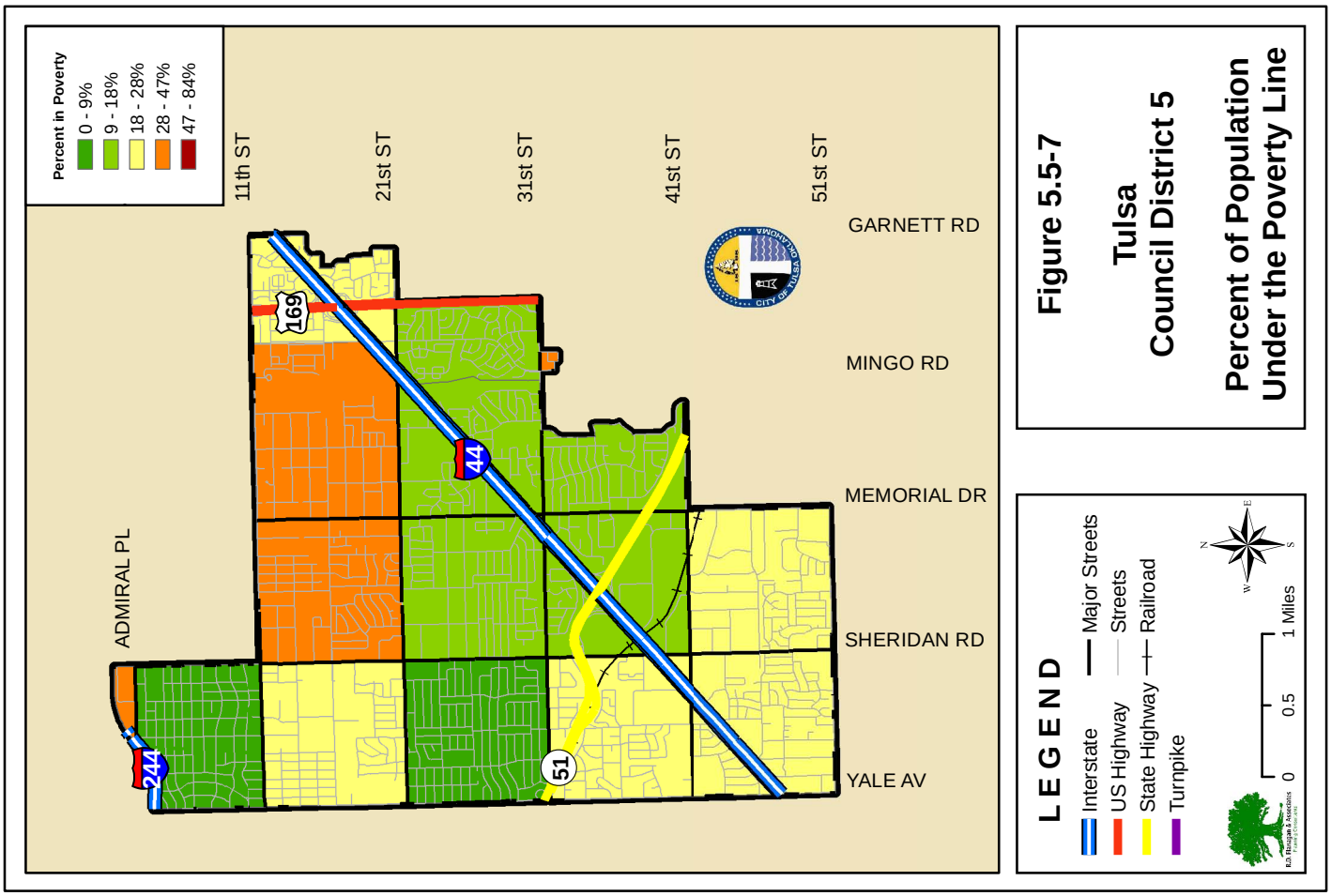


Figure 5.5-7

Tulsa Council District 5

Percent of Population Under the Poverty Line

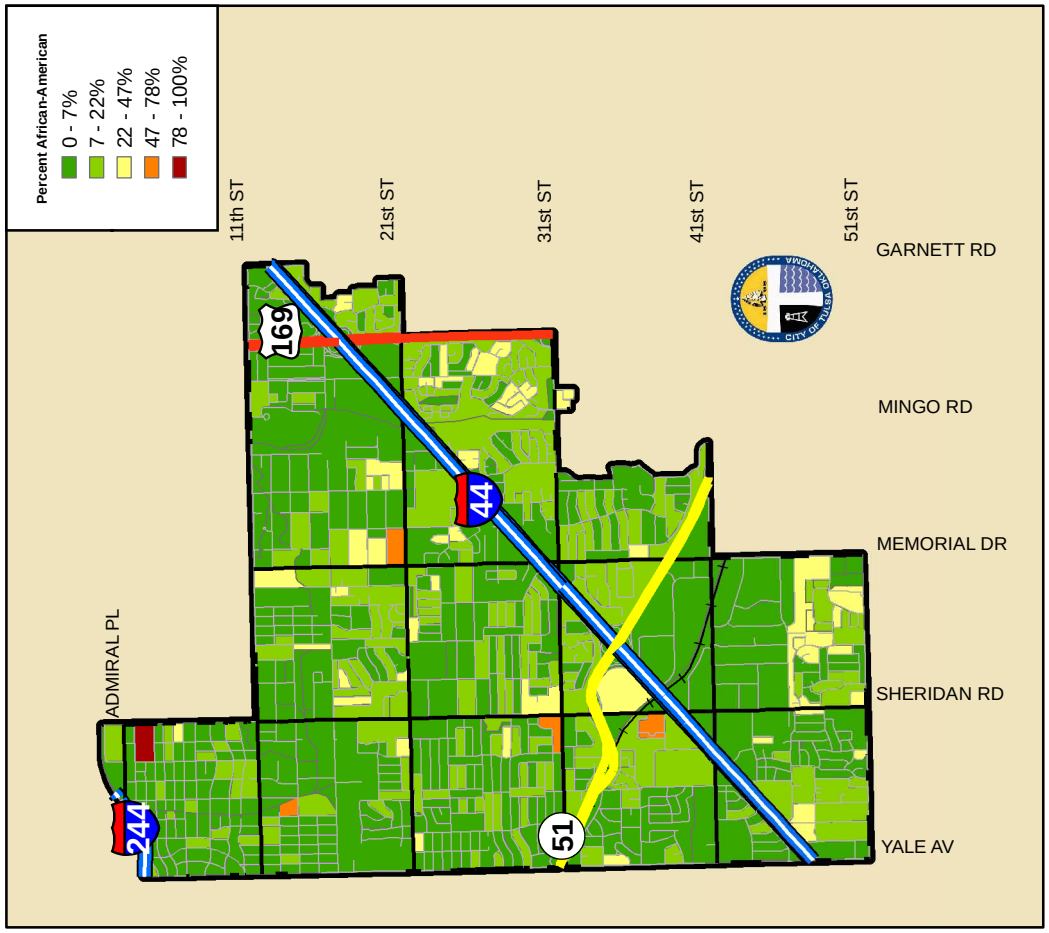


Figure 5.5-10

Tulsa Council District 5

Percent of Population of African-American Descent

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad

0 0.5 1 Miles

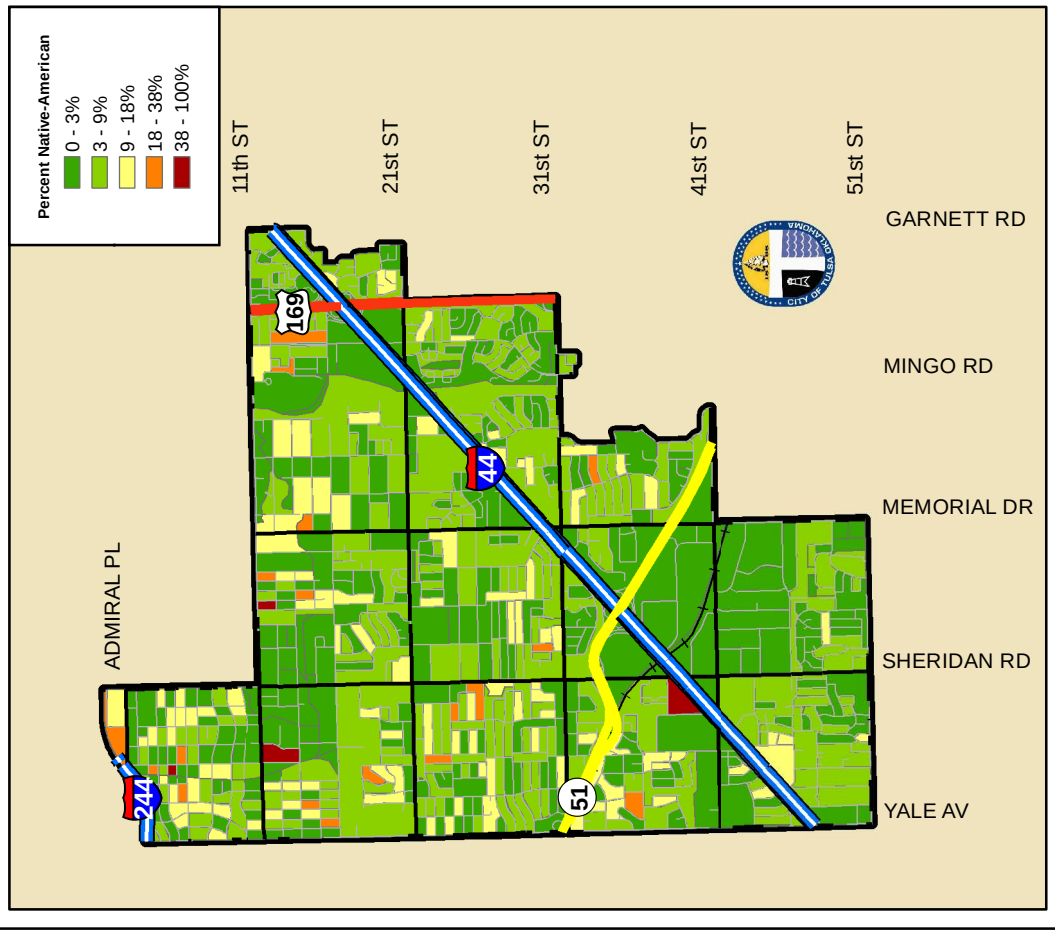


Figure 5.5-9

Tulsa Council District 5

Percent of Population of Native-American Descent

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad

0 0.5 1 Miles

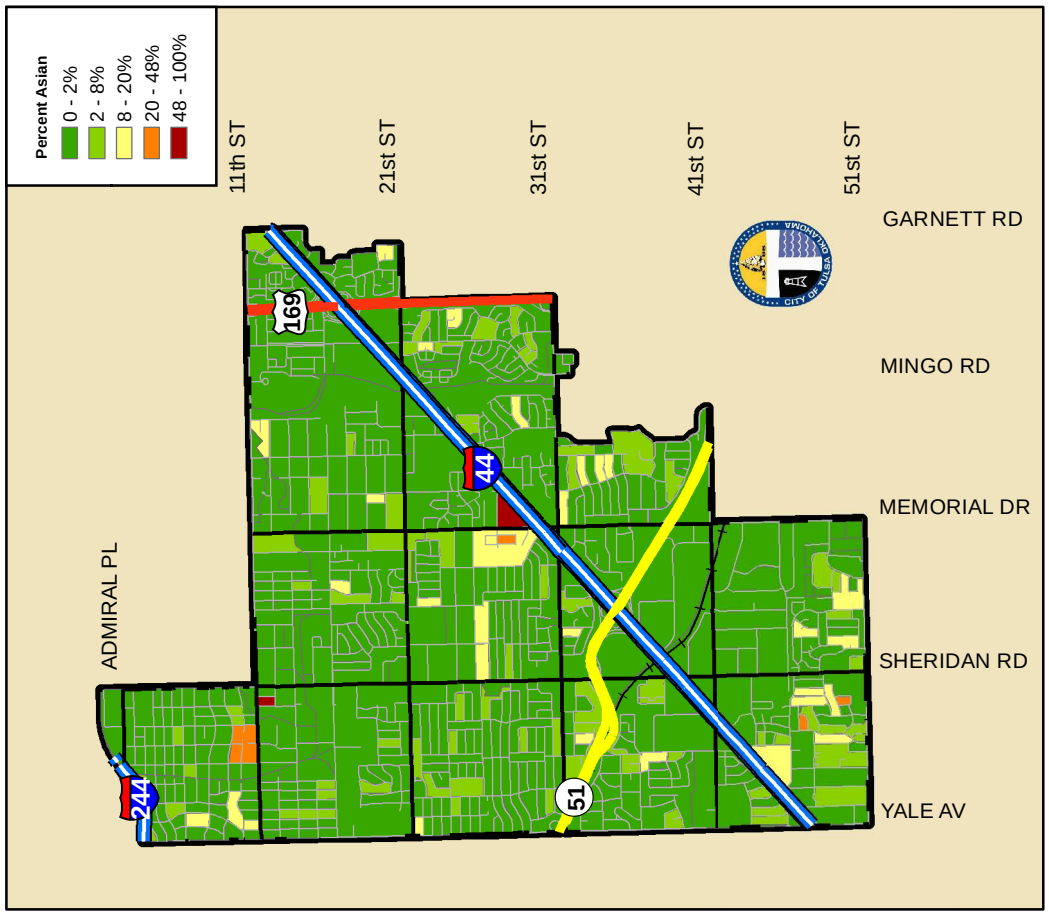


Figure 5.5-11

Tulsa Council District 5

Percent of Population of Asian Descent

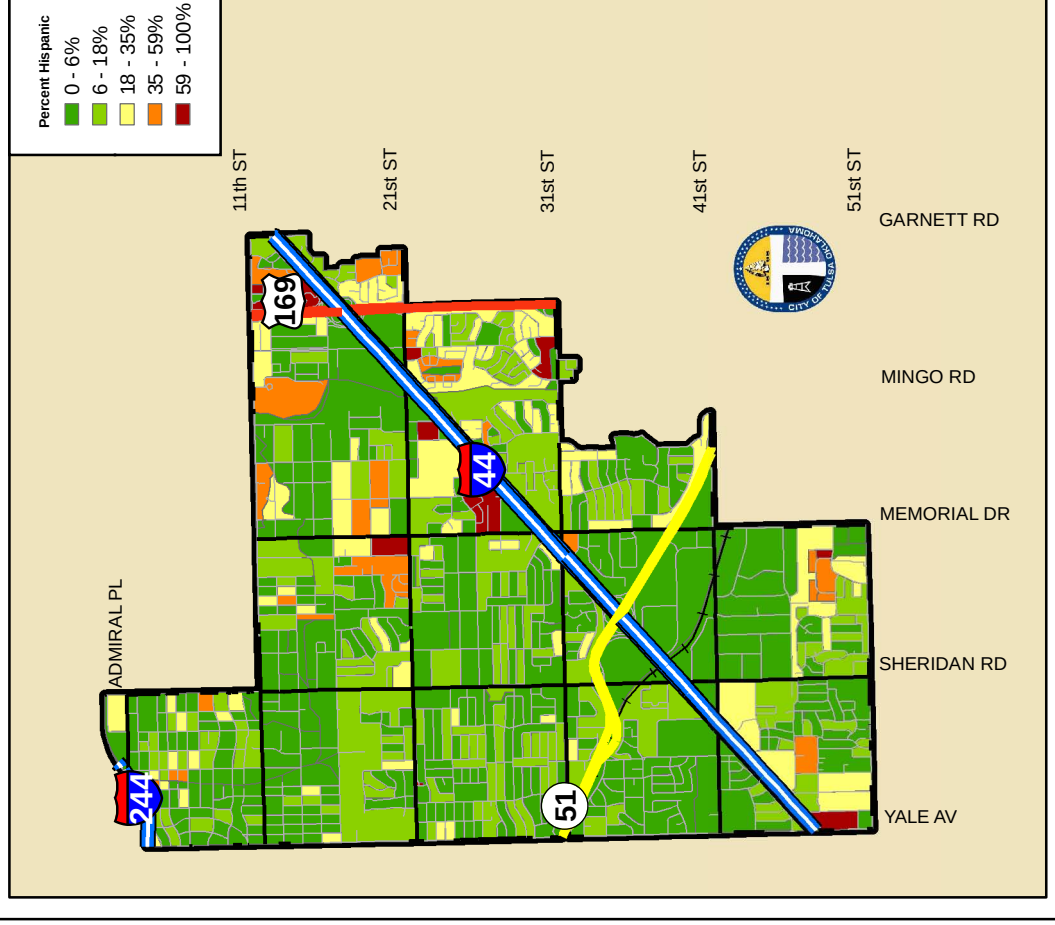


Figure 5.5-12

Tulsa Council District 5

Percent of Population of Hispanic Descent

Zoning

For the purpose of this plan, four of the 29 zoning districts: Agricultural, Single-Family Residential, Multi-Family Residential, Commercial, and Industrial were used to show zoning within District 5. The majority of the land area in District 5 is zoned for single-family residential usage, followed by commercial use, which is primarily ribbon development along the major arterials. The few areas zoned for multi-family usage are located sporadically throughout the district, also mainly along the major arterials. Industrial use areas are located in the northwest (south of 11th between Yale and S. 73rd E. Ave.) and southwest (north and south of E. 41st St. between Sheridan and Memorial Dr.) portions of the district. A map of zoning areas in Council District 5 is displayed in Figure 5.5-14.

Future Development

The City of Tulsa will continue to improve District 5's service infrastructures, such as flood control, water, sanitary sewer, and streets as budgets and priorities allow. For information regarding future development plans in the City of Tulsa, see Section 1.2.8.

5.5.1.8 Critical Facilities

There are 58 critical facilities in Tulsa Council District 5; these are listed in Table 5.5-3 and shown in Figure 5.5-2.

Table 5.5–3: Tulsa Council District 5 Critical Facilities

ID	Map ID	Facility Name	Address
		Government-City	
CF	13	Satellite Fuel Station	1747 S 101st E Ave
		Police Station	
PD	4	Tulsa Police Department (Support Div)	5963 E 13th
PD	6	Tulsa Police Department (East Div)	10122 E 11th St
PD	9	Fire Station 11 transferred to Police	5009 E. 15th St.
		Fire Station	
FD	20	Tulsa Fire Department #22	7303 E 15 St
FD	23	Tulsa Fire Department #25	7419 E 42nd Pl
		Government- State	
SG	2	Oklahoma Highway Patrol - Troop B HQ	9191 E Skelly Dr
		Government- Federal	
FG	17	USACE	1645 S101st E Ave
FG	18	Internal Revenue Service	1645 S101st E Ave
FG	19	USPS - Postage Handling Facility	2114 S91st E Ave
		Tulsa Public Schools	
ES	3	Bell Elementary School	6304 E Admiral Blvd
ES	24	Hoover Elementary School	2327 S Darlington
ES	26	Jones Elementary School	1515 S 71st E Ave
ES	34	MacArthur Elementary School	2182 S 73rd E Ave
ES	43	Peary Elementary School	10818 E 17 St
ES	49	Skelly Elementary School	2940 S 90th E Ave
ES	50	Skelly PreK- K	2714 S 90th E Ave
ES	55	Zarrow International School	3613 S Hudson Ave
MS	58	Hale Junior High School	2177 S 67 E Ave
HS	70	Nathan Hale High School	6960 E 21st St

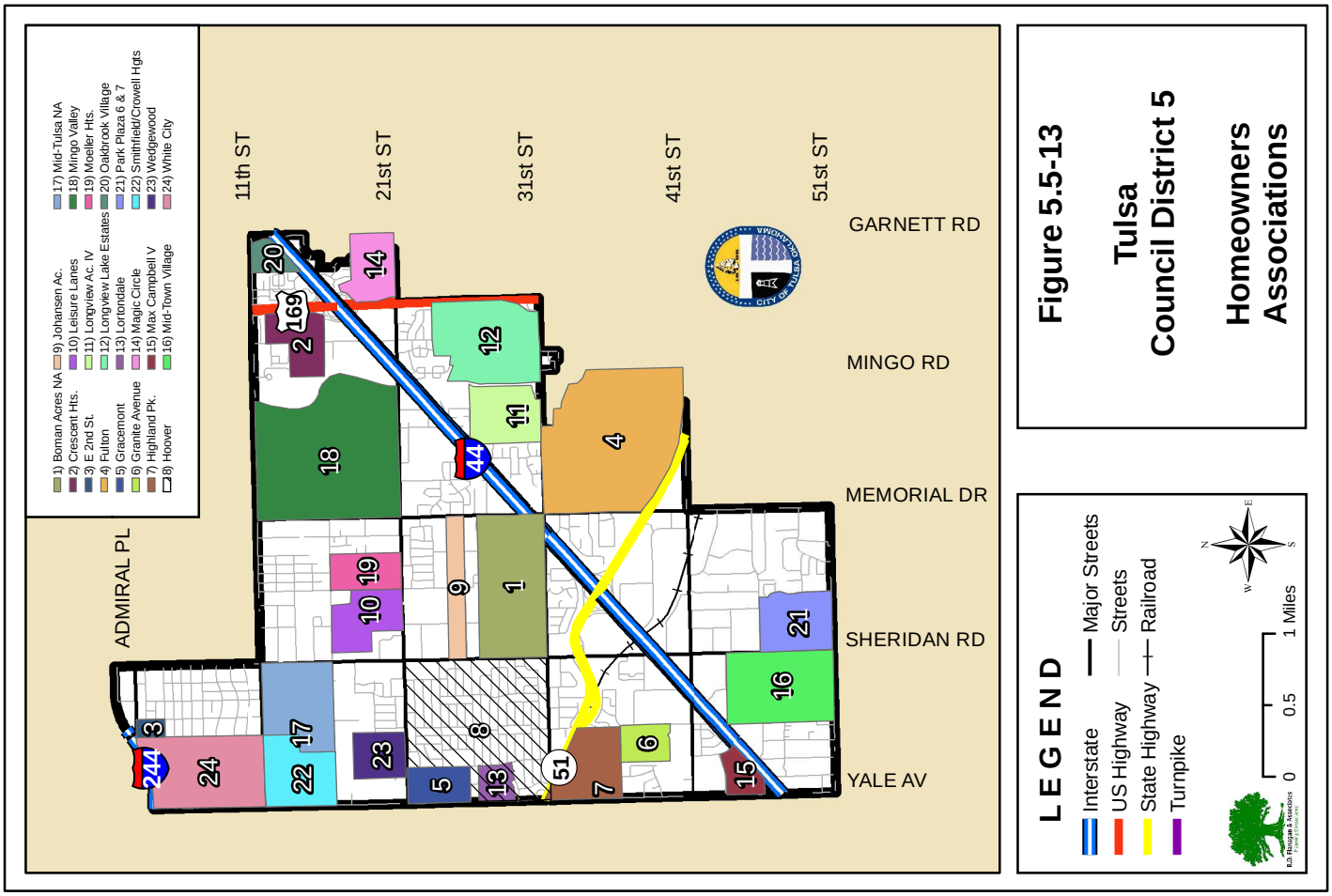


Figure 5.5-13

Tulsa Council District 5

Homeowners Associations

Figure 5.5-14

Tulsa Council District 5

Zoning

ID	Map ID	Facility Name	Address
A	75	Margaret Hudson	1136 S Allegheny Ave
A	76	Street School	1135 S Yale Ave
A	77	Tulsa Learning Academy HS	4107 S Yale Ste 143
A	78	Tulsa School of Arts & Sciences	5155 E 51st St #200
OT	79	Burbank / Indian Pupil Education	209 S Lakewood Ave
OT	82	Fulton Teaching and Learning Academy	8906 E 34th St
OT	83	Grant Transportation/ South Lot	7623 E 42nd Pl
Private School			
PS	1	Aldersgate Learning Center	3702 S 90th E Ave
PS	4	Bishop Kelly High School	3905 S. Hudson
PS	11	Happy Hands Educational Center	5717 E 32nd St
PS	15	Little Light House	5120 E. 36th
PS	22	Peace Academy	4620 S Irvington
PS	27	St. Pius X Catholic School	1717 S 75th East Ave
Child Care			
CC	1	ABC Child Development Center	7915 E. 17th St.
CC	10	Day Schools #1	5085 S. 76th East Ave.
CC	11	Day Schools #11	2437 S. Sheridan
CC	12	Day Schools #9	2327 S. Darlington
CC	34	Memorial Village Early Learning Center	8119 East 12th Street
Higher Education			
VT	7	Tulsa Technology Center - Lemley Campus	3420 S Memorial Dr
JC	10	Tulsa Community College - Conference Center	6111 E Skelly Dr
VT	11	Tulsa Technology Center - Skyline	6111 E Skelly Dr
Major Medical			
HO	5	Meadowbrook Specialty Hospital of Tulsa	3219 S 79th East Ave
Long Term Care			
AL	28	Heatheridge Assisted Living Community	2130 S 85th East Ave
RC	29	Heatheridge Residential Care	2130 S 85th East Ave
NH	41	Lakewood Care Center	6201 E 36th St
NH	42	Leisure Village	2154 S 85th East Ave
NH	44	ManorCare Health Services	2425 S Memorial Dr
NH	54	Parks Edge Nursing & Rehab Center	5115 E 51st St
IL	64	Sheridan Terrace	1937 S 68th East Ave
IL	73	The Broadmoor Retirement Community	8205 E 22nd St
NH	87	Tulsa Nursing Center	10912 E 14th St
IL	88	Tulsa Pythian Manor	6568 E 21st Pl
IL	94	Versailles Apartments	4816 S Sheridan
AL	101	Angel House Residential Assisted Living	10018 E 29th E Ave
AD	116	LIFE Senior Services, Inc	5950 E 31st St
AD	117	Oasis Adult Day Services	5525 E 51sr St Ste 400
Local Financial			
LF	4	Bank of Oklahoma Tech. Center	6424 E 41st St

5.5.2 Existing Mitigation Strategies

5.5.2.1 Council District 5 Warning Systems

Warning Sirens

As shown in Figure 5.5-15, there are eight warning sirens located within District 5. There are an additional eight sirens that, although located outside of the boundary lines, provide partial coverage in District 5. Five locations within District 5 are outside the range of warning sirens (including a Public School facility, fire station, police station and the Tulsa Nursing Center). These areas should be officially noted and sirens purchased to provide warning to all residents and critical facilities in the district.

Lightning Sensing and Warning

The City of Tulsa is home to multiple outdoor recreation areas for public use. There are six parks and five combination park and storm water detention facilities in District 5, mapped in Figure 5.5-16. Parks promote neighborhood revitalization and development, as well as youth development. As discussed in Chapter 4, it is important for outdoor recreation areas be equipped with lightning sensing and warning systems.

Tulsa Public Schools and the University of Tulsa use ThorGuard© to warn of lightning danger at outdoor recreation areas. A map showing ThorGuard© coverage areas in Tulsa is shown in Chapter 2, Figure 2-4. Public school districts in the surrounding Tulsa Metro Area should be encouraged to purchase and install lightning warning systems. Private schools in the area should also be informed of their options and encouraged to install such systems for their outdoor recreation areas.

5.5.3 Planning Process

The CAC/TAC met monthly during the planning process to review progress, identify issues, receive task assignments, and advise the consultants. Refer to Appendix C for meeting agendas.

5.5.4 Natural and Manmade Hazards

Hazards

General natural hazards, such as Tornadoes, High Winds, Lightning, Hail, Winter Storms, Extreme Heat, Drought, and Earthquakes affect all Districts in the City of Tulsa randomly and equally, and are addressed in Chapter 4.

Site specific hazards, such as Flooding, Dam Failures, Levee Failures, Expansive Soils, Wildfires, Fixed Site Hazardous Materials and Transportation-Hazardous Materials are addressed for Council District 5 in subsections 5.5.4.1 through 5.5.4.7, summarized in subsection 5.5.4.8, and shown on the composite map in Figure 5.5-23. Table 5.5-4 identifies the site-specific hazards that can particularly impact Tulsa Council District 5.

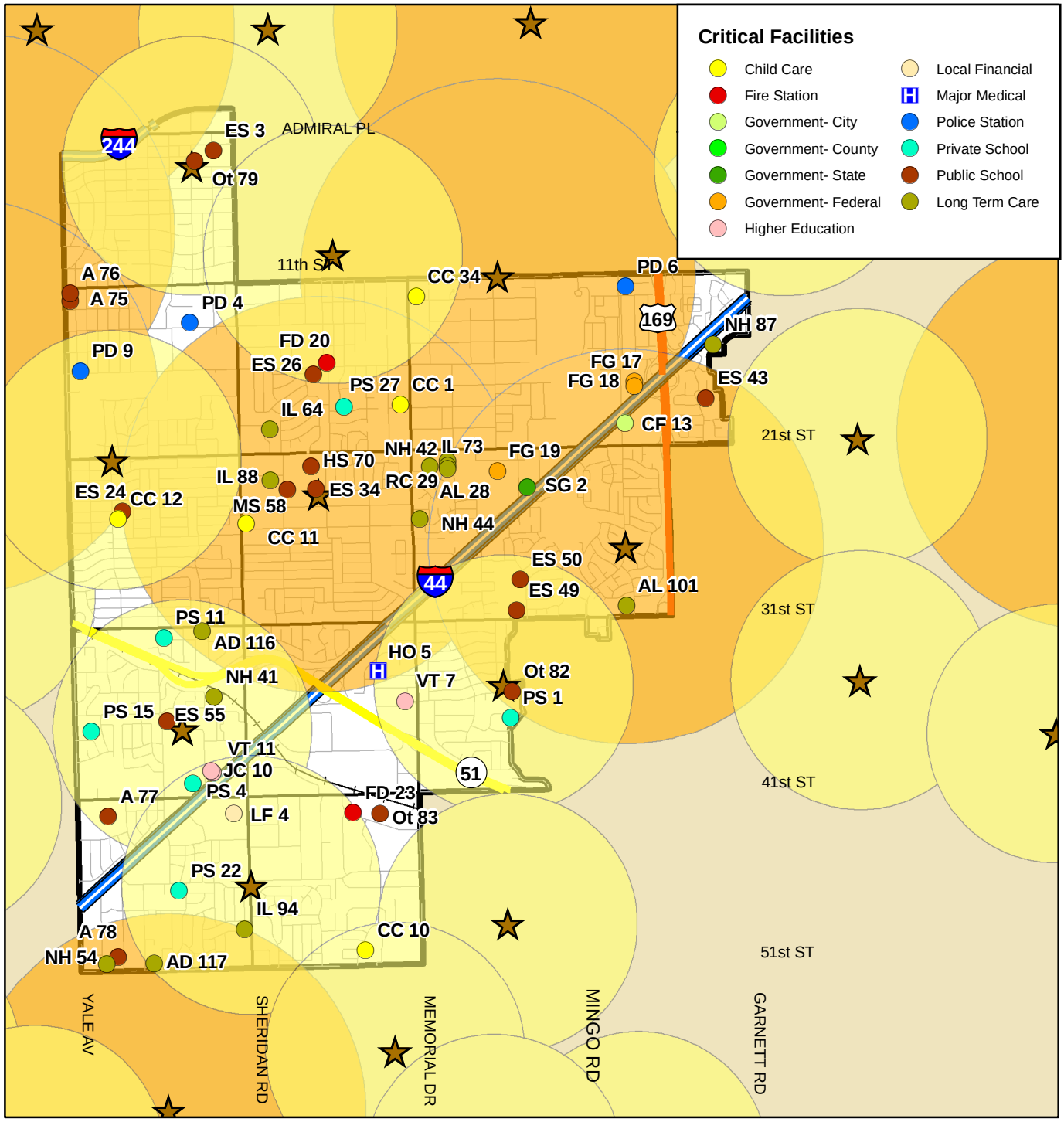
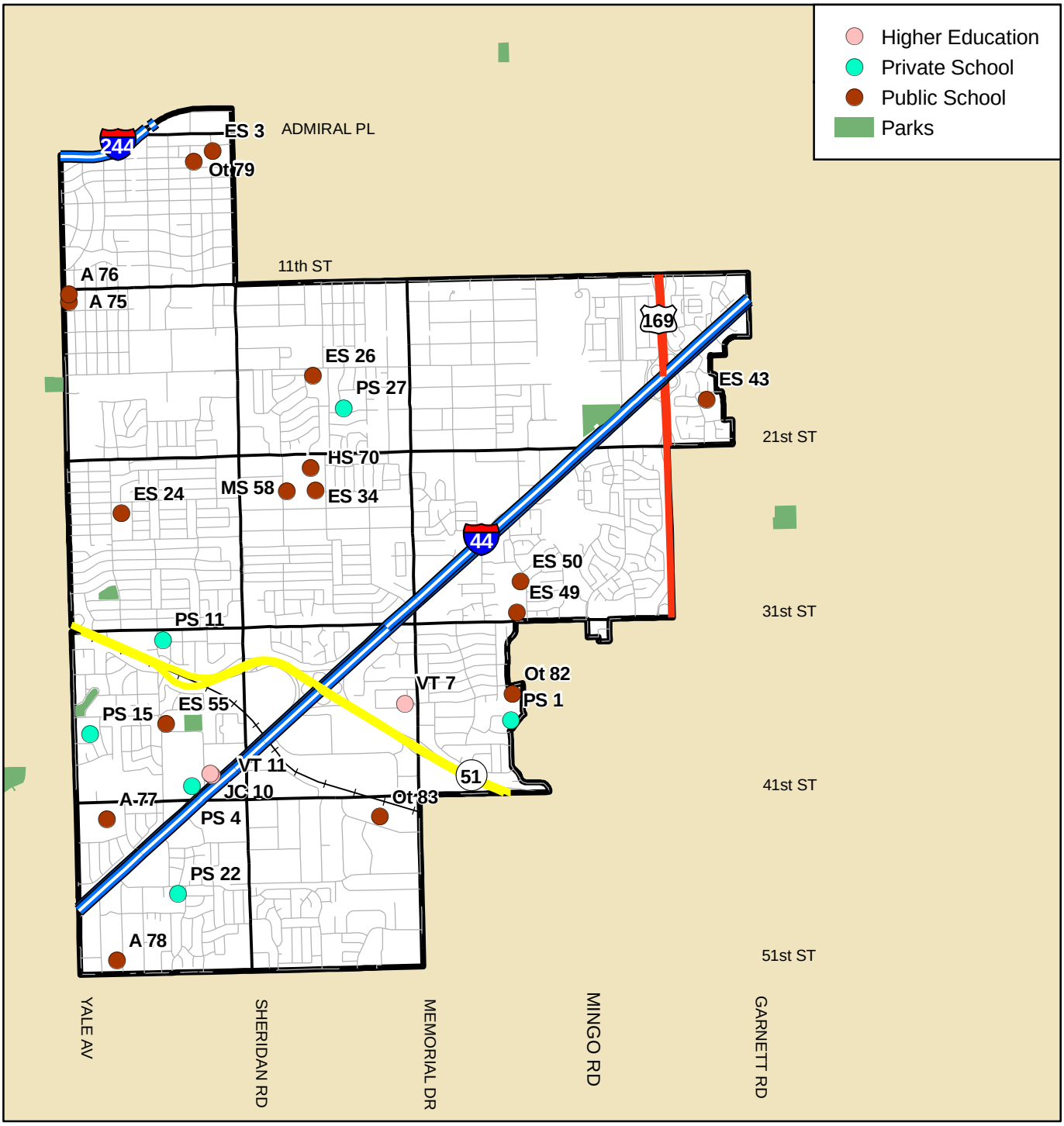


Figure 5.5-15

Tulsa Council District 5

Warning Sirens



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad

0 0.5 1 Miles

N W E S

R.D. Flanagan & Associates
Planning Consultants

Figure 5.5-16

Tulsa Council District 5

Schools & Parks

Table 5.5–4: Tulsa Council District 5 Site-Specific Hazard Impacts

Hazard	Area (sq. mi)	Improved Parcels	Est. Market Value	Percent of Area Impacted	Impacted Population
Floods	0.93	440	$85,513,089	7.21%	2,468
Dam Failures	0	0	$0	0	0
Levee Failure	0	0	$0	0	0
Highly Expansive Soils	6.51	7,442	$1,038,223,085	50.47%	21,171
Wildfires	0.18	395	$49,500,089	1.40%	197
Fixed-Site HazMat, ¼ Mi.	3.77	2,818	$642,384,235	29.22%	7,778
Transportation HazMat Highway	4.68	4,394	$773,019,736	36.28%	13,347
Transportation HazMat Railroad	1.16	884	$203,471,273	8.99%	2,518

Source: Tulsa County Assessor's Office, 2012

Tulsa Council District 5 has identified certain facilities as critical to the health, safety and welfare of its citizens, business and economy. Table 5.5-5 indicates, generally, the exposure of critical facilities to the seven site-specific hazards covered by this Plan Update.

Table 5.5–5: Tulsa Council District 5 Hazard Impacts on Critical Facilities

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Hazardous Material Sites	Transportation-Hazard
CF	13	Satellite Fuel Station	X	X	X	X	X	X	X	X	X	X			X			X
PD	4	Tulsa Police Department (Support Div)	X	X	X	X	X	X	X	X	X				X		X	
PD	6	Tulsa Police Department (East Div)	X	X	X	X	X	X	X	X	X				X			X
PD	9	Fire Station 11 transferred to Police	X	X	X	X	X	X	X	X	X						X	
FD	20	Tulsa Fire Department #22	X	X	X	X	X	X	X	X	X				X			
FD	23	Tulsa Fire Department #25	X	X	X	X	X	X	X	X	X						X	X
SG	2	Oklahoma Highway Patrol - Troop B HQ	X	X	X	X	X	X	X	X	X				X			X
FG	17	USACE	X	X	X	X	X	X	X	X	X				X	X		X
FG	18	Internal Revenue Service	X	X	X	X	X	X	X	X	X				X	X		X
FG	19	USPS - Postage Handling Facility	X	X	X	X	X	X	X	X	X				X		X	X
ES	3	Bell Elementary School	X	X	X	X	X	X	X	X	X				X		X	X
ES	24	Hoover Elementary School	X	X	X	X	X	X	X	X	X							
ES	26	Jones Elementary School	X	X	X	X	X	X	X	X	X				X			
ES	34	MacArthur Elementary School	X	X	X	X	X	X	X	X	X							
ES	43	Peary Elementary School	X	X	X	X	X	X	X	X	X				X	X		X
ES	49	Skelly Elementary School	X	X	X	X	X	X	X	X	X							
ES	50	Skelly PreK- K	X	X	X	X	X	X	X	X	X				X			
ES	55	Zarrow International School	X	X	X	X	X	X	X	X	X							X

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Hazardous Material Sites	Transportation-Hazard
MS	58	Hale Junior High School	X	X	X	X	X	X	X	X	X							
HS	70	Nathan Hale High School	X	X	X	X	X	X	X	X	X							
A	75	Margaret Hudson	X	X	X	X	X	X	X	X	X							
A	76	Street School	X	X	X	X	X	X	X	X	X							
A	77	Tulsa Learning Academy HS	X	X	X	X	X	X	X	X	X							X
A	78	Tulsa School of Arts & Sciences	X	X	X	X	X	X	X	X	X				X			
Ot	79	Burbank / Indian Pupil Education	X	X	X	X	X	X	X	X	X				X			
Ot	82	Fulton Teaching and Learning Academy	X	X	X	X	X	X	X	X	X				X			
Ot	83	Grant Transportation/ South Lot	X	X	X	X	X	X	X	X	X				X		X	X
PS	1	Aldersgate Learning Center	X	X	X	X	X	X	X	X	X				X			
PS	4	Bishop Kelly High School	X	X	X	X	X	X	X	X	X							X
PS	11	Happy Hands Educational Center	X	X	X	X	X	X	X	X	X						X	X
PS	15	Little Light House	X	X	X	X	X	X	X	X	X							
PS	22	Peace Academy	X	X	X	X	X	X	X	X	X				X			
PS	27	St. Pius X Catholic School	X	X	X	X	X	X	X	X	X							
CC	1	ABC Child Development Ctr	X	X	X	X	X	X	X	X	X				X			
CC	10	Day Schools #1	X	X	X	X	X	X	X	X	X							
CC	11	Day Schools #11	X	X	X	X	X	X	X	X	X							
CC	12	Day Schools #9	X	X	X	X	X	X	X	X	X							
CC	34	Memorial Village Early Learning Ctr	X	X	X	X	X	X	X	X	X				X			
VT	7	Tulsa Technology Center - Lemlely Campus	X	X	X	X	X	X	X	X	X				X			X
JC	10	Tulsa Community College - Conference Center	X	X	X	X	X	X	X	X	X							X
VT	11	Tulsa Technology Center - Skyline	X	X	X	X	X	X	X	X	X							X
HO	5	Meadowbrook Specialty Hospital of Tulsa	X	X	X	X	X	X	X	X	X						X	X
AL	28	Heatheridge Assisted Living Community	X	X	X	X	X	X	X	X	X							
RC	29	Heatheridge Residential Care	X	X	X	X	X	X	X	X	X							
NH	41	Lakewood Care Center	X	X	X	X	X	X	X	X	X				X		X	X
NH	42	Leisure Village	X	X	X	X	X	X	X	X	X							
NH	44	ManorCare Health Services	X	X	X	X	X	X	X	X	X							
NH	54	Parks Edge Nursing & Rehab Center	X	X	X	X	X	X	X	X	X				X			
IL	64	Sheridan Terrace	X	X	X	X	X	X	X	X	X	X			X			
IL	73	The Broadmoor Retirement Community	X	X	X	X	X	X	X	X	X							
NH	87	Tulsa Nursing Center	X	X	X	X	X	X	X	X	X							X
IL	88	Tulsa Pythian Manor	X	X	X	X	X	X	X	X	X				X			
IL	94	Versailles Apartments	X	X	X	X	X	X	X	X	X				X			

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Hazardous Material Sites	Transportation-Hazard
AL	101	Angel House Residential Assisted Living	X	X	X	X	X	X	X	X	X				X		X	X
AD	116	LIFE Senior Services, Inc	X	X	X	X	X	X	X	X	X				X			X
AD	117	Oasis Adult Day Services	X	X	X	X	X	X	X	X	X				X		X	
LF	4	Bank of Oklahoma Tech. Center	X	X	X	X	X	X	X	X	X						X	X

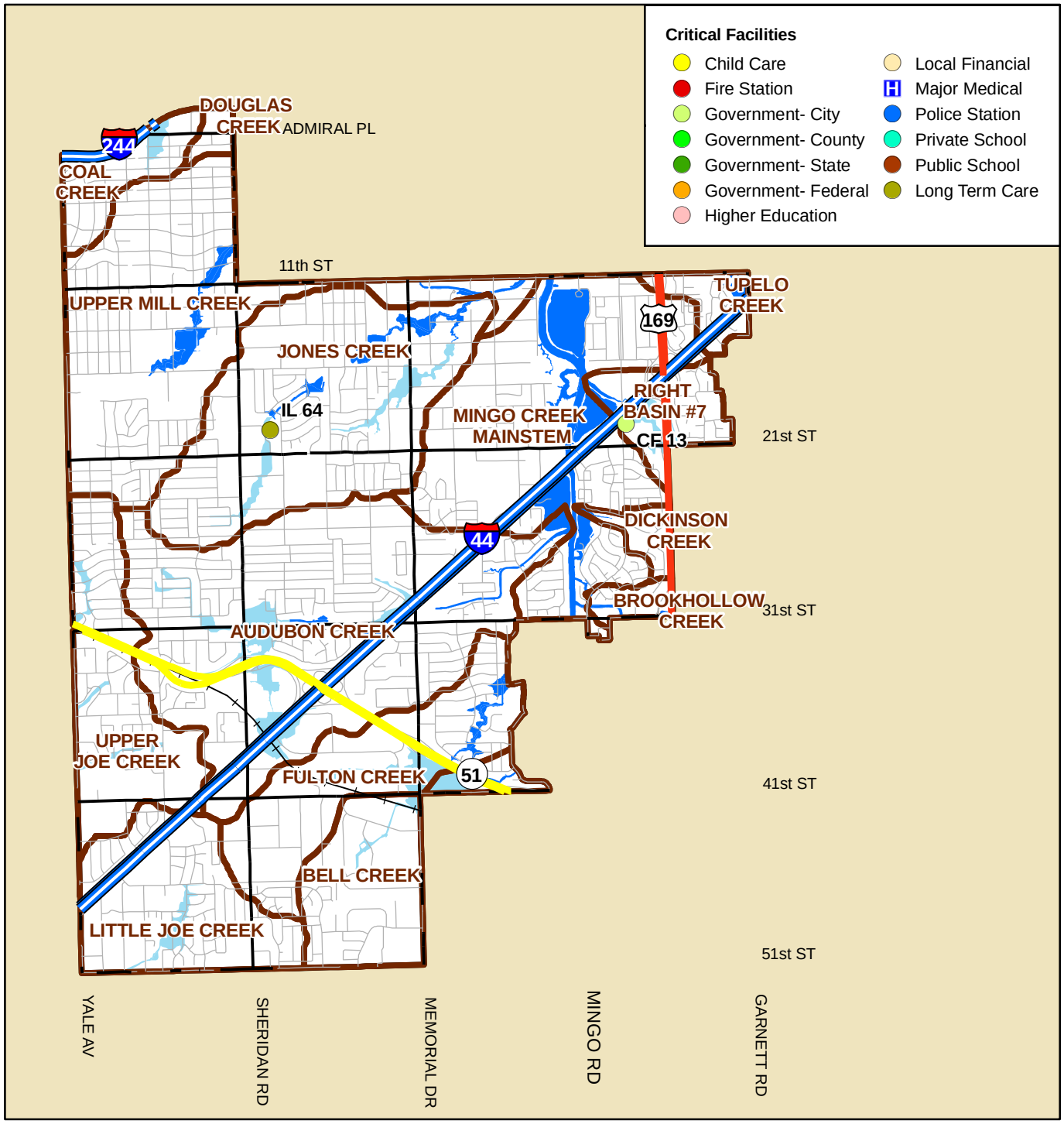
5.5.4.1 Flood

Location

District 5 is affected by both the City Regulatory Floodplain and Special Flood Hazard Area (SFHA). The combined floodplains comprise 0.93 sq. mi., or 7.2 percent of the land within the District boundary lines. A map of District 5 floodplains and drainage basins is listed in Table 5.5-6 and shown in Figure 5.5-17. District 5 contains a significant portion of what was once Tulsa's most frequently flooded drainage basin—Mingo Creek, with its tributary streams Mill Creek, Jones Creek, Audubon Creek, Mill Creek and Fulton Creek. The City's aggressive flood and storm water management program has, over the past 40 years, managed to make flooding in these drainage basins less frequent.

Table 5.5–6: Tulsa Council District 5 Streams and Drainage Basins

Basin	Total Drainage Area (sq. mi.)
AUDUBON CREEK	2.78
BELL CREEK	0.72
BROOKHOLLOW CREEK	0.08
COAL CREEK	0.31
DOUGLAS CREEK	0.06
FULTON CREEK	0.94
JONES CREEK	1.89
LITTLE JOE CREEK	0.97
MINGO CREEK MAINSTEM-LM	1.42
MINGO CREEK MAINSTEM-MUM	0.54
RIGHT BASIN #7	0.39
TUPELO CREEK	0.20
UPPER JOE CREEK	0.88
UPPER MILL CREEK	1.73
Total	12.90



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad
- Drainage Basins
- SFHA
- City Regulatory

0 0.5 1 Miles

Figure 5.5-17

Tulsa Council District 5

Drainage Basins & Floodplains

Impact/Vulnerability

In total, 310 residential single-family structures, 11 residential multi-family structures, 69 commercial buildings, 12 industrial buildings, and 38 buildings classified as *other* are touched by the 100-year floodplains of District 5. The structures have a total assessed value, adjusted for fair market price, of $85,513,089. The buildings touched by the 100-year flood are listed, by type, in Table 5.5-7.

Table 5.5–7: Tulsa Council District 5 Buildings Touched by 100 year Floodplain

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	310	$25,590,614
Residential Multi-Family	11	$10,831,798
Commercial	69	$37,678,988
Industrial	12	$3,359,800
Other	38	$8,051,889
Total	440	$85,513,089

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

There are two critical facilities in District 5 located in or near enough to the 100-year floodplain that the parcel, if not the building, is touched by it. These are listed in Table 5.5-5 and shown on the map in Figure 5.5-17. Flood damage could require them to close for a period of time if repairs are necessary.

Repetitive Loss Properties

There are 13 repetitive loss properties located in the boundary lines of Council District 5: three residential, one multi-family, and nine commercial.

Flood Control Projects

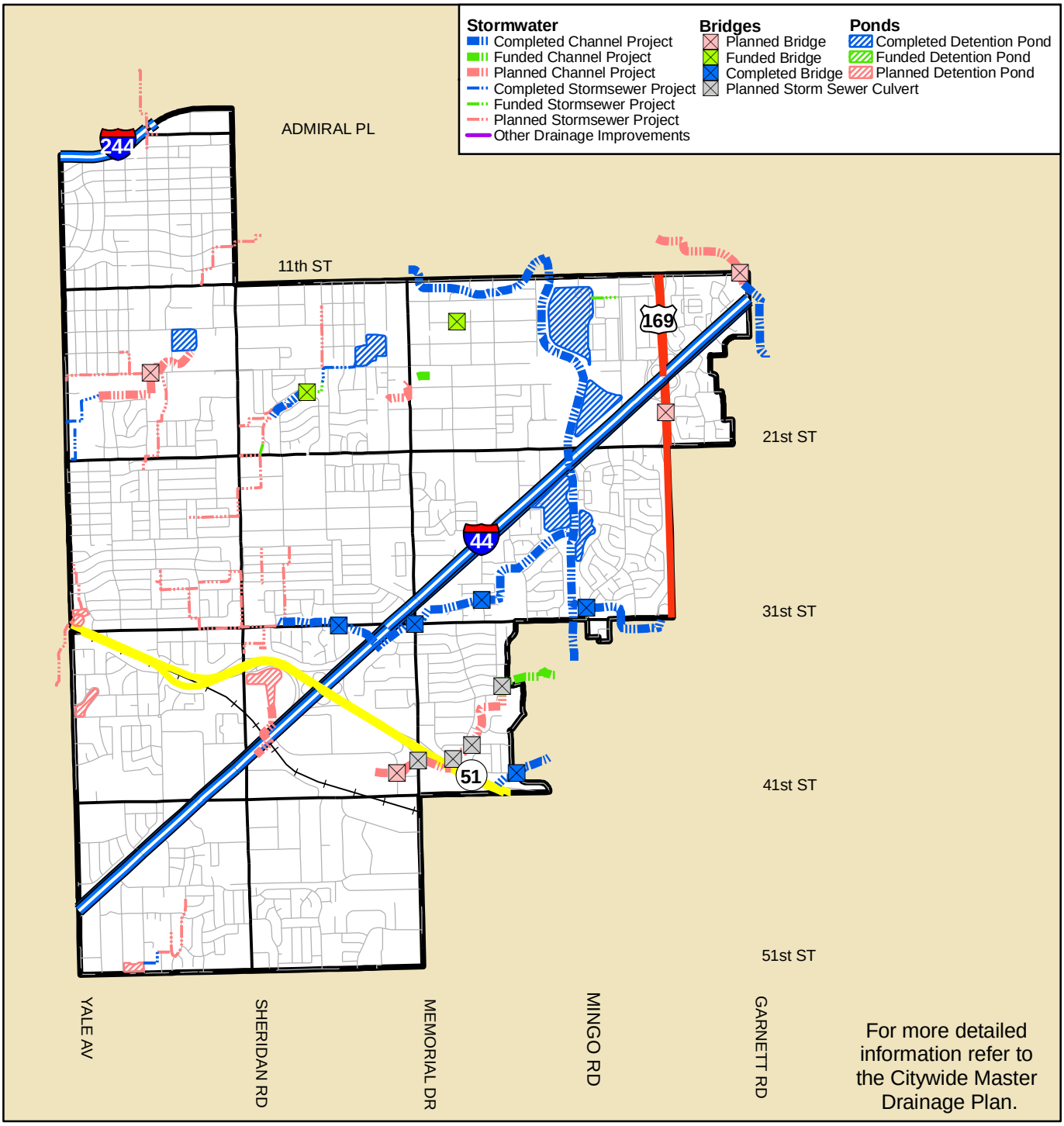
In Council District 5, many projects have been completed for flood control issues. Projects included in the 2008-2012 Capital Expenditures Plan that have impacted District 5 are listed in Table 5.5-8. Figure 5.5-18 displays flood control projects in Council District 5, identified in the 2004 Capital Improvements Plan.

It should be noted that the creeks that pass the two schools located on parcels touched by the 100-year floodplains (see Critical Facilities, above), have both been channelized and the buildings removed from the flood zone (although the parcels remain), as shown in Figure 5.5-18 and listed in Table 5.5-8, below.

Table 5.5–8: Tulsa Council District 5 Flood Control Projects 2008-2012

Project ID	Project Basin and Description	Budget
22	Crow Creek - 15th St. and BA Expressway Detention Basin & Storm Sewer Improvements	$4,210,000
47	Fulton Creek - 37th & Memorial Storm Sewer & Channel Improvements	$1,500,000
48	Fulton Creek – Lazy Circle Acres Channel Improvements	$1,400,000
59	Jones Creek - Storm Sewer, Channel & Bridge Replacement at 68th E. Pl. and 71st E. Avenue	$3,210,000

Source: PLANiTulsa Capital Expenditures Plan 2008-2012



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad

0 0.5 1 Miles

Figure 5.5-18

Tulsa Council District 5

Flood Control

Conclusion

Tulsa Council District 5 has a HIGH probability of and a HIGH vulnerability to the Flood hazard.

5.5.4.2 Dam Failure

District 5 would not be impacted by Dam Failure in the City of Tulsa. For an in-depth discussion of probable impacts from a failure of Skiatook Dam on Bird and Mingo creeks, see Chapter 4 and Chapter 5.3. Tulsa Council District 5 would not be directly impacted by this hazard and has no vulnerability to and no probability of the Dam Failure hazard

5.5.4.3 Levee Failure

District 5 is not located in or around any Levee inundation areas in the City of Tulsa. The District would not be directly impacted by this hazard and has no vulnerability to and no probability of the Levee Failure hazard.

5.5.4.4 Expansive Soils

Location

Council District 5 is underlain predominantly by soils with Low or High shrink/swell potential, with Very High expansive soils beneath less than one percent of the District. Highly expansive soils underlie almost exactly half of the District—49.9 percent. Moderately expansive soils make up 8.5 percent of the District, all of it east of S. Memorial Dr. Expansive soils in District 5 are summarized in Table 5.5-9 and mapped in Figure 5.5-19.

Table 5.5–9: Tulsa Council District 5 Expansive Soils

Expansion Potential	Area (sq mi)	Percent of Total District Boundaries
Very High	0.06	0.43%
High	6.45	49.98%
Moderate	1.10	8.50%
Low	5.24	40.62%
Water	0.06	0.47%
Total	12.90	100.00%

Impact/Vulnerability

According to 2012 Tulsa County Assessor data, 7,442 improved parcels in District 5 are underlain by soils with High to Very High shrink/swell potential, with an assessed value, adjusted for fair market price, of $1,038,223,085. A summary of District 5 parcels located on High to Very High expansive soils is included in Table 5.5-10.

Table 5.5–10: Tulsa Council District 5 Parcels on High to Very High Expansive Soils

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	6,385	$515,578,432
Residential Multi-Family	332	$81,554,067
Commercial	416	$319,005,782
Industrial	63	$28,627,366
Other	246	$93,457,438
Total	7,442	$1,038,223,085

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

There are 29 Critical facilities located on High expansive soils in District 5. Although it is likely the structures were engineered to account for the soils on which they are built, effort should be made to monitor the facilities for damages and report/repair as necessary. Table 5.5-5 indicates which critical facilities are located on soils with High to Very High shrink/well potential in District 5. These facilities are mapped in Figure 5.5-19.

Conclusion

Tulsa Council District 5 has a HIGH vulnerability to and HIGH probability of damage from the Expansive Soils hazard.

5.5.4.5 Wildfire

Location

Council District 5 is located in an urbanized and developed area in the center of Tulsa. The Wildfire Level of Concern (LOC) in District 5 is minimal. Only about 1.40 percent (0.18 sq mi) of land area in the District is considered to have a high level of wildfire concern—most of it along the Mingo Valley Expressway. A map displaying the Wildfire LOC of District 5 is shown in Figure 5.5-20.

Impact/Vulnerability

There are 395 improved parcels, in District 5, located in areas of Low to High Wildfire LOC. These are summarized in Table 5.5-11. The areas of greatest concern are located primarily around US Highway 169, running north and south through the eastern edge of the District. The LOC in this area ranges from 0 to 7 on the Wildfire Level of Concern Index. As mentioned in Chapter 4, it is not likely a wildfire would occur in the central, urbanized areas of Tulsa, as most of the land is covered in concrete and well-maintained lawns.

Table 5.5–11: Tulsa Council District 5 Parcels Touched by Wildfire Level of Concern

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	378	$25,512,500
Residential Multi-Family	4	$344,100
Commercial	8	$17,216,689
Industrial	0	$0
Other	5	$6,426,800
Total	395	$49,500,089

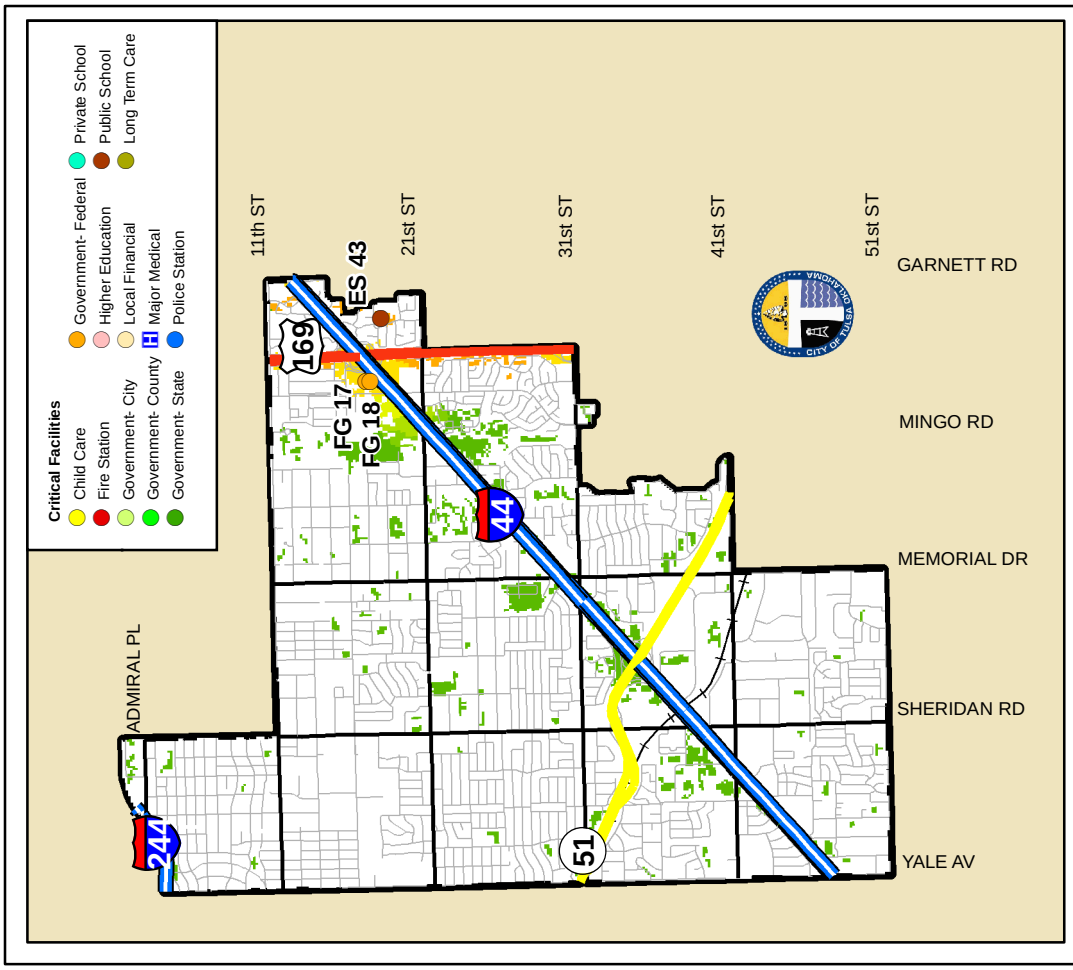
Source: Tulsa County Assessor's Office, 2012

Critical Facilities

This is certainly true for the three critical facilities in the District that have open land around them and a slightly elevated LOC rating: The US Army Corps of Engineers (FG17), the IRS (FG18) and Peary Elementary School (ES43), as listed in Table 5.5-2 and shown in Figure 5.5-20. Although these structures set on open land, the grounds and neighboring open spaces surrounding all three facilities are very well maintained and pose no significant wildfire risk.

Conclusion

Tulsa Council District 5 is considered to have a LOW vulnerability to and LOW probability of the Wildfire hazard.



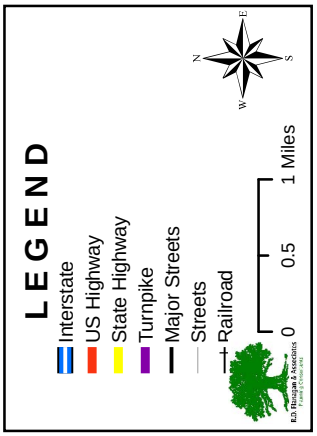
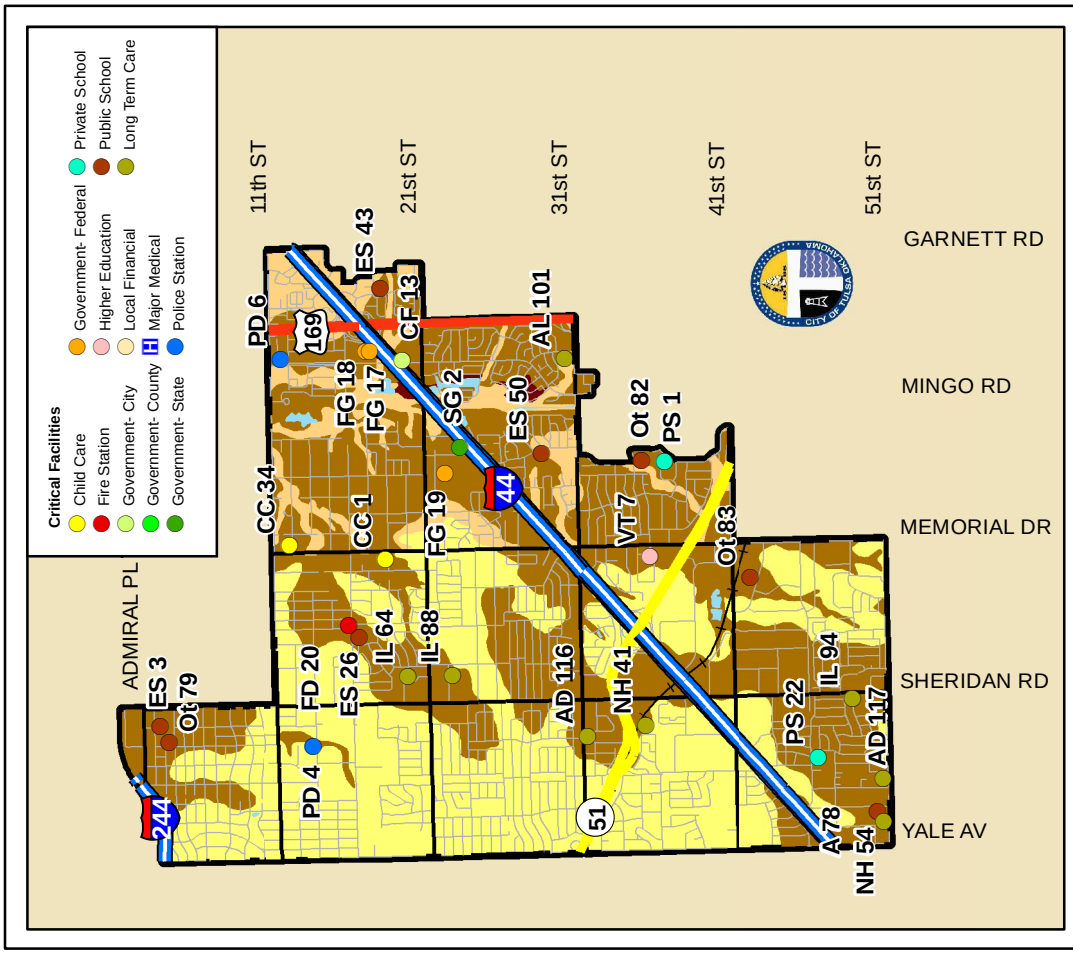


Figure 5.5-20

Tulsa Council District 5

Wildfire Level of Concern Index



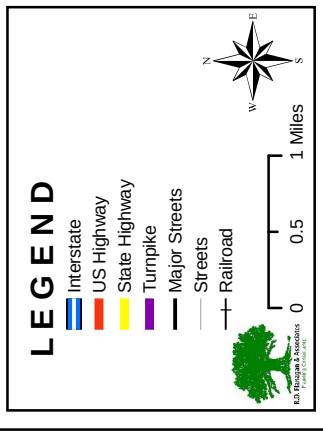


Figure 5.5-19

Tulsa Council District 5

Expansive Soils

5.5.4.6 Fixed Site Hazardous Materials

Location

There are 30 Tier II facilities within the boundaries of Tulsa Council District 5; 17 of which contain Extremely Hazardous Substances. The majority of these sites are clustered between S. Yale and S. Sheridan and E. 11th and E. 15th Sts., and around the junction of I-44 and the Broken Arrow Expressway. Due to the sensitive nature of this material, Tier II facilities in the District are mapped in Figure 5.5-21 to show only approximate location of the sites. A listing of EHS and Non-EHS Tier II facilities within the District can be found in Appendix E, and is available on a need-to-know basis.

Impact/Vulnerability

Of the total population residing in District 5, approximately 7,448 persons, 1,965 residential single-family structures, 165 residential multi-family structures, and 12 critical facilities are located within a ¼ mile radius of a Tier II site, according to the Marplot analysis, which uses 2010 Census data. The critical facilities include two fire departments and two police stations, four public schools, a US Postal facility, four care centers, a hospital, and one financial institution. A summary of the number of parcels located within ¼ mile of a Tier II facility in District 5 is included in Table 5.5-12.

Table 5.5–12: Tulsa Council District 5 Parcels in ¼ Mile Tier II Buffer

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	1,965	$162,844,977
Residential Multi-Family	165	$49,672,965
Commercial	307	$272,611,296
Industrial	95	$44,623,266
Other	286	$112,631,731
Total	2,818	$642,384,235

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Twelve critical facilities in Council District 5 are located within ¼ mile of a Tier II facility. Although structures themselves are not likely to be impacted, populations at the facilities would be at risk were a hazardous materials release to occur. Of high concern are the four schools and four residential care facilities in the District that are within ¼-mile of a Tier II site. Pre-planning is critical at these facilities. Effort should be made to ensure proper evacuation or shelter in place procedures are in place. A list of District 5 critical facilities located within ¼ mile of a Tier II facility is provided in Table 5.5-5.

Conclusion

Tulsa Council District 5 is considered to have a HIGH vulnerability to and MODERATE probability of a fixed-site hazardous materials release.

5.5.4.7 Transportation-Hazardous Materials

Location

Five significant transportation corridors cross Council District 5: Interstate 244, which runs along the far northwest boundary line of the District; Interstate 44, which crosses southwest to northeast through the District; US Highway 169/Mingo Valley Expressway, which runs north and south across the northeast corner of the District; and, State Highway 51/Broken Arrow Expressway; which runs roughly northwest-southeast across the southern quadrant of the District. The Union Pacific Railroad crosses the southern quadrant generally parallel with the BA Expy, from E 31st Street at Yale Ave. to

E 41st Street and S. Memorial. The railroad tracks in the northwest quadrant, between Admiral Pl. and 15th St. are no longer in use. There are no airports in District 5, although it does lie within the approach path to Tulsa International Airport. Transportation corridors in District 5 are shown in Figure 5.5-22.

Impact/Vulnerability

A ¼-mile transportation buffer for the five transportation corridors encompasses 49.54 percent of Council District 5 (or 6.39 sq. mi.). According to 2010 US Census data, 13,347 residents live or work within ¼ mile of the Highway corridor, and 2,518 reside within ¼ mile of the Railroad. The number of improved parcels by value, estimated for fair market price, and type within the Highway corridors are summarized in Table 5.5-13.

Table 5.5–13: Tulsa Council District 5 Parcels Touched by ¼ mile Highway Corridor

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	3,775	$280,504,060
Residential Multi-Family	170	$43,001,260
Commercial	296	$322,058,953
Industrial	20	$10,193,010
Other	133	$117,262,453
Total	4,394	$773,019,736

Source: Tulsa County Assessor's Office, 2012

There are 884 improved parcels in District 5 located within ¼ mile of the Union Pacific railroad line. These have a total assessed value, adjusted for fair market price, of $203,471,273. The numbers of District 5 parcels touched by the railroad corridor are summarized, by type, in Table 5.5-14.

Table 5.5–14: Tulsa Council District 5 Parcels Touched by ¼ mile Railroad Corridor

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	610	$42,363,960
Residential Multi-Family	55	$15,190,048
Commercial	99	$76,256,830
Industrial	25	$14,484,410
Other	95	$55,176,025
Total	884	$203,471,273

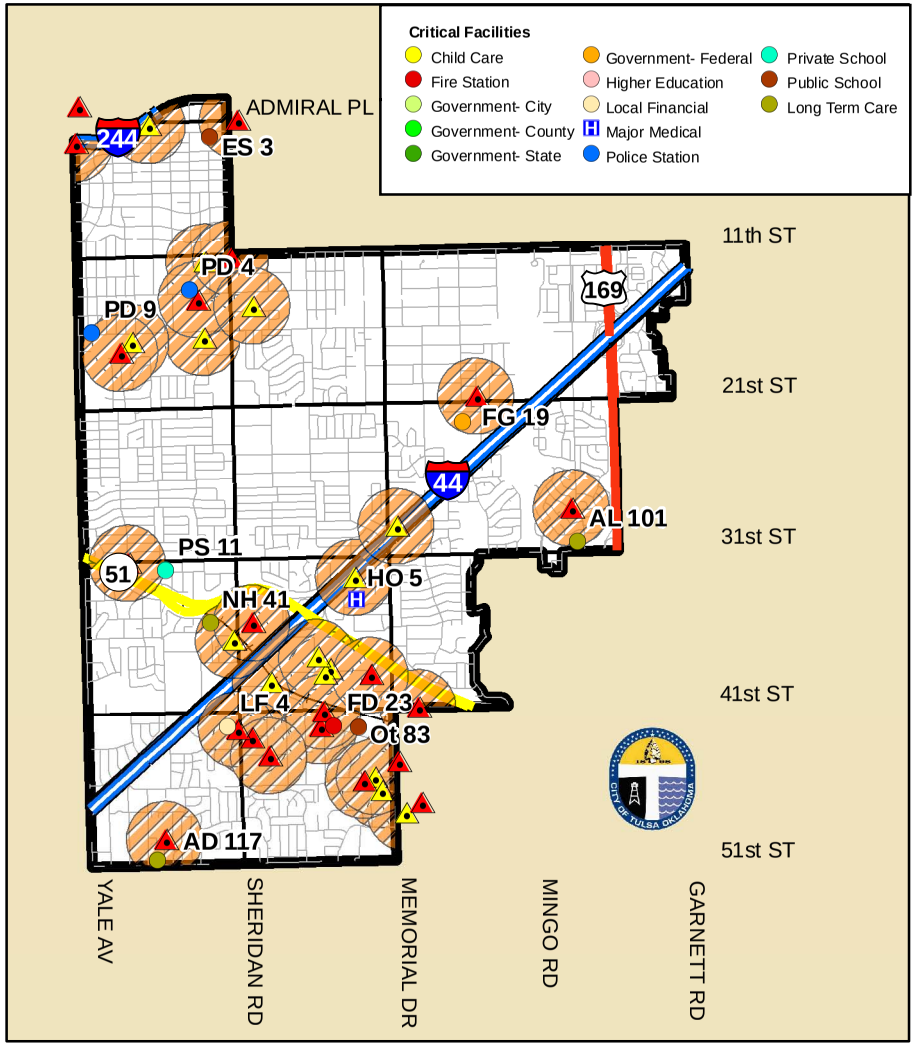
Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Twenty-three critical facilities in Council District 5 are located within ¼-mile of a transportation corridor. Although the structures themselves are not likely to be directly impacted by this hazard, persons living or working within these facilities do have a heightened vulnerability. Of particular concern are those that house functional needs populations, such as education facilities, long-term care facilities, and eldercare facilities. A transportation incident involving hazardous materials would likely require that people living or working in these facilities either shelter in place or evacuate. A list of critical facilities vulnerable to the Transportation hazard is included in Table 5.5-5 and mapped in Figure 5.5-22.

Conclusion

Tulsa Council District 5 has a HIGH vulnerability to and MODERATE probability of the Transportation hazard.



LEGEND

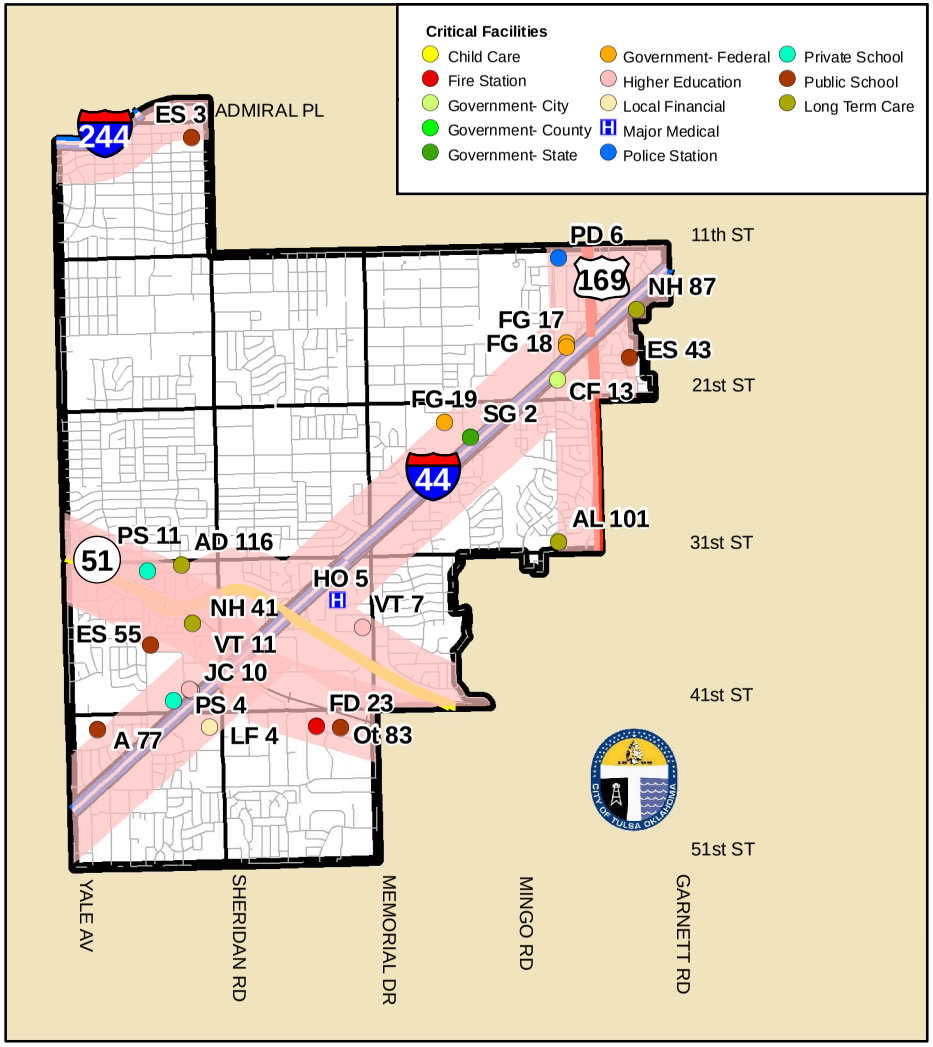
- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad
- 2010 EHS TierII
- 2010 non EHS TierII
- TierII 1/4mi Buffer

0 0.45 0.9 Miles

Figure 5.5-21

Tulsa
Council District 5

Fixed Site Hazardous Materials



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad
- Transport 1/4mi Buffer

0 0.5 1 Miles

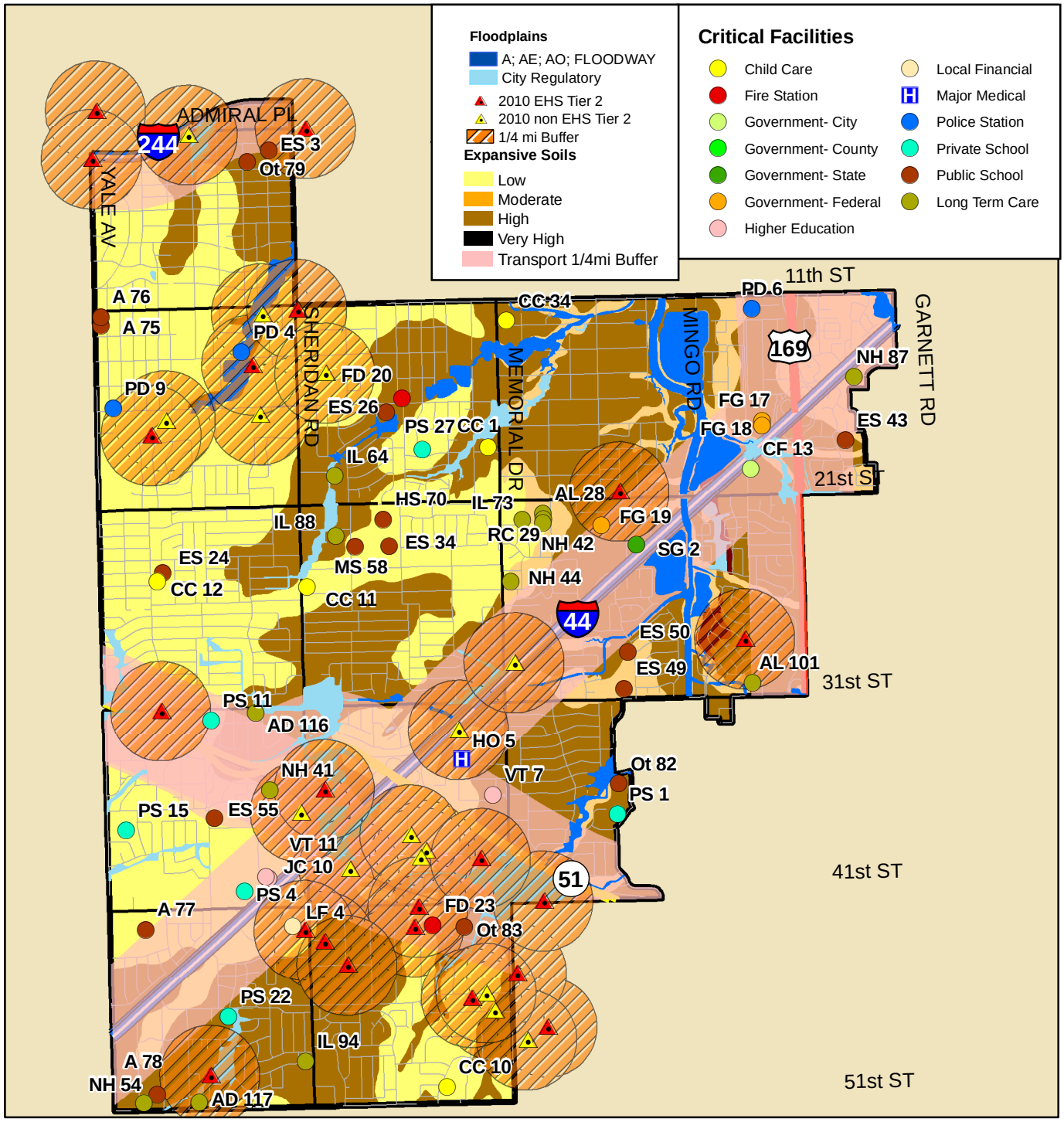
Figure 5.5-22

Tulsa
Council District 5

Transportation Corridors

5.5.4.8 Hazards Summary

Site-specific hazards, unique to Tulsa Council District 5, identified and mapped in this section, include Floods, Expansive Soils, Wildfires, Fixed-Site Hazardous Materials, and Transportation-Hazardous Materials. The Hazards Composite Map, shown in Figure 5.5-23, summarizes the areas of the district potentially impacted by these site-specific hazards.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Railroad

0 0.5 1 Miles

Figure 5.5-23

Tulsa Council District 5

Hazard Composite

City of Tulsa Multi-Hazard Mitigation Plan Update

Tulsa City Council District 6

R.D. Flanagan & Associates

Planning Consultants

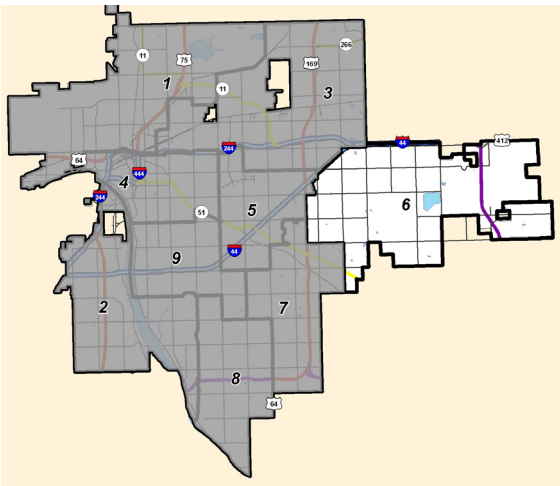
5.6 Tulsa City Council District 6

5.6.1 Introduction

5.6.1.1 Location

Council District 6 is located in east Tulsa, in Tulsa and Wagoner Counties, as shown in the Locator Map. Total land area within the District consists of approximately 37.88 sq mi., as shown in the District 6 Base Map in Figure 5.6-2. The District is bounded generally on the north by I-44 and US Highway 412, the east by Midway Rd. in Wagoner County, the south-east by E. 51st Street, the south-west by E. 61St Street, the west by US Highway 169, and the northwest by I-44.

Figure 5.6–1: Tulsa Locator Map – District 6



5.6.1.2 Byron "Skip" Steele Councilor District 6

Councilor Byron "Skip" Steele was sworn into office Monday, December 5, 2011.Councilor Byron "Skip" Steele is a lifelong Tulsa resident. He is a graduate of Thomas A. Edison High School. Councilor Steele has a Business degree from John F. Kennedy College and a graduate degree in Electronics. Councilor Steele has lived in District 6 since 1979. He has owned All Hours Computer Service, a computer and printer repair business, for the past 12 years. Before opening his own small business, Councilor Steel worked for Telex, Corp. in a variety of positions including as an engineer, technician, Human Resources Industrial Analyst and a corporate environmental specialist. While working for Telex, he served for 3 years as an elected Union representative. Working on computers is not only his occupation, it's also one of his hobbies. *(Source: http://www.tulsacouncil.org/)*

Councilor Byron "Skip" Steele

5.6.1.3 History

Cultural and Historic Properties

Tulsa Council District 6 is home to one cultural site; Martin Regional Library, which is displayed on the map in Figure 5.6-3. No structures in District 6 are listed on the National Register of Historic Places.

5.6.1.4 Demographics

Council District 6 had a 2010 US Census population of 47,887. A map displaying population density of the District is shown in Figure 5.6-4. Table 5.6-1 includes the demographic makeup of Council District 6. Maps displaying the demographic information in the table are included in Figures 5.6-5 through 5.6-12.

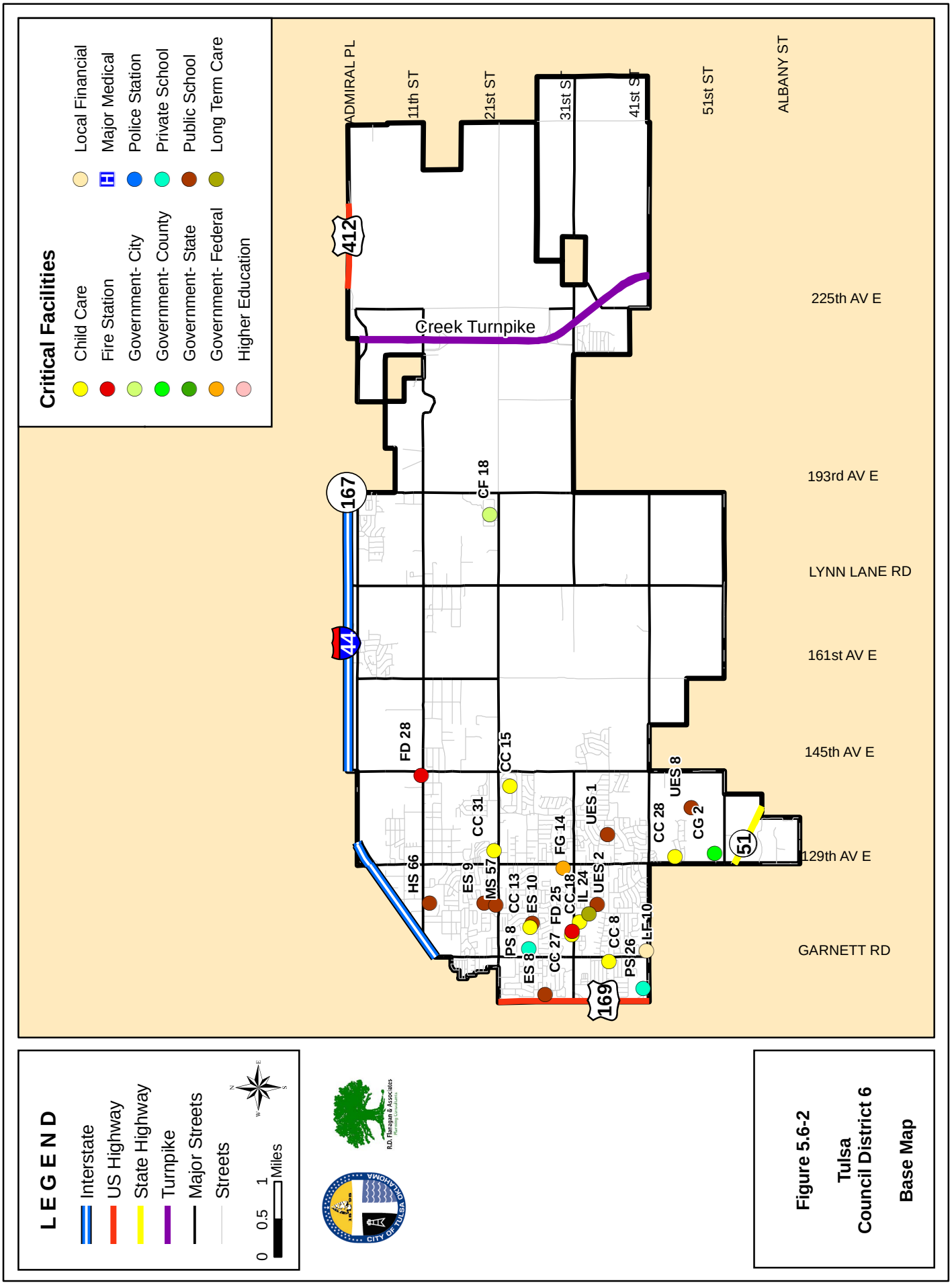
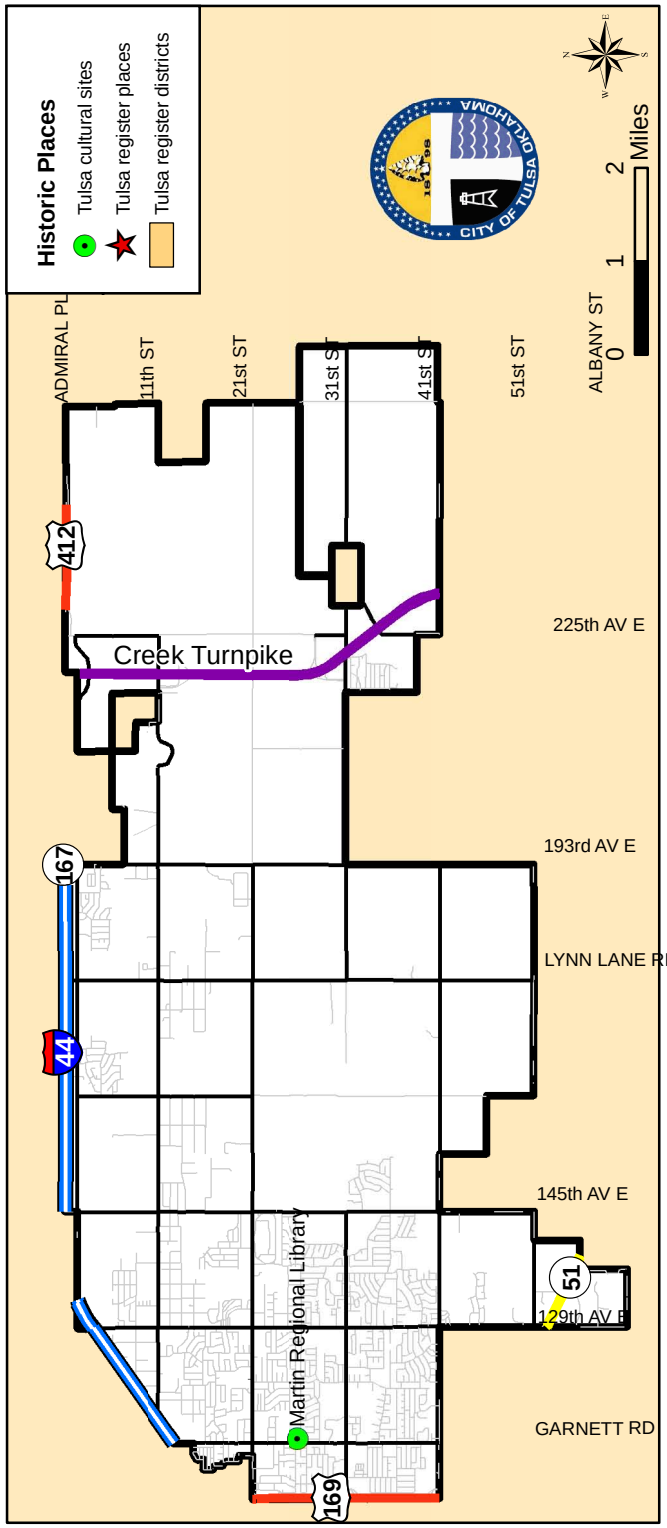


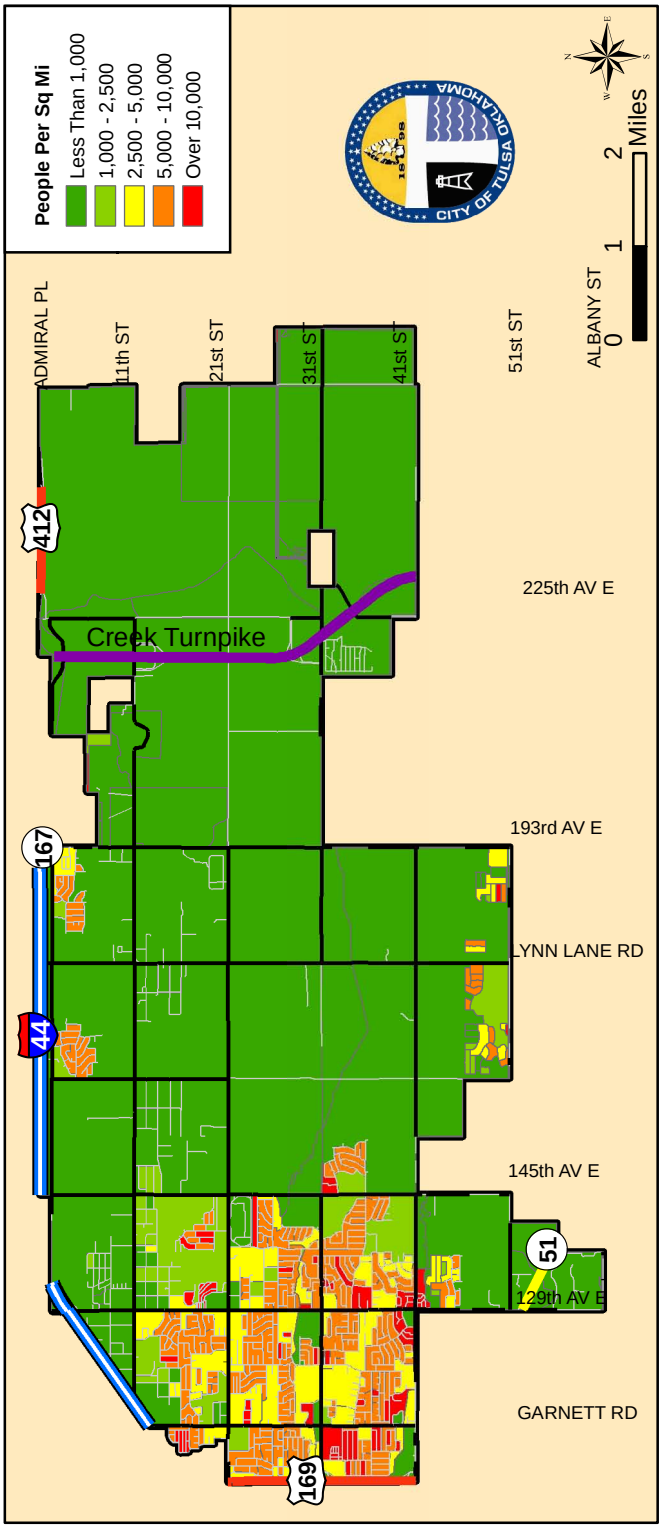
Figure 5.6-2
Tulsa Council District 6
Base Map



LEGEND

- Intersate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets

Figure 5.6-3
Tulsa Council District 6
Cultural and Historic Places



LEGEND

- Intersate
- US Highway
- State Highway
- Turnpike
- Major Streets
- N_S_Streets
- Streets

Figure 5.6-4
Tulsa Council District 6
Population Density

Table 5.6–1: Tulsa Council District 6 Demographic Information

Category	District	Tulsa
Persons under 5 years of age	9.41%	7.53%
Persons under age 18	30.40%	24.44%
Persons age 65 and older	7.99%	12.46%
Poverty Status in 2010 (individuals)	15.36%	19.36%
White	55.17%	62.81%
Native-American	5.38%	5.35%
African American	12.18%	15.67%
Asian	4.69%	2.39%
Hispanic	25.62%	13.93%
Total Population	47,887	401,265

Source: 2010 US Census

5.6.1.5 Infrastructure

Tulsa Council District 6 is dependent upon the lifelines of the City of Tulsa as identified in Section 1.2.6 of this Plan Update. Any unique vulnerability of District 6 in relation to the seven site-specific hazards identified in this plan will be addressed in Section 4, below.

5.6.1.6 Economy

The 2010 Census identified the average poverty threshold for a family of four with two children to be $22,133. Approximately 7,357 individuals, 15.36 percent of the population of District 6, were living below the poverty line in 2010. Figure 5.6-7 shows the percentage and distribution of people who have low incomes and are classified as living in poverty.

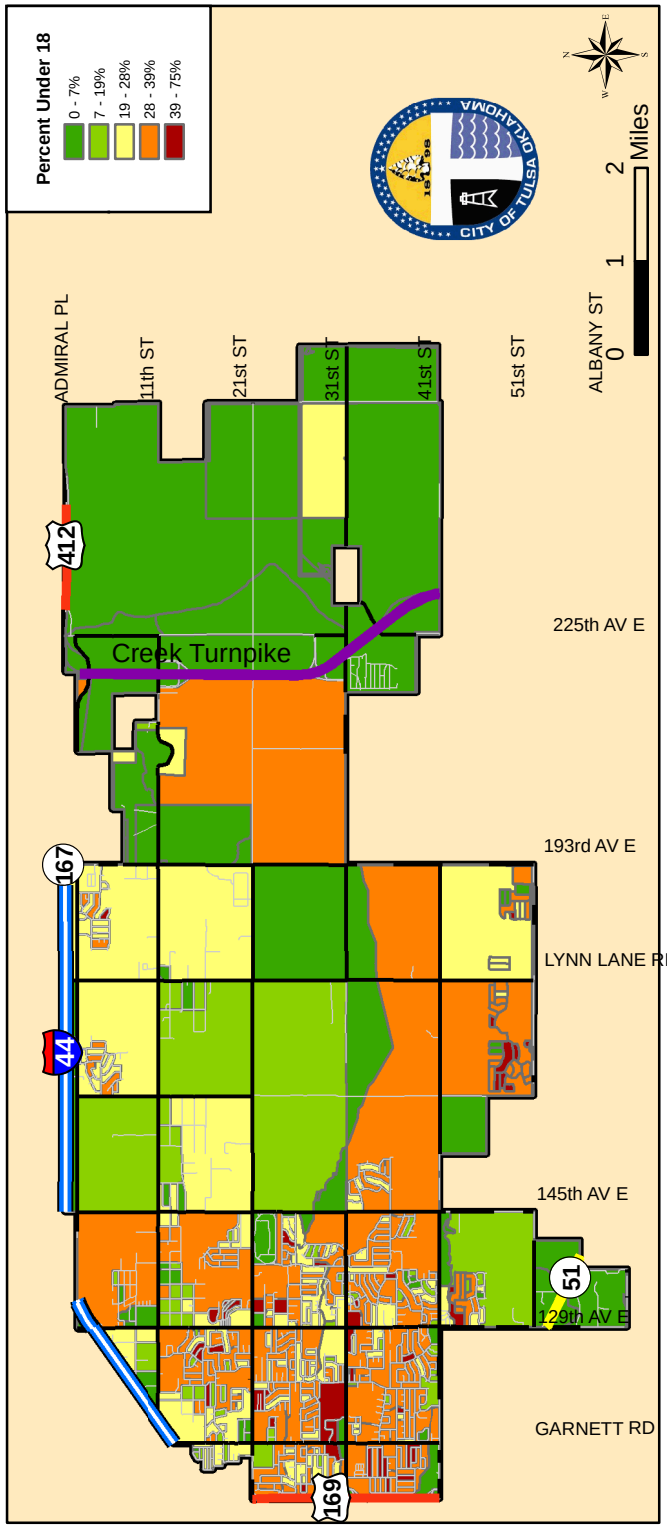
5.6.1.7 Development

According to the Tulsa County Assessor's Office, there are 13,629 parcels with improvements in District 6, with a total assessed value, adjusted for fair market price, of $1,331,133,294. The numbers of parcels with improvements, improvement values and type, are summarized in Table 5.6-2. No land, contents or tax exempt values are included. The District is made up of 14 homeowners associations, as shown in Figure 5.6-13.

Table 5.6–2: Tulsa Council District 6 Property Types by Assessed Values

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	12,991	$1,032,096,031
Residential Multi-Family	243	$66,901,836
Commercial	222	$151,228,754
Industrial	8	$22,633,481
Other	165	$58,273,192
Total	13,629	$1,331,133,294

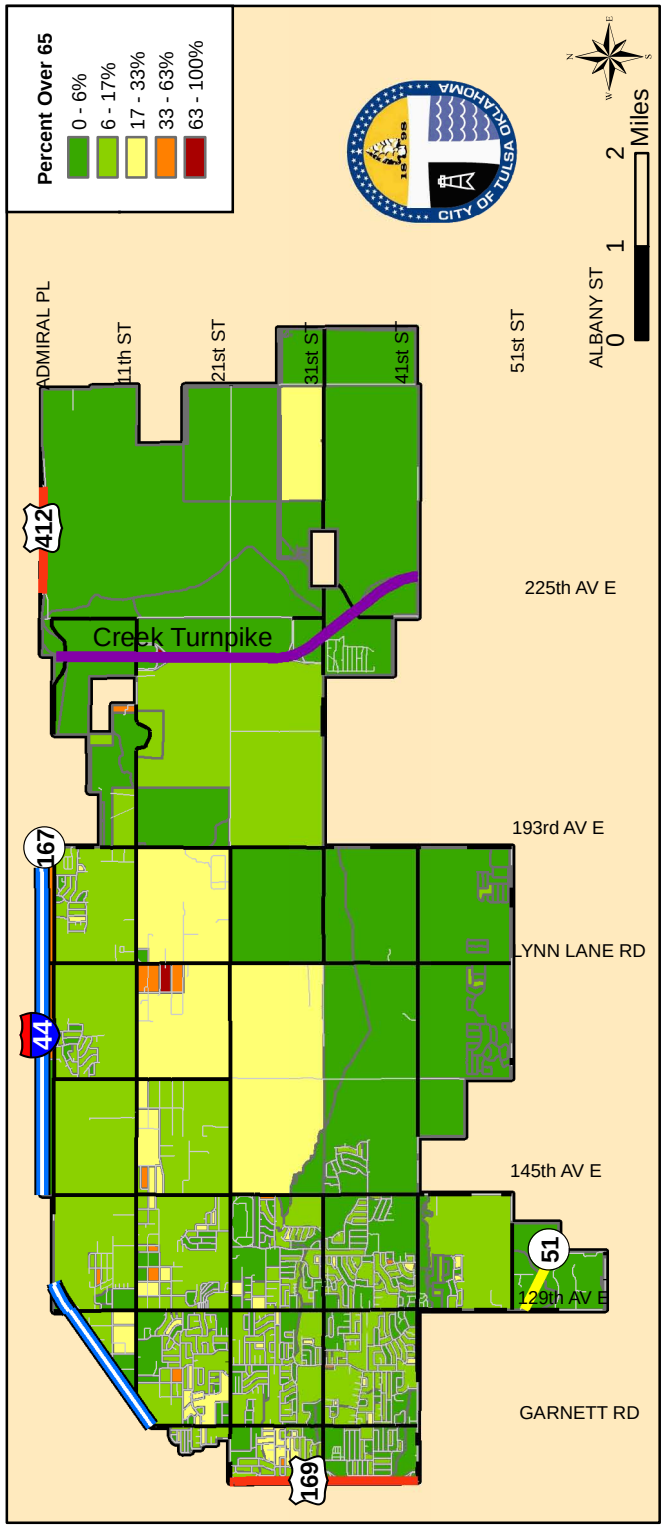
Source: Tulsa County and Wagoner Assessor's Office, 2012



LEGEND

- Intersate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets

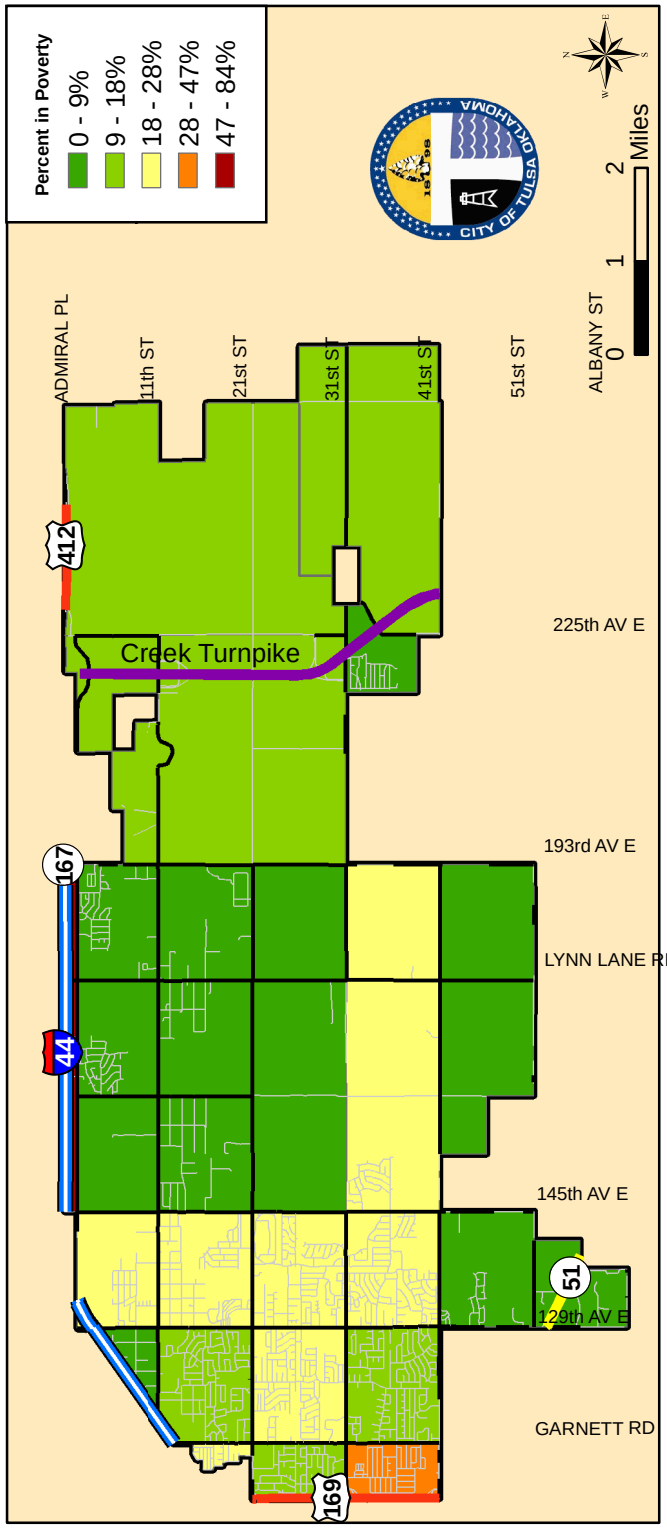
Figure 5.6-5
Tulsa Council District 6
Percent of Population Under Age 18



LEGEND

- Intersate
- US Highway
- State Highway
- Turnpike
- Major Streets
- N_S_Streets
- Streets

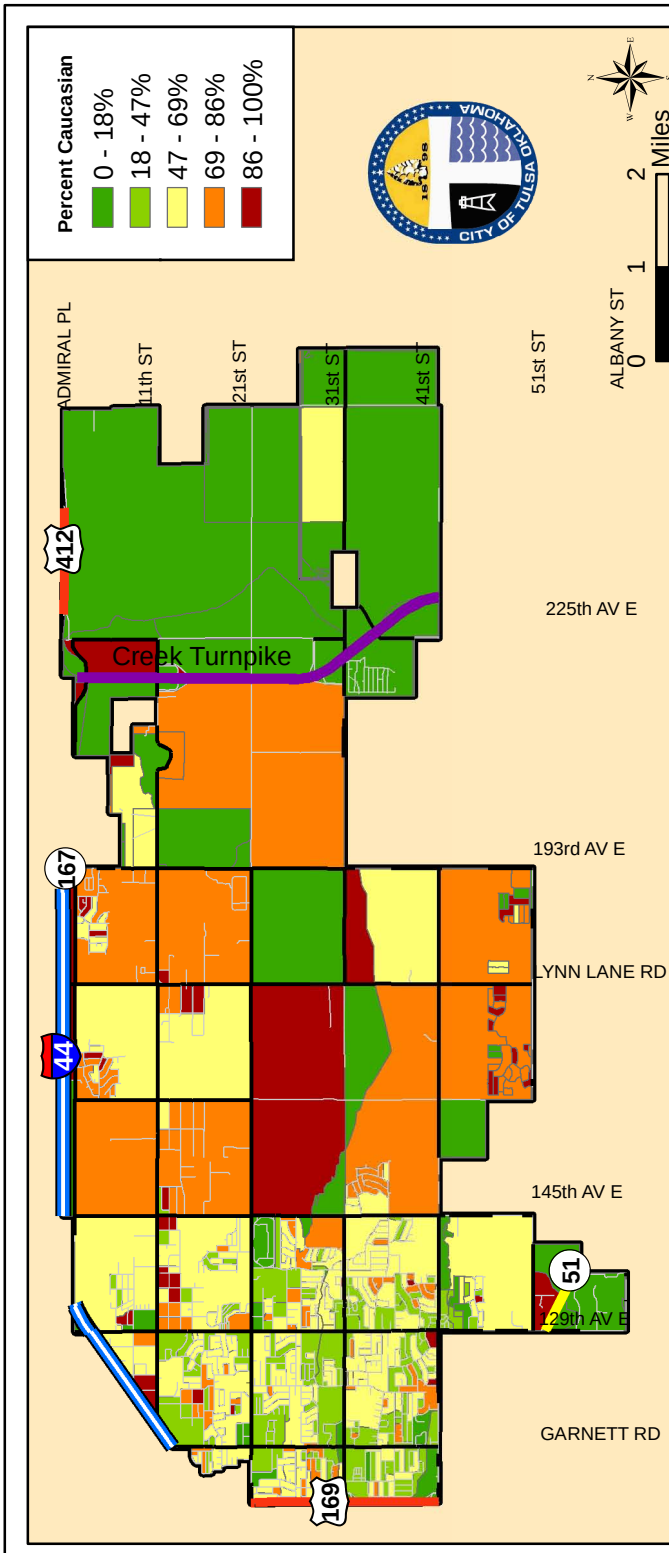
Figure 5.6-6
Tulsa Council District 6
Percent of Population Age 65 and Older



LEGEND

- Intersate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets

Figure 5.6-7
Tulsa
Council District 6
Percent of Population Under the Poverty Line



LEGEND

- Intersate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets

Figure 5.6-8
Tulsa
Council District 6
Percent of Population of Caucasian Descent

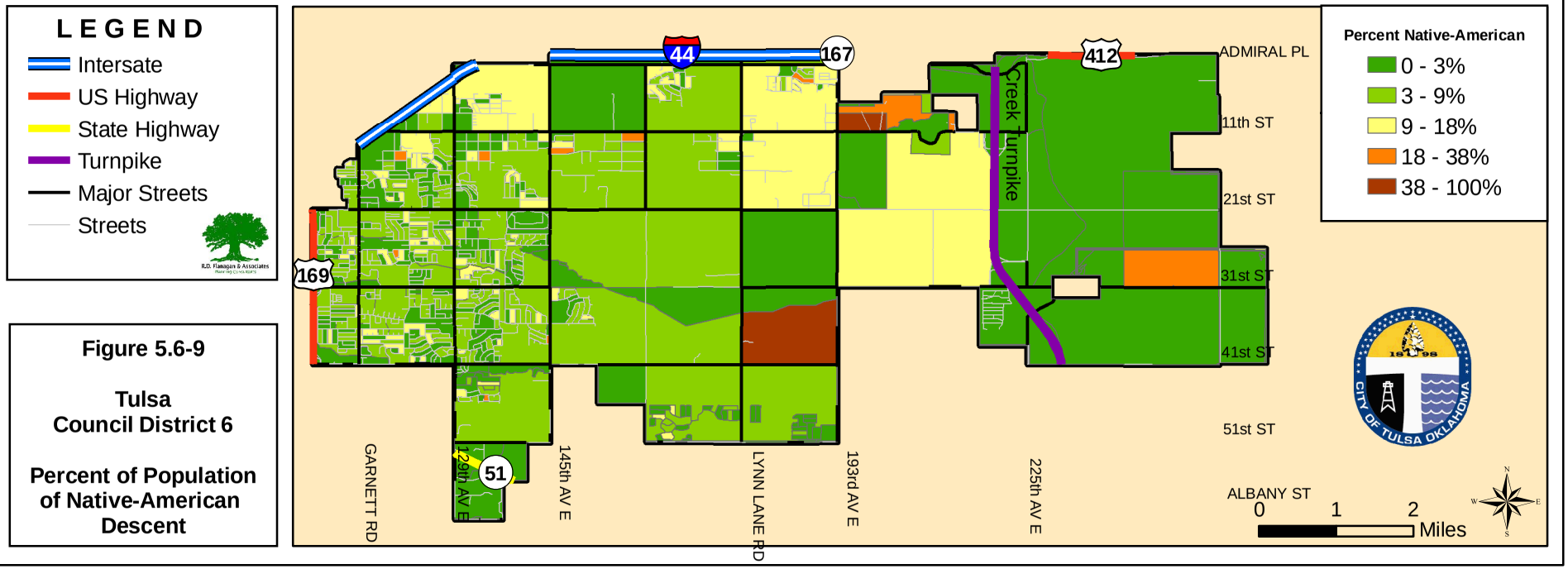


Figure 5.6-9

Tulsa Council District 6

Percent of Population of Native-American Descent

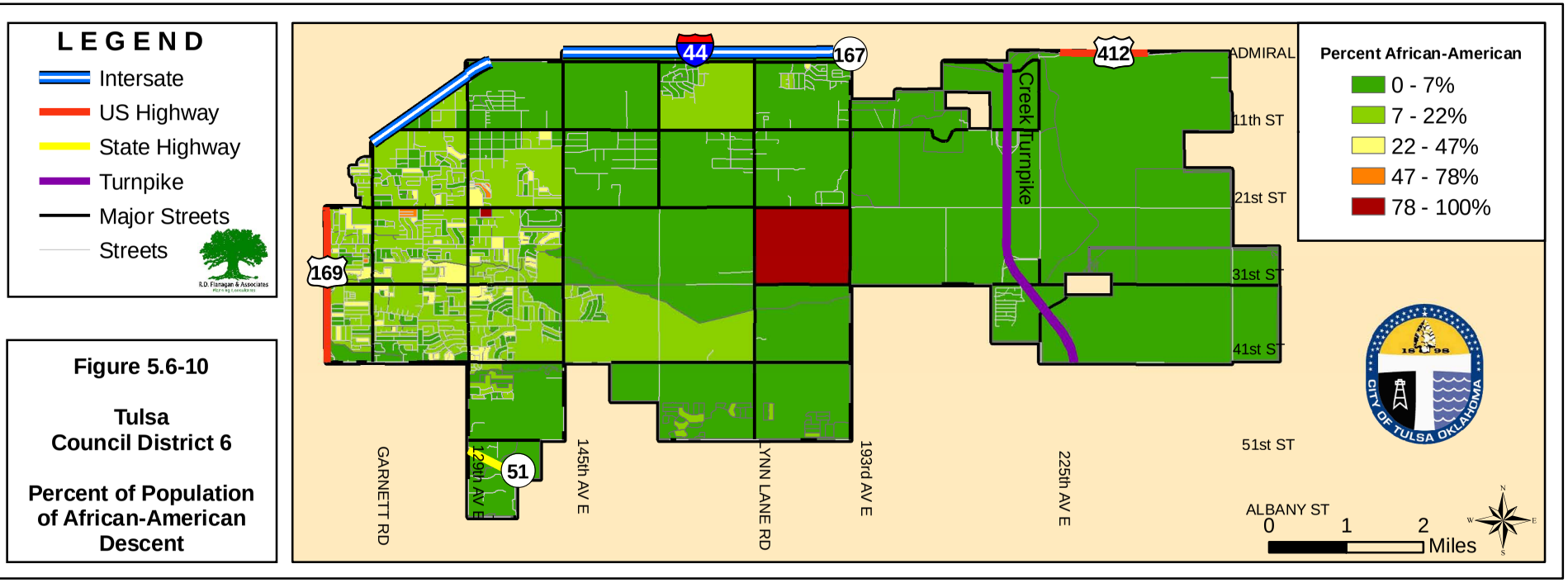
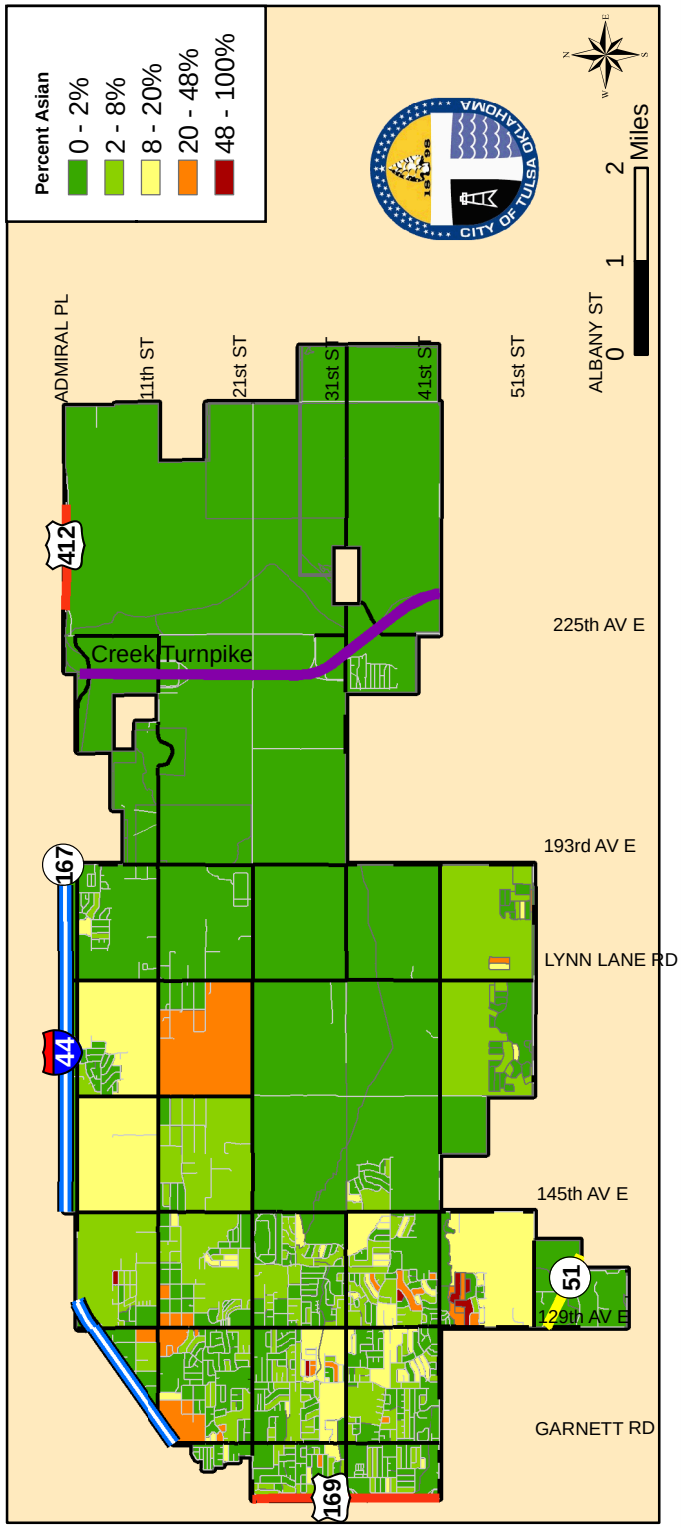


Figure 5.6-10

Tulsa Council District 6

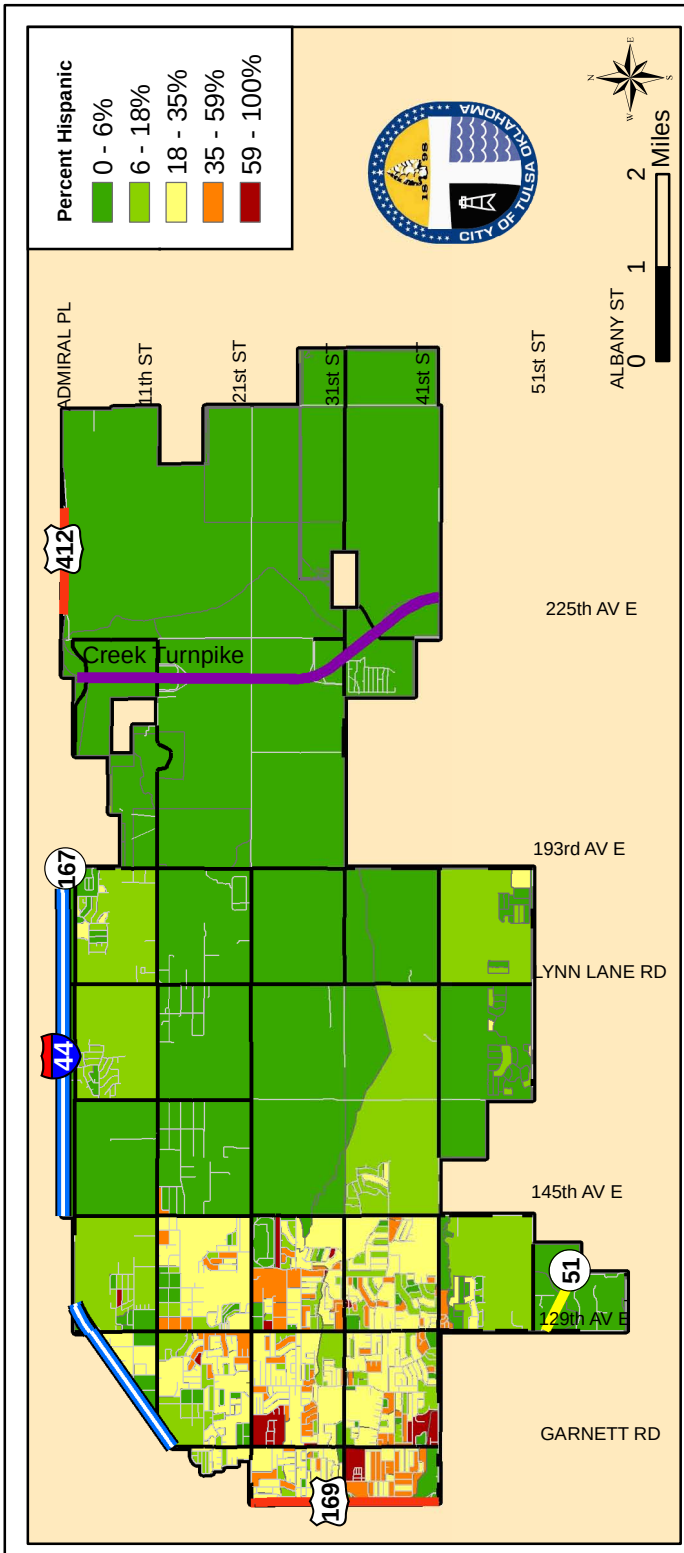
Percent of Population of African-American Descent



LEGEND

- Intersate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets

Figure 5.6-11
Tulsa Council District 6
Percent of Population of Asian Descent



LEGEND

- Intersate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets

Figure 5.6-12
Tulsa Council District 6
Percent of Population of Hispanic Descent

Zoning

For the purpose of this plan, four of the 29 zoning Districts: Single-Family Residential, Multi-Family Residential, Commercial, and Industrial were used to show zoning patterns within District 6. Zoning in the District is largely Single-Family Residential and Agricultural, with some Commercial uses clustered at the intersections of the major arterials in the western half of the District. Industrial uses are found along I-44 in the extreme north, and OK Hwy 51/Broken Arrow Expressway in the south, as seen in Figure 5.6-14.

Future Development

A high percentage of the land area in District 6 is undeveloped, providing much opportunity for expansion into East Tulsa. The PLANiTULSA *2010 Tulsa Vision Plan* lists the Eastgate Metroplex at East 21st and South 145th Avenue, as a potential future development area. The Eastgate Metroplex is currently an employment center, having been converted from a retail shopping mall. Under the vision, the area will continue to develop as an employment center and will be enhanced with transit service to downtown and neighborhoods in between. Retail, grocery and other services will be added to the office and other employment uses, transforming the area into a mixed-use center. Surrounding vacant land will provide space to develop new homes in a compact, pedestrian-friendly community that is predominately single family, but also includes some townhomes, apartments, and condos. These new neighborhoods will expand the range of transit-accessible housing options for people who work in the area.

The City of Tulsa will continue to improve District 6's service infrastructures, such as flood control, water, sanitary sewer, and streets as budget priorities and needs allow. For information regarding future development in the City of Tulsa, see Section 1.2.8.

5.6.1.8 Critical Facilities

There are 23 critical facilities in Tulsa Council District 6. Critical facilities in District 6 are listed in Table 5.6-3 and shown on the map in Figure 5.6-2.

Table 5.6–3: Tulsa Council District 6 Critical Facilities

ID	Map ID	Facility Name	Address
		Government-City	
CF	18	AB Jewell Water Treatment Plant	18707 E 21st St
		Fire Station	
FD	25	Tulsa Fire Department #27	11707 E 31st St
FD	28	Tulsa Fire Department #30	14333 E 11th St
		Government- County	
CG	2	Tulsa City-County Health Dept, Main	5051 S. 129th East Ave.
		Government- Federal	
FG	14	USPS - Eastside Tulsa	2920 S 129th E Ave
		Tulsa Public Schools	
ES	8	Columbus Elementary School	10620 E 27th St
ES	9	Cooper Elementary School	1808 S 123 E Ave
ES	10	Disney Elementary School	11702 E 25th St
MS	57	East Central Junior High School	12121 E 21st St
HS	66	East Central High School	12150 E 11th St

ID	Map ID	Facility Name	Address
Union Public Schools			
ES	1	Union George F Boevers Elementary	3433 S 133rd E Ave
ES	2	Union Briarglen Elementary	3303 S 121st E Ave
ES	8	Union Rosa Parks Elementary	13702 E 46th Pl S
Private School			
PS	8	Christview Christian Church	2525 S Garnett Rd
PS	26	Southpark Christian School	10811 E 41st
Child Care			
CC	8	Cornerstone Child Development Center	3434 S. Garnett Road
CC	13	Disney Family Center CAP	11610 East 25th St.
CC	15	Eastgate Early Education Center	14002 E. 21st St., Ste. 300
CC	18	Garnett Learning Center	12000 E. 31st St.
CC	27	KinderCare Learning Center	11633 E. 31st St. South
CC	28	KinderCare Learning Center	12928 E. 43 Pl. S.
CC	31	La Petite #7	1950 S. 131st East Ave.
Long Term Care			
IL	24	Garnett Village	3524 S 120th East Pl
Local Financial			
LF	10	Oklahoma Central Credit Union	11335 E 41st St

5.6.2 Existing Mitigation Strategies

Existing mitigation measures currently being implemented throughout the City of Tulsa are detailed in Chapter 2, *Existing Mitigation Strategies*. The information that follows in this section surveys the infrastructure in place for avoiding or mitigating the impacts of natural hazards, that can be looked at from the District level.

5.6.2.1 Council District 6 Warning Systems

Warning Sirens

As shown in Figure 5.6-15, there are seven warning sirens located within District 6. In addition, 12 sirens located outside of the boundary lines provide partial coverage in the District. As development spreads eastward to new areas, additional warning sirens should be purchased to provide warning to all residents in the District.

Lightning Sensing and Warning

The City of Tulsa is home to multiple outdoor recreation areas for public use; there are 11 parks in District 6, mapped in Figure 5.6-16. Parks promote neighborhood revitalization and development, including youth development. As discussed in Chapter 4, it is important for outdoor recreation areas be equipped with lightning sensing and warning systems. Tulsa Public Schools and the University of Tulsa use ThorGuard© to warn of lightning danger at outdoor recreation areas. A map showing ThorGuard© coverage areas in Tulsa is shown in Chapter 2, Figure 2-4. Public school districts in the surrounding Tulsa Metro Area should be encouraged to purchase and install lightning warning systems. Private schools in the area should also be informed of their options and encouraged to install such warning systems for their outdoor recreation areas.

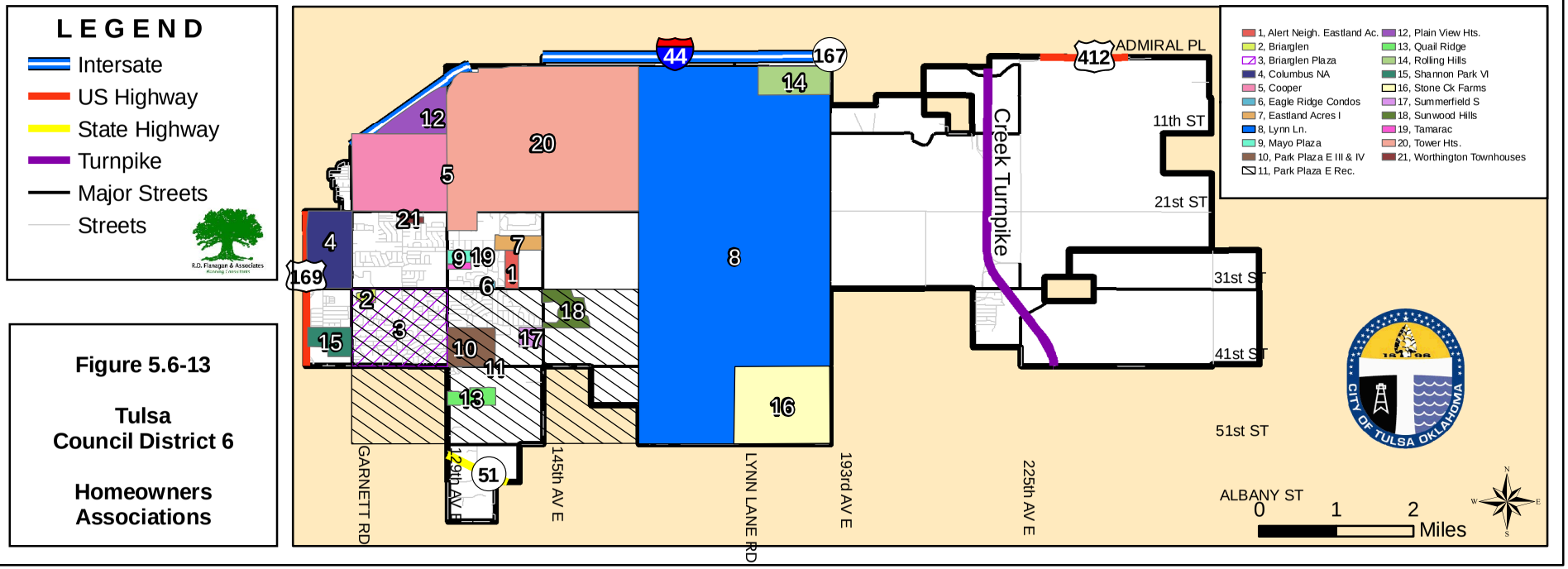


Figure 5.6-13

Tulsa Council District 6

Homeowners Associations

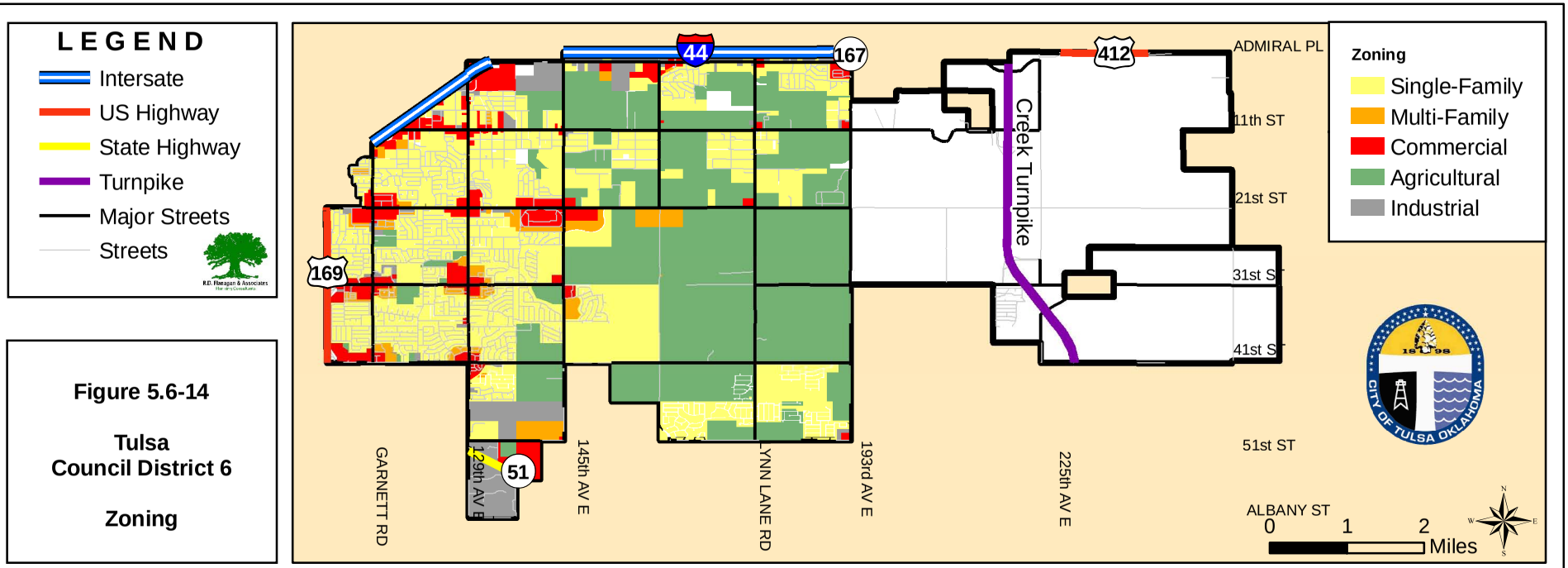


Figure 5.6-14

Tulsa Council District 6

Zoning

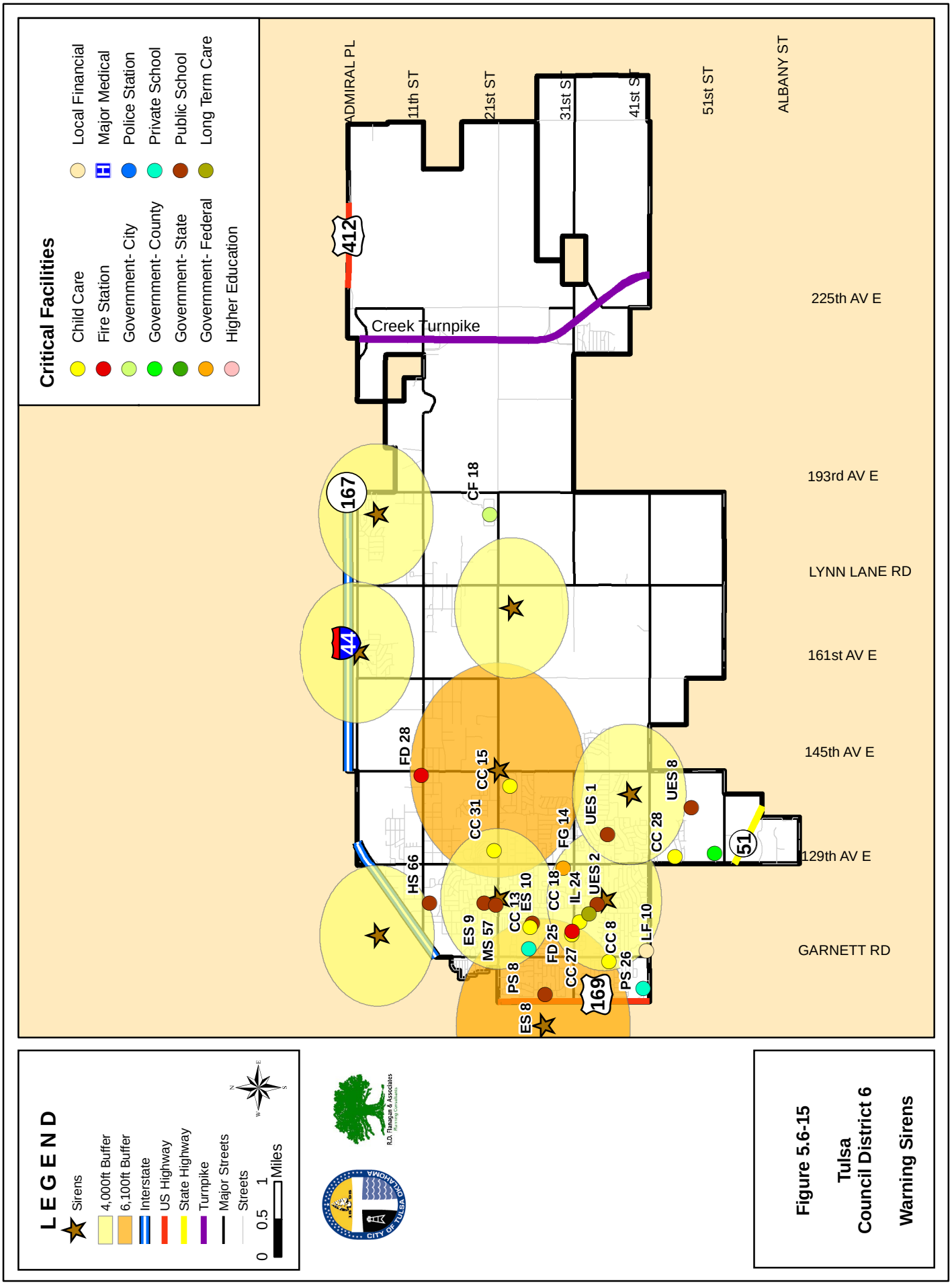


Figure 5.6-15
Tulsa
Council District 6
Warning Sirens

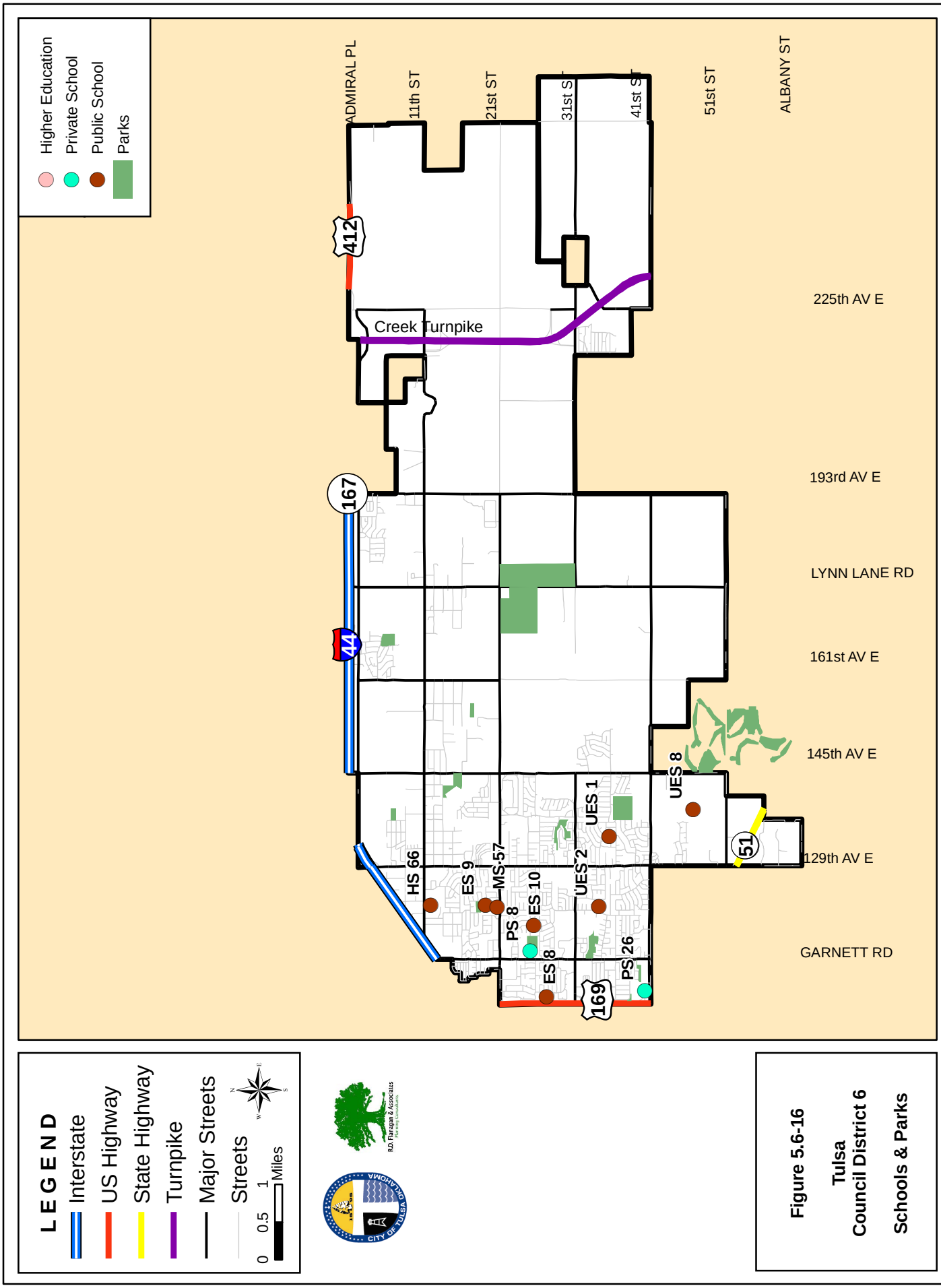


Figure 5.6-16
Tulsa Council District 6
Schools & Parks

5.6.3 Planning Process

The CAC/TAC met monthly during the planning process to review progress, identify issues, receive task assignments, and advise the consultants. Refer to Appendix C for meeting agendas.

5.6.4 Natural and Manmade Hazards

Hazards

General natural hazards, such as Tornadoes, High Winds, Lightning, Hail, Winter Storms, Extreme Heat, Drought, and Earthquakes affect all communities in the City of Tulsa randomly and each District has more or less the same vulnerability. These hazards are addressed in Chapter 4.

Site specific hazards, such as Flooding, Dam Failures, Levee Failures, Expansive Soils, Wildfires, Fixed Site Hazardous Materials and Transportation-Hazardous Materials impact each District differently, and are addressed for District 6 in subsections 5.6.4.1 through 5.6.4.7, and summarized in subsection 5.6.4.8 and the map in Figure 5.6-24.

Council District 6 has some level of vulnerability to six of the seven site-specific hazards addressed in this Plan Update. Table 5.6-4 identifies the site-specific hazards that can particularly impact District 6.

Table 5.6–4: Tulsa Council District 6 Site-Specific Hazard Impacts

Hazard	Area (Sq. mi)	Improved Parcels	Estimated Market Value	Percent of Area Impacted	Impacted Population
Floods	2.70	457	$41,785,455	7.13%	5,091
Dam failures- Lynn Lane	0.49	2	$80,020	1.29%	0
Levee Failure	0	0	0	0	0
Expansive Soils	13.23	7,949	$868,700,960	34.93%	21,032
Wildfires	28.81	316	$40,202,632	76.06%	10,728
Fixed-Site HazMat, ¼ Mi.	3.26	1,771	$229,573,923	8.61%	7,197
Transportation HazMat-Highway	5.06	1,547	$175,320,968	13.36%	3,963
Transportation – HazMat- Railroad	0.01	2	$9,347,300	0.03%	0

Source: Tulsa County Assessor 2012/US Census Data, 2010

Tulsa Council District 6 has identified certain facilities as critical to the health, safety and welfare of its citizens, business and economy. Table 5.6-5 indicates, generally, the exposure of critical facilities to the seven site-specific hazards covered by this Plan Update.

Table 5.6–5: Tulsa Council District 6 Hazard Impacts on Critical Facilities

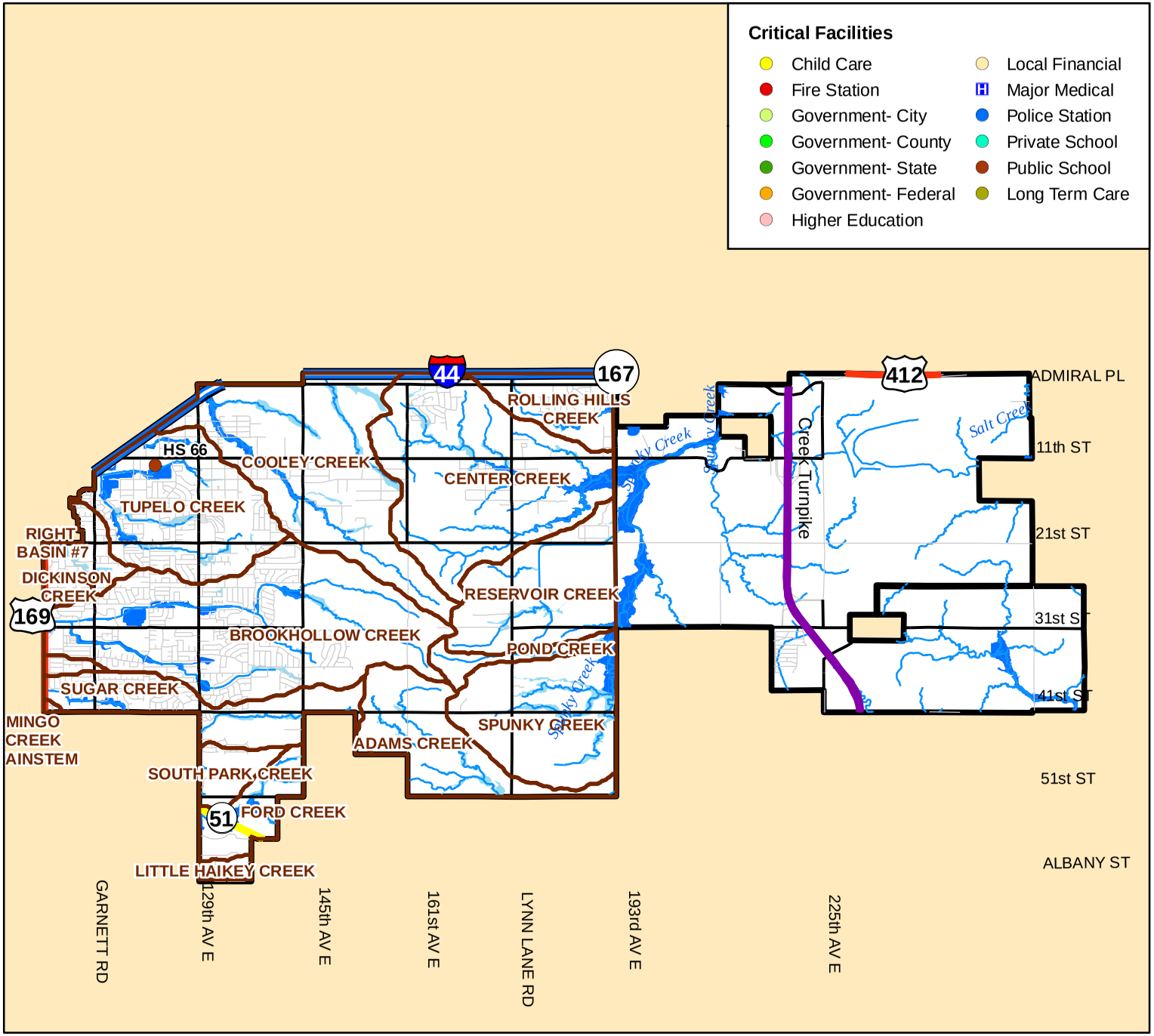
ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Hazardous Material Sites	Transportation-Hazard
CF	18	AB Jewell Water Treatment Plant	X	X	X	X	X	X	X	X	X		X				X	

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Hazardous Material Sites	Transportation-Hazard
FD	25	Tulsa Fire Department #27	X	X	X	X	X	X	X	X	X				X			
FD	28	Tulsa Fire Department #30	X	X	X	X	X	X	X	X	X							
CG	2	Tulsa City-County Health Dept, Main	X	X	X	X	X	X	X	X	X				X		X	
FG	14	USPS - Eastside Tulsa	X	X	X	X	X	X	X	X	X							
ES	8	Columbus Elementary School	X	X	X	X	X	X	X	X	X				X			X
ES	9	Cooper Elementary School	X	X	X	X	X	X	X	X	X						X	
ES	10	Disney Elementary School	X	X	X	X	X	X	X	X	X				X			
MS	57	East Central Junior High School	X	X	X	X	X	X	X	X	X						X	
HS	66	East Central High School	X	X	X	X	X	X	X	X	X	X						
UES	1	Union George F Boevers Elementary	X	X	X	X	X	X	X	X	X							
UES	2	Union Briarglen Elementary	X	X	X	X	X	X	X	X	X							
UES	8	Union Rosa Parks Elementary	X	X	X	X	X	X	X	X	X							
PS	8	Christview Christian Church	X	X	X	X	X	X	X	X	X							
PS	26	Southpark Christian School	X	X	X	X	X	X	X	X	X				X			X
CC	8	Cornerstone Child Development Ctr	X	X	X	X	X	X	X	X	X				X		X	
CC	13	Disney Family Ctr CAP	X	X	X	X	X	X	X	X	X				X			
CC	15	Eastgate Early Education Ctr	X	X	X	X	X	X	X	X	X				X			
CC	18	Garnett Learning Ctr	X	X	X	X	X	X	X	X	X				X			
CC	27	KinderCare Learning Ctr	X	X	X	X	X	X	X	X	X				X			
CC	28	KinderCare Learning Ctr	X	X	X	X	X	X	X	X	X						X	
CC	31	La Petite #7	X	X	X	X	X	X	X	X	X				X			
IL	24	Garnett Village	X	X	X	X	X	X	X	X	X				X			
LF	10	Oklahoma Central Credit Union	X	X	X	X	X	X	X	X	X				X			

5.6.4.1 Flood

Location

District 6 is affected by both the Special Flood Hazard Area (SFHA) and City Regulatory Floodplains. The combined floodplains comprise 2.70 sq. mi., or 7.13 percent of the land within the District's boundaries. A map of the drainage basins, SFHA and City Regulatory Floodplains in District 6 is shown in Figure 5.6-17. Streams in the District, along with their total drainage areas, are listed in Table 5.6-6.



LEGEND

- Drainage Basins
- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets
- Streams
- SFHA
- City Regulatory

0 0.5 1 Miles

Figure 5.6-17

Tulsa
Council District 6

Drainage Basins & Floodplains

Table 5.6–6: Tulsa Council District 6 Streams and Drainage Areas

Stream	Total Drainage Area (sq. mi.)
FORD CREEK	0.76
LITTLE HAIKEY CREEK	0.01
BROOKHOLLOW CREEK	4.65
SUGAR CREEK	1.48
LITTLE HAIKEY CREEK	0.04
COOLEY CREEK	3.28
TUPELO CREEK	2.47
RIGHT BASIN #7	0.53
ROLLING HILLS CREEK	0.78
CENTER CREEK	3.70
RESERVOIR CREEK	1.82
ADAMS CREEK	1.53
POND CREEK	0.57
SPUNKY CREEK	1.90
SOUTH PARK CREEK	0.39
MINGO CREEK MAINSTEM-MUM	0.13
Total	24.04

Impact/Vulnerability

In total, 421 single-family residential structures, 13 residential multi-family structures, seven commercial buildings, one industrial facility and 15 structures classified as *other* are touched by the 100-year floodplains of the City of Tulsa. Using 2010 US Census data, an estimated 5,091 residents were determined to be at risk to the flood hazard in District 6. The property parcels impacted by the 100-year flood are listed in Table 5.6-7.

Table 5.6–7: Tulsa Council District 6 Buildings Touched by 100 year Floodplain

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	421	$27,333,347
Residential Multi-Family	13	$4,071,180
Commercial	7	$8,690,142
Industrial	1	$1,115,086
Other	15	$575,700
Total	457	$41,785,455

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

One critical facility in District 6 is located within the 100-year floodplain: East Central High School, located at 12150 E 11th Street. Vulnerable critical facilities are identified in Table 5.6-5 and are shown in Figure 5.6-17. Flood damage could require them to close for a period of time if repairs are necessary.

Repetitive Loss Properties

There are four repetitive loss properties within Council District 6: two residential and two commercial.

Flood Control Projects

Tulsa's floodplain and stormwater program includes comprehensive watershed management, dedicated funds for maintenance and operation, and a $200 million capital improvements program. Although the District continues to be vulnerable to the Flood hazard, actions have been completed and new actions planned in order to mitigate against some of the flood problems that threaten District 6 as development occurs. Figure 5.6-18 displays flood control projects in District 6 identified in the 2004 Capital Improvements Plan. District 6 flood control projects budgeted in the 2008-2012 Capital Expenditures Plan are listed in the following Table.

Table 5.6–8: Tulsa Council District 6 Flood Control Projects 2008-2012

Project ID	Project Basin and Description	Budget
2	Brookhollow Creek - Bridges and Channel Improvements	$1,000,000
3	Brookhollow Creek - Eastland Mall Relief Drainage System (Adjacent Areas)	$430,000
4	Brookhollow Creek - Mayo Plaza Drainage Relief System	$1,670,000
5	Center Creek - Regional Detention Facility	$430,000
70	Mingo Creek (Lower) - Carriage Village Mobile Home Park	$5,130,000
82	Spunky/Adams Creek - Master Drainage Plan	$250,000
83	Rolling Hills - Rolling Hills Channel and Detention	$2,850,000
84	Tupelo Creek - 21st Street Detention Basin	$1,730,000
85	Tupelo Creek - Cherokee Village Relief Drainage System Ph 1.	$5,130,000
86	Tupelo Creek - Stacy Lynn 4th Addition Culvert (Phase 2)	$1,430,000
87	Tupelo Creek - Stacy Lynn 3rd Addition Culvert (Phase 3)	$2,380,000
88	Upper Brookhollow Creek - Detention Sites	$4,740,000

Source: PLANiTulsa Capital Expenditures Plan 2008-2012

Conclusion

Tulsa Council District 6 has a HIGH probability of and a HIGH vulnerability to the Flood hazard.

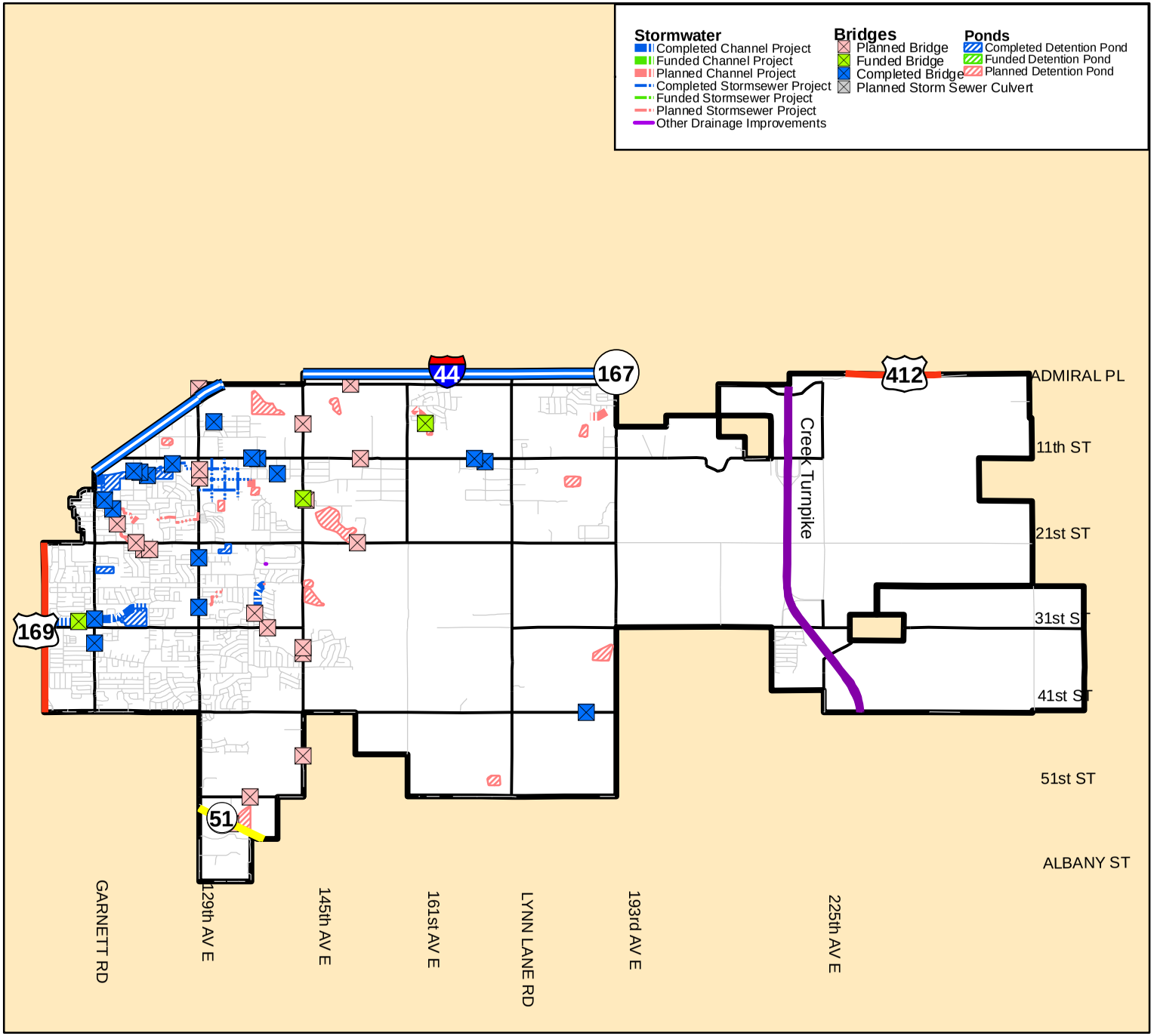
5.6.4.2 Dam Failure

Location

District 6 has one high-hazard dam within its boundaries, Lynn Lane Reservoir. A small area of the District, about 0.49 square miles in size, is located within the inundation area of a dam failure. Lynne Lane Reservoir is located at East 21st St. and 193rd E. Avenue. The capacity of the reservoir is 325 acre feet. It is used for raw water storage for the A. B. Jewell Water Treatment Plant, which is located across E. 21st St., directly north of the reservoir. A map displaying the inundation area of this high-hazard dam is shown in Figure 5.6-19.

Impact/Vulnerability

An event causing failure of Lynn Lane Reservoir would have minimal impacts on Tulsa Council District 6. The Dam is located away from populated areas. According to Tulsa County Assessor Data, two residential single family structures would be impacted by a breach of Lynn Lane Dam. The parcels have a value, adjusted for fair market price, of $80,020. No loss of life is anticipated as a result of a dam failure event.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Streets

0 0.5 1 Miles

For more detailed information refer to the Citywide Master Drainage Plan.

Figure 5.6-18

Tulsa Council District 6

Flood Control

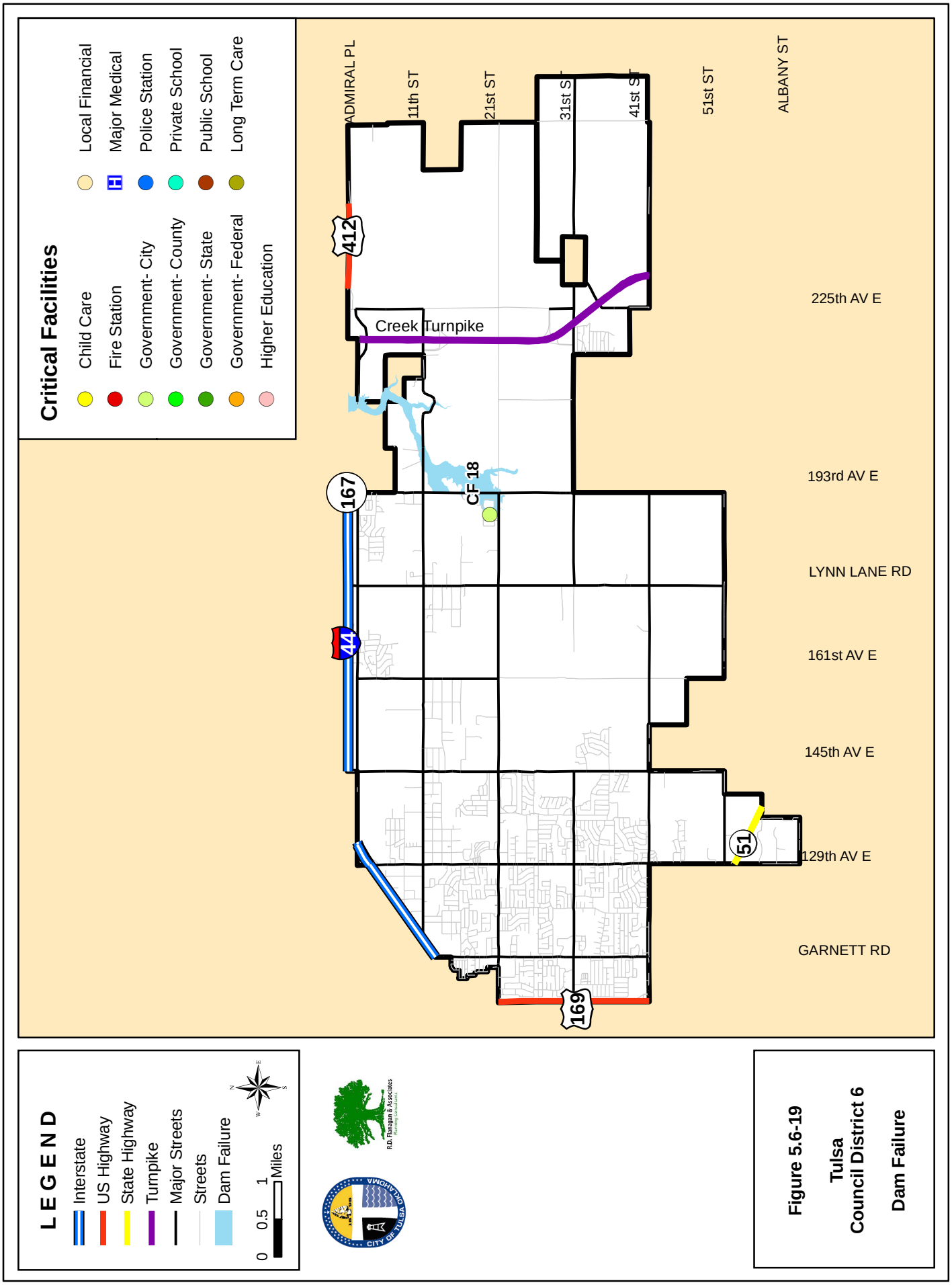


Figure 5.6-19
Tulsa Council District 6
Dam Failure

Critical Facilities

If Lynn Lane Reservoir were to fail, one critical facility would potentially be impacted: the A. B. Jewell Water Treatment Plant.

Conclusion

Tulsa Council District 6 has a LOW vulnerability to and a LOW probability of the Dam Failure hazard.

5.6.4.3 Levee Failure

Tulsa Council District 6 has no vulnerability to and no probability of the Levee Failure hazard.

5.6.4.4 Expansive Soils

Location

Council District 6 is underlain predominantly by soils with Low to Very High shrink/swell potential. Low to Moderate expansive soils comprises 63.33 percent while soils with High to Very High shrink/swell potential make up 34.93 percent. Expansive soils in District 6 are summarized in Table 5.6-9. A map showing the location of the Districts expansive soils is presented in Figure 5.6-20.

Table 5.6–9: Tulsa Council District 6 Expansive Soils

Expansion Potential	Area (Sq Mi)	Percent of Total City Limits
Very High	2.81	7.42%
High	10.42	27.51%
Moderate	15.03	39.68%
Low	8.96	23.65%
Water	0.66	1.74%
Total	37.88	100.00%

Impact/Vulnerability

According to 2012 Tulsa County Assessor data, 7,949 improved parcels in District 6 are underlain by highly expansive soils. A summary of District 6 improved parcels located on High to Very High expansive soils is included in Table 5.6-10. There are 13 critical facilities located on High and Very High expansive soils in District 6. Moderate to High expansive soils make up a large percentage of undeveloped areas in the eastern area of the District. As Tulsa continues to develop eastward, it is important that the public be made aware of expansive soil impacts and what can be done to reduce their risks.

Table 5.6–10: Tulsa Council District 6 Parcels on High to Very High Expansive Soils

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	7,609	$656,292,473
Residential Multi-Family	112	$34,137,536
Commercial	133	$115,123,490
Industrial	4	$21,257,381
Other	91	$41,890,080
Total	7,949	$868,700,960

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

There are 13 Critical facilities located on Highly expansive soils in the District. These include the AB Jewell Water Treatment Plant, one Fire Department (#27), one private school, two public schools, six child care facilities, one extended care facility, and one financial institution. These are listed in Table 5.6-5, and shown in the map in Figure 5.6-20. Although it is likely the structures were engineered to account for the soils on which they are built, effort should be made to monitor the facilities for damages and report/repair as necessary.

Conclusion

Tulsa Council District 6 has a HIGH vulnerability to and HIGH probability of the Expansive Soils hazard.

5.6.4.5 Wildfire

Location

The Wildfire Level of Concern (LOC) in District 6 ranges from 0 to 9 on the Wildfire LOC Index. A map displaying the Wildfire LOC of District 6 is shown in Figure 5.6-21.

Impact/Vulnerability

There are 315 improved parcels located in areas of Low to High Wildfire LOC in District 6, summarized in Table 5.6-11. Using US Census data, 1,040 people in District 6 were determined to be vulnerable to this hazard. The majority of District 6 has no to Low wildfire vulnerability; however, there are a few locations with Moderate wildfire vulnerability in the residential neighborhoods, located in the western area of the District. Of greatest concern are the areas to the east and west of the Creek Turnpike, south from US Hwy 412 to E 11th Street. The west side of the Turnpike is primarily wooded, before turning into a residential neighborhood. Residents of this area should be made aware of wildfire danger and educated on ways to mitigate around their property.

Table 5.6–11: Tulsa Council District 6 Parcels Touched by Wildfire Level of Concern

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	295	$15,852,693
Residential Multi-Family	1	$2,737,100
Commercial	7	$5,300,401
Industrial	1	$1,530,881
Other	12	$14,781,557
Total	316	$40,202,632

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Three critical facilities in District 6 are located in wildfire risk areas: one private school, one elementary school, and one child care facility. Though a wildfire is not likely to impact the urban areas of Tulsa, grasses and low lying shrubs around the facilities should be well maintained. For a list of critical facilities located in areas of Moderate to High Wildfire LOC, see Table 5.6-5.

Conclusion

Tulsa Council District 6 is considered to have a MODERATE vulnerability to and MODERATE probability of the Wildfire hazard.

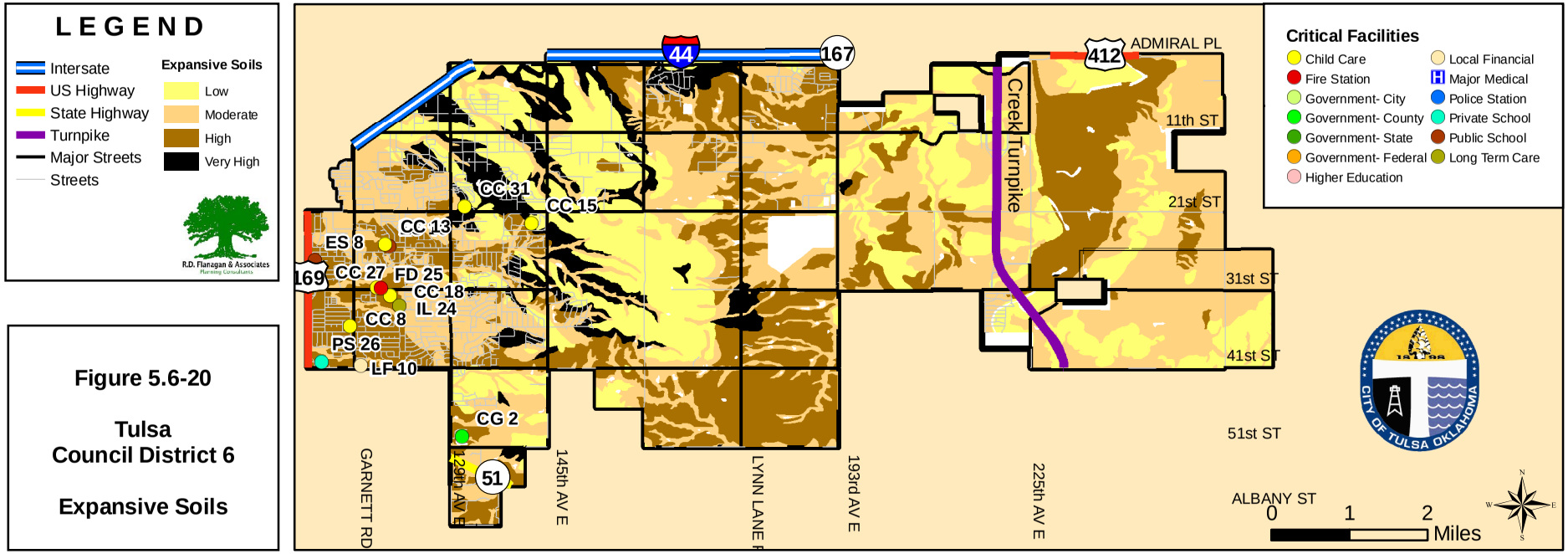


Figure 5.6-20

Tulsa Council District 6

Expansive Soils

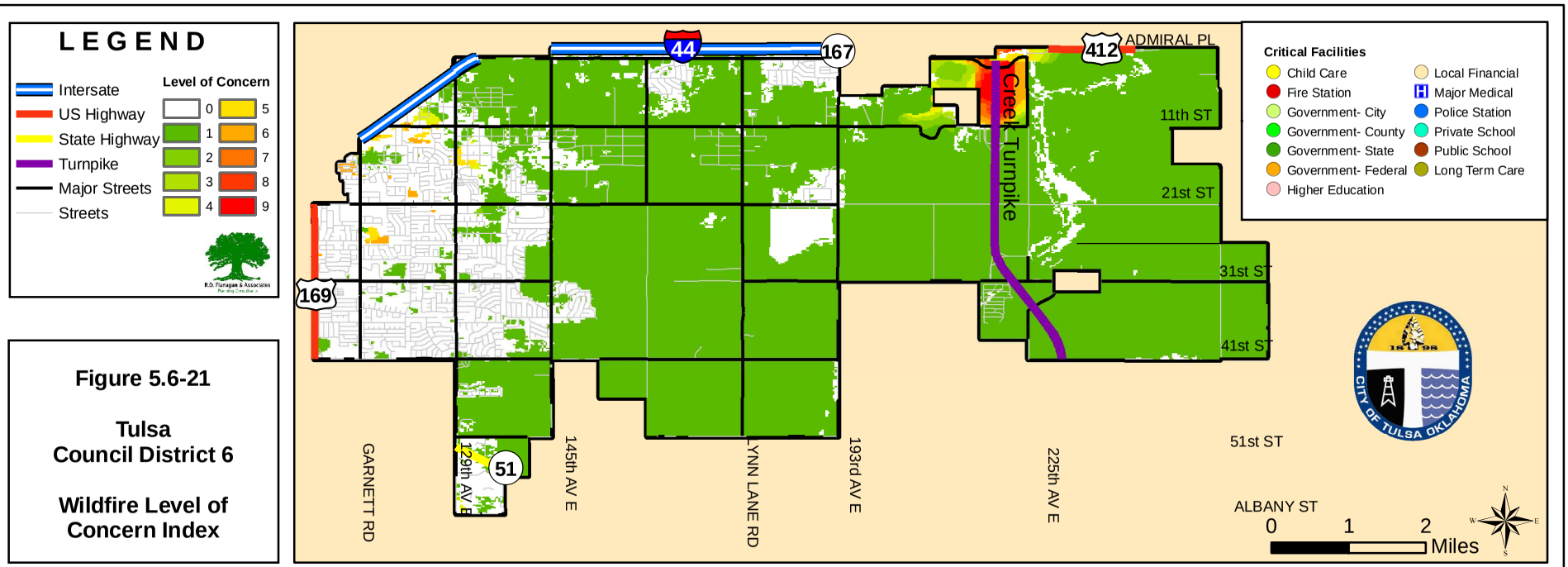


Figure 5.6-21

Tulsa Council District 6

Wildfire Level of Concern Index

5.6.4.6 Fixed Site Hazardous Materials

Location

There are 21 Tier II facilities either within or immediately adjacent to the boundaries of Tulsa Council District 6. Due to the sensitive nature of this material, Tier II facilities in the District are mapped in Figure 5.6-22 to show only approximate location of the sites. A listing of EHS and Non-EHS Tier II facilities in Council District 6 can be found in Appendix E, and is available on a need to know basis.

Impact/Vulnerability

According to the Marplot analysis, which uses 2010 US Census data, 7,197 people live or work within ¼ mile of a Tier II facility in District 6. Those living or working within the ¼ mile buffer zone are vulnerable to the impacts of this hazard, as described in Chapter 4. A summary of the number of parcels located within ¼ mile of one the 21 Tier II facilities in District 6, is included in Table 5.6-12.

Table 5.6–12: Tulsa Council District 6 Parcels in ¼ Mile Tier II Buffer

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	1,577	$125,294,862
Residential Multi-Family	117	$21,996,500
Commercial	39	$50,005,112
Industrial	3	$16,675,181
Other	35	$15,602,268
Total	1,771	$229,573,923

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Six critical facilities in Council District 6 are located within ¼ mile of a Tier II facility. Although structures are not likely to be impacted, populations at the facilities are at high risk if a hazardous materials release were to occur. Of high concern are the childcare and public school facilities in ¼ mile buffer of these Tier II sites. Pre-planning is critical at these facilities. Effort should be made to ensure proper evacuation or shelter in place procedures are posted and practiced. A list of District 6 critical facilities located within ¼ mile of a Tier II facility is provided in Table 5.6-5 and mapped in Figure 5.6-22 below.

Conclusion

Tulsa Council District 6 is considered to have a HIGH vulnerability to and LOW probability of a fixed-site hazardous materials release.

5.6.4.7 Transportation Hazards

Location

Five significant transportation corridors pass through District 6: Interstate 44 runs northeast along the far north-west boundary of the District before turning eastward along the District's northern boundary, then turning north again at its intersection with the Creek Turnpike. I-44 is duplexed with OK Hwy 66 to 200th E. Ave., and with US Hwy 412 to the Creek Turnpike. US Hwy 412 and 412P run along the northern boundary of the District from west to east, duplexed with I-44 and OK Hwy 66 (412P is also Admiral Pl.). US Highway 169 runs north-south along the western boundary of the District, between E. 21st St. and E. 41st St. The Creek Turnpike passes north-south through the eastern half of the District, between US Hwy 412 in the north to E. 41st St. in the south.

District 6 has one airport: Harvey Young Airport, a privately owned field for small aircraft, located at E. 15th St. and 135th E. Ave. There is an average of 87 aircraft based at the field, with 68 operations/day.

The Union Pacific Railroad passes just south of the extreme southern reach of District 6, between 129th E. Ave. and N. Hemlock Cir., but has a spur that reaches north into the District to the Zeledyne Glass Plant, at 129th E. Ave. and the Broken Arrow Expressway.

District 6 Transportation corridors and their ¼ mile buffer areas are shown in Figure 5.6-23.

Impact/Vulnerability

A ¼-mile transportation buffer for the five transportation corridors would encompass 13.39 percent of Council District 6 (or 5.07 sq. mi.), 1,549 improved parcels, 3,963 residents (based on 2010 Census number of people per square mile), and two of the District's critical facilities. According to Tulsa County Assessor data, 1,547 improved parcels in District 6 are touched by the ¼ mile buffer of a Highway, Interstate or railroad in the District, with a total value, assessed for fair market, of $175,320,968. The numbers of parcels touched by the highway corridors in District 6 are summarized, by type, in Table 5.6-13. In total, two improved parcels (one commercial and one industrial) in District 6 are located within ¼ mile of a rail line, with a total value, assessed for fair market, of $9,347,300. The numbers of District 6 parcels touched by the railroad corridors are summarized, by type, in Table 5.6-14.

Table 5.6–13: Tulsa Council District 6 Parcels Touched by ¼ mile Highway Corridor

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	1,392	$84,044,470
Residential Multi-Family	18	$1,807,000
Commercial	54	$41,887,721
Industrial	6	$15,781,500
Other	8	$31,800,277
Total	1,547	$175,320,968

Source: Tulsa County Assessors Office, 2012

Table 5.6–14: Tulsa Council District 6 Parcels Touched by ¼ mile Railroad Corridor

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	0	$0
Residential Multi-Family	0	$0
Commercial	1	$1,482,300
Industrial	0	$0
Other	1	$7,865,000
Total	2	$9,347,300

Source: Tulsa County Assessors Office, 2012

Although the structures themselves are not likely to be directly impacted by this hazard, persons living or working within these facilities are at heightened vulnerability.

Critical Facilities

Two critical facilities in District 6 are vulnerable to the transportation hazard. The facilities include one private school and one elementary school. As mentioned, children are among the most vulnerable populations in the City of Tulsa. A transportation incident involving hazardous materials that impacted one of these vulnerable facilities could be devastating to the community. Effort should be

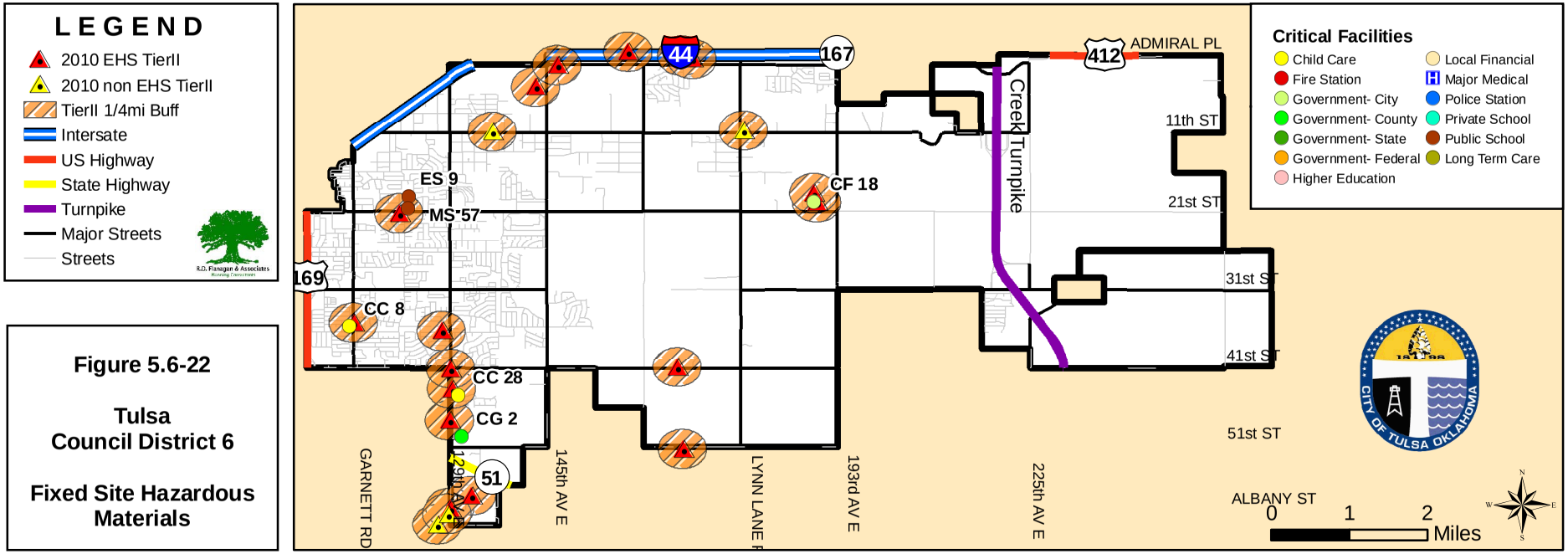


Figure 5.6-22

Tulsa Council District 6

Fixed Site Hazardous Materials

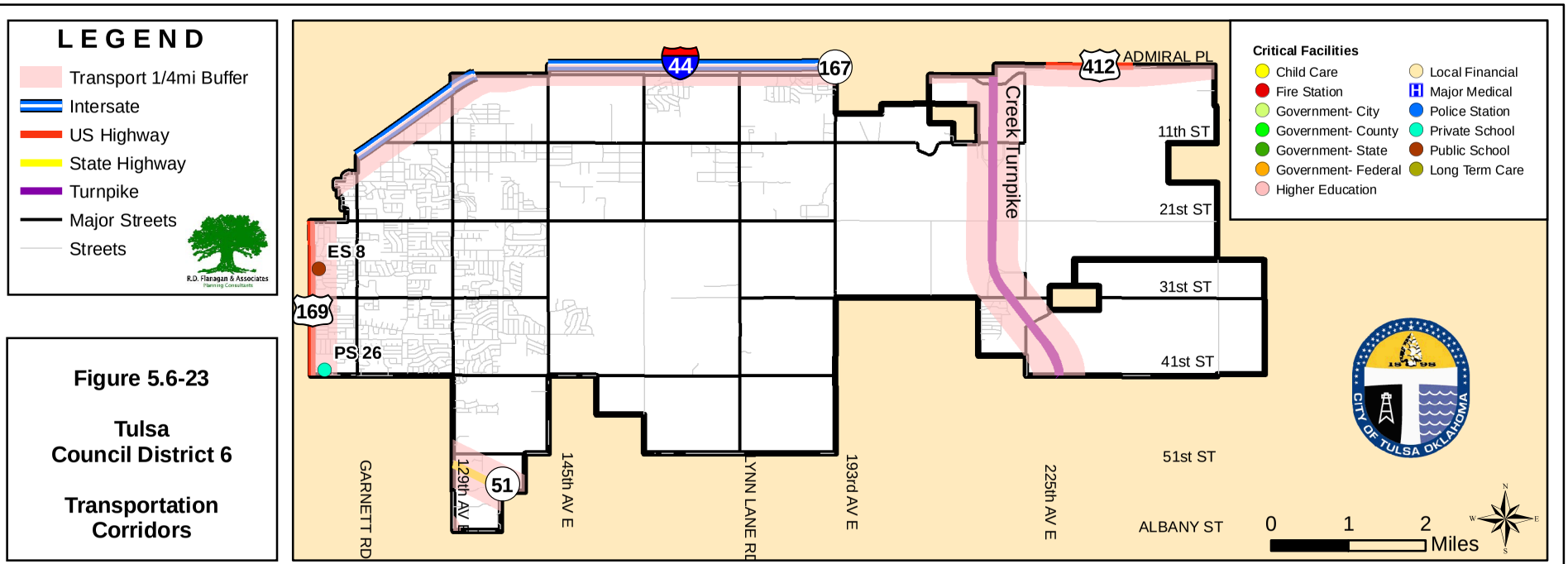


Figure 5.6-23

Tulsa Council District 6

Transportation Corridors

made to educate vulnerable populations on shelter-in-place or evacuation procedures. A list of critical facilities vulnerable to the Transportation hazard is included in Table 5.6-5.

Conclusion

Tulsa Council District 6 has a HIGH vulnerability to and HIGH probability of the Transportation hazard.

5.6.4.8 Hazards Summary

Site-specific hazards, unique to Tulsa Council District 6, identified and mapped in this section, include Floods, Dam Failures, Expansive Soils, Wildfires, Hazardous Materials, and Transportation. The Hazards Composite Map, shown in Figure 5.6-24, summarizes the areas of the District potentially impacted by these site-specific hazards.

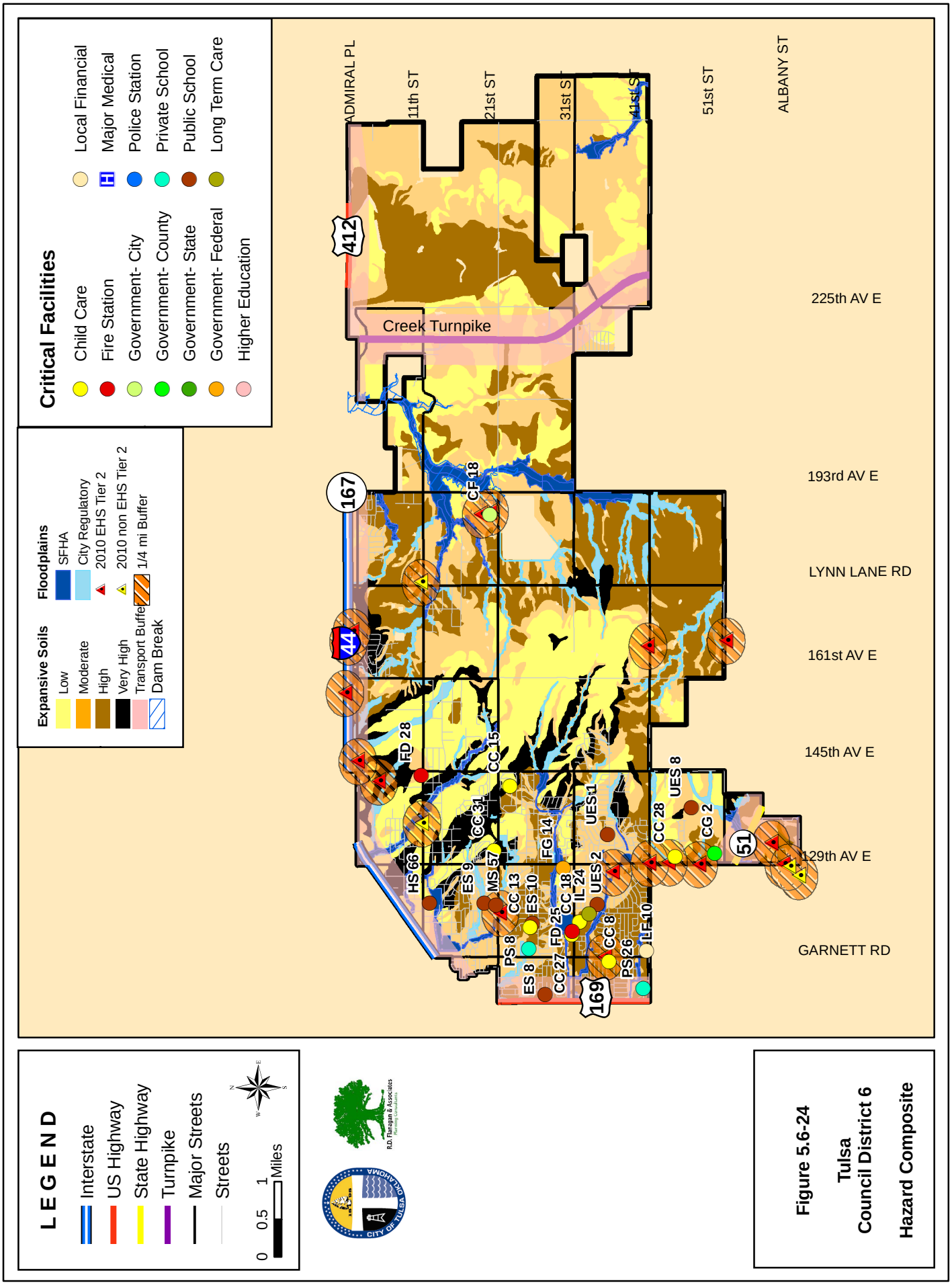


Figure 5.6-24
Tulsa Council District 6
Hazard Composite

City of Tulsa Multi-Hazard Mitigation Plan Update

Tulsa City Council District 7

R.D. Flanagan & Associates

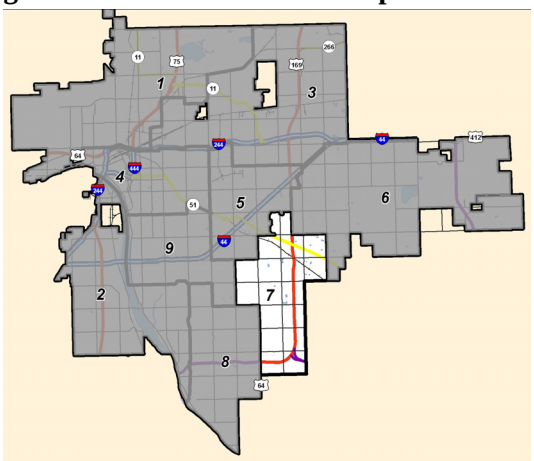
Planning Consultants

5.7 Tulsa City Council District 7

5.7.1 Introduction

5.7.1.1 Location

Figure 5.7–1: Tulsa Locator Map – District 7



Tulsa City Council District 7 is situated in southeast Tulsa, as shown in the Locator Map at right. The District is 17 sq mi. in size, and bounded on the north by E 31st and 41st Streets, the east by S Garnett Road and 129th E. Ave., the south by E 101st Street, and in the west by S Sheridan and Memorial Rds. (See the base map in Figure 5.7-2.) The District contains the upper Mingo Creek basin, flowing north into Bird Creek and the Verdigris River, and the Haikey Creek watershed, flowing south into the Arkansas River. It is crossed, from north to south, by the Mingo Valley Expressway (US Hwy 169), in the extreme north by the Broken Arrow Expressway, and in the extreme south by the Creek Turnpike.

5.7.1.2 Arianna Moore Councilor District 7

Councilor Arianna Moore was inaugurated for her first term as a Tulsa City Councilor on December 3, 2012. At age 26, she is the youngest councilor to have ever served on the Tulsa City Council. Arianna Moore has lived in the Tulsa metro area her entire life. She graduated from Bixby High School in 2005 and became a Golden Hurricane that same year at the University of Tulsa where she graduated in 2009 with a Bachelor of Arts in Communications and a Minor in Business. Soon after graduation, Arianna married Spencer in May 2009. Currently, she works for METLife as a Personal Marketing Assistant. Arianna has been involved with the city by volunteering her time as a board member for Counseling and Recovery Services, Community Relations and Resource Development Committee, and she chairs the Human Rights Committee. In her free time, Arianna enjoys spending time with her family and friends. She also takes pleasure in couponing and shopping and spoiling her Chihuahua, Duchess. *(Source: http://www.tulsacouncil.org/)*

Councilor Arianna Moore

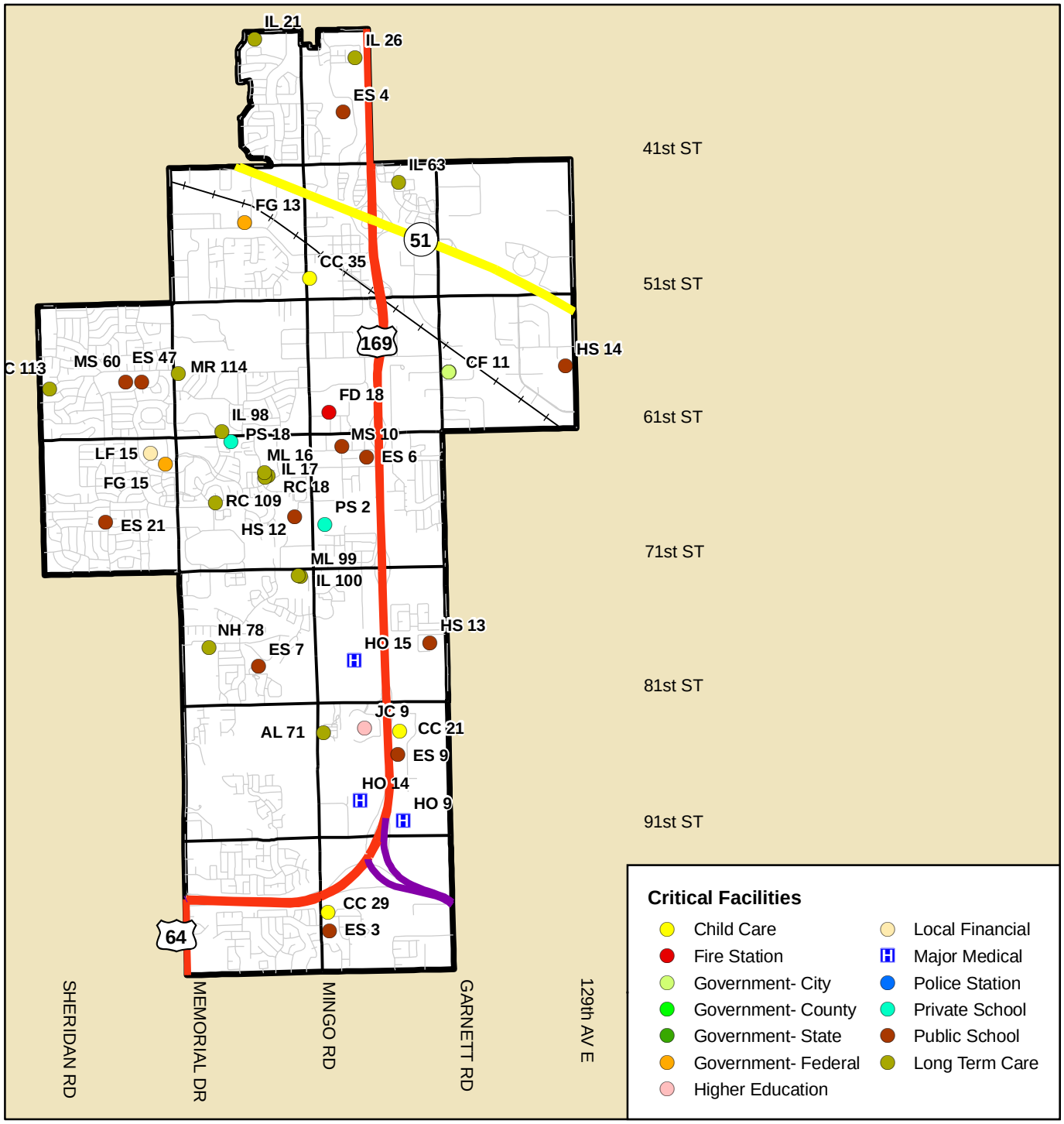
5.7.1.3 History

Cultural and Historic Properties

Tulsa Council District 7 is home to one cultural site; Hardesty Regional Library, displayed on the map in Figure 5.7-3. No structures in District 7 are listed on the National Register of Historic Places.

5.7.1.4 Demographics

Council District 7 had a 2010 Census population of 44,367. Table 5.7-1 shows the demographic makeup of the District. Maps illustrating the demographic information in the Table, and population density in the District, are presented in Figures 5.7-4 through 5.7-12.



LEGEND

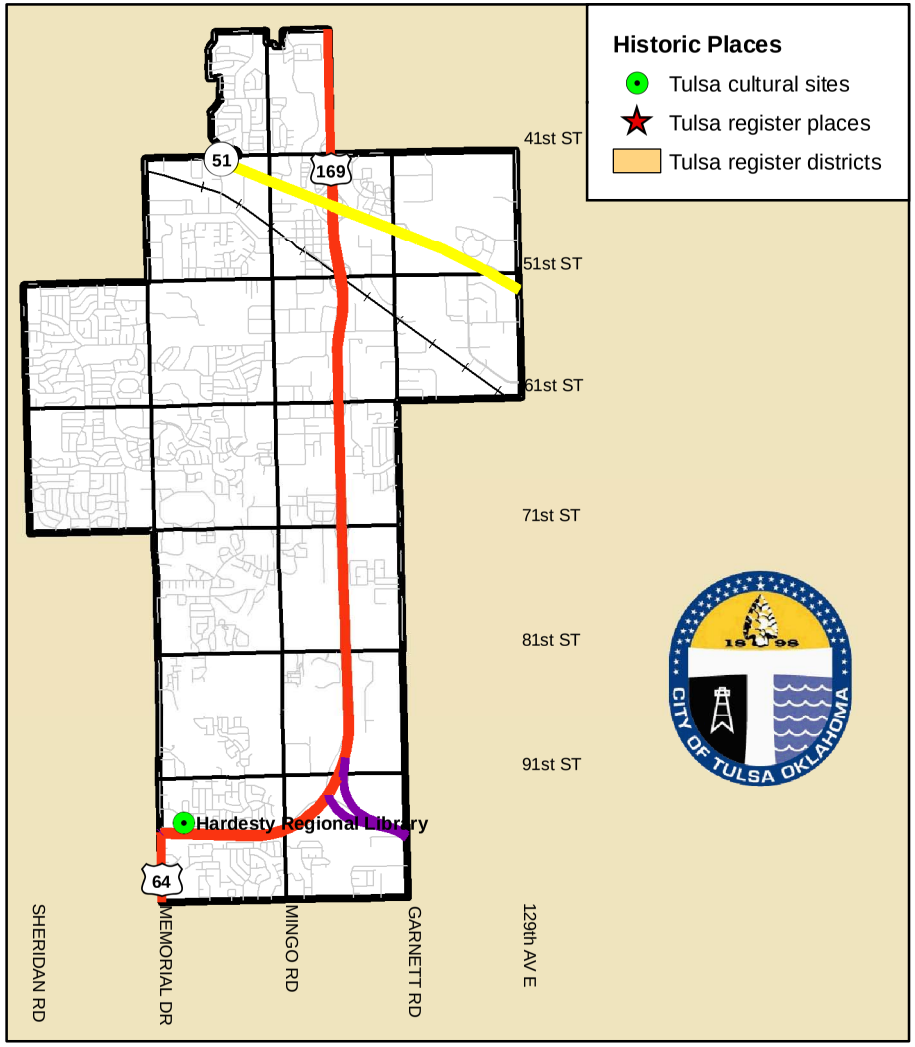
- Interstate
- US Highways
- State Highways
- Turnpike
- Major Roads
- Local Streets
- Railroads

0 0.5 1 Miles

Figure 5.7-2

Tulsa Council District 7

Basemap



LEGEND

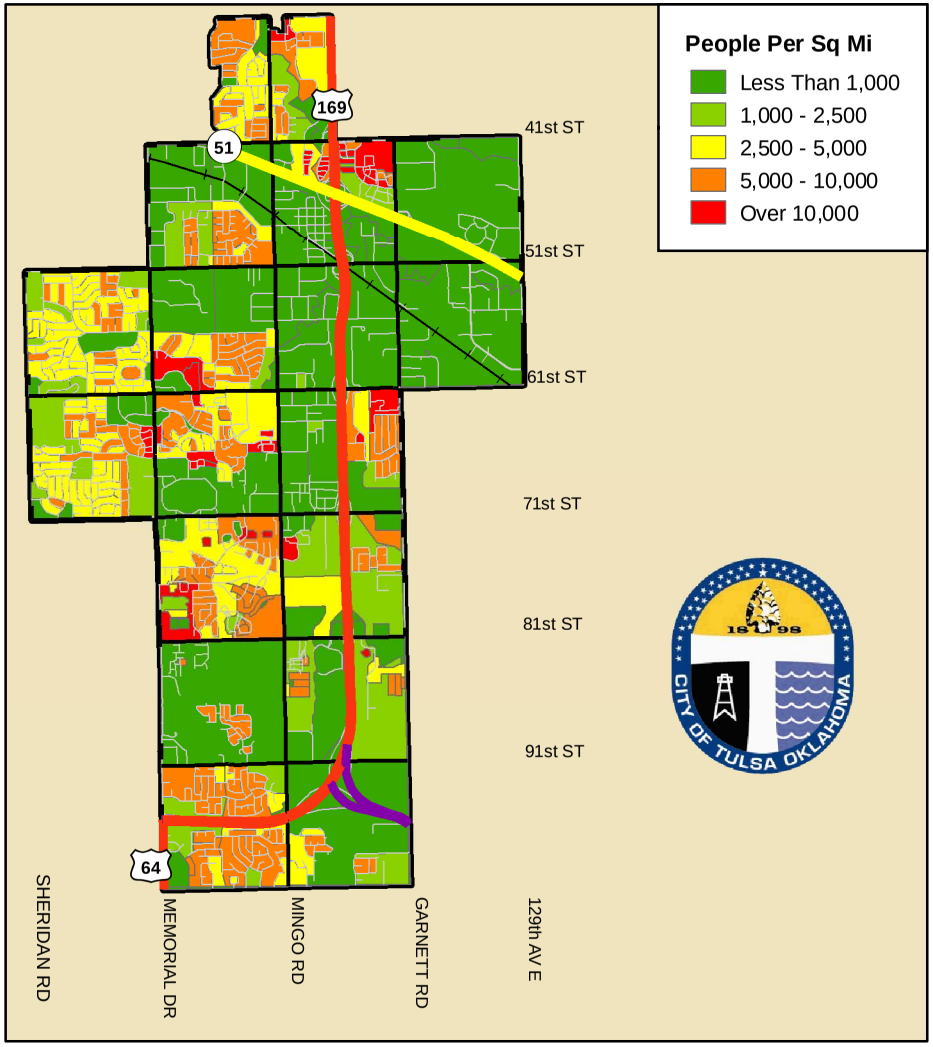
- Interstate
- US Highways
- State Highways
- Turnpike
- Major Roads
- Local Streets
- Railroads

0 0.5 1 Miles

Figure 5.7-3

Tulsa Council District 7

Cultural and Historic Places



LEGEND

- Interstate
- US Highways
- State Highways
- Turnpike
- Major Roads
- Local Streets
- Railroads

0 0.5 1 Miles

Figure 5.7-4

Tulsa Council District 7

Population Density

Table 5.7–1: Tulsa Council District 7 Demographic Information

Category	District	Tulsa
Persons under 5 years of age	6.75%	7.53%
Persons under age 18	23.59%	24.44%
Persons age 65 and older	13.40%	12.46%
Poverty Status in 2010 (individuals)	14.66%	19.36%
White	69.25%	62.81%
Native-American	4.22%	5.35%
African American	9.41%	15.67%
Asian	4.71%	2.39%
Hispanic	13.64%	13.93%
Total Population	44,367	401,265

Source: 2010 US Census

5.7.1.5 Infrastructure

Tulsa Council District 7 is dependent upon the lifelines of the City of Tulsa as identified in Section 1.2.6 of this Plan Update. Any unique vulnerability of Tulsa Council District 7 in relation to the seven site-specific hazards identified in this plan will be addressed in Section 5.7.4, below.

5.7.1.6 Economy

The 2010 US Census identified an income level of approximately $22,133 as the average poverty threshold for a family of four, including two children. Approximately 6,504 individuals, or 14.66% of all individuals in District 7, were living below the poverty line in 2010. The percentage of people living in poverty in District 7 is displayed in Figure 5.7-7.

5.7.1.7 Development

According to the Tulsa County Assessor's Office, there are 11,920 properties with improvements within District 7, with a total assessed value, adjusted for fair market price, of $2,695,570,073. District properties with improvements by value and type are listed in Table 5.7-2. No land, contents or tax exempt values are included. Homeowners associations are shown in Figure 5-7.13.

Table 5.7–2: Tulsa Council District 7 Property Types by Assessed Values

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	10,427	$1,178,883,162
Residential Multi-Family	204	$182,759,780
Commercial	632	$755,698,350
Industrial	118	$102,922,471
Other	539	$475,306,310
Total	11,920	$2,695,570,073

Source: Tulsa County Assessor's Office, 2012

Zoning

For the purpose of this plan, four of the 29 zoning districts (Single-Family Residential, Multi-Family Residential, Commercial, and Industrial) are used to show zoning patterns within District 7. Much of the land area in District 7 is zoned for single-family residential and commercial use. The few areas zoned for multi-family usage are distributed somewhat evenly in the west central part of the District.

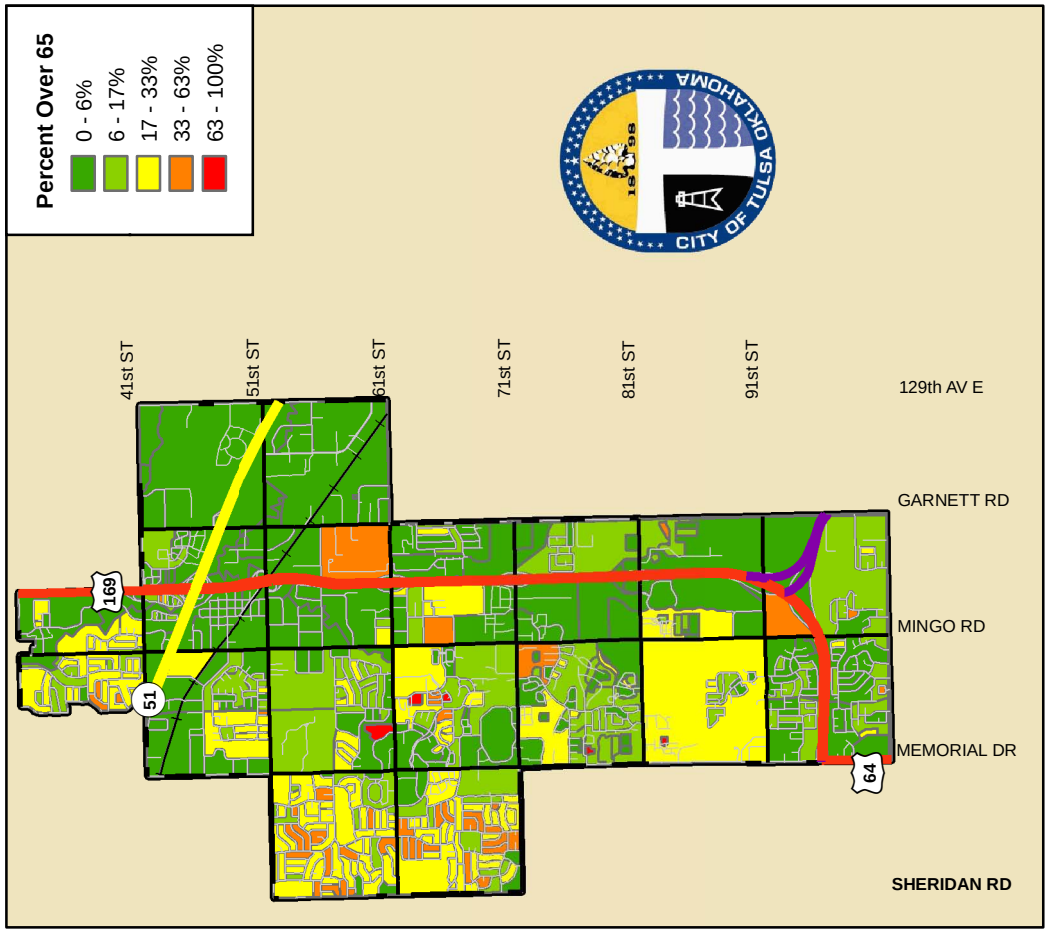


Figure 5.7-5

Tulsa Council District 7

Percent of Population Under Age 18

LEGEND

- Interstate
- US Highways
- State Highways
- Turnpike
- Major Roads
- Local Streets
- Railroads

0 0.5 1 Miles

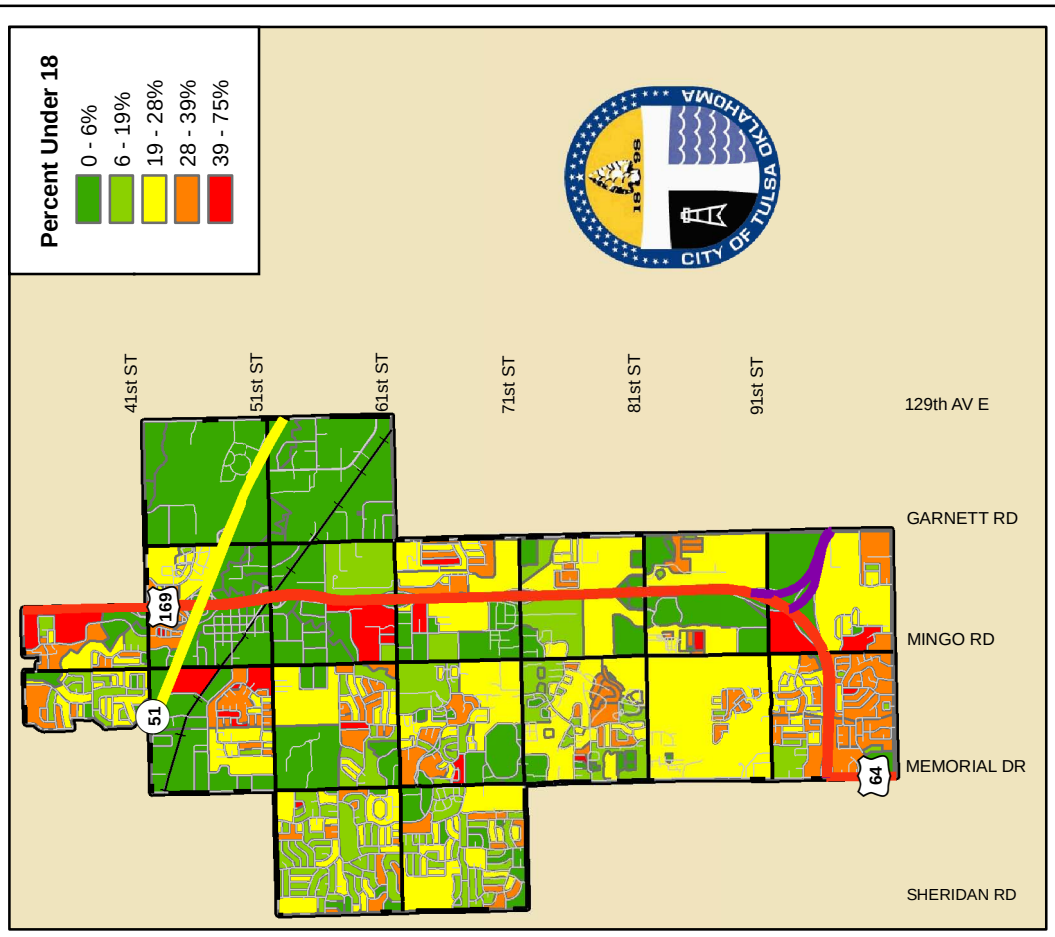


Figure 5.7-6

Tulsa Council District 7

Percent of Population Age 65 and Older

LEGEND

- Interstate
- US Highways
- State Highways
- Turnpike
- Major Roads
- Local Streets
- Railroads

0 0.5 1 Miles

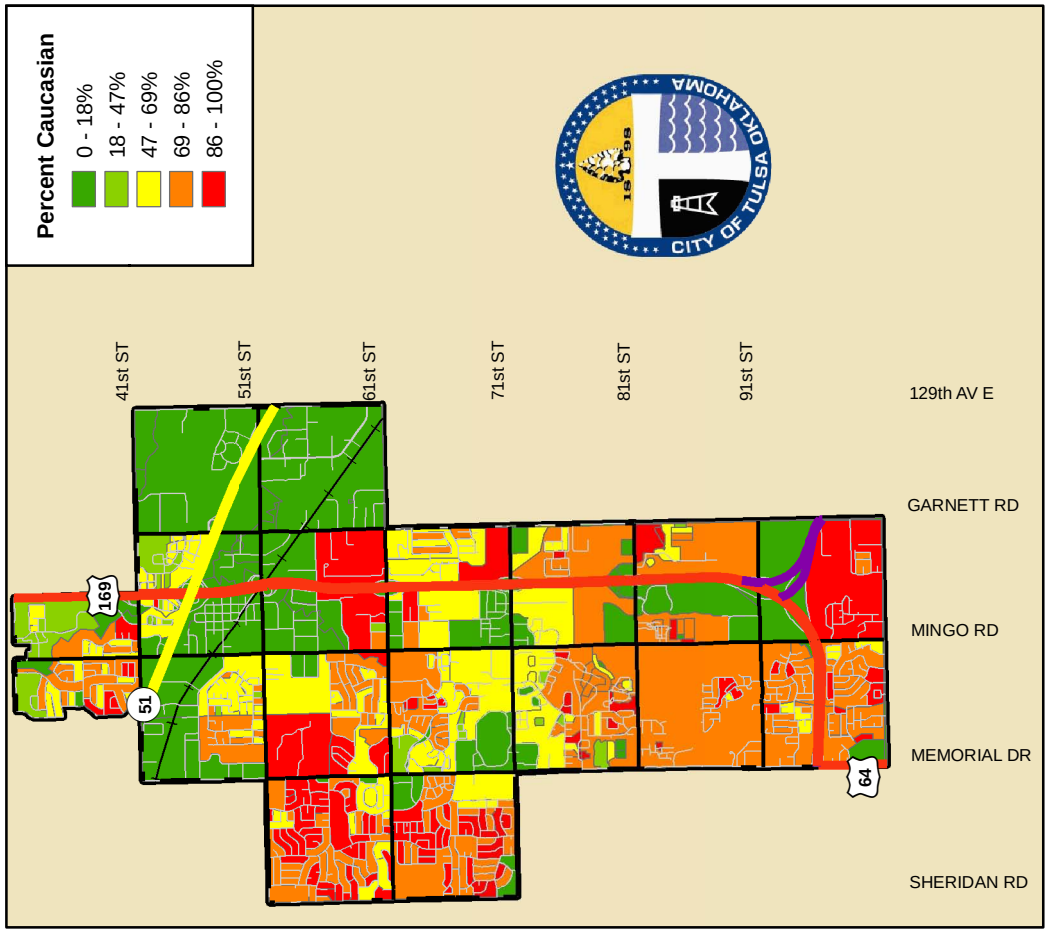


Figure 5.7-8

Tulsa Council District 7

Percent of Population of Caucasian Descent

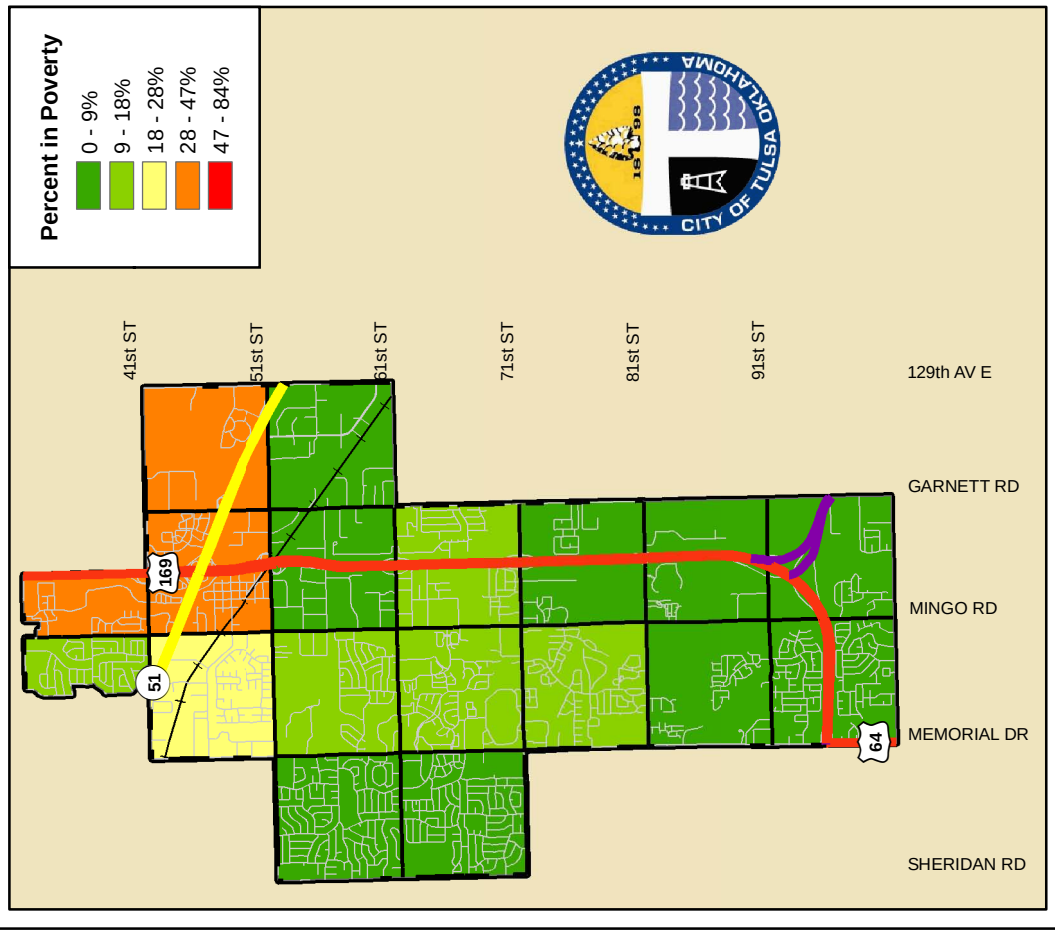


Figure 5.7-7

Tulsa Council District 7

Percent of Population Under the Poverty Line

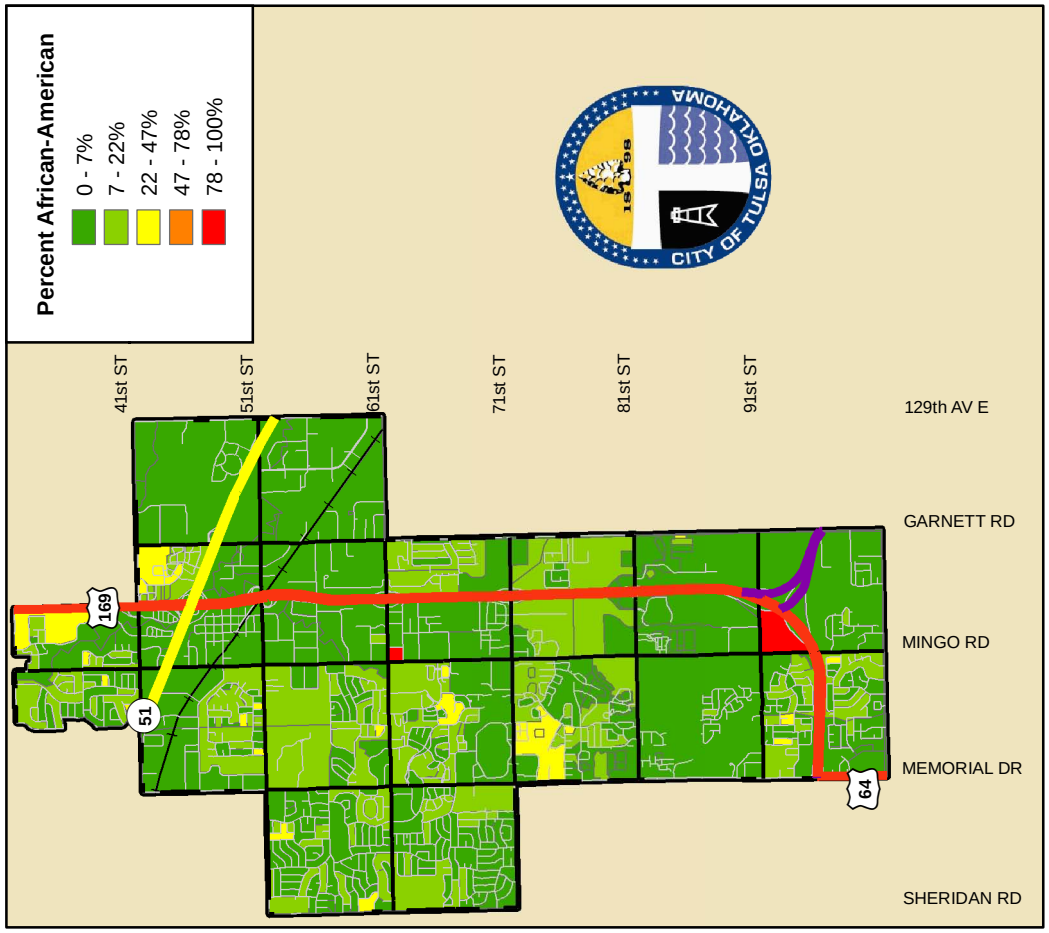
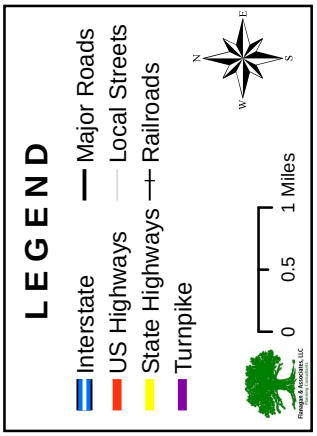


Figure 5.7-10

Tulsa Council District 7

Percent of Population of African-American Descent



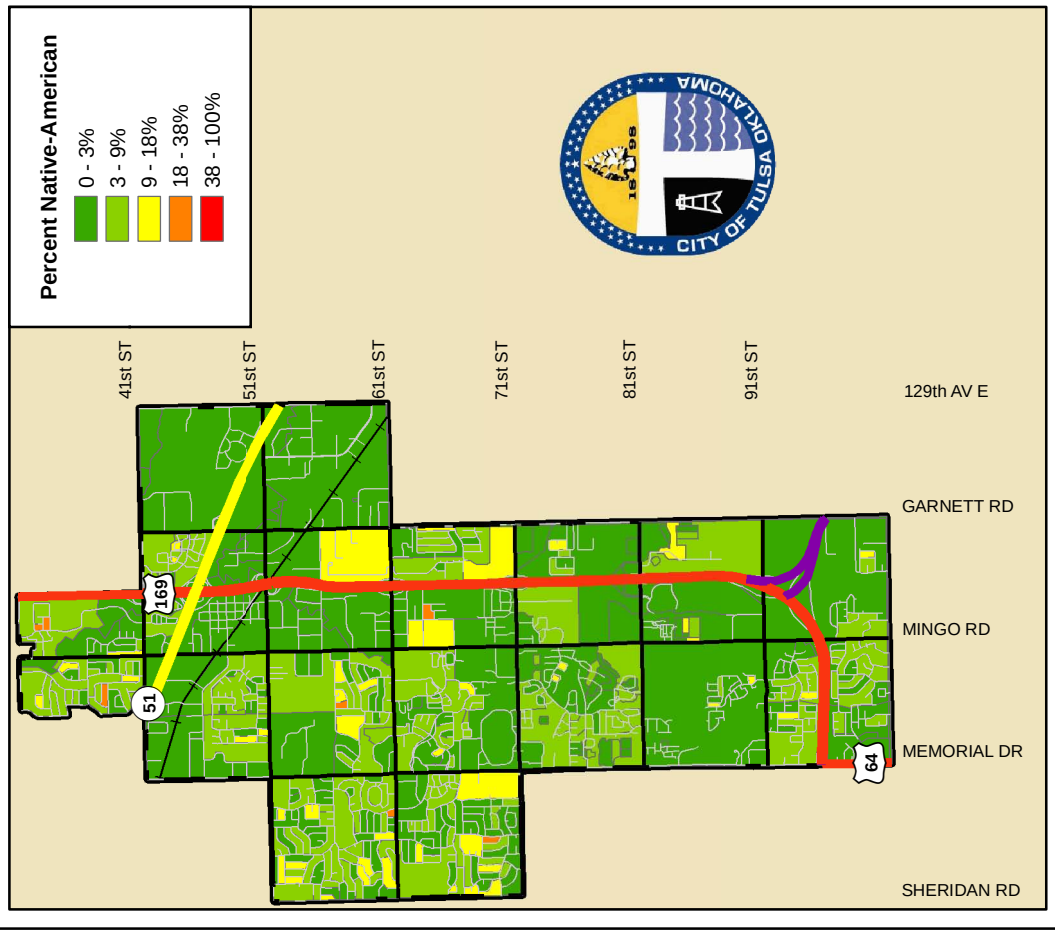
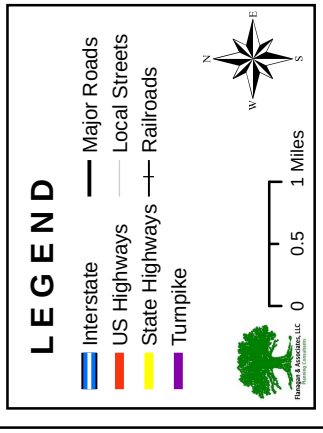


Figure 5.7-9

Tulsa Council District 7

Percent of Population of Native-American Descent



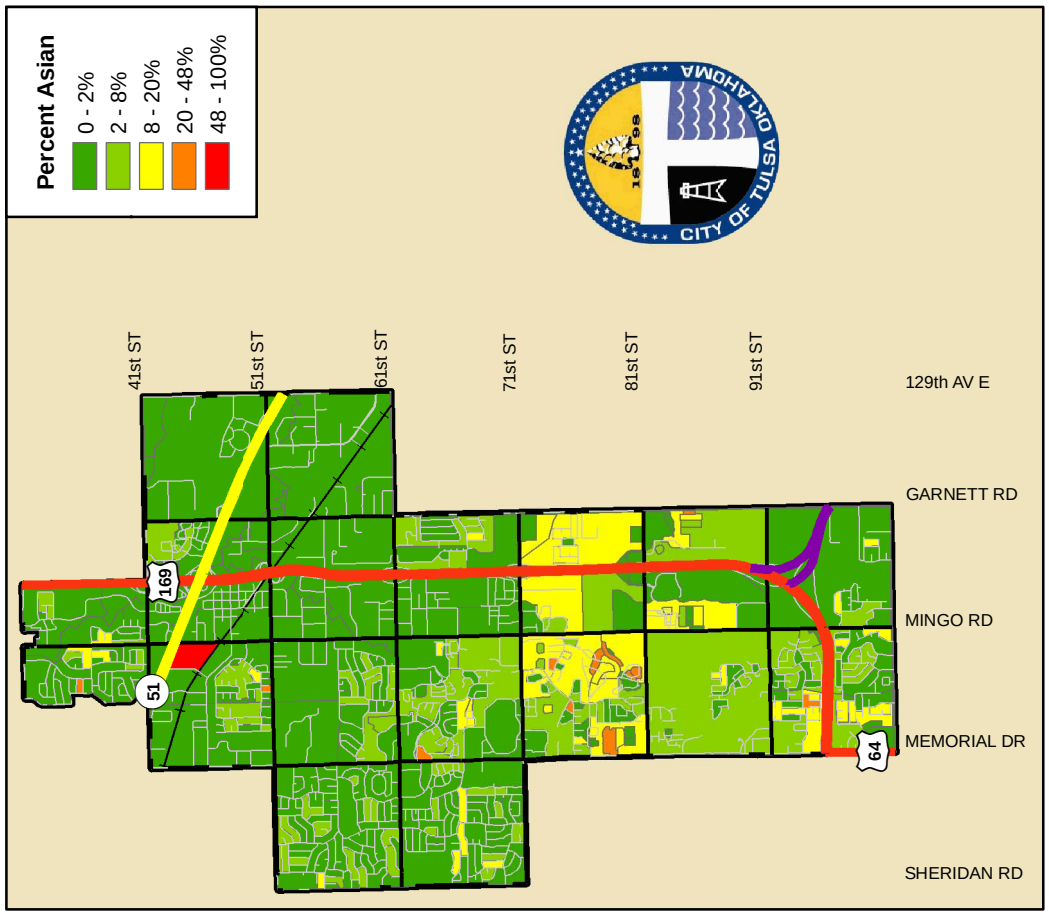


Figure 5.7-11

Tulsa Council District 7

Percent of Population of Asian Descent

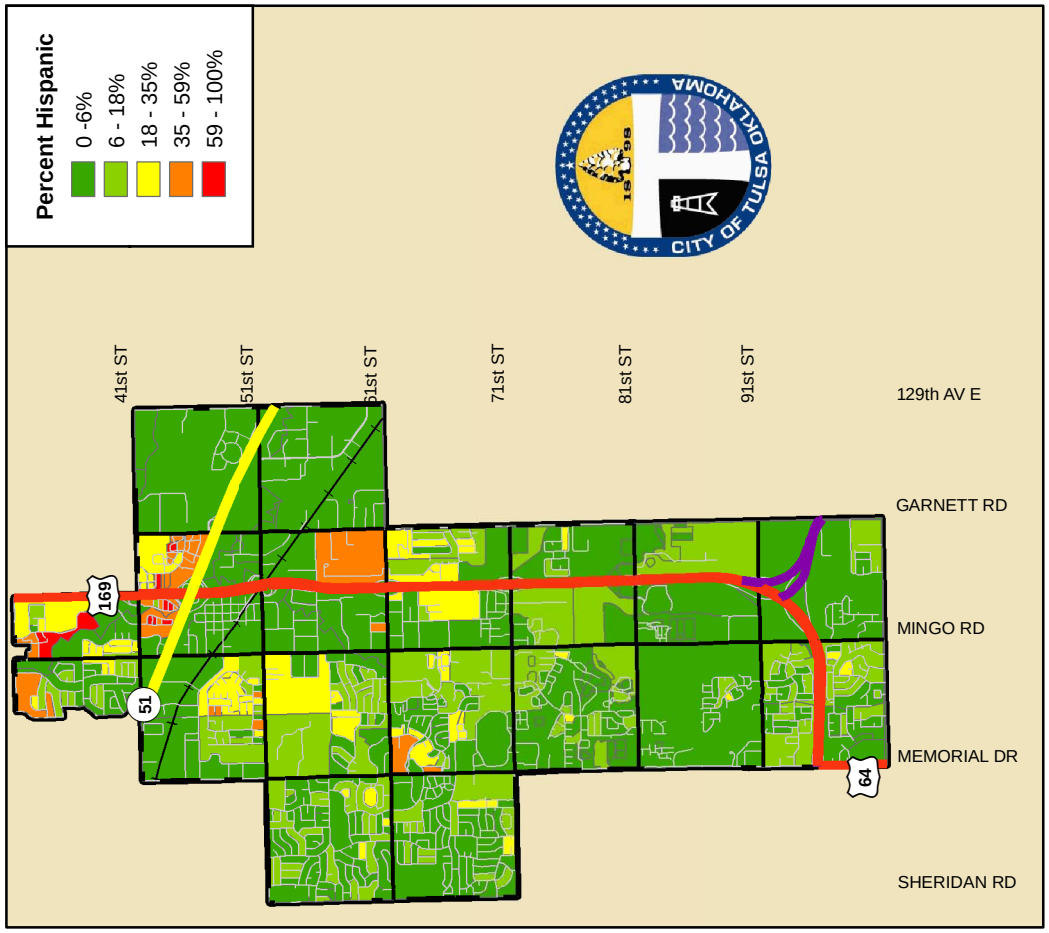


Figure 5.7-12

Tulsa Council District 7

Percent of Population of Hispanic Descent

Areas zoned for industrial use are predominately located in the northeast portion of the District. A map of zoning areas in Council District 7 is displayed in Figure 5.7-14.

Future Development

The City of Tulsa will continue to improve District 7's service infrastructures, such as flood control, water, sanitary sewer, and streets. For information regarding future development in the City of Tulsa, see Section 1.2.8.

5.7.1.8 Critical Facilities

There are 45 critical facilities in Tulsa Council District 7. Critical facilities in the District are listed in Table 5.7-3 and located in Figure 5.7-2.

Table 5.7–3: Tulsa Council District 7 Critical Facilities

ID	Map ID	Facility Name	Address
Government-City			
CF	11	Equipment Maintenance	5625 S Garnett Rd
CF	11	Street Dept Garage/Offices	5675 S Garnett Rd
CF	11	Water District Office/Warehouse	5605 S Garnett Rd
Fire Station			
FD	18	Tulsa Fire Department #20	9827 E 59th St
Government- Federal			
FG	13	USPS - Southeast Tulsa Post Office	9023 E 46th St
FG	15	FBI - Tulsa	8023 E63rd Pl
Tulsa Public Schools			
ES	21	Grissom Elementary School	6646 S 73rd E Ave
ES	47	Salk Elementary School	7625 E 58 St
MS	60	Memorial Jr High School	7502 E 57 St
Union Public Schools			
UES	3	Union Cedar Ridge Elementary	9817 S Memorial Dr
UES	4	Union Roy Clark Elementary	3656 S 103rd E Ave
UES	6	Union Robert Grove Elementary	10202 E 62nd St
UES	7	Union Wesley Jarman Elementary	9015 E 79th E Ave
UES	9	Union Thomas Jefferson Elementary	8418 S 107th E Ave
UMS	10	Union 6th - 7th Grade Center	1011 E 61st St
UHS	12	Tulsa Union High School	6636 S Mingo Rd
UHS	13	Union Intermediate High School	7616 S Garnett
UHS	14	Union Alternative School	5656 S 129th E Ave
Private School			
PS	18	Mingo Valley Christian School	8720 E. 61st
PS	2	Asbury United Methodist Weekday Preschool	6767 S Mingo Rd
Child Care			
CC	21	Hope Worship Center	8304 S. 107th East Ave.
CC	29	KinderCare Learning Center	9625 S. Mingo Rd.
CC	35	Miss Helen's Private School	4849 S. Mingo

ID	Map ID	Facility Name	Address
Higher Education			
JC	9	Tulsa Community College - Southeastern Campus	10300 E 81st St
Major Medical			
HO	9	Saint Francis Heart Hospital	10501 E 91st St
HO	14	South Crest Hospital	8801 S 101st East Ave
HO	15	Southwestern Regional Medical Center	10109 E 79th St
Long Term Care			
ML	16	Country Club of Woodland Hills	6333 S 91st East Ave
IL	17	Country Club of Woodland Hills	6333 S 91st East Ave
RC	18	Country Club of Woodland Hills Residential Care	6333 S 91st East Ave
IL	21	Disciples Village	9014 E 31st st
IL	26	Glenwood Apartments	10221 E 34th St
IL	63	Shadybrook Apartments	4203 S 109th East Ave
AL	71	Sterling House of Tulsa South	8231 S Mingo
NH	78	The Mayfair Nursing Center	7707 S Memorial Dr
IL	98	Woodland Manor	8641 E 61st St
ML	99	Woodland Terrace	9524 E 71st St
IL	100	Woodland Terrace	9524 E 71st St
RC	109	Hope of Angels	8516 E 65th St
RC	113	Trusted Care	5709 S 66th E Ave
RC	114	Woodland Park Home, Inc	5707 S Memorial
Local Financial			
LF	15	Triad Bank NA	7666 E 61st St

5.7.2 Existing Mitigation Strategies

Existing mitigation measures currently implemented throughout the City of Tulsa are detailed in Chapter 2, *Existing Mitigation Strategies*. The information that follows in this section surveys the infrastructure in place for avoiding or mitigating the impacts of natural hazards, that can be looked at from the District level.

5.7.2.1 Council District 7 Warning Systems

Warning Sirens

As shown in Figure 5.7-15, there are five warning sirens located within District 7, and five additional sirens outside of the boundary lines that provide partial coverage in the District. As development in the district continues, new warning sirens should be purchased to provide warning to all residents in the district.

Lightning Sensing and Warning

The City of Tulsa is home to multiple outdoor recreation areas for public use. There are 14 parks in District 7, mapped in Figure 5.7-16. Tulsa Council District 7 is home to Meadowbrook Country Club,

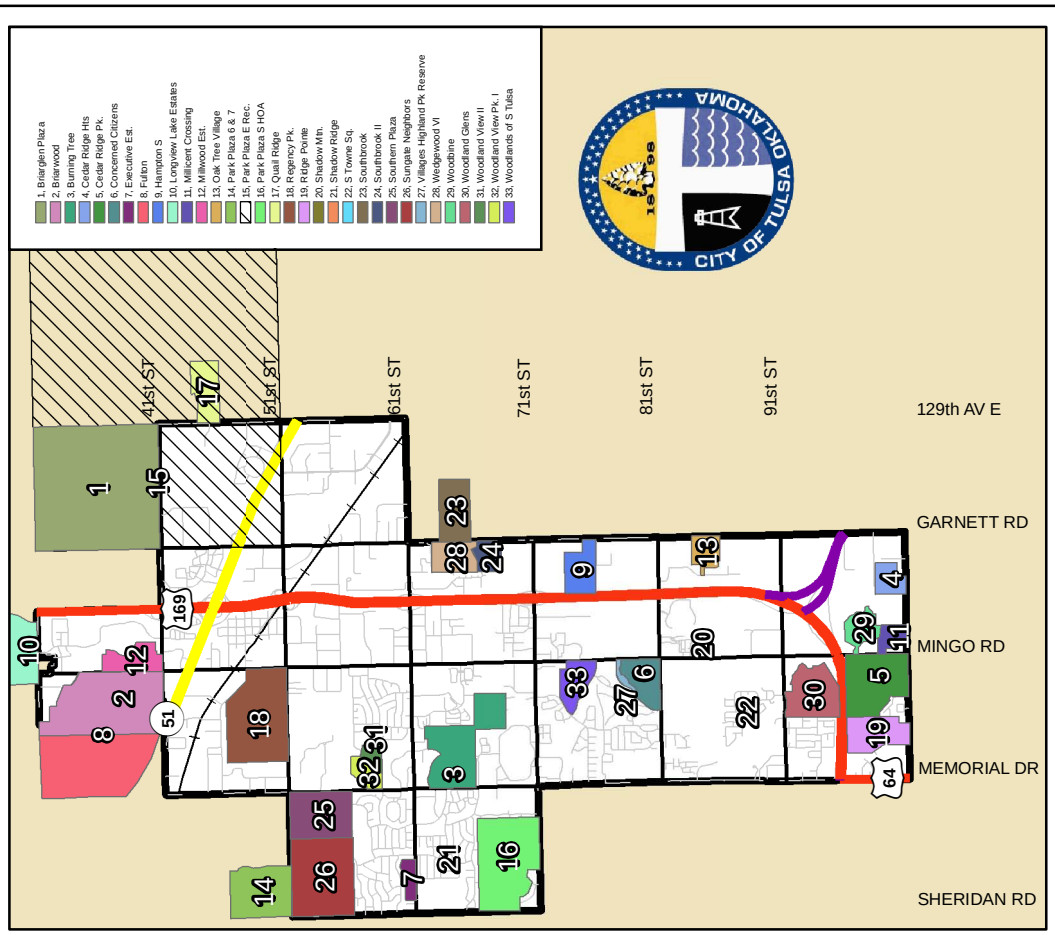


Figure 5.7-13

Tulsa Council District 7

Homeowners Associations

LEGEND

- Interstate
- US Highways
- State Highways
- Turnpike
- Major Roads
- Local Streets
- Railroads

0 0.5 1 Miles

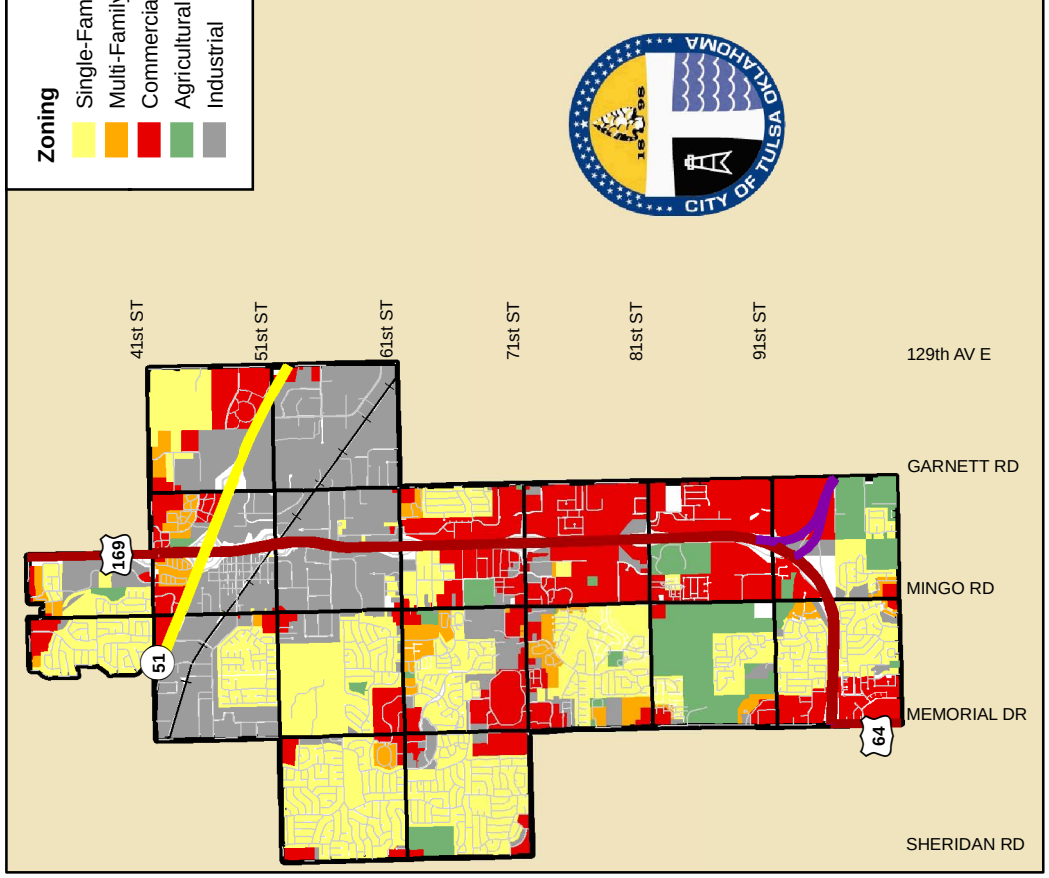


Figure 5.7-14

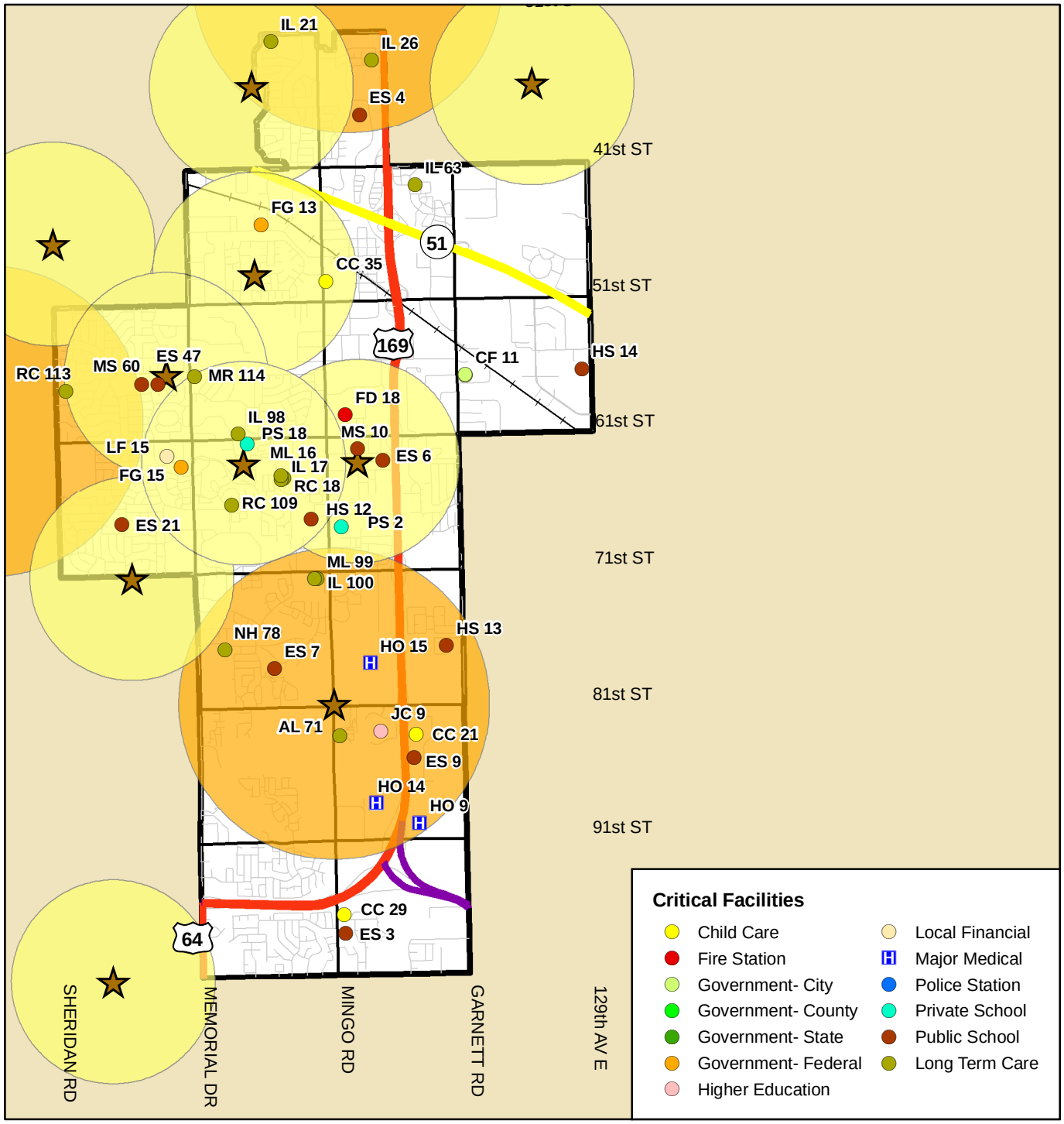
Tulsa Council District 7

Zoning

LEGEND

- Interstate
- US Highways
- State Highways
- Turnpike
- Major Roads
- Local Streets
- Railroads

0 0.5 1 Miles



LEGEND

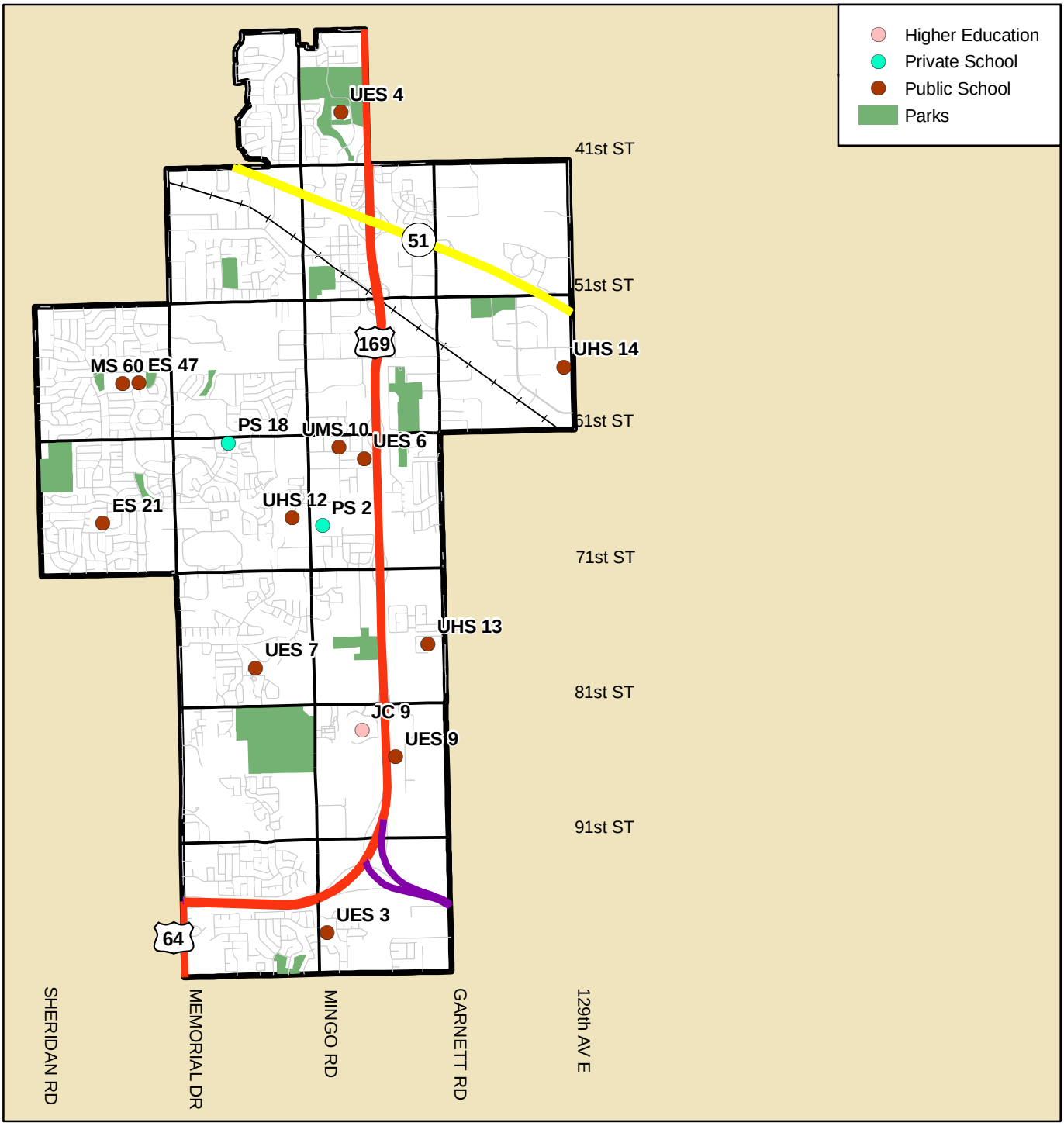
- Interstate
- US Highways
- State Highways
- Turnpike
- Major Roads
- Local Streets
- Railroads
- Sirens
- 4,000ft Buffer
- 6,100ft Buffer

0 0.5 1 Miles

Figure 5.7-15

Tulsa Council District 7

Warning Sirens



LEGEND

- Interstate
- US Highways
- State Highways
- Turnpike
- Major Roads
- Local Streets
- Railroads

0 0.5 1 Miles

Figure 5.7-16

Tulsa Council District 7

Schools & Parks

and multiple urban parks. Parks promote neighborhood revitalization and development, they also promote youth development. As discussed in Chapter 4, it is important for outdoor recreation areas to be equipped with lightning sensing and warning systems. Tulsa Public Schools and the University of Tulsa use ThorGuard© to warn of lightning danger at outdoor recreation areas. A map showing ThorGuard© coverage areas in Tulsa is shown in Chapter 2, Figure 2-4. Public school districts in the surrounding Tulsa Metro Area should be encouraged to purchase and install lightning warning systems. Private schools in the area school also be informed of their options and encouraged to install such warning systems at their outdoor recreation areas.

5.7.3 Planning Process

The CAC/TAC met monthly during the planning process to review progress, identify issues, receive task assignments, and advise the consultants. Refer to Appendix C for meeting agendas.

5.7.4 Natural and Manmade Hazards

Hazards

General natural hazards, such as Tornadoes, High Winds, Lightning, Hail, Winter Storms, Extreme Heat, Drought, and Earthquakes affect all communities in the City of Tulsa more or less randomly and equally, and are addressed in Chapter 4.

Site-specific hazards, such as Flooding, Dam Failures, Levee Failures, Expansive Soils, Wildfires, Fixed Site Hazardous Materials and Transportation-Hazardous Materials are addressed for District 7 in Subsections 5.7.4.1 through 5.7.4.7, below, and summarized in Subsection 5.7.4.8 and the map in Figure 5.7-23. Table 5.7-4 summarizes the exposure of Council District 7 to the site-specific hazards identified in this plan.

Table 5.7–4: Tulsa Council District 7 Site-Specific Hazard Impacts

Hazard	Area (Sq. mi)	Improved Parcels	Est. Market Value	Percent of Area Impacted	Impacted Population
Floods	1.73	470	$88,321,796	10.32%	2,842
Dam Failure	0	0	0	0	0
Levee Failure	0	0	0	0	0
Expansive Soils	7.43	5,692	$1,550,486,408	44.31%	15,599-
Wild Fires	6.43	296	$274,166,606	38.34%	13,039
Fixed-Site HazMat, ¼ Mi.	4.30	1,328	$603,618,103	25.64%	4,407
Transportation HazMat-Highway	5.51	2,153	$849,086,874	32.86%	8,859
Transportation HazMat-Railroad	1.75	522	$200,228,487	9.36%	172

Source: Tulsa County Assessor's Office, 2012

Tulsa Council District 7 has identified certain facilities as critical to the health, safety and welfare of its citizens, businesses and economy. Table 5.7-5 indicates, generally, the exposure of critical facilities to the seven site-specific hazards covered by this Plan Update.

Table 5.7–5: Tulsa Council District 7 Hazard Impacts on Critical Facilities

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Fixed Site Hazardous Materials	Transportation-Hazardous Materials
CF	11	Equipment Maintenance	X	X	X	X	X	X	X	X	X				X		X	X
CF	11	Street Dept Garage/Offices	X	X	X	X	X	X	X	X	X				X		X	X
CF	11	Water District Office/Warehouse	X	X	X	X	X	X	X	X	X				X		X	X
FD	18	Tulsa Fire Department #20	X	X	X	X	X	X	X	X	X				X			
FG	13	USPS - Southeast Tulsa Post Office	X	X	X	X	X	X	X	X	X				X		X	X
FG	15	FBI - Tulsa	X	X	X	X	X	X	X	X	X							
ES	21	Grissom Elementary School	X	X	X	X	X	X	X	X	X							
ES	47	Salk Elementary School	X	X	X	X	X	X	X	X	X				X			
MS	60	Memorial Jr High School	X	X	X	X	X	X	X	X	X				X			
UES	3	Union Cedar Ridge Elementary	X	X	X	X	X	X	X	X	X							X
UES	4	Union Roy Clark Elementary	X	X	X	X	X	X	X	X	X				X		X	X
UES	6	Union Robert Grove Elementary	X	X	X	X	X	X	X	X	X				X			X
UES	7	Union Wesley Jarman Elementary	X	X	X	X	X	X	X	X	X							
UES	9	Union Thomas Jefferson Elementary	X	X	X	X	X	X	X	X	X				X			X
UMS	10	Union 6th - 7th Grade Center	X	X	X	X	X	X	X	X	X							X
UHS	12	Tulsa Union High School	X	X	X	X	X	X	X	X	X							
UHS	13	Union Intermediate High School	X	X	X	X	X	X	X	X	X				X			
UHS	14	Union Alternative School	X	X	X	X	X	X	X	X	X				X		X	
PS	2	Asbury United Methodist Weekday Preschool	X	X	X	X	X	X	X	X	X					X		
PS	18	Mingo Valley Christian School	X	X	X	X	X	X	X	X	X				X			
CC	21	Hope Worship Ctr	X	X	X	X	X	X	X	X	X				X	X		X
CC	29	KinderCare Learning Ctr	X	X	X	X	X	X	X	X	X							X
CC	35	Miss Helen's Private School	X	X	X	X	X	X	X	X	X				X			X
JC	9	Tulsa Community College - Southeastern Campus	X	X	X	X	X	X	X	X	X					X		X
HO	9	Saint Francis Heart Hospital	X	X	X	X	X	X	X	X	X						X	X
HO	14	SouthCrest Hospital	X	X	X	X	X	X	X	X	X					X	X	X
HO	15	Southwestern Regional Medical Center	X	X	X	X	X	X	X	X	X				X			X
ML	16	Country Club of Woodland Hills	X	X	X	X	X	X	X	X	X				X			
IL	17	Country Club of Woodland Hills	X	X	X	X	X	X	X	X	X				X			
RC	18	Country Club of Woodland Hills Residential Care	X	X	X	X	X	X	X	X	X				X			
IL	21	Disciples Village	X	X	X	X	X	X	X	X	X							

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Fixed Site Hazardous Materials	Transportation-Hazardous Materials
IL	26	Glenwood Apartments	X	X	X	X	X	X	X	X	X				X			X
IL	63	Shadybrook Apartments	X	X	X	X	X	X	X	X	X				X			X
AL	71	Sterling House of Tulsa South	X	X	X	X	X	X	X	X	X				X	X		
NH	78	The Mayfair Nursing Center	X	X	X	X	X	X	X	X	X							
IL	98	Woodland Manor	X	X	X	X	X	X	X	X	X							
ML	99	Woodland Terrace	X	X	X	X	X	X	X	X	X						X	
IL	100	Woodland Terrace	X	X	X	X	X	X	X	X	X						X	
RC	109	Hope of Angels	X	X	X	X	X	X	X	X	X				X			
RC	113	Trusted Care	X	X	X	X	X	X	X	X	X				X			
MR	114	Woodland Park Home, Inc	X	X	X	X	X	X	X	X	X				X			
LF	15	Triad Bank NA	X	X	X	X	X	X	X	X	X							

5.7.4.1 Flood

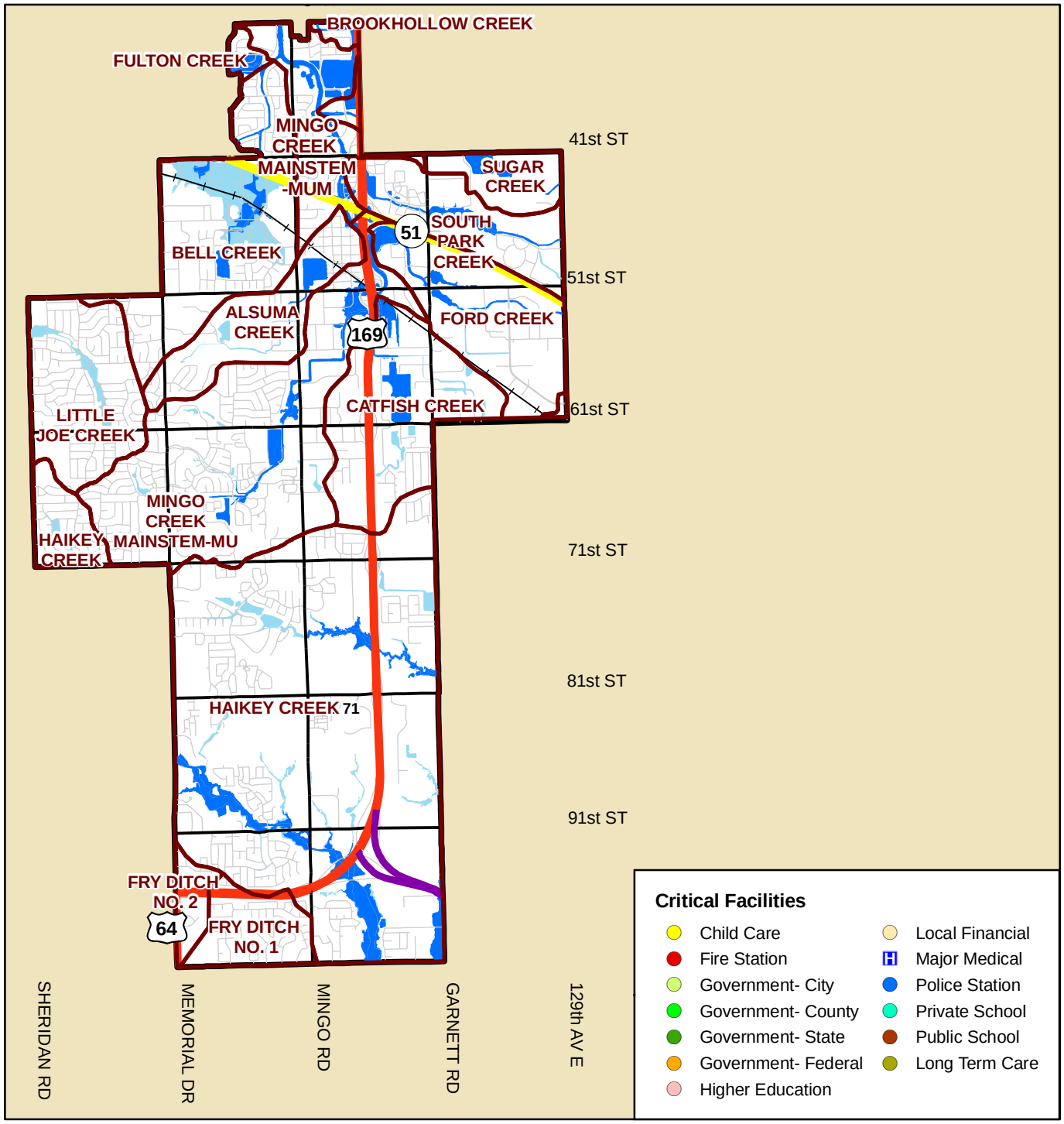
Location

District 7 is affected by both the Special Flood Hazard Area (SFHA) and City Regulatory Floodplains. The combined floodplains comprise 1.73 sq. mi., or 10.32 percent of the land within the district boundaries. A complete listing of drainage basins in District 6 and their total drainage area is included in Table 5.7-6. Figure 5.7-17 shows the drainage basins and their floodplains.

The northern half of District 7 drains into Mingo Creek and the Verdigris River. Mingo Creek rises in the high ground north of E. 71st St. and S. Memorial Dr., around Woodland Hills Shopping Center. The left bank tributaries to Mingo Creek in District 7, from south to north, are Alsuma Creek, Bell Creek and Fulton Creek; right bank tributaries are Catfish Creek, Ford Creek, Southpark Creek, and Sugar Creek. There are eight flood detention ponds on Mingo Creek and its tributaries in District 7. In the west-central portion of District 7, Little Joe Creek rises at about E. 61st St. and S. 74th E. Ave., and drains west into Joe Creek and the Arkansas River. Haikey Creek and West Haikey Creek and their several tributaries drain the southern part of District 7, generally south of E. 67th St., into the Arkansas River at E. 141st St. and 129th E. Ave.

Table 5.7–6: Tulsa Council District 7 Streams and Drainage Areas

Basin	Total Drainage Area (sq. mi.)
FRY DITCH NO. 1	0.45
FRY DITCH NO. 2	0.17



LEGEND

- Interstate
- US Highways
- State Highways
- Turnpike
- Major Roads
- Local Streets
- Railroads
- Basins
- SFHA
- City Regulatory

0 0.5 1 Miles

Figure 5.7-17

Tulsa Council District 7

Drainage Basins & Floodplains

Basin	Total Drainage Area (sq. mi.)
FORD CREEK	1.07
LITTLE HAIKEY CREEK	0.01
BROOKHOLLOW CREEK	0.05
HAIKEY CREEK	5.94
CATFISH CREEK	1.27
SUGAR CREEK	0.40
FULTON CREEK	0.08
AUDUBON CREEK	0.01
SOUTH PARK CREEK	0.76
BELL CREEK	1.57
LITTLE JOE CREEK	1.01
ALSUMA CREEK	0.75
MINGO CREEK MAINSTEM-MU	2.53
MINGO CREEK MAINSTEM-MUM	0.70
Total	16.77

Impact/Vulnerability

District 7 has 325 single-family residential structures, four multi-family residential structures, 34 commercial buildings, 15 industrial buildings, and 92 buildings classified as *other* that are touched by 100-year floodplains of Mingo Creek, Little Joe Creek and Haikey Creek, with a total assessed value, adjusted for fair market price, of $88,321,796. The property parcels impacted by the 100-year flood are listed by value and type in Table 5.7-7.

There are several areas which have experienced repeated street flooding in the District: E. 31st St. and Mingo Rd. (Mingo Creek); near E. 33rd St. and Mingo Rd. (Fulton Creek); E. 51st St. between Memorial Dr. and Mingo Rd. (Bell Creek); E. 81st St. between Memorial Dr. and Mingo Rd. (Little Haikey Creek); E. 85th St. and Mingo Rd. (Little Haikey Creek); and 101st St. and Mingo Rd. (Little Haikey Creek).

Table 5.7–7: Tulsa Council District 7 Buildings Touched by 100 year Floodplain

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	325	$24,229,640
Residential Multi-Family	4	$502,700
Commercial	34	$29,949,143
Industrial	15	$12,056,691
Other	92	$21,583,622
Total	470	$88,321,796

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

There are no critical facilities touched by or adjacent to the 100 year floodplain in District 7.

Repetitive Loss Properties

There are nine repetitive loss properties located in the boundaries of Tulsa Council District 7: four residential and five commercial.

Flood Control Projects

Tulsa's floodplain and stormwater program includes comprehensive watershed management, dedicated funds for maintenance and operation, and a $200 million capital improvements program. In Council District 7, many projects have been completed for flood control issues. Figure 5-7.18 displays flood control projects in Council District 7, identified in the 2004 Capital Improvements Plan. District 7 flood control projects budgeted in the 2008-2012 Capital Improvements Plan are listed in the following table.

Table 5.7–8: Tulsa Council District 7 Flood Control Projects 2008-2012

Project ID	Project Basin and Description	Budget
47	Fulton Creek - 37th & Memorial Storm Sewer & Channel Improvements	$1,500,000
48	Fulton Creek – Lazy Circle Acres Channel Improvements	$1,400,000
50	Haikey Creek - Shadow Mountain Detention Enlargement	$600,000
57	Joe Creek - Mockingbird Lake Dredging	$335,000
58	Joe Creek – South Fork, 3900 E. 60th Place Drainage Improvements	$100,000
60	Little Joe Creek – Crescent Park Channel Improvements (Phase 2)	$300,000
61	Little Joe Creek - Mainstem and Bridge Improvements	$1,170,000
62	Little Joe Creek - Sheridan and 54th Detention	$1,200,000
63	Little Joe Creek - Storm Sewer (72nd East and 55th St.)	$2,040,000
64	Little Joe Creek - Storm Sewer (73rd East and 58th St.)	$4,220,000
65	Little Joe Creek - Thornton YMCA Detention	$2,270,000
66	Little Joe Creek - Woodland View Detention	$3,100,000
74	North Fork Little Joe Creek - Storm Sewer Improvements (S. Irvington Ave. and S. Hudson Pl.)	$4,610,000
90	Upper Joe Creek - Langenheim Park Channel Improvements (Phase 1)	$3,000,000
91	Upper Joe Creek - Langenheim Park Detention & Storm Sewer (Phase 2)	$6,830,000

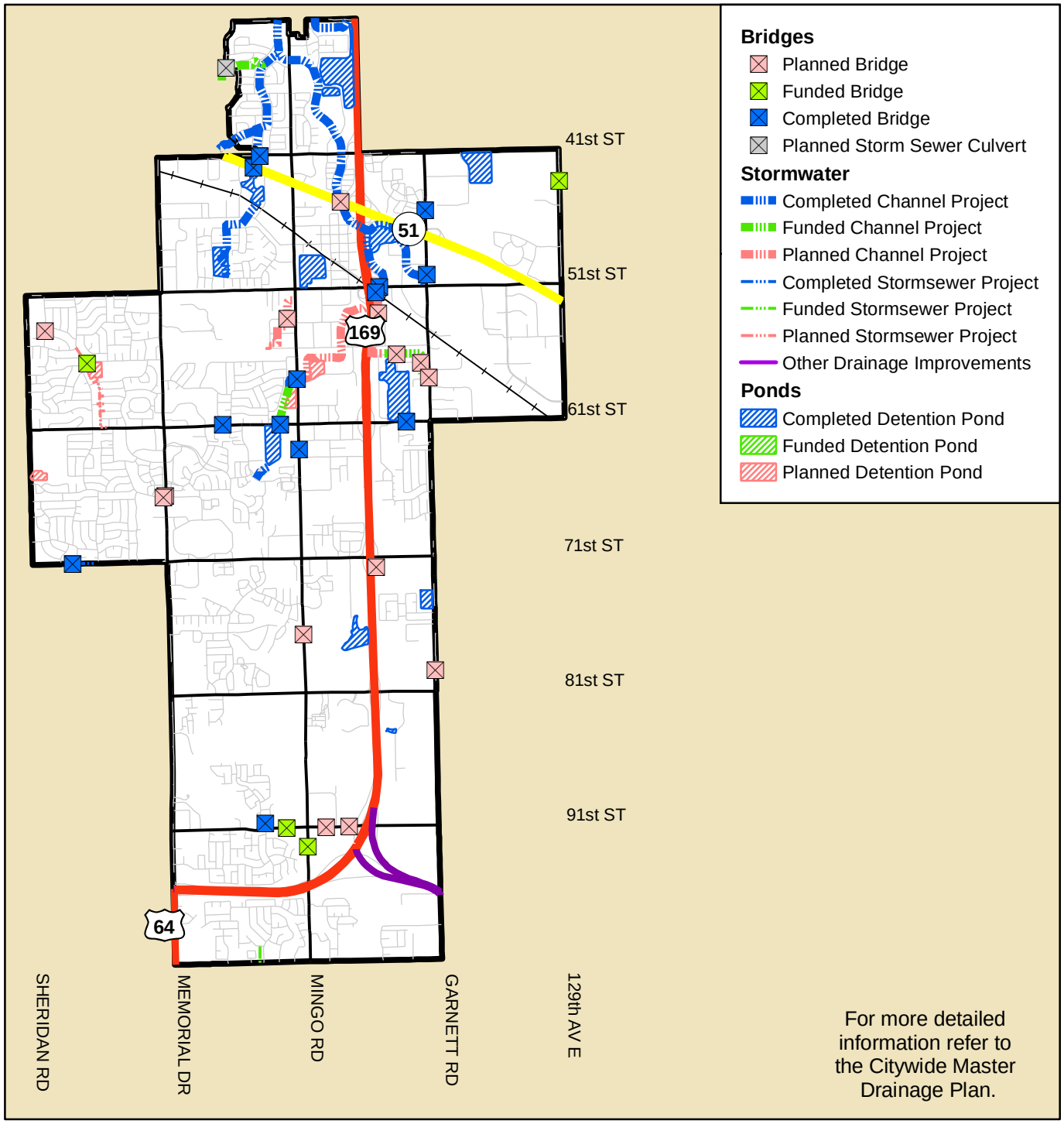
Source: PLANiTulsa Capital Expenditures Plan 2008-2012

Conclusion

Tulsa Council District 7 has a HIGH probability of and a HIGH vulnerability to the Flood hazard.

5.7.4.2 Dam Failure

District 7 is not located in or around Dam inundation areas in Tulsa. For an in-depth discussion of Dam Failure on the Arkansas River, Bird Creek and the Verdigris River, see Chapter 4 and Section 10, the Arkansas River Corridor. There are no parcels or critical facilities located in District 7 that are vulnerable to the impacts of a Dam or Levee failure. Tulsa Council District 7 would not be directly impacted by this hazard and therefore has no direct vulnerability to and no probability of the Dam Failure hazard. The District may be impacted by the secondary effects of this hazard such as power failure, road closures, and loss of critical infrastructure and communication.



LEGEND

- Interstate
- US Highways
- State Highways
- Turnpike
- Major Roads
- Local Streets
- Railroads

0 0.5 1 Miles

Figure 5.7-18

Tulsa Council District 7

Flood Control

5.7.4.3 Levee Failure

District 7 is not located in or around Levee inundation areas in Tulsa. For an in-depth discussion of Levee Failure on the Arkansas River, see Chapter 4 and Section 10, the Arkansas River Corridor.

There are no parcels or critical facilities located in District 7 are vulnerable to the impacts of a Levee failure. Tulsa Council District 7 would not be directly impacted by this hazard and therefore has no vulnerability to and no probability of the Levee Failure hazard.

5.7.4.4 Expansive Soils

Location

Council District 7 is underlain by soils with Low to Very High shrink/swell potential, summarized in Table 5.7-9. The District is underlain primarily by soils with Moderate to High shrink/swell potential. The area of the District that contains the largest percentage of highly expansive soils is north of E. 61st St., from Sheridan Ave. in the west to Garnett Rd. in the east. Low to Moderate expansive soils predominate south of E. 61st St., but with sizable patches of highly expansive soils east of Mingo Rd., between E. 61st St. and E. 85th St. A map showing the distribution of expansive soils in the District is presented in Figure 5.7-19.

Table 5.7–9: Tulsa Council District 7 Expansive Soils

Expansion Potential	Area (sq mi)	Percent of Total District Boundaries
Very High	0.10	0.61%
High	7.33	43.71%
Moderate	6.88	41.00%
Low	2.38	14.17%
Water	0.09	0.51%
Total	16.77	100.00%

Impact/Vulnerability

According to 2012 Tulsa County Assessor data, 5,692 parcels, or about 47.75 percent of improved parcels in District 7, are underlain by soils with High to Very High shrink/swell potential, with an assessed value, adjusted for fair market, of $1,550,486,408. A summary of District 7 parcels located on High and Very High expansive soils is presented in Table 5.7-10.

Table 5.7–10: Tulsa Council District 7 Parcels on High to Very High Expansive Soils

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	4,609	$424,220,826
Residential Multi-Family	126	$129,028,139
Commercial	392	$513,626,984
Industrial	118	$102,922,471
Other	447	$380,687,988
Total	5,692	$1,550,486,408

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

There are 25 critical facilities located on High and Very High expansive soils in District 7. These are listed in Table 5.7-5. It is likely most of these facilities were engineered and constructed, taking into account the soils on which they are built. It is not anticipated the shrinking/swelling of soils would cause extensive damage on these facilities, as almost all are substantial structures, whose mass offsets the shrinking and swelling action of the soils. However, all buried infrastructure in the District, as well as its extensive network of roads and parking lots, are all vulnerable to damage from expansive soils, particularly during extended periods of high heat and drought.

Conclusion

Tulsa Council District 7 has a HIGH vulnerability to and HIGH probability of being impacted by the Expansive Soils hazard.

5.7.4.5 Wildfire

Location

The areas of greatest Wildfire Level of Concern (LOC) are those located on the east and west sides of the Mingo Valley Expressway (US Hwy 169), between Mingo Rd. and Garnett Rd., from 61st St. in the north to E. 91st St. in the south; the wildfire LOC in these locations range from 0 to 7. A map displaying the Wildfire LOC of District 7 is shown in Figure 5.7-20.

Impact/Vulnerability

There are 296 improved parcels located in areas of Moderate to High Wildfire LOC in District 7. These are summarized in Table 5.7-11. The area of the District with the highest LOC is a densely wooded patch just south of Tulsa Community College (TCC) The TCC campus is well maintained, but the area south of the college and the Meadowbrook Country Club, and continuing west of Hillcrest Medical Center South to E. 91st St., is heavily wooded and grassy, and backs up against the Shadow Ridge residential district. Efforts to keep the undeveloped parcels in this area well maintained, especially during periods of extreme heat and drought. In addition, the public should be made aware of the dangers of wildfire and Firewise methods of landscaping. Several other patches of moderate wildfire concern are scattered along the Mingo Valley Expressway. One area is south of E. 61st St., along Mingo Creek, and another from E. 62nd to 66th St., between Mingo Rd. and US Hwy 169, north of Asbury Methodist Church. A third patch is from Lowes at E. 73rd St. south to the Southwestern Regional Medical Center, and west of the Center south to E. 81st St. The fourth patch is the open land to the north and east of St. Francis Hospital South.

Table 5.7–11: Tulsa Council District 7 Parcels Touched by Wildfire Level of Concern

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	239	$38,589,865
Residential Multi-Family	1	$7,718,600
Commercial	44	$124,863,401
Industrial	0	$0
Other	12	$102,994,740
Total	296	$274,166,606

Source: Tulsa County Assessor‘s Office, 2012

Critical Facilities

There are five critical facilities located in wildfire LOC areas. Table 5.7-5 lists the vulnerability of District 7 critical facilities to wildfire.

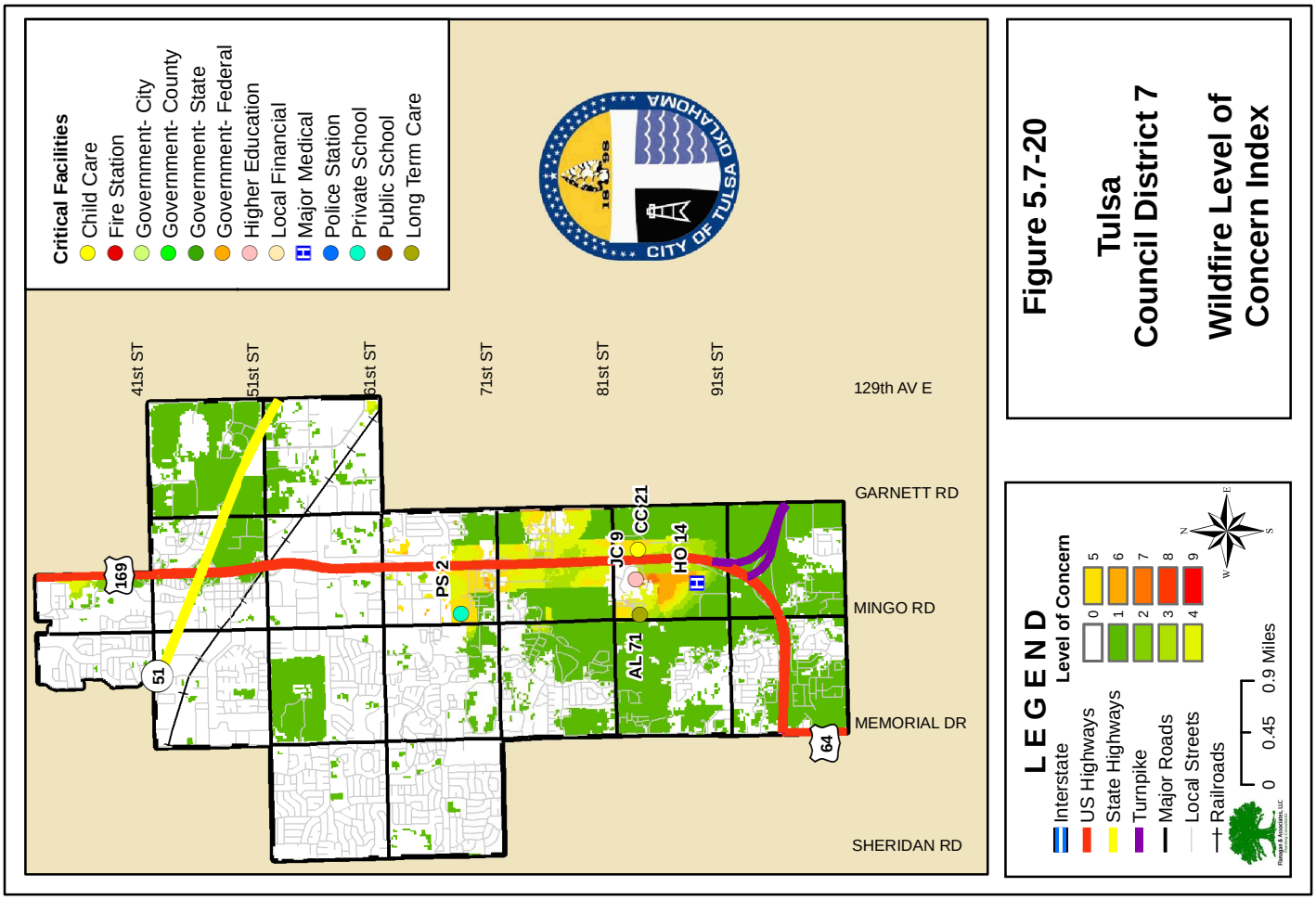


Figure 5.7-20

Tulsa Council District 7

Wildfire Level of Concern Index

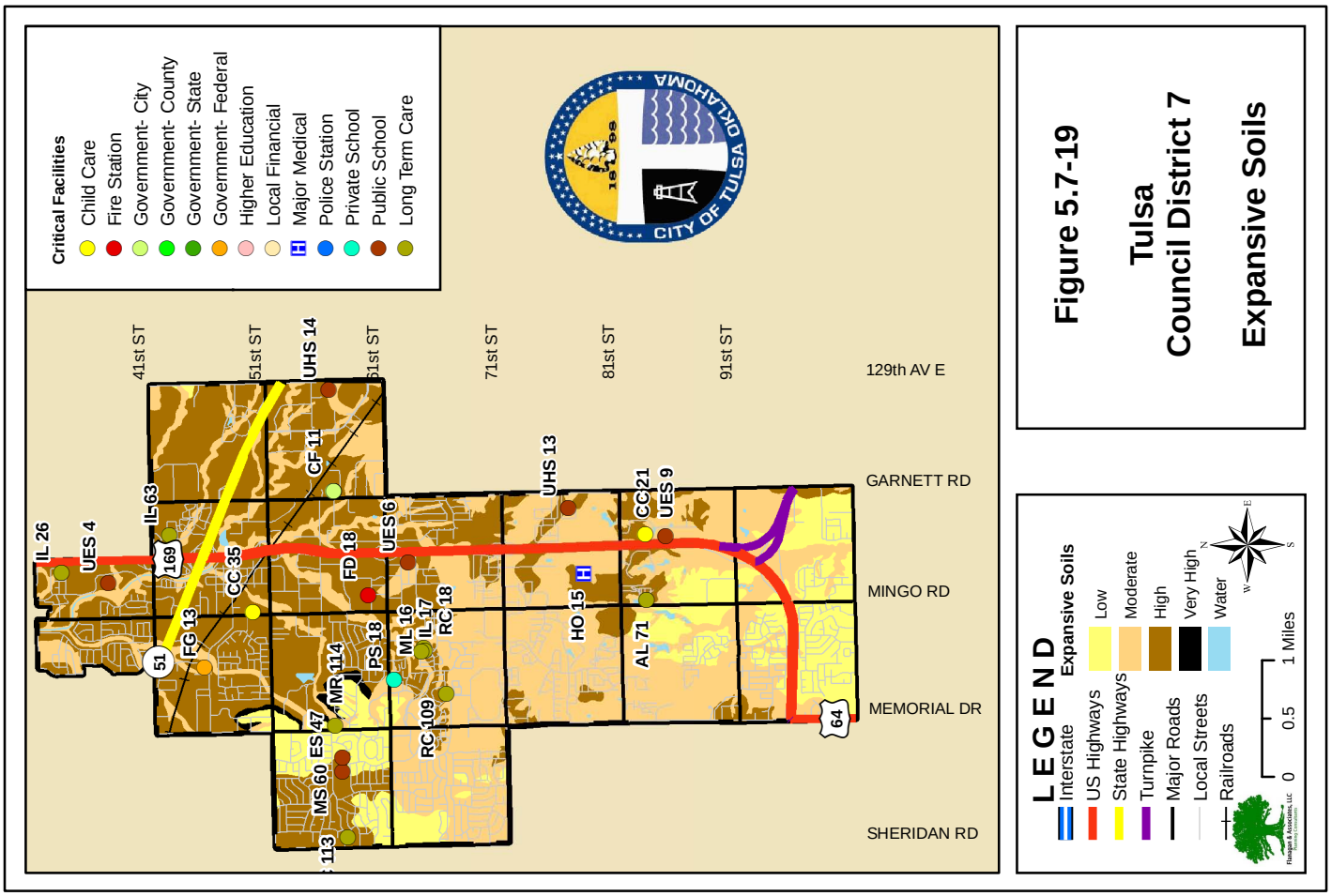


Figure 5.7-19

Tulsa Council District 7

Expansive Soils

Conclusion

Tulsa Council District 7 is considered to have a MODERATE vulnerability to and LOW probability of the Wildfire hazard.

5.7.4.6 Fixed Site Hazardous Materials

Location

There are 31 Tier II facilities within the boundaries of Tulsa Council District 7. Due to the sensitive nature of this material, Tier II facilities in the District are mapped in Figure 5.7-21 to show only approximate location of the sites. A listing of EHS and Non-EHS Tier II facilities in Council District 7 can be found in Appendix E, and is available on a need-to-know basis.

Impact/Vulnerability

According to the Marplot analysis, which uses 2010 US Census data, 4,407 people live or work within a ¼ mile radius of a Tier II facility in District 7. A summary of the number of parcels by improvement value, estimated for fair market price, and type located within ¼ mile of the 31 Tier II facilities in District 7, is included in Table 5.7-12.

Table 5.7–12: Tulsa Council District 7 Parcels in ¼ Mile Tier II Buffer

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	778	$79,129,695
Residential Multi-Family	19	$33,043,551
Commercial	190	$225,514,873
Industrial	73	$81,885,775
Other	268	$184,044,209
Total	1,328	$603,618,103

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Ten critical facilities in District 7 are located within ¼ mile of a Tier II facility; including three childcare facilities and three medical facilities. Because the high number of functional needs populations that occupy these facilities, special care should be taken to ensure all staff are aware of shelter in place and evacuation procedures. Critical facilities located within ¼ mile of a Tier II facility are identified in Table 5.7-5 and mapped in Figure 5.7-21.

Conclusion

Tulsa Council District 7 is considered to have a HIGH vulnerability to and MODERATE probability of a fixed-site hazardous materials release.

5.7.4.7 Transportation-Hazardous Materials

Location

There are five significant transportation corridors in District 7: US Highway 169, which runs north to south before curving to the west in the southern most corner of the district; US Highway 64 (Memorial Dr.), which briefly runs north to south in the far south west corner of the district before turning east and then north again, duplexing with US Hwy 169; State Highway 51 (Broken Arrow Expy) which runs northwest to southeast from E 41st St. to S 129th E. Ave; and the Creek Turnpike, which travels east-west, connects with US 169, and continues eastward out of the district as the Broken Arrow South Loop. The Union Pacific Railroad runs roughly northwest to southeast from S E. 41st St. and Memorial Dr. to E 61st St. and 129th E. Ave., with several industrial spurs branching briefly to the north at S. 89th E. Ave., and to the south and west at S. 109th E. Ave. There are no

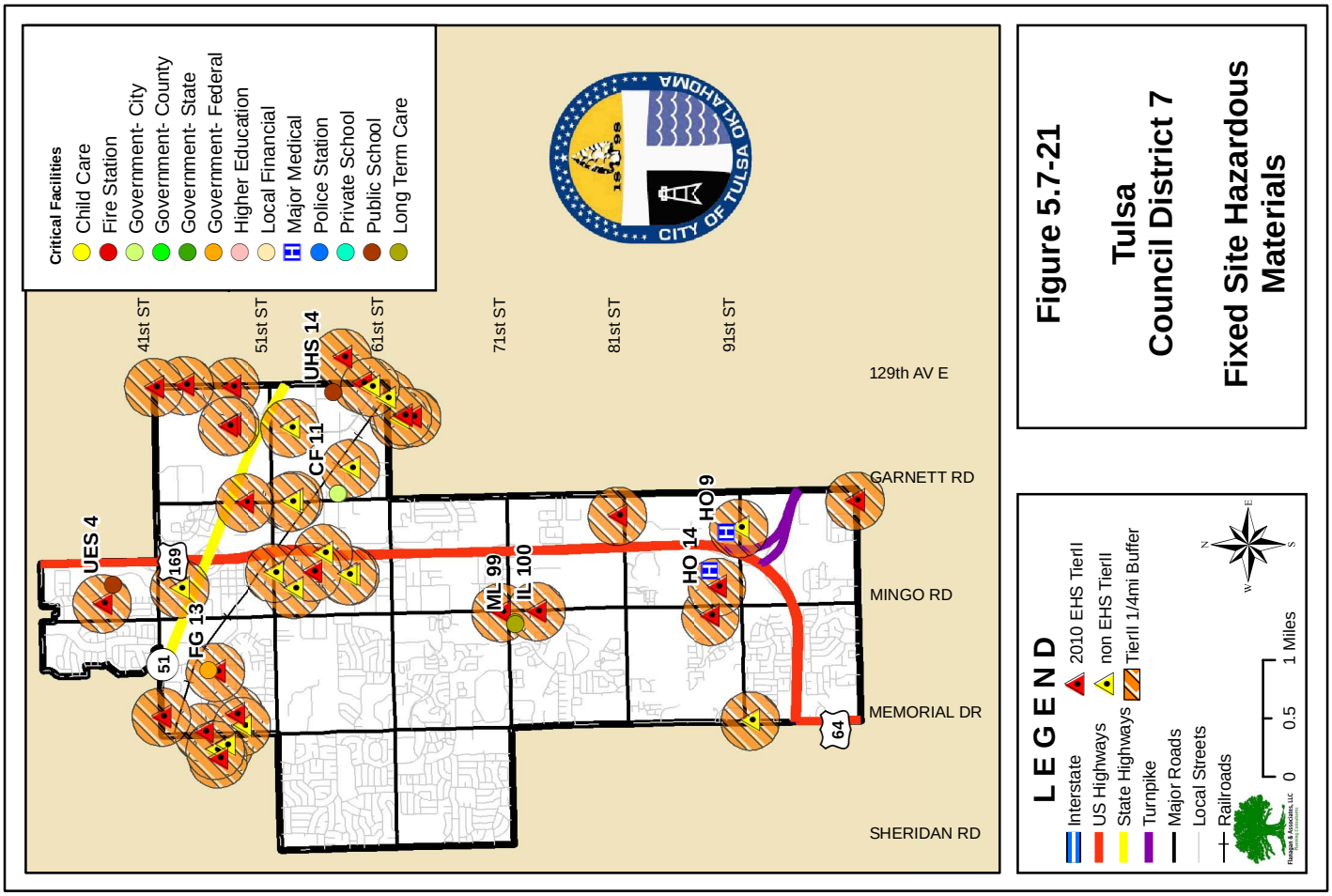


Figure 5.7-21

Tulsa Council District 7

Fixed Site Hazardous Materials

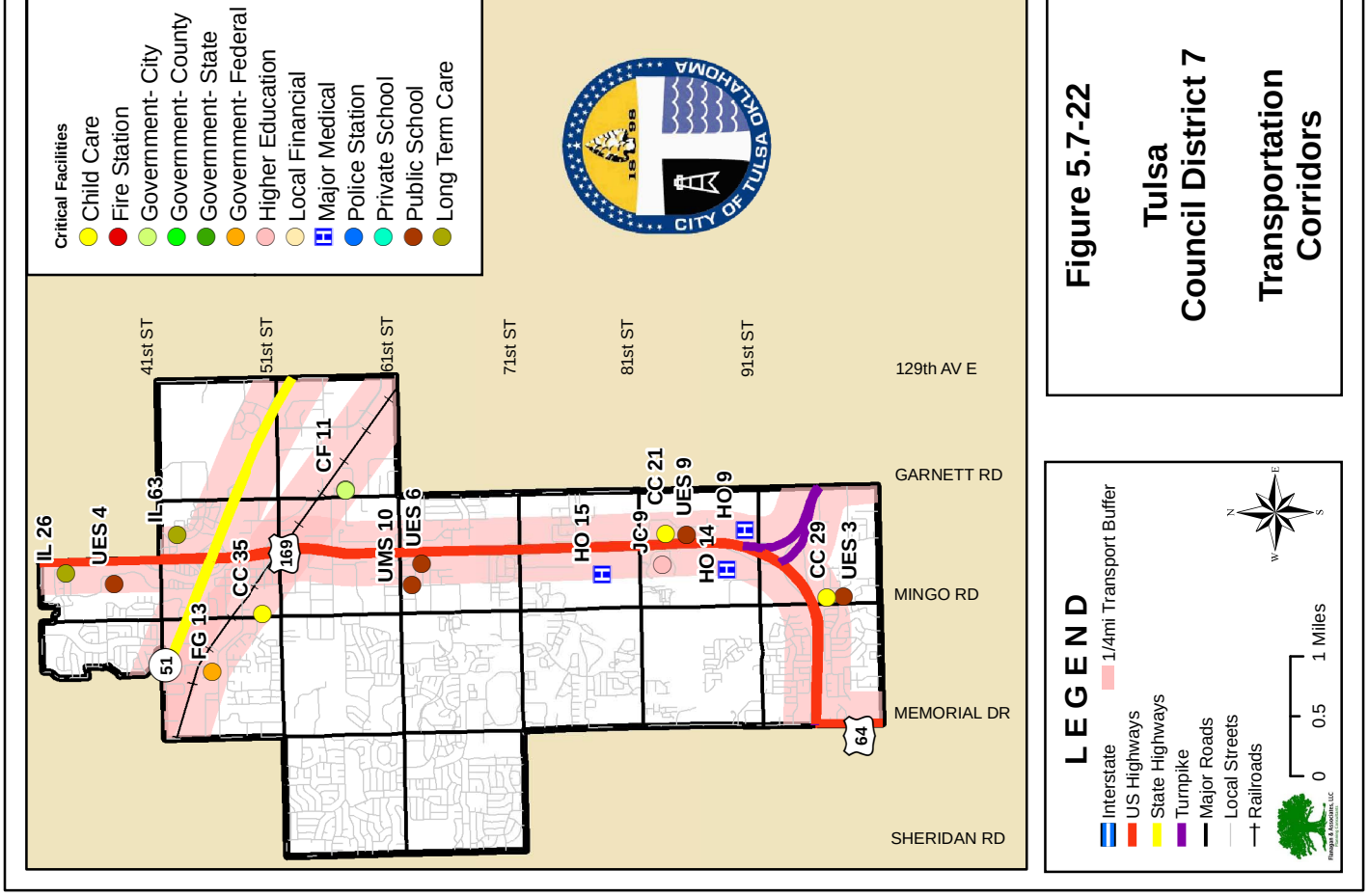


Figure 5.7-22

Tulsa Council District 7

Transportation Corridors

airports in District 7. The old 81st Street Airpark is no longer in existence. Transportation corridors in District 7 along with their respective ¼ mile buffer zones are shown in Figure 5.7-22.

Impact/Vulnerability

A ¼-mile transportation buffer for the five transportation corridors encompasses 43.29 percent of Council District 7 (or 7.08 sq. mi.), 2,675 parcels, 9,031 residents (based on 2010 US Census number of people per square mile), and 18 of the districts critical facilities. According to Tulsa County Assessor data, 2,153 improved parcels in District 7 are touched by the ¼ mile buffer of a Highway or Interstate in the District, with a total value, assessed for fair market price, of $849,086,874. The numbers of parcels touched by the highway corridors in District 7 are summarized, by type, in Table 5.7-13.

Table 5.7–13: Tulsa Council District 7 Parcels Touched by ¼ mile Highway Corridor

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	1,676	$202,166,769
Residential Multi-Family	10	$47,914,845
Commercial	181	$306,284,170
Industrial	35	$42,663,384
Other	251	$250,057,706
Total	2,153	$849,086,874

Source: Tulsa County Assessor's Office, 2012

A total of 522 improved parcels in the District are located within ¼ mile of the Union Pacific rail line and its spurs, with a total value, assessed for fair market price, of $200,228,487. The District 7 parcels touched by the railroad corridors are summarized, by type, in Table 5.7-14.

Table 5.7–14: Tulsa Council District 7 Parcels Touched by ¼ mile Railroad Corridor

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	135	$8,427,000
Residential Multi-Family	1	$1,649,400
Commercial	96	$48,570,965
Industrial	54	$53,276,793
Other	236	$88,304,329
Total	522	$200,228,487

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Eighteen critical facilities are located within the ¼ mile transportation corridors of District 7. Although the structures themselves are not likely to be directly impacted by this hazard, populations living or working within these facilities are at heightened vulnerability. Of particular concern are those facilities that house functional needs populations, such as education facilities, long-term care and eldercare facilities.

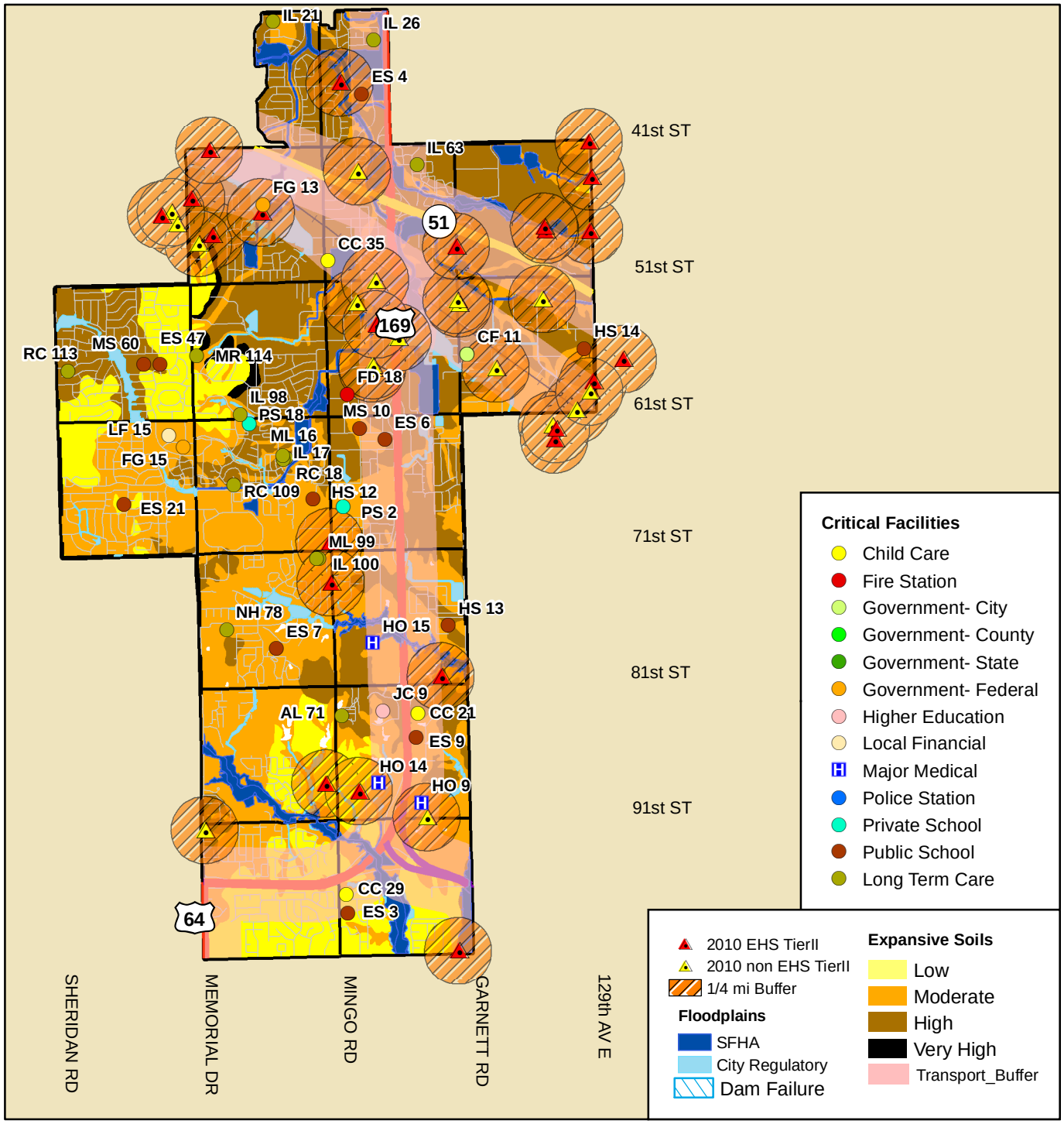
A transportation incident involving hazardous materials would likely require these facilities to either shelter in place or be evacuated. Facilities located within the transportation corridors in District 7 include childcare facilities, healthcare facilities, hospitals, and an elementary school and middle school. Patients and children within these facilities at the time of an incident may not be able to shelter in place or evacuate on their own. Plans should be in place to assist these vulnerable populations in reacting to shelter-in-place or evacuation plans. A list of critical facilities vulnerable to the Transportation hazard is included in Table 5.7-5 and mapped in Figure 5.7-22.

Conclusion

Tulsa Council District 7 has a HIGH vulnerability to and HIGH probability of the Transportation hazard.

5.7.4.8 Hazards Summary

Site-specific hazards, unique to Tulsa Council District 7, identified and mapped in this section, include Floods, Expansive Soils, Wildfires, Fixed-Site Hazardous Materials, and Transportation-Hazardous Materials. The Hazards Composite Map, shown in Figure 5.7-23, summarizes the areas of the district potentially impacted by these site-specific hazards.



LEGEND

- Interstate
- US Highways
- State Highways
- Turnpike
- Major Roads
- Local Streets
- Railroads

0 0.5 1 Miles

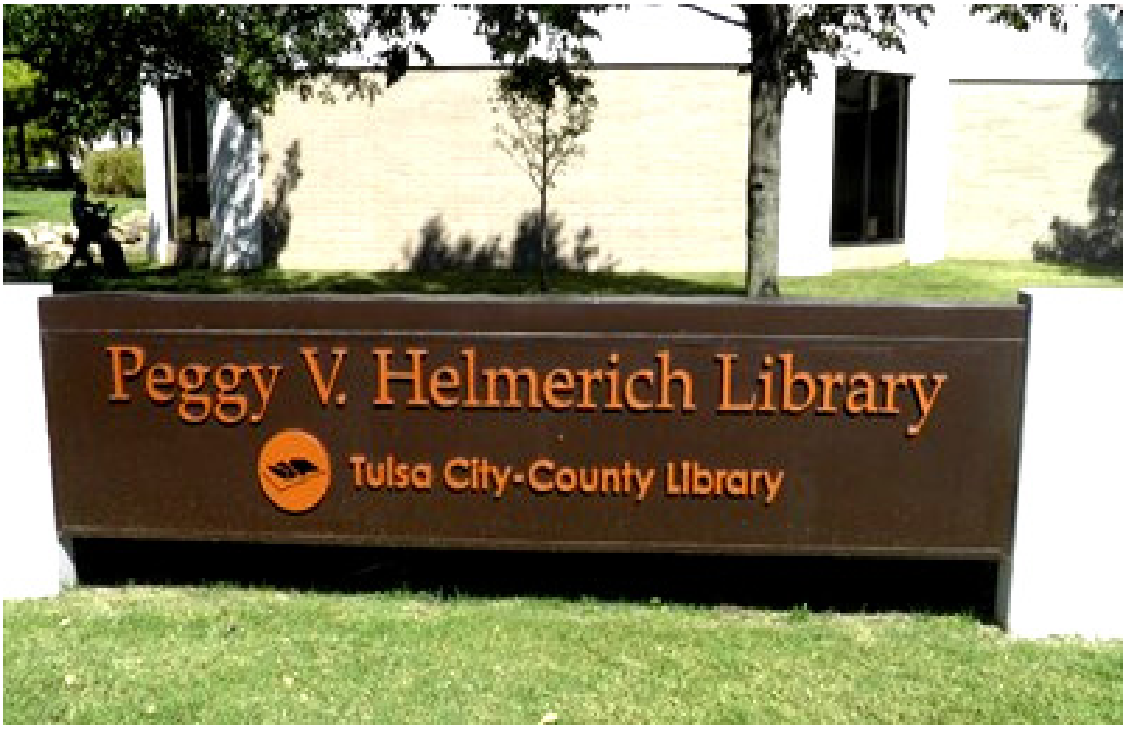
Figure 5.7-23

Tulsa Council District 7

Hazard Composite

City of Tulsa Multi-Hazard Mitigation Plan Update

Tulsa City Council District 8



R.D. Flanagan & Associates

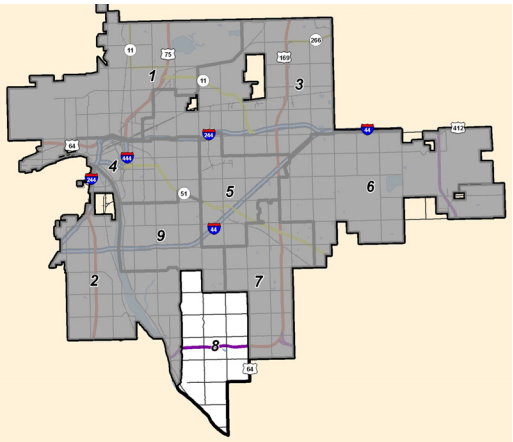
Planning Consultants

5.8 Tulsa City Council District 8

5.8.1 Introduction

5.8.1.1 Location

Figure 5.8–1: Tulsa Locator Map – District 8



Council District 8 is located in extreme south central Tulsa, as shown in the Locator Map at right. District 8 slopes generally southward from the South Tulsa hills, between E. 61st and E. 81st Streets, to the Arkansas River. The District is bounded by E. 61st St. and 71st St. on the north, Harvard Ave. on the west, the Arkansas River on the southwest, and by Sheridan Rd. and Memorial Dr. on the east. The Creek Turnpike crosses the District from west to east at about E. 95th St. The District is drained by Joe Creek, Fred Creek, Haikey Creek, Vensel Creek, Fry Ditch and South Tulsa Creek—all of which empty into the Arkansas River. The District is generally comprised of upscale housing developments and neighborhoods, some gated communities, numerous parks and detention ponds, elite schools and shopping venues. The total land area within District 8 consists of approximately 15.94 sq. mi., as shown in the District 8 Base Map in Figure 5.8-2.

5.8.1.2 Phil Lakin, Jr. Councilor District 8

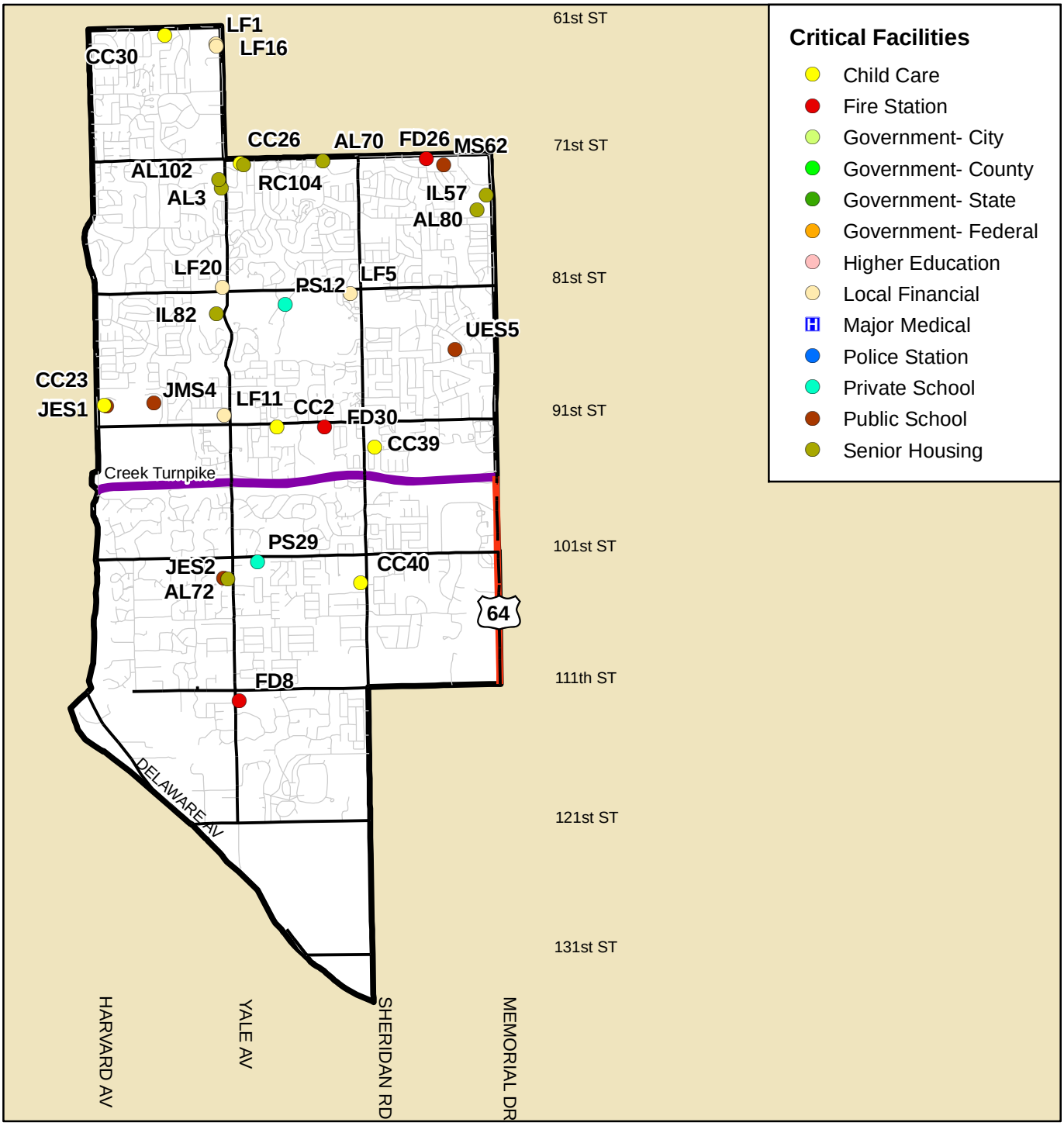
Phil Lakin, Jr. has lived in District 8 since he was 9 years old. He graduated from Jenks High School in 1985 and went on to obtain his BBA and MBA from Baylor University. He also is a graduate of Leadership Tulsa. Lakin is C.E.O. of the Tulsa Community Foundation (TCF) and has been since 1999. Lakin is known for working with donors, community leaders and elected officials to improve the Tulsa area. Before working for TCF, Lakin worked for Baylor University's Office of Development. Councilor Lakin is an active member of many community and governmental organizations. Before running for office, Lakin served on the State Board of Education, Metropolitan Tulsa Transit Authority and the Transportation Advisory Board. He resigned these positions in order to serve as City Councilor for District 8. He also recently served as president of the board for the Tulsa Zoo and helped during the Zoo's privatization efforts. Lakin still serves on the boards of the Folds of Honor Foundation, Tulsa Area United Way, Jenks Publics Schools Foundation and the Tulsa Community College Foundation. *(Source: http://www.tulsacouncil.org/)*

Councilor Phil Lakin, Jr.

5.8.1.3 History

Cultural and Historic Properties

Tulsa Council District 8 is home to one cultural site, Peggy V Helmerich Library, and one historic site, St. John Vianney Training School for Girls. Both are displayed on the map in Figure 5.8-3. St. John Vianney Training School is significant as the first architecturally important building on Tulsa's far south side. It was listed on the National Register of Historic Places of June 7, 1983, under National Register Criterion A and C. Its NRIS number is 83002139.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets

0 0.5 1 Miles

Figure 5.8-2

Tulsa Council District 8

Basemap

5.8.1.4 Demographics

Council District 8 had a 2010 Census population of 43,066. Table 5.8-1 includes the demographic makeup of Council District 8. Maps presenting the demographic information listed in the table, and population density in the District, are found in Figures 5.8-4 through 5.8-12.

Table 5.8–1: Tulsa Council District 8 Demographic Information

Category	District	Tulsa
Persons under 5 years of age	4.96%	7.53%
Persons under age 18	22.56%	24.44%
Persons age 65 and older	14.76%	12.46%
Poverty Status in 2010 (individuals)	8.15%	19.36%
White	84.02%	62.81%
Native-American	3.49%	5.35%
African American	3.83%	15.67%
Asian	3.01%	2.39%
Hispanic	4.61%	13.93%
Total Population	43,066	401,265

Source: 2010 US Census Data

5.8.1.5 Infrastructure

Tulsa Council District 8 is dependent upon the lifelines of the City of Tulsa as identified in Section 1.2.6 of this Plan Update. Any unique vulnerability of Tulsa Council District 8 in relation to the seven site-specific hazards identified in this plan will be addressed in Section 4, below.

5.8.1.6 Economy

The 2010 Census identified an income level of approximately $22,133 as the average poverty threshold for a family of four, including two children. District 8 is among the least impoverished Districts in Tulsa. Approximately 3,508 individuals or 8.15 percent of all individuals in District 8 were living below the poverty line in 2010.

5.8.1.7 Development

According to the Tulsa County Assessor's Office, there are 15,242 properties with improvements in District 8 with an adjusted value, adjusted for fair market, of $3,556,229,650. The numbers of properties with improvements, and improvement values, by type, are shown in Table 5.8-2. No land, contents or tax exempt values are included.

Table 5.8–2: Tulsa Council District 8 Property Types by Assessed Values

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	14,757	$3,022,787,170
Residential Multi-Family	176	$108,585,502
Commercial	229	$354,651,538
Industrial	0	$0
Other	80	$70,205,440
Total	15,242	$3,556,229,650

Source: Tulsa County Assessor's Office, 2012

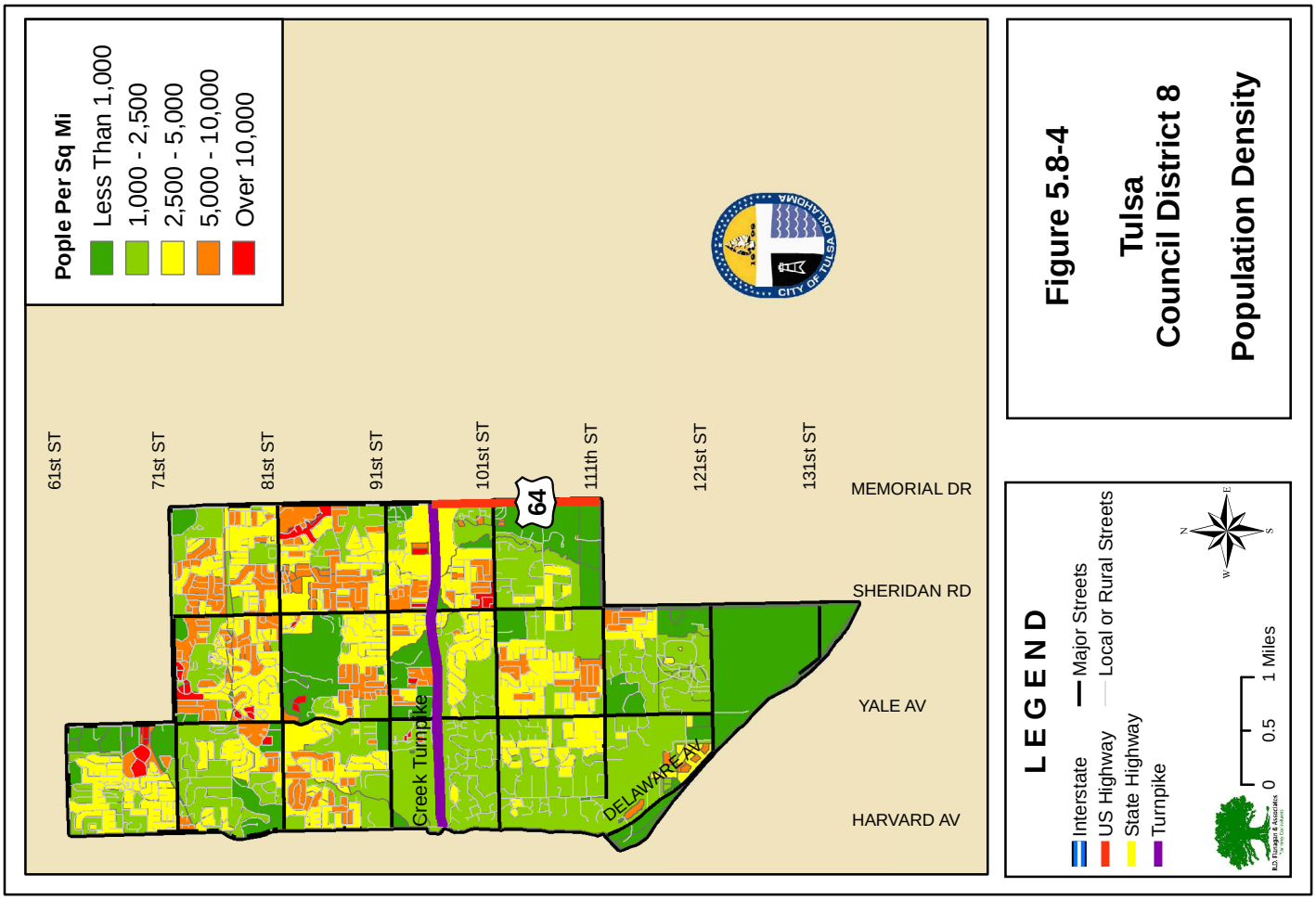


Figure 5.8-4

Tulsa Council District 8

Population Density

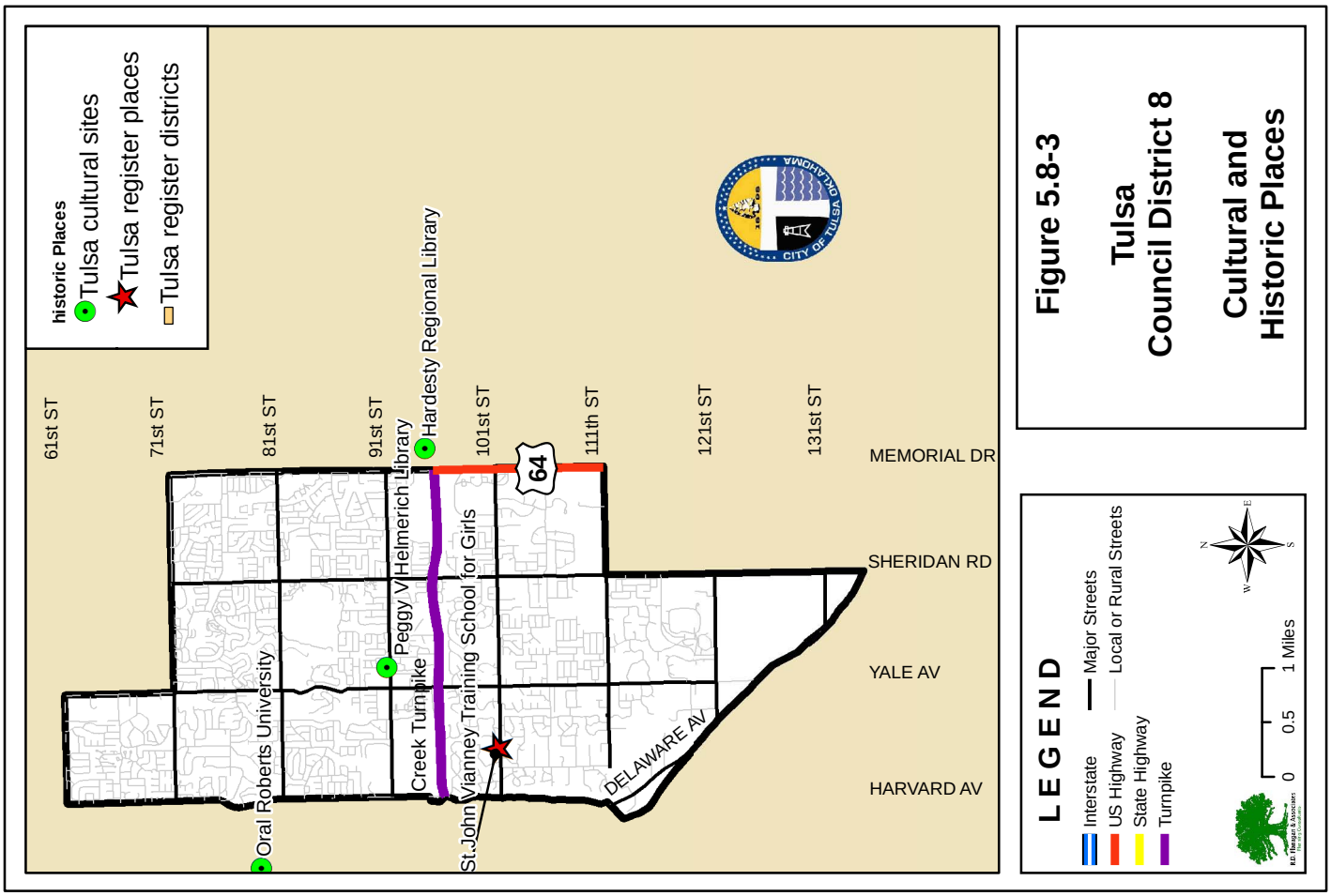


Figure 5.8-3

Tulsa Council District 8

Cultural and Historic Places

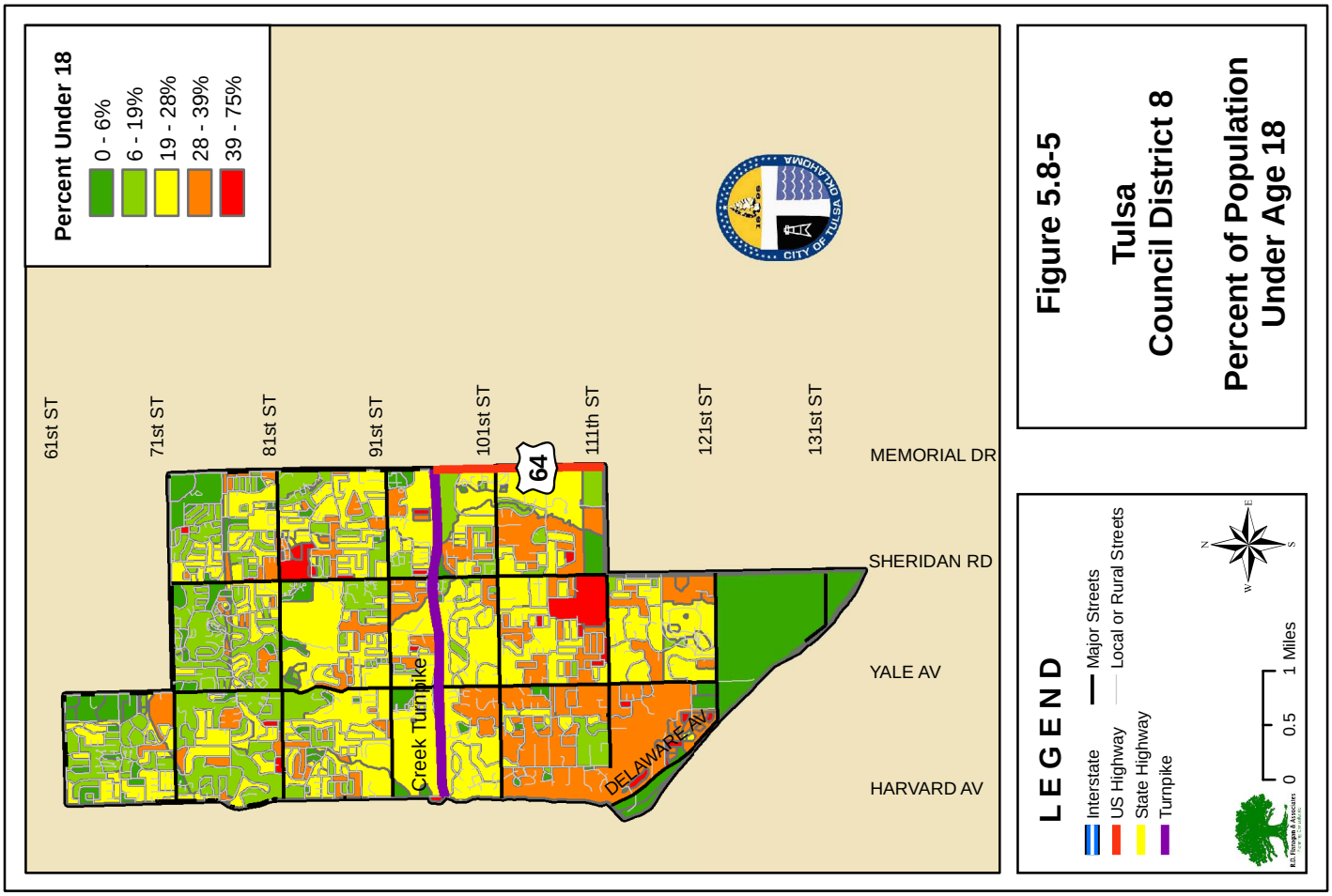


Figure 5.8-5

Tulsa Council District 8

Percent of Population Under Age 18

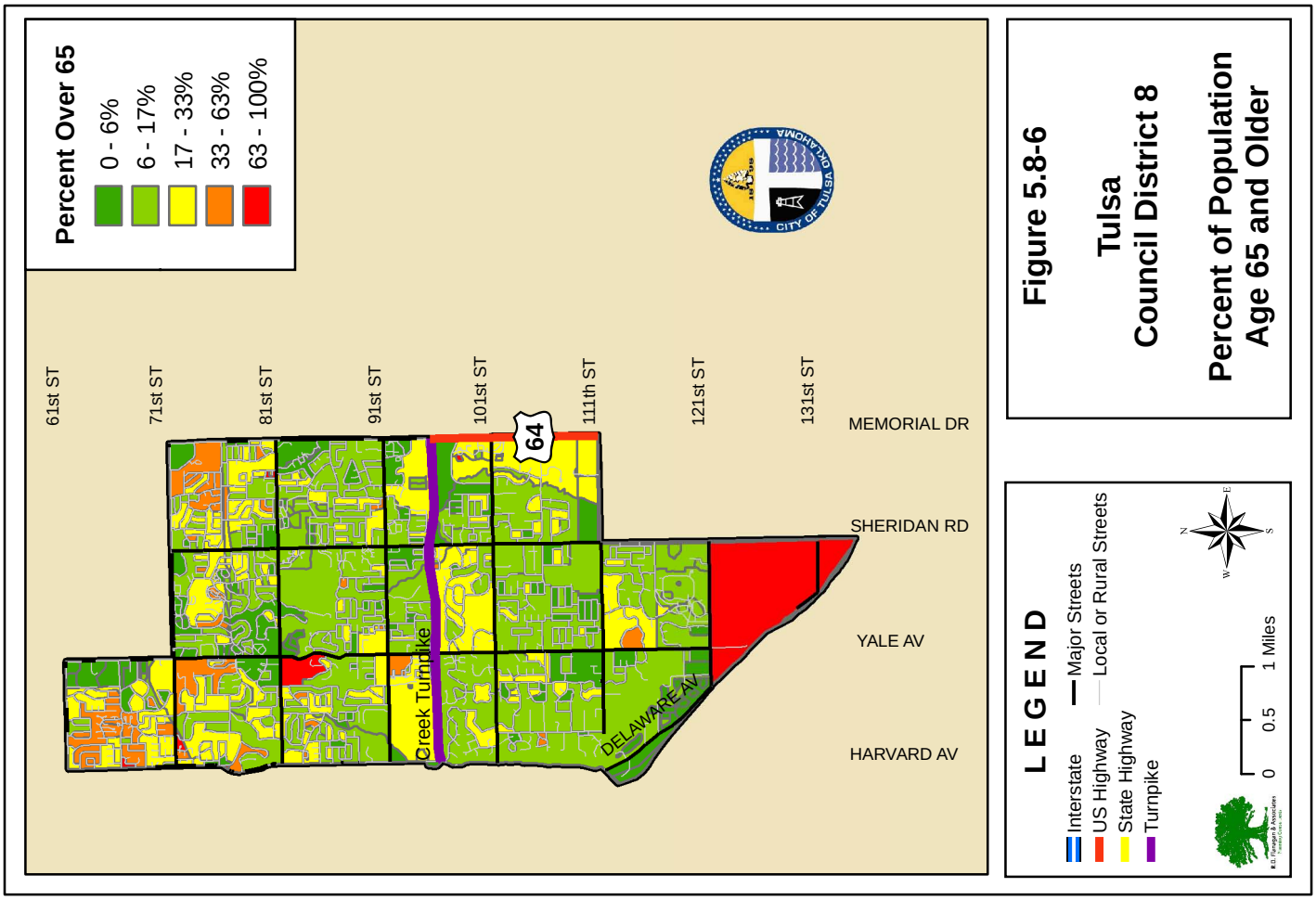
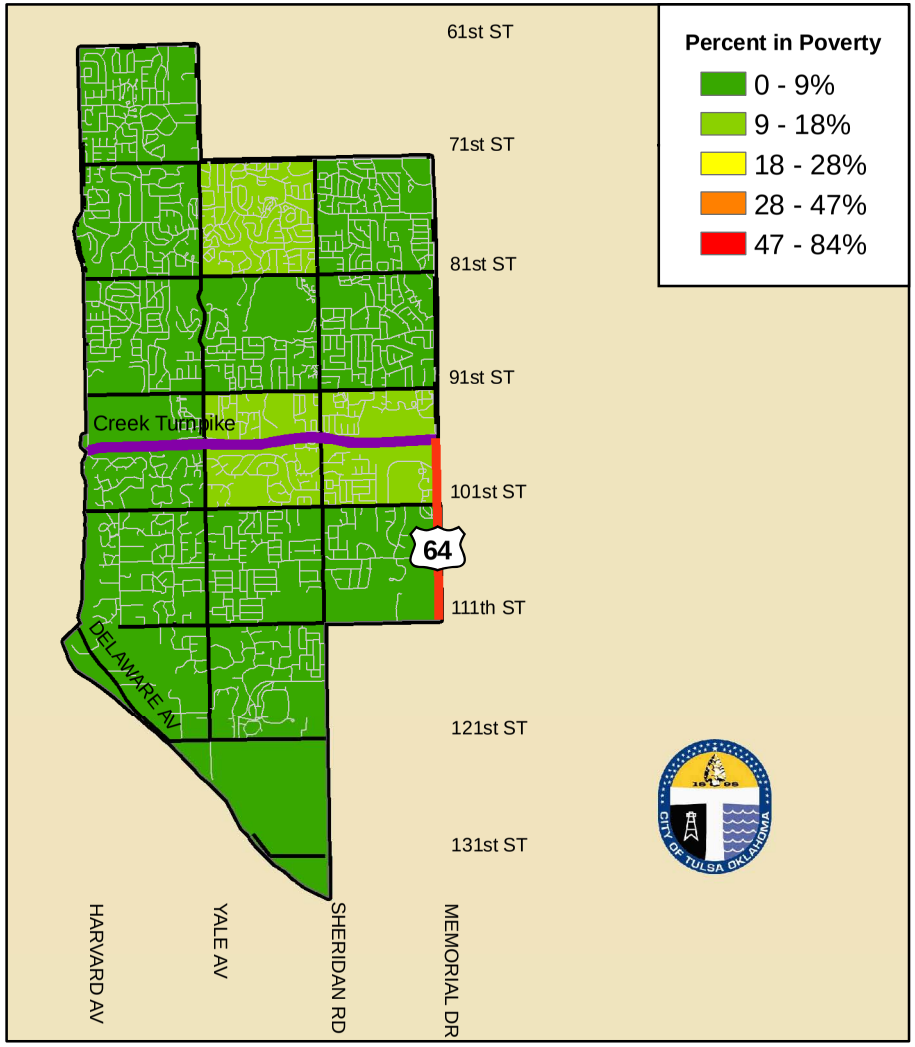


Figure 5.8-6

Tulsa Council District 8

Percent of Population Age 65 and Older



LEGEND

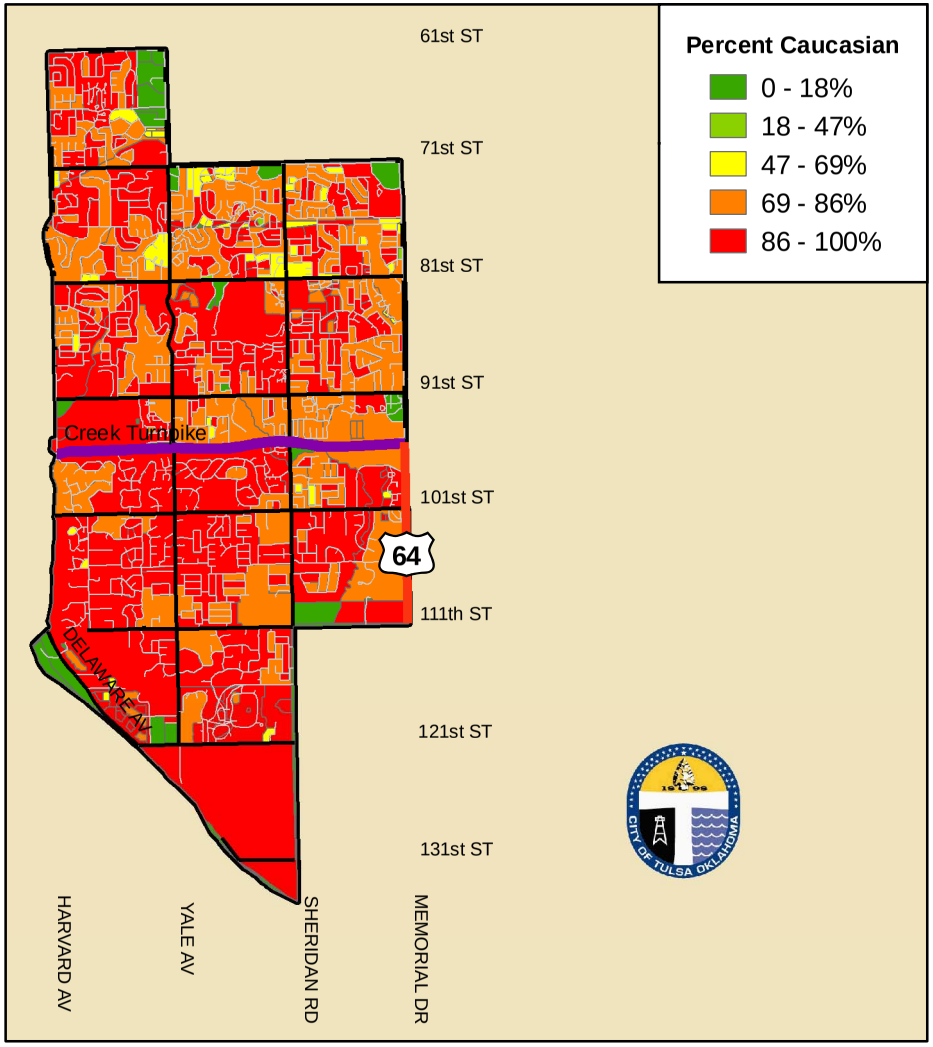
- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets

0 0.5 1 Miles

Figure 5.8-7

Tulsa
Council District 8

Percent of Population Under the Poverty Line



LEGEND

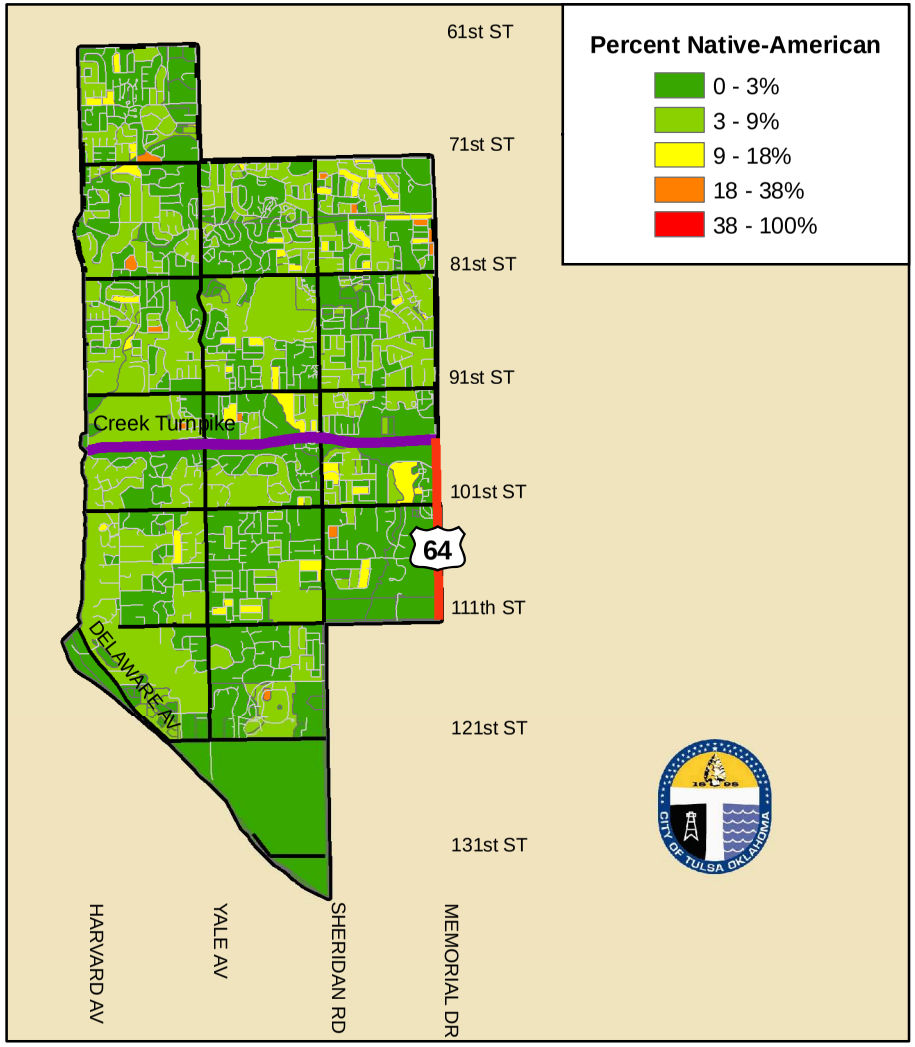
- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets

0 0.5 1 Miles

Figure 5.8-8

Tulsa
Council District 8

Percent of Population of Caucasian Descent



LEGEND

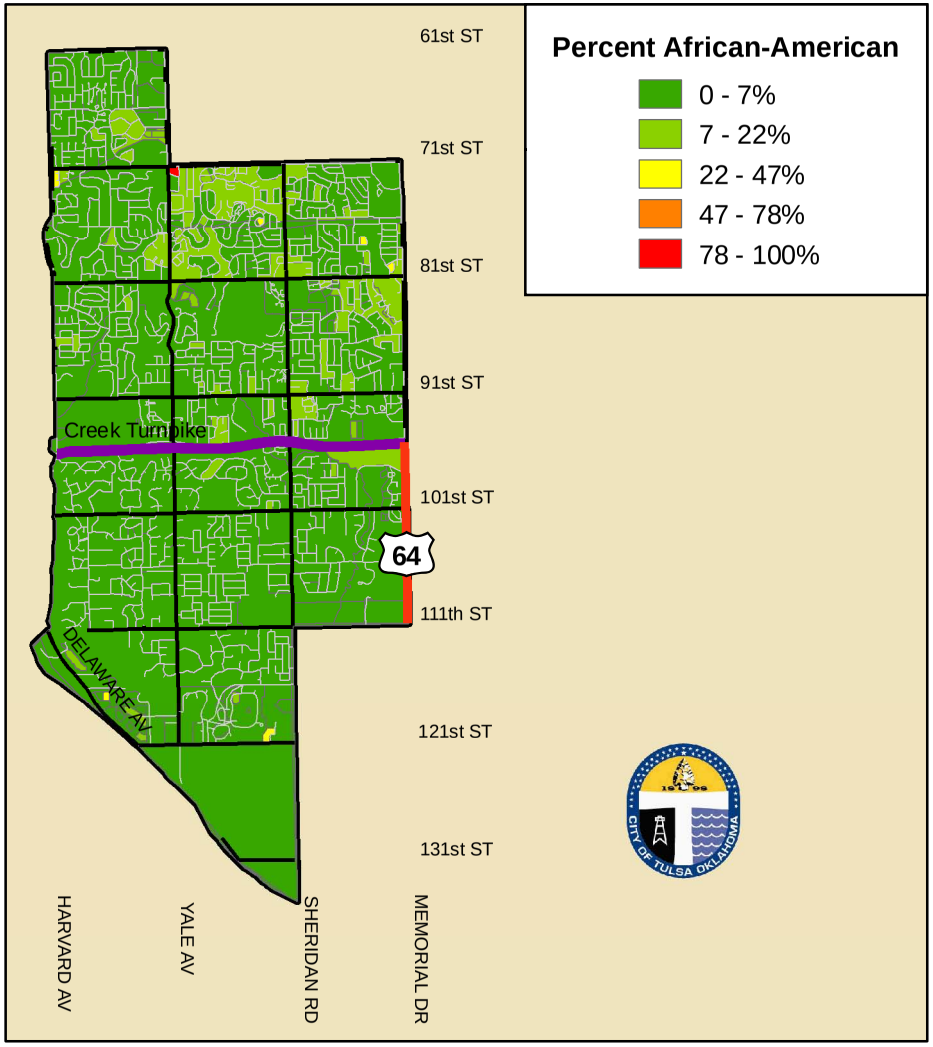
- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets

0 0.5 1 Miles

Figure 5.8-9

Tulsa
Council District 8

Percent of Population of Native-American Descent



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets

0 0.5 1 Miles

Figure 5.8-10

Tulsa
Council District 8

Percent of Population of African-American Descent

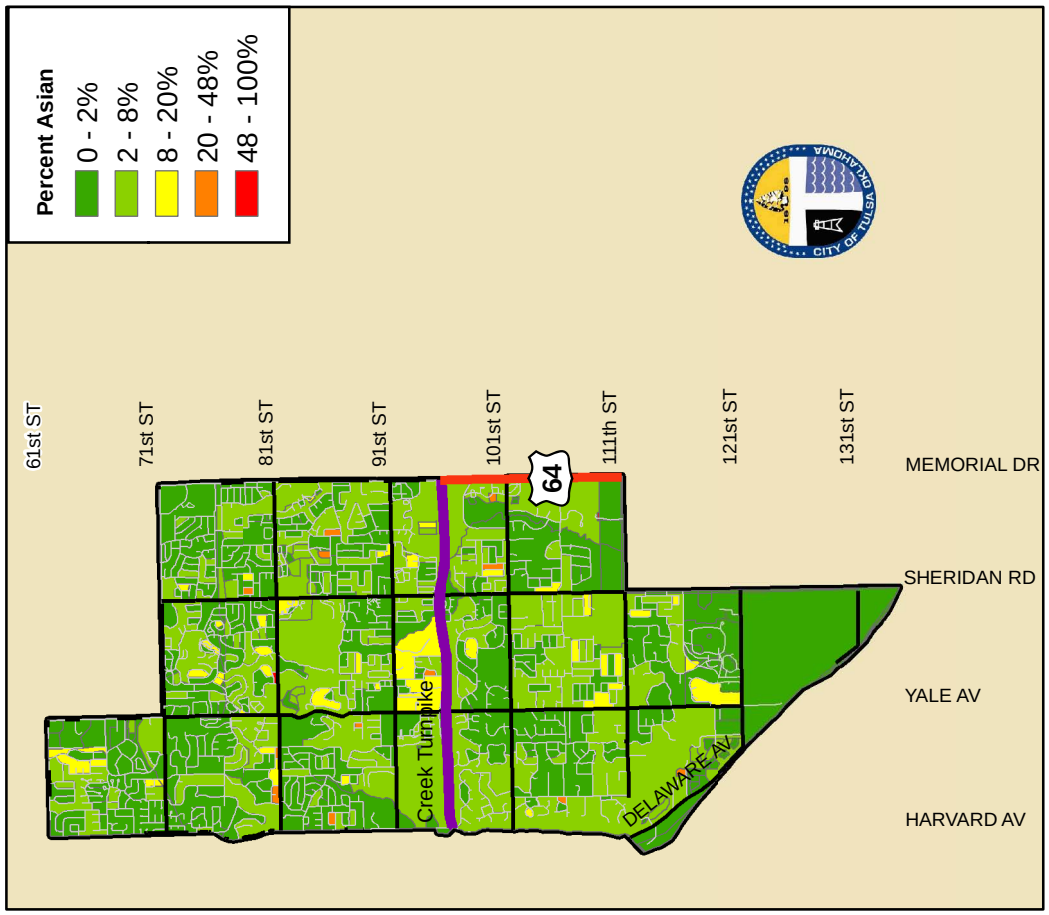


Figure 5.8-11

Tulsa Council District 8

Percent of Population of Asian Descent

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets

0 0.5 1 Miles

Figure 5.8-12

Tulsa Council District 8

Percent of Population of Hispanic Descent

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets

0 0.5 1 Miles

Tulsa Council District 8 is made up of 74 homeowners associations. The locations of these associations are displayed in Figure 5.8-13.

Zoning

For the purpose of this plan, four of the 29 zoning Districts—Single-Family Residential, Multi-Family Residential, Commercial, and Industrial, were used to show zoning patterns within District 8. Tulsa Council District 8 is primarily zoned for single-family residential usage with commercial and multi-family residential distributed primarily along Yale Avenue, north of the Creek Turnpike, and on Memorial Drive. Commercial nodes have clustered around major intersections and along 71st St. between Yale Ave. and Sheridan Rd. A map of zoning areas in Council District 8 is included in Figure 5.8-14.

Future Development

The City of Tulsa will continue to improve District 8's service infrastructures, such as flood control, water, sanitary sewer, and streets. For information regarding future development in the City of Tulsa, see Section 1.2.8.

5.8.1.8 Critical Facilities

There are 29 critical facilities in Tulsa Council District 8. Critical facilities in the District are listed in Table 5.8-3 and displayed in Figure 5.8-2.

Table 5.8–3: Tulsa Council District 8 Critical Facilities

ID	Map ID	Facility Name	Address
Fire Station			
FD	8	Tulsa Fire Department #9	11211 South Yale
FD	26	Tulsa Fire Department #28	7310 E 71st Street
FD	30	Tulsa Fire Department #32	6010 E 91st St
Tulsa Public Schools			
MS	62	Thoreau Demonstration Academy	7370 E 71st St
Union Public Schools			
UES	5	Union James Darnaby Elementary	7625 E87th St
Jenks Public Schools			
JES	1	Jenks East Elementary School	8925 S Harvard Ave
JES	2	Jenks Southeast Elementary School	10222 S Yale Ave
JMS	4	Jenks East Intermediate School	3933 E 91st St
Private School			
PS	12	Holland Hall	5666 E 81st St
PS	29	Town & Country School	5150 E 101st St
Child Care			
CC	2	ABC Preschool - Fellowship Bible Church	5434 E. 91st Street
CC	23	Jenks PS East Before & After Program	8925 S. Harvard
CC	26	KinderCare Learning Ctr	5110 East 71st St. S.
CC	30	Kirk Of The Hills Preschool	4102 E. 61st St.
CC	39	Shining Through Learning Ctr	6605 E. 93rd Street
CC	40	South Tulsa Baptist ELP	10310 S. Sheridan

ID	Map ID	Facility Name	Address
Long Term Care			
AL	3	Aberdeen Heights	7220 S Yale
IL	57	Quail Creek Villa	7334 S Memorial Dr
AL	70	Sterling House of Tulsa	6022 E 71st St
AL	72	The Arbors	10201 S Yale Ave
AL	80	The Parke Senior Living	7821 E 76th St
IL	82	Town Village	8222 S Yale Ave
AL	102	Cypress Springs	7210 S Yale Ave
RC	104	Comprehensive Community Rehabilitation Services, Inc	7112 S Canton
Local Financial			
LF	1	American Bank & Trust Corp	6100 S Yale Ave
LF	5	Bank South of Tulsa	6130 E 81st St
LF	11	ONB Bank & Trust Co.	8908 S Yale Ave
LF	16	Trust Co of Oklahoma	6120 S Yale Ave
LF	20	Tulsa Valley Bancshares	8080 S Yale Ave

5.8.2 Existing Mitigation Strategies

Existing mitigation measures currently being implemented throughout the City of Tulsa are detailed in Chapter 2, *Existing Mitigation Strategies*. The information that follows in this section surveys the infrastructure in place for avoiding or mitigating the impacts of natural hazards, that can be looked at from the District level.

5.8.2.1 Council District 8 Warning Systems

Warning Sirens

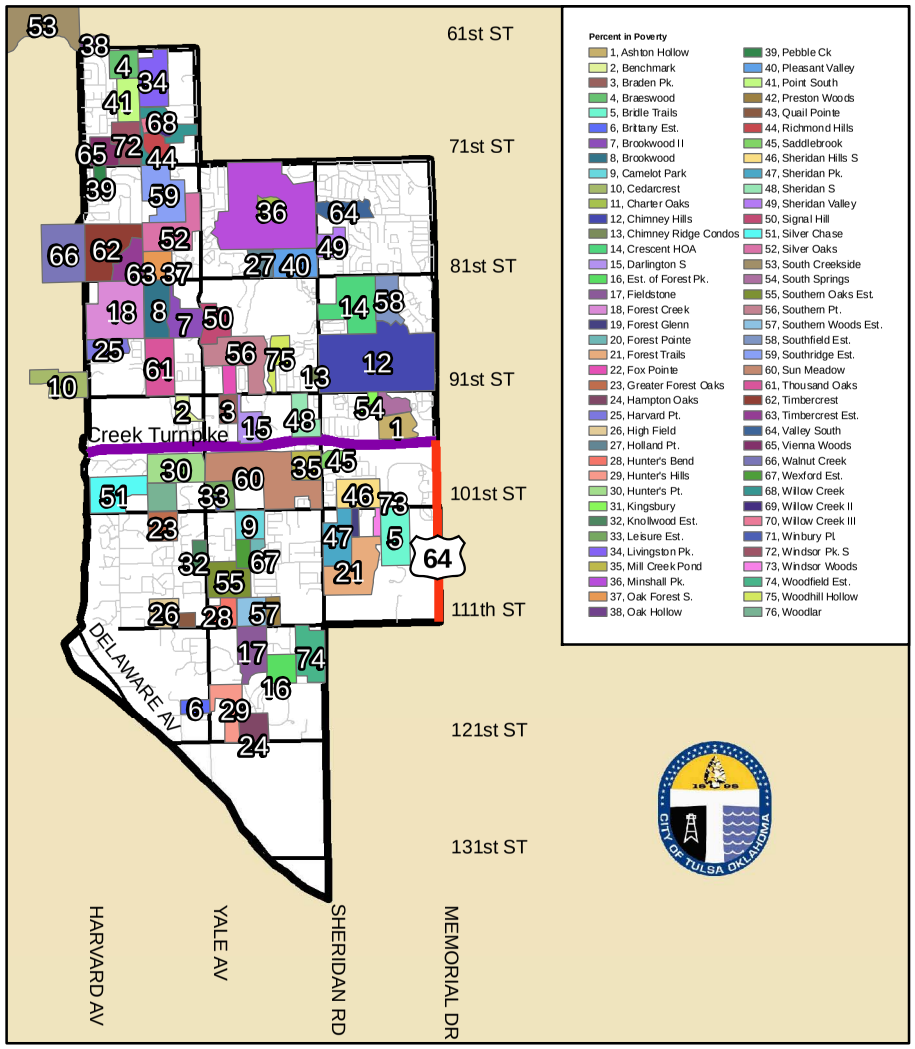
At the time of this plan update there were 10 warning sirens located in Tulsa Council District 8 and four located outside of, but with partial coverage within, the District. Each warning siren is audible for up to a mile. Information regarding the testing of warning sirens in the City of Tulsa is included in Chapter 2. Locations of sirens in District 8 are mapped in Figure 5.8-15.

Lightning Sensing and Warning

The City of Tulsa is home to multiple outdoor recreation areas for public use; there are 11 parks and recreational open spaces (including detention ponds) in District 8, mapped in Figure 5.8-16. Parks promote neighborhood revitalization and development, they also promote youth development. As discussed in Chapter 4, it is important for outdoor recreation areas be equipped with lightning sensing and warning systems. Tulsa Public Schools and the University of Tulsa use ThorGuard© to warn of lightning danger at outdoor recreation areas. A map showing ThorGuard© coverage areas in Tulsa is shown in Chapter 2, Figure 2-4. Public school districts in the surrounding Tulsa Metro Area should be encouraged to purchase and install lightning warning systems. Private schools in the area school also be informed of their options and encouraged to install lightning warning systems for coverage at outdoor recreation areas.

5.8.3 Planning Process

The CAC/TAC met monthly during the planning process to review progress, identify issues, receive task assignments, and advise the consultants. Refer to Appendix C for meeting agendas.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets

R.D. Flanagan & Associates

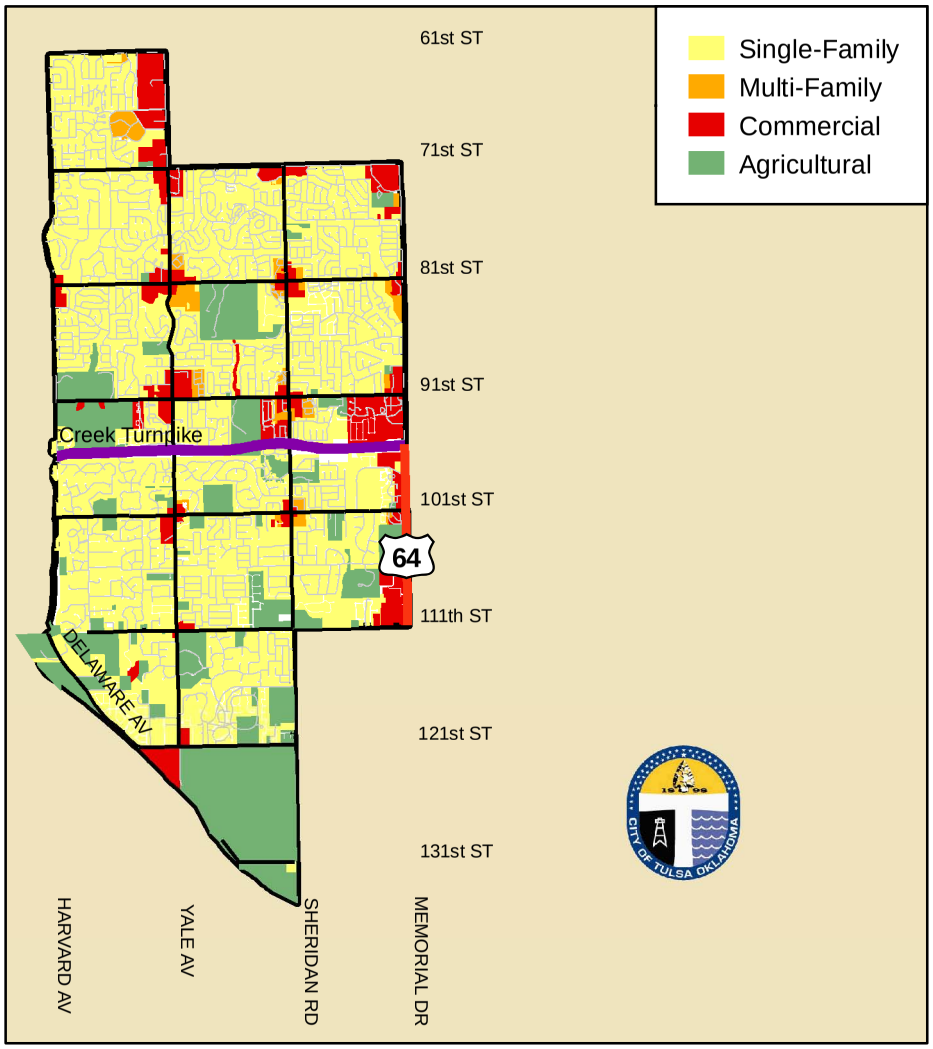
0 0.5 1 Miles

N W E S

Figure 5.8-13

Tulsa Council District 8

Homeowners Associations



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets

R.D. Flanagan & Associates

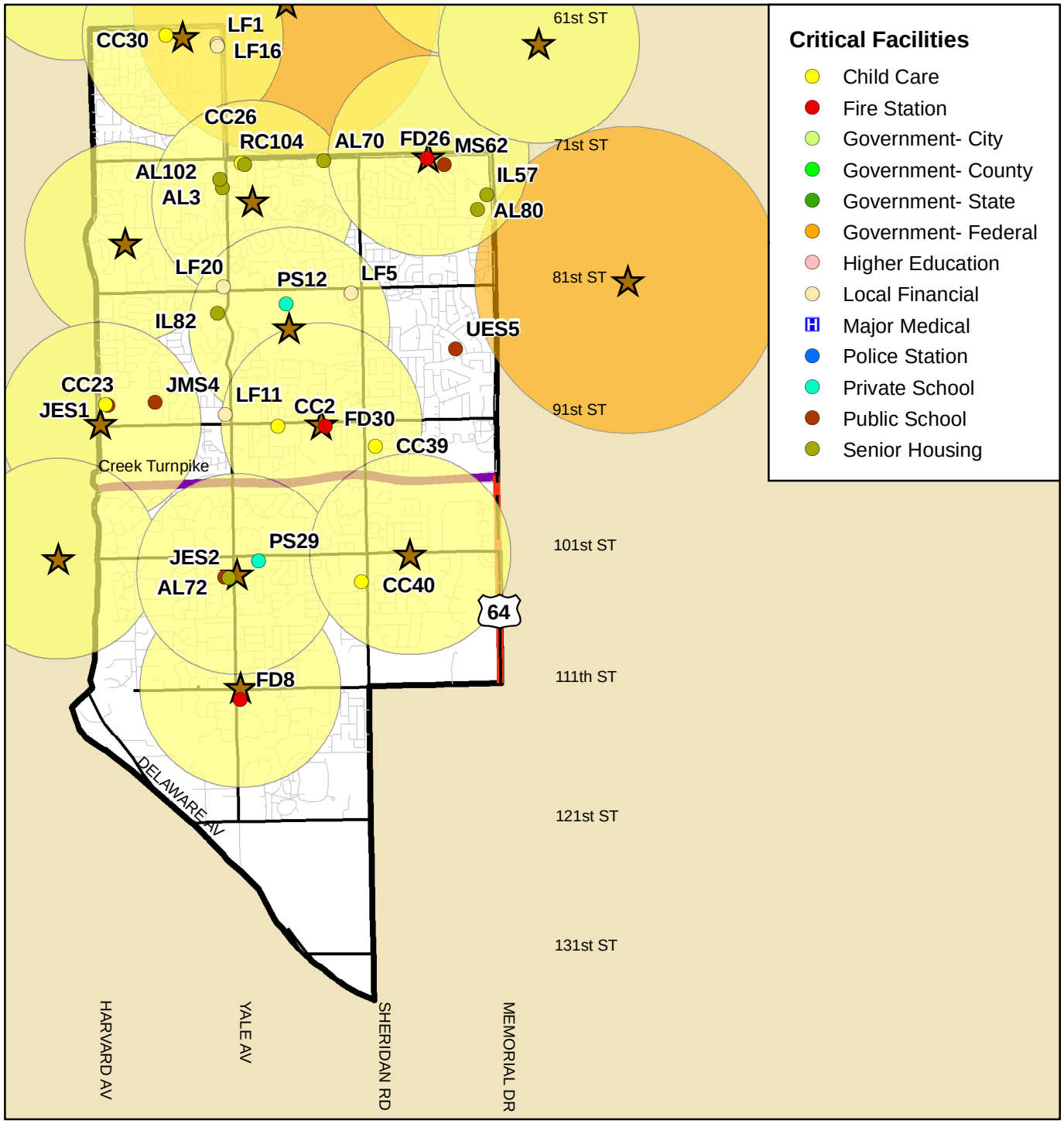
0 0.5 1 Miles

N W E S

Figure 5.8-14

Tulsa Council District 8

Zoning



LEGEND

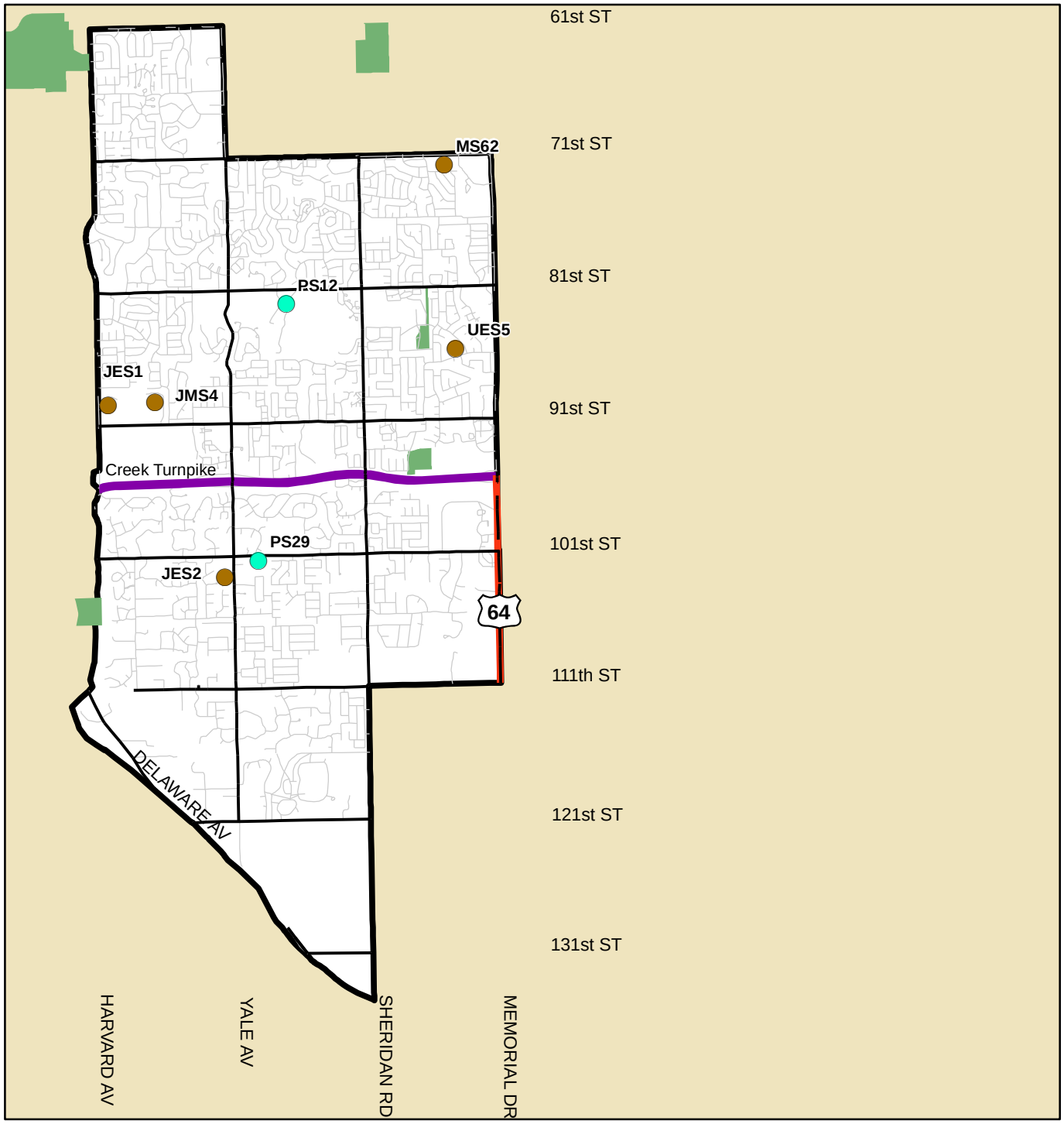
- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets
- Sirens
- 4,000ft Buffer
- 6,100ft Buffer

0 0.5 1 Miles

Figure 5.8-15

Tulsa Council District 8

Warning Siren



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets
- Private School
- Public School
- Parks

0 0.5 1 Miles

Figure 5.8-16

Tulsa Council District 8

Schools & Parks

5.8.4 Natural and Manmade Hazards

Hazards

General natural hazards, such as Tornadoes, High Winds, Lightning, Hail, Winter Storms, Extreme Heat, Drought, and Earthquakes affect all communities in the City of Tulsa randomly and equally, and are addressed in Chapter 4.

Site-specific hazards, such as Flooding, Dam Failures, Levee Failures, Expansive Soils, Wildfires, Fixed Site Hazardous Materials and Transportation-Hazardous Materials are addressed for Council District 8 in subsections 5.8.4.1 through 5.8.4.7, summarized in subsection 5.8.4.8 and shown on the map in Figure 5.8-24.

Table 5.8-4 identifies the site-specific hazards the can specifically impact Tulsa Council District 8.

Table 5.8–4: Tulsa Council District 8 Site-Specific Hazard Impacts

Hazard	Area (Sq. mi)	Improved Parcels	Est. Market Value	Percent of Area Impacted	Impacted Population
Floods	1.55	174	$51,609,298	9.72%	1,641
Dam failures	1.75	444	$190,506,189	10.97%	665
Levee Failure	0	0	0	0	0
Expansive Soils	0.67	891	$167,804,922	4.20%	1,443
Wild Fires	0	0	0	0	0
Fixed-Site HazMat, ¼ Mi.	1.46	1,041	$349,313,139	9.15%	2,171
Transportation HazMat-Highway	2.00	1,829	$442,842,581	12.94%	4,851
Transportation HazMat-Railroad	0	0	0	0	0

Tulsa Council District 8 has identified certain facilities as critical to the health, safety and welfare of its citizens, business and economy. Table 5.8-5 indicates, generally, the exposure of critical facilities to the six site-specific hazards covered by this Plan Update.

Table 5.8–5: Tulsa Council District 8 Hazard Impacts on Critical Facilities

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Hazardous Material Sites	Transportation-Hazard
FD	8	Tulsa Fire Department #9	X	X	X	X	X	X	X	X	X							
FD	26	Tulsa Fire Department #28	X	X	X	X	X	X	X	X	X							
FD	30	Tulsa Fire Department #32	X	X	X	X	X	X	X	X	X							
MS	62	Thoreau Demonstration Academy	X	X	X	X	X	X	X	X	X							
UES	5	Union James Darnaby Elementary	X	X	X	X	X	X	X	X	X				X			
JES	1	Jenks East Elementary School	X	X	X	X	X	X	X	X	X							
JES	2	Jenks Southeast Elementary School	X	X	X	X	X	X	X	X	X							

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Hazardous Material Sites	Transportation-Hazard
JMS	4	Jenks East Intermediate School	X	X	X	X	X	X	X	X	X							
PS	12	Holland Hall	X	X	X	X	X	X	X	X	X							
PS	29	Town & Country School	X	X	X	X	X	X	X	X	X							
CC	2	ABC Preschool - Fellowship Bible Church	X	X	X	X	X	X	X	X	X						X	
CC	23	Jenks PS East Before & After Program	X	X	X	X	X	X	X	X	X							
CC	26	KinderCare Learning Ctr	X	X	X	X	X	X	X	X	X						X	
CC	30	Kirk Of The Hills Preschool	X	X	X	X	X	X	X	X	X							
CC	39	Shining Through Learning Ctr	X	X	X	X	X	X	X	X	X							X
CC	40	South Tulsa Baptist ELP	X	X	X	X	X	X	X	X	X							
AL	3	Aberdeen Heights	X	X	X	X	X	X	X	X	X							
IL	57	Quail Creek Villa	X	X	X	X	X	X	X	X	X							
AL	70	Sterling House of Tulsa	X	X	X	X	X	X	X	X	X							
AL	72	The Arbors	X	X	X	X	X	X	X	X	X							
AL	80	The Parke Senior Living	X	X	X	X	X	X	X	X	X							
IL	82	Town Village	X	X	X	X	X	X	X	X	X							
AL	102	Cypress Springs	X	X	X	X	X	X	X	X	X							
RC	104	Comprehensive Community Rehabilitation Services, Inc	X	X	X	X	X	X	X	X	X						X	
LF	1	American Bank & Trust Corp	X	X	X	X	X	X	X	X	X						X	
LF	5	Bank South of Tulsa	X	X	X	X	X	X	X	X	X							
LF	11	ONB Bank & Trust Co.	X	X	X	X	X	X	X	X	X						X	
LF	16	Trust Co of Oklahoma	X	X	X	X	X	X	X	X	X						X	
LF	20	Oklahoma Central Credit Union	X	X	X	X	X	X	X	X	X							

5.8.4.1 Flood

Location

Council District 8 is affected by both the Special Flood Hazard Area (SFHA) and City Regulatory Floodplains. The combined floodplains comprise 1.55 sq. mi., or 9.72 percent of the land within the District boundaries. All streams in District 8 originate in the South Tulsa Hills and flow generally southwest and south into the Arkansas River. Streams in District 8 and their total drainage area are listed in Table 5.8-6. Figure 5.8-17 shows the District's drainage basins and their floodplains.

Table 5.8–6: Tulsa Council District 8 Streams and Drainage Areas

Stream	Total Drainage Area (sq. mi.)
VENSEL CREEK	4.24
FRY DITCH NO. 1	0.06
FRY DITCH NO. 2	4.73
SOUTH TULSA CREEK	2.95
SOUTH FORK JOE CREEK	0.42
HAIKEY CREEK	2.10
LITTLE JOE CREEK	0.01
FRED CREEK	1.42
MINGO CREEK MAINSTEM-MU	0.02
Total	15.95

Impact/Vulnerability

In total, 159 residential single family structures, four residential multi-family structures, three commercial buildings, and eight structures classified as *other* are located in the 100-year floodplains of Council District 8. The 174 improved parcels have an adjusted value, estimated for fair market price, of $51,609,298. Improved parcels in the District that are touched by the 100-year floodplain are listed, by type, in Table 5.8-7.

Table 5.8–7: Tulsa Council District 8 Buildings Touched by 100 year Floodplain

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	159	$33,975,300
Residential Multi-Family	4	$6,980,299
Commercial	3	$10,155,399
Industrial	0	$0
Other	8	$498,300
Total	174	$51,609,298

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

No critical facilities in the District are touched by the 100 year floodplain.

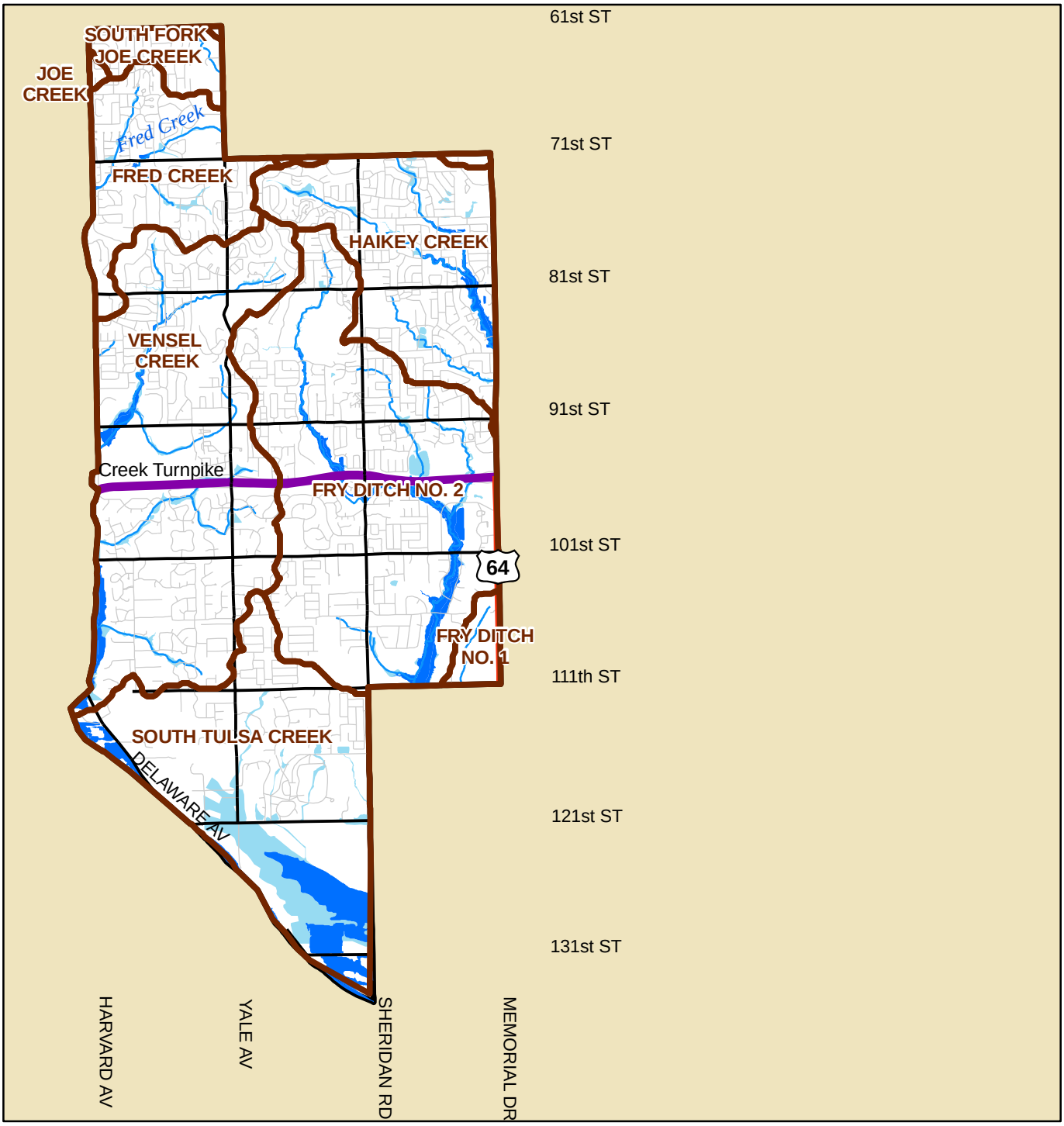
Repetitive Loss Properties

There are eleven repetitive loss properties located within the boundaries of Tulsa Council District 8: ten residential and one multi-family.

Flood Control Projects

Tulsa's floodplain and stormwater program includes comprehensive watershed management, dedicated funds for maintenance and operation, and a $200 million capital improvements program. In Council District 8, many projects have been completed for flood control issues.

Figure 5.8-18 displays flood control projects in District 8, identified in the 2004 Capital Improvements Plan. District 8 flood control projects budgeted in the 2008-2012 Capital Expenditures Plan are listed in Table 5.8-8.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets
- Basins
- SFHA
- City Regulatory
- Streams

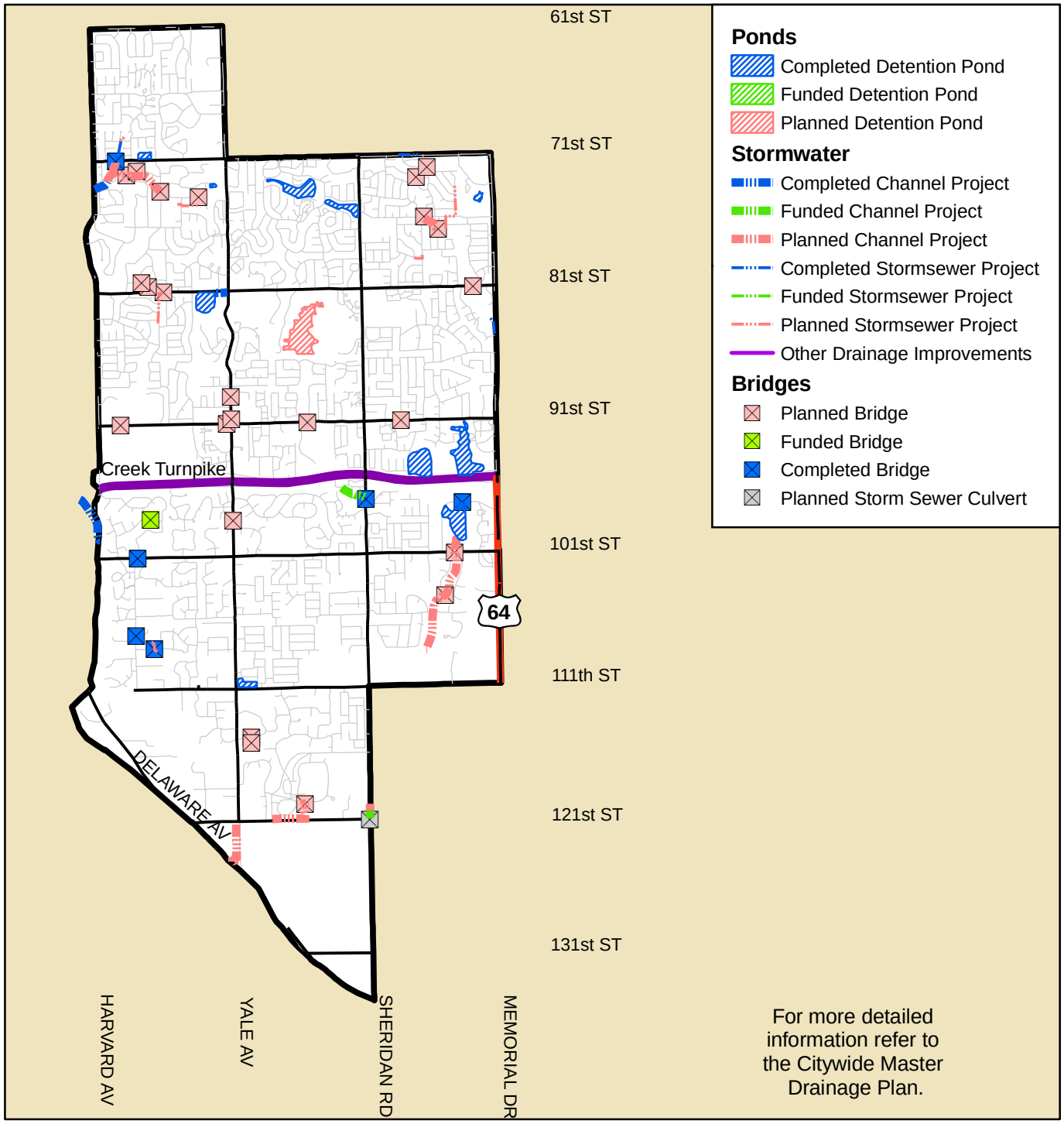
0 0.5 1 Miles

R.D. Flanagan & Associates
Planning Consultants

Figure 5.8-17

Tulsa Council District 8

Drainage Basins & Floodplains



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets

0 0.5 1 Miles

Figure 5.8-18

Tulsa Council District 8

Flood Control

Table 5.8–8: Tulsa Council District 8 Flood Control Projects 2008-2012

Project ID	Project Basin and Description	Budget
43	Fred Creek - Channel, Culverts, Rehab, and Maintenance (Phase 2)	$2,120,000
44	Fred Creek - Richmond Tributary Drainage Channel Improvements	$250,000
45	Fry Ditch #2 - Bank Stabilization & Erosion Control	$11,000,000
46	Fry Ditch #2 - Bridge No. 318A on 101st St. South and Channel Improvements	$4,200,000
51	Haikey Creek – 91st Street S. Bridge Culvert	$260,000
93	Vensel Creek – Erosion Control and Bank Stabilization	$2,550,000

Source: PLANiTulsa Capital Expenditures Plan 2008-2012

Conclusion

Tulsa Council District 8 has a HIGH probability of and a HIGH vulnerability to the Flood hazard.

5.8.4.2 Dam Failure

Location

District 8 is vulnerable to a breach or failure of Keystone Dam, as shown in Figure 5.8-19. The south-west corner of the District, from E 101st St to just south of E 131st St. and Sheridan Rd., is located in the Keystone Dam inundation area. Approximately 1.75 square miles of land, or 10.97 percent of land in the District, is vulnerable to the Dam failure hazard. For an in-depth discussion of Dam Failure on the Arkansas River, see Chapter 4, Dam Failure, and Section 5.10, Arkansas River Corridor.

Impact/Vulnerability

According to the Tulsa County Assessor, there are 444 improved parcels located in the dam inundation areas of District 8. A summary of the parcels by estimated fair market value and type, is included in Table 5.8-9. The greatest impact of a failure of a dam would be loss of life for those in the inundation area and damage to property. Using 2010 US Census data, an estimated 665 residents would be directly impacted by this hazard. Two Tier II facilities in the District would be impacted if the Keystone Dam were to break or fail. A release from one of these sites could result in secondary impacts to people and property outside the inundation area.

Table 5.8–9: Tulsa Council District 8 Parcels in Keystone Dam Inundation Area

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	439	$189,596,979
Residential Multi-Family	0	$0
Commercial	2	$449,500
Industrial	0	$0
Other	3	$459,710
Total	444	$190,506,189

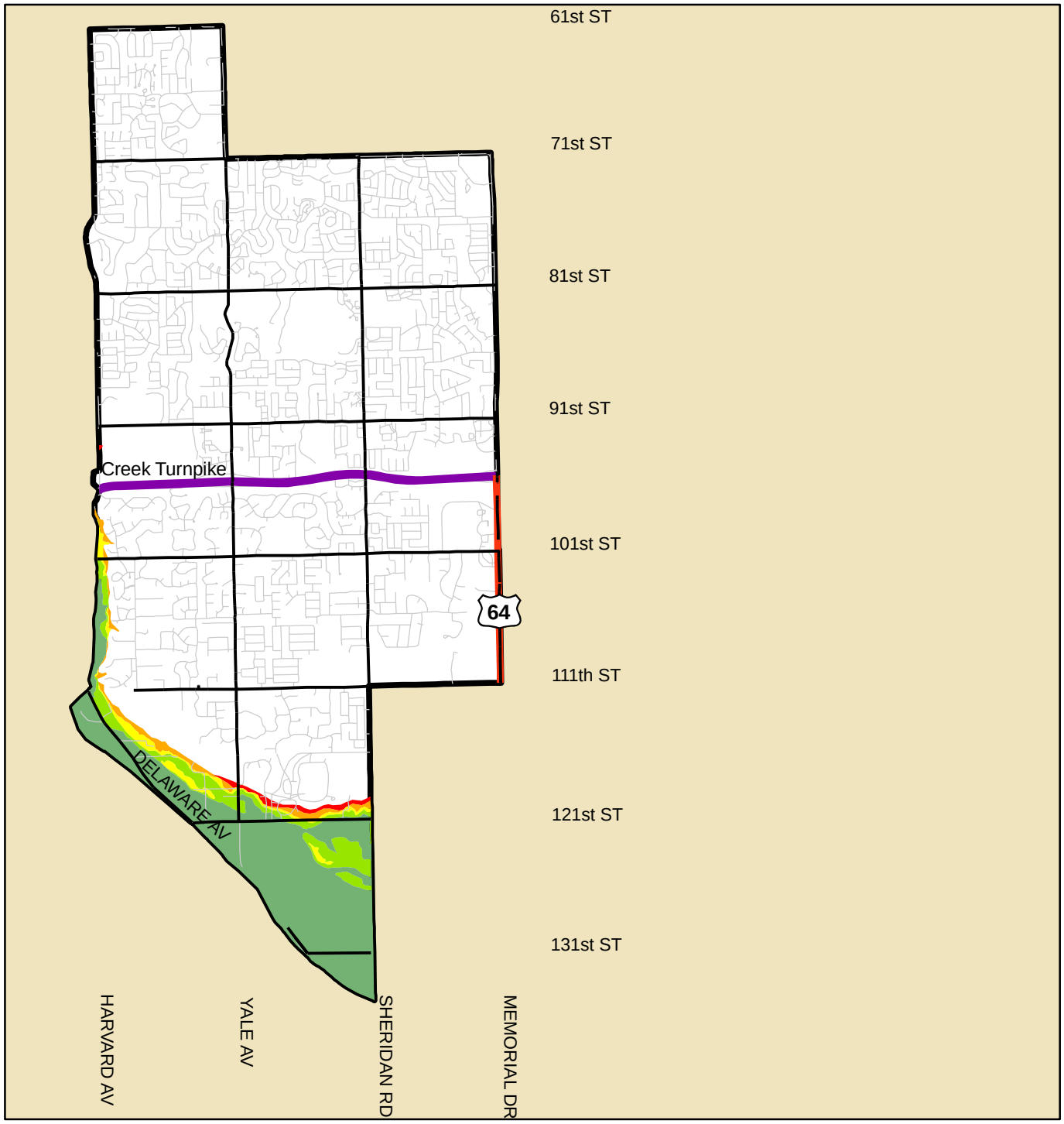
Source: Tulsa County Assessor's Office, 2012

Critical Facilities

No critical facilities in the District are located in the inundation area of Keystone Dam.

Conclusion

Tulsa Council District 8 has a HIGH vulnerability to and a LOW probability of the Dam Failure hazard.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets

Dam Failure

- 250,000 CFS
- 350,000 CFS
- 450,000 CFS
- Max Failure
- Dam Break

0 0.5 1 Miles

Figure 5.8-19

Tulsa Council District 8

Dam Failure

5.8.4.3 Levee Failure

There are no levees along the Arkansas River in Council District 8. The District would not be impacted by a flood event overtopping the levees upstream on the Arkansas River—other than the possibility of pollutants and hazardous materials that such a failure might release into the river and into areas inundated within the District.

5.8.4.4 Expansive Soils

Location

Council District 8 is underlain by soils with Low to Very High shrink/swell potential, summarized in Table 5.8-10, below. The majority of the District, 77.08 percent, is underlain by soils with Low shrink/swell potential. Moderate expansive soils make up 18.19 percent of the District, primarily in its northeast corner. A small area in the southeast corner of the District, about 4.19 percent if the total land area is comprised of soils with High to Very High shrink swell potential. A map showing the location of the District's expansive soils is presented in Figure 5.8-20.

Table 5.8–10: Tulsa Council District 8 Expansive Soils

Expansion Potential	Area (sq mi)	Percent of Total District Boundaries
Very High	0.21	1.29%
High	0.46	2.90%
Moderate	2.91	18.19%
Low	12.29	77.08%
Water	0.09	0.54%
Total	15.95	100.00%

Impact/Vulnerability

According to Tulsa County Assessor data, 891 parcels, or about 5.85 percent of the total parcels in District 8, are underlain by soils with High to Very High shrink/swell potential. The parcels have an assessed value, adjusted for fair market, of $167,804,922. A summary of District 8 parcels located on High to Very High expansive soils is included in Table 5.8-11.

Table 5.8–11: Tulsa Council District 8 Parcels on High to Very High Expansive Soils

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	837	$122,986,899
Residential Multi-Family	20	$17,969,301
Commercial	29	$26,249,646
Industrial	0	$0
Other	5	$599,076
Total	891	$167,804,922

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

There is one critical facility in District 8 located on High to Very High expansive soils; Union James Darnaby Elementary School. It is likely the facility was engineered taking into consideration the soils upon which it is constructed. It is not anticipated that the movement of soils will cause extensive

damage to the facility itself. The infrastructure that serves the facility, however, might well be impacted by soil movement, especially during times of drought.

Conclusion

Tulsa Council District 8 has a MODERATE vulnerability to and MODERATE probability of the Expansive Soils hazard.

5.8.4.5 Wildfire

Location

District 8 is located in an area with Low to No Wildfire Level of Concern (LOC). A map displaying the Wildfire LOC of District 8 is shown in Figure 5.8-21.

Impact/Vulnerability

All land areas in Council District 8 are rated from 0 to 1 on the Wildfire Level of Concern Index (LOC). Areas with a 1 on the LOC index are primarily developed with single-family residential neighborhoods and commercial property. The only risk would be in those areas not yet developed such as the area between E 121st and E 131st, between S Yale Avenue and S Sheridan Road. As with all undeveloped land, the area should be monitored, especially during periods of extreme heat and drought following a wet spring. Any controlled burning should be closely monitored.

Critical Facilities

No critical facilities in District 8 are considered vulnerable to this hazard.

Conclusion

With no areas in the District having a Wildfire LOC greater than 1 on the LOC Index, but a large portion of undeveloped land in the southern most corner of the District, ***Tulsa Council District 8 is considered to have a LOW vulnerability to and MODERATE probability of the Wildfire hazard***.

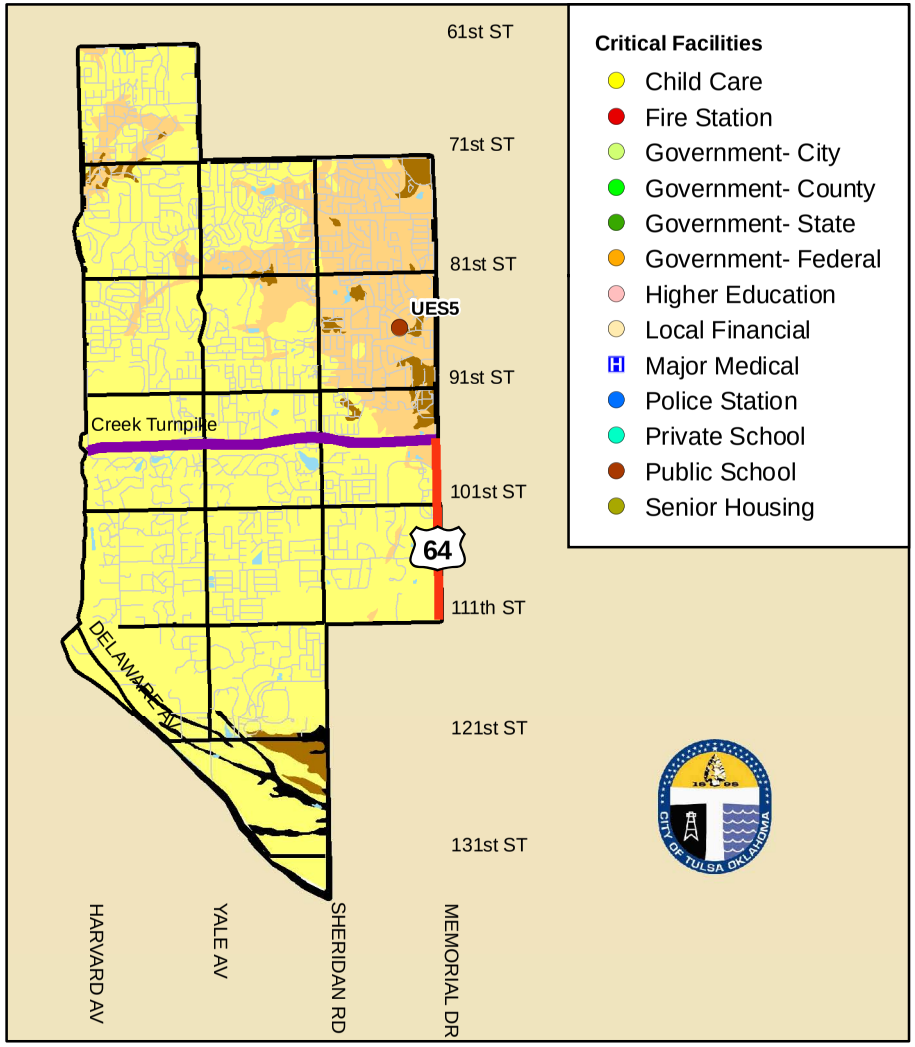
5.8.4.6 Fixed-Site Hazardous Materials

Location

There are eight Tier II facilities within or immediately adjacent to the boundaries of Tulsa Council District 8. Of the eight sites, five contain an Extremely Hazardous Substance (EHS). Due to the sensitive nature of this material, Tier II facilities in the District are mapped in Figure 5.8-22 to show only approximate location of the sites. A listing of EHS and Non-EHS Tier II facilities in Council District 8 can be found in Appendix E, and is available on a need to know basis.

Impact/Vulnerability

According to the Marplot analysis, which uses 2010 US Census data, 2,171 people living or working in Council District 8 are vulnerable to the impacts of this hazard, as described in Chapter 4. Information regarding the number of improved parcels by adjusted value, estimated for fair market price, and type, located within ¼ mile of a Tier II facility is included in Table 5.8-12.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets

Expansive Soils

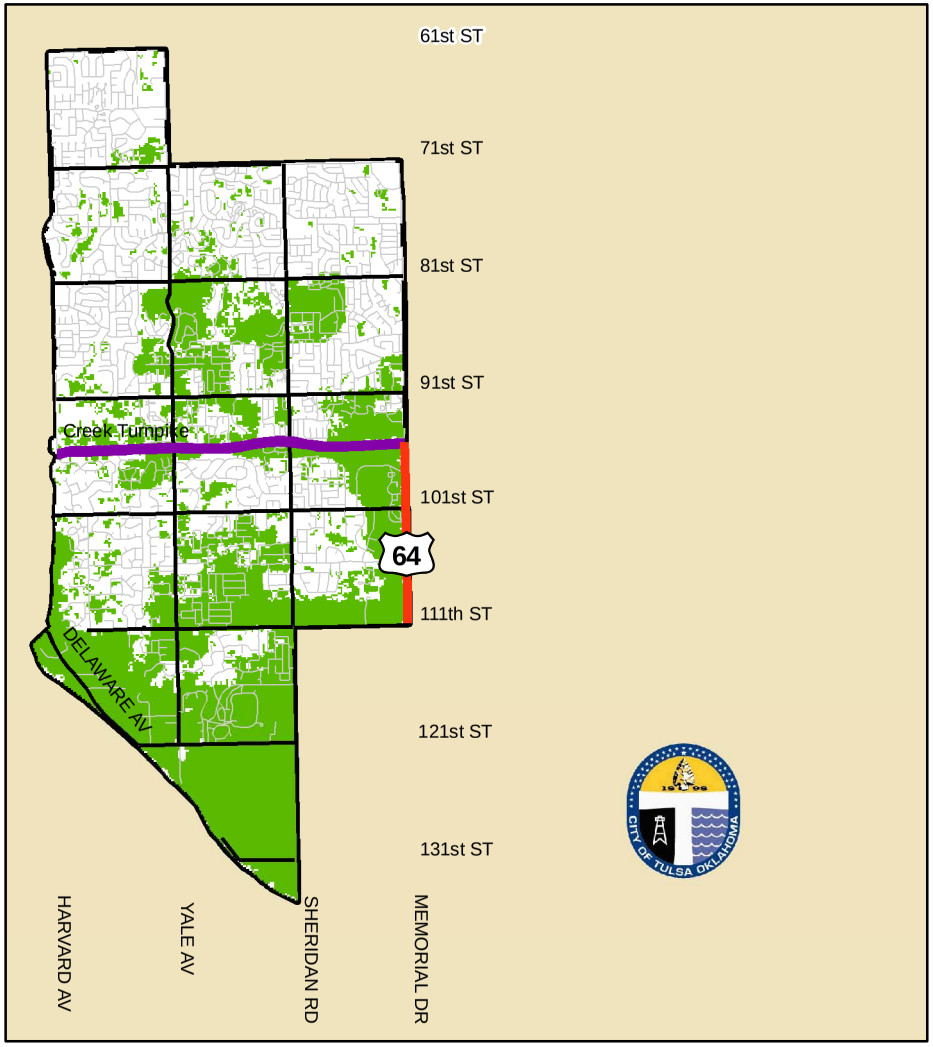
- Low
- Moderate
- High
- Very High
- Water

0 0.5 1 Miles

Figure 5.8-20

Tulsa Council District 8

Expansive Soils



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets

Level of Concern

0 1 2 3 4 5 6 7 8 9

0 0.5 1 Miles

Figure 5.8-21

Tulsa Council District 8

Wildfire Level of Concern Index

Table 5.8–12: Tulsa Council District 8 Parcels in ¼ Mile Tier II Buffer

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	911	$137,135,895
Residential Multi-Family	44	$13,884,900
Commercial	67	$160,194,059
Industrial	0	$0
Other	19	$38,098,285
Total	1,041	$349,313,139

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Six critical facilities in District 8 are located within ¼ mile of a Tier II facility, including two childcare and a long term care facility. Effort should be made to ensure all staff is aware of shelter-in-place and/or evacuation procedures of students and patients in these facilities. A list of District 8 critical facilities located within ¼ mile of a Tier II facility is included in Table 5.8-5 and mapped in Figure 5.8-22.

Conclusion

Tulsa Council District 8 is considered to have a MODERATE vulnerability to and LOW probability of a fixed-site hazardous materials release.

5.8.4.7 Transportation-Hazardous Materials

Location

There are two significant transportation corridors in District 8: the Creek Turnpike, which runs east to west through the center of the District in between E 91st St and E 101st St., and, US Highway 64 (Memorial Rd.), which runs briefly north to south along the eastern most edge of the District. There are no railways or airports located in Council District 8. Transportation corridors in the District, along with their respective ¼ mile buffer areas, are shown on the map in Figure 5.8-23.

Impact/Vulnerability

A ¼-mile transportation buffer for the two transportation corridors would encompass 12.94 percent of Council District 8 (or 2.00 sq. mi.), 4,851 residents (based on 2010 Census of people per square mile), and one critical facility. According to Tulsa County Assessor data, 1,829 parcels in District 8 are within the buffer of a Highway or Interstate corridor, with a total assessed value, adjusted for fair market price, of $442,842,581. The numbers of parcels touched by the highway corridors in District 8 are summarized, by type, in Table 5.8-13.

Table 5.8–13: Tulsa Council District 8 Parcels Touched by ¼ mile Highway Corridor

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	1,761	$356,516,551
Residential Multi-Family	1	$8,315,302
Commercial	56	$75,209,353
Industrial	0	$0
Other	11	$2,801,375
Total	1,829	$442,842,581

Source: Tulsa County Assessor's Office, 2012

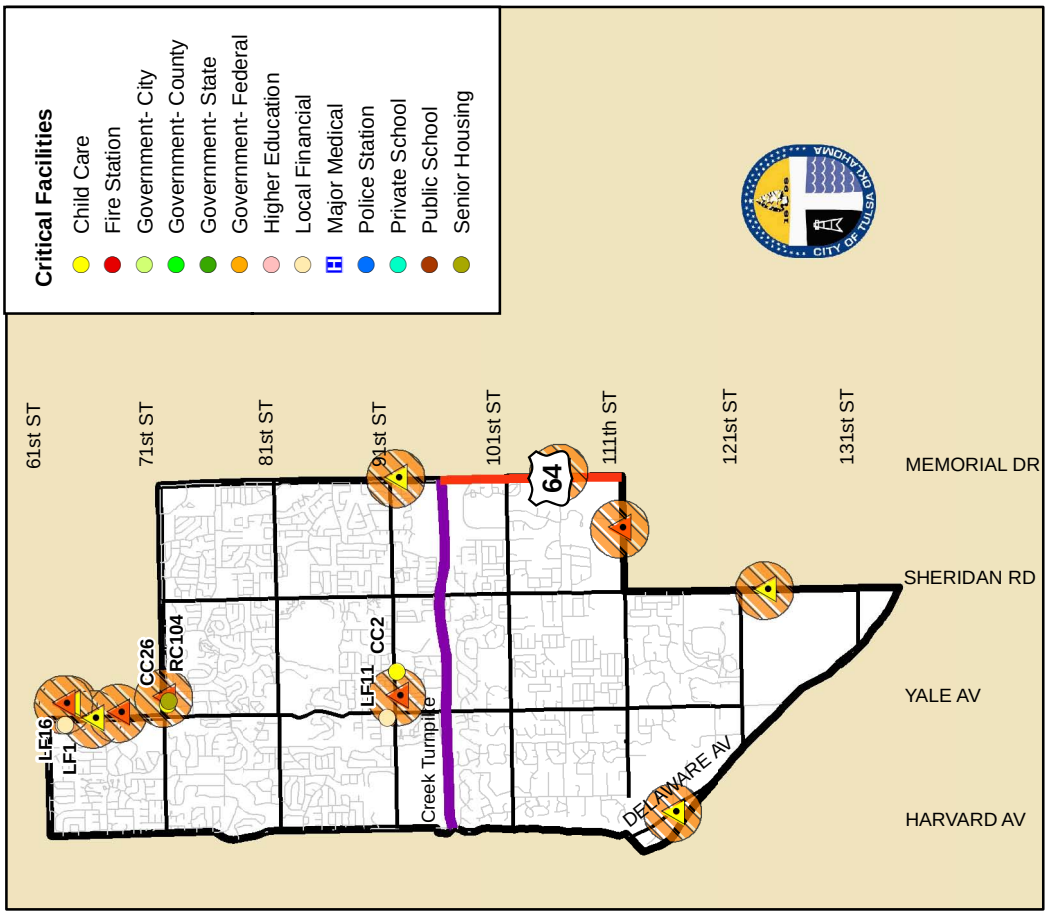


Figure 5.8-22

Tulsa Council District 8

Fixed Site Hazardous Materials

Figure 5.8-23

Tulsa Council District 8

Transportation Corridors

Critical Facilities

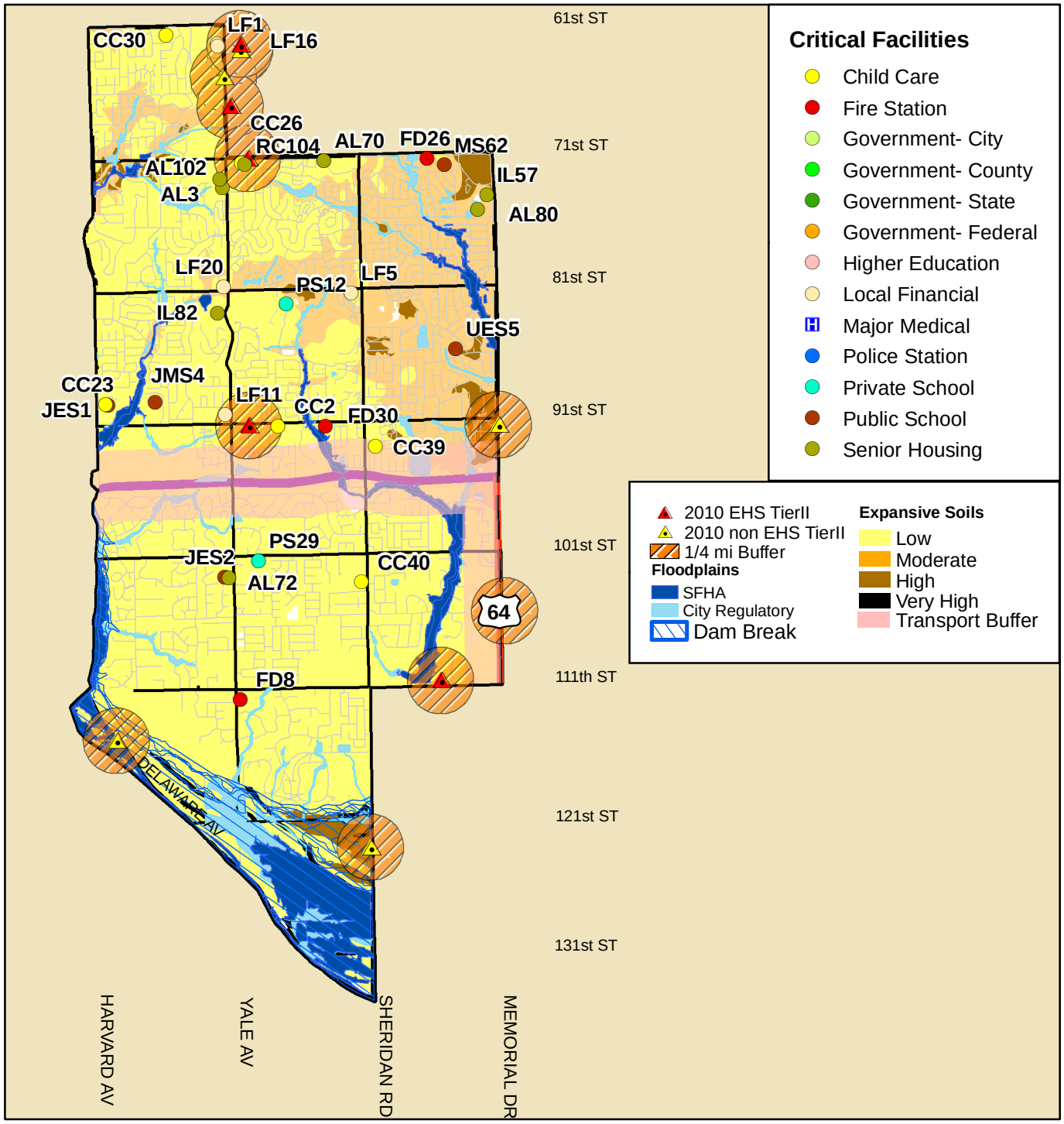
There is one critical facility that would be potentially impacted by a transportation incident involving a hazardous material release in the District, shown on the map in Figure 5.8-23. Effort should be made to ensure proper evacuation or shelter in place procedures are in place and practiced by staff and students of the facility.

Conclusion

Tulsa Council District 8 has a HIGH vulnerability to and MODERATE probability of the Transportation hazard.

5.8.4.8 Hazards Summary

Site-specific hazards, unique to Tulsa Council District 8, identified and mapped in this section, include Floods, Dam Failures, Expansive Soils, Wildfires, Hazardous Materials, and Transportation-Hazardous Materials. The Hazards Composite Map, shown in Figure 5.8-24, summarizes the areas of the District potentially impacted by these site-specific hazards.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets

0 0.5 1 Miles

Figure 5.8-24

Tulsa Council District 8

Hazard Composite

City of Tulsa Multi-Hazard Mitigation Plan Update

Tulsa City Council District 9

R.D. Flanagan & Associates

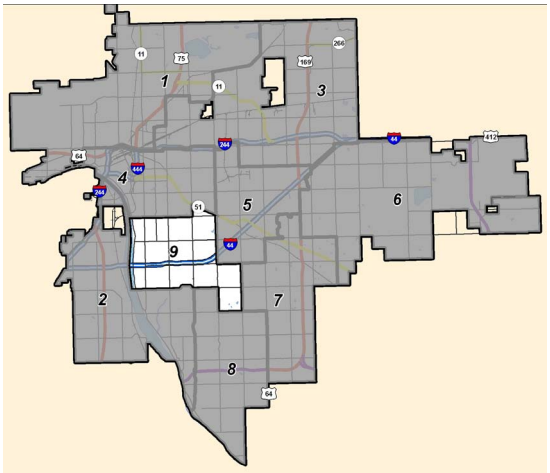
Planning Consultants

5.9 Tulsa City Council District 9

5.9.1 Introduction

5.9.1.1 Location

Figure 5.9–1: Tulsa Locator Map – District 9



Council District 9 is located in south-central Tulsa, as shown in the Locator Map at right. Total land area within District 9 consists of approximately 13.12 sq mi. As shown in the Base Map in Figure 5.9-2. The District is bounded generally on the north by E. 31st St. and the Broken Arrow Expy, on the east by S. Yale Ave. and S. Sheridan Rd., in the south by E. 61st St. and E. 71st St., and the west by the Arkansas River. The District slopes generally to the southwest, and is drained by Crow Creek, the Perryman Ditch, Joe Creek and its five tributary branches, and by a small stretch of Fred Creek in the extreme southeast corner. All streams drain west and south into the Arkansas River. The District includes Riverside Dr. and River Parks, Peoria Ave. and the Brookside business district, along with other major shopping nodes, including those on Harvard Ave. and Yale Ave., and is crossed from east to west by I-44 (Skelly Bypass). Since 1999, the District has been the home of the University of Oklahoma's Schusterman Center.

5.9.1.2 G.T Bynum-Councilor District 9

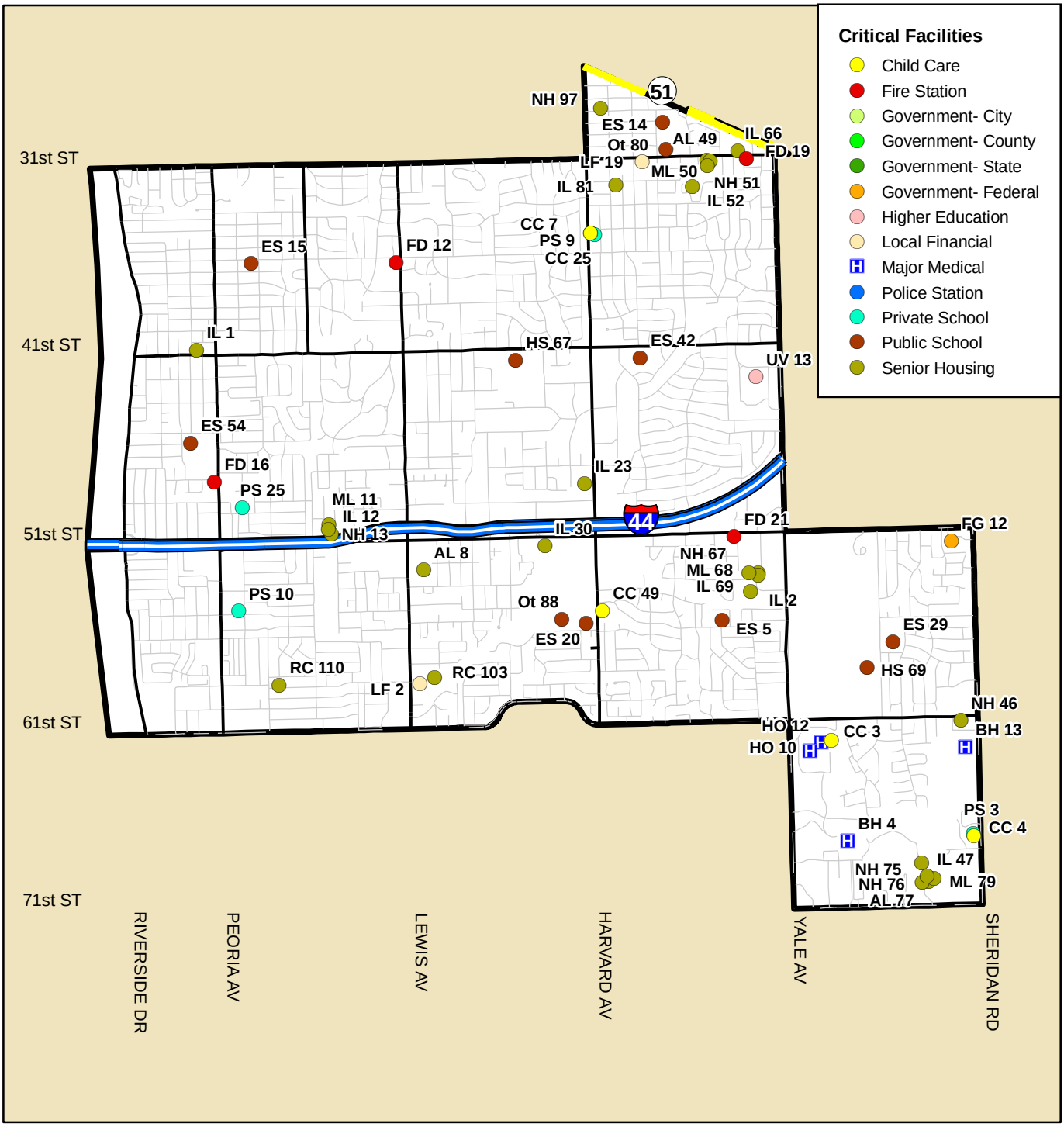
Councilor G.T. Bynum

Councilor G. T. Bynum was elected to the Tulsa City Council in 2008. In 2011, he was selected by his colleagues to serve as the youngest City Council Chairman in Tulsa history. During his time on the Tulsa City Council, Councilor Bynum worked to enact the largest streets improvement package in the City's history, crafted a budget amendment which put the Tulsa Police Department helicopters back into service, authored legislation creating the first municipal rainy day fund in Oklahoma, and coordinated efforts to establish the first municipal Veterans Treatment Court in the United States. Councilor Bynum is the managing partner of Capitol Ventures, a firm with offices in Tulsa and Washington, D.C., which assists Oklahoma companies with federal contracting and business development. Councilor Bynum currently serves on the Board of Directors for the Tulsa Historical Society and the Advisory Board for the University Of Oklahoma School Of Urban Design. He has previously served as a board member for Leadership Tulsa. In 2011, Councilor Bynum was selected as an Aspen Institute Rodel Fellow. *(Source: http://www.tulsacouncil.org/)*

5.9.1.3 History

Cultural and Historic Properties

Tulsa Council District 9 is home to three cultural sites and three historic sites, all are displayed on the map in Figure 5.9-3. Cultural sites include: the Brookside Library, Herman & Kate Kaiser Library,



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets
- Railroads

0 0.5 1 Miles

Figure 5.9-2

Tulsa Council District 9

Basemap

and the Schusterman-Benson Library. The District also contains three historic sites: the art deco City Veterinary Hospital in Brookside, the mid-century modern Robert Lawton Jones House, and Westhope, the Richard Lloyd Jones house designed by Frank Lloyd Wright. City Veterinary Hospital was listed on the National Register of Historic Places on August 26, 2008. It was listed under National Register Criteria C, and its NRIS number is 08000848. Robert Lawton Jones House was listed in the National Register on December 13, 2001. It was listed under Criterion C and its NRIS number is 01001355. Westhope was listed on April 10, 1975 under Criteria C, G, and its NRIS number is 75001575.

5.9.1.4 Demographics

Council District 9 had a 2010 Census population of 43,080. Table 5.9-1 includes the demographic makeup of Council District 9. A map displaying the population density of District 9 is shown in Figure 5.9-4. Maps presenting the demographic information listed in the table are included in Figures 5.9-5 through 5.9-12.

Table 5.9–1: Tulsa Council District 9 Demographic Information

Category	District	Tulsa
Persons under 5 years of age	6.07%	7.53%
Persons under age 18	18.73%	24.44%
Persons age 65 and older	17.97%	12.46%
Poverty Status in 2010 (individuals)	13.01%	19.36%
White	78.86%	62.81%
Native-American	4.96%	5.35%
African American	7.23%	15.67%
Asian	1.19%	2.39%
Hispanic	6.74%	13.93%
Total Population	43,080	401,265

Source: 2010 US Census

5.9.1.5 Infrastructure

Tulsa Council District 9 is dependent upon the lifelines of the City of Tulsa as identified in Section 1.2.6 of this Plan Update. Any unique vulnerability of Tulsa Council District 9 to the seven site-specific hazards identified in this plan will be addressed in Section 5.9.4, below.

5.9.1.6 Economy

The 2010 US Census identified an income level of approximately $22,133 as the average poverty threshold for a family of four, including two children. Approximately 5,606 individuals or 13.01 percent of all individuals in District 9 were living below the poverty line in 2010.

5.9.1.7 Development

According to the Tulsa County Assessor's Office, there are 15,994 properties with improvements within District 9, with a total assessed value, adjusted for fair market price, of $2,558,161,192. The numbers of properties with improvements and improvement values, by type, are shown in Table 5.9-2. No land, contents or tax exempt values are included. Tulsa Council District 9 is made up of 31 homeowner groups and associations, as displayed in Figure 5.9-13.

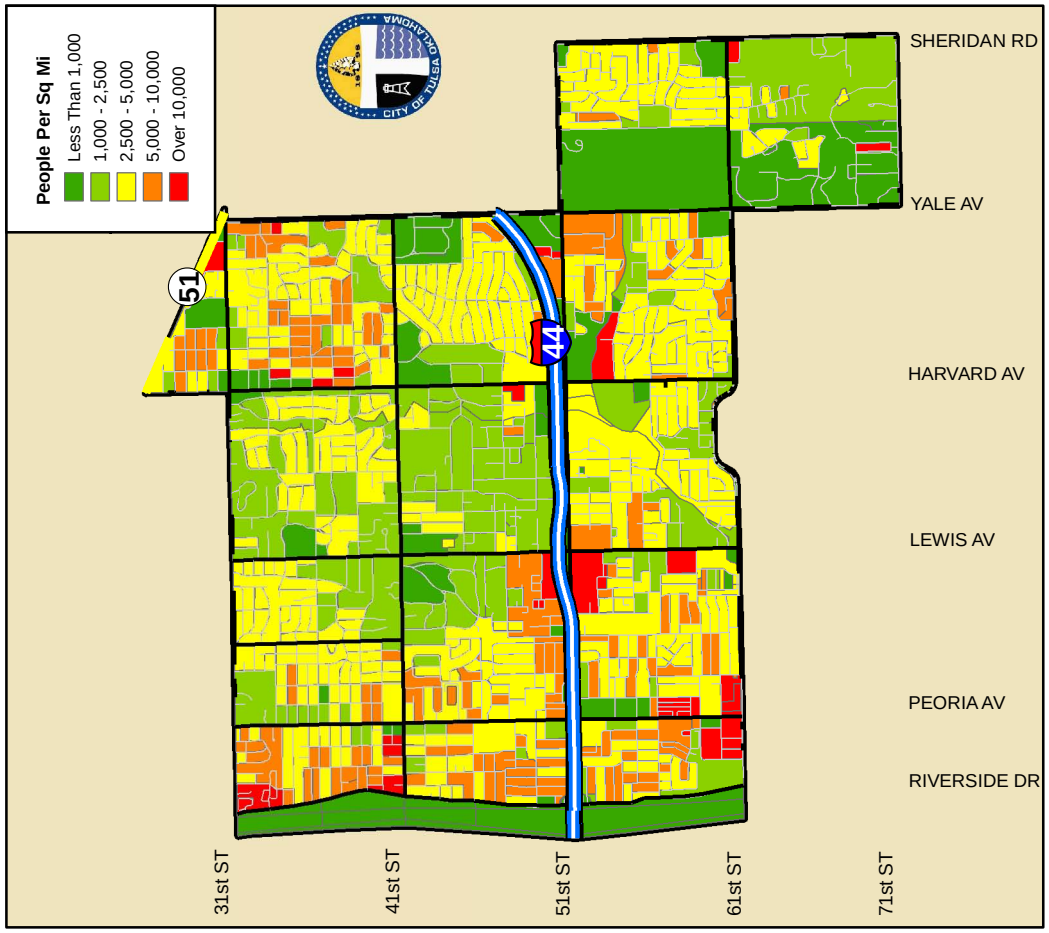


Figure 5.9-4

Tulsa Council District 9

Population Density

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets
- Railroads

0 0.5 1 Miles

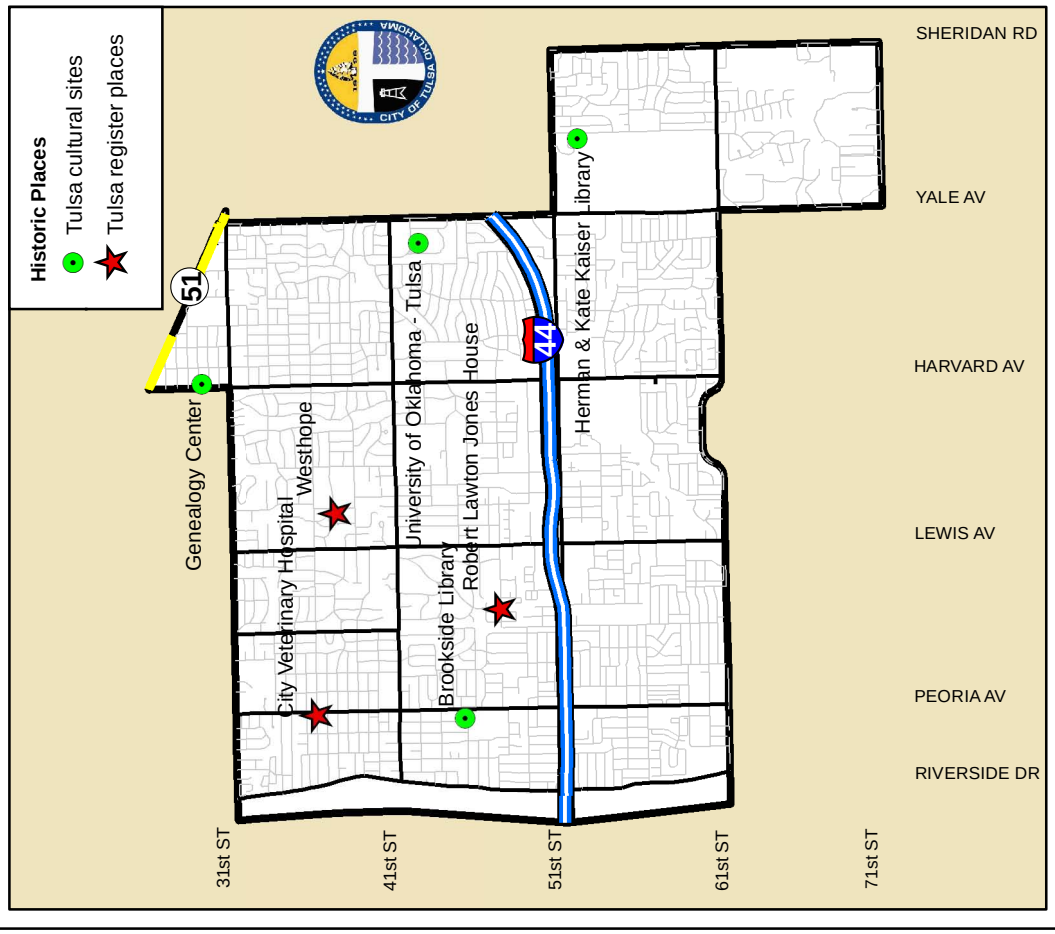


Figure 5.9-3

Tulsa Council District 9

Cultural and Historic Places

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets
- Railroads

0 0.5 1 Miles

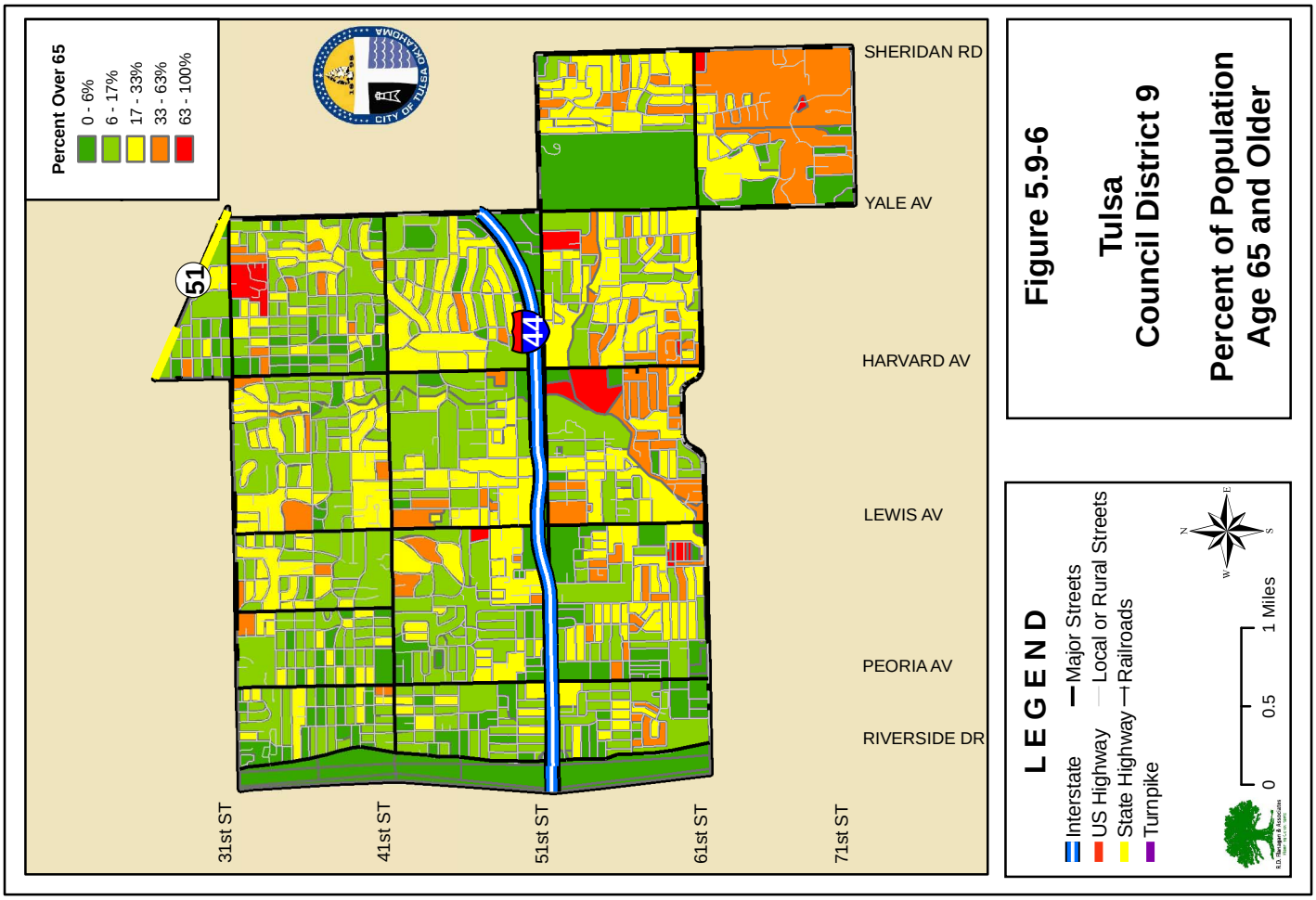


Figure 5.9-6

Tulsa Council District 9

Percent of Population Age 65 and Older

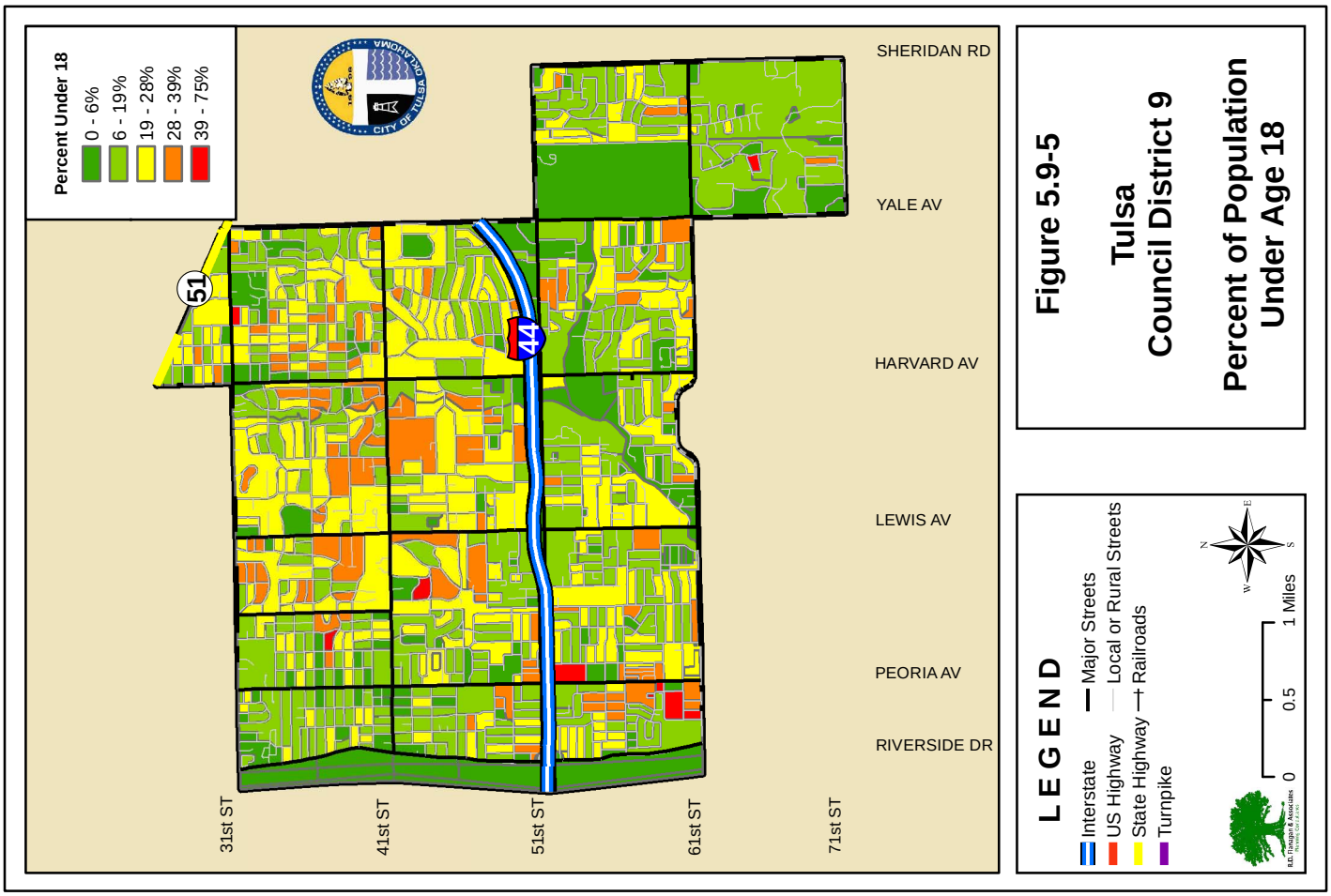


Figure 5.9-5

Tulsa Council District 9

Percent of Population Under Age 18

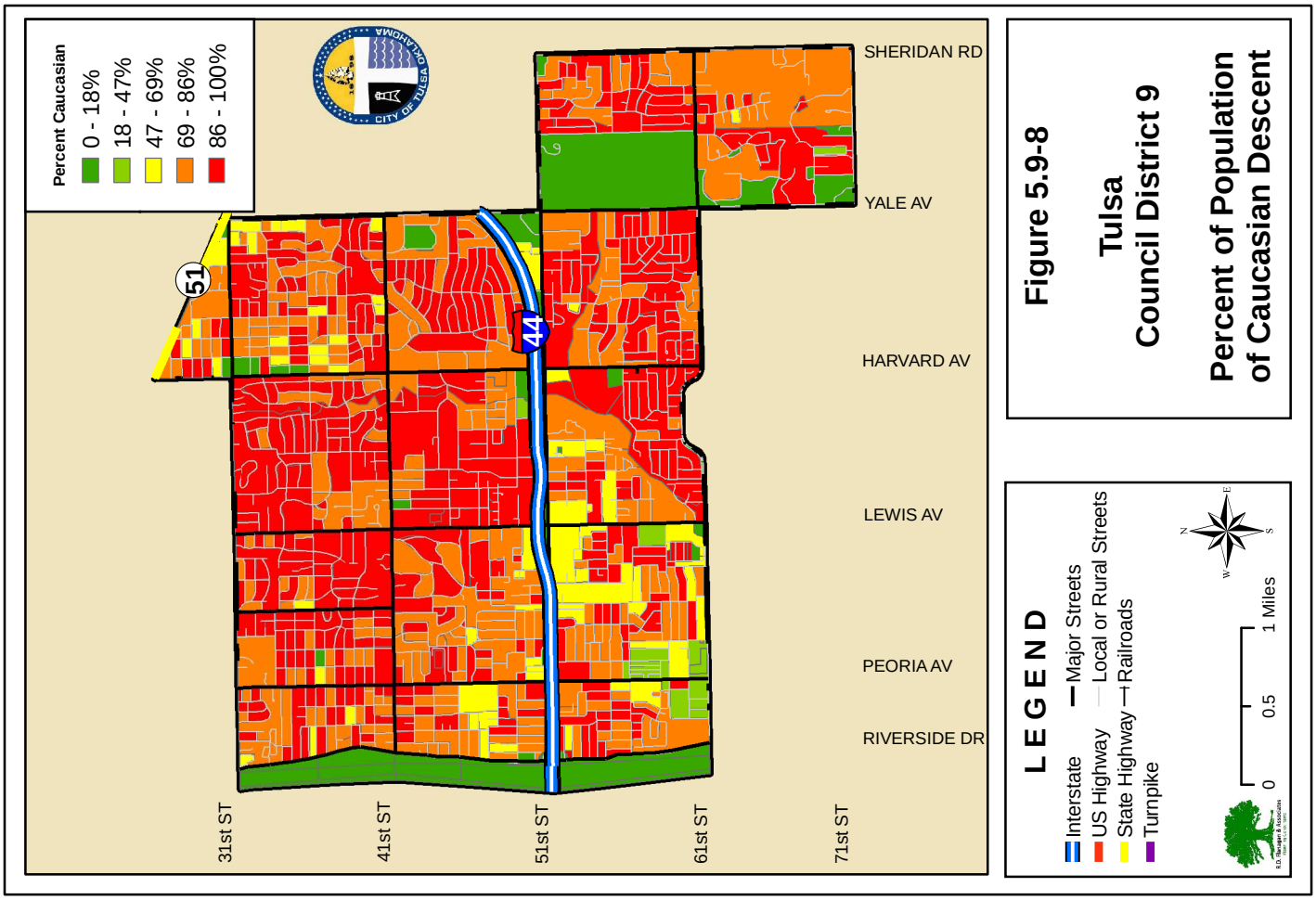


Figure 5.9-8

Tulsa Council District 9

Percent of Population of Caucasian Descent

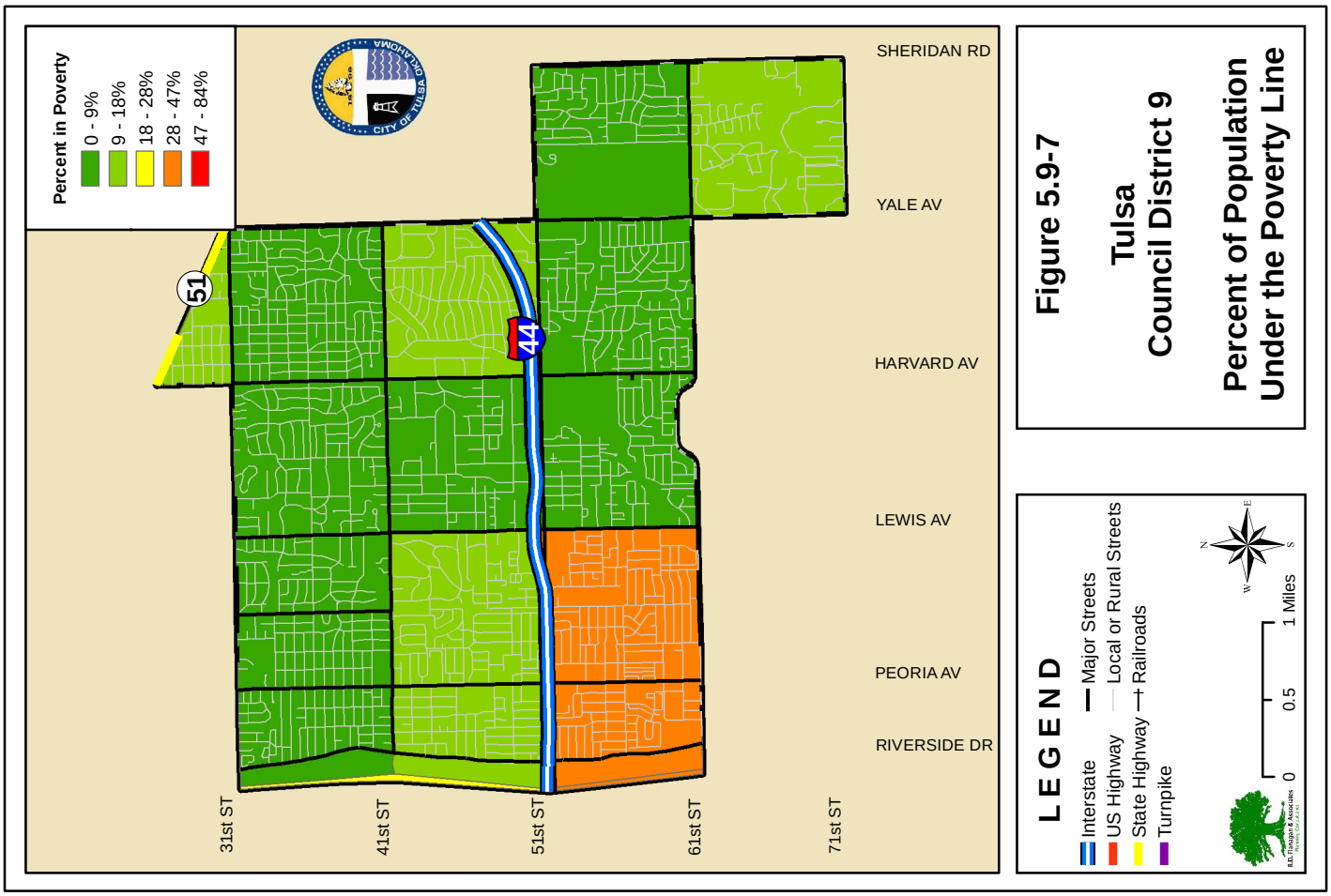


Figure 5.9-7

Tulsa Council District 9

Percent of Population Under the Poverty Line

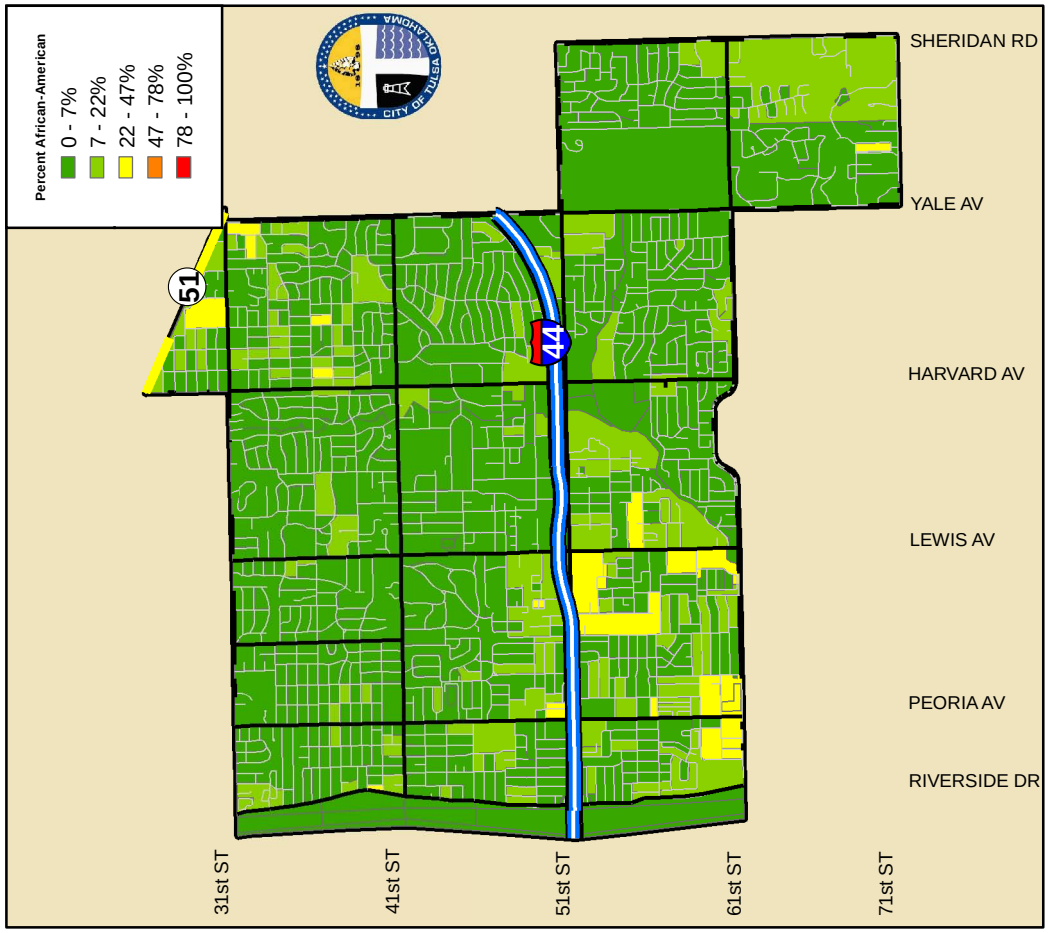


Figure 5.9-10

Tulsa Council District 9

Percent of Population of African-American Descent

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets
- Railroads

0 0.5 1 Miles

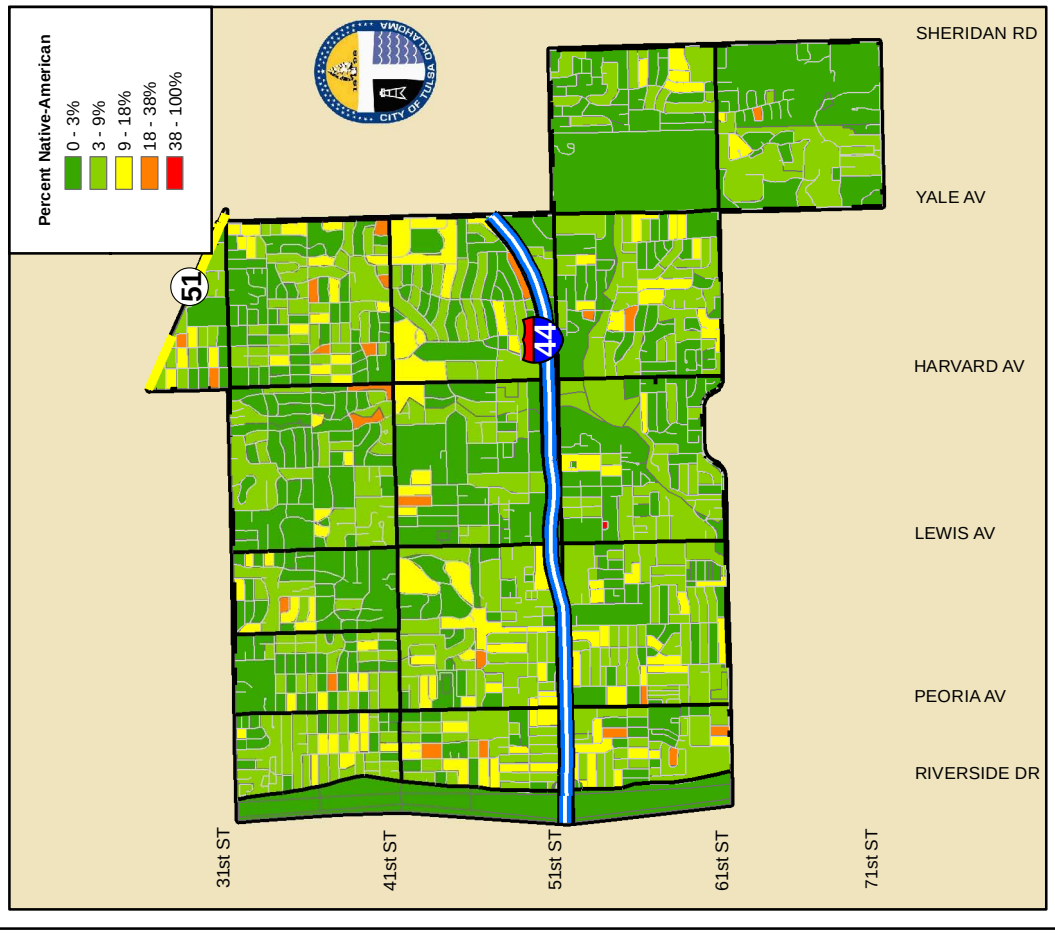


Figure 5.9-9

Tulsa Council District 9

Percent of Population of Native-American Descent

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets
- Railroads

0 0.5 1 Miles

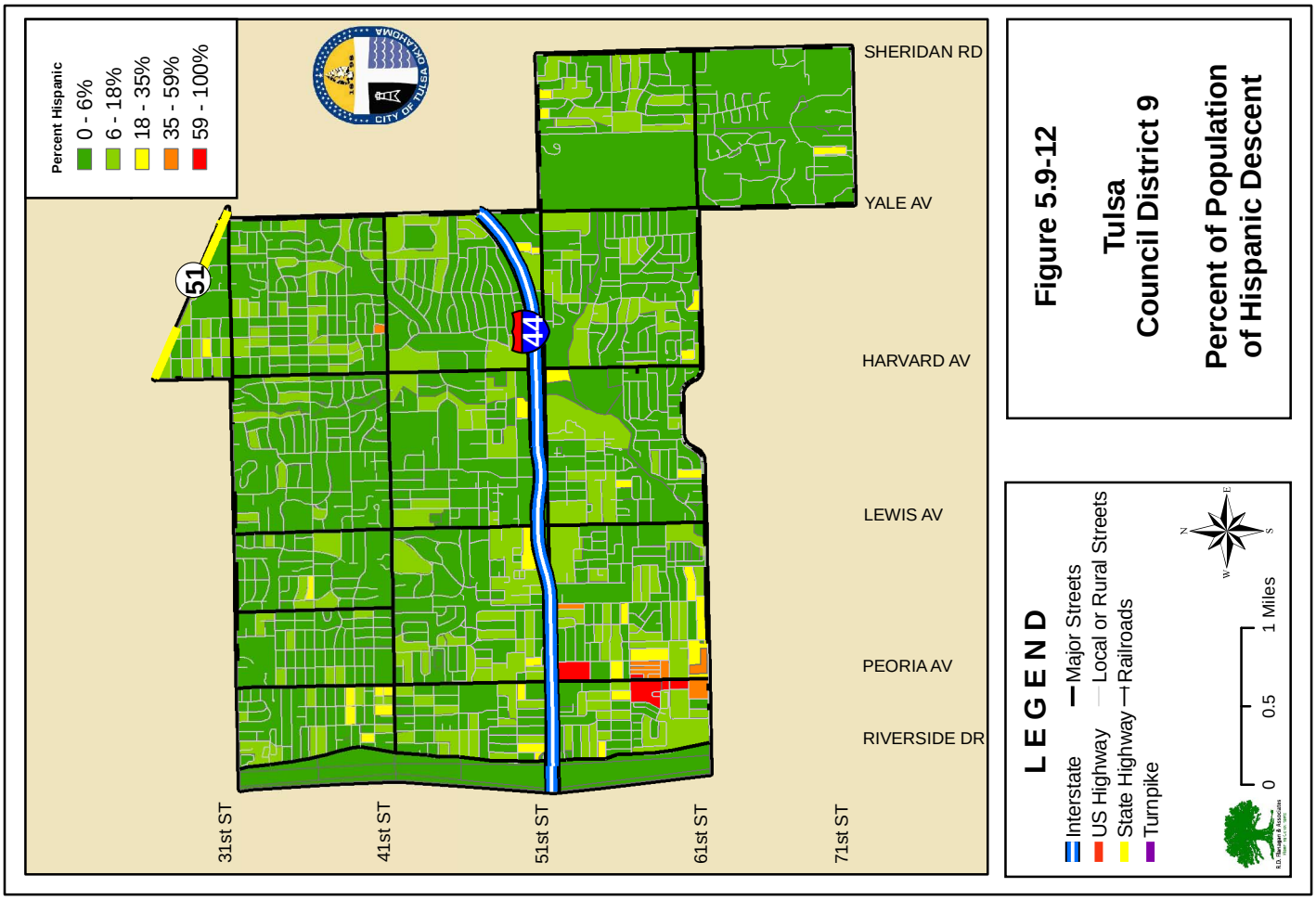


Figure 5.9-12
Tulsa
Council District 9
Percent of Population of Hispanic Descent

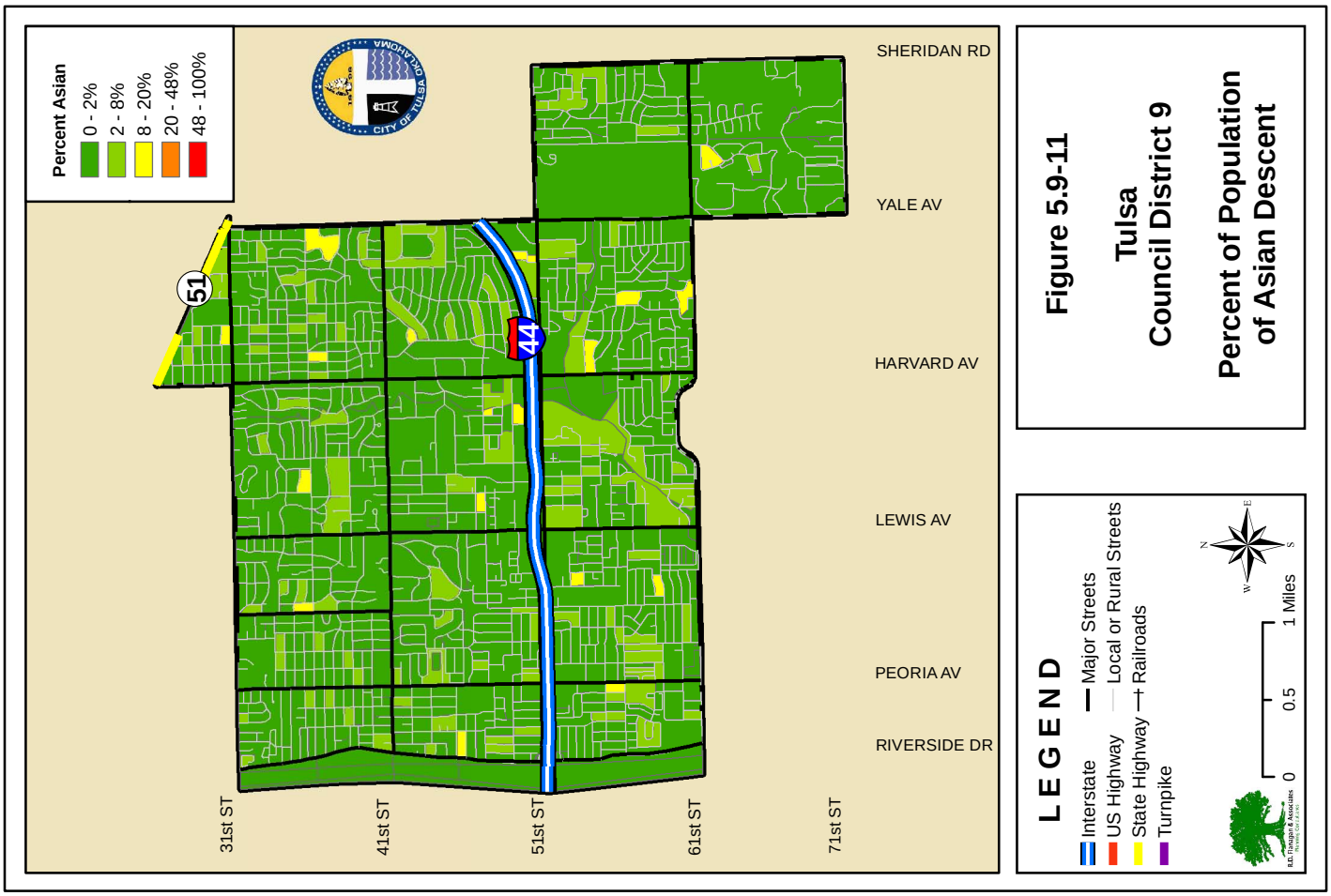


Figure 5.9-11
Tulsa
Council District 9
Percent of Population of Asian Descent

Table 5.9–2: Tulsa Council District 9 Property Types by Assessed Values

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	14,888	$1,938,088,249
Residential Multi-Family	401	$152,771,721
Commercial	535	$336,008,183
Industrial	2	$379,741
Other	168	$130,913,298
Total	15,994	$2,558,161,192

Source: Tulsa County Assessor's Office, 2012

Zoning

Tulsa Council District 9 is primarily zoned for single-family residential and commercial uses with, multi-family, tax exempt, and industrial distributed throughout. A map of zoning areas in Council District 9 is shown in Figure 5.9-14.

Future Development

The City of Tulsa will continue to improve District 9's service infrastructures, such as flood control, water, sanitary sewer, and streets. For information regarding future development in the City of Tulsa, see Section 1.2.8.

5.9.1.8 Critical Facilities

There are 58 critical facilities in Tulsa Council District 9. Critical facilities in the District are listed in Table 5.9-3 and mapped in Figure 5.9-2.

Table 5.9–3: Tulsa Council District 9 Critical Facilities

ID	Map ID	Facility Name	Address
		Fire Station	
FD	12	Tulsa Fire Department #14	3602 S. Lewis Ave
FD	16	Tulsa Fire Department #18	4802 S. Peoria Ave
FD	19	Tulsa Fire Department #21	4606 E. 31st St
FD	21	Tulsa Fire Department #23	4348 E. 51st St
		Government- Federal	
FG	12	USPS - Sheridan Tulsa Post Office	6110 E. 51st St
		Tulsa Public School	
ES	5	Carnegie Elementary School	4309 E. 56th St
ES	14	Eisenhower International School	2819 S. New Haven Ave
ES	15	Eliot Elementary School	1442 E. 36th St
ES	20	Grimes Elementary School	3111 E. 56th St
ES	29	Key Elementary School	5840 S. Hudson Ave
ES	42	Patrick Henry Elementary School	3820 E. 41st St
ES	54	Wright Elementary School	110 E. 45th Pl
HS	67	Edison Preparatory High School/ Middle School	2906 E. 41st St
HS	69	Memorial High School	5840 S. Hudson Ave
Ot	80	Charles C. Mason Education Service Center	3027 S. New Haven Ave
Ot	88	Nimitz Middle School (Storage)	3111 E. 56th St

ID	Map ID	Facility Name	Address
		Private School	
PS	3	Bethany Christian School	6730 S. Sheridan Rd
PS	9	Early Learning Center - Christ UMC	3515 S. Harvard
PS	10	Evangelistic Temple School	1339 E. 55th St
PS	25	School of Saint Mary	1365 E. 49th Pl
		Child Care	
CC	3	Ave Maria House	6161 S. Yale
CC	7	Christ Methodist ELC	3515 S. Harvard Ave.
CC	25	Kid's Connection Child Development Center	3515 S. Harvard
CC	30	Kirk Of The Hills Preschool	4102 E. 61st St.
CC	49	WABC Learning Center Inc.	5511 S. Harvard
		Higher Education	
UV	13	University of Oklahoma Schusterman Center	4502 E. 41st St.
		Major Medical	
BH	4	Laureate Psychiatric Clinic & Hospital	6655 S. Yale Ave
HO	10	Saint Francis Hospital	6161 S. Yale Ave
HO	12	Select Specialty Hospital - Tulsa	6161 S. Yale Ave, 5 South
BH	13	Shadow Mountain Behavioral Health System	6262 S. Sheridan Rd
		Long Term Care	
IL	1	4100 Apartments	3933 S. Norfolk Ave
IL	2	5400 South Apartments	4700 E. 54th St
AL	8	Brighton Gardens	5211 S. Lewis Ave
ML	11	Colonial Manor	5015 S. Victor Ave
IL	12	Colonial Manor	5015 S. Victor Ave
NH	13	Colonial Manor Nursing & Rehab Center	1815 E. Skelly Dr
IL	23	French Villa	4752 S. Harvard Ave
IL	30	Heatherwood Apartments	3006 E. 51st St
NH	46	Maplewood Care Center	6202 E. 61st St
IL	47	Montereau in Warren Woods	6800 S. Granite
AL	49	Oklahoma Methodist Manor	4134 E. 31st St
ML	50	Oklahoma Methodist Manor	4134 E. 31st St
NH	51	Oklahoma Methodist Manor	4134 E. 31st St
IL	52	Oklahoma Methodist Manor	4134 E. 31st St
IL	66	Southern Elms	4519 E. 31st St
NH	67	Southern Hills Rehab Center	5170 S. Vandalia
ML	68	Southern Hills Retirement Community	5170 S. Vandalia
IL	69	Southern Hills Retirement Community - The Villa	4515 E. 53rd St
NH	75	The Health Care Centers @ Montereau - Memory Support	6800 S. Granite
NH	76	The Health Care Centers @ Montereau - Skilled Nursing	6800 S. Granite
AL	77	The Health Centers @ Montereau - The Villa	6800 S. Granite Ave
ML	79	The Montereau in Warren Woods	6800 S. Granite
IL	81	The Scandia	3510 E. 32nd St

ID	Map ID	Facility Name	Address
NH	97	Wildwood Care Center	3333 E. 28th St
CC	103	The Villages at Southern Hills	5721 S. Lewis Ave
RC	110	Naquitas Niche, LLC	1521 E. 59th St
Local Financial			
LF	2	American TrustCorp	5727 S. Lewis Ave
LF	19	Tulsa Teachers Credit Union	3720 E. 31st St

5.9.2 Existing Mitigation Strategies

Existing mitigation measures currently being implemented throughout the City of Tulsa are detailed in Chapter 2, *Existing Mitigation Strategies*. The information that follows in this section surveys the infrastructure in place for avoiding or mitigating the impacts of natural hazards in District 9.

5.9.2.1 Council District 9 Warning Systems

Warning Sirens

At the time of this plan update there were seven warning sirens located in Tulsa Council District 9 and seven located outside of, but with partial coverage within, the District. Each warning siren is audible for up to a mile. Information regarding the testing of warning sirens in Tulsa is included in Chapter 2. Locations of sirens in District 9 are identified in Figure 5.9-15.

Lightning Sensing and Warning

The City of Tulsa is home to multiple outdoor recreation areas for public use. There are nine parks in District 9, as shown in Figure 5.9-16. These include LaFortune Park and Golf Course, sections of Riverparks, and multiple urban parks.

As discussed in Chapter 4, it is important that outdoor recreation areas be equipped with lightning sensing and warning systems. Tulsa Public Schools and the University of Tulsa use ThorGuard© to warn of lightning danger at outdoor recreation areas. A map showing ThorGuard© coverage areas in Tulsa is shown in Chapter 2, Figure 2-4.

Public school districts in the surrounding Tulsa Metro Area should be encouraged to purchase and install lightning warning systems. Private schools in the area school also be informed of their options and encouraged to install lightning warning systems for coverage at outdoor recreation areas.

5.9.3 Planning Process

The CAC/TAC met monthly during the planning process to review progress, identify issues, receive task assignments, and advise the consultants. Refer to Appendix C for meeting agendas.

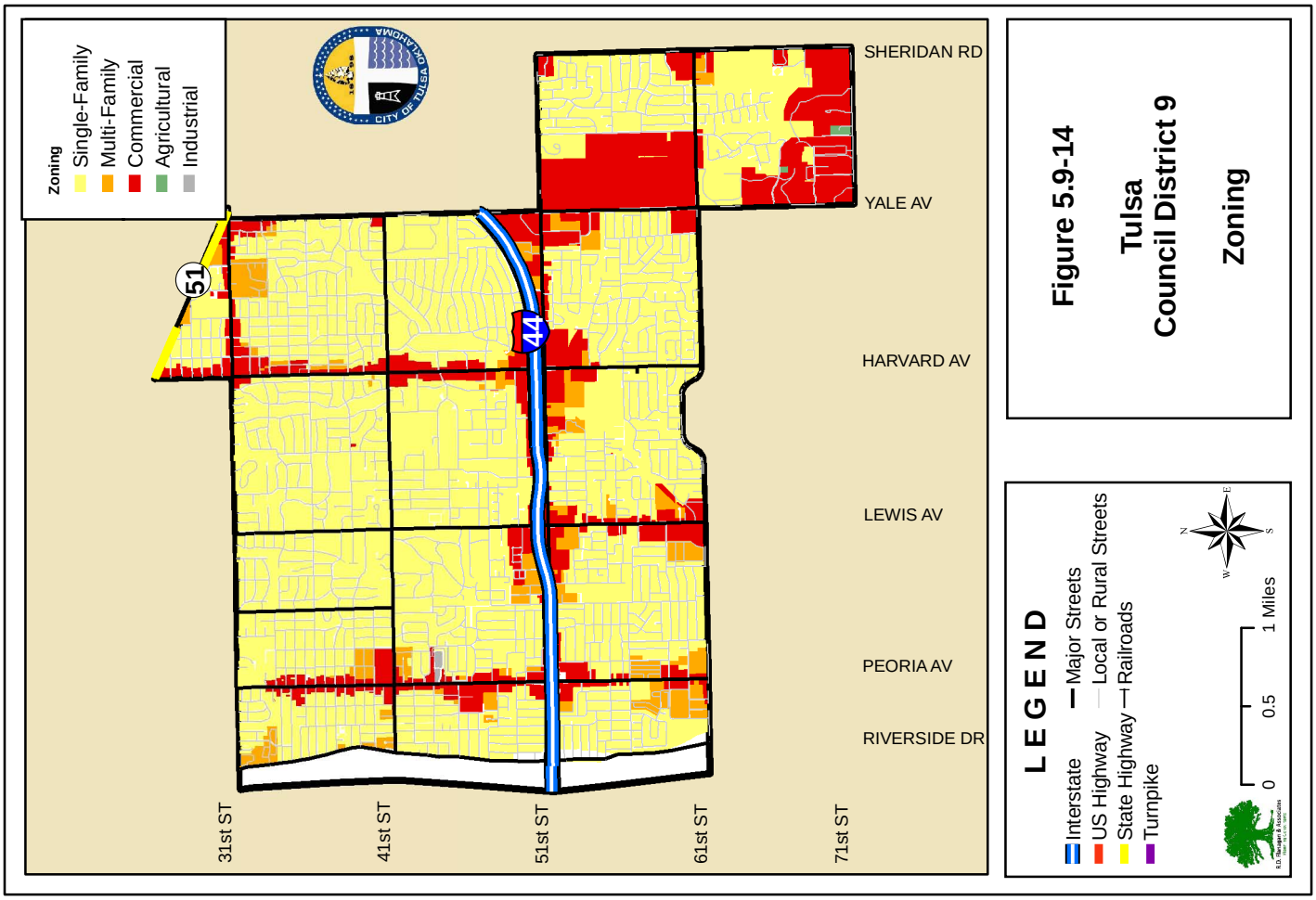


Figure 5.9-14
Tulsa Council District 9
Zoning

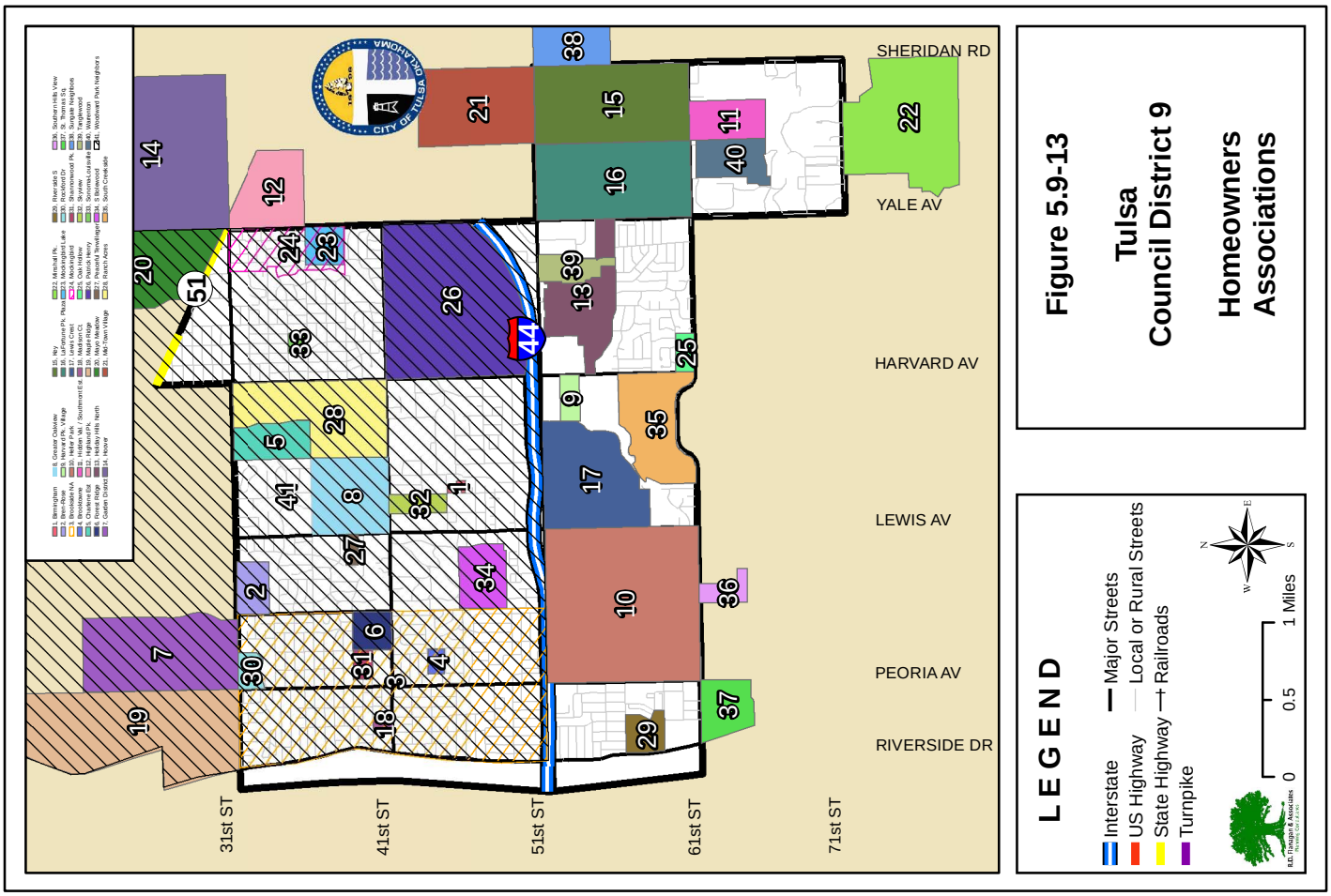
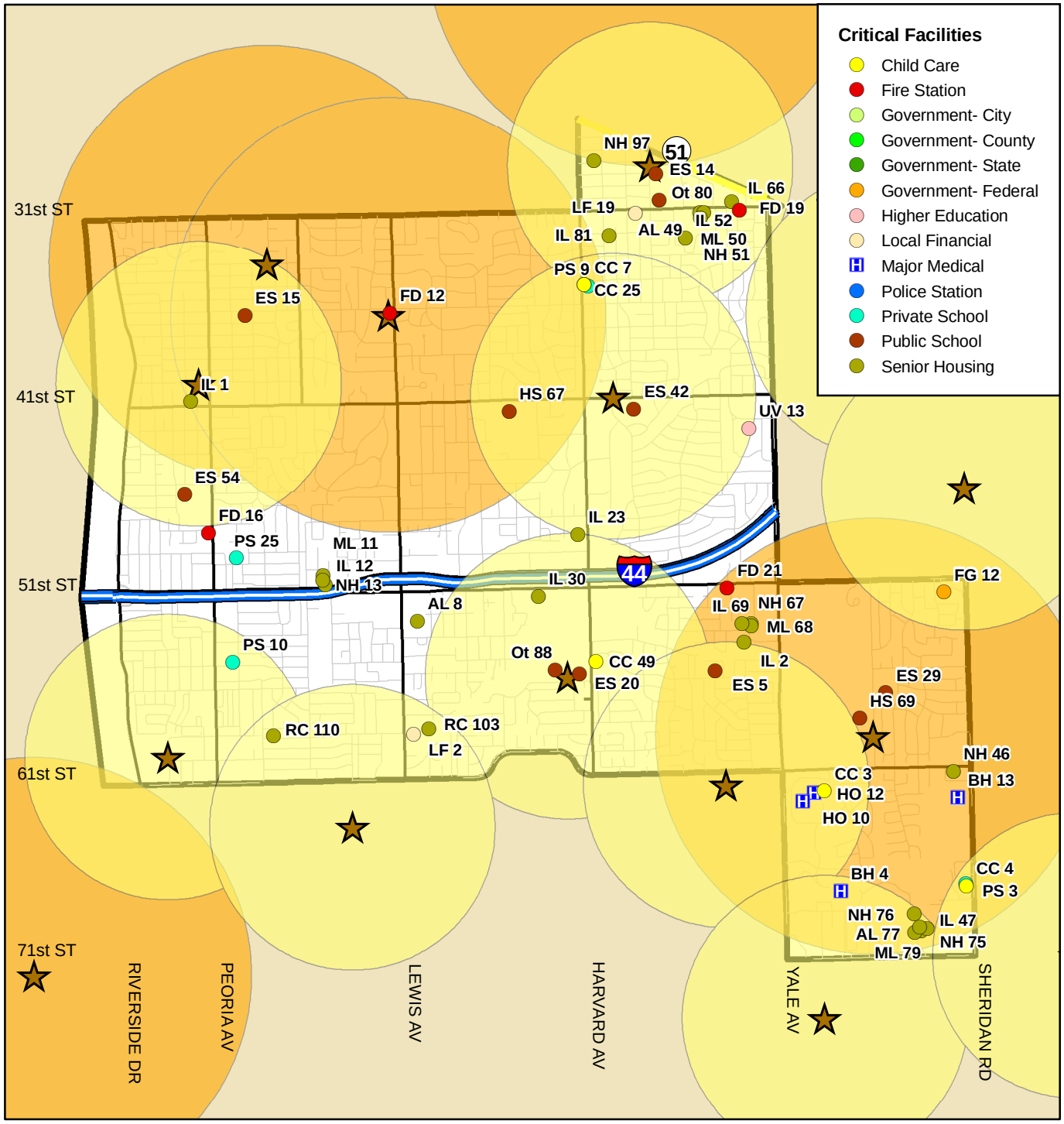


Figure 5.9-13
Tulsa Council District 9
Homeowners Associations



LEGEND

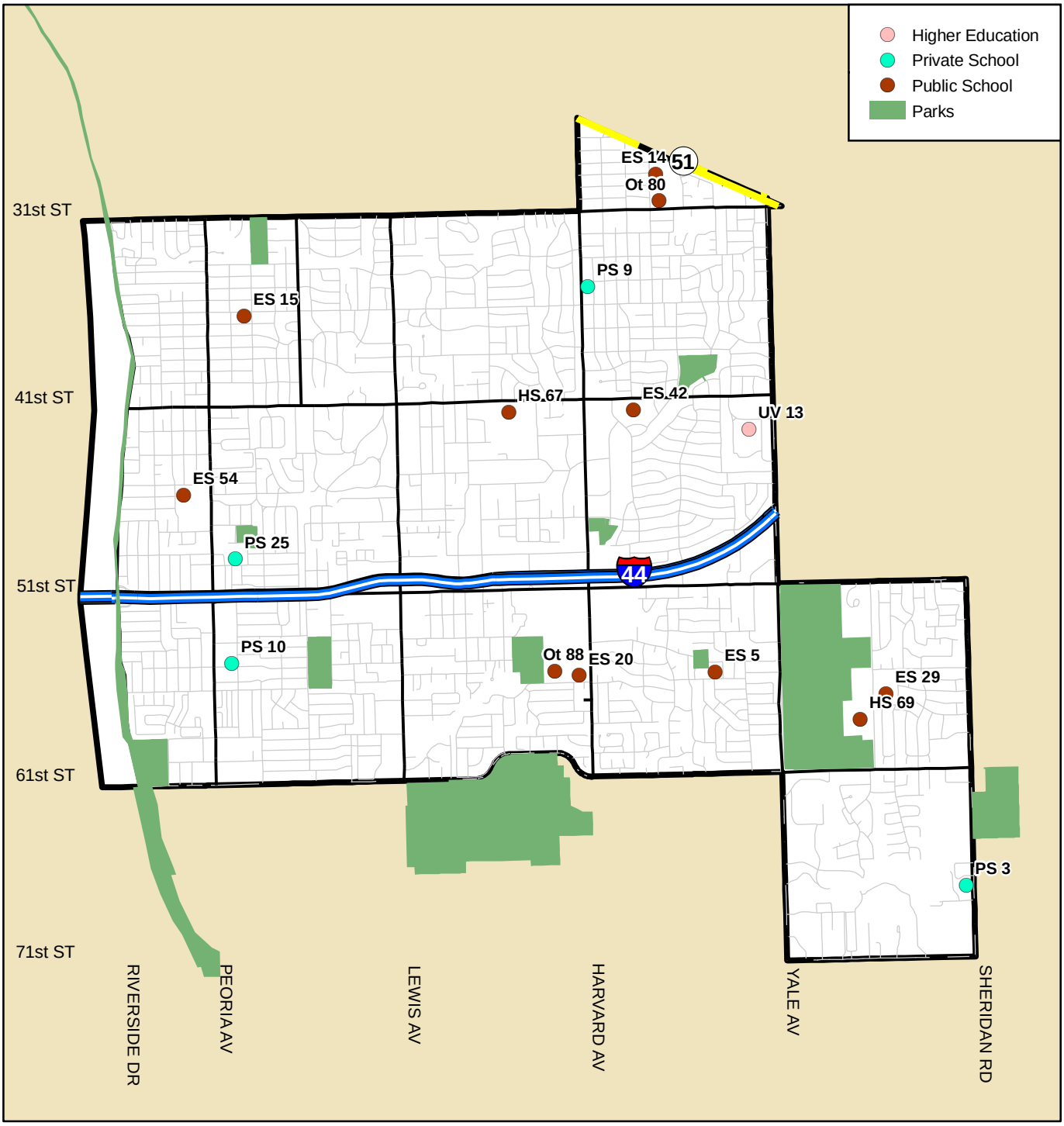
- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets
- Railroads

0 0.5 1 Miles

Figure 5.9-15

Tulsa Council District 9

Warning Sirens



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets
- Railroads

0 0.5 1 Miles

Figure 5.9-16

Tulsa Council District 9

Schools & Parks

5.9.4 Natural and Manmade Hazards

Hazards

Table 5.9-4 identifies the six site-specific hazards the can particularly impact Tulsa Council District 9. Site specific hazards, such as Flooding, Dam Failures, Levee Failures, Expansive Soils, Wildfires, Fixed Site Hazardous Materials and Transportation-Hazardous Materials are addressed for Council District 9 in subsections 5.9.4.1 through 5.9.4.7, and are summarized in subsection 5.9.4.8 and Figure 5.9-24.

General natural hazards, such as Tornadoes, High Winds, Lightning, Hail, Winter Storms, Extreme Heat, Drought, and Earthquakes affect all areas in the City of Tulsa randomly and equally, and are addressed in Chapter 4.

Table 5.9–4: Tulsa Council District 9 Site-Specific Hazard Impacts

Hazard	Area (Sq. mi)	Improved Parcels	Est. Market Value	Percent of Area Impacted	Impacted Population
Floods	1.85	1,797	$265,725,614	14.10%	5,367
Dam Failures	3.98	6,304	$708,749,020	30.34%	17,646
Levee Failure	0	0	0	0	0
Expansive Soils	3.36	4,241	$772,278,135	25.61%	10,333
Wild Fires	.02	2	$179,000	0.15%	0
Tier II Hazardous Materials	1.22	1,595	$360,851,080	9.30%	3,543
Transportation HazMat-Highway	2.34	2,664	$431,983,839	17.84%	8,273
Transportation HazMat- Railroad	0.28	367	$38,829,319	2.13%	1,203

Tulsa Council District 9 has identified certain facilities as critical to the health, safety and welfare of its citizens, business and economy. Table 5.9-5 indicates, generally, the exposure of critical facilities to the site-specific hazards covered by this Plan Update.

Table 5.9–5: Tulsa Council District 9 Hazard Impacts on Critical Facilities

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Hazardous Material Sites	Transportation-Hazard
FD	12	Tulsa Fire Department #14	X	X	X	X	X	X	X	X	X						X	
FD	16	Tulsa Fire Department #18	X	X	X	X	X	X	X	X	X		X					
FD	19	Tulsa Fire Department #21	X	X	X	X	X	X	X	X	X							X
FD	21	Tulsa Fire Department #23	X	X	X	X	X	X	X	X	X				X			X
FG	12	USPS - Sheridan Tulsa Post Office	X	X	X	X	X	X	X	X	X				X			
ES	5	Carnegie Elementary School	X	X	X	X	X	X	X	X	X				X			
ES	14	Eisenhower International School	X	X	X	X	X	X	X	X	X							X

ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Hazardous Material Sites	Transportation-Hazard
ES	15	Eliot Elementary School	X	X	X	X	X	X	X	X	X		X					
ES	20	Grimes Elementary School	X	X	X	X	X	X	X	X	X				X			
ES	29	Key Elementary School	X	X	X	X	X	X	X	X	X				X			
ES	42	Patrick Henry Elementary School	X	X	X	X	X	X	X	X	X				X			
ES	54	Wright Elementary School	X	X	X	X	X	X	X	X	X		X					
HS	67	Edison Preparatory High School/ Middle School	X	X	X	X	X	X	X	X	X							
HS	69	Memorial High School	X	X	X	X	X	X	X	X	X				X			
Ot	80	Charles C. Mason Education Service Center	X	X	X	X	X	X	X	X	X							X
Ot	88	Nimitz Middle School (Storage)	X	X	X	X	X	X	X	X	X				X			
PS	3	Bethany Christian School	X	X	X	X	X	X	X	X	X							
PS	9	Early Learning Center - Christ UMC	X	X	X	X	X	X	X	X	X						X	
PS	10	Evangelistic Temple School	X	X	X	X	X	X	X	X	X		X					
PS	25	School of Saint Mary	X	X	X	X	X	X	X	X	X		X					X
CC	3	Ave Maria House	X	X	X	X	X	X	X	X	X						X	
CC	4	Bethany Community School	X	X	X	X	X	X	X	X	X							
CC	7	Christ Methodist ELC	X	X	X	X	X	X	X	X	X						X	
CC	25	Kid's Connection Child Development Ctr	X	X	X	X	X	X	X	X	X						X	
CC	49	WABC Learning Ctr Inc.	X	X	X	X	X	X	X	X	X				X			
UV	13	University of Oklahoma Schusterman Center	X	X	X	X	X	X	X	X	X						X	
BH	4	Laureate Psychiatric Clinic & Hospital	X	X	X	X	X	X	X	X	X						X	
HO	10	Saint Francis Hospital	X	X	X	X	X	X	X	X	X						X	
HO	12	Select Specialty Hospital - Tulsa	X	X	X	X	X	X	X	X	X						X	
BH	13	Shadow Mountain Behavioral Health System	X	X	X	X	X	X	X	X	X							
IL	1	4100 Apartments	X	X	X	X	X	X	X	X	X		X					
IL	2	5400 South Apartments	X	X	X	X	X	X	X	X	X	X			X			
AL	8	Brighton Gardens	X	X	X	X	X	X	X	X	X							X
ML	11	Colonial Manor	X	X	X	X	X	X	X	X	X	X	X					X
IL	12	Colonial Manor	X	X	X	X	X	X	X	X	X	X	X					X
NH	13	Colonial Manor Nursing & Rehab Center	X	X	X	X	X	X	X	X	X	X	X					X

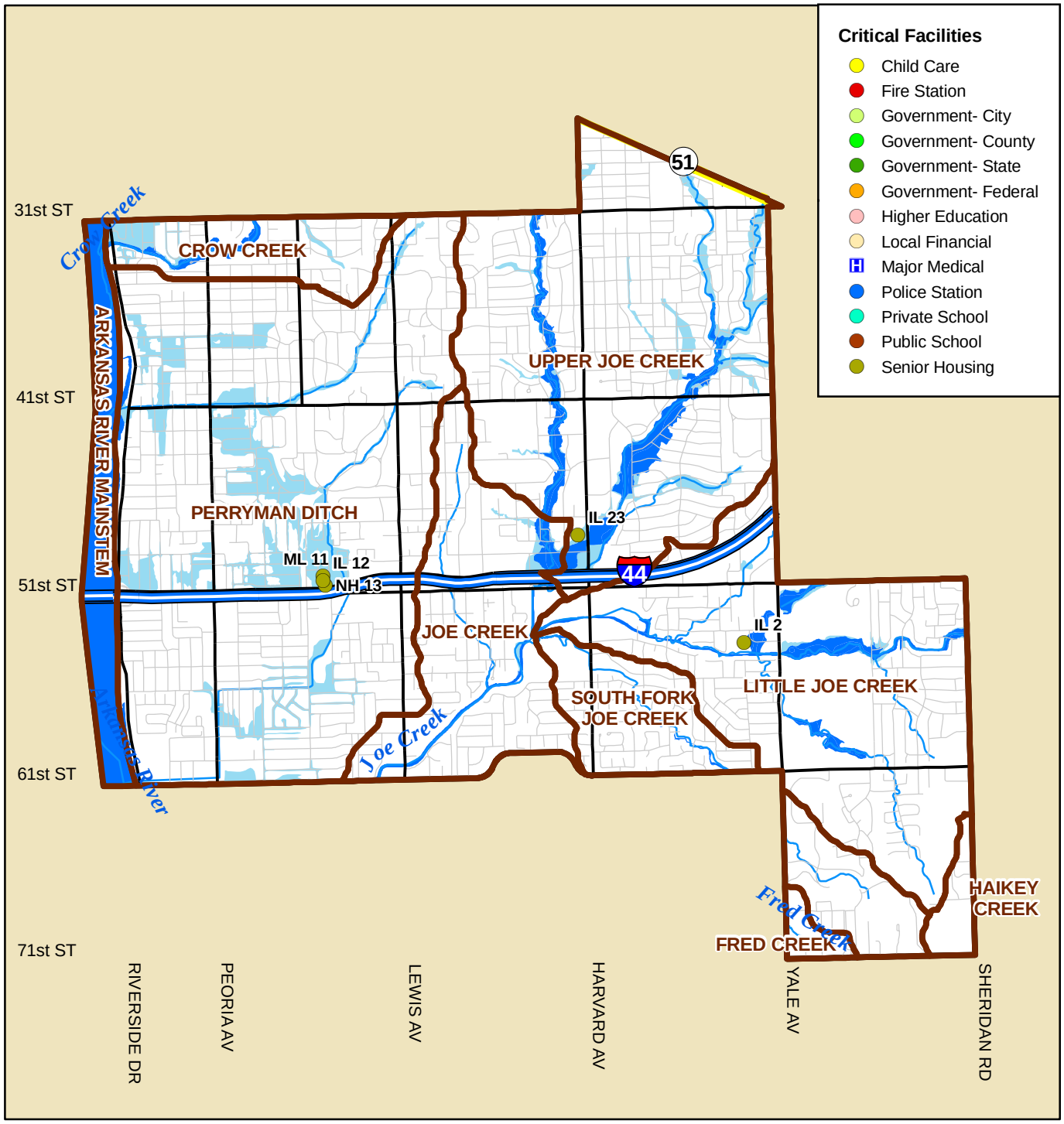
ID	Map ID	Facility Name	General Hazards									Site-Specific Hazards						
			Severe Winter Storm	High Wind	Tornado	Lightning	Hail	Extreme Heat	Drought	Earthquake	Urban Fire	Flood	Dam Failure	Levee Failure	Expansive Soil	Wildfire	Hazardous Material Sites	Transportation-Hazard
IL	23	French Villa	X	X	X	X	X	X	X	X	X	X			X			X
IL	30	Heatherwood Apartments	X	X	X	X	X	X	X	X	X				X		X	X
NH	46	Maplewood Care Center	X	X	X	X	X	X	X	X	X							
IL	47	Montereau in Warren Woods	X	X	X	X	X	X	X	X	X							
AL	49	Oklahoma Methodist Manor	X	X	X	X	X	X	X	X	X							X
ML	50	Oklahoma Methodist Manor	X	X	X	X	X	X	X	X	X							X
NH	51	Oklahoma Methodist Manor	X	X	X	X	X	X	X	X	X							X
IL	52	Oklahoma Methodist Manor	X	X	X	X	X	X	X	X	X							
IL	66	Southern Elms	X	X	X	X	X	X	X	X	X							X
NH	67	Southern Hills Rehab Center	X	X	X	X	X	X	X	X	X				X			
ML	68	Southern Hills Retirement Community	X	X	X	X	X	X	X	X	X				X			
IL	69	Southern Hills Retirement Community - The Villa	X	X	X	X	X	X	X	X	X				X			
NH	75	The Health Care Centers @ Montereau - Memory Support	X	X	X	X	X	X	X	X	X							
NH	76	The Health Care Centers @ Montereau - Skilled Nursing	X	X	X	X	X	X	X	X	X							
AL	77	The Health Centers @ Montereau - The Villa	X	X	X	X	X	X	X	X	X							
ML	79	The Montereau in Warren Woods	X	X	X	X	X	X	X	X	X							
IL	81	The Scandia	X	X	X	X	X	X	X	X	X							
NH	97	Wildwood Care Center	X	X	X	X	X	X	X	X	X							X
RC	103	The Villages at Southern Hills	X	X	X	X	X	X	X	X	X							
RC	110	Naquitas Niche, LLC	X	X	X	X	X	X	X	X	X		X					
LF	2	American TrustCorp	X	X	X	X	X	X	X	X	X		X		X			
LF	19	Tulsa Teachers Credit Union	X	X	X	X	X	X	X	X	X							

5.9.4.1 Flood

Location

District 9 is affected by both the Special Flood Hazard Area (SFHA) and City Regulatory Floodplains. The combined floodplains comprise 1.85 sq. mi., or 14.10 percent of the land within the District boundaries. Figure 5.9-17 displays the drainage basins and floodplains in District 9. A listing of the streams and drainage areas in District 9 is included in Table 5.9-6.

As stated above, District 9 reaches from the south Tulsa hills at Sheridan Rd. and E. 71st St. in the extreme southeast to the Arkansas River in the west. The land drains generally to the southwest.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets
- Railroads
- Basins
- SFHA
- City Regulatory
- Streams

0 0.5 1 Miles

Figure 5.9-17

Tulsa Council District 9

Drainage Basins & Floodplains

There are four primary stream systems in District 9: the Arkansas River, Crow Creek, the Perryman Ditch, and Joe Creek.

Table 5.9–6: Tulsa Council District 9 Streams and Drainage Areas

Stream	Total Drainage Area (sq. mi.)
SOUTH FORK JOE CREEK	0.95
HAIKEY CREEK	0.10
UPPER JOE CREEK	3.20
LITTLE JOE CREEK	2.25
CROW CREEK	0.47
JOE CREEK	1.08
PERRYMAN DITCH	4.54
FRED CREEK	0.10
ARKANSAS RIVER MAINSTEM	0.42
TOTAL	13.12

Impact/Vulnerability

In total, 1,638 residential single-family structures, 64 residential multi-family structures, 44 commercial buildings, and 51 buildings classified as *other* are touched by the 100-year floodplains of the Council District 9, with a total assessed value, adjusted for fair market price, of $265,725,614. The buildings touched by the 100-year flood are listed by type in Table 5.9-7.

Table 5.9–7: Tulsa Council District 9 Buildings Touched by 100 year Floodplain

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	1,638	$175,566,390
Residential Multi-Family	64	$35,740,601
Commercial	44	$44,447,223
Industrial	0	$0
Other	51	$9,971,400
Total	1,797	$265,725,614

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

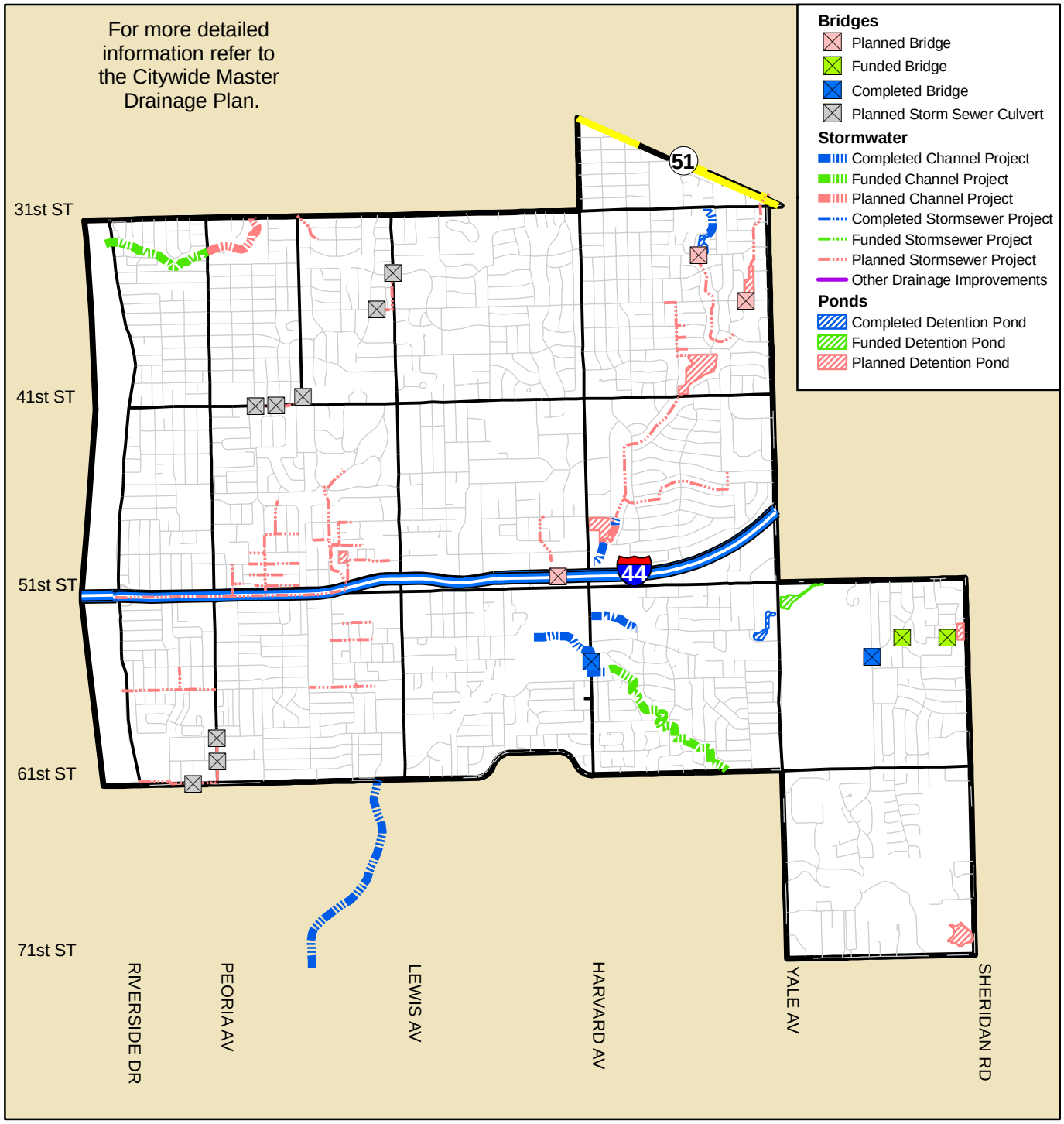
There are five critical facilities located in or around the 100 year floodplains in District 9. Critical facilities impacted by the 100 year floodplain are listed in Table 5.9-5.

Repetitive Loss Properties

There are a total of 32 repetitive loss properties located in the boundaries of Tulsa Council District 9: 14 residential and 18 mutli-family.

Flood Control Projects

Tulsa's floodplain and stormwater program includes comprehensive watershed management, dedicated funds for maintenance and operation, and a $200 million capital improvements program. In Council District 9, many projects have been completed for flood control issues. Figure 5.9-18 displays flood control projects in Council District 9, identified in the 2004 Capital Improvements Plan. District 9 flood control projects budgeted in the 2008-2012 Capital Expenditures Plan are listed in Table 5.9-8.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets
- Railroads

0 0.5 1 Miles

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Planning Consultants

Figure 5.9-18

Tulsa Council District 9

Flood Control

Table 5.9–8: Tulsa Council District 9 Flood Control Projects 2008-2012

Project ID	Project Basin and Description	Budget
23	Crow Creek - Cascia Hall Storm Sewer	$710,000
24	Crow Creek - Channel Rehabilitation and Culvert Replacement	$14,220,000
25	Crow Creek - Eight Acres Bank Restoration	$520,000
26	Crow Creek – Lewis Avenue Bridge Replacement & Channel Restoration	$830,000
27	Crow Creek - Rockbridge Storm Sewer	$420,000
28	Crow, Swan Creek and Travis Park - Storm Sewer, Inlets & Valves	$4,800,000
29	Crow Creek - Yorktown Apartments Channel & Berm	$690,000
55	Joe Creek - Channel Rehabilitation (Phase 2)	$6,000,000
56	Joe Creek – Erosion Control and Bank Stabilization	$900,000
57	Joe Creek - Mockingbird Lake Dredging	$335,000
81	Perryman Ditch - I-44 Storm Sewer	$61,620,000
90	Upper Joe Creek - Langenheim Park Channel Improvements (Phase 1)	$3,000,000

Source: PLANiTulsa Capital Expenditures Plan 2008-2012

Conclusion

Tulsa Council District 9 has a HIGH probability of and a HIGH vulnerability to the Flood hazard.

5.9.4.2 Dam Failure

Location

District 9 is vulnerable to the Dam Failure hazard. Keystone Dam is about 17 miles upriver from the northern boundary of the District. The District contains the 4-acre Warrenton Dam, located at about (what would be) E. 66th and S. Kingston Ave. (See Chapter 4 for Dam and lake specifications.) Approximately 3.98 square miles of land in District 9 would be impacted by this hazard.
Figure 5.9-19 shows the inundation area from a failure of the Dam. For an in-depth discussion of Dam Failure on the Arkansas River, see Chapter 4, Dam Failure and Section 5.10, *Arkansas River Corridor*.

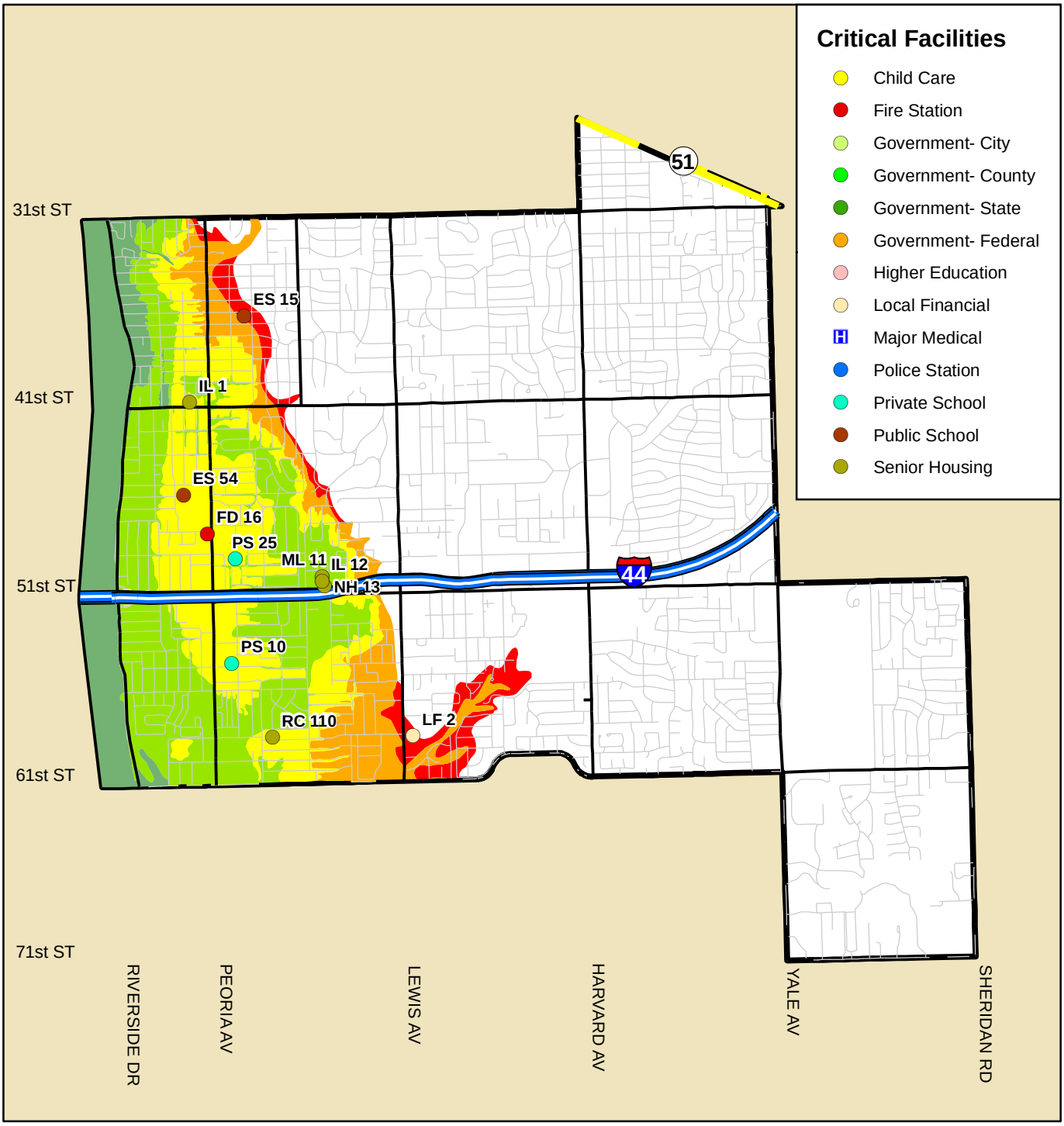
Impact/Vulnerability

In total, 6,239 improved parcels in District 9 would be impacted by a failure of Keystone Dam. According to Tulsa County Assessor data, the exposed parcels have a total value, estimated for fair market price, of $700,616,420. Warrenton Dam failure would impact 65 residential single-family parcels with a total value, estimated for fair market price, of $8,132,600. A summary of parcels impacted by a failure of Keystone Dam, by value and type, can be found in Table 5.9-9.

Table 5.9–9: Tulsa Council District 9 Parcels in Keystone Dam Break Inundation Area

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	5,773	$490,321,631
Residential Multi-Family	189	$65,886,732
Commercial	211	$122,274,332
Industrial	1	$275,741
Other	65	$21,857,984
Total	6,239	$700,616,420

Source: Tulsa County Assessor's Office, 2012



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets
- Railroads

Dam Break

- 250,000 CFS
- 350,000 CFS
- 450,000 CFS
- Max Failure
- Dam Break

0 0.5 1 Miles

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Planning Consultants

Figure 5.9-19

Tulsa Council District 9

Dam Failure

Critical Facilities

There are 11 critical facilities located within the inundation area of Keystone Dam in Council District 9. These are listed in Table 5.9-5 and shown on the map in Figure 5.9-19. All but two of the facilities house some of Tulsa's most vulnerable populations—children and the elderly. Populations occupying these facilities at the time of a dam breach or failure are highly exposed to the hazard impact. This is especially true of those unable to evacuate due to mental or physical disabilities. Pre-planning for a dam failure is essential for these facilities.

Conclusion

Tulsa Council District 9 has a HIGH vulnerability to and a LOW probability of the Dam Failure hazard.

5.9.4.3 Levee Failure

Tulsa Council District 9 does not have levees along its stretch of the Arkansas River, so would not be directly impacted by a levee failure. This being said, the District is subject to Arkansas River flooding and is particularly vulnerable to a failure of Keystone Dam. Should a flood on the river, or a dam failure, overtop the levees that protect the West Side refineries, District 9 could experience inundation by floodwaters laden with toxic materials.

5.9.4.4 Expansive Soils

Location

Council District 9 is underlain by soils with Low (70.83%) to High (25.57%) shrink/swell potential, summarized in Table 5.9-10, and illustrated in Figure 5.9-20. The highly expansive soils are almost entirely within the Joe Creek drainage.

Table 5.9–10: Tulsa Council District 9 Expansive Soils

Expansion Potential	Area (sq mi)	Percent of Total District Boundaries
Very High	0.01	0.08%
High	3.35	25.57%
Moderate	0.09	0.69%
Low	9.29	70.83%
Water	0.37	2.84%
Total	13.12	100.00%

Impact/Vulnerability

According to Tulsa County Assessor Data, 4,241 parcels, or about 25 percent of parcels with improvements in District 9, are underlain by soils with High to Very High shrink/swell potential. The parcels have a total improvement value, adjusted for fair market price, of $772,278,135. A summary of District 9 parcels located on High to Very High expansive soils is included in Table 5.9-11.

Table 5.9–11: Tulsa Council District 9 Parcels on High to Very High Expansive Soils

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	4,012	$558,633,178
Residential Multi-Family	77	$55,145,843
Commercial	130	$132,953,712
Industrial	0	$0

Improvement Type	Number	Est. Market Value
Other	22	$25,545,402
Total	4,241	$772,278,135

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

There are 16 critical facilities located on High to Very High expansive soils in District 9, displayed on the map in Figure 5.9-20. A complete inventory of critical facilities is included in Table 5.9-5. As it is likely soil plasticity was taken into account when these buildings were constructed, it is not anticipated that they will suffer extensive damage from this hazard. This cannot be said, however, about the buried infrastructure, such as water, sewer and gas lines.

Conclusion

Tulsa Council District 9 has a MODERATE vulnerability to and HIGH probability of the Expansive Soils hazard.

5.9.4.5 Wildfire

Location

District 9 is located in a fully urbanized area of Tulsa with virtually no Wildfire Level of Concern (LOC). There are few locations in the District with Low or Moderate LOC, and a very small area (0.02 square miles) at E. 61st St. and Riverside Dr. with a High wildfire LOC. A map displaying the Wildfire LOC of District 9 is shown in Figure 5.9-21.

Impact/Vulnerability

There are two parcels located in an area of High Wildfire LOC, summarized in Table 5.9-12. The area of the District with the greatest Wildfire LOC is Johnson Park, located between Riverside Drive and S Madison Avenue, north of E. 61st Street. The park has a rating of 6 on the Wildfire LOC Index. Effort should be made to keep the grass well maintained and to educate the residents surrounding the park of the fire danger, particularly during periods of extreme heat and drought.

Table 5.9–12: Tulsa Council District 9 Parcels Touched by Wildfire Level of Concern

Improvement Type	Number	Est. Market Value
Residential Single Family	2	$179,000
Residential Multi-Family	0	$0
Commercial	0	$0
Industrial	0	$0
Other	0	$0
Total	2	$179,000

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

No critical facilities in the district are located in areas vulnerable to Wildfire Concern.

Conclusion

Tulsa Council District 9 is considered to have a LOW vulnerability to and LOW probability of the Wildfire hazard.

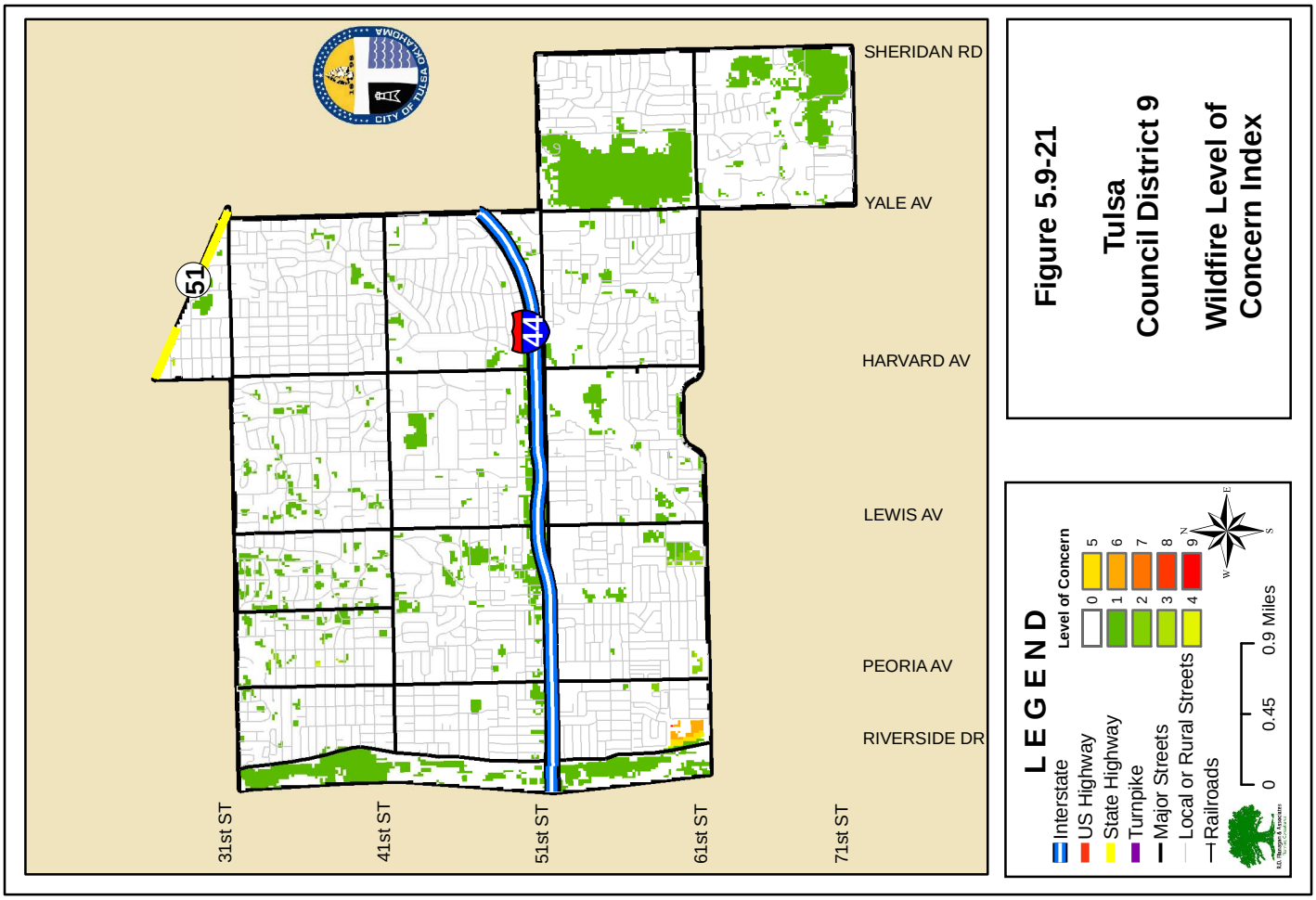


Figure 5.9-21

Tulsa Council District 9

Wildfire Level of Concern Index

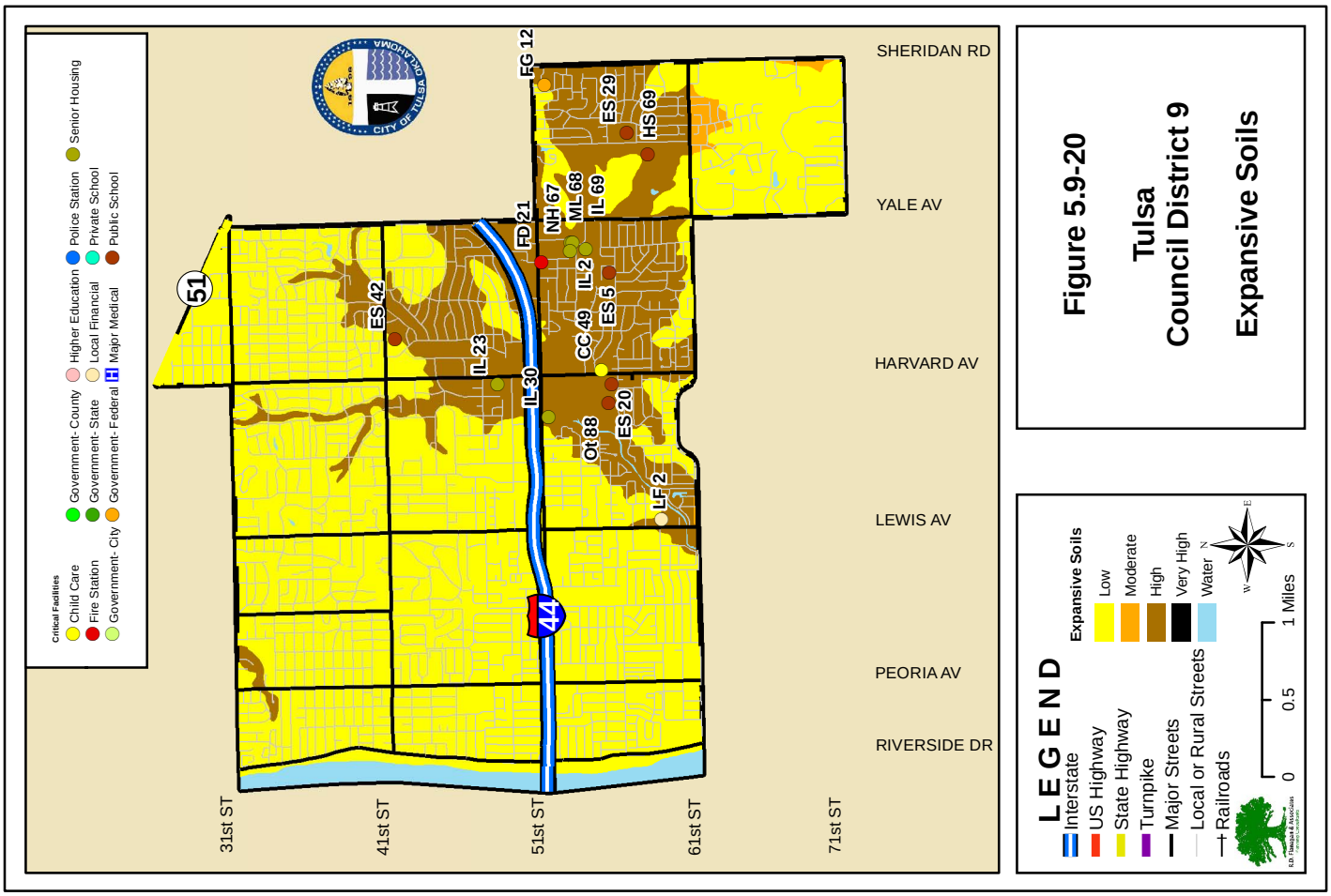


Figure 5.9-20

Tulsa Council District 9

Expansive Soils

5.9.4.6 Fixed-Site Hazardous Materials

Location

There are nine Tier II facilities within the boundaries of Tulsa Council District 9, eight of which contain extremely hazardous substances. Due to the sensitive nature of this material, Tier II facilities in the District are mapped in Figure 5.9-22 to show only approximate location of the sites. A listing of EHS and Non-EHS Tier II facilities in Council District 9 can be found in Appendix E, and is available on a need-to-know basis.

Impact/Vulnerability

There are 3,543 people living or working within a ¼ mile radius of the Tier II sites in District 9, according to the Marplot analysis, which uses 2010 US Census data. A summary of the number of parcels located within ¼ mile of a Tier II facility in the District is included in Table 5.9-13.

Table 5.9–13: Tulsa Council District 9 Parcels in ¼ Mile Tier II Buffer

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	1,469	$222,252,060
Residential Multi-Family	35	$15,875,315
Commercial	71	$61,345,305
Industrial	1	$104,000
Other	19	$61,274,400
Total	1,595	$360,851,080

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

There are 10 critical facilities in District 9 located within ¼ mile of a Tier II facility. Though structures are not likely to be impacted themselves, populations at the facilities are at high risk of being impacted if a hazardous materials event were to occur. Of high concern are the three childcare facilities and three medical facilities in ¼ mile buffer of the District's fixed-sites. Due to a high number of functional needs populations in these facilities, pre-planning is critical. Effort should be made to ensure proper evacuation or shelter-in-place procedures are in place. Critical facilities located within ¼ mile of a Tier II facility are identified in Table 5.9-5 and mapped in Figure 5.9-22.

Conclusion

Tulsa Council District 9 is considered to have a MODERATE vulnerability to and LOW probability of a fixed-site hazardous materials release.

5.9.4.7 Transportation Hazardous Materials

Location

As shown on the map in Figure 5.9-23, three significant transportation routes pass through District 9: Interstate 44, which runs east to west through the center of the District parallel to E 51st Street; US Hwy 51/US Hwy 64 (Broken Arrow Expressway) which runs briefly northwest to southeast along the northeast edge of the District; and the Union Pacific Railroad, located between the lanes of the Broken Arrow Expressway.

Impact/Vulnerability

A ¼-mile transportation buffer for the three transportation corridors would encompass 19.79 percent of Council District 9 (or 2.70 sq. mi.), 3,031 parcels, 9,476 residents (based on 2010 Census count of people per square mile) in District 9. According to Tulsa County Assessor data, 2,664 parcels with

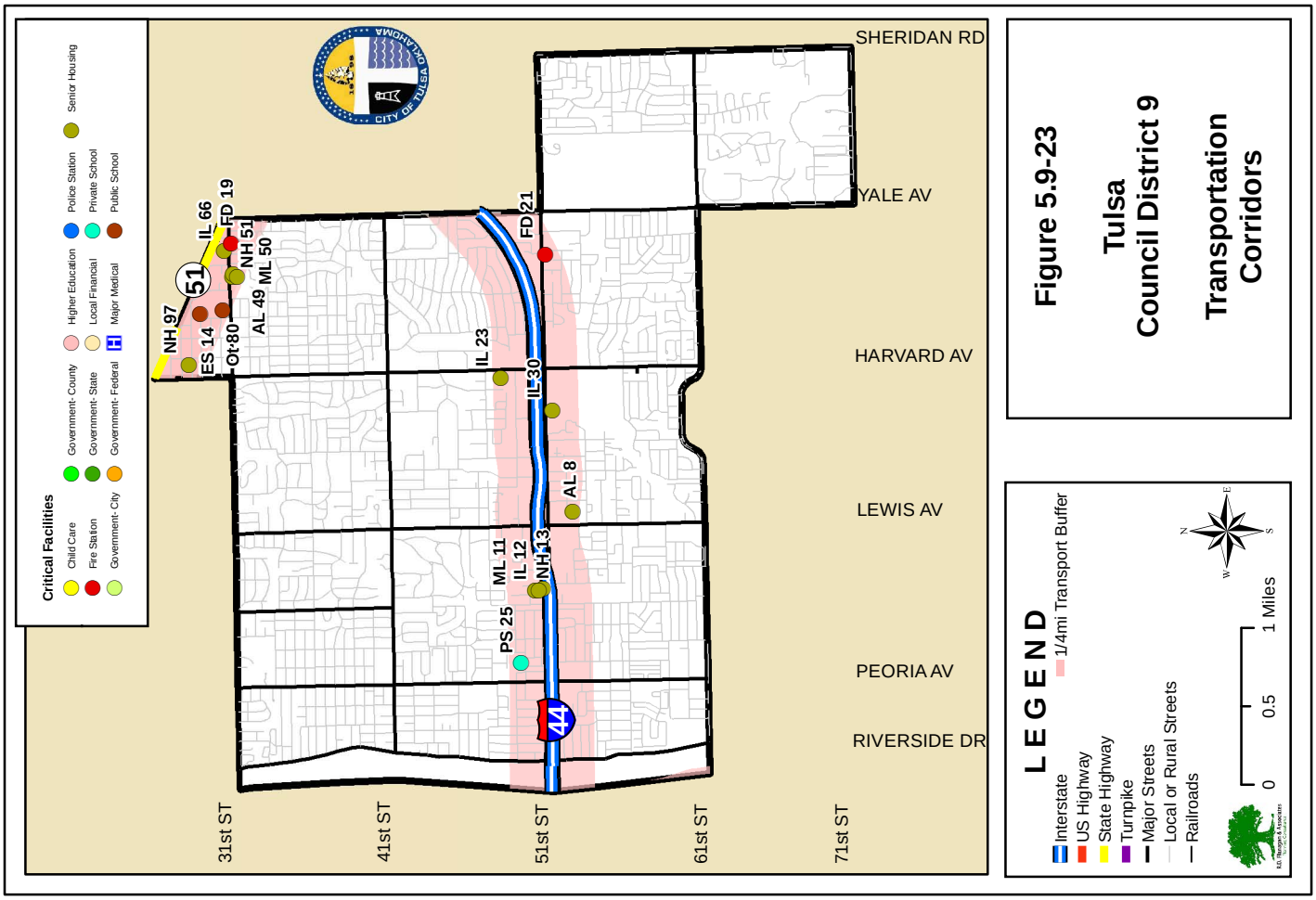


Figure 5.9-23

Tulsa Council District 9

Transportation Corridors

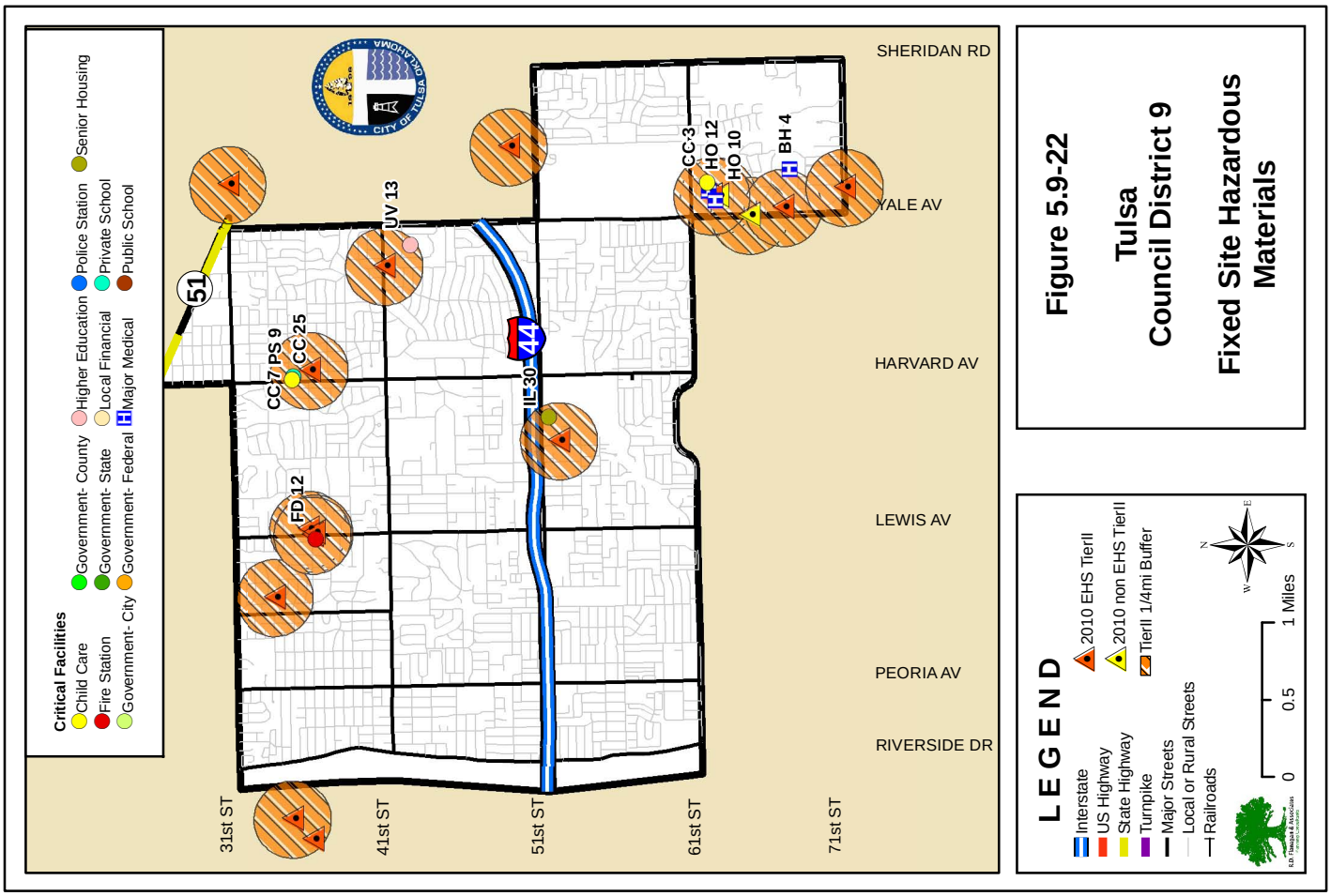


Figure 5.9-22

Tulsa Council District 9

Fixed Site Hazardous Materials

improvements in District 9 are touched by the Highway or Interstate buffer in the District, with a total value, assessed for fair market, of $431,983,839; these are summarized by type in Table 5.9-14.

Table 5.9–14: Tulsa Council District 9 Parcels Touched by ¼ mile Highway Corridor

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	2,387	$224,913,665
Residential Multi-Family	93	$82,912,504
Commercial	158	$105,364,886
Industrial	0	$0
Other	26	$18,792,784
Total	2,664	$431,983,839

Source: Tulsa County Assessor Data, 2012

In total, 367 parcels in District 9 are located within ¼ mile of a rail line, with a total value, assessed for fair market price, of $38,829,319. The parcels touched by the railroad corridor buffer zone are summarized, by type, in Table 5.9-15.

Table 5.9–15: Tulsa Council District 9 Parcels Touched by ¼ mile Railroad Corridor

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	306	$18,922,900
Residential Multi-Family	14	$6,594,336
Commercial	38	$10,480,001
Industrial	0	$0
Other	9	$2,832,082
Total	367	$38,829,319

Source: Tulsa County Assessor Data, 2012

Critical Facilities

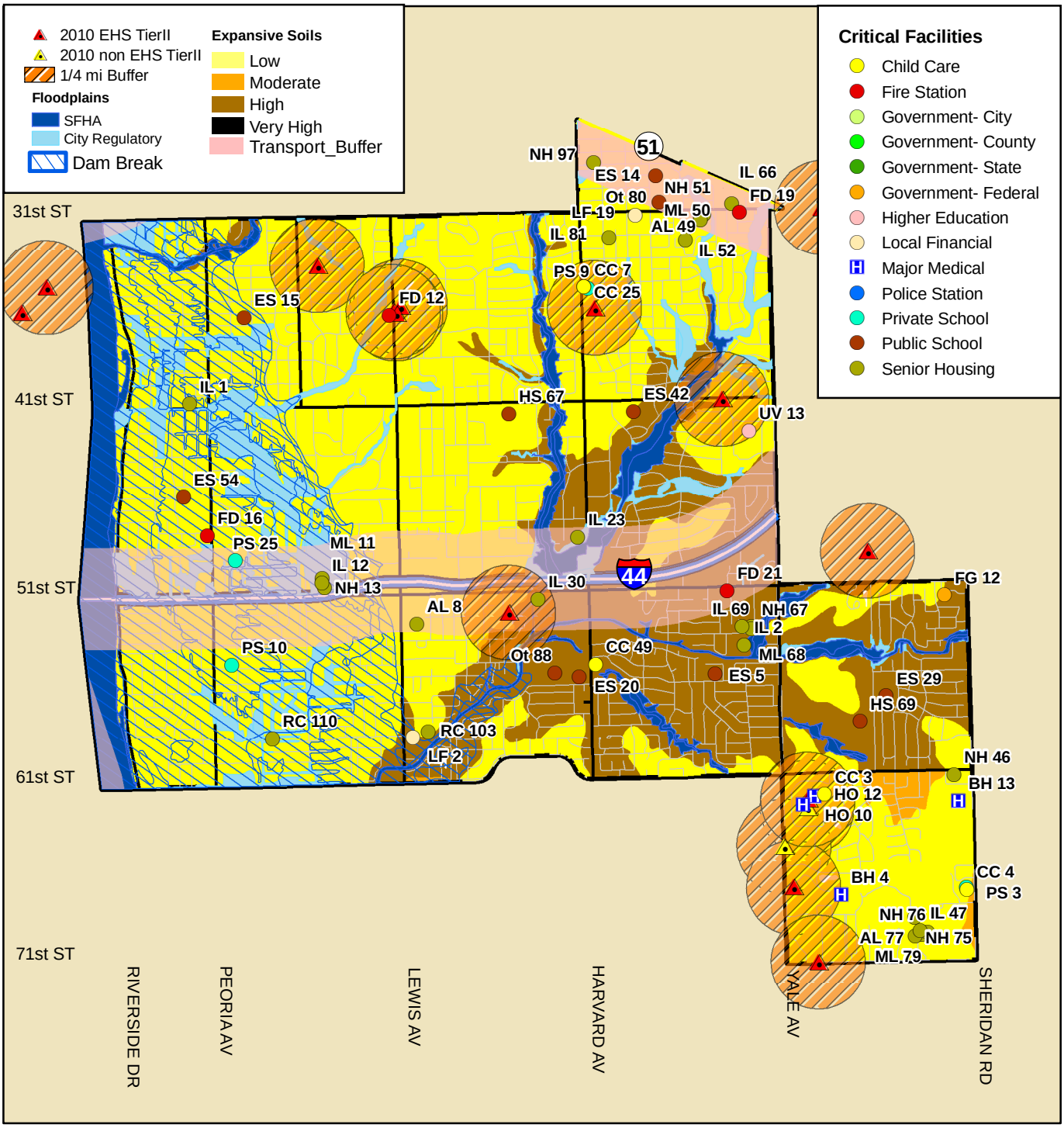
As previously mentioned, 16 of the Districts critical facilities are located within ¼ mile of a major transportation route: 11 long term care facilities, two Tulsa Public School facilities, one private school, and two fire departments. Of particular concern among the facilities are the long-term care facilities and schools. Occupants of these facilities include some of Tulsa's most vulnerable populations—children and the elderly. Because children and the elderly are often unable to evacuate or take precautionary measures on their own, it is crucial that preplanning and exercises occur at these facilities so employees and occupants are aware of evacuation and/or shelter in place procedures.

Conclusion

Tulsa Council District 9 has a HIGH vulnerability to and HIGH probability of the Transportation hazard.

5.9.4.8 Hazards Summary

Site-specific hazards, unique to Tulsa Council District 9, identified and mapped in this section, include Floods, Dam Failures, Expansive Soils, Wildfires, Hazardous Materials, and Transportation. The Hazards Composite Map, shown in Figure 5.9-24, summarizes the areas of the District potentially impacted by these site-specific hazards.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Major Streets
- Local or Rural Streets
- Railroads

0 0.5 1 Miles

Figure 5.9-24

Tulsa Council District 9

Hazard Composite

City of Tulsa Multi-Hazard Mitigation Plan Update

Arkansas River Corridor

R.D. Flanagan & Associates

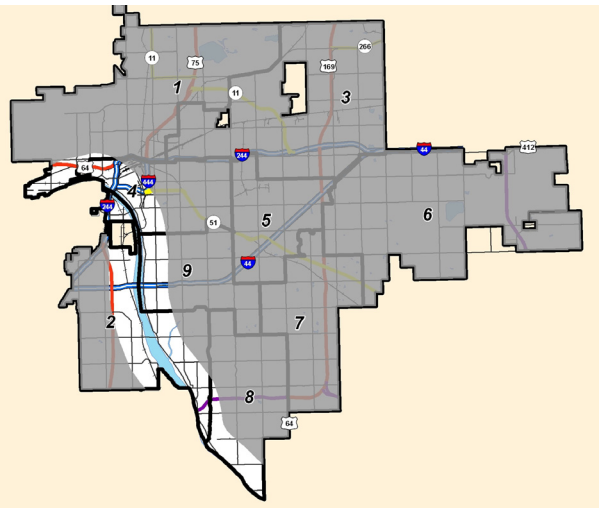
Planning Consultants

5.10 Arkansas River Corridor

5.10.1 Introduction

5.10.1.1 Location

Figure 5.10–1: Tulsa Locator Map – Arkansas River Corridor

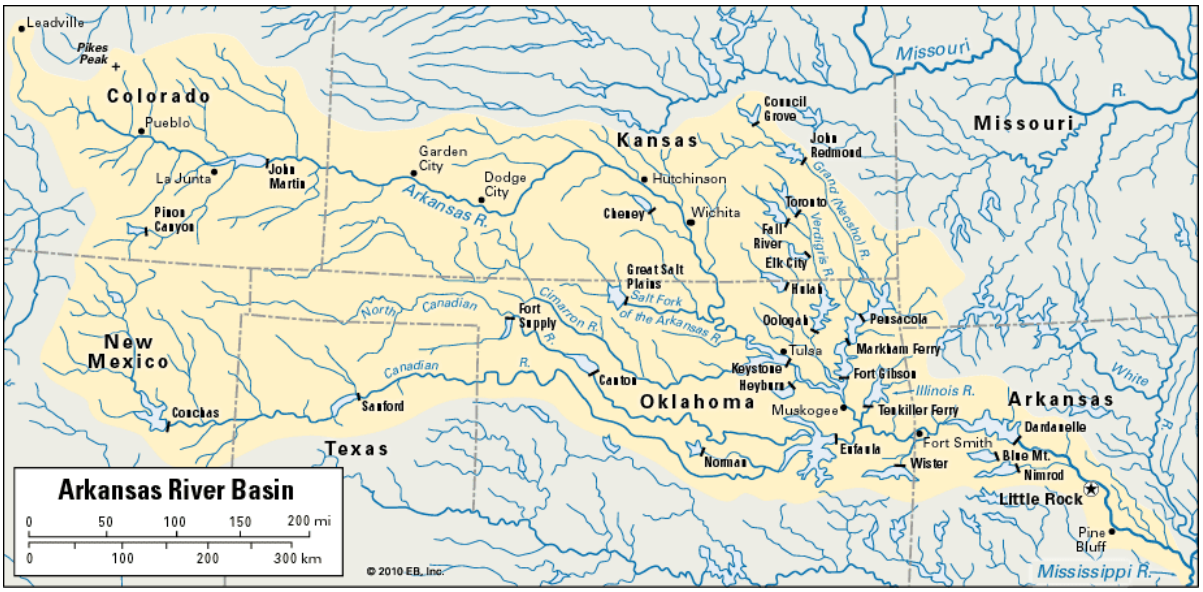


The Arkansas River, as it flows through Tulsa, is a unique and dominant land feature, and requires special attention and emphasis, when addressing the City's natural and man-made hazards. As shown in the Location Map, Figure 5.10-1, the river enters the corporate area in northwest Tulsa, near W. 11th St. and 25th W. Ave., flows east, then meanders to the south and southeast before exiting the City at E. 131st St. and S. Sheridan Ave.

5.10.1.2 Arkansas River Basin

The Arkansas River, a major tributary to the Mississippi River, is one of the longest rivers in the United States, as shown in the Basin Map in Figure 5.10-2. The river is some 1,450 miles in length, and drains over 168,000 square miles in Colorado, New Mexico, Kansas, Texas, Oklahoma, Missouri, and Arkansas. The Arkansas River's tributaries in Oklahoma include the Cimarron, Canadian, North Canadian, Verdigris, Neosho-Grand, and Illinois rivers. From its headwaters in the Collegiate Peaks of the Rocky Mountains, near Leadville, Colorado, the river flows southeast through Pueblo, Colorado, Garden City, Dodge City, Great Bend, Hutchinson, and Wichita, Kansas, Kaw Lake Reservoir, Ponca City, Lake Keystone, the cities of Tulsa and Muskogee, the Kerr Reservoir, and Ft. Smith, Little Rock, and Pine Bluff, Arkansas. It joins the Mississippi River just 50 miles north of the Arkansas, Mississippi and Louisiana state lines.

Figure 5.10–2: Arkansas River Basin



5.10.1.3 History

After removal from their Native American homelands in Alabama in the 1820s, the Lochapokas band of the Creek Nation settled at the bend of the Arkansas River in 1836, calling their new home Tulsey, meaning town, in what is now Tulsa.

Arkansas River Corridor

The Arkansas River Corridor area, as it flows through Tulsa is 17 miles in length, averages two miles in width, and encompasses some 25 sq. miles or about 12.5% of the corporate area. The Corridor passes through five of the nine City Council Districts. The Arkansas River Corridor is shown in the map in Figure 5.10-3

Cultural and Historic Properties

Tulsa Arkansas River Corridor contains four historic districts: the Buena Vista Park Historic District, Riverside Historic Residential District, Riverview Historic District, and Stonebreaker Heights Historic District. The Corridor is also home to six historic residences: the Carl Dresser House, Harwelden, McBirney Mansion, Moore Manor, the Riverside Studio (Spotlight Club), and the James A. Veasey House. A map displaying Cultural and Historic places in the Arkansas River Corridor are shown in Figure 5.10-4.

5.10.1.4 Demographics

The Arkansas River Corridor had a 2010 US Census population of 61,501. Table 5.10-1 includes the demographic makeup of the Arkansas River Corridor. A map displaying population density in the corridor is shown in Figure 5.10-5. Maps presenting the demographic information listed in the table are included in Figures 5.10-6 through 5.10-13.

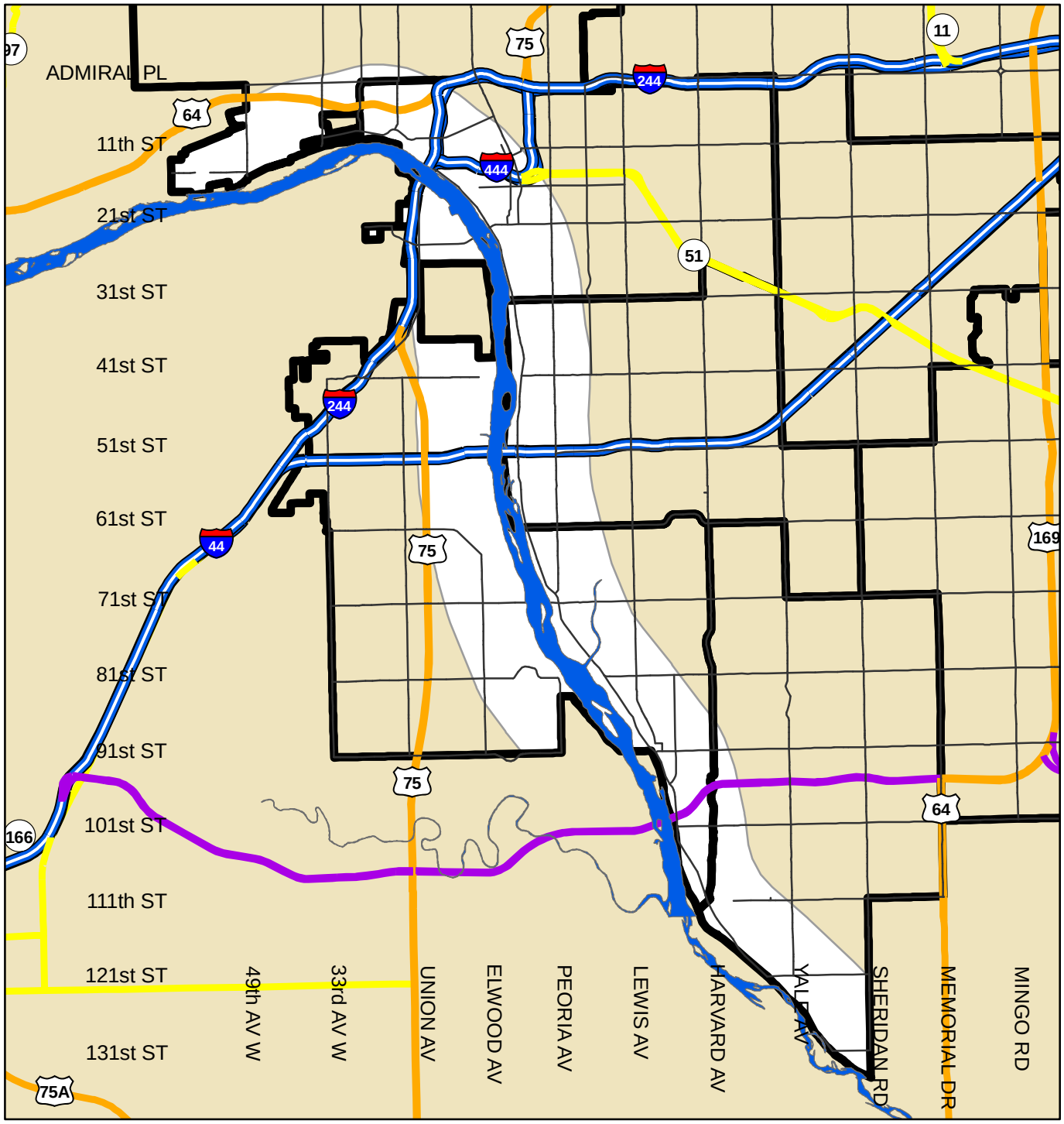
Table 5.10–1: Arkansas River Corridor Population

Category	Corridor		Tulsa	
	Number	Percent	Number	Percent
Persons under 5 years of age	4,420	7.19%	30,225	7.53%
Persons under age 18	12,900	20.98%	98,076	24.44%
Persons age 65 and older	6,677	10.86%	49,999	12.46%
Poverty Status in 2010 (individuals)	13,594	22.10%	77,674	19.36%
White	41,490	67.46%	252,020	62.81%
Native-American	3,785	6.15%	21,451	5.35%
African American	8,160	13.27%	62,872	15.67%
Asian American	1530	2.49%	9,584	2.39%
Hispanic	6,206	10.09%	55,885	13.93%
Total Population	61,501	100.00%	401,265	100.00%

Source: US Census Data, 2010

5.10.1.5 Infrastructure

The Arkansas River Corridor is dependent upon the lifelines of the City of Tulsa as identified in Section 1.2.6 of this Plan Update. Any unique vulnerability of Arkansas River Corridor in relation to the seven site-specific hazards identified in this plan will be addressed in Section 5.10.4, below.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- Arkansas River
- River Corridor

0 1 2 Miles

Figure 5.10-3

Arkansas River Corridor

Basemap

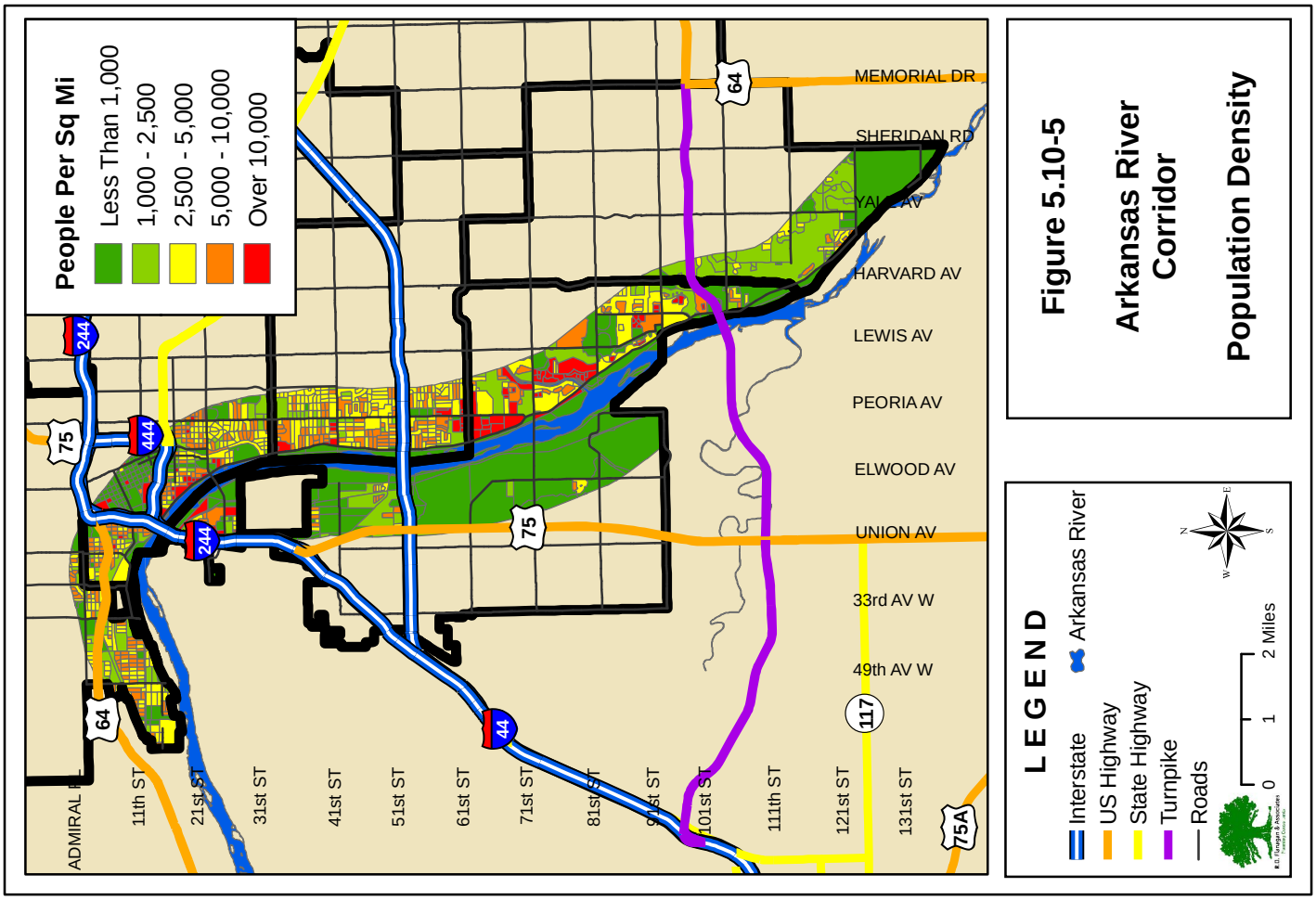


Figure 5.10-5
Arkansas River Corridor
Population Density

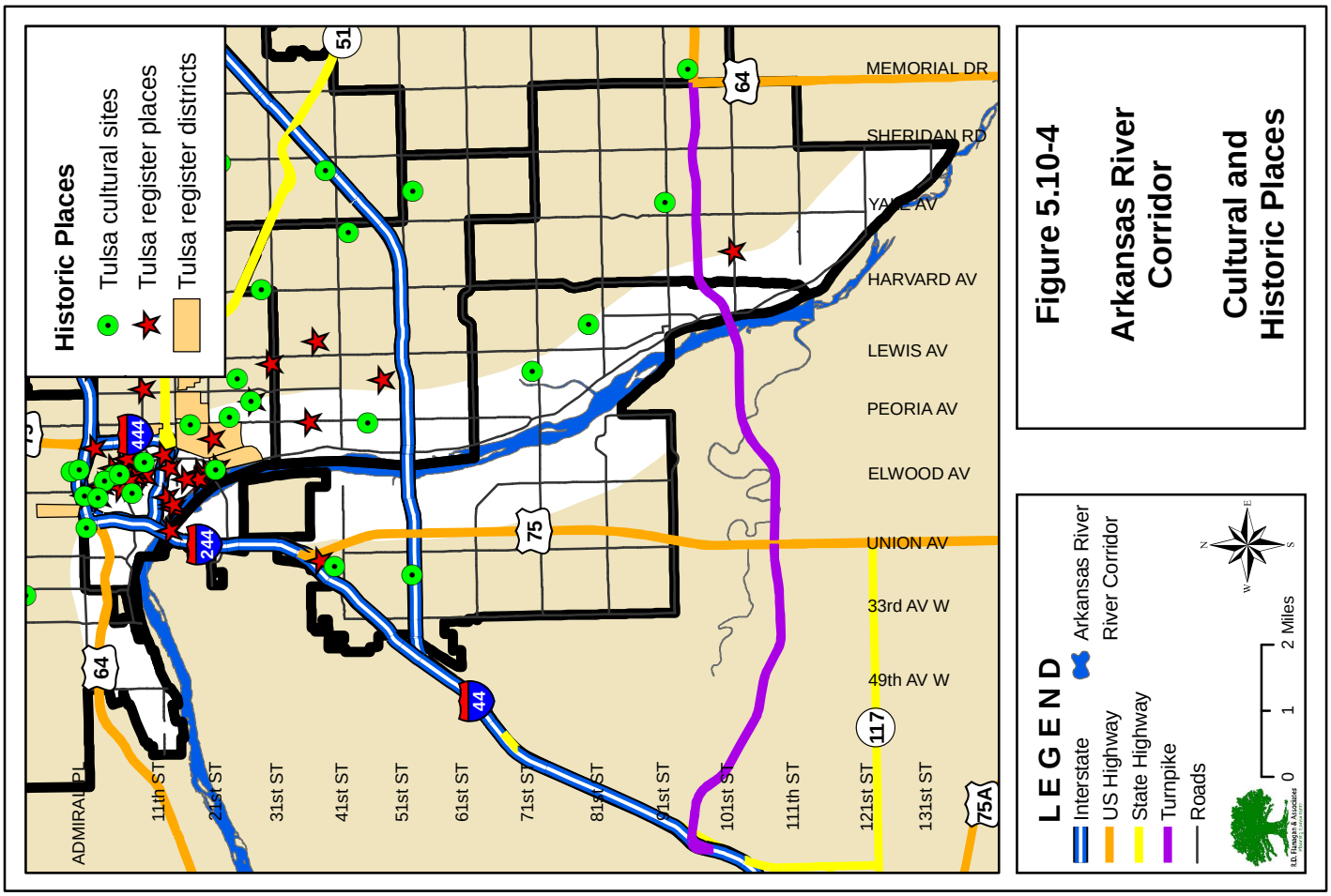


Figure 5.10-4
Arkansas River Corridor
Cultural and Historic Places

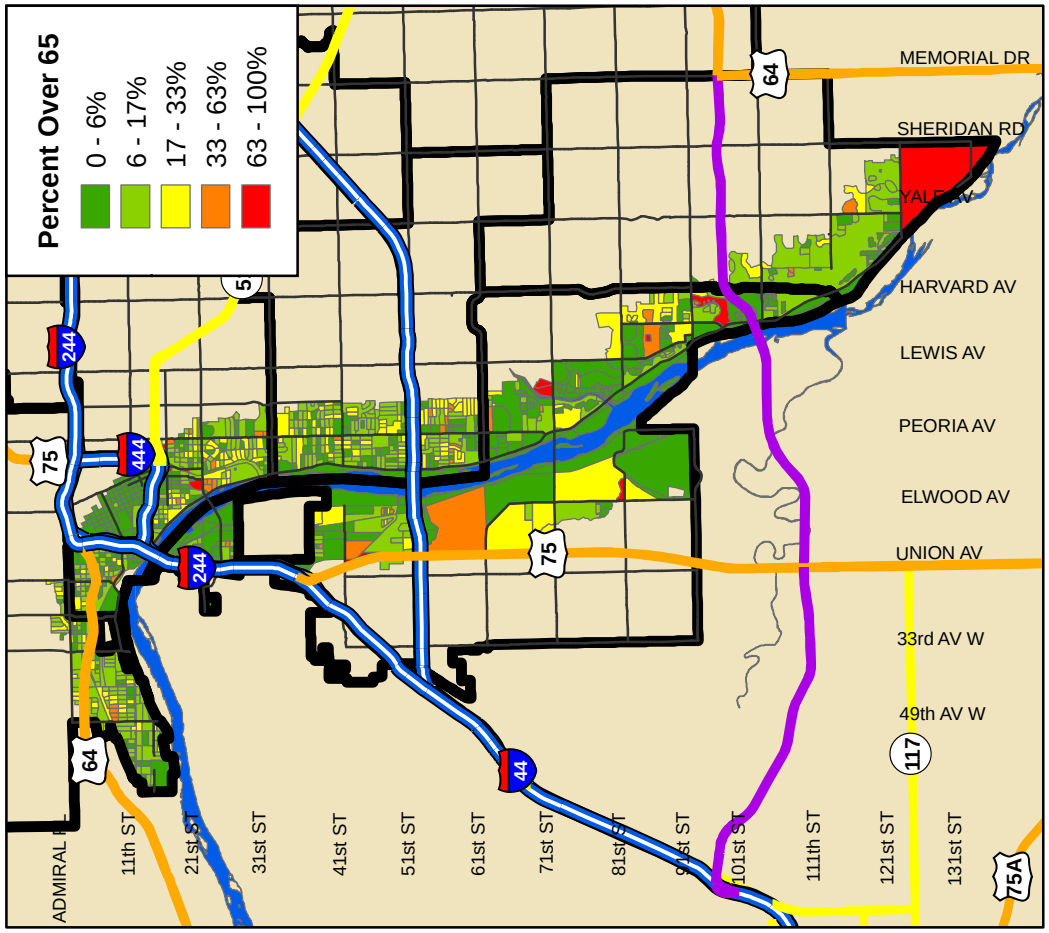


Figure 5.10-7

Arkansas River Corridor

Percent of Population Age 65 and Older

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- Arkansas River

0 1 2 Miles

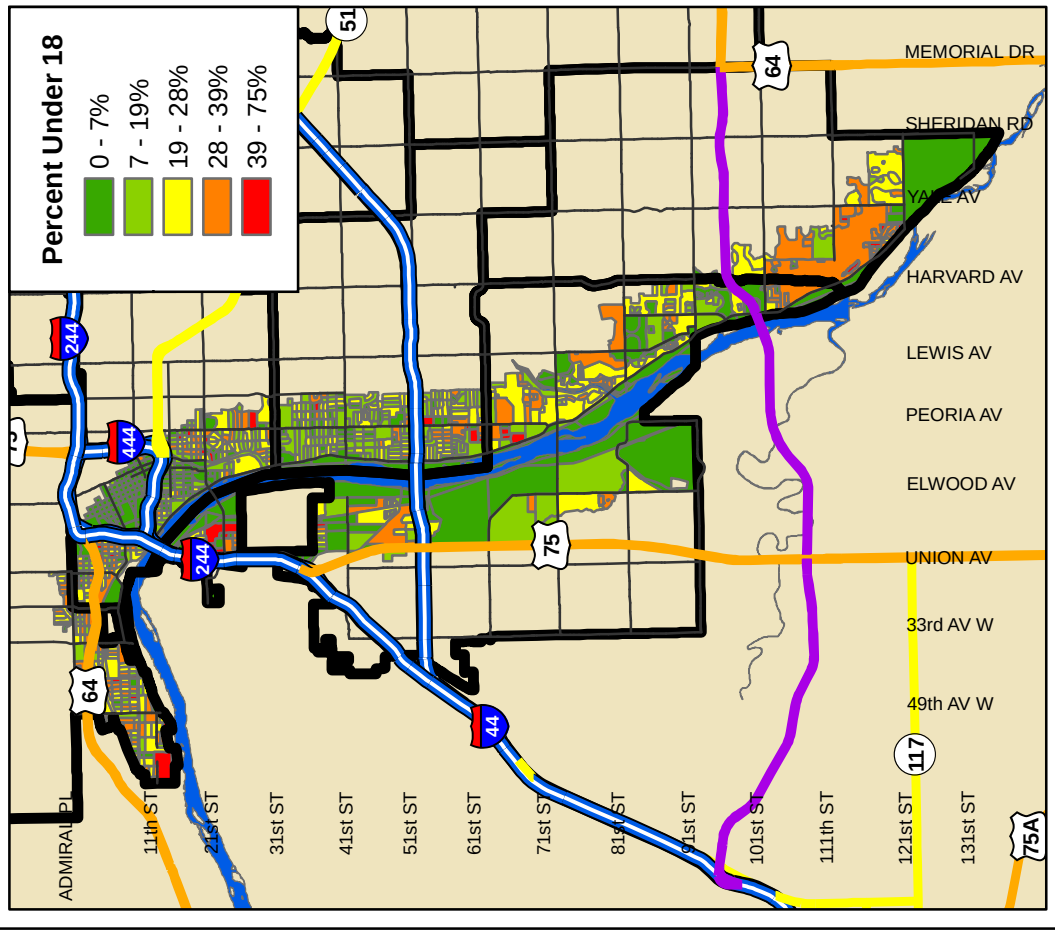


Figure 5.10-6

Arkansas River Corridor

Percent of Population Under Age 18

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- Arkansas River

0 1 2 Miles

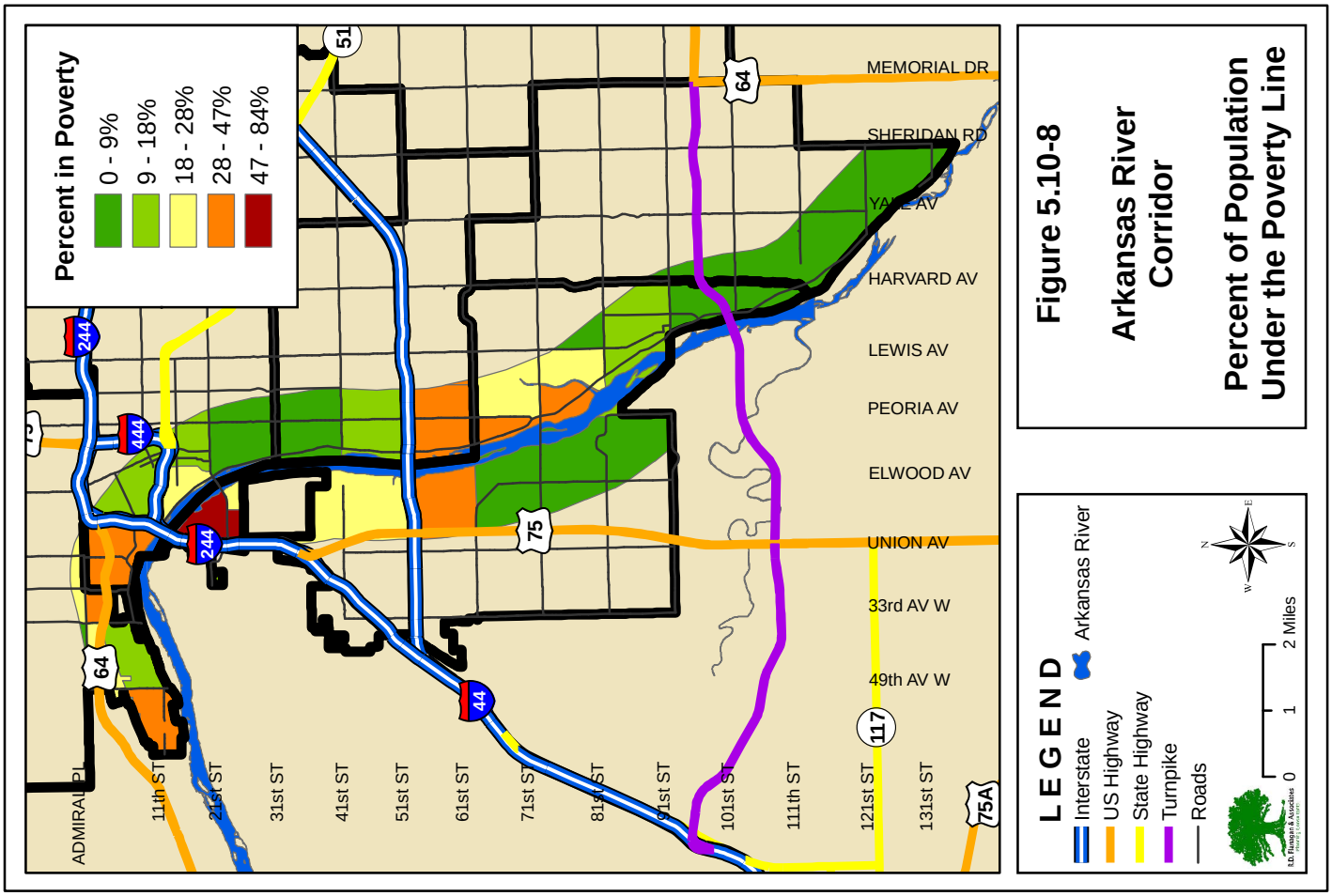


Figure 5.10-8

Arkansas River Corridor

Percent of Population Under the Poverty Line

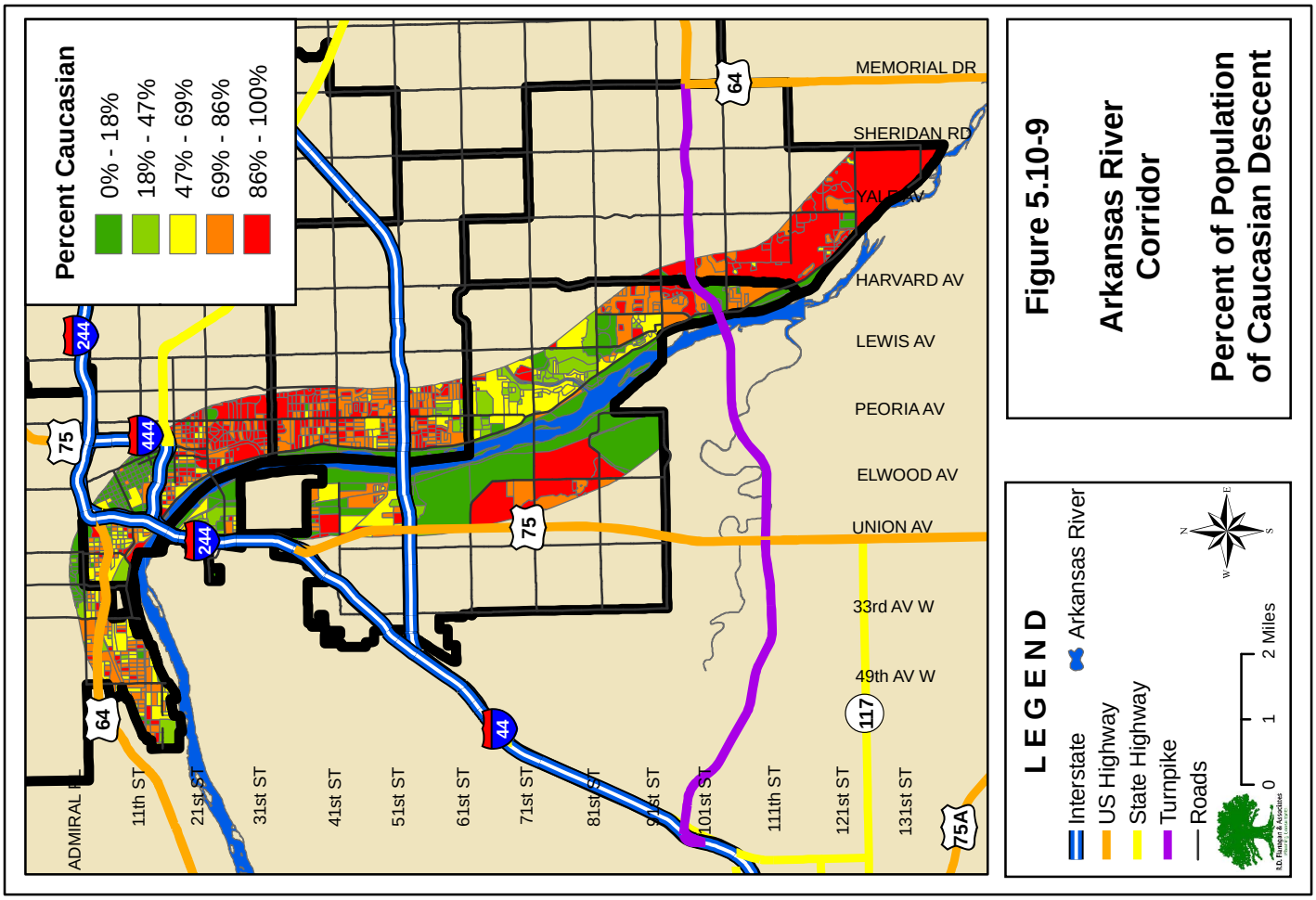


Figure 5.10-9

Arkansas River Corridor

Percent of Population of Caucasian Descent

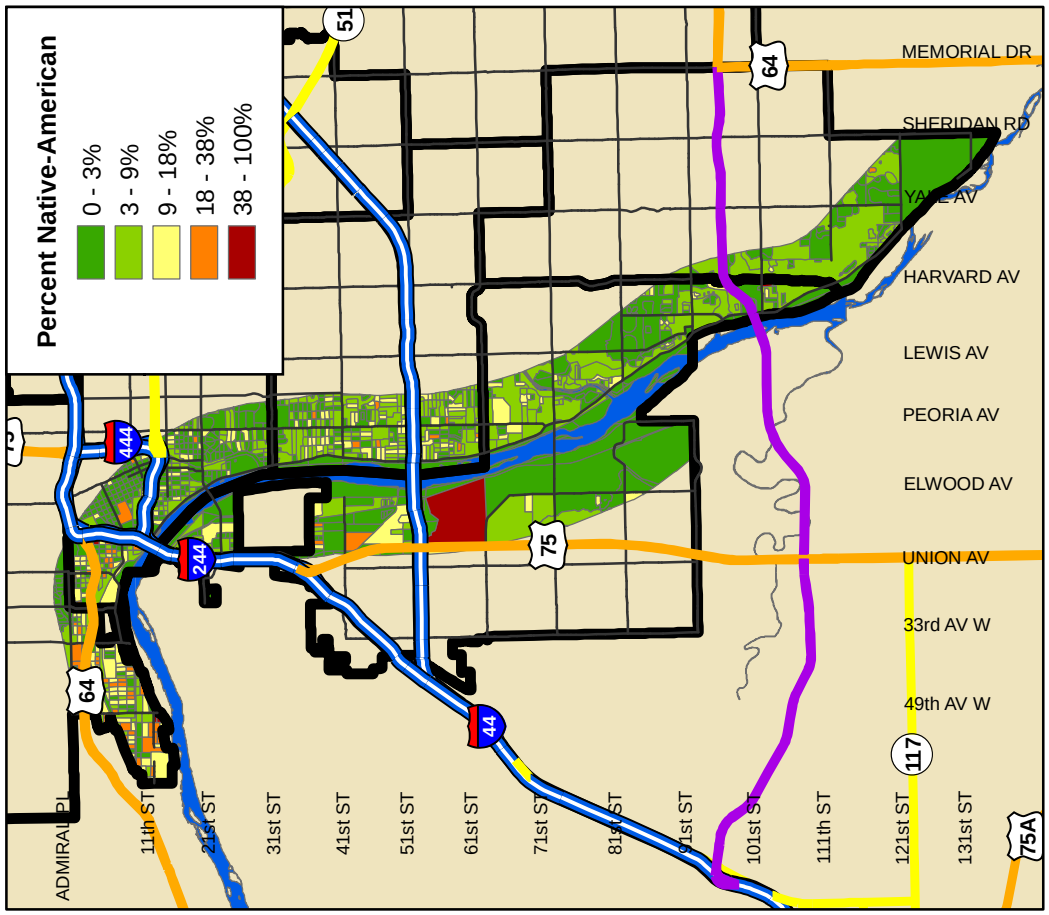


Figure 5.10-10

Arkansas River Corridor

Percent of Population of Native-American Descent

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- Arkansas River

0 1 2 Miles

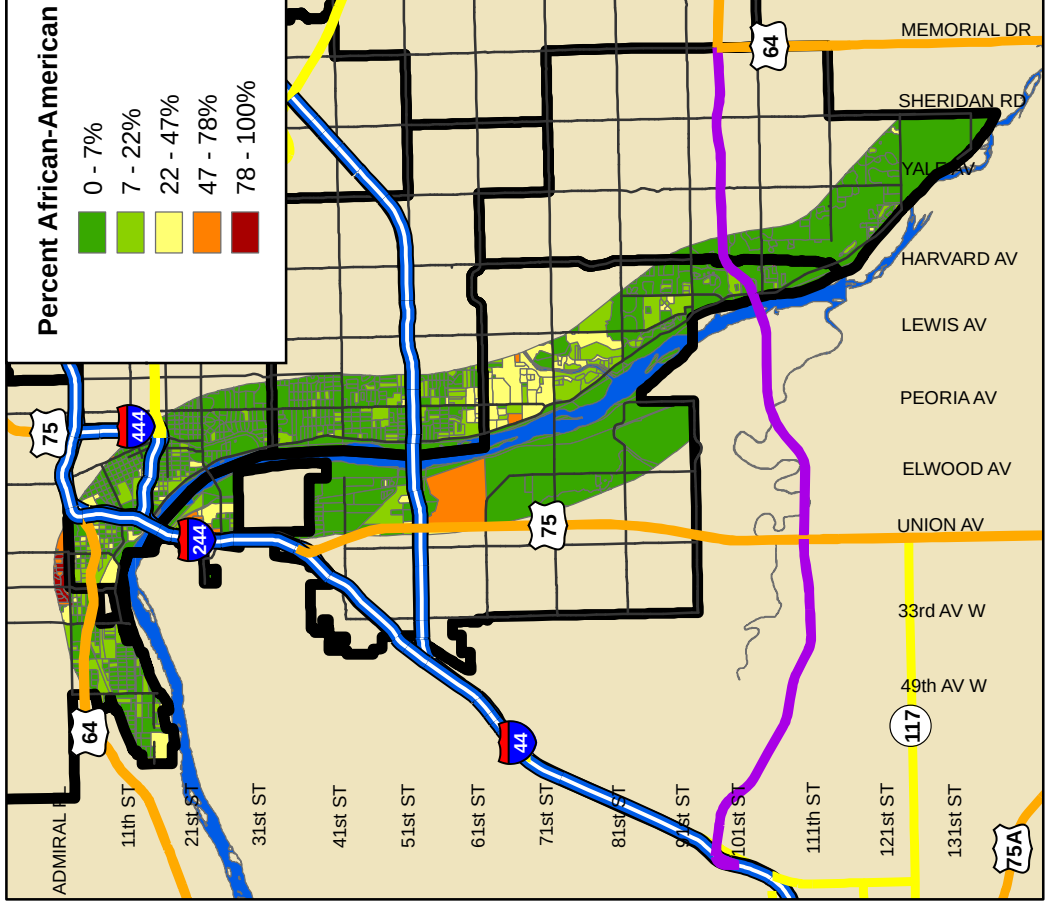


Figure 5.10-11

Arkansas River Corridor

Percent of Population of African-American Descent

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- Arkansas River

0 1 2 Miles

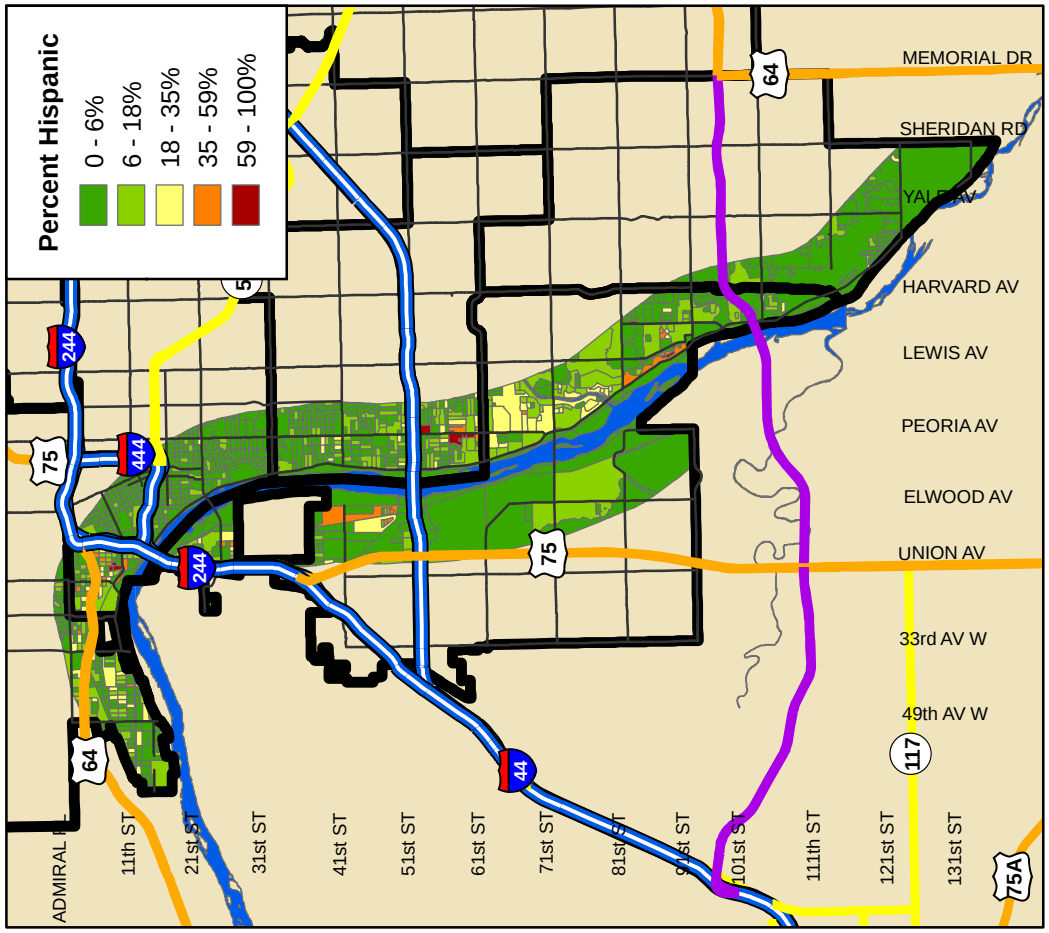


Figure 5.10-13

Arkansas River Corridor

Percent of Population of Hispanic Descent

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- Arkansas River

0 1 2 Miles

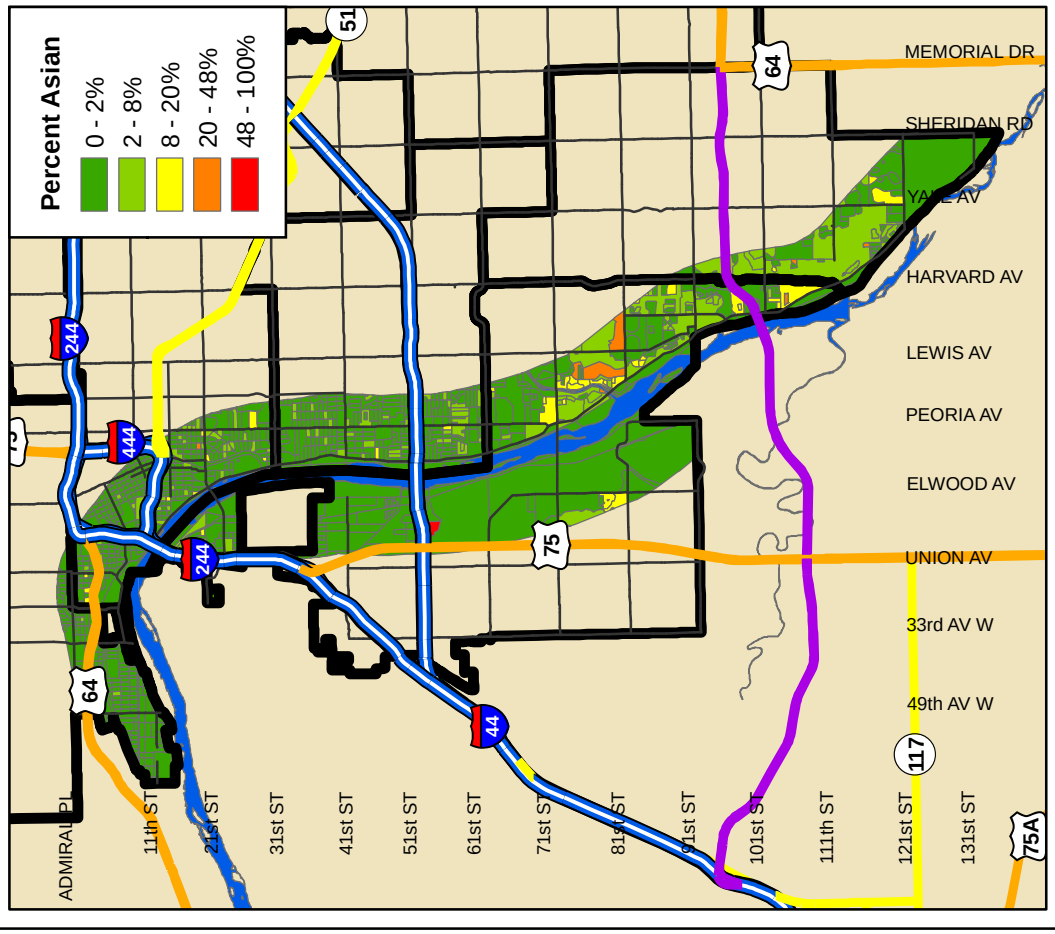


Figure 5.10-12

Arkansas River Corridor

Percent of Population of Asian Descent

LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- Arkansas River

0 1 2 Miles

5.10.1.6 Economy

The 2010 Census identified an income level of approximately $22,133 as the average poverty threshold for a family of four, including two children. Approximately 13,594 individuals or 22.10% of all persons in the Arkansas River Corridor were living below the poverty line in 2010. A map portraying areas of low income in Arkansas River Corridor is shown in Figure 5.10-8.

5.10.1.7 Development

According to the Tulsa County Assessor's Office, there are 18,239 properties with improvements in the Arkansas River Corridor with an adjusted value, estimated for fair market, of $3,232,600,526. The numbers of properties with improvements, and improvement values, by type, are shown in Table 5.10-2. No land, contents or tax exempt values are included. The Arkansas River Corridor is made up of 60 homeowners associations, displayed in Figure 5.10-14.

Table 5.10–2: Arkansas River Corridor Property Types by Assessed Values

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	16,244	$2,015,693,158
Residential Multi-Family	546	$202,679,427
Commercial	768	$808,456,239
Industrial	8	$46,787,534
Other	673	$158,984,168
Total	18,239	$3,232,600,526

Source: Tulsa County Assessor's Office, 2012

Zoning

For the purpose of this plan, five of the 29 zoning districts: Agricultural, Single- Family Residential, Multi-Family Residential, Commercial, and Industrial were used to show zoning patterns within the Arkansas River Corridor. The Corridor is primarily zoned for single-family residential uses, with commercial, multi-family, tax exempt, and industrial distributed throughout. A map of zoning areas in the Arkansas River Corridor is included in Figure 5.10-15.

Future Development

The City of Tulsa will continue to improve the Arkansas River Corridors service infrastructures, such as flood control, water, sanitary sewer, and streets. For information regarding future development plans in the City of Tulsa, see Section 1.2.8.

Figures 5.10-16 through 5.10-18 show areas that may be considered future development areas in the Arkansas River Corridor.

5.10.1.8 Critical Facilities

There are 105 critical facilities in the Arkansas River Corridor. Figure 5.10-19 and 5.10-20 shows the locations of these facilities within the Corridor. Critical facilities in the Corridor are listed in Table 5.10-3.

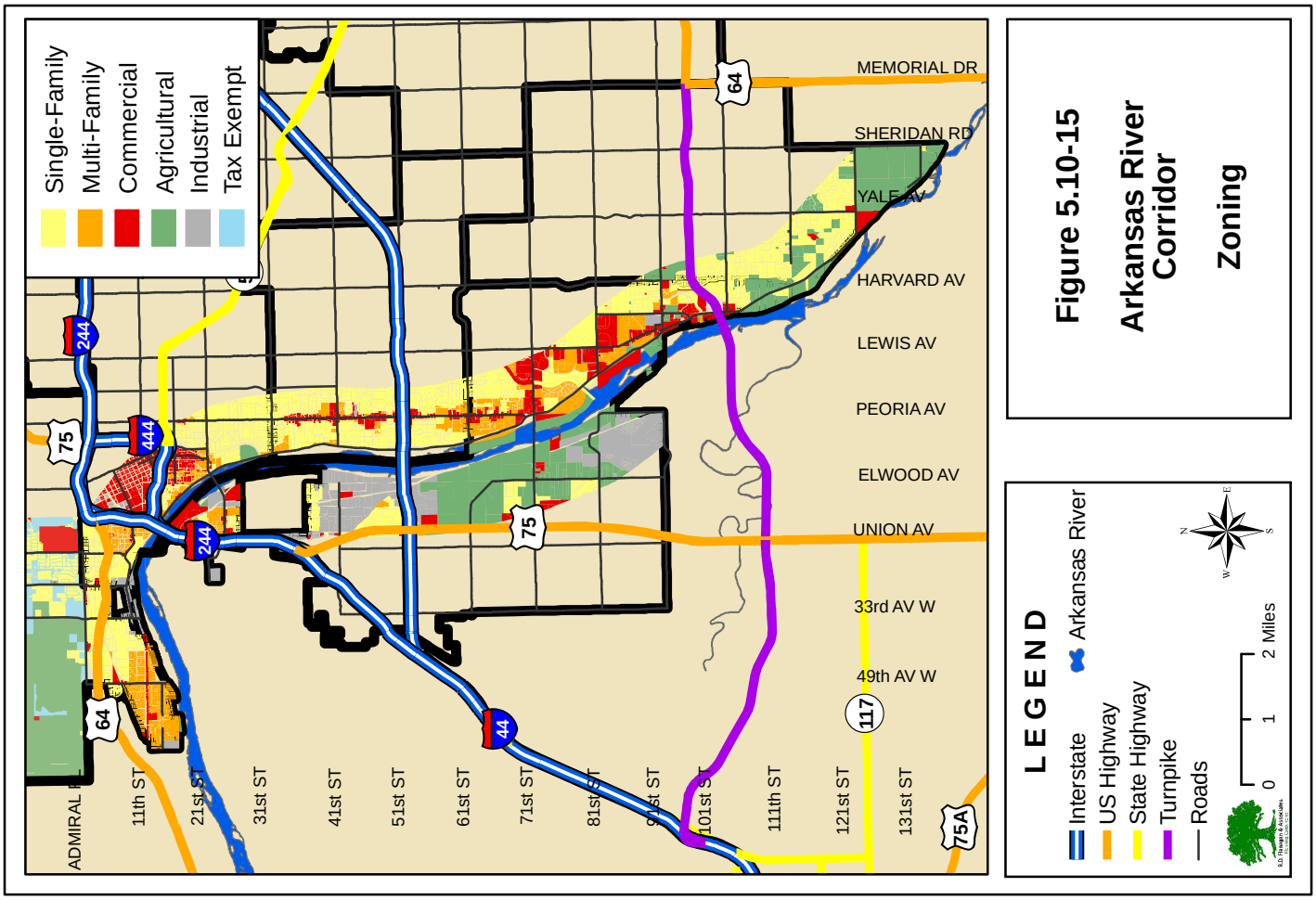


Figure 5.10-15
Arkansas River Corridor
Zoning

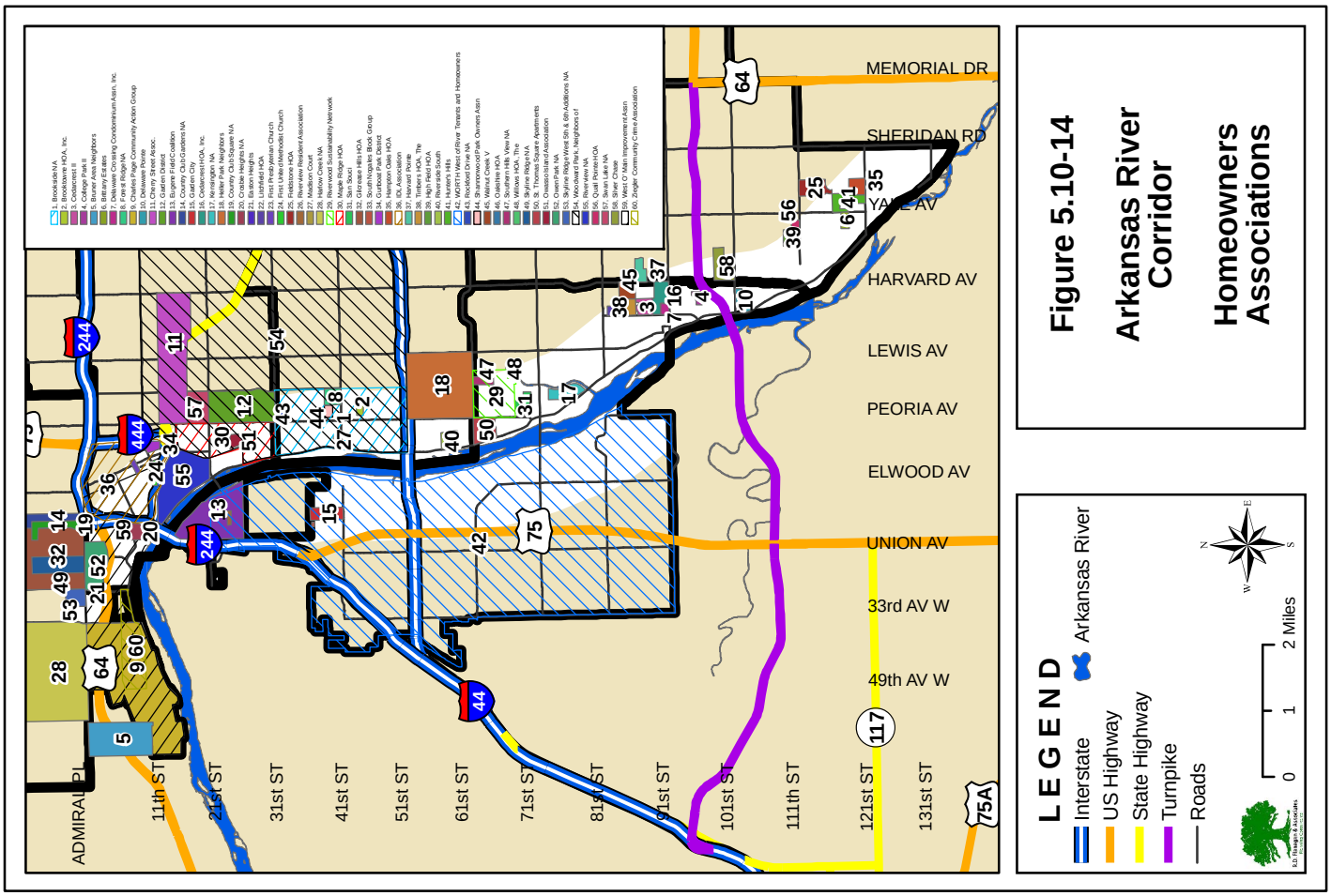


Figure 5.10-14
Arkansas River Corridor
Homeowners Associations

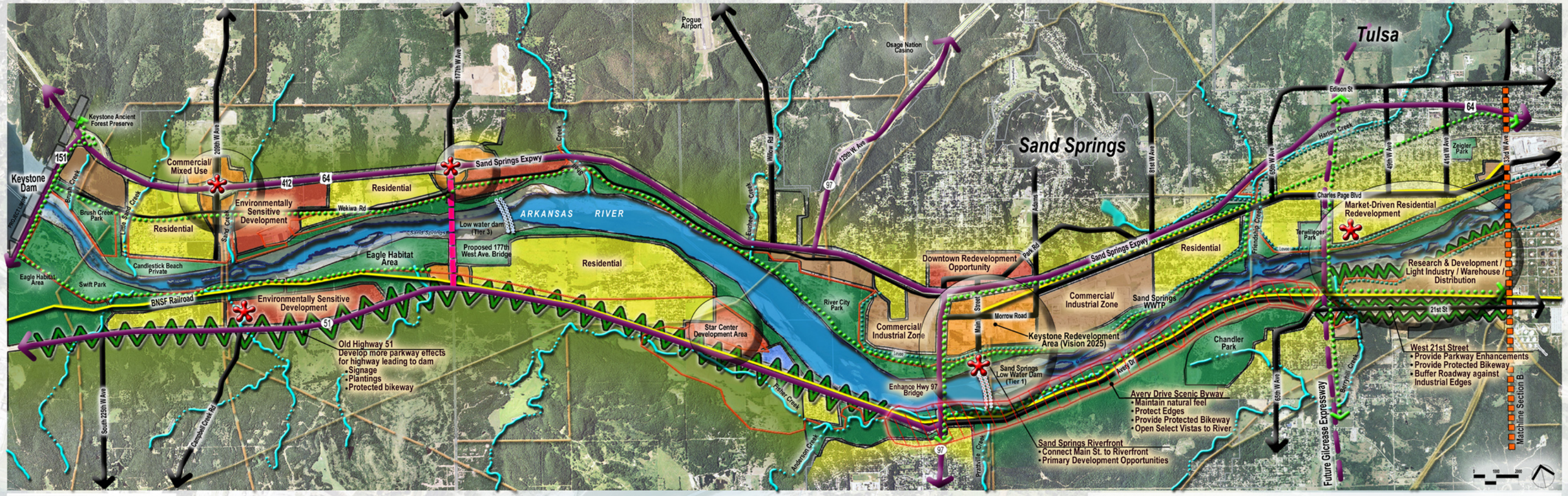


Figure 5.10-16

Vision Plan Land Use

Section A

Arkansas River Corridor VISION PLAN

INDIAN NATIONS COUNCIL OF GOVERNMENTS

Bixby ▪ Broken Arrow ▪ Jenks ▪ Sand Springs ▪ Tulsa ▪ Tulsa County ▪ River Parks Authority ▪ US Army Corps of Engineers ▪ Private Sector

Adopted July 2004

Update based on Arkansas River Corridor Master Plan September 2005

Carter Burgess

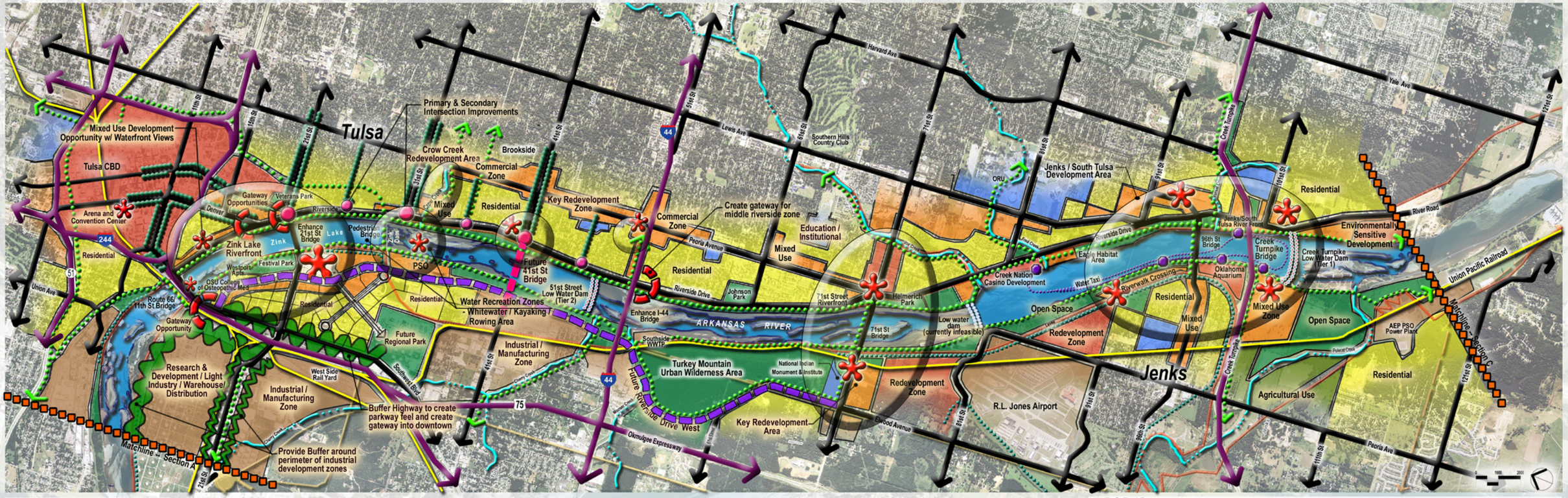


Figure 5.10-17

Vision Plan Land Use

Section B

Arkansas River Corridor VISION PLAN

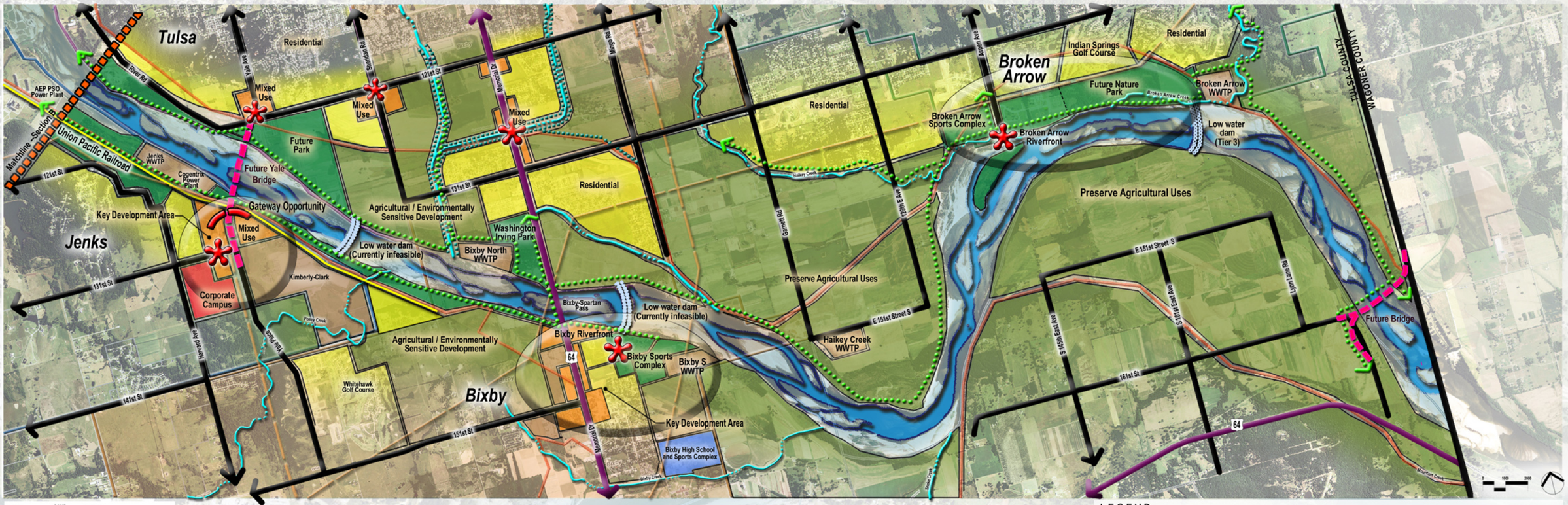
INDIAN NATIONS COUNCIL OF GOVERNMENTS

Bixby • Broken Arrow • Jenks • Sand Springs • Tulsa • Tulsa County • River Parks Authority • US Army Corps of Engineers • Private Sector

Adopted July 2004

Update based on Arkansas River Corridor Master Plan September 2005

Carter Burgess



LEGEND

- COMMERCIAL USES
- MIXED-USE ZONES
- INDUSTRIAL USES
- RESIDENTIAL ZONES
- AGRICULTURAL USES
- OPEN SPACE
- EDUCATIONAL / INSTITUTIONAL
- GATEWAY OPPORTUNITY
- SPECIAL DEVELOPMENT ZONE
- KEY DEVELOPMENT AREA
- LONG TERM LOW WATER DAM (TIER 3)
- CURRENTLY INFEASABLE LOW WATER DAM
- HIGHWAY
- THOROUGHFARE
- RAIL LINE
- POWER EASEMENT
- CREEK
- 1986 FLOOD LINE
- LEVEE
- HIKE/BIKE TRAIL
- PIPELINE CORRIDOR

Figure 5.10-18

Vision Plan Land Use

Section C

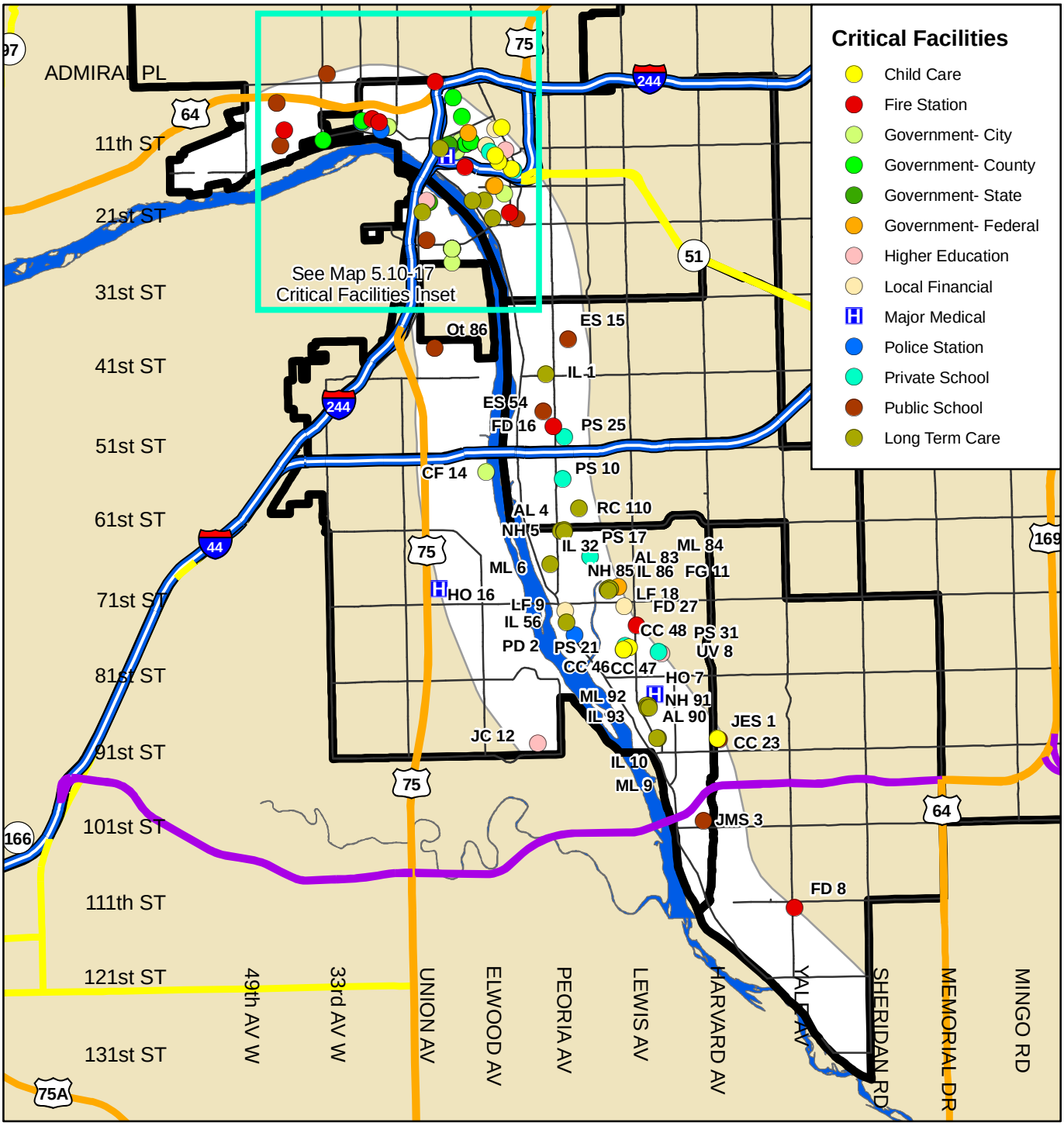


Figure 5.10-19

Arkansas River Corridor

Critical Facilities

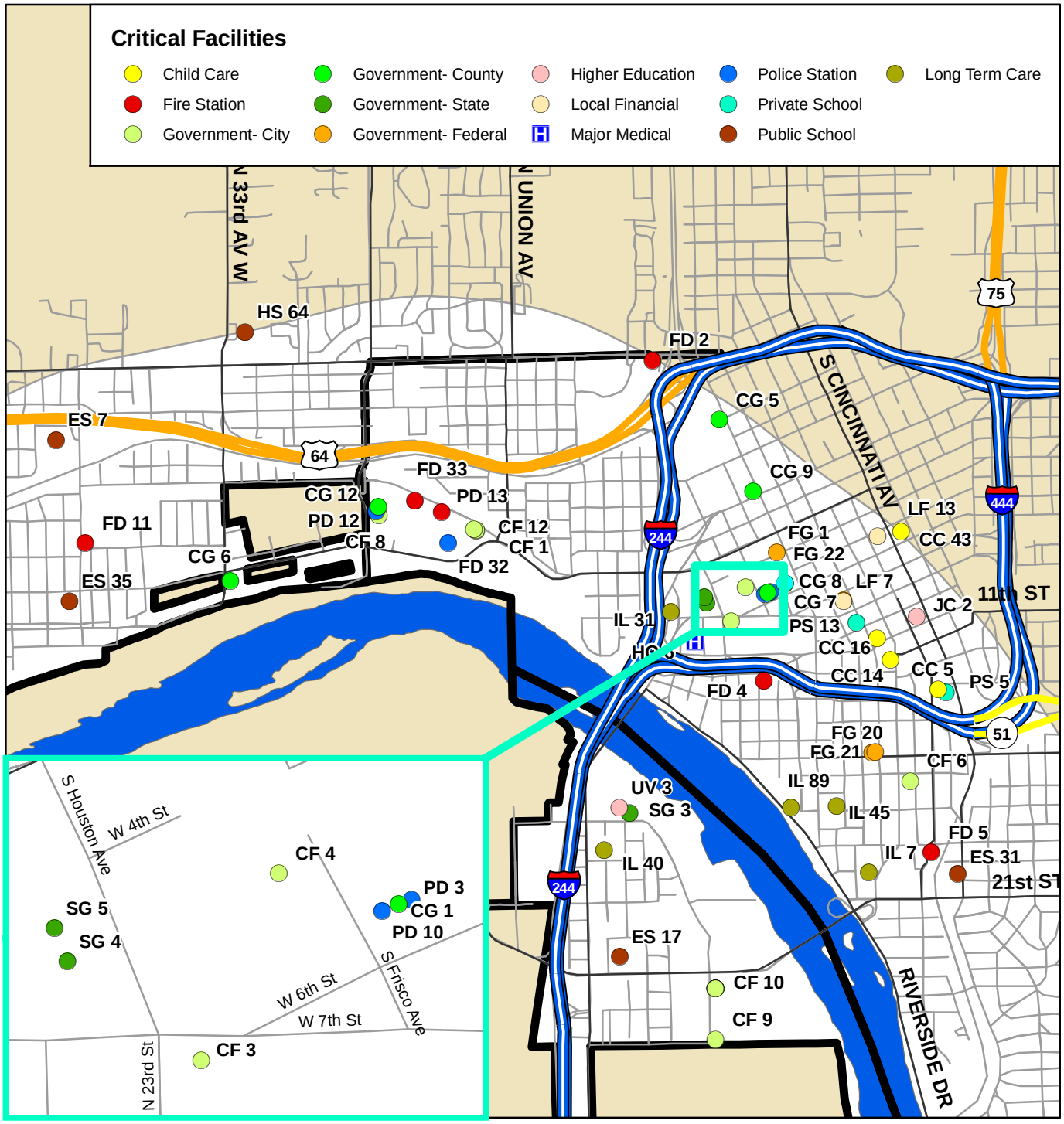


Figure 5.10-20

Arkansas River Corridor

Critical Facilities Inset

Table 5.10–3: Arkansas River Corridor Critical Facilities

ID	Map ID	Facility Name	Address
Government- City			
CF	1	City Garage	1720 W Newblock Park Dr
CF	3	River Parks Authority	707 S Houston Ave, S 510
CF	4	Tulsa Convention Center	100 Civic Center
CF	6	Community Service Council - Tulsa	16 E 16th St
CF	8	Juvenile Delinquency Project	315 S Gilcrease Museum Rd
CF	9	Field Customer Services	2445 S Jackson Ave
CF	10	Chemical Storage Building	2317 S Jackson Ave
CF	10	Fuel Facility	2317 S Jackson Ave
CF	10	Portable Building	2317 S Jackson Ave
CF	10	Storage Shed	2317 S Jackson Ave
CF	10	Surplus Facility	2317 S Jackson Ave
CF	10	Tire Shop	2317 S Jackson Ave
CF	10	W&M South Yard Storage Building	2317 S Jackson Ave
CF	10	W&M South Yard Office/stock Building	2317 S Jackson Ave
CF	10	Warehouse/Materials Stockroom	2317 S Jackson Ave
CF	12	Equipment Management	1720 Newblock Park Dr
CF	12	Structural Maintenance	1712 Charles Page Blvd
CF	14	Southside Water Treatment Plant	5300 S Elwood Ave
Police Station			
PD	2	Tulsa Police Station (Southwest Div)	7515 Riverside Pkwy
PD	3	Police Courts Building	600 Civic Center Plaza
PD	10	E-911 Building & PSRC Tower	911 Civic Center Plaza
PD	12	Juvenile Detention Center	315 S Gilcrease Museum Rd
PD	13	Adult Detention Center	1700 Charles Page Blvd
Fire Station			
FD	2	Tulsa Fire Department #2	524 W Edison
FD	4	Tulsa Fire Department #4	524 W 12th St
FD	5	Tulsa Fire Department #5	102 E 18th St
FD	8	Tulsa Fire Department #9	11211 South Yale
FD	11	Tulsa Fire Department #13	345 S 41st Av W
FD	16	Tulsa Fire Department #18	4802 S Peoria Ave
FD	27	Tulsa Fire Department #29	7429 S Lewis Ave
FD	32	Tulsa Fire Department Training	1760 Newblock Park Dr
FD	33	Tulsa Fire Department Supply	1790 Newblock Park Dr
Government-County			
CG	1	TAEMA Emergency Operations Center	600 Civic Center
CG	5	Tulsa County Correctional Facility	300 N. Denver
CG	6	Tulsa County Deputy Sheriff	3240 Charles Page Blvd
CG	7	Tulsa County Offices	500 S. Denver Ave
CG	8	Tulsa County Sheriff	500 S. Denver Ave
CG	9	Tulsa County Sheriff Office	303 W. 1st St.
CG	12	Tulsa County Juvenile Detention Center	315 S Gilcrease

ID	Map ID	Facility Name	Address
Government-State			
SG	3	Medical Examiner	1115 W 17th St
SG	4	Dept. of Human Services	444 S Houston
SG	5	Ok. State Office Building	440 S Houston
Government-Federal			
FG	1	USPS - Downtown Post Office	333 W 4th St
FG	11	USPS - Robert Jenkins Post Office	6910 S Yorktown
FG	20	ATF	125 W 15th St
FG	21	Secret Service	125 W 15th St
FG	22	US Attorney	110 W 7th St
Tulsa Public Schools			
ES	7	Choteau Elementary School	4132 W Cameron St
ES	15	Eliot Elementary School	1442 E 36th St
ES	17	Eugene Field Elementary School	2249 S Phoenix Ave
ES	31	Lee Elementary School	1920 S Cincinnati Ave
ES	35	Mark Twain Elementary School	541 S 43rd W Ave
ES	54	Wright Elementary School	110 E 45th Pl
HS	64	Central High School/ Junior High School	3101 W Edison St
Ot	86	McBirney Transportation/ West Lot	10112 W 36th Pl
Jenks Public Schools			
JES	1	Jenks East Elementary School	8925 S Harvard Ave
JMS	3	Jenks Middle School	3019 E 101st St
Private School			
PS	5	Boston Avenue Weekday School	1301 S Boston Ave
PS	10	Evangelistic Temple School	1339 E 55th St
PS	13	Holy Family Cathedral School	820 S. Boulder
PS	17	Metro Christian Academy	6363 S. Trenton
PS	21	ORU Academy	7777 S Lewis Ave
PS	25	School of Saint Mary	1365 E 49th Pl
PS	31	Victory Christian School	7700 S Lewis
Child Care			
CC	5	Boston Avenue UM Weekday School	1301 S. Boston Ave
CC	14	Early Learning Academy	1115 S. Boulder
CC	16	First Christian Child Development Center	913 S. Boulder
CC	23	Jenks PS East Before & After Program	8925 S. Harvard
CC	43	Trinity Episcopal Day School	501 S. Cincinnati Ave.
CC	46	Victory Christian School	7700 S. Lewis
CC	47	Victory Kids Care	7700 S. Lewis Ave.
CC	48	Victory Mothers Day Out	7700 S Lewis
Higher Education			
JC	2	Tulsa Community College - Metro Campus	909 S Boston Ave
UV	3	OSU College of Osteopathic Medicine	1111 W 17th St
UV	8	Oral Roberts University	7777 S Lewis Ave
JC	12	Tulsa Community College - Riverside	801 E 91st St

ID	Map ID	Facility Name	Address
Major Medical			
HO	6	Oklahoma State University Medical Center	744 W 9th St
HO	7	Oklahoma Surgical Hospital	2408 E 81st St Ste 300
HO	16	Tulsa Spine & Specialty Hospital	6901 S Olympia
Long Term Care			
IL	1	4100 Apartments	3933 S Norfolk Ave
AL	4	Ambassador's Courtyards	1380 E 61st St
NH	5	Ambassador Manor Nursing & Rehab Center	1340 E 61st St
ML	6	Ambassador Manor Nursing & Rehab Center	1340 E 61st St
IL	7	Boulder Plaza	1840 S Boulder
ML	9	Burgundy Place	8887 S Lewis Ave
IL	10	Burgundy Place	8887 S Lewis Ave
IL	31	Hewgley Terrace	420 S Lawton Ave
IL	32	Inhofe Plaza	6565 S Newport
IL	40	LaFortune Tower	1725 S Southwest Blvd
IL	45	Mansion House	1638 S Carson
IL	56	Prairie Rose	7401 Riverside Parkway
AL	83	Tulsa Jewish Retirement & Health Care Center	2025 E 71st St
ML	84	Tulsa Jewish Retirement & Health Care Center	2025 E 71st St
NH	85	Tulsa Jewish Retirement & Health Care Center	2025 E 71st St
IL	86	Tulsa Jewish Retirement & Health Care Center	2025 E 71st St
IL	89	Tulsa Pythian Manor West	1700 Riverside Dr
AL	90	University Village Retirement Community	8555 S Lewis Ave
NH	91	University Village Retirement Community	8555 S Lewis Ave
ML	92	University Village Retirement Community	8555 S Lewis Ave
IL	93	University Village Retirement Community	8555 S Lewis Ave
RC	110	Naquitas Niche, LLC	1521 E 59th St
Local Financial			
LF	7	Energy One Federal Credit Union	220 W 7th
LF	9	National Bank of Commerce	7127 Riverside
LF	13	Red Crown Federal Credit Union	509 S Boston
LF	18	Tulsa National Bancshares	7120 S Lewis Ave

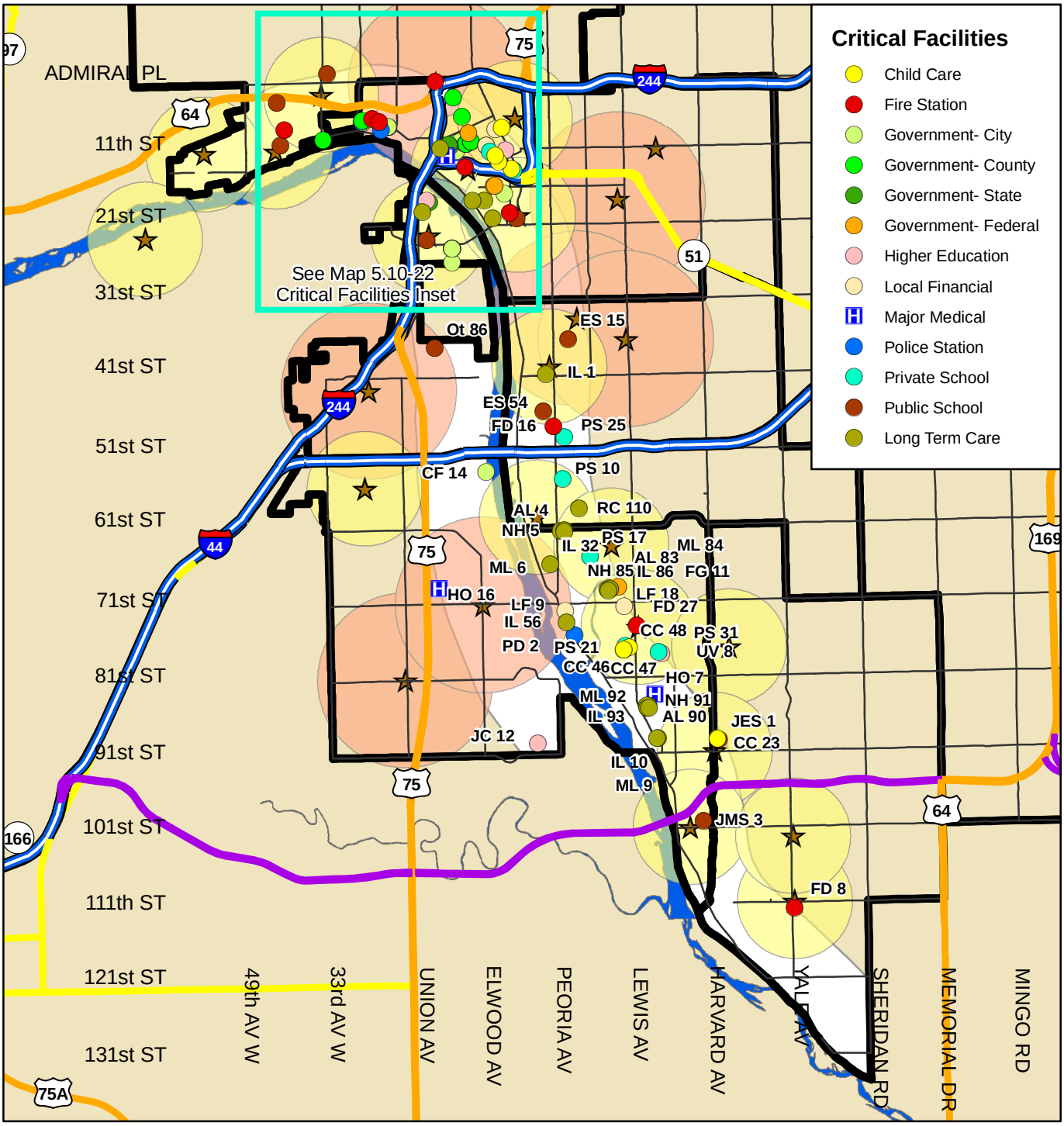
5.10.2 Existing Mitigation Strategies

Existing mitigation measures currently being implemented throughout the City of Tulsa are detailed in Chapter 2, *Existing Mitigation Strategies*. The information that follows in this section surveys the infrastructure in place for avoiding or mitigating the impacts of natural hazards, that can be looked at from a smaller area of the City.

5.10.2.1 Arkansas River Corridor Warning Systems

Warning Sirens

At the time of this plan update there were 15 warning sirens located in the Arkansas River Corridor and 10 located outside of, but with partial coverage within, the Corridor. Each warning siren is audible for up to a mile. Information regarding the testing of warning sirens in the City of Tulsa is included in Chapter 2. Locations of sirens in Arkansas River Corridor are mapped in Figure 5.10-18.



LEGEND

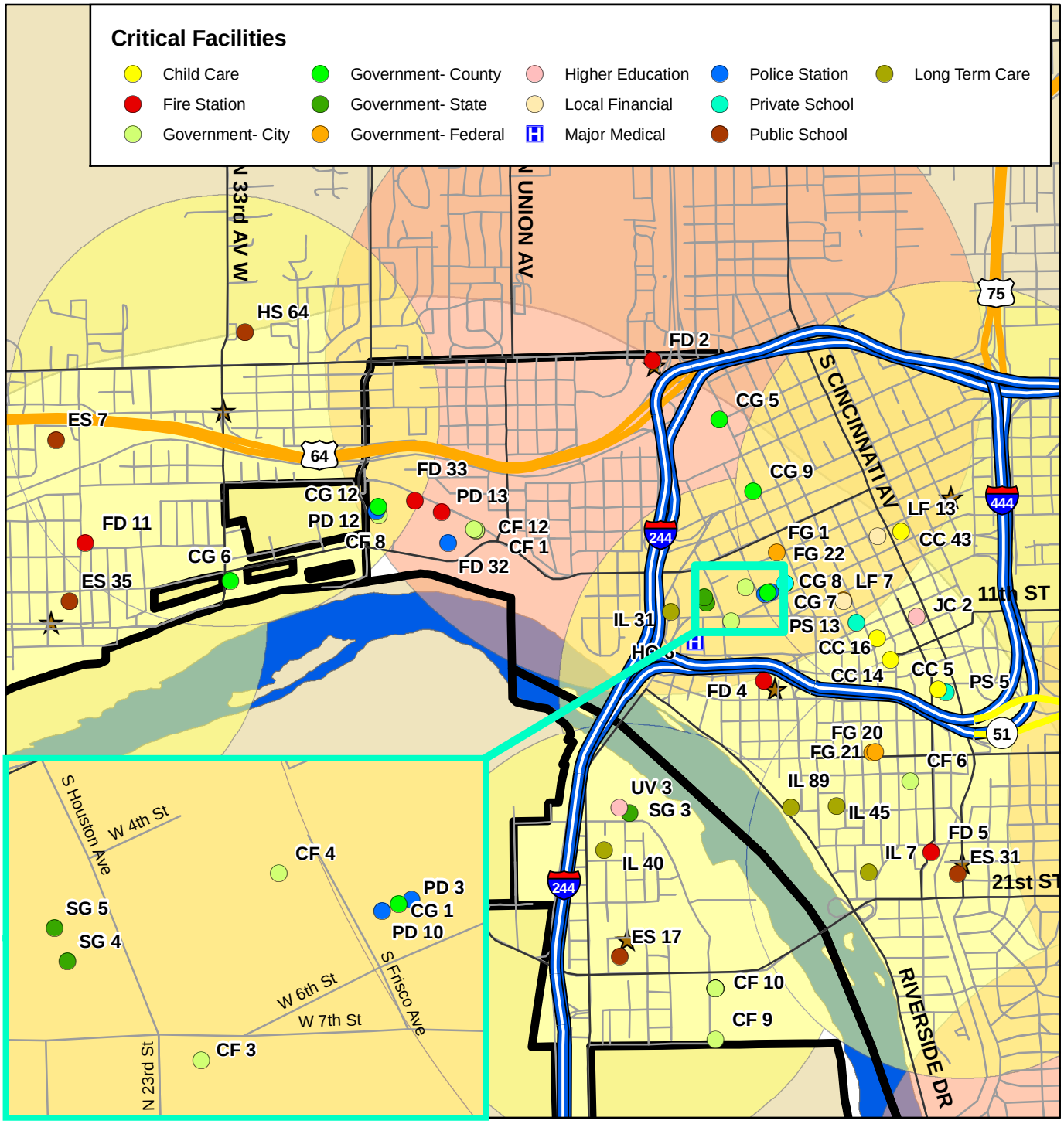
- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- Arkansas River
- River Corridor
- Sirens
- 4,000ft Buffer
- 6,100ft Buffer

0 1 2 Miles

Figure 5.10-21

Arkansas River Corridor

Warning Sirens



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- Arkansas River
- River Corridor
- Sirens
- 4,000ft Buffer
- 6,100ft Buffer

0 0.25 0.5 Miles

Figure 5.10-22

Arkansas River Corridor

Warning Sirens Inset

Lightning Sensing and Warning

The City of Tulsa is home to multiple outdoor recreation areas for public use; parks in the Arkansas River Corridor are mapped in Figure 5.10-20, including the extensive and enormously popular River Parks trails on both sides of the Arkansas, from the 11th St. bridge south to 71st St. on the west side and to 101st St. on the east. Major parks on the west side of the river include the River West Festival Park, the West Bank Soccer Complex and Turkey Mountain Park; on the east side are Helmrich Park, Riverside Park and Johnson Park. The north side of the Arkansas River, west of the 11th St. bridge, has Newblock Park and the Newblock Park Trail/Katy Jogging Trail complex that links River Parks to Sand Springs. Parks promote neighborhood revitalization and development, they also promote youth development. As discussed in Chapter 4, it is important that outdoor recreation areas be equipped with lightning sensing and warning systems.

5.10.3 Planning Process

The CAC/TAC met monthly during the planning process to review progress, identify issues, receive task assignments, and advise the consultants. Refer to Appendix C for meeting agendas.

5.10.4 Natural and Manmade Hazards

Hazards

General natural hazards, such as Severe Winter Storms, High Wind, Tornado, Lightning, Hailstorm, Extreme Heat, Drought, Earthquake, and Urban Fires affect all areas in the City of Tulsa randomly and equally, and are addressed in Chapter 4.

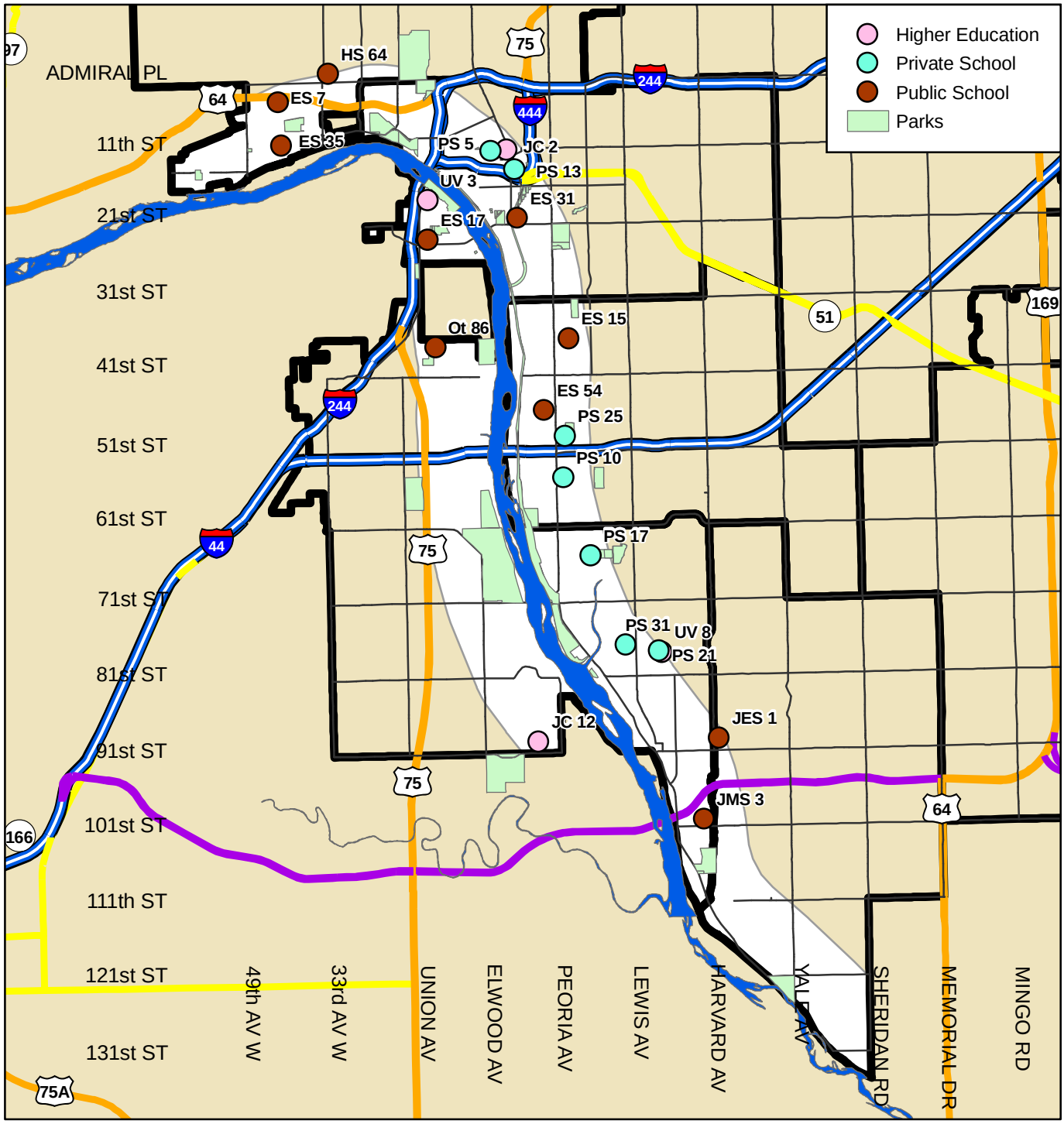
Site specific hazards, such as Flooding, Dam Failures, Levee Failures, Expansive Soils, Wildfires, Fixed Site Hazardous Materials and Transportation-Hazardous Materials are addressed for the Arkansas River Corridor in subsections 5.10.4.1 through 5.10.4.7, summarized in subsection 5.10.4.8 and shown on the map in Figure 5.10-33. Table 5.10-4 identifies the site-specific hazards that can particularly impact the Arkansas River Corridor.

Table 5.10–4: Arkansas River Corridor Site-Specific Hazard Impacts

Hazard Area	Area (Sq. mi)	Improved Parcels	Est. Market Value	Percent of Area Impacted	Impacted Population
Floods (100-year, 1-percent)	6.51	2,660	$257,596,374	25.66%	7,677
Dam Failure	16.99	11,040	$1,532,002,202	66.97%	41,126
Levee Failure	2.62	3,044	$121,417,735	10.33%	8,194
Highly Expansive Soils	2.22	1,680	$301,250,463	8.75%	8,576
Wildfire	0.79	135	$81,985,331	3.11%	1,712
Fixed-Site HazMat, ¼ Mi.	4.70	3,142	$837,754,006	18.53%	10,135
Transportation HazMat-Highway	4.88	4,587	$538,505,201	19.24%	12,987
Transportation HazMat-Rail Railroad	4.81	2,031	$251,582,076	18.96%	9,340

Source: Tulsa County Assessor's Office, 2012/US Census Data 2010

The City of Tulsa has identified certain facilities as critical to the health, safety and welfare of its citizens, business and economy. Table 5.10-5 indicates, generally, the exposure of critical facilities in the Arkansas River Corridor to the seven site-specific hazards covered by this Plan Update.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- Arkansas River
- River Corridor

0 1 2 Miles

Figure 5.10-23

Arkansas River Corridor

Schools & Parks

Table 5.10–5: Arkansas River Corridor Hazard Impacts on Critical Facilities

ID	Map ID	Facility Name	Site-Specific Hazards										
				Dam Release Rates									
			Flood	250 CFS	350 CFS	450 CFS	Dam Breach	Max Failure	Levee Failure	Expansive Soils	Wildfire	Fixed Site Hazardous Materials	Transportation Hazardous Materials
CF	1	City Garage	X			X			X				X
CF	3	River Parks Authority										X	X
CF	4	Tulsa Convention Center										X	X
CF	6	Community Service Council - Tulsa										X	X
CF	8	Juvenile Delinquency Project	X			X			X			X	X
CF	9	Field Customer Services				X			X				X
CF	10	Chemical Storage Building				X			X			X	X
CF	10	Fuel Facility				X			X			X	X
CF	10	Portable Building				X			X			X	X
CF	10	Storage Shed				X			X			X	X
CF	10	Surplus Facility				X			X			X	X
CF	10	Tire Shop				X			X			X	X
CF	10	W&M South Yard Storage Building				X			X			X	X
CF	10	W&M South Yard Office/stock Building				X			X			X	X
CF	10	Warehouse/Materials Stockroom				X			X			X	X
CF	12	Equipment Management	X			X			X				X
CF	12	Structural Maintenance	X			X			X				X
CF	14	Southside Water Treatment Plant			X							X	X
PD	2	Tulsa Police Station (Southwest Div)			X								
PD	3	Police Courts Building										X	X
PD	10	E-911 Building & PSRC Tower										X	X
PD	12	Juvenile Detention Center	X			X			X			X	X
PD	13	Adult Detention Center	X			X			X				X
FD	2	Tulsa Fire Department #2											X
FD	4	Tulsa Fire Department #4											X
FD	5	Tulsa Fire Department #5											
FD	8	Tulsa Fire Department #9											
FD	11	Tulsa Fire Department #13	X			X			X				
FD	16	Tulsa Fire Department #18				X							
FD	27	Tulsa Fire Department #29						X					
FD	32	Tulsa Fire Department Training	X			X			X				X
FD	33	Tulsa Fire Department Supply	X			X			X			X	X
CG	1	TAEMA Emergency Operations Center										X	X
CG	5	Tulsa County Correctional Facility								X		X	X
CG	6	Tulsa County Deputy Sheriff	X			X			X			X	X
CG	7	Tulsa County Offices										X	

ID	Map ID	Facility Name	Site-Specific Hazards										
				Dam Release Rates									
			Flood	250 CFS	350 CFS	450 CFS	Dam Breach	Max Failure	Levee Failure	Expansive Soils	Wildfire	Fixed Site Hazardous Materials	Transportation Hazardous Materials
CG	8	Tulsa County Sheriff										X	
CG	9	Tulsa County Sheriff Office										X	X
CG	12	Tulsa County Juvenile Detention Center	X			X			X			X	X
SG	3	Medical Examiner				X			X			X	X
SG	4	Dept. of Human Services										X	X
SG	5	Ok. State Office Building										X	X
FG	1	USPS - Downtown Post Office										X	
FG	11	USPS - Robert Jenkins Post Office				X				X		X	
FG	20	ATF										X	X
FG	21	Secret Service										X	X
FG	22	US Attorney										X	
ES	7	Choteau Elementary School				X			X				X
ES	15	Eliot Elementary School					X						
ES	17	Eugene Field Elementary School				X			X			X	X
ES	31	Lee Elementary School											
ES	35	Mark Twain Elementary School				X			X				X
ES	54	Wright Elementary School				X							
HS	64	Central High School/ Junior High School											
Ot	86	McBirney Transportation/ West Lot			X							X	X
JES	1	Jenks East Elementary School											
JMS	3	Jenks Middle School		X									X
PS	5	Boston Avenue Weekday School										X	X
PS	10	Evangelistic Temple School				X							
PS	13	Holy Family Cathedral School										X	X
PS	17	Metro Christian Academy						X		X			
PS	21	ORU eAcademy											
PS	25	School of Saint Mary				X							X
PS	31	Victory Christian School				X				X	X		
CC	5	Boston Avenue UM Weekday School									X	X	X
CC	14	Early Learning Academy										X	X
CC	16	First Christian Child Development Ctr										X	X
CC	23	Jenks PS East Before & After Program											
CC	43	Trinity Episcopal Day School										X	
CC	46	Victory Christian School				X				X			
CC	47	Victory Kids Care				X				X			

ID	Map ID	Facility Name	Site-Specific Hazards										
				Dam Release Rates									
			Flood	250 CFS	350 CFS	450 CFS	Dam Breach	Max Failure	Levee Failure	Expansive Soils	Wildfire	Fixed Site Hazardous Materials	Transportation Hazardous Materials
CC	48	Victory Mothers Day Out				X				X			
JC	2	Tulsa Community College - Metro Campus										X	
UV	3	OSU College of Osteopathic Medicine				X			X			X	X
UV	8	Oral Roberts University											
JC	12	Tulsa Community College - Riverside				X							
HO	6	Oklahoma State University Medical Center										X	X
HO	7	Oklahoma Surgical Hospital				X				X		X	
HO	16	Tulsa Spine & Specialty Hospital											X
IL	1	4100 Apartments				X							
AL	4	Ambassador's Courtyards	X		X								
NH	5	Ambassador Manor Nursing & Rehab Center	X		X								
ML	6	Ambassador Manor Nursing & Rehab Center	X		X								
IL	7	Boulder Plaza											
ML	9	Burgundy Place			X							X	
IL	10	Burgundy Place			X							X	
IL	31	Hewgley Terrace										X	X
IL	32	Inhofe Plaza			X								
IL	40	LaFortune Tower				X			X			X	X
IL	45	Mansion House											
IL	56	Prairie Rose				X					X		
AL	83	Tulsa Jewish Retirement & Health Care Center				X				X			
ML	84	Tulsa Jewish Retirement & Health Care Center				X				X			
NH	85	Tulsa Jewish Retirement & Health Care Center				X				X		X	
IL	86	Tulsa Jewish Retirement & Health Care Center				X				X			
IL	89	Tulsa Pythian Manor West						X					
AL	90	University Village Retirement Community				X				X			
NH	91	University Village Retirement Community			X					X			
ML	92	University Village Retirement Community			X					X			
IL	93	University Village Retirement Community				X				X			

ID	Map ID	Facility Name	Site-Specific Hazards										
				Dam Release Rates									
			Flood	250 CFS	350 CFS	450 CFS	Dam Breach	Max Failure	Levee Failure	Expansive Soils	Wildfire	Fixed Site Hazardous Materials	Transportation Hazardous Materials
RC	110	Naquitas Niche, LLC				X							
LF	7	Energy One Federal Credit Union										X	
LF	9	National Bank of Commerce			X								
LF	13	Red Crown Federal Credit Union										X	
LF	18	Tulsa National Bancshares				X				X			

5.10.4.1 Flood

Location

The Arkansas River Corridor is affected by both the City Regulatory Floodplains and the Special Flood Hazard Area (SFHA). The SFHA makes up a large portion of the Corridor. There are 13 tributaries that feed into the Arkansas River within the Corridor. North and east bank streams, from northwest to southeast, are Harlow Creek, Parkview Creek, Oak Creek, Elm Creek, Swan Creek, Crow Creek, Perryman Ditch, Joe Creek, Fred Creek, Vensel Creek, and the South Basin tributaries. West bank streams, from north to south, are Cherry Creek and Mooser Creek. The combined floodplains of the Arkansas River and its tributary streams comprise 6.51 sq. mi., or 25.66 percent of the land within the Corridor. Streams in Arkansas River Corridor and their total drainage areas within the Corridor are listed in Table 5.10-6. A map of Arkansas River Corridor drainage basins and 100 year Floodplains is displayed in Figure 5.10-21.

Table 5.10–6: Streams and Drainage Areas

Basin	Total Drainage Area (sq. mi.)
ARKANSAS RIVER LOCAL DRAINAGE	3.83
ARKANSAS RIVER MAINSTEM	2.57
CHERRY/REDFORK	0.98
CROW CREEK	0.74
DOWNTOWN	0.98
ELM CREEK	0.81
FRED CREEK	1.23
GARDEN CITY	0.33
HAGER CREEK	1.02
HARLOW CREEK	0.06
JOE CREEK	1.43
MOOSER CREEK	1.44
OAK CREEK	0.47
PARK VIEW CREEK	1.31

Basin	Total Drainage Area (sq. mi.)
PERRYMAN DITCH	2.73
SOUTH TULSA CREEK	2.33
SWAN-TRAVIS PARK	0.54
VENSEL CREEK	2.57
Total	25.37

Impact/Vulnerability

The October 5, 1986 flood on the Arkansas River was the flood of record for Tulsa. Although there has been debate about whether this event should be categorized as a "flood" or a "dam failure" event, the fact remains that over 310,000 cfs was surging down the Arkansas River at the time, and if the dam had not been in place an even worse flooding event could have occurred. As it was, the U.S. Army Corps of Engineers was forced to release 310,000 cfs into the Arkansas River, which was already flooding downstream in Bixby and Broken Arrow.

The river reached 25.21 feet in Tulsa, 2.5 feet above the previous flood of record of June 13, 1923. The World War II era levees protecting Newblock Park and the industries along Charles Page Blvd. held, as did those around the refineries on the west bank of the river. A private levee protecting Garden City in West Tulsa failed and water filled the community up to the eaves of many of its homes.

A total of $1.3 million damage was done to 14 homes, 11 industrial buildings and 39 mobile homes. The City purchased 13 parcels and cleared seven homes. There was also flooding along Riverside Drive at 71st St., and some scattered flooding from storm sewer backup in the low-lying area around 31st and Riverside Drive. A map displaying the 1986 Arkansas River Corridor flood inundation areas is shown in Figure 5.10-22.

Today, 2,358 residential single family structures, 60 residential multi-family structures, 77 commercial buildings, 11 industrial facilities and 154 structures classified as *other* remain in the 100-year floodplains of the Arkansas River Corridor. The 2,660 improved parcels have an adjusted value, estimated for fair market, of $257,596,374. Structures touched by the 100-year floodplain in the Arkansas River Corridor are listed, by type, in Table 5.10-7.

Table 5.10–7: Arkansas River Corridor, Parcels in the 100-year Floodplain

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	2,358	$173,122,284
Residential Multi-Family	60	$15,331,852
Commercial	77	$39,028,494
Industrial	11	$9,556,444
Other	154	$20,557,300
Total	2,660	$257,596,374

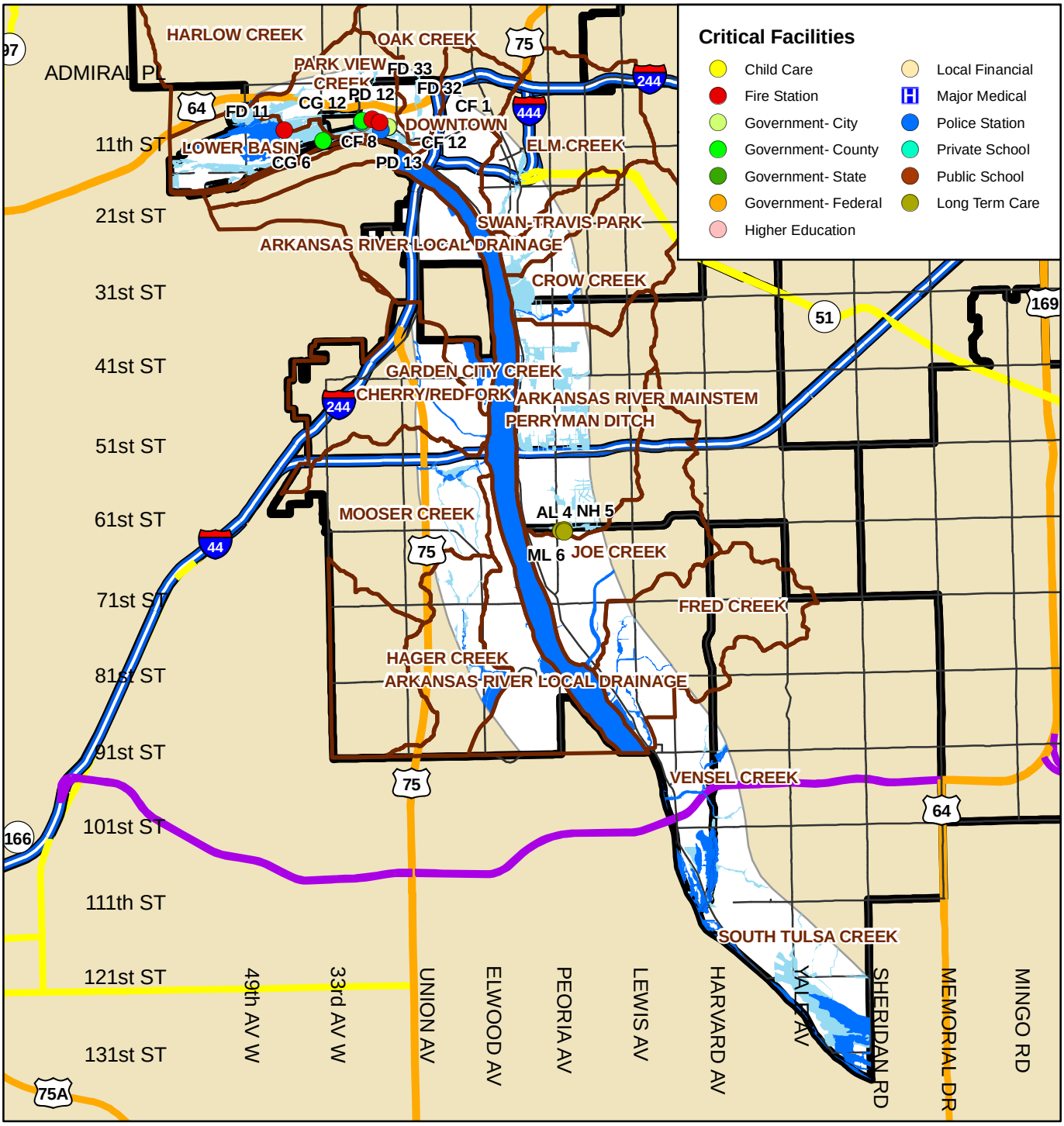
Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Of the buildings touched by the 100-year floodplains, 15 are critical facilities. A list of critical facilities impacted by the Flood hazard is included in Table 5.10-5.

Repetitive Loss

There are four residential repetitive loss properties located within the Arkansas River Corridor.



LEGEND

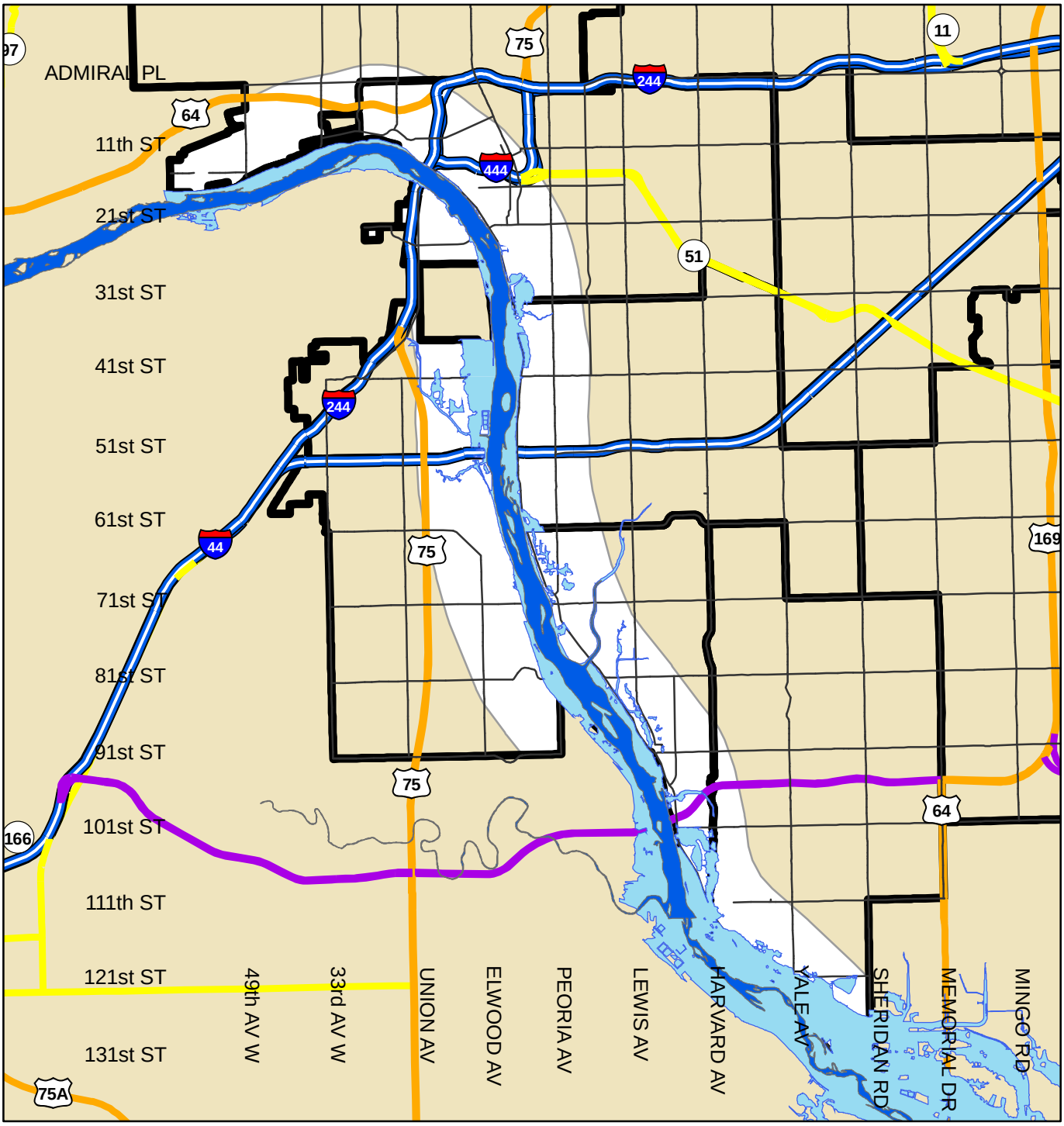
- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- Drainage Basins
- SFHA
- City Regulatory
- River Corridor

0 1 2 Miles

Figure 5.10-24

Arkansas River Corridor

Drainage Basins & Floodplains



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- Arkansas River
- River Corridor
- 1986 Floodplain

0 1 2 Miles

N W E S

Figure 5.10-25

Arkansas River Corridor

1986 Flood

Flood Control Projects

Tulsa's floodplain and stormwater program includes comprehensive watershed management, dedicated funds for maintenance and operation, and a $200 million capital improvements program. In the Arkansas River Corridor, many projects have been completed for flood control issues. Flood control projects for the Arkansas River Corridor are shown on the map in Figure 5.10-23, and are included in the flood control sections for City Council Districts 1, 2, 4, 8 and 9.

Conclusion

The Arkansas River Corridor has a HIGH probability of and a HIGH vulnerability to the Flood hazard.

5.10.4.2 Dam Failure

Location

The Arkansas River Corridor is located 11.5 miles downstream of Keystone Lake Dam. A map of the dam inundation areas in the Arkansas River Corridor is included in Figure 5.10-24. Figure 5.10-25 displays the inundation areas for releases of 250,000 CFS, 350,000 CFS, 450,000 CFS, Max Discharge, and Dam Break. The inundation area of Keystone Lake Dam encompasses 16.99 square miles, of 66.97 percent of land area in the Arkansas River Corridor.

Impact/Vulnerability

The Arkansas River Corridor is the most vulnerable area in the City of Tulsa to the Dam Failure hazard. A breach or failure of Keystone Lake Dam would cause complete devastation to the impacted area and tremendous loss of life and property.

According to Tulsa County Assessor Data, there are 11,040 improved parcels located in the dam inundation area of the Arkansas River Corridor. The parcels have a total value, estimated for fair market, of $1,532,002,202. A summary of the parcels impacted by a break of Keystone Dam, by estimated fair market value and type, is included in Table 5.10-8.

The greatest impact of a failure of a dam would be the loss of life of those in the inundation area, property damage and destruction or interruption of infrastructure. According to a Marplot analysis, which uses 2010 US Census information, approximately 41,126 persons living within the Arkansas River Corridor would be impacted by the Dam Failure hazard. In addition to tremendous loss of life and property, failure of Keystone Dam would devastate critical infrastructure, causing impacts throughout the city. Potential impacts of the Dam Failure hazard on Tulsa's infrastructure can be found in Chapter 4, Section 4.11.3.

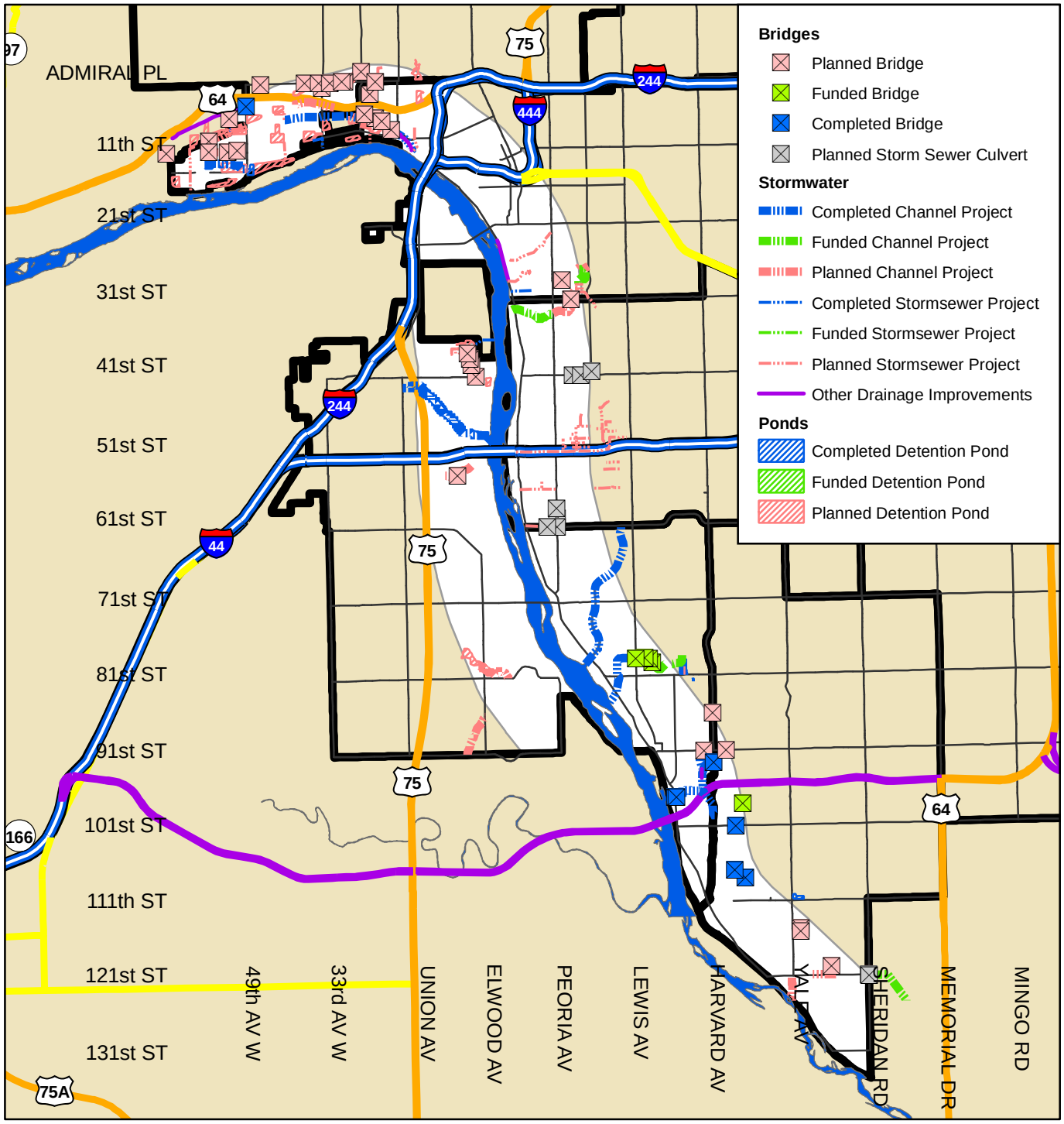
Table 5.10–8: Arkansas River Corridor Improved Parcels Keystone Dam Inundation Area

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	9,884	$888,706,086
Residential Multi-Family	364	$162,836,326
Commercial	486	$368,842,384
Industrial	49	$40,130,834
Other	257	$71,486,572
Total	11,040	$1,532,002,202

Source: Tulsa and County Assessor's Office, 2012

Critical Facilities

Included in the Keystone Dam inundation areas of the Arkansas River Corridor are 65 facilities identified as providing critical services to the City of Tulsa. A majority of the vulnerable facilities are



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- Arkansas River
- River Corridor

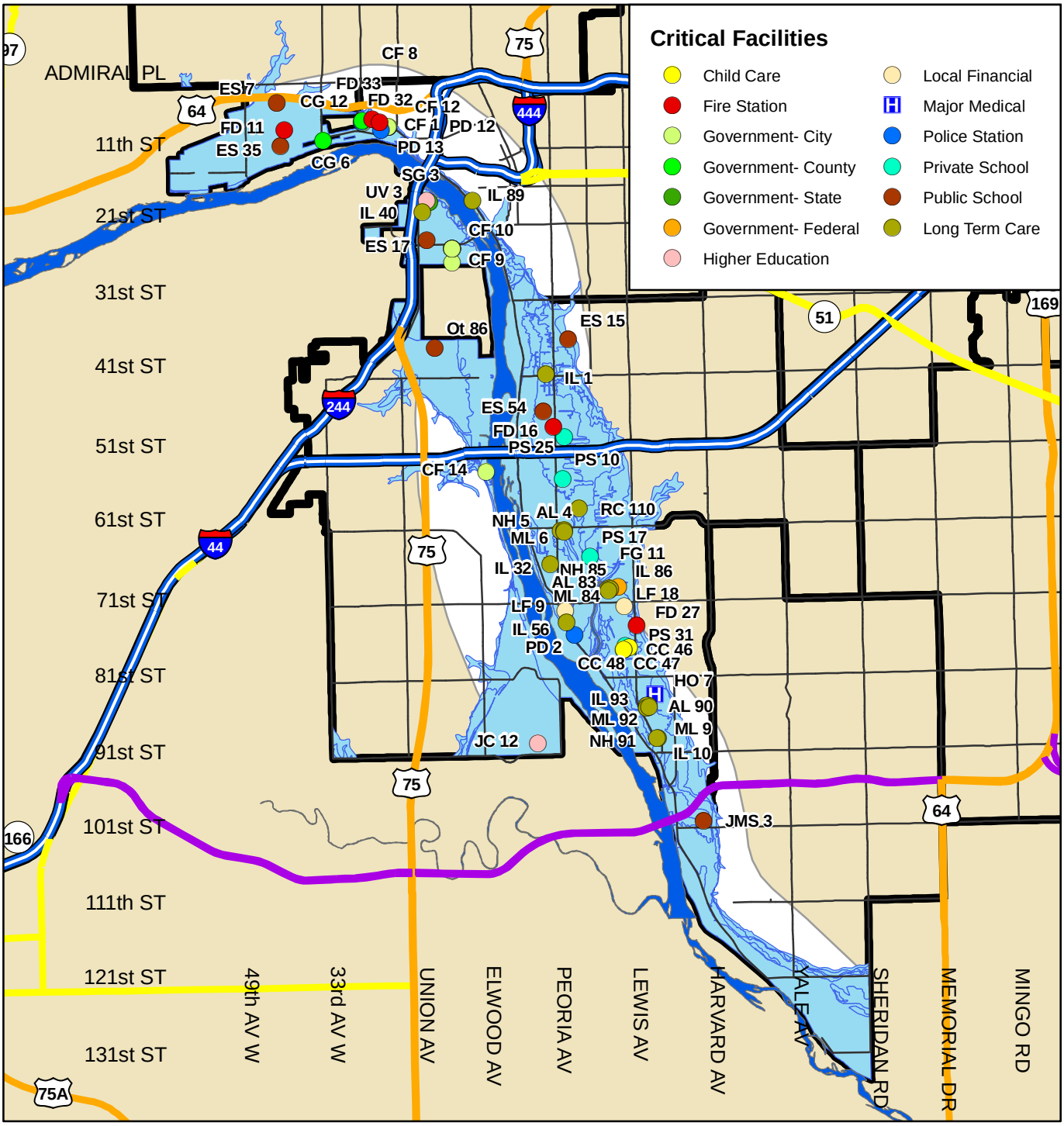
For more detailed information refer to the Citywide Master Drainage Plan.

0 1 2 Miles

Figure 5.10-26

Arkansas River Corridor

Flood Control



LEGEND

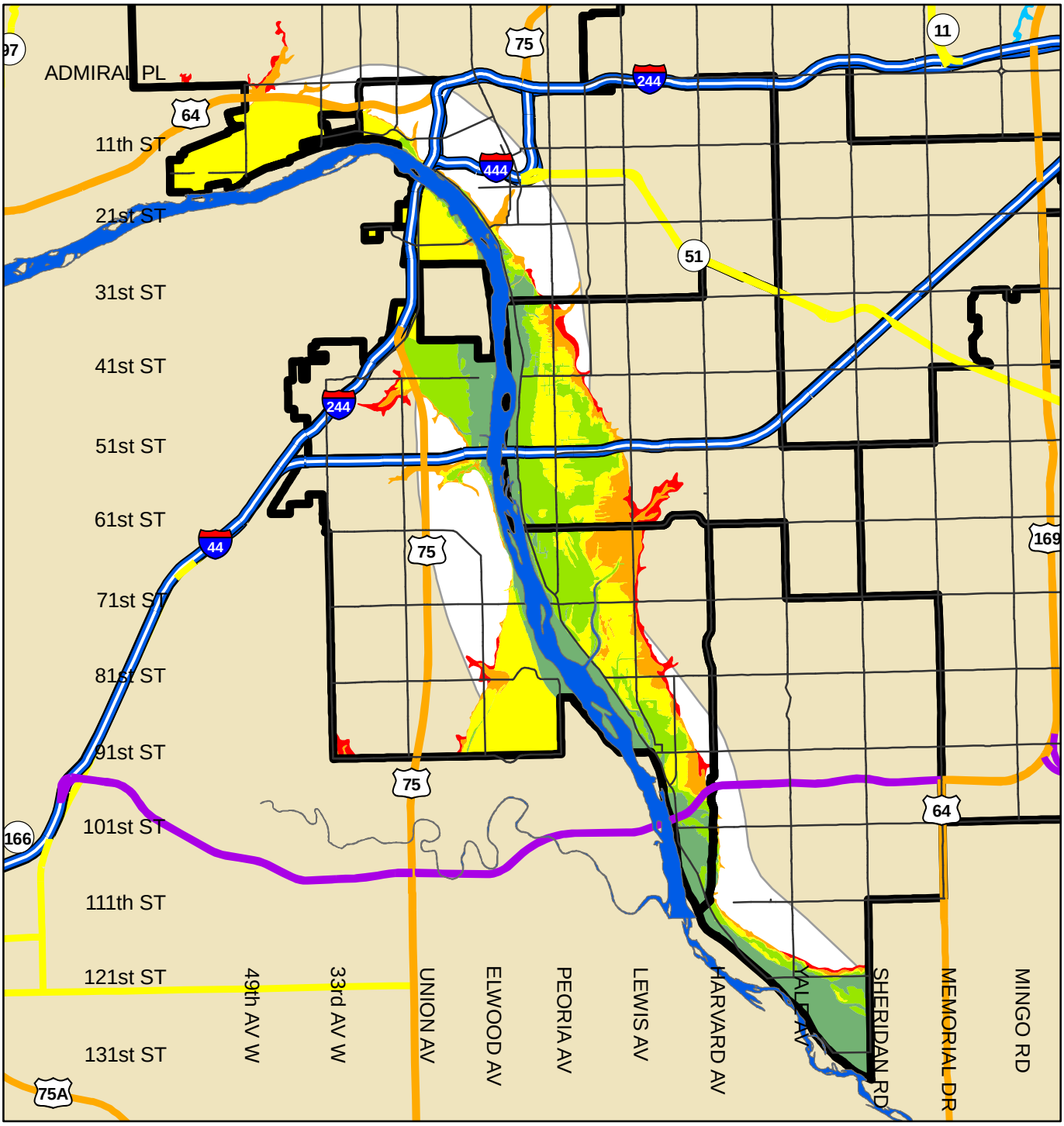
- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- Arkansas River
- Dam Inundation Area
- River Corridor

0 1 2 Miles

Figure 5.10-27

Arkansas River Corridor

Dam Failure



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- River Corridor
- 250,000 CFS
- 350,000 CFS
- 450,000 CFS
- Max Failure
- Dam Break
- Other Releases

0 1 2 Miles

N W E S

R.D. Flanagan & Associates
Planning Consultants

Figure 5.10-28

Arkansas River Corridor

Keystone Dam Failure Release Rates

childcare, educational, healthcare or nursing home facilities and house some of Tulsa's most vulnerable populations. Effort should be made to notify these facilities of their risk and ensure proper evacuation plans are in place.

Conclusion

The Arkansas River Corridor has a HIGH vulnerability to and LOW probability of the Dam Failure hazard.

5.10.4.3 Levee Failure

Location

There are four levees along the Arkansas River that protect the City of Tulsa from flooding. Three of these levees (one in Sand Springs, on the north bank, and two in Tulsa on the north and west banks) date from 1938-1944 and were constructed to protect the oil refineries and related industries from high water.

A fourth levee is a private dike that was constructed to protect the Garden City addition. The Sand Springs levee and the private levee at Garden City failed during the 310,000 cfs release from Keystone Dam in October 1986. The Sand Springs levee was quickly plugged, but the one at Garden City failed catastrophically.

These World War II era levees protect 7.8 sq. miles of land in Tulsa County from flooding. Much of this land is in Sand Springs and on the west bank, where the Holly Refinery is situated, and is outside Tulsa's corporate area. Only 2.62 sq. miles within the City of Tulsa is protected by the Arkansas River levees.

Impact/Vulnerability

A failure or overtopping of the Arkansas River levees poses a threat to the area of the Corridor north of E. 41st St. As stated above, 7.8 sq. miles of land in Tulsa County is vulnerable to levee failure, which includes 2.62 sq. miles within the City. The number of parcels in the Levee inundation areas is summarized in Table 5.10-9. A list of critical facilities that would be impacted is included in Table 5.10-5. Figure 5.10-26 shows the probable inundation areas from levee failures within the Corridor.

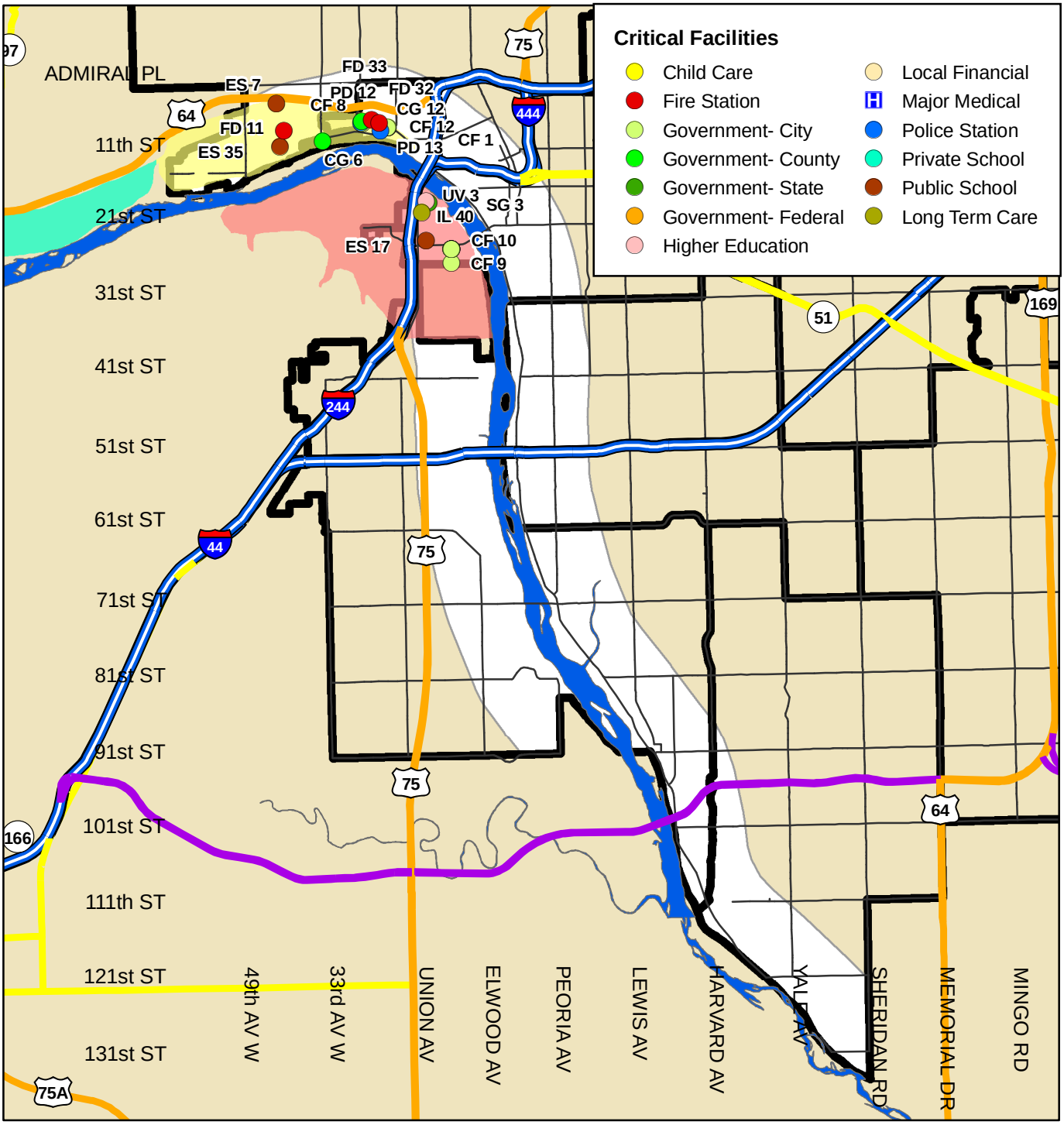
Table 5.10–9: Arkansas River Corridor Improved Parcels in Levee Inundation Area

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	2,185	$71,733,520
Residential Multi-Family	15	$14,859,400
Commercial	96	$11,211,965
Industrial	22	$9,232,200
Other	726	$14,380,650
Total	3,053	$121,502,545

Source: Tulsa County Assessor's Office, 2012

The impact of this hazard would be catastrophic to the Arkansas River Corridor due to the number of residents living or working in the Levee inundation area, and the value of the built environment. Approximately 13.32 percent of the population in the Arkansas River Corridor (8,194 residents) is vulnerable to the Levee Failure hazard.

Depending on warning time, persons in the Corridor would have little opportunity to react and evacuate the area to avoid loss of life. Property damage from Levee failure would be certain and significant.



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- Arkansas River
- Levee A
- Levee B
- Levee C
- River Corridor

0 1 2 Miles

Figure 5.10-29

Arkansas River Corridor

Levee Protection

Critical Facilities

There are 27 critical facilities in the inundation areas. These include City and County facilities belonging to the Sheriff's Office, Engineering Services and Fire Department (including juvenile detention facilities), elementary schools, OSU College of Osteopathic Medicine, various storage units, and one eldercare facility. Populations residing or working in these facilities at the time of Levee overtopping or failure would be exposed to the hazard impact. This is especially true of those unable to evacuate due to mental or physical disabilities, or incarceration. Pre-planning is essential at these facilities.

Conclusion

Tulsa's Arkansas River Corridor has a HIGH vulnerability to and a MODERATE probability of the Levee Failure hazard.

5.10.4.4 Expansive Soils

Location

The Arkansas River Corridor is underlain predominantly by soils with Low shrink/swell potential. Highly expansive soils make up only about 2.22 square miles of land, or 8.75 percent of total land area, in the Corridor.

Soils with a High shrink/swell potential are located primarily east of the Arkansas River from around E 101st and S. Harvard Avenue to E 61st in between S. Lewis and S. Peoria Avenue, as well as in the following areas: the north-west corner of the Arkansas River Corridor, just north of Highway 64, and west of the Arkansas River, north of I-44 and east of US 75.

Table 5.10-10 gives the percentages of the soil types for the Arkansas River Corridor. A map showing the location of the Corridors expansive soils is presented in Figure 5.10-27.

Table 5.10–10: Arkansas River Corridor Expansive Soils

Expansion Potential	Area(square miles)	Percent of Total District Limits
Very High	0.38	1.50%
High	1.84	7.25%
Moderate	1.09	4.30%
Low	19.54	77.02%
Water	2.52	9.93%
Total	25.37	100.00%

Impact/Vulnerability

As shown in Table 5.10-11, the Tulsa County Assessors Office lists 1,505 residential single-family parcels with improvements located on soils with Moderate to High shrink/swell potential. The parcels have an improvement value, adjusted for fair market price, of $301,250,463. As mentioned in Chapter 4, residential structures are far more vulnerable to the impacts of highly expansive soils than larger, heavier structure types.

Table 5.10–11: Buildings on Moderate to High Expansive Soils

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	1,505	$131,438,270
Residential Multi-Family	96	$23,532,500
Commercial	67	$141,314,233

Improvement Type	Number	Est. Market Value
Industrial	1	$207,900
Other	11	$4,757,560
Total	1,680	$301,250,463

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

There are 17 critical facilities located on High expansive soils in the Arkansas River Corridor. Though it is likely the structures were engineered to account for the soils upon which they are built, effort should be made to monitor the facilities for damages and report/repair as necessary. A listing of critical facilities underlain by High shrink/swell soils is included in Table 5.10-5 and shown in Figure 5.10-27. Given the increasing frequency of drought and extreme heat in the region, it is the Corridor's infrastructure buried in High expansive soils that would be at greatest risk of damage.

Conclusion

The Arkansas River Corridor has a HIGH vulnerability to and HIGH probability of the Expansive Soils hazard.

5.10.4.5 Wildfire

Location

The Arkansas River Corridor is primarily located in an area of Tulsa with no to Low Wildfire Level of Concern (LOC). A map displaying the Wildfire LOC of the Arkansas River Corridor is shown in Figure 5.10-28.

Impact/Vulnerability

The areas of the Arkansas River Corridor most vulnerable to the Wildfire hazard are those with Moderate to Very High Wildfire LOC. The most significant of these areas is located south of W. 71st St. and east of S. Elwood Ave., and north and east of Riverside Airport. Other areas with a high LOC are between S. Peoria and Lewis Ave., between E. 61st St. and E. 71st St., north and northwest of the Metro Christian Academy, and along Joe Creek between 71st St. and 81st St., north and west of Victory Christian. According to Tulsa County Assessors data, 71 parcels with improvements are located in areas of Moderate to Very High Wildfire LOC. A breakdown of improved parcels, by estimated fair market value and type, located in areas of Moderate to Very High Wildfire Concern is included in Table 5.10-12.

Table 5.10–12: Arkansas River Corridor Wildfire Level of Concern

Improvement Type	Number	Est. Market Value
Residential Single Family	88	$8,866,225
Residential Multi-Family	14	$42,698,406
Commercial	15	$13,100,900
Industrial	2	$1,630,200
Other	16	$15,689,600
Total	135	$81,985,331

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

Of the critical facilities in the Arkansas River Corridor, three are located in areas with Moderate to High Wildfire LOC, as shown in Table 5.10-5. That these facilities are in areas with a Moderate

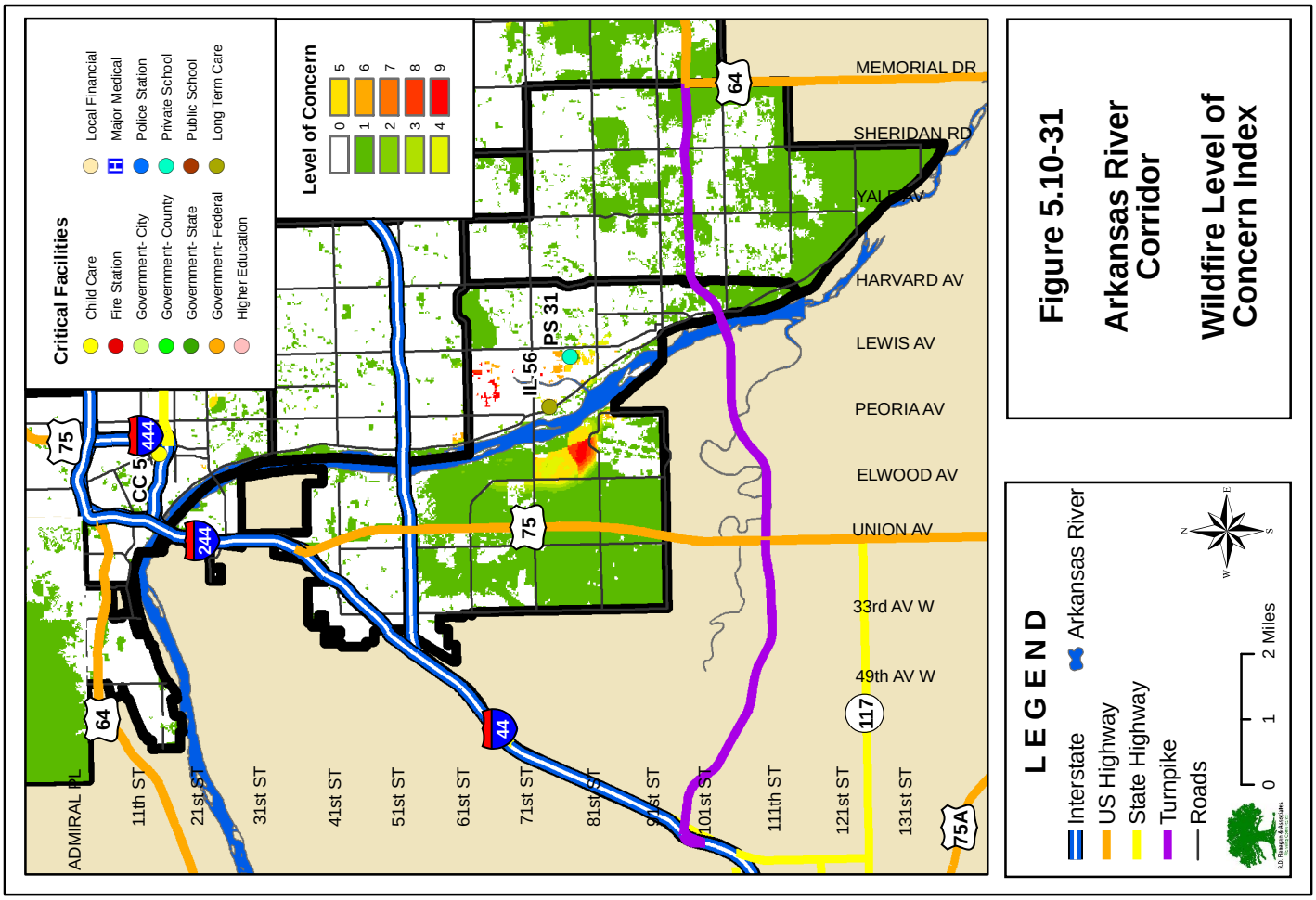


Figure 5.10-31
Arkansas River Corridor
Wildfire Level of Concern Index

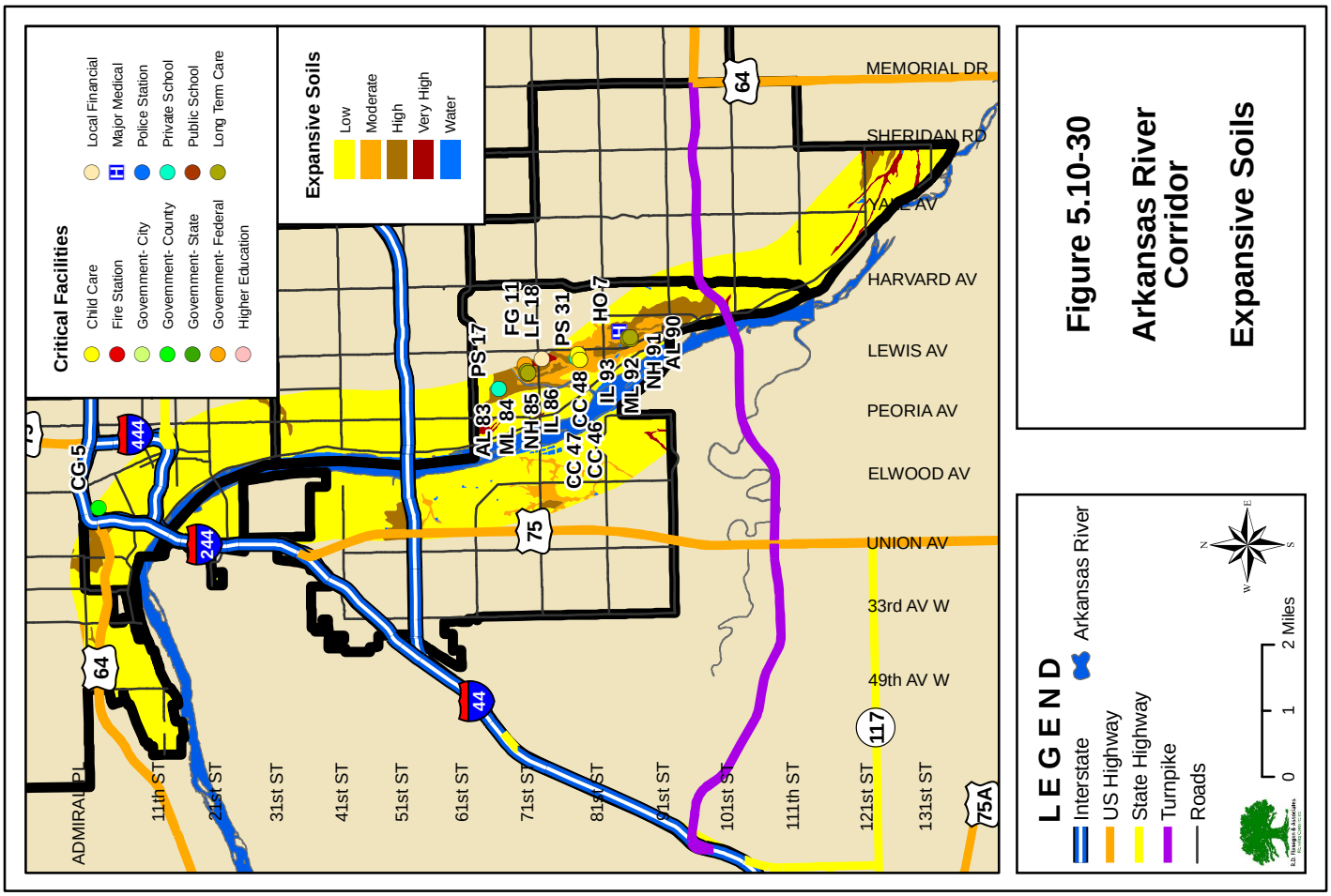


Figure 5.10-30
Arkansas River Corridor
Expansive Soils

to High LOC does not mean they are vulnerable to wildfire—in fact, they are not. Because of local maintenance, parking lots and other buffers, it is unlikely a wildfire would have any impact on them.

Conclusion

The Arkansas River Corridor is considered to have a LOW vulnerability to and LOW probability of the Wildfire hazard.

5.10.4.6 Fixed-Site Hazardous Materials

Location

There are 62 Tier II facilities within the boundaries of the Arkansas River Corridor, the great majority of them in City Council Districts 2 and 4. Of the other three Districts in the Corridor, District 1 has 4 Tier II facilities (none of them EHS), District 8 has one (non-EHS), and District 9 has two (both EHS).

Of the 62 sites in the Corridor, 32 contain an Extremely Hazardous Substance (EHS). Due to the sensitive nature of this data, Tier II facilities in the Corridor are mapped in Figure 5.10-29 to show only the approximate locations of the sites. A listing of EHS and Non-EHS Tier II facilities in the Arkansas River Corridor can be found in Appendix E, and is available on a need-to-know basis.

Impact/Vulnerability

According to the Marplot analysis, which uses 2010 US Census data, 10,135 people who live or work in the Arkansas River Corridor are vulnerable to the impacts of this hazard, as described in Chapter 4. The number of improved parcels by value and type, adjusted for fair market price, located within ¼ mile of a Tier II facility is presented in Table 5.10-13. Critical facilities within ¼ mile of a Tier II facility are indicated in Table 5.10-5 and mapped in Figure 5.10-29 and 5.10-30.

Table 5.10–13: Buildings Located within ¼ Mile Tier II Site

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	2,395	$230,797,522
Residential Multi-Family	86	$26,900,800
Commercial	248	$471,447,378
Industrial	45	$35,908,293
Other	366	$72,684,223
Total	3,142	$837,754,006

Source: Tulsa County Assessor's Office, 2012

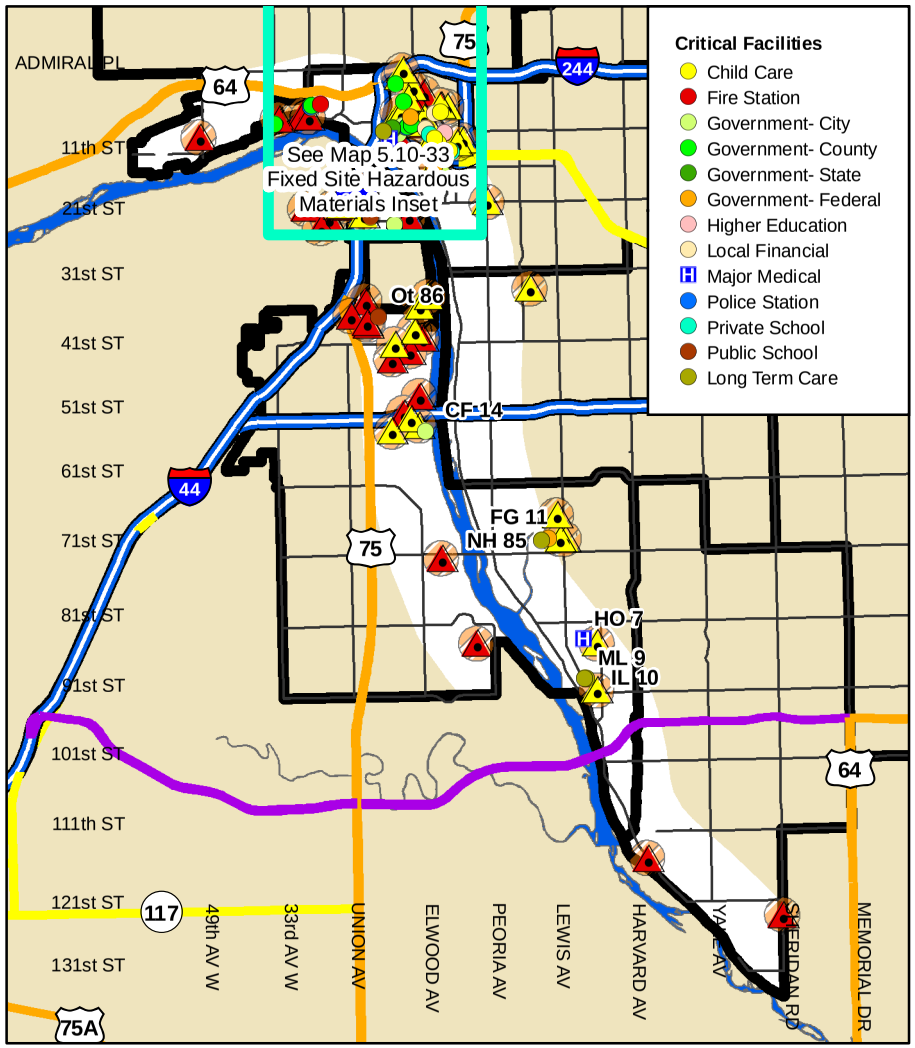
Conclusion

Tulsa Arkansas River Corridor is considered to have a HIGH vulnerability to and HIGH probability of a fixed-site hazardous materials release.

5.10.4.7 Transportation Hazardous Materials

Location

Seven significant transportation corridors cross through the Arkansas River Corridor: Interstate 244, Interstate 44, US Highway 64, US Highway 75, State Highway 51 (Broken Arrow Expy.), Oklahoma Creek Turnpike, and multiple railroads, including the BNSF, Union Pacific, Sand Springs Shortline, and Stillwater Central. A ¼-mile transportation buffer around the various transportation corridors encompasses 38.20 percent of the Arkansas River Corridor (or 9.69 sq. mi.). A map displaying the transportation corridors in the Arkansas River Corridor is included in Figure 5.10-31.



LEGEND

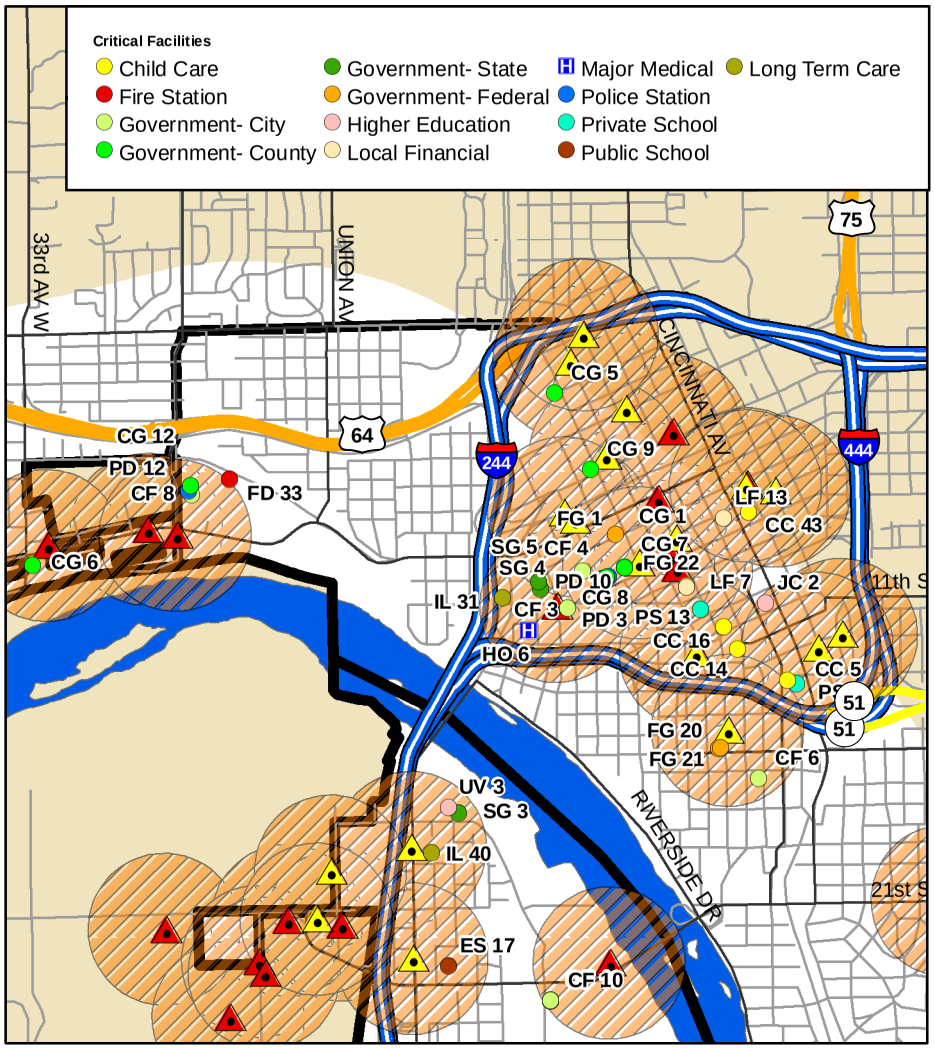
- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- Arkansas River
- 2010 EHS TierII
- 2010 non EHS TierII
- TierII 1/4mi Buffer

0 1 2 Miles

Figure 5.10-32

Arkansas River Corridor

Fixed Site Hazardous Materials



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- Arkansas River
- 2010 EHS TierII
- 2010 non EHS TierII
- TierII 1/4mi Buffer

0 0.25 0.5 Miles

Figure 5.10-33

Arkansas River Corridor

Fixed Site Hazardous Materials Inset

Impact/Vulnerability

According to 2010 US Census data, 12,987 people live within ¼-mile of the Highway/Interstate corridor and 9,340 reside within ¼ mile of one of the Railroads. The numbers of improved parcels by type and value, adjusted for fair market price, within the Highway corridors are summarized in Table 5.10-14.

Table 5.10–14: Arkansas River Corridor Parcels Touched by ¼-mile Highway Buffer

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	3,931	$294,142,388
Residential Multi-Family	149	$26,622,753
Commercial	209	$147,090,792
Industrial	18	$11,153,600
Other	277	$59,469,998
Total	4,587	$538,505,201

Source: Tulsa County Assessor's Office, 2012

There are 2,031 parcels in the Arkansas River Corridor located within ¼-mile of a rail line, with a total assessed value, adjusted for fair market price, of $251,582,076. The numbers of improved parcels within the Railroad transportation corridors are summarized in Table 5.10-15.

Table 5.10–15: Arkansas River Corridor Parcels Touched by ¼-mile Railroad Buffer

Improvement Type	*Number*	*Est. Market Value*
Residential Single Family	1,687	$56,215,256
Residential Multi-Family	27	$15,671,053
Commercial	120	$112,594,365
Industrial	45	$39,973,594
Other	139	$26,979,258
Total	2,031	$251,582,076

Source: Tulsa County Assessor's Office, 2012

Critical Facilities

There are 52 critical facilities within the Arkansas River Corridor located within the ¼-mile transportation buffer. Though the structures themselves are not likely to be directly impacted by this hazard, persons living or working within these facilities are at heightened vulnerability. Of particular concern are the facilities that house Tulsa's most vulnerable populations, such as education facilities, long-term care facilities, and eldercare facilities. A transportation incident involving hazardous materials would likely require shelter in place or evacuation procedures to be implemented at nearby critical facilities. A list of critical facilities vulnerable to the Transportation hazard is included in Table 5.10-5 and mapped in Figure 5.10-31 and 5.10-32.

Conclusion

The Arkansas River Corridor has a HIGH vulnerability to and HIGH probability of the Transportation hazard.

5.10.4.8 Hazards Summary

Site-specific hazards, unique to the Arkansas River Corridor, identified and mapped in this section, include Floods, Dam and Levee Failures, Expansive Soils, Wildfires, Fixed-Site Hazardous Materials, and Transportation-Hazardous Materials. The Hazards Composite Map, shown in Figure 5.10-33, summarizes the areas of the Corridor potentially impacted by these site-specific hazards.

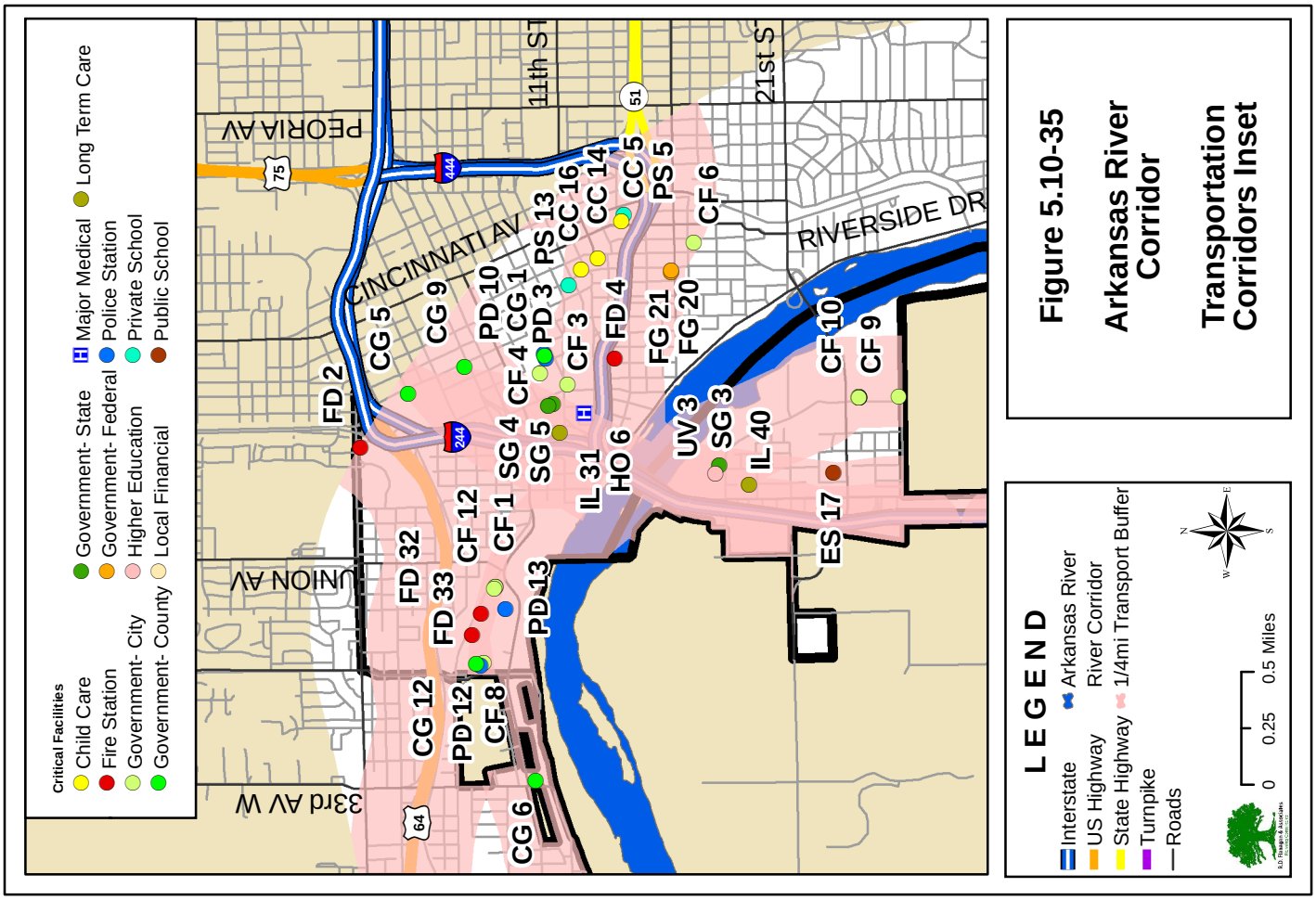


Figure 5.10-35
Arkansas River Corridor
Transportation Corridors Inset

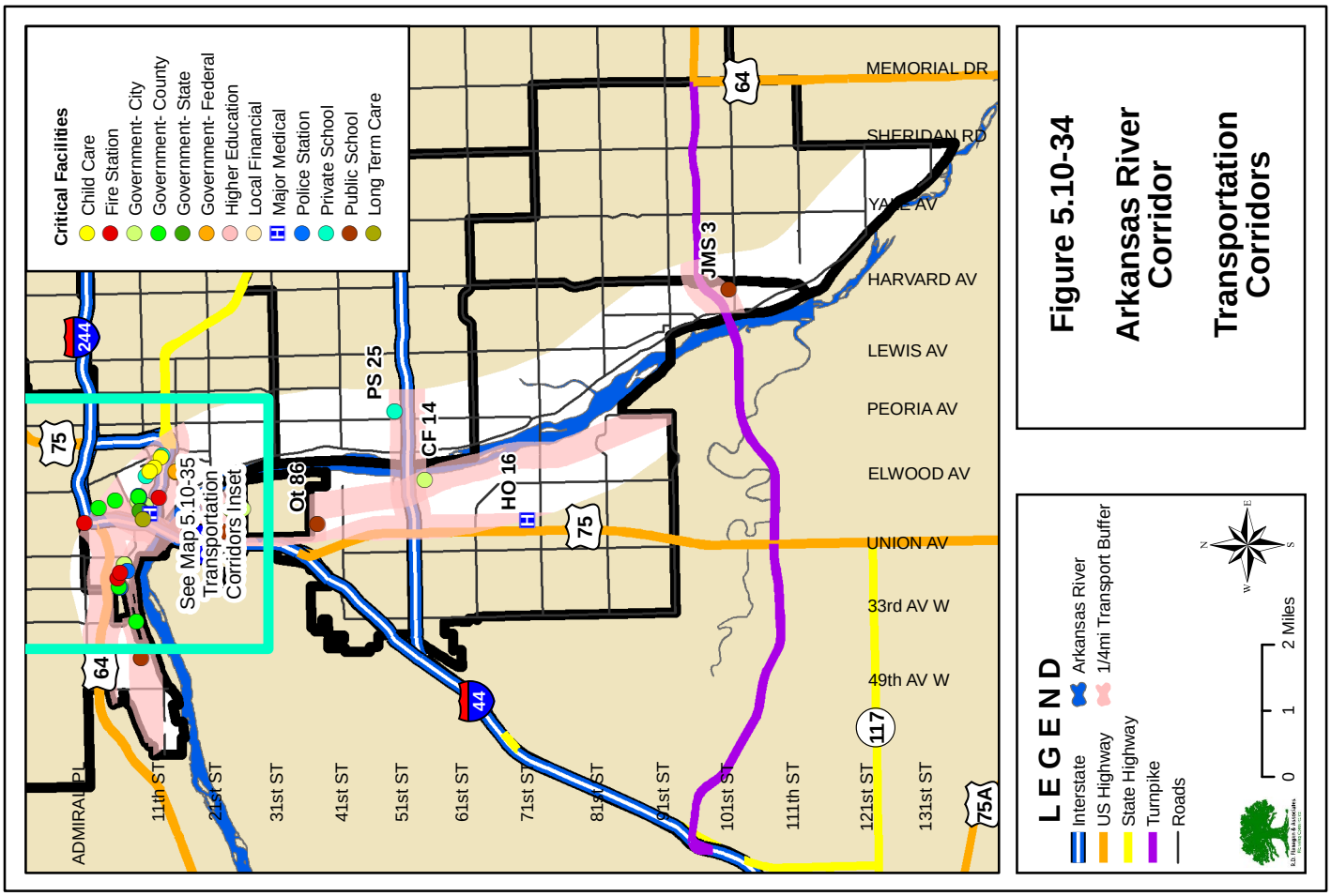
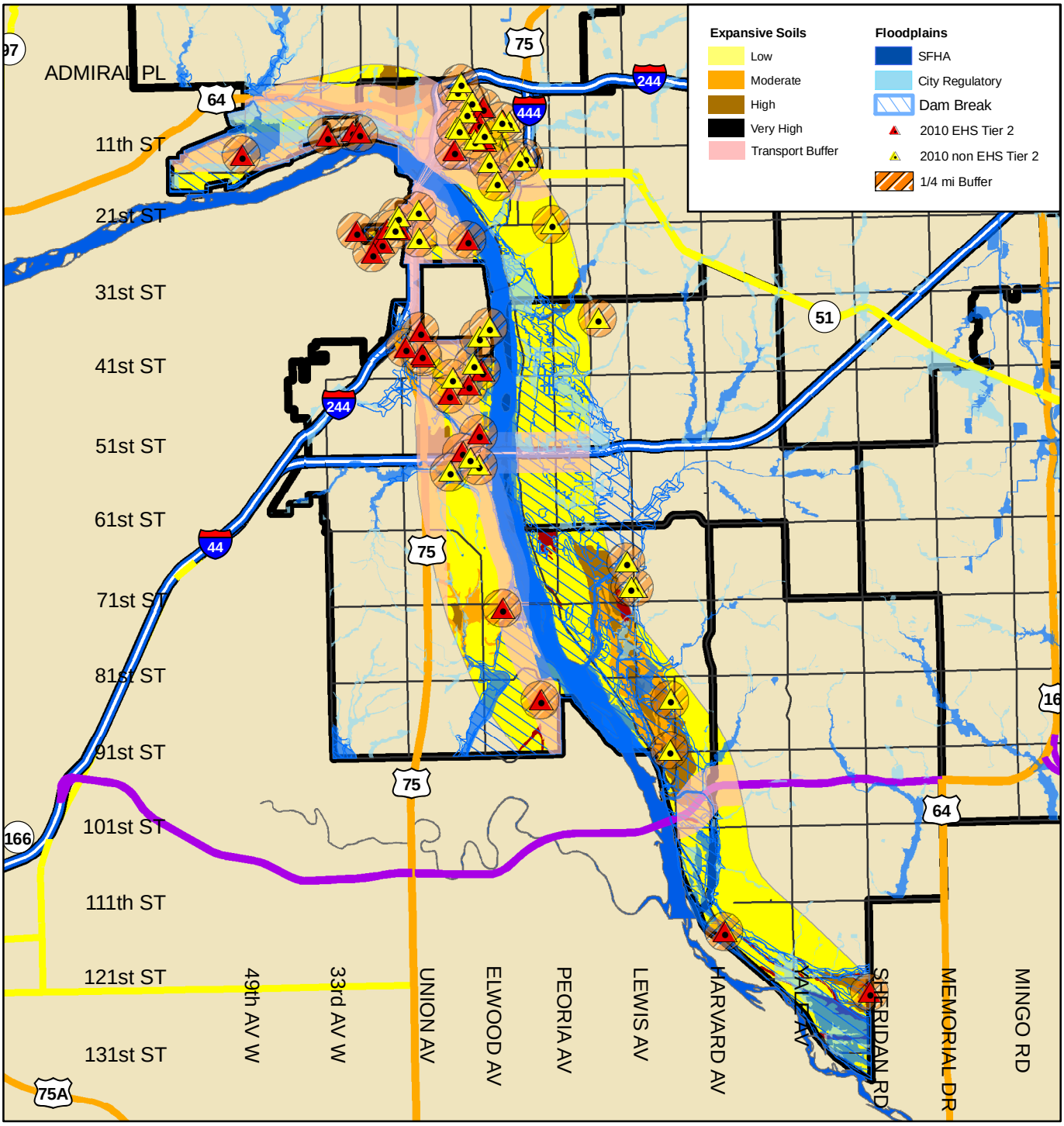


Figure 5.10-34
Arkansas River Corridor
Transportation Corridors



LEGEND

- Interstate
- US Highway
- State Highway
- Turnpike
- Roads
- Arkansas River

0 1 2 Miles

Figure 5.10-36

Arkansas River Corridor

Hazard Composite

Chapter 6: Mitigation Goals and Objectives

44 CFR Requirements met:

Requirement §201.6(c)(3): *The plan* ***shall*** *include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.*

Requirement §201.6(c)(3)(i): *[The hazard mitigation strategy* ***shall*** *include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.*

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

Included in this Chapter:

The Research, Review, and Prioritization Process

Mitigation Categories

6.1 Hazard Mitigation Goals

6.1.1 Mission Statement

6.1.2 Mitigation Goal

6.1.3 Goals for All Natural Hazards

6.2 Hazard-Specific Goals and Objectives

The Research, Review, and Prioritization Process

The Technical Advisory Committee (TAC), Citizens Advisory Committee (CAC), and supporting staff identified and prioritized the measures that will help protect the lives and property of the citizens of Tulsa.

Initially, Goals from the 2009 City of Tulsa Hazard Mitigation Plan were reviewed and evaluated by the Technical Advisory Committee based on both progress and actions taken based on the 2009 plan, and on development or review of other pertinent City of Tulsa plans. Goals that were deemed to be effective and pertinent to the current plan were retained and incorporated into the 2014 plan.

National literature and sources were researched to identify best practices mitigation measures for each hazard. These measures were documented, and staff screened several hundred recommended mitigation actions and selected those that were most appropriate for the Tulsa area. The HMPC reviewed the measures recommended by staff and revised, added, deleted, and approved measures for each hazard.

Members of the TAC and CAC will take into account five primary considerations when prioritizing mitigation measures: Of most importance when determining priority is the protection of life; mitigation measures that ultimately prevent the loss of life in the City of Tulsa will be placed at highest priority. Second, the TAC and CAC will identify which mitigation measures will prevent loss of property; participants will look at which hazards have caused the most property loss based on past event data. Third, the TAC and CAC will consider the mitigation measures that address multiple hazards in preventing loss of life and/or property; for example, public education and outreach programs mitigate against all hazards where lightning warning systems mitigate against only one hazard.

Next, an estimate will be made to determine the population served by each mitigation measure. Mitigation measures that are determined to do the greatest good for the greatest number of people will

be placed at higher priority than those that protect only a small portion of the population overall. Lastly, the cost of each project will be considered by each participating jurisdiction in the prioritization of mitigation measures. Project costs are continually changing. Therefore, a Benefit Cost Analysis (BCA) will be completed as funds become available and during project development. For mitigation measures in which it is not feasible to conduct a BCA, justification of project costs will be identified during project development.

In addition to the five criteria mentioned, the STAPLEE process, recommended by FEMA, will be heavily relied upon in prioritizing mitigation measures for the City of Tulsa. Table 6-1 lists the STAPLEE criteria.

Other considerations in prioritizing the mitigation measures include historical considerations and post-disaster conditions. For example, Tulsa's flood history and relationship with the Arkansas River may place flood mitigation at higher priority. The results of prioritization efforts were tabulated and the individual measures were ranked by priority. The measures were then grouped into categories. An overall list of mitigation measures identified for the City of Tulsa is included in the Chapter 7, *Action Plan*.

Table 6–1: STAPLEE Prioritization and Review Criteria

Evaluation Category	Sources of Information
Social	Members of Local, County and State Government were members of the Hazard Mitigation Planning Committee and had input throughout the planning process. Existing community plans were used wherever possible. Members of the Media were contacted and invited to attend all HMPC meetings.
Technical	The following Persons/Agencies were consulted as to the technical feasibility of the various projects: Tulsa City Council, Tulsa Public Works Department, Oklahoma State University Extension Service, Soil Conservation Service, National Weather Service, the Corps of Engineers, County and State Health Departments, and Oklahoma Forestry Service. All of these had their comments and suggestions incorporated.
Administrative	Staffing for proper implementation of the plan currently will rely on existing members of the various agencies involved. Technical assistance is available from contractors and various State Agencies. Some local jurisdictions have incorporated Hazard Mitigation efforts into their Capital Improvement Plans. The Stormwater Drainage & Hazard Mitigation Advisory Board has agreed to an annual review and assessment of the Plan and its progress. Operations Costs are under discussion by the relevant department heads.
Political	A representative of the Tulsa City Council and the Mayor or his representative attended the HMPC meetings and were consulted on all aspects of the Plan.
Legal	Members of the HMPC discussed legal issues with the City Council, and it was their opinion that no significant legal issues were involved in the projects that were selected by the HMPC.
Economic	Economic issues were the predominant issues discussed by all concerned, with an emphasis on cost/benefit review. Each entity felt that the projects selected would have a positive effect in that the projects would attract business and recreation to the area as well as help the community be better prepared for a disaster. Funding for the various projects was the major concern as local budgets were not capable of fulfilling the needs due to the economic down turn. Reliance on outside grants will be relied on heavily for completion of some projects.
Environmental	Oklahoma Department of Environmental Quality, Oklahoma Forestry Service, and the Oklahoma Water Resources Board were all consulted as to the environmental impact of the various projects and it was felt that there would be no negative impact. Local governments are currently considering zoning of environmentally sensitive areas.

Mitigation Categories

The measures that communities and individuals can use to protect themselves from, or mitigate the impacts of, natural and man-made hazards fall into six categories:

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

This chapter is organized by mitigation category, with the mission statement and goals listed first in section 6.1.

6.1 Hazard Mitigation Goals

6.1.1 Mission Statement

To create a disaster-resistant community and improve the safety and well-being of Tulsa by reducing deaths, injuries, property damage, environmental 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.

6.1.2 Mitigation Goal

To identify community policies, actions and tools for long-term implementation in order to reduce risk and future losses stemming from natural and technological hazards that are likely to impact the community.

6.1.3 Goals for All Natural Hazards

- Minimize loss of life and property from natural hazard events;
- Protect public health and safety;
- Increase public awareness of risk from natural hazards;
- Reduce risk and effects of natural hazards;
- Identify hazards and assess risk for local area;
- Ascertain historical incidence and frequency of occurrence;
- Determine increased risk from specific hazards due to location and other factors;
- Improve disaster prevention;
- Improve forecasting of natural hazard events;
- Limit building in high-risk areas;
- Improve building construction to reduce the dangers of natural hazards;
- Improve government and public response to natural hazard disasters.

6.2 Hazard-Specific Goals and Objectives

Flood	
GOAL: ***To reduce injuries and loss of life; trauma; damage to property, equipment and infrastructure; community disruption; and economic, environmental, and other losses caused by floods and flash floods.***	
Objective 1.	**Public Information & Education.** Improve public awareness of flood and flash flood hazards in general and at specific high-risk locations; and give people knowledge about measures they can use to protect themselves, their property and their community.
Objective 2.	**Preventive Measures.** Expand mapping, regulations, and loss-prevention programs in areas with high risks and catastrophic potential, such as local portions of multi-jurisdictional riverine floodways and floodplains where additional safety considerations are warranted because Tulsa does not have jurisdiction to regulate upstream and downstream runoff, blockages, or other actions that can affect Tulsans' safety.
Objective 3.	**Structural Projects.** Obtain funding for and implement projects that can reduce flood and drainage hazards, with consideration for comprehensive solutions in accord with watershed-wide management plans.
Objective 4.	**Property Protection.** Identify and protect people, structures, critical facilities, and critical infrastructure that are vulnerable to flood and flash flood hazards.
Objective 5.	**Emergency Services.** Identify the needs and implement additional emergency operations plans and services for areas at high risk of flooding, including additional prediction and forecasting capability, emergency alerts, and evacuation plans.
Objective 6.	**Natural Resource Protection.** Protect and enhance natural floodplain and stormwater resources by adopting and implementing sustainable flood-management policies that have few or no negative impacts and have positive environmental effects whenever possible.

Tornado	
GOAL: ***To reduce injuries and loss of life; trauma; damage to property, equipment and infrastructure; community disruption; and economic, environmental and other losses caused by tornadoes.***	
Objective 1.	**Public Information & Education.** Improve public awareness of tornado hazards, in general and in specific high-risk situations; and give people knowledge about measures they can use to protect themselves, their property, and their community.
Objective 2.	**Preventive Measures.** Prevent or reduce tornado losses by strengthening buildings and by publicizing, training, and creating market options for fortified new construction, retrofits, code changes and code-plus innovations.
Objective 3.	**Structural Projects.** Provide safe tornado shelters, SafeRooms, and fortified buildings for vulnerable populations, including children; offer training and incentives to encourage people of means to include shelters and SafeRooms in new and retrofit building projects.
Objective 4.	**Property Protection.** Identify and protect people, structures, and critical infrastructure that are vulnerable to tornado hazards, with emphasis on critical facilities.
Objective 5.	**Emergency Services.** Identify the needs for and implement additional emergency operations plans and services to expand tornado safety, including Community Emergency Response Team training.

Tornado	
Objective 6.	**Natural Resource Protection.** Take advantage of opportunities for tornado programs and policies that reduce negative environmental impacts. Examples include sustainable programs for debris management and recycling, and fortified construction with environmentally friendly materials.

High Wind	
GOAL: ***To reduce injuries and loss of life; trauma; damage to property, equipment and infrastructure; community disruption; and economic, environmental and other losses caused by high winds.***	
Objective 1.	**Public Information & Education.** Improve public awareness of high-wind hazards, in general and in specific high-risk situations; and give people knowledge about measures they can use to protect themselves, their property, and their community.
Objective 2.	**Preventive Measures**. Prevent or reduce tornado losses by strengthening buildings and by publicizing, training, and creating market options for fortified new construction, retrofits, code changes and code-plus innovations.
Objective 3.	**Structural Projects.** Provide fortified buildings for critical public facilities and vulnerable populations, including children; offer training and incentives to encourage people of means to build stronger structures in new and retrofit building projects.
Objective 4.	**Property Protection.** Identify and protect people, structures, and critical infrastructure that are vulnerable to high winds, with emphasis on critical facilities.
Objective 5.	**Emergency Services.** Identify needs for and implement additional emergency operations plans and services to expand safety in dangerous windstorms, including Community Emergency Response Team training.
Objective 6.	**Natural Resource Protection.** Take advantage of opportunities for high-wind programs and policies that reduce negative environmental impacts. Examples include sustainable programs for debris management and recycling, and fortified construction with environmentally friendly materials.

Lightning	
GOAL: ***To reduce injuries, loss of life, and damage to property, equipment and infrastructure caused by Lightning strikes.***	
Objective 1.	**Public Information & Education.** Improve public awareness of Lightning hazards and measures by which people can protect themselves, their property and their community.
Objective 2.	**Preventive Measures.** Identify the costs and the benefits of loss-prevention programs, such as whole building surge protection, with consideration for uncalculated benefits such as data or work productivity loss.
Objective 3.	**Structural Projects**. Provide for necessary construction, renovation, retrofitting or refurbishment of city infrastructure to protect vulnerable populations from the effects of lightning strikes.
Objective 4.	**Property Protection**. Identify ways to protect structures, infrastructure, and critical facilities and their occupants from damage caused by lightning strikes.
Objective 5.	**Emergency Services**. Establish or expand emergency services protocols that adequately address response scenarios in the event of incidents with the possibility of severe lightning.

Lightning	
Objective 6.	**Natural Resource Protection**. Ensure that lightning damage mitigation policies have no negative impacts and, whenever possible, provide positive enhancements to the environment.

Hail	
GOAL: ***To reduce the high costs of property and infrastructure damage caused by Hailstorms.***	
Objective 1.	**Public Information and Education.** Improve public awareness of Hailstorm hazards and measures by which people can protect themselves, their property and their community.
Objective 2.	**Preventive Measures**. Identify the costs and the benefits of loss-prevention ordinances, such as building codes, with consideration for uncalculated benefits such as employee downtime or loss of city services.
Objective 3.	**Structural Projects**. Identify costs and benefits of loss-prevention programs, such as covered vehicle parking, with consideration for uncalculated benefits such as averting response delays and business losses.
Objective 4.	**Property Protection.** Identify, fund, and implement projects to protect people and public and private property from losses in hail events, including critical infrastructure such as utilities or public vehicles.
Objective 5.	**Emergency Services**. Establish or expand emergency services protocols that adequately address response scenarios in the event of severe hail events.
Objective 6.	**Natural Resource Protection**. Ensure that Hail mitigation policies have no negative impacts and, whenever possible, provide positive enhancements to the environment. Encourage homeowners, for example, to use Class 4 roofing made of recycled materials.

Winter Storms	
GOAL: ***To reduce injuries and loss of life; trauma; loss of critical utilities; damage to property, equipment and infrastructure; community disruption; and economic, environmental and other losses caused by winter storms. Winter hazards can include extreme temperatures, ice and snow, high winds, and cascading hazards such as loss of utilities.***	
Objective 1.	**Public Information & Education.** Improve public awareness of winter storm hazards and give people knowledge about measures they can use to protect themselves, their property and their community.
Objective 2.	**Preventive Measures.** Identify costs and the benefits of loss-prevention programs such as burying power lines to reduce utility outages or building snow-load roofs, with consideration for uncalculated benefits such as averting environmental and business losses.
Objective 3.	**Structural Projects.** Identify, fund, and implement measures, such as winterization retrofits to homes, critical facilities, transportation systems and infrastructure, to avert or reduce losses from winter storms. Provide additional protection, such as generators and emergency shelters, for agencies and facilities that serve vulnerable populations.
Objective 4.	**Property Protection.** Identify, fund, and implement projects to protect people and public and private property from losses in winter storms.

Winter Storms	
Objective 5.	**Emergency Services.** Identify and expand emergency services for people who are at high risk in winter storms, such as the homeless, elderly, disabled, and oxygen-dependent people.
Objective 6.	**Natural Resource Protection.** Evaluate options and take advantage of opportunities for sustainable winter-storm policies and programs to reduce negative environmental impacts; examples include programs for debris management, streets snow removal, tree trimming and replacement, energy conservation, and winterization.

Heat	
GOAL: ***To reduce heat-related illnesses, loss of life, and exacerbation of other hazards such as drought and expansive soils caused by extreme Heat conditions.***	
Objective 1.	**Public Information and Education.** Improve public awareness of extreme heat hazards and measures by which people can protect themselves, their property and their community.
Objective 2.	**Preventive Measures.** Identify and protect people and critical infrastructure that are vulnerable to extreme heat conditions.
Objective 3.	**Structural Projects.** Provide for necessary construction, renovation, retrofitting or refurbishment of city properties to protect vulnerable populations from the effects of extreme heat.
Objective 4.	**Property Protection.** Implement construction and retrofitting measures to minimize the risk to public properties and their occupants caused by extreme heat.
Objective 5.	**Emergency Services.** Ensure that the Heat Emergency Action Plan is followed and that heat alerts are issued in a timely manner. Establish or expand emergency services protocols that adequately address response scenarios in the event of extreme heat.
Objective 6.	**Natural Resources Protection.** Ensure that extreme Heat mitigation policies have no negative impacts and, whenever possible, provide positive enhancements to the environment, such as the creation and development of urban green spaces.

Drought	
GOAL: ***To reduce the impact of Drought on property, infrastructure, natural resources and local government response functions.***	
Objective 1.	**Public Information and Education.** Improve public awareness of Drought and measures by which people can protect themselves, their property, and their community.
Objective 2.	**Preventive Measures.** Identify and protect resources and critical infrastructure that are vulnerable to Drought.
Objective 3.	**Structural Projects.** Provide for necessary construction, renovation, retrofitting or refurbishment to protect vulnerable structures from the effects of drought.
Objective 4.	**Property Protection.** Implement measures to minimize the risk to public property caused by drought events.
Objective 5.	**Emergency Services.** Establish or expand emergency services protocols that adequately address response scenarios in the event of drought.

Drought	
Objective 6.	**Natural Resource Protection.** Ensure that Drought mitigation policies have no negative impacts and, whenever possible, provide positive enhancements to the environment.

Expansive Soil	
GOAL: To reduce the damage and economic losses caused by expansive soils on property and local infrastructure.	
Objective 1.	**Public Information & Education.** Improve public awareness of expansive-soil hazards, with both general and site-specific information, and provide knowledge about available measures by which people can protect their property and their community.
Objective 2.	**Preventive Measures.** Avoid expansive-soils locations, whenever possible. Explore options for loss-mitigation from expansive soils, including building codes and code-plus options. Examine expansive soils before building critical facilities and infrastructure.
Objective 3.	**Structural Projects.** Identify and implement measures to reduce or avert expansive-soils damages and losses to structures and infrastructure, with emphasis on critical facilities and utilities.
Objective 4.	**Property Protection.** Identify and protect resources and critical infrastructure that are vulnerable to expansive soils.
Objective 5.	**Emergency Services.** Survey emergency and critical facilities for potential expansive-soil problems; repair and retrofit as needed; and consider soils when building emergency facilities.
Objective 6.	**Natural Resource Protection.** Protect and enhance natural resources by adopting and implementing sustainable expansive-soils policies that have few or no negative impacts and have positive environmental effects whenever possible.

Wildfire	
GOAL: ***To reduce injuries, loss of life, and damage to property, equipment and infrastructure caused by Wildfires.***	
Objective 1.	**Public Information & Education.** Improve public awareness of Wildfire hazards and measures by which people can protect themselves, their property and their community.
Objective 2.	**Preventive Measures.** Identify and protect populations, structures, and critical infrastructure that are vulnerable to Wildfires.
Objective 3.	**Structural Projects**. Include wildfire considerations in landscaping, public park, and other properties that would fall into wildland-urban interface or other areas of wildfire risk. Include infrastructure improvements that support effective firefighting.
Objective 4.	**Property Protection**. Implement building materials and techniques in retrofitting or in new construction to minimize the risk to public property caused by earthquakes.
Objective 5.	**Emergency Services**. Establish or expand emergency services protocols that adequately address response scenarios in wildfire events.
Objective 6.	**Natural Resource Protection.** Ensure that Wildfire mitigation policies have no negative impacts and, whenever possible, provide positive enhancements to the environment.

Earthquake	
GOAL: ***To reduce injury, loss of life, and damage to property, equipment and infrastructure caused by Earthquakes.***	
Objective 1.	**Public Information and Education.** Improve public awareness of Earthquake hazards and measures by which people can protect themselves, their property and their community.
Objective 2.	**Preventive Measures.** Identify and protect populations, structures, and critical infrastructure that are vulnerable to Earthquakes.
Objective 3.	**Structural Projects.** Provide for necessary construction, renovation, retrofitting or refurbishment to protect vulnerable structures from the effects of earthquakes.
Objective 4.	**Property Protection.** Implement building materials and techniques in retrofitting or in new construction to minimize the risk to public properties and their occupants caused by earthquakes.
Objective 5.	**Emergency Services.** Establish emergency services protocols that adequately address response scenarios in the event of earthquake.
Objective 6.	**Natural Resource Protection.** Take advantage of opportunities for tornado programs and policies that reduce negative environmental impacts. Examples include sustainable programs for debris management and recycling, and fortified construction with environmentally friendly materials.

Dam and Levee Break	
GOAL: ***To reduce injuries and loss of life; trauma; damage to property, equipment, critical facilities, and infrastructure; community disruption; and economic, environmental, and other losses caused by partial or total dam and levee failures.***	
Objective 1.	**Public information & education**. Improve public awareness of dam and levee break hazards, in general and at specific high-risk locations; and give people knowledge about measures they can use to protect themselves, their property, and their community.
Objective 2.	**Preventive measures.** Expand mapping, regulations, and loss-prevention programs in areas with high risks, including extension of flood insurance regulations behind high-risk levees; updated risk mapping downstream of high-risk dams; and pre-disaster evacuation and hazard-mitigation programs.
Objective 3.	**Structural projects.** Analyze safety of existing high-risk dams and levees, including maintenance programs and funding; and implement highest-priority measures to strengthen the structures and reduce risks.
Objective 4.	**Property protection measures.** Identify and protect people, structures, critical facilities, and critical infrastructure that are vulnerable to dam and levee break hazards.
Objective 5.	**Emergency services.** Identify needs for and implement additional emergency operations plans and services in areas at high risk from dam and levee breaks, including additional prediction and forecasting capability, emergency alerts, and evacuation plans.
Objective 6.	**Natural resource protection.** Protect and enhance natural resources by adopting and implementing sustainable dam and levee break policies that have few or no negative impacts and have positive environmental effects whenever possible. Include analysis of downstream impacts on environment and wildlife in dam and levee planning.

Chapter 7: Action Plan

44 CFR Requirements met:

Requirement §201.6(c)(3): *The plan* ***shall*** *include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.*

Included in this Chapter:

7.1 Recommended High Priority Action Plan

Requirement §201.6(c)(3)(ii): *[The mitigation strategy* ***shall*** *include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.*

Requirement: §201.6(c)(3)(ii): *[The mitigation strategy]* ***must*** *also address the jurisdiction's participation in the National Flood Insurance Program (NFIP), and continued compliance with NFIP requirements, as appropriate.*

Requirement: §201.6(c)(3)(iii): *[The mitigation strategy section* ***shall*** *include] an action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.*

Requirement §201.6(c)(3)(iv): *For multi-jurisdictional plans, there* ***must*** *be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.*

7.1 Recommended High Priority Action Plan

The City of Tulsa has reviewed and analyzed the risk assessment studies for the natural hazards and hazardous material events that may impact them. The community Hazard Mitigation Advisory Committees prioritized the mitigation measures using the STAPLEE process (see Chapter 6), and developed an Action Plan for the highest priority measures.

Statement of Mitigation Measures

Table 7-1 places each numbered mitigation measure listed in the following pages with the respective hazard or hazards the measure is to address. As will be seen, certain mitigation measures are recommended for multiple hazards.

Table 7–1: Measures Identified for Each Hazard

Hazard	Measures Addressing	Hazard	Measures Addressing
Severe Winter Storms	1,2,3,4,5,6,7,8,9,11,12,13,14,16,28,29,30,31,32,33	Urban Fires	1,2,3,4,5,6,7,8,9,13,24,49,58,59,60,61,62,63,64
High Winds	1,2,3,4,5,6,7,8,9,10,11,12,13,14,17,18,19,20,21,22,21,24,25,26,27,28,29,30,31,32,33,53	Floods	1,2,3,4,5,6,7,8,9,10,11,12,13,14,24,39,40,41,42,43,44,45,46,47,48,49,50,51,52
Tornadoes	1,2,3,4,5,6,7,8,9,10,11,12,13,14,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33	Dam Failure	1,2,3,4,5,6,7,8,9,12,13,14,39,40,41,42,43,44,45,46,47,48,49,50,51,52
Lightning	1,2,3,4,5,6,7,8,9,11,13,24,28,29,30,31,32,33,34,35,36,37,38	Levee Failure	1,2,3,4,5,6,7,8,9,12,13,14,39,40,41,42,43,44,45,46,47,48,49,50,51,52
Hailstorms	1,2,3,4,5,6,7,8,9,11,13,22,23,24,25,27,53	Expansive Soil	1,2,3,4,5,6,7,8,9,13,54,55,56,57
Extreme Heat	1,2,3,4,5,6,7,8,9,11,13,15,16,28,29,30,31,32,33	Wildfires	1,2,3,4,5,6,7,8,9,11,13,14,24,58,60,61,62,63,64,65,66
Drought	1,2,3,4,5,6,7,8,9,11,13,54,55,56,57,63,67,68,69	Fixed Site HazMat	1,2,3,4,5,6,7,8,9,13,49
Earthquakes	1,2,3,4,5,6,7,8,9,11,13,14,23,24,27,28,29,30,31,32,33,49	Transportation HazMat	1,2,3,4,5,6,7,8,9,13,49

Winter Storms, High Winds, Tornadoes, Lightning, Hail, Extreme Heat, Drought, Earthquakes, Urban Fires, Floods, Dam Failure, Levee Failures, Expansive Soils, Wildfires, Fixed Site Hazardous Materials, Transportation Hazards

1. **Develop and fund an All-Hazard Public Information, Education, and Awareness Program.**

Lead: Communications Dept., TAEMA, Engineering Services

Time Schedule: 2014-2019

Estimated Cost: $ 53,000

Source of Funding: Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: Provide funding to develop outreach programs to reach schools, libraries, civic organizations, neighborhood groups, and other opportunities. This would also include the development and production of PSA's and the production or be managed and implemented by Tulsa Partners in cooperation with the Tulsa Area purchase of educational videos and other materials to support them. This program would Emergency Management Agency, Tulsa Fire Department, and other agencies involved in public disaster education and information.

Winter Storms, High Winds, Tornadoes, Lightning, Hail, Extreme Heat, Drought, Earthquakes, Urban Fires, Floods, Dam Failure, Levee Failures, Expansive Soils, Wildfires, Fixed Site Hazardous Materials, Transportation Hazards

2. **Educate the public through various means, including social and electronic media on the importance of a Family Disaster Plan and Supply Kit and work with neighborhood associations to distribute Family Emergency Preparedness Guides to families.**

Lead:	Comm. Dept., TAEMA, Working in Neighborhoods, Public Schools
Time Schedule:	On-going
Estimated Cost:	$ 10,000 per year
Source of Funding:	Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: An informed public that understands the importance of having a Family Disaster Plan and an emergency supply kit.

Winter Storms, High Winds, Tornadoes, Lightning, Hail, Extreme Heat, Drought, Earthquakes, Urban Fires, Floods, Dam Failure, Levee Failures, Expansive Soils, Wildfires, Fixed Site Hazardous Materials, Transportation Hazards

3. **Develop a Pre-disaster recovery plan for Hazard/Disaster events.**

Lead:	Engineering Services
Time Schedule:	On-going
Estimated Cost:	$ 50,000
Source of Funding:	Local/General budget

Work Product/Expected Outcome: Intelligent, resilient reconstruction after a disaster event.

Winter Storms, High Winds, Tornadoes, Lightning, Hail, Extreme Heat, Drought, Earthquakes, Urban Fires, Floods, Dam Failure, Levee Failures, Expansive Soils, Wildfires, Fixed Site Hazardous Materials, Transportation Hazards

4. **Promote and implement hazard awareness programs in public and private schools as a means to get hazard outreach to families.**

Lead:	TAEMA, Communications Dept.,
Time Schedule:	On-going
Estimated Cost:	$ 10,000 per year
Source of Funding:	Local/General budget

Work Product/Expected Outcome: Even at an early age, children are able to absorb massive amounts of information. Disaster preparedness education should begin at an early age to allow children to absorb the information, and as a mechanism to encourage individual and family hazard awareness in their home.

Winter Storms, High Winds, Tornadoes, Lightning, Hail, Extreme Heat, Drought, Earthquakes, Urban Fires, Floods, Dam Failure, Levee Failures, Expansive Soils, Wildfires, Fixed Site Hazardous Materials, Transportation Hazards

5. **Develop a separate "public safety" information area in all public libraries and public recreation facilities to disseminate disaster safety information appropriate to the area and the season**

Lead:	City/County Library
Time Schedule:	On-going
Estimated Cost:	$
Source of Funding:	Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: Informational kiosks and display racks easily available to the public that contain brochures and materials on various natural and man-made hazards, and how citizens can prepare for, mitigate, respond to, and recover from disasters.

Winter Storms, High Winds, Tornadoes, Lightning, Hail, Extreme Heat, Drought, Earthquakes, Urban Fires, Floods, Dam Failure, Levee Failures, Expansive Soils, Wildfires, Fixed Site Hazardous Materials, Transportation Hazards

6. **Coordinate with emergency management and public health stakeholders (MRC, Red Cross, Tulsa County Health, etc.) to inventory disaster resources and Emergency Action Plans already in place in the City of Tulsa.**

Lead:	TAEMA
Time Schedule:	5 years
Estimated Cost:	Staff salaries
Source of Funding:	Local/General budget

Work Product/Expected Outcome: An inventory of disaster preparedness efforts and resources

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Winter Storms, High Winds, Tornadoes, Lightning, Hail, Extreme Heat, Drought, Earthquakes, Urban Fires, Floods, Dam Failure, Levee Failures, Expansive Soils, Wildfires, Fixed Site Hazardous Materials, Transportation Hazards

7. **Update and maintain the City of Tulsa Hazard Mitigation website with information promoting hazard mitigation and disaster awareness.**

Lead:	Communications Dept.
Time Schedule:	On-going
Estimated Cost:	Staff salaries
Source of Funding:	Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: Ability of the public to obtain the latest and most accurate information on natural and man-made hazards and measures to lessen their adverse impacts on lives, property and vital infrastructure.

Winter Storms, High Winds, Tornadoes, Lightning, Hail, Extreme Heat, Drought, Earthquakes, Urban Fires, Floods, Dam Failure, Levee Failures, Expansive Soils, Wildfires, Fixed Site Hazardous Materials, Transportation Hazards

8. **Work with organizations serving Functional/Access Needs Populations (elderly, wheelchair-bound, deaf, blind, etc.) that may require special assistance, that tie in with 9-1-1, GIS Systems, etc., so that vulnerable populations within the community can be checked on, notified, supported or educated effectively in the event of disasters.**

Lead:	Community Response Coalition, Communications Dept., Tulsa Partners
Time Schedule:	On-going
Estimated Cost:	$ 10,000 per year
Source of Funding:	Local/General budget

Work Product/Expected Outcome: Identification and location of most vulnerable populations and incorporation of response plan with existing emergency response providers' response operations.

Winter Storms, High Winds, Tornadoes, Lightning, Hail, Extreme Heat, Drought, Earthquakes, Urban Fires, Floods, Dam Failure, Levee Failures, Expansive Soils, Wildfires, Fixed Site Hazardous Materials, Transportation Hazards

9. **Develop a new Emergency Operations Center at the Expo Square.**

Lead:	Tulsa Area Emergency Management Agency
Time Schedule:	5 years
Estimated Cost:	$ 14 Million. $10.0 Mil for structure. $4 Mil for supplies and communications equipment.
Source of Funding:	Local/General budget, Sales Tax, Bond Issue, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: Build and equip a new Emergency Operations Center, to be located on the Tulsa County Fairgrounds property, to replace the aging and inadequate EOC currently located in the basement of the Tulsa Police/Courts Building. The new 15,000 sq. ft. EOC would be developed to FEMA 361 standards. HMGP funding would be used to supplement normal construction costs with the additional costs for increasing the "armoring" of the facility to meet the FEMA 361 standards for Community Safe Rooms.

High Winds, Tornadoes, Floods

10. Continue to evaluate, upgrade and maintain community-wide outdoor omni-directional voice/siren warning systems.

Lead: Tulsa Area Emergency Management

Time Schedule: 10 Years; 2013-2023

Estimated Cost: $ 1,000,000

Source of Funding: Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: 1) Identify locations where warning siren coverage has gaps and is less than effective, due to terrain, etc; 2) Routinely test sirens for operational adequacy and maintenance/system required; Goal: 98% coverage with omni-directional warning sirens.

Winter Storms, Hail, High Winds, Tornadoes, Lightning, Extreme Heat, Drought, Earthquakes, Floods, Wildfire

11. Continue to acquire and distribute NOAA Weather Radios to all Critical Facilities and the public.

Lead: TAEMA, TFD

Time Schedule: Ongoing

Estimated Cost: $ 5,000 per yr.

Source of Funding: Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: All Critical and Essential Facilities, and the public would have NOAA Weather Radios in the offices, businesses and residences to be warned of eminent hazardous weather events

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Winter Storms, High Winds, Tornadoes, Floods, Dam Failure, Levee Failure, Earthquakes

12. Develop / Review / Update the Debris Management Plan.

Lead: Streets & Stormwater Dept., TAEMA

Time Schedule: On going

Estimated Cost: $ 10,000

Source of Funding: Local/General budget

Work Product/Expected Outcome: 1) Identify locations clean-up crews can deposit debris before a final disposal. Public safety and efficiency in relocating debris piles should be considered; 2) Assess priorities for clearing routes involving critical structures or facilities.3) Purchase tub grinder for areas serviced by landfill.

Winter Storms, High Winds, Tornadoes, Lightning, Hail, Extreme Heat, Drought, Earthquakes, Urban Fires, Floods, Dam Failure, Levee Failure, Expansive Soils, Wildfires, Fixed Site Hazardous Materials, Transportation Hazards

13. Implement meeting with neighborhoods and vulnerable populations about Hazard Mitigation strategies.

Lead: Working in Neighborhoods,

Time Schedule: On going

Estimated Cost: Staff salaries

Source of Funding: Local/General budget

Work Product/Expected Outcome: Inform citizens about hazards that could impact their neighborhoods and Mitigation Strategies to protect lives and property.

Winter Storms, High Winds, Tornadoes, Earthquakes, Floods, Dam Failures, Levee Failures, Wildfires

14. Update Tulsa plans addressing donations management, volunteers, etc.

Lead: TAEMA, Volunteer Tulsa

Time Schedule: On-going

Estimated Cost: Staff Salaries

Source of Funding: Local/General budget

Work Product/Expected Outcome: Post disaster events can cause an influx of volunteers and donations to arrive in the impacted area. Updating the EOP with a donations management addendum, and continuing to make use of Volunteer Tulsa as a volunteer intake center, will allow for a more safe and sustainable city in a post-disaster event.

Extreme Heat

15. Continue and increase education of outdoor workers and other at-risk populations on the signs and symptoms of heat-related illness and steps that are available to prevent or respond to such illnesses.

Lead: Human Response Coalition, NWS, Communications, TAEMA, EMSA

Time Schedule: On-going

Estimated Cost: To be determined

Source of Funding: Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: A well/better informed most vulnerable population on preparedness, prevention, and response and treatment of heat-related illnesses.

Extreme Heat, Winter Storms

16. Identify public facilities that can function as cooling shelters during heat waves, power outages, extreme winter events, and develop protocols to inform the public when they're operable, and promote these facilities to vulnerable functional and access needs populations.

Lead: TAEMA,

Time Schedule: On-going

Estimated Cost: To be determined

Source of Funding: Local/General budget

Work Product/Expected Outcome: When extreme heat occurs or wind chill drops, a large number functional and access needs populations suffer. In order to alleviate heat illness during summertime heat waves and hyperthermia in the dead of winter, shelters should be pre designated and open when needed. The expected outcome includes shelters that are open to the public for refuge during extreme heat and winter events. The shelters should be publicized in advance of the event.

High Winds, Tornadoes

17. Initiate an Individual Safe Room Rebate Program

Lead: Engineering Services, TAEMA,

Time Schedule: On going

Estimated Cost: $ 2,500,000

Source of Funding: Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: Provide rebates in amounts up to 75% of cost, not to exceed a maximum rebate amount (to be determined at a later date) for individuals to install Safe Rooms in their residences. Either the shelter (if pre-built) or the installer (if built from raw materials) would be required to be certified by the National Storm Shelter Association (NSSA) in order to guarantee compliance with the FEMA 320 and/or 361 standards. B.3.1 – Safe Rooms.

High Winds, Tornadoes

18. Promote voluntary registration of Safe Rooms, and continue to update data base and GIS (lat/long) map to locate Safe Rooms in the event of a disaster.

Lead: 911

Time Schedule: On-going

Estimated Cost: Staff salaries

Source of Funding: Local/General budget

Work Product/Expected Outcome: After a disaster event, all landmarks become unrecognizable. Safe rooms save lives, but debris may cause occupants to become trapped until found in their respective location. Registration of safe rooms would reduce possible residual risks associated

with sheltering in safe rooms by allowing for fast recovery of persons who may be trapped within after a tornado event.

High Winds, Tornadoes

19. Educate residents, building professionals and Safe Room vendors on the ICC/NSSA "Standard for the Design and Construction of Storm Shelters" and consider incorporating into current regulatory measures.

Lead:	Engineering Services
Time Schedule:	On-going
Estimated Cost:	Staff Salaries
Source of Funding:	Local/General budget

Work Product/Expected Outcome: An educated citizenry and professional building and design community as to the advantages and requirements of the ICC/NSSA "Standard for the Design and Construction of Storm Shelters," and the adoption of an ordinance requiring that all safe rooms comply with the ICC/NSSA standard.

High Winds, Tornadoes

20. Develop a Safe Room Plan and provide employee safe-rooms at critical facilities, such as City Hall, fire stations and police stations to protect first responders.

Lead:	Engineering Services & Building Operations
Time Schedule:	2014-2016
Estimated Cost:	To be determined.
Source of Funding:	Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: Evaluate City facilities to determine where providing a Safe Room meeting the FEMA 361 standards would increase the capabilities of the city's being able to more effectively respond to a major disaster. Parameters such as level of critical operations, number of staff, degree of critical response operations, and current building architecture would all factor into the prioritization of incorporating a Safe Room as either a retrofit, as part of a remodel or expansion of existing facilities, or in the development of new City facilities.

High Winds, Tornadoes

21. Adopt an Ordinance requiring new Mobile Home Parks to provide storm shelters/safe rooms for their residents.

Lead:	Code Enforcement
Time Schedule:	2014-2019
Estimated Cost:	To be determined
Source of Funding:	Local/General budget

Work Product/Expected Outcome: Safe Rooms/Shelters in Mobile Home Parks.

High Winds, Tornadoes, Hail

22. Work with insurance companies to provide a public information program that communicates the advantages and costs of hail and wind resistant roofing.

Lead: Engineering Services, Insurance Commission

Time Schedule: On-going

Estimated Cost: $ 50,000

Source of Funding: Local/General budget

Work Product/Expected Outcome: A public information and education program to inform the public of the cost-effectiveness of hail and wind resistant roofing.

High Winds, Tornadoes, Earthquakes, Hail

23. Identify and develop public information and education programs and provide materials and mitigation measures that protect a building's roof, all outside openings, and the building envelope. Also research ways to improve quality of construction related to wind resistance. Top priority should be given to protection of the roof system, typically the most vulnerable and most expensive component to replace.

Lead: Engineering Services, Communications Dept., Development Services,

Time Schedule: 2014-2019

Estimated Cost: $ 53,333

Source of Funding: Local/General budget

Work Product/Expected Outcome: Enhanced construction practices for residences that will result in homes that will withstand most hazards.

Tornadoes, High Winds, Floods, Lightning, Hail, Earthquakes, Urban Fires, Expansive Soils, Wildfires

24. Train/Educate builders, developers, architects and engineers in techniques of disaster-resistant homebuilding, such as the Fortified Home standards developed by the Institute for Business & Home Safety (IBHS), the Blueprint for Safety guidelines developed by the Federal Alliance for Safe Homes (FLASH).

Lead: Engineering Services, Home Builders Assn., American Institute of Architects

Time Schedule: 2014-2019

Estimated Cost: $ 10,000

Source of Funding: Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: An educated planning, design, engineering, development, building and construction industry familiar with mitigation techniques, such as post-tension slab on grade foundations, IBHS connectivity construction, hail and wind-resistant roofing, fire-resistant siding, impact-resistant windows and doors on new residential construction in areas of

moderate or high risk from expansive soils, earthquakes, high winds, tornadoes, hail and wildfires.

High Winds, Tornadoes, Hail

25. Work with and encourage the Home Insurance Industry to take a more proactive role in promotion of, and education of the Public and Roofing/Home Building Industry about the Cost/Beneficial installation of Class 4 Hail and Wind-resistant shingles.

Lead:	Engineering Services
Time Schedule:	2014-2019
Estimated Cost:	$ 10,000
Source of Funding:	Local/General budget

Work Product/Expected Outcome: A better informed and educated homeowners and insured public about the cost/benefits of wind and hail-resistant roofing.

High Winds, Tornadoes

26. Develop a Model Safe Room Project for a Mobile Home Park in the City of Tulsa that includes the construction of a safe room meeting the criteria of FEMA Publication 361 and/or 320.

Lead:	Engineering Services, voluntary mobile home park
Time Schedule:	2014-2019
Estimated Cost:	$ 250,000
Source of Funding:	Local/General budget, CDBG, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: Model/pilot safe room/shelter constructed in a mobile home park, the most vulnerable housing population to high winds and Tornadoes,

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High Winds, Tornadoes, Hail, Earthquakes

27. When replaced, install Break/Shatter Resistant Glass in government offices, and critical facilities.

Lead:	Building Operations
Time Schedule:	On-going
Estimated Cost:	To be determined
Source of Funding:	Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: Critical Facilities with break-resistant windows that can continue operations without injury to critical personnel from flying glass during high wind events.

Winter Storms, High Winds, Tornadoes, Lightning, Extreme Heat, Earthquakes

28. Develop an Emergency Back-up Generator Hazard Mitigation Plan Annex to the Multi-Hazard Mitigation Plan for the community, assessing and prioritizing generator needs for critical facilities, both public and private. Assessment should include emergency generator needs, costs of installation for pads/transfer panels only, or for complete generator assembly installation.

Lead:	Building Operations
Time Schedule:	2014
Estimated Cost:	$ 100,000
Source of Funding:	Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: An Emergency Back-up Generator Hazard Mitigation Plan Annex that inventories Critical Facilities, including City Hall, Police Station, Public Works, County EMS, Nursing Homes, Early Childhood Centers, Community Emergency Shelters; sets priorities, evaluates current electrical usage, emergency electrical load/needs, fuel sources (natural gas/diesel/propane), pad location, wiring, transfer switches, contract or on-site, and generator type and size.

Winter Storms, High Winds, Tornadoes, Lightning, Extreme Heat, Earthquakes

29. Based on the results of the Emergency Back-up Generator Hazard Mitigation Plan Annex, provide wiring and transfer switches to accommodate emergency generators during disaster power outages for critical facilities including Emergency Operations Centers, City Hall, Dispatch, Police, Fire, Community Centers used for emergency housing during disasters, critical facilities, water treatment plants.

Lead:	Building Operations
Time Schedule:	2014-2019
Estimated Cost:	To be determined
Source of Funding:	Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: Critical public facilities with the ability to accommodate emergency back-up generators and able to provide essential public services and continuity of government during power outages.

Winter Storms, High Winds, Tornadoes, Lightning, Extreme Heat, Earthquakes

30. Obtain emergency generators for continuity of government/use during disaster power outages for critical facilities including Emergency Operations Centers, City Hall, Dispatch, Police, Fire, Community Centers used for emergency housing during disasters, critical facilities, lift stations, water treatment plants, and community medical facilities, as identified in the Emergency Back-up Generator Hazard Mitigation Plan Annex.

Lead:	Engineering Services
Time Schedule:	On going
Estimated Cost:	Undetermined
Source of Funding:	Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: This will provide sufficient generators or access to generators during a disaster that will provide sufficient power for critical community functions. This will aid in the recovery and response effort after a disaster.

Winter Storms, High Winds, Tornadoes, Lightning, Extreme Heat, Earthquakes

31. Adopt an Ordinance requiring generator pad and wiring/transfer switches for Elder Care Facilities and Nursing Homes, to accommodate Emergency Back-Up Generators in the event of prolonged power outages.

Lead:	Code Enforcement
Time Schedule:	2014-2019
Estimated Cost:	Minimal
Source of Funding:	Local/General budget

Work Product/Expected Outcome: Adoption of an Ordinance requiring generator pad and wiring/transfer switches for Elder Care Facilities and Nursing Homes, to accommodate Emergency Back-Up Generators in the event of prolonged power outages.

Winter Storms, High Winds, Tornadoes, Lightning, Extreme Heat, Earthquakes

32. Provide surge protection and backup power generators for computer-reliant and in existing critical facilities (e.g. City Hall, Engineering Services, police stations, fire stations, etc.).

Lead:	Building Operations
Time Schedule:	2014-2019
Estimated Cost:	To be determined
Source of Funding:	Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: Study to assess the needs of City Critical Facilities and computer reliant facilities, and implementation of the plan to provide the needed surge protection.

Winter Storms, High Winds, Tornadoes, Lightning, Extreme Heat, Earthquakes

33. Continue the comprehensive public education program on the dangers of carbon monoxide during extended power outages

Lead: Tulsa Fire Department, Communications, EMSA

Time Schedule: On going

Estimated Cost: To be determined

Source of Funding: Local/General budget

Work Product/Expected Outcome: Prepare for, and continue the comprehensive "just-in-time" public education campaign during extended power outages on the dangers connected with both improper use of portable generators and alternative heating sources, such as fireplaces and stoves. A great many illnesses and some deaths in Oklahoma have been recorded due to both these causes. While many materials are available for this program, some may have to be developed that are Tulsa specific. This program would be done in collaboration with Tulsa Area Emergency Management Agency, the Tulsa Health Department, the Tulsa Fire Department, PSO, and other concerned agencies.

Lightning

34. Work with City of Tulsa and Tulsa County Parks Departments, Tulsa Public Schools, Jenks and Union Schools to develop and implement a comprehensive Master Lightning Sensing and Warning System Plan and Program.

Lead: TAEMA, Parks Departments, School Districts

Time Schedule: 2014-2019

Estimated Cost: $ 50,000

Source of Funding: Local/General budget

Work Product/Expected Outcome: A lightning sensing and warning system that would provide city-wide coverage for vulnerable outside recreation areas.

Lightning

35. Work together with the Tulsa National Weather Service to promote awareness of lightning safety to students in the City of Tulsa through public education programs such as, "When thunder roars, go indoors!"

Lead: TAEMA, Communications Dept., National Weather Service

Time Schedule: On going

Estimated Cost: Minimal

Source of Funding: Local/General budget, NWS

Work Product/Expected Outcome: Awareness of the lightning hazard to students.

Lightning

36. Post warning signage at areas with Lighting Sensing & Warning Systems to inform the public what it means when the Lightning Warning sounds and what action should be taken.

Lead:	City/County Parks, School Districts,
Time Schedule:	On going
Estimated Cost:	$100 per location
Source of Funding:	Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: Warning signs to convey information regarding the meaning of the sirens.

Lightning

37. Educate the Public, and encourage the Utility Companies to provide information to their clients on Whole House Surge and Lightning Protection

Lead:	Communications Dept., PSO
Time Schedule:	On going
Estimated Cost:	To be determined.
Source of Funding:	Local/General budget,

Work Product/Expected Outcome: An informed public, aware of the risks associated with lightning, and ways they can mitigate against these risks in their home.

Lightning

38. Construct lightning rods or air terminals (strike termination devices) for protection of Critical Facilities

Lead:	Building Operations,
Time Schedule:	2014-2019
Estimated Cost:	To be determined
Source of Funding:	Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: Critical facilities and in the City of Tulsa, protected from surges in the event of a lightning strike.

Floods, Dam Failures, Levee Failures,

39. Continue Compliance with, and Participation in the National Flood Insurance Program (NFIP) and the Community Rating System (CRS).

Lead:	Engineering Services
Time Schedule:	On going
Estimated Cost:	$ 50,000 per year
Source of Funding:	Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: Continue to meet minimum NFIP requirements and exceed those requirements by enforcing local Regulatory Floodplain Ordinances and by participating in the Community Rating System (CRS) program.

Floods, Dam Failures, Levee Failures

40. Continue citizen floodplain and Flood Insurance education programs

Lead:	Engineering Services
Time Schedule:	On going
Estimated Cost:	$ 10,000 per year
Source of Funding:	Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: Increased flood insurance awareness and coverage.

Floods, Dam Failures, Levee Failures,

41. Continue to update and revise Basin-wide Master Drainage Plans where changed conditions warrant.

Lead:	Engineering Services
Time Schedule:	2014-2019
Estimated Cost:	$ 14,000,000
Source of Funding:	Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP, CTP Program.

Work Product/Expected Outcome: Many of the City's Master Drainage Plans are outdated and need to be revised. Master Drainage Plans will be developed for newly annexed areas of the City, and the 38 existing Basin-wide Master Drainage Plans will be updated with new hydrology, hydraulics, topography, surveyed First Finished Floor Elevations for structures in the floodplain, and revised recommended structural and non-structural mitigation measures to solve the flooding problems

Floods, Dam Failures, Levee Failures

42. Continue to acquire and remove floodplain and (future) repetitive loss properties where the community's Repetitive Loss and Flood and Drainage Annex to the Multi-Hazard Mitigation Plans identify acquisition as the most cost-effective and desirable mitigation measure.

Lead:	City of Tulsa Engineering Services
Time Schedule:	Ongoing
Estimated Cost:	$25,000,000
Source of Funding:	Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Acquisition and removal of all buildings from the floodplain where acquisition is deemed to be the most cost-effective means of flood mitigation and protection. The National Flood Insurance Program keeps track of insurance claims made for flood damages. Properties where claims of $1,000 or more have occurred at least twice in the past 10 years are called "Repetitive Loss Properties." In addition, the City of Tulsa keeps track of properties that suffer repeated damages that are less than $1,000 each.

Floods, Dam Failures, Levee Failures

43. Develop an Inter-jurisdictional comprehensive plan/process and risk analysis for the Arkansas River Corridor, taking Hazards into account.

Lead:	County Commission, TAEMA, USACE, Engineering Services
Time Schedule:	On going
Estimated Cost:	$ 3.4 million
Source of Funding:	Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP, USACE Silver Jackets Program.

Work Product/Expected Outcome: A multi-jurisdictional Comprehensive Plan for the Arkansas River corridor, Keystone Dam, levees, hazardous materials, development, transportation and land-use plans; emergency notification and evacuation plans; maintenance programs.

Floods, Dam Failures, Levee Failures

44. Fund, Implement, Construct recommendations of the Master Drainage Plans

Lead:	Engineering Services
Time Schedule:	On going
Estimated Cost:	$ 500,000,000
Source of Funding:	Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: Protection of all structures from flooding.

Floods, Dam Failures, Levee Failures

45. Develop public information and education plan for Arkansas River flooding, releases, dam failure.

Lead: TAEMA, Communications Dept., USACE

Time Schedule: Ongoing

Estimated Cost: $ 25,000 per year

Source of Funding: Local/General budget, USACE, Drainage District 12

Work Product/Expected Outcome: Increased awareness of the vulnerable populations of potential flooding, dam releases and failure, levee failure.

Floods, Dam Failures, Levee Failures

46. Prepare canned messages for Hazards for use of the City of Tulsa's Mass Notification System, e.g., flood warnings for floodplain properties, by stream segment/basin.

Lead: TAEMA, Communications Dept., Engineering Services, 911

Time Schedule: 2014-2015

Estimated Cost: Staff salaries

Source of Funding: Local/General budget.

Work Product/Expected Outcome: An "Emergency Telephone Notification System" (frequently referred to as Reverse 9-1-1) with which a community can send out a mass telephone announcement to targeted numbers in the 9-1-1 system, effectively supplementing a community's other warning systems. This is useful during a geographic-specific threat, such as a hazmat release, wildfire threat, etc., and can even be used for missing persons, Amber Alerts, and other non-disaster incidents. The ETNS would be integrated with the 9-1-1 GIS system to maintain updated information and data.

Floods, Dam Failures, Levee Failures

47. Develop a Relocation Plan, including housing, feeding massive populations.

Lead: American Red Cross, TAEMA, Tulsa Housing Authority, Working in Neighborhoods,

Time Schedule: 2014-2016

Estimated Cost: $ 25,000

Source of Funding: Local/General budget, Federal Emergency Management Agency

Work Product/Expected Outcome: A plan that addresses where the large number of people anticipated to be impacted by a historic flood event, dam, or levee failure on the Arkansas River would be relocated to.

Floods, Dam Failures, Levee Failures

48. Provide stricter floodplain regulations along the Arkansas River Corridor.

Lead: Development Services,

Time Schedule:

Estimated Cost: $

Source of Funding: Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: The City of Tulsa will identify and map the 1986 Arkansas River Flood, and adopt those flood limits plus one foot as the City's Regulatory Floodplain on the Arkansas River within the City-Limits of the City of Tulsa.

Floods, Dam Failures, Levee Failures, Earthquakes, Urban Fires, Hazardous Materials, Transportation Hazards

49. Develop a Plan for cascading events – earthquakes, dam failure, flooding, fires, power outages, hazardous materials events, evacuation during event.

Lead: TAEMA

Time Schedule: On-going On-going

Estimated Cost: Staff salaries

Source of Funding: Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: Continue to address cascading hazard events in the city of Tulsa EOP and exercise the plan as necessary.

Floods, Dam Failures, Levee Failures

50. Identify construction characteristics of the levees.

Lead: Levee District 12

Time Schedule: Ongoing

Estimated Cost: $ 3,000,000

Source of Funding: Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: A comprehensive analysis of the condition of the levees, and a recommended plan to improve their safety.

Floods, Dam Failures, Levee Failures

51. Develop a Comprehensive Levee Evaluation and Repair Plan

Lead: Levee District 12, Engineering Services, TAEMA,

Time Schedule: 2014-2019

Estimated Cost: To be determined

Source of Funding: Local/General budget, Sales Tax, Bond Issue, Federal Emergency Management Agency (FEMA), USACE.

Work Product/Expected Outcome: A detailed plan of action for the maintenance and certification of the levees. Preliminary evaluations performed by the Corps of Engineer in 2007-08 on the City of Tulsa levees have revealed a number of deficiencies in the system. They have also determined what would be involved in completing a comprehensive study to further define these needs, and to develop a program for funding and implementing corrections to those deficiencies. This program would need to be done in cooperation and collaboration with Tulsa County and the surrounding communities that rely upon the levee system for protection.

Floods, Dam Failures, Levee Failures

52. Develop a Levee Public Education and Evacuation Plan for at-risk areas of the community, including routes, transportation, and housing.

Lead: Levee District 12, USACE

Time Schedule: 2014-2016

Estimated Cost: To be determined

Source of Funding: Local/General budget, USACE

Work Product/Expected Outcome: This measure would provide a two-pronged approach to protecting that population: (1) a public education and information program targeting those vulnerable households, and (2) a formal evacuation plan as an addendum to the City of Tulsa Emergency Operations Plan. Funding would include the creation of area-specific, hazard-specific educational literature and distribution.

High Winds, Hail

53. Provide Class 4 hail-resistant roofing on planned public infrastructure projects

Lead: Engineering Services

Time Schedule: On going

Estimated Cost: To be determined

Source of Funding: Local/General budget, Federal Emergency Management Agency (FEMA) PDM and/or HMGP.

Work Product/Expected Outcome: Hail-resistant roofing on City of Tulsa buildings.

Drought, Expansive Soils

54. Establish an administrative procedure or change in City codes that require builders to check for expansive soils when applying for new residential construction permits, and to consider the use of foundations that mitigate expansive soil damages when in a moderate to high-risk area.

Lead: Engineering Services, Development Services

Time Schedule: Ongoing

Estimated Cost: Staff salaries

Source of Funding: Local/General budget,

Work Product/Expected Outcome: Investigate potential code changes or construction incentives to builders and developers for using mitigation techniques, such as post-tension slab on grade, drilled pier or other resistant foundations, on new residential construction in areas of moderate or high risk from expansive soils.

Drought, Expansive Soils

55. Educate builders on appropriate foundation types for soils with different degrees of shrink-swell potential. For example, using 'post-tensioned slab-on-grade' or 'drilled pier' vs. standard 'slab on grade' or 'wall on grade' foundations.

Lead: Engineering Services, Development Services, Home Builders Assn.

Time Schedule: On Going

Estimated Cost: Staff salaries

Source of Funding: Local/General budget

Work Product/Expected Outcome: A better educated building trades industry on expansive soils and foundation building/construction mitigation techniques.

Drought, Expansive Soils

56. Inform homeowners of landscaping measures, such as xeriscaping, drainage systems or ground sloping, that can mitigate foundation damage

Lead: Engineering Services

Time Schedule: Ongoing

Estimated Cost: $ 5,000/yr

Source of Funding: Local/General budget

Work Product/Expected Outcome: a better educated public and construction industry on measures that can mitigate damage due to Expansive Soils and Drought.

Drought, Expansive Soils

57. Implement/enforce an administrative procedure/ordinance to require permits for foundation repair.

Lead: Code Enforcement/Developmental Services

Time Schedule: Ongoing

Estimated Cost: Staff salaries

Source of Funding: Local/General budget

Work Product/Expected Outcome: A database on foundation repairs and costs due to expansive soils.

Urban Fires, Wildfires

58. Construct additional fire stations needed in outlying areas.

Lead: Tulsa Fire Department,

Time Schedule: On going

Estimated Cost: To be determined

Source of Funding: Local/General budget, Sales Tax, Bond Issue

Work Product/Expected Outcome: New Fire Stations in developing and under served areas of the City.

Urban Fires

59. Develop an Outreach and Public Information & Education Program on the benefits of Residential Sprinkler Systems.

Lead: Tulsa Fire Department, Communications Dept.

Time Schedule: 2014-2019

Estimated Cost: $ 20,000

Source of Funding: Local/General budget

Work Product/Expected Outcome: A Public Information Program and an educated public on the benefits of Residential Sprinkler Systems.

Urban Fires, Wildfires

60. Replace/continue replacing inadequately sized water lines with lines of sufficient size to provide proper fire protection to annexed and existing areas.

Lead: Engineering Services, Water Department

Time Schedule: Ongoing

Estimated Cost: Under Development

Source of Funding: Local/General budget, Sales Tax, Bond Issues

Work Product/Expected Outcome: Areas of the city with inadequate sized water lines to have better fire protection.

Urban Fires, Wildfires

61. Coordinate with County, Local Fire Chiefs, INCOG, Rural Fire Coordinator and State Forestry Department to obtain more fire training and fire fighting equipment for grass fires and wildfires.

Lead: Tulsa Fire Department,

Time Schedule: Ongoing

Estimated Cost: To be determined

Source of Funding: Local/General budget

Work Product/Expected Outcome: Better prepared, trained and coordinated regional wildfire fighting capabilities.

Urban Fires, Wildfires

62. Investigate and raise public awareness of using fire-resistant materials in buildings

Lead: Tulsa Fire Department, Engineering Services

Time Schedule: Ongoing

Estimated Cost: To be determined$

Source of Funding: Local/General budget

Work Product/Expected Outcome: An increase in the number of fire resistant homes in the City of Tulsa.

Drought, Urban Fires, Wildfires

63. Work with local fire departments to develop contingency plans for firefighting during periods when drought conditions may produce decreased water pressure and supply.

Lead: Tulsa Fire Department, Water Planning, Engineering Services

Time Schedule: Ongoing

Estimated Cost: To be determined

Source of Funding: Local/General budget

Work Product/Expected Outcome: Adequate water supply during periods of drought for fire fighting.

Urban Fires, Wildfires

64. Educate the public on the dangers of shake shingle roofing, and consider more stringent building codes for fire resistant roofing and other construction materials.

Lead: Engineering Services

Time Schedule: Ongoing

Estimated Cost: To be determined

Source of Funding: Local/General budget

Work Product/Expected Outcome: A better informed public on the benefits fire resistant roofing and construction materials.

Wildfires

65. Review the Firewise program and seek Firewise Community certification for a model neighborhood.

Lead: Tulsa Fire Department

Time Schedule: 2014-2016

Estimated Cost: Staff salaries

Source of Funding: Local/General budget, Dept. of Agriculture, Forestry

Work Product/Expected Outcome: Implement a wildfire safety program using materials from Firewise Community USA. The program would include the training of educators and inspectors, identification of high-risk neighborhoods and buildings, and developing agreed-upon, area-specific solutions to the fire issues. The State Firewise Specialist will review and then work with the community to seek project implementation funds, if necessary.

There are approximately 1,000 homes in the high-risk areas of the Tulsa urban-wildland interface. The goal is that a subdivision could be identified during this process that would seek Firewise certification through their Home Owners' Association and serve as a model for other homeowner's groups in the Tulsa area.

Wildfire

66. Assess fire response vehicle access to all areas with a High Level of Wildfire Concern. Identify /implement mitigation actions to reduce the level of difficulty to access the areas in the event of a wildland fire.

Lead: Tulsa Fire Department

Time Schedule: 2014-2019

Estimated Cost: To be determined

Source of Funding: Local/General budget

Work Product/Expected Outcome: Easy access to areas with a High Wildfire Concern around the Urban Interface Areas of Tulsa.

Drought

67. Encourage and educate the public on Low Impact Development (LID)

Lead: Sormwater, OSU

Time Schedule: On-going

Estimated Cost: To be determined

Source of Funding: Local/General budget, EPA

Work Product/Expected Outcome: Improved water quality, decreased urban runoff, water conservation; reduce the Urban Heat Island effect in the City of Tulsa (trees, green roofs, cool roofs, etc.)

Drought

68. Implement Water Sense program.

Lead: Water/Sewer Departments

Time Schedule: On-going

Estimated Cost: To be determined

Source of Funding: Local/General budget

Work Product/Expected Outcome: Reduced water consumption

Drought

69. Review the use of gray water sources to meet community requirements in, for example, irrigation and watering of golf courses and parks.

Lead: Water/Sewer

Time Schedule: On-going

Estimated Cost: Staff salaries

Source of Funding: Local/General budget

Work Product/Expected Outcome: More efficient use of existing water resources.

Chapter 8: Plan Maintenance and Adoption

This chapter includes a discussion of the plan maintenance process and documentation of the adoption of the plan by the Tulsa City Council.

8.1 Monitoring, Evaluating, and Updating the Plan

Included in this Chapter:

8.1 Monitoring, Evaluating, and Updating the Plan
8.2 Public Involvement
8.3 Incorporating the Multi-Hazard Mitigation Plan

The City of Tulsa will ensure that a regular review and update of the Multi-Hazard Mitigation Plan occurs. The Stormwater Drainage and Hazard Mitigation Advisory Board (SDHMAB) will continue to meet on a monthly basis, and the TTAC will continue to meet quarterly or as conditions warrant, to oversee and review updates and revisions to the plan. The City of Tulsa Lead Engineer, Stormwater Projects Coordinator will continue to head the Staff Technical Advisory Committee, which will monitor and oversee the day-to-day implementation of the plan. The Plan will be updated and resubmitted to the State and FEMA for approval prior to the 5-year approval period expiration, as per FEMA requirements.

Monitoring the Plan- Monitoring of the Plan, the Action Plan, and Mitigation Measures is the responsibility of the Emergency Manager, Special Projects Engineer, and Floodplain Administrator. Departments responsible for implementation of the Action Plan and the Mitigation Measures will update their Progress Reports on an annual basis, and report to the SDHMAB on progress and/or impediments to progress of the mitigation measures.

Evaluating the Plan- The *City of Tulsa Multi-Hazard Mitigation Plan* will be continually evaluated by the Project Manager, and a report will be made to the SDHMAB monthly. The evaluation will assess:

- Adequacy of adopted Goals and Objectives in addressing current and future expected conditions;
- Whether the nature and magnitude of the risks have changed;
- Appropriateness of current resources allocated for implementation of the Plan;
- To what extent the outcomes of the Mitigation Measures occurred as expected;
- Whether agencies, departments and other partners participated as originally anticipated.

Many Action Items recommended in this plan have already been incorporated into the City's *Capital Improvements Plan* process. These programs will continue to be monitored and updated on an annual basis, if not more often.

Updating the Plan- The *City of Tulsa Multi-Hazard Mitigation Plan* will be updated according to the following schedule:

1. Revise and Update- the City will incorporate revisions to the plan document identified during the monitoring and evaluation period, as well as items identified in the previous Planning Tool.

2. Submit for Review- the revised plan will be submitted to OEM and FEMA through the State Hazard Mitigation Officer for review and approval, and to FEMA no later than six (6) months prior to the end of the original performance period.
3. Final Revision and Adoption- if necessary, the plan will be revised per OEM and FEMA remarks, adopted by the Tulsa City Council, and the updated plan sent to FEMA prior to the expiration of the 5-year approval period.

8.2 Public Involvement

The City of Tulsa is committed to involving the public directly in updating and maintaining the Multi-Hazard Mitigation Plan.

Copies of the Plan will be maintained at the public library, and the plan will be placed on the website of the City of Tulsa.

Small area-specific meetings will be held on no less than a semi-annual basis at Public Libraries or other public venues. A public meeting will be held prior to submission of the update of the *City of Tulsa Multi-Hazard Mitigation Plan*. This meeting will be advertised to the general citizenry. This meeting will be held to update citizens on the progress that has been made in implementing the plan and related capital projects. The meetings will also be used to distribute literature and inform and educate citizens as to actions they can take to mitigate natural hazards, save lives, and prevent property damage. Input from the citizens will be solicited as to how the mitigation process can be more effective.

8.3 Incorporating the Multi-Hazard Mitigation Plan

The Hazard Mitigation Planning Committee recognizes the importance of fully integrating hazard mitigation planning and implementation into existing local plans, regulatory tools, and related programs; this process was used for the integration of the *2009 City of Tulsa Multi-Hazard Mitigation Plan*.

The City of Tulsa's local planning mechanisms available for incorporating the recommendations and requirements of the Hazard Mitigation Measures are listed below. The HMPC will ensure annual review of specific plans, ordinances, and codes identified in *Chapter 2*, to incorporate the requirements of this plan and hazard mitigation practices, into those documents whenever feasible.

Incorporation by the City of Tulsa

The *City of Tulsa Multi-Hazard Mitigation Plan* will be adopted by the Tulsa City Council as an amendment to the City's Comprehensive Plan. The Tulsa City Council will adopt the plan as a guide to City mitigation activities. Appropriate Action Items and Mitigation Measures from the plan will be incorporated into the following plans and codes:

- Capital Improvements Plan and planning process
- City of Tulsa Building Code
- Tulsa Emergency Operations Plan
- City of Tulsa Water and Sewer Plan
- City of Tulsa Comprehensive Plan

The Stormwater Drainage and Hazard Mitigation Advisory Board in conjunction with the Technical Advisory Committee will oversee the implementation of this plan once adopted. The process to include the adopted Mitigation Measures into other local planning mechanisms includes the following:

1. Mitigation Measures will be assigned to the appropriate departments for planning and implementation.
2. The responsible departments will report to the HMPC on an annual basis as to the progress made on each measure, identifying successes and impediments to their implementation.

To be included on the following pages of this chapter are the Resolution of Adoption of the *City of Tulsa*:

1. Tulsa Planning Commission
2. Tulsa City Council

4B

REQUEST FOR ACTION: RESOLUTION

Version: 01/27/2014

AGENDA FOR: [X] MAYOR [X] COUNCIL AUTHORITY: [ ] DATE: July 15, 2014

FOR INFORMATION CONTACT:

DEPARTMENT: ENGINEERING CONTACT NAME: Paul D. Zachary

ADDRESS: 2317 South Jackson Ave., Room S-312 TELE: 596-9475 (Bill H. Robison

RESOLUTION TYPE: Adopting Flood & Stormwater Management Plan RESO. #: 19557

ADDRESS: AMOUNT:

PROPERTY OWNER: CASE #:

PROJECT TITLE: 2014 MULTI-HAZARD MITIGATION PLAN PROJECT #:

ADDITION: TMAPC #:

AMENDMENT OF/BY RESOLUTION #: COUNCIL DIST.: PLANNING DISTRICT:

LOT: BLOCK: SECTION: TOWNSHIP: RANGE:

SUMMARY:

Sumitted for approval is the Resolution adopting the City of Tulsa 2014 Multi-Hazard Mitigation Plan. This Plan supersedes all previous multi-hazard mitigation plans.

APPROVED BY MAYOR
CITY OF TULSA
AUG 13 2014

Approved by
City Council on
AUG - 7 2014

BUDGET: FINANCE DIRECTOR APPROVAL:

FUNDING SOURCE:

REQUEST FOR ACTION: *All department items requiring Council approval must be submitted through Mayor's Office.*

Request approval of Resolution to adopt the City of Tulsa 2009 Multi-Hazard Mitigation Plan. Return two executed documents to Engineering Services, 2317 South Jackson Avenu, S312, Tulsa, OK 74107.

DEPARTMENT HEAD APPROVAL: DATE: 7/17/14

CITY ATTORNEY APPROVAL:

STORMWATER BOARD APPROVAL: JULY 15, 2014

MAYORAL APPROVAL: Jim Thomsey PRO-TEM 7/24/14

OTHER:

FOR CITY COUNCIL OFFICE USE ONLY: 14-627-1 DATE RECEIVED: 7/22/14

COMMITTEE: UED COMMITTEE DATE(S): 7/31/14 FIRST AGENDA DATE: 8/7/14

HEARING DATE: SECOND AGENDA DATE: APPROVED:

For City Clerk's Office Use Only (Agenda Date: MMDDYYYY; Sec #; Dept ##, Item ##, Sub-Item ##, Status: S=Synopsis):

08 - 11 - 2014	2	5	2		

RESOLUTIONS

Date Prepared: 07/15/2014

Dept. **ENGINEERING**

Reso Type

ADOPTING FLOOD & STORMWATER MANAGEMENT PLAN

2014 MULTI-HAZARD MITIGATION PLAN

Pln Dist

Addtn

TMA PC #

Coun Dist

Amt

Amd Of/ By

Proj #

Lot

Blk

Sec

Twn

Rng

'----- For City Clerk's Office Use Only * Data For Scanning * Please Do Not Alter -----

(Published in the Tulsa Business
& Legal News,
August 20, 2014.)

RESOLUTION 19557

A RESOLUTION ADOPTING THE CITY OF TULSA MULTI-HAZARD MITIGATION PLAN – 2014 UPDATE; AND DECLARING AN EMERGENCY.

WHEREAS, the City of Tulsa and its environs are subject to danger and damage from flooding, tornadoes, high winds, lightning, storms, transportation hazards, hazardous materials, and other natural hazards; and

WHEREAS, several different agencies, organizations and businesses have programs that can address these hazards or their impact, but there is an overriding need for a comprehensive, coordinated plan to assess the problems faced by the City and the measures that are and can be brought to bear on them; and

WHEREAS, the City of Tulsa participates in the National Flood Insurance Program; and

WHEREAS, the City of Tulsa has approximately 2200 structures in the Special Flood Hazard Area (SFHA);

WHEREAS, the City Council of Tulsa was awarded a Pre-Disaster Hazard Mitigation Grant Program planning grant in the amount of $222,312 to develop a multi-hazard mitigation plan which addresses natural hazards; and

WHEREAS, the 2000 Stafford Act mandates that communities must have an adopted, approved hazard mitigation plan before they can apply for funds from the Pre-Disaster or Post-Disaster Hazard Mitigation Grant Program, Flood Mitigation Assistance Program, Severe Repetitive Loss Program, and Repetitive Flood Claims Program; and

WHEREAS, the Tulsa City Council designated the Stormwater Drainage and Hazard Mitigation Board as the Hazard Mitigation Citizens Advisory Committee and the reviewing body of the planning process to include required public hearings and recommendations to the City Council in association with the information gathering and adoption of the Multi-Hazard Mitigation Plan; and

WHEREAS, the Stormwater Drainage and Hazard Mitigation Board considered said multi-hazard mitigation plan, after due and proper notice, and in public hearing on _____, has determined that it is in the best interest of the citizens of the City of Tulsa to recommend approval of such a plan to the Tulsa City Council subject to the changes described at the public hearing and incorporated within the document.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY OF TULSA, OKLAHOMA:

That the *City of Tulsa Multi-Hazard Mitigation Plan – 2014 Update,* as presented to the City Council and on file with the City Clerk, together with any and all graphic representations referenced in this Multi-Hazard Mitigation Plan and changes recommended by the Stormwater

7B

Drainage and Hazard Mitigation Board, are hereby approved and adopted as the *City of Tulsa Multi-Hazard Mitigation Plan – 2014 Update*.

ADOPTED, by the Council on this 7th day of August 2014.

Chair of the Council

ADOPTED, as an emergency measure, on this NA day of NA 2014.

NA

Chair of the Council

OFFICE OF THE CITY CLERK

Received by the City Clerk: _____ at _____.
Date Time

OFFICE OF THE MAYOR

Received by the Mayor: _____, at _____.
Date Time

Dewey F. Bartlett, Jr., Mayor

By: _____
Secretary

APPROVED by the Mayor of the City of Tulsa, Oklahoma: AUG 13 2014,
Date

at _____.
Time

Mayor

ATTEST:

Deputy City Clerk

CITY OF TULSA OKLAHOMA

APPROVED:

City Attorney

OK-MDS
8/14/14

MDS/eg

7/11/14

Appendix A: Glossary of Terms

***Anchoring*:** Special connections made to ensure that a building will not float off, blow off or be pushed off its foundation during a flood or storm.

***Base Flood*:** Flood that has a 1 percent probability of being equaled or exceeded in any given year. Also known as the 100-year flood.

***Base Flood Elevation (BFE)*:** Elevation of the base flood in relation to a specified datum, such as the National Geodetic Vertical Datum of 1929. The Base Flood Elevation is used as the standard for the National Flood Insurance Program.

***Basement*:** Any floor level below grade.

***Bedrock*:** The solid rock that underlies loose material, such as soil, sand, clay, or gravel.

***Building*:** A structure that is walled and roofed, principally above ground and permanently affixed to a site. The term includes a manufactured home on a permanent foundation on which the wheels and axles carry no weight.

***Community Rating System (CRS)*:** A National Flood Insurance Program (NFIP) that provides incentives for NFIP communities to complete activities that reduce flood hazard risk. When the community completes specified activities, the insurance premiums of policyholders in these communities are reduced.

***Computer-Aided Design And Drafting (CADD)*:** A computerized system enabling quick and accurate electronic 2-D and 3-D drawings, topographic mapping, site plans, and profile/cross-section drawings.

***Consequences*:** The damages, injuries, and loss of life, property, environment, and business that can be quantified by some unit of measure, often in economic or financial terms.

***Contour*:** A line of equal ground elevation on a topographic (contour) map.

***Critical Facility*:** Facilities that are critical to the health and welfare of the population and that are especially important during and following hazard events. Critical 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 term also includes buildings or locations that, if damaged, would create secondary disasters, such as hazardous materials facilities, vulnerable facilities, day care centers, nursing homes, and housing likely to contain occupants who are not very mobile. Other critical city infrastructure such as telephone exchanges and water treatment plants are referred to as lifelines. See Lifelines.

***Dam Breach Inundation Area*:** The area flooded by a dam failure or programmed release.

***Debris*:** The scattered remains of assets broken or destroyed in a hazard event. Debris caused by a wind or water hazard event can cause additional damage to other assets.

***Development*:** Any man-made change to real estate.

***Digitize*:** To convert electronically points, lines, and area boundaries shown on maps into x, y coordinates (e.g., latitude and longitude, universal transverse mercator (UTM), or table coordinates) for use in computer applications.

***Duration*:** How long a hazard event lasts.

***Earthquake*:** A sudden motion or trembling that is caused by a release of strain accumulated within or along the edge of earth's tectonic plates.

***Emergency*:** Any hurricane, tornado, storm, flood, high water, wind-driven water, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snowstorm, drought, fire, explosion, or other catastrophe in any part of the United States which requires federal emergency assistance to supplement State and local efforts to save lives and protect property, public health and safety, or to avert or lessen the threat of a disaster. Defined in Title V of Public Law 93-288, Section 102(1).

***Emergency Operations Center (EOC)*:** A facility that houses communications equipment that is used to coordinate the response to a disaster or emergency.

***Emergency Operations Plan (EOP)*:** Sets forth actions to be taken by State or local governments for response to emergencies or major disasters.

***Emergency Response Plan*:** A document that contains information on the actions that may be taken by a governmental jurisdiction to protect people and property before, during, and after a disaster.

***Extent*:** The size of an area affected by a hazard or hazard event.

***Fault*:** A fracture in the continuity of a rock formation caused by a shifting or dislodging of the earth's crust, in which adjacent surfaces are differentially displaced parallel to the plane of fracture.

***Federal Emergency Management Agency (FEMA)*:** The independent agency created in 1978 to provide a single point of accountability for all Federal activities related to disaster mitigation and emergency preparedness, response and recovery.

***FIPS*:** Stands for Federal Information Processing Standards. Under the Information Technology Management Reform Act (Public Law 104-106), the Secretary of Commerce approves standards

and guidelines that are developed by the National Institute of Standards and Technology (NIST) for Federal computer systems. These standards and guidelines are issued by NIST as Federal Information Processing Standards (FIPS) for use government-wide. NIST develops FIPS when there are compelling Federal government requirements such as for security and interoperability and there are no acceptable industry standards or solutions.

***Fire Potential Index (FPI)*:** Developed by United States Geological Survey (USGS) and United States Forest Service (USFS) to assess and map fire hazard potential over broad areas. Based on such geographic information, national policy makers and on-the-ground fire managers established priorities for prevention activities in the defined area to reduce the risk of managed and wildfire ignition and spread. Prediction of fire hazard shortens the time between fire ignition and initial attack by enabling fire managers to pre-allocate and stage suppression forces to high fire risk areas.

***Flash Flood*:** A flood event occurring with little or no warning where water levels rise at an extremely fast rate.

***Flood*:** A general and temporary condition of partial or complete inundation of normally dry land areas from (1) the overflow of inland or tidal waters, (2) the unusual and rapid accumulation or runoff of surface waters from any source, or (3) mudflows or the sudden collapse of shoreline land.

***Flood Depth*:** Height of the flood water surface above the ground surface.

***Flood Elevation*:** Elevation of the water surface above an established datum, e.g. National Geodetic Vertical Datum of 1929, North American Vertical Datum of 1988, or Mean Sea Level.

***Flood Hazard Area*:** The area shown to be inundated by a flood of a given magnitude on a map.

***Flood Insurance Rate Map (FIRM)*:** Map of a community, prepared by the Federal Emergency Management Agency, which shows both the special flood hazard areas and the risk premium zones applicable to the community.

***Flood Insurance Study (FIS)*:** A study that provides an examination, evaluation, and determination of flood hazards and, if appropriate, corresponding water surface elevations in a community or communities.

***Flood Mitigation Assistance Program (FMA)*:** A planning and project implementation grant program funded by the National Flood Insurance Program. Provides pre-disaster grants to State and local governments for both planning and implementation of mitigation strategies. Grant funds are made available from NFIP insurance premiums, and therefore are only available to communities participating in the NFIP.

***Flood of Record*:** The highest known flood level for the area, as recorded in historical documents.

***Floodplain*:** Any land area, including watercourse, susceptible to partial or complete inundation by water from any source.

***Floodproofing*:** Protective measures added to or incorporated in a building to prevent or minimize flood damage. “Dry floodproofing” measures are designed to keep water from entering a building. “Wet floodproofing” measures minimize damage to a structure and its contents from water that is allowed into a building.

***Floodway*:** The stream channel and that portion of the adjacent floodplain which must remain open to permit conveyance of the base flood. Floodwaters are generally the swiftest and deepest in the floodway. The floodway should remain clear of buildings and impediments to the flow of water.

***Freeboard*:** A margin of safety added to a protection measure to account for waves, debris, miscalculations, lack of scientific data, floodplain fill, or upstream development.

***Frequency*:** A measure of how often events of a particular magnitude are expected to occur. Frequency describes how often a hazard of a specific magnitude, duration, and/or extent typically occurs, on average. Statistically, a hazard with a 100-year recurrence interval is expected to occur once every 100 years on average, and would have a 1 percent chance – its probability – of happening in any given year. The reliability of this information varies depending on the kind of hazard being considered.

***Fujita Scale of Tornado Intensity*:** Rates tornadoes with numeric values from F0 to F5 based on tornado wind speed and damage sustained. An F0 indicates minimal damage such as broken tree limbs or signs, while an F5 indicates severe damage sustained.

***Functional Downtime*:** The average time (in days) during which a function (business or service) is unable to provide its services due to a hazard event.

***Geographic Area Impacted*:** The physical area in which the effects of the hazard are experienced.

***Geographic Information System (GIS)*:** A computer software application that relates physical features on the earth to a database to be used for mapping and analysis.

***Ground Motion*:** The vibration or shaking of the ground during an earthquake. When a fault ruptures, seismic waves radiate, causing the ground to vibrate. The severity of the vibration increases with the amount of energy released and decreases with distance from the causative fault or epicenter, but soft soils can further amplify ground motions.

***Hazard*:** A source of potential danger or adverse condition. An event or physical condition that has the potential to cause fatalities, injuries, property and infrastructure damage, agriculture loss, damage to the environment, interruption of business, or other types of harm or loss. Hazards, as defined in this study, will include naturally occurring events such as floods, dam failures, levee

failures, tornadoes, high winds, hailstorms, lightning, winter storms, extreme heat, drought, expansive soils, urban fires, wildfires that strike populated areas, and earthquakes. A natural event is a hazard when it has the potential to harm people or property. For purposes of this study, hazardous materials events are also included.

***Hazard Event*:** A specific occurrence of a particular type of hazard.

***Hazard Identification*:** The process of defining and describing a hazard, including its physical characteristics, magnitude and severity, probability and frequency, causative factors, and locations or areas affected.

***Hazard Mitigation*:** Sustained actions taken to reduce or eliminate long-term risk to human life and property from natural and technological hazards and their effects. Note that this emphasis on long-term risk distinguishes mitigation from actions geared primarily to emergency preparedness and short-term recovery.

***Hazard Mitigation Grant Program (HMGP)*:** Authorized under Section 404 of the Stafford Act; a FEMA disaster assistance grant program that funds mitigation projects in conformance with post-disaster mitigation plans required under Section 409 of the Stafford Act. The program is available only after a Presidential disaster declaration.

***Hazard Mitigation Plan*:** The plan resulting from a systematic evaluation of the nature and extent of vulnerability to the effects of natural hazards present in society that includes the actions needed to minimize future vulnerability to hazards. Section 409 of the Stafford Act requires the identification and evaluation of mitigation opportunities, and that all repairs be made to applicable codes and standards, as condition for receiving Federal disaster assistance. Enacted to encourage identification and mitigation of hazards at all levels of government.

***Hazard Profile*:** A description of the physical characteristics of hazards and a determination of various descriptors including magnitude, duration, frequency, probability, and extent. In most cases, a community can most easily use these descriptors when they are recorded and displayed as maps.

***HAZUS (Hazards U.S.)*:** A GIS-based nationally standardized earthquake loss estimation tool developed by FEMA.

***Hydrology*:** The science of dealing with the waters of the earth. A flood discharge is developed by a hydrologic study.

***Infrastructure*:** The public services of a community that have a direct impact on the quality of life. Infrastructure includes communication technology such as phone lines or Internet access, vital services such as public water supplies and sewer treatment facilities, and includes an area's transportation system such as airports, heliports; highways, bridges, tunnels, roadbeds, overpasses, railways, bridges, rail yards, depots, and waterways, canals, locks, and regional dams.

***Insurance Service Office, Inc. (ISO)*:** An insurance organization that administers several programs that rate a community's hazard mitigation activities.

***Intensity*:** A measure of the effects of a hazard event at a particular place.

***Landslide*:** Downward movement of a slope and materials under the force of gravity.

***Lifelines*:** Systems necessary for human life and urban function, especially during emergencies. Transportation and utility systems, as well as emergency service facilities are considered the lifelines of a community. Transportation systems include interstate, US, and state highways, roadways, railways, waterways, ports, harbors, and airports. Utility systems consist of electric power, gas and liquid fuels, telecommunications, water, and wastewater. Emergency service facilities include Emergency Alert System communication facilities, hospitals, and the police and fire departments.

***Liquefaction*:** The phenomenon that occurs when ground shaking causes loose soils to lose strength and act like viscous fluid. Liquefaction causes two types of ground failure: lateral spread and loss of bearing strength.

***Lowest Floor*:** Under the NFIP, the lowest floor of the lowest enclosed area (including basement) of a structure.

***Magnitude*:** A measure of the strength of a hazard event. The magnitude (also referred to as severity) of a given hazard event is usually determined using technical measures specific to the hazard.

***Mitigation*:** Sustained action taken to reduce or eliminate the long-term risk to human life and property from natural and technological hazards and their effects. Note that this emphasis on long-term risk distinguishes mitigation from actions geared primarily to emergency preparedness and short-term recovery (Burby, 1998).

***National Flood Insurance Program (NFIP)*:** A federal program created by Congress in 1968 that provides the availability of flood insurance to communities in exchange for the adoption and enforcement of a minimum floodplain management ordinance specified in 44 CFR §60.3. The ordinance regulates new and substantially damaged or improved development in identified flood hazard areas.

***National Geodetic Vertical Datum of 1929 (NGVD)*:** Datum established in 1929 and used in the NFIP as a basis for measuring flood, ground, and structural elevations, previously referred to as Sea Level Datum or Mean Sea Level. The Base Flood Elevations shown on most of the Flood Insurance Rate Maps issued by the Federal Emergency Management Agency are referenced to NGVD.

***National Weather Service (NWS)*:** Prepares and issues flood, severe weather, and coastal storm warnings and can provide technical assistance to Federal and state entities in preparing weather and flood warning plans.

***Oklahoma Department of Civil Emergency Management (ODCEM)*:** The State department responsible for hazard mitigation, community preparedness, emergency response, and disaster recovery.

***Oklahoma Water Resources Board (OWRB)*:** The State agency responsible for administration of the National Flood Insurance Program, and the dam safety program.

***Planimetric*:** Describes maps that indicate only man-made features like buildings.

***Planning*:** The act or process of making or carrying out plans; the establishment of goals, policies and procedures for a social or economic unit.

***Planning for Post-Disaster Reconstruction*:** The process of planning (preferably prior to an actual disaster) those steps the community will take to implement long-term reconstruction with one of the primary goals being to reduce or minimize its vulnerability to future disasters. These measures can include a wide variety of land-use planning tools, such as acquisition, design review, zoning, and subdivision review procedures. It can also involve coordination with other types of plans and agencies but is distinct from planning for emergency operations, such as restoration of utility services and basic infrastructure.

***Preparedness*:** Activities to ensure that people are ready for a disaster and respond to it effectively. Preparedness requires figuring out what will be done if essential services break down, developing a plan for contingencies, and practicing the plan.

***Probability*:** A statistical measure of the likelihood that a hazard event will occur.

***Project Impact*:** A program that encourages business, government agencies and the public to work together to build disaster-resistant communities.

***Reconstruction*:** The long-term process of rebuilding the community's destroyed or damaged buildings, public facilities, or other structures.

***Recovery*:** The process of restoring normal public or utility services following a disaster, perhaps starting during but extending beyond the emergency period to that point when the vast majority of such services, including electricity, water, communications, and public transportation have resumed normal operations. Recovery activities necessary to rebuild after a disaster include rebuilding homes, businesses and public facilities, clearing debris, repairing roads and bridges, and restoring water, sewer and other essential services. Short-term recovery does not include the reconstruction of the built environment, although reconstruction may commence during this period.

***Recurrence Interval*:** The time between hazard events of similar size in a given location. It is based on the probability that the given event will be equaled or exceeded in any given year.

***Repetitive Loss Property*:** A property that is currently insured for which two or more National Flood Insurance Program losses (occurring more than ten days apart) of at least $1000 each have been paid within any 10-year period since 1978. While Repetitive Loss Properties constitute only 2% of insured properties, they account for 40% of flood damage claims against the NFIP.

***Replacement Value*:** The cost of rebuilding a structure. This is usually expressed in terms of cost per square foot, and reflects the present-day cost of labor and materials to construct a building of a particular size, type and quality.

***Retrofitting*:** Modifications to a building or other structure to reduce its susceptibility to damage by a hazard.

***Richter Scale*:** A numerical scale of earthquake magnitude devised by seismologist C.F. Richter in 1935.

***Risk*:** The estimated impact that a hazard would have on people, services, facilities, and structures in a community; the likelihood of a hazard event resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate or low likelihood of sustaining damage above a particular threshold due to a specific type of hazard event. It also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

***Risk Assessment*:** A process or method for evaluating risk associated with a specific hazard and defined in terms of probability and frequency of occurrence, magnitude and severity, exposure and consequences. Also defined as: "The process of measuring the potential loss of life, personal property, housing, public facilities, equipment, and infrastructure; lost jobs, business earnings, and lost revenues, as well as indirect losses caused by interruption of business and production; and the public cost of planning, preparedness, mitigation, response, and recovery. (Burby, 1998).

***Riverine*:** Of or produced by a river.

***Scale*:** A proportion used in determining a dimensional relationship; the ratio of the distance between two points on a map and the actual distance between the two points on the earth's surface.

***Scarp*:** A steep slope.

***Scour*:** Removal of soil or fill material by the flow of flood waters. The term is frequently used to describe storm-induced, localized conical erosion around pilings and other foundation supports where the obstruction of flow increases turbulence.

***Seismicity*:** Describes the likelihood of an area being subject to earthquakes.

***Special Flood Hazard Area (SFHA)*:** An area within a floodplain having a 1 percent or greater chance of flood occurrence in any given year (100-year floodplain); represented on Flood Insurance Rate Maps by darkly shaded areas with zone designations that include the letter A or V.

***Stafford Act*:** The Robert T. Stafford Disaster Relief and Emergency Assistance Act, PL 100-107 was signed into law November 23, 1988 and amended the Disaster Relief Act of 1974, PL 93-288. The Stafford Act is the statutory authority for most Federal disaster response activities, especially as they pertain to FEMA and its programs.

***State Hazard Mitigation Team*:** Composed of key State agency representatives, the team evaluates hazards, identifies strategies, coordinates resources, and implements measures that will reduce the vulnerability of people and property to damage from hazards. The Oklahoma State Hazard Mitigation Team is convened by the Oklahoma Department of Emergency Management (ODCEM), and includes the State departments of Agriculture, Climatological Survey, Commerce, Environmental Quality, Health, Human Services, Insurance, Transportation, Wildlife Conservation, Conservation Commission, Corporation Commission, Historical Society, Insurance Commission, Water Resources Board, Association of County Commissioners (AACCO), Oklahoma Municipal League (OML), Department of Housing and Urban Development (HUD), and the U.S. Army Corps of Engineers (USACE).

***State Hazard Mitigation Officer (SHMO)*:** The representative of state government who is the primary point of contact with FEMA, other state and Federal agencies, and local units of government in the planning and implementation of pre- and post-disaster mitigation activities.

***Stormwater Management*:** Efforts to reduce the impact of stormwater or snowmelt runoff on flooding and water quality.

***Stormwater Detention*:** The storing of stormwater runoff for release at a restricted rate after the storm subsides, or the flood crest passes.

***Substantial Damage*:** Damage of any origin sustained by a structure in a Special Flood Hazard Area whereby the cost of restoring the structure to its before-damaged condition would equal or exceed 50 percent of the market value of the structure before the damage.

***Surface Faulting*:** The differential movement of two sides of a fracture – in other words, the location where the ground breaks apart. The length, width, and displacement of the ground characterize surface faults.

***Tectonic Plate*:** Torsionally rigid, thin segments of the earth's lithosphere that may be assumed to move horizontally and adjoin other plates. It is the friction between plate boundaries that cause seismic activity.

***Topographic*:** Characterizes maps that show natural features and indicate the physical shape of the land using contour lines. These maps may also include man-made features.

***Tornado*:** A violently rotating column of air extending from a thunderstorm to the ground.

***Vulnerability*:** Describes how exposed or susceptible to damage an asset is. Vulnerability depends on an asset's construction, contents, and the economic value of its functions. Like indirect damages, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power – if an electric substation is flooded, it will affect not only the substation itself, but a number of businesses as well. Often, indirect effects can be much more widespread and damaging than direct ones.

***Vulnerability Assessment*:** The extent of injury and damage that may result from a hazard event of a given intensity in a given area. The vulnerability assessment should address impacts of hazard events on the existing and future built environment.

***Wildfire*:** An uncontrolled fire spreading through vegetative fuels, exposing and possibly consuming structures.

***Zone*:** A geographical area shown on a Flood Insurance Rate Map (FIRM) that reflects the severity or type of flooding in the area.

Appendix B: Mitigation Strategies

The following items illustrate many of the broad mitigation strategies that communities, tribes, counties, and other entities can implement to help protect lives, property and the environment in their jurisdictions. The following grid lists the six basic mitigation categories outlined by FEMA (introduced in Chapter 2), the strategies that fall in those categories, and the hazards those strategies may be effective for.

Many of the strategies, while listed under one category, may have elements that include other categories as well. For example, almost all strategies have a Public Information & Education component, where homeowners and business owners are educated about possible measures they may take on their own.

Category	Mitigation Strategy		Hazards Impacted
Public Information & Education	B.1.1	Public Information Program Strategy	All Hazards
	B.1.2	Educational Programs	All Hazards
	B.1.3	Outreach Projects	All Hazards
	B.1.4	Technical Assistance	All Hazards
	B.1.5	Map Information	All Hazards
	B.1.6	Library	All Hazards
	B.1.7	Web Sites	All Hazards
	B.1.8	Real Estate Disclosure	Flood, Expansive Soils
	B.1.9	Firewise Communities	Wildfire
	B.1.10	Business Continuity Planning & Mitigation	Flood, Tornado, High Wind, Lightning, Hail, Winter Storm, Heat, Wildfire, Earthquake, Dam Break
Preventive Measures	B.2.1	Planning	All Hazards
	B.2.2	Zoning	All Hazards
	B.2.3	Floodplain Development Regulations	Flood, Dam Break
	B.2.4	Stormwater Management	Flood, Dam Break
	B.2.5	Building Codes	Flood, Tornado, High Wind, Lightning, Hail, Winter Storm, Expansive Soil, Wildfire, Earthquake
	B.2.6	IBHS Fortified Home Program	Flood, Tornado, High Wind, Lightning, Hail, Wildfire, Earthquake
	B.2.7	Smoke Detectors	Fires
	B.2.8	Hurricane Fasteners	Tornado, High Wind, Earthquake
	B.2.9	Mobile Home Tie-Downs	Tornado, High Wind
	B.2.10	Lightning Warning Systems	Lightning
	B.2.11	Power Outages from Winter Storms	Winter Storm, Lightning
	B.2.12	Standby Electric Generators	Tornado, High Wind, Lightning, Winter Storm
	B.2.13	Critical Facility Protection	All Hazards
	B.2.14	Extreme Heat Protection	Extreme Heat
	B.2.15	Proper Storage and Disposal of Hazardous Materials	Floods
	B.2.16	Water Conservation	Drought
	B.2.17	Open Space Preservation	Flood, Drought, Dam Break

Category	Mitigation Strategy		Hazards Impacted
Structural Projects	B.3.1	Safe Rooms	Tornado, High Wind
	B.3.2	School Safe Rooms	Tornado, High Wind
	B.3.3	Reservoirs &Detention	Flood
	B.3.4	Levees & Floodwalls	Flood, Dam Break
	B.3.5	Channel Improvements	Flood, Dam Break
	B.3.6	Crossings & Roadways	Flood, Dam Break
	B.3.7	Drainage & Storm Sewer Improvements	Flood, Dam Break
	B.3.8	Drainage System Maintenance	Flood, Dam Break
Property Protection	B.4.1	The City's Role	All Hazards
	B.4.2	Insurance	Flood, Tornado, High Wind, Lightning, Hail, Winter Storm, Wildfire, Earthquake, Dam Break
	B.4.3	Acquisition & Relocation	Flood
	B.4.4	Building Elevation	Flood, Dam Break
	B.4.5	Barriers	Flood, Dam Break
	B.4.6	Retrofitting	Flood, Tornado, High Wind, Lightning, Hail, Expansive Soil, Wildfire, Earthquake
	B.4.7	Impact Resistant Windows & Doors	Tornado, High Wind, Hail
	B.4.8	Lightning Protection Systems	Lightning
	B.4.9	Surge and Spike Protection	Lightning
	B.4.10	Landscaping for Wildfire Prevention	Wildfire
Emergency Services	B.5.1	Threat Recognition	Flood, Tornado, High Wind, Lightning, Hail, Winter Storm, Heat, Drought, Wildfire, Earthquake, Dam Break
	B.5.2	Warning	Flood, Tornado, High Wind, Lightning, Hail, Winter Storm, Heat, Drought, Wildfire, Earthquake, Dam Break
	B.5.3	9-1-1 & 2-1-1	All Hazards
	B.5.4	Emergency Telephone Notification Systems (ETNS)	Flood, Winter Storm, Heat, Wildfire
	B.5.5	Response	Flood, Tornado, High Wind, Lightning, Hail, Winter Storm, Heat, Drought, Wildfire, Earthquake, Dam Break
	B.5.6	Emergency Operations Plan (EOP)	Flood, Tornado, High Wind, Lightning, Hail, Winter Storm, Wildfire, Earthquake, Dam Break
	B.5.7	Incident Command System (ICS)	Flood, Tornado, High Wind, Lightning, Hail, Winter Storm, Wildfire, Earthquake, Dam Break
	B.5.8	Mutual Aid / Interagency Agreements	Flood, Tornado, High Wind, Lightning, Hail, Winter Storm, Wildfire, Earthquake, Dam Break
	B.5.9	CERT (Community Emergency Response Teams)	Flood, Tornado, High Wind, Winter Storm, Heat, Wildfire, Earthquake, Dam Break
	B.5.10	Debris Management	Flood, Tornado, High Wind, Winter Storm, Wildfire, Earthquake
	B.5.11	Critical Facilities Protection	Flood, Tornado, High Wind, Lightning, Hail, Winter Storm, Wildfire, Earthquake, Dam Break

Category	Mitigation Strategy		Hazards Impacted
	B.5.12	Site Emergency Plans	Flood, Tornado, High Wind, Lightning, Hail, Winter Storm, Wildfire, Earthquake, Dam Break
	B.5.13	Post-Disaster Recovery & Mitigation	Flood, Tornado, High Wind, Lightning, Hail, Winter Storm, Wildfire, Earthquake, Dam Break
	B.5.14	StormReady Communities	Flood, Tornado, High Wind, Hail, Winter Storm
Natural Resource Protection	B.6.1	Wetland Protection	Flood, Wildfire
	B.6.2	Erosion and Sedimentation Control	Flood, Wildfire
	B.6.3	River Restoration	Flood, Wildfire
	B.6.4	Best Management Practices	Flood
	B.6.5	Dumping Regulations	Flood, Tornado, High Winds, Winter Storm

B.1 Public Information and Education

A successful public information and education program involves both the 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 – preventive, structural, property protection, emergency services, and natural resource protection – begin with public information and education.

B.1.1 Public Information Program Strategy

Getting Your Message Out

Professional advertising agencies may be willing to help get the message out regarding disaster preparedness and mitigation at little or no cost. They have a vested interest in their community and want to keep it safe. The same holds true for the media. The local newspaper, radio or television will contribute to keeping a safe and prepared community. Invite them to, and let them participate in special events, meetings, practice exercises, etc.

Education alliance partners, such as a restaurants, convenience stores or the library, can put preparedness tips on tray liners or sacks, distribute brochures or allow you to erect a display with disaster information of local interest.

Many other options are available such as including brochures with utility bills, presentations at local gatherings, billboards, direct mailing and websites.

Summer camps, and other educational programs for children, can teach a new generation about nature, natural hazards, and preservation

General

Numerous publications on tornadoes, thunderstorms, lightning, winter storms and flooding are available through NOAA. Up to 300 copies of most publications can be ordered from your local National Weather Service, NOAA Outreach Unit or American Red Cross. Many of the brochures can be downloaded from www.nws.noaa.gov/om/brochures.shtml.

For a nominal fee the American Red Cross offers videos on general preparedness, winter storms, chemical emergencies, hurricanes and earthquakes.

The National Weather Service issues watches and warnings for tornadoes, severe thunderstorms, floods, winter storms and extreme heat that may include “Call to Action” statements. The messages appear on the NWS telephone line, the local weather service office website and on television stations carrying Emergency Alert System messages.

Communities can encourage residents to prepare themselves by stocking up with necessary items and planning for how family members should respond if any of a number of possible emergency or disaster events strike.

Hazard Brochures
Area agencies or the American Red Cross have available the book *Repairing Your Flooded Home* and fliers *Are You Ready for a Flood?* and *Avoiding Flood Damage.* For a summary of what to do after a tornado see www.redcross.org/services/disaster/0,1082,0_502_,00.html. The brochure *Taking Shelter From the Storm: Building a Safe Room Inside Your Home* is available from FEMA. A copy of the brochure can be requested from the FEMA website www.fema.gov/fima/tsfs02.shtm. *Are You Ready for a Tornado?* is available from the American Red Cross, FEMA and the National Oceanic and Atmospheric Administration. Area agencies or the American Red Cross have available the fliers *Are You Ready For a Heat Wave? Are You Ready For a Winter Storm?* and *Are You Ready For a Thunderstorm?*

After reviewing the possible and locally implemented public information activities covered in the previous sections, the Public Information Outreach Strategy Team prepared a Public Information Program Strategy. Following the Community Rating System format, the strategy consists of the following parts:

The local hazards, discussed in Chapter 4 of this plan

a. The safety and property protection measures appropriate for the hazards, discussed in Chapter 5 and this Appendix.
b. Hazard-related public information activities currently being implemented in the community, including those by non-government agencies (discussed in Chapter 2)
c. Goals and Objectives for the community's public information program (covered in Chapter 5)
d. Outreach projects that will reach the goals (see Chapter 6, Action Items and Table 6-1.)
e. A process for monitoring and evaluating the projects (see Chapter 7)

B.1.2 Educational Programs

A community's most important natural resource is its children. They will inherit the resources, infrastructure and development built by earlier generations at great cost and effort. They will also face the same natural forces that bring floods, tornadoes, storms and other hazards.

Environmental education programs can teach children about natural hazards, the forces that cause them, and the importance of protecting people, property and nature, such as watersheds and floodplains. Educational programs can be undertaken by schools, park and recreation departments, conservation associations, and youth organizations, such as the Boy Scouts, Campfire Girls and summer camps. An activity can be complex enough as to require course curriculum development, or as simple as an explanatory sign near a river.

Educational programs designed for children often reach adults as well. Parents often learn innovative concepts or new ideas from their children. If a child comes home from school with an assignment in water quality monitoring, the parents will normally become interested in finding out about it as well.

There are many programs that provide information and curriculum materials on nature and natural hazards. On FEMA website www.fema.gov/kids/ kids can learn about having a family disaster plan, what kids might feel in and following a disaster, what the different disasters are, what to do during a disaster, take quizzes and play games. There is also information on how to get a free video, brochures and other fun stuff.

Another site, for students and educators on water resources, is the USGS "Water Science for Schools" wwwga.usgs.gov/edu/. The American Red Cross has a 24-page *Disaster Preparedness Coloring Book* for kids age 3-10. The coloring book is available online and can be printed from www.redcross.org/pubs/dspubs/genprep.html.

Youth programs and activities often include posters, coloring books, games, and references. Hands-on models that allow students to see the effects of different land use practices are also available through local natural resources conservation districts.

B.1.3 Outreach Projects

Mapping and library activities are not of much use if no one knows they exist. An outreach project can remedy this. Sending notices to property owners can help introduce the idea of property protection and identify sources of assistance.

Outreach projects are the first step in the process of orienting property owners to property protection and assisting them in designing and implementing a project. They are designed to encourage people to seek out more information in order to take steps to protect themselves and their properties.

The most effective types of outreach projects are mailed or otherwise distributed to flood-prone property owners or to everyone in the community. Other approaches include the following:

- Articles and special sections in newspapers
- Radio and TV news releases and interview shows
- Hazard protection video for cable TV programs or to loan to organizations
- Presentations at meetings of neighborhood, civic or business groups

- Displays in public buildings or shopping malls
- Floodproofing open houses

Research has proven that outreach projects work. However, awareness of the hazard is not enough. People need to be told what they can do about the hazard, so projects should include information on safety, health, and property protection measures. Research has also shown that a properly run local information program is more effective than national advertising or publicity campaigns.

B.1.4 Technical Assistance

While general information helps, most property owners do not feel ready to take major steps, like retrofitting their buildings, without help or guidance. Local building department staff members are experts in construction. They can provide free advice, not necessarily to design a protection measure, but to steer the owner onto the right track.

Building, public works, and engineering staff members visit properties and offer suggestions. Most can recommend or identify qualified or licensed companies, an activity that is especially appreciated by owners who are unsure of the project or the contractor.

Technical assistance can be provided in one-on-one sessions with property owners or can be provided through seminars. For instance, seminars or “open houses” can be provided on retrofitting structures, selecting qualified contractors, and carrying out preparedness activities.

B.1.5 Map Information

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, expansive soils, and other hazards that have a geographical distribution. Real estate agents and house hunters can find out if a property is flood-prone and whether flood insurance may be required.

Maps provide a wealth of information about past and potential hazards. Geographic Information Systems, sometimes called smart maps, provide efficiency and add to capabilities of many government services. County assessors, public works, parks and recreation, and 911 services are all typical departments capable of applying GIS applications to improve their services. GIS allows trained users to complete comprehensive queries, extract statistical information, and completely manage all relevant spatial information and the associated attribute information that pertain to those departments.

Flood maps

Several legal requirements are tied to FEMA’s Flood Insurance Rate Maps (FIRMs) and Flood Insurance Study Maps. These include building regulations and the mandatory purchase of flood insurance. FEMA provides floodplain and FIRM information as a mitigation service. The City can help residents submit requests for map amendments and revisions when these are needed to show that a building is outside the mapped floodplain.

Although FEMA maps are accurate, users and inquirers must remember that maps are not perfect. They display only the larger flood-prone areas that have been studied. In some

areas, watershed developments make even recent maps outdated. Those inquiring about flood maps must be reminded that being outside the mapped floodplain is no guarantee that a property will never flood. In fact, many properties that flood are not located in a designated floodplain.

By taking the initiative locally to accurately map problem areas with information not already on FEMA maps, a community can warn residents about potential risks that may not have been anticipated. Upgrading maps provides a truer measure of risks to a community.

Other Hazard Data

Other data that can be shown on maps include those hazards that are distributed geographically. These include:

- Dam breach inundation areas
- Levee failure inundation areas
- Expansive soils
- Wildfire risk zones
- Earthquake risk zones
- Hazardous materials sites
- Wetlands

General location maps for many of these natural and man-made hazards have been developed by U. S. Army Corps of Engineers, Association of South Central Governments (ASCOG), Oklahoma Geological Survey, and R. D. Flanagan & Associates, several of which are included in this City of Tulsa Hazard Mitigation Plan study.

Flood zone determinations are available, free of charge, to any citizen through the Floodplain Administrator in the Tulsa County Commissioner's Office. If the determination is for a building permit, local ordinances must be followed.

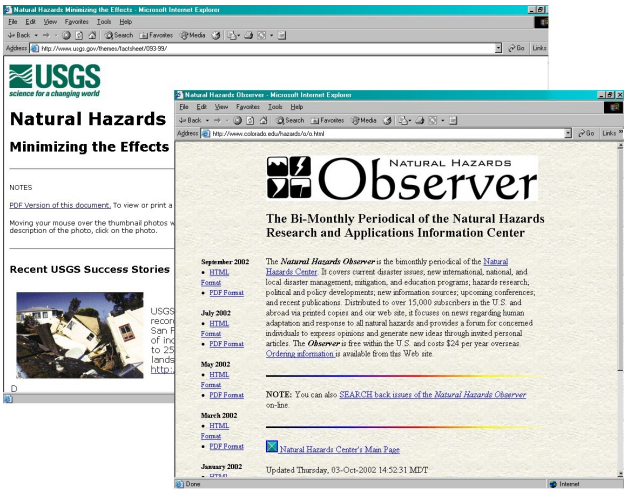
B.1.6 Library

The City of Tulsa Public Libraries are places 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.

The local public library System maintains flood related documents required under the NFIP and CRS. The documents are available to the public in the library.

B.1.7 Web Sites

Today, Web sites are becoming more popular as research tools. They provide quick access to a wealth of public and private sites and sources of information. Through links to other



Web sites have become one of the most popular research tools

Web sites, there is almost no limit to the amount of up to date information that can be accessed by the user.

The City of Tulsa Web site can be accessed at www.CityOfTulsa.org. FEMA's Mapping Web site is at www.fema.gov/business/nfip/mscjumppage.shtm. Additional web sites related to specific hazards are listed in the following table.

Table B–1: Multi-Hazard Mitigation Web Sites

Agency	Web Address
General	
Federal Emergency Management Agency	www.fema.gov
Oklahoma Dept. of Emergency Management	www.odcem.state.ok.us
Institute for Business and Home Safety	www.ibhs.org/
USGS – Hazards Page	www.usgs.gov/themes/hazard.html
Floods	
Oklahoma Water Resources Board	www.owrb.state.ok.us/
Oklahoma Floodplain Managers Association	www.okflood.org/
U.S. Army Corps of Engineers	www.usace.army.mil/
National Flood Insurance Program	www.fema.gov/nfip/whonfip.shtm
Stormwater Manager's Resource Center	www.stormwatercenter.net/
High Winds	
National Climatic Data Center	www.ncdc.noaa.gov/oa/ncdc.html
Lightning	
National Lightning Safety Institute	www.lightningsafety.com/nlsi_lls.html
Extreme Heat	
National Weather Service – Heat Index	www.hpc.ncep.noaa.gov/heat_index.shtml
Hail	
FLASH – Hail damage, protecting your home	www.flash.org/activity.cfm?currentPeril=5&activityID=164
Drought	
OWRB – Drought Monitoring Page	www.owrb.state.ok.us/supply/drought/drought_index.php
Expansive Soils	
US Department of Agriculture	www.usda.gov/
Natural Resource Conservation Service	www.nrcs.usda.gov/
Wildfires	
USGS Wildfires	www.usgs.gov/themes/wildfire.html
Earthquakes	
U.S. Geological Survey	www.usgs.gov/
Oklahoma Geological Survey	www.okgeosurvey1.gov/home.html
National Geophysical Data Center	www.ngdc.noaa.gov/
Dam Failures	
Oklahoma Water Resources Board	www.owrb.state.ok.us/
US Army Corps of Engineers	www.usace.army.mil/
Grand River Dam Authority	www.grda.com/

B.1.8 Real Estate Disclosure

After a flood or other natural disaster, people often say they would have taken steps to protect themselves if they had known their property was exposed to a hazard.

Flood insurance is required for buildings located within the base floodplain if the mortgage or loan is federally insured. However, because this requirement has to be met only ten days before closing, applicants are often already committed to purchasing a property when they first learn of the flood hazard.

Flooding and other hazards are sometimes not disclosed until it is too late. Hazard maps can help homebuyers avoid surprises like this.

The "Residential Property Condition Disclosure Act" requires sellers to provide potential buyers with a completed, signed and dated "Residential Property Condition Disclosure Statement". Included in the statement are disclosures regarding flooding and flood insurance. For a copy of the "Residential Property Condition Disclosure Statement" see www.orec.state.ok.us/pdf/disclose3.pdf.

B.1.9 Firewise Communities

While incorporating components from several of the different mitigation strategies, Firewise primarily depends on homeowners taking actions to protect their own property, so Public Education and Information is key to the success of the Firewise program. While it is not possible, or in many cases even desirable, to prevent wildfires, it is certainly possible, by interrupting the natural flow of the fire, to assure that wildfires will not produce catastrophic home or crop losses. In the words of Judith Cook, Project Manager for Firewise Communities/USA, “We can modify our home ignition zones. We’re basically saying to the fire, ‘there’s nothing for you here!’”

Firewise Community USA is a project of the National Wildfire Coordinating Group. It recognizes communities that have gone through a process to reduce the dangers of wildfires along what is referred to as the Wildland-Urban Interface (WUI). Additional information on the Firewise Community program can be found at www.firewise.org/usa.

In order to become a Firewise Community, a community will:

1. Contact a Firewise Specialist. In Oklahoma, the Firewise Specialist may be reached through the Oklahoma Department of Agriculture, Forestry Services, at (405) 521-3864. The Specialist will coordinate with local fire officials to schedule a site visit and assess the community.

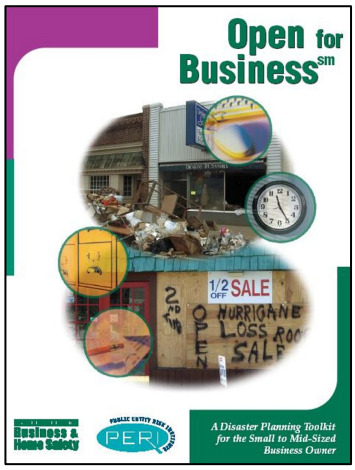
2. The community will create a Firewise Board that includes homeowners, fire professionals, and other stakeholders.
3. The Firewise Specialist will schedule a meeting with the Board to present the assessment report for review and acceptance.
4. The Board will use the report to create agreed-upon, area-specific solutions to the fire issues, which the Specialist will review and, if acceptable, will work with the community to seek project implementation funds, if necessary.

A home in the WUI surrounded by a "defensible" zone that helped protect it from damage during a wildfire outbreak

5. Local solutions will be implemented following a schedule designed by the local Board and the Specialist, A permanent Firewise task force or committee is created that will maintain the program into the future.
6. A completed plan and registration form will be submitted to Firewise Communities/USA for formal recognition of the Community.

B.1.10 Business Continuity Planning and Mitigation

While Business Continuity Planning (BCP) can include portions from many of the categories listed in this chapter, an integrated program for businesses is a frequently neglected component in a community's mitigation strategy. It has been demonstrated repeatedly that many businesses that close their doors following a disaster either fail to re-open, or struggle to remain open following the event. This is especially true of small to medium businesses that may rely on a limited number of locations and a narrow customer base, or may not have the economic reserves to recover from financial losses. The lack of ability to recover may be for several reasons:



- Absenteeism from employees who are affected or who have affected family members;
- Psychological trauma from losing co-workers;
- Loss of an irreplaceable executive or manager;
- Economic stress on the business from having to make repairs and replenish stock over and above what may be covered by insurance;
- Loss of revenue from having the doors closed for even a short period of time;
- Loss of the customer base, either from people who are forced to evacuate the area or who may not have immediate disposable income for the company's products;
- Loss of a critical customer or the vendor of a critical inventory item ("upstream" and "downstream" issues);

- Loss of critical data, either paper or electronic records;
- An interruption in community infrastructure (utilities, road access, media losses, etc.).

In addition, the loss of a business, even for a short period of time, may adversely affect the community in many ways, some of which may include:

- Loss of tax revenue for city services;
- Loss of jobs for community residents;
- Loss of access to the company's products (especially significant if the company supplies an essential service or product, such as construction equipment, medications, transportation, or groceries);
- Effective Business Continuity Planning (BCP) may include such activities as:
- Making regular back-ups of critical data and keeping it in an off-site location;

Insurance is a start, but won't cover the cost of lost sales, lost jobs and lost customers if a business is affected

- Maintaining accurate contact information (phone, e-mail, pager, etc.) on critical employees;
- Identifying potential off-site locations that can be used in case the primary location of the company is damaged or inaccessible;
- Reviewing all activities of a company and identifying which activities are critical and must resume right away, which are less critical and may not need to resume for a short period of time, and which activities can be put on hold for a longer period of time;
- Developing "canned" PR pieces that can be quickly disseminated in the event of an incident at the company;
- Having an honest conversation with insurers to determine that policies are sufficiently inclusive and appropriate for the business;
- Communicating with suppliers and critical customers on what their emergency response and business resumption plans include.

Business continuity planning can be facilitated by the community in a number of ways, primarily in the area of Public Information.

- The Chamber of Commerce may sponsor programs such as the Institute for Business & Home Safety's (IBHS) *Open For Business* presentation. For more information, see www.ibhs.org/business_protection.
- The American Red Cross has also teamed with the Federal Emergency Management Agency to produce the *Emergency Management Guide for Business and Industry*.

More information is available at www.redcross.org/services/disaster/0,1082,0_606_,00.html.

Several professional groups such as the Association of Contingency Planners (www.acp-international.com/okla/) or ARMA, a professional organization of Records & Information Management professionals (www.arma.org) may be available in your area to assist with developing disaster preparedness and mitigation plans or exploring ways to safeguard critical records and information.

In addition, if a community is promoting Community Emergency Response Teams (CERT), business CERTs can be developed to respond to a disaster, not only within a neighborhood, but also within a business establishment. CERTs are trained in disaster organization, immediate disaster evaluation, immediate disaster first aid, light search and rescue, and light fire suppression. For more information on CERT, see www.citizencorps.gov/cert.

B.1.11 Conclusions

1. There are many ways public information programs can be used so people and businesses will be more aware of hazards they face and how they can protect themselves.
2. Most public information activities can be used to advise people about all hazards, not just floods.
3. Other public information activities require coordination with other organizations, such as schools and real estate agents.
4. There are several area organizations that can provide support for public information and educational programs.

B.1.12 Recommendations

The areas of greatest likelihood to strengthen the community in this area would include identifying and developing a Public Education and Outreach manager at the city offices, and coordinating with other agencies engaged in these kinds of activities. In addition, the recent ice storms have indicated a strong need for developing business continuity support for the small business community.

Refer to *Chapter 6: Action Plan* for a complete listing of all recommended mitigation measures by hazard and priority.

Refer to *Chapter 6: Action Plan and Mitigation Measures,* Table 6–1, for a complete listing of all recommended mitigation measures by hazard and priority.

Figure B–1: Public Service Notice for Flooding

Flood Safety

- Do not walk through flowing water. Drowning is the number one cause of flood deaths. Currents can be deceptive; six inches of moving water can knock you off your feet. Use a pole or stick to ensure that the ground is still there before you go through an area where the water is not flowing.
- Do not drive through a flooded area. More people drown in their cars than anywhere else. Don't drive around road barriers; the road or bridge may be washed out.
- Stay away from power lines and electrical wires. The number two flood killer after drowning is electrocution. Electrical current can travel through water. Report downed power lines to the Mayor's Action Line, 596-2100.
- Look out for animals that have been flooded out of their homes and who may seek shelter in yours. Use a pole or stick to poke and turn things over and scare away small animals.
- Look before you step. After a flood, the ground and floors are covered with debris including broken bottles and nails. Floors and stairs that have been covered with mud can be very slippery.
- Be alert for gas leaks. Use a flashlight to inspect for damage. Don't smoke or use candles, lanterns, or open flames unless you know the gas has been turned off and the area has been ventilated.
- Carbon monoxide exhaust kills. Use a generator or other gasoline-powered machine outdoors. The same goes for camping stoves. Charcoal fumes are especially deadly -- cook with charcoal outdoors.
- Clean everything that got wet. Flood waters have picked up sewage and chemicals from roads, farms, factories, and storage buildings. Spoiled food, flooded cosmetics, and medicine can be health hazards. When in doubt, throw them out.
- Take good care of yourself. Recovering from a flood is a big job. It is tough on both the body and the spirit and the effects a disaster has on you and your family may last a long time.

B.2 Preventive Measures

Preventive activities are designed to keep matters from occurring or getting worse. Their objective is to ensure that future 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, open space preservation, building codes, drainage criteria, master drainage plans and floodplain development regulations, and stormwater management. These aspects of preventive measures are discussed in this section as follows:

B.2.1 Planning

B.2.2 Zoning

B.2.3 Open space preservation

B.2.4 Building codes

B.2.5 Floodplain development regulations

B.2.6 Stormwater management

The first three measures (planning, zoning, and open space preservation) work to keep damage-prone development *out* of hazardous or sensitive areas.

The next two measures (building codes and floodplain development regulations) impose standards on what is allowed to be built *in* the floodplain. These protect buildings, roads, and other facilities from flood damage and prevent the new development from making any existing flood problem worse. Building codes are also critical to mitigating the impact of non-flood hazards on new buildings.

Stormwater management addresses the runoff of stormwater from new developments onto other properties and into floodplains.

Small public meetings geared toward specific sections of the community proved fruitful in the development of the plan

B.2.1 Planning

While plans generally have limited authority, they reflect what the community would like to see happen in the future. Plans guide other local measures such as capital improvements and the development of ordinances. Planning can include, but is not limited to:

• Capital Improvement Plans	Infrastructure planning decisions can affect flood hazard mitigation. For example, decisions to extend roads or utilities to an area may increase exposure. Communities may consider structural flood protections such as levees or floodwalls.
• Zoning Ordinance Adoption or Amendments	Examples of zoning methods that affect flood hazard mitigation include: 1. Adopting ordinances that limit development in the floodplain. 2. Limiting the density of developments in the floodplain. 3. Requiring floodplains be kept as open space.
• Subdivision Ordinances or Amendments	Subdivision design standards can require elevation data collection during the platting process. Lots may be required to have buildable space above the base flood elevation.
• Building Code Adoption or Amendments	Requirements for building design standards and enforcement include: 1. A residential structure be elevated. 2. A non-residential structure be elevated or floodproofed.
• Conservation Easements	Conservation easements may be used to protect environmentally significant portions of parcels from development. They do not restrict all use of the land. Rather, they direct development to areas of land not environmentally significant.
• Transfer of Development Rights	In return for keeping floodplain areas in open space, a community may agree to allow a developer to increase densities on another parcel that is not at risk. This allows a developer to recoup losses from non-use of a floodplain site with gains from development of a non-floodplain site.
• Purchase of Easement / Development Rights	Compensating an owner for partial rights, such as easement or development rights, can prevent a property from being developed contrary to a community's plan to maintain open space. This may apply to undeveloped land generally or to farmland in particular.
• Stormwater Management Ordinances or Amendments	Stormwater ordinances may regulate development in upland areas in order to reduce stormwater run-off. Examples of erosion control techniques that may be employed within a watershed are include proper bank stabilization with sloping or grading techniques, planting vegetation on slopes, terracing hillsides, or installing riprap boulders or geotextile fabric.

• Multi-Jurisdiction Cooperation Within Watershed	Forming a regional watershed council helps bring together resources for comprehensive analysis, planning, decision-making, and cooperation.
• Comprehensive Watershed Tax	A tax can be used as a mitigation action in several ways: 1. tax funds may be used to finance maintenance of drainage systems or to construct reservoirs. 2. tax assessments may discourage builders from constructing in a given area. 3. taxes may be used to support a regulatory system.
• Post-Disaster Recovery Ordinance	A post-disaster recovery ordinance regulates repair activity, generally depending on property location. It prepares a community to respond to a disaster event in an orderly fashion by requiring citizens to: 1. obtain permits for repairs. 2. refrain from making repairs. 3. make repairs using standard methods.

B.2.2 Zoning

Tulsa's zoning ordinances regulate development by dividing the community into zones or districts and setting development criteria for each zone or district. Zoning ordinances are considered the primary tool to implement a comprehensive plan's guidelines for how land should be developed. They are in the process of revising their City Comprehensive Plan.

B.2.3 Floodplain Development Regulations

Most communities with a flood problem participate in the National Flood Insurance Program (NFIP). The NFIP sets minimum requirements for subdivision regulations and building codes. These are usually spelled out in a separate ordinance.

Experience showed that the National Flood Insurance Program's minimum standard is insufficient for developing urban communities such as Tulsa. The city's regulations exceed the NFIP's minimum national standards in several significant ways.

The Community Rating System (CRS) is a companion program to the NFIP. It rewards a community for taking actions over and above minimum NFIP requirements with the goal of further reducing flood damages in the community. The more actions a community takes, the lower the premiums for flood insurance within that community.

Subdivision regulations govern how land will be subdivided into individual lots, and set the construction and location standards for the infrastructure the developer builds to serve those lots, including roads, sidewalks, utility lines, storm sewers, and drainageways. They provide an additional vehicle for floodplain development rules. For example, some communities require that every subdivision in a floodplain provide a building site above the flood level for every lot and/or require streets to be at or no more than one foot below the base flood elevation.

Floodplains are only part of flood-management considerations. Water gathers and drains throughout entire watersheds, from uplands to lowlands. Each watershed is an interactive

Minimum National Flood Insurance Program Regulatory Requirements

The National Flood Insurance Program (NFIP) is administered by the Federal Emergency Management Agency (FEMA). As a condition of making flood insurance available for their residents, communities that participate in the NFIP agree to regulate new construction in the area subject to inundation by the 100-year (base) flood.

There are four major floodplain regulatory requirements. Additional floodplain regulatory requirements may be set by state and local law.

1. All development in the 100-year floodplain must have a permit from the community. The NFIP regulations define "development" as any manmade change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations or storage of equipment or materials.
2. Development should not be allowed in the floodway. The NFIP regulations define the floodway as the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot. The floodway is usually the most hazardous area of a riverine floodplain and the most sensitive to development. At a minimum, no development in the floodway may cause an obstruction to flood flows. Generally an engineering study must be performed to determine whether an obstruction will be created.
3. New buildings may be built in the floodplain, but they must be protected from damage by the base flood. In riverine floodplains, the lowest floor of residential buildings must be elevated to or above the base flood elevation (BFE). Nonresidential buildings must be either elevated or floodproofed.
4. Under the NFIP, a "substantially improved" building is treated as a new building. The NFIP regulations define "substantial improvement" as any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the start of construction of the improvement. This requirement also applies to buildings that are substantially damaged.

Communities are encouraged to adopt local ordinances that are more comprehensive or provide more protection than the state or Federal criteria. This is especially important in areas with older Flood Insurance Rate Maps that may not reflect the current hazard. Such ordinances could include prohibiting certain types of highly damage-prone uses from the floodway or requiring that structures be elevated 1 or more feet above the BFE. The NFIP's Community Rating System provides insurance premium credits to recognize the additional flood protection benefit of higher regulatory standards.

element of the whole. A change at one place can cause changes elsewhere, whether planned or inadvertent. Tulsa is continuing the process of the development or updating of comprehensive, basin-wide Master Drainage Plans that identify existing and potential future drainage and flooding problems to public facilities and private property.

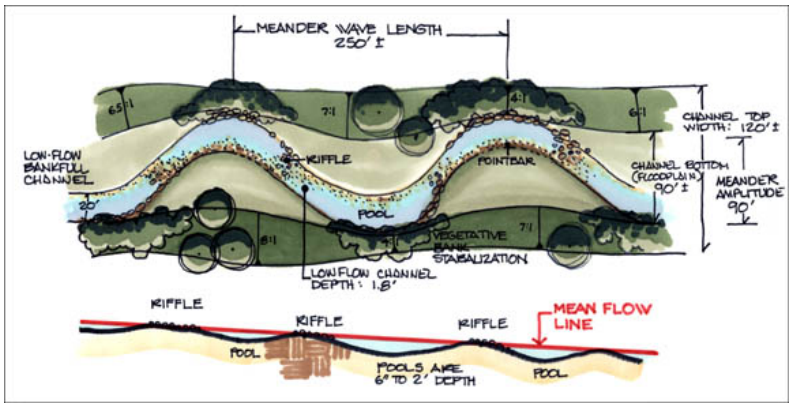
B.2.4 Stormwater Management

Development outside a floodplain can contribute significantly to flooding problems. Runoff is increased when natural ground cover is replaced by urban development. To prevent stormwater from flooding roads and buildings, developers construct storm sewers and improve ditches to carry the water away more efficiently.

As watersheds develop, runoff usually becomes deeper and faster and floods become more frequent. Water that once lingered in hollows, meandered around oxbows, and soaked into the ground now speeds downhill, shoots through pipes, and sheets off rooftops and paving.

Insurance purposes require that NFIP floodplain maps must be based on existing watershed development, but unless plans and regulations are based on future watershed urbanization, development permitted today may flood tomorrow as uphill urbanization increases runoff.

This combination of increased runoff and more efficient stormwater channels leads to increases in downstream storm peaks and changes in the timing when storm peaks move downstream. Unconstrained watershed development often will overload a community's drainage system and aggravate downstream flooding.



In addition to detention facilities, stormwater management plans can include restoring some channelized streams with meanders and native vegetation to slow runoff and prevent flash flooding

A second problem with stormwater is its impact on water quality. Runoff from developed areas picks up pollutants on the ground, such as road oil and lawn chemicals, and carries them to the receiving streams.

Tulsa enforces the NFIP minimum regulations and maps, in order to maintain eligibility for federal flood insurance.

Retention / Detention

Some communities with stormwater management regulations require developers to build retention or detention basins to minimize the increases in the runoff rate caused by impervious surfaces and new drainage systems. Generally, each development must not let stormwater leave at a higher rate than under pre-development conditions. Tulsa does require a drainage plan from new developments.

The Community Rating System (CRS) uses three factors to measure the impact of stormwater management regulations on downstream flooding:

1. What developments have to account for their runoff? If only larger subdivisions have to detain the increased runoff, the cumulative effect of many small projects can still produce greater flows to downstream properties.
2. How much water is managed? Historically, local stormwater management programs address smaller storms, such as the 2- or 10-year storms. The CRS reflects the growing realization nationally that the runoff from larger storms must be managed. It provides full credit only for programs that address all storms up to the 100-year storm.
3. Who is responsible to ensure that the facility works over time? Roads and sewers are located on dedicated public rights-of-way and the community assumes the job of maintaining them in the future. Stormwater management detention basins have traditionally stayed on private property and maintenance has been left up to owner. Often homeowners associations do not know how and do not have the capability to properly maintain these facilities. Half the CRS credit is based on whether the community assumes responsibility to ensure that the facilities are maintained.

Stormwater Detention Ponds manage the increased runoff from new developments, temporarily store flood waters, and can be used for community parks, recreation, and open-space

Watershed Approaches

The standard regulatory approach of requiring each development to manage stormwater to the same criteria has several shortcomings:

1. It does not account for differences in stream and watershed conditions (although the standards can be revised to reflect findings from watershed studies).
2. Municipalities within the same watershed may require different levels of control of stormwater.
3. There is no review of the downstream impacts from runoff or any determination of whether the usual standards compound existing flooding problems.
4. It results in many small basins on private property that may or may not be properly maintained.

The way to correct these deficiencies is to conduct a master study of the watershed to determine the appropriate standards for different areas and, sometimes, to identify where a larger central basin would be more effective and efficient than many smaller ones. The

CRS provides up to double the stormwater management regulations credit if communities adopt such master plans.

B.2.5 Building Codes

Hazard protection standards for all new and improved or repaired buildings can be incorporated into the local building code. These standards should include criteria to ensure that the foundation will withstand flood forces and that all portions of the building subject to damage are above, or otherwise protected from, flooding.

Building codes are also a prime mitigation measure for other natural hazards, especially earthquakes, tornadoes, windstorms and heat and cold. When properly designed and constructed according to code, the average building can withstand the impacts of most of these forces. The code could include provisions such as:

- Requiring sprinkler systems for fire protection in larger or public buildings,
- Regulating overhanging masonry elements that can fall during an earthquake,
- Ensuring that foundations are strong enough for earth movement and that all structural elements are properly connected to the foundation, and
- Making sure roofing systems will handle high winds and expected snow loads.

Tulsa has adopted and enforces 2006 International Building Codes (IBC), which include the International Residential Code, the Plumbing Code, Mechanical Code, Fire Code, and Residential and Fuel Gas Codes.

B.2.6 IBHS Fortified Home Program

What is a Fortified Home

The *Fortified…for Safer Living* home program gives builders and homeowners a set of criteria for upgrades that help reduce the risk of damage from natural disasters. The program raises a homes' overall safety above building code minimum requirements. During construction and upon completion a home is inspected and certified as a "Fortified…for Safer Living" home.

The combination of materials and techniques produces residences equipped to better resist hurricanes, tornadoes, fire and floods. The fortified home construction method produces homes that are comfortable while being resistant to natural disasters.

The following are features of a "Fortified…for Safer Living" home:

- The home and critical utilities are elevated by reinforced continuous piles a minimum of two feet above ground-level walls, stairs and Base Flood Elevation (BFE).
- The home is connected from the peak of the roof to the foot of the reinforced piles to form a continuous load path capable of withstanding 130 mph winds.
- Windows, doors and other openings are properly flashed and protected to withstand the impact of windborne debris without penetration of wind and water.
- The roof truss system has a 110 mph wind rated covering, a secondary moisture barrier, twice the required underlayment, thicker plywood deck sheathing and a stronger holding nail and nailing pattern.

- Other features include non-combustible roof materials, reinforced entry garage doors and landscaping techniques reducing wildfire and flooding vulnerability.
- A certified inspector verifies all required Fortified home products and materials are installed correctly in accordance with manufacturer's specifications for "Fortified…for Safer Living" program specifications.
- The home and property are also verified to be a low risk hazard for exposure to wildfire.

For more information about fortified homes, see www.concretehomescouncil.org/p_room/SBGFortified.pdf.

Economics of a Fortified Home

Cost (new home)

Depending on the quality of the material the buyer chooses, the cost to add fortified features could be as low as five percent of the total cost of a new home. See the following table, from the Institute of Business and Home Safety (IBHS) website at www.ibhs.org/research_library/view.asp?id=277, for a typical upgrade.

Table B–2: Cost Differentials for Fortified Home vs. standard Construction

As-built base home price: $151,500 (including lot and options, before "Fortified" upgrade).

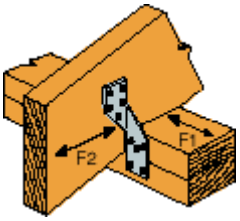
	Standard Home	*"Fortified" Home*	*Incremental Cost to "Fortify"*
Windows and doors	5,450*	$15,500** ($7,700)	$10,050 ($2,250)
Garage doors	$650	$1,250	$600
Roof decking	$650	$1,750	$1,100
Sealing roof joints	$0	$650	$650
Roof covering	$2,350	$3,350	$1,000
Concrete/steel down pours	$0	$500	$500
Fortified inspection costs	$0	$1,000	$1,000
		Total increment cost:	$14,900 ($7,100)
		% of base cost:	9.8% (4.7%***)

* Based on selection of PGT® window & door products.
** Fortified with PGT® WinGuard™ impact-resistant windows & doors.
*** Cost of panel shutters instead of impact-resistant windows.

Cost (existing home)

Many of the fortification techniques used to build new homes are too expensive as retrofits. Fortifying is much more expensive when a home is already built. However, there are creative ways to reduce costs and still fortify an existing home. Improving roof decking on an existing structure would cost about $5,000. For $50 a certain type of glue gun available in most hardware stores can retrofit a roof as effectively as if a new roof had been put on with wood screws.

Savings



In Florida, a fortified home can save homeowners over 20% in insurance premiums. A standard brick, stone, or masonry house in a coastal area, with a deductible of $500 and a 2% hurricane deductible, would generate an annual premium of $2,240. In contrast, the same home with the additional fortified construction features would pay an annual premium of $1,746, a savings of $504, or 22.5%. Also, underwriting guidelines may be relaxed for fortified homes. Insurers may make exceptions for fortified homes in areas where they wouldn't normally write policies.

Lower deductibles may be available. In Florida, policies covering wind damage typically have a deductible of 2% of the covered amount. On a $150,000 home the deductible would be $3,000. Fortified homeowners may be eligible for a flat deductible of $500.

As for intangible savings, personal photographs, important family documents and computer data are just a few of the items a fortified home may protect. Additionally there is the inconvenience and cost of other living arrangements while a home is being rebuilt.

For more information about one insurer's guidelines on insuring fortified homes see www.roughnotes.com/rnmag/august01/08p52.htm.

B.2.7 Smoke Detectors

Smoke detectors save lives. Approximately two-thirds of fatal fires occur in the 10% of homes not protected with smoke detectors. You are twice as likely to die in a fire if you do not have a properly operating smoke detector.

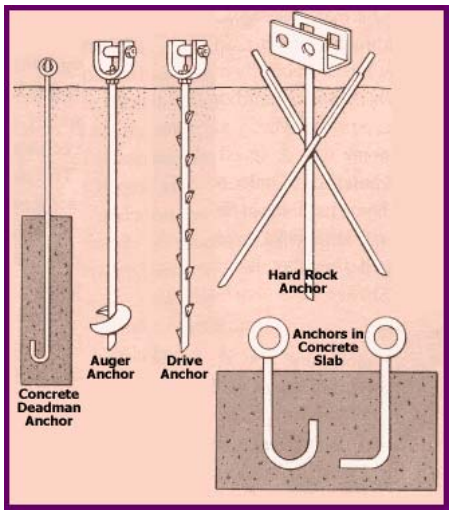
There are two basic types of smoke detectors - photoelectric and ionization. Photoelectric smoke alarms generally are more effective at detecting slow-smoldering fires, fires that might smolder for hours before bursting into flames. Ionization smoke alarms are more effective at detecting fast-flaming fires, fires that consume materials rapidly and spread quickly.

Test smoke detectors every month, change the batteries twice per year, clean detectors at least once per year and replace smoke detectors every 10 years. For more facts about smoke detectors see www.firemar.state.ok.us/forms/lg-alarm.pdf.

B.2.8 Hurricane Fasteners

A home's roof system is its most vulnerable and expensive component. Hurricane roof-to-wall and additional straps are metal connectors designed to hold a roof to its walls in high winds. They make a home's roof-to-wall connection five-to-15 times stronger than traditional construction and can prevent damage in winds at least 75 mph. In many coastal communities, reinforcing connections are enforced as a code restriction for new homes. Although designed to protect roofs during the extended and violent winds of hurricanes, these fasteners have proven effective in preventing roof removal in tornado events. For more information on hurricane fasteners and straps and protecting your roof, go to www.nhc.noaa.gov/HAW2/pdf/hurricane_retrofit.pdf.

B.2.9 Mobile Home Tie-Downs



Tie-downs are devices that anchor or otherwise secure a mobile home to the ground in order to protect the mobile home and its surroundings from damage caused by wind and/or other natural forces. All tie-downs must comply with the specifications of the home manufacturer or, in the absence of such specifications, with standards set by the City Building Inspector.

Anchors are available for different types of soil conditions, including concrete slab. Auger anchors have been designed for both hard soil and soft soil. Rock anchors or drive anchors allow attachment to a rock or coral base. This type of anchor is also pinned to the ground with crossing steel stakes.

B.2.10 Lightning Warning Systems

There are two basic types of warning systems:

Strike Location and Identification Systems sense the electromagnetic pulse or the electrostatic pulse that accompanies a lightning discharge. Sensors and processing equipment work from those pulses or transients. These systems are most useful for tracking storms, locating a lightning strike and producing density plots of lightning activity by geographical area. They do not provide early warning of an impending storm.

Pre-storm Warning Systems sense the conditions that precede a storm. All severe storms create a related electrostatic field. This field provides a reliable storm signature that is peculiar to severe storms and can be related to the severity of the storm. That signature is present prior to lightning activity and provides a measurable parameter for pre-storm warning. The electrostatic field strength is directly related to the state of the storm and/or its proximity to the site. Therefore, an increase in the electrostatic field is an indicator of a storm moving into or building up over the area. The warning time is determined by the rate of buildup or the rate of movement of the storm.

Table B–3: Lightning Detection Options
From the National Lightning Safety Institute

Lightning Detection Options - Accuracy vs. Cost vs. Complexity			
Source of Information	**Accuracy**	**Cost**	**Complexity**
Hearing thunder	Danger is near	None	Simple
TV weather channel	General info.	None	Simple
Weather radios	General info.	Up to $40	Simple

Lightning Detection Options - Accuracy vs. Cost vs. Complexity			
Source of Information	**Accuracy**	**Cost**	**Complexity**
Handheld detectors	50-60% accurate	Up to $500	Somewhat
Boltek system (www.boltek.com)	70-80% accurate	Up to $1,500	Somewhat
ThorGuard system (www.thorguard.com)	85-90%	$1,000 - $6,500	Somewhat
WXLine system (www.WXLine.com)	90-95% accurate	Up to $7,000	Somewhat
Subscription service	95%+ accurate	Monthly fee	Simple

Essential companions to any type of lightning warning system include:

- A written Lightning Safety Policy;
- Designation of Primary Safety Person;
- Determination of when to suspend activities;
- Determination of Safe/Not Safe Shelters;
- Notification to Persons at Risk;
- Education: at a minimum consider posting information about lightning and the organization's safety program;
- Determination of when to resume activities.

The above options can be developed with many variations, up to and including all-in-one units that include a lightning threat detector, strobe light and 360° warning horn, and fully-automated programmable computer to pre-set various options for different types of facilities, such as times of operation, degrees of sensitivity, and appropriate sounding of an "all clear" signal.

B.2.11 Power Outages from Winter Storms

Power outages from winter storms can lead to an abundance of problems. Traffic can be disrupted with the loss of traffic signals. Homeowners without power will resort to candles or open flames for heat and light. Generators are noisy, produce potentially deadly exhaust and can cause power spikes damaging equipment. Kerosene heaters burn oxygen and increase the potential of asphyxiation and production of carbon monoxide. With fuel burning equipment there is a constant danger of fire or explosion, burns and breathing poisonous exhaust. In addition, the inability to heat a home increases the risk of pipes freezing.

Power lines can be protected and power outages prevented by:

- Replacing existing power lines with heavier T-2 line, shorter spans, and heavier poles and crossbars. It is estimated this will increase the overall strength of power distribution lines by 66%.

- Burying utility lines. This removes the risk of power outages due to ice accumulation or tree limbs bringing down power lines.
- Pruning trees away from power lines and enforcing policies regarding tree limb clearances.
- Designed-failure allowing for lines to fall or fail in small sections rather than as a complete system.

For a success story on windstorm power outage mitigation, see https://www.llis.dhs.gov/bestpracticeslist. Options for alternate power sources are described at www.currentsolutionspc.com/doc/distributed.pdf.

When power outages occur, the first imperative in emergency power planning is to equip essential facilities with permanent backup power, and to make sure existing backup sources are properly sized and maintained. Essential post-disaster services include:

- Medical care
- Drinking water supply
- Police and fire protection
- Refrigeration
- Communications
- Pollution control (especially wastewater treatment)
- Transportation (especially airports and seaports)
- Weather forecasting
- Temporary relief shelter
- Emergency response command and control

Backup systems should be sized to meet the requirements of a facility's necessary public services. Some facilities, such as wastewater treatment plants and hospitals, are so important that backup systems should be sized to carry full loads. All backup power systems should be covered by a complete and consistent planned maintenance program that includes regular inspection and operational testing.

B.2.12 Standby Electric Generators

Standby electric generators can provide an extra sense of security during unpredictable weather and resulting power outages. But even small, portable electric generators – if used improperly – can threaten resident safety and the safety of power company linemen working on the electrical system. For information on safely purchasing and using a residential generator, see http://www.redcross.org/prepare/disaster/power-outage/safe-generator-use.

Before purchasing a generator, consider how it will be used. That will help ensure buying a generator that is correctly sized for the application in mind. Portable, gasoline-driven generators are designed to be used for appliances with cords connected to them. Typically, they are not designed to be connected to a home or building wiring. Citizens should not attempt to install these devices to an electrical panel.

Fixed Generators

Large, fixed generators generally are directly connected to building wiring to provide standby power during emergencies or power outages. However, the wiring needs to be properly installed by a qualified electrical contractor. Properly installing a “permanent” generator is extremely dangerous, and usually requires an electrical permit from the local electrical or building inspector's office. Picking an appropriate fixed-site emergency generator involves a number of issues including:

- Type of fuel – Usually a choice between natural gas or diesel, depending on the availability of either fuel in an emergency, and any possible regulations concerning on-site storage. Natural gas emits far fewer exhaust emissions, which may also be a factor.
- Proper voltage – It’s usually best for an emergency generator to match your standard incoming voltage, whether it’s single-phase 120/240 or three-phase 277/480, which is the more common commercial application.
- Power requirements – this will entail (a) identifying your critical functions, and (b) having an electrical professional rate the running/start-up kilowatt (kW) requirements for those functions. (See Table B-4 below for some basic power ratings for typical applications.)
- Cost – even a small (30-45 kW, 277/480 volt) natural gas standby generator can cost $10,000, plus expenses for installation and automatic transfer switches. Most emergency operations centers, 911 dispatch centers, and other critical facilities will need a generator with higher requirements.

"Back feeding" - a dangerous condition

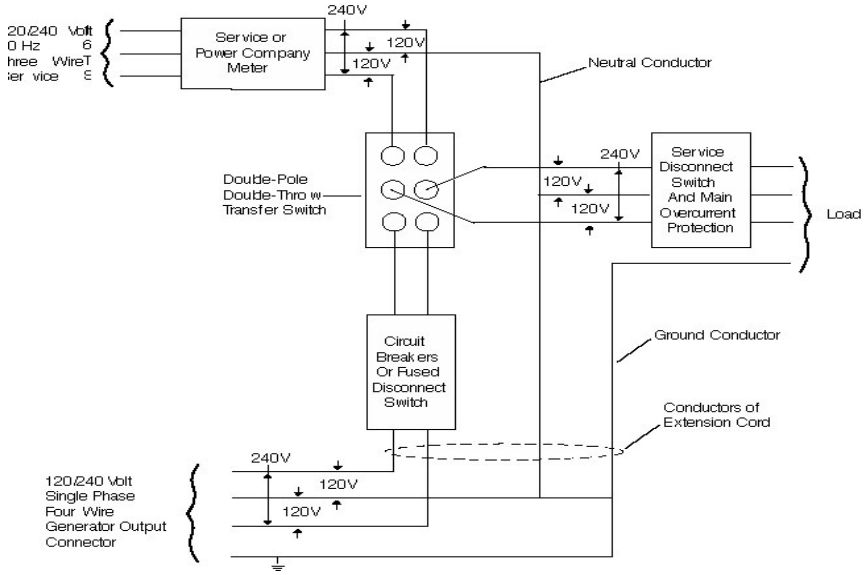
Improperly connecting a portable generator to electric wiring can produce “back feed” – a dangerous current that can electrocute or critically injure residents or others. Back feed into power lines from a generator could create “hot” power lines during an outage. Linemen who expect the line to be de-energized could be injured.

One good way to avoid back feeding is to install a double-pole, double throw transfer-switch gear. A qualified electrical contractor can install this transfer switch so that dangerous back feed can be prevented. “In accordance with the National Electrical Code, paragraph 700-6; Transfer equipment shall be designed and installed to prevent the inadvertent interconnection of normal and emergency sources of supply in any operation of the transfer equipment. Automatic transfer switches shall be electrically operated and mechanically held.” The transfer switch must be a break-before-make switch, which will “break” the electrical connection with commercial power lines before it “makes” the connection between the generator and wiring. The switch also will prevent utility power from damaging the generator when regular service is restored. An electrical diagram of an installation using a transfer switch appears in Figure B-2.

Since transfer switches can be expensive, another way to install a generator is to have a sub-panel with main breakers and power from the main panel or generator. Main panel breaker and generator breaker in sub-panel would have handles interlocked to prevent both from being opened and closed at the same time. This prevents back feed to commercial power when the generator is in use.

For commercial emergency installations, it is also critical that an electrical professional review what the standard and max loads will be on the system. An evaluation needs to be made as to what critical functions need to be operational – HVAC, communications, lighting, security, cooking capabilities, and so on. In health care facilities, assistive devices and water supply equipment can pull large quantities of power, which will need to be taken into account.

Figure B-2: Standby power equipment and



Typical wattage requirements are described in the following table:

Table B–4: Typical Wattage Requirements for Generator Usage

Item	Running Watts	Item	Running Watts
Air conditioner (12,000 BTU)	1,700	Furnace Fan (1/3 HP)	1,200
Battery Charger (20 A)	500	Light Bulb	100
Chain Saw	1,200	Microwave Oven	1,000
Circular Saw	1,000	Oil Burner on Furnace	300
Coffee Maker	1,000	Radio	50
Compressor (1 HP)	2,000	Refrigerator	600
Deep Freeze	500	Submersible Pump (1 HP)	2,000
Electric heater (small)	1,500	Sump Pump	600
Electric Range (1 element)	1,500	Television	300

Source: Above information adapted from American Electric Power, *A Word About Portable Electric Generators*, and Flathead Electric Cooperative, *Safely Installing Your Electric Generator, 2007.*

B.2.13 Critical Facility Protection

Critical facilities require a higher level of protection because they are vital public facilities, reduce pollution of floodwaters by hazardous materials, and ensure that the facilities will be operable during emergencies. The Community Rating System (CRS) provides credit for regulations protecting critical facilities from the 500-year flood.

Critical facilities should be constructed on properly compacted fill and have the lowest floor (including basement) elevated at least one foot above the elevation of the 500-year flood. A critical facility should have at least one access road connected to land outside the

500-year floodplain capable of supporting a 4,000-pound vehicle. The top of the road must be no lower than six inches (6”) below the elevation of the 500-year flood.

B.2.14 Extreme Heat Protection

Elderly, children, low-income individuals and people with compromised immune systems are more vulnerable to health risks due to intense climate changes, especially extreme heat.

Aging is often accompanied by chronic illnesses that may increase susceptibility to extreme environmental conditions. Poverty among elderly increases the risk.

Children are vulnerable due to their size, behavior and fact that they are growing and developing. Children living in poverty or without access to proper medical care are especially vulnerable.

Low-income individuals are less likely to be able to afford air-conditioning and have less access to health care.

Cancer, AIDS and diabetes compromise individual’s immune systems. Afflicted individuals are more susceptible to physical stresses such as those during extreme heat.

Steps to protect individuals from the heat include:

- Install window air-conditioners snugly and insulate spaces for a tighter fit.
- Hang shades, draperies, awnings or louvers on windows receiving morning or afternoon sun. Awnings or louvers can reduce heat entering the house by as much as 80%.
- Stay indoors as much as possible. If air conditioning is not available stay on the lowest floor out of the sunshine.
- Drink plenty of water and limit alcoholic beverages.
- Dress in light-colored, loose fitting clothes that cover as much skin as possible.
- Take a cool bath.
- Slow down.

Suggestions for a community heat emergency intervention plan include:

- Standardizing guidelines for providing warnings to the public, including not only the National Weather Service, but also Emergency Medical Services, the Health Department, Emergency Management and other recognized community agencies.
- The public must have access to the steps to take to lessen the likelihood of heat problems, such as staying in air-conditioning, if possible, and drinking plenty of fluids.
- A room air conditioner loan program for bed-ridden/chair-ridden individuals can assist those individuals who cannot physically leave their homes to visit an air-conditioned location each day.
- “Buddy systems” can be established where an individual is assigned to check on people at risk. The “buddy” should be trained to deal with heat related emergencies.

- Utility companies should not be allowed to terminate service during a heat emergency, even if individuals have not paid their bill.

For more information on extreme heat, mitigation and protection from the heat see www.fema.gov/hazards/extremeheat/heatf.shtm.

B.2.15 Proper Storage and Disposal of Hazardous Materials

Household chemicals and motor oil dumped down drains or directly onto the ground can work their way into the waterways and ground waters. Oil from a single oil change can ruin one million gallons of fresh water. Used crankcase oil has been reported to account for more than 40% of the oil pollution in waterways.

Most public and private vehicle maintenance facilities have well-developed systems to store their waste oil for recycling. However, "do-it-yourselfers" account for a large percentage of the oil changes in any community. Therefore, it is important for community recycling and solid waste management programs to include a system for waste oil collection and provide ways to collect and dispose of household chemicals.

Many counties and communities offer household pollutant collection events. Among the pollutants collected are oil-based paints, paint thinners, pesticides, fertilizers, cleansers, acids, ammunition, batteries, motor oil, and antifreeze. Residents are not charged for items collected. Events are typically funded by participating communities.

Containers of hazardous materials should not be located in a flood hazard area. If such a location is necessary hazardous material containers need to be anchored. Contents can contaminate water and multiply the damaging effects of flooding by causing fires or explosions, or by otherwise making structures unusable. Buoyant materials should be anchored. If they float downstream they may cause additional damage to buildings or bridges or may plug a stream resulting in higher flood heights.

Websites, such as earth911.com, provide lists of hazardous waste recycling centers and used oil collection facilities based on zip code and materials.

B.2.16 Water Conservation

97% of the earth's water is in the oceans and 2% is trapped in icecaps and glaciers, leaving only about 1% of the earth's water available for human consumption. The water supply is taxed to supply all the competing interests: residential - including drinking and sanitation, manufacturing, environmental, agricultural, and recreational.

Conserving water conserves energy - gas, electric or both, reduces monthly water and sewer bills and postpones the construction of or eliminates the need to build expensive capital projects such as wastewater or water treatment plants that will need future maintenance.

Plumbing codes implemented in Phoenix Arizona in 1990 required low-flow faucets, show heads, and toilets. Since then water consumption per capita has decreased 27 percent. Other cities, such as Wilsonville, Oregon, have implemented an inverted block water rate structure charging customers higher rates as water consumption increases.

Public education can have the most significant impact. Household water conservation tips include:

- Updating plumbing fixtures with low-flow devices.
- Keeping a pitcher of water in the refrigerator instead of running the tap.
- Watering the yard and gardens in the morning or evening when temperatures are cooler to minimize evaporation.
- Collecting water used for rinsing and reusing it to water plants.
- Turning off the water while brushing teeth and shaving.
- Landscaping with drought-resistant, low water use plants.
- Using a hose nozzle and turning off the water while washing cars.

B.2.17 Open Space Preservation

Keeping the floodplain open and free from development is the best approach to preventing flood damage. Preserving open space is beneficial to the public in several ways. Preserving floodplains, wetlands, and natural water storage areas maintains the existing stormwater storage capacities of an area. These sites can also serve as recreational areas, greenway corridors and provide habitat for local flora and fauna. In addition to being preserved in its natural landscape, open space may also be maintained as a park, golf course, or in agricultural use.

B.2.18 Conclusions

1. Planning and zoning will help Tulsa develop the community proactively so that the resulting infrastructure is laid out in a coherent and safe manner.
2. Building codes for foundations, sprinkler systems, masonry, and structural elements such as roofs are prime mitigation measures for occurrences of floods, tornadoes, high winds, extreme heat and cold, lightning strikes, and earthquakes.
3. Public education (see Section B.1) can demonstrate preventive measures individuals and businesses can use to protect their own lives and facilities.
4. Tulsa participates in the NFIP and uses subdivision regulations to control the direction of floodplain development.
5. Deficiencies in stormwater management can be corrected by conducting a master study of watersheds to determine appropriate standards for different areas.

B.2.19 Recommendations

Refer to *Chapter 6: Action Plan*, for a complete listing of all recommended mitigation measures by hazard and priority.

B.3 Structural Projects

Structural projects are usually designed by engineers or architects, constructed by the public sector, and maintained and managed by governmental entities. Structural projects traditionally include stormwater detention reservoirs, levees and floodwalls, channel modifications, drainage and storm sewer improvements, and community tornado safe-rooms.

B.3.1 Safe Rooms

Safe rooms are specially constructed shelters intended to protect occupants from tornados and high winds. Constructed of concrete and steel, properly built safe rooms can provide protection against wind speeds of 250mph and airborne debris traveling as fast as 100mph.

A safe room can be incorporated into the construction of a new home, or can be retrofitted above or below ground into an existing home. The cost of constructing a safe room is between $2500 and $6000, depending on the room size, location and type of foundation on which the home is built. Safe rooms can function year-round as a usable area, such as a bathroom, closet or utility room.

The State of Oklahoma, FEMA and communities may offer reimbursement grants for construction of certain categories of Safe Rooms through the Hazard Mitigation Grant Program (HMPG).

FEMA 320, *Taking Shelter From the Storm: Building a Safe Room Inside Your Home* has specific designs for tornado and hurricane safe rooms. To obtain a copy of FEMA 320 refer to http://www.fema.gov/safe-room-resources/fema-p-320-taking-shelter-storm-building-safe-room-your-home-or-small-business.

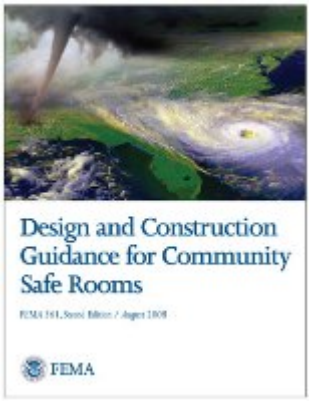
Dr. Ernst Kiesling, Civil Engineering Professor at Texas Tech University inspects a safe room in the aftermath of the May 8, 2003 tornadoes in Moore, Oklahoma.

National Storm Shelter Association

The National Storm Shelter Association (NSSA) is an industry organization developed to ensure the highest quality of manufactured and constructed storm shelters. The NSSA has developed a program to verify that design, construction, and installation of storm shelters are in compliance with the most comprehensive and extensive safety standards available. Without full compliance with the standard, vulnerabilities may exist and safety may be compromised. Shelter-producing members of the NSSA submit shelter designs to the scrutiny of an independent third-party engineering company and have their shelters tested for debris impact resistance (FEMA 320 designs have been tested). In addition they will file a certificate of installation with NSSA for each shelter.

Upon building or installing a storm shelter, the member applies a seal to the shelter certifying that it is designed, built, and installed to meet the NSSA standard. Only the shelter producer or an agency that carefully inspects the shelter design, construction, and installation may certify compliance with an applicable standard. Claims of "FEMA Certified" or "Texas Tech Certified" are misleading since neither FEMA nor the Texas Tech Wind Science and Engineering Research Center (contributors to the FEMA standards for individual and community SafeRooms) certifies shelter quality. This program not only provides assurance to the user of a storm shelter that it has been built to a certain performance standard, but it shifts some responsibility from the community to provide verification from building inspectors for compliance and reduces building inspectors' training requirements. Additional information on the NSSA certification program can be obtained at www.nssa.cc.

B.3.2 School Safe Rooms



In the past, a school's interior areas, especially hallways, have been designated as the best place to seek refuge from violent storms. However, in 1999 the hallways of two schools in Sedgwick County, Kansas received significant damage which could have resulted in student casualties had school been in session. See https://www.llis.dhs.gov/content/protecting-school-children-tornadoes for more information.

FEMA 361 publication, *Design and Construction Guidance for Community Shelters*, provides guidelines for constructing school safe rooms. A community shelter strong enough to survive a violent storm can also be used as a cafeteria, gymnasium or other common area.

Schools, administration buildings, and institutions of higher learning are required to have written plans and procedures in place for protecting students, faculty, administrators, and visitors from natural and man-made disasters and emergencies. The requirement, directed by Oklahoma House Bill HB1512, was enacted May 29, 2003.

For an example of a community putting together schools safe rooms, see Maple School's story at https://www.llis.dhs.gov/content/community-supports-safe-room. To receive a copy of FEMA 361, see http://www.fema.gov/safe-room-resources/fema-p-361-design-and-construction-guidance-community-safe-rooms. For more information on HB1512, see http://www.oklegislature.gov/BillInfo.aspx?Bill=HB1512.

B.3.3 Reservoirs and Detention

Reservoirs control flooding by holding high flows behind dams or in storage basins. After a flood peaks, water is released or pumped out slowly at a rate that the river can accommodate downstream. The lake created may provide recreational benefits or water supply (which could help mitigate a drought).

Reservoirs are suitable for protecting existing development downstream from the project site. Unlike levees and channel modifications, they do not have to be built close to or disrupt the area to be protected. Reservoirs are most efficient in deeper valleys where there is more room to store water, or on smaller rivers where there is less water to store. Building a reservoir in flat areas and on large rivers may not be cost-effective, because large areas of land have to be purchased.

Reservoirs provide storage of rainwater without the hazards of maintaining a dam

In urban areas, some reservoirs are simply manmade holes dug to store floodwaters. When built in the ground, there is no dam for these retention and detention basins and no dam failure hazard. Wet or dry basins can also serve multiple uses by doubling as parks or other open space uses.

B.3.4 Levees and Floodwalls

Probably the best-known flood control measure is an earthen barrier (levee) or concrete (floodwall) erected between the watercourse and the property to be protected. Levees and floodwalls confine water to the stream channel by raising its banks. They must be well designed to account for large floods, underground seepage, pumping of internal drainage, and erosion and scour.

Failure to maintain levees can lead to significant loss of life and property if they are stressed and broken or breached during a flood event. An inspection, maintenance and enforcement program helps ensure structural integrity.

Levees placed along the river or stream edge degrade the aquatic habitat and water quality of the stream. They also are more likely to push floodwater onto other properties upstream or downstream. To reduce environmental impacts and provide multiple use benefits, a setback levee (set back from the floodway) is the best project design. The area inside a setback levee can provide open space for recreational purposes and provide access sites to the river or stream.

B.3.5 Channel Improvements

By improving channel conveyance, more water is carried away at a faster rate. Improvements generally include making a channel wider, deeper, smoother or straighter. Some smaller channels in urban areas have been lined with concrete or put in underground pipes.

B.3.6 Crossings and Roadways

Culverts like this one can constrict flow and cause backwater flooding

In some cases, buildings may be elevated above floodwaters, but access to the building is lost when floodwaters overtop local roadways, driveways, and culverts or ditches. Depending on the recurrence interval between floods, the availability of alternative access, and the level of need for access, it may be economically justifiable to elevate some roadways and improve crossing points.

For example, if there is sufficient downstream channel capacity, a small culvert that constricts flows and causes localized backwater flooding may be replaced with a larger culvert to eliminate flooding at the waterway crossing point. The potential exacerbating of adjacent or downstream flooding needs to be considered before implementing any crossing or roadway drainage improvements.

B.3.7 Drainage and Storm Sewer Improvements

Man-made ditches and storm sewers help drain areas where the surface drainage system is inadequate, or where underground drainageways may be safer or more practical. Storm sewer improvements include installing new sewers, enlarging small pipes, and preventing back flows. Particularly appropriate for depressions and low spots that will not drain naturally, drainage and storm sewer improvements usually are designed to carry the runoff from smaller, more frequent storms.

Because drainage ditches and storm sewers convey water faster to other locations, improvements are only recommended for small local problems where the receiving stream or river has sufficient capacity to handle the additional volume and flow of water. To reduce the cumulative downstream flood impacts of numerous small drainage projects, additional detention or run-off reduction practices should be provided in conjunction with the drainage system improvements.

B.3.8 Drainage System Maintenance

The drainage system may include detention ponds, stream channels, swales, ditches and culverts. Drainage system maintenance is an ongoing program to clean out blockages caused by an accumulation of sediment or overgrowth of weedy, non-native vegetation or debris, and remediation of stream bank erosion sites.

Drainageways are inspected regularly for blockage from debris

"Debris" refers to a wide range of blockage materials that may include tree limbs and branches that accumulate naturally, or large items of trash or lawn waste accidentally or

intentionally dumped into channels, drainage swales or detention basins. Maintenance of detention ponds may also require revegetation or repairs of a restrictor pipe, berms or overflow structure.

Maintenance activities normally do not alter the shape of a channel or pond, but they do affect how well a drainage system can do its job. Sometimes it is a very fine line that separates debris that should be removed from natural material that helps form habitat.

B.3.9 Conclusions

1. Reservoirs can hold high flows of water that can later be released slowly or retained for recreational purposes or drought mitigation.
2. Levees and floodwalls are not as effective overall because of possible underground seepage, erosion, degradation of aquatic habitat and water quality, and ineffectiveness in large floods.
3. Channel improvements allow more water to be carried away faster.
4. The effectiveness of elevating buildings depends on the availability of alternative access when flooding occurs.
5. Crossing and roadway drainage improvements must take into account additional detention or run-off reduction.
6. Drainage and storm sewer improvements carry runoff from smaller, more frequent storms.
7. Drainage system maintenance is an ongoing project of removing debris that decreases the effectiveness of detention ponds, channels, ditches, and culverts.

B.3.10 Recommendations

Refer to *Chapter 6: Action Plan*, for a complete listing of all recommended mitigation measures by hazard and priority.

B.4 Property Protection

Property protection measures are used to modify buildings or property subject to damage from various hazardous events. The property owner normally implements property protection measures. However, in many cases technical and financial assistance can be provided by a governmental agency. Property protection measures typically include acquisition and relocation, flood-proofing, building elevation, barriers, retrofitting, safe rooms, hail resistant roofing, insurance, and the like.

B.4.1 The City's Role

Property protection measures are usually considered the responsibility of the property owner. However, the City should be involved in all strategies that can reduce losses from natural hazards, especially acquisition. There are various roles the City can play in encouraging and supporting implementation of these measures.

Providing basic information to property owners is the first step in supporting property protection measures. Owners need general information on what can be done. They need to see examples, preferably from nearby.

Financial Assistance

Communities can help owners by helping to pay for a retrofitting project, just like they pay for flood control projects. Financial assistance can range from full funding of a project to helping residents find money from other programs. Some communities assume responsibility for sewer backups and other flood problems that arose from an inadequate public sewer or drain system.

Less expensive community programs include low interest loans, forgivable low interest loans and rebates. A forgivable loan is one that does not need to be repaid if the owner does not sell the house for a specified period, such as five years. These approaches do not fully fund the project but they cost the community treasury less and they increase the owner's commitment to the flood protection project.

Often, small amounts of money act as a catalyst to pique the owner's interest to get a self-protection project moving. Several Chicago suburbs have active rebate programs that fund only 20% or 25% of the total cost of a retrofitting project. These programs have helped install hundreds of projects that protect buildings from low flood hazards.

Acquisition Agent

The City can be a focal point for many acquisition projects. In most cases, when acquisition of a property is feasible, the City is the ultimate owner of the property, but in other cases, the school district or other public agencies can assume ownership and the attendant maintenance responsibilities.

Other Incentives: "Non-financial Incentives"

Sometimes only a little funding is needed to motivate a property owner to implement a retrofitting project. A flood insurance premium reduction will result if a building is elevated above the flood level. This reduction is not enough to take much of a bite out of the cost of the project, but it reassures the owner that he or she is doing the right thing.

Other forms of floodproofing are not reflected in the flood insurance rates for residential properties, but they may help with the Community Rating System, which provides a premium reduction for all policies in the community.

Other incentives to consider are programs to help owners calculate the benefits and costs of a project and a "seal of approval" for retrofitted buildings. The latter would be given following an inspection that confirms that the building meets certain standards. There are many other personal but non-economic incentives to protect a property from flood damage, such as peace of mind and increased value at property resale.

B.4.2 Insurance

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. There are three types of insurance coverage:

NFIP Coordinator Dianna Herrera presenting a class on flood insurance requirements

1. The standard homeowner's, dwelling, and commercial insurance policies cover against the perils of wildfire and the effects of severe weather, such as frozen water pipes.
2. Many companies sell earthquake insurance as an additional peril rider on homeowner's policies. Individual policies can be written for large commercial properties. Rates and deductibles vary depending on the potential risk and the nature of the insured properties.
3. Flood insurance is provided under the National Flood Insurance Program.

Flood Insurance

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.

Building coverage is for the structure. Contents coverage is for the removable items inside an insurable building. A renter can take out a policy with contents coverage, even if there is no structural coverage.

Some people have purchased flood insurance because the bank required it when they got a mortgage or home improvement loan. Usually these policies just cover the building's structure and not the contents.

In most cases, a 30-day waiting period follows the purchase of a flood insurance policy before it goes into effect. The objective of this waiting period is to encourage people to keep a policy at all times. People cannot wait for the river to rise before they buy their coverage.

B.4.3 Acquisition and Relocation

Moving out of harm's way is the surest and safest way to protect a building from damage. Acquiring buildings and removing them is also a way to convert a problem area into a community asset and obtain environmental benefits.

The major difference between the two approaches is that acquisition is undertaken by a government agency, so the cost is not borne by the property owner, and the land is converted to public use, such as a park. Relocation can be either government or owner-financed.

Moving a home out of the floodplain is sometimes the only way to protect it from flooding

While almost any building can be moved, the cost goes up for heavier structures, such as those with exterior brick and stone walls, and large or irregularly shaped buildings. However, experienced building movers know how to handle any job.

Cost

An acquisition budget should be based on the median price of similar properties in the community, plus $10,000 to $20,000 for appraisals, abstracts, title opinions, relocation benefits, and demolition. Costs may be lower after a flood or other disaster. For example, the community may have to pay only the difference between the full price of a property and the amount of the flood insurance claim received by the owner.

One problem that sometimes results from an acquisition project is a "checkerboard" pattern in which nonadjacent properties are acquired. This can occur when some owners, especially those who have and prefer a waterfront location, prove reluctant to leave. Creating such an acquisition pattern in a community simply adds to the maintenance costs that taxpayers must support.

Relocation can be expensive, with costs ranging from $30,000 for a small wood frame building to over $60,000 for masonry and slab on grade buildings. Two story houses are more expensive to move because of the need to relocate wires and avoid overpasses. Additional costs may be necessary for acquiring a new lot on which to place the relocated building and for restoring the old site. Larger buildings may have to be cut and the parts moved separately. Because of all these complications, there are cases where acquisition is less expensive than relocation.

Where Appropriate

Acquisition and relocation are appropriate in areas subject to:

- Flash flooding
- Deep waters
- Dam break flooding
- Landslides

- Potential hazardous materials spills
- Other high hazard that affects a specific area

Acquisition and relocation are not appropriate for hazards like tornadoes or winter storms because there are no areas safe from the hazard. Relocation is also preferred for large lots that include buildable areas outside the hazardous area or where the owner has a new lot in a safer area.

Acquisition (followed by demolition) is preferred over relocation for buildings that are difficult to move, such as larger, slab foundation, or masonry structures, and for dilapidated structures that are not worth protecting.

B.4.4 Building Elevation

Raising a building above the flood level is the best on-site property protection method for flooding. Water flows under the building, causing little or no damage to the structure or its contents. Alternatives are to elevate on continuous foundation walls (creating an enclosed space below the building) or elevation on compacted earthen fill.

B.4.5 Barriers

Barriers keep surface waters from reaching a building. A barrier can be built of dirt or soil ("berm") or concrete or steel ("floodwall"). In cases of shallow flooding, regrading a yard can provide the same protection as a separate barrier.

FEMA documents offer advice on floodproofing homes for private residents.

B.4.6 Retrofitting

This term covers a variety of techniques for modifying a building to reduce its susceptibility to damage by one or more hazards.

Where Appropriate

Some of the more common approaches are:

Floods and dam failures:

- Dry floodproofing keeps the water out by strengthening walls, sealing openings, or using waterproof compounds or plastic sheeting on walls. Dry floodproofing is not recommended for residential construction.
- Wet floodproofing, using water resistant paints and elevating anything that could be damaged by a flood, allows for easy cleanup after floodwaters recede. Accessory structures or garages below the residential structure are potential candidates for wet floodproofing.
- 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
- Using special roofing shingles designed to interlock and resist uplift forces
- 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:

- Replacing wood shingles with fire resistant roofing
- Adding spark arrestors on chimneys
- Landscaping to keep bushes and trees away from structures
- Installing sprinkler systems
- Installing smoke alarms

Earthquake:

- Retrofitting structures to better withstand shaking.
- Tying down appliances, water heaters, bookcases and fragile furniture so they won't fall over during a quake.

Common Measures

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

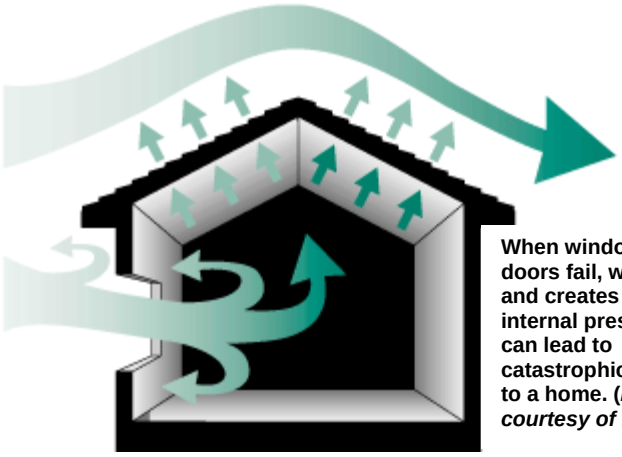
- Strengthening roofs and walls to protect from wind and earthquake forces.

- 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.

B.4.7 Impact Resistant Windows and Doors

Doors and windows can be the most vulnerable components of your home. During high wind events, such as thunderstorms or tornadoes, wind-driven debris can easily penetrate unprotected or unreinforced windows and doors, breaching the secure envelope of the structure. The debris and rain may cause damage to interior furnishings or harm to residents, but the wind itself can create extreme pressures on the walls and ceiling, leading to catastrophic structural failure. This danger can be mitigated by the installation of impact-resistant windows and doors.



When windows and doors fail, wind enters and creates an internal pressure that can lead to catastrophic damage to a home. (*Drawing courtesy of Flash.org*)

Windows

Today's impact-resistant glass sandwiches a laminated inner layer made of polyvinyl butyral, a plastic, between two sheets of glass. Stronger than a car windshield, the glass might shatter if a heavy object crashes into it, but it won't break to bits. That makes wind less likely to penetrate the envelope of a home and create interior pressure severe enough to blow a roof off. Impact-resistant windows are only as strong, though, as the frame in which they rest. “An impact resistant window is tested as a unit that includes the glass, the frame as well as the attachment hardware and the installation method.” (*FLASH*)

The second type of impact-resistant glass uses a film applied to the surface. Impact-resistant film is placed over the glass to keep windows from shattering into sharp particles if broken. Since these films are added to the glass, they may not be as effective as a standard impact-resistant system. Their durability depends on how well the glass and protective laminate stay in the frame and window assembly. They will be effective against smaller objects, but larger pieces of debris may still take the window out of the frame. For more information on protective window films and other technologies,

visit the International Window Film Association's website. (http://www.iwfa.com/ConsumerInfo/SafetySecurity.aspx).

While costs for replacing window glass or using impact-resistant glass in new construction can be expensive, there are additional benefits that may be gained. Impact-resistant glass has been used successfully to reduce burglaries, vandalism and break-ins with both homes and businesses. In addition, using an impact-resistant glazing that is also more energy efficient can produce substantial energy savings. According to the Partnership for Advancing Housing Technology (PATH), a public-private partnership between leaders in the homebuilding, product manufacturing, and insurance industries and several Federal agencies:

> Special glass "…can be used to both make windows impact resistant and more energy efficient. Low-E and solar control low-E (also called spectrally selective) coatings can be used to boost the energy efficiency of windows. Low-E double pane windows, most common in cold and moderate climates, are more energy efficient than clear windows because the low-E coating reduces heat loss through the window.
>
> Solar control glass, also called Low E2, is a good glass for hot climates because, in addition to improving the insulating ability of windows, it also limits solar heat gain by blocking passage of infrared and some ultraviolet rays. Solar control glass allows a higher level of visible light to pass through a window with less solar heat gain reduction than tinted window coatings."

PATH gives a tentative cost estimate for using impact resistant glass systems in a model 2,250 sq. ft. home at $14,850. (www.pathnet.org/sp.asp?id=18692). In addition, residential users may view a window and door protection cost estimate tool at the FLASH.org site www.blueprintforsafety.org/tools/shuttertoolhome.aspx.

One manufacturer provides the following pricing table for commercial applications:

Table B–5: Impact Resistant Windows Cost Estimate Table

The following pricing table is for estimating purposes only. Changes in dimensions, glass types, finishes, hardware selection, volume discounts, and other variables could raise or lower prices. (Provided by CGI Windows, **www.cgiwindows.com**.)

APPROXIMATE IMPACT RESISTANT PRICING 2007 - COMMERCIAL GRADE ALUMINUM PRODUCTS

Product	W	x	H	Max. Design Pressure (PSF)	COS*
Series 238 - Casement Window	24"	x	48	+110 / -120	$400.12
Series 238 - Casement Window	30"	x	60	+110 / -120	$526.63
Series 238 - Casement Window	36"	x	60	+110 / -120	$593.31
Series 238 - Casement Window	32"	x	72	+85 / -85	$625.18
Series 360 - Single Hung Window	36"	x	72	+100 / -167.2	$593.80
Series 360 - Single Hung Window	54"	x	96"	+100 / -120	$1,274.27
Series 450 - Pair of Door	74 1/2"	x	96 3/4	+100 / -110	$2,425.69

Aluminum Finish: White, Bronze, or Driftwood ESP
Glass Type: 7/16" Laminated Glass Typical (Ann/Ann) / 5/16" Lami Glass at Single Hungs (Ann/Ann)
Glass Color: Clear, Gray, Bronze, Dark Gray (Turtle Code)
** Note: Cost excludes special items, colonial muntins, HS/HS Glass, Temp/Temp Glass, aluminum tube mullions, shipping, shop drawings, installation, permits, special engineering, windload calculations, etc.*

Garage Doors

Garage doors are particularly vulnerable, especially doublewide garage doors because of their long span and, frequently, lightweight materials. Reinforced garage door and track systems are available to help avoid that problem. Retrofit kits are also available to reinforce existing garage doors, but the retrofit kits do not provide the same level of protection as systems designed to be wind and impact-resistant. (*Source: Federal Alliance for Safe Homes – FLASH.* www.flash.org.)

Illustrating the dangers of unreinforced garage doors, in all but the house at upper left, these doors have been breached, leading to substantial roof damage – in some cases, completely removing a second floor. But in the home with an intact garage door, the roof is almost entirely undamaged.

B.4.8 Lightning Protection Systems

The purpose of a lightning protection system is to intercept lightning and safely direct its current to ground. If the system is properly designed, installed and maintained it can provide almost 100% protection to buildings.

The system for an ordinary structure includes at least air terminals (lightning rods), down conductors, and ground terminals. These three elements of the system must form a continuous conductive path for lightning current. Many systems of air terminals now may not even be connected to the building. They may be comprised of freestanding cables or towers above or next to the building.

National Fire Protection Association document NFPA 780, *Standard for the Installation of Lightning Protection Systems* describes lightning protection system installation requirements. NFPA 780 is available through http://www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=780.

B.4.9 Surge and Spike Protection

The average home has 2,200 or more power surges annually, 60% of which are generated within the home. Most surges are caused by motors starting in air conditioners, garage

doors, refrigerators and other major appliances. Electronic appliances can be damaged or destroyed by over-voltage surges or spikes.

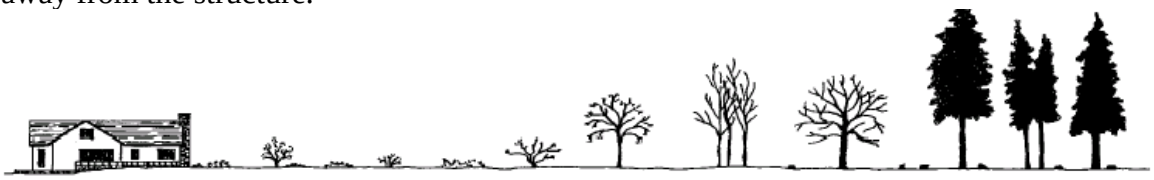
Whole house surge protectors offer the first line of defense against high-energy, high-voltage surges. These devices thwart the energy of the initial surge and reduce it before it reaches electrical appliances. In many cases this level of protection is enough to protect the home. Surge protectors should be sufficient to also provide "spike protection," which can defend against the extremely high spiking voltage created by lightning strikes. Many surge protectors, while effective against routine voltage fluctuations, may not defend against high level spikes.

Surge protection devices connected directly to appliances offer the second line of defense. They are the only defense against surges within the home as when, for example, a large appliance kicks in. The combination of whole house and point-of-use surge protection provides the best possible protection.

For more information on whole house and point-of-use surge protectors, refer to www.howstuffworks.com/surge-protector.htm.

B.4.10 Landscaping for Wildfire Prevention

The chance of losing property due to wildfire can be reduced using fire prevention landscaping techniques. The amount of cleared space around a home improves its ability to survive a wildfire. A structure is more likely to survive when grasses, trees and other common fuels are removed, reduced or modified to reduce a fire's intensity and keep it away from the structure.



Zone 1: Moist and trim. Turf, perennials, groundcovers and annuals form a greenbelt that is regularly watered and maintained. Shrubs and trees are located at least 10 feet from the house.

Zone 2: Low and sparse. Slow growing, drought-tolerant shrubs and groundcovers keep fire near ground level. Native vegetation can be retained if it is low growing, does not accumulate dry, flammable material and is irrigated.

Zone 3: High and clean. Native trees and shrubs are thinned and dry debris on the ground is removed. Overgrowth is removed and trees are pruned every 3-5 years.

Zone 4: Natural area. Native plants are selectively thinned. Highly flammable vegetation is replaced with less fire-prone species.

For comprehensive lists of steps to protect your home before, during and after a wildfire, see www.fema.gov/pdf/library/98surst_wf.pdf or www.cnr.uidaho.edu/extforest/F3.pdf.

B.4.11 Conclusions

1. Acquisition and relocation of property is the most effective for property protection in the case of hazards that are expected to occur repeatedly in the same locations. Acquisition followed by demolition is preferable.

2. Other methods of property protection for flooding include raising building elevations and building berms and floodwalls.
3. Building modifications are also appropriate for some hazards.
4. Property insurance has the advantage of protecting the property without human intervention.
5. The City can help in reducing losses from natural hazards by providing financial assistance, having an acquisition program, and other incentives.

B.4.12 Recommendations

Refer to *Chapter 6: Action Plan*, for a complete listing of all recommended mitigation measures by hazard and priority.

B.5 Emergency Services

Emergency services measures protect people during and after a hazard event. Locally, Tulsa Area Emergency Management coordinates these measures in cooperation with emergency management in nearby counties and communities. Measures include preparedness, threat recognition, warning, response, critical facilities protection, and post-disaster recovery and mitigation.

B.5.1 Threat Recognition

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

Emergency Alert System (EAS)

Using digital technology to distribute messages to radio, television and cable systems, the EAS provides state and local officials with the ability to send out emergency information targeted to a specific area. The information can be sent electronically through broadcast stations and cable systems even if those facilities are unattended.

Floods

A flood threat recognition system provides early warning to emergency managers. A good system will predict the time and height of the flood crest. This can be done by measuring rainfall, soil moisture, and stream flows upstream of the community and calculating the subsequent flood levels.

Areas subject to flooding should be clearly posted

On larger rivers the National Weather Service hydrology office in Tulsa does the measuring and calculating, which is in the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA). Flood threat predictions are disseminated on the NOAA Weather Wire or NOAA Weather Radio. NOAA Weather Radio is considered by the federal government to be the official source for weather information.

The National Weather Service issues notices to the public, using two levels of notification:

Flood watch: conditions are right for flooding

Flood warning: a flood has started or is expected to occur

On smaller rivers, local rainfall and river gages are needed to establish a flood threat recognition system. The National Weather Service may issue a "flash flood watch." This means the amount of rain expected will cause ponding and other flooding on small

streams and depressions. These events are sometimes so localized and rapid that a “flash flood warning” may not be issued, especially if no gages or other remote threat recognition equipment is available.

Meteorological Hazards

The National Weather Service is the prime agency for detecting meteorological threats, such as tornadoes, thunderstorms, and winter storms. As with floods, the Federal agency can only look at the large scale, e.g., whether conditions are appropriate for formation of a tornado. For tornadoes and thunderstorms, the county or municipalities can provide more site-specific and timely recognition by sending out spotters to watch the skies when the Weather Service issues a watch or warning.

NOAA All-Hazard Radios

The National Oceanographic and Atmospheric Administration (the parent agency for the National Weather Service) maintains a nationwide network of radio stations broadcasting continuous weather information direct from regional National Weather Service offices. The NWS broadcasts warnings, watches, forecasts, Amber Alerts and other hazard and safety information 24 hours a day. Post-event information is also broadcast for natural hazards (such as tornados and earthquakes) and environmental hazards (such as chemical releases or oil spills).

These broadcasts can be received by any radio capable of receiving the Weather Service frequency. NOAA All Hazard Radios have the additional advantage of being activated by a pre-broadcast signal transmitted by the NWS, coming off standby and sounding an alert tone loud enough to wake sleeping individuals before transmitting the warning message. NOAA Weather Radio receivers can be purchased at many retail stores that sell electronic merchandise. Typical cost of a residential grade NOAA Weather Radio is between $20 and $200.

For more information on NOAA Weather Radios, see www.nws.noaa.gov/nwr/.

B.5.2 Warning

After the threat recognition system tells the CEMA that a flood or other hazard is coming, the next step is to notify the public and staff of other agencies and critical facilities. Earlier and more specific warnings enable more people to implement protective measures. The following are some of the more common warning methods:

Broadcast announcements & EAS	Good tools for delivering an alert to a wide coverage area but not well-suited for delivering “actionable” information to specific population segments. For an EAS to be effective, it is essential for the target audience to be tuned in to a regional station. Actual practice shows this is not always the case, particularly late at night when the general population is asleep.

Door-to-door Notification	Door-to-door notification would be an ideal way to communicate with specific individuals or neighborhoods. However, efficiency is impacted by the number of addresses to be contacted, the number of personnel available to "walk the streets", and the amount of time available prior to the event (i.e., evacuation). It is highly unlikely that sufficient public safety personnel would be available to effectively provide such door-to-door notification services. Door-to-door also has the potential of putting first responders in harm's way.
Mass Notification System	Tulsa's Everbridge mass notification system can be used to reach large numbers of citizens quickly and efficiently with warning messages. Citizens are able to enter their contact preferences (phone, text, or email) and opt out of non-emergency messages.
Other Communications Devices	There are other communication devices available that may be able to receive emergency notifications However, as with Weather Alert Radio, their level of penetration throughout the population is too low to ensure effective delivery. Selecting distinct population segments based on geography with such devices is also a problem.
Outdoor warning sirens	Sirens can be effective in their ability to alert people within hearing distance that a crisis or emergency situation may exist. Outdoor warning sirens and public address systems are commonly located in densely populated urban settings, but are not as useful in rural areas. Sirens are intended to alert the public to implement some pre-determined action (i.e., tune to radio and television for specific information on a hazard). However the public generally has no awareness of the need to do so and often will ignore sirens thinking they are a "test" unless they see the hazard approaching, which is often then too late to take appropriate action. In addition, in many areas, sirens are used only for specific emergencies, such as floods or tornadoes, and are of little use in helping public safety personnel alert residents to other events/crises.
NOAA Weather Radio	Weather Alert Radio, while an invaluable tool, has limited applicability. Lacking proper feedback, public safety and emergency management officials have no way of being sure that everyone in their jurisdiction can be reached with such announcements because, similar to broadcast announcements, the audience must have a NOAA radio, and be tuned in.
Sirens on public safety vehicles	These have many of the same drawbacks as both door-to-door notification and outdoor warning sirens. Emergency vehicle sirens do not provide "actionable" information on how to respond. In addition, crucial emergency service personnel may be tied up when their services are more urgently needed for response.

Adapted from *NENA Minimum Standards for Emergency Telephone Notification Systems, NENA 56-003, June 12, 2004*

Multiple or redundant systems are the most effective, since people do not hear one warning, they may still get the message from another part of the system. Each has advantages and disadvantages. Outdoor warning sirens can reach the most people quickly (except those around loud noise, such as at a factory or during a thunderstorm), but they do not explain what hazard is coming and cannot be sounded unless a timely means of threat recognition exists. Radio and TV provide a lot of information, but people have to know to turn them on. Telephone trees are fast, but can be expensive and do not work when phones lines are down.

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).

B.5.3 9-1-1 and 2-1-1

Some communities have expanded their basic 9-1-1 location identification telephone service to include features such as "enhanced 9-1-1" registering name, address, and a description of the building/site. Additionally, non-emergency 2-1-1 service can be used to have people call to get information, such as locations of cooling shelters during a heat wave. For information on coverage areas and contact information for area 2-1-1 systems, see www.211oklahoma.org. For Tulsa, *HelpLine 2-1-1*, in Tulsa, at 918-836-2111, operates 2-1-1.

B.5.4 Emergency Telephone Notification Systems (ETNS)

It has become more common to use a "Emergency Telephone Notification System" (frequently referred to as reverse 9-1-1) with which a community can send out a mass telephone announcement to targeted numbers in the 9-1-1 system, effectively supplementing a community's other warning systems. An effective ETNS can offer certain advantages over other systems:

- ETNS systems provide the ability to precisely target populations in specific geographic locations better than existing alternatives, particularly when ETNS systems were integrated with geographic information systems (GIS) maps commonly used by 9-1-1 systems;
- The telephone, more than any other communications medium, allows officials to deliver specific actionable information that lets those in harm's way know exactly what to do, what to expect, or what to look for;
- The telephone is always on, providing the opportunity to reach nearly everyone in a target area either live or through voicemail.
- Many systems also offer the option of allowing people to call in and retrieve the same message or an updated one. This can reduce the subsequent number of calls to 9-1-1 from people who did not fully understand the message the first time. (*Source: NENA Minimum Standards for Emergency Telephone Notification Systems, NENA 56-003, June 12, 2004*)

Tulsa has several warning and notification systems in place, including an Ever bridge mass notification system capable of sending out approximately 50,000 calls a minute. See Chapter 2, Section 6.4 for more information.

B.5.5 Response

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:

- Activating the emergency operations room (emergency management)

- Closing streets or bridges (police or public works)
- Shutting off power to threatened areas (utility company)
- 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 (engineering)
- Security and other protection measures (police)

In the event of an emergency, responders must make an organized effort to minimize the impacts of the incident.

An emergency action plan ensures that all bases are covered and that the response activities are appropriate for the expected threat. These plans are developed in coordination with the agencies or offices that are given various responsibilities.

Emergency response plans should be updated annually to keep contact names and telephone numbers current and to make sure that supplies and equipment that will be needed are still available. They should be critiqued and revised after disasters and exercises to take advantage of the lessons learned and changing conditions. The end result is a coordinated effort implemented by people who have experience working together so that available resources will be used in the most efficient manner.

B.5.6 Emergency Operations Plan (EOP)

An EOP develops a comprehensive (multi-use) emergency management program which seeks to mitigate the effects of a hazard, to prepare for measures to be taken which will preserve life and minimize damage, to respond during emergencies and provide necessary assistance and to establish a recovery system in order to return communities to their normal state of affairs. The plan defines who does what, when, where and how in order to mitigate, prepare for, respond to and recover from the effects of war, natural disasters, technological accidents and other major incidents / hazards.

The *Comprehensive Preparedness Guide (CPG) 101: Developing and Maintaining Emergency Operations Plans* version 2.0 is available from FEMA. The guide provides ideas and advice to state and local emergency managers in their efforts to develop and maintain an EOP. More information and complete copies of the guide are available through FEMA and their website at http://www.fema.gov/plan.

Funding for creating or updating an EOP is available from FEMA. For information on how to obtain funding contact the Oklahoma Office of Homeland Security or go to http://www.ok.gov/homeland/.

The State of Oklahoma's Emergency Operations Plan is published on http://www.ok.gov/OEM/Programs_&_Services/Planning/State_Emergency_Operations_Plan_-_EOP.html.

B.5.7 Incident Command System (ICS)

The Incident Command System is the model tool for the command, control and coordination of resources at the scene of an emergency. It is a management tool of procedures for organizing personnel, facilities, equipment and communications. ICS is based upon basic management skills managers and leaders already know: planning, directing, organizing, coordinating, communicating, delegating and evaluating.

Continuity of Operations (COOP) planning should be addressed in the EOP. COOP ensures the essential functions of an organization, including government, can continue to operate during and after an emergency incident. An incident may prevent access to normally operating systems, such as physical plant, data or communication networks, or transportation. Government, business, other organizations, and families should be encouraged to prepare by regularly backing up computer drives, copying essential files, and storing these items in a separate location.

ICS is not a means to wrestle control or authority away from agencies or departments, a way to subvert the normal chain of command within a department or agency, nor is it always managed by the fire department, too big for small everyday events or restricted to use by government agencies and departments. ICS is an adaptable methodology suitable for emergency management as well as many other categories. If leadership is essential for the success of an event or a response, ICS is the supporting foundation for successfully managing that event.

The Incident Command System is built around five major management activities. These activities are:

- Command – sets objects and priorities and has overall responsibility at the incident or event.
- Operations – conducts tactical operations to carry out the plan and directs resources.
- Planning – develops the action plan to accomplish objectives and collects and evaluates information.
- Logistics – provides resources and services to support incident needs.
- Finance / Administration – monitors costs, provides accounting, reports time and cost analysis.

The system can grow or shrink to meet changing needs. This makes it very cost-effective and efficient. The system can be applied to a wide variety of situations such as fires, multi-jurisdiction and multi-agency disasters, hazardous material spills and recovery incidents, pest eradication programs and state or local natural hazards management.

For a detailed description of ICS, a diagram of ICS organization, or checklists of duties for each management activity and links to other resources see http://www.fema.gov/incident-command-system.

B.5.8 Mutual Aid / Interagency Agreements

Local governments should establish mutual aid agreements for utility and communications systems, including 9-1-1. Mutual aid or interagency agreements have value for preventing or responding to other hazard or emergency situations, as fire and police departments often do.

B.5.9 CERT (Community Emergency Response Team)

After a major disaster, local emergency teams quickly become overwhelmed. CERT is designed to have trained groups of citizens in every neighborhood and business ready to assist first responders (police, firefighters and EMSA) during an emergency.

CERT programs train and equip citizens in neighborhoods and businesses enabling them to "self-activate" immediately after a disaster. CERT teams are trained in:

- Disaster preparedness.
- Light fire and suppression.
- Light search and rescue.
- Basic medical care.

FEMA grants have been given to states for funding CERT programs or expanding existing teams. For more information on the CERT program talk to your local emergency management official or visit http://www.fema.gov/community-emergency-response-teams

B.5.10 Debris Management

The tornados of May 3, 1999 left an estimated 500,000 cubic yards of debris. Debris in the aftermath of a disaster poses significant health and safety risks. Debris can include fuel containers, chemicals, appliances and explosives.

Two key considerations regarding debris management are the need for rapid removal and protection of the public health and environment. Before a disaster strikes, communities should set up staging area(s) where citizens and cleanup crews can take debris prior to final disposal.

Community members can participate in debris control by securing debris, yard items, or stored objects that my otherwise be swept away, damaged, or pose a hazard if floodwaters would pick them up and carry them away. Additionally, a community can pass and enforce an ordinance regulating dumping.

For the Oklahoma Department of Environmental Quality's *Disaster Debris Management Guidelines for County and Municipal Governments* see document, https://www.deq.state.ok.us/tornado/DisasterDebrisMgtwlocaloffices.pdf

B.5.11 Critical Facilities Protection

"Critical facilities" are previously discussed in Section 2.3.5. Generally, they fall into three categories:

- Buildings or locations vital to the response and recovery effort, such as police and fire stations and telephone exchanges;
- Buildings or locations that, if damaged, would create secondary disasters, such as hazardous materials or utility facilities, or water treatment plants; and
- Locations that would require extraordinary response or preparedness measures, such as hospitals, retirement homes, or childcare facilities.

In addition, since September 11th, FEMA has also included financial institutions as critical facilities, because of the potential devastating effect on the community infrastructure upon their loss.

Protecting critical facilities during a disaster is the responsibility of the facility owner or operator. However, if they are not prepared for an emergency, the rest of the community could be impacted. If a critical facility is damaged, workers and resources may be unnecessarily drawn away from other disaster response efforts. If the owner or operator adequately prepares such a facility, it will be better able to support the community's emergency response efforts.

Most critical facilities have full-time professional managers or staff who are responsible for the facility during a disaster. These people often have their own emergency response plans. Many facilities would benefit from early disaster warning, disaster response planning, and coordination with community disaster response efforts.

Schools are critical facilities not only because of the special population they accommodate, but because they are often identified as shelter sites for a community. Processes and procedures can be developed to determine mitigation priorities incorporated into capital improvement plans that will ensure these buildings function after an event.

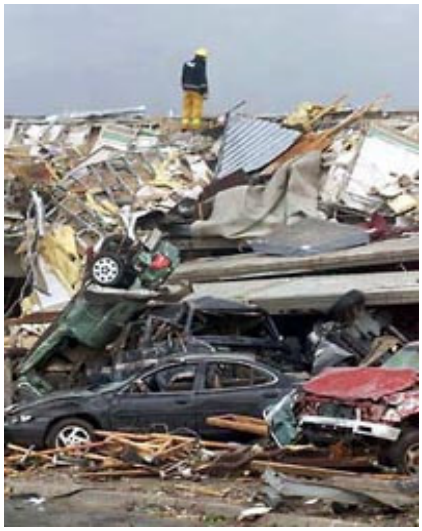
B.5.12 Site Emergency Plans

Communities can encourage development and testing of internal emergency plans and procedures, including continuity planning, by businesses and other organizations.

Communities should develop and test site emergency plans for schools, factories, office buildings, shopping malls, hospitals, correctional facilities, stadiums, recreation areas, and other similar facilities.

B.5.13 Post-Disaster Recovery and Mitigation

After a disaster, communities should undertake activities to protect public health and safety, facilitate recovery, and help people and property for the next disaster. Throughout the recovery phase, everyone wants to get “back to normal.” The problem is,



A firefighter searches through the remains of a hotel in Midwest City.
Oklahoman Staff Photo by Paul Hellstern

"normal" means the way they were before the disaster. Measures needed include the following:

Recovery Actions

- 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 Actions

- 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

Requiring permits, conducting inspections, and enforcing the NFIP substantial improvement/substantial damage regulations can be very difficult for local, understaffed overworked offices after a disaster. If these activities are not carried out properly, not only does the municipality miss a tremendous opportunity to redevelop or clear out a hazardous area, it may be violating its obligations under the NFIP.

B.5.14 StormReady Communities

StormReady, a program started in Oklahoma in 1999, helps arm America's communities with the communication and safety skills needed to save lives and property before and during an event. *StormReady* communities are better prepared to save lives from the onslaught of severe weather through better planning, education, and awareness.

StormReady has different guidelines for different sized communities. To be StormReady a community must:

- Establish a 24-hour warning point and emergency operations center.
- Have more than one way to receive severe weather warnings and forecasts and to alert the public.
- Create a system that monitors weather conditions locally.
- Promote the importance of public readiness through community seminars.

- Develop a formal hazardous weather plan, which includes training severe weather spotters and holding emergency exercises.

The economic investment in *StormReady* will depend on current assets. There is currently no grant funding for becoming *StormReady*. However, the Insurance Services Organization (ISO) may provide community rating points to *StormReady* communities. Those points may be applied toward lowering flood insurance rates.

For details on how to become *StormReady* and the requirements based on community size see http://www.stormready.noaa.gov/.

B.5.15 Conclusions

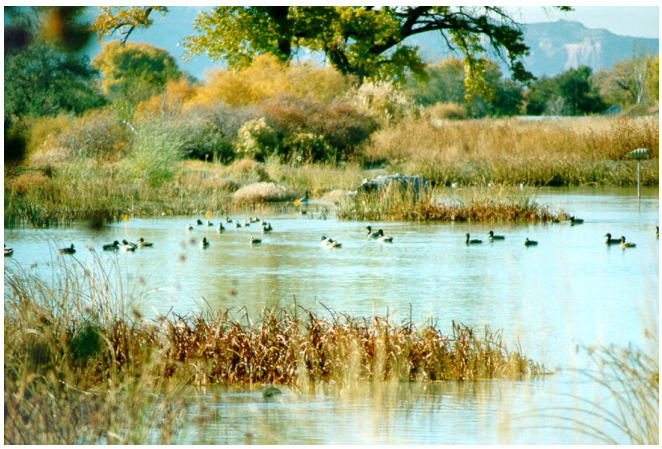
1. Using solid, dependable threat recognition systems is first and foremost in emergency services.
2. Following a threat recognition, multiple or redundant warning systems and instructions for action are most effective in protecting citizens.
3. Good emergency response plans that are updated yearly ensure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

B.5.16 Recommendations

Refer to *Chapter 6: Action Plan and Mitigation Measures,* Table 6–1, for a complete listing of all recommended mitigation measures by hazard and priority.

B.6 Natural Resource Protection

Natural resource protection activities are generally aimed at preserving and restoring the natural and beneficial uses of natural areas. In doing so, these activities enable the beneficial functions of floodplains and drainageways to be better realized. These natural functions include:



Wetlands are a valued resource to ecosystems and should be protected.

- Storage of floodwaters
- Absorption of flood energy
- Reduction of flood scour
- Infiltration and aquifer/groundwater recharge
- Removal/filtration of excess nutrients, pollutants, and sediments from floodwaters
- Habitat for flora and fauna
- Recreation and aesthetic opportunities, and
- Opportunities for off-street hiking and biking trails

This Section reviews natural resource protection activities that protect natural areas and mitigate damage from other hazards. Integrating these activities into the hazards mitigation program will not only reduce the City's susceptibility to flood damage, but will also improve the overall environment.

B.6.1 Wetland Protection

Wetlands are often found in floodplains and low lying areas of a watershed. Many wetlands receive and store floodwaters, thus slowing and reducing downstream flows. They also serve as a natural filter, which helps to improve water quality, and provide habitat for many species of fish, wildlife, and plants.

Wetlands

- Store large amounts of floodwaters
- Reduce flood velocities and erosion
- Filter water, making it cleaner for those downstream
- Provide habitat for species that cannot live or breed anywhere else

Wetlands are regulated by the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency under Section 404 of the Clean Water Act. Before a "404" permit is issued, the plans are reviewed by several agencies, including the Corps and the U.S. Fish and Wildlife Service. Each of these agencies must sign off on individual permits. There are also nationwide permits that allow small projects that meet certain criteria to proceed without individual permits.

B.6.2 Erosion and Sedimentation Control

Farmlands and construction sites typically contain large areas of bare exposed soil. Surface water runoff can erode soil from these sites, sending sediment into downstream waterways. Sediment tends to settle where the river slows down and loses power, such as when it enters a lake or a wetland.

Construction projects, which can expose large areas to erosion, should be closely monitored.

Sedimentation will gradually fill in channels and lakes, reducing their ability to carry or store floodwaters. When channels are constricted and flooding cannot deposit sediment in the bottomlands, even more is left in the channels. The result is either clogged streams or increased dredging costs.

Not only are the drainage channels less able to do their job, but also the sediment in the water reduces light, oxygen, and water quality and often brings chemicals, heavy metals and other pollutants. Sediment has been identified as the nation's number one nonpoint source pollutant for aquatic life.

Practices to reduce erosion and sedimentation have two principal components:

1. Minimize erosion with vegetation and
2. Capture sediment before it leaves the site.

Lack of vegetation along drainage channels promotes erosion

Slowing surface water runoff on the way to a drainage channel increases infiltration into the soil and reduces the volume of topsoil eroded from the site. Runoff can be slowed down by measures such as terraces, contour strip farming, no-till farm practices, sediment fences, hay or straw bales (as illustrated), constructed wetlands, and impoundments (e.g., sediment basins and farm ponds).

Erosion and sedimentation control regulations mandate that these types of practices be incorporated into construction plans. They are usually oriented toward construction sites rather than farms. The most common approach is to require applicants for permits to submit an erosion and sediment control plan for the construction project. This allows the applicant to determine the best practices for the site.

One tried and true approach is to have the contractor design the detention basins with extra capacity. They are built first, so they detain runoff during construction and act as sediment catch basins. The extra capacity collects the sediment that comes with the runoff until the site is planted and erosion is reduced.

B.6.3 River Restoration

There is a growing movement that has several names, such as “stream conservation,” “bioengineering” or “riparian corridor restoration.” The objective of these approaches is to return streams, stream banks and adjacent land to a more natural condition, including the natural meanders. Another term is “ecological restoration” which restores native indigenous plants and animals to an area.

A key component of these efforts is using appropriate native plantings along the banks that resist erosion. This may involve “retrofitting” the shoreline with willow cuttings, wetland plants, and/or rolls of landscape material covered with a natural fabric that decomposes after the banks are stabilized with plant roots.

Retrofitting streambanks with willow cuttings and geotextiles can be more cost effective than riprap or concrete-lined floodways.

Studies have shown that after establishing the right vegetation, long-term maintenance costs are lower than if the banks were concrete. The Natural Resources Conservation Service estimates that over a ten-year period, the combined costs of installation and maintenance of a natural landscape may be one-fifth of the cost for conventional landscape maintenance, e.g., mowing turf grass.

B.6.4 Best Management Practices

Point source pollutants come from pipes such as the outfall of a municipal wastewater treatment plant. State and federal water quality laws have reduced the pollutants that come from these facilities.

Non-point source pollutants come from non-specific locations and are harder to regulate. Examples are lawn fertilizers, pesticides, and other farm chemicals, animal wastes, oils from street surfaces and industrial areas, and sediment from agriculture, construction, mining and forestry. These pollutants are washed off the ground’s surface by stormwater and flushed into receiving storm sewers, ditches and streams.

Best management practices (BMPs) are measures that reduce nonpoint source pollutants that enter the waterways. BMPs can be implemented during construction and as part of a project’s design to permanently address nonpoint source pollutants.

There are three general categories of BMPs:

1. **Avoidance**—Setting construction projects back from the stream.
2. **Reduction**—Preventing runoff that conveys sediment and other water-borne pollutants, such as planting proper vegetation and conservation tillage.
3. **Cleansing**—Stopping pollutants after they are en route to a stream, such as using grass drainageways that filter the water and retention and detention basins that let pollutants settle to the bottom before they are drained.

In addition to improving water quality, BMPs can have flood related benefits. By managing runoff, they can attenuate flows and reduce the peaks after a storm. Combining water quality and water quantity measures can result in more efficient multi-purpose stormwater facilities.

Because of the need to clean up our rivers and lakes, there are several laws mandating the use of best management practices for new developments and various land uses. The furthest reaching one is the U.S. Environmental Protection Agency's National Pollutant Discharge Elimination System (NPDES) requirements.

B.6.5 Dumping Regulations

NPDES addresses liquid pollutants. Dumping regulations address solid matter, such as shopping carts, appliances and landscape waste that can be accidentally or intentionally thrown into channels or wetlands. Such materials may not pollute the water, but they can obstruct even low flows and reduce the channels' and wetlands' ability to convey or clean stormwater.

Many cities have nuisance ordinances that prohibit dumping garbage or other "objectionable waste" on public or private property. Waterway dumping regulations need to also apply to "non-objectionable" materials, such as grass clippings or tree branches which can kill ground cover or cause obstructions in channels.

Many people do not realize the consequences of their actions. They may, for example, fill in the ditch in their front yard not realizing that it is needed to drain street runoff. They may not understand how regrading their yard, filling a wetland, or discarding leaves or branches in a watercourse can cause a problem to themselves and others. Therefore, a dumping enforcement program should include public information materials that explain the reasons for the rules as well as the penalties.

Regular inspections to catch violations also should be scheduled. Finding dumped materials is easy; locating the source of the refuse is hard. Usually the owner of property adjacent to a stream is responsible for keeping the stream clean. This may not be fair for sites near bridges and other public access points.

B.6.6 Conclusions

1. Wetlands play an important role in natural course of flood control, preservation of water quality, and wildlife habitation, making a strong case for their protection.
2. Erosion can be reduced by use of vegetation. Sedimentation should be captured before it leaves its original location with oversized detention basins.
3. Vegetation used along riverbanks works more effectively in river maintenance than using banks made of concrete.
4. Nonpoint source pollutants are best managed by keeping construction projects away from streams, reducing sediment runoff, and using grass drainageways and detention basins for filtration.
5. Dumping regulations need to be communicated to the public and enforced.
6. The establishment and maintenance of wildlife habitat and natural ecosystems should be an important aspect of any drainage system program the City may implement in regards to floodplain management. This can be developed in cooperation with the

Oklahoma Department of Wildlife Conservation, allowing aquatic plants and wildlife to be established in stormwater detention ponds and floodways.

B.6.7 Recommendations

Refer to *Chapter 6: Action Plan*, for a complete listing of all recommended mitigation measures by hazard and priority.

Appendix C: Meeting Agendas and Sign-in Sheets

This appendix has the Agendas and Sign-in sheets for meetings that were held during the planning process. See Chapter 3 for list of meetings and dates.

AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Public Outreach
CRS
May 11, 2011 – 1:30 p.m.
PW Engineering Services
Conference Room S-328

Multi-Hazard Mitigation Plan:

1. Historic Preservation Annex Status.
2. SDHMAB Updates. Hazard Mitigation Measures
3. Prioritizing Mitigation Measures.
4. Grant for Mitigation plan update. Submitted
5. Hager Creek acquisition area strategy.

Public Outreach:

1. Spreading the Word on Mitigation Measures.
2. Outreach Methods for Disaster Preparedness and CRS Credit.
3. Outreach for new 2012 DFIRMs.

CRS:

1. Status of 2011 Reverification.
2. Floodplain Database
3. Other Items.

Next Meeting: June 8, 2011, PW Engineering Services
Conference Room 328

Adjorn

COT-CRS/HM/CPS 1:30 pm 5/11/11

BROBISON, D BERRY, RDE, TIM LOVELL

MULTI-HAZARD MITIGATION PLAN

1. HISTORIC PRESERVATION ANNEX STATUS - No progress. State looking into HP Districts
2. SDHMAB UPDATES - HM measures

TIM LOVELL - REGION VI -

Child Care Resource Center -

Save the Children - Business Continuity Training;

Karen Smith (funded by United Way);

Nat Assn of Child Care Resource + Referral Agencies has an emergency planning guide for Child Care facilities.

Next June meet - Child Resources Center -

NFIP Presentation on Changes to NFIP;

TIM - Sustainability; Brett Fiedler - Mayors Office.

Safe + Sustainability Planning Model;

OC Survey -

WISCONSIN CONFERENCE - Jim Lovell;

8 Communities w/ HM Projects - Wildfire, Soldiers Grove (Relocation), Bill Becker;

June 21st NEMA Awards (Soldiers Grove).

NAPA Valley - Flood; San Diego - Wildfire;

Miami Dade - (Multiple Hazards); Chicago - Extreme Heat Plan;

RR / w/ Pinky on status of COT HM Update

SIREN - (BR to Pinky) -

1. Meet
2. Warning Siren
3. Thursday:
4. Outreach

5. INGER CREEK ACQUISITION -

Letters of interest - 4 properties - HMGP -
$800K package;

PUBLIC OUTREACH -

French - changes to CRS.

IBC/IRC 2009 Grant Earthly (code Council).
State Considering adopting State Building
Codes: State to adopt

COMBINED COMMITTEE MEETING

SIGN-IN SHEET

Meeting Date: May 11, 2011

NAME*	INITIAL	E-MAIL ADDRESS	PHONE NO.	MEMBER	GUEST
City of Tulsa					
Kenneth Hill		kenhill@cityoftulsa.org	596-7274	X	
Bill Robison	BHR	brobison@cityoftulsa.org	596-9475	X	
Michelle Lester		mlester@cityoftulsa.org	596-7266	X	
G. David Steele		dsteele@cityoftulsa.org	596-7285	X	
Bob Bledsoe		Bobbledsoe@cityoftulsa.org	596-1279	X	
Kim Meloy		kmeloy@cityoftulsa.org	596-7271	X	
Michael Baker		MBaker@cityoftulsa.org	596-9420	X	
Dave Berry	DRB	dberry@tulsarealtors.com	637-5359	X	
Roy Foster		rfoster@cityoftulsa.org	596-1344	X	
Richard Green		rgreen@cityoftulsa.org	596-7816	X	
Richard Hall		RichHall@cityoftulsa.org	596-1782	X	
Chief C.A. LaCroix		RJolliff@cityoftulsa.org	596-9898	X	
Roger Jolliff		MMcCool@cityoftulsa.org	596-9890	X	

Deborah Stowers		Dstowers@cityoftulsa.org	596-9498	X	
Consultants					
Ron Flanagan (consultant)	RDF	rdflanagan@rdflanagan.com	749-2696	X	
David Wakefield (consultant)		dwakefield@rdflanagan.com	749-2696	X	
Subconsultants					
Tim Lovell	TML	tulsapartners@gmail.com	632-0044	X	
JoAnn Woody		Jiwoody1017@sbcglobal.net		X	
SD&HMAB					
Kyle Brierly		kylebrierly@rooter.com	622-6996	X	
Gary Cheatham		garycheatham@sbcglobal.net	695-8876	X	
Judith Finn		judithfinn@att.net	587-1800	X	
Ann Patton		ann.patton@sbcglobal.net	296-1959	X	
Bob Roberts		brob11@swbell.net		X	
Guest					
					X
					X
					X
					X

AMENDED AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

3:00 P.M., Tuesday, May 17, 2011

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

Gary Cheatham, Chair
Judith Finn, Vice-Chair
Ann Patton, Secretary
Kyle Brierly, Member
Bob Roberts, Member

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Deborah Stowers, Asst. Secretary & Records Custodian
Jack Page, OWRB Accredited Floodplain Administrator
Mark Swiney, Board Counsel

FILED
CITY OF TULSA
STATE OF OKLAHOMA
2011 MAY 13 A 10:49
MICHAEL P. KIER
CITY CLERK

Call to Order & Roll Call ..... **Chair**

I. ADMINISTRATIVE MATTERS

A. **Approval/Correction of Minutes: April 19, 2011** ..... **Chair**

II. BOARD ACTION ITEM

A. **Election of Officers** ..... **Chair**

B. **Discuss and consider recommending amendments to Title 11-A, Chapter2, Sections 200 and 202** ..... **Ken Hill**

III. REPORTS

A. **Director's Report** ..... **Clayton Edwards**
   1) **Monthly Financial Report** ..... **Alan Rowland**
   2) **Proposed Fund Transfers** ..... **Alan Rowland**
   3) **Capital Projects Status Report** ..... **Deborah Stowers**

B. **Floodplain Administrator's Report** ..... **Jack Page**
   1) **Permit Center Report** ..... **Harold Tohlen**

C. **Implementation of the Mitigation Plan** ..... **Bill Robison**

IV. DISCUSSION ITEMS

A. **Stormwater Design Criteria Manuel** ..... **Bill Robison**
B. **City of Tulsa Codes for Safe Rooms** ..... **David Steele**
C. **Low Impact Development** ..... **Bill Robison**
D. **SDAHMB Process for Appeals** ..... **Mark Swiney**
E. **Electronic Delivery of Meeting Packets** ..... **Gary Cheatham**
F. **Arkansas River West Bank Development** ..... **Ann Patton**

V. APPEALS & VARIANCES - None

VI. NEW BUSINESS – None

Please Note: The OMA limits "new business" to only those matters not known about, or which could not have been reasonably foreseen, prior to the posting of the Agenda.

VII. FUTURE AGENDA ITEMS

VIII. PUBLIC COMMENTS

Although the OMA limits Board action to those matters specifically listed on this Agenda, the Board solicits and encourages public comments and ideas.

IX. MEETING CLOSURE ..... **Chair**

X. NEXT MEETING ..... **June 21, 2011**

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

MINUTES
STORMWATER DRAINAGE AND HAZARD MITIGATION ADVISORY BOARD
Tuesday, May 15, 2011
2317 South Jackson Room S213, Tulsa, OK 74107

Members Present
Gary Cheatham, Chairman
Judith Finn, Vice Chairman
Ann Patton, Member
Bob Roberts, Member

Absent
Kyle Brierly, Member

Others Present

Michelle Barnett	Enercon
Bob Bledsoe	Communications
Graham Brannin	Public Works, Environmental Operations
Robert Dimmick	Finance Department
Chris Forster	Public Works, Policy Development
Ken Hill	Public Works, Assistant Director
Philip Howery	Public Works, Underground Collections
Jack Page	Development Services, Director
David Steele	Development Services
Deborah Stowers	Public Works, Engineering Services
Mark Swiney	City Legal
Laguitia Tate	Public Works, Engineering Services
Roy Teeters	Public Works, Surface Drainage & Vegetation Management
Bryan Young	Public Works, Public Facilities Maintenance
Paul Zachary	Public Works, Engineering Services

DRAFT

Call to Order and Roll Call

At 3:07 p.m. Deborah Stowers called roll and established a quorum before Gary Cheatham called the meeting to order.

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of Minutes: April 19, 2011

The April 19, 2011 minutes were approved unanimously.

II. BOARD ACTION ITEMS

A. Discuss and Consider Recommending Amendments to Title 11-A, Chapter 2, Sections 200 and 202.

Ken Hill explained the changes to the Stormwater Drainage System Service Charge. These changes included adding "or gravel surface" to Section 200.C Equivalent Service Unit, deleting the word gravel from Section 200.D, Impervious Surface and to add the definition of gravel to the section. In Section 202, under All Other Real Estate, the explanation separating gravel from impervious service was added, the calculation of gravel surfaces under Gravel Surfaces, and the excess capacity credit under Rate Schedule.

Mr. Hill suggested that if the SDAHMB was in agreement with the changes, to recommend approval to submit to the City Council for changes to Title 11-A, Chapter 2, Sections 200 and 202.

After discussion regarding the changes with Jack Page, the motion to move for City Council approval was approved by SDAHMB.

B. Election of Officers

Judith Finn motioned that the officers remain in their current positions. This motion passed unanimously.

III. REPORTS

A. Director's Report

1) Monthly Financial Report

Chris Forster reported that total revenue year to date is $19 million and total resources are $23 million. All revenues are on track with miscellaneous revenue up by $150 thousand due to late fees. The expenditures are year to date $20.6 million. Actual billings are $18.6 million and actual collections are $18.5 million. Stormwater billings are dead even with last year. Fees-in-lieu fund for April is $160.5 thousand and year to date is $540.6 thousand.

2) Proposed Fund Transfers

Chris Forster reported there were no proposed fund transfers.

3) Capital Projects Status Report

Deborah Stowers presented the May capital projects status report highlighting:

i. Fred Creek Drainage design is 57% complete
ii. Vensel Creek design (88th St to 84 St) is 16% complete
iii. Elm Creek design is 98% complete

Ms. Patton inquired about an update on the reorganization of the Public Works Department. Bob Bledsoe and Ken Hill suggested that someone from the Mayor's office should speak on that subject.

Ms. Patton suggested inviting someone from the Mayor's office to speak on this item and that it remain on the agenda until the reorganization is complete.

DRAFT

B. Floodplain Administrator's Report

1) Permit Center Report

David Steele reported the month of April had six permits issued in the regulatory floodplain and two permits in the FEMA floodplain which resulted in $183.75 in permit fees and $58,727.48 in fees-in-lieu of detention. There was one watershed permit and three elevation certificates received, one in residential and two in commercial. There were no violations of floodplain ordinances.

C. Implementation of the Mitigation Plan

No update.

IV. DISCUSSION ITEMS

A. Stormwater Design Criteria Manual

Deborah Stowers explained that Bill Robison was waiting for the completion of the Public Works Department reorganization.

B. City of Tulsa Codes for Safe Rooms

Mr. David Steele stated that there is nothing new to report for this month because they are still waiting on the passing of a statewide uniform building code and he presented the actual wording of the code (748:20-5-6. IRC 2009 Chapter 3 Building Plans, Section R323).

Ms. Patton wanted to know why the City was waiting on the State to adopt the code and requested that we adopt a code now.

Jack Page explained that it was the Home Builders Association that prevented them from going ahead with the code primarily because of the electrical code issues and the residential swimming pools. Mr. Page explained that the code itself is a blanket of lots of things and he didn't want the home builders to be able to pick and choose what they want out of the code.

Judith Finn expressed her concerns about or danger of piecemeal of the safety standards and Mr. Page explained that the codes are more market driven to a great extent more than they are research driven.

After further discussion regarding the requirements and minimum standards for safe rooms, Ann Patton made a motion that the Board recommends the City of Tulsa to adopt an ordinance that provides the minimum standards (one of the following: ICC/NSSA 500 or FEMA 320 or other equivalent engineered system) for safe rooms and to not wait for the State.

Judith Finn seconds the motion and the motion passed unanimously.

DRAFT

C. Low Impact Development

Graham Brannin introduced Michelle Barnett from Enercon to give an overview of the specifics of LID. Ms. Barnett gave a presentation highlighting what LID is and is not, why we are talking about LID in the first place, the current paradigm, the benefits and the barriers.

D. SDAHMB Process for Appeals

Mark Swiney presented the Board of Adjustment process and thinks that these procedures will work well with this board.

Ms Finn asked to make these procedures more formal, so Ms. Patton recommended that Ms. Finn and Mr. Swiney work together to develop a step by step process to be presented at next month's meeting.

E. Electronic Delivery of Meeting Packets

Ann Patton and Judith Finn prefer to continue getting the paper packets. Bob Roberts would like to continue receiving the electronic packets and Gary Cheatham will try the electronic packet one more time before deciding.

Mr. Cheatham requested that more details be included on the active Capital Improvement Projects. Paul Zachary said that a weekly report is sent weekly to the City Manager and Mayor and suggested that this report should have the details requested.

F. Arkansas River Bank Development

Ann Patton inquired about the flood standards on building along the river. Jack Page explained that the regulatory standard is the one hundred year floodplain and that maps are available on the 1986 flood. He further stated that they reported this month significantly improving a project that is in the floodplain and that there is some discussion about the wisdom of expanding facilities that are in the floodplain.

Ms. Finn asked that if the City was going to be funding the development that they are putting out bids on. Bob Bledsoe explained that the City is asking developers to propose what they would like to do with the property and the usual boards and commissions will do the approving.

Ms Finn also inquired about the legal liability in the inviting developers to build in a floodplain and Mr. Page explained that the City has a flood insurance program and rules and regulations that guide developers on the requirements to build in a floodplain.

V. APPEALS & VARIANCES

There were no appeals.

VI. NEW BUSINESS - None

VII. FUTURE AGENDA ITEMS -None

VIII. PUBLIC COMMENTS - None

IX. MEETING CLOSURE

Upon receiving no other comments or further questions, Mr. Chairman thanked everyone for attending and adjourned the meeting at 5:26 p.m.

X. NEXT MEETING – June 21, 2011

DRAFT

AMENDED AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

3:00 P.M., Tuesday, June 21, 2011

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

Gary Cheatham, Chair
Judith Finn, Vice-Chair
Ann Patton, Secretary
Kyle Brierly, Member
Bob Roberts, Member

--

Deborah Stowers, Asst. Secretary & Records Custodian
Jack Page, OWRB Accredited Floodplain Administrator
Mark Swiney, Board Counsel

FILED
CITY OF TULSA
STATE OF OKLAHOMA
2011 JUN 20 A 10: 18
MICHAEL P. KIER
CITY CLERK

Call to Order & Roll Call ..... **Chair**

I. ADMINISTRATIVE MATTERS

- **A. Approval/Correction of Minutes: May 17, 2011** ..... **Chair**

II. BOARD ACTION ITEM - None

III. REPORTS

- **A. Director's Report** ..... **Clayton Edwards**
  - **1) Monthly Financial Report** ..... **Alan Rowland**
  - **2) Proposed Fund Transfers** ..... **Alan Rowland**
  - **3) Capital Projects Status Report** ..... **Deborah Stowers**
  - **4) Reorganization of Public Works Department** ..... **Mayor's Office**
- **B. Floodplain Administrator's Report** ..... **Jack Page**
  - **1) Permit Center Report** ..... **Harold Tohlen**
- **C. Implementation of the Mitigation Plan** ..... **Bill Robison**

IV. DISCUSSION ITEMS

- **A. Safe Room Development** ..... **David Steele**
- **B. Low Impact Development** ..... **Bill Robison**
- **C. Stormwater Design Criteria Manuel** ..... **Bill Robison**
- **D. SDAHMB Process for Appeals** ..... **Mark Swiney**
- **E. Arkansas River West Bank Development** ..... **Roger Acebo**

V. APPEALS & VARIANCES - None

VI. NEW BUSINESS – None

Please Note: The OMA limits "new business" to only those matters not known about, or which could not have been reasonably foreseen, prior to the posting of the Agenda.

VII. FUTURE AGENDA ITEMS

VIII. PUBLIC COMMENTS

Although the OMA limits Board action to those matters specifically listed on this Agenda, the Board solicits and encourages public comments and ideas.

IX. MEETING CLOSURE ..... **Chair**

X. NEXT MEETING ..... **July 18, 2011**

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

MINUTES
STORMWATER DRAINAGE AND HAZARD MITIGATION ADVISORY BOARD
Tuesday, June 21, 2011
2317 South Jackson Room S213, Tulsa, OK 74107

Members Present	**Absent**
Gary Cheatham, Chairman	Ann Patton, Member
Judith Finn, Vice Chairman	
Kyle Brierly, Member	
Bob Roberts, Member	

Others Present

Roger Acebo	Economic Development of Real Estate Management
Bob Bledsoe	Communications
Graham Brannin	Public Works, Environmental Operations
Roy Foster	Public Works, Quality Assurance
Philip Howery	Public Works, Underground Collections
Linda McPherson	Public Works, Utilities Services
Bill Robison	Public Works, Engineering Services
David Steele	Development Services
Deborah Stowers	Public Works, Engineering Services
Roy Teeters	Public Works, Surface Drainage & Vegetation Management
Bryan Young	Public Works, Public Facilities Maintenance
Paul Zachary	Public Works, Engineering Services

DRAFT

Call to Order and Roll Call

At 3:10 p.m. Deborah Stowers called roll and established a quorum before Gary Cheatham called the meeting to order.

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of Minutes: May 17, 2011

The May 17, 2011 minutes were approved unanimously.

II. BOARD ACTION ITEMS - None

IV. DISCUSSION ITEMS

E. Arkansas River West Bank Development

Roger Acebo spoke on the Request for Proposal (RFP) now being offered by the City of Tulsa and released by the Mayor's office for the Tulsa Public Works West Tulsa Facility, West Tulsa Park and the River Festival Park, highlighting portions of the RFP. It was released on April 29th with a three month period (July 29th) for the proposals to be submitted. Eleven contractors have shown interest with maybe two or three others. No major restrictions were included for what was expected to be proposed. Mr. Acebo directed any other interest to the link (www.cityoftulsa.org/tulsariver) of the RFP.

Once the proposals are received, an assessment committee made up with the Councilor for this area, the Commissioner, and the TDA board chair will assess the pros and cons.

III. REPORTS

A. Director's Report

1) Monthly Financial Report

Deborah Stowers referred the Board to the financial report for the month of May stating the end of the budget year shows that percent of budget is 93.5 and YTD estimate is 92.9%. Fee-in-lieu funds for May are $67,399 and year to date is $608,041.

2) Proposed Fund Transfers

No report.

3) Capital Projects Status Report

Deborah Stowers presented the June capital projects status report stating that Joe Creek – 53rd & Lewis is currently underway.

4) Reorganization of Public Works Department

Gary Cheatham informed the board that he was asked to be included in the interviewing process for the directors for the newly formed departments and did interview four candidates for one of the positions, but the decision will be left with the Mayor. The Mayor has included the board in the process but do not know to what extent.

B. Floodplain Administrator's Report

1) Permit Center Report

David Steele reported the month of May had seven permits issued in the regulatory floodplain and twelve permits in the FEMA floodplain which resulted in $288.75 in permit fees and $46,326.72 in fees-in-lieu of detention. Nine commercial of the twelve permits in FEMA floodplain were all City of Tulsa projects, therefore is sort of misleading. There were two elevation certificates received and two from previous permits. There were no violations of floodplain ordinances.

C. Implementation of the Mitigation Plan

Bill Robison distributed the Status of Tulsa Mitigation Measures list and discussed the status, grants, and the priorities of the categories. The board members need to rank the categories from the list and compare scores to come up with how to analyze.

IV. DISCUSSION ITEMS

A. Safe Room Development

David Steele spoke on the status on developing a safe room code. It is no longer on hold pending a State code. The state is in the process of adopting the IRC code 2009 and they did modify to include Section R.323.1 of Title 748 Uniform Building Code regarding safe rooms which included the minimum standard ICC/NSSA 500 or FEMA 320 or other equivalent engineered systems.

Jack Page has made the decision that the City of Tulsa will no longer wait on the State to pass this code. It has to go to the State legislature and to the Governor before being implemented. Mr. Page made a decision to go forward to the City Council and the Mayor to amend Chapter 3, Title 51 to adopt a safe room standard for code enforcement.

B. Low Impact Development

Bill Robison distributed a report and discussed the measures of the pros and cons of LID from an engineering services view. These measures included rain gardens, pervious pavement, cisterns/reuse and green roofs.

DRAFT

C. Stormwater Design Criteria Manual

Bill Robison informed the Board that this is on hold pending the reorganization of the Public Works Department.

D. SDAHMB Process for Appeals

Judith Finn presented the process of Rules for Hearings on Appeals and Variances that she and Mark Swiney had compiled.

The Appeal and Variances will be moved up on the agenda permanently.

V. APPEALS & VARIANCES

There were no appeals.

VI. NEW BUSINESS - None

VII. FUTURE AGENDA ITEMS -None

VIII. PUBLIC COMMENTS - None

IX. MEETING CLOSURE

Upon receiving no other comments or further questions, Mr. Chairman thanked everyone for attending and adjourned the meeting at 5:00 p.m.

X. NEXT MEETING – July 19, 2011

DRAFT

AMENDED AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

3:00 P.M., Tuesday, July 19, 2011

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

Gary Cheatham, Chair
Judith Finn, Vice-Chair
Ann Patton, Secretary
Kyle Brierly, Member
Bob Roberts, Member

--

Deborah Stowers, Asst. Secretary & Records Custodian
Jack Page, OWRB Accredited Floodplain Administrator
Mark Swiney, Board Counsel

FILED
CITY OF TULSA
STATE OF OKLAHOMA
2011 JUL 14 A 11:59
MICHAEL P. KIER
CITY CLERK

Call to Order & Roll Call ..... **Chair**

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of Minutes: June 21, 2011 ..... **Chair**

II. APPEALS & VARIANCES - None

III. BOARD ACTION ITEM

A. SDAHB Process for Appeals ..... **Mark Swiney**

IV. REPORTS

B. Director's Report ..... **Clayton Edwards**
- **1) Monthly Financial Report** ..... **Alan Rowland**
- **2) Proposed Fund Transfers** ..... **Alan Rowland**
- **3) Capital Projects Status Report** ..... **Deborah Stowers**

B. Floodplain Administrator's Report ..... **Jack Page**
- **1) Permit Center Report** ..... **Harold Tohlen**

C. Implementation of the Mitigation Plan ..... **Bill Robison**
- **1) Lightning Notification** ..... **Bob Roberts**

V. DISCUSSION ITEMS

A. Safe Room Development ..... **David Steele**
B. Low Impact Development ..... **Bill Robison**
C. Stormwater Design Criteria Manual ..... **Bill Robison**

VI. NEW BUSINESS – None

Please Note: The OMA limits "new business" to only those matters not known about, or which could not have been reasonably foreseen, prior to the posting of the Agenda.

VII. FUTURE AGENDA ITEMS

VIII. PUBLIC COMMENTS

Although the OMA limits Board action to those matters specifically listed on this Agenda, the Board solicits and encourages public comments and ideas.

IX. MEETING CLOSURE ..... **Chair**

X. NEXT MEETING ..... **August 16, 2011**

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

MINUTES
STORMWATER DRAINAGE AND HAZARD MITIGATION ADVISORY BOARD
Tuesday, July 19, 2011
2317 South Jackson Room S213, Tulsa, OK 74107

Members Present
Gary Cheatham, Chairman
Judith Finn, Vice Chairman
Ann Patton, Member
Bob Roberts, Member

Absent
Kyle Brierly, Member

Others Present

Bob Bledsoe	City of Tulsa, Communications
Graham Brannin	City of Tulsa, Streets & Stormwater
Carl Craigo	City of Tulsa, Engineering Department
Jim East	George Kaiser Family Foundation
Chris Forster	City of Tulsa, Finance
David Steele	City of Tulsa, Development Services
Mark Swiney	City of Tulsa, Legal
Laguitia Tate	City of Tulsa, Engineering Department
Bryan Young	City of Tulsa, Streets and Stormwater
Paul Zachary	City of Tulsa, Engineering Department

DRAFT

Call to Order and Roll Call

At 3:04 p.m. Carl Craigo called roll and established a quorum before Gary Cheatham called the meeting to order.

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of Minutes: June 21, 2011

The June 21, 2011 minutes were approved unanimously.

II. APPEALS & VARIANCES - None

III. BOARD ACTION ITEMS

A. SDAHB Process for Appeals

Mark Swiney indicated that the process he and Judith Finn drafted was presented to the Board at the last meeting. Gary Cheatham asked if this process would conflict with the bylaws and Mr. Swiney informed him that an approval by the Board would supersede and that this process would be added to the bylaws. Mr. Cheatham asked that the bylaws and all amendments are sent electronically to the Board. After the modifications to the process, this item will be voted on for approval at next meeting.

IV. REPORTS

A. Director's Report

1) Monthly Financial Report

Chris Forster informed the Board that Finance Accounting was still closing the books for end of fiscal year, therefore there is no financial report generated for this month.

2) Proposed Fund Transfers

Chris Forster reported there were no proposed fund transfers.

3) Capital Projects Status Report

Carl Craigo presented the July capital report stating:

a) Fred Creek is 65% complete
b) Vensel Creek is 30% complete

Mr. Cheatham inquired about Mingo Creek and Mr. Craigo informed him that there is a project in that area and City of Tulsa maintenance is doing sedimentation north of Pine.

Mr. Cheatham also asked about the major sedimentation at 31st & Mingo behind Southern Agriculture and Brian Young informed him that Southern Agriculture owns that area and will not allow the City of Tulsa to enter to mow regularly. Mr. Young also stated that the City will occasionally go in and clean the area after obtaining permission, but the area is not one that is routinely maintained.

B. Floodplain Administrator's Report

1) Permit Center Report

David Steele reported the month of June had no permits issued for commercial in the regulatory floodplain. There was a total of five in regulatory floodplain and two in the FEMA floodplain which resulted in $157.50 in permit fees and $10,686.98 in fees-in-lieu of detention. All eight elevation certificates received were residential. There were three commercial permits in floodplain that required detention. There has been an increase in permits issued for residential interior remodeling, additions to the homes, swimming pools, etc. and not quite as many new residences.

C. Implementation of the Mitigation Plan

The Board agreed that they hope to adopt this plan at the next meeting after modifications and updates of priorities are set.

1) Lightening Notification

Bob Roberts gave a power point presentation on lightening notification because one of the measures identified in the City of Tulsa Mitigation Plan is to develop a lightening warning system.

Mr. Roberts is the Emergency Manager for Tulsa Public Schools and informed the Board that several units called Thor Guard have been installed within the TPS system and gave an overview of the system itself. He also recommended that the City of Tulsa and Tulsa County partner with the TPS rather than start from scratch. This will save the City and TPS a considerable amount of money noting that the installation would cost approximately $20,000 per unit and is grant eligible.

Mr. Cheatham suggested that the first step would be to contact the City of Tulsa Emergency Manager and inform him that the Board had reviewed this and that it may be considered.

Ms. Patton suggested that the meeting that Bill Robison has each month on the Mitigation Plan would be a good place to discuss this issue and requested that Mr. Roberts begin attending these meetings.

DRAFT

IV. DISCUSSION ITEMS

A. Safe Room Development

David Steele informed the Board that the State adopted IRC code 2009 with amendments. Mr. Steele stated that the City of Tulsa will hopefully adopt IRC 2009 after Jack Page, along with other city staff, make the necessary changes that will include the City of Tulsa code requirements.

Ms. Ann Patton requested that Bill Robison give the Board a report on grant application for safe room incentive program.

B. Low Impact Development

Graham Brannin presented a video on LID and informed the Board of the exciting things happening around the City of Tulsa on low impact development infrastructure. The sustainability plain is being developed and is very much a topic. Mr. Brannin also stated that there are some large private construction projects coming up in Tulsa and will be working together to take care of any hurdles that may develop.

This presentation can be accessed via the internet: http://www.phillywatersheds.org/ (link onto picture at bottom left of this screen).

C. Stormwater Design Criteria Manual

No Report

DRAFT

VI. NEW BUSINESS

Ms. Ann Patton informed the Board about the Natural Hazard Mitigation Association (NHMA) and gave an overview of the conference she attended in Colorado. She also suggested that other member and staff should become members and will forward more information via e-mail.

Ms. Ann Patton asked for an update on the Public Works Department and Mr. Paul Zachary responded by informing the Board of the current reorganization that consist of three department configurations: Water & Sewer, Streets & Stormwater, and Engineering. Mr. Zachary stated that the Mayor's direction is that all issues were being addressed and that it can be done. The coordination and/or work effort is not vertical; it is horizontal and everyone will have to work with others. He also stated that whatever organizational structure is final; we still have a job to do and coordinate and are looking forward to being finished with the reorganization and re-establishing some of the things we've had in the past such as coordination meetings and getting the right people at the right table regardless of who they report to. Mr. Zachary stated that he is encouraged about going back to three departments and that it can work.

Mr. Zachary informed the Board that he plans to attend the monthly meeting and Dan Crossland will make the decision of his designee. He also stated that along with Roy Foster and Bryan Young, a standard report could be generated to keep the Board abreast of all the topics.

VII. FUTURE AGENDA ITEMS -None

VIII. PUBLIC COMMENTS - None

IX. MEETING CLOSURE

Upon receiving no other comments or further questions, Mr. Chairman thanked everyone for attending and adjourned the meeting at 4:27 p.m.

X. NEXT MEETING – August 16, 2011

AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Public Outreach
CRS
August 10, 2011 – 1:30 p.m.
PW Engineering Services
Conference Room S-328

Multi-Hazard Mitigation Plan:

1. Individual Safe Room Program
2. ThorGuard
3. Historic Preservation Annex Status.
4. SDHMAB Updates. Hazard Mitigation Measures
5. Prioritizing Mitigation Measures.
6. Grant for Mitigation Plan Update. Status Update
7. Hager Creek Acquisition Area Grant.

Public Outreach:

1. New Outreach Video Production.
2. Outreach Methods for Disaster Preparedness and CRS Credit.
3. Status update: 2012 DFIRMs.

CRS:

1. Status of 2011 Reverification.
2. Contents of the EOP.
3. Other Items.

Next Meeting: September 14, 2011, PW Engineering Services Conference Room 328

Adjourn

(1)

8/10/11

SUE PRICE, Park Dept.; (Lucy Dolman, Park Director)
ROGER DUFFE, Tulsa Co EM; BILL ROBISON - COT
DAVE BERRY, TIM LOVELL (Tulsa Partners);
LUCY DOLMAN (Parks Dept) Richard Bales (Tul Co Parks)
SHERYL SIDIKI (

A.2 THORGUMRN -
130 parks, + County, Riverparks.
on Park Dept website; Expo - Square -
260 events per year;
AA → RDF&A to prepare a map of City, County Parks
& School Sites; (OK to DW create map);

A. HAZARD MITIGATION PLAN
1. INDIVIDUAL SAFE ROOM PROGRAM - Develop a plan
TL - NSSA - member Safe Room Assn member;
Thurs 11th 9:00 EOC Fire Station - Owasso; (City Hall ok) -
200 S. Cedar (76th & Cedar).
ICC-500 code - for safe Rooms; NSSA ?
AA → list of requirements from Steve Poledino.
→ Open grants.

MASS COMMUNICATIONS -

A DAY W/O PAUSINES Fri Sept 30, Holiday Inn Downtown

(2)

T-SW/CRS/HMV

Flood - high low
Tornado - steady.
TAEMA does not sound warning for floods, PW does.

A→ Both City + County HM Plans need Dam Failure Plans for Arkansas River.

AA→ ✓ w/ State Historical Society for official Historic Mnpp. Districts.
→ Historic Preservation website.

4. PRIORITIZATION MEASURES
BK - Send us mit measures for prioritization.

6. HM/

COMBINED COMMITTEE MEETING

SIGN-IN SHEET

Meeting Date: ~~August 10~~, 2011
8/10

NAME*	INITIAL	E-MAIL ADDRESS	PHONE NO.	MEMBER	GUEST
Bill Robison	BAR	brobison@cityoftulsa.org	596-9475	X	
G. David Steele		dsteele@cityoftulsa.org	596-7285	X	
Bob Bledsoe		Bobbledsoe@cityoftulsa.org	596-1279	X	
Kim Meloy		kmeloy@cityoftulsa.org	596-7271	X	
Michael Baker		MBaker@cityoftulsa.org	596-9420	X	
Dave Berry	DRB	dberry@tulsarealtors.com	637-5359	X	
Roy Foster		rfoster@cityoftulsa.org	596-1344	X	
Lucy Dolman	LAD	ldolman@cityoftulsa.org	596-2490	X	
Richard Hall		RichHall@cityoftulsa.org	596-1782	X	
Michelle Lester		mlester@cityoftulsa.org	596-7266	X	
Chief C.A. LaCroix		RJolliff@cityoftulsa.org	596-9898	X	
Roger Jolliff	RJ	~~MMcCool@cityoftulsa.org~~	~~596-9890~~	X	
Ron Flanagan (consultant)	RDF	rdflanagan@rdflanagan.com	749-2696	X	
David Wakefield (consultant)		dwakefield@rdflanagan.com	749-2696	X	

Tim Lovell		tulsapartners@gmail.com	632-0044	X	
Sheryl Siddiqui	SS	sherylsiddiqui@yahoo.com	706-3595		
JoAnn Woody		Jiwoody1017@sbcglobal.net		X	
Kyle Brierly		kylebrierly@rooter.com	622-6996	X	
Gary Cheatham		garycheatham@sbcglobal.net	695-8876	X	
Judith Finn		judithfinn@att.net	587-1800	X	
Ann Patton		ann.patton@sbcglobal.net	296-1959	X	
Bob Roberts		brob11@swbell.net		X	
Sue Price	SP	sprice@cityoftulsa.org	596 2527		X
					X
					X
					X
					X
					X
					X
					X
					X

AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

3:00 P.M., Tuesday, August 16, 2011

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

Gary Cheatham, Chair
Judith Finn, Vice-Chair
Ann Patton, Secretary
Kyle Brierly, Member
Bob Roberts, Member

--

Deborah Stowers, Asst. Secretary & Records Custodian
Jack Page, OWRB Accredited Floodplain Administrator
Mark Swiney, Board Counsel

FILED
CITY OF TULSA
STATE OF OKLAHOMA
2011 AUG 11 A 10: 45
MICHAEL P. KIER
CITY CLERK

Call to Order & Roll Call ..... **Chair**

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of Minutes: July 19, 2011 ..... **Chair**

II. APPEALS & VARIANCES

A. Requiring the preparation of Letter of Map Revision to FEMA by Ken Brashear regarding a proposed low water crossing of Spunky Creek, southeast of 11th & 193rd East Avenue.

III. BOARD ACTION ITEM

A. SD&HMAB Process for Appeals ..... **Mark Swiney**
B. Approval of 2011 Regulatory Floodplain Atlas ..... **Bill Robison**

IV. REPORTS

C. Director's Report ..... **Clayton Edwards**
  1) Monthly Financial Report ..... **Alan Rowland**
  2) Proposed Fund Transfers ..... **Alan Rowland**
  3) Capital Projects Status Report ..... **Deborah Stowers**
B. Floodplain Administrator's Report ..... **Jack Page**
  1) Permit Center Report ..... **Harold Tohlen**
C. Implementation of the Mitigation Plan ..... **Bill Robison**

V. DISCUSSION ITEMS

A. Safe Room Development ..... **David Steele**
B. Low Impact Development ..... **Bill Robison**
C. Stormwater Design Criteria Manual ..... **Bill Robison**
D. Strategic Planning Process ..... **Ann Patton**

VI. NEW BUSINESS – None

Please Note: The OMA limits "new business" to only those matters not known about, or which could not have been reasonably foreseen, prior to the posting of the Agenda.

VII. FUTURE AGENDA ITEMS

VIII. PUBLIC COMMENTS

Although the OMA limits Board action to those matters specifically listed on this Agenda, the Board solicits and encourages public comments and ideas.

IX. MEETING CLOSURE ..... **Chair**

X. NEXT MEETING ..... **September 20, 2011**

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

MINUTES
STORMWATER DRAINAGE AND HAZARD MITIGATION ADVISORY BOARD
Tuesday, August 16, 2011
2317 South Jackson Room S213, Tulsa, OK 74107

Members Present
Gary Cheatham, Chairman
Kyle Brierly, Member
Ann Patton, Member

Absent
Judith Finn, Vice Chairman
Bob Roberts, Member

Others Present

Bob Bledsoe	City of Tulsa, Communications
Ken Brashear	Homeowner
Robert Dimmick	City of Tulsa, Finance
Ron Flanagan	Flanagan & Associates, LLC
Michael Ling	Horizon Engineers
Tim Lovell	Tulsa Partners
Linda McPherson	City of Tulsa, Finance
Jack Page	City of Tulsa, Development Services
Alan Rowland	City of Tulsa, Finance
Deborah Stowers	City of Tulsa, Engineering Department
Mark Swiney	City of Tulsa, Legal
Roy Teeters	City of Tulsa, Streets and Stormwater
Harold Tohlen	City of Tulsa, Development Services
Theron Warlick	City of Tulsa, Planning
Bryan Young	City of Tulsa, Streets and Stormwater
Paul Zachary	City of Tulsa, Engineering Department

DRAFT

Call to Order and Roll Call

At 3:02 p.m. Deborah Stowers called roll and established a quorum before Gary Cheatham called the meeting to order.

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of Minutes: July 19, 2011

The July 19, 2011 minutes were approved unanimously.

II. APPEALS & VARIANCES

A. Requiring the preparation of Letter of Map Revision to FEMA by Ken Brashear regarding a proposed low water crossing of Spunky Creek, southeast of 11th & 193rd East Avenue.

Mr. Gary Cheatham wanted documentation in the minutes that the process for Rules for Hearings on Appeals and Variances had not been adopted yet, but that it was being followed in general for these proceedings.

Harold Tohlen informed the Board that the current and only access Mr. Brashear has to this property is through a low water crossing through Spunky Creek. Some rapid flows occur in this creek when it rains. Two or three feet are not uncommon with just a small rain. The drainage basin goes all the way to the vicinity of Lynn Lane and 51st Street. It is a large basin.

After the preliminary analysis, Mr. Tohlen met with Mr. Brashear and his engineer on July 27, 2011 and their proposal included a multiple pipe crossing. The pipes that were being proposed were eight feet in diameter and did not pass the one hundred year storm. They were advised at this time that this was in the FEMA floodway and this kind of impact would require a Conditional Letter of Map Revision (CLOMR) and a Letter of Map Revision (LOMR). They were also informed that this was in accordance with FEMA regulations and the City of Tulsa ordinances and was advised to talk to the floodplain administrator, Mr. Jack Page. It was confirmed the next day that there were no other options available and they were notified on the July 28th. They were then informed of the appeal process.

Mr. Page explained the process and suggested that Mr. Brashear go through the analysis, follow the rules and afterward, there should be no reason a permit cannot be issued. The City of Tulsa is not allowed to approve this without going through the CLOMR process and he informed the Board that the City's recommendation is to deny this appeal because of the federal guidelines.

Mr. Michael Ling, P.E. with Horizon Engineering Services Company presented some maps and floodway data sheet of Spunky Creek and explained his survey saying that the flow line has dropped therefore the current model is not correct. He stated that based on physical evidence they surveyed in the field, a cross section would not affect anyone upstream or downstream. Any back up of the stream would be on Mr. Brashear's property.

Mr. Brashear informed the Board he is driving through the solid rock creek bottom containing water every day. In addition, this is the original crossing to his home that was purchased twelve years ago.

After further discussion, the Board voted to uphold the City of Tulsa staff recommendation and unanimously denied the appeal. Mr. Brashear was informed that he had a right to appeal this decision to the City Council through the City Clerk's office within ten days.

DRAFT

III. BOARD ACTION ITEMS

A. SD&HMAB Process for Appeals

Mark Swiney asked the Board to continue this item for another month so that he may make revisions to the process and submit it in a final form.

Ann Patton suggested that the process be adopted at this meeting with the pending revisions that included an addition of Step 11 informing the applicant and/or the City of Tulsa staff of their rights to appeal to the City Council. Gary Cheatham also suggested some revisions to Steps 1, 9 and 10.

After the revisions were discussed, the Board adopted this process subject to the revisions.

Mr. Cheatham thanked Mr. Swiney and Ms. Judith Finn for their work on this process.

B. Approval of 2011 Regulatory Floodplain Atlas

Deborah Stowers reported that there were no major changes to the Atlas and the Board voted to approve.

IV. REPORTS

A. Director's Report

1) Monthly Financial Report

Alan Rowland reported year to date estimate for total revenue, monthly budgeted revenue estimates, stormwater billings, and collections for the month of July. He also did a comparison of monthly budget estimates stormwater billings to prior year and reported the stormwater fee-in-lieu funds.

2) Proposed Fund Transfers

Alan Rowland reported there were no proposed fund transfers.

3) Capital Projects Status Report

Deborah Stowers presented the August capital report stating:

a) Jones Creek is 96% complete
b) Fred Creek is 83% complete
c) Vensel Creek is 50% complete
d) Joe Creek-53rd & Lewis is 13% complete

B. Floodplain Administrator's Report

1) Permit Center Report

Harold Tohlen reported that there were six permits issued in the month of July, five in the regulatory floodplain and one in FEMA. He made a brief report on the two commercial and the one watershed permits issued. There were a total of ten permits issued with fees-in-lieu of detention with a total of $81,189.92 collected on nine of them.

Mr. Cheatham asked about the siltation at 31st & Mingo and Bryan Young inform him that he did investigate and there is minor siltation and will not impede the flood waters.

B. Implementation of the Mitigation Plan

Ron Flanagan, accompanied by Tim Lovell with Tulsa Partners and Theron Warlick with City of Tulsa Planning, presented an overview power point presentation on hazards. A proposed hazards study schedule was distributed. He informed the Board that the City of Tulsa has been approved by FEMA and the State to update the hazard mitigation plan and this will be ongoing for the next three years. He also informed them that as the Stormwater Board, they would be attending their meetings every month for the next eight months and would like for them to consider allocating at least thirty minutes on the agenda for presentations.

Mr. Flanagan informed the Board that they have a number of processes going on including the hazard mitigation plan and the community rating system (CRS) plan and is trying to find a way, at the federal level, to merge these two plans together. At the hazard mitigation conference in Boulder, FEMA expressed how they want to combine these two plans and Mr. Flanagan says that Tulsa has the opportunity and can show the rest of the nation. One of the purposes of this hazard mitigation program is not just to identify the hazards that impact people, but to educate the public as well as the elected officials. He suggested that a City planner attend the monthly CRS Program and Hazard Mitigation meetings.

Theron Warlick stated that mitigation planning is too important to be relegated to special planning purpose, but should be part of the comprehensive planning.

DRAFT

Tim Lovell stated the Tulsa Partners are accurately working on getting more citizen participation.

Ms. Patton wants a couple of other projects considered to be coordinated in the plan such as recovery planning and a strategic plan. Mr. Flanagan added that the emergency evacuation should also be added.

Mr. Flanagan also stated that the insurance companies would have to be brought in as partners because they would be the beneficiaries of the plan. He also want the Board to commit to being involved in this process and dedicate as much time on hazard mitigation as on flooding issues and other hazards.

Mr. Flanagan also suggested that these mitigation meeting be posted on TGOV once a month and Bob Bledsoe informed him that the TGOV staff and/or budget just do not have the availability for all of the Boards and Commissions meetings that do City affairs and suggested a Public Relation Plan. Mr. Cheatham suggested the newspaper, but Mr. Flanagan said that this process is too complicated for the newspaper.

IV. DISCUSSION ITEMS

A. Safe Room Development

Deborah Stowers reported that Bill Robison needs to detail out the program before making application to OEM. It will be administered by someone outside City staff, most likely Tulsa Partners. There are numerous requirements each sub-applicant will need, such as total cost, location, suppliers, latitude and longitude. Also, if more than 100' from the house, it will need clearance from the archeological society. Mr. Robison hopes to have this outlined by the end of September.

DRAFT

B. Low Impact Development

Deborah Stowers stated that they are hoping to get a test section of permeable pavement installed at a City facility soon and is also trying to incorporate some LID into the new Traffic Engineering facility.

C. Stormwater Design Criteria Manual

Deborah Stowers reported that they are presently trying to get the ordinances revised to determine responsibility for each duty that reads director and department.

D. Strategic Planning Process

No Report

VI. NEW BUSINESS

VII. FUTURE AGENDA ITEMS -None

VIII. PUBLIC COMMENTS - None

IX. MEETING CLOSURE

Upon receiving no other comments or further questions, Mr. Chairman thanked everyone for attending and adjourned the meeting at 5:30 p.m.

X. NEXT MEETING – September 20, 2011

AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Public Outreach
CRS
September 7, 2011 – 1:30 p.m.
PW Engineering Services
Conference Room S-328

Multi-Hazard Mitigation Plan:

1. Hazard Mitigation Plan Update.
2. Gaining Public Participation.
3. Public Meeting Strategies.
4. Individual Safe Room Program.
5. ThorGuard.
6. Historic Preservation Annex Status.
7. SDHMAB Updates. Hazard Mitigation Measures.
8. Prioritizing Mitigation Measures.

Public Outreach:

1. New Outreach Video Production Relating to HM Update.
2. Video Production & Editing, TGOV/Private.
3. Mass Communication System Update.
4. Status update: 2012 DFIRMs.

CRS:

1. Status of 2011 Reverification.
2. Other Items.

Next Meeting: October 5, 2011, PW Engineering Services
Conference Room 328

Adjourn

COMBINED COMMITTEE MEETING

SIGN-IN SHEET

Meeting Date: ~~August 10~~ Sept. 7, 2011

NAME*	INITIAL	E-MAIL ADDRESS	PHONE NO.	MEMBER	GUEST
Bill Robison	BHR	brobison@cityoftulsa.org	596-9475	X	
G. David Steele		dsteele@cityoftulsa.org	596-7285	X	
Bob Bledsoe	BB	Bobbledsoe@cityoftulsa.org	596-1279	X	
Kim Meloy		kmeloy@cityoftulsa.org	596-7271	X	
Michael Baker		MBaker@cityoftulsa.org	596-9420	X	
Dave Berry	DRB	dberry@tulsarealtors.com * dberryinternational1@gmail.com	637-5359	X	
Roy Foster		rfoster@cityoftulsa.org	596-1344	X	
Lucy Dolman		ldolman@cityoftulsa.org	596-2490	X	
Richard Hall		RichHall@cityoftulsa.org	596-1782	X	
Michelle Lester		mlester@cityoftulsa.org	596-7266	X	
Roger Jolliff		RJolliff@cityoftulsa.org	596-9898	X	
Ron Flanagan (consultant)	RDF	rdflanagan@rdflanagan.com	749-2696	X	
David Wakefield (consultant)		dwakefield@rdflanagan.com	749-2696	X	
Tim Lovell		tulsapartners@gmail.com	632-0044	X	

Sheryl Siddiqui		sherylsiddiqui@yahoo.com	706-3595	X	
JoAnn Woody		Jiwoody1017@sbcglobal.net		X	
Kyle Brierly		kylebrierly@rooter.com	622-6996	X	
Gary Cheatham		garycheatham@sbcglobal.net	695-8876	X	
Judith Finn		judithfinn@att.net	587-1800	X	
Ann Patton		ann.patton@sbcglobal.net	296-1959	X	
Bob Roberts	BR	brob11@swbell.net		X	
Sue Price	SP	sprice@cityoftulsa.org	596-2527	X	
Barry Hughes		advertisingimpact@cox.net	274 9914		X
Megan McCann		mmccann@tulsacouncil.org	596-1944		X
					X
					X
					X
					X
					X
					X

AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Public Outreach
CRS
October 5, 2011 – 1:30 p.m.
PW Engineering Services
Conference Room S-328

Multi-Hazard Mitigation Plan:

1. Hazard Mitigation Plan Update.
2. Gaining Public Participation.
3. Public Meeting Strategies.
4. Individual Safe Room Program.
5. ThorGuard.
6. Historic Preservation Annex Status.
7. Historic Preservation Continued Meetings.
8. PodCast: http://stormsmart.org/uploads/patchwork-quilt/patchwork_quilt.pdf
9. SDHMAB Updates. Hazard Mitigation Measures.
10. Prioritizing Mitigation Measures.

Public Outreach:

1. New Outreach Video Production Relating to HM Update.
2. Video Production & Editing, TGOV/Private.
3. Mass Communication System Update.
4. Status update: 2012 DFIRMs.

CRS:

1. Status of 2011 Reverification.
2. BCEGS Rating and its Effect on CRS
3. Other Items.

Next Meeting: November 2, 2011, PW Engineering Services
Conference Room 328

Adjourn

COMBINED COMMITTEE MEETING

SIGN-IN SHEET

Meeting Date: October 5, 2011

NAME*	INITIAL	E-MAIL ADDRESS	PHONE NO.	MEMBER	GUEST
Bill Robison	BJR	brobison@cityoftulsa.org	596-9475	X	
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Bob Bledsoe		Bobbledsoe@cityoftulsa.org	596-1279	X	
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Michael Baker		MBaker@cityoftulsa.org	596-9420	X	
Dave Berry	DRB	dberry@tulsarealtors.com	637-5359	X	
Roy Foster		rfoster@cityoftulsa.org	596-1344	X	
Lucy Dolman		ldolman@cityoftulsa.org	596-2490	X	
Richard Hall		RichHall@cityoftulsa.org	596-1782	X	
Michelle Lester		mlester@cityoftulsa.org	596-7266	X	
Roger Jolliff		RJolliff@cityoftulsa.org	596-9898	X	
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David Wakefield (consultant)		dwakefield@rdflanagan.com	749-2696	X	
Tim Lovell	TML	tulsapartners@gmail.com	632-0044	X	

Bob Roberts Bill c S Siddiqui

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Kyle Brierly		kylebrierly@rooter.com	622-6996	X	
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Judith Finn		judithfinn@att.net	587-1800	X	
Ann Patton		ann.patton@sbcglobal.net	296-1959	X	
Bob Roberts		brob11@swbell.net		X	
Sue Price		sprice@cityoftulsa.org	596-2527	X	
					X
					X
					X
					X
					X
					X
					X

COMBINED COMMITTEE MEETING

SIGN-IN SHEET

Meeting Date: ~~October 5,~~ Dec 7 2011

NAME*	INITIAL	E-MAIL ADDRESS	PHONE NO.	MEMBER	GUEST
Bill Robison	BHR	brobison@cityoftulsa.org	596-9475	X	
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Kim Meloy		kmeloy@cityoftulsa.org	596-7271	X	
Michael Baker		MBaker@cityoftulsa.org	596-9420	X	
Dave Berry	DRB	dberry@tulsarealtors.com McGraw Realtors. Buskin Team	637-5359	X	
Roy Foster		rfoster@cityoftulsa.org	596-1344	X	
Lucy Dolman		ldolman@cityoftulsa.org	596-2490	X	
Richard Hall		RichHall@cityoftulsa.org	596-1782	X	
Michelle Lester		mlester@cityoftulsa.org	596-7266	X	
Roger Jolliff		RJolliff@cityoftulsa.org	596-9898	X	
Ron Flanagan (consultant)	RDF	rdflanagan@rdflanagan.com	749-2696	X	
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Tim Lovell	TML	tulsapartners@gmail.com	632-0044	X	

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JoAnn Woody		Jiwoody1017@sbcglobal.net		X	
Kyle Brierly		kylebrierly@rooter.com	622-6996	X	
Gary Cheatham		garycheatham@sbcglobal.net	695-8876	X	
Judith Finn		judithfinn@att.net	587-1800	X	
Ann Patton		ann.patton@sbcglobal.net	296-1959	X	
Bob Roberts		brob11@swbell.net		X	
Sue Price		sprice@cityoftulsa.org	596-2527	X	
Henry Townsend	HDYT	hdytownsend@peoplepc.com	628-0651		X
JK EVICKS	JKE	jevicks@bama.com	732-2183		X
Jeff Goss		jeff@servetulsa.com	230-8429		X
Josh Miller		joshua.a.miller.rd09@statefarm.com	627-1833	X	X
KATHRYN SPENCER		KSPENCER@cityoftulsa.org	918-591-4375		X
					X
					X
					X

Kim Melay & Bob
re Web site & address
searchable

BOK advertising

AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Public Outreach
CRS
January 4, 2012 – 10:00 a.m.
PW Engineering Services
Conference Room S-328

Local TV talk show
& Home improvement shows

Joplin re tornado video
CoC survivor continuity
mtg in March

Collective Strength
(Surveys)

HMGP re fortified Const?

City Hall in Neighborhoods?
Coordinate Cassandra Love

Multi-Hazard Mitigation Plan:

1. Hazard Mitigation Plan Update.
2. Gaining Public Participation.
3. Public Meeting Strategies. – City Life Flyer – Facebook HBA
   info on media
4. City Council Presentation. – TGOV
   Civic Groups
5. Individual Safe Room Program. – subcommittee to meet w/ Melissa
   Ron D-Steele Bert, Tim
6. ThorGuard.
   Jami re Water Quality Venues
7. SDHMAB Updates. Hazard Mitigation Measures.
8. Prioritizing Mitigation Measures.

Public Outreach:

1. New Outreach Video Production Relating to HM Update. Insurance adjusters
2. Video Production & Editing, TGOV/Private.
3. Mass Communication System Update.
4. Public Outreach Committee, mortgage banker.

CRS:

1. December 15th Webinar. Personal outreach
   OPS committee
2. Other Items.

Next Meeting: February 1 2012, 10:00 a.m. PW Engineering Services
Conference Room 328

Adjourn

Mitigation Measures: Fortified Const advertising by supplier

(1)

COT HM/CRS 1/4/12

1. HM Plan Update –
   goes back to Consultant Selection Committee (?)
2. PUBLIC PARTICIPATION –
3. PUBLIC MEETING STRATEGIES
   City Hall in neighborhoods;
→ Introduction Presentation for City Council.
   Henry – LEPC – shelter in Place Brochure; renters also;
   – make it relevant;
Bill – Questionnaire on City website –
Facebook site – TULSA HAZARDS – Calendar, events, links to surveys;
Bob Bledsoe – link to map.
Sheryl – TV meteorologists; local talk shows;
Dave Berry – Termites;
Richard Hall – Facebook – Fire Dept outreach;
David Steele – Homebuilders –
   RC 09 – new code;
SUE – where do you need to go to get information
Jamie – SW Quality – outreach organizations –
Henry – Rotary Club; Toastmasters Club; Kiwanis; –

6. THORGUARD
7. SDHMMB mit measures
8. Prioritization of mit measures –

5. INDIVIDUAL SAFE RETURN.

BILL ROBISON

DAVID STEELE

DAVE BERRY

RICHARD HALL

TIM LOVELL

SHERYL SIDDIQUI

SUE PRICE — Parks

HENRY TOWNSEND - LEPC

J.K. EVICKS PORMS

CURT EASTER TAEMS

JAMI SKIMBO - WATER QUALITY

THERON WARLICK - Planning

COMBINED COMMITTEE MEETING

SIGN-IN SHEET

Meeting Date: January 4, 2012

NAME*	INITIAL	E-MAIL ADDRESS	PHONE NO.	MEMBER	GUEST
Bill Robison	BJR	brobison@cityoftulsa.org	596-9475	X	
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Kim Meloy		kmeloy@cityoftulsa.org	596-7271	X	
Michael Baker		MBaker@cityoftulsa.org	596-9420	X	
Dave Berry	DRB.	dberry@tulsarealtors.com	637-5359	X	
Roy Foster		rfoster@cityoftulsa.org	596-1344	X	
Lucy Dolman		ldolman@cityoftulsa.org	596-2490	X	
Richard Hall	R.H.	RichHall@cityoftulsa.org	596-1782	X	
Michelle Lester		mlester@cityoftulsa.org	596-7266	X	
Roger Jolliff		RJolliff@cityoftulsa.org	596-9898	X	
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Judith Finn		judithfinn@att.net	587-1800	X	
Ann Patton		ann.patton@sbcglobal.net	296-1959	X	
Bob Roberts		brob11@swbell.net		X	
Sue Price	SP	sprice@cityoftulsa.org	596-2527	X	
Henry Townsend	HDYT	hdytownsend@peoplepc.com	628-0651	X	
J K Evicks	JKE	jevicks@bama.com	732-2183	X	
Josh Miller		joshua.a.miller.r2d9@statefarm.com	627-1833	X	
Kathryn Spencer		kspencer@cityoftulsa.org	591-4375	X	
CURT EASTER	CE	ceaster@cityoftulsa.org	596 9897		X
Jami Skimbo	JAS	jskimbo@cityoftulsa.org	596-4376		X
[illegible]	TW	twarlick@cityoftulsa.org	576-5677	X	X
					X

AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

3:00 P.M., Tuesday, January 17, 2012

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

Gary Cheatham, Chair
Judith Finn, Vice-Chair
Ann Patton, Secretary
Kyle Brierly, Member
Bob Roberts, Member

--

Deborah Stowers, Asst. Secretary & Records Custodian
Harold Tohlen, Interim OWRB Accredited Floodplain Administrator
Mark Swiney, Board Counsel

FILED
CITY OF TULSA
STATE OF OKLAHOMA
2012 JAN 12 P 1:07
MICHAEL P. KIER
CITY CLERK

Call to Order & Roll Call ..... **Chair**

I. ADMINISTRATIVE MATTERS

- **A. Approval/Correction of Minutes: December 20, 2011** ..... **Chair**

II. APPEALS & VARIANCES - None

III. BOARD ACTION ITEM

- **A. Gravel Credit Ordinance** ..... **Bill Robison/Mark Swiney**
- **B. Strategic Plan Subcommittee** ..... **Ann Patton**

IV. REPORTS

- **A. Director's Report** ..... **Paul Zachary/Dan Crossland**
  - **1) Monthly Financial Report** ..... **Tammy Pitts**
  - **2) Proposed Fund Transfers** ..... **Tammy Pitts**
  - **3) Capital Projects Status Report** ..... **Deborah Stowers**
- **B. Floodplain Administrator's Report** ..... **Harold Tohlen**
  - **1) Permit Center Report** ..... **Harold Tohlen**
- **C. Hazard Mitigation Update** ..... **Bill Robison**

V. DISCUSSION ITEMS

- **A. Low Impact Development** ..... **Bill Robison**
- **B. Stormwater Design Criteria Manual** ..... **Bill Robison**
- **C. Tulsa Hazard Mitigation Measures Priorities** ..... **Bill Robison**
- **D. Update on Levee Issues** ..... **Ann Patton**
- **E. CRS Program & Hazard Mitigation Meeting Volunteers** ..... **Bob Roberts**

VI. NEW BUSINESS - None

VII. FUTURE AGENDA ITEMS - None

VIII. PUBLIC COMMENTS

Although the OMA limits Board action to those matters specifically listed on this Agenda, the Board solicits and encourages public comments and ideas.

IX. MEETING CLOSURE ..... **Chair**

X. NEXT MEETING ..... **February 21, 2012**

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

MINUTES
STORMWATER DRAINAGE AND HAZARD MITIGATION ADVISORY BOARD
Tuesday, January 17, 2012
2317 South Jackson Room S213, Tulsa, OK 74107

Members Present
Gary Cheatham, Chairman
Judith Finn, Vice Chairman
Ann Patton, Member
Bob Roberts, Member

Members Absent
Kyle Brierly, Member

Others Present

Ron Flanagan	R.D. Flanagan & Associates
M. Todd Kilpatrick	Tulsa Levee 12
Matt Liechti	City of Tulsa, Engineering Department
Bill Robison	City of Tulsa, Engineering Department
Alan Rowland	City of Tulsa, Finance Department
David Steele	City of Tulsa, Development Services Department
Deborah Stowers	City of Tulsa, Engineering Department
Mark Swiney	City of Tulsa, Legal Department
Roy Teeters	City of Tulsa, Streets & Stormwater Department
Scott VanLoo	City of Tulsa, Streets & Stormwater Department

DRAFT

Call to Order and Roll Call

At 3:04 p.m. Deborah Stowers called roll and established a quorum before Gary Cheatham called the meeting to order.

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of Minutes: December 20, 2011

After corrections, the December 20, 2011 minutes were approved unanimously.

II. APPEALS & VARIANCES - None

III. BOARD ACTION ITEMS

A. Gravel Credit Ordinances

Bill Robison distributed and explained a draft of the ordinance with all of the modifications.

Mark Swiney explained that the Board, being an advisory Board, would decide whether to recommend the passive of this ordinance to the City Council and Mayor.

After discussions on whether to leave the process as a case by case basis with the appeal process or to recommend passive of an ordinance, a motion was made to table this item until a unified agreement with all of the different departments. The motion passed unanimously.

B. Strategic Plan Subcommittee

Ann Patton discussed the difference between the Strategic Plan and the Hazard Mitigation Plan and how important it is to have a strategic plan because of the break up of Public Works.

Ron Flanagan informed the Board that the Oklahoma Floodplain Managers Association has an extensive three day strategic planning session every year and Bill Robison is the vice-president this year and will be president next year. Mr. Robison will have the knowledge and resources to assist the Board with this plan.

Mr. Flanagan said that goals, objectives, priorities, and hazard mitigation measures will have to be set to form a program for the City of Tulsa for at least the next five years.

A motion was made to establish a strategic plan subcommittee along with at least two Board members to set goals and objectives for three years for Stormwater Planning and Hazard Mitigation. The motion passed unanimously.

Members will come up with top goals and attend next Multi-Hazard Mitigation Plan meeting held February 1, 2012 at 9:00 am in conference room S328.

DRAFT

IV. REPORTS

A. Director's Report

Roy Teeters reported that a contractor will begin work on February 1, 2012 on one mile section of the creek at 31st & Mingo. Right of Way in Engineering is working on getting the deed changed to City of Tulsa ownership.

Mr. Teeters also informed the Board that a jogger had been attacked by two dogs at the Golden Valley detention pond. This pond had signage to allow off leash dogs, but the signs were removed the same day of the attack. The Bark Park Task Force has been informed of the change and will no longer have the off leash possibilities with detention ponds.

1) Monthly Financial Report

Alan Rowland reported that total revenue for the month of December is 48.9%. All of the revenues categories are down except for license and permits. Appropriations and commitments year-to-date estimate is 54.8% and actual is 55.1%. The fund balance is down about $250 thousand for the year. Actual collections are 101% for the month and 99% for the year. Fee-in lieu collected was $25,437.

2) Proposed Fund Transfers

There were no proposed transfers for the month of December.

3) Capital Projects Status Report

Deborah Stowers presented the January 2012 capital report stating:

a) Vensel Creek-Grupe Channel is 95% complete with design.
b) Vensel Creek-Phase 1 is 56% complete with design.
c) Swan Travis Park is 100% complete with design
d) Joe Creek-53rd & Lewis is 88% complete with construction.

B. Floodplain Administrator's Report

David Steele informed the Board of the new Planning director, Dawn Warrick from Louisville, KY. She was the floodplain administrator for Fayetteville, AR. She is very much familiar with floodplain management; therefore administration has decided not to fill Jack Page's position at this time. Harold Tohlen is back to his old job as Infrastructure Development Manager and he is the Floodplain Administrator for the City of Tulsa. Ms. Patton suggested inviting Ms. Warrick to future meetings.

1) Permit Center Report

David Steele reported that there were four permits issued in the month of December in the regulatory floodplain and one in FEMA. Permit fees totaled $484.75. Mr. Tohlen made a brief report on the seven commercial permits. Fees-in-lieu of detention collected was $38,185.84. The comparison of the year 2010 and the year 2011 remains pretty steady in actual permitting.

C. Hazard Mitigation Update

Bill Robison informed the Board that there was a clause in the FEMA guidance manual to have a resolution to update the Hazard Mitigation plan. The Mayor and the City Council will need to sign the resolution authorizing the update.

V. DISCUSSION ITEMS

A. Low Impact Development

Bill Robison said that they selected a sight in the west yard and will put in a test section of pervious pavement.

B. Stormwater Design Criteria Manual

Bill Robison said that he has begun substituting Floodplain Administrator or City Engineer in the manual to replace Director. The Floodplain Administrator and City Engineer will scrutinize to see if they are in agreement.

C. Tulsa Hazard Mitigation Measures Priorities

Bill Robison said he has taken all of the information received regarding the priorities measures and have sorted and entered it in a spreadsheet. It is not quite finished, but will e-mail what is completed to Board members after the meeting.

D. Update on Levee Issues

Ann Patton introduced M. Todd Kilpatrick, Levee Commissioner of drainage District 12 to give an update on the levee issues. Mr. Kilpatrick discussed the twenty miles of levee that is in need of funding to meet standards of the Corp of Engineers and FEMA. The estimated cost to repair these deficiencies will require an investment of $20 million or more. The more pressing thing besides these standards is the FEMA accreditation which will end August 31, 2013. This will need funding of $70 thousand per mile to keep the accreditation. The funding to get this accreditation is important because it would give us an additional two years. He also stated that he is trying to make it a priority to get the FEMA accreditation for the people who are inside this district because personal property and lives are at risk.

DRAFT

Gary Cheatham asked for more updated and detailed information of the levees. Bill Robison and Ron Flanagan will present this information at next meeting.

E. CRS Program & Hazard Mitigation Meeting Volunteers

Gary Cheatham may attend the next meeting.

VI. NEW BUSINESS - None

VII. FUTURE AGENDA ITEM

Invite new Planning Director, Dawn Darrick.

VIII. PUBLIC COMMENTS - None

IX. MEETING CLOSURE

Upon receiving no other comments or further questions, Ms. Patton thanked everyone for attending and adjourned the meeting at 4:36 p.m.

X. NEXT MEETING – February 21, 2011

DRAFT

MINUTES
CITY OF TULSA
2012 MULTI-HAZARD MITIGATION PLAN UPDATE
COMBINED COMMITTEE MEETING
Wednesday, February 1, 2012

Members Present		**Members Absent**	
Bledsoe, Bob	CoT, Communications	Brierly, Kyle	CoT SDHMAB
Berry, Dave	Realtor	Baker, Michael	CoT
Easter, Curt	TAEMA	Cheatham, Gary	CoT SDHMAB
Flanagan, Ron	Hazards Consultant	Dolman, Lucy	CoT Park Dept.
Lovell, Tim	Tulsa Partners	Evicks, J.K.	Bama Co.
Miller, Josh	State Farm Insurance	Finn, Dr. Judith	CoT SDHMAB
Robison, Bill	CoT, Project Mgr.	Foster, Roy	CoT
Steele, David	CoT Permits	Hall, Richard	CoT FD
Skimbo, Jami	CoT,	Jolliff, Roger	TAEMA
Townsend, Henry	TCC LEPC	Lester, Michelle	CoT
		Meloy, Kim	CoT, Communications
		Price, Sue	CoT
		Patton, Ann	CoT SDHMAB
		Roberts, Bob	CoT SDHMAB
		Spencer, Kathryn	CoT
		Siddiqui, Sheryl	Language & Culture
		Wakefield, David	RDF&A Consultants
		Warlick, Theron	CoT Planning

Call to Order
The meeting of the City of Tulsa 2012 Multi-Hazard Mitigation Plan Update Combined Citizens and Technical Advisory Committee was called to order by Project Manager Bill Robison at 10:00 am, Wednesday, February 1st, 2012, Engineering South Bldg., Room S-328, 2317 S. Jackson Ave.,

AGENDA:

Multi-Hazard Mitigation Plan

1. Multi Hazard Mitigation Plan Update

Bill Robison (**BR**)- I'm going to jump around with the agenda, a bit.

4. City Council Presentation

Bill Robison (**BR**) We haven't gotten approval to make a presentation to the City Council;

5. Individual Safe Room Program-

Met with Melissa Moore, State Safe Room program Officer, on Jan. 27th, we may do a couple of hundred Safe Rooms initially, to get our bearings and experience. It will be a multi-phased program as HMGP funding permits. State has no funding available, don't want to advertise the Program, and have to wait a long time.
Ron Flanagan (**RDF**) We are thinking about setting up an expo for the Safe Room Vendors, so the participants can see and cost the various Safe Rooms.
BR: All Safe Rooms will have to be NSSA certified.

2. Gaining Public Participation

Dave Berry (**DB**)- The Home and Garden Show might be a good opportunity. Discussion about booth, H&G Show dates, handout materials
Josh Miller (**JM**)- the big H&G Show is in March, but there a four each year. We also have the opportunity to discuss other Hazard Mitigation related issues, such as tornado clips, impact-resistant roofing;
Tim Lovell (**TL**)- Tulsa Partners has a Safe Room display; there is a question of audience. Most people are there to look at gardens; not many stop by to get information on hazards.
BR- Cautions about vendors/conflict of interest, looking like we are promoting one vendor, etc. Average Safe Room cost is $2,700; $2,000 cap is fine.
JM- If we miss the March H&G Show, there are other shows, State Fair, Landscaping & Remodeling shows. We need a model so we can set it up in any shows. Chamber Visitor's Bureau has a list of all of the various shows.
Discussion of ways to get peoples' attention to the booth;
BR- We'd like to find something on IBHS wind-resistant clips; I've seen it in print, but haven't seen a model.
Discussion on Building Codes, fortified building techniques, opportunities for public information and education.
Henry Townsend (**HT**)- Discussion on Manufactured Housing, and vulnerability to high winds and tornadoes; things that can be done to protect families in mobile homes and manufactured housing; Vulnerability of mobile home communities; 50% of all tornado deaths are people who live in mobile homes. CDBG funds can be used for mobile home community safe rooms, but the CDBG process is highly political, most goes to community services. Highly competitive. Mobile Home Safe Rooms are something that deserves our attention.

6. Thorguard

BR- Parks is not here today. We need to coordinate with Parks and Tulsa Public Schools, and figure out where we are going with that program..

7. SDHMAB Updates. Hazard Mitigation Measures

BR- Their main issue is where we are with the Safe Room Program. There's no funding.

8. Prioritizing Mitigation Measures

BR- The SDHMAB wants us to help prioritize the Mitigation Measures. Three Board Members have responded, and scored about a third of the Mitigation Measures in the Plan.

Public Outreach

1. New Outreach Video Production Relating to HM Update
2. Video Production & Editing, TGOV/Private

BR- I talked to Megan w/ TGOV, we want to move forward in producing some Mitigation videos;
TL- The Language & Culture Bank is also working with outreach to the diverse populations throughout the community, in multi-languages. Sheryl Siddiqui is a dream to work with, very positive, upbeat, trying to work with people.
BR- Discussion on TGOV constraints/considerations.
Bob Bledsoe (**BB**)- TGOV doesn't really have a staff. They have Megan and Matt; according the Charter they are part of the City Council. The new City Council is making a concerted effort to get along. Some cities have embraced the government access television, and have production staffs, and others have let it languish. The Mayor's office has hired a Channel 2 news gal, and she produces really good video quickly, and is very good.

Community Rating System (CRS)

BR- CRS changes. It's been completely overhauled, and is in its final draft form before OMB, anticipating approval in March or April, and we have EMI courses set up here in Oklahoma, from July 30th through August 2nd, in Del City. OFMA is sponsoring it. The challenge is that it's a 4 day long course in Del City.
RDF- Anyone with a federally insured mortgage has to have flood insurance. In Tulsa, 30% of the people in the SFHA have flood insurance, that's over twice the national average of 12%. But, we have to have 50% participation before we van be a Class 1 CRS Community. We have enough points, it's just this one issue that keeps us from having a 45% flood insurance discount for our citizens. I can't believe that 70% of the homes in the floodplain don't have mortgages. The banks are simply not doing due diligence. Bill wants to have us increase.
We are doing a project for the City to identify properties in the floodplain that do not have flood insurance; and then to research the County Assessor's office to find out if they have a mortgage, and who the lending institution is.
BR- We send out an annual floodplain notification mailing telling all floodplain residents that if they have a federally insured mortgage, they are requires to have flood insurance. Privacy Act concerns limits what we can do.

Discussion among the participants about flood insurance and different possible strategies to increase insurance participation, Real Estate and Insurance Industry considerations and possible strategies. Need for a coordinated approach.

TL- Tulsa Partners is having a Day Without Business, on business continuity, on March 15, 9:00 am to 3:30 pm, Holiday Inn; you can register on line at tulsapartners.org , cost is $65.00; keynote address by the president of the Joplin Chamber of Commerce.

Homeland Security has announced that they have a Citizen Corps grants for public information and education, outreach.

NHMA may get a grant from FEMA for incentives for mitigation and resilience. Tulsa may be one of the communities selected.

The meeting was adjourned at 11:15 am.

The next meeting will be Wednesday, March 7th at 10:00 am.

Consultant will notify Team Members by e-mail on the Monday before the meeting.

Meeting was turned back to Bill Robison, and meeting was adjourned at 12:00 pm.

Respectfully submitted,

Bill Robison, P.E., CFM, Project Manager

Ronald D. Flanagan, CFM, Consultant

AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Public Outreach
CRS
February 1, 2012 – 10:00 a.m.
PW Engineering Services
Conference Room S-328

Multi-Hazard Mitigation Plan:

1. Hazard Mitigation Plan Update.
2. Gaining Public Participation.
3. Public Meeting Strategies.
4. City Council Presentation.
5. Individual Safe Room Program.
6. ThorGuard.
7. SDHMAB Updates. Hazard Mitigation Measures.
8. Prioritizing Mitigation Measures.

Public Outreach:

1. New Outreach Video Production Relating to HM Update.
2. Video Production & Editing, TGOV/Private.
3. Mass Communication System Update.
4. Public Outreach Committee, mortgage banker.

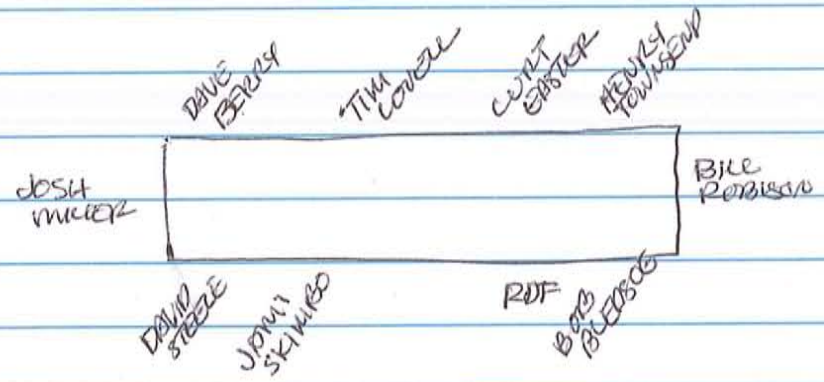
CRS:

1. July 30, 2012 Workshop EMI F-328.
2. Other Items.

Next Meeting: March 7, 2012, 10:00 a.m. PW Engineering Services Conference Room 328

Adjourn

COT HM/CRS MEETING 2/1/12



PICS – 1) Jami Skimbo 2) Bledso. 3) Henry
4) Bill Robison 5) Berry 6) Steele
7) Carter 8) Jim 9)
10)

BIOS
B. Bledsoe

5. INDIVIDUAL SAFE ROOM PROGRAM

+ March – Home + Garden Show –
Tulsa COT has a booth –
Chamber's Visitor's Bureau.
D. Steele – info on permits for saferooms;
H. Townsend – Mobile Homes/Mfg. housing.
Jami will send info on shows/exhibits

THOREUARD –

SDHMAP – Bill – Mitigation Measures – Prioritization

PUBLIC OUTREACH –

CRS

July 30 thru Aug 2, workshops in Del City 4 day long course.

OFMA April 5 Spring Workshop.
March 15 – Day w/o Business.

COMBINED COMMITTEE MEETING

SIGN-IN SHEET

Meeting Date: February 1, 2012

	NAME*	INITIAL	E-MAIL ADDRESS	PHONE NO.	MEMBER	GUEST
S	Bill Robison	BHR	brobison@cityoftulsa.org	596-9475	X	
S	G. David Steele	GDS	dsteele@cityoftulsa.org	596-7285	X	
S	Bob Bledsoe	RB	Bobbledsoe@cityoftulsa.org	596-1279	X	
S	Kim Meloy		kmeloy@cityoftulsa.org	596-7271	X	
S	Michael Baker		MBaker@cityoftulsa.org	596-9420	X	
C	Dave Berry	DRB	dberry@tulsarealtors.com	637-5359	X	
S	Roy Foster		rfoster@cityoftulsa.org	596-1344	X	
S	Lucy Dolman		ldolman@cityoftulsa.org	596-2490	X	
S	Richard Hall		RichHall@cityoftulsa.org	596-1782	X	
S	Michelle Lester		mlester@cityoftulsa.org	596-7266	X	
S	Roger Jolliff		RJolliff@cityoftulsa.org	596-9898	X	
	Ron Flanagan (consultant)	RDF	rdflanagan@rdflanagan.com	749-2696	X	
	David Wakefield (consultant)		dwakefield@rdflanagan.com	749-2696	X	
C	Tim Lovell	TML	tulsapartners@gmail.com	632-0044	X	

C	Sheryl Siddiqui		sherylsiddiqui@yahoo.com	706-3595	X	
OMIT	JoAnn Woody		Jiwoody1017@sbcglobal.net		X	
C	Kyle Brierly		kylebrierly@rooter.com	622-6996	X	
C	Gary Cheatham		garycheatham@sbcglobal.net	695-8876	X	
C	Judith Finn		judithfinn@att.net	587-1800	X	
C	Ann Patton		ann.patton@sbcglobal.net	296-1959	X	
C	Bob Roberts		brob11@swbell.net		X	
S	Sue Price		sprice@cityoftulsa.org	596-2527	X	
C	Henry Townsend	HDT	hdytownsend@peoplepc.com	628-0651	X	
C	J K Evicks		jevicks@bama.com	732-2183	X	
C	Josh Miller		joshua.a.miller.r2d9@statefarm.com	627-1833	X	
S	Kathryn Spencer		kspencer@cityoftulsa.org	591-4375	X	
S	Jami Skimbo	JAS	jskimbo@cityoftulsa.org	591-4376	X	
S	Curt Easter	CE	ceaster@cityoftulsa.org	596-9897	X	
						X
						X

AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

3:00 P.M., Tuesday, February 21, 2012

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

Gary Cheatham, Chair
Judith Finn, Vice-Chair
Ann Patton, Secretary
Kyle Brierly, Member
Bob Roberts, Member

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Deborah Stowers, Asst. Secretary & Records Custodian
Harold Tohlen, OWRB Accredited Floodplain Administrator
Mark Swiney, Board Counsel

Call to Order & Roll Call ..... Chair

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of Minutes: January 17, 2012 ..... Chair

II. APPEALS & VARIANCES - None

III. BOARD ACTION ITEM

A. Gravel Credit Ordinance ..... Bill Robison/Mark Swiney

IV. REPORTS

A. Director's Report ..... Paul Zachary/Dan Crossland
- **1) Monthly Financial Report ..... Tammy Pitts**
- **2) Proposed Fund Transfers ..... Tammy Pitts**
- **3) Capital Projects Status Report ..... Deborah Stowers**

B. Floodplain Administrator's Report ..... Harold Tohlen
- **1) Permit Center Report ..... Harold Tohlen**

C. Hazard Mitigation Update ..... Bill Robison

V. DISCUSSION ITEMS

A. Low Impact Development ..... Bill Robison
B. Stormwater Design Criteria Manual ..... Bill Robison
C. Tulsa Hazard Mitigation Measures Priorities ..... Bill Robison
D. Strategic Plan Subcommitee ..... Ann Patton
E. Update on Levee Issues ..... Bill Robison
F. CRS Program & Hazard Mitigation Meeting Volunteers ..... Bob Roberts

VI. NEW BUSINESS - None

VII. FUTURE AGENDA ITEMS - None

VIII. PUBLIC COMMENTS

Although the OMA limits Board action to those matters specifically listed on this Agenda, the Board solicits and encourages public comments and ideas.

IX. MEETING CLOSURE ..... Chair

X. NEXT MEETING ..... March 20, 2012

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

MINUTES
STORMWATER DRAINAGE AND HAZARD MITIGATION ADVISORY BOARD
Tuesday, February 21, 2012
2317 South Jackson Room S213, Tulsa, OK 74107

Members Present
Gary Cheatham, Chairman
Kyle Brierly, Member
Ann Patton, Member
Bob Roberts, Member

Members Absent
Judith Finn, Vice Chairman

Others Present

Bob Bledsoe	City of Tulsa, Communications
Ron Flanagan	R.D. Flanagan & Associates
Matt Liechti	City of Tulsa, Engineering Department
Linda McPherson	City of Tulsa, Finance Utilities
Janet Meshek	Meshek & Associates
Bill Robison	City of Tulsa, Engineering Department
Alan Rowland	City of Tulsa, Finance Department
David Steele	City of Tulsa, Development Services Department
Deborah Stowers	City of Tulsa, Engineering Department
Laguitia Tate	City of Tulsa, Engineering Department
Bryan Young	City of Tulsa, Streets & Stormwater Department

DRAFT

Call to Order and Roll Call

At 3:04 p.m. Deborah Stowers called roll and established a quorum before Gary Cheatham called the meeting to order.

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of Minutes: January 17, 2012

The January 17, 2012 minutes were approved unanimously.

II. APPEALS & VARIANCES - None

III. BOARD ACTION ITEMS

A. Gravel Credit Ordinances

Bill Robison distributed a draft ordinance amending Title II-A and informed the Board that he had discussed this with Harold Tohlen and Paul Zachary and it is the opinion of all as engineers that over time gravel will evidently become impervious.

Mr. Robinson said that Mr. Zachary suggested a sliding scale impervious decreasing the percentage yearly as the gravel becomes impervious, but Mr. Robison personal opinion is to be consistent and

leave the ordinance as it is (appeal process) concerning gravel and accept the excess capacity credit portion.

After further discussion a motion was made to accept the gravel portion of the ordinance with the thirty five percent credits and this past with Ann Patton voting no.

The excess capacity credit portion past unanimously.

The ordinance will be put on City Council agenda for approval.

IV. REPORTS

A. Director's Report

Matt Lietchi informed the Board that he and Paul Zachary met with Todd Kilpatrick of the levee district to discuss the issues that have already been brought forward. It was agreed that the City of Tulsa is tax exempt therefore is not technically obligated to pay a fee to the levee district for assessment, but did agree to continue to voluntarily pay. They will be talking to the County about opportunities for finding match money.

They are also currently working on the 2013 funding package and have scheduled $2.5 million dollars per year from the utility stormwater fee. They are also looking at different stormwater projects that include Dirty Butter facility at Gilcrease Pond, Joe Creek basin relief line located at in the 47th & Florence area and Perryman Ditch at Rockford & 51st St. and are finding a local match to assist whenever grants are received.

1) Monthly Financial Report

Alan Rowland reported that total resources year to date estimate for the month of January is 63% of the actual 61.8% with year to date actual $16,350,000. Charges and services are down due to credits for over billings. Total revenue for the month is 57.1%. Appropriations and commitments year-to-date estimate is 62.3% and actual is 60.8%. Actual billings for the month of January are $28 thousand below estimated budget and $264 thousand below for the year. Actual collections are 97% for the month and 98% for the year. Fee-in lieu collected was $100,202.

Gary Cheatham asked that in the future that a pie chart of the distribution of funds be included in the report.

2) Proposed Fund Transfers

There were no proposed transfers for the month of January.

3) Capital Projects Status Report

Deborah Stowers presented the January 2012 capital report stating:

a) Joe Creek site A11 advertised with a street rehabilitation project and will start construction soon.
b) Jones Creek Tributary has opened and awaiting award.
c) Vensel Creek-Grupe Channel is in the process of being awarded to Tri-Star.
d) Joe Creek-53rd & Lewis is 99% complete with construction.

B. Floodplain Administrator's Report

No Report.

DRAFT

1) Permit Center Report

David Steele reported there are more pre-development commerces already this year than it was all of last year. For the month of January there were five permits issued in the in the regulatory floodplain and four in FEMA. Permit fees totaled $206.50. Mr. Steele made a brief report on the four commercial and the four watershed permits issued in the floodplain and the eight commercial and one watershed issued with fees-in-lieu of detention. Fees-in-lieu of detention collected was $96,070.80.

C. Hazard Mitigation Update

Bill Robison informed the Board that there was a resolution authorizing the update of the hazard mitigation plan and is moving forward to City Council.

Mr. Robison distributed information summarizing the City/County Safe Room Rebate Program. Anyone can apply right now using the Oklahoma Department of Emergency Management website **www.soonercare.ok.gov**.

Mr. Robison explained the procedures of applying and general requirements to receive the rebate of 75% of the actual cost of the safe room up to a maximum of $2,000. Homeowners may purchase any safe room that meets or exceeds FEMA 320/361 specifications.

Mr. Robison asked that the Board forward any other suggestions or comments to him.

DRAFT

V. DISCUSSION ITEMS

A. Low Impact Development

Bill Robison informed the Board that a pervious concrete test was being done in the west yard on March 6, 2012. There will be five various companies from the Tulsa area doing a 12’ x 100’ area. Each company will pour a 20’ x 12’ strip and it will be tested two weeks afterward and then every six months to determine which one performs the best. This pervious concrete is primarily for parking lot areas and not for heavy traffic.

B. Stormwater Design Criteria Manual

Bill Robison said that the manual was distributed to the staff on February 20, 2012 for another review after the editing from director and department to floodplain administrator (Harold Tohlen) or city engineer (Paul Zachary).

C. Tulsa Hazard Mitigation Measures Priorities

Bill Robison discussed the process of rating the measures and asked the Board to prioritize and submit to him.

D. Strategic Plan Subcommittee

Ann Patton said that the scheduled meeting was canceled due to emergencies and recommended that the subcommittee try again to meet in March and present to the Board recommendations on the scope, the recommended goals in April and milestone to carry out the goals in May.

E. Update on Levee Issues

Janet Meshek of Meshek & Associates distributed maps and information on drainage Levee District 12 and gave an overview of the levee survey to assure that everything is as it should be. Ms. Meshek also

discussed the one hundred year and the levee study property distribution by type (levee A, levee B, and levee C) 350K CFS floodplains along the Arkansas River and the certifications required by FEMA and Corp of Engineers.

The next step is getting the rest of the values. The levee district will go out with a contract to work on the $1.4 million for assessment to perceive certification. Also needed is to educate the leaders in the community so that they may educate the citizens regarding evacuation plans and risk.

Ann Patton informed the Board that Tulsa County News (west Tulsa) has written a series (three articles and an editorial) on the levees and Bill Robison will scan and distribute.

F. CRS Program & Hazard Mitigation Meeting Volunteers

No discussion.

VI. NEW BUSINESS - None

VII. FUTURE AGENDA ITEM

Invite new Planning Director, Dawn Warrick.

VIII. PUBLIC COMMENTS - None

IX. MEETING CLOSURE

Upon receiving no other comments or further questions, Mr. Cheatham thanked everyone for attending and adjourned the meeting at 5:09 p.m.

X. NEXT MEETING –March 20, 2012

DRAFT

FILED
CITY OF TULSA
STATE OF OKLAHOMA

2012 MAR 15 P 2:11

MICHAEL P. KIER
CITY CLERK

AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

3:00 P.M., Tuesday, March 20, 2012

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

Gary Cheatham, Chair
Judith Finn, Vice-Chair
Ann Patton, Secretary
Kyle Brierly, Member
Bob Roberts, Member

--

Deborah Stowers, Asst. Secretary & Records Custodian
Harold Tohlen, OWRB Accredited Floodplain Administrator
Mark Swiney, Board Counsel

Call to Order & Roll Call ..... **Chair**

I. ADMINISTRATIVE MATTERS

- **A. Approval/Correction of Minutes: February 21, 2012** ..... **Chair**

II. APPEALS & VARIANCES - None

III. BOARD ACTION ITEM - None

IV. REPORTS

- **A. Director's Report** ..... **Paul Zachary/Dan Crossland**
  - **1) Monthly Financial Report** ..... **Tammy Pitts**
  - **2) Proposed Fund Transfers** ..... **Tammy Pitts**
  - **3) Capital Projects Status Report** ..... **Deborah Stowers**
- **B. Floodplain Administrator's Report** ..... **Harold Tohlen**
  - **1) Permit Center Report** ..... **Harold Tohlen**
- **C. Hazard Mitigation Update** ..... **Bill Robison**

V. DISCUSSION ITEMS

- **A. Low Impact Development** ..... **Bill Robison**
- **B. Stormwater Design Criteria Manual** ..... **Bill Robison**
- **C. Tulsa Hazard Mitigation Measures Priorities** ..... **Bill Robison**
- **D. Strategic Plan Subcommitee** ..... **Ann Patton**
- **E. CRS Program & Hazard Mitigation Meeting Volunteers** ..... **Bob Roberts**

VI. NEW BUSINESS - None

VII. FUTURE AGENDA ITEMS - None

VIII. PUBLIC COMMENTS

Although the OMA limits Board action to those matters specifically listed on this Agenda, the Board solicits and encourages public comments and ideas.

IX. MEETING CLOSURE ..... **Chair**

X. NEXT MEETING ..... **April 17, 2012**

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

MINUTES
STORMWATER DRAINAGE AND HAZARD MITIGATION ADVISORY BOARD
Tuesday, March 20, 2012
2317 South Jackson Room S213, Tulsa, OK 74107

Members Present
Gary Cheatham, Chairman
Judith Finn, Vice Chairman
Ann Patton, Member
Bob Roberts, Member

Members Absent
Kyle Brierly, Member

Others Present

Robert Dimmick	City of Tulsa, Finance Department
Ron Flanagan	R.D. Flanagan & Associates
Tammy Pitts	City of Tulsa, Finance Department
Larry Poffenberger	3167 East 21st Place
Bill Robison	City of Tulsa, Engineering Department
Alan Rowland	City of Tulsa, Finance Department
David Steele	City of Tulsa, Development Services Department
Deborah Stowers	City of Tulsa, Engineering Department
Bryan Young	City of Tulsa, Streets & Stormwater Department

DRAFT

Call to Order and Roll Call

At 3:07 p.m. Deborah Stowers called roll and established a quorum before Gary Cheatham called the meeting to order.

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of Minutes: March 20, 2012

The March 20, 2012 minutes were approved unanimously.

II. APPEALS & VARIANCES - None

III. BOARD ACTION ITEMS

IV. REPORTS

A. Director's Report

Paul Zachary discussed the two areas that flooded with the recent storms. They were located at 81st and Elwood and the pedestrian bridge on Riverside. The 81st & Elwood location floods often and is approximately a $20 million project to completely fix the problem. There is a pipe collapsed at the pedestrian bridge in between Riverside and the Arkansas River. Engineering is currently designing a solution to this problem.

Ron Flanagan and Ann Patton discussed the nuisance flooding and the transportation system and a process to get the message out to the voting public and the City Council.

1) Monthly Financial Report

Tammy Pitts presented the monthly financial report for February 2012. The year-to-date total revenue is approximately $15.3 million and year-to-date estimate is 66.6% with actual at 65.2%. Year-to date for encumbrances and commitments is about $17.6 million and is at 66.7% of the year-to-date estimate for appropriations of expenditures. The monthly revenue budget on actual billings and actual collections is year-to-date about $15.3 million. Actual billings are approximately $15 million and 98% or about $14.7 has been collection. Fee-in-lieu collected for the month is $32.7 thousand.

The rate model requested for the 2013 budget has not yet been completed due to other departments being added. It will be available at next month's meeting and the proposed budget will be presented to the City Council at the end of April.

Mr. Cheatham and Ms. Patton expressed their concerns about the stormwater funds being diverted to other areas during the reorganization of Public Works. Mr. Zachary stated the focus is being brought back to where it used to be in stormwater drainage. Ms. Patton requested that capital improvement projects be added to the monthly agenda.

Mr. Zachary informed the Board that five year sales tax and a three year bond issues are being looked at to be voted on in the spring or early summer of 2013. The sales tax is up June 30, 2014 and the plan is to have the funding packages ready to be voted on in the late spring or early summer of 2013. It will go to the City Council in the time frame of November or December. Between the two programs, the dollars generated is around $631 million. There is a list of large stormwater projects included and other projects except water.

DRAFT

2) Proposed Fund Transfers

There were no proposed transfers for the month of February.

3) Capital Projects Status Report

Deborah Stowers presented the March 2012 capital report stating that the Jones Creek Tributary contract is being awarded to Crossland. There are several projects in the process to start construction, but is waiting on contract approval.

B. Floodplain Administrator's Report

No Report.

1) Permit Center Report

David Steele reported there were four permits issued in the in the regulatory floodplain and eight in FEMA for the month of February. Permit fees totaled $613.25. Mr. Steele made a brief report on the five commercial, one watershed and the six residential permits issued in the floodplain and the four commercial issued with fees-in-lieu of detention. Fees-in-lieu of detention collected was $29,779.68. The fee will increase on April 1, 2012 from $.56 per square foot to $.74 per square foot for impervious pavement.

There has been an increase in safe room permits and the system can generate a list of these permits by address. The fee is between $150 and $180 per safe room and that assures that they are being constructed according to the FEMA and ICC/NSSA 500 standards.

C. Hazard Mitigation Update

Bill Robison informed the Board that the contract has finally been processed through City Legal and they are getting started on the hazard mitigation update. FEMA has new requirements stating that before the end of the grant, the plan has to go to the State for approval, then to the Federal for approval and then be adopted before the expiration of plan; therefore that timeframe is approximately thirteen months to submit the plan to FEMA.

Mr. Robinson discussed public involvement and leveraging social media communication on hazard mitigation. There is a booth at the City Hall in Your Neighborhood meetings at each of the City Council districts.

Bob Roberts recommended to get public feedback by attending and asking to speak on this subject at different organizations and/or neighborhood association meetings.

Ann Patton also suggested beginning an outreach program at the malls. She also wants a resolution passed by the City Council stating that they would personally support the plan by helping to organize opportunities to present the mitigation issues in their districts.

After discussion of time devotion to the hazard mitigation plan, Judith Finn made a motion to devote one hour next month to the item and to move it to the beginning of the agenda. The motion passed unanimously.

All other reports on the agenda will begin at approximately 4:00 p.m.

DRAFT

V. DISCUSSION ITEMS

A. Low Impact Development

Bill Robison informed the Board that a pervious concrete test patch was done in the west yard on March 6, 2012. The five various companies were to come up with their own mix design. There were quite varying infiltration rates. There is a meeting with the concrete contractor on March 21st and he will be looking at the infiltration rates to compare them to the mix designs to identify why one is working better than the other.

B. Stormwater Design Criteria Manual

Bill Robison said that the manual was distributed to the staff on February 20, 2012 for another review after the editing from director and department to floodplain administrator (Harold Tohlen) or city engineer (Paul Zachary). Mr. Robinson will be meeting with staff next Tuesday, March 27th to get comments and the manual should be finalized soon.

C. Tulsa Hazard Mitigation Measures Priorities

Bill Robison received some of the prioritize ratings from the Board members and this should be ready next month.

D. Strategic Plan Subcommittee

Ann Patton and Judith Finn distributed some recommendations and gave an overview of the five goals and objectives and areas of emphasis that appears the Board could be useful over the coming year.

The final recommendation is that this becomes an annual process and that there will be a strategic planning process for the upcoming years.

Mr. Cheatham asked Deborah to research on goals and objectives to assure that the by-laws are being followed and not duplicated.

E. CRS Program & Hazard Mitigation Meeting Volunteers

Bob Roberts suggested removing this as an agenda item and the Board agreed.

VI. NEW BUSINESS

Judith Finn made a motion for Ann Patton to be empowered by the Board to prepare a news release with the assistance of the staff on stormwater drainage and hazard mitigation. After the Board comments, the motion passed unanimously.

VII. FUTURE AGENDA ITEM

Invite new Planning Director, Dawn Warrick.

VIII. PUBLIC COMMENTS

Larry Poffenberger, 3167 E. 21st Pl., explained that the ground steadily slopes from Admiral to 21st Place and creates a lot of runoff from the asphalt that the storm drainage is not handling. Mr. Poffenberger distributed pictures of the area and his property. He informed the Board that the damage to his driveway and the air conditioning unit. Also underneath the residence is continually wet causing a problem with mold and causing wood to rot on the garage.

Mr. Poffenberger believes the private businesses north are dumping trash in this area. The City cleaned this area about ten years ago, but it is due to be cleaned again. There is a paved alleyway. If the area was cleaned and graded properly, it would eliminate a lot of the runoff. Mr. Poffenberger also believes the asphalt starting two miles north is causing the problem.

The City of Tulsa has informed Mr. Poffenberger that he would have to get with the private business neighbors north of the area to resolve the problem because runoff from private property to private property is civil matter to be resolved between property owners.

Deborah Stowers informed the Board that Stormwater Design has investigated the site and determined that the water drainage is coming from the private businesses to the north and not from across the street. Ms. Stowers also stated that the City does not get involved in issues with citizens against citizens or neighbors against neighbors. This is a very localize situation. Investigation is still in progress in investigating the stormwater system behind this area.

Gary Cheatham asked that this situation be tabled until next month and an updated report on the findings is presented at that time. Mr. Cheatham informed Mr. Poffenberger that he would be contacted when more information is available.

A motion was made to table this situation until next month's meeting and it was passed unanimously.

IX. MEETING CLOSURE

Upon receiving no other comments or further questions, Mr. Cheatham thanked everyone for attending and adjourned the meeting at 5:09 p.m.

X. NEXT MEETING – March 20, 2012

DRAFT

MINUTES
CITY OF TULSA
2012 MULTI-HAZARD MITIGATION PLAN UPDATE
COMBINED COMMITTEE MEETING
Thursday, April 12, 2012; 1:30 pm

Members Present		**Members Absent**	
Robison, Bill	CoT, Project Mgr.	Swift, Mark,	Hazards Consultant
Flanagan, Ron	Hazards Consultant	Baker, Michael	CoT
Mack, Annalise	Hazards Consultant	Brierly, Kyle	CoT SDHMAB
Berry, Dave	Realtor	Cheatham, Gary	CoT SDHMAB
Bledsoe, Bob	CoT, Communications	Dolman, Lucy	CoT Park Dept.
Combs, Sara Kelly	Mortgage Officer	Easter, Curt	TAEMA
Evicks, J.K.	Bama Co.	Finn, Dr. Judith	CoT SDHMAB
Hall, Richard	CoT FD	Foster, Roy	CoT
Lovell, Tim	Tulsa Partners	Jolliff, Roger	TAEMA
Meloy, Kim	CoT, Communications	Lester, Michelle	CoT
Miller, Josh	State Farm Insurance	Patton, Ann	CoT SDHMAB
Roberts, Bob	CoT SDHMAB	Price, Sue	CoT
Siddiqui, Sheryl	Language & Culture	Skimbo, Jami	CoT
Warlick, Theron	CoT Planning	Spencer, Kathryn	CoT
		Steele, David	CoT Permits
,		Townsend, Henry	TCC LEPC
		Wakefield, David	RDF&A Consultants

Call to Order
The meeting of the City of Tulsa 2012 Multi-Hazard Mitigation Plan Update Combined Citizens and Technical Advisory Committee was called to order by Project Manager Bill Robison at 1:30 pm, Thursday, April 12th, 2012, Engineering South Bldg., Room S-328, 2317 S. Jackson Ave.,

AGENDA:
Introduction of participants;
Sheryl Siddiqui reported on the status of the Language & Culture Bank translations, making PSAs on getting people ready to deal with hazards. Completed include English, Spanish, Burmese, & Russian; yesterday we recorded Chinese, Hmong, Vietnamese & African-American. Today we will do Arabic, Urdu, Turkish, and Sign Language. Also reached out to Perry Broadcasting, an African-American owned media company which has agreed to run PSAs on the MTUL weekend show. Additionally, PSAs will be shown at upcoming cultural festivals & on TGOV & TCC TV channels.
Bill Robison (**BR**)- Can we get them to mention the Hazard Mitigation Plan?
Multi-Hazard Mitigation Plan

1. Multi Hazard Mitigation Plan Update

Flanagan (**RDF**)- Today we are going to do a quick overview of the Planning Process
PP 1 City of Multi-Hazard Mitigation Plan Update
PP 2 Consultants: Flanagan, Swift & Wetmore

PP 3 Tornado Cloud

RDF- We are subject to severe weather patterns in Oklahoma.

PP 4 Greensburg, Kansas Tornado devastation

PP 5 Picher, OK May 30, 2008 Tornado destruction

PP 6 Oklahoma Natural Hazards Insurance Losses graph.

RDF- Oklahoma has the 3rd highest insurance rates in the nation; How are we going to get the community, various institutions and organizations to engage in this planning process and take it seriously? Getting people's attention is going to be our big challenge. Discussion of insurance losses.

PP 7 Plan Objective: To provide guidance for community activities for the next five years.

PP 8 Objectives of Mitigation Planning: 1. To identify the Hazards that could impact the community; 2. Identify who those vulnerable populations are; 3. and to identify measures that can reduce or eliminate (mitigate) the losses upon the community.

PP 9 Mitigation Planning Process: Step 1. Organize to Prepare the Plan.

PP 10 Tulsa 2012 HM Plan Project Timeline: (**RDF):** 36 month Period of Performance; We have 1 year to prepare the Plan and get it submitted to the State & FEMA.

PP 11 Tulsa Storm Drainage & Hazard Mitigation Advisory Board

PP 12 Steps 2 & 3- (**RDF**) Public participation is going to be our greatest challenge.

PP 13 Meaningful Citizens Participation & Involvement; (**RDF**) Tulsa Partners did a wonderful conference on *A Day With out Business*, business continuity conference.

PP 14 List of Tulsa Hazard Mitigation Plans- (**RDF)**: How do these various Plan work together? Tim Lovell (**TL**) Also the City of Tulsa Sustainability Plan needs to be coordinated with as well;

PP 15 Other Tulsa Plans- (**RDF**) Other related planning processes include the Community Rating System (CRS) Plan, and the update of the Emergency Operating Procedures (EOP); Need an inventory and update of all of the Critical Facilities;

PP 16 Flood-related Planning Processes

PP 17 Map of Inventory of Higher Education Critical Facilities

PP 18 Hazards Study Schedule:

March 2012	Organize to Prepare the Plan
April 2012	Introduction, Plan Process Overview
May 2012	High Winds, Tornadoes, Safe Rooms\
June 2012	Extreme Heat, Drought
July 2012	Haz Mat, Transportation Hazards, LEPC
August 2012	Earthquakes, Expansive Soils, Building Codes
Sept. 2012	Urban Fires, Wildfires
Oct. 2012	Floods, Dam & Levee Failures
Nov. 2012	Severe Winter Storms
Dec. 2012	Lightning, Hail, Warning Systems
Jan. 2013	Hazards Review/Mitigation Measures

PP 19 `Moore, OK 1999 Tornado Path

PP 20 Joplin, MO Tornado Destruction (**RDF**)-Discussion of the Joplin Tornado and critique of the recovery process.

PP 21 Tulsa Tornado Scenario

PP 22 Tulsa City Council Districts; (**RDF**)- We want to try a different approach in this Plan. We want to consider, rather than do this plan at the community level, to do the plans at the Council District level.

PP 23 City Hall in the Neighborhood

PP 24 City Departments Displays and Booths

PP25 Bill Robison & Hazard Mitigation Plan Booth

PP 26 District 1 Site-Specific Hazards map

PP 27 District 2 Haz Mat Sites

PP 28 Council District 2

PP 29 Council District 3: Theron Warlick (**TL**)- It's definitely important to take Hazards into account when we do these Small Area Plans. It's a little different scope than we are used to, but we need to take these considerations into account.

PP 30 Council District 4

PP 31 Council District 5

PP 32 Council District 6- (**RDF**) This is where the future growth is going to be taking place. Look at the Expansive Soils. How are we going to mitigate that hazard in future development?

PP 33 Council District 7

PP 34 Council District 8

PP 35 Council District 9

PP 36 Post Disaster Recovery Planning- (**RDF**) Discussion on the importance of a Champion, elected official advocate for a successful planning process and effective Hazard Mitigation. Bill Robison (**BR**):; Bob Bledsoe (**BB)**): Bob Roberts (**BRob**): PlaniTulsa used Social Media very effectively; hit the civic organizations, Elks, etc.; Travis Meyer, Tom Bennett,

PP 37 Contacts for More Information

PP 38 The End

The April Power Point presentation can be viewed at:
www.rdflanagan.com/Tulsa/MHMP2012Update/Tulsa_HM_2012_Update.ppt

The Audio recording of this meeting can be accessed at:
www.rdflanagan.com/tulsa/mhmp2012update/COT_MHMP_12-04-12.wma

The meeting was adjourned at 11:15 am.
The next meeting will be **Thursday, May 10th at 1:30 pm**. Consultant will notify Team Members by e-mail on the Monday before the meeting.

Meeting was turned back to Bill Robison, and meeting was adjourned at 12:00 pm.

Respectfully submitted,

Bill Robison, P.E., CFM, Project Manager

Ronald D. Flanagan, CFM, Consultant

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Meeting Sign in Sheet

R.D. FLANAGAN & ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	**Tulsa, OK – 2013 MULTI-HAZARD MITIGATION PLAN UPDATE**		
Purpose of Meeting:	**Introduction**		
Date of Meeting:	**April 12, 2012**	**Time Begin: 1:30 pm**	**Time End:** 3:15

	Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	RDF	Flanagan, Ron	Consultant	T	918-749-2696	rdflanagan@rdflanagan.com
	am	Mack, Annalise	Consultant	T	918-749-2696	amack@rdflanagan.com
		Swift, Mark, P.E.	Consultant	T	918-582-1380	
**	BHR	1. Robison, Bill, P.E.	Project Manager	T	918-596-9475	brobison@cityoftulsa.org
		2. Baker, Michael		T	918-596-9420	MBaker@cityoftulsa.org
**	DRB	3. Berry, Dave	Realtor	C	918-637-5359	dberry@tulsrealtors.com
*	RB	4. Bledsoe, Bob	CoT Communications	T	918-596-1279	Bobbledsoe@cityoftulsa.org
**		5. Brierly, Kyle	SDHMAB Member	C	918-622-6996	kylebrierly@rooter.com
**		6. Cheatham, Gary	SDHMAB Chair	C	918-695-8876	garycheatham@sbcglobal.net
		7. Dolman, Lucy		T	918-596-2490	ldolman@cityoftulsa.org
*		8. Easter, Curt	Emergency Management	T	918-596-9897	ceaster@cityoftulsa.org
	JE	9. Evicks, J. K.	Bama	C	918-732-2183	jevicks@bama.com
		10. Finn, Judith, Dr.	SDHMAB Vice-Chair	C	918-587-1800	judithfinn@att.net

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	11. Foster, Roy		T	918-596-1344	rfoster@cityoftulsa.org
	12. Goss, Jeff			918-230-8429	jeff@servetulsa.com
R.H.	13. Hall, Richard	Fire Dept. Planning	T	918-596-1782	RichHall@cityoftulsa.org
	14. Jolliff, Roger	Emergency Manager	T	918-596-9898	RJolliff@cityoftulsa.org
	15. Lester, Michelle	CoT Real Eatate	T	918-596-7266	mlester@cityoftulsa.org
* TML	16. Lovell, Tim	Tulsa Partners, Director	C	918-632-0044	tulsapartners@gmail.com
	17. Meloy, Kim	CoT Communications	T	918-596-7271	kmeloy@cityoftulsa.org
	18. Miller, Josh	Insurance Industry	C	918-627-1833	Joshua.a.miller.r2d9@statefarm.com
*	19. Patton, Ann	SDHMAB Member	C	918-296-1959	Ann.patton@sbcglobal.net
	20. Price, Sue		T	918-596-2527	sprice@cityoftulsa.org
	21. Roberts, Bob	SDHMAB Member	C	918-	Brob11@swbell.net
	22. Siddiqui, Sheryl	Language & Culture Bank	C	918-706-3595	sherylsiddiqui@yohoo.com
	23. Skimbo, Jami		T	918-596-4376	jskimbo@cityoftulsa.org
	24. Spencer, Kathryn		T	918-591-4375	kspencer@cityoftulsa.org
*	25. Steele, G. David	Development Services	T	918-596-7085	dsteele@cityoftulsa.org
*	26. Townsend, Henry	TCC LEPC, Chair	T	918-628-0651	hdytownsend@peoplepc.com
TW	27. Warlick, Theron	CoT Planning	T	918-596-	twarlick@cityoftulsa.org
SC	28. Sara Kelly Combs	Mortgage Officer		918-704-4575	Sarakellycombs@gmail.com

AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Public Outreach
CRS
April 12, 2012 – 1:30 p.m.
PW Engineering Services
Conference Room S-328

Multi-Hazard Mitigation Plan:

1. Hazard Mitigation Plan Update.
2. Gaining Public Participation.
3. Public Meeting Strategies.
4. City Council Presentation.
5. Individual Safe Room Program.
6. ThorGuard.
7. SDHMAB Updates. Hazard Mitigation Measures.
8. Prioritizing Mitigation Measures.

Public Outreach:

1. New Outreach Video Production Relating to HM Update.
2. Video Production & Editing, TGOV/Private.
3. Mass Communication System Update.
4. Public Outreach Committee, mortgage banker.

CRS:

1. July 30, 2012 Workshop EMI F-328.
2. Other Items.

Next Meeting: T.B.D., 2012, 1:30 p.m. PW Engineering Services Conference Room 328

Adjourn

AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

3:00 P.M., Tuesday, April 17, 2012

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

Gary Cheatham, Chair
Judith Finn, Vice-Chair
Ann Patton, Secretary
Kyle Brierly, Member
Bob Roberts, Member

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Deborah Stowers, Asst. Secretary & Records Custodian
Harold Tohlen, OWRB Accredited Floodplain Administrator
Mark Swiney, Board Counsel

FILED
CITY OF TULSA
STATE OF OKLAHOMA
2012 APR 13 A 9:59
MICHAEL P. KIER
CITY CLERK

Call to Order & Roll Call ..... **Chair**

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of Minutes: March 20, 2012 ..... **Chair**

II. ISSUES

A. Hazard Mitigation Plan Overview ..... **Bill Robinson/Ron Flanagan**

III. APPEALS & VARIANCES - None

IV. BOARD ACTION ITEM

A. Strategic Plan ..... **Judith Finn/Ann Patton**

V. REPORTS

A. Director's Report ..... **Paul Zachary/Dan Crossland**
- **1) Monthly Financial Report** ..... **Tammy Pitts**
- **2) Proposed Fund Transfers** ..... **Tammy Pitts**
- **3) Capital Improvement Projects** ..... **Bill Robison**
- **4) Capital Projects Status Report** ..... **Deborah Stowers**

B. Floodplain Administrator's Report ..... **Harold Tohlen**
- **1) Permit Center Report** ..... **Harold Tohlen**

VI. DISCUSSION ITEMS

- **A. Low Impact Development** ..... **Bill Robison**
- **B. Stormwater Design Criteria Manual** ..... **Bill Robison**
- **C. Tulsa Hazard Mitigation Measures Priorities** ..... **Bill Robison**
- **D. Status of the HB2836 Bill** ..... **Bill Robison**
- **E. Runoff at 3167 East 21st Place** ..... **Deborah Stowers**

VII. NEW BUSINESS - None

VIII. FUTURE BUSINESS - None

IX. PUBLIC COMMENTS

Although the OMA limits Board action to those matters specifically listed on this Agenda, the Board solicits and encourages public comments and ideas.

X. MEETING CLOSURE ..... **Chair**

XI. NEXT MEETING ..... **May 15, 2012**

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

MINUTES
STORMWATER DRAINAGE AND HAZARD MITIGATION ADVISORY BOARD
Tuesday, April 17, 2012
2317 South Jackson Room S213, Tulsa, OK 74107

Members Present
Gary Cheatham, Chairman
Judith Finn, Vice Chairman
Ann Patton, Member
Kyle Brierly, Member

Members Absent
Bob Roberts, Member

Others Present

Bob Bledsoe	City of Tulsa, Communications Department
Ron Flanagan	R.D. Flanagan & Associates
Tammy Pitts	City of Tulsa, Finance Department
Alan Rowland	City of Tulsa, Finance Department
David Steele	City of Tulsa, Development Services Department
Mark Swiney	City of Tulsa, Legal
Deborah Stowers	City of Tulsa, Engineering Department
Laguitia Tate	City of Tulsa, Engineering Department
Bryan Young	City of Tulsa, Streets & Stormwater Department

DRAFT

Call to Order and Roll Call

At 3:10 p.m. Deborah Stowers called roll and established a quorum before Gary Cheatham called the meeting to order.

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of Minutes: March 20, 2012

The March 20, 2012 minutes were approved unanimously.

II. ISSUES

A. Hazard Mitigation Plan Overview

Ron Flanagan, R.D. Flanagan & Associates, gave a power point presentation on the overview of the planning process and issues unresolved concerning the hazard mitigation plan. The presentation has been presented to the hazard mitigation planning committee staff and has been approved for the Stormwater Drainage and Hazard Mitigation Advisory Board's review. The consultant team on this project is Mr. Flanagan, Mark Swift of Swift Water Resources, and French Wetmore & Associates from Seattle, WA.

Mr. Flanagan discussed the insurance premiums paid verses the losses incurred in the last five years and informed the Board that Oklahoma presently has the third highest rates in the nation.

The objective of this plan is to provide guidance for community activities for the next five years and to ensure that the City of Tulsa and other partners implement activities that are most effective and appropriate for mitigating natural and man-made hazard. This would include indentifying the hazards that could impact the community, the vulnerable population, and measures that can be taken to reduce or eliminate the impact of those hazards.

The mitigation planning process is to organize to prepare the plan which would include citizens' advisory committee, staff technical advisory committee, and council district citizens' participation. Other steps would include involving the public and coordinate with other agencies and organizations in council districts through neighborhood associations.

Mr. Flanagan informed the Board that the process has to be completed three years from the time that the federal money was obligated (April 28, 2011) and it has to be submitted to FEMA a year before the expiration date.

One of the greatest challenges in emergency management, locally and nationally, is meaningful citizens' participation and involvement and the broader question is how to get this information to the public as a whole so that they can protect themselves.

There are other related plans such as the community rating system process, HUD housing mitigation plan and the department of commerce business continuity planning. These are different federal agencies doing different planning processes and not working together.

Other Tulsa plans that have an impact on the hazard mitigation plan are the comprehensive, small area, capital improvements, master drainage, historic preservation hazard mitigation, Tulsa public schools hazard mitigation, and parks and recreation. The challenge is to bring all of these plans together as a comprehensive whole.

DRAFT

Ann Patton suggested inviting members from the other agencies to be involved in the Tulsa Plan or invite them to the Board's meetings to give presentations on their plans.

Mr. Flanagan also informed the Board that the hazard mitigation exhibits were set up at each city hall in the neighborhoods meeting in each city council district and brochures were distributed informing the public of this plan.

Post disaster recovery planning should be addressed by community leaders as part of the hazard mitigation planning process. Unless we build back better, we are merely re-investing in the repeat for the next disaster.

Mr. Flanagan asked the Board for guidance on where to go from here and what needs to be done differently than five years ago during the planning process.

Ms. Patton recommended contacting Michael Willis with the County to get involved.

Judith Finn suggested getting a war room at City Hall to coordinate the plans processes. Ms. Finn also suggested presenting this to the Mayor and elected officials and present with the answer and not problem.

Deborah Stowers recommended going to the next step of getting this information on the website.

Other suggestions were to invite City planning groups and the media weathermen to attend Board meetings.

Ann Patton asked Mr. Flanagan to come up with a strategy utilizing the City of Tulsa planning department and present recommendations to the Board.

III. APPEALS & VARIANCES – None

IV. BOARD ACTION ITEMS

A. Strategic Plan

Judith Finn is in the process of researching the ordinances, therefore the plan is not complete. This item was tabled to the May 15, 2012 meeting.

V. REPORTS

A. Director's Report

Deborah Stowers reported that Bridge 318A on 101st between Memorial and Sheridan is under construction.

Bryan Young informed the Board that a new contractor (Mow Town, LLC) started April 15, 2012 mowing the drainage facilities on a two week cycle. This is a one year contract with four renewals every January.

1) Monthly Financial Report

Tammy Pitts presented the monthly financial report for March 2012. Total revenue is still performing well and is approximately $17.2 million. Appropriations and commitments as expected at 75% of the year-to-date estimate of 77.4%. Actual billings verses actual collections are at 99%. Fee-in-lieu collected for the month is $27.3 thousand.

Alan Rowland informed the Board that the Mayor would be presenting the proposed FY-13 budget to the City Council on April 26th. Mr. Alan distributed a draft of stormwater scenario assumptions and discussed the approved FY-12 budget and the projected operating statement for stormwater enterprise for FY-13. Mr. Rowland and Ms. Pitts also distributed and discussed FY-13 highlights, fund summary and pie charts of FY-13 proposed budget by account groups.

DRAFT

2) Proposed Fund Transfers

There were no proposed transfers for the month of March.

3) Capital Improvements Projects

Deborah Stowers informed the Board that Bill Robison has a list and will provide it at the next meeting.

4) Capital Projects Status Report

No Report.

B. Floodplain Administrator's Report

David Steele provided a map by INCOG and explained the new City of Tulsa annexed area (annexation amending ordinance #22570).

1) Permit Center Report

David Steele reported there were seven permits issued in the in the regulatory floodplain and two in FEMA for the month of March. Permit fees totaled $250.00. Mr. Steele made a brief report on the two commercial, two watersheds, five residential permits issued in the floodplain and the four commercial issued with fees-in-lieu of detention. Fees-in-lieu of detention collected was $13,849.36.

V. DISCUSSION ITEMS

A. Low Impact Development

No Report.

B. Stormwater Design Criteria Manual

Nothing finalized.

C. Tulsa Hazard Mitigation Measures Priorities

Bill Robison received some of the prioritize ratings from the Board members and this should be ready next month.

D. Status of Oklahoma House Bill 2836

The Board voted unanimously to oppose legislation that would weaken floodplain management programs in Tulsa and other Oklahoma communities, and asked the Board chairman to notify the Mayor, City Council, and Tulsa area legislators as well as OFMA (Oklahoma Floodplain Manager Association) and ASFPM (Association of State Floodplain Managers).

Bill Robison and Bob Bledsoe will assist in getting the e-mail addresses of the contacts mentioned above.

E. Runoff at 3167 East 21st Place

Deborah Stowers provided an update on the drainage complaint that was brought to the Board at the last meeting. Stormwater Maintenance inspected the lines and found that the line that was to go up the ally way was not installed. We are currently having plans drawn up to install this line and inlet just upstream of the property. It will not totally solve the problem, however it will help. We will keep the Board and the citizen up to date on the progress.

DRAFT

VI. NEW BUSINESS

VII. FUTURE AGENDA ITEM

Invite new Planning Director, Dawn Warrick.

VIII. PUBLIC COMMENTS - None

IX. MEETING CLOSURE

Upon receiving no other comments or further questions, Mr. Cheatham thanked everyone for attending and adjourned the meeting at 5:55 p.m.

X. NEXT MEETING – May 16, 2012

MINUTES
CITY OF TULSA
2012 MULTI-HAZARD MITIGATION PLAN UPDATE
GIS USERS GROUP MEETING
Tuesday, April 24, 2012; 10:00 am

Members Present		**Members Absent**	
Robison, Bill	CoT, Project Mgr.	Swift, Mark,	Hazards Consultant
Bailey, Brett	Police Dept.	Gregorovic, John	Tulsa IT
Bickle, Kurt	INCOG	Jolliff, Roger	TAEMA
Brooks, Tyler	Flanagan & Assoc.	Easter, Curt	TAEMA
Flanagan, Ron	Hazards Consultant	Warlick, Theron	CoT Planning
Simmons, Ty	INCOG	Hall, Richard	CoT FD
Stall, Chad	Engr. Services	Mike Battenfield	CoT Park Department
Wakefield, David	Flanagan & Assoc.		
Weddington, Carl	Police Dept.		
Woodworth, Steve	Engr. Services		
Wooley, Russell	Assessors Office		

Call to Order
The meeting of the City of Tulsa 2012 Multi-Hazard Mitigation Plan Update GIS Users Group was called to order by Project Manager Bill Robison at 10:00 am, Tuesday, April 24th, 2012, Engineering South Bldg., Room S-218, 2317 S. Jackson Ave.,

AGENDA:
Introduction of participants;
Multi-Hazard Mitigation Plan

1. Multi Hazard Mitigation Plan Update

Flanagan (**RDF**)- Today we are going to do a quick overview of the Planning Process. The objective of this meeting is to find out what kinds of resources we have, who has them, what can we do to ensure that the information we collect can be shared with everybody, that we are all on the same page, and that we don't duplicate anyone's work.

PP 1 City of Multi-Hazard Mitigation Plan Update

PP 2 Consultants: Flanagan, Swift & Wetmore;

(RDF): French Wetmore is a national consultant to FEMA and the CRS program. The Hazard Mitigation Planning Program is going on throughout the nation, in every state, county, and community in the country, and the CRS is a flood planning program, where communities get discounted flood insurance premiums for their citizens. Tulsa is #2 in the nation, and we will be a Class 1 before long. CRS has a parallel planning process that almost mirrors the Hazard Mitigation Planning Process, so if we do this right, we can kill two birds with one stone. In addition, the State is now in the process of wanting all of the community and County Emergency Operating Procedures (EOP) updated. There are a lot of similarities of what we are going to be doing with Hazard Mitigation and CRS Planning,

and what Roger Jolliff is going to be doing updating the City and County EOPs. We have all of these planning processes going on, and very little coordination.

PP 3 Tulsa Plans

(RDF): Description of the various Hazard Mitigation Planning programs. HUD has a planning process for Public Housing, and Department of Commerce has a Business Continuity Planning going on.

PP 4 Other Tulsa Plans;

(RDF): Tulsa Planning Department has the Tulsa Comprehensive Plan, PlaniTulsa, and Small Area Plans; Public Works has Capital Improvements Plans, Master Drainage Plans; Historic Preservation Hazard Mitigation Plan; Tulsa Public Schools now has a Hazard Mitigation Plan; and Parks and Recreation has a plan.

PP 5 Update of HM Plan, CRS, and City/County EOP

Update of 2007 Hazard Mitigation Plan Critical Facilities

(RDF): In the last HM Plan, we had identified all of the Critical Facilities throughout the City of Tulsa. A Critical Facility is defined by FEMA as those facilities where the impact is much greater on the community than just on that building. For example is a Police or Fire Station were hit by a tornado. If they were damaged or destroyed, the First Responders could not help the public during a disaster. Continuity of government would be impaired.

PP 6 Map of City of Tulsa Critical Facilities.
PP 7 2007 Federal, State & County Facilities
PP 8 2007 Major Medical Facilities.
PP 9 2007 Local Financial Facilities.
PP 10 2007 Educational Facilities.
PP 11 2007 Private Schools
PP 12 2007 Childcare Facilities.
PP 13 2007 Senior Housing.
PP 14 INCOG Environmentally Sensitive Areas.

Preliminary Inventory Maps of Critical Facilities

PP 15 2012 Preliminary Childcare Facilities.;
PP 16 2012 Preliminary Colleges & Jr. Colleges.
PP 17 2012 Preliminary Local Government
PP 18 2012 Preliminary County Government:
PP 19 2012 Preliminary State Government
PP 20 2012 Preliminary EMSA.
PP 21 2012 Preliminary Fire Stations
PP 22 2012 Preliminary Hospitals.
PP 23 2012 Preliminary Nursing Homes.
PP 24 2012 Preliminary Police Stations
PP25 2012 Preliminary Post Offices
PP 26 2012 Preliminary Public Schools
PP 27 2012 Preliminary Private Schools

Proposed Example Maps of Council Districts

PP 28 Council Districts

PP 29 Example of a Site-Specific Council District Hazards Map

(RDF): There are two types of Hazards: 1) General Hazards- hazards that impact the entire community: drought, heat, hail, lightning, severe winter storms, high winds, tornadoes, urban fires, and earthquakes. They affect everybody equally.

But, there are six Site-Specific Hazards that affect each property differently and individually, and they include floods, dam failure, fixed hazardous materials sites, transportation hazards, wildfires, and expansive soils.

PP 30 Example, Hazardous Materials Sites, Council District 2

PP 31 Council District 2- Critical facilities Layer

PP 32 Council District 2- Parks

PP 33 Council District 2- Historic Register Sites

PP 34 Council District 2- Expansive Soils

PP 35 Council District 2- Floodplains

PP 36 Council District 2- Dam Inundation Areas

Kurt Bickle **(KB)** INCOG: INCOG has 2010 Census information; Barbara Gibson is our person that handles 2010 Census data; have it at the Bolck Level, in a GIS format.

(RDF): Where are these changes taking place? Where are concentrations of non-English speaking populations? What languages do we need to communicate with them?

PP 37 Council District 2- Population Over Age 65 (2000 Census)

PP 38 Council District 2- Wildfire Level of Concern

PP 39 Council District 2- 2008 City Zoning

PP 40 Council District 2- Home Owners Associations

(RDF): This information is based on the 2008 HM Plan. We need your help to update this information. A lot of this information is not going to change, like Expansive Soils, but what has changed are Critical Facilities.

PP 41 Council District 2- Site Specific Hazards

PP 42 Council District 3- Site Specific Hazards

PP 43 Council District 4- Site Specific Hazards

PP 44 Council District 5- Site Specific Hazards

PP 45 Council District 6- Site Specific Hazards

(RDF): This is of particular interest, because it is our future growth area. Look at these expansive soils. Here we are writing on a clean slate. How are we going to write on it? Are we just going to continue what we're doing, or are we going to build better than what we've done in the past?

PP 46 Council District 7- Site Specific Hazards

PP 47 Council District 8- Site Specific Hazards

PP 48 Council District 9- Site Specific Hazards

(RDF): So, that's where we are. What kinds of information and layers have you got, and how can we all get together and share this information, so that we are all working with the same data?

Bill Robison **(BR):** It would be very helpful to us, take Fire Stations for example, Haz Mat equipment is stored at certain locations, some of their locations are going to be more critical to a disaster response than others; we have layers that show road over topping in rainfall events, it is really important for us all to work together.
Brett Bailey **(BB):** At this time, we have no future facilities planned. We have the Main Station, 3 Uniform Divisions, Support Division which has the Police Mobile Command Post, SWAT Team, Bomb Squad; at another site we have our Disaster Response Team. Also the Garage, and Academy.
(BR): When we started Risk Map, they had us do a database of all City facilities for the HAZUS; Police & Fire updated it;
(RDF): Everybody thinks that we have all of this information, we have information that we've been gathering and developing over the years, and try to keep it up to date, but we never know if it is up to date, or if new data is available.

General discussion about difficulty of keeping information and data layers current and updated. Discussion of sirens;
(KB): INCOG has all of the siren locations, their radii. We can provide it to you, and Roger can check and update it. We are all about Regionalism.
(RDF): To sum this up, How are we going to work more closely with each other, to make sure we are all on the same page?
(KB): We will compile the list and send it to everybody in here, how current it is.
(BR): It would be good if we had a list of what data is being kept, and who is responsible for updating it and keeping it current.

Discussion of other data bases for Critical Facilities, such as Cell Phone Towers, electric sub-stations, sewer lift stations.
(RDF): To what extent are you interested in this ongoing Hazard Mitigation Planning Process? We meet monthly, and cover 2 hazards per month. You are welcomed, invited to participate in the monthly committee meetings.
Steve Woodworth **(SW):** We are definitely interested in being on the mailing list, so we can see what is being considered, and what we can contribute. Discussion of GIS formats, compatibility, inter operability; John Gregorovic, manages Tulsa IT.
(RDF): What kind of City of Tulsa GIS User's Group have you all got set up? Answer: There is no City of Tulsa GIS Users group.

PP 49 Post Disaster Recovery Planning-
PP 50 Contacts for More Information
PP 38 The End

The April 24th GIS User Group Power Point presentation can be viewed at:
www.rdflanagan.com/Tulsa/GIS/Tulsa-HM-2012-GIS-Meeting.ppt

The Audio recording of this meeting can be accessed at:
www.rdflanagan.com/Tulsa/GIS/T-HM-GIS-01.wma

www.rdflanagan.com/Tulsa/GIS/T-HM-GIS-02.wma

Project Manager/Consultant will notify Team Members by e-mail of the next meeting.

Meeting was turned back to Bill Robison, and meeting was adjourned at 11:30 am.

Respectfully submitted,

Bill Robison, P.E., CFM, Project Manager

Ronald D. Flanagan, CFM, Consultant

Meeting Sign in Sheet

R.D. FLANAGAN & ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	**Tulsa, OK – 2013 MULTI-HAZARD MITIGATION PLAN UPDATE**		
Purpose of Meeting:	GIS users		
Date of Meeting:	**April 24, 2012**	**Time Begin:**	**Time End:**

Name	Position or Organization	Phone(s)	E-mail
Kurt Bickle	INCOG	918 579-9460	kbickle@incog.org
Ty Simmons	INCOG	918 579-9436	tsimmons@incog.org
RUSSELL WOOLEY	ASSESSORS office	918-596-5127	RWOOLEY@TULSACOUNTY.ORG
Steve Woodworth	Graphics Engineering Services	918-596-9570	swoodwor@cityoftulsa.org
CARL WEDDINGTON	TULSA POLICE	918-596-9121	CWEDDINGTON@CITYOFTULSA.ORG.
BRET BAILEY	TPD	918.669.6008	BRBAILEY@CITYOFTULSA.ORG
Bill Robison	City of Tulsa	918-596-9475	brobison@cityoftulsa.org
David Schofield	RDFLANAGAN	918-749-2696	
Tyler Brooks	RD flanagan	(918) 282-2322	tbrooks@rdflanagan.com
Chad Stall	Graphics Engineering Graphics	(918) 596-2595	cstall@cityoftulsa.org
RON FLANAGAN	RDF&A	918-749-2696	rdflanagan@rdflanagan.com

Meeting Sign in Sheet

R.D. FLANAGAN & ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	**Tulsa, OK – 2013 MULTI-HAZARD MITIGATION PLAN UPDATE**		
Purpose of Meeting:	**Tornadoes/High Winds/Safe Rooms**		
Date of Meeting:	**May 10, 2012**	**Time Begin: 1:30 pm**	**Time End:**

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	Flanagan, Ron	Consultant	T	918-749-2696	rdflanagan@rdflanagan.com
AM	Mack, Annaelise	Consultant	T	918-749-2696	amack@rdflanagan.com
	Angela Swift Swift, Mark, P.E.	Consultant	T	918-582-1380	angela.swift@swreusa.com
BAR	1. Robison, Bill, P.E.	Project Manager	T	918-596-9475	brobison@cityoftulsa.org
	2. Baker, Michael		T	918-596-9420	MBaker@cityoftulsa.org
DB	3. Berry, Dave	Realtor	C	918-637-5359	dberry@tulsrealtors.com
BB	4. Bledsoe, Bob	CoT Communications	T	918-596-1279	Bobbledsoe@cityoftulsa.org
	5. Brierly, Kyle	SDHMAB Member	C	918-622-6996	kylebrierly@rooter.com
	6. Cheatham, Gary	SDHMAB Chair	C	918-695-8876	garycheatham@sbcglobal.net
SC	7. Combs, Sara Kelly	Mortgage Officer		918-704-4575	sarakellycombs@gmail.com
	8. Dolman, Lucy		T	918-596-2490	ldolman@cityoftulsa.org
CE	9. Easter, Curt	Emergency Management	T	918-596-9897	ceaster@cityoftulsa.org

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	10. Evicks, J. K.	Bama	C	918-732-2183	jevicks@bama.com
	11. Finn, Judith, Dr.	SDHMAB Vice-Chair	C	918-587-1800	judithfinn@att.net
	12. Foster, Roy		T	918-596-1344	rfoster@cityoftulsa.org
	13. Goss, Jeff			918-230-8429	jeff@servetulsa.com
RH	14. Hall, Richard	Fire Dept. Planning	T	918-596-1782	RichHall@cityoftulsa.org
	15. Jolliff, Roger	Emergency Manager	T	918-596-9898	RJolliff@cityoftulsa.org
	16. Lester, Michelle	CoT Real Eatate	T	918-596-7266	mlester@cityoftulsa.org
TM	17. Lovell, Tim	Tulsa Partners, Director	C	918-632-0044	tulsapartners@gmail.com
	18. Meloy, Kim	CoT Communications	T	918-596-7271	kmeloy@cityoftulsa.org
	19. Miller, Josh	Insurance Industry	C	918-627-1833	Joshua.a.miller.r2d9@statefarm.com
	20. Patton, Ann	SDHMAB Member	C	918-296-1959	Ann.patton@sbcglobal.net
	21. Price, Sue		T	918-596-2527	sprice@cityoftulsa.org
	22. Roberts, Bob	SDHMAB Member	C	918-	Brob11@swbell.net
SS	23. Siddiqui, Sheryl	Language & Culture Bank	C	918-706-3595	sherylsiddiqui@yohoo.com
	24. Skimbo, Jami		T	918-596-4376	jskimbo@cityoftulsa.org
	25. Spencer, Kathryn		T	918-591-4375	kspencer@cityoftulsa.org
	26. Steele, G. David	Development Services	T	918-596-7085	dsteele@cityoftulsa.org
HDYT	27. Townsend, Henry	TCC LEPC, Chair	T	918-628-0651	hdytownsend@peoplepc.com

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
TW	28. Warlick, Theron	CoT Planning	T	918-596-	twarlick@cityoftulsa.org
	29. PATRICK FOX	" "		596·8546	PFOX@CITYOFTULSA.ORG
	30. Josh Donaldson	*COT Planning		576-5686	jdonaldson@cityoftulsa.org
	31. Graham Bransin	COT-W&S		596-9806	gbransin@cityoftulsa.org
	32. Tom Bennett	Tulsa Partners		639-8102	tom@jimsafe.com
TY	33. TERRY YOUNG	CONSULTANT ~~FLANAGAN~~ &	T	749-2696	TYoung@rdflanagan.com
	34.				
	35.				
	36.				
	37.				
	38.				
	39.				
	40.				
	41.				
	42.				
	43.				
	44.				
	45.				

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	46.				
	47.				

Meeting Notes

R.D. FLANAGAN
& ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	City of Tulsa, OK HM Plan Update	**Date:**	April 12, 2012

	Travel Time	Mileage	Meeting
Begin:	1:00 pm		1:30 p.m.
End:			
Total			

Location:

Attending:	
Ron Flanagan	
See sign-in sheet	
Documents Received:	

Topics Covered: Earthquakes and Expansive Soils

Notes:

MINUTES
CITY OF TULSA
2012 MULTI-HAZARD MITIGATION PLAN UPDATE
COMBINED COMMITTEE MEETING
Thursday, May 10, 2012; 1:30 pm

Members Present		**Members Absent**	
Robison, Bill	CoT, Project Mgr.	Swift, Mark,	Hazards Consultant
Flanagan, Ron	Hazards Consultant	Baker, Michael	CoT
Mack, Annalise	Hazards Consultant	Brierly, Kyle	CoT SDHMAB
Swift, Angela	Engineering Consultant	Cheatham, Gary	CoT SDHMAB
Bennett, Tom	NSSA/Tulsa Partners	Dolman, Lucy	CoT Park Dept.
Berry, Dave	Realtor	Evicks, J.K.	Bama Co.
Bledsoe, Bob	CoT, Communications	Finn, Dr. Judith	CoT SDHMAB
Brannin, Graham	CoT WPS	Foster, Roy	CoT
Combs, Sara Kelly	Mortgage Officer	Gross, Jeff	ServeTulsa
Donaldson, Josh	CoT Planning	Jolliff, Roger	TAEMA
Easter, Curt	TAEMA	Lester, Michelle	CoT
Fox, Patrick	CoT Planning	Meloy, Kim	CoT, Communications
Hall, Richard	CoT FD	Miller, Josh	State Farm Insurance
Lovell, Tim	Tulsa Partners	Patton, Ann	CoT SDHMAB
Siddiqui, Sheryl	Language & Culture	Price, Sue	CoT
Townsend, Henry	TCC LEPC	Roberts, Bob	CoT SDHMAB
Warlick, Theron	CoT Planning	Skimbo, Jami	CoT
Young, Terry	RDF&A Consultants.	Spencer, Kathryn	CoT
		Steele, David	CoT Permits
		Wakefield, David	RDF&A Consultants

Call to Order
The meeting of the City of Tulsa 2012 Multi-Hazard Mitigation Plan Update Combined Citizens and Technical Advisory Committee was called to order by Project Manager Bill Robison at 1:30 pm, Thursday, May 10th, 2012, Engineering South Bldg., Room S-328, 2317 S. Jackson Ave.,

AGENDA:
Introduction of participants:
New members: Tom Bennett, Graham Brannin, Josh Donaldson, Patrick Fox, Angela Swift, Terry Young.

Multi-Hazard Mitigation Plan

1. Multi Hazard Mitigation Plan Update

Flanagan (**RDF**)- Today we have a lot to cover: High Winds, Tornadoes, IBHS Fortified Homes Standards, and Safe Rooms; Tim Lovell will be presenting the Draft Public Information and Education Strategy for your review and comment.

PP 1 City of Multi-Hazard Mitigation Plan Update, High Winds & Tornadoes
PP 2 Consultants: Flanagan, Swift, Tulsa Partners & French & Associates.
PP 3 Presentation Outline

	RDF: Tim Lovell has drafted a Public Participation, Information & Education Strategy, that he will be presenting; We will be looking at Council Districts and neighborhood associations;
PP 4	Mitigation Planning Process: Steps 2 & 3;
PP 5	Greatest Challenges: Meaningful Public Participation
PP 6	Hazards Study Schedule.
PP 7	City Hall in the Neighborhood. Successful Public Outreach program, a model that we would like to continue.
PP 8	Hazard Mitigation Plan Booth at City Hall in the Neighborhood.
PP 9	**High Winds**.
PP 10	High Winds Video.
PP 11	Graph Contrasting High Winds & Tornadoes
PP 12	High Winds Damage, Tulsa Downburst.
PP 13	Graphic showing wind and Gable and Hip Roofed Houses.
PP 14	Pictures of High Wind Damage to Gabled Buildings;
PP 15	Pictures of High Wind & Tree Damage.
PP 16	Pictures of High Wind Damage to Substantial Structures.
PP 17	History of Tulsa High Wind Events.
PP 18	Vulnerable Populations:
PP 19	Goals & Objectives for High Winds.
PP 20	**Tornadoes**
PP 21	Collage of Pictures of Tornado Destruction.
PP 22	Historic US Tornado Paths, 1950-2003
PP 23	F-2 or Greater map, 1921-1995.
PP 24	US Tornado Deaths chart, 1875-2010
	Discussion of Mobile Home Park Safe Rooms; Deaths due to High Winds & Tornadoes, mobile home vulnerability;
PP 25	Tulsa Area Tornado Facts
PP 26	Picture, Tornado destruction, Greensburg, Kansas, May 4, 2007
PP 27	Picture, Moore, OK May 3, 1999 Tornado paths
PP 28	Pictures, Tornado Destruction, OKC, May 10, 2010
PP 29	Picture, Joplin HS, May 22, 2011
PP 30	Picture, Joplin, MO, widespread destruction.
	Discussion of Joplin's response & recovery program, re-establish the pre-disaster status-quo;
PP 31	Post-Disaster Recovery Planning: "Build Back Better"
PP 32-38	Examples and % Damage to Typical Residential Structures with F-0 to F-5 damage
PP 39-40	Maps of Historic Tulsa Tornado Paths, 1950-2005
PP 41	Map of Tulsa Tornado Scenario
PP 42	**Critical Facility Tornado Issues**
PP 43	Picture, Greensburg, KS High School
PP 44	Picture, Moore, OK Kelly Elementary School Tornado Destruction
PP 45	Picture, Elementary School, Before & After

PP 46 Picture, Xenia, Ohio, school tornado window damage
PP 47 Picture, school children sheltering in hallway
PP 48 Picture, Alabama school hallway after tornado
PP 49 Tornado Goals & Objectives

PP 50 **Potential Mitigation Measures**
PP 51 Adopt Ordinances requiring additional Fortified building guideleins for residential structures.
PP 52 IBHS Fortified program
PP 53 Tornado video
PP 54 Graphic, IBHS Fortified Home Structural Load Path
PP 55 Picture, Foundation Anchor Bolts
PP 56 Diagram, Foundation to Floor Sill/Plate anchors
PP 57 Picture, Wall to Foundation anchors
PP 58 Picture, Floor sill plate ripped off of foundation bolts
PP 59 Picture, Wall Studs not connected to Flood Sill/Plate
PP 60 Picture, Roof to Wall straps
PP 61 Wyandotte Tribal Nation Fortified Housing
PP 62 Picture, Tornado destruction with double-wide garage doors
PP 63 Picture, Tornado damage to garage doors
PP 64 Picture, recommended single-bay garage doors
Tom Bennett (TB): (President, NSSA, member Tulsa Partners, meteorologist at Channel 6) Comments about Hurricane-resistant double-wide garage doors, cost an additional $800. Garage doors are the biggest factor in house failure; if the garage doors fail, the roof and rest of the house fail.
Tim Lovell: IBHS is developing Fortified for Existing Homes Standards;
TB: FLASH has something on their website about retrofitting your home, and the cost is less than $5,000.
PP 65 Comparison of Home Design after Tornado Event
PP 66 Video, IBHS Wind Research Center demonstration: conventional house vs. built to IBHS Fortified Home Standards.
PP 67 Video, 100 mph wind demonstration
Audio Stop 44:00
PP 68 Impact Resistant Window Systems
PP 69 Impact Resistant Window Systems

PP 70 **Safe Rooms**
PP 71 Types of Safe Rooms: Community & Individual Safe Rooms
PP 72 Community Safe Rooms;
PP 73 Mitigation Measure: Install Safe Rooms in Critical Facilities
PP 74 Mitigation Measure: Educate building professionals about ICC/NSSA Safe Room Guidelines/Requirements
PP 75 Individual Safe Rooms;
PP 76 Types and Costs of Individual Safe Rooms;
PP 77 Above Ground, Outside Safe Rooms;

PP 78 Above Ground, Inside Safe Room;
PP 79 Below Ground, Outside Safe Room;
PP 80 Below Ground, Inside Safe Room;
PP 81 Picture, Safe Room after a Tornado; need for GIS location of Safe Rooms
PP 82 *SoonerSafe*- Oklahoma Safe Room Rebate Program;
PP 83 Individual Safe Room Programs (HMGP); Communities can apply every year for individual safe-room programs, depending on funding.
PP 84 Basic Safe Room Program Process;
PP 85 Status of High Wind/Tornado Measures in Previous Plan
PP 86 Mitigation Measure: Develop a Safe Room Program for City of Tulsa Facilities;
PP 87 Mitigation Measure: Individual Safe Rooms Rebate Program;
PP 88 Mitigation Measure: Educate Public & Builders re: NSSA Standards;
PP 89 Mitigation Measure: Safe Rooms in Mobile Home Parks
PP 90 Hazards Vulnerability Analysis:

	Occurrence		**Impact**				**Mit**	**Resources**		**Total**
Hazard	**Hist.**	**Prob.**	**Hum**	**Prop.**	**Infra.**	**Bus.**	**Act.**	**Int.**	**Ext.**	
High Winds	5	5	2	2	1	2	3	5	3	**3.7**
Tornadoes	5	5	3	4	3	3	4	4	3	**5.0**

Discussion and Possible Action on Setting Next Meeting Date
The Hazard Mitigation Team agreed to meet at 1:30 pm, on Thursday, June 7th at the 2nd Floor Engineering Services Conference Room, 2117 S. Jackson.

The May High Winds & Tornado Power Point presentation can be viewed at: http://www.rdflanagan.com/Tulsa2012PublicMHMP/Presentations/TulsaHM2012UpdateHighWinds&Tornadoes.ppt

The meeting was adjourned at 4:15 pm.

The next meeting will be **Thursday, June 7th at 1:30 pm**. Consultant will notify Team Members by e-mail on the Monday before the meeting.

Meeting was turned back to Bill Robison, and meeting was adjourned at 4:15 pm.

Respectfully submitted,

Bill Robison, P.E., CFM, Project Manager

Ronald D. Flanagan, CFM, Consultant

AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Public Outreach
CRS
May 10, 2012 – 1:30 p.m.
PW Engineering Services
Conference Room S-328

Multi-Hazard Mitigation Plan:

1. Hazard Mitigation Plan Update.
    A. High Winds
    B. Tornadoes
    C. Safe Rooms
    D. IBHS Building Standards
2. Gaining Public Participation.
3. Public Meeting Strategies.
4. City Council Presentation.
    A. Report on Meeting w/ Councilor Cue
    B. HM Plan Presentation to City Council
5. Individual Safe Room Program.
6. ThorGuard.
7. SDHMAB Updates. Hazard Mitigation Measures.
8. Prioritizing Mitigation Measures.

Public Outreach:

1. New Outreach Video Production Relating to HM Update.
2. Video Production & Editing, TGOV/Private.
3. Mass Communication System Update.
4. Public Outreach Committee, mortgage banker.

CRS:

1. July 30, 2012 Workshop EMI F-328.
2. Other Items.

Next Meeting: **June 7, 2012, 1:30 p.m**. PW Engineering Services Conference Room 328

Adjourn

FILED
CITY OF TULSA
STATE OF OKLAHOMA

2012 MAY 11 A 8:31

MICHAEL R. KIER
CITY CLERK

AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

3:00 P.M., Tuesday, May 15, 2012

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

Gary Cheatham, Chair
Judith Finn, Vice-Chair
Ann Patton, Secretary
Kyle Brierly, Member
Bob Roberts, Member

--

Deborah Stowers, Asst. Secretary & Records Custodian
Harold Tohlen, OWRB Accredited Floodplain Administrator
Mark Swiney, Board Counsel

Call to Order & Roll Call ..... **Chair**

I. ADMINISTRATIVE MATTERS

- **A. Approval/Correction of Minutes: April 17, 2012** ..... **Chair**

II. ISSUES

- **A. Hazard Mitigation Plan Overview** ..... **Bill Robinson/Ron Flanagan**

III. APPEALS & VARIANCES - None

IV. BOARD ACTION ITEM

- **A. Strategic Plan** ..... **Judith Finn/Ann Patton**
- **B. Election of Officers** ..... **Chair**

V. REPORTS

- **A. Director's Report** ..... **Paul Zachary/Dan Crossland**
  - **1) Monthly Financial Report** ..... **Tammy Pitts**
  - **2) Proposed Fund Transfers** ..... **Tammy Pitts**
  - **3) Capital Improvement Projects** ..... **Bill Robison**
  - **4) Capital Projects Status Report** ..... **Deborah Stowers**
- **B. Floodplain Administrator's Report** ..... **Harold Tohlen**
  - **1) Permit Center Report** ..... **David Steele**

VI. DISCUSSION ITEMS

- **A. Low Impact Development** ..... **Bill Robison**
- **B. Stormwater Design Criteria Manual** ..... **Bill Robison**
- **C. Tulsa Hazard Mitigation Measures Priorities** ..... **Bill Robison**
- **D. Status of the House Bill 2836** ..... **Bill Robison**

VII. NEW BUSINESS - None

VIII. FUTURE BUSINESS - None

IX. PUBLIC COMMENTS

Although the OMA limits Board action to those matters specifically listed on this Agenda, the Board solicits and encourages public comments and ideas.

X. MEETING CLOSURE ..... **Chair**

XI. NEXT MEETING ..... **June 19, 2012**

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

MINUTES
STORMWATER DRAINAGE AND HAZARD MITIGATION ADVISORY BOARD
Tuesday, May 15, 2012
2317 South Jackson Room S213, Tulsa, OK 74107

Members Present
Gary Cheatham, Chairman
Judith Finn, Vice Chairman
Ann Patton, Member
Bob Roberts, Member

Members Absent
Kyle Brierly, Member

Others Present

Bob Bledsoe	City of Tulsa, Communications Department
Ron Flanagan	R.D. Flanagan & Associates
Jacob Hagen	City of Tulsa, Water & Sewer Department
Tim Lovell	Tulsa Partners
Annie Mack	R.D. Flanagan & Associates
Tammy Pitts	City of Tulsa, Finance Department
Bill Robison	City of Tulsa, Engineering Department
David Steele	City of Tulsa, Development Services Department
Mark Swiney	City of Tulsa, Legal
Deborah Stowers	City of Tulsa, Engineering Department
Laguitia Tate	City of Tulsa, Engineering Department
Scott Vanloo	City of Tulsa, Water & Sewer Department

DRAFT

Call to Order and Roll Call

At 3:14 p.m. Deborah Stowers called roll and established a quorum before Gary Cheatham called the meeting to order.

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of Minutes: April 17, 2012

The April 17, 2012 minutes were approved unanimously.

II. ISSUES

A. Hazard Mitigation Plan Overview

Ron Flanagan, R.D. Flanagan & Associates stated that one of the objectives was to get an elective official to be a champion for the planning process concerning the hazard mitigation plan; therefore a meeting was set up with Councilor Cue along with Tim Lovell, Tulsa Partners and a power point presentation geared to her area was given. Councilor Cue informed them that she is on board partly because of the warning sirens needed in west Tulsa and the Tulsa Hills area and she would inform the other councilors of this concern. Bill Robison contacted Councilor Cue and this resulted in a

presentation to be given to the City Council on the next scheduled Public Works Committee meeting which was Thursday, May 17th.

Mr. Flanagan also informed the Board that they have attended and set up exhibits at all of the city hall in your neighborhood meetings. They would like to have a meeting in all of the districts with the Councilor and get their feedback to what extent they would like to be involved in the process. They would also like to send out a letter to all of the homeowner associations' presidents to get their feedback.

There was good participation at the last staff meeting. Three staff members from the City of Tulsa planning department attended and they want to take this program to the small area planning. It was also decided to identify and bring in experts for each of the fifteen hazards to give the presentations.

Mr. Flanagan gave a power point presentation on high winds, tornados, and institute for business and home safety (IBHS) fortified homes. The consultant team on this project is Flanagan & Associates, Swift Water Resources Engineers, Tulsa Partners, and French & Associates from Seattle, WA. This presentation was an overview consisting of the vulnerable populations and resources, goals and objectives, area tornado facts, and post-disaster recovery planning. The goals and objectives are to reduce injuries and loss of life; trauma; damage to property, equipment and infrastructure; community disruption; and economic environmental and other losses caused by high winds. The time for post-disaster planning is before the disaster and should be addressed by community leaders as part of this planning process. Unless built back better, we are merely re-investing in the repeat for the next disaster.

DRAFT

Annie Mack, Flanagan & Associates, continued the presentation to cover safe rooms. Community and individual safe rooms need to meet or exceed criteria of FEMA. Ms. Mack gave details on the community tornado safe rooms and types and costs of individual inside and outside safe rooms.

Programs for safe rooms include the Individual Safe Room Programs (monies available through FEMA hazard mitigation grant program), the statewide SoonerSafe Safe Room Program (register at **www.soonercare.ok.gov**), and Basic Program Process (the local jurisdiction determines reimbursement amount).

Tim Lovell, Tulsa Partners distributed information and discussed Public Information and Education Strategy. There are two inter-related goals for this strategy: the short-term goal of public participation and the long term goal of ongoing education, outreach and engagement in hazard mitigation activities.

Recommendations for the short-term strategy is outreach through City Council Districts, Neighborhoods, and other City District stakeholder groups; outreach through city-wide civic organizations and diverse community networks; outreach through community networks associated with other community networks associated with community plans and city department activities; media strategy (news media/social media); and outcome measurements.

Recommendations for the long term strategy include constructing program for public information meeting new CRS requirements; critical role of hazard mitigation/CRS meeting and SDHMAB; continued engagement of stakeholders and communication on mitigation measures; media strategy (new media/social media); and outcome measurements

Mr. Lovell hopes that this information provides an overview of how such a two-pronged strategy can be implemented. The next steps for implementing would be developing a proposed budget for those parts related to the update process and deciding who is responsible for it. Tulsa Partners is willing to assist in this effort in whatever way the City of Tulsa and Flanagan & Associates deems appropriate.

III. APPEALS & VARIANCES – None

IV. BOARD ACTION ITEMS

A. Strategic Plan

Judith Finn is in the process of researching the ordinances, therefore the plan is not complete.

B. Election of Officers

Election was held and resulted in a unanimous vote for Judith Finn, chairman; Ann Patton, vice-chairman; and Bob Roberts as secretary.

V. REPORTS

A. Director's Report – No report.

1) Monthly Financial Report

Tammy Pitts distributed and discussed an overview memo regarding the FY-13 budget updates on the stormwater enterprise fund. The Mayor's submittal to City Council for operating is less than requested by the directors. The only expansion items are the study, public education and training related to Stormwater Quality Permit as mandated by EPA/ODEQ for $140 thousand and the mowing of the newly annexed areas of Tulsa for $100 thousand. Due to a smaller budget and a larger than estimated fund balance, the transfer for FY-13 is $5.5 million.

Tammy Pitts presented the monthly financial report for April 2012. Total revenue year-to-date is at $19.1 million. Year-to-date expenditures/encumbrances/commitments is approximately$21.4 million, 81% of the year-to-date estimate. Actual billings verses actual collections are at 99%. Fee-in-lieu collected for the month is $181.1 thousand.

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2) Proposed Fund Transfers

There were no proposed transfers for the month of April.

3) Capital Improvements Projects

Bill Robison reported that there was no change in capital improvement projects except for examining the urgent small project list. The City of Tulsa is not required to pay levee assessment fee but volunteers to pay part of it.

4) Capital Projects Status Report

Deborah Stowers presented the May 2012 capital report stating that the site A-11 is under construction. Several projects are waiting on contract approval and will start construction soon.

B. Floodplain Administrator's Report

1) Permit Center Report

David Steele reported there were nineteen permits issued in the in the regulatory floodplain and two in FEMA for the month of April. Permit fees totaled $711.00. Three out of the five elevation certificates

required were received. Mr. Steele made a brief report on the twelve commercial, two watersheds, seven residential permits issued in the floodplain and the five commercial issued with fees-in-lieu of detention. Fees-in-lieu of detention collected was a total of $181,101.40 which include the $25.981.40 reimbursement received from the City of Broken Arrow for the regional detention pond located west of Garnett Road and north of 61st St.

V. DISCUSSION ITEMS

A. Low Impact Development

Bill Robison informed the Board that Dawn Warrick of the planning department and INCOG were reworking the zoning codes.

B. Stormwater Design Criteria Manual

Bill Robison reported that Janet Meshek and Mark Swift are finalizing the last changes and should be ready to submit to City Council in a month.

C. Tulsa Hazard Mitigation Measures Priorities

Bill Robison distributed prioritize ratings received from the Board members for review.

D. Status of Oklahoma House Bill 2836

Bill Robison stated that this bill has been reworded quite a bit and is in committee right now. It is worded to let the home builders know that it only affects the legislation pertaining to post 1980 communities; therefore it would not affect Tulsa.

DRAFT

VI. NEW BUSINESS

VII. FUTURE AGENDA ITEM

Invite new Planning Director, Dawn Warrick.

VIII. PUBLIC COMMENTS - None

IX. MEETING CLOSURE

Upon receiving no other comments or further questions, Mr. Cheatham thanked everyone for attending and adjourned the meeting at 4:57 p.m.

X. NEXT MEETING – June 19, 2012

TCLEPC Meeting:

Name	Organization	Address	Tel. #	E-mail
Tim Hoss	OSHMC		918-599-5610	THOSS@OSHMC.NET
KEN TABOR	COT-WMS		918 591-4390	KTABOR@CITYOF TULSA.ORG
DAN MILLER	TULSA POLICE		918 740-9121	DMILLER@CITYOFTULSA.ORG
Henry Townsend	TCLEPC		918 628 0651	hdytownsend@peoplepc.com
Alicia Etgen	THD		9185954554	aetgen@tulsa-health.org
RON FLANAGAN	RDF & A		918-749-2696	rdflanagan@rdflanagan.com
annie mack	" "		" "	amack@rdflanagan.com
Jeff Condray	Tulsa Airport Authority		918 838 5048	jeffrey.condray@cityofTulsa.org
Valerie Sharpsteen	Bama		918-732-2127	vsharpsteen@bama.com
Gay Campbell	Saint Francis		918-494-2497	agcampbell@saintfrancis.com
Sue Parnell	St. John-BA/Owasso		918-994-8135	sue.parnell@sjmc.org
Bob Roberts	TPS/TPI		file	
JE VICKS	Bama		918-732-2183	jevicks@bama.com
Jimmy Looney	FBI		918-698-4526	jimmy.looney@ic.fbi.gov
Artie PALK	Sand Springs Emergency Mgmt		918-246-2610	afpalk@sandsprings ok.org

Meeting Sign in Sheet

R.D. FLANAGAN & ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	**Tulsa, OK – 2013 MULTI-HAZARD MITIGATION PLAN UPDATE**		
Purpose of Meeting:	**Extreme Heat**		
Date of Meeting:	**June 7, 2012**	**Time Begin: 1:30 pm**	**Time End:**

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	Flanagan, Ron	Consultant	T	918-749-2696	rdflanagan@rdflanagan.com
AM	Mack, Annaelise	Consultant	T	918-749-2696	amack@rdflanagan.com
	Young, Terry	Consultant	T	918-749-2696	tyoung@rdflanagan.com
	Swift, Mark, P.E.	Consultant	T	918-582-1380	swre@sbcglobal.net
	Swift, Angela	Swift Water Resources	T	918-582-1380	angela.swift@swreusa.com
BHR	1. Robison, Bill, P.E.	Project Manager	T	918-596-9475	brobison@cityoftulsa.org
	2. Baker, Michael		T	918-596-9420	MBaker@cityoftulsa.org
	3. Bennett, Tom	Tulsa Partners	C	918-639-8102	tom@jimsafe.com
DRB	4. Berry, Dave	Realtor	C	918-637-5359	dberry@tulsrealtors.com
BB	5. Bledsoe, Bob	CoT Communications	T	918-596-1279	Bobbledsoe@cityoftulsa.org
	6. Brannin, Graham	CoT Planning and Intergovt Admin	T	918-749-7440	gbrannin@cityoftulsa.org
	7. Brierly, Kyle	SDHMAB Member	C	918-622-6996	kylebrierly@rooter.com
	8. Cheatham, Gary	SDHMAB Chair	C	918-695-8876	garycheatham@sbcglobal.net

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	9. Combs, Sara Kelly	Mortgage Officer		918-704-4575	sarakellycombs@gmail.com
	10. Dolman, Lucy		T	918-596-2490	ldolman@cityoftulsa.org
	11. Donaldson, Josh	CoT Planning Dept	T	918-576-5686	jdonaldson@cityoftulsa.org
	12. Easter, Curt	Emergency Management	T	918-596-9897	ceaster@cityoftulsa.org
	13. Evicks, J. K.	Bama	C	918-732-2183	jevicks@bama.com
	14. Finn, Judith, Dr.	SDHMAB Vice-Chair	C	918-587-1800	judithfinn@att.net
	15. Foster, Roy		T	918-596-1344	rfoster@cityoftulsa.org
	16. Fox, Patrick	CoT Planning Dept	T	918-576-5685	pfox@cityoftulsa.org
	17. Goss, Jeff			918-230-8429	jeff@servetulsa.com
RH	18. Hall, Richard	Fire Dept. Planning	T	918-596-1782	RichHall@cityoftulsa.org
RJ	19. Jolliff, Roger	Emergency Manager	T	918-596-9898	RJolliff@cityoftulsa.org
	20. Lester, Michelle	CoT Real Eatate	T	918-596-7266	mlester@cityoftulsa.org
TMC	21. Lovell, Tim	Tulsa Partners, Director	C	918-632-0044	tulsapartners@gmail.com
	22. Meloy, Kim	CoT Communications	T	918-596-7271	kmeloy@cityoftulsa.org
	23. Miller, Josh	Insurance Industry	C	918-627-1833	Joshua.a.miller.r2d9@statefarm.com
	24. Patton, Ann	SDHMAB Member	C	918-296-1959	Ann.patton@sbcglobal.net
	25. Price, Sue		T	918-596-2527	sprice@cityoftulsa.org

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	26. Roberts, Bob	SDHMAB Member	C	918-	Brob11@swbell.net
	27. Siddiqui, Sheryl	Language & Culture Bank	C	918-706-3595	sherylsiddiqui@yohoo.com
	28. Skimbo, Jami		T	918-596-4376	jskimbo@cityoftulsa.org
	29. Spencer, Kathryn		T	918-591-4375	kspencer@cityoftulsa.org
	30. Steele, G. David	Development Services	T	918-596-7085	dsteele@cityoftulsa.org
	31. Townsend, Henry	TCC LEPC, Chair	T	918-628-0651	hdytownsend@peoplepc.com
	32. Warlick, Theron	CoT Planning	T	918-596-	twarlick@cityoftulsa.org
	33. Hughes, Barry	Impact		918-274-9914	advertisingimpact@cox.net
	34. Stevens, Chris	EMSA		918 830-8214	Stevensc@EMSA.Net
	35. Bruer, Kelli	EMSA		918-596-3140	bruerk@emsa.net
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Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
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	46.				
	47.				
	48.				
	49.				
	50.				
	51.				

Meeting Notes

R.D. FLANAGAN
& ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	City of Tulsa, OK HM Plan Update	**Date:**	June 7, 2012

	Travel Time	Mileage	Meeting
Begin:	1:00 pm		1:30 p.m.
End:			
Total			

Location:

Attending:	
Ron Flanagan	
See sign-in sheet	
Documents Received:	

Topics Covered: Extreme Heat

Notes:

AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Public Outreach
CRS
June 7, 2012 – 1:30 p.m.
PW Engineering Services
2317 S. Jackson Ave.
2nd Floor Conference Room S-213

Multi-Hazard Mitigation Plan:

1. City Council Presentation.
    A. Report on Meeting w/ Council Public Works Committee
    B. HM Plan Presentation to Council District 5, June 19th
2. Hazard Mitigation Plan Update.
    A. Extreme Heat
    B. Drought (Introduction/Summary)
3. Gaining Public Participation.
4. Public Meeting Strategies.

Public Outreach:

1. New Outreach Video Production Relating to HM Update.
2. Video Production & Editing, TGOV/Private.

Next Meeting: **July 5, 2012, 1:30 p.m**. PW Engineering Services Conference Room 218

Adjourn

AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Public Outreach
CRS
June 14, 2012 – 1:30 p.m.
PW Engineering Services
Conference Room S-328

1. Individual Safe Room Program.
2. ThorGuard.
3. SDHMAB Updates. Hazard Mitigation Measures.
4. Prioritizing Mitigation Measures.

Public Outreach:

1. New Outreach Video Production Relating to HM Update.
2. Video Production & Editing, TGOV/Private.
3. Mass Communication System Update.
4. Public Outreach Committee, mortgage banker.

CRS:

1. July 30, 2012 Workshop EMI F-328.
2. Other Items.

Next Meeting: **July 12, 2012, 1:30 p.m**. PW Engineering Services Conference Room 328

Adjourn

AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

3:00 P.M., Tuesday, June 19, 2012

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

Judith Finn, Chair
Ann Patton, Vice-Chair
Bob Roberts, Secretary
Kyle Brierly, Member
Gary Cheatham, Member

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Deborah Stowers, Asst. Secretary & Records Custodian
Harold Tohlen, OWRB Accredited Floodplain Administrator
Mark Swiney, Board Counsel

FILED
CITY OF TULSA
STATE OF OKLAHOMA
2012 JUN 15 A 9:33
MICHAEL P. KIER
CITY CLERK

Call to Order & Roll Call ..... Chair

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of Minutes: May 15, 2012 ..... Chair
B. Expiration and reauthorization of terms of Board Members ..... Chair

II. ISSUES (SUSTAINABLE TULSA)

A. Hazard Mitigation Plan Element: ..... Bill Robinson/Ron Flanagan
B. Consideration of related issues:
   1) Pre- and post emergency planning.
   2) Key policy issues: city, county, state
   3) Ordinance changes required
   4) New capital outlays, bond issues, grants implicated
   5) Public education and engagement regarding this element of the plan. e.g. Lecture series using experts identified by Flanagan & Associates, Jim Schwab, etc.
   6) Priority of this element (high, medium, low).
   7) Integration of planning: GIS System, coordination with city, county state, and federal hazard mitigation efforts.
   8) Barriers to implementation of this element of the plan.
   9) Assignments
C. Silver Jacket Project ***(Action Required)***
D. Levee Decision by US Corp of Engineers.
E. Strategic Planning: Report from Judith Finn/Ann Patton. Request for identified staff member to provide overall technical assistance and planning advice to the Board.

III. APPEALS & VARIANCES - None

IV. REPORTS

Paper reports from staff will be reviewed by the Board outside the meeting. Reporters should plan to identify key issues which are suggested by their reports, such as policy, ordinance, and capital considerations.

A. A.Director's Report ..... Paul Zachary/Dan Crossland
   1) Monthly Financial Report ..... Tammy Pitts
   2) Proposed Fund Transfers ..... Tammy Pitts
   3) Capital Improvement Projects ..... Bill Robison
   4) Capital Projects Status Report ..... Deborah Stowers
B. Floodplain Administrator's Report ..... Harold Tohlen
   1) Permit Center Report ..... David Steele

Continued on Page 2

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

3:00 P.M., Tuesday, June 19, 2012

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

V. DISCUSSION ITEMS

A. Low Impact Development ..... Bill Robison
B. Stormwater Design Criteria Manual ..... Bill Robison
C. Tulsa Hazard Mitigation Measures Priorities ..... Bill Robison
D. Permit and Watershed Characterization Program ..... Scott VanLoo

VI. PUBLIC COMMENTS

Although the OMA limits Board action to those matters specifically listed on this Agenda, the Board solicits and encourages public comments and ideas.

VII. MEETING CLOSURE ..... Chair

VIII. NEXT MEETING ..... July 17, 2012

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

MINUTES
STORMWATER DRAINAGE AND HAZARD MITIGATION ADVISORY BOARD
Tuesday, June 19, 2012
2317 South Jackson Room S213, Tulsa, OK 74107

Members Present
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Bob Roberts, Secretary
Kyle Brierly, Member

Members Absent
Ann Patton, Vice Chairman
Gary Cheatham, Member

Others Present

Bob Bledsoe	City of Tulsa, Communications Department
Ron Flanagan	R.D. Flanagan & Associates
Jacob Hager	City of Tulsa, Streets & Stormwater Department
Matt Liechti	City of Tulsa, Engineering Department
Tim Lovell	Tulsa Partners
Grasshopper Mendoza	Idea Village (the Water Challenge) New Orleans
Steve Picou	Idea Village (the Water Challenge) New Orleans
Bill Robison	City of Tulsa, Engineering Department
David Spear	City of Tulsa, Planning & Economic Development Department
Deborah Stowers	City of Tulsa, Engineering Department
Mark Swiney	City of Tulsa, Legal
Laguitia Tate	City of Tulsa, Engineering Department
Roy Teeters	City of Tulsa, Streets & Stormwater Department
Scott Vanloo	City of Tulsa, Water & Sewer Department
Bryan Young	City of Tulsa, Streets & Stormwater Department

DRAFT

Call to Order and Roll Call

At 3:15 p.m. Deborah Stowers called roll and established a quorum before Judith Finn called the meeting to order.

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of Minutes: May 15, 2012

The May 15, 2012 minutes were approved unanimously.

B. Expiration and reauthorization of terms of Board Members

Judith Finn wants the members of the Board to be aware of their term expirations and to assure they get reauthorized if they want to continue to serve.

II. ISSUES

A. Hazard Mitigation Plan Element

Bill Robison

B. Consideration of Related Issues

C. Silver Jacket Project *(Action Required)*

Bob Roberts informed the Board that the Silver Jacket Program comes out of the Corp of Engineers. Its' mission is to foster an effective and continuous collaboration between state and federal agencies to reduce the risk of flooding and other natural disasters in the United States. The overarching mission is to enhance response and recovery efforts when such events occur. No single agency has all the answers, but often multiple programs can be leveraged to provide a cohesive solution. It brings together multiple state, federal, as well as tribal and local agencies to learn from one another and apply their knowledge to reduce risk. It is a collaboration of agencies, such as State Hazard Mitigation Officer and State National Flood Insurance Program Coordinator. Silver Jacket provides a common forum to address the state's flood risk management priorities and the programs are developed at the state level.

Silver Jacket is utilizing technical resources and data from FEMA, NOAA, USGS, and USACE. This information will be collected in one location using a tool called SimSuite. SimSuite is a GIS mapping tool where additional layers can be added to assist local governments' development of their EAPs, IRMs and strategic plans for prioritized levee repair and maintenance activities.

They have one pilot project in the state and it is in Miami, OK. They are proposing to work with the City of Tulsa, Tulsa County, and the Natural Hazard Mitigation Association and will be applying for grants for the funding.

Tim Lovel (Tulsa Partners) added that the reason they along with NHMA are interested is because they have developed a project with FEMA at the national level for resilient neighbors creating a network of communities around the country. Tulsa Partners is serving as a local representative for NHMA.

Mr. Robert motioned for the Board to recommend to the City of Tulsa to foster partnership and continue this project and it passed unanimously.

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D. Levee Decision by US Corp of Engineers

E. Strategic Planning

III. APPEALS & VARIANCES – None

IV. REPORTS

A. Director's Report – No report.

1) Monthly Financial Report - No report.

2) Proposed Fund Transfers – No report.

3) Capital Improvements Projects

Bill Robison reported that there was no change in capital improvement projects except for examining the urgent small project list. The City of Tulsa is not required to pay levee assessment fee but volunteers to pay part of it.

4) Capital Projects Status Report

Deborah Stowers presented the May 2012 capital report stating that the site A-11 is under construction. Several projects are waiting on contract approval and will start construction soon.

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1) Permit Center Report

David Steele reported there were nineteen permits issued in the in the regulatory floodplain and two in FEMA for the month of April. Permit fees totaled $711.00. Three out of the five elevation certificates required were received. Mr. Steele made a brief report on the twelve commercial, two watersheds, seven residential permits issued in the floodplain and the five commercial issued with fees-in-lieu of detention. Fees-in-lieu of detention collected was a total of $181,101.40 which include the $25.981.40 reimbursement received from the City of Broken Arrow for the regional detention pond located west of Garnett Road and north of 61st St.

V. DISCUSSION ITEMS

A. Low Impact Development

Bill Robison informed the Board that Dawn Warrick of the planning department and INCOG were reworking the zoning codes.

B. Stormwater Design Criteria Manual

Bill Robison reported that Janet Meshek and Mark Swift are finalizing the last changes and should be ready to submit to City Council in a month.

DRAFT

C. Tulsa Hazard Mitigation Measures Priorities

Bill Robison distributed prioritize ratings received from the Board members for review.

D. Permit and Watershed Characterization Program

VI. NEW BUSINESS

VII. FUTURE AGENDA ITEM

Invite new Planning Director, Dawn Warrick.

VIII. PUBLIC COMMENTS - None

IX. MEETING CLOSURE

Upon receiving no other comments or further questions, Ms. Finn thanked everyone for attending and adjourned the meeting at 5:20 p.m.

X. NEXT MEETING – July 21, 2012

Meeting Sign in Sheet

R.D. FLANAGAN & ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	**TULSA MULTI-HAZARD MITIGATION PLAN 2012 UPDATE**		
Purpose of Meeting:	**CITY COUNCIL DISTRICT 5**		
Date of Meeting:	**June 19, 2012**	**Time Begin: 6:00 pm**	**Time End:**

Name	Position or Organization	Phone(s)	E-mail
1. DAVID WHITE	WHITE CITY N.A.	(918) 284-2222	dcwtulsa@cox.net
2. Barbara FINDEISS	Child Abuse Network	(918) 624-0209	bfindeiss@childabusenetwork.org
3. Sandra Rogers		(918) 834-6918	rrogers3288@sbcglobal.net.
4. Gary & Sue Kruse	Mid Town Village NA	918 622 3630	Gary.Kruse@News06.net
5. Ed & Jane Wheeler	Bowman Acres	918 622 7237	Dwheeler6715@SBCglobal.net
6. Lynette Barber	Moeller Heights	918 6648706	Lynettefb@aol.com
7. Jeanette Friedl	" "	918 794-2310	—
8. Larry Wolverton	Hoover Neighborhood Assoc	918 835 0157	
9. Wendy Sheets	Hoover	918-845-4123	wendy-sheets@utulsa.edu
10. Jeannie McDaniel	State House	918-605-2056	jeanniemcdaniel@OKhouse.gov
11. Shannon Moore	Bowman Acres/Secretary	918-798-1072	shanrinya@gmail.com
12. NORMA HOWELL	Louise Lanes	918-835-8668	norlow32@sbcglobal.net
13. KATHY SEBERT	MOELLER HEIGHTS N.A.	(918) 622-1940	Kasebert@aol.com

Name	Position or Organization	Phone(s)	E-mail
14. Dail Kelley	Magic Circle N.H. Ass	234-6349	buckskinwarren@cox.net
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Tulsa City Council District 5
Neighborhood Associations Leadership Meeting
Tuesday, June 19, 2012
6:00 Nathan Hale Library

Name	Neighborhood Association	Email
DAVID WHITE	WHITE CITY	dcwTulsa@cox.net
Sandra Rogers	Lewis Lanes	rrogers3288@sbcglobal.net
David & Jane Wheeler	Bowman Acres	DWheeler 6715@sbcglobal.net
Sue & Gary Kruse	Mid-town Village	Gary.Kruse@Newson6.net
David Kelley		

Meeting Sign in Sheet

R.D. FLANAGAN & ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	**Tulsa, OK – 2013 MULTI-HAZARD MITIGATION PLAN UPDATE**		
Purpose of Meeting:	**Hazardous Material & Transportation Hazards**		
Date of Meeting:	**July 5, 2012**	**Time Begin: 1:30 pm**	**Time End:**

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	Flanagan, Ron	Consultant	T	918-749-2696	rdflanagan@rdflanagan.com
	Mack, Annaelise	Consultant	T	918-749-2696	amack@rdflanagan.com
	Young, Terry	Consultant	T	918-749-2696	tyoung@rdflanagan.com
	Swift, Mark, P.E.	Consultant	T	918-582-1380	swre@sbcglobal.net
	Swift, Angela	Swift Water Resources	T	918-582-1380	angela.swift@swreusa.com
	1. Baker, Michael		T	918-596-9420	MBaker@cityoftulsa.org
	2. Bennett, Tom	Tulsa Partners	C	918-639-8102	tom@jimsafe.com
DRB	3. Berry, Dave	Realtor	C	918-637-5359	dberry@tulsarealtors.com
	4. Bledsoe, Bob	CoT Communications	T	918-596-1279	Bobbledsoe@cityoftulsa.org
	5. Brannin, Graham	CoT Planning and Intergovt Admin	T	918-749-7440	gbrannin@cityoftulsa.org
	6. Brierly, Kyle	SDHMAB Member	C	918-622-6996	kylebrierly@rooter.com
	7. Bruer, Kelli	EMSA		918-596-3140	bruerk@emsa.net
	8. Cheatham, Gary	SDHMAB Chair	C	918-695-8876	garycheatham@sbcglobal.net

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	9. Combs, Sara Kelly	Mortgage Officer		918-704-4575	sarakellycombs@gmail.com
	10. Dolman, Lucy		T	918-596-2490	ldolman@cityoftulsa.org
JD	11. Donaldson, Josh	CoT Planning Dept	T	918-576-5686	jdonaldson@cityoftulsa.org
	12. Easter, Curt	Emergency Management	T	918-596-9897	ceaster@cityoftulsa.org
JKE	13. Evicks, J. K.	Bama	C	918-732-2183	jevicks@bama.com
	14. Finn, Judith, Dr.	SDHMAB Vice-Chair	C	918-587-1800	judithfinn@att.net
	15. Foster, Roy		T	918-596-1344	rfoster@cityoftulsa.org
	16. Fox, Patrick	CoT Planning Dept	T	918-576-5685	pfox@cityoftulsa.org
	17. Goss, Jeff			918-230-8429	jeff@servetulsa.com
	18. Hall, Richard	Fire Dept. Planning	T	918-596-1782	RichHall@cityoftulsa.org
	19. Hughes, Barry	Impact		918-274-9914	advertisingimpact@cox.net
	20. Jolliff, Roger	Emergency Manager	T	918-596-9898	RJolliff@cityoftulsa.org
	21. Lester, Michelle	CoT Real Eatate	T	918-596-7266	mlester@cityoftulsa.org
TML	22. Lovell, Tim	Tulsa Partners, Director	C	918-632-0044	tulsapartners@gmail.com
	23. Meloy, Kim	CoT Communications	T	918-596-7271	kmeloy@cityoftulsa.org
	24. Miller, Josh	Insurance Industry	C	918-627-1833	Joshua.a.miller.r2d9@statefarm.com
	25. Patton, Ann	SDHMAB Member	C	918-296-1959	Ann.patton@sbcglobal.net

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	26. Price, Sue		T	918-596-2527	sprice@cityoftulsa.org
BR	27. Roberts, Bob	SDHMAB Member / TRS	C	918-497-8845	Brob11@swbell.net
BNR	28. Robison, Bill, P.E.	Project Manager	T	918-596-9475	brobison@cityoftulsa.org
	29. Siddiqui, Sheryl	Language & Culture Bank	C	918-706-3595	sherylsiddiqui@yohoo.com
	30. Skimbo, Jami		T	918-596-4376	jskimbo@cityoftulsa.org
	31. Spencer, Kathryn		T	918-591-4375	kspencer@cityoftulsa.org
	32. Steele, G. David	Development Services	T	918-596-7085	dsteele@cityoftulsa.org
	33. Stevens, Chris	EMSA		918-830-8214	stevensc@emsa.net
HDYT	34. Townsend, Henry	TCC LEPC, Chair	T	918-628-0651	hdytownsend@peoplepc.com
	35. Warlick, Theron	CoT Planning	T	918-596-	twarlick@cityoftulsa.org
	36. Wright Scott	Haz Mat	T	698 1085	—
	37. SEE, S.D.	HAZ MAT	T	596-4406	Steve.See @ cityoftulsa.org
	38. Balogh A.K	Hazmat	T	591-4406	Abalogh @ " "
	39. Ator Paul	Haz-Mat Coord.		596-1810	Paul Ator @ City of tulsa.org
	40. Martin, D.C.	Hazmat	T	591-4406	dcmartin @ city of tulsa.org
	41.				
	42.				
	43.				

AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Public Outreach
CRS
July 5, 2012 – 1:30 p.m.
PW Engineering Services
2317 S. Jackson Ave.
2nd Floor Conference Room S-213

Multi-Hazard Mitigation Plan:

1. City Council Presentations.
    A. HM Plan Presentation to Council District 5, June 19th
    B. HM Plan Presentation to Council District 6, July 10th
2. Hazard Mitigation Plan Update.
    A. Fixed Site Hazardous Materials

       Hazardous Materials

       Extremely Hazardous Materials

       Mass Communications Systems
    B. Transportation Hazards
    C. Local Emergency Planning Committee

Next Meeting: **August 2, 2012, 1:30 p.m**. Earthquakes, Expansive Soils, Building Codes; PW Engineering Services
Conference Room 218

Adjourn

Meeting Sign in Sheet

R.D. FLANAGAN & ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	**Tulsa, OK – 2013 MULTI-HAZARD MITIGATION PLAN UPDATE**		
Purpose of Meeting:	**Earthquakes, Expansive Soils, and IBHS Building Codes**		
Date of Meeting:	**August 2, 2012**	**Time Begin: 1:30 pm**	**Time End:**

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
RDF	Flanagan, Ron	Consultant	T	918-749-2696	rdflanagan@rdflanagan.com
AM	Mack, Annaelise	Consultant	T	918-749-2696	amack@rdflanagan.com
	Young, Terry	Consultant	T	918-749-2696	tyoung@rdflanagan.com
	Swift, Mark, P.E.	Consultant	T	918-582-1380	swre@sbcglobal.net
	Swift, Angela	Swift Water Resources	T	918-582-1380	angela.swift@swreusa.com
	1. Ator, Paul	HazMat Coordinator	T	918-596-1810	paulator@cityoftulsa.org
	2. Baker, Michael		T	918-596-9420	MBaker@cityoftulsa.org
	3. Balogh, A.K.	HazMat	T	918-591-4406	abalogh@cityoftulsa.org
	4. Bennett, Tom	Tulsa Partners	C	918-639-8102	tom@jimsafe.com
DRB	5. Berry, Dave	Realtor	C	918-637-5359	dberry@tulsarealtors.com
BB	6. Bledsoe, Bob	CoT Communications	T	918-596-1279	Bobbledsoe@cityoftulsa.org
	7. Brannin, Graham	CoT Planning and Intergovt Admin	T	918-749-7440	gbrannin@cityoftulsa.org
	8. Brierly, Kyle	SDHMAB Member	C	918-622-6996	kylebrierly@rooter.com

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	9. Bruer, Kelli	EMSA		918-596-3140	bruerk@emsa.net
	10. Cheatham, Gary	SDHMAB Chair	C	918-695-8876	garycheatham@sbcglobal.net
	11. Combs, Sara Kelly	Mortgage Officer		918-704-4575	sarakellycombs@gmail.com
	12. Dolman, Lucy		T	918-596-2490	ldolman@cityoftulsa.org
JD	13. Donaldson, Josh	CoT Planning Dept	T	918-576-5686	jdonaldson@cityoftulsa.org
	14. Easter, Curt	Emergency Management	T	918-596-9897	ceaster@cityoftulsa.org
JKE	15. Evicks, J. K.	Bama	C	918-732-2183	jevicks@bama.com
	16. Finn, Judith, Dr.	SDHMAB Vice-Chair	C	918-587-1800	judithfinn@att.net
	17. Foster, Roy		T	918-596-1344	rfoster@cityoftulsa.org
	18. Fox, Patrick	CoT Planning Dept	T	918-576-5685	pfox@cityoftulsa.org
	19. Goss, Jeff			918-230-8429	jeff@servetulsa.com
RH	20. Hall, Richard	Fire Dept. Planning	T	918-596-1782	RichHall@cityoftulsa.org
BH	21. Hughes, Barry	Impact		918-274-9914	advertisingimpact@cox.net
	22. Jolliff, Roger	Emergency Manager	T	918-596-9898	rjolliff@cityoftulsa.org
	23. Lester, Michelle	CoT Real Eatate	T	918-596-7266	mlester@cityoftulsa.org
TM L	24. Lovell, Tim	Tulsa Partners, Director	C	918-632-0044	tulsapartners@gmail.com
	25. Martin, D.C.	HazMat	T	918-591-4406	dcmartin@cityoftulsa.org

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	26. Meloy, Kim	CoT Communications	T	918-596-7271	kmeloy@cityoftulsa.org
	27. Miller, Josh	Insurance Industry	C	918-627-1833	joshua.a.miller.r2d9@statefarm.com
	28. Patton, Ann	SDHMAB Member	C	918-296-1959	ann.patton@sbcglobal.net
	29. Price, Sue		T	918-596-2527	sprice@cityoftulsa.org
	30. Roberts, Bob	SDHMAB Member/TPS	C	918-497-8845	brob11@swbell.net
	31. Robison, Bill, P.E.	Project Manager	T	918-596-9475	brobison@cityoftulsa.org
	32. See, S.D.	HazMat	T	918-596-4406	steve.see@cityoftulsa.org
	33. Siddiqui, Sheryl	Language & Culture Bank	C	918-706-3595	sherylsiddiqui@yohoo.com
	34. Skimbo, Jami		T	918-596-4376	jskimbo@cityoftulsa.org
	35. Spencer, Kathryn		T	918-591-4375	kspencer@cityoftulsa.org
	36. Steele, G. David	Development Services	T	918-596-7085	dsteele@cityoftulsa.org
	37. Stevens, Chris	EMSA		918-830-8214	stevensc@emsa.net
	38. Townsend, Henry	TCC LEPC, Chair	T	918-628-0651	hdytownsend@peoplepc.com
	39. Warlick, Theron	CoT Planning	T	918-576-5677	twarlick@cityoftulsa.org
	40. Wright, Scott	HazMat	T	918-698-1085	
	41. THORNTON, Tim	PARKS		918-519-8701	timthornton@cityoftulsa.org
	42. Lewis, Brian	Stormwater Quality		918-591-4341	blewis@cityoftulsa.org
	43.				

AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Public Outreach
August 2, 2012 – 1:30 p.m.
PW Engineering Services
2317 S. Jackson Ave.
2nd Floor Conference Room S-213

Multi-Hazard Mitigation Plan:

1. Hazard Mitigation Plan Update.
    A. Earthquakes
    B. Expansive Soils
    C. Existing and IBHS Fortified Building Codes

Next Meeting: **September 6, 2012, 1:30 p.m**. Urban Fires & Wildfires;

PW Engineering Services Conference Room 218

Adjourn

AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

3:00 P.M., Tuesday, August 21, 2012

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

Judith Finn, Chair
Ann Patton, Vice-Chair
Bob Roberts, Secretary
Kyle Brierly, Member
Gary Cheatham, Member

--

Deborah Stowers, Asst. Secretary & Records Custodian
Harold Tohlen, OWRB Accredited Floodplain Administrator
Mark Swiney, Board Counsel

FILED
CITY OF TULSA
STATE OF OKLAHOMA
2012 AUG 17 A 11:21
MICHAEL P. KIER
CITY CLERK

Call to Order & Roll Call ..... Chair

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of Minutes: June 19, 2012 ..... Chair

II. ISSUES (SUSTAINABLE TULSA)

A. Report from the Chair/Bob Roberts on Strategic Planning for Fortified Homes implementation in Tulsa.

B. Levee Decision by U.S. Army Corps of Engineers. Vision 2 Funding for Levees ..... Todd Kilpatrick

C. System Wide Improvement Framework (SWIF) & FEMA Accreditation Todd Kilpatrick

D. Hazard Mitigation Plan Element: Soils, Earthquakes, Institute for Business & Home Safety (IBHS) ..... Bill Robinson/Ron Flanagan

1) Pre- and post emergency planning.
2) Key policy issues: city, county, state.
3) Ordinance changes required.
4) New capital outlays, bond issues, grants implicated.
5) Public education and engagement regarding this element of the plan. e.g. Lecture series using experts identified by Flanagan & Associates, Jim Schwab, etc.
6) Priority of this element (high, medium, low).
7) Integration of planning: GIS System, coordination with city, county state, and federal hazard mitigation efforts.
8) Barriers to implementation of this element of the plan.
9) Assignments.

E. Continuing review of and oversight of implementation of key aspects of Mitigation Plan Update.

F. Hazard Mitigation Plan Councilors District Meetings ..... Ron Flanagan

G. City of Tulsa Mass Communication System ..... Bill Robison

H. Silver Jacket Program ..... Bob Roberts/Tim Lovell

I. United Nations International Day of Disaster Reduction: October 13, 2012 ..... Bob Roberts

III. APPEALS & VARIANCES - None

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

3:00 P.M., Tuesday, August 21, 2012

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

IV. REPORTS

Paper reports from staff will be reviewed by the Board outside the meeting. Reporters should plan to identify key issues which are suggested by their reports, such as attention to matters of policy, ordinances, and capital considerations.

A. Director's Report ..... Paul Zachary/Dan Crossland
   1) Monthly Financial Report ..... Tammy Pitts
   2) Proposed Fund Transfers ..... Tammy Pitts
B. Capital Improvement Projects ..... Bill Robison
   1) Capital Projects Status Report ..... Deborah Stowers
C. Floodplain Administrator's Report ..... Harold Tohlen
   1) Permit Center Report ..... David Steele

DISCUSSION ITEMS

A. Low Impact Development ..... Bill Robison
B. Stormwater Design Criteria Manual ..... Bill Robison
C. Tulsa Hazard Mitigation Measures Priorities ..... Bill Robison
D. Save Our Streams Signage ..... Scott VanLoo

VI. PUBLIC COMMENTS

Although the OMA limits Board action to those matters specifically listed on this Agenda, the Board solicits and encourages public comments and ideas.

VII. MEETING CLOSURE ..... Chair

VIII. NEXT MEETING ..... September 18, 2012

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

SIGN IN SHEET

FOR

STORMWATER DRAINAGE AND HAZARD MITIGATION ADVISORY BOARD
Tuesday, August 21, 2012 3:00 P.M.
2317 S. Jackson, Engineering Services Conference Room S213
Tulsa, Oklahoma 74017

NAME	ORGANIZATION	CONCERN
M. Todd Kilpatrick	Tulsa Levee 12	
Jackie Lancaster	Tulsa Levee 12	
BU Bledsoe	COT-Communications	
Ron Franzan	RDF & A.	
Skip Steele	TULSA	
David Steele	COT - Dev. Services	
Roy Teeters	COT - Stormwater	
Bill Robinson	COT Project Coordination	
Jacob Hagen	COT Stormwater	
Tim Lovelc	Tulsa Partners	
Yuen Ho	COT Development Services -	
Bob Roberts	TPS (TPI)	
Judith Finn	SDHMAB	
Annie Mack	RDF & A	
Mark Swiney	City Legal Dept.	
Kyle Briery	SD HMAB	
Matt Liechty	COT	
Ann Patton		

Meeting Sign in Sheet

R.D. FLANAGAN & ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	**Tulsa, OK – 2013 MULTI-HAZARD MITIGATION PLAN UPDATE**		
Purpose of Meeting:	**Drought and Wildfires**		
Date of Meeting:	**September 6, 2012**	**Time Begin: 1:30 pm**	**Time End:** 4:00

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	Flanagan, Ron	Consultant	T	918-749-2696	rdflanagan@rdflanagan.com
am	Mack, Annaelise	Consultant	T	918-749-2696	amack@rdflanagan.com
	Young, Terry	Consultant	T	918-749-2696	tyoung@rdflanagan.com
MS	Swift, Mark, P.E.	Consultant	T	918-582-1380	swre@sbcglobal.net
	~~Swift,~~ Angela	Swift Water Resources	T	918-582-1380	angela.swift@swreusa.com
BRR	1. Robison, Bill, P.E.	Project Manager	T	918-596-9475	brobison@cityoftulsa.org
	2. Ator, Paul	HazMat Coordinator	T	918-596-1810	paulator@cityoftulsa.org
	3. Baker, Michael		T	918-596-9420	MBaker@cityoftulsa.org
	4. Balogh, A.K.	HazMat	T	918-591-4406	abalogh@cityoftulsa.org
	5. Bennett, Tom	Tulsa Partners	C	918-639-8102	tom@jimsafe.com
DRB	6. Berry, Dave	Realtor (McGraw).	C	918-637-5359	dberry@tulsarealtors.com
	7. Bledsoe, Bob	CoT Communications	T	918-596-1279	Bobbledsoe@cityoftulsa.org
	8. Brannin, Graham	CoT Planning and Intergovt Admin	T	918-749-7440	gbrannin@cityoftulsa.org

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	9. Brierly, Kyle	SDHMAB Member	C	918-622-6996	kylebrierly@rooter.com
	10. Bruer, Kelli	EMSA		918-596-3140	bruerk@emsa.net
	11. Cheatham, Gary	SDHMAB Chair	C	918-695-8876	garycheatham@sbcglobal.net
SKC	12. Combs, Sara Kelly	Mortgage Officer		918-704-4575	sarakellycombs@gmail.com
	13. Dolman, Lucy		T	918-596-2490	ldolman@cityoftulsa.org
	14. Donaldson, Josh	CoT Planning Dept	T	918-576-5686	jdonaldson@cityoftulsa.org
	15. Easter, Curt	Emergency Management	T	918-596-9897	ceaster@cityoftulsa.org
	16. Evicks, J. K.	Bama	C	918-732-2183	jevicks@bama.com
	17. Finn, Judith, Dr.	SDHMAB Vice-Chair	C	918-587-1800	judithfinn@att.net
	18. Foster, Roy		T	918-596-1344	rfoster@cityoftulsa.org
	19. Fox, Patrick	CoT Planning Dept	T	918-576-5685	pfox@cityoftulsa.org
	20. Goss, Jeff			918-230-8429	jeff@servetulsa.com
RH.	21. Hall, Richard	Fire Dept. Planning	T	918-596-1782	RichHall@cityoftulsa.org
BH	22. Hughes, Barry	Impact		918-274-9914	advertisingimpact@cox.net
RJ	23. Jolliff, Roger	Emergency Manager	T	918-596-9898	rjolliff@cityoftulsa.org
	24. Lester, Michelle	CoT Real Eatate	T	918-596-7266	mlester@cityoftulsa.org
	25. Lewis, Brian	Senior Environmental Monitoring Tech		405-306-7780	blewis@cityoftulsa.org

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
TL	26. Lovell, Tim	Tulsa Partners, Director	C	918-632-0044	tulsapartners@gmail.com
	27. Martin, D.C.	HazMat	T	918-591-4406	dcmartin@cityoftulsa.org
	28. Meloy, Kim	CoT Communications	T	918-596-7271	kmeloy@cityoftulsa.org
	29. Miller, Josh	Insurance Industry	C	918-627-1833	joshua.a.miller.r2d9@statefarm.com
	30. Patton, Ann	SDHMAB Member	C	918-296-1959	ann.patton@sbcglobal.net
	31. Price, Sue		T	918-596-2527	sprice@cityoftulsa.org
	32. Roberts, Bob	SDHMAB Member/TPS	C	918-497-8845	brob11@swbell.net
	33. See, S.D.	HazMat	T	918-596-4406	steve.see@cityoftulsa.org
	34. Siddiqui, Sheryl	Language & Culture Bank	C	918-706-3595	sherylsiddiqui@yohoo.com
	35. Skimbo, Jami		T	918-596-4376	jskimbo@cityoftulsa.org
	36. Spencer, Kathryn		T	918-591-4375	kspencer@cityoftulsa.org
	37. Steele, G. David	Development Services	T	918-596-7085	dsteele@cityoftulsa.org
	38. Stevens, Chris	EMSA		918-830-8214	stevensc@emsa.net
	39. Thornton, Tim	Parks Maint. Supervisor		918-519-8701	timthorton@cityoftulsa.org
	40. Townsend, Henry	TCC LEPC, Chair	T	918-628-0651	hdytownsend@peoplepc.com
	41. Warlick, Theron	CoT Planning	T	918-576-5677	twarlick@cityoftulsa.org
	42. Wright, Scott	HazMat	T	918-698-1085	
	43. Grant, Martha	Tulsa Partners			

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	44. James Spicer	GreenCountryPermaculture		928.583.4815	greencountrypermaculture@gmail.com.
	45. Mike Gurley	State Farm Insurance		918-899-2462	mike.gurley@aita2@statefarm.com mgurley
	46.				
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AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Public Outreach
September 6, 2012 – 1:30 p.m.
PW Engineering Services
2317 S. Jackson Ave.
2nd Floor Conference Room S-213

Multi-Hazard Mitigation Plan:

1. Hazard Mitigation Plan Update.
    A. Drought- Joan Arthur, CoT Water Dept.
    B. Wildfires- Richard Hall, Tulsa Fire Department
2. Public Participation & Involvement-CRS-HM Meeting
3. Next SDHMA Board Meeting: Sept. 20th, 2:00 pm, Rm. S-213
4. Next TAC Meeting: **October 6, 2012, 1:30 p.m**. Floods, Dam Failures & Levees;

Engineering Services Conference Room 213

Adjourn

FILED
CITY OF TULSA
STATE OF OKLAHOMA

SPECIAL MEETING AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

2012 SEP 18 A 9:40

2:00 P.M., Thursday, September 20, 2012

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

MICHAEL F. KIER
CITY CLERK

Judith Finn, Chair
Ann Patton, Vice-Chair
Bob Roberts, Secretary
Kyle Brierly, Member
Gary Cheatham, Member

--

Deborah Stowers, Asst. Secretary & Records Custodian
Harold Tohlen, OWRB Accredited Floodplain Administrator
Mark Swiney, Board Counsel

Call to Order & Roll Call ..... Chair

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of Minutes: August 21, 2012 ..... Chair

II. ISSUES (SUSTAINABLE TULSA)

A. Hazard Mitigation Plan Element:
Urban Fires, Wildfires ..... Bill Robinson/Ron Flanagan

1) Pre- and post emergency planning.
2) Key policy issues: city, county, state.
3) Ordinance changes required.
4) New capital outlays, bond issues, grants implicated.
5) Public education and engagement regarding this element of the plan. e.g. Lecture series using experts identified by Flanagan & Associates, Jim Schwab, etc.
6) Priority of this element (high, medium, low).
7) Integration of planning: GIS System, coordination with city, county state, and federal hazard mitigation efforts.
8) Barriers to implementation of this element of the plan.
9) Assignments.

B. Continuing review of and oversight of implementation of key aspects of Mitigation Plan Update:
1) Fortified Homes and Tulsa Codes ..... Ron Flanagan

C. Community Rating System (CRS) ..... French Wetmore

D. Hazard Mitigation Plan Councilors District Meetings ..... Ron Flanagan

E. City of Tulsa Mass Communication System ..... Bill Robison

F. Silver Jacket Program ..... Bob Roberts/Tim Lovell

G. United Nations International Day of Disaster Reduction:
October 13, 2012 ..... Bob Roberts

III. APPEALS & VARIANCES - None

(Continued on other side)

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

3:00 P.M., Tuesday, September 18, 2012

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

IV. REPORTS

Paper reports from staff will be reviewed by the Board outside the meeting. Reporters should plan to identify key issues which are suggested by their reports, such as attention to matters of policy, ordinances, and capital considerations.

A. Director's Report ..... Paul Zachary/Dan Crossland
   1) Monthly Financial Report ..... Tammy Pitts
   2) Proposed Fund Transfers ..... Tammy Pitts
   3) Stream Monitoring Update ..... Scott VanLoo
B. Capital Improvement Projects ..... Bill Robison
   1) Capital Projects Status Report ..... Deborah Stowers
C. Floodplain Administrator's Report ..... Harold Tohlen
   1) Permit Center Report ..... David Steele
D. Fee-in-Lieu Funds Report ..... Deborah Stowers
E. Updating the Master Drainage Plans ..... Bill Robison

V. DISCUSSION ITEMS

A. Low Impact Development ..... Bill Robison
B. Stormwater Design Criteria Manual ..... Bill Robison
C. Tulsa Hazard Mitigation Measures Priorities ..... Bill Robison

VI. PUBLIC COMMENTS

Although the OMA limits Board action to those matters specifically listed on this Agenda, the Board solicits and encourages public comments and ideas.

VII. MEETING CLOSURE ..... Chair

VIII. NEXT MEETING ..... October 16, 2012

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

SIGN IN SHEET

FOR

STORMWATER DRAINAGE AND HAZARD MITIGATION ADVISORY BOARD
Thursday, September 20, 2012 2:00 P.M. — 5:00 pm
2317 S. Jackson, Engineering Services Conference Room S213
Tulsa, Oklahoma 74017

NAME	ORGANIZATION	CONCERN
Deborah Stowers	City of Tulsa	
French Wetmore	French & Assoc.	Consult.
Ron Flanagan	RD Flanagan & Assoc	Consult.
Bob Roberts	TPS / TPI	
Tim Lovell	Tulsa Partners	Consult
Judith A. Finn	SDHMAB	
Bill Robinson	COT	Stormwater
Ann Patton	COT	
M. [illegible]	Levee 12	Levee
Scott Vorhes	COT	Stormwater Quality
Bryan Young	COT	stormwater Maint.
Jacob Hagen	COT	Stormwater Quality

Meeting Sign in Sheet

R.D. FLANAGAN & ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	**Hazard Mitigation CAC/TAC Subcommittee**		
Purpose of Meeting:	**City of Tulsa Small Area Plans Meeting**		
Date of Meeting:	**September 25, 2012**	**Time Begin: 3:00 pm**	**Time End:**

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
JF	1. Finn, Judith, Dr.	SDHMAB ~~Vice~~-Chair	C	918-587-1800	judithfinn@att.net
	2. Patton, Ann	SDHMAB ~~Member~~ Vice Chair	C	918-296-1959	ann.patton@sbcglobal.net
	3. Roberts, Bob	SDHMAB Member/TPS	C	918-497-8845	brob11@swbell.net
	4. Brierly, Kyle	SDHMAB Member	C	918-622-6996	kylebrierly@rooter.com
BHR	5. Robison, Bill, P.E.	Project Manager	T	918-596-9475	brobison@cityoftulsa.org
	6. Flanagan, Ron	Consultant	C	918-749-2696	rdflanagan@rdflanagan.com
	7. Lovell, Tim	Tulsa Partners, Director	C	918-632-0044	tulsapartners@gmail.com
	8. Simmons, David	P-III · Planning			
	9. Matt Liechti	COT	T	918-596-9240	mliechti@cityoftulsa.org
	10. Barry Long	Urban Design Associates		412.263.5200	barry.long@urbandesignassociates.com
	11. Courtney Chadney	NRI / CAP		409.466.5430	cchadney@captc.org
AM	12. Annie Mack	RDF			
	13. Brenda Mellor	CAP		918-499-3943	

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	14. M. Todd Kilpatrick	Levee Comm.		918 591-6116	TKilpatrick@TulsaCounty.org
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Meeting Sign in Sheet

R.D. FLANAGAN & ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	**Tulsa, OK – 2013 MULTI-HAZARD MITIGATION PLAN UPDATE**		
Purpose of Meeting:	**Flood, Dam and Levee Failures**		
Date of Meeting:	**October 4, 2012**	**Time Begin: 1:30 pm**	**Time End:**

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	Flanagan, Ron	Consultant	T	918-749-2696	rdflanagan@rdflanagan.com
	Mack, Annaelise	Consultant	T	918-749-2696	amack@rdflanagan.com
	Young, Terry	Consultant	T	918-749-2696	tyoung@rdflanagan.com
MSS	Swift, Mark, P.E.	Consultant	T	918-582-1380	swre@sbcglobal.net
	Swift, Angela	Swift Water Resources	T	918-582-1380	angela.swift@swreusa.com
BRR	1. Robison, Bill, P.E.	Project Manager	T	918-596-9475	brobison@cityoftulsa.org
	2. Ator, Paul	HazMat Coordinator	T	918-596-1810	paulator@cityoftulsa.org
	3. Baker, Michael		T	918-596-9420	MBaker@cityoftulsa.org
	4. Balogh, A.K.	HazMat	T	918-591-4406	abalogh@cityoftulsa.org
	5. Bennett, Tom	Tulsa Partners	C	918-639-8102	tom@jimsafe.com
DRB	6. Berry, Dave	Realtor (McGraw)	C	918-637-5359	dberry@tulsarealtors.com
BB	7. Bledsoe, Bob	CoT Communications	T	918-596-1279	Bobbledsoe@cityoftulsa.org

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	8. Brannin, Graham	CoT Planning and Intergovt Admin	T	918-749-7440	gbrannin@cityoftulsa.org
	9. Brierly, Kyle	SDHMAB Member	C	918-622-6996	kylebrierly@rooter.com
	10. Bruer, Kelli	EMSA		918-596-3140	bruerk@emsa.net
	11. Cheatham, Gary	SDHMAB Chair	C	918-695-8876	garycheatham@sbcglobal.net
	12. Combs, Sara Kelly	Mortgage Officer		918-704-4575	sarakellycombs@gmail.com
	13. Dolman, Lucy		T	918-596-2490	ldolman@cityoftulsa.org
	14. Donaldson, Josh	CoT Planning Dept	T	918-576-5686	jdonaldson@cityoftulsa.org
	15. Easter, Curt	Emergency Management	T	918-596-9897	ceaster@cityoftulsa.org
	16. Evicks, J. K.	Bama	C	918-732-2183	jevicks@bama.com
	17. Finn, Judith, Dr.	SDHMAB Vice-Chair	C	918-587-1800	judithfinn@att.net
	18. Foster, Roy		T	918-596-1344	rfoster@cityoftulsa.org
	19. Fox, Patrick	CoT Planning Dept	T	918-576-5685	pfox@cityoftulsa.org
	20. Goss, Jeff			918-230-8429	jeff@servetulsa.com
	21. Grant, Martha	Tulsa Partners			
	22. Gurley, Mike	State Farm Insurance		918-899-2462	Mike.gurley@ait2@statefarm.com
RH.	23. Hall, Richard	Fire Dept. Planning	T	918-596-1782	RichHall@cityoftulsa.org
	24. Hughes, Barry	Impact		918-274-9914	advertisingimpact@cox.net

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	25. Jolliff, Roger	Emergency Manager	T	918-596-9898	rjolliff@cityoftulsa.org
	26. Lester, Michelle	CoT Real Eatate	T	918-596-7266	mlester@cityoftulsa.org
	27. Lewis, Brian	Senior Environmental Monitoring Tech		405-306-7780	blewis@cityoftulsa.org
TML	28. Lovell, Tim	Tulsa Partners, Director	C	918-632-0044	tulsapartners@gmail.com
	29. Martin, D.C.	HazMat	T	918-591-4406	dcmartin@cityoftulsa.org
	30. Meloy, Kim	CoT Communications	T	918-596-7271	kmeloy@cityoftulsa.org
	31. Miller, Josh	Insurance Industry	C	918-627-1833	joshua.a.miller.r2d9@statefarm.com
	32. Patton, Ann	SDHMAB Member	C	918-296-1959	ann.patton@sbcglobal.net
	33. Price, Sue		T	918-596-2527	sprice@cityoftulsa.org
	34. Roberts, Bob	SDHMAB Member/TPS	C	918-497-8845	brob11@swbell.net
	35. See, S.D.	HazMat	T	918-596-4406	steve.see@cityoftulsa.org
	36. Siddiqui, Sheryl	Language & Culture Bank	C	918-706-3595	sherylsiddiqui@yohoo.com
	37. Skimbo, Jami		T	918-596-4376	jskimbo@cityoftulsa.org
	38. Spencer, Kathryn		T	918-591-4375	kspencer@cityoftulsa.org
	39. Spicer, James	Greencountry Permaculture LLC		928-583-4815	greencountrypermaculture@gmail.com
	40. Steele, G. David	Development Services	T	918-596-7085	dsteele@cityoftulsa.org
	41. Stevens, Chris	EMSA		918-830-8214	stevensc@emsa.net

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	42. Thornton, Tim	Parks Maint. Supervisor		918-519-8701	timthorton@cityoftulsa.org
	43. Townsend, Henry	TCC LEPC, Chair	T	918-628-0651	hdytownsend@peoplepc.com
	44. Warlick, Theron	CoT Planning	T	918-576-5677	twarlick@cityoftulsa.org
	45. Wright, Scott	HazMat	T	918-698-1085	
	46. LAUB, Keith	ESF 6/7 TCC	T	918-595-7567	KEITH.LAUB@TULSACC.EDU
	47. Charles Hardt	Guest		918-369-5858	georgia.hardt@cox.net
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AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Technical Advisory Committee Meeting
October 4, 2012 – 1:30 p.m.
PW Engineering Services
2317 S. Jackson Ave.
2nd Floor Conference Room S-213

Multi-Hazard Mitigation Plan:

1. Hazard Mitigation Meetings/Activities Summary
    A. 9/10/12 Levee Presentation to County Commission, Vision 2
    B. 9/14/12 Sub-Committee Mtg. w/ George Geissler, Dir., OK AG
    C. 9/19/12 Levee Presentation to City Council, Vision 2
    D. 9/20/12 SDHMAB- French Wetmore, CRS, PPI;
    E. 9/25/12 Eugene Field Small Area Plan coordination mtg.
    F. 9/26/12 Fortified Homes PI&E Grant Application meeting
2. **Hazard Mitigation Plan Update**.
    A. Floodplain Management- Mark Swift, SWRE.
    B. Dam Failures
    C. Levee Failures
3. Next SDHMA Board Meeting: Oct. 16th, 2:00 pm, Levee District # 12 Tour.
4. Next TAC Meeting: **November 1, 2012, 1:30 p.m**. Severe Winter Storms Engineering Services Conference Room 213

Adjourn

Meeting Sign in Sheet

R.D. FLANAGAN & ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	**Tulsa, OK – 2013 MULTI-HAZARD MITIGATION PLAN UPDATE**		
Purpose of Meeting:	**Winter Storms and Fires**		
Date of Meeting:	**November 1, 2012**	**Time Begin: 1:30 pm**	**Time End:**

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
RDF	Flanagan, Ron	Consultant	T	918-749-2696	rdflanagan@rdflanagan.com
am	Mack, Annaelise	Consultant	T	918-749-2696	amack@rdflanagan.com
	Young, Terry	Consultant	T	918-749-2696	tyoung@rdflanagan.com
	Swift, Mark, P.E.	Consultant	T	918-582-1380	swre@sbcglobal.net
	Swift, Angela	Swift Water Resources	T	918-582-1380	angela.swift@swreusa.com
BWR	1. Robison, Bill, P.E.	Project Manager	T	918-596-9475	brobison@cityoftulsa.org
	2. Ator, Paul	HazMat Coordinator	T	918-596-1810	paulator@cityoftulsa.org
	3. Baker, Michael		T	918-596-9420	MBaker@cityoftulsa.org
	4. Balogh, A.K.	HazMat	T	918-591-4406	abalogh@cityoftulsa.org
	5. Bennett, Tom	Tulsa Partners	C	918-639-8102	tom@jimsafe.com
DRB	6. Berry, Dave	Realtor	C	918-637-5359	dberry@tulsarealtors.com
	7. Bledsoe, Bob	CoT Communications	T	918-596-1279	Bobbledsoe@cityoftulsa.org

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	8. Brannin, Graham	CoT Planning and Intergovt Admin	T	918-749-7440	gbrannin@cityoftulsa.org
	9. Brierly, Kyle	SDHMAB Member	C	918-622-6996	kylebrierly@rooter.com
	10. Bruer, Kelli	EMSA		918-596-3140	bruerk@emsa.net
	11. Cheatham, Gary	SDHMAB Chair	C	918-695-8876	garycheatham@sbcglobal.net
SKC	12. Combs, Sara Kelly	Mortgage Officer		918-704-4575	sarakellycombs@gmail.com
	13. Dolman, Lucy		T	918-596-2490	ldolman@cityoftulsa.org
	14. Donaldson, Josh	CoT Planning Dept	T	918-576-5686	jdonaldson@cityoftulsa.org
	15. Easter, Curt	Emergency Management	T	918-596-9897	ceaster@cityoftulsa.org
	16. Evicks, J. K.	Bama	C	918-732-2183	jevicks@bama.com
	17. Finn, Judith, Dr.	SDHMAB Vice-Chair	C	918-587-1800	judithfinn@att.net
	18. Foster, Roy		T	918-596-1344	rfoster@cityoftulsa.org
	19. Fox, Patrick	CoT Planning Dept	T	918-576-5685	pfox@cityoftulsa.org
	20. Goss, Jeff			918-230-8429	jeff@servetulsa.com
	21. Grant, Martha	Tulsa Partners			
	22. Gurley, Mike	State Farm Insurance		918-899-2462	Mike.gurley@ait2@statefarm.com
RH.	23. Hall, Richard	Fire Dept. Planning	T	918-596-1782	RichHall@cityoftulsa.org
	24. Hardt, Charles			918-369-5858	georgia.hardt@cox.net

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	25. Hughes, Barry	Impact		918-274-9914	advertisingimpact@cox.net
	26. Jolliff, Roger	Emergency Manager	T	918-596-9898	rjolliff@cityoftulsa.org
KL	27. Laub, Keith	ESF 6/7 TCC	T	918-595-7567	Keith.laub@tulsacc.edu
	28. Lester, Michelle	CoT Real Eatate	T	918-596-7266	mlester@cityoftulsa.org
	29. Lewis, Brian	Senior Environmental Monitoring Tech		405-306-7780	blewis@cityoftulsa.org
TML	30. Lovell, Tim	Tulsa Partners, Director	C	918-632-0044	tulsapartners@gmail.com
	31. Martin, D.C.	HazMat	T	918-591-4406	dcmartin@cityoftulsa.org
	32. Meloy, Kim	CoT Communications	T	918-596-7271	kmeloy@cityoftulsa.org
	33. Miller, Josh	Insurance Industry	C	918-627-1833	joshua.a.miller.r2d9@statefarm.com
	34. Patton, Ann	SDHMAB Member	C	918-296-1959	ann.patton@sbcglobal.net
	35. Price, Sue		T	918-596-2527	sprice@cityoftulsa.org
	36. Roberts, Bob	SDHMAB Member/TPS	C	918-497-8845	brob11@swbell.net
	37. See, S.D.	HazMat	T	918-596-4406	steve.see@cityoftulsa.org
	38. Siddiqui, Sheryl	Language & Culture Bank	C	918-706-3595	sherylsiddiqui@yohoo.com
	39. Skimbo, Jami		T	918-596-4376	jskimbo@cityoftulsa.org
	40. Spencer, Kathryn		T	918-591-4375	kspencer@cityoftulsa.org
	41. Spicer, James	Greencountry Permaculture LLC		928-583-4815	greencountrypermaculture@gmail.com

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	42. Steele, G. David	Development Services	T	918-596-7085	dsteele@cityoftulsa.org
	43. Stevens, Chris	EMSA		918-830-8214	stevensc@emsa.net
	44. Thornton, Tim	Parks Maint. Supervisor		918-519-8701	timthorton@cityoftulsa.org
	45. Townsend, Henry	TCC LEPC, Chair	T	918-628-0651	hdytownsend@peoplepc.com
TW	46. Warlick, Theron	CoT Planning	T	918-576-5677	twarlick@cityoftulsa.org
	47. Wright, Scott	HazMat	T	918-698-1085	
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Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
SP	60. Steve Pike	MIC National Weather Svc		918 832-4115	steven.pike@noaa.gov
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AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Technical Advisory Committee Meeting
November 1, 2012 – 1:30 p.m.
PW Engineering Services
2317 S. Jackson Ave.
2nd Floor Conference Room S-213

Multi-Hazard Mitigation Plan:

1. Hazard Mitigation Meetings/Activities Summary
   A. 10/16/12 SDHMAB District 12 Levee Tour
2. **Hazard Mitigation Plan Update**.
   A. Severe Winter Storms- Steve Piltz, National Weather Service.
   B. Urban Fires- Richard Hall, Tulsa Fire Department
3. Next SDHMA Board Meeting: Tuesday, Nov. 20th, 3:00 pm.
4. Next TAC Meeting: **December 6, 2012, 1:30 p.m**. Lightning, Hail, Lightning Sensing & Warning Systems
   Engineering Services Conference Room 213

Adjourn

Meeting Sign in Sheet

R.D. FLANAGAN & ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	**Hazard Mitigation CAC/TAC Subcommittee**		
Purpose of Meeting:	**Arkansas River/Keystone Dam**		
Date of Meeting:	**November 9, 2012**	**Time Begin: 11:30 am**	**Time End:**

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
JF	1. Finn, Judith, Dr.	SDHMAB Vice-Chair	C	918-587-1800	judithfinn@att.net
AP	2. Patton, Ann	SDHMAB Member	C	918-296-1959	ann.patton@sbcglobal.net
	3. Roberts, Bob	SDHMAB Member/TPS	C	918-497-8845	brob11@swbell.net
	4. Brierly, Kyle	SDHMAB Member	C	918-622-6996	kylebrierly@rooter.com
BHR	5. Robison, Bill, P.E.	Project Manager	T	918-596-9475	brobison@cityoftulsa.org
RDF	6. Flanagan, Ron	Consultant	C	918-749-2696	rdflanagan@rdflanagan.com
	7. Lovell, Tim	Tulsa Partners, Director	C	918-632-0044	tulsapartners@gmail.com
	8. Hall, Richard	Fire Dept. Planning	T	918-596-1782	RichHall@cityoftulsa.org
	9. Geissler, George	Dept. of Ag., Director	T		George.Geissler@ag.ok.gov
	10. M. Todd Kilpatrick	Levee Dist. 12		918-591-6116	TKilpatrick@tulsacounty.org
CB	11. Baker, Chris	Army Corps of Engineers		918-669-4910	christopher.t.baker@usace.army.mil
	12. Clyde, Tony	Army Corps of Engineers		918-669-7556	tony.clyde@usace.army.mil
	13. Rossman, Ed	Army Corps		918 669 4921	Edwin J. Rossman@USACE.Army.mil

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
JSW	14. Jaime Watts	USACE TULSA		918.899.7485	Jaime.S.Watts@usace.army.mil
(illegible)	15. R. Brandon Perkins	Residential Developer		918-724-5990	Brandon@MyNewLot.com
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Meeting Sign in Sheet

R.D. FLANAGAN & ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	**Tulsa, OK – 2013 MULTI-HAZARD MITIGATION PLAN UPDATE**		
Purpose of Meeting:	**Hail and Lightning**		
Date of Meeting:	**December 6, 2012**	**Time Begin: 1:30 pm**	**Time End:**

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
RDF	Flanagan, Ron	Consultant	T	918-749-2696	rdflanagan@rdflanagan.com
am	Mack, Annaelise	Consultant	T	918-749-2696	amack@rdflanagan.com
	Young, Terry	Consultant	T	918-749-2696	tyoung@rdflanagan.com
	Swift, Mark, P.E.	Consultant	T	918-582-1380	swre@sbcglobal.net
	Swift, Angela	Swift Water Resources	T	918-582-1380	angela.swift@swreusa.com
BJR	1. Robison, Bill, P.E.	Project Manager	T	918-596-9475	brobison@cityoftulsa.org
	2. Ator, Paul	HazMat Coordinator	T	918-596-1810	paulator@cityoftulsa.org
	3. Baker, Michael		T	918-596-9420	MBaker@cityoftulsa.org
	4. Balogh, A.K.	HazMat	T	918-591-4406	abalogh@cityoftulsa.org
	5. Bennett, Tom	Tulsa Partners	C	918-639-8102	tom@jimsafe.com
DB	6. Berry, Dave	Realtor	C	918-637-5359	dberry@tulsarealtors.com
	7. Bledsoe, Bob	CoT Communications	T	918-596-1279	Bobbledsoe@cityoftulsa.org

BB

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
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	9. Brierly, Kyle	SDHMAB Member	C	918-622-6996	kylebrierly@rooter.com
	10. Bruer, Kelli	EMSA		918-596-3140	bruerk@emsa.net
	11. Cheatham, Gary	SDHMAB Chair	C	918-695-8876	garycheatham@sbcglobal.net
	12. Combs, Sara Kelly	Mortgage Officer		918-704-4575	sarakellycombs@gmail.com
	13. Dolman, Lucy		T	918-596-2490	ldolman@cityoftulsa.org
	14. Donaldson, Josh	CoT Planning Dept	T	918-576-5686	jdonaldson@cityoftulsa.org
	15. Dugan, Bob	ThorGuard			
	16. Easter, Curt	Emergency Management	T	918-596-9897	ceaster@cityoftulsa.org
	17. Evicks, J. K.	Bama	C	918-732-2183	jevicks@bama.com
	18. Finn, Judith, Dr.	SDHMAB Vice-Chair	C	918-587-1800	judithfinn@att.net
	19. Foster, Roy		T	918-596-1344	rfoster@cityoftulsa.org
	20. Fox, Patrick	CoT Planning Dept	T	918-576-5685	pfox@cityoftulsa.org
	21. Goss, Jeff			918-230-8429	jeff@servetulsa.com
	22. Grant, Martha	Tulsa Partners			
	23. Gurley, Mike	State Farm Insurance		918-899-2462	Mike.gurley@ait2@statefarm.com
R/t	24. Hall, Richard	Fire Dept. Planning	T	918-596-1782	RichHall@cityoftulsa.org

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	25. Hardt, Charles			918-369-5858	georgia.hardt@cox.net
BH	26. Hughes, Barry	Impact		918-274-9914	advertisingimpact@cox.net
	27. Jolliff, Roger	Emergency Manager	T	918-596-9898	rjolliff@cityoftulsa.org
	28. Laub, Keith	ESF 6/7 TCC	T	918-595-7567	Keith.laub@tulsacc.edu
	29. Lester, Michelle	CoT Real Eatate	T	918-596-7266	mlester@cityoftulsa.org
	30. Lewis, Brian	Senior Environmental Monitoring Tech		405-306-7780	blewis@cityoftulsa.org
TML	31. Lovell, Tim	Tulsa Partners, Director	C	918-632-0044	tulsapartners@gmail.com
	32. Martin, D.C.	HazMat	T	918-591-4406	dcmartin@cityoftulsa.org
NM	33. McGavock, Nicole	NWS			
	34. Meloy, Kim	CoT Communications	T	918-596-7271	kmeloy@cityoftulsa.org
	35. Miller, Josh	Insurance Industry	C	918-627-1833	joshua.a.miller.r2d9@statefarm.com
	36. Patton, Ann	SDHMAB Member	C	918-296-1959	ann.patton@sbcglobal.net
	37. Price, Sue		T	918-596-2527	sprice@cityoftulsa.org
SP	38. Piltz, Steve	NWS			
BR	39. Roberts, Bob	SDHMAB Member/TPS	C	918-497-8845	brob11@swbell.net
	40. See, S.D.	HazMat	T	918-596-4406	steve.see@cityoftulsa.org
SS	41. Siddiqui, Sheryl	Language & Culture Bank	C	918-706-3595	sherylsiddiqui@yohoo.com

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	42. Skimbo, Jami		T	918-596-4376	jskimbo@cityoftulsa.org
	43. Spencer, Kathryn		T	918-591-4375	kspencer@cityoftulsa.org
	44. Spicer, James	Greencountry Permaculture LLC		928-583-4815	greencountrypermaculture@gmail.com
	45. Steele, G. David	Development Services	T	918-596-7085	dsteele@cityoftulsa.org
	46. Stevens, Chris	EMSA		918-830-8214	stevensc@emsa.net
	47. Thornton, Tim	Parks Maint. Supervisor		918-519-8701	timthorton@cityoftulsa.org
	48. Townsend, Henry	TCC LEPC, Chair	T	918-628-0651	hdytownsend@peoplepc.com
	49. Warlick, Theron	CoT Planning	T	918-576-5677	twarlick@cityoftulsa.org
	50. Wright, Scott	HazMat	T	918-698-1085	
	51. Perkins, Brandon			918-724-5990	Brandon@MyNewLot.com
	52.				
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Meeting Notes

R.D. FLANAGAN & ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	City of Tulsa, OK HM Plan Update	**Date:**	November 1, 2012

	Travel Time	Mileage	Meeting
Begin:	1:00 pm		1:30 p.m.
End:			
Total			

Location:

Attending:	
Ron Flanagan	
See sign-in sheet	
Documents Received:	

Topics Covered: Winter Storms and Fires

Notes:

AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Stormwater Drainage & Hazard mitigation Advisory Board
Technical Advisory Committee Meeting
December 6, 2012 – 1:30 p.m.
PW Engineering Services
2317 S. Jackson Ave.
2nd Floor Conference Room S-213

Multi-Hazard Mitigation Plan:

1. **Hazard Mitigation Plan Update**.
   A. Hail- Steven Piltz, National Weather Service.
   B. Lightning-, Nicole McGavock, National Weather Service
   C. Lightning Sensing & Warning Systems, Bob Dugan, ThorGuard. Mr. Dugan, founder and president of ThorGuard, is traveling to Tulsa from Florida to make this presentation. Tulsa Public Schools has begun implementing the ThorGuard Lightning Sensing & Warning Systems.
2. Next SDHMA Board Meeting: Tuesday, Dec. 18th, 3:00 pm.
3. Next TAC Meeting: **January 3, 2013, 1:30 p.m**. Hazards Review; Mitigation Measures
   Engineering Services Conference Room 213

Adjourn

AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Public Outreach
CRS
December 7, 2011 – 10:00 a.m.
PW Engineering Services
Conference Room N-100

Multi-Hazard Mitigation Plan:

CD for Jeff

1. Hazard Mitigation Plan Update. Red Cross
2. Gaining Public Participation. Local network media WIN Utilities Co, Home inspectors, HBA
3. Public Meeting Strategies. Ok for existing outreach strategy
4. Individual Safe Room Program. Lara Webb - Christensen
5. ThorGuard.
6. Nation Hazard Mitigation Association. Tulsa Award
7. SDHMAB Updates. Hazard Mitigation Measures.
8. Prioritizing Mitigation Measures.

Public Outreach: Website - Community
Website - Personal Mitigation Measures

1. New Outreach Video Production Relating to HM Update.
2. Video Production & Editing, TGOV/Private.
3. Mass Communication System Update.
4. Outreach to insurance agents.

CRS:

1. Status of 2012 Program Changes.
2. December 15th Webinar
3. Other Items.

Next Meeting: January 4, 2012, 10:00 a.m. PW Engineering Services Conference Room 328

Adjourn

Jan - Intro
Feb - Winter Storm
March - Flooding / dam failure
Apr - High wind tornado / IBHS - Tom Bennett
May Lightning / Hail
June - Ext Heat / Drought
July - Earthquake / Expansive Soil / Landslides
Aug Haz Mat - Trains
Sept
Oct - Fire / Wildfire
Nov Haz Recreo / Mit Measures
Dec

The Office

Cataloger / Library of prepared PSA's
Make info available in as many ways as possible
Social media - web, etc.
Private/Public Partnership - produce/air video
Get facts in written form prepared for media
Program intro for council
Coordinate with OEMA
Marketing Plan

Meeting Sign in Sheet

R.D. FLANAGAN & ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	**Tulsa, OK – 2013 MULTI-HAZARD MITIGATION PLAN UPDATE**		
Purpose of Meeting:	**Arkansas River**		
Date of Meeting:	**January 3,2013**	**Time Begin: 1:30 pm**	**Time End:**

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	Flanagan, Ron	Consultant	T	918-749-2696	rdflanagan@rdflanagan.com
am	Mack, Annaelise	Consultant	T	918-749-2696	amack@rdflanagan.com
	Young, Terry	Consultant	T	918-749-2696	tyoung@rdflanagan.com
	Swift, Mark, P.E.	Consultant	T	918-582-1380	swre@sbcglobal.net
	Swift, Angela	Swift Water Resources	T	918-582-1380	angela.swift@swreusa.com
BHR	1. Robison, Bill, P.E.	Project Manager	T	918-596-9475	brobison@cityoftulsa.org
	2. Ator, Paul	HazMat Coordinator	T	918-596-1810	paulator@cityoftulsa.org
	3. Baker, Michael		T	918-596-9420	MBaker@cityoftulsa.org
	4. Balogh, A.K.	HazMat	T	918-591-4406	abalogh@cityoftulsa.org
	5. Bennett, Tom	Tulsa Partners	C	918-639-8102	tom@jimsafe.com
	6. Berry, Dave	Realtor	C	918-637-5359	dberry@tulsarealtors.com
RB	7. Bledsoe, Bob	CoT Communications	T	918-596-1279	Bobbledsoe@cityoftulsa.org

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
CH	25. Hardt, Charles			918-369-5858	georgia.hardt@cox.net
BH	26. Hughes, Barry	Impact		918-274-9914	advertisingimpact@cox.net
	27. Jolliff, Roger	Emergency Manager	T	918-596-9898	rjolliff@cityoftulsa.org
	28. Laub, Keith	ESF 6/7 TCC	T	918-595-7567	Keith.laub@tulsacc.edu
	29. Lester, Michelle	CoT Real Eatate	T	918-596-7266	mlester@cityoftulsa.org
	30. Lewis, Brian	Senior Environmental Monitoring Tech		405-306-7780	blewis@cityoftulsa.org
TML	31. Lovell, Tim	Tulsa Partners, Director	C	918-632-0044	tulsapartners@gmail.com
	32. Martin, D.C.	HazMat	T	918-591-4406	dcmartin@cityoftulsa.org
	33. McGavock, Nicole	NWS			
	34. Meloy, Kim	CoT Communications	T	918-596-7271	kmeloy@cityoftulsa.org
	35. Miller, Josh	Insurance Industry	C	918-627-1833	joshua.a.miller.r2d9@statefarm.com
AP	36. Patton, Ann	SDHMAB Member	C	918-296-1959	ann.patton@sbcglobal.net
	37. Price, Sue		T	918-596-2527	sprice@cityoftulsa.org
	38. Piltz, Steve	NWS			
	39. Roberts, Bob	SDHMAB Member/TPS	C	918-497-8845	brob11@swbell.net
	40. See, S.D.	HazMat	T	918-596-4406	steve.see@cityoftulsa.org
	41. Siddiqui, Sheryl	Language & Culture Bank	C	918-706-3595	sherylsiddiqui@yohoo.com

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	8. Brannin, Graham	CoT Planning and Intergovt Admin	T	918-749-7440	gbrannin@cityoftulsa.org
	9. Brierly, Kyle	SDHMAB Member	C	918-622-6996	kylebrierly@rooter.com
	10. Bruer, Kelli	EMSA		918-596-3140	bruerk@emsa.net
	11. Cheatham, Gary	SDHMAB Chair	C	918-695-8876	garycheatham@sbcglobal.net
SKC	12. Combs, Sara Kelly	Mortgage Officer		918-704-4575	sarakellycombs@gmail.com
	13. Dolman, Lucy		T	918-596-2490	ldolman@cityoftulsa.org
	14. Donaldson, Josh	CoT Planning Dept	T	918-576-5686	jdonaldson@cityoftulsa.org
	15. Dugan, Bob	ThorGuard			
	16. Easter, Curt	Emergency Management	T	918-596-9897	ceaster@cityoftulsa.org
	17. Evicks, J. K.	Bama	C	918-732-2183	jevicks@bama.com
JF	18. Finn, Judith, Dr.	SDHMAB Vice-Chair	C	918-587-1800	judithfinn@att.net
	19. Foster, Roy		T	918-596-1344	rfoster@cityoftulsa.org
	20. Fox, Patrick	CoT Planning Dept	T	918-576-5685	pfox@cityoftulsa.org
	21. Goss, Jeff			918-230-8429	jeff@servetulsa.com
	22. Grant, Martha	Tulsa Partners			
	23. Gurley, Mike	State Farm Insurance		918-899-2462	Mike.gurley@ait2@statefarm.com
RH.	24. Hall, Richard	Fire Dept. Planning	T	918-596-1782	RichHall@cityoftulsa.org

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	42. Skimbo, Jami		T	918-596-4376	jskimbo@cityoftulsa.org
	43. Spencer, Kathryn		T	918-591-4375	kspencer@cityoftulsa.org
	44. Spicer, James	Greencountry Permaculture LLC		928-583-4815	greencountrypermaculture@gmail.com
	45. Steele, G. David	Development Services	T	918-596-7085	dsteele@cityoftulsa.org
	46. Stevens, Chris	EMSA		918-830-8214	stevensc@emsa.net
	47. Thornton, Tim	Parks Maint. Supervisor		918-519-8701	timthorton@cityoftulsa.org
	48. Townsend, Henry	TCC LEPC, Chair	T	918-628-0651	hdytownsend@peoplepc.com
	49. Warlick, Theron	CoT Planning	T	918-576-5677	twarlick@cityoftulsa.org
	50. Wright, Scott	HazMat	T	918-698-1085	
	51.				
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AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Stormwater Drainage & Hazard Mitigation Advisory Board
Technical Advisory Committee Meeting
January 3, 2013 – 1:30 p.m.
PW Engineering Services
2317 S. Jackson Ave.
2nd Floor Conference Room S-213

Multi-Hazard Mitigation Plan:

1. **Hazard Mitigation Plan Update**.
    A. Arkansas River Corridor.
        i. History
        ii. Levees
        iii. Corridor Development Plans
        iv. Natural & Man-made Hazards
2. Next SDHMA Board Meeting: Tuesday, Jan. 15th, 3:00 pm.
3. Next TAC Meeting: **February 7, 2013, 1:30 p.m**. Public Information, Education and Participation.
   Engineering Services Conference Room 213

Adjourn

Meeting Sign in Sheet

R.D. FLANAGAN & ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	**Tulsa, OK – 2013 MULTI-HAZARD MITIGATION PLAN UPDATE**		
Purpose of Meeting:	**Public Information and Education**		
Date of Meeting:	**February 7,2013**	**Time Begin: 1:30 pm**	**Time End:**

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	Flanagan, Ron	Consultant	T	918-749-2696	rdflanagan@rdflanagan.com
am	Mack, Annaelise	Consultant	T	918-749-2696	amack@rdflanagan.com
	Swift, Mark, P.E.	Consultant	T	918-582-1380	swre@sbcglobal.net
	Swift, Angela	Swift Water Resources	T	918-582-1380	angela.swift@swreusa.com
BMR	1. Robison, Bill, P.E.	Project Manager	T	918-596-9475	brobison@cityoftulsa.org
	2. Ator, Paul	HazMat Coordinator	T	918-596-1810	paulator@cityoftulsa.org
	3. Baker, Michael		T	918-596-9420	MBaker@cityoftulsa.org
	4. Balogh, A.K.	HazMat	T	918-591-4406	abalogh@cityoftulsa.org
	5. Bennett, Tom	Tulsa Partners	C	918-639-8102	tom@jimsafe.com
DB	6. Berry, Dave	Realtor McGraw	C	918-637-5359	dberry@tulsarealtors.com
	7. Bledsoe, Bob	CoT Communications	T	918-596-1279	Bobbledsoe@cityoftulsa.org
	8. Brannin, Graham	CoT Planning and Intergovt Admin	T	918-749-7440	gbrannin@cityoftulsa.org

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	9. Brierly, Kyle	SDHMAB Member	C	918-622-6996	kylebrierly@rooter.com
	10. Bruer, Kelli	EMSA		918-596-3140	bruerk@emsa.net
	11. Cheatham, Gary	SDHMAB Chair	C	918-695-8876	garycheatham@sbcglobal.net
SKC	12. Combs, Sara Kelly	Mortgage Officer		918-704-4575	sarakellycombs@gmail.com
	13. Dolman, Lucy		T	918-596-2490	ldolman@cityoftulsa.org
	14. Donaldson, Josh	CoT Planning Dept	T	918-576-5686	jdonaldson@cityoftulsa.org
	15. Dugan, Bob	ThorGuard			
	16. Easter, Curt	Emergency Management	T	918-596-9897	ceaster@cityoftulsa.org
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	26. Hughes, Barry	Impact		918-274-9914	advertisingimpact@cox.net

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RJ	27. Jolliff, Roger	Emergency Manager	T	918-596-9898	rjolliff@cityoftulsa.org
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	30. Lewis, Brian	Senior Environmental Monitoring Tech		405-306-7780	blewis@cityoftulsa.org
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	34. Meloy, Kim	CoT Communications	T	918-596-7271	kmeloy@cityoftulsa.org
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	38. Piltz, Steve	NWS			
	39. Roberts, Bob	SDHMAB Member/TPS	C	918-497-8845	brob11@swbell.net
	40. See, S.D.	HazMat	T	918-596-4406	steve.see@cityoftulsa.org
	41. Siddiqui, Sheryl	Language & Culture Bank	C	918-706-3595	sherylsiddiqui@yohoo.com
SJS	42. Skimbo, Jami	CoT SLM	T	918-596-4376	jskimbo@cityoftulsa.org
	43. ~~Spencer, Kathryn~~ Julianna Monnot	COT SLM	T	918-591-4375	~~kspencer~~ Jmonnot@cityoftulsa.org

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	44. Spicer, James	Greencountry Permaculture LLC		928-583-4815	greencountrypermaculture@gmail.com
	45. Steele, G. David	Development Services	T	918-596-7085	dsteele@cityoftulsa.org
	46. Stevens, Chris	EMSA		918-830-8214	stevensc@emsa.net
	47. Thornton, Tim	Parks Maint. Supervisor		918-519-8701	timthorton@cityoftulsa.org
	48. Townsend, Henry	TCC LEPC, Chair	T	918-628-0651	hdytownsend@peoplepc.com
	49. Warlick, Theron	CoT Planning	T	918-576-5677	twarlick@cityoftulsa.org
	50. Wright, Scott	HazMat	T	918-698-1085	
	51. Lisa Piccolo	R.O. Flanagan + Ass.		918 6335670	lpiccolo@wildblue.net
	52. Tina Peña	Language Culture Bank		918-595-8386	TULIPAN35@aol.com
	53.				
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Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	61.				
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	67.				
	68.				

Committee Member Biography
Multi-Hazard Mitigation Plan
Citizens' Advisory Committee
Technical Advisory Committee

R.D. Flanagan & Associates

City of Tulsa, OK

Name: Julianna M Monnot

Committee(s): ☐ Citizen Advisory Committee ☐ Technical Advisory Committee

Phone (Work): (918) -591-4375 *Phone (Home):* (918) -938-6054

Phone (Fax): (918)-591-4399 *E-mail:* Jmonnot@cityoftulsa.org

Mailing Address: 4502 S. Galveston Ave

City: Tulsa *State/Zip:* OK 74107

Employer: City of Tulsa

Position: Stormwater Educaton Coordinator

Education: Degree	Field	School
Env Managment		NSU

Organization(s): Name	Position (Example--Past President, Board Member)

Other certifications, training or experience relevant to the disaster mitigation plan:

To add additional relevant information or comments, use back of form.

Please e-mail to rdflanagan@rdflanagan.com or fax to (918) 749-2697

AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Stormwater Drainage & Hazard Mitigation Advisory Board
Technical Advisory Committee Meeting

February 7, 2013 – 1:30 p.m.
PW Engineering Services
2317 S. Jackson Ave.
2nd Floor Conference Room S-213

City of Tulsa Multi-Hazard Mitigation Plan Update:

1. **Hazard Mitigation Plan Update**.
    A. Public Information, Education & Participation
        i. Program for Public Information
        ii. Target Audiences
        iii. Assess Public Information Needs
        iv. Coordinate with other PI Programs & Initiatives
        v. Measure/Evaluate Outcomes
2. Next SDHMA Board Meeting: Tuesday, Feb. 19th, 3:00 pm.
   Engineering Services Conference Room 213
3. Next TAC Meeting: **March 7, 2013, 1:30 p.m**. Hazards Review & Mitigation Measures Confirmation.
   Engineering Services Conference Room 213

Adjourn

City of Tulsa
Hazard Mitigation Technical Advisory Committee
February 7, 2013

The TAC met at 1:30 pm, Thursday, February 7th at Engineering Services, 2317 S. Jackson. The subject was Public Education and Engagement, presented by Tim Lovell, executive Director, Tulsa Partners.

Tim presented a Power Point Presentation that combined the new FEMA Community Rating System (CRS) Public Participation and Involvement requirements, adapted to the needs of All-Hazards Mitigation. Tim facilitated an interactive participation and involvement of the TAC members. A Flip-Chart summary of ideas and issues of the participants included:

Targets

Senior Health Care Facilities
Senior care facilities
Churches
Realtors
Building Trade Associations
Policy Makers, Politicians
Government Entities
Chamber of Commerce
Public Housing
Special Needs Populations
Non-Profit Organizations
Neighborhood Associations
Critical Facilities
Foreign Language Speakers
Bankers/Lenders/Mortgage Inst.
Historic Properties
School Children
Civic Groups
Day Care Facilities
Confinement Facilities
Media
Tribal Nations

Pre-Packaged PPI/PPE Programs

Salvation Army
StormReady
City-County Health
Metropolitan Ministry/Alliance
FireWise
Medical Response
Local Emergency Planning Committee
IBHS/FLASH

Issue: Coordination

Media
Joint Information Center
New Ideas
Meteorologists
Human Response Coalition

Action

Keep Messages Small and Simple
What You Can Do About It
Key Messages to Builders
Incentives
Raise Awareness
Neighbor-to-Neighbor
Teachable Moments
Build "Know Your Neighborhood Network

Recommendations

Sarah Kelly Combs, Mortgage Banker- Have a Clear Message; Lower Loss of Life

Dave Berry, Realtor- Realtors, Hazards Information, Awareness

Roger Jolliff, Director, Tulsa City County Emergency Management- Many Messages; Ways to get the Message out; Use of Social Media

Keith Laub, Tulsa Community College- One Unified Voice on All Hazards

Charles Hardt, Retired, Director, CoT Public Works- Need a Simple, Specific Comprehensive Plan

Richard Hall, Planner, Tulsa Fire Department- Target Audience; Slogans, e.g., "Turn Around, Don't Drown"

J. K. Evicks, BAMA Industries- Focus, Identify Audience; Clear, Concise Message

Bob Roberts, Emergency Manager, Tulsa Public Schools, SDHMA Board Member- Need for a Pilot; Infrastructure

Julianna Monnot, CoT Water-Sewer Dept, Public Information Officer- Prepare for Teachable Moments

Bob Bledsoe, CoT Communications Officer- Need Salesmen

Lisa Piccolo, Planning Liaison, Pawnee- Personal Safety, Risk Analysis

Ann Patton, SDHMAB Board Member, Vice Chair Natural Hazards Mitigation Association- On-Going, Longer Term Focus beyond the HM Plan

Annie Mack, Consultant, Flanagan & Assoc.- Need for Focus on Hazardous Materials and Transportation Hazards

Bill Robison, P.E., CoT HM Project Manager, Lead Engineer, Stormwater Planning- One Message that addresses all Hazards; Measurable Outcomes

Tim Lovell, Exec. Director, Tulsa Partners- Continue TAC Meetings

Ron Flanagan, Consultant- Need for a Stable Funding Source for Public Information & Engagement.

MINUTES

STORMWATER DRAINAGE AND HAZARD MITIGATION ADVISORY BOARD

Tuesday February 19, 2013
2317 South Jackson Room S213, Tulsa, OK 74107

Members Present
Judith Finn, Chairman
Ann Patton, Vice Chairman
R. Brandon Perkins, Member
Kyle Brierly, Member

Absent
Bob Roberts, Secretary

Others Present

Bob Bledsoe	City of Tulsa, Communications Department
Ron Flanagan	R.D. Flanagan & Associates
Jacob Hagen	City of Tulsa, Streets & Stormwater Department
Roger Jolliff	TAEMA
M. Todd Kilpatrick	Tulsa County Levee District 12
Tim Lovell	Tulsa Partners
Brenda Miller	Community Action Project
Bill Robison	City of Tulsa, Engineering Department
Sandy Silman	City of Tulsa, Engineering Department
Henry Som de Cerff	City of Tulsa, Engineering Department
Deborah Stowers	City of Tulsa, Engineering Department
Mark Swift	Swift Water Resource Engineering
Mark Swiney	City of Tulsa, Legal Department
Janine VanValkenburgh	City of Tulsa, Legal Department
Theron Warlick	City of Tulsa, Planning Department
Doug Wilson	City of Tulsa, Engineering Department
Bryan Young	City of Tulsa, Streets & Stormwater Department

DRAFT

Call to Order and Roll Call

At 3:07 p.m. Deborah Stowers called roll and established a quorum before Chair Dr. Judith Finn called the meeting to order.

Assignments

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of Minutes: January 15, 2013

The Board voted unanimously to approve a motion to table the January 15, 2013 minutes.

B. Discussion and approval of ordinance amending Title 26, Chapter 3, "Detention Facilities and Recreational Areas Supervised by Public Works", permitting a handgun to be brought into City-owned Detention facilities if the owner of the handgun has a license for same pursuant to the Oklahoma Self-Defense Act.

Mark Swiney informed the Board that their approval was not needed for this amended ordinance, but wanted to advise them of the change.

There are two kinds of park and recreation areas in the City of Tulsa: one kind is the public park operated by the Parks Department and the other is detention pond that has a secondary use as a recreation area operated by the Engineering and Stormwater Department. There has been an ordinance for many years forbidding any firearms to be brought into a park or a recreation area. The state statue self-defense act which provides that a person can be license to carry a handgun if he/she goes through the training and examination process provided by the state. There is a state statue that says a person who has a valid handgun license under the self-defense act specifically may carry a handgun into a park or recreation area; therefore the City of Tulsa ordinance that prohibits handguns has to be amended. It is only amended as far as handguns are concerned. Rifles, shotguns, unlicensed, or any other person who doesn't have a license under this act is still prohibited. The amended ordinance is only to comply with the state statue and will be presented to the City Council with the understanding of this mandate.

Assignments

C. Eugene Field Redevelopment Plans

Ron Flanagan began his presentation with introducing key players interested in this project: Brenda Miller who is a Community Action Project consultant, City of Tulsa planner Theron Warlick, City of Tulsa attorney Janine VanValkenburg, and City of Tulsa attorney Mark Swiney.

Mr. Flanagan informed the Board that the City of Tulsa is engaged in a small area planning process throughout the City of Tulsa addressing certain problem areas that don't go along with the Vision 2010 plan, therefore they are going into these areas and developing more detailed plans. One of these areas is the Eugene Field located between the Holly refinery on the west bank, I-244 and the Arkansas River.

DRAFT

There was a meeting with the Eugene Field small area planning team in September and various natural and man-made hazards that could impact the area were presented to them.

The planning team presented their plans to demolish the Brightwater public housing and was seeking a $30 million grant. The concern is the awareness of the things that can impact high-density low income housing, the industrial uses that surrounds this area and the Arkansas River on the east and north banks. This area is one of the most hazard prone areas in the City of Tulsa.

There are general hazards that impact the entire community that include winter storms, tornadoes & high winds, earthquakes & expansive soils, lightning, hail, extreme heat, and ozone. The other kind of hazards is site-specific hazards that include flooding & dam & levee failures and hazardous materials sites and transportation hazards.

This part of the city cannot be abandoned because of the hazards; therefore some of the recommended mitigation measures were presented and discussed so that this project could move forward in a safe and rational manner. *(Attach A)*

Educating the public and selling the public on hazard mitigation measures, especially construction oriented, is the goal.

This project could serve as a model for safe housing for the rest of the nation, as Tulsa has with its nationally recognized floodplain management program.

Theron Warlick distributed a hand-out of the Eugene Field small area plan and he and Brenda Miller explained the planned development. *(Attach B)* He also mentioned that they are working on getting some of the hazard mitigation ideas into the plan and working on getting some of the specifics incorporated into the development improvement proposal. The recommended mitigation measures will began to show in the draft plan in the next few weeks.

Brandon Perkins expressed that as a community that we need to address the underlying problems first such as levees, hazards, railroads, etc. before being asked to invest $30 million.

Dr. Judith Finn stated that the ozone in Tulsa has tripled in the last ten years. Recent research shows heart damage in normal healthy young people, young children have lung development problems and it exacerbates asthma. The concern is children being outside playing in parks in this area; therefore an indoor recreation center is probably needed so that they are exposed no more than two hours to ozone.

Dr. Finn said that the river is also an attractive nuisance for children and asked if there was a presumption that the fish could be eaten from the river. Doug Wilson stated that there was an environmental study, but it had nothing to do with fish. It was soil sampling on the west Tulsa Park and resulted in typical urban soil. It will need some more analysis because there were some exclusions.

Ann Patton stated that she would implore the planners of this area to focus on the hazards along the river.

Mr. Warlick informed the Board that they will be talking about hazard mitigation ideas in the plan, but there will probably be at least one developer saying that anytime you raise standards above the norm, people will be afraid to invest.

DRAFT

D. Presentation of Board Notebooks and Discussion of Ordinance Governing the work of the Board

Dr. Judith Finn presented to the Board notebooks containing documents of Stormwater Drainage and Hazard Mitigation Advisory Board reference materials needed at all times prepared with the help of Ron Flanagan and staff.

Dr. Finn expressed concern with the current ordinance creating the Board and the fact that it still states Public Works director. This was tabled for a later Board meeting.

Dr. Finn asked Ron Flanagan to include in the notebook the power point presentations for each hazard, the master drainage plan list with the year it was updated, the strategic plan, all of the recommendations from the Technical Advisory Committee on each hazard in the mitigation plan, the bylaws, and the ethics handbook.

Assignments

Doug Wilson to give specific detailed updated report on soil samples.

Mr. Flanagan to include documents in notebook requested by Dr. Finn.

E. 2013 Strategic Plan for Board

Dr. Judith Finn and Ann Patton stated that there are three priorities in this comprehensive plan: the master drainage plan for the northwest quadrant, public engagement in the northwest quadrant in conjunction with the Silver Jacket Project, and a master generator plan for high-priority critical facilities.

After discussion, the Board voted to adopt these three as their top priorities for the hazard mitigation plan and was passed unanimously.

F. Review and Discussion of Budget Priorities

No Discussion.

II. ISSUES

A. Hazard Mitigation Plan:
Public Participation and Engagement

Tim Lovell stated that at the last Technical Advisory Committee meeting, the suggested proposed priorities by focusing on the northwest quadrant and focusing on public engagement were discussed. The focus was on the term engagement as opposed to public information. Developing champions within neighborhoods and outreach through school children to reach families was also the focus.

Mr. Lovell informed them that he has had a discussion with Bob Roberts and has attended an Emergency Management Advisory Board at Tulsa Public Schools. The engagement strategy with the hazard mitigation plan was mentioned and at a later date, he would like their input on how to implement within the schools.

Roger Joliff continues to work with the state on getting a Map Your Neighborhood program.

Public information education must be integrated into the hazard mitigation plan document.

Environmental Education Committee comprised from different departments of the City of Tulsa and community groups that meets monthly. Mr. Flanagan presented the Arkansas River and public information to this group at the last meeting.

Funding issue for this plan for public information and education was discussed because the stormwater drainage fees primarily all goes to operation and maintenance. The Board needs a more active role in the budget process and to recommend priorities with education being high on the list.

B. Continuing review of and oversight of implementation of key aspects Mitigation Plan Update:

1) Fortified Homes and Tulsa Codes (Grant Application, Dawg Haus)

No Discussion.

Assignments

DRAFT

III. APPEALS & VARIANCES – None

Assignments

IV. REPORTS

Beginning January 2013, the Board will hear oral reports on a quarterly basis unless something of interest arises. Monthly paper reports submissions from staff are to continue and will be reviewed by the Board outside the meeting. Reporters should plan to identify key issues which are suggested by their reports, such as attention to matters of policy, ordinances, and capital considerations.

V. PUBLIC COMMENTS - None

VI. MEETING CLOSURE

Upon receiving no other comments or further questions, Dr. Finn adjourned the meeting at 5:15 p.m.

VII. NEXT MEETING – March 19, 2013

DRAFT

Meeting Sign in Sheet

R.D. FLANAGAN & ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	**Tulsa, OK – 2013 MULTI-HAZARD MITIGATION PLAN UPDATE**		
Purpose of Meeting:	**Public Mitigation Measures**		
Date of Meeting:	**March 7,2013**	**Time Begin: 1:30 pm**	**Time End:** 3:30 = 2.5

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	Flanagan, Ron	Consultant	T	918-749-2696	rdflanagan@rdflanagan.com
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	Swift, Angela	Swift Water Resources	T	918-582-1380	angela.swift@swreusa.com
BHR	1. Robison, Bill, P.E.	Project Manager	T	918-596-9475	brobison@cityoftulsa.org
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	3. Baker, Michael		T	918-596-9420	MBaker@cityoftulsa.org
	4. Balogh, A.K.	HazMat	T	918-591-4406	abalogh@cityoftulsa.org
	5. Bennett, Tom	Tulsa Partners	C	918-639-8102	tom@jimsafe.com
DRB	6. Berry, Dave	Realtor	C	918-637-5359	dberry@tulsarealtors.com
	7. Bledsoe, Bob	CoT Communications	T	918-596-1279	Bobbledsoe@cityoftulsa.org
	8. Brannin, Graham	CoT Planning and Intergovt Admin	T	918-749-7440	gbrannin@cityoftulsa.org

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	14. Donaldson, Josh	CoT Planning Dept	T	918-576-5686	jdonaldson@cityoftulsa.org
	15. Dugan, Bob	ThorGuard			
	16. Easter, Curt	Emergency Management	T	918-596-9897	ceaster@cityoftulsa.org
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	18. Finn, Judith, Dr.	SDHMAB Vice-Chair	C	918-587-1800	judithfinn@att.net
	19. Foster, Roy		T	918-596-1344	rfoster@cityoftulsa.org
	20. Fox, Patrick	CoT Planning Dept	T	918-576-5685	pfox@cityoftulsa.org
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	22. Grant, Martha	Tulsa Partners			
	23. Gurley, Mike	State Farm Insurance		918-899-2462	Mike.gurley@ait2@statefarm.com
R.H.	24. Hall, Richard	Fire Dept. Planning	T	918-596-1782	RichHall@cityoftulsa.org
	25. Hardt, Charles			918-369-5858	georgia.hardt@cox.net
	26. Hughes, Barry	Impact		918-274-9914	advertisingimpact@cox.net

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
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	29. Lester, Michelle	CoT Real Eatate	T	918-596-7266	mlester@cityoftulsa.org
	30. Lewis, Brian	Senior Environmental Monitoring Tech		405-306-7780	blewis@cityoftulsa.org
TML	31. Lovell, Tim	Tulsa Partners, Director	C	918-632-0044	tulsapartners@gmail.com
	32. Martin, D.C.	HazMat	T	918-591-4406	dcmartin@cityoftulsa.org
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	34. Meloy, Kim	CoT Communications	T	918-596-7271	kmeloy@cityoftulsa.org
	35. Miller, Josh	Insurance Industry	C	918-627-1833	joshua.a.miller.r2d9@statefarm.com
	36. Monnot, Julianna	CoT SLM	T	918-591-4375	jmonnot@cityoftulsa.org
	37. Patton, Ann	SDHMAB Member	C	918-296-1959	ann.patton@sbcglobal.net
	38. Pena, Tina	Language and Culture Bank	T	918-595-8386	TULIPAN35@aol.com
	39. Price, Sue		T	918-596-2527	sprice@cityoftulsa.org
	40. Piltz, Steve	NWS			
	41. Roberts, Bob	SDHMAB Member/TPS	C	918-497-8845	brob11@swbell.net
	42. See, S.D.	HazMat	T	918-596-4406	steve.see@cityoftulsa.org
	43. Siddiqui, Sheryl	Language & Culture Bank	C	918-706-3595	sherylsiddiqui@yohoo.com

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	44. Skimbo, Jami		T	918-596-4376	jskimbo@cityoftulsa.org
	45. Spicer, James	Greencountry Permaculture LLC		928-583-4815	greencountrypermaculture@gmail.com
	46. Steele, G. David	Development Services	T	918-596-7085	dsteele@cityoftulsa.org
	47. Stevens, Chris	EMSA		918-830-8214	stevensc@emsa.net
	48. Thornton, Tim	Parks Maint. Supervisor		918-519-8701	timthorton@cityoftulsa.org
	49. Townsend, Henry	TCC LEPC, Chair	T	918-628-0651	hdytownsend@peoplepc.com
	50. Warlick, Theron	CoT Planning	T	918-576-5677	twarlick@cityoftulsa.org
	51. Wright, Scott	HazMat	T	918-698-1085	
	52.				
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Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
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Meeting Notes

R.D. FLANAGAN
& ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	City of Tulsa, OK HM Plan Update	**Date:**	March 7, 2013

	Travel Time	Mileage	Meeting
Begin:	1:00 pm		1:30 p.m.
End:			
Total			

Location:

Attending:	
Ron Flanagan	
See sign-in sheet	
Documents Received:	

Topics Covered: Mitigation Measures

Notes:

AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

3:00 P.M., Tuesday, March 19, 2013

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

Dr. Judith Finn, Chair
Ann Patton, Vice-Chair
Bob Roberts, Secretary
Kyle Brierly, Member
Brandon Perkins - Member

--

Deborah Stowers, Asst. Secretary & Records Custodian
Harold Tohlen, OWRB Accredited Floodplain Administrator
Mark Swiney, Board Counsel

FILED
CITY OF TULSA
STATE OF OKLAHOMA
2013 MAR 15 A 10: 20
MICHAEL P. KIER
CITY CLERK

Call to Order & Roll Call.....Chair

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of January 15, 2013Minutes
Approval/Correction of February 19, 2013Minutes: ..... Dr. Judith Finn

B. Preparation of Hazard Mitigation Measures for Subcommittees 61st and Peoria ..... Ron Flanagan

C. Review and Discussion of Budget Priorities ..... Bill Robison

D. Development of a White Paper on the Arkansas River and 61st and Peoria Hazard Report ..... Dr. Judith Finn

E. 2009 Hazard Mitigation Plan into the PlanIt Tulsa Comprehensive Plan ..... Ron Flanagan/Brandon Perkins

F. Eugene Field Redevelopment Project.....Bill Robison/Theron Warlick
1) Inclusion of Hazard Mitigation Measures
2) Updated Report on Soil Samples on West Tulsa Park

II. ISSUES (SUBSTANABLE TULSA)

A. Hazard Mitigation Plan Element:
Hazard Mitigation Measures.....Bill Robison/Ron Flanagan
1) Review of Technical Advisory Committee Report.
2) Key policy issues: city, county, state.
3) Ordinance changes required.
4) New capital outlays, bond issues, grants implicated.
5) Priority of this element (high, medium, low).
6) Barriers to implementation of this element of the plan.
7) Assignments.

B. Continuing review of and oversight of implementation of key aspects of Mitigation Plan Update:
1) Fortified Homes and Tulsa Codes
(Grant Application, Dawg Haus) ..... Bill Robison

III. APPEALS & VARIANCES - None

(Continued on other side)

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

3:00 P.M., Tuesday, March 19, 2013

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

IV. REPORTS

Beginning January 2013, the Board will hear oral reports on a quarterly basis unless something of interest arises. Monthly paper reports submission from staff are to continue and will be reviewed by the Board outside the meeting. Reporters should plan to identify key issues which are suggested by their reports, such as attention to matters of policy, ordinances, and capital considerations.

A. 2014 Budget Report ..... Alan Rowland/Tammy Pitts

V. PUBLIC COMMENTS

Although the OMA limits Board action to those matters specifically listed on this Agenda, the Board solicits and encourages public comments and ideas.

VI. MEETING CLOSURE ..... Chair

VII. NEXT MEETING ..... April 16, 2013

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SIGN IN SHEET

FOR

STORMWATER DRAINAGE AND HAZARD MITIGATION ADVISORY BOARD
Tuesday, March 19, 2013 3:00 P.M.
2317 S. Jackson, Engineering Services Conference Room S213
Tulsa, Oklahoma 74017

NAME	ORGANIZATION	CONCERN
ROGER JOLLIFF	TAEMA	—
Bob Bledsoe	COT-Communications	
[illegible]	COT-Finance	
Bob Roberts	TPS	
Alan Rowland	COT	
Deborah Hawkins	COT	
TIM LOVELL	TULSA PARTNERS	
MARK SWINEY	CITY OF TULSA LEGAL DEPT.	
JUDITH A. FINN	SDAHMAB	
Jacquita Tate	COT	
Scott VanSeer	COT	
ROY TEETERS	STREETS + STORMWATER	
RON FLANAGAN		
R Brandon Perkins		

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FILED
CITY OF TULSA
STATE OF OKLAHOMA
2013 MAR 15 A 10: 20
MICHAEL P. KIER
CITY CLERK

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(Grant Application, Dawg Haus) ..... Bill Robison

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Meeting Sign in Sheet

R.D. FLANAGAN & ASSOCIATES
Planning Consultants
www.rdflanagan.com

Project:	**Tulsa, OK – 2013 MULTI-HAZARD MITIGATION PLAN UPDATE**		
Purpose of Meeting:	**Public Mitigation Measures**		
Date of Meeting:	**April 11, 2013**	**Time Begin: 1:30 pm**	**Time End:** 2:45 – 1.25 1.75

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
RDF	Flanagan, Ron	Consultant	T	918-749-2696	rdflanagan@rdflanagan.com
	Mack, Annaelise	Consultant	T	918-749-2696	amack@rdflanagan.com
	Swift, Mark, P.E.	Consultant	T	918-582-1380	swre@sbcglobal.net
AMS	Swift, Angela	Swift Water Resources	T	918-582-1380	angela.swift@swreusa.com
BJR	1. Robison, Bill, P.E.	Project Manager	T	918-596-9475	brobison@cityoftulsa.org
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	4. Balogh, A.K.	HazMat	T	918-591-4406	abalogh@cityoftulsa.org
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DBB	6. Berry, Dave	Realtor	C	918-637-5359	dberry@tulsarealtors.com
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	8. Brannin, Graham	CoT Planning and Intergovt Admin	T	918-749-7440	gbrannin@cityoftulsa.org

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	11. Cheatham, Gary	SDHMAB Chair	C	918-695-8876	garycheatham@sbcglobal.net
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	16. Easter, Curt	Emergency Management	T	918-596-9897	ceaster@cityoftulsa.org
SJE	17. Evicks, J. K.	Bama	C	918-732-2183	jevicks@bama.com
	18. Finn, Judith, Dr.	SDHMAB Vice-Chair	C	918-587-1800	judithfinn@att.net
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	22. Grant, Martha	Tulsa Partners			
	23. Gurley, Mike	State Farm Insurance		918-899-2462	Mike.gurley@ait2@statefarm.com
RH.	24. Hall, Richard	Fire Dept. Planning	T	918-596-1782	RichHall@cityoftulsa.org
	25. Hardt, Charles			918-369-5858	georgia.hardt@cox.net
	26. Hughes, Barry	Impact		918-274-9914	advertisingimpact@cox.net

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	29. Lester, Michelle	CoT Real Eatate	T	918-596-7266	mlester@cityoftulsa.org
	30. Lewis, Brian	Senior Environmental Monitoring Tech		405-306-7780	blewis@cityoftulsa.org
TML	31. Lovell, Tim	Tulsa Partners, Director	C	918-632-0044	tulsapartners@gmail.com
	32. Martin, D.C.	HazMat	T	918-591-4406	dcmartin@cityoftulsa.org
	33. McGavock, Nicole	NWS			
	34. Meloy, Kim	CoT Communications	T	918-596-7271	kmeloy@cityoftulsa.org
	35. Miller, Josh	Insurance Industry	C	918-627-1833	joshua.a.miller.r2d9@statefarm.com
	36. Monnot, Julianna	CoT SLM	T	918-591-4375	jmonnot@cityoftulsa.org
	37. Patton, Ann	SDHMAB Member	C	918-296-1959	ann.patton@sbcglobal.net
	38. Pena, Tina	Language and Culture Bank	T	918-595-8386	TULIPAN35@aol.com
	39. Price, Sue		T	918-596-2527	sprice@cityoftulsa.org
	40. Piltz, Steve	NWS			
	41. Roberts, Bob	SDHMAB Member/TPS	C	918-497-8845	brob11@swbell.net
	42. See, S.D.	HazMat	T	918-596-4406	steve.see@cityoftulsa.org
	43. Siddiqui, Sheryl	Language & Culture Bank	C	918-706-3595	sherylsiddiqui@yohoo.com

Initial	Name	Position or Organization	T/C	Phone(s)	E-mail
	44. Skimbo, Jami		T	918-596-4376	jskimbo@cityoftulsa.org
	45. Spicer, James	Greencountry Permaculture LLC		928-583-4815	greencountrypermaculture@gmail.com
	46. Steele, G. David	Development Services	T	918-596-7085	dsteele@cityoftulsa.org
	47. Stevens, Chris	EMSA		918-830-8214	stevensc@emsa.net
	48. Thornton, Tim	Parks Maint. Supervisor		918-519-8701	timthorton@cityoftulsa.org
	49. Townsend, Henry	TCC LEPC, Chair	T	918-628-0651	hdytownsend@peoplepc.com
	50. Warlick, Theron	CoT Planning	T	918-576-5677	twarlick@cityoftulsa.org
	51. Wright, Scott	HazMat	T	918-698-1085	
	52.				
	53.				
	54.				
	55.				
	56.				
	57.				
	58.				
	59.				
	60.				

AGENDA

City of Tulsa
Multi-Hazard Mitigation Plan
Stormwater Drainage & Hazard Mitigation Advisory Board
Technical Advisory Committee Meeting

April 11, 2013 – 1:30 p.m.
PW Engineering Services
2317 S. Jackson Ave.
2nd Floor Conference Room S-213

City of Tulsa Multi-Hazard Mitigation Plan Update:

1. **Hazard Mitigation Plan Update**.
   A. Mitigation Measures Review & Confirmation
   B. Risk Matrix Analysis for all Hazards
2. Next SDHMA Board Meeting: Tuesday, April 16th, 3:00 pm.
   Engineering Services Conference Room 213
3. Next TAC Meeting: **May 9, 2013, 1:30 p.m**. Final HM Plan Review & Comment
   Engineering Services Conference Room 213

Adjourn

AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board
3:00 P.M., Tuesday, May 21, 2013
2317 South Jackson, Conference Room S213, Tulsa, OK 74107

Dr. Judith Finn, Chair
Ann Patton, Vice-Chair
Bob Roberts, Secretary
Kyle Brierly, Member
Brandon Perkins - Member

--

Deborah Stowers, Asst. Secretary & Records Custodian
Harold Tohlen, OWRB Accredited Floodplain Administrator
Mark Swiney, Board Counsel

Call to Order & Roll Call ..... Chair

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of March 19, 2013 Minutes ..... Dr. Judith Finn

B. 2013 Adoption of the Regulatory Floodplain Atlas/Maps ..... Bill Robison

C. Development of a White Paper on the Arkansas River and 61st and Peoria Hazard Report ..... Dr. Judith Finn

D. 2009 Hazard Mitigation Plan into the PlanIt Tulsa Comprehensive Plan ..... Ron Flanagan/Brandon Perkins

E. Eugene Field Redevelopment Project ..... Bill Robison/Theron Warlick
1) Inclusion of Hazard Mitigation Measures
2) Updated Report on Soil Samples on West Tulsa Park

II. ISSUES (SUBSTANABLE TULSA)

A. Hazard Mitigation Plan Element:
Hazard Mitigation Measures ..... Bill Robison/Ron Flanagan
1) Review of Technical Advisory Committee Report.
2) Key policy issues: city, county, state.
3) Ordinance changes required.
4) New capital outlays, bond issues, grants implicated.
5) Priority of this element (high, medium, low).
6) Barriers to implementation of this element of the plan.
7) Assignments.

B. Continuing review of and oversight of implementation of key aspects of Mitigation Plan Update:
1) Fortified Homes and Tulsa Codes
(Grant Application, Dawg Haus) ..... Bill Robison

III. APPEALS & VARIANCES - None

(Continued on other side)

FILED
CITY OF TULSA
STATE OF OKLAHOMA
2013 MAY 17 P 12: 23
MICHAEL P. KIER
CITY CLERK

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

3:00 P.M., Tuesday, May 21, 2013

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

IV. REPORTS

Beginning January 2013, the Board will hear oral reports on a quarterly basis unless something of interest arises. Monthly paper reports submission from staff are to continue and will be reviewed by the Board outside the meeting. Reporters should plan to identify key issues which are suggested by their reports, such as attention to matters of policy, ordinances, and capital considerations.

A. Director's Report ..... Paul Zachary/Dan Crossland
   1) Monthly Financial Report ..... Tammy Pitts
   2) Proposed Fund Transfers ..... Tammy Pitts
   3) Stream Monitoring Update ..... Scott VanLoo
B. Capital Improvement Projects ..... Bill Robison
   1) Capital Projects Status Report ..... Deborah Stowers
C. Floodplain Administrator's Report ..... Harold Tohlen
   1) Permit Center Report ..... Harold Tohlen
D. Fee-in-Lieu Funds Report ..... Bill Robison
E. Updating the Master Drainage Plans ..... Bill Robison

V. PUBLIC COMMENTS

Although the OMA limits Board action to those matters specifically listed on this Agenda, the Board solicits and encourages public comments and ideas.

VI. MEETING CLOSURE ..... Chair

VII. NEXT MEETING ..... June 18, 2013

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

Meeting Minutes
Tulsa County Local Emergency Planning Committee
May 22nd, 2013
www.tulsalepc.info

Call to Order

- The meeting was held at the Tulsa Health Department.
- The meeting was called to order by Chairman Henry Townsend at 09:31.
- 25 members and guests were in attendance.

Reports

Treasurers Report
- Heather Morgan reported the current balance is $24,175.51
- Report accepted as presented.

Secretary's Report
- Review of the minutes from the March 27th meeting.
- Minutes accepted as presented.

Business

24 Hour Contact Information
- Members had previously been asked to review the four proposals under consideration for 24/7 Telephone Answering services, and submit their preference to Tim Hoss at thoss@osumc.net by April 15, 2013. With all votes tallied, *Voice Nation* was the chosen provider.

Holley Refinery Community Advisory Panel (CAP) Meeting
- Tim Hoss spoke briefly about the CAP, and the impressive Safety & Environmental Monitoring program Holley Refinery has in place.

Speaker

- Ron Flanagan, of Flanagan & Associates tulsaupdate@rdflanagan.com spoke in detail about the Tulsa County Multi-Hazard Mitigation Plan; and more specifically about Transportation & Fixed Site Hazardous Materials and how these subjects dovetail with the function of the TCLEPC. Mr. Flanagan asked the members if they could come up with two mitigation

measures that could be implemented. After discussion amongst the group, the following suggestion was made;

- Have canned messages in multiple languages ready to send via mass notification, for shelter in place and/or evacuation notices.

Future Presentation

- Henry Townsend mentioned that he would like to put together a group of speakers to discuss how flooding would adversely affect Tulsa County, and in particular, some of its more vulnerable chemical manufacturing and storage facilities.

Next Meeting

- Next meeting is scheduled for July 31st, 2013.
- Meeting location will be at the Tulsa County Health Department – 51st & 129th.
- Meeting time will be 09:30.

Adjournment

- With all business conducted, the meeting was called to adjourn at 11:41.

Respectfully Submitted,
Tim Hoss, CHSP, CHEM
Secretary, TCLEPC

AGENDA

FILED
CITY OF TULSA
STATE OF OKLAHOMA
2013 JUN 14 A 11: 09
MICHAEL P. KIER
CITY CLERK

Stormwater Drainage and Hazard Mitigation Advisory Board
3:00 P.M., Tuesday, June 18, 2013
2317 South Jackson, Conference Room S213, Tulsa, OK 74107

Dr. Judith Finn, Chair
Ann Patton, Vice-Chair
Bob Roberts, Secretary
Kyle Brierly, Member
Brandon Perkins, Member

--

Deborah Stowers, Asst. Secretary & Records Custodian
Harold Tohlen, OWRB Accredited Floodplain Administrator
Mark Swiney, Board Counsel

Call to Order & Roll Call ..... Chair

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of May 21, 2013 Minutes ..... Dr. Judith Finn

B. Gravel Ordinance ..... Paul Zachary

C. Structural/Non-Structural Planning for Mitigation of Flooding in the Northwest Quadrant of Tulsa ..... Paul Zachary/Todd Kilpatrick/Bill Robison

D. Key Policy Issues: City, County, State ..... Dr. Judith Finn
1) Role of Corps of Engineers in planning for Northwest Quadrant (i.e. What has been done and what remains to be done in the coming year)
2) Funding issues
3) Ordinance changes required
4) New capital outlays, bond issues, grants implicated
5) Priority of this element (high, medium, low)
6) Barriers to implementation of this element of the plan

E. Report on Worldwide Outreach by the Board to Tulsa Global Alliance (SE Asian Guests of the U.S. State Department) by members of the Board, The Hazard Mitigation Team and the Hazard Mitigation Consultant ..... Bob Roberts/Tim Lovell

F. Discussion on Waiving Permitting Fees for Storm Shelters ..... Ann Patton

G. Annual Election of Officers ..... Dr. Judith Finn

II. ISSUES (SUBSTANABLE TULSA)

A. Discussion of Draft of Chapter 5 of Hazard Mitigation Plan ..... Bill Robison/Ron Flanagan

B. Continuing review of and oversight of implementation of key aspects of Mitigation Plan Update:
1) Fortified Homes and Tulsa Codes (Grant Application, Dawg Haus) ..... Bill Robison

III. APPEALS & VARIANCES - None

(Continued on other side)

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

3:00 P.M., Tuesday, June 18, 2013

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

REPORTS

Beginning January 2013, the Board will hear oral reports on a quarterly basis unless something of interest arises. Monthly paper reports submission from staff are to continue and will be reviewed by the Board outside the meeting. Reporters should plan to identify key issues which are suggested by their reports, such as attention to matters of policy, ordinances, and capital considerations.

IV. PUBLIC COMMENTS

Although the OMA limits Board action to those matters specifically listed on this Agenda, the Board solicits and encourages public comments and ideas.

V. MEETING CLOSURE ..... Chair

VII. NEXT MEETING ..... July 16, 2013

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

AGENDA

FILED
CITY OF TULSA
STATE OF OKLAHOMA
2013 AUG 16 A 9:44
MICHAEL P. KIER
CITY CLERK

Stormwater Drainage and Hazard Mitigation Advisory Board
3:00 P.M., Tuesday, August 20, 2013
2317 South Jackson, Conference Room S213, Tulsa, OK 74107

Dr. Judith Finn, Chair
Ann Patton, Vice-Chair
Bob Roberts, Secretary
Kyle Brierly, Member
Brandon Perkins, Member

--

Deborah Stowers, Asst. Secretary & Records Custodian
Harold Tohlen, OWRB Accredited Floodplain Administrator
Mark Swiney, Board Counsel

Call to Order & Roll Call ..... Chair

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of June 18, 2013 Minutes ..... Dr. Judith Finn

B. Status Report on Structural/Non-Structural Planning for Mitigation of Flooding in the Northwest Quadrant of Tulsa ..... Paul Zachary

C. Levee Funding, Stormwater Management, Maintenance and Permeable Concrete Issues in the Plan for the Gathering Place ..... Paul Zacchary

D. Briefing on the Gathering Place ..... Deborah Stowers

E. Discussion on Waiving Permitting Fees for Storm Shelters ..... Ann Patton

F. Discussion on Raising Stormwater Fees ..... Dr. Judith Finn

G. Discussion on Tornado Conference Plan ..... Dr. Judith Finn

H. Discussion of Proposed Dates for 2014 Regular Meetings ..... Dr. Judith Finn

II. ISSUES (SUBSTANABLE TULSA)

A. Discussion of Draft of Chapter 5 of Hazard Mitigation Plan
..... Bill Robison/Ron Flanagan
Key Policy Issues: City, County, State
1) Role of Corps of Engineers in planning for Northwest Quadrant (i.e. what has been done and what remains to be done in the coming year)
2) Funding issues
3) Ordinance changes required
4) New capital outlays, bond issues, grants implicated
5) Priority of this element (high, medium, low)
6) Barriers to implementation of this element of the plan

B. Continuing review of and oversight of implementation of key aspects of Mitigation Plan Update:
1) Fortified Homes and Tulsa Codes (Grant Application, Dawg Haus) ..... Bill Robison

(Continued on other side)

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board

3:00 P.M., Tuesday, August 20, 2013

2317 South Jackson, Conference Room S213, Tulsa, OK 74107

III. APPEALS & VARIANCES

A. Stormwater Drainage System Service Charge by the Department of the Air Force, 138th Fighter Wing Air National Guard (ANG), 9100 East 46th Street North (north end of the airport grounds) in accordance with Tulsa Revised Ordinance (TRO) Title II-A, Chapter 2, Section 204.

IV. REPORTS

Beginning January 2013, the Board will hear oral reports on a quarterly basis unless something of interest arises. Monthly paper reports submission from staff are to continue and will be reviewed by the Board outside the meeting. Reporters should plan to identify key issues which are suggested by their reports, such as attention to matters of policy, ordinances, and capital considerations

V. PUBLIC COMMENTS

Although the OMA limits Board action to those matters specifically listed on this Agenda, the Board solicits and encourages public comments and ideas.

VI. MEETING CLOSURE ..... Chair

VII. NEXT MEETING ..... September 10, 2013

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

AGENDA

Stormwater Drainage and Hazard Mitigation Advisory Board
3:00 P.M., Tuesday, September 10, 2013
2317 South Jackson, Conference Room S213, Tulsa, OK 74107

Dr. Judith Finn, Chair
Ann Patton, Vice-Chair
Bob Roberts, Secretary
Kyle Brierly, Member
Brandon Perkins, Member

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Deborah Stowers, Asst. Secretary & Records Custodian
Harold Tohlen, OWRB Accredited Floodplain Administrator
Mark Swiney, Board Counsel

FILED
CITY OF TULSA
STATE OF OKLAHOMA
2013 SEP -6 P 12:47
MICHAEL P. KIER
CITY CLERK

Call to Order & Roll Call ..... Chair

I. ADMINISTRATIVE MATTERS

A. Approval/Correction of August 20, 2013 Minutes ..... Dr. Judith Finn

B. Silver Jacket Presentation ..... Corps of Engineers

C. Update on Waiving Permitting Fees for Storm Shelters ..... Harold Tohlen

D. Update on Raising Stormwater Fees ..... Alan Rowland

E. Update on High Winds and Tornado Conference Plan ..... Brandon Perkins

F. Report on Approving Permits In the Floodplain ..... Harold Tohlen

II. KEY POLCY ISSUES IN HAZARD MITIGATION PLAN

A. Discussion of Draft of Chapter 5 of Hazard Mitigation Plan
..... Bill Robison/Ron Flanagan

1) Role of Corps of Engineers in planning for Northwest Quadrant (i.e. what has been done and what remains to be done in the coming year)
2) Funding issues
3) Ordinance changes required
4) New capital outlays, bond issues, grants implicated
5) Priority of this element (high, medium, low)
6) Barriers to implementation of this element of the plan

B. Continuing review of and oversight of implementation of key aspects of Mitigation Plan Update:

1) Fortified Homes and Tulsa Codes (Grant Application, Dawg Haus) ..... Bill Robison
2) Nursing Homes/Generators ..... Ron Flanagan
3) Disaster Plans for School Children and Daycare Centers ..... Bob Roberts

III. APPEALS & VARIANCES - None

(Department of the Air Force, Air National Guard is tabled until 10/15/2013)

(Continued on other side)

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

IV. REPORTS

Beginning January 2013, the Board will hear oral reports on a quarterly basis unless something of interest arises. Monthly paper reports submission from staff are to continue and will be reviewed by the Board outside the meeting. Reporters should plan to identify key issues which are suggested by their reports, such as attention to matters of policy, ordinances, and capital considerations.

V. PUBLIC COMMENTS

Although the OMA limits Board action to those matters specifically listed on this Agenda, the Board solicits and encourages public comments and ideas.

VI. MEETING CLOSURE ..... Chair

VII. NEXT MEETING ..... October 15, 2013

Should you wish to attend and participate in the Board's meeting but require SPECIAL ACCOMMODATIONS pursuant to the AMERICANS WITH DISABILITIES ACT, please contact the City's Stormwater Design Staff by calling 918/596-9498 as soon as possible but at least 24 hours prior to the meeting so that we can meet your needs.

Appendix D: Status of 2009 Mitigation Measures

Priority	Category	Measure	Current Status (Complete, Ongoing, In Process, Not yet begun, Modified, Dropped)
1	*Floods, Extreme Heat, Wildfires, Winter Storms, Dam/Levee Failure*	Incorporate an Emergency Telephone Notification System (ETNS) into the Tulsa Emergency Communications Center	Completed
2	*Floods, Tornadoes, High Winds, Lightning, Hail, Winter Storms, Wildfires, Earthquakes, Dam/Levee Failure*	Construct a new Emergency Operations Center	Deferred
3	*Floods, Tornadoes, High Winds, Lightning, Winter Storms, Earthquakes, Dam/Levee Failure*	Develop a Master Generator Plan for the City of Tulsa	80% Complete, Ongoing, In Process
4	*Tornadoes, High Winds*	Develop a Safe Room plan for City of Tulsa facilities	Ongoing
5	*Tornadoes, High Winds*	Individual Safe Room rebate program	In Process, NOI Submitted
6	*Lightning*	Install Lightning Warning & Alert Systems in public recreation areas	Ongoing
7	*Floods, Tornadoes, High Winds, Lightning, Hail, Winter Storms, Extreme Heat, Drought, Expansive Soil, Wildfires, Earthquakes, Dam/Levee Failure*	Public Education & Information Program Development	Ongoing, Formed PPI Committee
8	*Floods, Tornadoes, High Winds, Hail, Winter Storms, Extreme Heat, Wildfires, Earthquakes, Dam/Levee Failure*	Develop a Special Needs registry through the 9-1-1 databases to assist with educating, alerting, evacuating, or responding to vulnerable populations during disaster	Partially Complete, Coordinate list from social service agencies
9	*Floods, Tornadoes, High Winds, Lightning, Winter Storms, Earthquakes, Dam/Levee Failure*	Provide for back-up power sources for City water treatment plants to avoid water shortages during extended power outages	Partially Complete
10	*Winter Storms, High Winds, Tornadoes, Earthquakes*	Provide backup power generators to five additional city fueling facilities	Completed

Priority	Category	Measure	Current Status (Complete, Ongoing, In Process, Not yet begun, Modified, Dropped)
11	*Floods, Dam/Levee Failures*	Implement structural and non-structural flood mitigation measures for flood-prone properties, as recommended in the basin-wide master drainage plans	Ongoing
12	*Floods, Tornadoes, High Winds, Lightning, Hail, Winter Storms, Heat, Wildfires, Earthquakes, Dam/Levee Failure*	Develop enhanced Emergency Planning for Special Needs populations in the City of Tulsa Emergency Operations Plan and other planning documents	Ongoing
13	*Floods, Dam/Levee failure*	Acquire and remove Repetitive Loss Properties and repeatedly flooded properties where the City's Repetitive Loss and master drainage plans identify acquisition to be the most cost effective and desirable mitigation measure	Ongoing
14	*Floods, Dam/Levee failure*	Develop a Comprehensive Levee evaluation and repair Plan	Ongoing, Funded
15	*Floods, Dam/Levee failure*	Develop a Levee Public Education and Evacuation Plan for at-risk areas of the community	Ongoing,
16	*Floods, Tornadoes, High Winds, Lightning, Hail, Winter Storms, Extreme Heat, Wildfires, Earthquakes, Dam/Levee Failure*	Disaster Resistant Business Program	Ongoing, Tulsa Partners
17	*Expansive Soils*	Consider establishing an administrative procedure or change in City codes for requiring builders to check for expansive soils when they apply for permits for new residential construction and for using foundations that mitigate expansive soil damages when in a moderate or high-risk area.	Deferred
18	*Floods, Dam/Levee Failure*	Continue to update and revise Basin-wide Master Drainage Plans where changed conditions warrant.	Ongoing-Funded East Tulsa, NW Basin
19	*Floods, Tornadoes, High Winds, Lightning, Hail, Winter Storms, Extreme Heat, Drought, Expansive Soil, Wildfires, Earthquakes, Dam/Levee Failure*	Develop multi-lingual Disaster Education PSA's and educational videos	In Progress, in conjunction with CRS

Priority	Category	Measure	Current Status (Complete, Ongoing, In Process, Not yet begun, Modified, Dropped)
20	*Floods, Tornadoes, High Winds, Lightning, Winter Storms, Extreme Heat, Wildfires, Earthquakes, Dam/Levee Failures*	Develop a separate "public safety" information area in all public libraries and public recreation facilities to disseminate disaster safety information appropriate to the area and the season	Ongoing
21	*Tornadoes, High Winds*	Educate residents, building professionals and Safe Room vendors on the ICC/NSSA "Standard for the Design and Construction of Storm Shelters" and consider incorporating into current regulatory measures	Ongoing
22	*Floods, Tornadoes, High Winds, Lightning, Hail, Winter Storms, Extreme Heat, Drought, Expansive Soil, Wildfires, Earthquakes*	Train/Educate builders, developers, architects and engineers in techniques of disaster-resistant homebuilding	Ongoing
23	*Winter Storms, Tornadoes, High Winds*	Develop a comprehensive public education program on the dangers of carbon monoxide during extended power outages	Ongoing, Fire Dept, ONG, PSO Utilities
24	*Tornadoes, High Winds*	Develop a model Safe Room project for a Mobile Home Park in the City of Tulsa	Deferred
25	*Extreme Heat*	Supplement the current Heat Coalition program to loan window air conditioners to an extremely medically vulnerable population during the summer months	Deferred
26	*Extreme Heat*	Review the safety of Playground materials during extreme heat events	In Progress, Partially Complete
27	Wildfire	Implement a Firewise Community Education and Information Program	Deferred
28	Floods, Dam/Levee Failure	Provide stricter floodplain regulations along the Arkansas River corridor.	In Progress
29	Floods, Dam/Levee Failure	Consider establishing an administrative procedure or change in City codes for requiring builders to develop a site drainage plan ensuring "no adverse impact" when they apply for permits for new residential construction.	Completed, Required in Plats
30	Floods, Dam/Levee Failure	Continue National Flood Insurance Program (NFIP) and Community Rating System (CRS) Participation	Ongoing, CRS-2

Appendix E: City of Tulsa Tier II Facilities

District 1

Facility	Address	Contains EHS	People within 1/4 mile
Bama Frozen Dough	2435 N Lewis	Yes	82
City of Tulsa--MOHAWK WATER TREATMENT PLANT	3600 E Mohawk Blvd	Yes	10
PSO-46th Street North Substation	1364 E 46th St N & Peoria	Yes	172
PSO-Mohawk Pump Station Substation	3730 Mohawk Blvd	Yes	0
PSO-Pine & Peoria Substation	1518 S Peoria Ave	Yes	88
Qwest Tulsa TI	38 N Peoria Ave	Yes	141
Univar USA Inc. - Tulsa OK	4500 N Peoria	Yes	55
Cox Communications--Downtown	105 W Easton St	Yes	221
Cox Communications--Owasso	10036 N 145th E Ave	Yes	196
Airgas Mid South, Inc- Tulsa Peoria	31 North Peoria Avenue	Yes	185
Anheuser-Busch Sales of Oklahoma	2929 North Florence	Yes	0
AT&T - TU FILLMORE CO - R66115	5480 N Peoria Ave	Yes	569
City of Tulsa--Flat Rock Creek Flow Equalization B	3104 E 56th st N	No	0
Empire Castings	2729 Charles Page Blvd	No	0
EXTERRAN	2940 N Toledo	No	8
Fo-Mac	2621 N Iroquois Ave	No	271
INSERV Manufacturing Services Mohawk Plant	3500 N Toledo	No	28
John Crane Lemco	2931 E Apache St	No	196
LUCKY SAM 3	3407 N Lewis	No	279
Metal Dynamic Corporation	1145 N Iroquois St	No	199
NORDAM Transparency Division – Archer	1050 E Archer St	No	144
NORTH AMERICAN COMPOSITES COMPANY	1012 E Oklahoma St	No	129
Oseco	1701 W Tacoma	No	287
Port City Metal Services	3101 Charles Page Blvd	No	203
SUPER TRIP	911 E 36th St	No	229
Troco Oil Company	516 S25 W Ave	No	253
UPS Ground Freight Inc. (Formerly Overnight Trans	2319 N Harvard	No	196
Yaffe Metals	7300 Charles Page Blvd	No	824

Facility	Address	Contains EHS	People within 1/4 mile
YRC Inc. (532)	14549 E Admiral Pl	No	300
Air Liquide--Tulsa	1319 N Peoria	No	90
Action Spring Co, Inc.	3003 E Apache	No	0
AIRCRAFT CYLINDERS OF AMERICA INC	1006 E Independence St	No	368
Airgas Mid South, Inc. - Tulsa Peoria Campus (Upda	31 North Peoria Avenue	No	169

District 2

Facility	Address	Contains EHS	People within 1/4 mile
BEST WELDERS SUPPLY INC.	1824 Southwest Blvd	Yes	528
Conley Corporation	2795 E 91st St	Yes	1,033
Coral Swimming Pool Supply	2315 E 69th St	Yes	707
Envirosolve	2120 SW Boulevard	Yes	599
HARCROS CHEMICALS INC - TULSA BRANCH	3810 South Elwood	Yes	46
Holly Refining and Marketing - Tulsa Refinery (Wes	1700 South Union	Yes	0
Metal Services Inc.	640 West 41st Street	Yes	0
Pepsi Bottling Group ~ Tulsa	510 West Skelly Drive	Yes	21
PSO--Oak 138kV Substation	5718 S 45th W Ave	Yes	83
PSO--Oral Roberts Substation	8300 South Delaware	Yes	668
PSO--Southern Hills Substation	6600 S Lewis Ave	Yes	1,438
PSO--Tulsa Power Station	3600 S Elwood	Yes	30
PSO--Tulsa Power Station Substation	325 E 36th	Yes	0
Cox Communications--Cox Office	11811 E 51st St	Yes	457
Cox Communications--West	6001 S 33rd W Ave	Yes	457
A Clean Environment, Inc.	2700 S 25th West Ave	Yes	41
AT&T - TU HICKORY CO - R66121	2512 W 41se Pl	Yes	471
AT&T - TU WOODCREST WEST REMOTE CO - R66747	6909 S Lewis Ave	Yes	786
BakerPetrolite- Tulsa, Ok	1818 West 21st Street	Yes	0
LIMCO AIREPAIR INTERNATIONAL	5304 S Lawton	Yes	97
City of Tulsa--Southside Wastewater Treatment Plan	5300 S Elwood Av	Yes	0
City of Tulsa--Cherry Creek Lift Station	4899 S Elwood Ave	No	106
City of Tulsa--Southside Dewatering Facility	236 E 71st	No	0
Frontier Plastic Fabricators	4518 E 56th Street South	No	60
Fuel Marketing Corporation Terminal	3202 W 21st Street	No	0
Holly Energy Partners - Tulsa Terminal	1307 W 35th Street	No	37
MID-CONTINENT CONCRETE COMPANY	431 w 23rd St	No	0

Facility	Address	Contains EHS	People within 1/4 mile
MIDWESTERN MANUFACTURING COMPANY - 2119	2119 S Union Ave	No	0
MIDWESTERN MANUFACTURING COMPANY - 3601	3601 W 48th Street	No	363
North American Galvanizing Company- Tulsa Plant 1	1800 West 21st Street	No	0
ONG West Tulsa Service Center	7002 S Union Avenue	No	0
R. L. Jones Jr. Airport (RVS)	2605 S Elwood Avenue	No	0
Rainbow Concrete--Tulsa South Elmwood	4001 South Elmwood Ave	No	17
Riverside Chevrolet - Sonic Automotive Inc.	707 W 51st Street	No	113
Rust-Oleum Corporation	1326 W 37th Place	No	239
Sherwin-Williams #4332	3699 S 73rd Street	No	91
Warren Equipment Company	3641 S Tacoma Ave	No	65
Praxair Services Inc.	1335 E 37th Pl	No	239
Tulsa Tube Bending Company	4192 S Galveston Ave	No	84
AAA Cooper Transportation-TUL	4310 South Jackson Ave	No	126
Aaon, Inc	2425 S Yukon Ave	No	0
ABC Coating	2236 South Yukon	No	0
Ameron Pole Products Division	2333 S Yukon St	No	0
B&M Oil Company--TULSA	5731 S 49th West Avenue	No	21

District 3

Facility	Address	Contains EHS	People within 1/4 mile
Airgas Mid South, Inc- Tulsa 181 TSGP	1011 North Lewis Avenue	Yes	491
Airgas Mid South, Inc. - 56th Street (Updated 6-09	9741 E 65th Street North	Yes	0
Aluminum Hardcoat Co.	6002 E Tecumseh	Yes	657
AMERICAN AIRLINES COMPOSITE CENTER	11711 East Pine	Yes	0
AMERICAN AIRLINES TULSA M&E CENTER	3800 N Mingo Rd	Yes	0
Ameristar Fence Products	1555 N Mingo Rd	Yes	44
APAC-Central Inc. - Tulsa Maintenance Facility	12810 East 36th Street North	Yes	0
AT&T - OK3000	NE CORNE OF 171ST & YALE AVE	Yes	520
AT&T - OK4041	4021 N Mingo Rd	Yes	0
AT&T - TU 1504 N 105 E AVE WHSE-LEASE - RQ4165	1504 N 105th E Ave	Yes	0
AT&T - TU TEMPLE CO - R66159	6605 E Admiral Pl	Yes	346

Facility	Address	Contains EHS	People within 1/4 mile
City of Tulsa--Northside Wastewater Treatment Plan	5628 N 105th E Ave	Yes	0
Cox Communications--Harvard	1442 N Harvard Ave	Yes	198
Estes Incorporated (007)--Tulsa	11391 E Tecumseh	Yes	0
Hewlett-Packard Company - MGG03	4000 Mingo Rd	Yes	0
INTERSTATE TOOL MANUFACTURING COMPANY	1044 N Columbia Pl	Yes	633
John Zink Company - Apache Facility	11920 E Apache	Yes	0
NORDAM Repair Division	11200 E Pine	Yes	0
Oklahoma Air National Guard- Tulsa AGS	9100 E 46th St N	Yes	0
Precise Machining & Manufacturing L.L.C.	12716 E Pine St	Yes	0
PSO--American Airline Substation	N of AA Maintenance Bldg	Yes	0
PSO--Dawson Substation	Mingo and 0.5 miles N of traffic circle	Yes	104
PSO--Yale & Archer Substation	4910 E Archer	Yes	393
QUALITY PLATING CO OF TULSA	2665 N Darlington	Yes	54
RSC Equipment Rental #660	2807 N Garnett Rd	Yes	0
The Bama Companies, Inc. - Warehouse 2	5307 E Pine St	Yes	414
The Crosby Group - McKissick Plant	PO Box 3128, 2857 Dawson Rd	Yes	519
UNITED PLATING	4118 N Mingo Rd	Yes	0
United Stationers Supply Company	1870 N 109 E Ave	Yes	0
US Cellular--Owasso MTSO	3131 N Garnett	Yes	0
ACCURATE MANUFACTURING, INC	2765 DAWSON ROAD	No	300
Acme Brick Company - Tulsa Plant	4103 Dawson Road	No	496
Alpha Investment Casting Corporation	2441 E Independence	No	611
AMERICAN AIRLINES TULSA APU & ACCESSORY	6650 East Apache	No	22
AMERICAN AIRLINES WHEEL & BRAKE CENTER	525 North Memorial Drive	No	269
Anixter Fasteners	1102 North Garnett Road, Suite 105-108	No	0
APAC-Central Inc. - East Quarry (Limestone Surface	3605 N 129th East Avenue	No	0
APAC-Central Inc. - Tulsa Drum Asphalt Plant	13215 East 36th Street North	No	0
APAC-Central Inc. - Tulsa Gencor Asphalt Plant	14115 East 36th Street North	No	0
Atlantic Southeast Airlines - TUL	7777 East Apache	No	0
AUSTIN POWDER CENTRAL STATES LLC - TULSA	3122 N Mingo Valley Expressway	No	0
Auto-Chlor Services L.L.C.	14422 East Marshall Street	No	29
Avis Rent A Car System, LLC	2136 N 73rd East Ave	No	0

Facility	Address	Contains EHS	People within 1/4 mile
Avis Rent A Car System, LLC - Tulsa International	7727 East Young Place	No	0
Bizjet International	3515 N Sheridan	No	0
Bluelinx--Tulsa Distribution Center	5717 N Mingo Rd	No	0
Borg Compressed Steel Corporation	1032 N Lewis Ave	No	297
Budget Rent A Car System, Inc. - Tulsa Internation	7727 E Young Pl	No	0
Central Tube and Bar	5110 N Mingo Rd	No	0
City of Tulsa--Apache Lift Station	10302 E Apache	No	0
City of Tulsa--Coal Creek Flow Equalization Basin	3131 N Erie	No	22
City of Tulsa--Mingo Flow Equalization Basin	10468 E Pine St	No	47
Crane Carrier Company	1925 N Sheridan	No	341
CRC EVANS PIPELINE INTERNATIONAL	10700 E Independence	No	14
ENERGY EXCHANGER	1844 N Garnett Rd	No	0
FAA Facility - Tulsa ATCT	3232 N Memorial Dr	No	0
FedEx Express-TULR	2121 N 85th E Ave	No	0
FedEx Ground - Tulsa	12615 E Apache St N	No	0
Geophysical Research Corporation	6540 E Apache St	No	94
H&L Tooth Company	10055 E 56th St	No	0
Hertz Rent-a-Car--Tulsa East Young	7727 E Young Pl #200	No	0
Hertz Rent-a-Car--Tulsa N. 73rd	2110 N 73rd E Ave	No	0
Hoffman Fixtures Company	1826 N 106th E Ave	No	0
LAMPTON WELDING SUPPLY CO INC - TULSA	5550 E Admiral Pl	No	358
McJunkin Red Man Measurement	14035 E Marshall	No	0
McJunkin Red Man Measurement- East Facility	14242 E Marshall	No	2
MID-CONTINENT CONCRETE COMPANY	9501 Mohawk Blvd	No	0
Orica U.S.A.	12502 E 36th St N	No	0
Pinnacle Airlines - TUL Airport	7777 E Apache St	No	0
Pryer Machine and Tool Inc.	2230 N Sheridan Rd	No	223
Quiktrip Hangar	7121 E Young Pl	No	0
Ramsey Winch Company	1600 N Garnett Rd	No	0
SBS INDUSTRIES, INC.	1843 N 106th E Ave	No	0
Sunstate Equipment Co. - Tulsa	1615 N 105th E Ave	No	0
Synergy - 3602 N. Mingo Valley Expressway	3602 N Mingo Valley Expressway	No	0
Synergy - 11920 E. Apache	11920 E Apache	No	0
Tulco Oils--Tulsa	5240 E Pine St	No	213
Tulsa Aircraft Engines	9311 E 44th St N	No	0
Tulsa Asphalt - Becco Plant #2	13737 E 46th St N	No	0

Facility	Address	Contains EHS	People within 1/4 mile
Tulsa International Airport - American Parking	7777 E Apache St	No	0
Tulsa International Airport - Maintenance Facility	7777 E Apache St	No	0
Tulsa International Airport - QTA Tank Farm	7331 E Apache	No	0
Tulsa International Airport Fuel Facility	3002 N 77th St	No	0
UPS--Tulsa Air Cargo Road	2100 Air Cargo Rd	No	0
Valmont/Newmark - Tulsa	801 N Xanthus	No	547
Walden's Machine Inc.	3030 N Erie	No	3
Warren Equipment Company	3601 N Garnett Rd	No	0
Waste Management--Quarry RDF	4041 N 141st E Ave	No	0
WELSCO INC	1825 N 106th E Ave	No	0
World Publishing Co.	315 S Boulder	No	111

District 4

Facility	Address	Contains EHS	People within 1/4 mile
Bama Pie	2745 E 11th St	Yes	1,024
Chromium Plating Company	412 N Cheyenne	Yes	2,177
Fabriclean of Tulsa	808 S Yorktown	Yes	659
FC ZIEGLER	415 E 12th St	Yes	246
Level 3 Communications - Tulsa TULSAOK6W	16719 E Admiral Pl	Yes	45
MCI - TUCCOK TUCLOK TUCMOK	100 W 5th St, 7th Floor, Level B, Level C	Yes	111
PSO--Carson OK Substation	11th & Carson	Yes	316
PSO--Denver Substation	1st & Denver	Yes	241
PSO--Kenosha Substation	802 E 4th St	Yes	121
PSO--Zunis Substation	1125 S Lewis St	Yes	822
Qwest Tulsa POP	419 E 1st St	Yes	42
Southwest United Industries	422 S St Louis Ave	Yes	217
Trigen-Tulsa Energy Corporation	202 S Frisco	Yes	246
University of Tulsa-Physical Plant	3015 E 8th St	Yes	1,632
US Cellular--Tulsa MTSO	1210 S Detriot Ave	Yes	214
Windstream NuVox Tulsa Central Office	1437 S Boulder Suite 130	Yes	687
American Cold Storage	505 West 2nd	Yes	246
AT&T - OK2970	UNKNOWN	Yes	866
AT&T - TU NATIONAL PRONTO HUT DSA 2041 - R66669	12738 W 40th	Yes	759
AT&T - TU TOLL SWBT COMMON - R67102	510 S Detroit / 510 S Elgin	Yes	210
AT&T Mobility--TULSA BSC 01	424 S Detroit	Yes	205

Facility	Address	Contains EHS	People within 1/4 mile
DELTA T LIMITED	1507 E 7th St	No	559
Magellan Pipeline Company - Tulsa Tower	One Williams Center MD 27-3	No	49
NORDAM Prism Division	530 S Kenosha	No	167
Oklahoma State University Medical Center	744 W 9th	No	957
ONEOK Parking Garage	112 W 6th St	No	157
ONEOK Plaza	100 W 5th St	No	152
St. John Medical Center	1923 S Utica Ave	No	278
SUPERIOR LINEN SERVICE	534 S Rockford St	No	394
Tulsa Welding School	2545 E 11sth St	No	1,257
VICTOR WELDING SUPPLY	123 S Peoria	No	171
World Publishing Company	3503 N Sheridan Rd	No	0
Hillcrest Medical Center	1120 S Utica	No	707
AT&T - R51199	424 S Detroit Ave	No	205

District 5

Facility	Address	Contains EHS	People within 1/4 mile
Bodycote Thermal Processing	4208 S 74th E Ave	Yes	0
Canfield and Joseph	6536 E 42nd St	Yes	2
Continental Industries	4102 S 74th E Ave	Yes	0
Harrison Manufacturing	6130 E 13th St	Yes	3
PSO--15th & Fulton Substation	5524 E 15th St	Yes	328
PSO--21st & 89 East Ave. Substation	9001 E 21st St	Yes	322
PSO--South Hudson Substation	5701 E 50th St	Yes	960
PSO--Tulsa Southeast Substation	3415 S Sheridan	Yes	181
Sam's Club #8263	4420 S Sheridan Rd	Yes	33
SOUTHERN MATERIAL HANDLING COMPANY	8188 E 44th St	Yes	0
Cox Communications--Tulsa MTC	6804 E 44th St	Yes	2
INTERSTATE BRANDS--WONDER BREAD	1111 S Sheridan	Yes	387
AT&T - TU NATIONAL CO - R66133	8321 E 41st	Yes	0
AT&T - TU NATIONAL RS - R66124	1545 S 101st E Ave	Yes	1,420
AT&T - TULSOKRA	5310 E 31st St	Yes	721
AT&T Mobility--79TH ST MTSO	3802 S 79th E Ave	Yes	0
AVITROL CORPORATION	7644 East 46th Street	Yes	616
NuCO2 Supply LLC Tulsa Depot	7336 E 38th St	No	0
ONG Tulsa Garage/15th Street Center	5848 E 15th St	No	39
Oral Health Products	6847 E 40th St	No	0
PSO--Distribution Dispatch Center	3600 S Sheridan Rd	No	927

Facility	Address	Contains EHS	People within 1/4 mile
PSO--Mid-Metro	5524 E 15th	No	600
Quikrete of Tulsa	6204 E 11th St	No	277
Saia Inc	7398 E 38th St	No	0
Saint Francis Health System Interchange Plaza	3218 S 79th E Ave	No	264
Sherwin-Williams #9743	7671 E 46th Pl	No	534
Sherwin-Williams Chemical Coatings #1406	3719 S 73rd E Ave	No	0
Roto-Rooter	8125 E Skelly Dr	No	587
Anchor Paint Mfg. Co., Inc.	6707 E 14th Street	No	178
Baker Hughes Centrlift	7655 East 46th Street	No	288

District 6

Facility	Address	Contains EHS	People within 1/4 mile
Cintas Corporation #63	5940 S. 129th E. Ave.	Yes	0
City of Tulsa--AB JEWELL WATER TREATMENT PLANT	18707 E 21 St	Yes	0
HSBC Card Services Inc.	4848 S 129th E Ave	Yes	51
Level (3) Communications LLC - Tulsa	16901 E Admiral Pl	Yes	45
Level 3 Communicaitons - Tulsa TULSAOKA2	16719 E Admioral Pl	Yes	45
MCI - TUCROK	4500 S 129th E Ave, Suite 185	Yes	341
PSO--East 41st Street Substation	16815 E 41st St	Yes	0
PSO--Ford Glass Plant Substation	5719 S 129th E Ave	Yes	0
PSO--Lynn Lane Substation	18819 E 21st St	Yes	0
PSO--Mayo Road Substation	3606 S 129th E Ave	Yes	1651
Windstream Broken Arrow North Central Office	201 E Omaha	Yes	207
Cox Communications--Garnett Hub	2115 S 120th E Ave	Yes	1057
American Cold Storage@ Crossroads	420 s 145th E Ave	Yes	0
AT&T - TU GENERAL ADAMS CO - R66118	14506 E Admiral	Yes	0
AT&T - TU NATIONAL RS - R66079	3424 S Garnett	Yes	1697
AT&T Mobility--AWE - 41ST AND 129TH--BELOW THRESHO	13128 East 41st Street	Yes	2121
AT&T Mobility--Tulsa Call Center - OK0005	15901 E Skelly Drive	Yes	0
Rainbow Concrete--Tulsa East 11th	13521 E 11th St	No	77
Reddy Pipe & Supply Inc	17801 E 11th St	No	22

District 7

Facility	Address	Contains EHS	People within 1/4 mile
Gardner Denver Inc (Well Service Pumps)	4747 S 83rd E Ave	Yes	313
PSO--81st & Garnett Substation	81st & Garnett	Yes	100
PSO--Mingo Substation	9875 E 73rd St	Yes	812
PSO--Owasso 88th & Mingo Substation	6791 N 97th E Ave	Yes	0
Sam's Club #6342	6922 S Mingo Rd	Yes	112
State Farm Insurance - Tulsa Operations Center	12222 State Farm Blvd	Yes	0
State Service Systems (Division of Loreal/SalonCen	10405-B E 55th pl	Yes	0
The Original Chili Bowl	9016 E 46th St	Yes	218
US Cellular--Tulsa Call Center	4700 S Garnett, Suite 100	Yes	0
Verizon Wireless--TULSA MSC	12223 State Farm Blvd	Yes	0
Verizon Wireless--TULSA_STAGING_FACILITY	2013 N Willow Rd	Yes	0
Windstream Broken Arrow Cedar Ridge Remote	11105 S 101 St E	Yes	294
Windstream Broken Arrow Metro Park Remote	2105 N Willow	Yes	0
Windstream Broken Arrow West Central Office	7200 S Mingo Rd	Yes	1309
Southcrest Hospital	8801 S 101 E Ave	Yes	0
CarMax 7191 Tulsa	9131 S Memorial Dr	No	700
Cohesant Materials	13105 E 61se St S, Suite A	No	0
Emoteq Corporation	10002 E 43rd St S	No	699
Hilti Inc	5400 S 122nd E Ave	No	0
Oil States Barlow-Hunt	10322 E 58th St	No	7
PAS Technologies Inc.	10325 E 58th St	No	7
PSO--Alsuma Service Center	5300 S Garnett	No	0
Saint Francis South Hospital	10505 E 91se St	No	0
Sonoco Products	10008 E 52nd St	No	0
T. D. Williamson - Tulsa Urethane Facility	10727 E 55th Pl	No	0
TruGreen Lawncare	2200 N Willow Ave	No	0
TULSA RUBBER COMPANY	5202 S Garnett	No	0
UPS--Tulsa East Avenue	5805 S 118th E Ave	No	0
TruGreen Landcare	10203 E 51st	No	0
Air Power Systems	8178 E 44th Street	No	162
Air Products & Chemicals, Inc.	6001 South 129th East Avenue	No	0

District 8

Facility	Address	Contains EHS	People within 1/4 mile
PSO--Bixby 111th Street Substation	111th St S between Memorial & Sheridan	Yes	185
PSO--Warren Medical Center Substation	6675 S Yale	Yes	257
RSC Equipment Rental #338	10601 S Memorial Dr	Yes	190
Cox Communications--Braden Hub	9122 S Braden Ave	Yes	526
AT&T - TU WOODCREST CO - R66165	5303 E 71st St	Yes	923
City of Tulsa--Southeast Basin Lift Station	12600 S Sheridan	No	2
Road Science L.L.C.	6502 S Yale Ave	No	0
Anchor Delaware Sand Plant	11472 South Delaware	No	88

District 9

Facility	Address	Contains EHS	People within 1/4 mile
PSO--36th & Lewis Substation	3545 S Lewis Ave	Yes	433
PSO--52nd & Delaware Substation	5201 S Delaware Pl	Yes	534
PSO--Tulsa Sunray Refinery Substation	1831 S 33rd W Ave	Yes	854
Saint Francis Hospital	6161 S Yale Ave	Yes	150
'University of Oklahoma, Tulsa'	4502 W 41st St	Yes	563
US Cellular--36th and Lewis	3603 A South Lewis	Yes	433
Cox Communications--Indianapolis	3605 S Indianapolis Ave	Yes	1039
AT&T - TU RIVERSIDE CO - R66144	3601 S Lewis Ave	Yes	433
Laureate Psychiatric Clinic and Hospital	6655 S Yale Ave	No	92

Appendix F: Repetitive Loss Area Plan

The Repetitive Loss Area Plan is currently in the process of being updated to comply with the new Community Rating System (CRS) requirements.

Appendix F will be completed by September, 2014 and, when approved by ISO, will be submitted as an amendment to the City of Tulsa 2014 Multi-Hazard Mitigation Plan Update.