

Special Topics

Tulsa County Disaster Resiliency Assessment

The purpose of this section is to assess at the county level key components of disaster resiliency. Housing location and quality as well as planning activities can help reduce impacts from disaster events and allow for faster recovery. Disasters can include tornadoes, extreme weather, high winds, as well as man-made events. These events may largely be inevitable, but the ability to reduce damage and casualties as well recovery can be improved with good planning.

C.0 Comprehensive Plans & Hazard Mitigation Plans

There are 5 key cities within the county: Tulsa, Broken Arrow, Bixby, Jenks, and Owasso.

Comprehensive plans are the guiding documents for cities of various sizes to address key aspects of their community from land use, transportation, environment, housing, and economic development. Of the 5 key cities, all have comprehensive plans that have been adopted. Of these plans the following text highlights language in these plans that addresses land use decisions that reduce placing housing and businesses within historical areas of risk (e.g. flooding) and other supporting actions to increase disaster resiliency.

City of Tulsa Comprehensive Plan: The plan included language that focuses on transportation improvements within the city and how they have to potential to aid in reducing emergency response times. However, these improvements appeared to addressing daily emergency response issues rather than disaster-related emergencies.

The plan also contains language the supports green infrastructure to aid with stormwater runoff and mitigates flash flooding

City of Bixby Comprehensive Plan: Language in plan identifies the safest routes though the city for the transport of hazardous wastes or chemical. This is done to mitigate the risk of disaster events related to the transportation on these materials. The plans also discuss the necessity for the notification of these transports prior to the planned transport of these materials.

Bixby's drainage and storm water management system keeps new development out of flood-risk areas and reduces flood-risk in present flood prone areas. Bixby's sewer and water system connects to all existing structures and all areas of potential development in the city. The city also restricts certain types of development in flood plains.

City of Broken Arrow: The Downtown Master Plan for Broken Arrow (adopted in 2005) was acquired. However there is very little language in plan that address disaster resiliency. There was little mentioning of development in floodplains and no mentioning of disaster mitigation or emergency management issues.

City of Jenks: The Comprehensive Plan language discourages structural development in floodways. The plan highlights the areas of the city most vulnerable to flood hazards.

Based on the review of the existing and available comprehensive plans for the area, it is recommended that any future comprehensive planning work done include coordination and goals to address disaster

resiliency. City policies allow no residential construction in floodplains, except as approved by Federal Emergency Management Agency guidelines. The city concluded a new flood study of the area to update floodway maps. According to the plan this was expected to be accepted by FEMA and released in 2008.

The City of Jenks has a Hazard Mitigation Plan that was adopted in 2004 (it isn't clear whether that has been updated). The city utilized the hazard mitigation plan in accordance with the comprehensive plan as a planning tool for the mitigation of hazardous material incidents and natural hazards within the community.

City of Owasso- The Comprehensive Plan has very little language in plan that address disaster resiliency. There was little mentioning of development in floodplains and no mentioning of disaster mitigation or emergency management issues.

The other key plan for a city to manage, mitigate and plan for recovery related to disasters is a **Hazard Mitigation Plan** (or Emergency Management Plan). Often low density counties, the Hazard Mitigation Plan is done at the county level, though some cities may augment the county plan with a city plan.

Tulsa County does have a Hazard Mitigation Plan (including the proposed 2015 updates). Numerous municipalities within Tulsa County also have their own HMPs. This includes: The City of Tulsa, the City of Bixby, the City of Broken Arrow, and the City of Owasso.

C.2.1.1. Historical Data on Natural Disasters and Other Hazards

Data on historical damages and casualties is typically collected as part of a **Hazard Mitigation Plan** preparation to determine the appropriate planning measures and actions to take before and after an event.

Tulsa County

The proposed 2015 Tulsa County Hazard Mitigation Plan identifies the 13 hazards facing the Tulsa County. This includes:

1. Floods
2. Tornados
3. High Winds
4. Lighting
5. Hailstorms
6. Sever Winter Storms
7. Extreme Heat
8. Drought
9. Expansive Soils
10. Wildfires
11. Earthquakes
12. Hazardous Materials Events
13. Dam breaks

Table 1 (Also referred to as Appendix 6)

Natural Hazard Assessments		
Each hazard is assigned a likelihood rating based on the criteria and methods described below.		
Likelihood of Event "Rating" is based on the following definitions		
Highly likely (HL)	Event is probable within the calendar year.	
Likely (L)	Event is probable within the next three years.	
Occasional (O)	Event is probable within the next five years.	
Unlikely (UL)	Event is possible within the next ten years.	
Based on History, and using the information described above, Likelihood of Event is "Quantified" as follows:		
Highly Likely (HL)	Event has 1 in 1 year chance of occurring	1/1 = 100%
Likely (L)	Event has 1 in 3 years chance of occurring	1/3 = 33%
Occasional (O)	Event has 1 in 5 years chance of occurring	1/5 = 20%
Unlikely (UL)	Event has 1 in 10 years chance of occurring	1/10 = 10%
Which results in the following "Ranges" of Likelihood:		
Event is "Highly Likely" to occur – History of events is greater than 33%.		
Event is "Likely" to occur – History of events is greater than 20%, but less than or equal to 33%.		
Event could "Occasionally" occur – History of events is greater than 10%, but less than or equal to 20%.		
Event is "Unlikely," but is possible of occurring – History of events is less than 10%.		
<p>Example: NWS-NCDC records show that 38 tornados were reported in Example County between 01/01/1950 and 12/31/2003. 38 events divided by 53 years = 0.72(72%) which would make future occurrences "Highly Likely" to happen.</p> <p>This table's format, categories, and the criteria for completing the table, was supplied by the Oklahoma Department of Emergency Management, 06/29/2004.</p>		

Table 2 (Also referred to as Appendix 6)

Hazard Summary Tulsa County Summary of Hazards for the Tulsa County Multi-Hazard Mitigation Plan Source: NOAA national climatic data center, except wildfires and hazmat events which came from Tulsa Area Emergency Management Agency					
Hazard Event	History	Estimated Total Dollar Loss (\$\$)	Average Cost Per Event (\$\$)	Likelihood Percentage	Likelihood Rating
Floods	Two County events, 2010 thru 2014	0	0	2/5=40%	HL
Tornado	Three County events, 2010 thru 2014	950000	316666	3/5=60%	HL
High Wind	Two County events, 2010 thru 2014	10000	5000	2/5=40%	HL
Lightning	Six County events, 2010 thru 2014	750000	125000	6/5>100%	HL
Hail	40 County events, 2010 thru 2014	460000	11500	40/5>100%	HL
Winter Storms	Eight County events, 2010 thru 2014	0	0	8/5>100%	HL
Extreme Heat	One County event, 2010 thru 2014	0	0	1/5=20%	O
Drought	16 County events, 2010 thru 2014	0	0	16/5>100%	HL
Expansive Soils (1)	Zero County events, 2010 thru 2014	0	0	0/5=0%	UL
Wildfire (2)	165 events, 2010 thru 2014	0	0	165/5>100%	HL
Earthquake	Zero County events, 2010 thru 2014	0	0	0/5=0%	UL
Hazmat Events (2)	80 events, 2010 thru 2014	0	0	80/5>100%	HL
Dam Break	Zero County events, 2010 thru 2014	0	0	0/5=0%	UL
Note: where zero events or zero dollar amounts are shown, this means there was no data reported for the hazard event.					

The proposed 2015 Tulsa County Hazard Mitigation Plan outlines each hazard (see below) with its historical context in Tulsa County. The HMP also outlines the goals and objectives for each hazard.

The overall general goal of the HMP is to protect vulnerable populations and critical facilities from hazards.

Objectives:

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

Flood

Historical Context: “Historically, Tulsa County, has recognized flooding as a hazard. The County joined the National Flood Insurance Program (NFIP) in 1981, adopting a Flood Damage Prevention Resolution, and requiring that all future development be built one foot above the 100-year base flood elevation. According to the National Climatic Data Center, from 2010 through 2014, the Tulsa County has had two flood events from 2010 through 2014.”

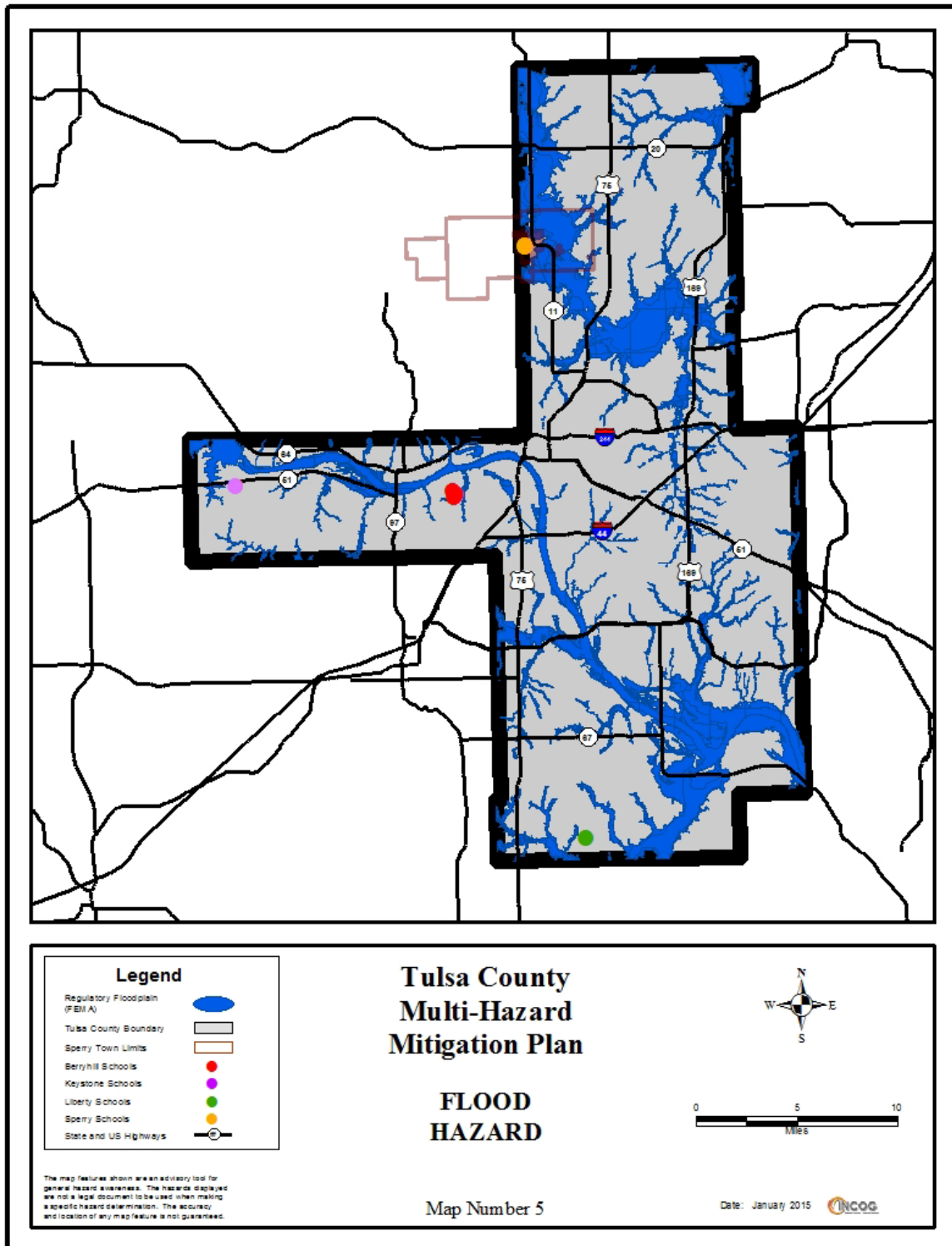
“The County floodplain administrator reports they are 29 repetitive loss structures in unincorporated Tulsa County that are insured through the National Flood Insurance Program; 27 are single family residential structures and two are commercial. Damaged structures are rebuilt in conformance with the County’s flood damage prevention ordinance.” (Proposed 2015 Tulsa County Hazard Mitigation Plan)

Table 3 UNINCORPORATED TULSA COUNTY: TOTAL BUILDINGS IN FLOODPLAIN

	Number of Buildings	Building Value (\$\$)	Contents Value (\$\$)	Total Value (\$\$)
Residential	1425	121,000,390	566,805	1,700,415
Commercial	70	35,523,965	35,523,965	71,047,930
Agricultural	90	1,133,610	121,000,390	242,000,780
TOTAL	1585	157,657,965	157,091,160	314,749,125

“There are no critical facilities in the regulatory floodplain. Any future building in a flood hazard will be built in conformance with the County Flood Damage Prevention Ordinance as part of the County’s membership in the NFIP; therefore, future buildings will not be considered by FEMA as at risk from the regulatory floodplain.” (Proposed 2015 Tulsa County Hazard Mitigation Plan)

Figure 1



Hazard Mitigation Plan Hazard-Specific Goal and Objectives:

Goal - Flood Hazard: To reduce the risk of flood hazard in the County

Objectives:

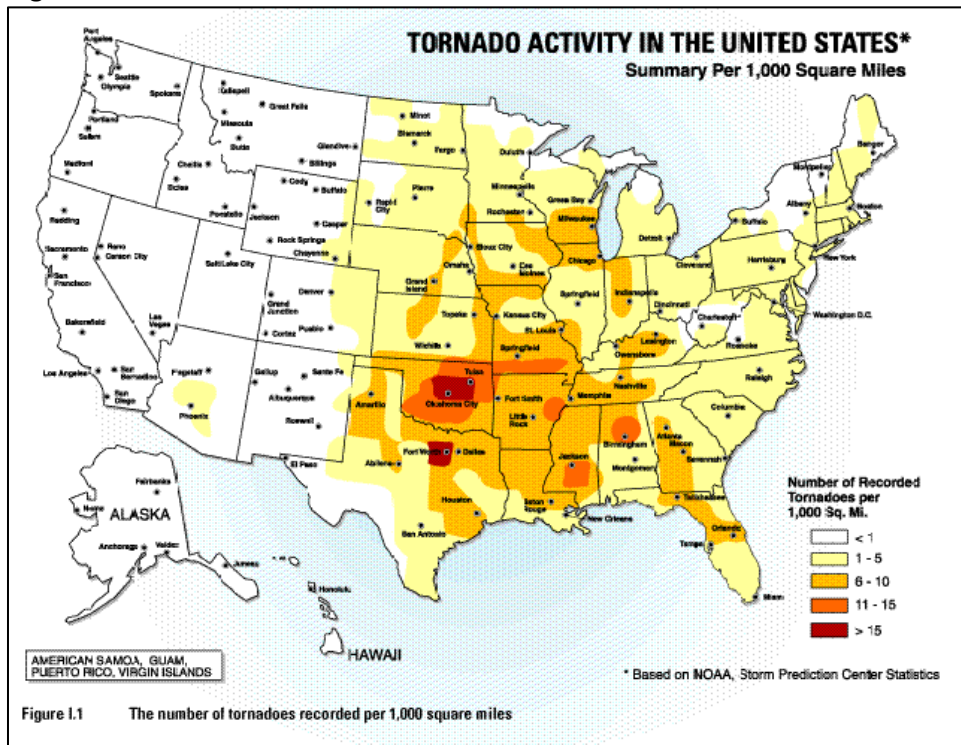
1. Identify buildings at risk from the 100-year regulatory flood.
2. Ensure that development does not increase flooding downstream or have off-site adverse impacts.
3. Identify and maximize the natural and beneficial uses of the floodplain.
4. Implement the best flood control measures to reduce vulnerability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

Tornado

Historical Context: “From 2010 through 2014, there were three tornadoes in Tulsa County. Meteorological conditions have not changed, so future tornado events should occur at the same probability as previous events. No area of the County is any more or less at risk from the tornado hazard. According to the likelihood rating from Appendix 6 (the definition of the likelihood scale is shown in Appendix 6), the likelihood of a tornado hazard in the County is “highly likely”. (Proposed 2015 Tulsa County Hazard Mitigation Plan)

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

Figure 2



Utilizing warning systems, County residents can take appropriate precautions prior to and during these events. As a result, casualty rates are low. The popularity of mobile/manufactured housing has increased susceptibility of existing structures to tornados. The use of better building techniques, tie-down systems and the availability of storm shelters all help mitigate losses in the County.

Hazard Mitigation Plan Hazard-Specific Goal and Objectives:

Goal - Tornado Hazard: To reduce the risk from tornados in the County.

Objectives:

1. Encourage building of individual safe rooms and storm shelters.

For all the county profiles for this study we are providing maps of the historic tornados mapped over the developed social vulnerability index. This is in addition to the data prepared and summarized from the HMP in this section.

NOAA data shows the following historic data on disaster events for the county:

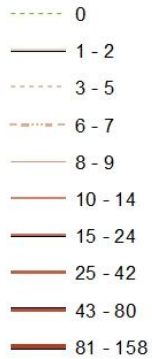
Historic data on tornados between 1950-2014 there are 67 tornados documented. There were 382 injuries that occurred connected to these tornados, with 7 of those injuries happening in the 2006 tornado and 130 occurring in the 1993 tornado. There were 15 fatalities connected to tornadoes during this time period, 7 of which occurred in 1993. Property losses between 1950-1996 ranged from \$83,538,553.00 to \$835,385,650.00. (The accounting methods used for losses changed in 1996.) The losses estimated between 1996-2014 was \$13,270,000.00.

Social Vulnerability - Impacts on Housing & Disaster Resiliency

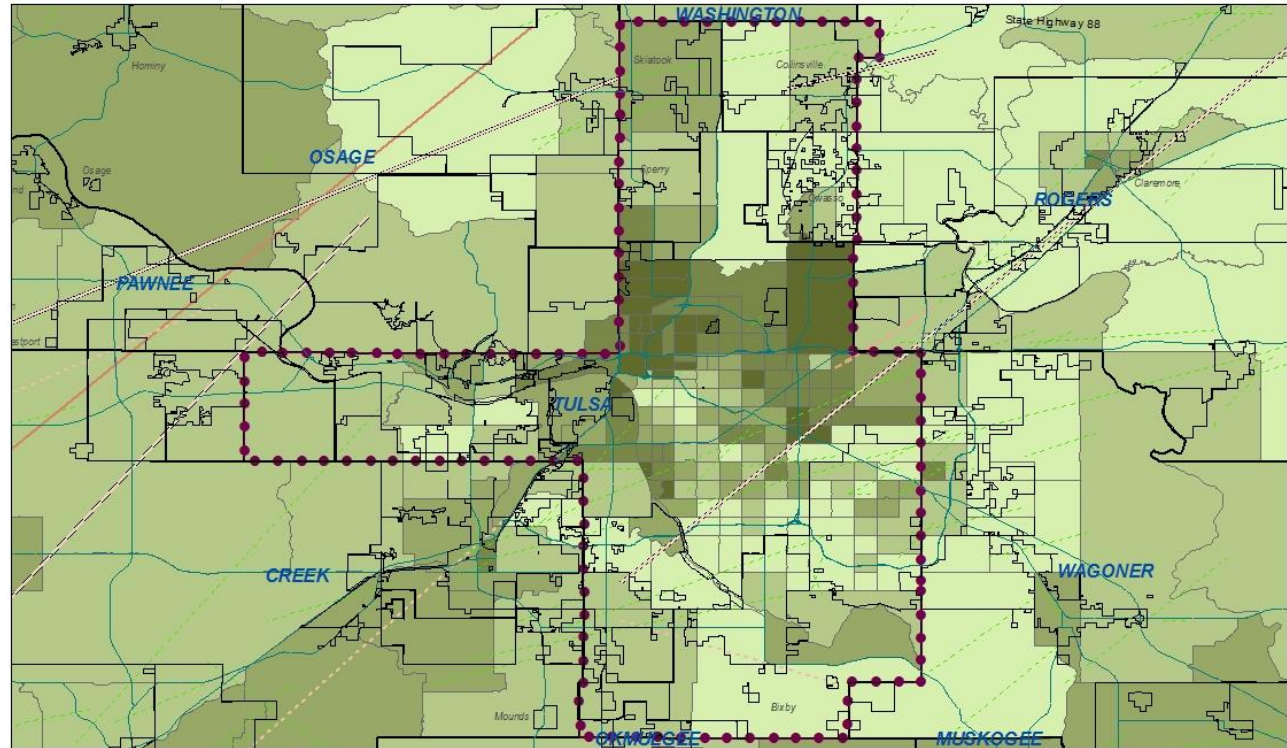
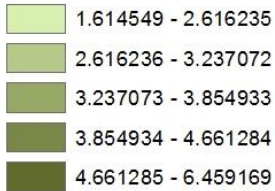
Tornado Events 1950 - 2014

Tulsa County

of fatalities associated with event



Social Vulnerability Index



19XX or 20XX Year of Event

Selected County Boundary

Oklahoma Municipal Boundaries

COUNTY NAME



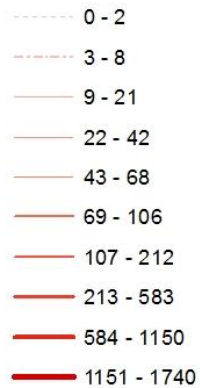
0 3.5 7 14 Miles

Sources: Shannon Van Zandt, Texas A&M, Hazard Planning materials, and 2009-2013 American Community Survey, Tables B11003, B01001, B17001, B08301, B25044, B25001, B25042, B02001, B03002, B26001, B25036, B17001, B25043, S1501, B23025 & B06007

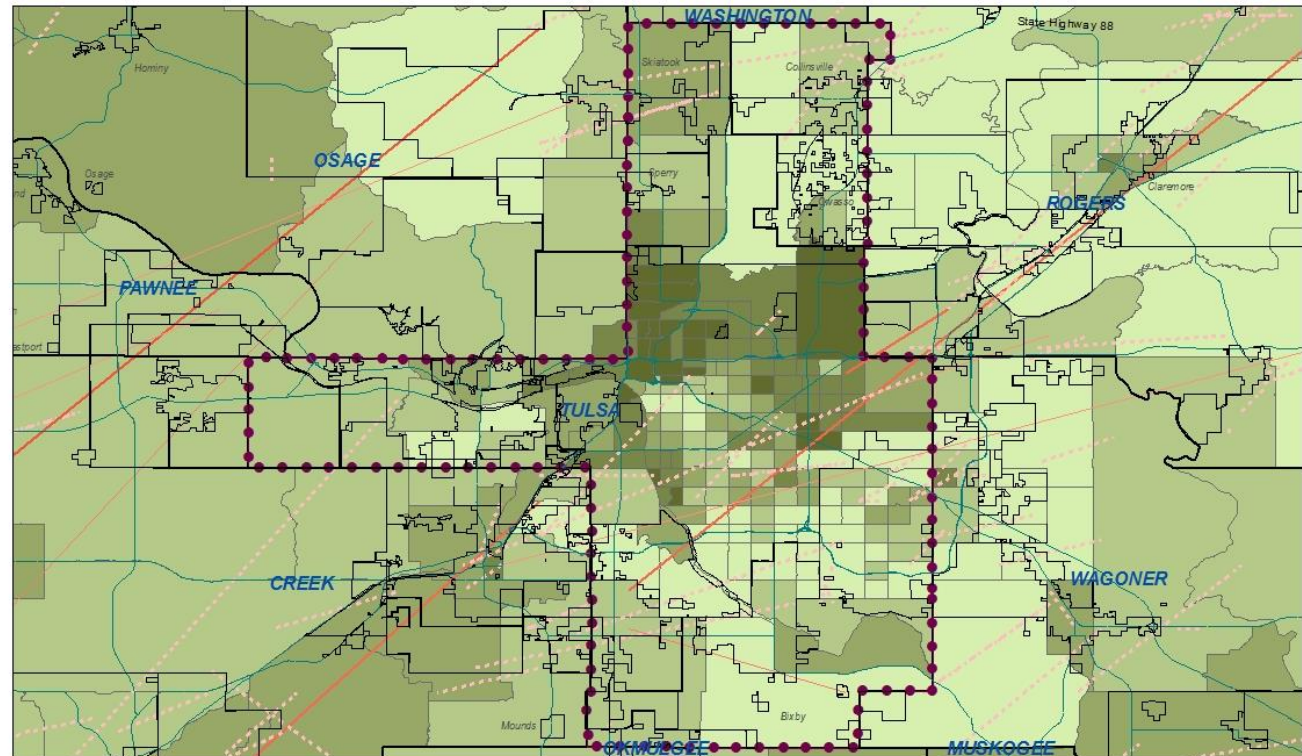
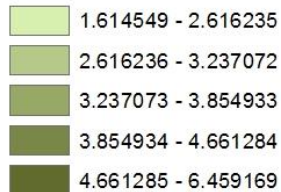
Social Vulnerability - Impacts on Housing & Disaster Resiliency

Tornado Events 1950 - 2014 Tulsa County

of injuries associated with event



Social Vulnerability Index



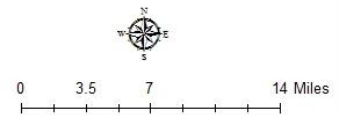
19XX or 20XX Year of Event

Oklahoma Municipal Boundaries

Selected County Boundary

COUNTY NAME

Sources: Shannon Van Zandt, Texas A&M, Hazard Planning materials, and 2009-2013 American Community Survey, Tables B11003, B01001, B17001, B08301, B25044, B25001, B25042, B02001, B03002, B26001, B25036, B17001, B25043, S1501, B23025 & B06007



Social Vulnerability - Impacts on Housing & Disaster Resiliency

Tornado Events 1950 - 2014 Tulsa County

Tornado prior to 1996

\$ losses associated with event

- >\$50
- \$50-\$500
- \$500-\$5,000
- \$5,000-\$50,000
- \$50,000-\$500,000
- \$500,000-\$5,000,000
- \$5,000,000-\$50,000,000
- \$50,000,000

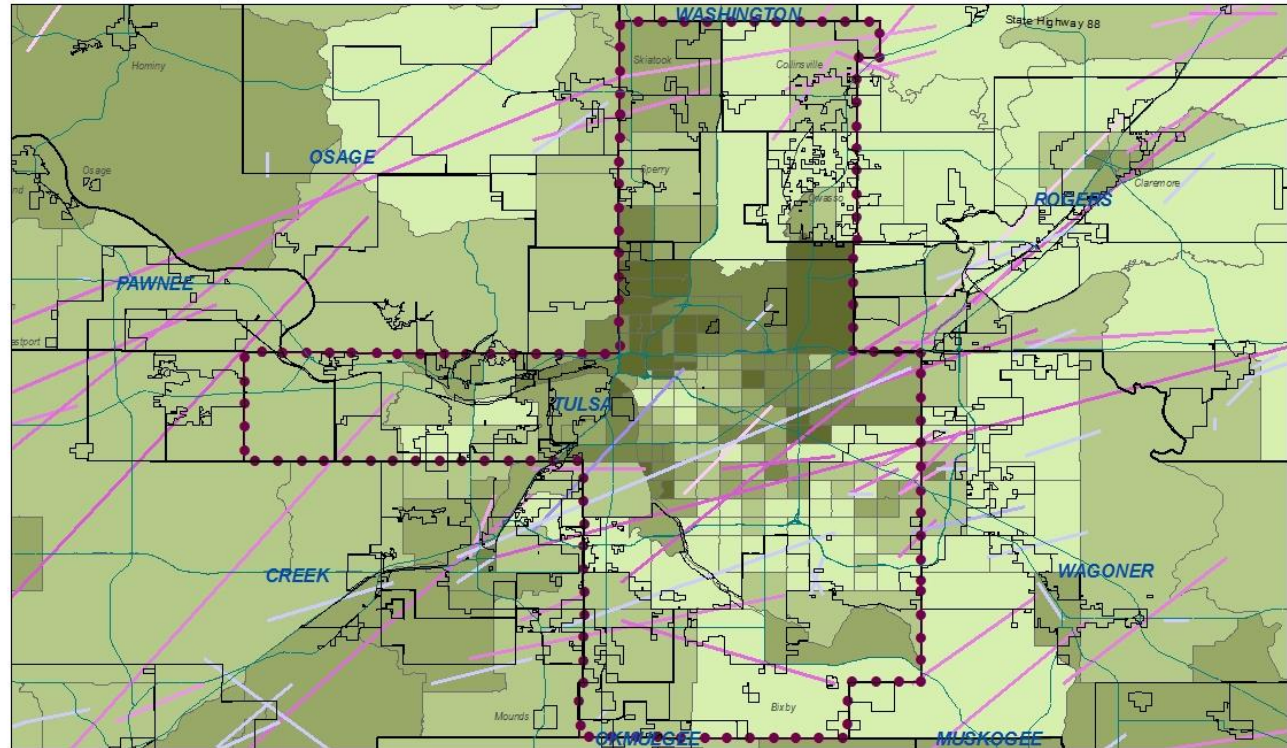
Tornadoes after 1996

\$ in millions in losses associated with event (accounting categories changed in 1996)

- 0.00 - 0.91
- 0.92 - 3.20
- 3.21 - 8.50
- 8.51 - 13.11
- 13.12 - 125.34
- 125.35 - 370.00
- 370.01 - 1000.00
- 1000.01 - 2800.10

Social Vulnerability Index

- 1.614549 - 2.616235
- 2.616236 - 3.237072
- 3.237073 - 3.854933
- 3.854934 - 4.661284
- 4.661285 - 6.459169



19XX or 20XX Year of Event ● Selected County Boundary

Oklahoma Municipal Boundaries COUNTY NAME

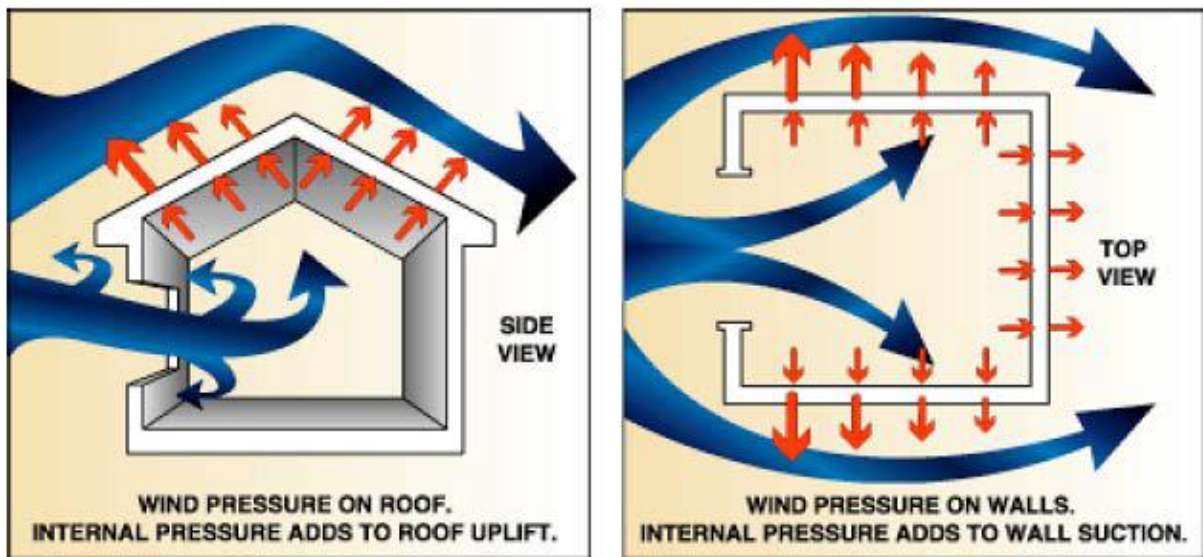


Sources: Shannon Van Zandt, Texas A&M, Hazard Planning materials, and 2009-2013 American Community Survey, Tables B11003, B01001, B17001, B08301, B25044, B25001, B25042, B02001, B03002, B26001, B25036, B17001, B25043, S1501, B23025 & B06007

High Winds

Historical Context: “According to the National Climatic Data Center, Tulsa County has had two recorded high winds events during the period of 2010 through 2014. Meteorological conditions have not changed, so future high wind events should occur at the same probability as previous events. No area of the County is any more or less at risk from the high wind hazard. According to the likelihood rating from Appendix 6 (the definition of the likelihood scale is shown in Appendix 6), the likelihood of a high wind hazard in the County is “highly likely”. (Proposed 2015 Tulsa County Hazard Mitigation Plan)

Figure 3 Diagram of Windstorm Effects



“Winds are always part of severe storms such as tornados and thunderstorms, but do not have to accompany a storm to be dangerous. Straight-line winds and microbursts can all cause injury and damage. Very little available data exists separate from thunderstorms or tornado data. Any efforts made to mitigate for tornados or thunderstorm winds should address the hazard of high winds.” (Proposed 2015 Tulsa County Hazard Mitigation Plan)

Hazard Mitigation Plan Hazard-Specific Goal and Objectives:

Goal - High Winds Hazard: To reduce the risk from high winds in the County

Objectives:

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

Lightning

Historical Context: “For Tulsa County, the National Climatic Data Center (NCDC) reports six lightning events during the five year period from 2010 through 2014. Meteorological conditions have not changed, so future lightning events should occur at the same probability as previous events. No area of the County is any more or less at risk from the lightning hazard. According to the likelihood rating from Appendix 6 (the definition of the likelihood scale is

shown in Appendix 6), the likelihood of a lightning hazard in the County is “highly likely”. (Proposed 2015 Tulsa County Hazard Mitigation Plan)

Hazard Mitigation Plan Hazard-Specific Goal and Objectives:

Goal - Lightning Hazard: To reduce the risk from lightning in the County.

Objectives:

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

Hail Storms

Historical Context: “According to the National Climatic Data Center, Tulsa County has had 40 hail hazard events of hail diameter $\frac{3}{4}$ inch and greater during the period from 2010 through 2014. The location of this hazard is uniform over the entire County area. No areas of the County, including the Town of Sperry and the four participating Schools, are any more or less at risk from a hail storm hazard.” (Proposed 2015 Tulsa County Hazard Mitigation Plan)

Hazard Mitigation Plan Hazard-Specific Goal and Objectives:

Goal - Hailstorm Hazard: To reduce the risk from hailstorms in the County.

Objectives:

1. Promote construction of hail resistant roofs.

Severe Winter Storms

Historical Context: “For Tulsa County, the National Climatic Data Center (NCDC) reports eight winter storm events during the five year period from 2010 through 2014. Meteorological conditions have not changed so future events should occur at the same probability as the previous events. According to the likelihood rating from Appendix 6 (the definition of the likelihood scale is shown in Appendix 6), the likelihood of a winter storm hazard in Tulsa County is “highly likely”. (Proposed 2015 Tulsa County Hazard Mitigation Plan)

“Tulsa County is affected periodically by heavy snow and ice that cause damage. Trees and power lines fall due to the weight of ice and snow causing power outages. Icy roads cause accident rates to increase and impair the ability for emergency vehicles to respond which can result in more injuries and a higher loss of life. A major winter storm can be very dangerous. Preparing for cold weather conditions and responding to them effectively can reduce the dangers caused by winter storms.”

Hazard Mitigation Plan Hazard-Specific Goal and Objectives:

Goal - Winter Storm Hazard: To reduce the hazards from winter storms in the County.

Objectives:

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

Extreme Heat

Historical Context: “According to the National Climatic Data Center, one extreme heat event was reported in Tulsa County from 2010 through 2014. Meteorological conditions have not

changed so future events should occur at the same probability as the previous events. The likelihood of a heat hazard in Tulsa County is “occasional”.

“Tulsa County considers a heat index between 95 and 105 degrees to be of minor severity. Tulsa County considers a heat event with a heat index above 105 degrees to be of major severity. Young children, elderly people, and those who are sick or overweight are more likely to become victims to extreme heat. Other conditions that can limit the ability to regulate temperature include fever, dehydration, heart disease, mental illness, poor circulation, sunburn, prescription drug use, and alcohol use. Another segment of the population at risk is those whose jobs consist of strenuous labor outside. When temperatures reach 90 degrees and above, people and animals are more likely to suffer sunstroke, heat cramps, and heat exhaustion.” (Proposed 2015 Tulsa County Hazard Mitigation Plan)

According to the proposed 2015 Tulsa County HMP, extreme heat can have a structural impact. Roads can buckle during times of extreme heat. Tar becomes soft and can allow concrete to settle, creating gaps and uneven surfaces. Extreme heat leads to rapid evaporation of ponds and lakes, depleting water sources used by both farmers and the community. Often times, residents use additional water during extreme heat to counter the drying of soils and prevent vegetation from dying. This additional strain on water systems can lead to low water pressure, and can cause water shortages when firefighters are trying to save property and brush land dried out by the extreme heat.

Hazard Mitigation Plan Hazard-Specific Goal and Objectives:

Goal 7 Extreme Heat: To reduce the risk from extreme heat in the County.

Objectives:

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

Drought

Historical Context: According to the National Climatic Data Center, 16 drought events were reported in Tulsa County from 2010 through 2014. Meteorological conditions have not changed so future events should occur at the same probability as the previous events. According to the likelihood rating from Appendix 6 (the definition of the likelihood scale is shown in Appendix 6), the likelihood of a heat hazard in Tulsa County is “highly likely”. (Proposed 2015 Tulsa County Hazard Mitigation Plan)

Hazard Mitigation Plan Hazard-Specific Goal and Objectives:

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

Objectives:

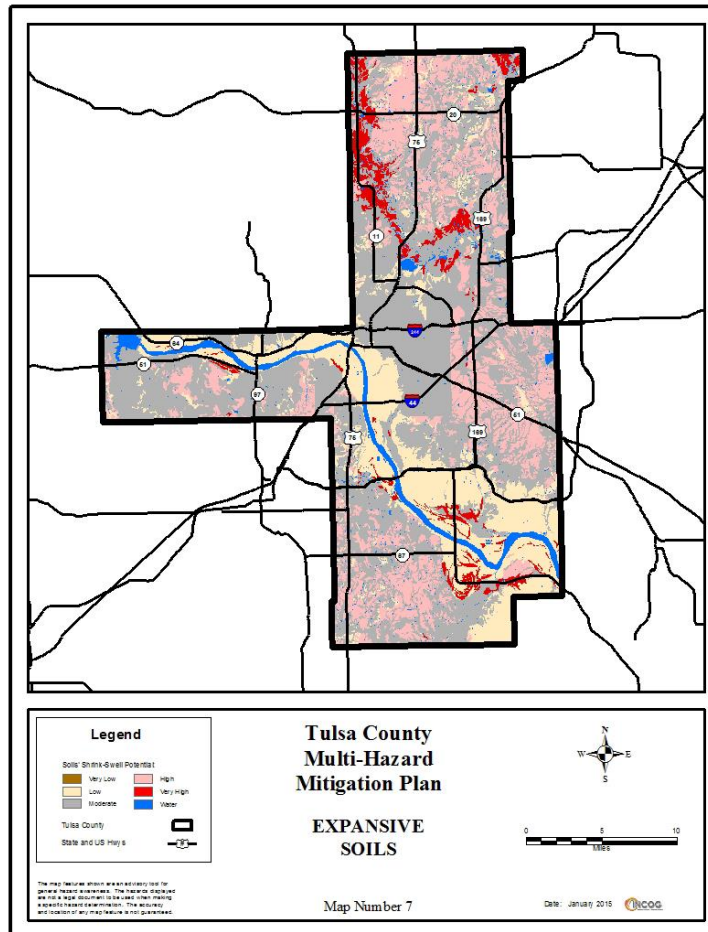
1. Reduce damage to property and building foundations due to drought by improving building codes.

Expansive Soils

Historical Context: “The Natural Resources Conservation Service (NRCS) has identified the soils in Tulsa County. The expansive tendency of a soil is a function of its shrink-swell

potential. The shrink swell potential of the soils in Tulsa County is shown on Map Number 7 in Appendix 1. The majority of the soils in Tulsa County are in the moderate and high shrink swell potential. The soils properties have not changed so future occurrences of soils expansion and contraction will continue. An estimate of future occurrences is rated as “unlikely” for Tulsa County, as shown in the Likelihood Rating field in the Hazard Summary Table in Appendix 6 (the definition of the likelihood scale is shown in Appendix 6), because no data is reported for this hazard.” (Proposed 2015 Tulsa County Hazard Mitigation Plan)

Figure 4



Hazard Mitigation Plan Hazard-Specific Goal and Objectives:

Goal 9 Expansive Soil Hazard: Reduce structure's susceptibility to soil movement.

Objectives:

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

Wildfires

Historical Context: "The areas in the unincorporated Tulsa County in the communities' wildland-urban interface are at higher risk from a wildfire so are more vulnerable. The areas outside of the communities' wildland-urban interface can be at less risk, so less vulnerable to a wildfire.

Table 3-28 shows the numbers of structures in the unincorporated Tulsa County within the communities' wildland-urban interface." (Proposed 2015 Tulsa County Hazard Mitigation Plan)

Table 3-28
**UNINCORPORATED TULSA COUNTY STRUCTURES IN THE CITIES' WILDLAND-
 URBAN INTERFACE**

Type	# of Structures	Structure Value (\$)
Residential	6900	591,826,587
Commercial	343	290,039,378
Agricultural	126	2,624,616
TOTAL	7369	884,490,581

Hazard Mitigation Plan Hazard-Specific Goal and Objectives:

Goal 10 Wildfire Hazard: To reduce the threat of wildfire hazards and their financial impact to the County

Objectives:

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

Earthquakes

Background: According to the Proposed 2015 Tulsa County Hazard Mitigation Plan, all areas, and all buildings, in the County are at equal risk from this hazard.

There is no historical context provided in the HMP for earthquakes.

Hazard Mitigation Plan Hazard-Specific Goal and Objectives:

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

Objectives:

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

Hazardous Materials Events

Background: The public is most at risk from hazardous materials when they are being transported. The County has defined the State and US Highways, and the railroads, as the major transportation routes through the County. (Proposed 2015 Tulsa County Hazard Mitigation Plan)

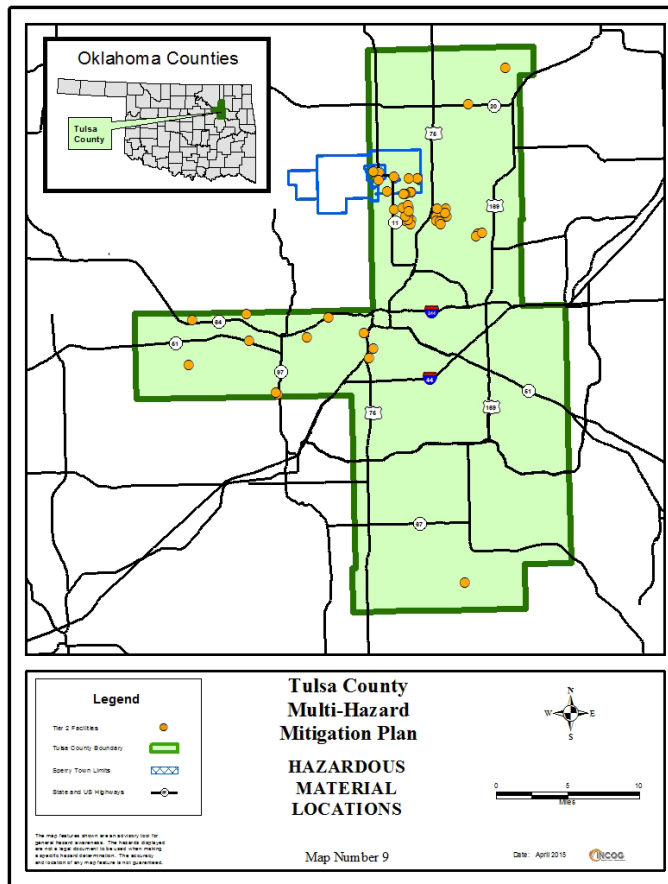
Hazard Mitigation Plan Hazard-Specific Goal and Objectives:

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

Objectives:

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

Figure 5



Dam Breaks

Historical Context: “The dam break hazard in Tulsa County is the high hazard dams. High hazard dams prepare an emergency action plan (EAP) which would make a determination on the number of structures and infrastructure in each dam’s dam break inundation area. For the Keystone Lake dam, their EAP identifies structures or infrastructure in the inundation areas. Their addresses are on file with TAEMA. Therefore, the number of structures is not included in this plan and an estimated damage is not done.” (Proposed 2015 Tulsa County Hazard Mitigation Plan)

According to the Proposed 2015 Tulsa County Hazard Mitigation Plan, “A related threat to Tulsa is posed by the Arkansas River levees, built in 1945 and protecting 2,271 residences, 149 commercial properties & 106 industrial parcels with improvement values (\$147,453,020 in assessed improvements). Failure of the levees along the Arkansas River would have a devastating impact upon the City of Tulsa and Tulsa County. It is likely that a major Keystone Dam release could cause these levees to overtop and subsequently fail.”

“The worst-case event, failure of Keystone Dam and the Arkansas River levees, could impact 14,285 parcels with improvements within the city limits of Tulsa, create a severe risk for an estimated 48,000 people, cause an estimated \$1,843,401,375 in damage to an estimated 14,285 buildings including 67 critical facilities. In addition, it could produce widespread power outages, and release of hazardous chemicals.”

Hazard Mitigation Plan Hazard-Specific Goal and Objectives:

Goal 13 Dam Break Hazard: To reduce the risk of a dam break hazard in the County.

Objectives:

1. Identify dams that could impact the County.
2. Identify areas at risk.

Hazard Mitigation Summaries of Cities within Tulsa County

Multiple municipalities within Tulsa County also have Hazard Mitigation Plans. This Includes the City of Tulsa, Bixby, Owasso, and Broken Arrow.

City of Tulsa (*information specific to the City of Tulsa and not mentioned in Tulsa County HMP*)

The City of Tulsa highlighted the same hazards within their HMP as the Tulsa County HMP. Major highlights for the City of Tulsa HMP are:

- Tornado – Goals:
 - 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.
 - City of Tulsa – Individual SafeRoom Rebate Program

City of Broken Arrow

Summary for the City of Broken Arrow HMP are:

- The Broken Arrow HMP received a 5-year update in 2010. Updates appear to have been adopted in 2011.
- The HMP highlights the six primary goals for the HMP:
 - Goal 1: Protect lives and property.
 - Goal 2: Enhance public understanding of risk from natural hazards.
 - Goal 3: Reduce prolonged business displacement.
 - Goal 4: Streamline government and public response to natural hazard disasters.
 - Goal 5: Reduce damage to city’s lifelines and Continuity of Government.
 - Goal 6: Encourage and support improved forecasting of natural hazard events.
- The disasters identified in the Broken Arrow HMP reflected those highlighted in the Tulsa County HMP.
- Flood and Stormwater Management Plan with initiatives for 2011-2016.
- Environmental Action Plan.
- Summary of other applicable city documents relevant to hazard mitigation including Comprehensive Plan (amended in 2003) and city codes and ordinances. However the HMP

does not go into detail about Comprehensive Plan goals or how specific codes/ordinances apply to hazard mitigation.

- City of Broken Arrow Hazard Mitigation Planning Team

City of Bixby

Summary for the City of Bixby HMP are:

- The City of Bixby HMP is received an approval (on November 15, 2010) from FEMA for the next five years. This plan is currently out of compliance.
- The disasters identified in the Bixby HMP reflected those highlighted in the Tulsa County HMP.
- The City of Bixby has 15 Warning Sirens.
- Bixby is currently evaluating their emergency management program and policies in order to receive the StormReady Community accreditation in the future.
- Flood and Stormwater Management – Bixby voters chose to allocate funds (a total of \$42M over two years) for numerous flood control projects in the city.
- The city has adopted the International Building Code (2003)
- No public storm shelters were identified in the City of Bixby HMP.
- The city utilizes a “reverse 9-1-1” telephone warning system to send out an emergency notification call to all numbers in 9-1-1 system in the event of emergencies.
- City has Community Emergency Response Team (CERT) to provide immediate, local aid after disasters.
- Mutual-aid agreements with surround municipalities.
- The city utilizes 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.

Table 4 Bixby Summary of Damages (2004-2008)

Hazard	Events	Events/ Year	Total Property Damage	Property Dmg/ Event	Property Dmg/ Year	Injuries	Injuries/ Event	Injuries/ Year	Deaths	Deaths/ Event	Deaths/ Year
Floods	22	1.1	\$3.74 Mil	\$169,863	\$186,850	0	0	0	2	0.1	0.1
Tornadoes	1	0.05	\$2,000	\$2,000	\$20	0	0	0	0	0	0
High Winds	43	2.87	\$142,000	\$3,302	\$9,467	0	0	0	0	0	0
Lightning	1	0.07	\$25,000	\$25,000	\$1,667	0	0	0	0	0	0
Hail	38	2.53	\$75,000	\$1,974	\$5,000	0	0	0	0	0	0
Winter Storms ¹	29	1.93	\$50.15 Mil	\$1.7 Mil	\$3.34 Mil	0	0	0	0	0	0
Extreme Heat ¹	10	.67	\$0	\$0	\$0	52	5.2	3.47	13	1.3	.87
Drought ¹	8	.53	\$0	\$0	\$0	0	0	0	0	0	0
Expansive Soils	<i>Insufficient Data</i>										
Urban Fires ²	70	14.0	\$2,307Mil	\$32,965	\$461,510	1	0.01	0.2	4	0.06	0.8
Wildfires ²	163	36.8	\$7,610	\$47	\$1,520	<i>Insufficient Data</i>					
Earthquakes	0	0	\$0	\$0	\$0	0	0	0	0	0	0
HazMat, Fixed	0	0	\$0	\$0	\$0	0	0	0	0	0	0
Dam Failures	0	0	\$0	\$0	\$0	0	0	0	0	0	0
Transportation	1	0.1	<i>Insufficient Data</i>			0	0	0	0	0	0

Figure 6

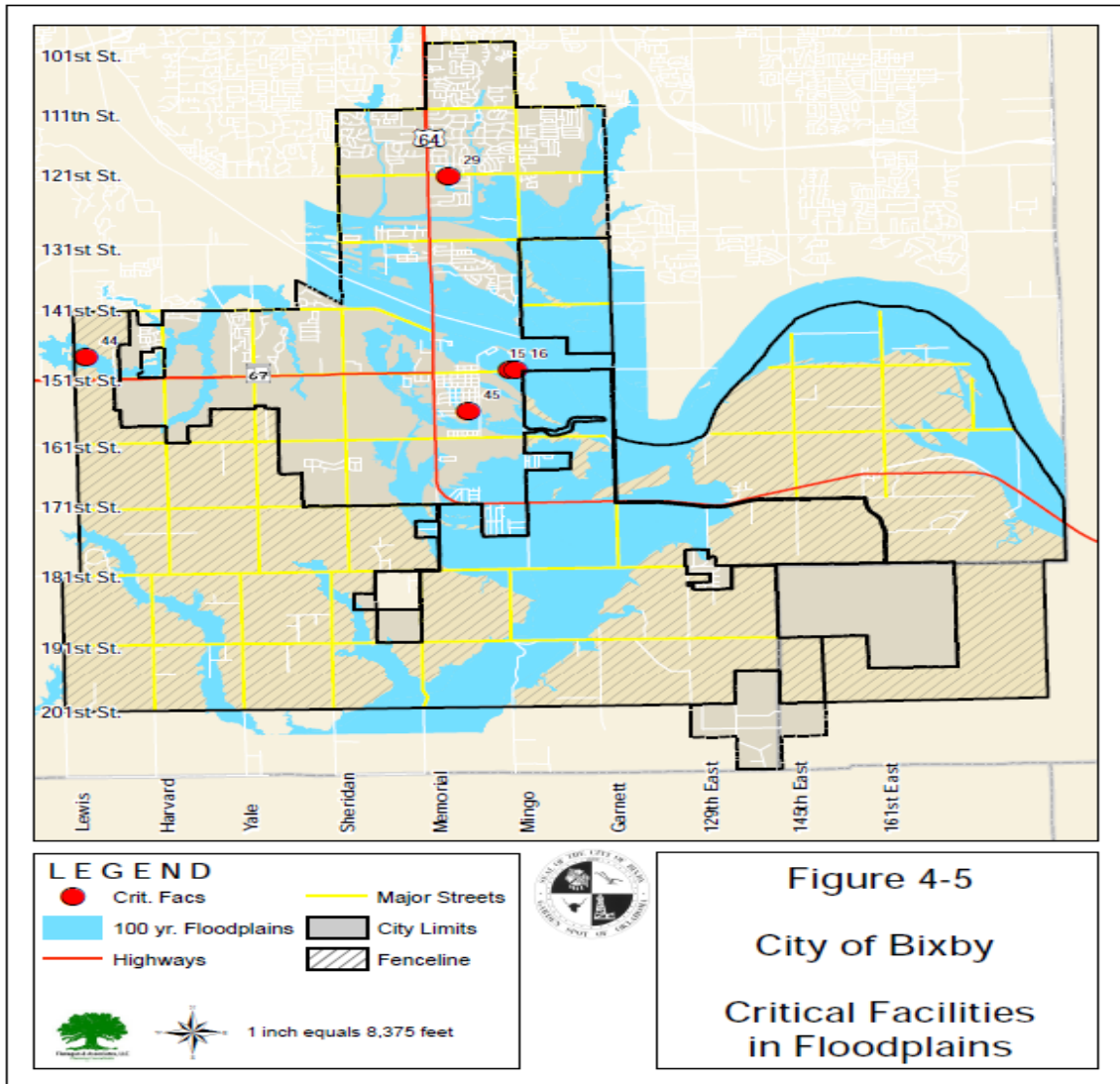


Figure 7

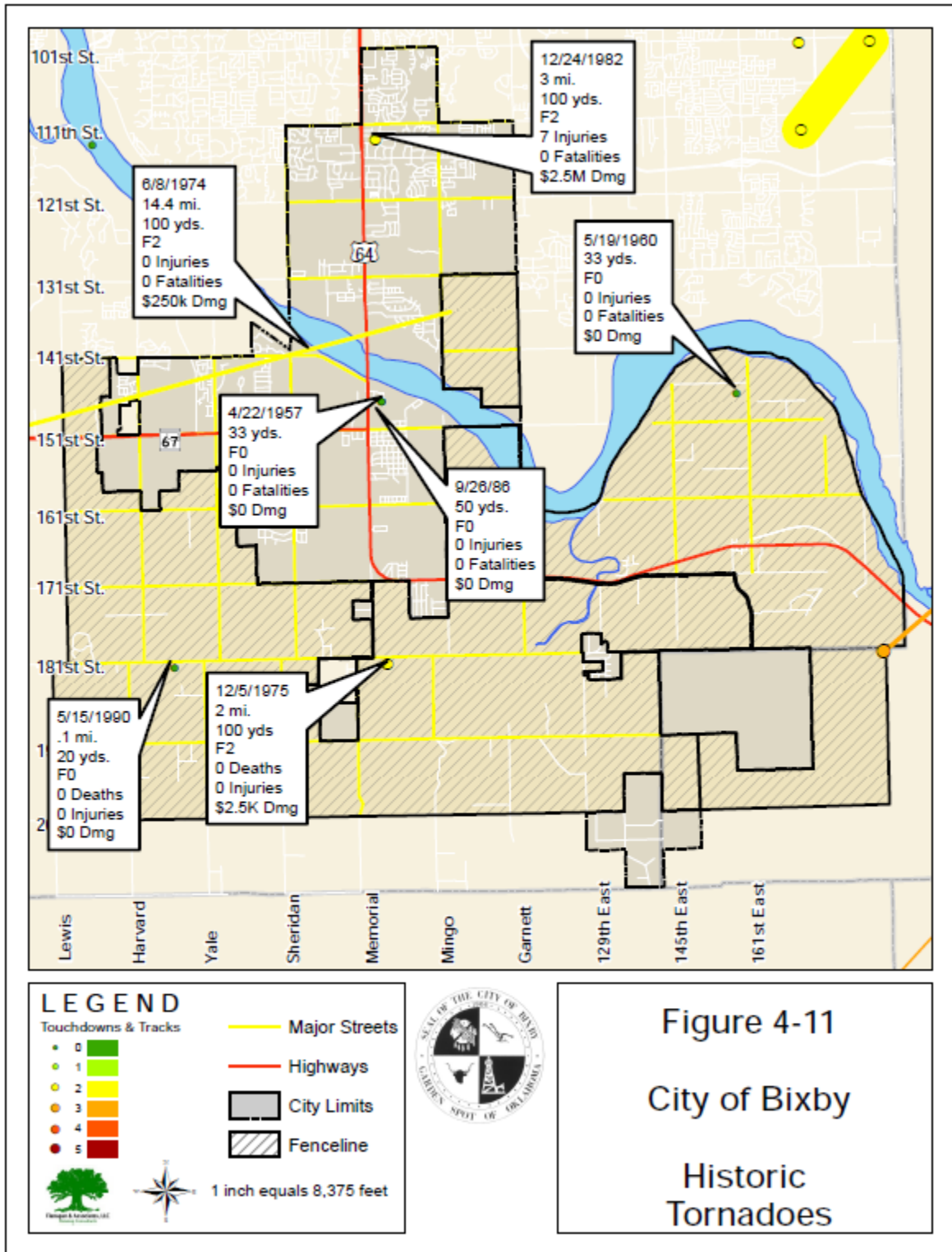
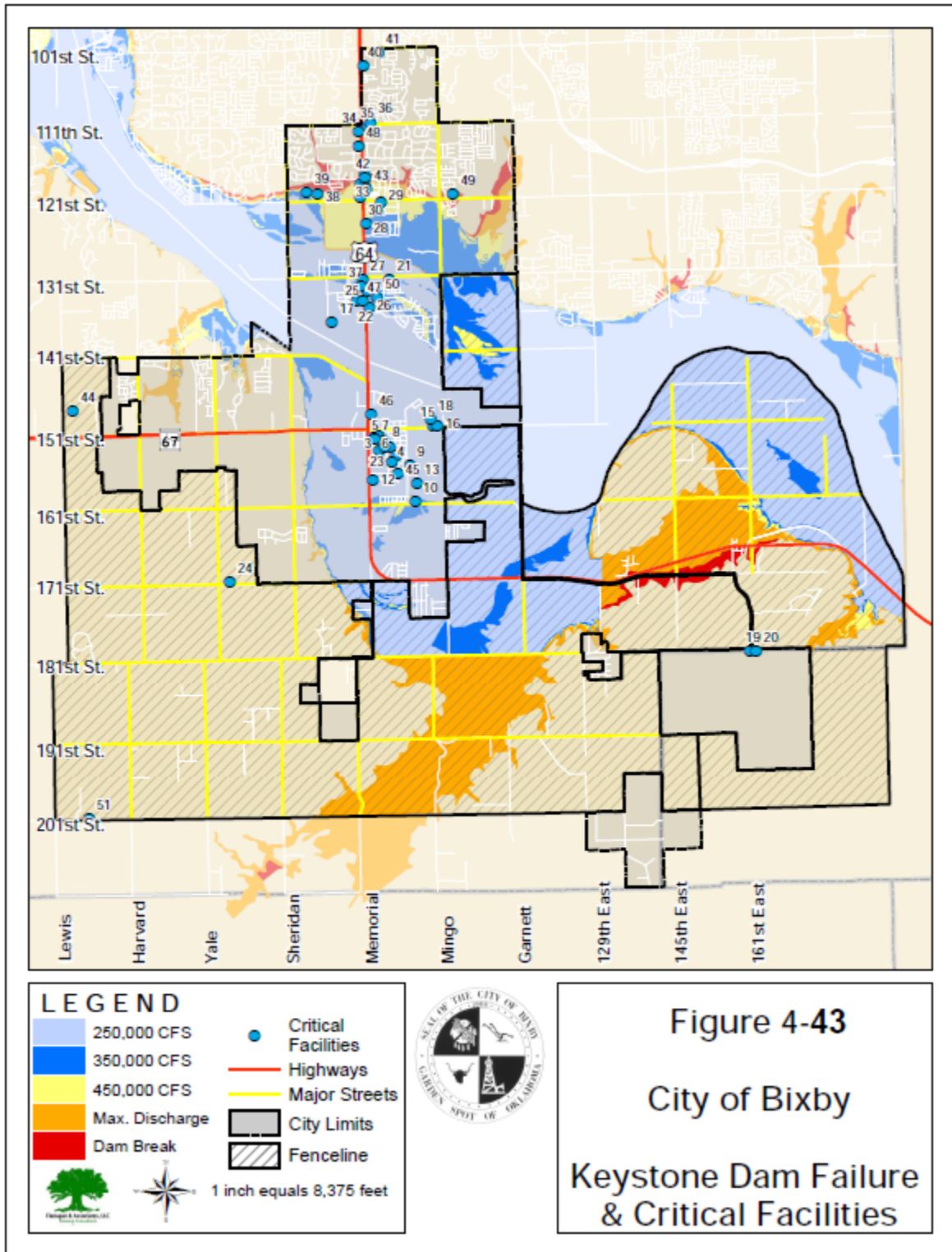


Figure 8



City of Owasso

Summary for the City of Owasso HMP are:

- The City of Owasso updated the Hazard Mitigation Plan in 2013. No final dates were noted for dates of FEMA approval.
- To create a disaster-resistant community and improve the safety and well-being of the citizens of the City of Owasso by reducing deaths, injuries, property damage, environmental losses, and other losses from natural and technological hazards in a manner that advances community goals, quality of life, and results in a more livable, viable, and sustainable community.
- The disasters identified in the Owasso HMP reflected those highlighted in the Tulsa County HMP.
- No public storm shelters were identified in the City of Owasso HMP. However the HMP Goal #3 encourages building of individual safe rooms and storm shelters.
- Owasso participates in the National Flood Insurance Program (NFIP). The NFIP sets minimum requirements for subdivision regulations and building codes. Storm water management regulations require developers to mitigate any increase in runoff due to their development. Building codes require standards for new building construction.

Figure 9

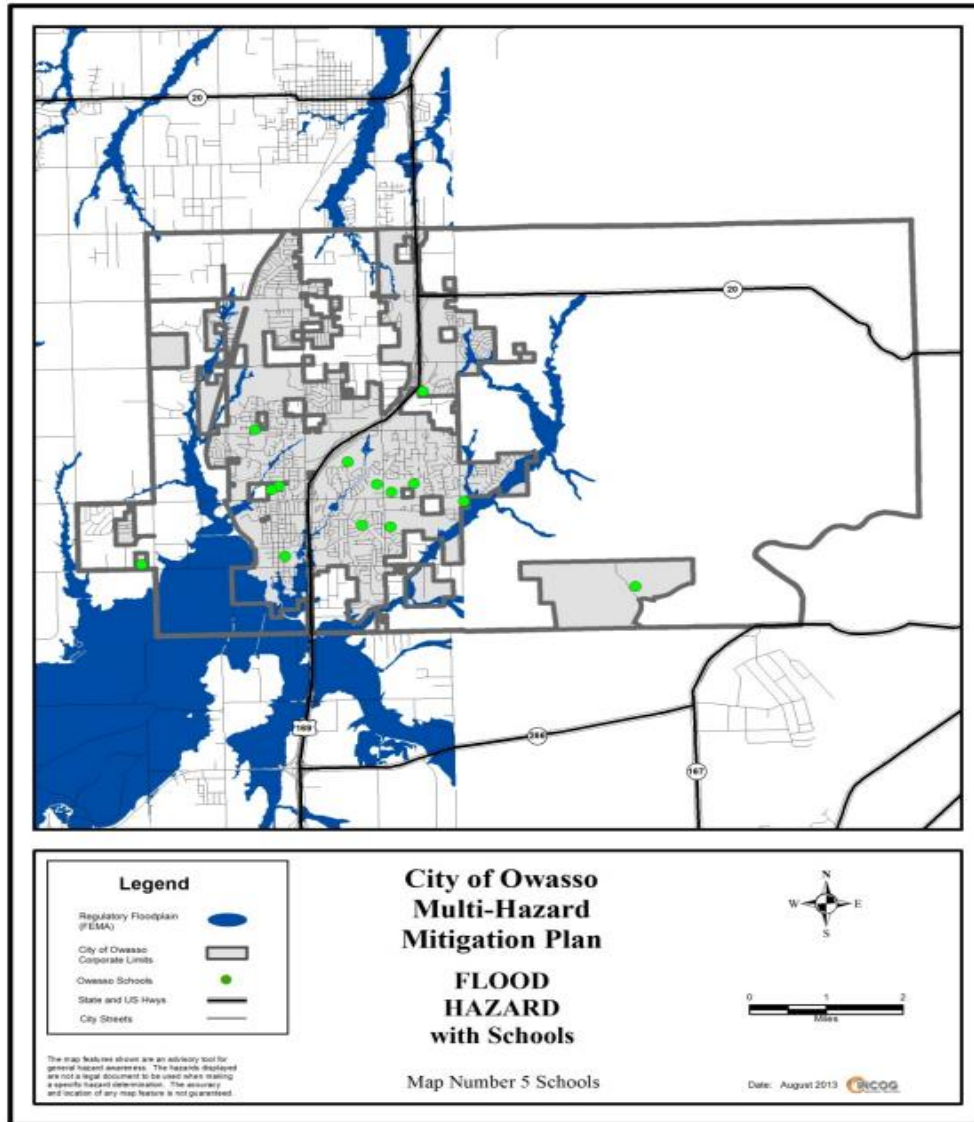


Figure 10

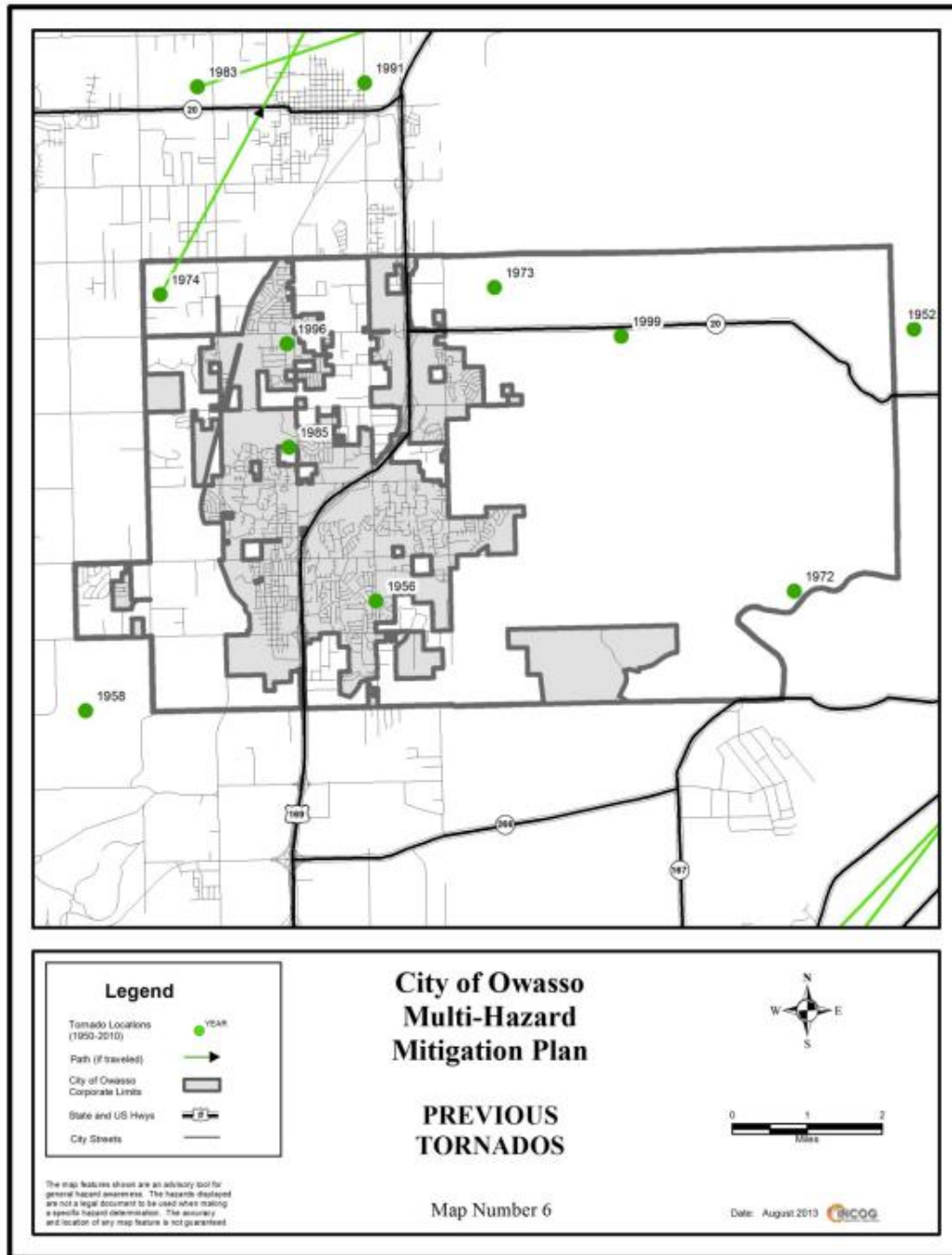
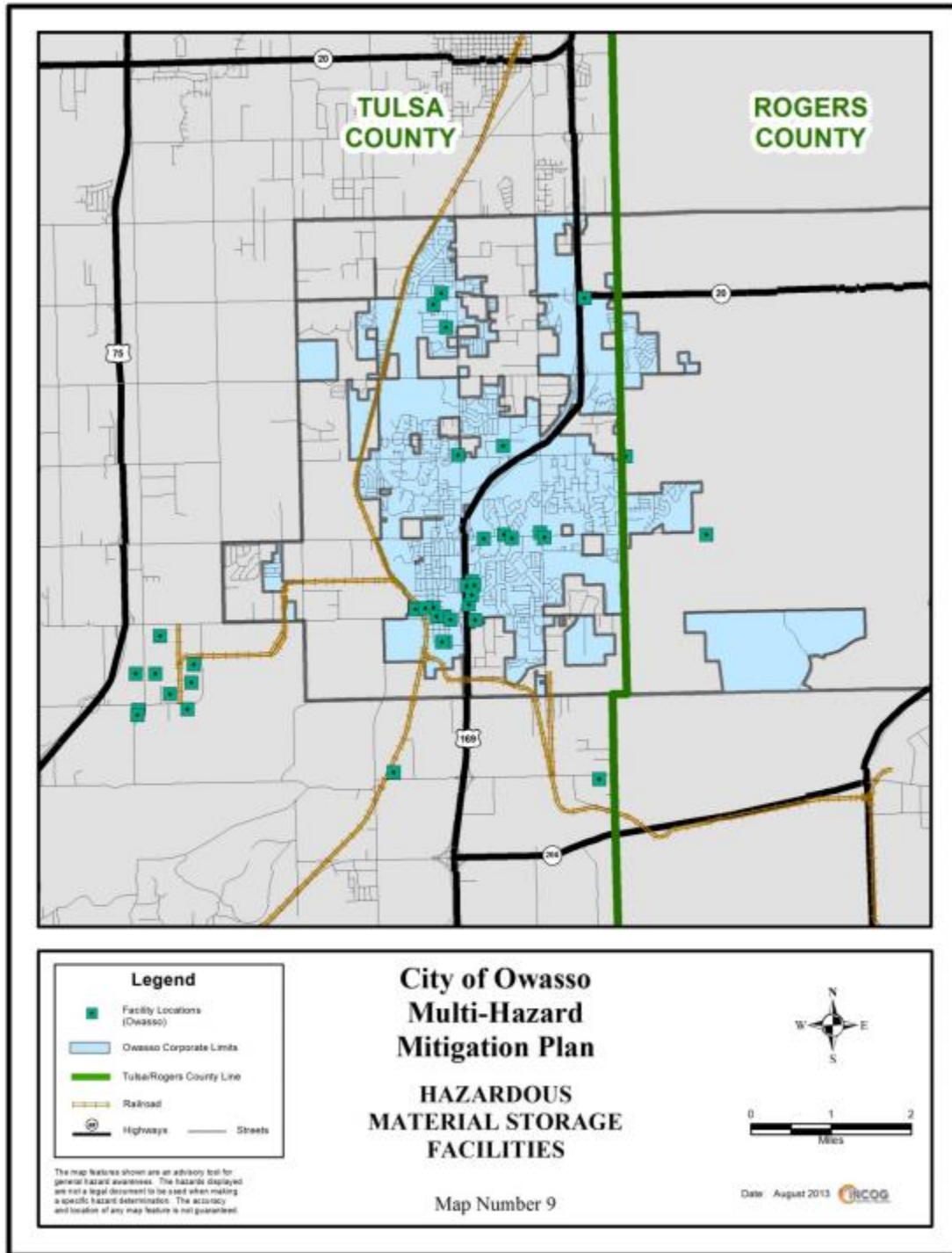


Figure 11



C.2.1.2; C.2.1.6; C.2.1.7; C.2.1.8 Shelters from Disaster Event

The cities of Tulsa, Broken Arrow, Owasso, Jenks, and Bixby all have an online storm shelter registries. However no estimates were found of total shelters registered.

Bixby Online registration:

http://www.bixby.com/pdf/storm_shelter_form.pdf

Broken Arrow Online registration:

<http://www.brokenarrowok.gov/index.aspx?nid=398>

Glenpool – call to register:

Community Development Department -- 918-322-5409

Tulsa & Unincorporated Tulsa County -- Tulsa Area Emergency Management Agency -- 918-596-9899

Sand Springs online registration:

<https://ok-sandsprings.civicplus.com/MyAccount?from=Url&url=/FormCenter/Police-Department-3/Storm-Shelter-Registration-Form-58&anchor=&validationMessage=>

City of Tulsa Online registration:

<https://www.cityoftulsa.org/public-safety/storm-shelter-registration.aspx>

City of Jenks Online registration:

<http://www.jenks.com/city/storm-shelter-registry>

C.2.1.3 Public Policy and Governance to Build Disaster Resiliency

Numerous municipalities within Tulsa County have adopted the International Building Code and regulate development within floodways. Many of these municipalities have adopted local policies to address flood-related issues within their communities.

C.2.1.4 Local Emergency Response Agency Structure

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 Tulsa County Hazard Mitigation Planning Committee is made up of 17 individuals; each representing city departments, schools, and external parties.

According to the proposed 2015 Tulsa County HMP, the primary point of contact is the Director of the Tulsa Area Emergency Management Agency. The Second contact is the Deputy Director.

C.2.1.5 Threat & Hazard Warning Systems

The identified Threat & Hazard Warning Systems for Tulsa County include:

- Sirens - Agency operates 84 sirens in the outdoor warning system, some of which are in the City of Tulsa, others located in unincorporated areas of Tulsa County. The Coverage area for a single siren is 4,100ft. The City of Bixby operates 15 sirens with coverage throughout city jurisdiction.
- Phone notification (TulsaAlert: call, email, or text alerts.)
- Emergency Broadcast System (EAS- utilizes FM, AM, and TV broadcast stations.)
- Flood Alert System that monitors rainfall and stream levels.

Figure 12

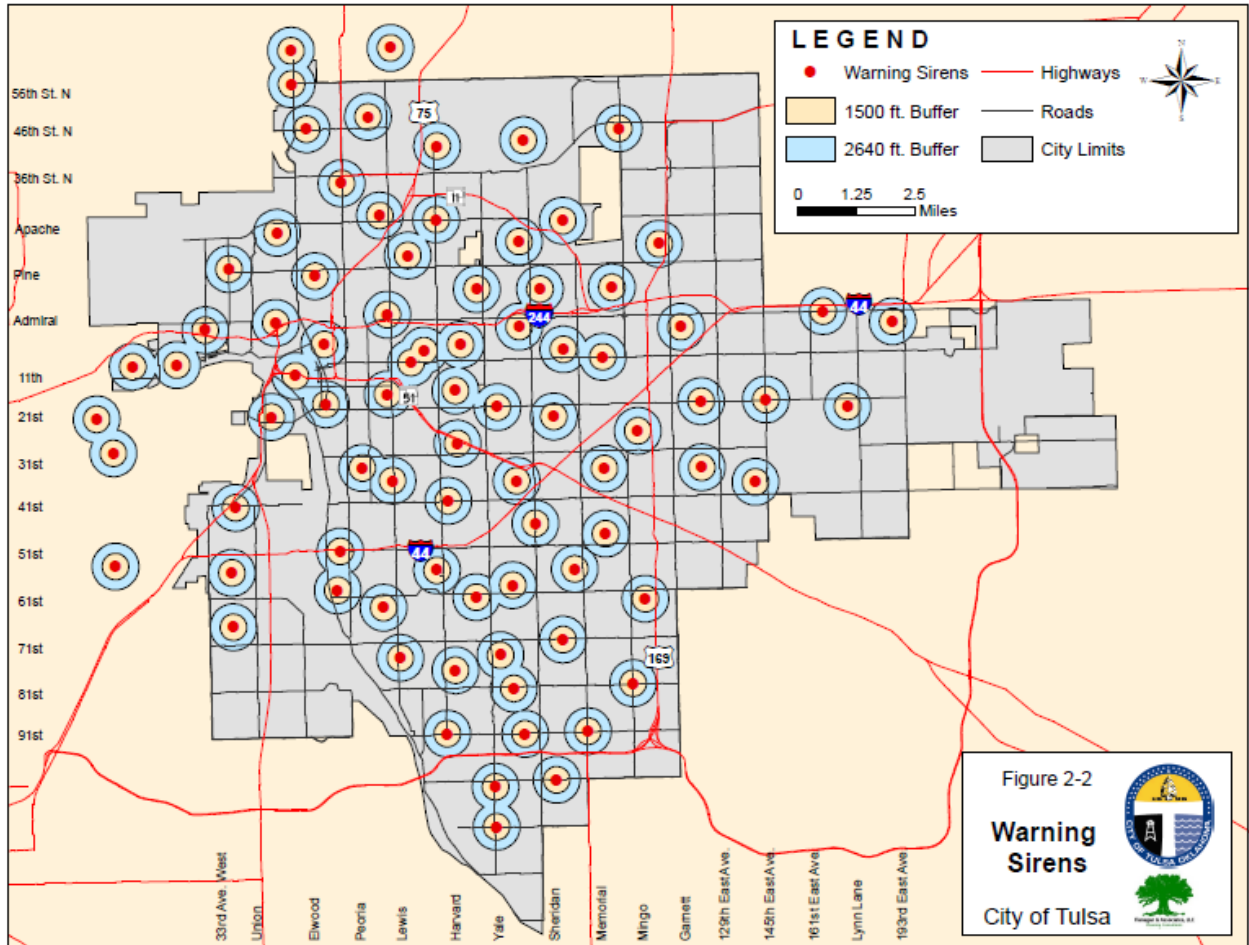
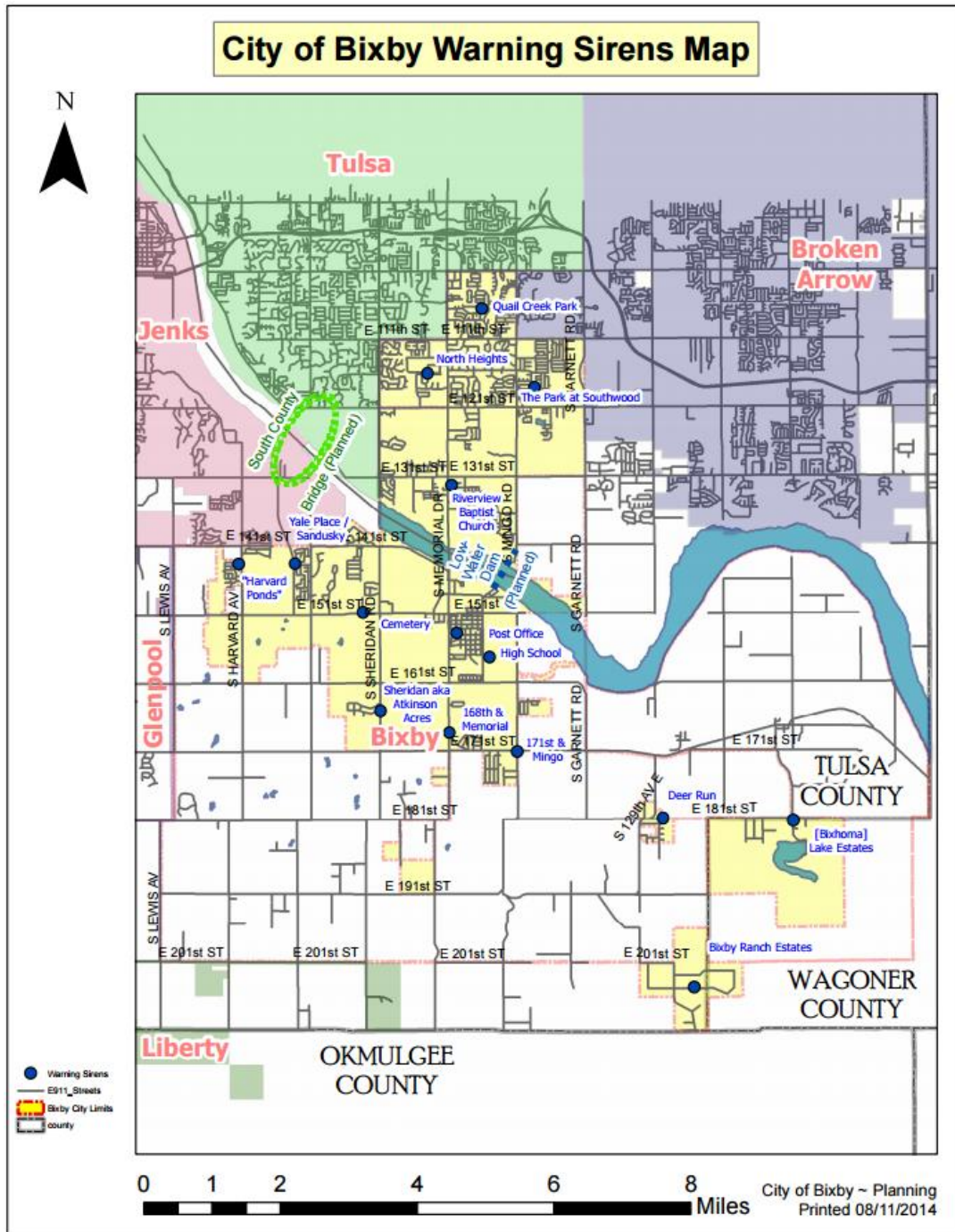


Figure 13



Social Vulnerability

Based on the research work done by the Texas A&M University Hazard Reduction and Recovery Center, an added component is being included in this section. Social vulnerability can place households at a further disadvantage during and after a disaster. This analysis is assessing for the



county the levels of social vulnerability based on demographic indicators to highlight 'hotspots' or counties that have higher social vulnerability. That combined with Hazard Mitigation Plans – or lack thereof – can highlight places where additional work is needed to reduce impacts on households.

Social Vulnerability Analysis - Tulsa County

Base Social Vulnerability Indicators (%)		2nd Order	3rd Order
1.) Single Parent Households	17.39%	0.248	3.369 Social Vulnerability 'Hotspot' or Area of Concern
2.) Population Under 5	7.43%	(Child Care Needs)	
3.) Population 65 or Above	12.31%	0.206	
4.) Population 65 or Above & Below Poverty Rate	8.27%	(Elder Needs)	
5.) Workers Using Public Transportation	0.77%	0.075	
6.) Occupied Housing Units w/o Vehicle	6.69%	(Transportation Needs)	
7.) Housing Unit Occupancy Rate	89.40%	2.58 (Temporary Shelter and Housing Recovery Needs)	
8.) Rental Occupancy Rate	39.06%		
9.) Non-White Population	35.17%		
10.) Population in Group Quarters	1.47%		
11.) Housing Units Built Prior to 1990	74.26%		
12.) Mobile Homes, RVs, Vans, etc.	2.78%		
13.) Poverty Rate	15.90%		
14.) Housing Units Lacking Telephones	1.94%		
15.) Age 25+ With Less Than High School Diploma	11.40%	0.261	
16.) Unemployment Rate	7.14%	(Civic Capacity Needs)	
17.) Age 5+ Which Cannot Speak English Well or Not At All	5.57%		

Sources: Shannon Van Zandt, Texas A&M, Hazard Planning materials, and 2009-2013 American Community Survey, Tables B11003, B01001, B17001, B08301, B25044, B25001, B25042, B02001, B03002, B26001, B25036, B17001, B25043, S1501, B23025 & B06007

Social Vulnerability Index

By County



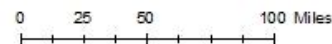
Levels of Social Vulnerability Analysis

Base Social Vulnerability Indicators (Percentages)	2 nd Order	3 rd Order
1. Single parent households with children/ Total Households	Child care needs	Social vulnerability "Hotspot" or area of concern
2. Population 5 or below/Total Population		
3. Population 65 or above/Total Population		
4. Population 65 or above & below poverty/Pop. 65 or above	Elder needs	
5. Workers using public transportation/Civilian pop. 16+ and employed	Transportation Needs	
6. Occupied housing units without a vehicle / Occupied housing units (Hus)		
7. Occupied housing units / Total housing units	Temporary Shelter and housing Recovery needs	
8. Persons in renter occupied housing units/ Total housing units		
9. Non-white population/Total population		
10. Population in group quarters / Total population		
11. Housing units built 20 years ago / Total housing units		
12. Mobile Homes/ Total housing units		
13. Persons in poverty / Total population	Civic Capacity needs	
14. Occupied housing units without a telephone/ Total occupied HU		
15. Population above 25 with less than high school/ Total pop above 25		
16. Population 16+ in labor force an unemployed/ Pop in Labor force 16+		
17. Population above 5 that speak English not well or not at all / Pop >5		

Legend

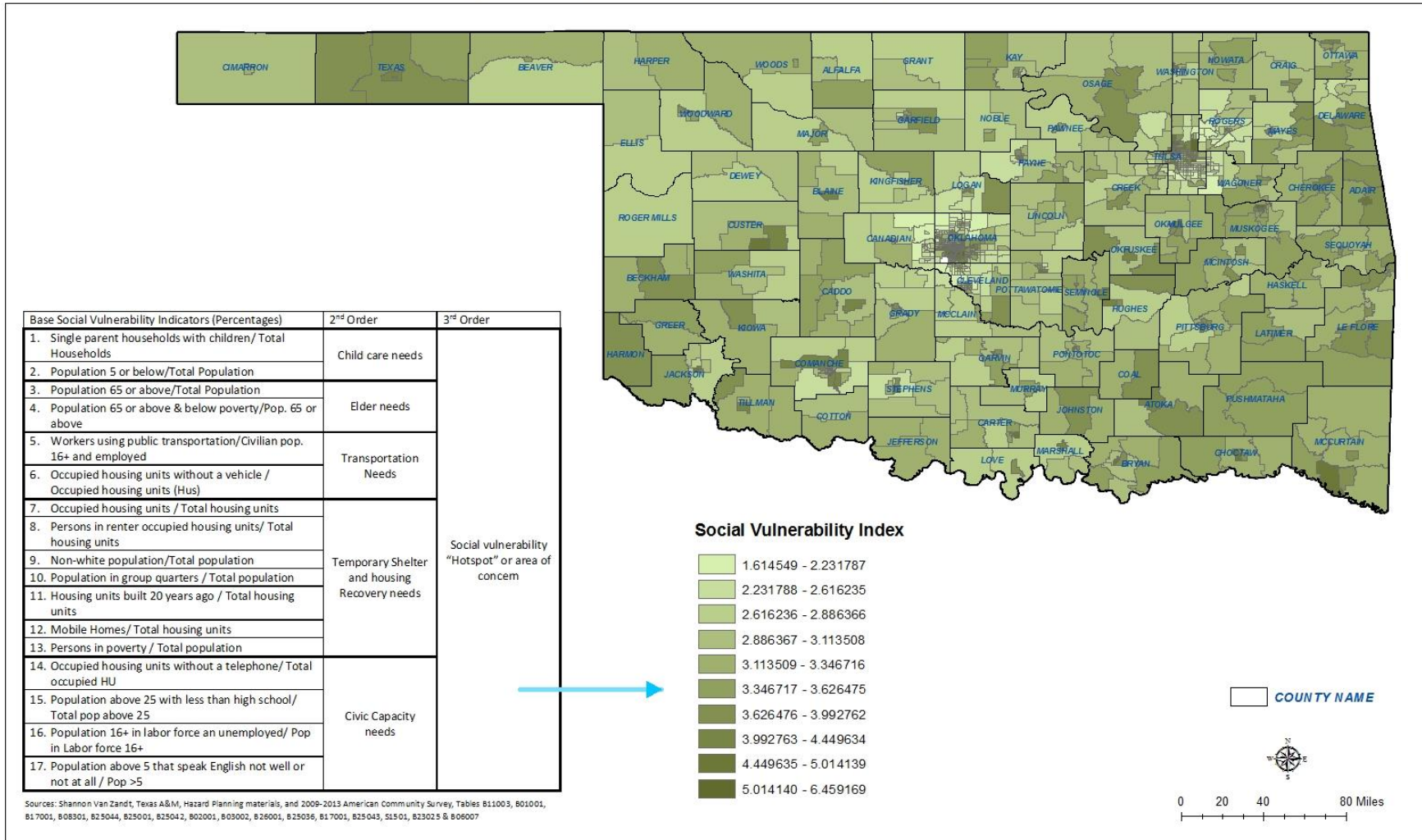
Social Vulnerability "Hot Spots"

- 2.6340 - 2.9760
- 2.9761 - 3.2170
- 3.2171 - 3.4180
- 3.4181 - 3.6370
- 3.6371 - 3.9500



Source: Shannon Van Zandt, Texas A&M, Hazard Planning materials; 2009-2015 American Community Survey, Tables B11003, B01001, B17001, B02001, B2002, B2003, B2004, B2005, B2006, B2007, B2008, B2009, B2010, B2011, B2012, B2013, B2014, B2015, B2016, B2017, B2018, B2019, B2020, B2021, B2022, B2023, B2024, B2025, B2026, B2027, B2028, B2029, B2030, B2031, B2032, B2033, B2034, B2035, B2036, B2037, B2038, B2039, B2040, B2041, B2042, B2043, B2044, B2045, B2046, B2047, B2048, B2049, B2050, B2051, B2052, B2053, B2054, B2055, B2056, B2057, B2058, B2059, B2060, B2061, B2062, B2063, B2064, B2065, B2066, B2067, B2068, B2069, B2070, B2071, B2072, B2073, B2074, B2075, B2076, B2077, B2078, B2079, B2080, B2081, B2082, B2083, B2084, B2085, B2086, B2087, B2088, B2089, B2090, B2091, B2092, B2093, B2094, B2095, B2096, B2097, B2098, B2099, B2100, B2101, B2102, B2103, B2104, B2105, B2106, B2107, B2108, B2109, B2110, B2111, B2112, B2113, B2114, B2115, B2116, B2117, B2118, B2119, B2120, B2121, B2122, B2123, 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Social Vulnerability - Impacts on Housing & Disaster Resiliency



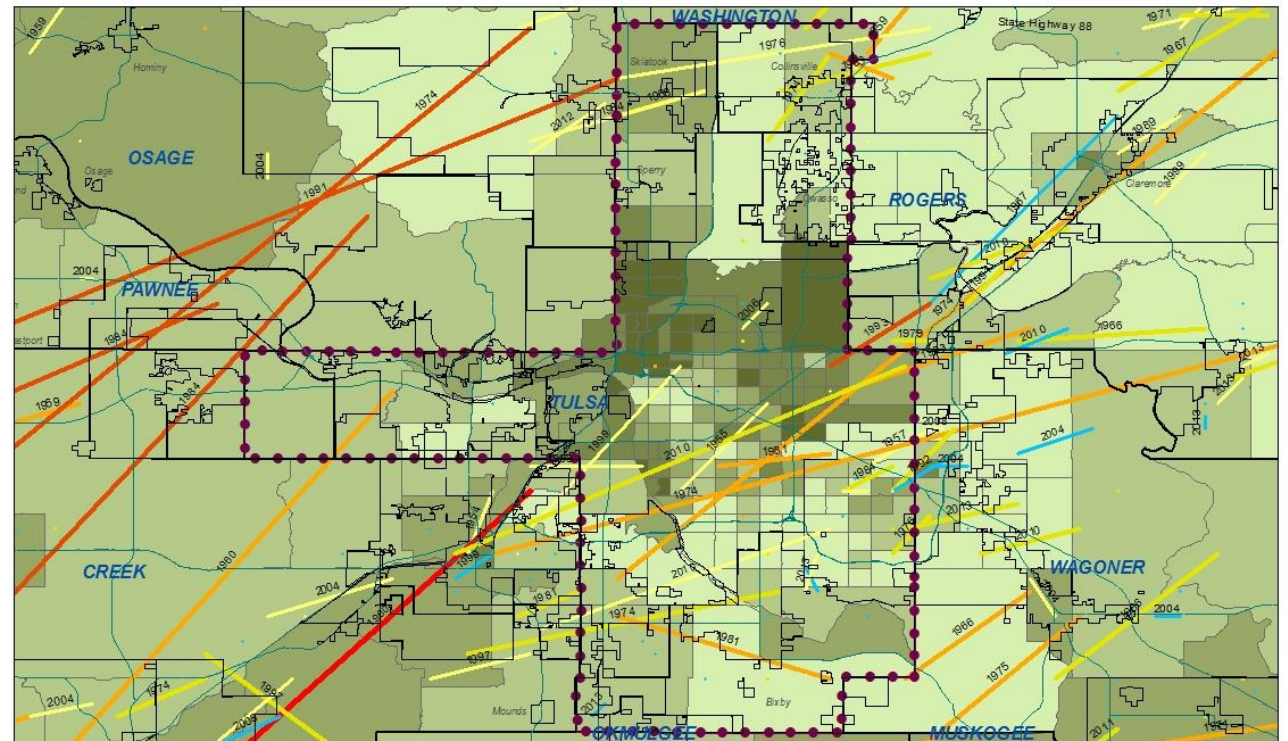
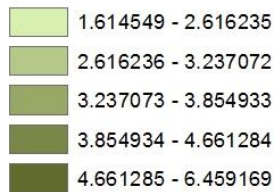
Social Vulnerability - Impacts on Housing & Disaster Resiliency

Tornado Events 1950 - 2014 Tulsa County

Tornado Magnitude



Social Vulnerability Index

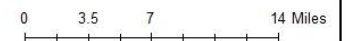


19XX or 20XX Year of Event

Selected County Boundary

Oklahoma Municipal Boundaries

COUNTY NAME



Sources: Shannon Van Zandt, Texas A&M, Hazard Planning materials, and 2009-2013 American Community Survey, Tables B11003, B01001, B17001, B08301, B25044, B25001, B25042, B02001, B03002, B26001, B25036, B17001, B25043, S1501, B23025 & B06007

Social vulnerability combined with the devastating impacts of a natural or man-made disaster can compound a household's ability to recover and in fact can place those individuals at an even greater gap or disadvantage prior to the event (Shannon Van Zandt, Texas A&M, Hazard Planning).

This county falls about average per this index for social vulnerability when comparing as a county to other counties in the state. Looking at the census tract level, Tulsa – particularly North Tulsa – has increased social vulnerability. Combine that with the tornados, as one physical hazard or event that occurs, people in these areas may have additional difficulties during an event due to transportation and family needs. Additionally recovery for socially vulnerable populations can be slow and may require additional outside assistance.

Recommendations for this county:

- Continue to update and maintain the county HMP and include attention to areas within the county that in addition to physical vulnerability may have compounding social vulnerability factors.
- Efforts to strengthen building codes related to tornadoes and natural disasters should be considered.
- Pursue grants and funding for public storm shelters. Planning for shelters from disaster events for multifamily, HUD and LIHTC units, in addition to all housing in the community should be incorporated with any effort to increase housing.